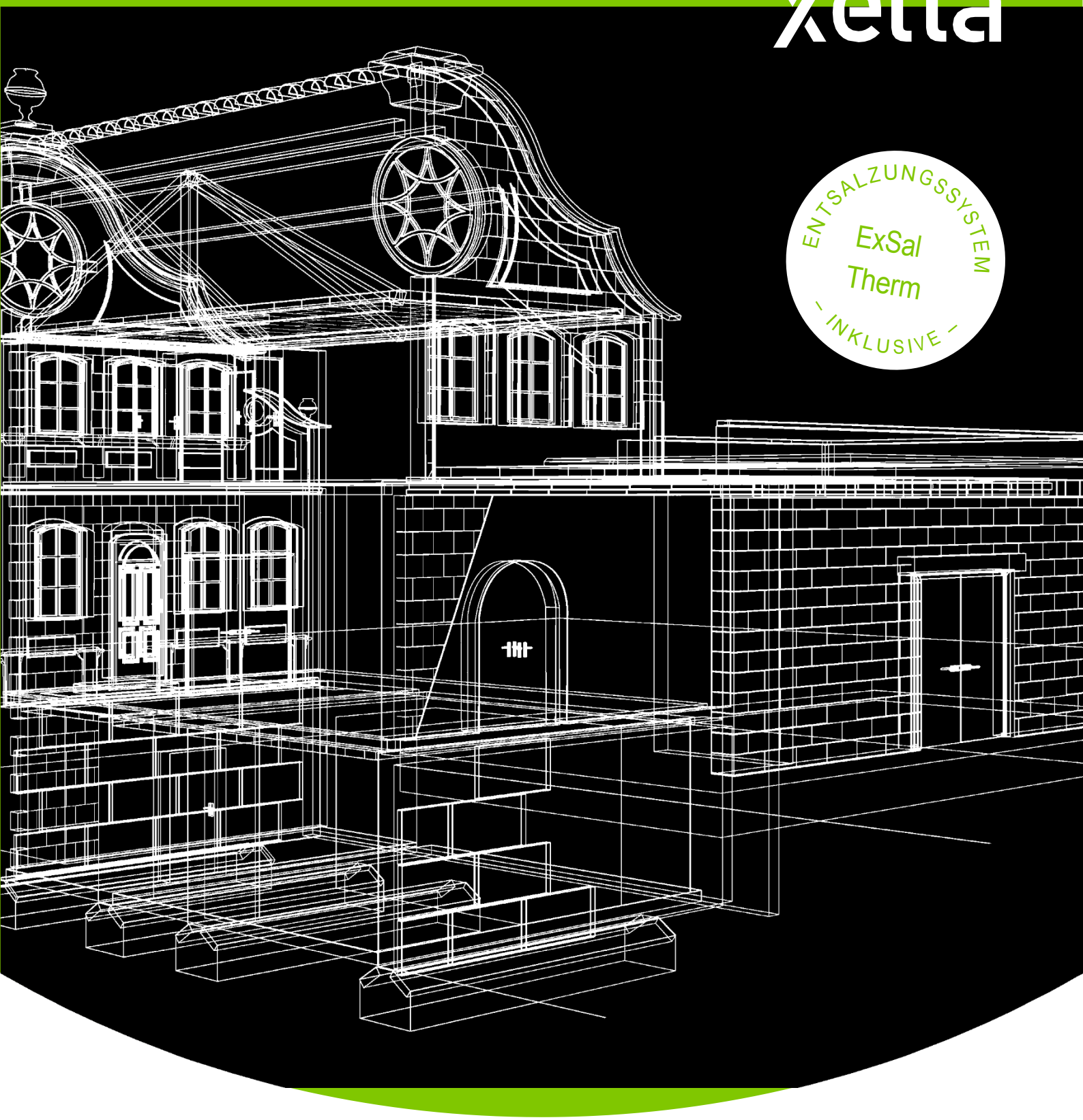
Edition 3

Xella



The Insulation Book

Sustainable planning and insulation

multipor

Foreword

Multipor has been firmly established on the market as an ecological insulation material for over 20 years. Multipor is the undisputed market leader in the field of mineral insulation systems, particularly in the areas of facade and interior insulation.

The 20th anniversary in 2017 was the impetus for numerous innovations relating to Multipor. The further development of applications in the field of air duct insulation and the expansion of services are just a few examples.

Multipor once again demonstrates its outstanding building physics properties in terms of thermal insulation, fire protection, moisture protection, ecology, and sound insulation. The anniversary year showed that the mineral insulation system also functions flawlessly in the long term. A 20-year-old Multipor composite thermal insulation system was opened in two places on a post-war detached house and inspected by an independent expert. The result: even after 20 years of use, the insulation material is still intact, dry, and functional.

Our goals for the coming years are to maintain and further develop the building physics properties of Multipor. Our demands on our product are increasing, as are those of end consumers, particularly in the areas of energy efficiency, safety, sustainability, cost-effectiveness, and healthy living. Significantly higher requirements for energy-efficient construction methods and the use of highly effective insulation systems; the discussion about fire-safe facades is also still ongoing. We are meeting these challenges with an ecological, recyclable insulation material that is sustainable in the long term.

We are also pleased to present our new, partly digital services. The Multipor processing animations, which are freely available online, and a handy printed manual show how to correctly process Multipor mineral insulation systems. The modern animated films offer basic tips for professional processing. The short clips have been deliberately developed with only a few explanatory texts and are also easy to understand for international processors. As an individual planning service, we also offer thermal bridge calculations, thermographic images, and building physics analyses. New in 2018 is the determination of the U-value of existing walls using non-destructive U-value measurement by our Multipor application technology.

Take advantage of our expertise gained from over 20 years and more than 25 million square meters of insulated surfaces worldwide. See for yourself how good our Multipor mineral insulation systems are. Find out more in our new insulation book about thermal insulation and use the tips on choosing the right insulation system and its applications. We hope you enjoy reading, planning, and building!



the Management Board
Xella Deutschland GmbH
Patrik Poláková



Dr. Clemens Aberle Chairman of
Head of Product Management
Xella Deutschland GmbH

Latest edition also available online!

The Insulation Book online

Always available, always up to date!



www.multipor.de/daemmbuch

The Multipor insulation book with all the information about our mineral insulation systems is also available online. An optimized search function for all relevant content, such as our construction details, as well as the integration of interactive content make the website an online compendium of knowledge about insulation with Multipor.

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Building Information Modelling
All information at: **www.multipor.de/bim**

Refurbishment, renovation, modernization

Thermal insulation with Multipor insulation systems can be
Reliable execution in new buildings as well as in buildings undergoing renovation. The special combination of Multipor mineral insulation boards WI and Multipor clay mortar enables the historic building fabric to be preserved during the energy-efficient renovation of half-timbered buildings.



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Flat roof

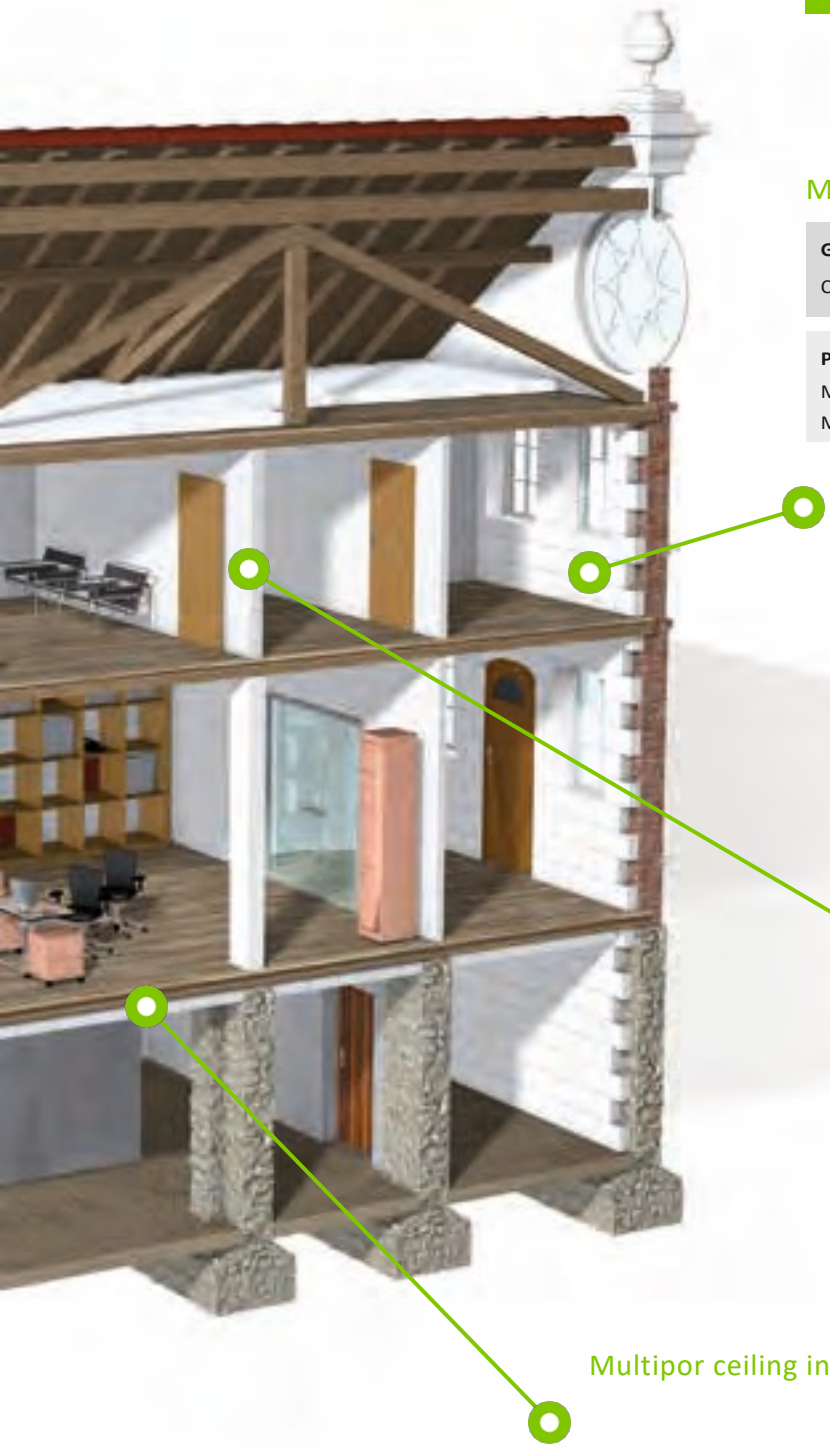
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* Further information on Ytong aerated concrete and Silka calcium silicate bricks can be found in the construction book at **www.ytong-silka.de/baubuch** .



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Commercial and new buildings

Commercial and new buildings require individual solutions that are tailored to the respective property types and requirements. Multipor makes it easy to meet the various energy requirements.

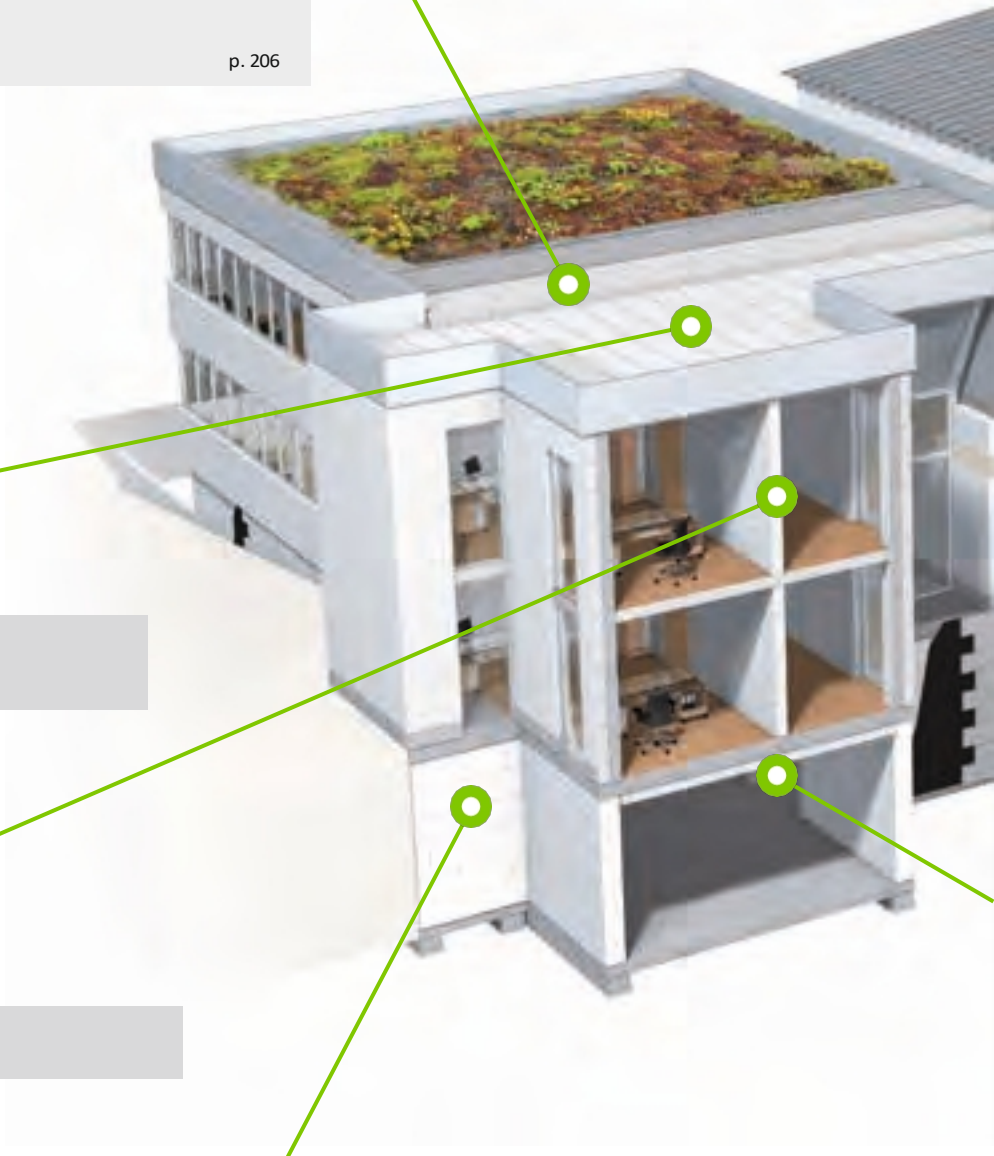
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Flat roof

Products and processing

Ytong and Silka building materials *

Interior wall

Products and processing

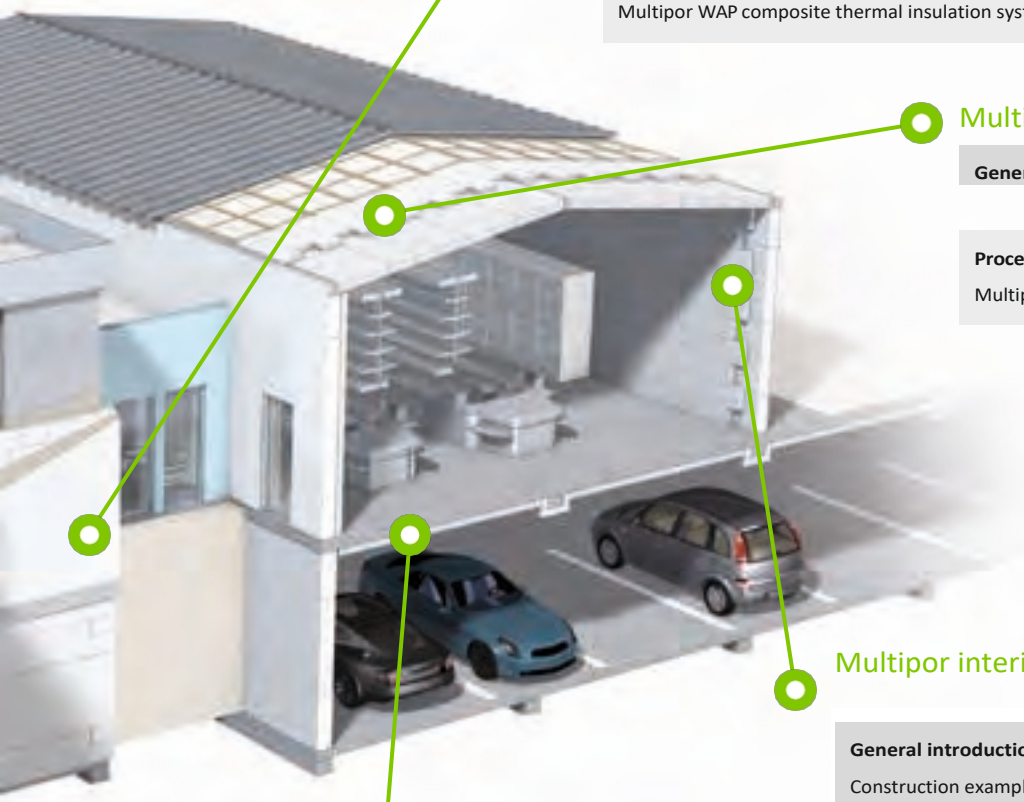
Ytong and Silka building materials *

Basement wall

Products and processing

Ytong and Silka building materials *

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SYSTEM SOLUTIONS ECOLOGICALLY SUSTAINABLE HEALTHY LIVING NATURALLY PURE MINERAL VERSATILE VAPOR PERMEABLE NEW CONSTRUCTION INHIBITS MOLD FORMATION MODERNIZATION ENVIRONMENTALLY FRIENDLY ECONOMICAL SOUND INSULATION ENERGY EFFICIENCY RESOURCE CONSERVATION ECONOMICALECONOMICAL DIFFUSION CAPILLARY ACTIVE EXCELLENT ECO-BALANCE 100% RECYCLABLE VAPOR PERMEABLE ENERGY EFFICIENT VERSATILE SUSTAINABLE ECOLOGICAL DIFFUSION OPEN ENVIRONMENTALLY FRIENDLY ECONOMICAL

1 Natural insulation with a system





ÖKOLOGISCH

NACHHALTIG

WOHNGESUND

NATÜRLICH DÄMMEN MIT SYSTEM

Multipor – sustainable and versatile!

Multipor insulation systems are the ecological solution for sustainable construction and renovation. This is because the core component of the systems, the Multipor insulation board, is a completely mineral insulation material based on sand, lime, cement, and water. Thanks to its special material structure, which is similar to the proven solid building material Ytong,
the lightweight, easy-to-handle board offers an optimal combination of important properties: dimensionally stable, vapor-permeable, and non-combustible.



The areas of application for the insulation systems in new and old buildings include interior insulation, underside ceiling insulation, basement insulation, and garage insulation, as well as the insulation of air shafts, solid roofs, pitched roofs, and flat roofs. Multipor mineral insulation boards are also used as a composite thermal insulation system (ETICS) approved by the building authorities. With their versatile application, Multipor insulation systems can contribute to achieving the current climate protection targets and a climate-neutral building stock by 2050. The advantages of energy-efficient building renovation make these systems, which are designed for durability and stable value, attractive to public clients and investors as well. These target groups need certainty in all matters—including the dismantling and disposal of building materials.

Multipor is also future-proof thanks to its availability within the framework of BIM, the new interdisciplinary and model-based working method. This makes planning and construction more reliable. But what impact does the new BIM planning method have on work processes, and what new roles and responsibilities does it entail? We address these and other topics in the updated third edition of the Multipor Insulation Book.



The unique advantages of Multipor insulation systems

Multipor mineral insulation boards are an ecological, completely mineral-based insulation material made from sand, lime, cement, and water. Thanks to their special material structure, these lightweight and easy-to-handle boards offer a combination of important properties. When used as part of the system, this results in unique advantages.

System provider

Multipor offers a complete insulation system for every area of application. Whether for facade insulation, interior insulation, ceiling and roof insulation – all relevant system components are available for the successful implementation of an insulation measure. The extensive product range includes Multipor mineral insulation boards, accessories, tools, and services. This ensures that all system components are optimally coordinated with each other.

Does not burn, does not smolder, does not smoke

The mineral Multipor insulation board belongs to building material class A1 and is non-combustible. Even at the highest temperatures, toxic fumes, smoke, or dripping are impossible. It is therefore only logical that the Multipor WAP composite thermal insulation system with appropriately approved finishing plasters has already been successfully installed in many places in kindergartens, schools, hospitals, and other public buildings. The system is also an excellent choice for multi-story residential buildings, as it meets all thermal and fire protection requirements.

Solid, dimensionally stable, woodpecker-proof

Whether on the mechanically heavily loaded facade of a school or in a single-family home in need of renovation, the pressure-resistant Multipor mineral insulation boards WAP prove their strength everywhere. The comparatively high bulk density of approx. 110 $^{kg/m^3}$enables a monolithic system structure when bonded, which sounds like a solid wall when tapped. This prevents damage from woodpeckers, and even rodents will break their teeth on the solid insulation material.



Protection against algae and fungi – without biocides

Surface moisture causes microbiological infestation. With the Multipor WAP composite thermal insulation system, this moisture does not occur in the first place. Rapid drying, high heat storage capacity, and water absorption prevent the problem in a natural way

. This is because mineral systems have optimal diffusion properties. They do not completely "seal" walls, but can absorb and release moisture.

This results in a balanced temperature and moisture balance. Unlike many conventional plastic-bonded insulation systems, the Multipor ETICS with mineral finishing plaster does not require the use of toxic biocides in the final coating.



Thermal insulation

Mineral-based and free of fibers, Multipor mineral insulation boards offer a new level of thermal insulation: solid and highly insulating with a thermal conductivity of up to

λ = 0.042 W/(mK). Insulation with Multipor significantly reduces energy consumption,

resulting in long-term energy and cost savings. Insulation is not only beneficial in terms of heating costs; optimal thermal insulation also increases the value of the property. The increasingly stringent requirements of the Energy Saving Ordinance are also easily met.



Quick and easy to install

With Multipor WI mineral insulation boards, interior insulation can be installed without the use of complex vapor barriers. The handy format and low weight of the insulation boards require hardly any effort. Fittings and recesses for pipe penetrations can be cut to size easily and accurately. The solid and dimensionally stable material can be processed quickly and easily. The absence of fibers makes it pleasant and safe for the installer. Multipor mineral insulation boards WI are simply bonded with Multipor lightweight mortar, which is specially designed for the system. The boards can be easily finished, e.g., by sanding.



Moisture protection and a good indoor climate

Conventional solutions for vapor-proof interior insulation have led to a variety of damage and costly renovations due to faulty installation of the vapor barrier. In contrast, the diffusion-open and capillary-active Multipor mineral insulation board has the ability to regulate the moisture balance itself. It can absorb and release condensation (dew) without losing its basic product properties, thus ensuring a balanced indoor climate.



Ecological insulation system

Multipor mineral insulation boards are manufactured in an environmentally friendly manner from the mineral raw materials lime, sand, cement, and water, to which a pore former is added. These ingredients make Multipor an ecologically safe building material. Multipor mineral insulation boards have been awarded the certificate of the Institute for Construction and Environment (IBU) for their exemplary environmental compatibility.

Multipor has also been awarded the natureplus quality mark as a sustainable, future-proof product. The certification of Multipor mineral insulation boards confirms that the product is free of harmful substances, does not release any emissions that are harmful to health, and has an excellent ecological balance—from the raw materials used to production and disposal.



BUILDING INFORMATION MODELLING

Successful planning and construction with BIM

Digitalization is also advancing in the construction industry.
Xella provides a large part of its Multipor insulation solutions as BIM objects in the common Revit and ArchiCAD formats on its website. From here, the data can be transferred directly into the planning process.

Complete system structures

All relevant data for planning facade, interior wall, roof, or ceiling insulation is available for Multipor. On this basis, planners can integrate system solutions with different insulation effects into their projects. Multipor experts have compiled more than 150 common designs for facade insulation (ETICS), interior wall insulation, and roof and ceiling insulation from the diverse product range and prepared them as BIM objects. In addition to Multipor mineral insulation boards, the system solutions also include the other wall layers, so that users can take complete system structures into account.

The fourth dimension

BIM data models consider the entire building life cycle: from the design idea to the recycling of the building. The fourth dimension, "time," allows the entire construction process to be planned and visualized. Cross-trade work on the model helps specialist planners to optimize construction site and logistics processes. Quantities, construction costs and materials, machinery, and personnel are calculated in advance in the model. This allows construction and assembly processes to be simulated. Deadlines can be predicted more accurately, and collisions and problems can be identified at an early stage. BIM data models are valuable foundations for building management, demolition, and disposal or material recycling.

It's that easy

The Multipor library contains more than 150 standard insulation designs as BIM objects in Autodesk Revit and ArchiCAD file formats. Log in atwww.multipor.de/bim and download the appropriate product free of charge for unlimited use.



Xella is driving forward the digital transformation

The goal of digital transformation at Xella is to expand and optimize collaboration with our customers using digital planning aids and process automation. We want to further advance digitalization in the construction industry and lead the way as a digital partner. Our digital service encompasses all consulting services with the aim of optimizing wall constructions at an early stage, avoiding planning errors, and facilitating the processing of our products. Seven digital product modules are offered throughout the phases of a construction project, from the initial idea for a building to its implementation. If you have any questions, for example about thermal bridges or implementation details, contact Xella for expert advice and pre-planned digital detailed solutions. Based on the construction plan, wall elements are designed and implementation drawings are produced to guarantee optimal and cost-efficient use of materials. A final product module includes digital construction instructions, which increase the quality of implementation on construction sites.

Xella is a reliable partner for customers in every phase of the project. It supports them from the initial project consultation consulting to implementation instructions, enabling them to build faster, more economically, and without errors.

In conversation ...

Dr. Clemens Aberle, Head of Product Management at Xella Deutschland GmbH, reports on current topics and developments at Multipor.



What's new at Multipor?
Multipor has undergone continuous development in recent years. In addition to the demand for system solutions and increased market requirements in terms of thermal insulation and fire protection, Multipor has also addressed the issues of digitalization and services. Numerous services have been developed to simplify the planning and processing of Multipor. Examples include the development of a non-destructive U-value measurement as a preparatory measure for renovation with interior insulation, and the creation of high-quality 3D animated films that show the correct processing of Multipor in all areas of application.

What contribution does Multipor make in the area of recycling? On the one hand, Multipor is a completely mineral-based product made from natural and mineral raw materials. On the other hand, Multipor meets the requirements of the circular economy principle in new construction: The Multipor
recycling concept provides for the residue-free reuse of single-type cuttings and construction site residues. We collect these residues in our big bags, sort them, and then return them to the raw material cycle for use in other products. During production, processing residues are also returned directly to production, thus conserving valuable resources.

How does Multipor contribute to safety in new construction and building renovation?
With Multipor, you are choosing a fire-safe insulation material. It complies with building material class A1 and is therefore non-combustible. Multipor does not drip or emit smoke in the event of a fire, which is particularly relevant for interior and ceiling insulation, but is also becoming increasingly important for all other applications. When Multipor is used for complete insulation in exterior areas, i.e., from the foundation to the roof, there is no need to install fire barriers, and people and buildings are optimally protected in the event of a fire.



What trends in insulation can we expect to see? We are already noticing a shift in customer thinking in the construction industry. In the coming years, environmental friendliness will play an increasingly important role in purchasing decisions, with a trend towards ecological and sustainable building materials. Insulation materials that are harmful to the environment are becoming significantly less important compared to mineral insulation materials. Fire protection is also playing a role here again – demand for safe, non-combustible materials is constantly increasing. Incidentally, this topic is also very relevant for painters and drywall installers, who see fire protection as an important issue for the future alongside energy efficiency and insulation.

How can the insulation market be assessed in general? Many public buildings such as schools and kindergartens, but also historic buildings, are increasingly being insulated with Multipor. The decisive factors here are also convincing fire protection and ecological aspects. In new construction, it is generally noticeable that private builders are influencing the decision on insulation materials more often than in the past.

However, the situation on the overall ETICS market remains tense. High construction costs already play a major role today, which is why the usefulness of insulation is often questioned. The expected Building Energy Act GEG 2018 could possibly provide new impetus, but this remains to be seen. Interior insulation remains a topic for the renovation market and for competent suppliers. Support in the form of technical services from the industry is important here, as is the long-term experience that we at Multipor have as pioneers in interior insulation.



Recycling – the eternal cycle

Humans leave behind a wide variety of waste that cannot be reintegrated into natural material cycles and thus pollute our environment for a long time. The valuable resources contained in waste are irretrievably lost after only one use in incinerators or landfills.

In the long term, we will inevitably have to orient ourselves towards the life cycle principle of the natural environment. The solution is product design in which all materials used circulate in technical and biological cycles. It is therefore important to think ahead – to think about sustainable product cycles.

For economic and ecological reasons, Multipor is interested in recycling as many of the raw materials used as possible. For this reason, Multipor complies with the requirements of the circular economy principle. This means that it can be returned to the raw material cycle and used for new Multipor or aerated concrete products in the production cycle.

Xella closes the cycle for Multipor residues with big bags

Xella Germany has developed a simple and effective concept to close the cycle for Multipor mineral insulation boards.
Far too good to be thrown away: Multipor mineral insulation boards have been popular insulation materials for years, mainly due to their excellent thermal insulation properties. This is due to the air trapped in the pores. And air is known to be a very good insulator. On most construction sites, however, offcuts from processing end up – albeit in small quantities – in the construction waste containers, i.e. in the trash. This means disposal costs for the processor, and the residual material is irretrievably lost as a raw material. In the search for an ecological and economical solution, the big bag principle came into play. In addition to the material, customers can order a recycling construction site set consisting of a big bag, coded sealing straps, a return slip, and accompanying information material.

The sorted Multipor offcuts are collected in the big bag directly on the construction site. Sealed with the coded straps and placed on a pallet, the big bags are returned to the factory locations. There, the offcuts are ground and returned to production.

Particularly noteworthy: at 210 million tons per year, mineral waste accounts for around 60 percent of all waste in Germany. This is another reason why the Multipor material cycle is ecologically and economically valuable for the environment.

Further information on recycling can also be found on the Internet at www.multipor.de/recycling.

The Multipor recycling concept provides for the residue-free reuse of single-type cuttings and construction site waste.
Multipor residues are collected on the construction site and taken back free of charge at our plant in Stulln.

Dr. Clemens Aberle,
Head of Product Management, Xella Germany





Expert inspection of a facade with a composite thermal insulation system made of Multipor mineral insulation boards

Damage-free and fully functional even after 20 years

Xella Germany wanted to know for sure and had an independent expert inspect a single-family home from the 1950s that had been built 20 years ago using the then-new Multipor mineral insulation boards. The result: a stable, functional, and dry insulation material was revealed beneath the thick layer of plaster.

The single-family home in Stulln was built in the 1950s and comprehensively modernized 20 years ago in accordance with the energy standards of the time. The facade was fitted with a composite thermal insulation system made of Multipor mineral insulation boards. At the time, the owners had deliberately chosen the newly developed ecological insulation material, which is manufactured in an environmentally friendly process using only lime, sand, cement, and water. Even after this long period of time, the exterior of the facade was intact and made a good impression, apart from the usual dirt and barely noticeable dowel marks. At least visually, no defects or damage could be detected. The owner planned to repaint the facade. This provided an opportunity to open up the facade beforehand in order to check the actual condition of the composite thermal insulation system. Manufacturer Xella Germany commissioned independent expert Michael Hladik to assess and document the condition.

The expert first confirmed that the building envelope was in perfect visual condition and emphasized: "The graying is mainly due to dust emissions from the surrounding area. There were no signs of microbial infestation." For a more detailed examination, the expert identified a total of four critical areas on the weather side of the house. First, an opening was made in a window corner on the first floor and another on the ground floor in the area of a window sill. The result: in both cases, the Multipor composite thermal insulation system showed no abnormalities. No moisture ingress or cavities were visible either behind the crack-free top layer or at the vulnerable joints and ends of the top layer.

The expert was also unable to detect any signs of algae or fungi, which are often the cause of complaints with composite thermal insulation systems. The report attributes this to the fact that the system components, consisting of reinforced base coat, mineral finishing coat, and mineral insulation material, form a homogeneous unit. "The mineral system," according to the report, "absorbs moisture on the one hand and dries quickly on the other." This means that the most important basis for microbial infestation, namely moisture, is not sufficiently available.

Since the results were positive at two extremely critical locations, the two other locations originally planned were not opened in order to avoid unnecessarily destroying an obviously intact facade. Tests of the samples taken in the laboratory of Xella Technologie- und Forschungsgesellschaft mbH confirmed the expert's findings regarding the dry condition and the lambda value.





Michael Hladik – the expert Michael Hladik is a generally sworn and court-certified expert for plasters and composite thermal insulation systems.

He founded the Austrian Plaster Working Group (ÖAP) in 1987 and was its president until 2002.

Michael Hladik expanded his area of expertise as a long-standing member of various committees of the Austrian Standards Institute (ÖN) and as a member of the Austrian Society for Construction Law (ÖGEBAU) and the Austrian Society for Thermography (ÖGfTh).

Born in 1949, Hladik is the owner of an expert office for building damage diagnostics, evidence preservation, and expert opinions in Natters near Innsbruck.
He has more than 40 years of professional experience in the construction industry, is the publisher of specialist literature, and has been working as a specialist consultant in all German-speaking countries for more than two decades. Most recently, he founded the Austrian Window Sill Working Group.



20 years of Multipor mineral insulation boards

Twenty years after entering the market, Multipor is the leader in mineral insulation.

Multipor celebrates its birthday: In 1997, Hebel in Hennersdorf began developing a mineral insulation board. Twenty years later, Multipor is the undisputed market leader in the field of mineral insulation systems. Since its development, over 25 million square meters of facade surfaces, interior walls, flat roofs, and basement ceilings have been constructed using Multipor mineral insulation systems.

As early as 1990, initial considerations were made to develop a lightweight insulation board from Hebel aerated concrete. To this end, the Hebel Technical Center was built at the Hennersdorf site, which was to serve, among other things, as a pilot plant for future insulation board production. The technical center began operations in August 1996 and produced the first Hebel HD 100 insulation boards. Originally, additional plant locations throughout Germany were planned for the production of the insulation board. Ultimately, the Hebel plant in Stulln in the Upper Palatinate was converted for the production of the board. Production began in April 1999 in a 3-shift operation. In mid-2000, Fels Werke GmbH took over the Stulln site from Hebel AG, and the product was now marketed under the name "Fermacell mineral insulation board

MD." In 2003, the building materials group Xella was formed under Haniel, and Fermacell mineral insulation board eventually became Multipor.

Frank Georgi, who has been with the company since the beginning and is a technical consultant at Multipor, looks back: "From a product that was hardly noticed at first, Multipor has developed into a high-performance and competitive player in the insulation market, offering efficient interior insulation and impressive system solutions in ETICS."

At the beginning of 2007, the production of Multipor mineral insulation boards at the Stulln plant was already running in four shifts. In order to meet the increasing demand, production also started at the Ytong plant in Cologne-Porz in 2008. Even after 20 years of continuous use, the mineral insulation system has lost none of its performance. On the contrary:
Thanks to its product properties and versatile applications in both new and existing buildings, Multipor is one of the market leaders in the field of mineral insulation systems. Frank Georgi sums it up:
"Multipor stands for ecology, sustainability, environmental awareness, reliable fire protection, and customer focus."

2020

Multipor processing videos show correct system installation

Xella Germany is continuing to expand its digital service tools and providing detailed processing videos free of charge.

The modern animated processing films offer basic information on the professional processing of Multipor mineral insulation systems and clearly illustrate the individual work steps.

The videos show how Multipor mineral insulation systems are processed correctly. Processing Multipor mineral insulation boards is quick, easy, and safe. The boards are lightweight, easy to work with, and free of fibers and harmful substances. Nevertheless, there are a few things to keep in mind, and the installation must be carried out carefully. The modern, animated installation videos show exactly how this is done. Step by step, viewers are guided through the individual installation phases, from preparation to completion. At the same time, specific attention is drawn to the technical details.

The photorealistic 3D animation provides basic information on professional processing and is a clear guide to correct construction.

The video series complements the company's digital services. The short clips have been deliberately developed with only a little explanatory text and are also easy to understand for foreign processors. They are optimized for use on mobile devices such as smartphones or tablets and allow users to find out more directly on the construction site if they are unsure about anything. The processing videos are available in German and English atwww.multipor.de/videos or on the Multipor YouTube channel.



Environmental certificates according to international standards

Multipor has three environmental declarations that comply with global standards. With the following three environmental certificates, planners and builders can make an informed decision based on independently verified data in favor of an ecological and low-emission insulation system that is mainly made from the mineral-based raw materials lime, sand, cement, and water.

The environmental product declaration of the Institute for Construction and Environment (IBU) in accordance with ISO 14025 and 14040 ff. as well as DIN EN 15804 confirms that Multipor mineral insulation boards are low in pollutants, do not release any emissions that are harmful to health, and have an excellent ecological balance.

In addition, Multipor has been awarded the "natureplus" environmental seal, which is known for its high ecological requirements "natureplus" environmental seal, which is renowned for its high ecological standards. The recognized environmental label in accordance with ISO 14024 is awarded exclusively to construction products that consist of sustainably available raw materials, are produced in a climate-friendly and clean manner, and do not release any substances harmful to health into the environment.

Air pollution in indoor spaces can be objectively measured and thus transparently presented and compared. For this reason, Multipor mineral insulation boards have been tested and certified for VOC content by the private eco-INSTITUT in Cologne. Volatile organic hydrocarbons can cause symptoms such as discomfort, headaches, or fatigue. The test showed that Multipor is free of harmful concentrations of VOCs. Both the Multipor mineral insulation board and the Multipor lightweight mortar have achieved the highest standard, A+. This means that the product, which is made from ecological raw materials, has been awarded the eco-INSTITUT label.

Comprehensive services with added value

Multipor has undergone continuous development in recent years. In addition to the increased demand for tailor-made and future-proof system solutions, Multipor has also addressed the issues of digitalization and services. Numerous services have been developed with an exemplary all-round service that significantly simplifies the planning and processing of Multipor insulation systems.

In addition to classic building physics services such as U-value measurements or WUFI calculations, a large proportion of Multipor insulation systems are offered as BIM objects. High-quality processing animations serve as clear instructions and are freely available on the website or the Multipor YouTube channel. More than 15 specialist advisors are available for direct contact on site in Germany alone. The service package is rounded off with training on how to process our systems directly on the construction site. The Ytong Silka Academy also offers a series of webinars that cover various topics related to Multipor insulation systems. If you have any questions about planning and executing insulation tasks, take advantage of our expertise and our free consulting service and give us a call.



Our expert advisors

Our nationwide field staff are not only experienced in providing technical advice on Multipor insulation systems. As trained and Dekra-certified energy consultants, they support our customers in all matters relating to energy-efficient insulation and the Energy Saving Ordinance (EnEV). We regularly train our sales staff on current developments in the construction industry at the Ytong Silka Academy. This ensures that our field service employees are always up to date
of technology. Our construction consultants and key account managers are also BIM-trained and therefore competent contacts.
All this with just one goal in mind: providing expert advice to you, our customers.



Comprehensive construction site service

The Multipor demonstration specialist is there for you on the construction site. They will be happy to give you or your construction expert helpful tips on how best to use and process our products so that everything runs smoothly on the construction site right from the start. This guarantees economical processing and optimum execution quality. Request the Multipor construction site service via our sales representatives.



Construction consulting and technical calculations

True specialists always have the big picture in mind. That's why we support you with building physics calculations as needed and by appointment – whether it's calculation methods for thermal bridges or non-destructive U-value measurement as a preparatory measure for renovation with interior insulation. We always look at the complete task, from the technical basics to the use of our products at your customers' sites. Our experienced construction practitioners will help you quickly and competently. Even when things get a little trickier and more specialized, we won't leave you out in the cold. For example, our technical service offers expert assistance in calculating the transient hygrothermal behavior of multi-layer components under natural climatic conditions – also known as WUFI calculation. Thermographic imaging makes it easy to identify weak points in buildings and develop a renovation concept. Benefit from the many years of experience and ongoing training of our application engineers and become a reliable partner for your customers.



Digital services

The consistent digitization of processes and services increases the transparency and efficiency of collaboration. Architects and planners have a wide selection of Multipor BIM objects available online. Available in Revit and ArchiCAD formats, the data can be transferred directly into the insulation planning process. The product ranges are stored in the data sets, ensuring a high degree of planning reliability. In addition to geometric information, the BIM objects also contain additional information ranging from processing to product certifications.

Webinars are becoming increasingly popular. That is why the Ytong Silka Academy combines traditional face-to-face seminars with digital learning technologies. Our webinar series covers various topics related to Multipor insulation systems and explains the planning and application of the various insulation systems.

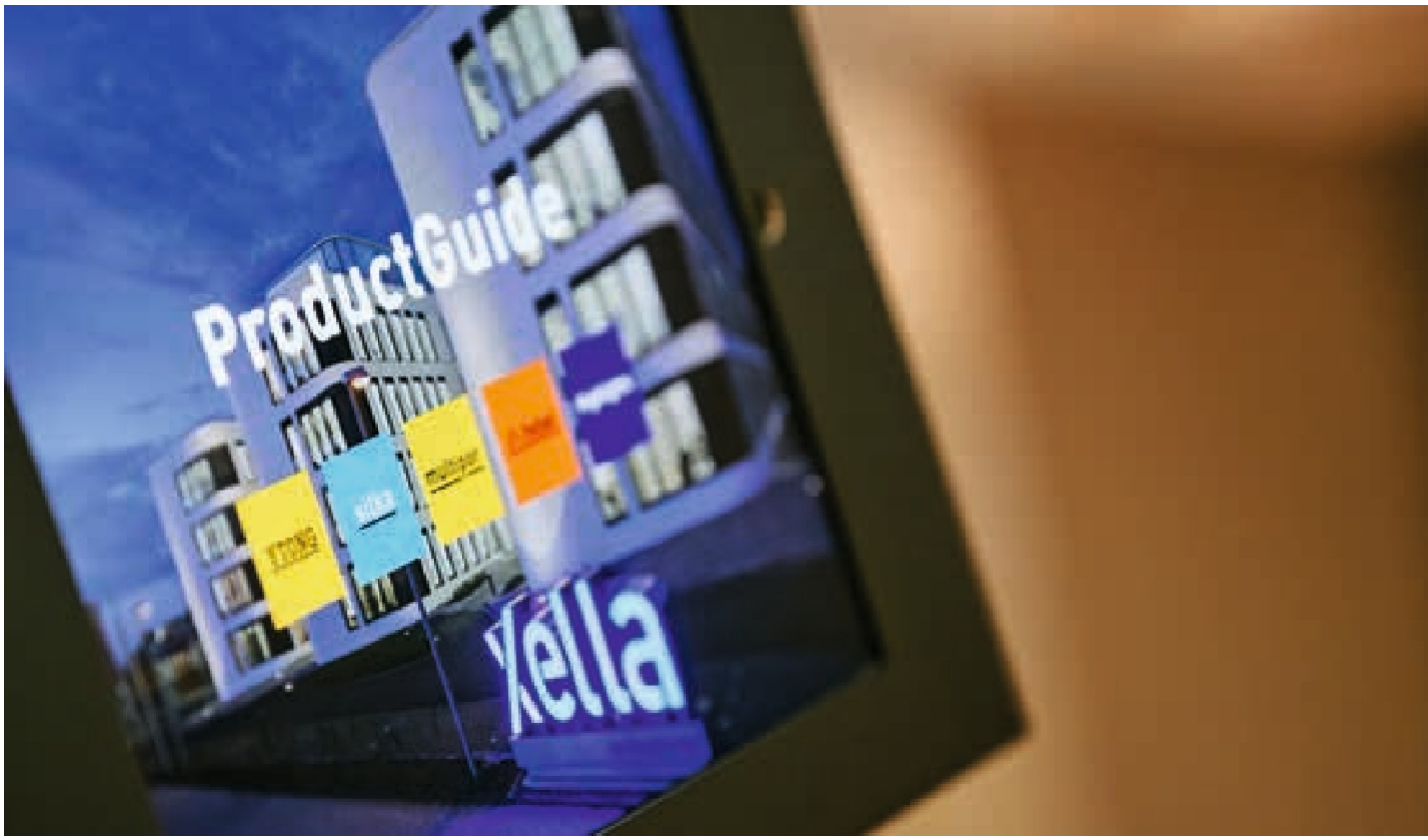
Our high-quality processing animations, which are available for all Multipor application areas, serve as easy-to-understand instructions and offer basic information on the professional processing of our Multipor insulation systems. The modern animated films are available free of charge on the website or the Multipor YouTube channel.



Customer information and technical construction consultants

Our Xella customer information service provides you with reliable, straightforward, and free information about our products and services at any time in a direct conversation: Tel. 0800 523 5665. Or if you need it in writing: info@xella.com.

Customer information also gives you access to our technical construction advisors, who can quickly and competently answer all your questions about the planning, application, and processing of our Multipor insulation systems. Our construction advisors are trained, experienced construction practitioners who are available to provide you with free advice and support during the planning and construction phases. This allows you to remain flexible in your day-to-day business.



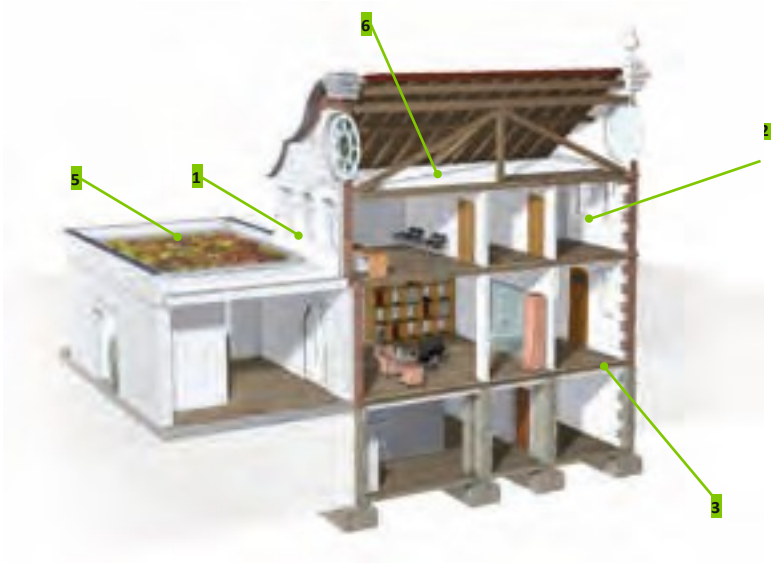
FACADE INSULATION ECOLOGICAL DIMENSIONALLY STABLE INTERNAL INSULATION ROOF INSULATION CEILING INSULATION SYSTEM SOLUTIONS ENERGY INHIBITS MOLD FORMATION WOODPECKER-PROOF SOLID NON-COMBUSTIBLE EASY TO PROCESS INHIBITS ALGAEAND FUNGUS FORMATION HOMOGENEOUS RELIABLE IN USE VERSATILE RESOURCE-EFFICIENT NO THERMAL BRIDGES PRESSURE-RESISTANT WOODPICKE-PROOF ECONOMICAL EFFICIENT ENERGY-EFFICIENT LIGHTWEIGHT ROOF INSULATION NON-COMBUSTIBLE ROOF INSULATION HOM

2 Multipor insulation systems



2.0 Multipor insulation systems

Insulation systems



After more than 20 years of continuous use, the mineral Multipor insulation system has lost none of its innovative power. On the contrary: thanks to its unique properties and versatile applications in both new and existing buildings, the Multipor insulation system is firmly established in the market. At the heart of the system is the Multipor mineral insulation board, which is manufactured in a resource-saving manner using natural and mineral ingredients such as sand, lime, cement, and water. It also offers reliability in planning and construction as well as structural functionality. This makes the Multipor mineral insulation board an insulation material that meets the requirements of any construction project in an economical, efficient, and sustainable manner.

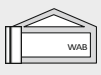
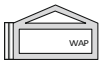
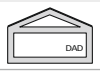
System reliability for a variety of applications

Depending on the area of application (see Fig. 1) and the requirements of the structure to be insulated , Multipor insulation systems offer the right solution.

1 Multipor thermal insulation composite system WAP

An ecological, solid, dimensionally stable, and non-combustible Multipor thermal insulation composite system enables seamless, thermal bridge-free exterior walls from single-family homes to multi-story buildings. The comprehensive mineral system is rounded off by important complementary products such as Multipor finishing plaster. In particular, the structural properties of the Multipor WAP composite thermal insulation system offer unique advantages and are decisive for sustainable, high-value facade insulation that meets all the energy requirements of the EnEV and efficiency house classes.

Fig. 1: Areas of application and abbreviations according to DIN 4108-10

Wall			Roof / ceiling		
WAB		External insulation of the wall behind cladding	DEO		Internal insulation of the ceiling or floor slab (upper side) under screed without sound insulation requirements
WAP		External insulation of the wall under plaster	DI		Internal insulation of the ceiling (underside) or roof, insulation under the rafters/under the supporting structure, suspended ceiling, etc.
WI		Internal insulation of the wall	DAA		External insulation of roof or ceiling, protected from weathering, insulation under waterproofing
WTR		Insulation of room partition walls	DAD		External insulation of roofs or ceilings, protected from weathering, insulation under roofing

Multipor material and ETICS approvals ensure application safety.

The insulation system with appropriately approved finishing plasters belongs to building material class A. It does not burn or smolder, it does not drip, and it does not produce toxic fumes or smoke. The ETICS thus meets all fire protection requirements without the usual fire barriers.

The higher bulk density compared to other systems enables a monolithic system structure that is solid, dimensionally stable, and secure, and can also withstand heavy mechanical loads.

In combination with mineral and vapor-permeable plaster systems, the Multipor WAP thermal insulation composite system dries quickly and has very good heat storage capacity, which prevents long-lasting surface moisture.



and thus prevent algae and fungal growth, in line with the motto "What stays dry longer remains algae-free longer."

2 Multipor interior insulation systems

The Multipor interior insulation system WI is diffusion-open, capillary-active, and allows for interior wall insulation of buildings worth preserving. Several million square meters



living space and valuable, newly utilized building fabric. Even listed buildings can be carefully modernized in accordance with today's requirements and without impairing the overall impression, strictly in accordance with the requirements of monument preservation.

The coordinated Multipor system components, such as e.g. Multipor lightweight mortar and reinforcement fabric, enable retroactive and modern interior insulation without costly and error-prone vapor barriers. Excess room humidity is absorbed by the mineral insulation board and later released back into the room air. Multipor not only improves the thermal insulation value and surface temperature, but also regulates the humidity balance in the living space in a natural way and contributes positively to the indoor climate. Interior wall insulation with the pollutant-tested



Multipor interior insulation system WI clay

Multipor interior insulation systems are therefore the ideal basis for healthy living. This is also confirmed by the latest VOC analysis by the independent eco-INSTITUT in Cologne.

Multipor interior insulation system WI clay
Multipor mineral insulation boards WI and Multipor clay mortar are the ideal combination when it comes to the energy-efficient renovation of half-timbered buildings. Both materials complement each other perfectly thanks to their structural properties. The diffusion-open insulation system compensates for unwanted condensation and prevents moisture damage in the long term. The result: an optimal indoor climate and protection for the historic and valuable wall construction. Multipor clay mortar is a mixture of clay powder and natural sands, contains no chemical additives, and
is also suitable for allergy sufferers due to its ecological properties.
suitable.

3 Multipor ceiling insulation system DI When insulating underground garages and basement ceilings, the non-combustibility and thermal insulation properties of Multipor mineral insulation boards DI and Multipor lightweight mortar guarantee low heating costs and high fire protection. In particular, the quick and easy adhesive installation allows for economical implementation of insulation measures in new or existing buildings. This is precisely why the mineral Multipor DI ceiling insulation system in residential and office buildings as well as special structures (e.g., shopping centers and stadiums).

4 air shaft insulation Air quality is playing an increasingly important role in modern buildings. The sometimes immense amounts of fresh air are sucked in through solid, appropriately dimensioned air shafts, fed into technical air treatment systems, and then distributed throughout the building. The walls of the air shafts must be insulated, which places special demands on the quality of the insulation materials used. Multipor mineral insulation boards and their system components meet these high standards and are the ideal insulation material for high indoor air quality.

5 Multipor roof systems DAA/DAD There are various insulation options for pitched and flat roofs, but only the Multipor roof



Table 1: Multipor mineral insulation boards Thermal resistance (R-value) [m²K/W]

Rated thermal conductivity (λ) [W/(mK)]	Panel thickness [mm]													
	50	60	80	100	120	140	160	180	200	220	240	260	280	300
0.042	–	1.429	1.905	2.381	2.857	3,333	3,810	4,286	4,762	5,238	5.714	6,190	6,667	7,143
0.045	1.111	1.333	1.778	2.222	2.667	3.111	3,556	4,000	4,444	4,889	5,333	5,778	6,222	6.667
0.047	–	–	–	–	2.553	2,979	3,404	3,830	4,255	4,681	5,106	5,532	5,957	6,383

Available on request or double-layer design

DAA and DAD systems can withstand all loads. Thanks to their non-compressibility, high pressure resistance, and non-combustibility, they can be used in all kinds of applications—from loaded to unloaded steep and flat roofs. Gradient insulation made with Multipor mineral insulation boards also guarantees reliable flat roof drainage.

6 Screed insulation

Due to their high compressive strength and resistance to compression, Multipor mineral insulation boards are used in floor construction. Whether for attic renovation or as screed insulation in industrial floors, Multipor meets all expectations in terms of energy conservation and load distribution with appropriately dimensioned layer construction.

Thermal insulation

Building owners and users invest around a quarter of Germany's total energy consumption in maintaining comfortable room temperatures. Modern new buildings constructed in accordance with the latest energy saving regulations do little to change this statistic.

In contrast, unrenovated and existing buildings constructed before 1980 are real energy wasters. They still account for over 75% of the total building stock. Multipor insulation systems can significantly reduce energy consumption through retroactive insulation measures in a structurally sound manner. Energy-efficient construction in existing buildings is not only economically sensible, but also increases the value of the property and offers a higher quality of living.

Multipor insulation systems always provide suitable thermal protection in accordance with EnEV requirements or efficiency house classes. In addition, they offer the following for structural buildings as interior, ceiling, roof or facade insulation, whereby the effectiveness of the insulation in the construction is expressed in terms of thermal resistance (R-value in m²K/W) (see Table 1).

Fire protection

Mineral and natural raw materials make Multipor a non-combustible insulation material that belongs to building material class A1 according to DIN EN 13501-1. Even in combination with the mineral Multipor lightweight mortar for bonding and reinforcing, the overall system is classified as non-combustible. This means a high degree of planning and execution reliability, especially for ceiling, roof, and facade insulation, in order to meet fire protection requirements. This also increases safety for users and investors in



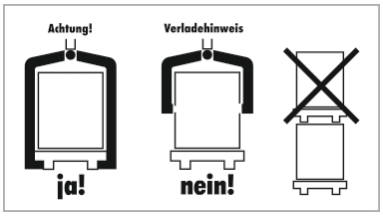
a high degree of planning and execution reliability in order to meet fire protection requirements. This also increases safety for users and investors in interior insulation.

Ecology in the manufacture of Multipor mineral insulation boards The success story of the mineral and diffusion-open Multipor insulation systems began over 20 years ago. We recognized the need for innovative and user-friendly insulation solutions and, with the further development of lower thermal conductivities of Ytong aerated concrete, laid the foundation for Multipor. A natural and mineral raw material supply of sand, lime, cement, and water paved the way from aerated concrete blocks to purely mineral insulation material, which—thanks to the technical expertise gained from Ytong aerated concrete production—has the best possible building physics properties.
Multipor mineral insulation boards are manufactured in a similar way to Ytong aerated concrete. Ground quartz sand, lime, and cement are mixed with other raw materials to form a raw mass, and after adding a pore former, this is poured into molds. This creates uniform small pores measuring 0.5 to 1.5 mm. The subsequent steam curing process produces a naturally identical mineral (tobermorite), which significantly determines the properties of the mineral insulation board. Incidentally, steam, condensate, and production waste are reused in an environmentally friendly manner during the production process. Finally, Multipor mineral insulation boards are stacked in handy small packages on Euro pallets and sealed in recyclable shrink wrap.

Certified environmental protection Due to its natural ingredients, the Multipor mineral insulation board is an ecologically valuable insulation material that contains neither fibers nor harmful substances. The European Product Declaration (EPD) makes the ecological properties transparent through the declaration of the Institut Bauen und Umwelt e. V. (Institute for Building and Environment). In addition, the mineral insulation board is unique in Europe thanks to its natureplus certification and VOC testing by eco-INSTITUT Cologne.

Delivery and handling
Multipor insulation systems and all system components should be delivered as directly as possible to the processing site in order to avoid unnecessary time-consuming and costly intermediate transport. If intermediate storage is nevertheless necessary, solid, level, and dry storage areas ensure smooth construction progress and also prevent damage to materials. Our experienced freight forwarders have vehicles equipped with a hydraulic crane or forklift that carefully places the insulation boards as individual items or on pallets next to the vehicle on a level surface. Depending on the agreement and technical conditions, it is also possible to store the materials near the installation site.

Fig. 2: Loading instructions



On special order, we deliver to smaller construction sites with particularly compact motor vehicles, which are also suitable for delivering smaller additional quantities. Only suitable lifting tools approved by the employers' liability insurance association may be used for unloading and

moving, only suitable lifting tools approved by the employers' liability insurance association may be used. Multipor mineral insulation boards can also be transported on paved surfaces using a pallet truck. To unload the package, the loading clamp grips around the package under the pallet and lifts the load safely. Under no circumstances should it grip or press against the Multipor mineral insulation boards (see Fig. 2), nor should the pallets be stacked. Unloading using slings, ropes, or chains should also always be avoided, as these can cause damage to the material.

Palletized Multipor mineral insulation boards are bundled in handy small packages and protected from the weather by a film. This also ensures the stability of the packaging unit and should therefore only be removed shortly before installation.

Building with system building materials

The Multipor insulation systems product range, comprising mineral insulation boards, accessories, tools, and services, provides a practical and economical solution for all building component applications. Our Multipor technical advisors will be happy to answer any questions you may have about the product and technology. They will help you with the correct practical application of the insulation material and with economical and safe planning—for example, by providing building physics verification using modern hygrothermal calculation methods.

You can find your local Multipor consultant in the contact section of our website at **www.multipor.de**.

SYSTEM SOLUTIONS THERMAL INSULATIONCOMPOSITE SYSTEM FACADE AESTHETIC ECOLOGICAL HIGH THERMAL INSULATION ENERGY EFFICIENT DIFFUSION OPEN CAPILLARY ACTIVE HOMOGENEOUS NEW CONSTRUCTION RENOVATION INHIBITS ALGAE FORMATION BUILDING INSPECTION APPROVED APPLICATION SAFETY SOLID DIMENSIONALLY STABLE SPSAFE NON-COMBUSTIBLE 100% RECYCLABLE SUSTAINABLE RESIDENTIAL SOUND INSULATION RENOVATION ECONOMICAL AESTHETIC FACADE INSULATION DIFFUSION-OPEN INHIBITS ALGAE FORMATION

3 Multipor Thermal Insulation Composite System WAP



Multipor WAP composite thermal insulation system

- Efficient thermal insulation for high-quality building solutions in new and old buildings
- Mineral-based e thermal insulation composite system
- Highly effective in inhibiting algae growth and fungal infestation
- Ecologically excellent insulation material certified by natureplus, IBU declaration, and highest category A+ from eco-INSTITUT
- Building authority-approved system
- Non-combustible: with approved mineral finishing plasters

Thermal insulation composite systems (WAP/WDVS) are heat-insulating facade systems whose insulation material is bonded to the exterior wall of the building, additionally secured mechanically with dowels, and then covered with a base coat and top coat of plaster. The individual components form a fully coordinated, tested, and building authority-approved system that can be safely installed, including the necessary accessories and supplementary products. The Multipor WAP composite thermal insulation system has German general building authority approval (abZ) and a European technical assessment.

ETICS have been used as insulating exterior wall constructions for over 50 years – initially mainly in renovation projects, but now also in new buildings, because good insulation of the building envelope is becoming increasingly important as energy prices rise. Poorly insulated exterior walls, on the other hand, allow around a third of heating energy. Those who insulate their homes today in line with modern standards will not only save energy tomorrow, but can also benefit from numerous subsidies (e.g., through the subsidy measures offered by the Kreditanstalt für Wiederaufbau, www.kfw.de).

Eco-friendly? Of course!
However, high energy consumption not only puts a strain on household budgets, but the reckless waste of fossil fuels is also ecologically irresponsible. We believe that every ton of CO_2 is one ton too many.

Mission 2020
Awareness of intelligent construction has long since become established, and sustainability is now both demanded and promoted. The requirements of the Energy Saving Ordinance (EnEV 2014) are becoming stricter with each amendment, as the German government is pursuing clear goals: by 2020, total emissions of harmful greenhouse gases are to be reduced by 40%. January 1, 2016, the EnEV tightened the requirements, among other things by reducing the permissible annual primary energy demand for residential buildings by 25% compared to today's reference building. Further information on the current EnEV can be found in chapter 7.1.6.

Which is the right approach? Insulation measures have been the focus of attention for several years. Modern low-energy houses in particular are still usually insulated with ecologically questionable petroleum-based polystyrene products. From a building physics perspective, it is highly questionable to upgrade older facades with diffusion-tight plastic sheathing for energy efficiency instead of making ecology and healthy living the contemporary standard when selecting materials. One example is the Feldberger Hof family hotel in the Black Forest, which is described in more detail in chapter 3.6. The motto here was: Think before you act! Consequently,

the proven sustainable Multipor insulation system was used with future generations in mind.

Cost-effectiveness in application and energy balance Anyone who invests in real estate wants to know that their capital is well invested. A high-quality ETICS with the Multipor WAP thermal insulation composite system is a worthwhile investment that not only reduces energy costs but also increases the value of the property, thereby helping to reduce vacant housing

Since the introduction of EnEV 2014 on May 1, 2014, the following applies with regard to the energy performance certificate: To make the expected energy consumption easier to understand, an energy performance certificate must be presented to the buyer or tenant without being requested when selling or re-letting a property. For new construction projects, a preliminary energy performance certificate must be provided to the builder, which must be replaced by a valid energy performance certificate after completion of the construction project.
provisional energy performance certificate, which must be replaced by a valid energy performance certificate after completion of the construction project.

The unique advantages of the ecological and mineral Multipor thermal insulation composite system
The fact is: not all insulation is the same. In new buildings and renovations, in addition to maximum insulation effectiveness, other building physics properties are also important, which are taken into account by the intelligent Multipor thermal insulation composite system WAP.



1. Does not ... er, or smoke

The Multipor ETICS with appropriately approved mineral finishing plasters belongs to building material class A from the base to the roof and is non-combustible. With this system, both the dripping of burning material and the formation of toxic smoke are prevented. No wonder that the Multipor WAP composite thermal insulation system has already been successfully installed in many places in kindergartens, schools, hospitals, and other public buildings. The system is also ideal for multi-story residential buildings, as it meets all thermal and fire protection requirements without the need for special solutions (e.g., fire barriers).



2. Protection against algae and fungi – without biocides

Surface moisture causes microbiological infestation. With the Multipor WAP composite thermal insulation system with mineral finishing plaster, this moisture does not arise in the first place: rapid drying and a high heat storage capacity for an insulating material prevent the problem in a natural way, as mineral systems have optimal diffusion properties. They do not "seal" walls, but absorb moisture and release it again, resulting in a balanced temperature and moisture balance. Unlike many conventional, plastic-bonded insulations, this Multipor ETICS does not contain any toxic biocides in the final coating.



3. Solid, dimensionally stable, woodpecker-proof

Whether it's the mechanically stressed facade of a school or a single-family home in need of renovation, the pressure-resistant Multipor WAP mineral insulation boards show their strength everywhere and thus meet existing requirements as a complete system. The comparatively high bulk density of approx. 110 $^{kg/m^3}$enables a monolithic system structure that sounds like a solid wall in a "knock test." This means that damage from woodpeckers is not an issue and protection against rodents is also guaranteed.

.



Intelligent insulation

Lime, sand, cement, and water – Multipor mineral insulation boards are made from natural mineral raw materials, are completely harmless to health, 100% recyclable and have optimal diffusion properties. A Multipor WAP composite thermal insulation system largely eliminates thermal bridges and promises a pleasant indoor climate all year round. The intelligence of the Multipor system solution is also evident in its ease of use: Multipor mineral insulation boards WAP can be easily shaped to any form, ensuring
thus ensuring maximum cost-effectiveness and efficiency. Thanks to its ecological properties, the system is also particularly suitable for obtaining sustainability certificates (e.g., according to DGNB or LEED).

. The specific product characteristics can be found in the online DGNB Navigator on the Internet at www.dgnb-navigator.de.

Ecology/sustainability

The Multipor WAP mineral insulation board is an ecological and biologically recommended alternative to conventional insulation materials – the ideal solution for environmentally and health-conscious customers and builders. In fact, residual or waste pieces can be easily and cost-effectively recycled (in Multipor Big Bags) or disposed of as single-type construction waste in landfills [waste code according to the European Waste Catalogue (EAKV):
17 01 01]. These facts are confirmed by the natureplus environmental label, the IBU declaration awarded by the Institute for Building and Environment e. V., and the highest category A+ from the eco-INSTITUT.

THIRD-PARTY VERIFIED EPD ISO 14025 and EN 15804 Institut Bauen und Umwelt e.V.

natureplus® No. 0404-0812-086-I

General introduction and planning 3.1

Solid Multipor mineral insulation boards WAP

The high bulk density of Multipor mineral insulation boards WAP (glued and doweled) compared to conventional insulation materials enables a "quasi-monolithic" system structure. This means that when you tap on the facade, it sounds more like a solid wall than conventional composite thermal insulation systems. The Multipor WAP composite thermal insulation system with mineral insulation boards therefore represents a high-quality, solid, and sustainable construction method—especially in combination with Ytong aerated concrete and Silka sand-lime brick with an identical raw material base.

EnEV requirements for exterior walls in new buildings

In new buildings, the Multipor WAP composite thermal insulation system easily and smoothly meets the requirements of the Energy Saving Ordinance – and even exceeds them. Further information on the current EnEV can be found in chapter 7.1.6. The combination of the Multipor WAP composite thermal insulation system and Ytong masonry offers optimal solutions for highly thermally insulated exterior walls walls in KfW efficiency house or passive house standards. Combined with Silka sand-lime brick, in addition to improving energy efficiency, it also meets increased requirements for the load-bearing capacity of exterior walls (e.g., in multi-story buildings). Table 2 provides an overview of the U-values that can be achieved.

EnEV renovation requirements for exterior walls

In Germany, there are an above-average number of residential units that are in poor to inadequate condition due to their age.

Table 1: Product data for Multipor WAP composite thermal insulation system – main system components

	Multipor mineral insulation board WAP	Multipor lightweight mortar
Regulations	European Technical Assessment ETA-05/0093	Lightweight plaster mortar LW in accordance with EN 998-1
Dry bulk density	100–115 kg/m³	approx. 770 kg/m³
Compressive strength	≥ 300 kPa	CS II; 1.50 – 5.0 N/mm²
Transverse tensile strength/adhesive tensile strength	≥ 80 kPa	≥ 250 kPa
Shear strength	≥ 30 kPa	–
Thermal conductivity	λ = 0.045 W/(mK) (rated value)	$\lambda_{10,dry}$ = 0.18 W/(mK)
Water vapor diffusion resistance factor	μ = 3	μ ≤ 10
Modulus of elasticity	approx. 200–300 N/mm²	approx. 2,000 N/mm²
Water absorption – Short term (24 h) according to DIN EN 1609 – Long term (28 days) according to DIN EN 12087	W_p ≤ 2.0 kg/m² W_{LP} ≤ 3.0 kg/m²	– –
Water absorption – Capillary water absorption according to DIN EN 1015-18	–	W2, c ≤ 0.2 kg/(m² $min^{0.5}$)
Building material class	A1; non-combustible Melting point > 1,200°C	A2-s1, d0; non-combustible
Dimensions / Delivery quantity	600 x 390 mm d = 60–300 mm (in 20 mm increments)	20 kg/bag
Material requirements	4.3 panels/m²	approx. 30 l/20 kg; sufficient for approx. 6 m² bonding or reinforcement with a layer thickness of 5 mm

%0.1 General introduction and planning

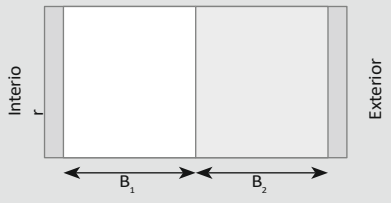
Table 2: U-values of functional walls with Multipor mineral insulation boards WAP – new construction

Designation	Ytong Po enbeton					Silka sand-lime brick	
	PP 4-0.50 / λ = 0.12 W/(mK)			PP 2-0.35 / λ = 0.09 W/(mK)		Solid XL 20-2.0 / λ = 1.1 W/(mK)	
Wall thickness B_1 in cm	15	20	24	30	36.5	17.5	24.0
Multipor insulation thickness B_2 in cm	U-values [W/(m² K)]						
6	0.35	0.30	0.28	0.20	0.18	0.57	0.55
8	0.30	0.27	0.25	0.19	0.16	0.45	0.44
10	0.27	0.24	0.22	0.17	0.15	0.38	0.37
12	0.24	0.22	0.20	0.16	0.14	0.32	0.32
14	0.22	0.20	0.19	0.15	0.13	0.28	0.28
16	0.20	0.18	0.17	0.14	0.13	0.25	0.25
18	0.18	0.17	0.16	0.13	0.12	0.23	0.22
20	0.17	0.16	0.15	0.12	0.11	0.21	0.20
22	0.16	0.15	0.14	0.12	0.11	0.19	0.19
24	0.15	0.14	0.13	0.11	0.10	0.17	0.17
26	0.14	0.13	0.12	0.11	0.10	0.16	0.16
28	0.13	0.12	0.12	0.10	0.09	0.15	0.15
30	0.12	0.12	0.11	0.10	0.09	0.14	0.14

≤ Reference value (0.28 W/m²K) Recommendation for EnEV standard houses Recommendation for energy-efficient houses Recommendation for passive houses

Wall structure
2.0 cm interior plaster, λ = 0.51 W/(mK)
B_1 cm Ytong aerated concrete or Silka sand-lime brick
B_2 cm Multipor mineral insulation board WAP
1.3 cm adhesive, reinforcement and top coat, $\lambda_{10, dry}$ = 0.18 W/(mK) (Multipor lightweight mortar)

R_{si} + R_{se} = 0.17 m²K/W



Thermal insulation, resulting in high energy costs and uncomfortable living conditions in both summer and winter. The solution: a highly thermally insulating and ecological Multipor WAP composite thermal insulation system that can be easily and economically applied to mineral substrates such as masonry or concrete. This is because the EnEV 2014 places higher demands on thermal insulation in the case of renovation and exterior plaster renewal than in new buildings. Table 3 provides an overview of the U-values to be achieved.

Table 3: U-values of functional walls with Multipor mineral insulation boards WAP – renovation

Designation	Solid brick				Aerated concrete		Lightweight concrete hollow blocks		
	ρ = 1.6 kg/dm³ , λ = 0.68 W/(mK)				ρ = 0.5 kg/dm³ , λ = 0.14 W/(mK)		ρ = 0.9 kg/dm³ , λ = 0.44 W/(mK)		
Wall thickness B_1 in cm	24.0	30.0	36.5	50.0	20	24.0	24.0	36.5	50.0
Multipor insulation thickness B_2 in cm	U-values [W/(m²K)]								
6	0.51	0.48	0.46	0.42	0.33	0.30	0.46	0.41	0.36
8	0.41	0.40	0.38	0.36	0.29	0.26	0.38	0.34	0.31
10	0.35	0.34	0.33	0.31	0.25	0.24	0.33	0.30	0.27
12	0.30	0.29	0.29	0.27	0.23	0.21	0.29	0.26	0.24
14	0.27	0.26	0.25	0.24	0.21	0.20	0.25	0.24	0.22
16	0.24	0.23	0.23	0.22	0.19	0.18	0.23	0.21	0.20
18	0.22	0.21	0.21	0.20	0.17	0.17	0.21	0.20	0.18
20	0.20	0.19	0.19	0.18	0.16	0.16	0.19	0.18	0.17
22	0.18	0.18	0.17	0.17	0.15	0.15	0.17	0.17	0.16
24	0.17	0.16	0.16	0.16	0.14	0.14	0.16	0.15	0.15
26	0.16	0.15	0.15	0.15	0.13	0.13	0.15	0.14	0.14
28	0.15	0.14	0.14	0.14	0.13	0.12	0.14	0.14	0.13
30	0.14	0.14	0.13	0.13	0.12	0.12	0.13	0.13	0.12

Recommendation: Modernization in accordance with EnEV standard house level Recommendation: Modernization to energy efficiency

Recommendation for passive houses

Wall construction
1.5 cm interior gypsum plaster, λ = 0.51 W/(mK) B_1 cm existing wall
2.0 cm existing exterior plaster, λ = 1.0 W/(mK) B_2 cm Multipor mineral insulation board WAP
1.3 cm adhesive, reinforcement and top coat, $\lambda_{10, dry}$ = 0.18 W/(mK) (Multipor lightweight mortar)

$R_{si} + R_{se}$ = 0.17 m² K/W



For detailed thermal insulation verification, Table 4 contains the thermal resistance for the various Multipor mineral insulation boards WAP in the respective board thicknesses:

Table 4: Multipor mineral insulation boards WAP – dimensions and thermal resistance R [m²K/W]

Thermal conductivity Design value	Panel thickness [mm]												
	60	80	10	12	140	160	180	200	220	240	260	280	300
λ = 0.045 W/(mK)	1.333	1.778	2.222	2.667	3.111	3,556	4,000	4,444	4,889	5,333	5,778	6,222	6,667

3.1 General introduction and planning

Table 5: Product specifications for Multipor base insulation boards

Regulations	European Technical Assessment ETA 05/0093
Dry bulk density	100–115 kg/m³
Compressive strength	≥ 300 kPa
Transverse tensile strength/adhesive tensile strength	≥ 80 kPa
Thermal conductivity	λ = 0.045 W/(mK) (rated value)
Water vapor diffusion resistance factor	= 3
Dimensions	600 x 390 mm d = 100–240 mm (in 20 mm increments)
Material requirements	4.3 panels/m²

Table 6: Product characteristics Multipor sealing slurry

Delivery form	Bagged
Compressive strength	≥ 15 N/mm²
Fresh mortar density	approx. 1.83 g/m³
Layer thickness bonding	5.0 mm
Layer thickness reinforcement	4.0 – 5.0 mm
Consumption: – Bonding – Reinforcement	 6.25 kg/m² 6.25 kg/m²
Weight per bag	25 kg
Pallet contents	49 bags

Multipor base insulation board

The ideal complementary product for facade insulation is the Multipor base insulation board (Table 5). It is solid, weather-resistant, highly heat-insulating, and classified as a Class A1 building material, meaning it is non-combustible.

In combination with Multipor facade insulation, this creates a uniform composite thermal insulation system from the base to the roof, which eliminates thermal bridges and makes the installation of cumbersome and error-prone fire barriers unnecessary.

The advantages of the Multipor base insulation board are:

- Resistant, even under the harshest conditions
- Does not burn, smolder, or smoke
- No material changes in the system, no thermal bridges
- Uniform facade structure
- Easy and safe to process

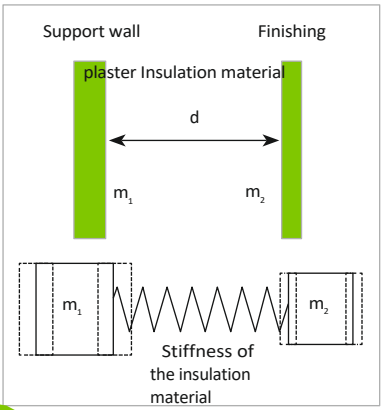
The Multipor base insulation board is always processed with the mineral Multipor sealing slurry (Table 6).

Fire protection

The planned composite thermal insulation system (WAP/WDVS) must comply with all thermal and fire protection requirements. This means that, depending on the building, it must also be checked whether the insulation material used meets the national building regulations (usually the applicable state building regulations). Regardless of the state in which the measure is implemented, the Multipor composite thermal insulation system WAP with mineral finishing plasters meets all fire protection requirements as a non-combustible system fire protection without the need for costly solutions such as fire barriers. It can be ideally supplemented and optimized with the Multipor base insulation board, which is also non-combustible. If you have any further questions your local Multipor consultant in the contact section of our website at www.multipor.de.

Multipor mineral insulation boards WAP, in combination with Multipor lightweight mortar wall constructions with a non-combustible system structure in accordance with fire protection class A2 and thus meet all fire protection requirements. In the event of a fire, they do not produce any smoke gases that are hazardous to health and are therefore very successful in public buildings such as kindergartens, schools, or hospitals. Their non-combustibility also allows them to be used in multi-story buildings up to 100 m high. It should be noted that, according to fire protection standard DIN 4102, ETICS must generally only be installed with insulation material of building material class A in buildings higher than 22 m above ground level. Furthermore, due to the non-combustibility of Multipor WAP mineral insulation boards, the fire barriers required for combustible insulation materials over 100 mm thick above window and door openings are no longer necessary. This eliminates the need for troublesome and error-prone material changes in the system, resulting in further cost savings.

Fig. 1: Mass-spring-mass system





Practical tip: To achieve building material classification in the A2 system, a mineral-based system is required: As an adhesive and reinforcing mortar, Multipor lightweight mineral mortar must always be used in combination with an appropriately approved finishing plaster, as adhesive mortars and finishing plasters with relatively high organic content (e.g., synthetic resin plasters) can worsen the fire protection classification.

Sound insulation

The sound insulation standard DIN 4109 regulates, among other things, the sound insulation requirements against external noise,
which depend on the use of the building and the relevant external noise level.
Composite thermal insulation systems always influence the sound insulation of exterior walls and must therefore be taken into account when verifying sound insulation.
Measurements show that Multipor mineral insulation boards WAP have no negative influence on the airborne sound insulation of the exterior wall.

Sound insulation model for composite thermal insulation systems

An exterior wall insulated with a composite thermal insulation system can be regarded as a so-called mass-spring-mass system (Fig. 1). The "hard" materials, i.e., the top coat and reinforcement plaster on one side and the wall building material on the other, represent the mass bodies. These are connected by the insulation material, which acts as an acoustically dynamic spring when sound is applied. At the resonance frequency, the solid wall – insulation material – exterior plaster system is particularly susceptible to vibrations. Sound transmission works better in this frequency range. Or, to put it another way: sound insulation is poorer in this frequency range.

The mass of the insulation material and its dynamic stiffness have a direct influence on sound insulation and, in particular, on the resonance frequency. Resonance frequencies in the audible range can result in the sound insulation of a wall being worse after insulation work than in its uninsulated state.

The resonance frequency is therefore the main factor in assessing the acoustic performance of an ETICS. The Multipor WAP composite thermal insulation system performs particularly well in this respect, as it has a higher dynamic stiffness than insulation systems made of mineral fiber or EPS and therefore achieves a higher resonance frequency. This means that sound insulation in the low-frequency range—i.e., precisely where there are high levels of road noise, especially in inner-city areas—is not negatively affected.

In addition, sound measurements carried out at several recognized institutes have shown that a Multipor WAP composite thermal insulation system does not impair the sound insulation value of an exterior wall, which is relevant for sound insulation certification (Table 7). Depending on the exterior wall

3.1 General introduction and planning

construction, an improvement of up to 2 dB is achieved, which means that it is one of the best insulation systems, especially in the low-frequency noise range (traffic noise).
the best insulation systems. Furthermore, numerous studies have found no deterioration in the rated sound insulation value.

wall construction	Sound insulation measure [R_w]	Change in sound insulation [R_w] compared to bare wall
Silka calcium silicate brick		
d = 17.5 cm		
Bulk density = 1,800 kg/m³	52 dB	
+ 6 cm Multipor ETICS	54 dB	(+2) dB
+ 20 cm Multipor ETICS	52 dB	(+/–0) dB
Ytong aerated concrete		
d = 24 cm		
Bulk density = 350 kg/m³	46 dB	
+ 20 cm Multipor ETICS	46 dB	(+/–0) dB

Sound insulation according to building authority approval

According to building authority Approval Z-33.43-596, which is decisive for the Multipor WAP composite thermal insulation system, the following equation applies to verify the sound insulation rating R_w of the wall construction:

R_w= $R_{w,o}$ + Δ R_w with

$R_{w,o}$ Rated sound insulation value of the solid wall without ETICS

Δ R_w Correction value as follows:

Δ R_w = 0 dB for load-bearing walls with a surface-related mass ≥ 300 kg/m², an insulation thickness of 60 mm, and a plaster system with a surface-related mass ≤ 10 kg/m²

Δ R_w = – 2 dB for all other construction variants

In accordance with general building approval Z-33.43-596, the correction values include a flat-rate safety factor of -2 dB specified by the DIBt, which was applied to the test values. However, according to the aforementioned tests, a Multipor WAP composite thermal insulation system does not lead to any deterioration in reality.

Spectrum adjustment values

Sound perception is a complex process and depends on many factors. The most important variables for characterizing sound signals are the audible frequencies between 20 and 20,000 Hz and the sound pressure. Thermal insulation composite systems must therefore demonstrate their sound insulation properties against external noise, with traffic noise almost always providing the dominant noise component. The main difference between traffic noise and interior noise pollution results from the different and frequency-dependent sound insulation measures that arise from the combination of load-bearing masonry and thermal insulation. The two different effects sometimes give residents the subjective impression that the sound insulation is inadequate, even if the legal sound insulation requirements are met.

In order to realistically record human noise perception, DIN EN ISO 717-1 introduced the so-called spectrum adaptation values in 1997. The adaptation value C stands for residential activity and the adaptation value C_{tr} for traffic noise.

	All tests Multipor thermal insulation composite system WAP [dB]	Other systems [dB]
$\Delta (R_w + C_{tr})$	approx. +1.2	–2.6

Source: other insulation systems: Technical System Information 7 – Sound Insulation – Fachverband Wärme-dämm-Verbundsysteme e. V., p. 35

The spectrum adjustment values can be calculated using the measured sound insulation values without the need for further separate measurements. The correction values are determined mathematically using the available measured values.

The correction value $\Delta (R_w + C_{tr,})$ is more suitable for evaluating the sound insulation of an exterior wall construction than the R_w value alone. The value describes the change in sound insulation of a wall insulated with an ETICS compared to a wall without insulation. It is therefore the sum of the differences in the sound insulation values of a wall in relation to the condition without and with ETICS.

$$\Delta_{Rw} = {}_{Rw,ETICS} - {}_{Rw,wall}$$
$$\Delta_{Ctr} = {}_{Ctr,ETICS} - {}_{Ctr,wall}$$
$$\Delta (R_w + C_{tr,}) = \Delta R_w + \Delta C_{tr}$$

This value can mean better or worse sound insulation in relation to traffic noise and is defined in accordance with DIN EN ISO 717-1 as corresponding to human hearing perception.

In addition to other advantages, the positive product properties of Multipor are evident here once again.

properties of Multipor are evident here once again. According to measurements taken in 2012, a Multipor WAP composite thermal insulation system causes no normative change in terms of the rated sound insulation index R_w. The average value of all sound insulation tests on walls with the Multipor WAP composite thermal insulation system results in an average improvement value of approx. 1.2 dB (Table 8).

This means that, on average, the Multipor WAP composite thermal insulation system offers a difference of approx. 4 dB compared to other systems. At a sound level of 20 dB, this means that the actual perceived traffic noise is almost halved. A sound level of 20 dB corresponds to a clearly audible noise (computer fan, rustling leaves, etc.). It is conceivable that even twice this level of noise can affect sleep patterns. When using a Multipor WAP composite thermal insulation system, even significant traffic noise such as stationary buses or heavy truck traffic is perceived as less disturbing compared to other systems. – are perceived as less disturbing which significantly improves the quality of living. At a sound level of 20 dB, a change of 5 dB is perceived as a doubling or halving of the noise perception.

Planning documents

The usability of ETICS is in general building authority approvals. The DIBt has approved the Multipor thermal insulation composite system WAP with the approval number Z-33.43-596 as a bonded and doweled system for general building use and lists the essential system components and their use as follows:

- Multipor lightweight mortar as system adhesive
- Multipor mineral insulation board WAP
- Multipor screw dowel with abZ
- Multipor lightweight mortar as reinforcement plaster
- Multipor reinforcement fabric
- Approved finishing plaster or Multipor lightweight mortar as finishing plaster

When using the non-combustible Multipor base insulation board, the following components are also required:

- Multipor base insulation board
- Multipor sealing slurry

The mineral insulation material enables ecologically optimized insulation on solid mineral substrates such as masonry and concrete – with or without plaster. Optimal combinations

3.1 General introduction and planning

Table 9: Minimum number of dowels Dowel/insulation board, depending on wind suction load according to DIN EN 1991-1-4

Dowel load class [kN/dowel]	Wind pressure w_e [kN/m]			
	≤ – 0.56	≤ – 0.77	≤ – 1.0	≤ – 1.6
≥ 0.20	1	1	2	2

are achieved in new buildings using Silka sand-lime brick or Ytong aerated concrete in combination with Multipor. Even uninsulated mineral substrates on old facades can be brought up to the latest energy standards with a Multipor WAP thermal insulation composite system. However, substrates made of wood, steel, or sheet metal substructures are unsuitable for this purpose. In the base area, base insulation boards must be used and installed in accordance with our processing guidelines. In addition, care must be taken to apply vertical waterproofing to the exterior wall in accordance with DIN 18533 before installing the base insulation.

Exterior walls are naturally exposed to large temperature fluctuations and various weather conditions.

. According to DIN 4108-3, the requirements for ETICS are based on the regional climate, driving rain exposure, and the type of building. A Multipor WAP composite thermal insulation system provides reliable, long-term protection for the building structure – after all, Multipor WAP mineral insulation boards are water-repellent and can be used safely in combination with suitable plaster structures when exposed to moisture (such as rain and periods of bad weather).

Mechanical fastening/dowels Multipor mineral insulation boards WAP are additionally fastened with Multipor screw dowels approved for construction purposes. Careful workmanship results in a high-quality and functional ETICS that is at least equal to painted plaster facades in terms of life expectancy.

. Depending on the region, location, and height of the building, different wind suction loads are applied, which are based on the requirements of DIN EN 1991-1-4. Wind forces exert tensile stress on both the Multipor mineral insulation board WAP and the adhesive bond. The forces that occur are safely transferred to the load-bearing substrate via the approved Multipor screw anchors.
According to the general building approval Z-33.43-596, at least one screw anchor approved by the building authorities is required for each insulation board (see Table 9).

For determining the number of dowels, see Chapter 3.4.

Further planning documents for the Multipor WAP composite thermal insulation system

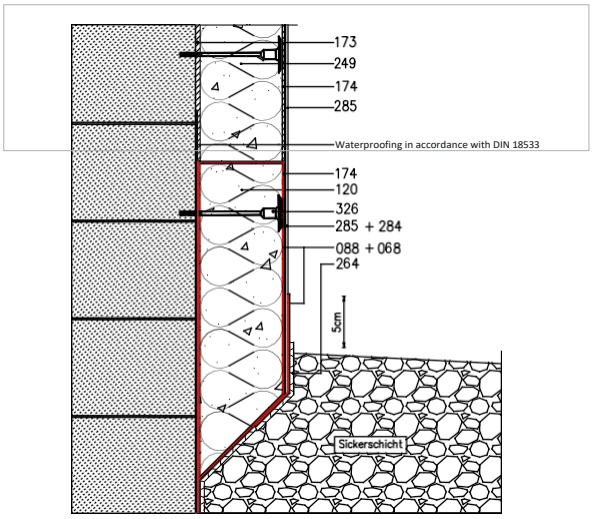
The following regulations must be applied in their currently valid versions as a minimum:

- General building authority approval Z-33.43-596 "Multipor composite thermal insulation system"
- Safety data sheets for system components
- DIN 4108-2: Thermal insulation and energy economy in buildings – Part 2: Minimum requirements for thermal insulation
- DIN 4108-3: Thermal insulation and energy economy in buildings – Part 3: Climate-related moisture protection; requirements, calculation methods, and information for planning and execution
- DIN 4108-4: Thermal insulation and energy economy in buildings – Part 4: Thermal and moisture protection design values
- DIN 4108-10: Thermal insulation and energy economy in buildings – Part 10: Application-related requirements for thermal insulation materials – Factory-made thermal insulation materials
- DIN 18195: Waterproofing of buildings – Terms
- DIN 18533: Waterproofing of building components in contact with the ground
- DIN EN 13914-1 and DIN 18550-1 – Plaster and plaster systems
- DIN EN ISO 6946: Building components – Thermal resistance and thermal transmittance – Calculation methods
- DIN EN 15026: Thermal and moisture behavior of building components and elements – Evaluation of moisture transfer by numerical simulation
- DIN 55699: Installation of composite thermal insulation systems
- DIN 18345: VOB German Construction Contract Procedures – Part C: General Technical Contract Conditions for Construction Work (ATV) – Composite thermal insulation systems
- DIN 18202: Tolerances in building construction – Structures
- Energy Saving Ordinance EnEV in its current version (EnEV 2014 dated May 1, 2014)
- Professional Association of Plasterers for Interior Finishing and Facades – Guideline: Connections to windows and roller shutters for plaster, composite thermal insulation systems, and drywall construction
- Federal Committee for Paint and Property Protection: Information sheet no. 21 – Technical guidelines for the planning and processing of composite thermal insulation systems

3.2 Construction examples of WAP composite thermal insulation systems

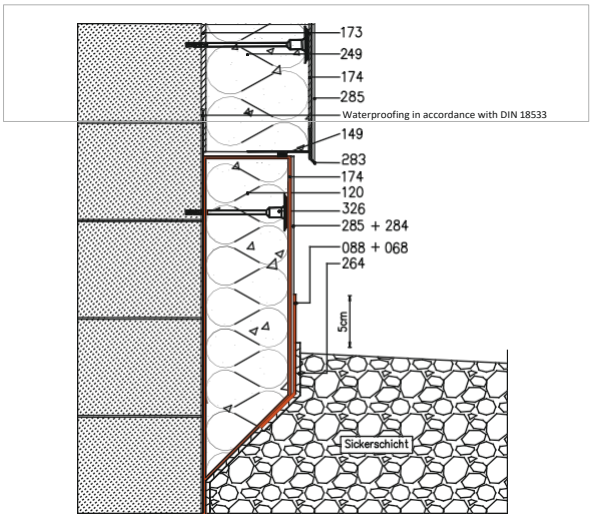
Construction examples of the Multipor WAP composite thermal insulation system

Base insulation, ETICS flush with base



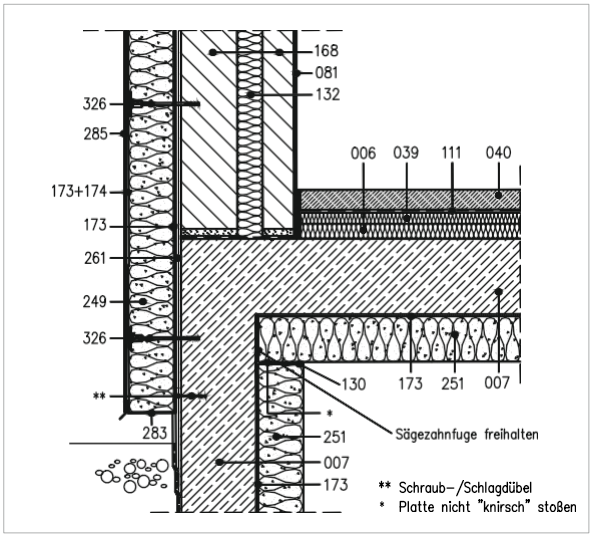
WAP composite thermal insulation system 19-05

Base insulation with protruding ETICS



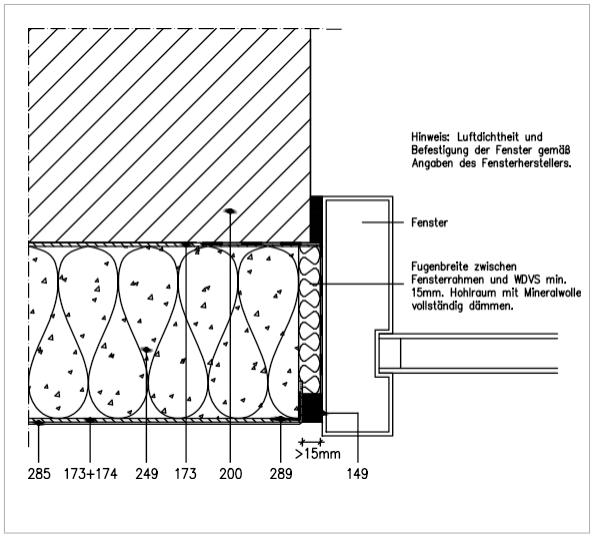
WAP composite thermal insulation system 19-052

Base insulation during renovation with baseboard



WAP composite thermal insulation system 19-04

Connection for flush-mounted or front-mounted windows



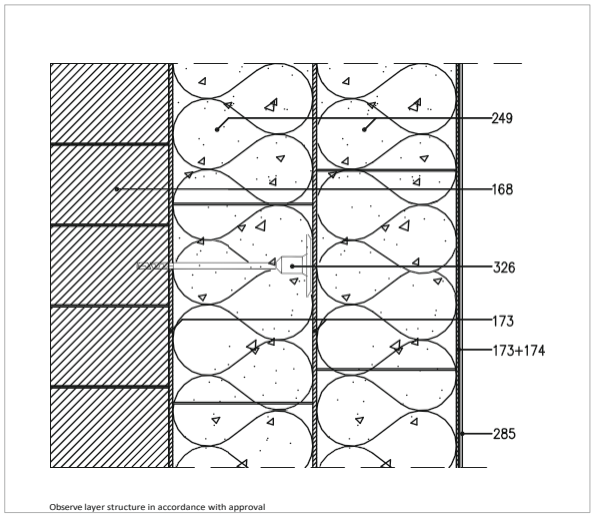
WAP composite thermal insulation system 19-05

001	Ytong masonry	08	Multipor sealing slurry	174	Multipor reinforcement mesh		
006	Thermal insulation	111	Separation or protective layer	200	Ytong/Silka masonry		
007	Reinforced concrete ceiling	12	Multipor base insulation panel	249	Multipor mineral insulation board WAP		
039	Impact sound insulation	14	Movement-absorbing	251	Multipor ceiling insulation DI	284	Base coat
04	Floating screed		Plaster profile	261	Existing old plaster	28	System-compliant finishing plaster
06	Base coat plaster	168	Existing masonry	26	Dimpled membrane	289	Fabric angle bracket
081	Interior plaster	173	Multipor lightweight mortar	283	Base trim profile with drip edge	326	Multipor screw anchor

These and other design examples can be found at www.multipor.de/konstruktionsbeispiele

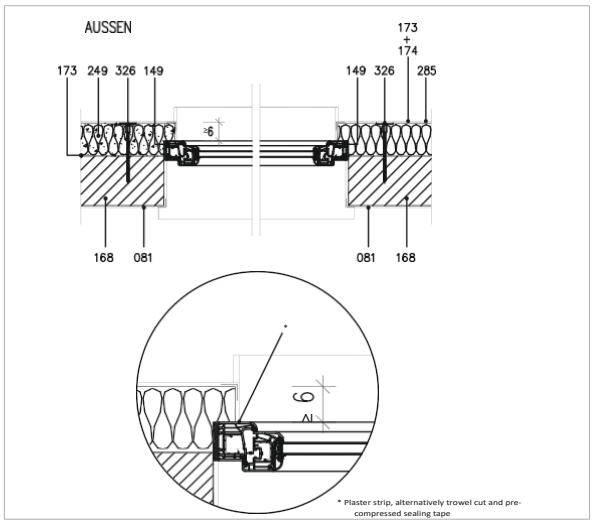
Construction examples Multipor composite thermal insulation system WAP

System structure, 2-layer Bonding up to 300 mm



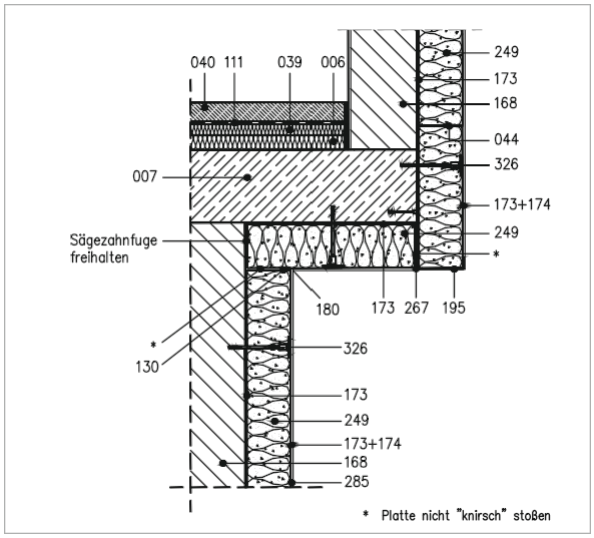
WAP composite thermal insulation system 19-003

Horizontal section Window



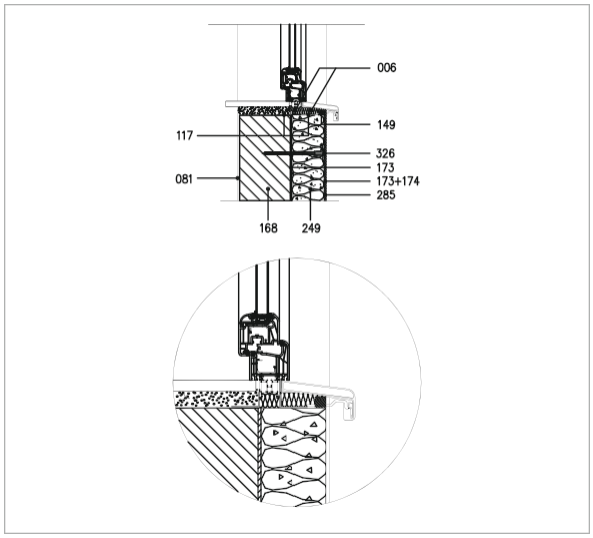
WAP composite thermal insulation system 19-020

Recess with end profile



WAP composite thermal insulation system 19-03

Vertical section Window with parapet



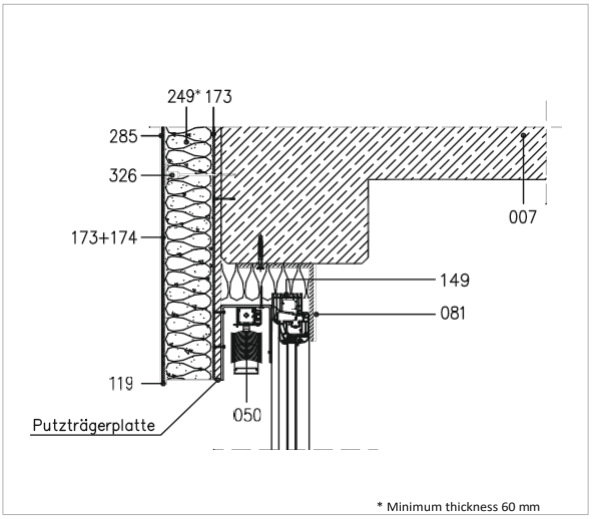
Note: Window sill support bracket
WAP composite thermal insulation system 19-021

006	Thermal insulation	117	Elastic sealing tape		
007	Reinforced concrete ceiling	130	Elastic jointing		
039	Impact sound insulation	149	Movement-absorbing plastering profile	195	End profile
040	Floating screed	168	Existing masonry	24	Multipor mineral insulation board WAP
04	Open butt joint	17	Multipor lightweight mortar	267	Expansion joint profile (with joint sealing tape)
081	Interior plaster	174	Multipor reinforcement mesh	285	System-compliant finishing plaster
111	Separation or protective layer	180	Trowel cut	326	Multipor screw anchor

3.2 Construction examples Thermal insulation composite system WAP

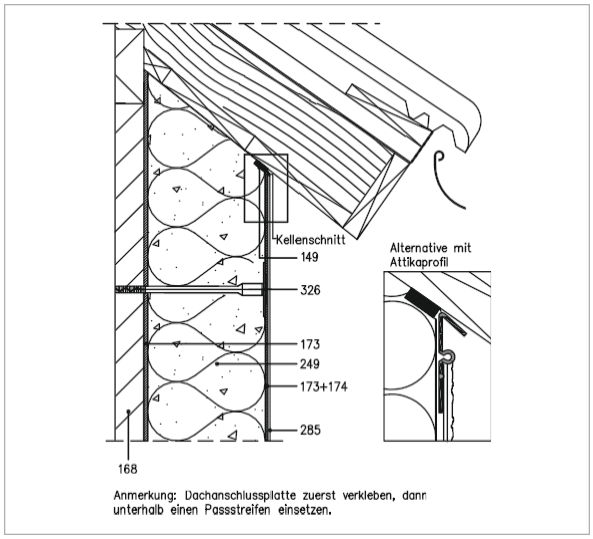
Construction examples Multipor composite thermal insulation system WAP

Finish for external blinds with plaster base plate I



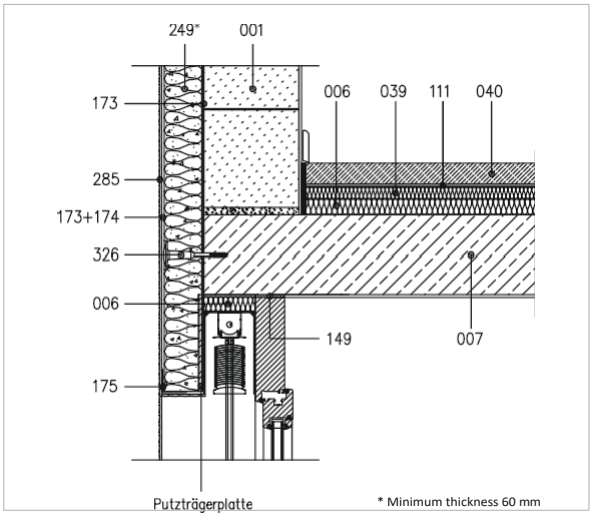
WAP composite thermal insulation system 19-043

Connection of eaves with roof overhang



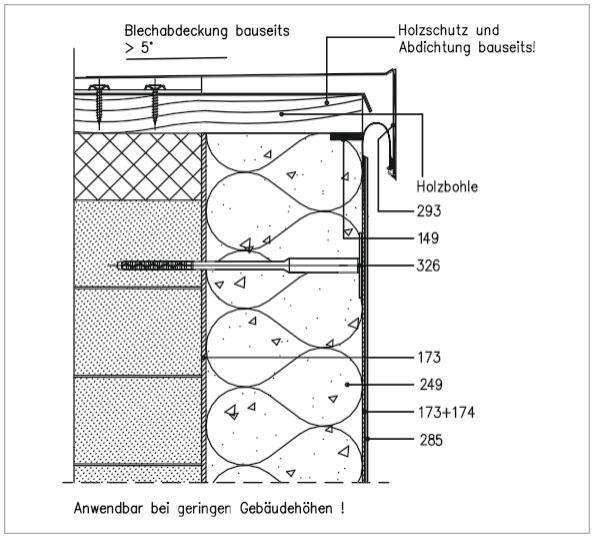
WAP composite thermal insulation system 19-02

Exterior blind connection with plaster base board II



WAP composite thermal insulation system 19-044

Parapet with small sheet metal cover for low building heights

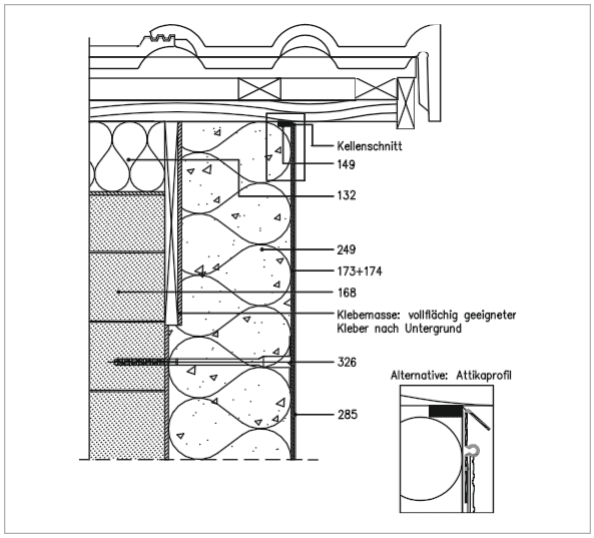


WAP composite thermal insulation system 19-03

001	Ytong masonry	0	Interior plaster	174	Multipor reinforcement mesh
006	Thermal insulation	111	Separating or protective layer	175	Corner protection rail
007	Reinforced concrete ceiling	119	Plaster finishing profile	249	Multipor mineral insulation board WAP
039	Impact sound insulation	14	Pre-compressed sealing tape	28	System-compliant finishing plaster
04	Floating screed	168	Existing masonry	29	Attic profile
05	Blinds	173	Multipor lightweight mortar	326	Multipor screw anchor

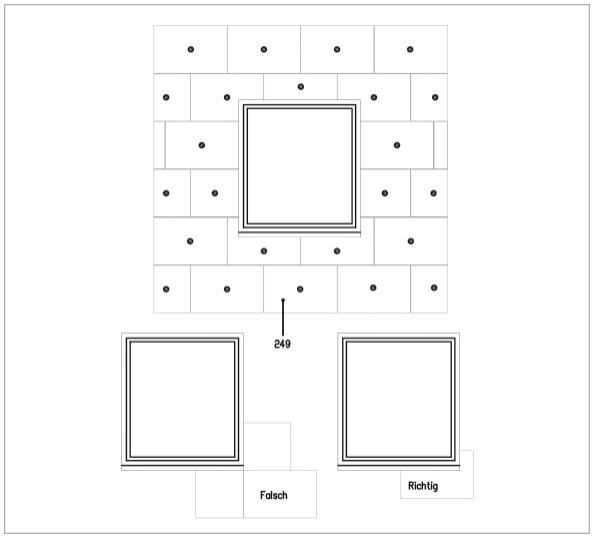
Construction examples Multipor composite thermal insulation system WAP

Gable connection



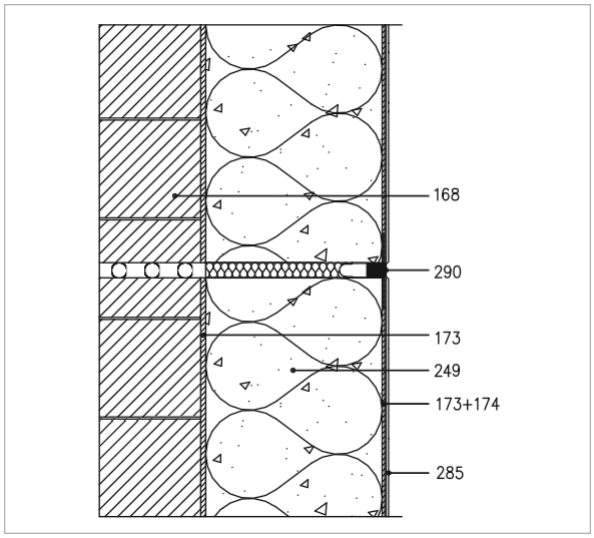
WAP composite thermal insulation system 19-028

Panel arrangement for facade openings
Including system dowels



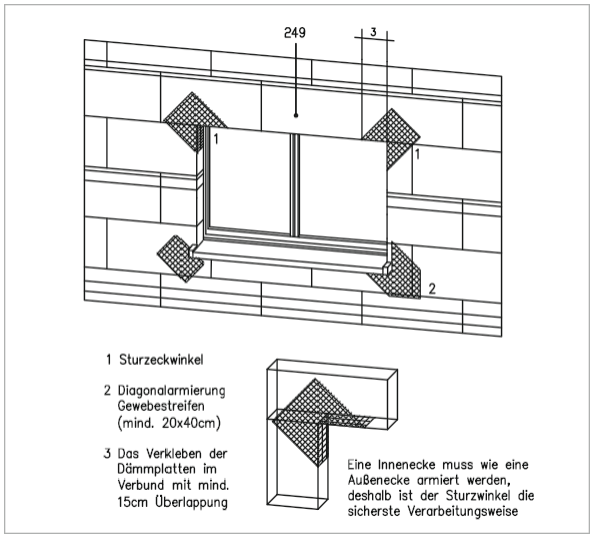
WAP composite thermal insulation system 19-004

Movement joint with expansion profile



WAP composite thermal insulation system 19-015

Facade opening Diagonal reinforcement



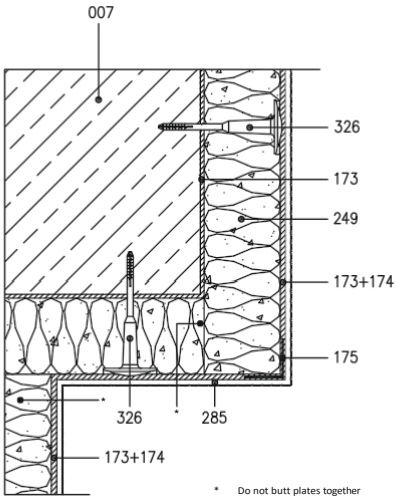
WAP composite thermal insulation system 19-004a

132 Mineral fiber board
149 Pre-compressed sealing tape
168 Existing masonry
173 Multipor lightweight mortar
174 Multipor reinforcement mesh
249 Multipor mineral insulation board WAP
285 System-compliant finishing plaster
290 Expansion joint profile with sealing tape
326 Multipor screw dowel

%0.2 Construction examples for WAP composite thermal insulation system

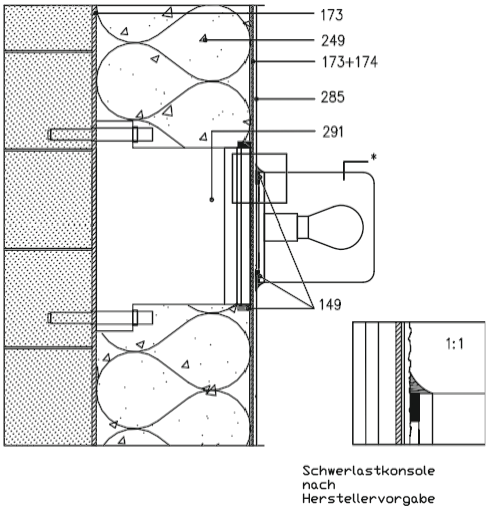
Construction examples Multipor composite thermal insulation system WAP

Transition to cantilevered component



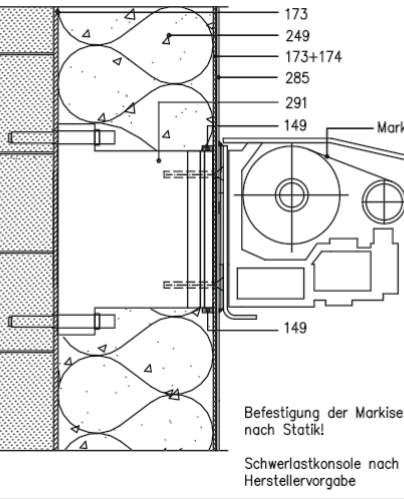
WAP composite thermal insulation system 19-036

Fastening of light loads (variant)



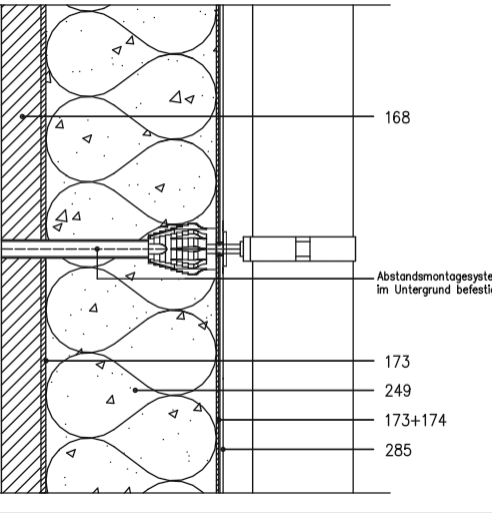
WAP composite thermal insulation system 19-01

Awning attachment



WAP composite thermal insulation system 19-016

Fastening rainwater downpipe (variant)



WAP composite thermal insulation system 19-019

007 Reinforced concrete ceiling
149 Elastic sealing tape
168 Existing masonry
173 Multipor lightweight mortar
174 Multipor reinforcement mesh
175 Corner protection rail
249 Multipor mineral insulation board WAP
285 System-compliant mineral Top coat
291 Heavy-duty bracket
326 Multipor screw anchor

These and other design examples can be found at www.multipor.de/konstruktionsbeispiele

Transitions, connections, and finishes on composite thermal insulation systems WAP 3.3

The quality and durability of a composite thermal insulation system depend on the materials used, correct workmanship, and good planning and implementation of transitions, connections, and terminations.

All connections and finishes must be designed in such a way that adjacent components can absorb temperature and/or moisture-related changes in shape without damage. The structural requirements placed on an ETICS, such as thermal, fire, and moisture protection, as well as airtight and windproof connections for doors and windows, for example, must be met and permanently maintained.

Particular attention must be paid to the careful planning and execution of connections, especially when renovating existing buildings to improve their energy efficiency. In particular, the condition of components to be connected, such as rafters, must be recorded and taken into account in the planning. All components to be connected, including windows, doors, and rafters, must be installed before the insulation work begins, provided they are being replaced as part of the energy-efficient renovation. Existing movement and expansion joints should generally be retained and not insulated over. To assist with planning, Multipor offers design examples that planners can use as a basis for developing project-specific details. These can be found in the download area at www.multipor.de.

The following connections must generally be taken into account for almost all properties:

- Roof
- Exterior wall connections
- Balcony and/or terrace
- Windows and doors, including window sills
- Roller shutter and external blind boxes
- Base For construction examples, see section 3.2.

Note: The commonly used standard profiles are included in our current price list as part of the system and are available for delivery.

Brief description of transitions and connections Terminations must be made at all ends of an ETICS. These terminations can also occur within the facade area or on building corners.

- The example of an eaves connection illustrates how important it is to plan the details carefully before starting work. Connections to eaves must be made to be rainproof, but at the same time they can include roof ventilation. Such a connection can be created by combining a suitable roof ventilation profile with a pre-compressed joint sealing tape.
- A combination of a base strip and joint sealing tape can be used not only in the base area but also as a connection to dormers or pent roofs, whereby a base rail can also serve as a side closure. Similarly, care must be taken to ensure a connection to a parapet is impervious to driving rain.
- In the area of wall surfaces, transition connections to a post-and-beam or rear-ventilated facade are sometimes necessary. For connections to the entrance path as well as to the terrace and/or balcony, a splash- and rainwater-tight transition must be created.

%0.3 Transitions, connections, and terminations to composite thermal insulation systems WAP



Multipor plaster strip W32-plus



Multipor plaster strip W36-plus, alternatively W38-pro



Multipor plaster strip W31

Applications

The following pages describe some common applications for transitions, connections, and terminations in the Multipor WAP composite thermal insulation system.

Window connection

The connection to a window frame can be formed in the traditional way using a combination of Multipor joint sealing tape and a trowel cut. From a processing point of view, the use of Multipor plastering strips [1 – 3] has proven successful. These have the advantage that, on the one hand, they provide a seal to the frame (e.g., by means of integrated joint sealing tape or PE tape for bonding) and, on the other hand, they can be easily incorporated into the undercoat plaster thanks to the welded fabric strip. The profiles also have adhesive strips for a protective film, which protects the windows from dirt during the execution phase. This creates a decoupled and driving rain-proof solution between the Multipor WAP composite thermal insulation system and the window frame.

For large window and door openings, as well as for connections that have to absorb greater compensatory movements, we recommend the use of plaster strips that are connected to the respective frame with an integrated joint sealing tape (Tab. 1) [2]. These profiles are not glued to the frames; instead, the sealing level is ensured by the joint sealing tape. The profiles are fixed in the insulation layer with plastic nails and embedded in the plaster with the connected fabric strip.

For the execution, it is important that both the insulation and the strip connect well and that the fabric strip is embedded in the reinforcement layer with sufficient overlap (≥ 10 cm).

To avoid thermal bridges, the window frames within the reveal must be insulated with reveal insulation boards. For flush-mounted or front-mounted windows, the Multipor WAP thermal insulation composite system must be extended to the frame.

Alternatively, a solution with joint sealing tape and the formation of a shadow joint is possible.

Window sill connection

As with all connections, the utmost care must be taken when connecting a window sill. For aluminum window sills, the bottom and side connections are always made with Multipor joint sealing tapes or suitable connection profiles [4][5]. For noise

Table 1: Window connection profiles up to 10 m² Window size and 300 mm insulation thickness

Connection profiles	Window in masonry	Window flush with masonry	Window in front of masonry
W32-plus	up to 160 mm	up to 160 mm	–
W36-plus	up to 300 mm	up to 300 mm	up to 300 mm
W38-pro	up to 300 mm	up to 300 mm	up to 300 mm



Attaching the bottom sealing tape



Edge profile with joint sealing tape

For insulation purposes, the underside of the window sill must be fitted with a so-called anti-drumming strip. A rubber lip seal must be attached to the rear of the vertical screw-on bar before the bar is screwed to the lower frame.

Aluminum window sills longer than 3 m must be fitted with waterproof butt connectors so that temperature-related changes in the length of the window sills can be absorbed without damage.

To ensure a secure lateral connection, use edge profiles [5] that are factory-fitted or can be attached on site. We recommend installing sliding pieces that can absorb movement and are waterproof. These must also be fitted with Multipor joint sealing tape on the sides and above for connection to the Multipor WAP composite thermal insulation system.

Ensure that there is sufficient lateral plaster clearance to the edge profiles. This allows for unrestricted movement absorption.

between the edge profile and the window sill. Cavities under the window sills must be avoided and filled with insulating material. This prevents condensation from forming under the metal window sill due to convection.

Sealing level In principle, installed window sills form the first sealing level against driving rain and moisture ingress into the insulation system. It is important that the connections between the window sill, edge profiles, and ETICS are permanently impervious to driving rain. Furthermore, they must be able to drain surface water in a controlled manner.

If a permanent seal cannot be guaranteed via the first sealing layer (window sill), a second sealing layer must be installed below the window sill. This second sealing layer, which is designed in a trough shape (under the window sill and on the reveals), can be created using Multipor sealing slurry. Proceed as follows.

The Multipor insulation boards, which serve as a support for the window sill, are cut to the required height and angle (≥ 5°). The W43 end profile is then installed on the front edge of the insulation board. The profile is installed so that the transparent drip edge faces forward. The horizontal fabric strip welded to the plastic profile, which is located on the sloped horizontal surface under the window sill, is embedded over its entire surface into the sealing slurry. The fabric must not be visible or show through at any point. The sealing slurry must be applied in the reveals up to the height of the edge profile (approx. 5 cm high). This creates a trough-shaped seal under the window sill. The fabric strip, which is located vertically on the front of the insulation layer, is embedded using Multipor lightweight mortar.

Optionally, the joint between the window sill and the frame and reveals can be sealed with a sealing tape in case of heavy driving rain.

Further information on the installation of metal window sills in ETICS can be found in the information sheet "Recommendations for the installation/replacement of metal window sills (ETICS facade)" from the Gütegemeinschaft Wärmedämmung von Fassaden e. V. (Quality Association for Thermal Insulation of Facades).

3.3 Transitions, connections, and finishes on composite thermal insulation systems WAP

Natural stone window sills
The insulation seal under a natural stone window sill must be neatly finished with a fabric corner bracket before installing the window sill. Furthermore, a joint sealing tape or flexible sealant should be applied to the front edge.

Natural stone window sills do not usually have edge profiles, so the joints required for the reveal and window frame must be connected with a suitable sealing material that is permanently elastic. Alternatively, and to avoid maintenance joints, suitable profiles, e.g., W32-plus, can also be used. Furthermore, there should be a transverse groove on the left and right for targeted water drainage.

Roller shutter and external blind boxes For roller shutter and external blind boxes that are to be integrated into the Multipor WAP thermal insulation composite system for thermal reasons, connections to the boxes and guide rails must be formed [6]. Just like windows, these boxes can be recessed, flush with the plaster, or protruding from the outer wall surface.

For recessed and flush-mounted roller shutter boxes, the Multipor WAP composite thermal insulation system must be applied over the box with a minimum thickness of 60 mm. The use of plaster base boards may be advisable and necessary in this case.

6



available for connection to the guide rails. Front-mounted roller shutters require a special connection.
When insulating the reveal, special care must be taken at the transition to the interior to prevent unnecessary heat loss and the risk of condensation and mold formation.
In addition to functionality, requirements regarding visual appearance must also be taken into account for all connections. However, galvanized or aluminum plaster and corner protection rails from the interior plastering sector are not suitable for use in composite thermal insulation systems.

Base design
In principle, various base designs are possible. Classic base insulation without ground contact can be chosen, as is often found in the renovation of old apartment buildings.

The lower base connection can be formed with a base profile [7]. An L-shaped

7



Inserting the WAP mineral insulation board

9



Base profile with drip edge

10



Base design with Multipor base insulation panels


11

Fabric corner bracket

Plastic profile with the shorter, vertical leg doweled to the existing wall. Depending on the planned insulation thickness, the profile can be extended with suitable additional elements.

The front edge is then formed by a clip-on profile [8], which has a drip edge and is embedded in the plaster with the welded mesh [9].

Alternatively, the base connection can be formed by using two Multipor fabric corner angles. A fabric corner profile with an integrated drip edge must be used for the front end.

Once the base height has been determined, the Multipor base plaster strips must be connected to the existing wall at the correct height. Strip connectors prevent possible cracking at the joints.
The lower base area is the area with the highest splash water exposure. The part in contact with the ground can also be exposed to high mechanical and hygric loads. The splash water area must extend at least 30 cm above the


12

side plaster finish

planned ground level. A vertical waterproofing of the substrate wall in accordance with DIN 18533
is an essential prerequisite. To minimize the thermal bridge effect, the base insulation must extend to 50 cm below the lower edge of the basement ceiling
.
Alternatively, the insulation can be installed with or without offset up to the actual facade insulation up to approx. 20 cm below the ground level using the mineral Multipor base insulation board [10].

Building and reveal corners For building and reveal corners, the use of Multipor fabric corner profiles with welded fabric has proven successful. The fabric pieces must be integrated into the surface reinforcement of the Multipor WAP composite thermal insulation system with sufficient overlap [11].

Plaster finish and decorative profiles
Plaster finish profiles can be used in particular to create different plaster surfaces or color transitions.


13

Movement joint profile

[12]. Some of these also have welded mesh pieces and can be integrated into the reinforcement layer with sufficient overlap. The profile then has the layer thickness of the top coat of plaster and ensures for a visually high-quality plaster finish.

Movement and expansion joints
Movement and expansion joints existing in the existing structure must be incorporated into the insulation layer. Movement and expansion joints must not be insulated under any circumstances. Otherwise, there is a risk of uncontrolled cracks forming and further consequential damage occurring.
Various profiles are available [13]. The choice of profile is determined by the degree of movement of the joint, its horizontal or vertical position, and the possible type of movement relative to each other – e.g., transverse or parallel. To prevent moisture damage, it is recommended that a suitable joint sealing tape be installed first in horizontal joints and then the selected movement joint profile be incorporated.

3.3 Transitions, connections, and terminations on composite thermal insulation systems WAP

14



Water tap (penetration)

15



Aestuver joint tape

16



Joint sealant with fire protection properties

Note: The commonly used standard profiles are included in our current price list as part of the system and are available for delivery.

Penetrations – as many as necessary, as few as possible Penetrations should only be made where they are unavoidable. Possible examples include brackets for parapets, water taps, railings, awnings, and canopies [14]. The connection to penetrations must also be permanent and impervious to driving rain. Therefore, all penetrations should be installed on the facade before the insulation work is carried out. The Multipor WAP composite thermal insulation system is connected to the penetrations using Multipor joint sealing tapes and a trowel cut. Suitable heat-insulating mounting elements can prevent penetrations, thereby reducing the number of thermal bridges. Multipor spiral dowels can be used for light loads (see section 3.8 on fastening loads with Multipor composite thermal insulation systems WAP).

Larger lamps or pipe clamps for rainwater downpipes can be fastened using mounting cylinders or blocks integrated into the insulation layer. They also serve as a pressure base to absorb compressive forces.
This prevents cracks in the plaster coating caused by the load of the mounted objects. Scaffold anchor penetrations that are unavoidable for safety reasons can be sealed with scaffold anchor closures that are driving rain-proof, free of thermal bridges, and visually inconspicuous.

Detailed fire protection solutions
Fire protection aspects may also play a role in the connections described above. The requirements are regulated in the state building codes. Since Multipor insulation materials meet the requirements for building material class A1 according to DIN EN 13501 and
the system with approved surface plaster variants, almost all fire protection details can be implemented with Multipor. Compared to combustible insulation materials, Multipor allows for solutions without fire barriers and material changes throughout the entire system structure, which offers particular financial and practical construction advantages.

Special joint sealing tapes or permanently elastic fire protection compounds are available from Fermacell Aestuver for movement joints with fire protection requirements [15] [16]. More information on Fermacell Aestuver products can be found on the Internet at www.aestuver.de.

Note: For all transitions, connections, and terminations described above, the specifications and guidelines of the accessory product manufacturers must be observed in addition to the processing guidelines (Chapter 3.7).

Mechanical fastening of WAP composite thermal insulation system 3.4

Wind load determination and dowel dimensioning

The Multipor WAP composite thermal insulation system is a bonded and doweled system and is regulated by building authorities in accordance with DIBt approval Z-33.43-596. The Multipor mineral insulation boards WAP attached to the facade are subjected to various types of stress during processing and the subsequent use phase. Both the dead loads of the system and the hygrothermal effects are absorbed by the adhesive strength of the Multipor lightweight mortar. In most cases, the greatest forces are wind loads. It is easy to imagine that wind blowing against the facade exerts pressure forces on it. All system components of the Multipor composite thermal insulation system WAP can absorb these loads well and transfer them to the facade. At the same time, wind suction loads can occur in the corner areas of buildings suction loads can occur in the corners of buildings, which are greater in amount than the wind pressure forces. Dowels are used to safely absorb and transfer these loads, which are arranged accordingly to transfer the wind suction loads into the load-bearing substrate.

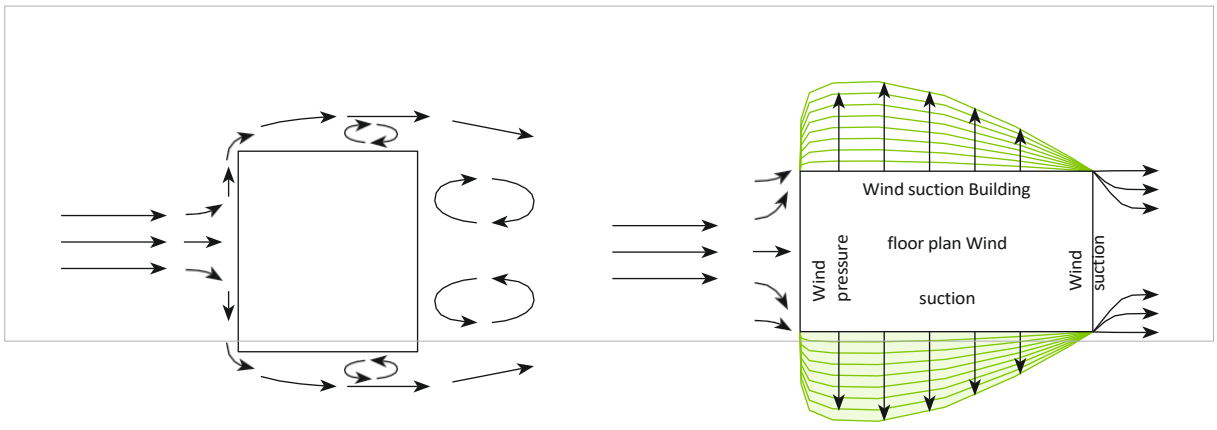
Explanation of wind suction

From a technical point of view, wind suction on surfaces represents a force generated by wind flow on the surfaces. This is also known as the Bernoulli effect. David Bernoulli discovered the relationship between flow cross-section, velocity, and pressure. The effect can be seen on a bridge pier in a river.
Reducing the cross-sectional area of the river increases the flow velocity of the water. speed of the water increases. This effect also occurs in buildings that are exposed to wind (Fig. 1).

When the wind flows onto a facade, it accumulates and exerts pressure on the facade. This is known as dynamic pressure. However, the wind does not remain on the facade
"hang" on the facade, but flows along the facade and over the roof. This creates air vortices at the edges of the building. The passing wind carries gas particles from the air at the surface with it. This creates negative pressure perpendicular to the surfaces around which the wind flows.

The higher the wind speed and the smaller the vortex, the greater the negative pressure. The corner and vortex areas to be taken into account in calculations are shown in Germany in

Fig. 1: Wind suction on the building envelope



3.4 Mechanical fastening Composite thermal insulation system WAP

Fig. 2: Wind zone map (according to DIN 1991-1-4 NA)



This is regulated by D Sea coast is wake vortices also ca r wind loads the rear side of the building wall exposed to han gle-family home in Frankfurt the wind. am Main, for example.

Especially in coastal areas, wind suction can generate great forces on flat roofs and facades.

According to DIN EN 1991-1-4, the wind load depends on the building geometry, the wind zone (Fig. 2), and the surrounding topography.

The composite thermal insulation system absorbs the stresses caused by wind loads by bonding it to the wall surface with lightweight mortar and doweling it into the load-bearing substrate. The wind-induced

Wind suction forces are always greatest at the edges of buildings. For the purpose of measuring wind loads, these are always considered as static surface loads for the sake of simplicity.

Dowel fastening

The dowels, which always require general building approval when used in a composite thermal insulation system, absorb the attacking wind suction forces. The wind suction forces usually represent the greatest loads on the dowels and are therefore used as the basis for design, even if other loads may also be absorbed by the dowels.

The length and type of dowel depends, among other things, on the substrate, e.g., concrete, solid brick, perforated brick, or aerated concrete, as well as the thickness of the insulation material.

Determination of wind suction forces

The wind load acting on the facade is determined in accordance with DIN EN 1991-1-4, including the associated national application document DIN EN 1991-1-4/NAD.

The entire Federal Republic of Germany is divided into 4 wind zones with different wind speeds $v_{b,0}$ (v_{ref}) and wind speed pressures $q_{b,0}$ (Table 1). As the wind zone map (Fig. 2) shows, zones 1 and 2 cover most of the Federal Republic in terms of area. The wind load applicable to a building is

Table 1: Basic wind speeds v (v) and corresponding speeds

Wind zone	$v_{b,0}$ (v_{ref})	$q_{b,0}$
1	22.5 m/s	0.32 kN/m²
2	25.0 m/s	0.39 kN/m²
3	27.5 m/s	0.47 kN/m²
4	30.0 m/s	0.56 kN/m²

Either taken from the wind zone map or an online table from the German Institute for Building Technology.

All facades of a building must be analyzed using the geometric dimensions of length, width, and height. A maximum of four different wind suction areas (A, B, C, E) are distinguished. Area D refers to the side exposed to the wind, on which the wind generates pressure forces (see Fig. 3). The length of the wind suction areas must be determined from the geometric boundary conditions and the rules of DIN EN 1991-1-4.

The strongest wind suction forces occur in area A, decreasing significantly in the direction of the wind (areas B and C) (see Figs. 1 and 3). Area E occurs on the rear side of the building exposed to the wind and corresponds in magnitude to area C. The side exposed to the wind is defined as area D. The compressive stress generated by the wind has a positive sign. The wind suction of wind zone areas A, B, C
and E has a negative sign. Since the wind can blow from any direction, area A can also occur equally at all corners of the building. Therefore, it is necessary for the design to apply the four possible wind directions to the building mathematically in the case of a rectangular floor plan and to superimpose the results from all calculations on each wall.

The determination of the relevant wind load – and thus also the calculation of the number of dowels to be installed – can be carried out in three ways, whereby a distinction is made between the simplified, the practical, and the mathematical methods.

Simplified method

In the simplified method, the velocity pressure for buildings up to a height of 25 m may be assumed to be constant over the entire height of the building in accordance with the standard. The highest height is decisive.

The corresponding decisive velocity pressures for the wind suction areas are listed in Table 2.

Practical method

An even easier method to use is the practical method. As with the simplified method
methods, only for:

- Buildings up to a height of 25 m
- Exclusively for rectangular buildings
- Height-to-width ratio h/d < 2

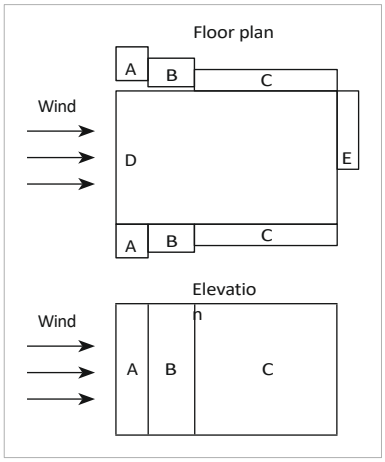
The method can only be used up to wind zone 3. The classification of suction areas according to Figure 3 does not apply to this method.

Only the required number of dowels for the area with the greatest wind suction forces (wind suction area A) is determined. The dowel quantities determined in this way are installed uniformly on all wall surfaces.

Calculation method

The calculation method must always be used for buildings over 25 m high. However, it can also be used for any other building.

Fig. 3: Wind suction areas



3.4 Mechanical fastening Composite thermal insulation system WAP

Table 2: Excerpt from DIN EN 1991-1-4

Wind zone		Velocity pressure q_p in kN/m² for a building height h within the limits of		
		h ≤ 10 m	10 m < h ≤ 18 m	18 m < h ≤ 25 m
1	Inland	0.50	0.65	0.75
2	Domestic	0.65	0.80	0.9
	Coast and islands in the Baltic Sea	0.85	1.0	1.1
3	Inland	0.80	0.95	1.10
	Coast and islands in the Baltic Sea	1.05	1.2	1.30
4	Inland	0.95	1.15	1.30
	North Sea and Baltic Sea coast and islands in the Baltic Sea	1.25	1.40	1.55
	Islands in the North Sea	1.40	–	–

Table 3: Aerodynamic coefficients $c_{pe,1}$ for vertical walls of rectangular buildings

Range	A	B	C	E
h/d	$c_{pe,1}$			
≥ 5	−1.7	−1.1	−0.7	−0.7
1	−1.4	−1.1	−0.5	−0.5
≤ 0.25	−1.4	−1.1	−0.5	−0.5

Intermediate values may be interpolated.
Explanation h/d: h is the height of the building, d is the smaller value of the length and width of the building.

For all buildings that cannot be assigned to the simplified or practical method, a detailed wind load calculation must be carried out in accordance with DIN EN 1991-1-4, taking into account the National Application Document (NAD) (the highest height is decisive).

Depending on the building geometry, the velocity pressures and aerodynamic coefficients must be determined for all facade surfaces differentiated by height. It is recommended and common practice to perform this wind suction calculation using suitable software in order to determine the wind suction load specific to the building. The method also works for buildings that allow for design according to the simplified method.
Particularly for building heights just above 10 or 18 m, this can result in savings in dowels and thus also in costs compared to the simplified method.

Design wind load

To determine the relevant wind force loads, you need the wind zone, the corresponding base velocity pressure $q_{b,0}$, the height-dependent relevant velocity pressure $q_p(z)$, and the aerodynamic coefficients c_{pe} (Table 1). These are also referred to as external pressure coefficients. The aerodynamic coefficients have a negative sign and can be found in Table 3. A negative external pressure coefficient means that wind suction occurs at the location under investigation.

The relevant (peak) velocity pressure $q_p(z)$ depends on the height of the building and is determined in accordance with DIN 1991-1-4, NA.B3.3.

For building heights ≤ 7 m, the following applies: $q_p(z) = 1.5 \cdot q_b$

The product of the decisive velocity pressure $q_p(z)$ and the aerodynamic coefficients gives the decisive wind loads w_e($w_e = q_p(z) \cdot c_{pe)}$ for the respective suction areas.

Comparison of wind suction loads according to the calculated and simplified methods (Table 4)

Determination of the effective wind suction load using the mathematical method: Small building, h = 7 m, h/d = 2, wind zone 1

Design wind pressure q_b (z), depending on height, according to DIN EN 1991-1-4, NA.B.1: q_p (z) = 1.5 · $q_{b,0}$ = 1.5 · 0.32 kN/m² = 0.48 kN/m²

Note: The value is smaller than the value in Table 2 (0.50 kN/m²). This can be explained by the fact that the table is to be used for the simplified method and includes safety factors.

Table 4: Comparison of the mathematical and simplified methods

Area	Calculated wind suction	Simplified method
A	$w_{e,A} = q_p$ (z) · $c_{pe,1A}$ = 0.48 kN/m² · −1.475[1)] = −0.71 kN/m²	0.50 · −1.475 = −0.74 kN/m²
B	$w_{e,B} = q_p$ (z) · $c_{pe,1B}$ = 0.48 kN/m² · −1.1 = −0.53 kN/m²	0.50 · −1.1 = −0.55 kN/m²
C (and E)	$w_{e,C} = q_p(z) \cdot c_{pe,1C}$ = 0.48 kN/m² · −0.55[(1)]) = −0.26 kN/m²	0.50 · −0.55 = −0.28 kN/m²

(1)) Numerical values interpolated

The values calculated in this way can be used to determine the required number of anchors. The comparative values printed for comparison purposes are taken from the simplified method. They can be read from Table 2 without calculating the height-dependent velocity pressure and then simply multiplied by the aerodynamic coefficients.

The wind suction loads determined in this way can then be used to determine the required quantities of dowels with the aid of Table 7.

The differences between the two methods are illustrated by the following examples.

Examples of simplified and mathematical methods

1. Example for determining wind suction loads

Initial conditions:
Small rectangular residential building, simplified method Wind load zone 1
Dimensions: b = 10 m, l = 14 m, h = 10 m

Calculated effect of wind loads:
Figures 4 and 5 show the forces to be taken into account for wind in accordance with the standard. Figure 4 shows that wind suction and wind pressure are considered to be constant over the height.

%0.4 Mechanical fastening of composite thermal insulation system WAP

Within one-fifth of the longer side of the building exposed to the wind or the height (whichever is smaller), the greatest wind suction load occurs at the corners (edge area).

Since the wind can come from all directions, these wind suction loads can also occur at all corner areas at height. The other wall areas
of the walls arranged parallel to the wind direction are also subject to a corresponding wind suction load.

This example shows that, taking into account the two wind directions relevant for area A, 40% of the wall area must be considered as corner area for the gable wall.

In the case of low wind loads and building heights, and in order to avoid execution errors, it is therefore advisable to use dowels for these

Fig. 4: Wind suction zones, gable and side view

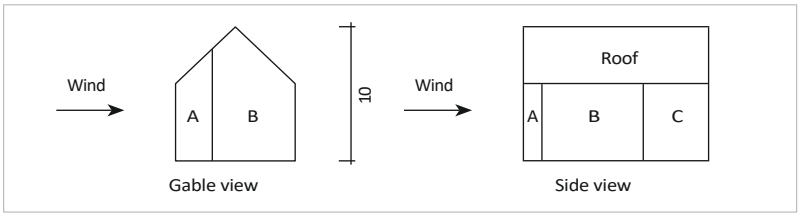


Fig. 5: Wind suction zones Longitudinal and transverse floor plan

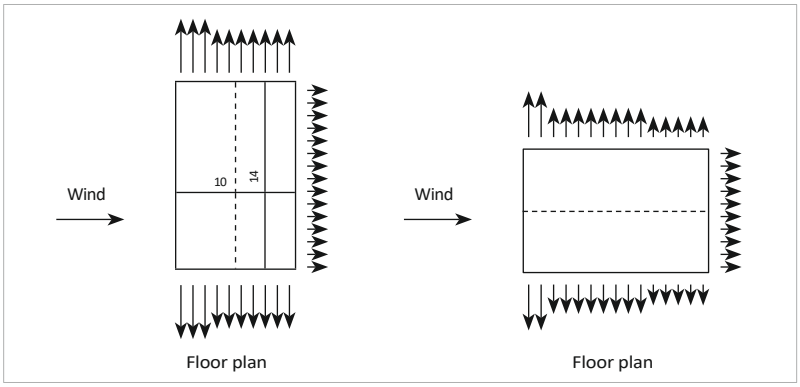


Table 5: Dowel quantities according to simplified method

Range	w_e	n_{Dowel}
A	0.74 kN/m²	4.4
B	0.55 kN/m²	3.3
C	0.28 kN/m²	1.6

* Minimum number of dowels: 1 dowel/panel; 4.3/m²

Calculate edge areas and arrange them over the entire building area (practical method).

Determining the number of dowels

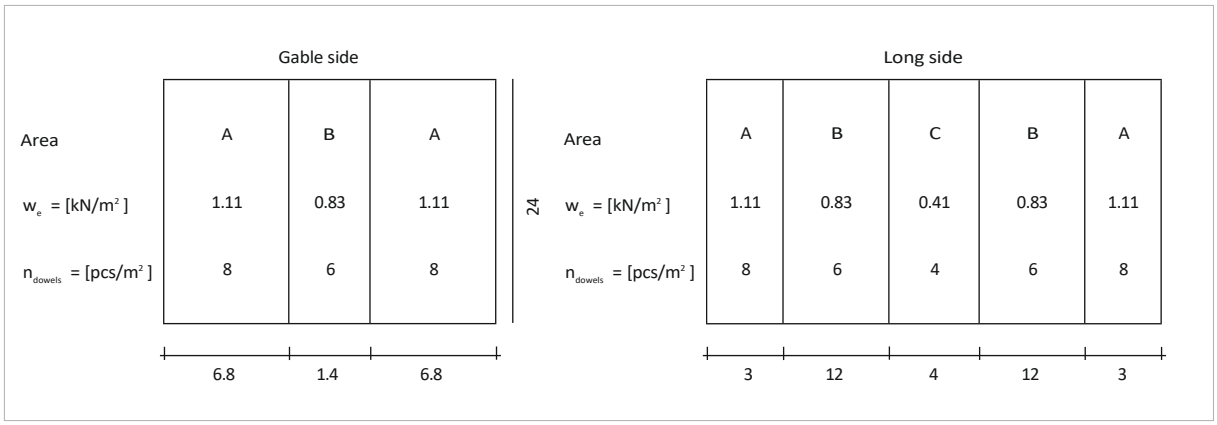
Using the wind suction forces determined according to the simplified method, the required number of dowels can now be determined using Table 7 – based on one square meter in each case.

Area A is decisive. It should be noted that the minimum number of dowels specified in the building authority approval must not be exceeded (one dowel per mineral insulation board).

2. Example for determining wind suction load

Initial conditions:
Tall rectangular building, flat roof, mathematical and simplified method Wind load zone 1
Dimensions: b = 15 m, l = 34 m, h = 24 m (Figs. 6 and 7)

Fig. 6: Wind zones and wind forces with the required number of anchors after directional superposition according to the simplified method



The wind distribution over a floor plan is qualitatively equivalent to the previous example. Figures 6 and 7 show the relevant areas after superimposing all wind directions, including the loads and the required number of dowels, differentiated according to simplified and mathematical methods.

Fig. 7: Wind zones and wind forces with the required number of dowels after directional superposition according to the mathematical method

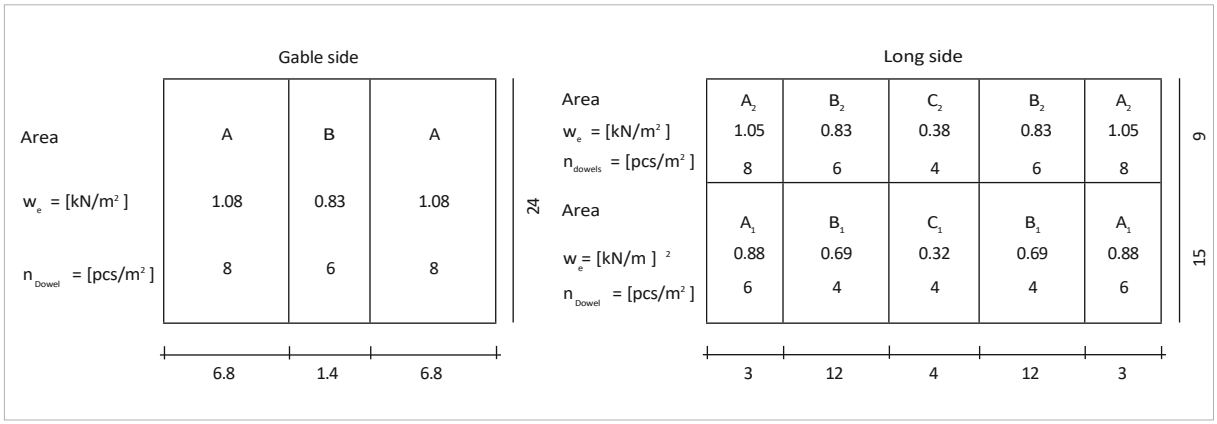


Table 6: Comparison of wind suction forces w_e in kN/m², simplified and calculated methods

Wind zone	A	B	C
Simplified method	1.11	0.83	0.41
Calculated method			
Long side			
Calculated > 15 m	1.05	0.83	0.38
Calculated < 15 m	0.88	0.69	0.32
Short side			
Total height	1.08	0.83	–

3.4 Mechanical fastening Composite thermal insulation system WAP

However, wind forces are no longer constant over height in the calculation method (Fig. 7). The relevant reference heights and height ranges must be determined in accordance with the rules of DIN EN 1991-1-4.

It can be seen here (Fig. 7) that it is advisable to define the range and determine the required number of dowels using Table 7 from an economic point of view.

Due to the geometric boundary condition of this example, according to which the smaller width is less than the height, no height differentiation is to be made on the gable side.

General determination of the number of dowels

The required number of dowels can now be easily determined using the calculated wind suction forces – based on one square meter and taking into account the dowel load class.

Table 7: Calculated required number of anchors per m² according to the simplified method based on height and wind zone

			Building height								
			< 10 m			< 18 m			< 25 m		
Wind zone range (h/d ≤ 2)			A	B	C/E	A	B	C/E	A	B	C/E
Wind zone 1 – inland	w_e [kN/m²]		0.738[3]	0.55[3]	0.275[3]	0.959[3]	0.715[3]	0.358[3]	1.106[3]	0.825[3]	0.413[3]
	Dowel load class w_{RD} [kN]	0.1[1]	7.4	5.5	2.8[3]	9.6	7.2	3.6[3]	11.1	8.3	4.1[3]
	Anchor load class w_{RD} [kN]	0.167[2]	4.4	3.3[3]	1.6[3]	5.7	4.3	2.1[3]	6.6	4.9	2.5[3]
Wind zone 2 – Inland	w_e [kN/m²]		0.959[3]	0.715[3]	0.358[3]	1.18[3]	0.88[3]	0.44[3]	1.328[3]	0.99[3]	0.495[3]
	Dowel load class w_{RD} [kN]	0.1[1]	9.6	7.2	3.6[3]	11.8	8.8	4.4	13.3	9.9	5.0
	Anchor load class w_{RD} [kN]	0.167[2]	5.7	4.3	2.1[3]	7.1	5.3	2.6[3]	8.0	5.9	3.0[3]
Wind zone 2 – Coast and islands Baltic Sea	w_e [kN/m²]		1.254[3]	0.935[3]	0.468[3]	1.475[3]	1.1[3]	0.55[3]	1.623[3]	1.21[3]	0.605[3]
	Anchor load class w_{RD} [kN]	0.1[1]	12.5	9.4	4.7	14.8	11.0	5.5	16.2	12.1	6.1
	Anchor load class w_{RD} [kN]	0.167[2]	7.5	5.6	2.8[3]	8.8	6.6	3.3[3]	9.7	7.2	3.6[3]
Wind zone 3 – Inland	w_e [kN/m²]		1.18[3]	0.88[3]	0.44[3]	1.401[3]	1.045[3]	0.523[3]	1.623[3]	1.21[3]	0.605[3]
	Anchor load class w_{RD} [kN]	0.1[1]	11.8	8.8	4.4	14.0	10.5	5.2	16.2	12.1	6.1
	Anchor load class w_{RD} [kN]	0.167[2]	7.1	5.3	2.6[3]	8.4	6.3	3.1[3]	9.7	7.2	3.6[3]
Wind zone 3 – Baltic Sea coast and islands	w_e [kN/m²]		1.549[3]	1.155[3]	0.578[3]	1.77[3]	1.32[3]	0.66[3]	1.918[3]	1.43[3]	0.715[3]
	Anchor load class w_{RD} [kN]	0.1[1]	15.5	11.6	5.8	17.7	13.2	6.6	19.2	14.3	7.2
	Anchor load class w_{RD} [kN]	0.167[2]	9.3	6.9	3.5[3]	10.6	7.9	4.0[3]	11.5	8.6	4.3
Wind zone 4 – Inland	w_e [kN/m²]		1.401[3]	1.045[3]	0.523[3]	1.696[3]	1.265[3]	0.633[3]	1.918[3]	1.43[3]	0.715[3]
	Dowel load class w_{RD} [kN]	0.1[1]	14.0	10.5	5.2	17.0	12.7	6.3	19.2	14.3	7.2
Wind zone 4 – North Sea and Baltic Sea coast and islands in the Baltic Sea	Anchor load class w_{RD} [kN]	0.167[2]	8.4	6.3	3.1[3]	10.2	7.6	3.8[3]	11.5	8.6	4.3
	w_e [kN/m²]		1.844[3]	1.375[3]	0.688[3]	2.065[3]	1.54[3]	0.77[3]	2.286[3]	1.705[3]	0.853[3]
	Anchor load class w_{RD} [kN]	0.1[1]	18.4	13.8	6.9	20.7	15.4	7.7	22.9	17.1	8.5
	Anchor load class w_{RD} [kN]	0.167[2]	11.0	8.2	4.1[3]	12.4	9.2	4.6	13.7	10.2	5.1
Wind zone 4 – North Sea islands	w_e [kN/m²]		2.065[3]	1.54[3]	0.77[3]						
	Anchor load class w_{RD} [kN]	0.1[1]	20.7	15.4	7.7						
	Dowel load class w_{RD} [kN]	0.167[2]	12.4	9.2	4.6						

[1] Insulation thickness 60/80 mm [2] Insulation thickness 100 to 300 mm [3] Minimum number of dowels 1 dowel/panel; 4.3/m²

Explanatory example for determining dowels according to Table 7

- The wind force w_e is: 0.96 kN/m²
- The force w_{RD} that can be absorbed per dowel is: 0.167 kN/dow
- Required number of dowels: $n_{dowels} = w_e/w_{RD} = 0.96$ kN/m²/0.167 kN/dowels = 5.7 dowels/m²
- Selected: 6 dowels/m² or 1.5 dowels per panel (390 × 600 mm)

Examples 1 and 2 clearly show that, when comparing the simplified and mathematical methods, there is significant potential for savings, particularly for buildings up to 15 m in height, whereas an exact calculation of the number of dowels required for a residential building (maximum height 10 m) does not result in any significant savings.

In example 2, it can be seen that the mathematical method saves dowels compared to the simplified method (see Figures 6 and 7). For this purpose, a wind load calculation must be carried out by an engineering firm.

In the calculated example, 2 dowels/m² can be saved on each of the two long sides of the building over a height of 15 m and a width of 30 m (excluding area C, as there is no reduction in the number of dowels).

Dowel savings: 2 long sides of the building · 2 dowels/m² · 15 m (height) · 30 m (length) = 1,800 dowels

The dowel costs consist of material and labor costs. It is clear that the mathematical method is the more economical one for the example building examined. At the same time, the contractor must ensure that the calculated number of dowels is actually installed in accordance with the static wind load calculation.

Finally, the steps for determining wind load and dowel requirements are briefly listed again

- Determination of the wind zone depending on the location of the building
- Consideration of the relevant wind directions, determination of the wind suction areas (A, B, C) and the superposition
- Determination of the aerodynamic coefficients (c_{pe})
- Determination of the height, height gradation, and height-dependent velocity pressures [q_p (z)]
- Determination of the relevant suction forces by multiplying the velocity pressures by the aerodynamic coefficients for all surface areas

The wind loads determined in this way can be used to determine the required quantities of dowels. The rules of DIN EN-1991-1-4 and the associated national annex must be observed.

The procedure for the simplified method is similar, but the height-dependent velocity pressures do not need to be determined, as the wind pressure is assumed to be constant over height in the simplified method.

In the practical method, only the wind pressure from Table 2 needs to be multiplied by the aerodynamic coefficient for area A (edge zone). The number of dowels determined in this way must then be applied to the entire building.

The relevant dowel load class depends on the thickness of the insulation material.
Our Multipor technical advisors will be happy to assist you with the exact dowel dimensioning. You can find your local technical advisor in the contact section at www.multipor.de.

%0.5 Curtain-type rear-ventilated facade (VHF)



RATIO shopping center in Baunatal

Is a curtain-type rear-ventilated facade (VHF) with Multipor a contradiction to a composite thermal insulation system, or does a VHF even represent an improvement?

We think it is a useful addition!

Just like composite thermal insulation systems, curtain-type rear-ventilated facades offer the possibility of adapting an existing building to increased energy requirements with appropriate insulation thicknesses and without losing usable floor space or living space. The curtain-type rear-ventilated facade is a structurally complex but robust construction method for the building envelope in terms of building physics and mechanical load-bearing capacity.

Curtain-type rear-ventilated facades have the advantage of being able to set design accents with numerous materials, such as clinker brick slips or thick plaster coatings. The design can be adapted to the building architecture in terms of color and by combining different surface materials, thus allowing the construction of individual facades.

Multipor mineral insulation boards WAP have a European Technical Assessment ETA-05/0093 for use as insulation material within a curtain-type ventilated facade and are regulated by DIN 4108-10 as WAB (WAB = external insulation of the wall behind cladding).

Curtain-type rear-ventilated facade The curtain-type rear-ventilated facade (VHF) is a widely used type of building envelope in European industrial and office construction, and to some extent also in residential construction, which is characterized by an air layer between the insulated building and the weather skin. This air layer ensures constant rear ventilation of the outer skin and separates it from

from the insulated supporting structure in terms of moisture and heat. This separation in turn allows a closed insulation layer to be installed on the outside of the building, which is separated from the layer exposed to the weather and thus also carrying water. This type of facade can protect against moisture damage in critical areas in winter – for example, due to snow accumulation.

Multipor as insulation material for VHF
Multipor offers many advantages as an insulation material for rear-ventilated curtain walls:

- Multipor WAP mineral insulation boards are pressure-resistant and dimensionally stable.
- The substructure can be attached directly to Multipor, thereby significantly reducing thermal bridge losses in the substructure compared to conventional systems (see Figures 1 and 2).
- Multipor mineral insulation boards WAP are easy to handle, easy to work with, and can be laid flat or upright.
- Thanks to the diffusion-open and capillary-active material properties, moisture can be reliably transported from the inside to the outside through vapor diffusion, and moisture that cannot be completely ruled out even in extreme weather conditions can be reliably absorbed and released back into the air layer.

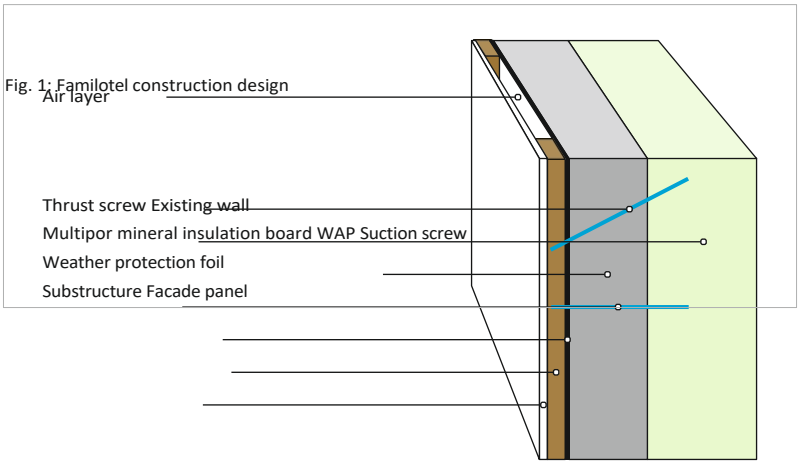


Fig. 1: Familotel construction design

- In addition to the advantages mentioned above, Multipor mineral insulation boards WAP are also a non-combustible, smoke-proof, and drip-proof material with fire protection class A1 according to DIN EN 13501-1.

Surface design
If clinker brick slips are desired as the outer skin, the Multipor mineral insulation board WAP is used as insulation in combination with a suitable carrier board as a rear-ventilated facade.
Thick plaster coatings or alternating exterior cladding are also possible with a curtain wall. There are no limits to the design possibilities.

The use of Multipor in rear-ventilated facades is not incompatible with a composite thermal insulation system. The Familotel Feldberg project, which features a rear-ventilated facade and Multipor mineral insulation boards WAP as insulation, is a good example of this (Fig. 1; see also section 3.6).

berger Hof project is a good example of this (Fig. 1; see also Chapter 3.6).

The system structure of VHF curtain-type rear-ventilated facades is regulated by DIN 18516. Its essential components include the outer skin, air layer, insulation layer, and supporting structure.

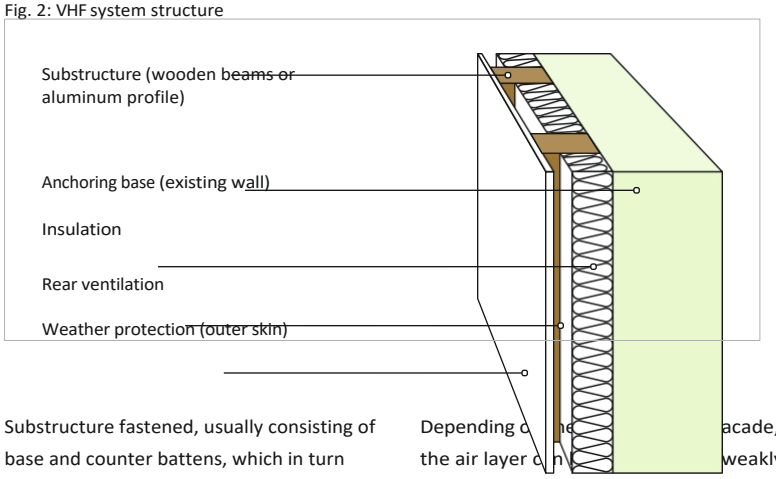
The outer skin
The outer skin can be made of various materials, such as

- high-pressure laminate panels
- Metal sheets and sandwich materials
- Plastics
- Fiber cement panels
- Mineral panel materials
- Natural stone panels and clinker brick slips on carrier panels

The outer skin always acts as a weather protection layer and repels driving rain and moisture. The outer skin is mounted on a

3.5 Curtain-type rear-ventilated facade (VHF)

Fig. 2: VHF system structure



Substructure fastened, usually consisting of base and counter battens, which in turn are fastened directly or by means of brackets to the supporting structure. The fastening elements penetrate the insulation layer and thus usually form thermal bridges or weak points in the construction of rear-ventilated curtain walls (see Figs. 1 and 2).

Wood and metal constructions are the main materials used for the substructure to which the outer skin is attached, either visibly or concealed.

Air layer

The air layer is an essential element of rear-ventilated curtain walls. It is connected to the outside air via supply and exhaust air openings to ensure permanent rear ventilation. The substructure consisting of battens and counter battens must therefore be arranged in such a way that air circulation is not impeded.

Depending on the [illegible] facade, the air layer can be weakly or strongly ventilated air layer.

When calculating the thermal resistance, a special feature must be taken into account if the component has air layers.

Stationary air layers contribute to thermal insulation. They are considered stationary if the following specifications are met for their opening to the outside environment:

- No air flow through the layer is possible.
- Openings have a maximum area of 500 mm^2 per m length (in the horizontal direction) for vertical air layers.
- Openings have a maximum area of 500 mm^2 per m^2 of surface area for horizontal air layers.

The thermal resistance of these air layers depends on their thickness on the one hand and on the direction of the heat flow on the other.

An air layer is considered to be weakly ventilated if the following applies to its opening:

- over 500 mm^2 to 1,500 mm^2 per m length (in the horizontal direction) for vertical air layers
- Over 500 mm^2 to 1,500 mm^2 per m^2 Surface area for horizontal air layers

The thermal resistance of weakly ventilated air layers can be calculated in accordance with DIN EN ISO 6946.

An air layer is considered to be strongly ventilated if the ventilation opening size is greater than:

- over 1,500 mm^2 per m length (in the horizontal direction) for vertical air layers
- over 1,500 mm^2 per m^2 surface area for horizontal air layers

A brief description of how the thermal resistance of a rear-ventilated curtain wall with an air layer is calculated can be found in section 7.1.1. The type of rear ventilation selected depends in particular on the facade construction itself, whereby the calculated influence of the air layer must always be taken into account. When determining the thickness of the insulation material, a slight increase in thickness is usually sufficient to compensate for the influence compared to a construction without or with a stationary air layer.

Supporting structure
The supporting structure absorbs the forces and forms the actual enclosure of the building.
All loads from the rear-ventilated curtain wall are transferred to the supporting structure via the substructure and the connection to the supporting structure. Windows and doors are usually attached directly to the supporting structure.

Insulation layer/insulation material
Ideally, the insulation layer seamlessly encloses the entire building and incorporates all opening elements (windows, doors) on the same level. Mineral wool, wood fiber insulation materials, or extruded polystyrene are usually used conventionally.

The thickness of the insulation material can be varied and planned together with the substructure.

Combination with the Multipor WAP composite thermal insulation system
Multipor mineral insulation boards WAP are particularly suitable for use as curtain-type rear-ventilated facades in all public buildings where the facade is subject to high wear and tear due to its use (e.g., entrance areas of schools).

The upper floors, which are not exposed to increased mechanical stress, can then be constructed using the Multipor WAP composite thermal insulation system. This creates a durable and economical solution that meets the requirements.

One possible advantage of VHF is that damage to individual facade elements can be repaired or replaced more easily than is the case with damage to composite thermal insulation systems.

Residential construction
A combination of VHF and ETICS can also be useful for single-family homes.

This means that a VHF on the weather side of a building can literally withstand both driving rain and extreme solar radiation, improving heat protection in summer. The ETICS areas on the other walls are exposed to lower hygrothermal stresses. This allows for a design that is planned for all directions, offering optimum maintenance and durability.

Conclusion
Curtain-type rear-ventilated facades with Multipor mineral insulation boards WAP are not a contradiction to composite thermal insulation systems with Multipor WAP, but rather a sensible technical and/or stylistic extension. Hydrothermally highly resilient facades can be created here, which are very robust and allow for a variety of surface designs. With Multipor, the substructure can be attached directly to the insulation boards. Continuous wooden beams or aluminum profiles up to the supporting structure are no longer necessary. The obstacle of conventional systems with regard to thermal bridges is thus overcome with curtain-type rear-ventilated facades with Multipor.

In view of the properties of both design variants, numerous useful combinations and systems can be created.

If you have any further questions, please contact our Multipor technical advisors. You can find your local contact in the contact section at www.multipor.de.

%0.6 Reference reports Multipor Facade insulation



Reference report: Prefabricated building in Eisenach

Improving the thermal insulation of their prefabricated buildings is often a particular challenge for housing operators in eastern Germany. When renovating the facade of a large prefabricated building complex in Eisenach, the local municipal housing association (SWG) relied on the structural and material advantages of a mineral-based composite thermal insulation system (ETICS). The Multipor ETICS WAP used provided a two-layer insulation, it ensured a high level of structural thermal insulation in an economical and sustainable manner.

High thermal insulation and attractive appearance
In addition to modernizing the heating and sanitary facilities of the prefabricated building block, the facade renovation required a significant increase in structural thermal insulation. SWG used appropriate thermal insulation measures to improve the appearance of the building at the same time.

Mineral and diffusion-open The facades of the prefabricated building had already been thermally upgraded in the 1990s, but had since developed significant defects.
In addition to the plaster coming loose due to weathering, these also included heavy algae growth and holes caused by woodpeckers. Due to the damage found, the decision was made to use the stable Multipor ETICS with mineral finishing plaster. Its diffusion openness prevented moisture from forming on the





outer wall surface. This reduced the risk of microorganisms colonizing the surface, even without the use of biocides.

Fire and sound insulation
The selected ETICS also impressed the planners and builders with its other positive properties. In addition to high fire protection without the need for fire barriers, the non-combustible insulation material (building material class A) also offered improved sound insulation of up to 2 decibels compared to an uninsulated wall.

Easy to work with
The mineral insulation boards were also very easy to process, which proved to be an advantage

. The planned structure of the facade with projections and recesses as well as window sills and cornices could be easily realized with Multipor without additional sheet metal coverings.

Problematic substrate A prerequisite for the adhesion of the new ETICS was sufficient load-bearing capacity of the substrate. To achieve this, the old paint from the GDR era had to be removed after the damaged EPS insulation had been removed. The unevenness of the substrate posed a particular challenge. In consultation with SWG, the planners opted for a two-layer
ETICS consisting of a glued

The lower insulation layer was used to divide the facade surface and realign individual areas. Larger unevennesses were compensated for by cutting the insulation boards to size or sanding them down.

ETICS installation completed quickly
The renovation began in June 2015. The project was completed on schedule in December 2015. This meant that the residents were able to enjoy the significantly improved thermal insulation before the onset of winter.
winter.

reference reports Multipor facade insulation



Reference report: Familotel Feldberg

For the facade renovation of the Familotel "Feldberger Hof" on the Feldberg in the Black Forest, the owners were looking for a long-term weather-resistant solution. The physical properties of the building in favor of Multipor WAP mineral insulation boards, which were to be used as a rear-ventilated facade construction. Manufactured exclusively from mineral, natural base and raw materials, Multipor WAP mineral insulation boards provide economical thermal insulation and all important fire protection requirements for insulation materials.

Exposed location with aggressive weather conditions The task was to renovate the facade of a hotel complex with an adjoining apartment complex to improve its energy efficiency. The exposed mountain location at an altitude of facade renovation of a hotel complex with an adjoining apartment complex. The exposed mountain location at an altitude of 1,300 m and the weather conditions there – with frequent and sometimes extreme driving rain and hurricane-force winds of up to 200 km/h – placed extraordinary demands on the insulation material to be used.

extraordinary demands on the insulation material to be used. In a total of two construction phases, the facade was to be renovated and brought up to the latest standards.

Compressive strength, weather resistance, and fire safety
The construction and the insulation material had to be weather-resistant in the long term while also guaranteeing a high level of fire protection and enabling quick processing. In addition, the rear-ventilated





facade construction had to have high compressive strength. The Multipor WAP mineral insulation board that was ultimately selected meets all these requirements.

Ecology included

The awards from natureplus, the Institute for Building and Environment, and the eco-INSTITUT documented and verified the ecology, sustainability, and healthy living properties of the Multipor mineral insulation board WAP.

High exposure to driving rain

Due to its exposed location, the facade construction is subject to excessive driving rain. This is not a problem for the rear-ventilated curtain facade with Multipor mineral insulation boards WAP, as the mineral insulation is able to temporarily store moisture and release it again in a controlled manner.

Processing

A total of around 500 m² of Multipor mineral insulation boards WAP were required for the renovation of the apartment complex per construction phase. The work was carried out on an existing wall made of 24 cm thick KS masonry, which is plastered on the inside with 2 cm thick lime-cement plaster. In combination with the 18 cm thick Multipor mineral insulation boards WAP, this creates a virtually monolithic system structure. In this case, it was planned as a rear-ventilated facade construction. For this purpose, a weather protection membrane ($s_{d} \leq 0.12$ m) was applied, onto which the necessary substructure for the large-format high-pressure laminate panels, anchored in the solid sand-lime brick wall, substructure for the large-format high-pressure laminate panels. So-called suction screws were used, which serve to introduce the vertical loads and were specially manufactured for the insulation project.

Since the substructure made of larch wood was fixed directly to the Multipor mineral insulation boards WAP on the facade protection membrane with suction and thrust screws, no thermal bridges were created. The facade construction now achieves a U-value of 0.216 W/(m²K).

This project clearly demonstrates how flexible Multipor insulation systems can be.



Reference report: High-rise project in Kempten

The nine-story high-rise building in Kempten, Bavaria, had to undergo extensive renovation because the existing rear-ventilated curtain wall facade had been constructed with materials containing asbestos and had also suffered moisture damage over the years. Aware of the complications involved, the selection of the new composite thermal insulation system was of particular importance to Sozialbau Kempten Wohnungs- und Städtebau GmbH. The list of requirements included basic points such as fire protection, protection against algae and fungi, ecology, and recycling.

An insulation system that meets the challenge The Multipor WAP composite thermal insulation system was able to meet the housing association's high requirements and impressed above all with its mineral composition in all the required areas.

Fire protection
The Multipor WAP composite thermal insulation system always meets the fire protection requirements, as the purely mineral Multipor WAP mineral insulation boards are non-combustible and therefore classified as building material class A1. The Multipor lightweight mortar, the Multipor reinforcement fabric, and the mineral finishing plaster with silicate facade paint round off the system and are classified as non-combustible in fire protection class A2.





Algae and fungi

The building owners also demanded reliability when it came to algae and fungi, as the high-rise building is located in the immediate vicinity of the Iller mountain river. With the previous composite thermal insulation system, this proximity led to increased algae and fungal growth on the facade. The future system had to be ecologically safe—and therefore free of biocides—to ensure a long-lasting clean facade. The Multipor WAP composite thermal insulation system was particularly impressive here due to its high diffusion capacity, which prevents moisture formation on the insulated wall surface. The diffusion-open combination of coordinated system components prevents moisture accumulation on the wall surface because it absorbs moisture, stores it temporarily, and releases it again through rapid drying.

system components prevents moisture accumulation on the wall surface because it absorbs the moisture, stores it temporarily, and releases it again through rapid drying. With the Multipor WAP thermal insulation composite system with mineral finishing plaster, the use of biocides and other chemicals can also be completely dispensed with.

Ecology and recycling

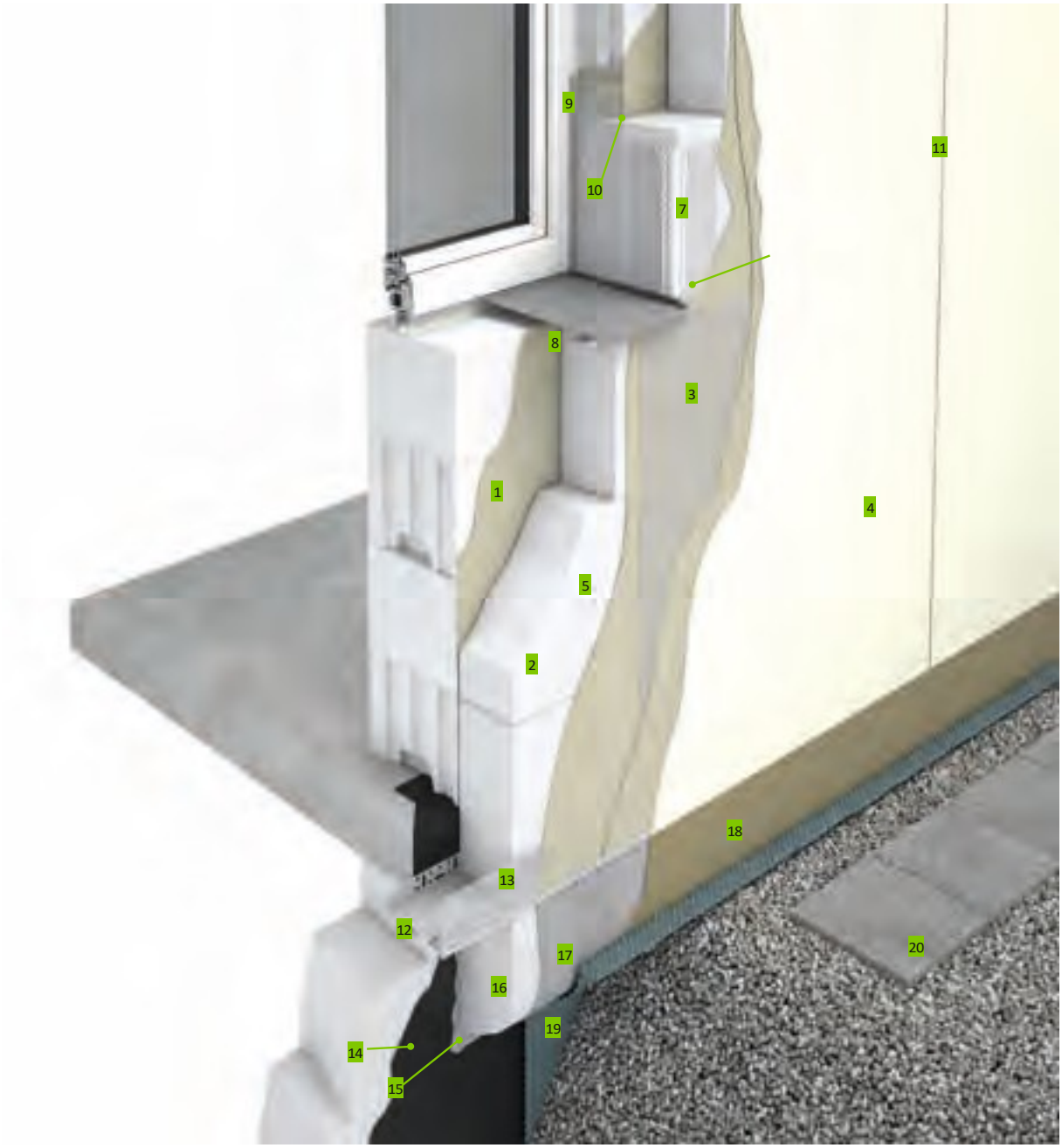
Ecological and recycling requirements were also discussed and, thanks to meaningful environmental certificates, were easily met by the Multipor WAP thermal insulation composite system.

Representative examples include the natureplus environmental label, known for its high ecological standards, and the environmental declaration of the Institut Bauen und Umwelt e. V. (Institute for Construction and the Environment). The numerous certifications result from the natural and mineral composition of Multipor mineral insulation boards WAP, which consist solely of lime, sand, cement, and water. This means that Multipor recycling is not an issue, as the mineral raw materials can be reused. Pure Multipor (processing residues) is returned in big bags and fed back into the production cycle – completely uncomplicated.

%0.7 Processing Multipor thermal insulation composite system WAP

The Multipor WAP composite thermal insulation system is a high-quality insulation system that meets all the requirements of modern construction. The products are subject to ongoing internal and external quality control in the factories, whereby careful handling of the Multipor mineral and base insulation boards during processing and in subsequent work rounds off the quality of execution.

Fig. 1: Overview of the Multipor thermal insulation composite system and its components



1 Multipor lightweight mortar for bonding Multipor mineral insulation boards WAP to the substrate. If necessary, a sandy or chalky substrate/old plaster can be consolidated with Multipor deep primer.

2 Insulation layer made of Multipor mineral insulation boards WAP in thicknesses of
60 to 300 mm, single or double layer

3 The Multipor reinforcement fabric 4 x 4 mm is worked into the upper third of the 5 to 6 mm thick reinforcement layer of Multipor lightweight mortar. Each fabric strip must overlap by at least 10 cm. In areas at risk of impact, additional reinforcement can be provided with Multipor reinforced mesh without overlap under the surface reinforcement.

4 The system is finished with thin-layer mineral plasters, Multipor silicate plasters, or Multipor silicone resin plasters in grain thickness. Multipor structural plaster (scratch coat/disc plaster) and Multipor Munich rough plaster (roll plaster) are available with
2 or 3 mm grain size. To extend the processing times of the thin-layer structural fine plasters, the reinforcement layer can be treated beforehand either with Multipor burn-on barrier, which reduces the absorbency of the substrate, or with Multipor plaster primer.

5 Multipor screw anchors for system-compliant anchoring of wall and base insulation

6 Reinforcement arrow for diagonal reinforcement at all corners of windows and doors below the surface reinforcement

7 Fabric corner profile for reinforcement at corners and edges, applied before surface reinforcement

8 Joint sealing tape or connection profile for a tight and permanently elastic transition/connection to wood, sheet metal, plastic, steel, etc.

9 Plaster strip W32-plus, W36-plus, or W38-pro for a driving rain-tight plaster connection with fabric for windows, doors, and similar building components

10 Multipor soffit panel for insulating door and window soffits without changing materials

11 The W50-3 movement joint profile is used for small component movements, such as in terraced houses, both on flat surfaces and on internal and external corners. Building expansion joints with greater deformations must be accommodated with the expansion joint profiles in the ETICS.

12 SOLI-TEX base rail, W61, with extension profile W63 if necessary

13 W61 clip-on profile, which can also be used for side finishes, alternatively W66-2 base edge profile

14 Building waterproofing

15 Multipor sealing slurry as a waterproof coating for the Multipor base insulation board

16 Multipor base insulation board for thermal insulation of walls in contact with the ground.

17 For base reinforcement, Multipor reinforcement fabric 4 x 4 mm is embedded in the Multipor sealing slurry.

18 Multipor lightweight mortar in felt plaster texture as base plaster

19 Drainage mat

20 Gravel fill / sidewalk paving

3.7 Processing Multipor thermal insulation composite system WAP

Work guidelines and calculation basis
When calculating the costs for a composite thermal insulation system, the labor and material costs must be determined. The Multipor WAP composite thermal insulation system need not shy away from a cost comparison.

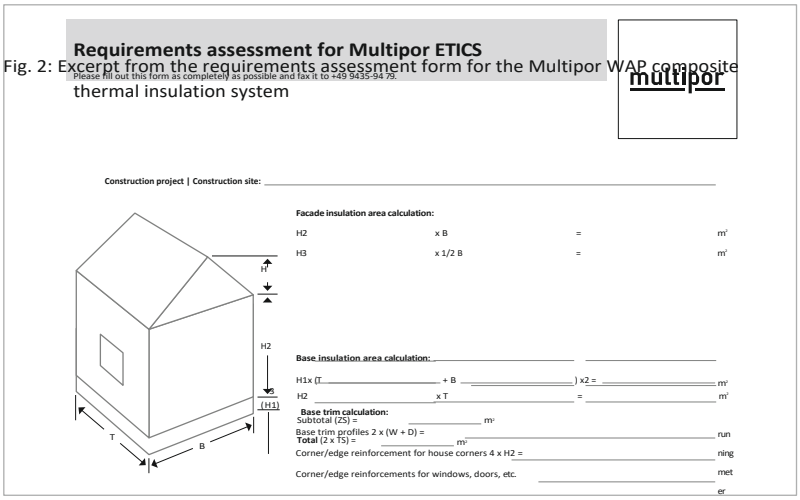
Working time guidelines
Our many years of experience show that the working time guidelines are almost equivalent to those for conventional ETICS.

Table 1 shows the work
Time values for Multipor thermal insulation composite systems WAP with a thermal resistance
R of 3.5 m² K/W can be taken.

For systems with other thermal resistances, the Professional Association of Plasterers for Interior Finishing and Facades has created a calculation aid that you can use to calculate your insulation project in consultation with the relevant Multipor consultant (Fig. 2).

Material requirements
At the same time, our Multipor consultants will help you determine the required material requirements.

We will be happy to provide you with a form for determining the quantities required for a Multipor WAP composite thermal insulation system. Please contact your Multipor consultant,
and we will send you a property-specific quote immediately.


Requirements assessment for Multipor ETICS

Please fill out this form as completely as possible and fax it to +49 9435-94 79.

multipor

Construction project | Construction site: _____

Facade insulation area calculation:

H2 x B = m²

H3 x 1/2 B = m²

H1

H2

(H1)

T

B

Base insulation area calculation: _____

H1x (T _____ + B _____) x2 = _____ m²

H2 _____ x T _____ = _____ m²

Base trim calculation:

Subtotal (ZS) = _____ m²

Base trim profiles 2 x (W + D) = _____ run

Total (2 x ZS) = _____ m² _____ ning

Corner/edge reinforcement for house corners 4 x H2 = _____ met

Corner/edge reinforcements for windows, doors, etc. _____ er

run

ning

met

er

Fig. 2: Excerpt from the requirements assessment form for the Multipor WAP composite thermal insulation system

Table 1: Guideline values for processing times

Work step	Time estimate
Bonding	12–20 min/m²
Dowel	2–3 min/dowel
Reinforcement/fabric filling	15–20 min/m²
Top coat	8–12 min/m²

Work safety on the construction site To avoid accidents, the regulations of the employers' liability insurance association must always be observed.

In addition to general construction site safety measures, the installation of Multipor insulation systems involves further requirements in the area of work and protective scaffolding. Here too, regulations from a technical and trade association perspective apply to ensure smooth construction site operations.

The generally applicable safety and hygiene measures as well as the regulations of the professional associations, such as the wearing of safety goggles and dust masks during grinding work, especially when working overhead, must always be observed.

Structural requirements The following requirements must be met:

- Before work begins, all necessary connections (such as pipe penetrations, electrical installations, etc.) must be completed.
- In wall constructions, the vertical and horizontal barrier layers against penetrating or rising moisture must be functional.

- The temperature of the air, the material, and the component must not fall below 5 °C during processing, hardening, and drying.
- Sufficient roof overhangs must be provided.
- Subsequent additions and installations such as awnings, blinds, mailboxes, rainwater pipes, etc. must be taken into account during the planning stage.
- Movement and expansion joints are incorporated into the Multipor WAP composite thermal insulation system using suitable profiles.
- Connections to windows, exterior doors, window sills, etc. must be made with suitable plaster strips, joint sealing tapes, etc.
- The interior plastering and screed work must be completed and dry.

Substrate assessment/ -pre-treatment

The requirements for the substrate condition are defined in the system approval as follows:

- Highly absorbent or sandy substrates must be reinforced with a suitable primer.
- The wall surface must be solid, dry, and free of grease and dust. The compatibility of any existing coatings with the adhesive mortar must be checked by a specialist.
- The wall must have sufficient load-bearing capacity for the use of dowels. In the case of substrates made of standard masonry or concrete, sufficient strength can usually be assumed without further verification.
- Unevenness of up to 1 cm/m can be bridged, but greater unevenness must be mechanically leveled or compensated for with plaster in accordance with DIN EN 998-1. For all other substrates, the load-bearing capacity must be verified by means of dowel pull-out tests.
- Existing insulation layers must be removed before applying Multipor mineral insulation boards.

The substrate must be checked by an expert, especially in old buildings and where plaster and paint coatings are present:

In order to be able to assess the long-term compatibility of existing, unknown coatings with Multipor lightweight mortar, it is possible to conduct a site-specific test using an entire Multipor Mine-

1



Preparation Substrate testing

If there are different substrates, the tests must be carried out on each substrate accordingly. After the adhesive has been allowed to harden and dry for at least one week, the panel is torn off. Alternatively, it is possible to apply a fabric embedded in adhesive mortar, cover it with a film, and also tear it off after about a week. If the adhesive does not adhere to the substrate or if the old coating shows signs of softening, the required compatibility is not given [1] [2]. This is a quick test suitable for use on construction sites. Substrate testing is not regulated by standards.

Depending on local conditions, different measures are required for substrate preparation, which are the responsibility of the specialist craftsman (Table 2).

2



Plaster substrate testing

3.7 Processing Multipor thermal insulation composite system WAP

Table 2: Substrate testing for bonding Multipor ETICS (according to the Federal Committee for Paint and Material Protection)

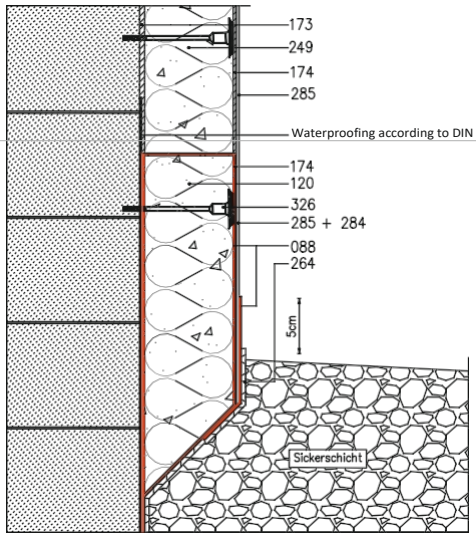
Test for	Test method	Detection	Technical information and measures
Surface strength	Scratch test with a solid, sharp-edged object	Surface is damaged under moderate pressure	Remove loose, flaky, or brittle parts manually or mechanically; soft layers are not a suitable substrate for ETICS
	Rub with your hand	With slight abrasion	Treat with plaster-strengthening primer
		For heavy, deep abrasion	Level out any imperfections
	Moisten with water until saturated and perform a scratch test	If the surface softens during the wetting test	Remove unstable plaster, apply leveling plaster if necessary
Stability of existing old coating	Scratch test with a solid, sharp object	Coating parts splinter off even under moderate pressure Scratch marks are jagged or bulging	Remove old coating/plaster, apply leveling plaster if necessary
Compatibility with existing old coating	Tear-off test	Detachment	Remove old coating/plaster, apply leveling plaster if necessary
Moisture	Visual inspection and scratch test if necessary	Damp areas, water marks, discoloration are visible	Structural/physical causes must be eliminated on site, allow to dry
Efflorescence	Visual inspection	Mostly white salts or lime leaching	Structural/physical causes must be remedied on site, then allow to dry and remove salts
Moss and algae infestation	Visual	Green or dark growth	Remove mechanically or by high-pressure hot water cleaning; if necessary, additionally disinfect the affected areas.
Other types of contamination	Visual inspection, feel (tactile test)	Color, smear effect, stickiness	Remove
Absorbency	Wetting test with water	With high absorbency, rapid water absorption and rapid darkening	Equalize highly absorbent or unevenly absorbent substrates with a primer coat

Base formation

The base area is the part of the facade that is subject to the greatest mechanical and moisture-related stresses, which necessitate the use of perimeter and/or base insulation boards. Before applying the base insulation, the exterior wall must be equipped with vertical waterproofing in accordance with DIN 18533. The boards can then be applied with a suitable adhesive, whereby the base area must be at least 30 cm high above the ground level [3 – 6].

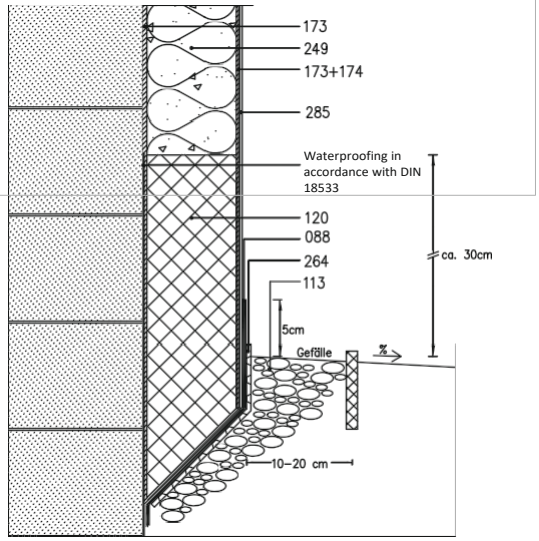
The basis for the use and installation of the Multipor base insulation panel is the general technical information, brochures, and product data sheets approved by the manufacturer. The Multipor base insulation panel is only intended for use in base areas and must not be used as perimeter insulation in the area of basement walls. Furthermore, use in areas subject to accumulated moisture or water pressure is not permitted. The maximum embedment depth below the top edge of the ground (OKG) is 20 cm. According to DIN 55699, the height of the splash zone is at least 30 cm above OKG.

3



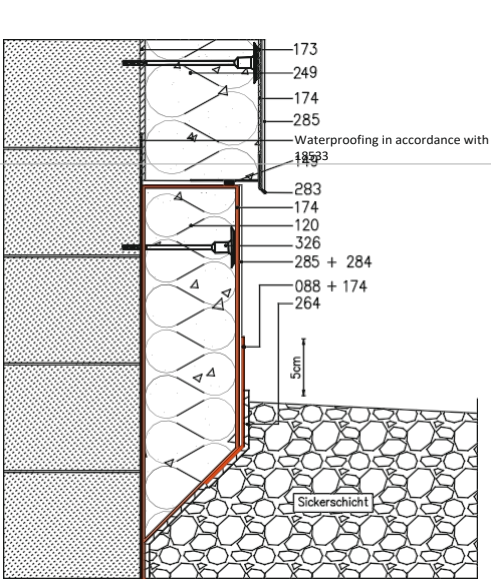
Base insulation, ETICS flush with base 19-051

5



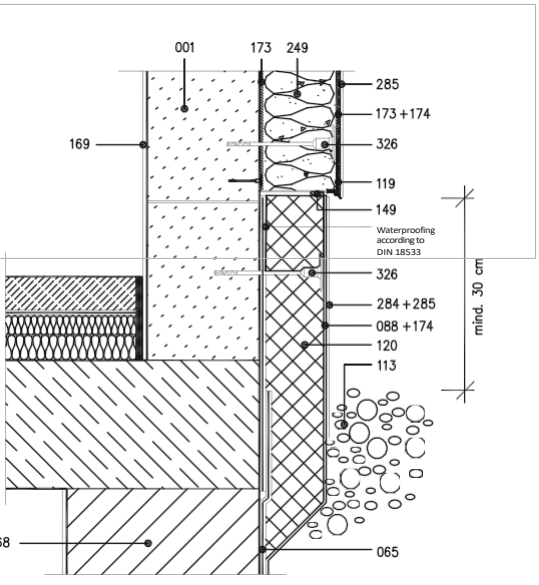
Base insulation with perimeter insulation flush with ETICS 19-008

4



Base insulation with protruding ETICS 19-052

6



Transition in the ground and splash water area on site 19-010
Existing base insulation incl. drainage

001	Ytong masonry	14	Pre-compressed sealing tape		
06	Basement waterproofing	168	Existing masonry	26	Dimpled membrane
08	Multipor sealing slurry	169	Interior plaster available	28	Base trim profile with drip edge
113	Drainage layer	17	Multipor lightweight mortar	28	Base coat
119	Plaster finishing profile	174	Multipor reinforcement mesh	285	System-compliant finishing plaster
12	Multipor base insulation board	249	Multipor mineral insulation board WAP	326	Multipor screw anchor

3.7 Processing Multipor WAP composite thermal insulation system

7



Cut Multipor base insulation board at an angle

8



Apply Multipor sealing slurry over the entire surface with a 12-tooth trowel

9



Press down and float in the Multipor base insulation panel

The substrate must be suitable for mineral sealing slurries and must be stable and clean. For building waterproofing with thick bitumen coatings, suitable mineral bonding bridges must be used before the Multipor base insulation board is bonded. Building waterproofing made of bitumen waterproofing membranes or plastic waterproofing membranes is not suitable as a substrate for the Multipor base insulation board.

Multipor base insulation boards must always be bonded using the mineral Multipor sealing slurry. The lower edge of the Multipor base insulation boards can be cut at a 45° angle [7]. The bevel facilitates subsequent sealing of the insulation board and complete, cavity-free filling of the working space when constructing the outdoor facilities. Cut surfaces must be primed. If the base insulation board is laid butt-jointed on a foundation projection or existing perimeter insulation, the lower edge remains straight.

. The Multipor sealing slurry is applied to the entire surface of the base insulation board with a 12-tooth trowel [8]; professional floating [9] ensures that the Multipor base insulation board is bonded over the entire surface.

In contrast to the processing in the WI, DI, WAP, and DAA areas, the butt joints and any existing bearing joints in the base area are also filled tightly with sealing slurry. In general, a minimum application thickness of 4 mm of Multipor sealing slurry must be maintained for each processing step. The base insulation board is then fixed with Multipor screw anchors [10].
One dowel is used to secure each insulation board, which works out to approx. 4.3 dowels/m². Cut-to-size boards are also secured with one fastener per board. Fastening is carried out before reinforcing and coating the surface, always above the 15 cm zone of the standard-compliant building waterproofing. The final reinforcement

10



Insert Multipor screw anchors, fix Multipor base insulation board and leave to dry for 24 hours

11



For the reinforcement layer, apply Multipor sealing slurry to the Multipor base insulation board

The reinforcement layer consists of Multipor reinforcement fabric 4x4 mm and Multipor sealing slurry. This is applied with a delay of at least one day after bonding, using a 12 mm trowel, and

worked into the upper third of the reinforcement layer [11] [12]. The lower edge of the coating – including the reinforcement fabric – is extended 10 cm beyond the end of the panel and forms a tight seal up to the building waterproofing.

The following variants can be used as top coat:

- Multipor lightweight mortar, felted, thickness approx. 3 mm
- Finishing plasters in accordance with Multipor ETICS approval (Z-33.43-596), which are suitable for use in areas exposed to splashing water

If the insulation thickness of the base insulation and Multipor ETICS is the same, always use double reinforcement with Multipor reinforcement mesh 4x4 mm.

Due to the variety of finishing plasters that can be used, water-repellent coatings must always be used that are suitable for the type and composition of the finishing plaster. The area of the finishing plaster and paint that is in contact with the ground must be protected from moisture. An additional coating with Multipor mineral sealing slurry [13] is suitable for this purpose. As a rule, an additional protective layer (e.g., dimpled membrane) with a sliding function should be provided between the sealing slurry and outdoor installations. The upper edge of both measures ends usually 50 mm above the top edge of the concrete. The adjacent covering surfaces of the outdoor facilities must be designed with either a gradient to be carried out or a clean drainage (box gutters). To reduce the impact of splashing water, gravel strips with a width of approx. 30–50 cm have proven to be very effective [14].

Base finish

There are two equivalent options available for the base finish:

1. On the one hand, it is possible to install the suitable combined base profile (SOLI-TEX) in a trough shape and, depending on the insulation thickness, with the corresponding screws/dowels and interconnected with system-compliant base connectors. The profile must then be aligned using a spirit level or plumb line and fastened to the wall structure approximately every 30 cm [15]. Due to thermal expansion, the base profiles should not be pressed together. Pre-fabricated elements (with miter) are suitable for outside corners, and spacers between the base rail and wall element are suitable for uneven substrates. As an additional, quick, and thermal bridge-free alternative, the combination of the W63 extension profile and the W62-2 clip-on profile can be easily and simply installed between the Multipor mineral insulation board WAP and the recessed base insulation. The welded reinforcement mesh is then worked into the surface reinforcement and, together with the integrated drip edge, forms a clean finish for the top coat of plaster.

12


Apply Multipor reinforcement mesh and plaster

13

Coat the top coat in the area in contact with the ground with Multipor sealing slurry

14

Lay gravel strips

15

Base rail, doweled

16

Base trim with fabric angle

17

Base finish with fabric angle

18

Mix Multipor lightweight mortar

2. An alternative is to attach a fabric corner bracket to the wall with Multipor lightweight mortar and then glue the Multipor mineral insulation board WAP into it. A fabric corner bracket W40-2 with drip edge formation ensures that the lower boards are enclosed in a U-shape by fabric and fabric corner angles [16] [17], creating a fully plastered base.

Mixing the Multipor lightweight mortar
Multipor lightweight mortar is mixed with the amount of water specified on the mortar container, observing the specified processing and safety instructions. Multipor lightweight mortar may be processed at air, material, and component temperatures between 5 °C and
30 °C air, material, and component temperature.
The Multipor lightweight mortar mixed in this way can then be used to bond, reinforce, and, if necessary, plaster the Multipor WAP mineral insulation boards. Using a slow-running mixer and a robust mixing paddle with long blades, the mortar mixture can be mixed to a consistency that is easy to work with [18]. After a 5 minutes, before the lightweight mortar is processed.

- 8 l water requirement per 20 kg bag of lightweight mortar when mixing with the mixing paddle
- Processing time: approx. 1.5 hours, depending on weather conditions
- Due to the high yield of Multipor lightweight mortar, the 30 l of fresh mortar per bag is sufficient for full-surface adhesive mortar application in a 5 mm layer thickness for approx. 6 m² of bonding or reinforcement. The buttering-floating or edge bead-dot method requires a higher amount of adhesive, depending on the substrate condition.

The delivery and processing instructions on the mortar container must always be followed. Multipor lightweight mortar can be stored dry on pallets for up to 12 months from the date of manufacture . Only Multipor lightweight mortar is suitable for the Multipor WAP thermal insulation composite system; otherwise, damage-free and structurally sound bonding and functionality of the system cannot be guaranteed.

Bonding Multipor mineral insulation boards WAP Before bonding Multipor
Mineral Insulation Boards WAP, the following work should be completed:

- Windows and doors must be installed.
- All plaster strips on windows, doors, etc. should be installed [19].
- A pre-compressed joint sealing tape or a suitable plastering strip must be inserted between the Multipor mineral insulation board WAP and the adjacent component at all connections (e.g., window sill) [20].
- The Multipor lightweight mortar is applied to the entire surface of the back of the panel using a suitable notched trowel [21], with a ridge height of 10 to 12 mm


19

Attaching the plaster strip


20

joint sealing tape on the window sill


21

Multipor lightweight mortar applied to insulation board

to compensate for unevenness in the substrate of up to 5 mm.

- For larger unevenness (up to 10 mm), the board can also be installed using the buttering-floating method ("fresh on fresh") or using the edge bead-dot method with at least 70% adhesive surface coverage [22]. The Multipor WAP mineral insulation boards must be floated and pressed into place [23].
- If the Multipor lightweight mortar is applied with a plastering machine, it must be applied to the back of the board and combed through.
- Panel bonding begins at the lower corner of the house, with the panel joints being tightly and firmly butted together and continuously bonded in a pattern with at least 15 cm overlap.
- Butt joints and bed joints are not bonded.
- To avoid cracks, the panels should be notched at window and door corners so that there are no continuous joints in the corners.

[24].

- Multipor WAP mineral insulation boards are bonded in layers at building corners, with one board edge protruding beyond the building corner by the thickness of the board plus the thickness of the mortar [25]. Any protrusion after the adhesive mortar has hardened can be quickly and easily leveled with the Multipor sanding board.
- Any gaps or joints in the insulation layer can be professionally filled with Multipor mineral insulation boards WAP or Multipor filling mortar.

Connection to windows, window sills, and roller shutters, see also section 3.3

The following points must be taken into account:

- The Multipor WAP composite thermal insulation system can be connected to reveals or window frames either with joint sealing tape and a trowel cut or with a suitable plastering strip. Fabric strips of the plastering strips


22

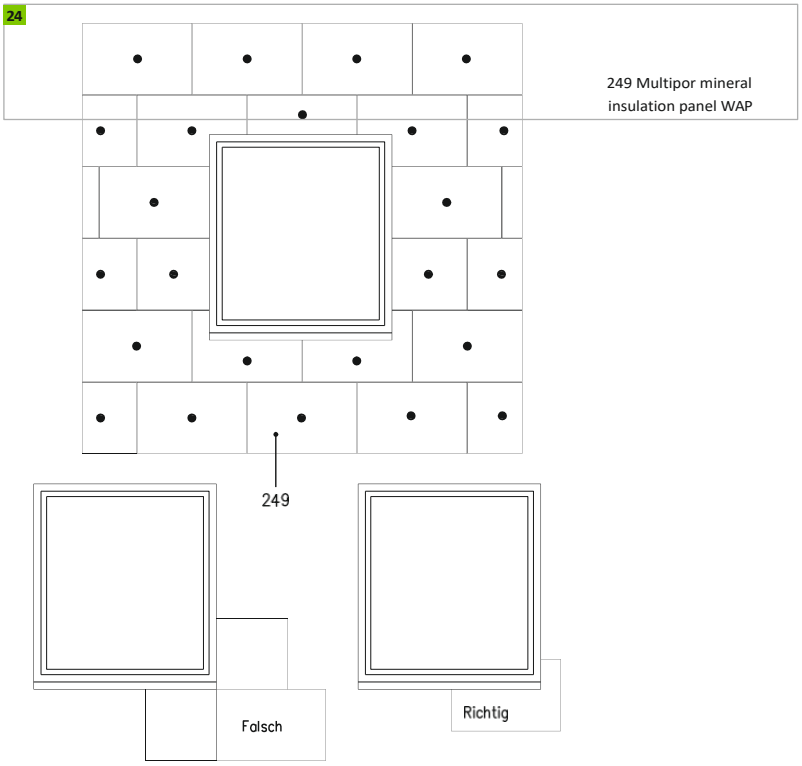
Edge bead point bonding


23

Press down and float in the Multipor mineral insulation board

3.7 Processing Multipor thermal insulation composite system WAP

24



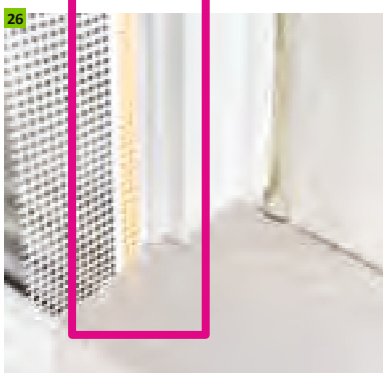
Panel arrangement for facade openings including system dowels 19-004

25



Panel offset at building corners

26



Over-insulation of window frames

can be embedded directly into the surface reinforcement.

- For windows flush with the wall or set forward, the window frame must be insulated by at least 3 cm (as much as possible) [26].
- Window sills must be installed with a sufficient slope (at least 5° or 8% = 0.8 on 10 cm).
- The installation and connection of a window sill must be carried out with the utmost care.
- Before attaching the screw-on bar to the window frame, the rubber sealing strips provided for this purpose must be inserted.
- Window sills with a projection > 150 mm must also be secured with window sill brackets.

. These must be attached to the load-bearing wall before installing the window sill.

- The length of the window sill must be prepared so that the inner edges of the edge profile are flush with the top coat of plaster. For window sill lengths > 3 m,

  waterproof butt connectors must be installed to

  to accommodate thermal length changes. Waterproof, movement-absorbing edge profiles,

  so-called sliding pieces, are recommended.
- For noise insulation, an anti-drumming layer must be installed under each window sill.
- The underside connection of the window sill to the Multipor WAP composite thermal insulation system

can be made using joint sealing tape or W43 end profile.

- Roller shutter boxes located within the insulation layer are insulated (insulation thickness at least 60 mm) [28]. For large window openings or roller shutter boxes whose front side is not suitable as an adhesive substrate, plaster base panels must be used.
- Roller shutter and external blind guide rails can be connected to the Multipor thermal insulation composite system WAP from the front or side using plaster strips [29].
- For roller shutter boxes that protrude from the insulation layer, the insulation must be extended to the boxes (not crimped).


27

Connection to external blind box


28

Over-insulation of external blind box


29

Adhesive plaster strip

and connect using suitable plastering strips.

Cutting/processing Multipor mineral insulation boards WAP

The following points must be taken into account when cutting and processing:

- Multipor mineral insulation boards WAP can be cut easily, accurately, and without effort using a fine-toothed foxtail saw [30]. There is no need to worry about dust exposure, except in the case of extensive machine sawing work with fast-running cutting tools.
- The Multipor sanding board can be used to quickly correct slight height differences after bonding [31]. It can also be used to adapt the boards to the existing building geometry and curved or arched floor plans [32] [33]. If necessary, sanded surfaces must be primed before applying the reinforcement.

Dowel fixing of Multipor mineral insulation boards WAP

Before doweling, the following points must be observed:

- Multipor mineral insulation boards WAP must generally be doweled with at least one Multipor screw dowel (plate diameter ≥ 60 mm) per insulation board, whereby the adhesive requires a minimum setting time of one day. The Multipor screw dowel must be inserted before applying the reinforcement plaster and fabric [34] [35].
- Among other things, the wind load standard DIN EN 1991-1-4 must be taken into account, which may increase the number of dowels required.
- The anchoring depths depend on the manufacturer's specifications and the substrate (Table 3).
- When selecting the dowel, it must be ensured that it is approved for use in the system and can prove the usage category indicated on the dowel in accordance with the substrate. If the existing anchoring substrate cannot be clearly identified, pull-out tests must be carried out on the construction site.


30

Cutting the mineral insulation board


31

Sanding the surface


32

Adjusting the insulation board

3.7 Processing Multipor thermal insulation composite system WAP

33



Curved facade surface

34



Drilling

Table 3: Categories of use for insulation anchor fastenings

A	B	C	D	E
Concrete	Solid brick	Perforated block	Aggregate-porous lightweight concrete	Aerated concrete

35



Insert screw anchors

Applying corner formations and profiles

The following must be observed during this step:

- Before applying the surface reinforcement, use Multipor lightweight mortar to apply fabric corner angles to building corners and window and door reveals in order to reinforce the edge formation [36] [37].
- Reinforcement arrows embedded in Multipor lightweight mortar or a piece of fabric cut to size (approx. 20 x 40 cm) prevent notch stress cracks in the corner areas of window and door openings. They must also be applied under the surface reinforcement [38].

Reinforcement of mineral insulation boards

Before applying the reinforcement plaster, the following requirements must be met:

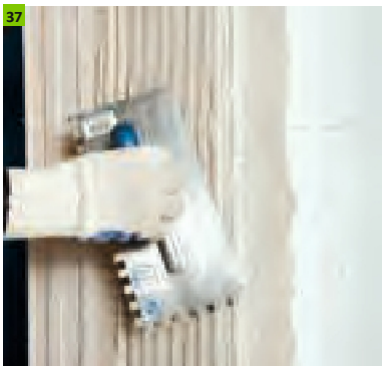
- The adhesive mortar under the Multipor WAP mineral insulation boards must be sufficiently firm.
- All necessary Multipor screw anchors must be flush with the surface.
- The surface of the Multipor mineral insulation boards WAP must be level, dry, and free of damage and dirt. Any misalignments at the board joints must be sanded down to a level surface .
- Open joints between the Multipor mineral insulation boards WAP must be closed with insulation material or Multipor filling mortar.
- The connections to other building components (e.g., penetrations or window frames) must be completed.

36



Fabric corner profile on outer corner

37



Fabric corner profile at opening


38

Reinforcement arrows above window opening


39

Apply reinforcement plaster


40

Insert reinforcement mesh

- Partially inserted mesh corner beads, plastering strips, and reinforcement arrows must be fixed with Multipor lightweight mortar. The lightweight mortar must be sufficiently dry and hardened.

Apply the Multipor lightweight mortar to the Multipor mineral insulation boards WAP with a suitable notched trowel to a thickness of 5 mm [39].
The Multipor reinforcement fabric can then be pressed into the wet reinforcement mortar in vertical or horizontal strips without creases using a trowel or float [40], whereby the fabric strips must overlap by at least 10 cm at the joints and the Multipor reinforcement fabric must subsequently lie in the upper third of the reinforcement layer.

In areas with additional fabric reinforcement (window reveals, etc.), the Multipor reinforcement fabric should overlap the fabric corner angles in the same way as for surface reinforcement. If necessary, apply another layer of reinforcement mortar mortar application, fresh on fresh, in order to be able to cover the fabric completely with filler [41].

Applying the top coat

Before applying the finishing coat, the following conditions must be met [42]:

- The reinforcement layer must be largely hardened and dry. As a rule of thumb: 1 day of standing time per mm of plaster thickness in normal weather conditions.
- Depending on the weather and the finishing coat, a burn barrier or a bonding agent can be applied between the base coat and the finishing coat.
- The air and surface temperature must be between 5 °C and 30 °C.
- The following finishing plasters on a reinforcement layer of Multipor lightweight mortar are approved: Multipor lightweight mortar, Multipor structural plaster, Multipor rough plaster, Multipor silicate plaster, and Multipor silicone resin plaster.
- For paints and colored finishing plasters, the light reflectance value must be ≥ 30.


41

Plastering reinforcement fabric


42

Applying the top coat


43

Texturing the top coat

3.7 Processing Multipor thermal insulation composite system WAP

Apply the plaster over the entire surface with a stainless steel trowel, smooth to grain thickness and immediately afterwards use a suitable trowel to evenly round off or texture the surface. The finished finishing coat thickness is 2 to 3 mm [42] [43], depending on the grain thickness. To avoid unevenness in the surface texture, the surfaces should be created continuously and without interruption. Drying times may vary depending on temperature, layer thickness, relative humidity, and wind conditions.

The list of suitable and approved finishing plasters in accordance with the above specifications can be found atwww.multipor.de/ downloads.

Ceramic cladding Ceramic cladding in the form of clinker brick slips, tiles, natural stone slabs, or thick-layer finishing plaster cannot be applied directly to the Multipor WAP thermal insulation composite system. If such a thick-layer top coat is planned, it can be applied to a cementitious plaster base board and a suitable substructure. Fermacell Powerpanel H($_{2}$ O has proven particularly effective in this regard, and its outdoor use is described in the current planning and processing instructions from Fermacell GmbH. Further information on **Multipor WAP composite thermal insulation** together with coordinated components, form a complete thermal insulation

Applying paint coatings The following paint

Table 4: Material consumption of the base components

Material	Approximate consumption
Multipor lightweight mortar, bonding	3.5 kg/m² for full-surface bonding with a 12 mm notched trowel 4.5 kg/m² for edge bead point up to 1 cm
Multipor mineral insulation boards	4.3 boards/m²
Multipor screw anchors	At least 1 anchor/panel corresponds to 4.3 anchors/m²
Multipor reinforcement mesh	1.1 m²/m²
Multipor lightweight mortar, reinforcement	3.5 kg/m² – a 20 kg bag is therefore sufficient for 6 m² with a layer thickness of 5 mm
Multipor mineral finishing plasters	Grain size 0–2 mm – 3.2 kg/m² Grain size 0–3 mm – 4.0 kg/m²
Multipor silicate plaster	Grain size 0–2 mm – 3.0 kg/m² Grain size 0–3 mm – 4.3 kg/m²
Multipor silicone resin plaster	Grain size 0–2 mm – 3.1 kg/m² Grain size 0–3 mm – 4.3 kg/m²
Multipor lightweight mortar as finishing plaster	Grain size 0–2 mm – 2.5 kg/m²

the Multipor thermal insulation composite system WAP:

- Mineral paints
- Diffusion-open silicate paints (note layer thicknesses)

Recommendation: You can achieve a good surface finish with Multipor silicate facade paint.

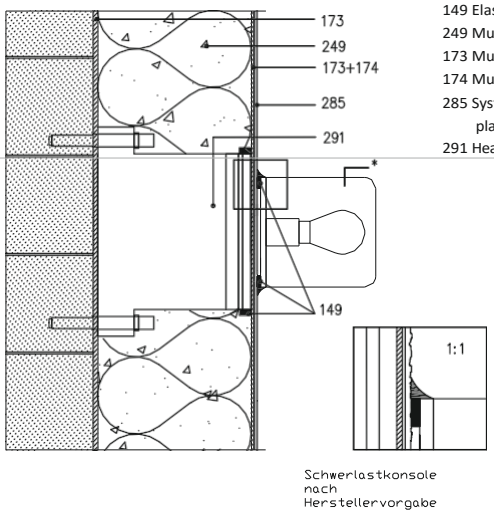
Depending on the type of paint, the substrates (mineral finishing plaster) may need to be primed. As with finishing plasters, the light reflectance value must be ≥ 30.

for information on the approximate material consumption of the basic components.

If you have any further questions, please contact our Multipor technical advisors. You can find your local contact in the contact section at www.multipor.de.

Fastening loads with Multipor composite thermal insulation systems WAP 3.8

1



* Lamp, mailbox, or similar loads
149 Elastic sealing tape
249 Multipor mineral insulation board WAP
173 Multipor lightweight mortar
174 Multipor reinforcement fabric
285 System-compliant mineral finishing plaster
291 Heavy-duty bracket

Fastening of light loads (variant)

The fastening of loads depends on the expected load and stress. This is also the main factor determining the choice of fastener and its position.

- Mechanical fastening of light static loads in Multipor mineral insulation board WAP
- Mechanical fastening of heavy loads through the Multipor mineral insulation board WAP in load-bearing substrate

Note: In buildings that are exposed to heavy public traffic, the loads to be fastened should generally be anchored in the load-bearing substrate to prevent vandalism damage.

Fastening light loads Spiral anchors: Light, stationary loads such as light signs [1] or house numbers up to 6 kg pull-out load with a maximum hole spacing of 600 mm can be fastened directly into the Multipor mineral insulation board WAP using the Multipor spiral dowel [2].

The dowel can be inserted directly without drilling. Before carefully screwing in the Multipor spiral dowel (50 mm, 85 mm) with a Torx bit, carefully score the plaster shell including the reinforcement mesh with a utility knife [3] to avoid damage to the facade and the Multipor mineral insulation board WAP [4].

2



Multipor ETICS spiral dowel

3



Carefully slitting the plaster shell

4



Inserting the Multipor spiral dowel

For exterior components, the attached objects must be sealed all around so that no moisture can penetrate.

3.8 Fastening loads with Multipor thermal insulation composite systems WAP

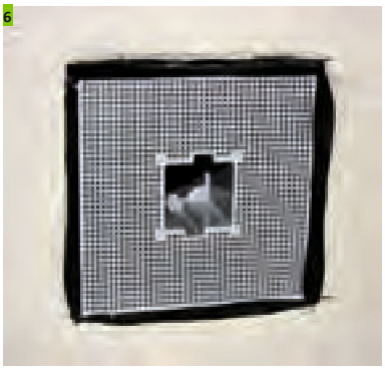
5



Multipor telescopic device carrier This carrier can be used for dowel-free installation of lights, motion detectors, and other devices. It can be combined and extended vertically and horizontally with a minimum center distance of 120 mm. Installation takes place before the insulation work. The integrated cable routing enables convenient and secure connection to the electrical cable. The device carrier can be loaded with up to 5 kg [5][6].

Fastening heavy loads and dynamic loads We recommend that loads over 6 kg, as well as all movable and variable loads and dynamic loads/stresses, should not be fastened to the Multipor mineral insulation board WAP, but always to the load-bearing substrate.
As an alternative to push-through mounting, thermally insulated heavy-duty brackets, e.g., from Dosteba, can be installed.

6



Spacer mounting systems
Various spacer mounting systems from several manufacturers are available on the market. A suitable spacer mounting system must be selected and installed according to the type of load. Among other things, suitable system solutions for the following applications must be purchased separately.

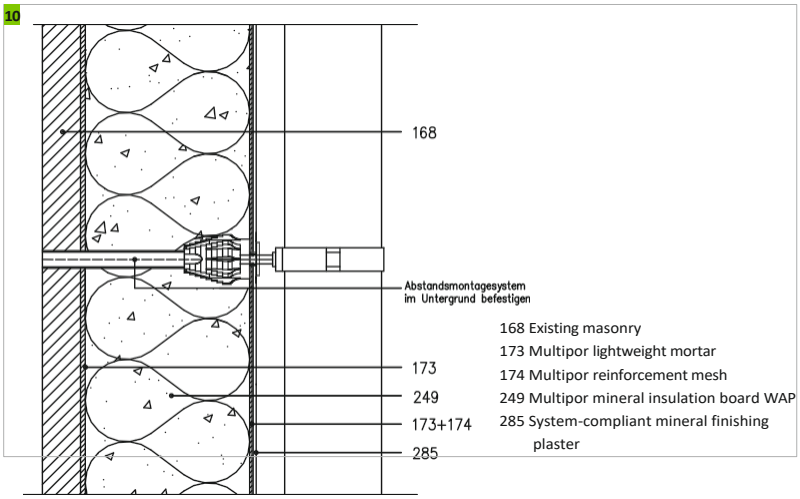
- Fastening of rainwater pipes [10]
- Attachment of canopies
- Fastening of awnings (Awnings are anchored to the load-bearing substrate with a spacer mounting in accordance with DIN EN 13561 "Awnings – Performance and safety requirements" with a spacer mounting anchored in a load-bearing substrate [11].)
- Hanging baskets
- Ladder hooks

Pressure distribution plates, mounting cylinders, and mounting blocks Pressure distribution plates are suitable for objects that exert pressure on the facade after installation. They are therefore suitable, for example, Well suited as a substrate for letterboxes and newspaper tubes. The outer shell of electrical intercom and doorbell systems can also be securely fastened to the pressure distribution plates.

Mounting cylinders and mounting blocks are available on the market for fastening objects such as shutters, lighting, or rainwater pipes. These are usually made of EPS with a high density and can be easily plastered over with system-compliant plasters. They are available as bar stock or as individual elements depending on the thickness of the insulation material. The bar stock has a circumferential grid at defined intervals, which makes it easier to cut to the respective insulation thickness and enables a precise saw cut. Screws can be screwed in several times without the mounting elements losing their durability.

For further information, please contact the respective manufacturers of these elements. Our Multipor application technology team will also be happy to advise you.

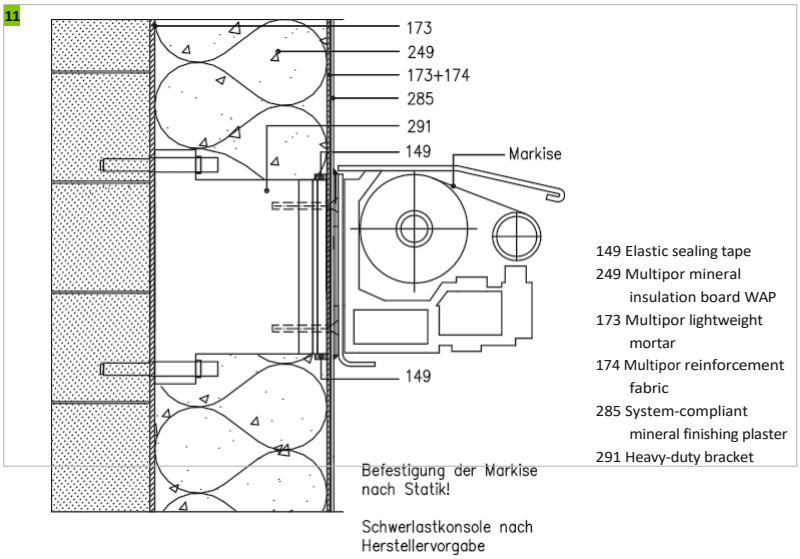
10



168 Existing masonry
173 Multipor lightweight mortar
174 Multipor reinforcement mesh
249 Multipor mineral insulation board WAP
285 System-compliant mineral finishing plaster

Fastening variant for rainwater downpipe

11



149 Elastic sealing tape
249 Multipor mineral insulation board WAP
173 Multipor lightweight mortar
174 Multipor reinforcement fabric
285 System-compliant mineral finishing plaster
291 Heavy-duty bracket

Awning mounting option

ECONOMICAL HEALTHY LIVING CAPILLARY ACTIVE DIFFUSION RENOVATION MODERNIZATION LISTED FACADE HALF-TIMBERED CELLAR ECOLOGICAL NATURAL SUSTAINABLE HIGH THERMAL INSULATION ENERGY EFFICIENT RELIABLE IMPLEMENTATION INHIBITS CHIMNEYMOLD FORMATION COMFORTABLE CLIMATE NON-COMBUSTIBLE SOLID CREATIVE SURFACE DESIGN SOUND INSULATION RELIABLE PLANNING EXECUTION SAFETY CAPILLARY ACTIVE DIFFUSION OPEN ECONOMICAL RENOVATION BASEMENT FA

4 Multipor interior insulation systems



Multipor interior insulation system WI/ Multipor WI compact plus

- Economical interior insulation systems for renovation and new construction
- A truly comfortable indoor climate thanks to special thermal and hygroscopic properties
- Ideal for mold prevention
- Preservation of listed and historic facades
- Ideally suited for half-timbered buildings and basement rooms
- Useful when boundary construction rules out the use of an ETICS
- DGNB certification and KfW funding possible
- Healthy living and ecologically excellent systems, confirmed by natureplus, IBU declaration, and the highest category A+ from the eco-INSTITUT

It is not uncommon for older buildings to have poor or inadequate thermal insulation. Insufficient thermal insulation of exterior components also promotes mold growth inside the building and leads to high energy consumption in winter and high indoor temperatures in summer. The consequences: an uncomfortable indoor climate and, in some cases, considerable structural damage. When renovating existing buildings, it is no longer enough to simply install new heating systems and windows. It is also important to preserve the diversity of the facades while optimizing them in an energy-efficient and moderate manner. Creating a comfortable living environment also plays a major role.

So if mold remediation, thermal bridge optimization, or interior insulation measures at the highest energy level are required

, Multipor interior insulation systems offer the perfect solution. With the slim, space-saving Multipor WI compact plus in thicknesses of 30 and 40 mm or with the WI interior insulation system with insulation thicknesses between 60 and 200 mm, Multipor meets all the requirements of modern interior insulation.

There are good reasons in terms of building physics for insulating a building with a Multipor interior insulation system:

- Increased surface temperature prevents condensation from forming on the surface
- This prevents moisture-related mold growth on the wall surface
- Improved thermal comfort
- Longevity of the building, where compliance with minimum thermal insulation requirements is not the only priority
- Even small insulation thicknesses in existing buildings improve the indoor climate and ensure comfort
- Meets the highest energy requirements, even up to the passive house standard possible in terms of building physics

Interior insulation with Multipor mineral insulation boards is therefore much more than just a cosmetic improvement to the building. It is often the only solution for improving the energy efficiency and living comfort of a building and ensuring that the property can be operated economically in the long term.

Multipor interior insulation WI If the focus is on economical, energy-efficient insulation measures
old and new buildings, the Multipor interior insulation system WI is used. With insulation thicknesses of 60 to 200 mm

(> 200 mm double-layer installation possible), even demanding renovation goals can be achieved, even in listed buildings. Multipor mineral insulation boards WI ensure that interior rooms heat up quickly and thus offer optimum thermal insulation. The high diffusion openness and capillary activity also enable structurally safe insulation without a vapor barrier in half-timbered houses.

- Optimal solution for high-quality energy-efficient renovation
- Economical interior insulation system, also for new buildings
- Diffusion-open and capillary-active – no vapor barrier required
- Preservation of listed and historic facades
- Ideally suited for half-timbered buildings and basement rooms
- Useful when boundary construction rules out the use of an ETICS
- Quick, easy, and safe installation without additional doweling
- Healthy living and ecologically excellent system, confirmed by natureplus, IBU declaration, and the highest category A+ from the eco-INSTITUT

Multipor WI compact plus
Multipor WI compact plus is used when mold prevention and thermal bridge optimization are the main priorities. The slim and therefore compact insulation boards, with a thickness of only 30 or 40 mm, ensure minimal loss of living space. Their use effectively raises the surface temperature of the walls, which prevents mold growth and increases living comfort. Lower heating costs are included.

- Energy efficiency improvements to existing walls prevent mold growth
- Improved living comfort
- Diffusion-open and capillary-active – no vapor barrier required
- Effective thermal insulation with λ = 0.045 W/(mK) despite minimal loss of space
- Quick, easy, and clean processing
- Effortless transport and easy handling to the construction site thanks to cardboard packaging
- Healthy living and ecologically excellent system, confirmed by natureplus, IBU declaration, and the highest category A+ from the eco-INSTITUT



Multipor mineral insulation board WI



Multipor mineral insulation board WI compact plus



Thomasblock, Oldenburg



Old weaving mill, Fulda

4.1 General introduction and planning

Table 1: Product specifications for Multipor interior insulation systems

	Multipor mineral insulation board WI	Multipor WI compact plus	Multipor lightweight mortar
Regulations	European Technical Assessment ETA-05/0093	European Technical Assessment ETA-05/0093	Lightweight mortar LW according to EN 998-1
Dry bulk density	85–95 kg/m³	100–115 kg/m³	approx. 770 kg/m³
Compressive strength	≥ 200 kPa	≥ 300 kPa	CS II; 1.50–5.0 N/mm²
Thermal conductivity Design value	λ = 0.042 W/(mK)	λ = 0.045 W/(mK)	$\lambda_{10,dry}$ = 0.18 W/(mK)
Water vapor diffusion resistance factor	μ = 2	μ = 3	μ ≤ 10
Building material class	A1; non-combustible (melting point > 1,200 °C)	A1; non-combustible (melting point > 1,200 °C)	A2-s1, d0; non-combustible
Dimensions / Delivery quantity	600 x 390 mm d = 60–200 mm (> 200 mm two-layer installation possible) (in 20 mm increments) Special format d = 50 mm with λ = 0.045 W/(mK) and μ = 3	500 x 390 x 30/40 mm (L x W x D)	20 kg/bag

Experience proves us right Millions of square meters of interior wall surfaces insulated with Multipor Interior Insulation System WI or Multipor WI compact plus confirm the successful results of our more than 20 years of work in the field of interior insulation. This experience enables you to modernize existing buildings with interior insulation in a contemporary and energy-efficient manner.

Advantages at a glance

- Diffusion-open and capillary-active – no vapor barrier required in the system structure
- Best fire protection – non-combustible insulation material (building material class A1)
- Combined thermal insulation and storage
- Solid sound – like monolithic masonry
- High compressive strength in combination with fabric-reinforced plaster
- Safe and easy to work with
- Can be used on many existing surfaces
- Design freedom thanks to flexible surface design with interior silicate paints or mineral plasters and fillers, right through to wall heating systems on Multipor mineral insulation boards
- Experienced provider and pioneer in capillary-active interior insulation
- Tried and tested over many years

Natural, ecological, and healthy for living

Its natural ingredients make the Multipor mineral insulation board an ecologically valuable and pollutant-free insulation material.

The product declaration (EPD), issued by the Institut Bauen und Umwelt e. V., can be found in the download area at www.multipor.de and documents, for example, the ecological properties. The strict natureplus certification of the insulation board also confirms its environmental compatibility. Excellent quality in terms of healthy living is also certified by the eco-INSTITUT in Cologne –

Category A+: In rooms insulated with Multipor mineral insulation boards, there is no risk of VOC exposure from the insulation systems.

Non-combustibility provides safety

Existing or optimized fire protection is extremely important, especially when renovating existing buildings. Time has not left the existing walls unscathed, and fire protection measures were usually not even considered during the construction phase. Multipor mineral insulation boards are classified as a building or insulation material in building material class A1 (non-combustible) according to DIN EN 13501-1. Together with the corresponding Multipor lightweight mortar, the systems are completely safe, because even in the event of a fire at the highest temperatures, they do not produce smoke, toxic fumes, or



no burning dripping – advantages that can save lives. According to the test certificate, Multipor protects the structure for 90 to 120 minutes, depending on the thickness of the insulation material and the structure.

Sound insulation with Multipor

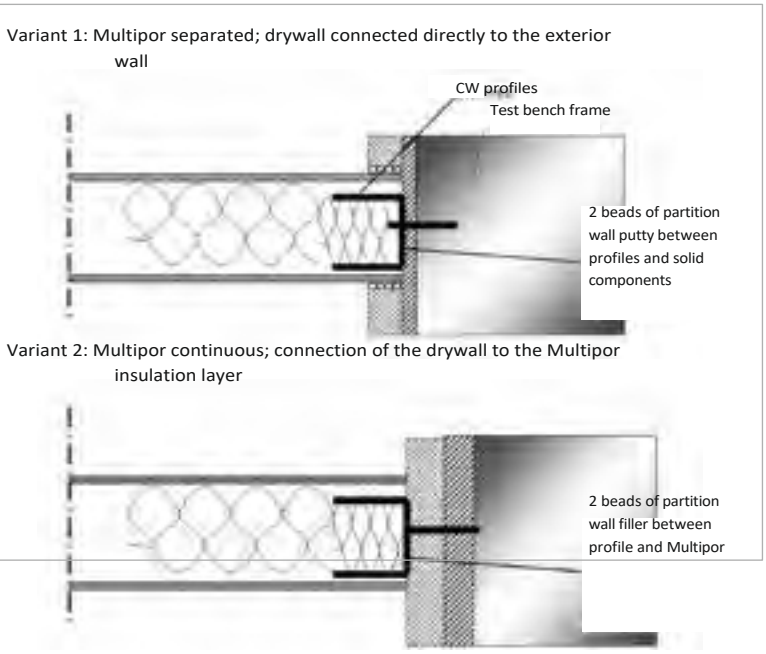
Insulation materials often change the acoustic properties of the component – interior insulation in particular has a significant effect on the sound insulation of the wall. That is why we examine the influencing factors on both the insulated component and subsequently constructed partition walls at our Xella Technology and Research Center.

On the test bench, we measured the sound transmission through the flanking components insulated with Multipor and examined the effect on the rated sound insulation value of the partition wall. Different installation situations were considered (Fig. 1). As part of these measurements, we were able to
No significant effects on the sound insulation value of the separating component can be observed.

Retrofitted interior walls in drywall construction allow
continue to offer full flexibility in living space design, as the interior insulation does not need to be opened at the connection to the partition walls for sound insulation purposes (Fig. 1).

We will be happy to provide you with a corresponding test report from Xella Technologie- und Forschungsgesellschaft mbH on request.

Fig. 1: Sound transmission via flanking solid wall of a drywall



4.1 General introduction and planning

Free surface design The Multipor WI interior insulation system and Multipor WI compact plus are as versatile in their application as they are in the possibilities for subsequent surface design – offering plenty of scope for your own creativity. Here are a few examples:

- Thin-layer felt, textured, and smooth plasters on the reinforcement layer
- Diffusion-open wallpaper and paint coatings
- Drywall solutions on substructure
- Tiles on the reinforcement layer

For instructions on surface design, please refer to Chapter 4.4 or the technical information sheet "Surface Design," which is available for download at www.multipor.de.

A thorough assessment as the basis for reliable planning

As the level of insulation increases, so does the planning effort. However, the maximum energy-saving insulation thickness is not always the most sensible solution for existing buildings. In addition to energy considerations, indoor air quality and DIN 4108-3 (Thermal insulation in building construction; Part 3: Climate-related moisture protection) also play a decisive role. If thermal insulation that meets today's standards is not possible in many existing buildings, even a lower insulation thickness can significantly improve the quality of living and noticeably save energy.

Before planning interior insulation, the existing structure must therefore be assessed in accordance with Figure 2. This provides information about the insulation objective defined by the building owner (e.g., minimum thermal insulation achieved) in coordination with possible usage or monument protection requirements. This ensures the long-term functionality of the construction and renovation work.

An on-site inspection—with at least visual checks—is essential in order to be able to assess the existing structural situation reliably and comprehensively.
The focus here is less on thermal performance and more on assessing the overall structural situation, including moisture, sound, and (if applicable) fire protection.

The following criteria should be set out in writing between the client and the planner:

- Location assessment of the building (protected or exposed location, etc.)
- General condition of the masonry/existing structure
- Current moisture condition of the existing structure, taking into account the degree of salt contamination if applicable
- Protection against driving rain (cladding, paint, plaster) and exposure to driving rain on the exterior facade
  Exposure of individual facades (according to Table 2)
- Other sources of moisture in the structure (rising damp, defective rainwater drainage, etc.)
- Indoor climate conditions
- Building condition analysis with damage assessment and, if necessary,
  mapping and property data collection
- Subsequent use of the building or rooms to be upgraded in terms of energy efficiency

A good indoor climate is crucial

Interior insulation with Multipor can contribute to achieving various energy standards beyond the minimum thermal protection requirements and thus guarantees an energy upgrade for buildings. On the other hand, it also improves well-being by increasing the surface temperature and counteracts mold problems. However, during renovation, connecting components and adjacent ceilings and walls should always be taken into account. Thermal bridge simulations can be very helpful here in order to uncover further energy weak points in the construction and to remedy them as part of the construction project.

Rooms that are only used occasionally, such as churches or other public buildings, can be heated quickly and comfortably thanks to interior insulation with Multipor. The heating energy used remains in the room and is not immediately dissipated to the outside via cold interior walls.

Fig. 2: Flow chart for the planning and implementation of interior insulation



Good indoor climate thanks to a coordinated overall concept Old, leaky windows lead to intensive air exchange in the building, thereby reducing the risk of mold growth. On the other hand, they cause high heating costs. The installation of new windows therefore requires an energy-efficient overall concept, because installing thermal insulation windows without internal insulation increases the risk of mold growth. For this reason, we always recommend insulating the exterior walls, including window reveals, when replacing windows, because moisture does not condense on warm surfaces – a prerequisite

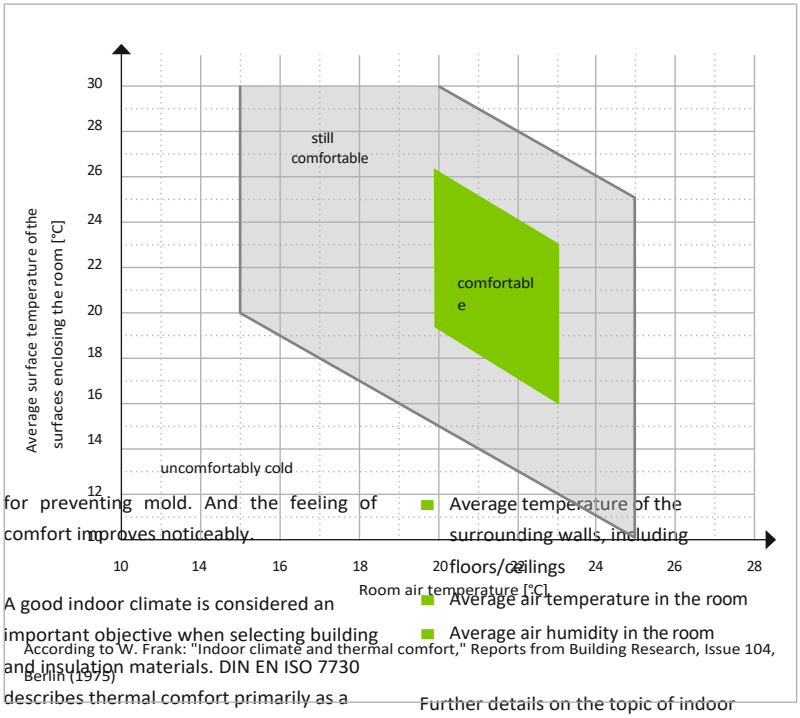


Table 2: Overview of driving rain exposure groups according to DIN 4108-3

Stress group	Description
Stress group I	■ Applies to annual precipitation amounts < 600 mm ■ Applies to higher precipitation amounts in particularly wind-protected locations
Stress group II	■ Applies to an annual precipitation amount of 600 to 800 mm ■ Applies to higher precipitation amounts in particularly wind-protected locations ■ Applies to high-rise buildings and houses in exposed locations that would otherwise be classified in group I
Stress group III	■ Applies to an annual precipitation amount > 800 mm ■ Applies to lower precipitation amounts in windy areas ■ Applies to high-rise buildings and houses in exposed locations that would otherwise be classified in Group II

4.1 General introduction and planning

Fig. 3: Thermal comfort during sedentary work, moderate activity, and appropriately adapted clothing as a function of the average surface temperature of the surfaces enclosing the room and the room air temperature; for more details, see Chapter 7.1



According to W. Frank: "Indoor climate and thermal comfort," Reports from Building Research, Issue 104, Berlin (1975)

for preventing mold. And the feeling of comfort improves noticeably.

A good indoor climate is considered an important objective when selecting building and insulation materials. DIN EN ISO 7730 describes thermal comfort primarily as a feeling of satisfaction with the ambient climate. Although each person develops their own individual ideas about this feeling, it is possible to define generally applicable comfort ranges (Fig. 3). The following main factors contribute to a comfortable indoor climate:

Further details on the topic of indoor climate and some examples are discussed and explained in detail in Chapter 7 on building physics.

Practical tip: In rooms that are only used occasionally, internal insulation with a Multipor internal insulation system allows rooms to heat up quickly while increasing comfort.

Requirements for interior insulation

Retrofitted interior insulation affects the structural behavior of existing buildings. In particular, water vapor diffusion from the inside to the outside must be taken into account, along with the possible formation of condensation on the original, now cold interior surface of the building component. This also means that the exterior wall dries much more slowly after exposure to driving rain, as the average temperature in the building component is lowered. However, careful planning, a high-quality system such as Multipor interior insulation systems, and meticulous execution guarantee successful insulation.

The Multipor WI interior insulation system and Multipor WI compact plus are considered pioneers in diffusion-open interior insulation. Their product and material properties have promoted awareness of simple and structurally sound construction.
Proof of this can be found in a study that found no damage after almost
20 years of interior insulation with Multipor in a residential complex. Take advantage of the expertise of our Multipor consultants to successfully implement your upcoming renovation projects together.



Requirements of the current EnEV for existing buildings

The current Energy Saving Ordinance discusses the level of requirements for the renovation of existing buildings. The minimum thermal insulation must be observed for the interior insulation of exterior walls, even if the current EnEV no longer regulates interior wall insulation in the case of renovation. A recommended U-value of 0.35 W/(m²K) for interior insulation is easily achievable with Multipor, both technically and in terms of building physics.

Multipor interior insulation systems offer optimal solutions for the current general requirements for existing exterior walls. Furthermore, the regulation stipulates that in building constructions, "the influence of structural thermal bridges on heating energy consumption is kept as low as possible." The flat-rate thermal bridge allowance for interior insulation could initially negate a well-thought-out solution from an energy perspective or lead to uneconomical insulation thicknesses. This represents a further energy-saving potential of up to 30% in relation to the annual heating requirements of a building. You can find more information on the EnEV in chapter 7.1.6.

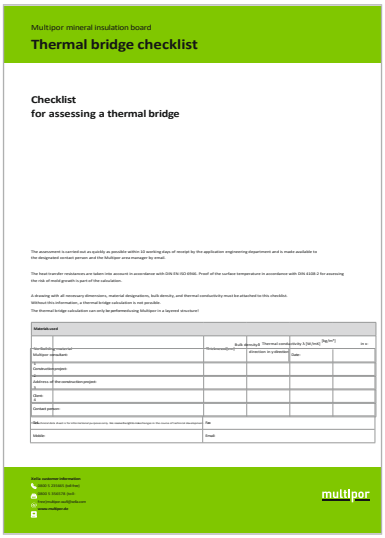
Practical tip: Even though the current EnEV does not specify any requirements in connection with interior insulation, a U-value of 0.35 W/m²K is sensible and feasible in terms of building physics with MPO. It is climate-friendly and therefore environmentally friendly in the long term, and also easy on the wallet.

Our service for you: We offer you exemplary, mathematical verification of selected thermal bridges in a wide variety of constructions and structures. You can find the required checklist in the download area at www.multipor.de.

Types of interior insulation systems

There are basically two options for interior insulation:

1. Diffusion-retarding and diffusion-tight interior insulation systems (Fig. 4): These systems, such as pre-wall constructions with mineral wool and vapor barrier foil or nearly diffusion-tight synthetic foams, prevent vapor diffusion into the wall and thus also prevent the existing wall construction from drying out inward, as would be possible in summer. At the same time, they require high-quality workmanship, especially in the area of details and connections. Diffusion-retarding or diffusion-tight systems require great care during installation and also during use. An airtight design and analogous connections to adjacent components are paramount, as even a retrofitted socket that has been installed improperly can lead to moisture damage. Experience shows that such systems – especially in the connection area – can be damaged under construction site conditions and during subsequent use.


Multipor mineral insulation board
Thermal bridge checklist

Checklist
for assessing a thermal bridge

multipor

4.1 General introduction and planning

2. Diffusion-open, capillary-active interior insulation systems (Fig. 5): These modern, safe, and long-proven systems allow vapor diffusion into the wall, absorb the moisture that accumulates, buffer it, and transport it back to the interior surface by capillary action. This, on the one hand, the moisture level in the wall can be permanently reduced to a non-critical level, and on the other hand, the wall remains diffusion-open and can thus both cushion moisture peaks from the room air and dry out increased moisture loads from the existing structure to the inside. The multipor interior insulation systems are ideally suited for this purpose. The numerous areas of application will be explained in more detail below.

For a basic explanation of how the different systems work, please refer to the explanations in Chapter 7 on building physics.

Fig. 4: Principle of how diffusion-retardant interior insulation works

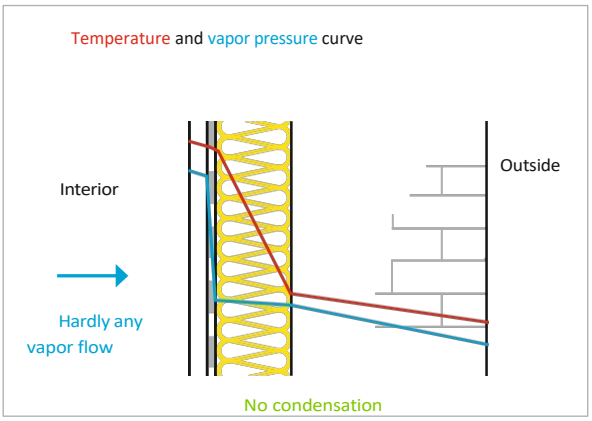
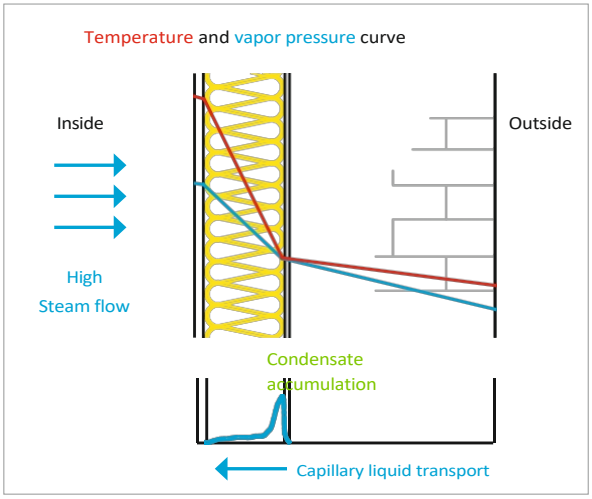


Fig. 5: Principle of how diffusion-open interior insulation works



Prof. Dr.-Ing. Hartwig M. Künzel from the Fraunhofer Institute in Holzkirchen on the subject of building physics verification of interior insulation systems: When it comes to moisture transport through building components, practitioners primarily think of vapor diffusion, dew point, and the Glaser method in DIN 4108. If a component is classified as safe according to Glaser, then think primarily of vapor diffusion, dew point, and the Glaser method in DIN 4108. If a building component is classified as safe according to Glaser, all relevant points are clarified for the planner. Only when unexpected moisture damage occurs or the planned building component fails the standard calculation according to Glaser are alternative assessment options sought. Winter condensation due to vapor diffusion is only one of many moisture loads, so that a positive assessment according to DIN 4108 can simulate non-existent moisture safety. Room air convection, precipitation, or rising moisture are not taken into account here. The same applies to building moisture, which is becoming increasingly problematic due to today's time pressures. In order to also capture these influences , it is necessary to move away from the simple stationary evaluation method according to Glaser to a realistic simulation of the moisture conditions in building components, whereby specially developed unsteady calculation methods have proven to be a reliable and practical solution, as pointed out in the new draft of DIN 4108-3. The now widely used transient simulation model WUFI® (see also Chapter 7) analyzes the requirements in terms of material and climate data as well as the accuracy of the calculations, thus offering numerous advantages for practical application. The following areas of application and possible conclusions regarding climate-related hygrothermal component behavior are worth mentioning, which go far beyond the previous assessment options according to Glaser:

- Real condensation situation during the heating period, taking into account water vapor sorption and capillary conduction
- Drying out of building moisture
- Summer condensation due to reverse diffusion
- Solar radiation, driving rain exposure, and surface condensation on roofs and facades
- Influence of moisture on energy balance

The results for moisture and temperature in the building component are available in any location and time resolution and can be used for:

- Extrapolating test results
- Transferring proven designs to other climatic conditions
- Planning new construction, conversion, and renovation measures
- Developing and optimizing building products
- Determining maximum permissible indoor humidity loads
- Determination of the hygrothermal conditions and application limits of building materials and components

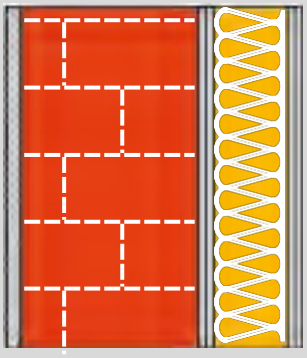
The advantages outlined above have led to strong demand for computational analyses in recent years, particularly in the field of old building renovation, as standard solutions often fail. The Multipor mineral insulation board WI has already been used many times and with growing success in interior insulation. Since this product is stored in the "WUFI(®)database," transient calculations for a wide variety of component structures are possible at any time.

In 1997, on the initiative of the WTA (Scientific-Technical Working Group for Building Maintenance and Monument Preservation), a WTA working group was formed to draw up practical guidelines and establish regulated use of hygrothermal simulation methods in the construction industry.

4.1 General introduction and planning



Fig. 6: Example wall structure with Multipor interior insulation

Solid interior insulation without vapor barrier: Construction structure from left to right	
Material	
Exterior plaster CS II	
Masonry (brick)	
Interior plaster CS II	
Multipor lightweight mortar	
Multipor mineral insulation board	
Reinforcement (Multipor lightweight mortar)	
Finishing plaster/felted (Multipor lightweight mortar or fine lime plaster)	

Wall construction with Multipor interior insulation systems
If effective thermal insulation is the main priority, Multipor mineral insulation boards WI in thicknesses of 60 to 140 mm are used.
However, from a building physics perspective, thicker insulation materials are also suitable for energy-efficient renovation at the highest level. This makes it possible to achieve 80% savings in heating oil and CO_2 emissions for the building component without any problems.

Practical tip: The following rule of thumb applies: U-value x 10 = heating oil consumption in liters per m^2 of heated area and heating period, U-value x 10 x 3 = CO_2 emissions in kg per m^2 of heated area and heating period.

Figure 6 shows an example of the system structure of Multipor interior insulation systems. The system structure forms the basis for the U-value calculations in Tables 3 and 4 with different wall types.

This should be distinguished from residential renovation, which primarily aims to improve the indoor climate and/or prevent mold. However, due to the lower insulation thickness, only a "still comfortable" indoor climate can be achieved (Fig. 3).

Tables 3 and 4 show the potential of interior insulation depending on the renovation goal, based on different wall structures. While insulation with Multipor WI compact plus focuses on increasing the interior temperature of the exterior wall, structures with higher insulation thicknesses show the potential for energy-efficient renovation through a significant improvement in the U-value.

Component constructions with Multipor interior insulation systems We have verified all of the following layer structures with Multipor mineral insulation board have been verified by means of numerical climate simulations. We applied the temperature, relative humidity, direct and indirect solar radiation, and driving rain on the outside in accordance with the climate in central Germany, and a constant air temperature of 20 °C and 50% relative humidity on the inside in accordance with DIN 4108.
The result: the increase in water content during the cold half of the year – mainly in the form of gas as relative humidity in the pore air – is not critical, as it dries out completely during the evaporation period in all cases. However, when installing Multipor interior insulation systems, the current installation instructions must be followed in order to ensure the long-term functionality of the system in terms of building physics.
In order to respond even more precisely to specific customer requirements and sub-

Table 3: Improvement of the U-values of double-shell walls through Multipor interior wall insulation WI

Wall structure before	Thickness d [mm]	U-values [W/(m² K)]	Wall structure with Multipor WI compact plus λ = 0.045 W/(mK)		Wall construction with Multipor WI λ = 0.042 W/(mK)				
			30 [mm]	40 [mm]	60 [mm]	80 [mm]	100 [mm]	120 [mm]	140 [mm]
Calcium silicate brick λ = 0.99 W/(mK)	115	U-value before	2.43	2.43	2.43	2.43	2.43	2.43	2.43
		U-value after	0.92	0.76	0.54	0.43	0.36	0.30	0.27
	240	U-value before	1.86	1.86	1.86	1.86	1.86	1.86	1.86
		U-value after	0.82	0.69	0.50	0.41	0.34	0.29	0.26
	300	U-value before	1.67	1.67	1.67	1.67	1.67	1.67	1.67
		U-value after	0.78	0.66	0.49	0.40	0.33	0.29	0.25

Assumptions: Solid brick: λ = 1.2 W/(mK), d = 11.5 cm, no air layer, masonry according to table, interior plaster: λ = 0.51 W/(mK), d = 15 mm, After renovation: Lightweight mortar: $\lambda_{10,dry}$ = 0.18 W/(mK), d = 10 mm, heat transfer resistances: R_{si} = 0.13 m^2 K/W, R_{se} = 0.04 m^2 K/W

4.1 General introduction and planning

Table 4: Improvement of the U-values of existing monolithic walls through Multipor interior wall insulation

Wall structure before	Thickness d [mm]	U-values [W/(m² K)]	Wall structure with Multipor WI compact plus λ = 0.045 W/(mK)		Wall construction with Multipor WI λ = 0.042 W/(mK)				
			30 [mm]	40 [mm]	60 [mm]	80 [mm]	100 [mm]	120 [mm]	140 [mm]
Brick λ = 0.86 W/(mK)	115	U-value before	2.76	2.76	2.76	2.76	2.76	2.76	2.76
		U-value after	0.97	0.80	0.56	0.44	0.36	0.31	0.27
	175	U-value before	2.31	2.31	2.31	2.31	2.31	2.31	2.31
		U-value after	0.91	0.76	0.54	0.43	0.36	0.30	0.27
	240	U-value before	1.97	1.97	1.97	1.97	1.97	1.97	1.97
		U-value after	0.85	0.72	0.52	0.41	0.35	0.30	0.26
	300	U-value before	1.73	1.73	1.73	1.73	1.73	1.73	1.73
		U-value after	0.80	0.68	0.50	0.40	0.34	0.29	0.26
	365	U-value before	1.53	1.53	1.53	1.53	1.53	1.53	1.53
		U-value after	0.76	0.65	0.48	0.39	0.33	0.28	0.25
Calcium silicate brick λ = 0.99 W/(mK)	115	U-value before	2.9	2.90	2.90	2.90	2.90	2.90	2.90
		U-value after	0.99	0.81	0.56	0.44	0.37	0.31	0.27
	175	U-value before	2.46	2.46	2.46	2.46	2.46	2.46	2.46
		U-value after	0.93	0.77	0.55	0.43	0.36	0.31	0.27
	240	U-value before	2.12	2.12	2.12	2.12	2.12	2.12	2.12
		U-value after	0.88	0.74	0.53	0.42	0.35	0.30	0.26
	300	U-value before	1.88	1.88	1.88	1.88	1.88	1.88	1.88
		U-value after	0.83	0.70	0.51	0.41	0.34	0.30	0.26
Aerated concrete λ = 0.21 W/(mK)	115	U-value before	1.29	1.29	1.29	1.29	1.29	1.29	1.29
		U-value after	0.69	0.60	0.45	0.37	0.32	0.28	0.24
	240	U-value before	0.73	0.73	0.73	0.73	0.73	0.73	0.73
		U-value after	0.49	0.44	0.36	0.31	0.27	0.24	0.21
	300	U-value before	0.60	0.60	0.60	0.60	0.60	0.60	0.60
		U-value after	0.43	0.39	0.32	0.28	0.25	0.22	0.20
Aerated concrete assembly component λ = 0.14 W/(mK)	150	U-value before	0.77	0.77	0.77	0.77	0.77	0.77	0.77
		U-value after	0.51	0.46	0.37	0.31	0.27	0.24	0.22
	200	U-value before	0.60	0.60	0.60	0.60	0.60	0.60	0.60
		U-value after	0.43	0.39	0.32	0.28	0.25	0.22	0.2
	250	U-value before	0.32	0.32	0.32	0.32	0.32	0.32	0.32
		U-value after	0.37	0.34	0.29	0.26	0.23	0.21	0.19
Concrete λ = 2.1 W/(mK)	200	U-value before	3.08	3.08	3.08	3.08	3.08	3.08	3.08
		U-value after	1.01	0.82	0.57	0.45	0.37	0.31	0.27
	250	U-value before	2.87	2.87	2.87	2.87	2.87	2.87	2.87
		U-value after	0.99	0.81	0.56	0.44	0.37	0.31	0.27
	300	U-value before	2.69	2.69	2.69	2.69	2.69	2.69	2.69
		U-value after	0.96	0.79	0.56	0.44	0.36	0.31	0.27

Assumptions: Masonry according to table, interior plaster: λ = 0.51 W/(mK), d = 20 mm; exterior plaster: λ = 1.0 W/(mK), d = 20 mm; heat transfer resistances: R_{si} = 0.13 m² K/W, R_{se} = 0.04 m²K/W

Our expert Multipor consultants are on hand to help you deal with different building and component variants.

Multipor offers its customers a moisture technology verification service with transient verification programs for a wide variety of constructions and structures (see section 7.2.5). Our expertise is based on thousands of project-specific evaluations for successful and practical implementation. In addition, a checklist for reliable planning is available to our customers in the download area at www.multipor.de.

WTA recommendations on interior insulation must be taken into account
The Scientific and Technical Working Group for Building Maintenance and Monument Preservation (WTA) has published a series of information sheets on these topics. The information sheets from Department 6 (Physical Fundamentals) include information on interior insulation and its verification, while Department 8 (Half-timbered Buildings) provides many useful tips on the topic of energy-efficient half-timbered building renovation in its series of information sheets.

Xella Deutschland GmbH is actively involved in a wide variety of working groups and is also a supporting member of the WTA, which means that new findings and experiences from the working group – and beyond – can be published in a timely manner.

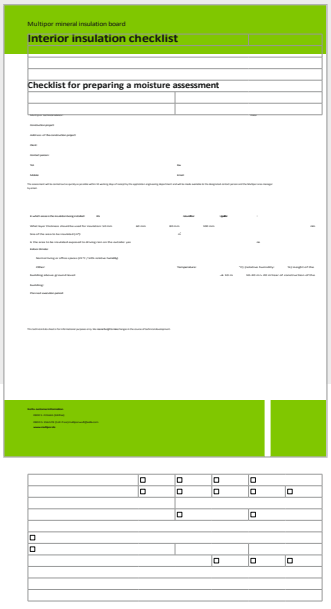
The application of the simulation methods described above, taking into account the relevant WTA information sheets, leads to successful verification and the safe implementation of vapor-permeable, capillary-active Multipor interior insulation systems.

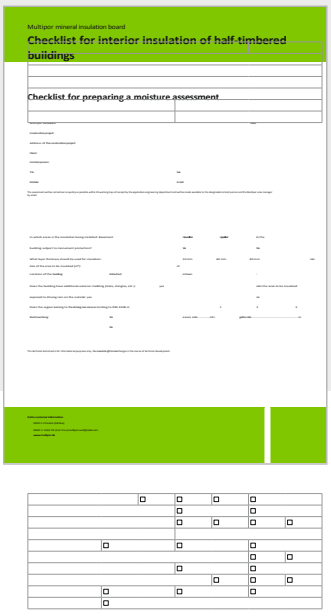
In addition, this method can also be used to include the moisture behavior of adjacent components – such as connecting wooden

This ensures a safe wall structure and planning reliability for sensitive construction details.

Countless mathematical verifications prove that the solid and mineral systems function flawlessly in implementation. Numerous positive user experiences with Multipor interior insulation systems also underscore their effective and lasting contribution to energy-saving heat and moisture protection.

Practical tip: We would be happy to determine the U-value of your existing wall to be insulated using non-destructive U-value measurement. Please contact our application engineering department for more information.


Multipor mineral insulation board
Interior insulation checklist
Checklist for preparing a moisture assessment


Multipor mineral insulation board
Checklist for interior insulation of half-timbered buildings
Checklist for preparing a moisture assessment

Project and reference report





Thomasblock (former Donnerschwee barracks), Oldenburg

- Renovation and careful conversion of the barracks into residential accommodation
- Preservation of the listed facade
- Comfortable indoor climate and sustainable environmental compatibility
- High thermal insulation and optimum fire protection
- Fast processing without vapor barrier

Property	
Building type	Residential quarter
Location	Oldenburg
Application	Interior insulation
Products used	■ Multipor mineral insulation board WI, d = 100 mm ■ Multipor lightweight mortar

Project and reference report





Community elementary school, Duisburg

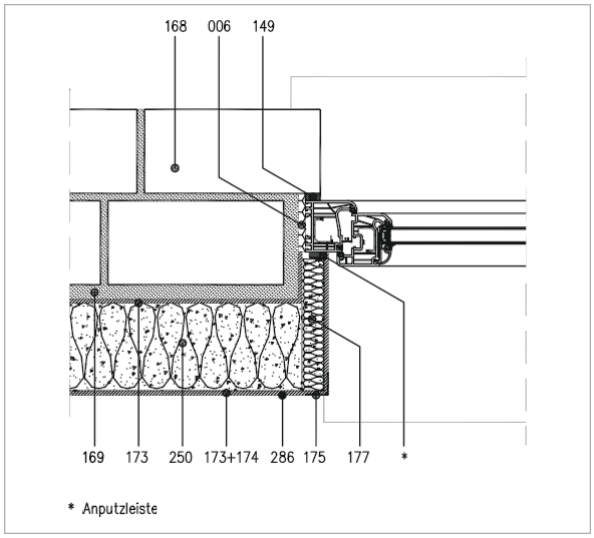
- Energy-efficient modernization of a listed school building
- Achievement of the EnEV standard valid at the time
- Energy cost savings of 70%
- High health compatibility
- Fast and economical processing of around 1,400 m² of Multipor mineral insulation boards

Property data	
Building type	School
Location	Duisburg
Application	Interior insulation
Products	■ 900 m² Multipor mineral insulation board d = 100 mm 500 m² Multipor mineral insulation board d = 60 mm ■ Multipor lightweight mortar

4.2 Construction examples of interior insulation systems

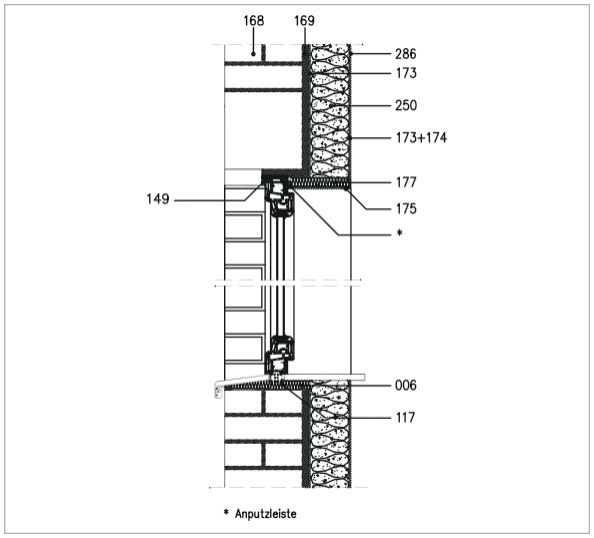
Construction examples of interior insulation systems

Horizontal section Window



Interior insulation 16-001

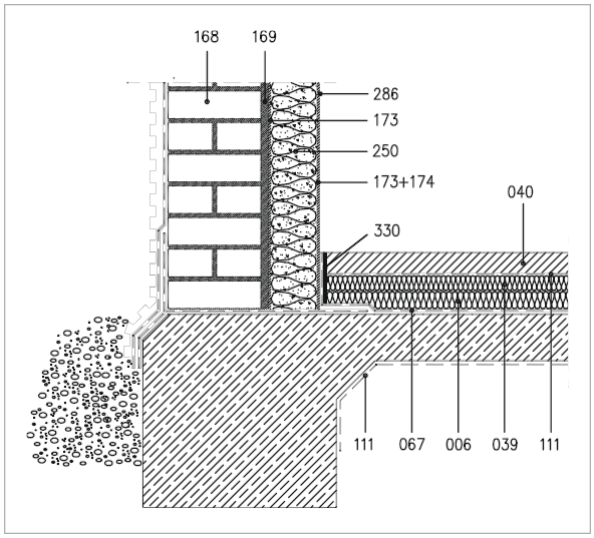
Vertical section window



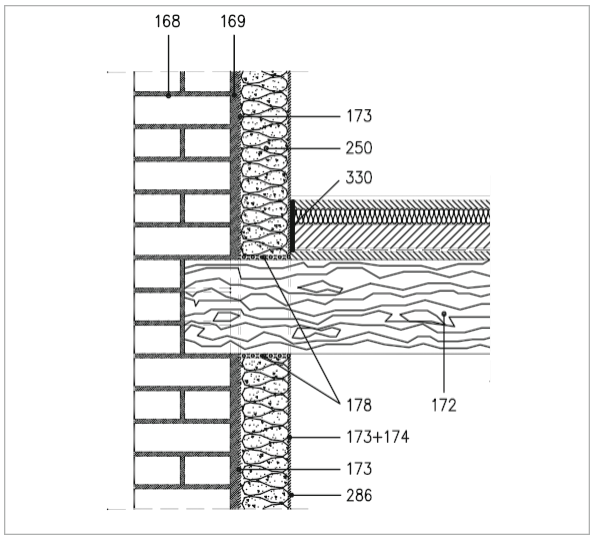
Interior insulation 16-002

Cross-section of foundation/exterior wall with interior insulation

Interior insulation 16-003



Wooden beam ceiling with exposed beams / exterior wall with interior insulation



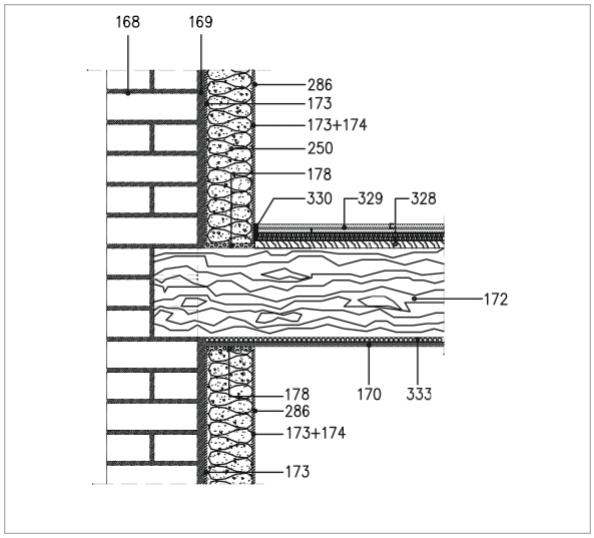
Interior insulation 16-004

006	Thermal insulation				
03	Impact sound insulation	168	Existing masonry	175	Corner protection rail
04	Floating screed	169	Interior plaster available	177	Multipor soffit panel
067	Horizontal waterproofing/barrier layer		(without leveling plaster)	178	Multipor hemp felt insulation strip
11	Separation or protective layer	17	Wooden beams	250	Multipor interior insulation WI
117	Elastic sealing tape	173	Multipor lightweight mortar	286	System-compatible interior plaster
149	Pre-compressed sealing tape	174	Multipor reinforcement fabric	330	Screed edge insulation strip

These and other construction examples can be found at www.multipor.de/konstruktionsbeispiele

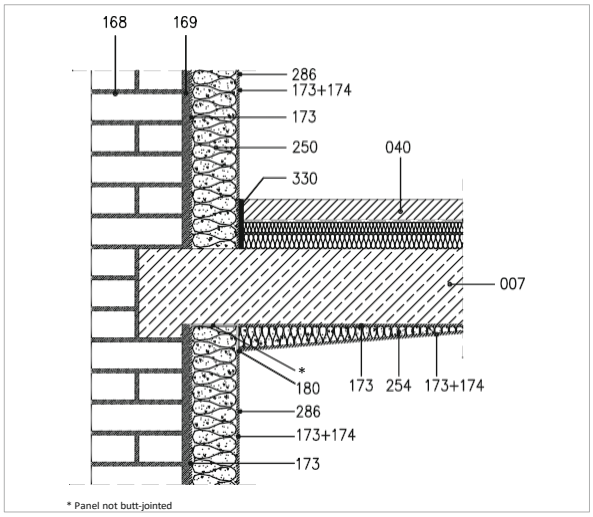
Construction examples of interior insulation systems

Wooden beam ceiling without visible beams / Exterior wall with interior insulation



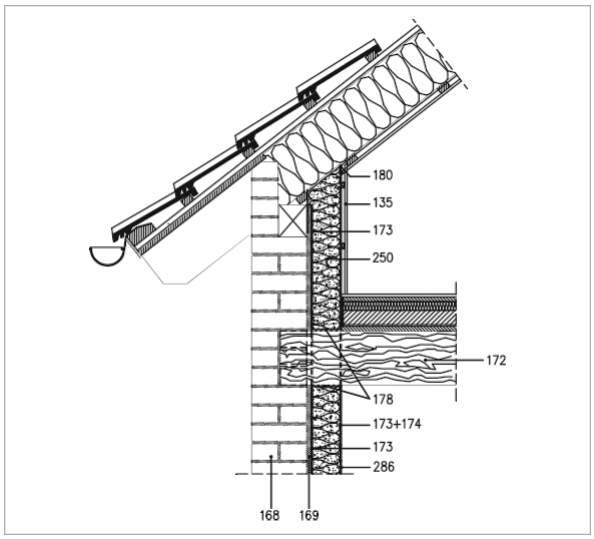
Interior insulation 16-005

Reinforced concrete ceiling with insulation wedge / Exterior wall with interior insulation



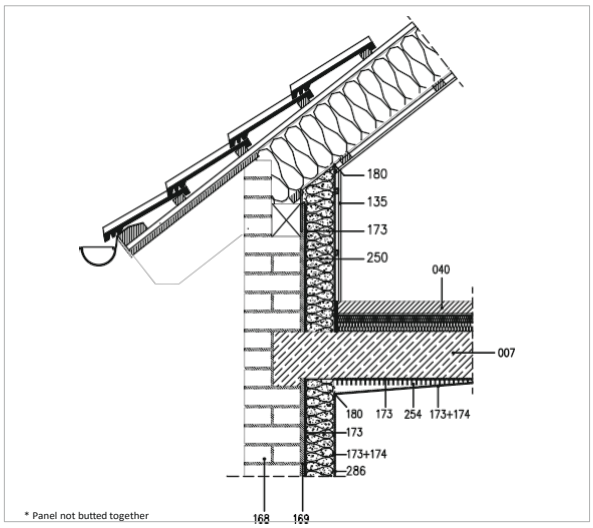
Interior insulation 16-006

Roof connection with wooden beam ceiling



Interior insulation 16-009

Roof connection with solid ceiling



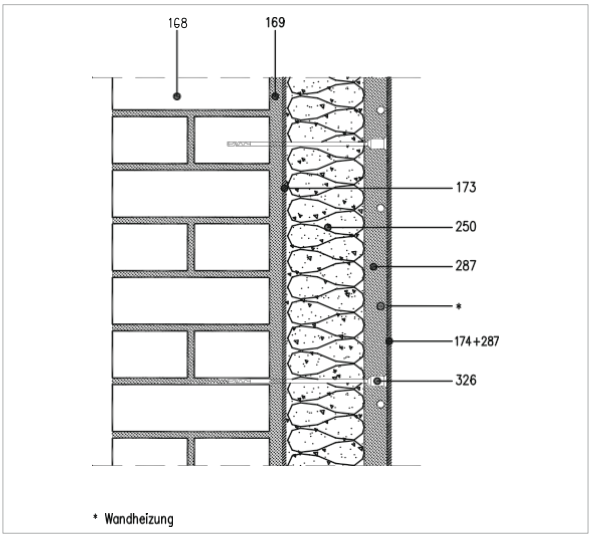
Interior insulation 16-010

007	Reinforced concrete ceiling				
04	Floating screed	172	Wooden beams	254	Multipor insulation wedge
135	Plasterboard	173	Multipor lightweight mortar	286	System-compliant interior plaster
168	Existing masonry	174	Multipor reinforcement mesh	32	Plank flooring
169	Interior plaster available (without leveling plaster)	17	Multipor hemp felt insulation strips	329	Dry screed
		180	Trowel cut	330	Screed edge insulation strip
170	Ceiling plaster present	250	Multipor interior insulation WI	33	Reed

4.2 Construction examples of interior insulation systems

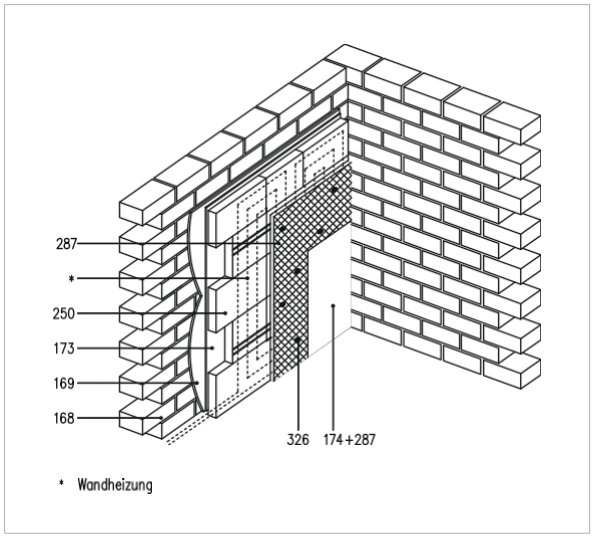
Construction examples of interior insulation systems

Cross-section with wall heating



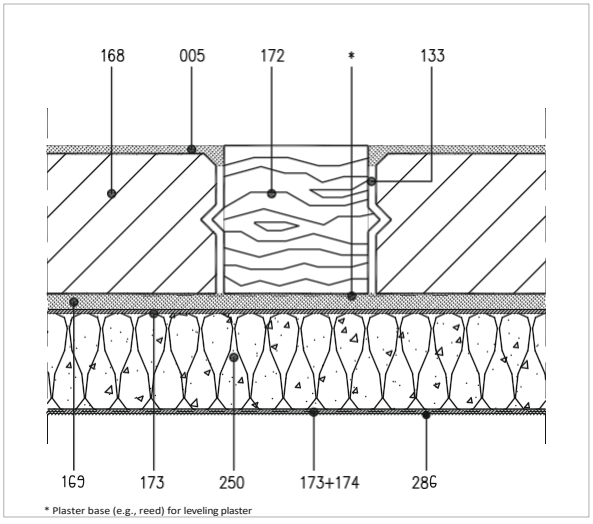
Interior insulation 16-007

Wall heating – spatial representation



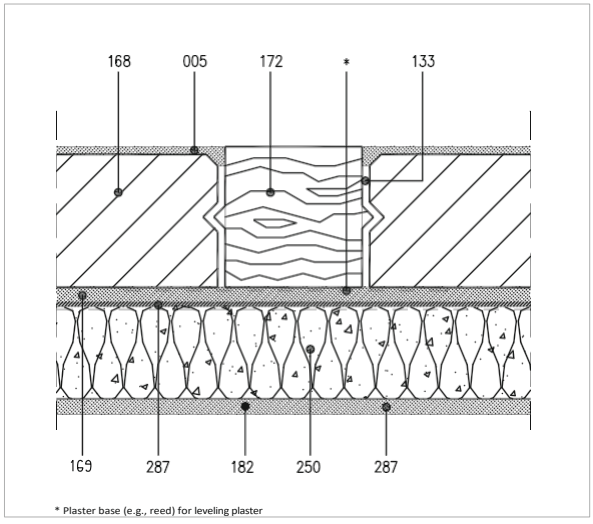
Interior insulation 16-008

Half-timbered construction /
Interior insulation with Multipor lightweight mortar



Interior insulation 16-011

Half-timbered construction /
Interior insulation with Multipor clay mortar



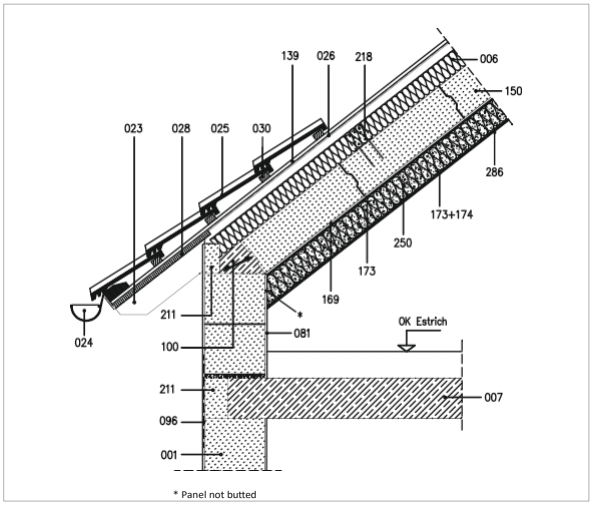
Interior insulation 16-012

005 Exterior plaster
026 Underlay membrane, diffusion-open
133 Lightweight mortar
168 Existing masonry
169 Interior plaster present (without leveling plaster)
17 Wooden beams
173 Multipor lightweight mortar
174 Multipor reinforcement fabric
182 Multipor reinforcement mesh 7 x 7 mm
250 Multipor interior insulation WI
28 System-compliant interior plaster
287 Multipor clay mortar
326 Multipor screw anchors (through the fabric, approx. 4 anchors per m²)

These and other construction examples can be found at www.multipor.de/konstruktionsbeispiele

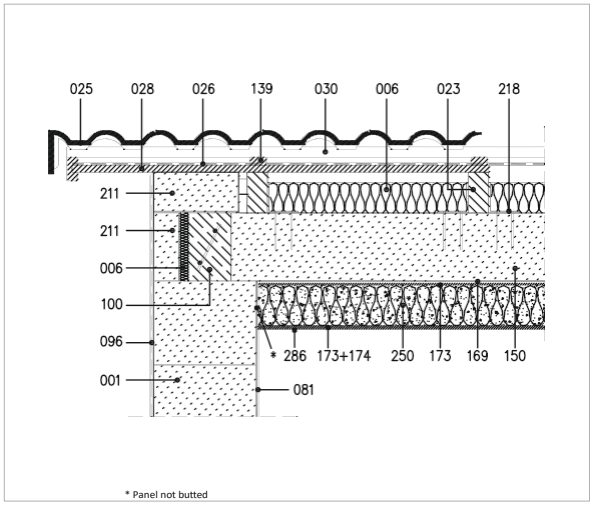
Construction examples of interior insulation systems

Ytong solid roof with Multipor mineral insulation board on the underside, eaves detail



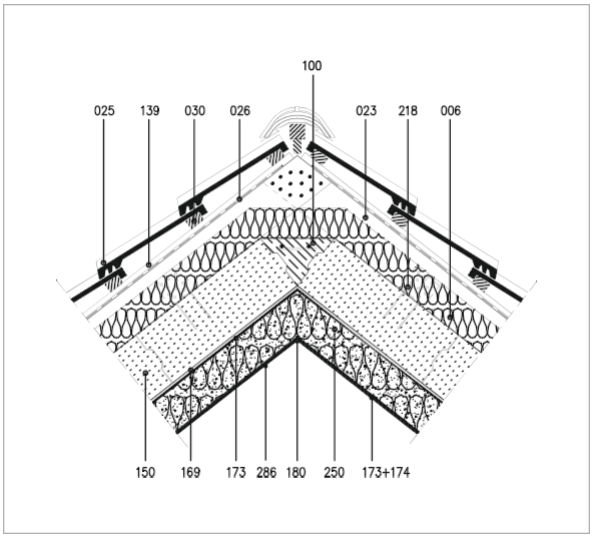
Interior insulation 16-013

Ytong solid roof with Multipor mineral insulation board underneath, verge detail



Interior insulation 16-014

Ytong solid roof with Multipor mineral insulation board underneath, ridge detail

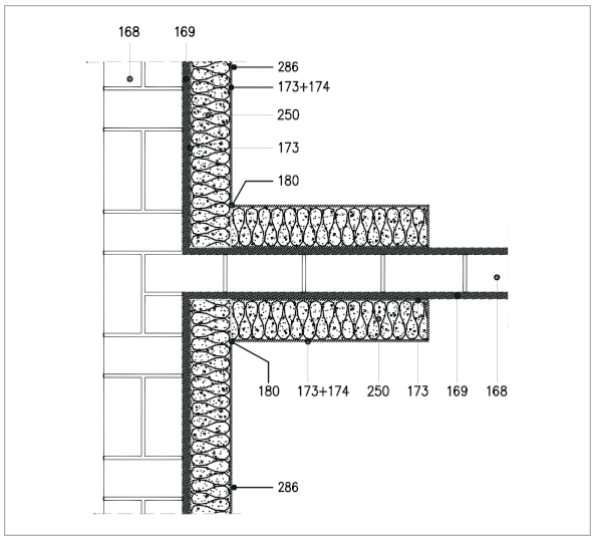


Interior insulation 16-015

001 Ytong masonry
006 Thermal insulation
007 Reinforced concrete ceiling
023 Rafters
024 Rain gutter
025 Roof tiles
026 Underlay membrane, diffusion-open
028 Wooden formwork
03 Roof battens
08 Interior plaster
096 Fabric insert
100 Ring anchor
139 Lathing
150 Ytong roof panel
169 Interior plaster available
173 Multipor lightweight mortar
174 Multipor reinforcement mesh
180 Trowel cut
211 Ytong flat construction panel
218 Galvanized steel angle bracket
250 Multipor interior insulation WI
286 System-compliant interior plaster

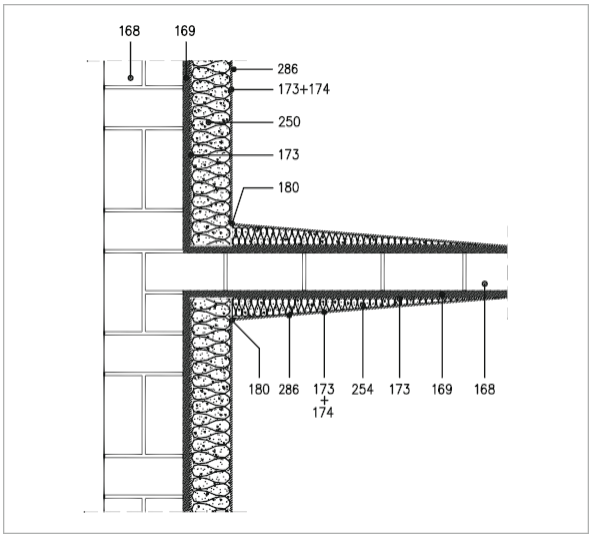
Construction examples of interior insulation systems

Integrating existing interior wall with straight insulation board



Interior insulation 16-016

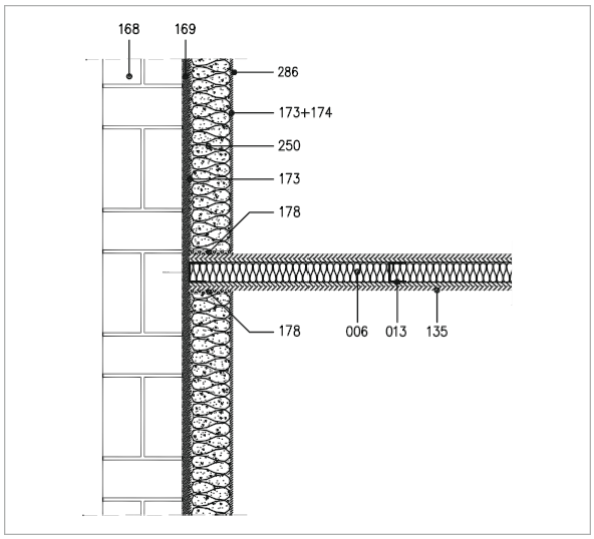
Integrating existing interior wall with insulation wedge



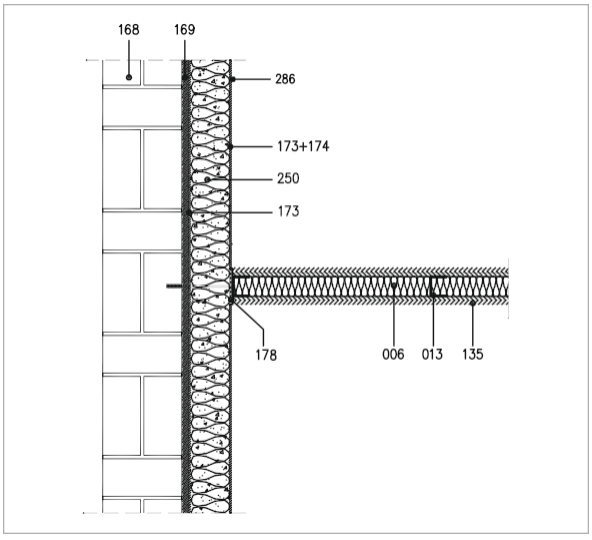
Interior insulation 16-017

Connection of drywall directly to the exterior wall

Interior insulation 16-018



Connection of the drywall directly to the Multipor insulation layer



Interior insulation 16-019

006 Thermal insulation
013 Steel profile
135 Gypsum fiberboard
168 Existing masonry
169 Interior plaster present (without leveling plaster)
173 Multipor lightweight mortar
174 Multipor reinforcement fabric
178 Multipor hemp felt insulation strips
180 Trowel cut
25 Multipor interior insulation WI
254 Multipor insulation wedge
28 System-compliant interior plaster

These and other construction examples can be found at www.multipor.de/konstruktionsbeispiele

Tools and accessories for
bricklaying and insulation

Xella



www.multipor-werkzeugshop.de

multipor

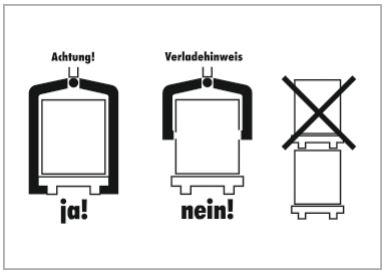
4.3 Products and system components

The solid and dimensionally stable Multipor mineral insulation boards WI and WI compact plus are both handy and lightweight and can be processed quickly, easily, and cleanly with a sanding board and saw. Thanks to the coordinated Multipor lightweight mortar, they can also be bonded quickly, so that mechanical fastening is usually unnecessary. The products are subject to continuous internal and external quality control during production before they are transported to the application site or temporary storage. High system safety during use rounds off the product quality.

Delivery and handling

The Multipor WI interior insulation system, including all system components, should be delivered as directly as possible to the processing site in order to avoid unnecessary time-consuming and cost-intensive intermediate transport. If intermediate storage is nevertheless necessary, firm, level, and dry storage areas must be ensured. Our experienced shipping companies have vehicles equipped with a hydraulic crane or forklift that can handle the insulation.

Fig. 1: Loading instructions



plates as individual items or pallets carefully next to the vehicle on a level surface. Depending on the agreement and technical conditions, it is also possible to store them near the installation site. On special order, we deliver to smaller construction sites with particularly compact motor vehicles, which are also suitable for delivering smaller additional quantities.

Only suitable lifting equipment approved by the employers' liability insurance association may be used for unloading and moving. Multipor mineral insulation boards can also be transported on paved surfaces using a pallet truck.

To unload the package, the loading clamp grips around the package under the pallet and lifts the load safely. Under no circumstances should it grip or press against the Multipor mineral insulation boards WI (see Fig. 1), nor should the pallets be stacked. Unloading using slings, ropes, or chains should also always be avoided, as these can cause damage to the material.

Palletized Multipor mineral insulation boards WI are bundled in handy small packages and protected from the weather by a film. This also ensures the stability of the package unit and should therefore only be removed shortly before installation. Multipor WI compact plus is also palletized, but is additionally packed in handy cartons and delivered to the construction site or retailer.



Multipor pallet



Carton Multipor WI compact plus



Small package Multipor mineral insulation board WI



Multipor tools

For easy and safe processing

Tools and accessories at: **multipor-werkzeugshop.de**



System add-on products, such as Multipor soffit panels or Multipor insulation wedges, which can be used to reduce thermal bridges, are also conveniently and securely packaged in cartons. The packaging can be disposed of sustainably in accordance with Interseroh contract number 31560. This is another way in which we contribute to climate and environmental protection.

Tools and aids

Tools designed specifically for Multipor interior insulation systems enable professional and rapid construction progress.

Fine-toothed Multipor handsaw

The fine-toothed Multipor handsaw allows Multipor mineral insulation boards to be cut easily, quickly, and precisely [1] [7–10].

Multipor notched trowel

The Multipor notched trowel ensures that Multipor lightweight mortar is applied to the entire surface of the mineral insulation boards. Notching per board thickness:

≤ 140 mm panel thickness = 12 mm, from 160 mm panel thickness = 15 mm.

For optimum application every time, the notched trowel should be cleaned thoroughly immediately after use [2].

Multipor mixing paddle

Multipor lightweight mortar is best mixed in a Multipor bucket using a slow-running mixer and a robust Multipor mixing paddle with long blades until the desired consistency is achieved.

For consistently optimal mixing results, the mixing paddles should be cleaned thoroughly immediately after use [3].

Multipor sanding board

Multipor WI and WI compact plus mineral insulation boards are easy to sand. After sanding, remove the sanding dust from the treated surface with a hand brush or industrial vacuum cleaner to ensure that the Multipor lightweight mortar has the necessary adhesion [4] [11].



Multipor insulation wedge

1



Multipor foxtail

2



Multipor notched trowel

3



Multipor mixing paddle

4

4.3 Products and system components



Multipor sanding board



Multipor bucket



Mixing Multipor lightweight mortar

System components

Multipor lightweight mortar

Multipor lightweight mortar is mixed with the amount of water specified on the bag, observing the processing and safety instructions provided. Multipor lightweight mortar may be processed at air, material, and component temperatures between +5 °C and + 30 °C air, material, and component temperature. Using a slow-running mixer and a robust mixing paddle with long blades, the mortar mixture can be mixed to a consistency that is easy to work with. The mortar should be left to mature for about 5 minutes and then mixed again before use [6].

- 8 l water requirement per 20 kg bag of Multipor lightweight mortar when mixing with the mixing paddle
- Processing time: approx. 1.5 hours, depending on weather conditions. Can be processed at air, material, and component temperatures between +5 °C and +30 °C.
- Due to the high yield of Multipor lightweight mortar, the 30 l of fresh mortar per bag is sufficient for up to 6 m² of bonding surface with a layer thickness of 5 mm, depending on the substrate condition.
- Multipor lightweight mortar can of course also be processed with standard plastering machines. The respective settings are device-specific.

Always observe the delivery and processing instructions on the container . Multipor lightweight mortar can be stored dry on the pallet for 12 months from the date of manufacture.

Only Multipor lightweight mortar must be used, otherwise damage-free and structurally functional bonding of the system cannot be guaranteed.



Easy cutting



Creating a recess

Multipor hemp felt insulation strips as decoupling

The first row of interior insulation must be installed with particular care to ensure that it is plumb and level. Any differences in height compared to the adjacent floor structure must also be taken into account. Structures that are expected to exhibit different expansion behavior or settlement also require a decoupling strip between the components. Multipor

Hemp felt insulation strips are particularly well suited for optimal sound and elastic decoupling of Multipor mineral insulation boards WI and WI compact plus when installing interior insulation against connecting building components (ceilings, floors, or interior walls) [12].

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Notching panels for existing electrical cables

11



Adapting the panel to round and square shapes

Table 1: Technical data for Multipor lightweight mortar

Lightweight mortar	LW according to EN 998-1
Compressive strength class	CS II; 1.5–5.0 N/mm²
Diffusion resistance factor	$\mu \leq 10$
Capillary water absorption	W2, c ≤ 0.2 kg/(m² $min^{0.5}$)
Thermal conductivity	$\lambda_{10,dry}$ = 0.18 W/(mK)
Building material class	A2-s1, d0; non-combustible
Weight per bag	20 kg
Pallet contents	40 bags

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Multipor hemp felt insulation strips

Table 2: Technical data for Multipor hemp felt insulation strips

100% hemp fibers	
Bulk density	155–210 kg/m³
Thermal conductivity	$\lambda_{10,dry}$ = 0.047 W/(mK)
Water vapor diffusion resistance factor	μ = 1 to 2
Building material class	E
Specific heat capacity	c = 2,300 J/(kgK)
Roll dimensions L x W x H	25 m x 50 mm x 5 mm 25 m x 100 mm x 5 mm

4.3 Products and system components

Table 3: Technical data for Multipor soffit panels

Dry bulk density	approx. 115 kg/m³		
Compressive strength	≥ 350 kPa		
Tensile strength	≥ 80 kPa		
Thermal conductivity	λ = 0.047 W/(mK)		
Water vapor diffusion resistance factor	μ = 3		
Building material class	A1; non-combustible		
Dimensions, delivery format	Dimensions L x W x H [mm]	Pieces/box	m² /carton
	600 x 250 x 20	12	1.80
	600 x 250 x 30	8	1.2
	600 x 250 x 40	6	0.9

Multipor soffit panels Thermal bridges can best be reduced in the soffit area with Multipor soffit panels. Depending on the space available and requirements, panels with thicknesses of 20, 30, and 40 mm are available, which are processed in the same way as Multipor mineral insulation panels WI and WI compact plus [13] [14].

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Multipor soffit panel

14



Processing Multipor soffit panels

Table 4: Technical data for Multipor insulation wedges

Dry bulk density	approx. 95 kg/m³		
Compressive strength	≥ 200 kPa		
Thermal conductivity	λ = 0.042 W/(mK)		
Water vapor diffusion resistance factor	μ = 2		
Building material class	A1; non-combustible		
Dimensions, delivery format	Dimensions L x W x H [mm]	Pieces/box	m² /carton
	390 x 500 x 60/20	10	1.95

Multipor insulation wedge

To reduce thermal bridges, Multipor insulation wedges can be used to insulate connecting interior walls and ceilings in the area adjacent to the exterior wall, extending 500 mm into the room. Installation is similar to that of Multipor mineral insulation boards WI [15] [16].

15



Multipor insulation wedge

16



Binding wall with the Multipor insulation wedge

Table 5: Technical data for Multipor reinforcement mesh 4 x 4 mm

Alkali-resistant glass mesh for indoor and outdoor use, white	
Weight	160 +/– 5 g/m²
Mesh size	4 x 4 mm
Strength – Delivery condition – After aging (ETAG 004)	 ≥ 1,750 N/5 cm ≥ 50% and ≥ 1,000 N/5 cm
Roll dimensions – Width – Length	 1 m 25 or 50 m
Requirements	Approx. 1.1 m²/m²

Multipor reinforcement mesh 4 x 4 mm

The Multipor reinforcement mesh can be embedded in the upper third of the freshly applied lightweight mortar with light pressure and should overlap by at least 10 cm at the joints [17] [18]. The requirement is 1.10 m²/m². Rolls 1 m wide and 25 or 50 m long are generally available [19].

Work safety on the construction site

To avoid accidents, the regulations of the employers' liability insurance association must always be observed.

In addition to the general construction site safety measures, the installation of Multipor insulation systems requires compliance with further requirements in the area of work and protective scaffolding. Here, too, regulations from a technical and trade association perspective apply to ensure smooth construction site operations.

The generally applicable safety and hygiene measures as well as the regulations of the employers' liability insurance association always apply, such as wearing safety goggles and dust masks during sanding work, especially when working overhead.

17



18



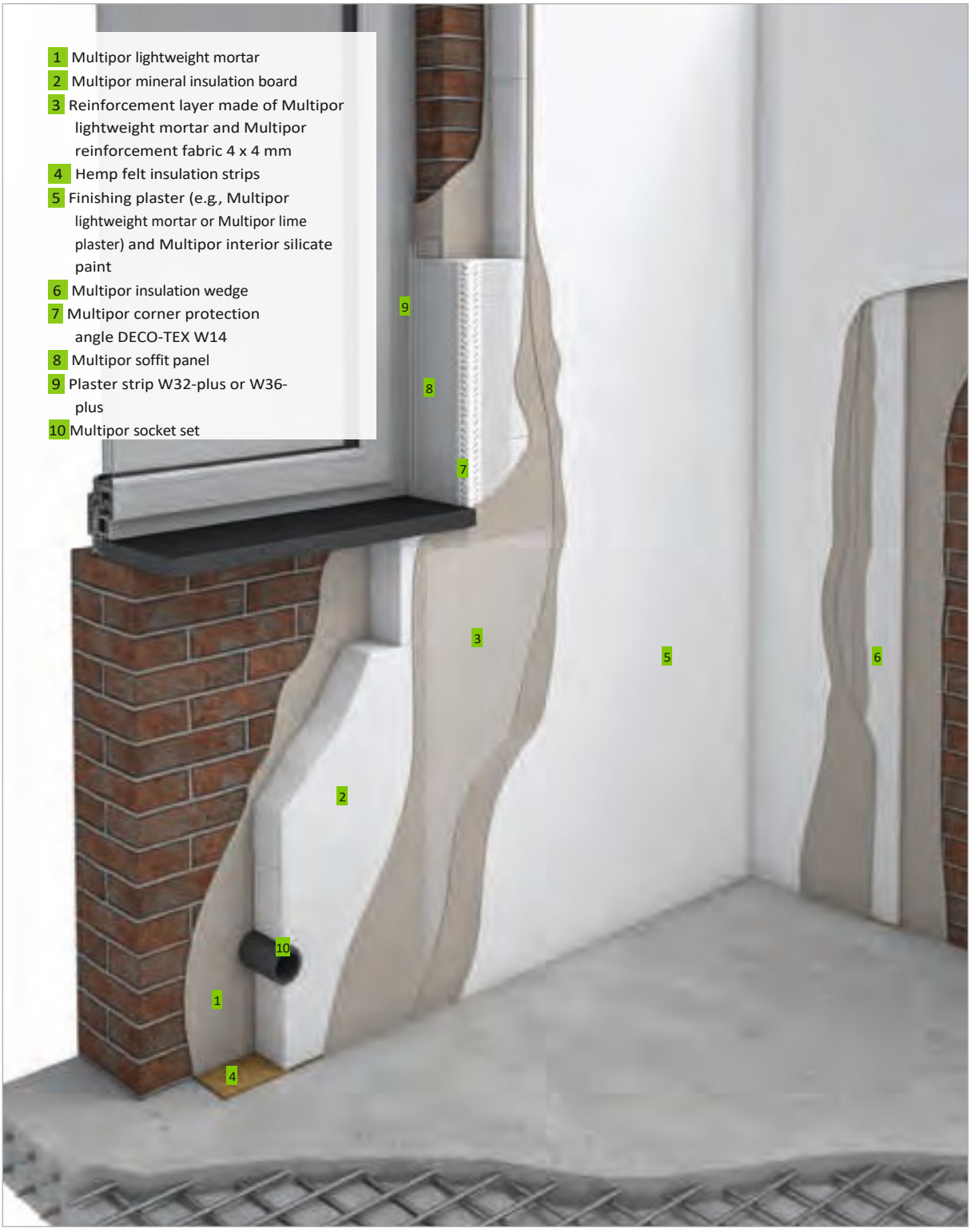
... and pull tight

19



System mesh: Multipor reinforcement mesh (25 or 50 m)

4.4 Processing Multipor interior insulation systems with lightweight mortar



Advantages:

- Practical construction solutions for interior insulation without a vapor barrier
- Diffusion-open and capillary-active
- System reliability thanks to coordinated system components
- Moisture-regulating with high reserves
- Application reliability – proven by more than 20 years of practical experience
- Step-by-step renovation of individual residential units/rooms possible
- Non-combustible, as it is mineral-based
- Easy to install and work with using standard construction site tools
- On stable substrates, pure bonding is usually sufficient – no dowels required

In order to effectively improve the thermal insulation of elaborately designed or listed historic facades, internally insulated exterior walls are often the only option. The Multipor WI interior insulation system or Multipor WI compact plus can also be used in new buildings with exposed concrete facades, for example. The water vapor-permeable, capillary-active Multipor interior insulation systems are ideal for the interior insulation of various solid wall materials and eliminate the need for costly installation of a vapor barrier.

Practical tip: We would be happy to determine the U-value of your existing wall to be insulated using non-destructive U-value measurement. Please contact our application technology department for more information.

Table 1: Multipor mineral insulation boards – dimensions and thermal resistance R [m²K/W]

Thermal conductivity Design value	Panel thickness [mm] Multipor WI compact plus			Panel thickness [mm] Multipor interior insulation system WI												
	30	40	5	6	8	10	120	140	160	180	200	220	240	260	280	300
λ = 0.042 W/(mK)	–	–	–	1.429	1.905	2,381	2,857	3,333	3,810	4,286	4,762	5,238	5.714	6,190	6,667	7.143
λ = 0.045 W/(mK)	0.667	0.889	1.111	–	–	–	–	–	–	–	–	–	–	–	–	–

> 200 mm insulation thickness Two-layer installation possible

Requirements for exterior walls The wall on which the Multipor interior insulation system is to be installed must be protected against rising and penetrating moisture. An existing and functional horizontal or vertical masonry waterproofing is a basic requirement and, if necessary, must be retrofitted using suitable means and methods. Pressurized water (e.g., groundwater) poses a particular problem – a property-specific assessment is required in this case.

Driving rain protection
In order to qualify the exterior facade as rainproof, DIN 4108-3 provides guidelines for assessment, which represents a planning service in advance. If this assessment is not possible beyond doubt, an initial estimate of the water absorption of the exterior facade can be made, for example, using Karsten's tube. Further detailed investigations of the wall structure may be necessary based on this. If damage or defects are found – e.g., defective joint mortar – appropriate renovation measures must be carefully selected and carried out.
An effective means of providing effective protection against driving rain is moisture-adaptive impregnation, which – in consultation with the manufacturer of the respective facade protection

4.4 processing Multipor interior insulation systems with lightweight mortar

Table 2: Substrate assessment for interior insulation

Existing substrate	Measure	Recommendation
Flat, fully jointed masonry	None	If necessary, remove dust, dirt, and paint
Uneven substrate	Apply leveling plaster	Lime-cement plaster CS II
Uneven or loose old plaster	Level or remove	Level the substrate with lime-cement plaster CS II if necessary
Lime or lime-cement plaster	None	If necessary, remove dust, dirt, and loose particles; renew selectively if necessary
Gypsum plaster	Remove	Remove gypsum plaster completely
Old paint	Remove	Remove paint completely (e.g., by milling)
Wallpaper	Remove	Wash off, mill off, etc., wash off paste residue
Saturated masonry	Seal, dry out	Renew horizontal or vertical sealing, dry out
Half-timbered walls with clay plaster, interior	If necessary, leveling plaster made of clay	System structure with clay plaster (see section 4.5)
Lightweight constructions	Not a suitable substrate	Not suitable for insulation with Multipor
Existing old insulation (e.g., HWL boards or similar)	Remove	Remove old insulation materials, level the substrate with lime-cement plaster CS II if necessary

1



Existing wall

2



assessment of the flatness of the substrate

to be repeated at specified intervals. Further information and recommendations for assessment can be found in WTA data sheets 6–4 "Interior insulation according to WTA I: Planning guide," 6–5 "Interior insulation according to WTA II: Verification of interior insulation systems using numerical calculation methods," 8–4 "Half-timbered building restoration according to WTA IV: Exterior cladding" and 8–5 "Half-timbered building restoration according to WTA V: Interior insulation."

Substrate

Multipor interior insulation systems require a sufficiently level substrate to ensure full-surface adhesion. The substrate must also be stable, free of residues that reduce adhesion, and dry [1] [2].

Non-load-bearing old plaster, barrier layers, paint, wallpaper, etc. must be removed in advance and any defects repaired, whereas silicate paints that silicify with the substrate are suitable for bonding in many cases. If the interior plaster is completely removed, a leveling layer may be necessary in some circumstances, for example, in the case of large joint cavities.

A leveling coat is necessary. A preliminary coat of plaster compensates for larger uneven areas in the existing substrate. Defects are best repaired with plaster mortar CS II in accordance with DIN EN 998-1 with a compressive strength of at least 1.5 to 5 N/mm^2 and plastered, for example with Multipor lightweight mortar. To ensure sufficient adhesion, the plaster base must always be checked in advance by the specialist contractor carrying out the work. The general testing requirements are specified in "General Technical Contract Conditions (ATV)" section 3.1.1 DIN 18350 "Plaster and stucco work" VOB/C.

Freshly plastered substrates require a defined drying time before Multipor mineral insulation boards can be installed. The manufacturer's instructions must be observed.


3
Mixing Multipor lightweight mortar


4
Cleaning the tools


5
Applying the lightweight mortar


6
Combing lightweight mortar


7
Apply mortar to the entire surface of the mineral insulation board


8
Decoupling strips, e.g., made of hemp

Construction site conditions

When processing and curing Multipor lightweight mortar, the room and component temperature must be between +5 °C and +30 °C. The relative humidity should not exceed 80%.

Building components adjacent to the ground

Building components adjacent to the ground must be permanently protected against rising and penetrating moisture in the floor and wall areas. As a rule, this is achieved by waterproofing the outside in accordance with DIN 18533 during construction. The same applies to the floor slab (base plate). Bitumen or plastic sealing membranes, for example, are suitable for subsequent waterproofing in accordance with DIN 18533.

Mixing Multipor lightweight mortar

Multipor lightweight mortar (20 kg/bag) is mixed with the amount of water specified on the container. To achieve the right consistency, use a mixer with a slow-running agitator and a robust mixing paddle with long blades [3]. The mixed lightweight mortar should be left to mature for about 5 minutes and then stirred again. 20 kg of lightweight mortar combined with the required amount of mixing water yields approx. 30 liters of fresh mortar.

Thorough cleaning of tools and mixing equipment immediately after use or during longer work interruptions ensures optimum mixing and processing results [4].

Bonding the Multipor mineral insulation board

Multipor lightweight mortar applied and combed over the entire surface of the back of the Multipor mineral insulation board with a 12 mm Multipor notched trowel creates an optimal adhesive bond [5–7].

Depending on the thickness of the insulation material to be processed, we recommend the use of different lightweight mortars for the necessary full-surface bonding

4.4 Processing Multipor interior insulation systems with lightweight mortar



Preparation



Insert



Butt and bearing joints tightly butted

Tooth trowel for corresponding web heights of the lightweight mortar:

- 12 mm trowel for insulation thicknesses up to 140 mm
- 15 mm trowel for insulation thicknesses of 160 mm and above

This allows even slight unevenness in the substrate to be compensated for. Freshly laid Multipor mineral insulation boards (buttering-floating method) compensate for additional unevenness if necessary.
For diffusion-open, capillary-active systems such as the Multipor interior insulation system WI or WI compact plus, the following must be observed:

- Full-surface bonding using Multipor lightweight mortar
- Professional floating of the Multipor mineral insulation board
- Mortar-free butt and bed joints [12–14]

Therefore, larger tolerances in the substrate must be leveled with a suitable leveling plaster before starting the insulation work. Table 2 "Substrate assessment for interior insulation" provides a decision-making aid here.

The first row must be laid with particular care to ensure that it is plumb and flush, taking into account any differences in height to the adjacent floor structure. If structures (e.g., wooden beam ceilings or wooden floors) are expected to exhibit different expansion behavior or settlement, a decoupling strip with Multipor hemp felt insulation strips is required between the components [8]. The Multipor mineral insulation boards must be bonded over the entire surface with Multipor lightweight mortar in a staggered pattern with a joint offset of at least 15 cm [9–11]. Once the adhesive has been applied, the Multipor mineral insulation boards must be pressed into the wall surface to be insulated and bonded over the entire surface. Only full-surface bonding prevents warm, moist indoor air from flowing behind the insulation layer and ensures not only moisture exchange but also the long-term structural functionality of the interior insulation. Figures [12–14] show the behavior of the Multipor lightweight mortar ridges when the Multipor mineral insulation boards are properly pressed into place.



Multipor lightweight mortar strips



Bridges blur to ...



... full-surface bonding

thermal insulation boards. It is not necessary to interlock the insulation boards with the inner wall corners; instead, they are simply pushed tightly together. When reinforcing later, do not pull the fabric around the inner corner.

Cutting and adjusting

The Multipor mineral insulation board can be easily and quickly adapted to local conditions, and even custom pieces can be quickly cut to any size with the fine-toothed Multipor foxtail [15]. For small panel offsets, the Multipor sanding board creates flat surfaces for subsequent coating work [16] [17]. Any sanding dust produced must be removed from the insulation panel surface before applying the reinforcement plaster; if necessary, the sanded surface must be re-primed.

Solid floor slabs

A vapor barrier between two floors is not necessary.

Wooden beam ceiling with upper planking Wooden beam ceilings can have
have upper planking made of tongue-and-groove boards or wood-based panels. When renovating old buildings, the structural condition of the wooden beam ceiling must be checked before installation and repaired if necessary. The substrate must not give way or spring (remedy: screw loose floorboards back in place).

The Multipor mineral insulation boards should be laid on the subfloor if possible, with the screed to be installed subsequently being elastically decoupled from the insulation boards by means of edge insulation strips. If installation cannot begin on the subfloor, it should be carried out directly from the upper edge of the finished floor on the wall to be insulated (the existing thermal bridge of the ceiling must be evaluated in the planning stage – see section 7.1.3). The insulation must also be elastically decoupled from elastic components (such as wooden floors) using Multipor hemp felt insulation strips [18].

Wooden beam ceilings that are integrated into the Multipor mineral insulation boards must also be elastically decoupled in the integration area using a decoupling strip made of the same material. This cushions any vibrations in this component and prevents them from being transferred to the insulation material.

Reinforce the insulation board surface To reinforce the insulation board surface, apply the reinforcement plaster, consisting of Multipor lightweight mortar, over the entire surface in a medium layer thickness of 5 mm using a 10 mm or
12 mm notched trowel. Then press in the alkali-resistant Multipor reinforcement fabric and carefully work it into the upper third of the reinforcement layer [19] [20].

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Cutting fitting plates

16



Grinding down uneven areas

17

18



Elastic decoupling from the floor

4.4 Processing Multipor interior insulation systems with lightweight mortar



Applying the reinforcement layer



Embedding the fabric



Multipor lime fine plaster

- Reinforcement: Multipor lightweight mortar approx. 3 to 4 $^{kg/m^2}$ with a layer thickness of 5 mm
- Fabric: Multipor reinforcement fabric 4 x 4 mm approx. 1.1 m^{2/m^2}(overlap approx. 10 cm)

For interior wall areas subject to impact (e.g., in stairwells or public buildings such as schools), additional alkali-resistant reinforced mesh (additional reinforcement) increases the compressive strength of the surface. It is embedded in the Multipor lightweight mortar as an additional fabric filler below the normal reinforcement layer, butt-jointed and without overlapping. The reinforced reinforcement must be dry before applying the full-surface system reinforcement. It must also be installed before setting edge protection and expansion joint profiles.

Coatings

The surface finish of the Multipor interior insulation system WI and WI compact plus can be done in various ways – plastering, painting, or tiling are all possible. Clay plasters and drywall panels are also a solution and offer great creative freedom in terms of design and interior finishing.

Finishing plasters on the reinforcement layer

The final coat of Multipor lightweight mortar or Multipor fine lime plaster [21] is applied in a layer thickness of 2 to 3 mm and promptly felted and textured [22] [23]. Multipor lime plaster is applied in a layer thickness of 2 mm and is suitable for creating very high-quality surfaces.

Once prepared in this way, the surface design can begin with paper wallpaper or Multipor interior silicate paint. Alternatively, high-quality plaster mortar CR in accordance with EN 998-1, CS I/CS II or silicate textured plasters, e.g. Multipor silicate plaster, can be applied with a trowel in grain thickness and textured while still fresh [24]. The gypsum surface fillers for smoothing are applied in





Felting the plaster



Texturing with a trowel

Maximum layer thickness of 3 mm and clay or fine clay plaster in 3 to 5 mm layer thickness. The total plaster thickness (reinforcement layer and top coat) must not exceed 8 mm. The plaster surfaces can then be colored with Multipor interior silicate paint, but only after the plaster has completely dried. Consumption:

- Finish coat with Multipor lightweight mortar: approx. 2 kg/m² for a layer thickness of 2 to 3 mm
- Finishing plaster with Multipor lime plaster: approx. 2 kg/m² for a layer thickness of 2 mm (see Table 3)
- Please refer to the respective technical data sheets for the consumption of suitable plasters from other manufacturers.

In addition, other mineral lightweight plasters can also be used as finishing plaster, as long as they do not exceed the strength of category CS II. As a rule, the finishing plaster thickness should not exceed 3 mm, and the plaster and reinforcement layer

≤ 8 mm and never thicker than the respective underlying reinforcement layer. In addition, sufficient adhesion of the finishing plasters to the Multipor lightweight mortar must be ensured – plaster test areas created in advance are suitable for this purpose.

Wallpaper

Wallpaper can also be applied to Multipor interior insulation systems. We recommend the following types and materials:

- Woodchip wallpaper
- Embossed paper wallpaper
- Printed paper wallpaper

Under normal living conditions (20 °C and an average relative humidity of 50 to max. 60 %), there are no restrictions from a building physics perspective.

Woodchip, embossed paper, and fiberglass wallpapers are primarily suitable for plaster substrates made of

Table 3: Multipor fine lime plaster/lime smoothing compound

Technical data	Multipor fine lime plaster	Multipor lime smoothing compound
Compressive strength	CS II 1.5 – 5.0 N/mm²	> 1.0 N/mm²
Vapor diffusion resistance factor	μ ≤ 13	μ ≤ 25
Bulk density	1,800 kg/m³	984 kg/m³
Building material class	A1; non-combustible	A1; non-combustible
Air and ambient temperature	≥ 5 °C to +30 °C	≥ 5°C to +30 °C
Processing time	Approx. 70–110 min.	Approx. 120 min.
Delivery form	25 kg per bag 48 bags per pallet	20 kg per bag, 48 bags per pallet
Storage	dry on pallet, approx. 12 months	dry, approx. 6 months
Water quantity per bag	approx. 5.5–6.0 l	approx. 8–9 l
Yield per bag	Approx. 14 l fresh mortar; sufficient for approx. 5.0 m² with a layer thickness of 3 mm	with a layer thickness of 2 mm approx. 10 m²
Consumption per m²	with a max. layer thickness of approx. 3 mm approx. 5.0 kg/m²	approx. 2.0 kg/m² for a maximum layer thickness of 2 mm

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26



Application of Multipor interior silicate paint

27



Painting with Multipor interior silicate paint

4.4 Processing Multipor interior insulation systems with lightweight mortar

Multipor lightweight mortar. Finer paper wallpapers are more suitable for plaster surfaces made of Multipor lime fine plaster or Multipor lime smooth plaster, in accordance with the required surface quality (Q1 to Q4, see information sheet "Plaster surfaces in interior areas," published by the German Federal Association of the Gypsum Industry).

Paint coatings

There are numerous color options available. We generally recommend diffusion-open silicate interior wall paints in accordance with DIN 18363 so as not to impair the functionality of Multipor interior insulation systems. Multipor interior silicate paint [25] is ideally suited for this purpose: Applied to Multipor lime fine plaster, Multipor lightweight mortar, and all other mineral substrates, it provides decorative coatings for interior use. Free of preservatives and plasticizers, it also naturally inhibits the growth of bacteria and fungi on the surface. Delivered ready to use in a 15-liter bucket, the paint only needs to be stirred briefly before it can be applied in one or two coats by brush, roller, or airless spray [26] [27].

The consumption per coat of paint is approx. 0.15 $^{l/m^2}$ undiluted, depending on the absorbency and structure of the substrate.

The fine grain size of the interior silicate paint of less than 100 µm ensures a matt dull and naturally white surface. Water-soluble and lime-compatible tinting colors also allow for colorful paint applications.

Walls in rooms without visually demanding surface requirements (e.g., underground garages, storage rooms) can also be coated directly by brushing, rolling, or spraying – without restricting diffusion capacity. If the Multipor mineral insulation boards have been cleaned of dust before the paint is applied, Multipor interior silicate paint is also ideal for optimizing the surface here. Hairline cracks can sometimes form hairline cracks can form over the panel joints if Multipor lightweight mortar is applied directly to the panel surface in a thin layer without the required reinforcement fabric.

Drywall panels

With this type of surface design, the substructure consists, for example, of wooden slats that are fastened to the load-bearing substrate with appropriate dowels through the Multipor mineral insulation boards. First, any unevenness in the butt joints or bearing joints must be leveled with a sanding board.

Practical tip: Mineral-based plasters and paints complement Multipor interior insulation systems perfectly.

The drywall panels, for example Fermacell gypsum fiber boards or Powerpanel H_2O, can then be fastened to the wooden slats. Each step should be carried out in accordance with the panel manufacturer's processing instructions. Once the drywall panels have been attached to the substructure, a cavity is created – particularly suitable as an installation level for cables, cavity wall boxes, pipes, etc. As it is located directly in front of the fully bonded insulation layer, the insulation is not washed away by warm, humid room air. This means that there are no structural objections.

Surface design on drywall panels

The respective manufacturers provide information about possible final coatings on the drywall panels. We recommend the use of diffusion-open coatings so that the interior insulation remains functional in the long term.

Wet rooms and waterproofing / use of a vapor barrier According to DIN 4108-3, domestic kitchens and bathrooms as well as living rooms and offices are generally classified as "dry rooms." Under normal use, the average relative humidity here is not significantly higher than in living spaces due to heating and ventilation, so that additional waterproofing is usually not necessary. In areas exposed to splashing water – for example, behind bathtubs or shower cubicles – a liquid waterproofing should be applied to the existing reinforcement plaster layer in accordance with the recognized rules of technology or the current ZDB information sheet.

ZDB information sheet. Additional information can be found in the current version of the ZDB information sheet "Sealing in combination with tiles and slabs."

Rooms subject to high moisture stress (commercially used wet rooms, commercial kitchens, spa/wellness areas, and swimming pools) are excluded from this regulation. In these cases, individual building physics verification using transient simulation programs (see "Interior Insulation Checklist" in the download area at www.multipor.de) to confirm the functionality of the overall construction is mandatory.

Dowel fixing in special situations

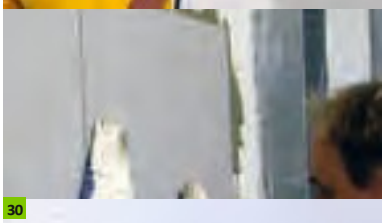
Multipor mineral insulation boards applied to a substrate suitable for adhesive bonding do not need to be doweled. An exception to this are old plasters that are sandy and have been treated with a silicate-based plaster stabilizer. In this case, the insulation boards must be additionally fastened with a Multipor screw dowel (plate diameter ≥ 60 mm) in the center of the load-bearing substrate for full-surface bonding [28].

Tiles on the Multipor WI interior insulation system

On a load-bearing substrate suitable for bonding, Multipor mineral insulation boards WI can also be covered with tiles [29]. The reinforcement layer is anchored to the load-bearing substrate with additional dowels (plate diameter ≥ 60 mm) through the fabric using the wet-on-wet method. A level substrate is particularly important for large-format tiles or stoneware slabs (e.g, 60 x 60 cm). This is a prerequisite for a fully bedded wall covering and a secure hold.

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30



Setting the screw anchor

31



Installing the soffit panel

32



Installing the plaster strip

33

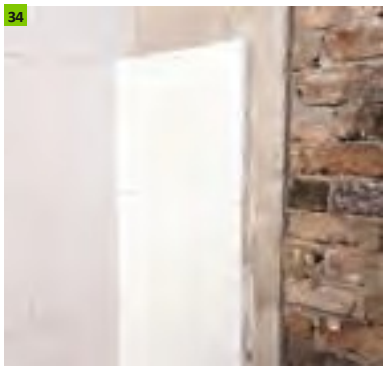


Installing the insulation wedge

4

4.4 Processing Multipor interior insulation systems with lightweight mortar

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Integrating interior wall, insulated with insulation wedge

35



comb through the recess on the back

36



Creating a recess

When applying tiles to the Multipor WI interior insulation system, the following applies:

- Tile weight max. 25 kg/m²
- Insulation dowels with a plate diameter ≥ 60 mm
- Dowel consumption: approx. 4 pieces/m²
  Fresh in fresh through the reinforcement layer

For applying the tiles, we recommend bonding them in a thin bed with a flexible adhesive and grouting them with a flexible grout mortar. The Multipor WI compact plus interior insulation system is excluded from this.

Regardless of this, we recommend covering only 2/3 to a maximum of 3/4 of the walls with tiles. This preserves the moisture regulation function of the wall in terms of building physics.

Reveals

Sill plates of various types can be optimally insulated with Multipor reveal panels. Here too, the Multipor lightweight mortar should be applied to the entire surface of the Multipor reveal panel with a 12 mm notched trowel and

. The web height should then be approximately 10 mm. It is important that the reveal insulation boards are not glued tightly against window or door frames, but are elastically decoupled using suitable decoupling profiles (e.g., Multipor plaster strips). This prevents cracks from forming later on [31] [32].

Insulation wedges

To reduce thermal bridges, connecting interior walls in the connection area of the exterior wall should be insulated approximately 50 cm wide into the room. Multipor mineral insulation board WI or Multipor insulation wedges are used for this purpose, which are processed in the same way as mineral insulation boards. Interlocking with the insulation boards on the inside of the exterior wall is not necessary [33] [34].

Practical tip: Multipor soffit panels and Multipor insulation wedges are an ideal addition to the system for window and door connections.

Electrical installations Interior insulation improves the thermal insulation of a poorly insulated exterior wall construction. To avoid thermal bridges, electrical installations with switches, cables, and sockets should not penetrate the insulation if possible and should be placed in less sensitive areas such as interior walls. The use of so-called surface-mounted systems (cable duct/skirting board) is also possible. If the above design is not desired or feasible, the following design instructions must be observed before the actual insulation work:

- Exact location of switches, sockets, and junction boxes
- For new installations, the cables are routed and fixed in the existing wall or on the substrate.

Practical tip: Heating and water pipes must be taken into account separately in the planning.

If the cables are laid on the existing wall, the Multipor mineral insulation

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Multipor interior insulation box

38



Built-in Multipor interior insulation box

plates must be recessed accordingly on the back before bonding [35] [36].

The new Multipor interior insulation box [37] [38] is recommended for the permanent, secure, and thermal bridge-free fastening of switches, sockets, and other devices in interior-insulated exterior walls. It is particularly suitable for use in the diffusion-open Multipor interior insulation system with insulation thicknesses of 30 to 100 mm.

Advantages:

- Optimized for installation in insulated interior walls
- Guaranteed thermal bridge-free installation
- Moisture-regulating and insulating at the same time
- Prevents moisture-related structural damage

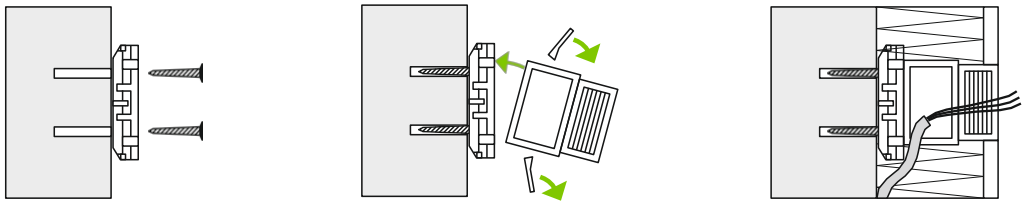
Extensive component testing at the Institute for Building Climate Control at TU Dresden has confirmed the functionality of the Multipor interior insulation box. The study shows that the innovative interior insulation box can prevent hygrothermal damage.

Another proven option is the Multipor socket set [39], consisting of a carrier plate and an extension ring. It is used for secure fastening to the insulated substrate. The extension can be adjusted to the insulation thickness in 5 mm increments and is particularly advisable for existing installations. The socket set extends existing appliance or appliance connection sockets in the retrofitted insulation and ensures secure fastening of sockets, for example.

Any gaps between the socket and the insulation material can be professionally filled with Multipor filling mortar. The final surface design is carried out in accordance with the options already mentioned.

Electrical installations must always be fixed to a load-bearing substrate [40]. Switch boxes, socket boxes, junction boxes, and other electrical items must be mechanically and securely fixed to the existing wall in advance mechanically and securely to the existing wall using mounting plates and extensions [41] [42].

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Attach the front panel to the wall.

Break off the nail tabs on the ISO extension ring and screw the ring to the front section (40 mm device screws).

Several ISO extension rings can be mounted to adjust to the thickness of the insulation material can be installed.

Installation of Multipor socket set

4.4 Processing Multipor interior insulation systems with lightweight mortar

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Socket set, mounted on the wall

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Preparation of the insulation

42



Multipor completely finished

The Multipor telescopic device holder and the Multipor telescopic device box can also be adjusted continuously to the insulation thicknesses used. Electrical items can then be attached to them easily and securely [43] [44].

In general, electrical sockets and cables attached to Multipor mineral insulation boards do not constitute a professional and permanent installation and are therefore not recommended. In the case of drywall panels, electrical installations are attached to the facing shell and the cables are routed in the cavity in front of the insulation board.

Other installations or additions: Insulation of roller shutter boxes Roller shutter boxes in old buildings (next to windows) are a major cause of significant heat loss, often associated with drafts, due to technically outdated construction methods. Since roller shutter boxes are usually inadequately insulated or not insulated at all, or are not airtight, thermal bridges are created there, which can lead to increased heating costs. Roller shutter boxes are structurally part of the wall, as they separate the indoor and outdoor climate. Although they account for a comparatively small proportion of the total wall area, they are the weakest component in terms of energy efficiency.

As roller shutter boxes are part of energy-efficient building renovation, they are becoming increasingly important, with the result that well-known manufacturers offer corresponding interior renovation systems for almost every roller shutter situation. Please contact your Multipor specialist advisor for more information.

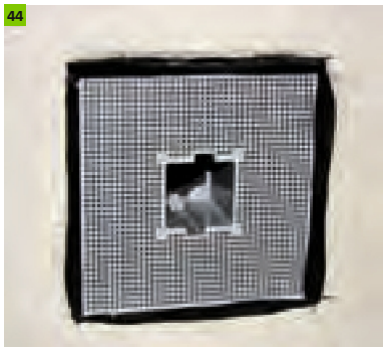
Radiator mounting Radiator niches originally had an aesthetic function. In the past, radiators were very deep, but thanks to the niches, they did not protrude so far into the living space. From a construction point of view, however, these niches reduce the thickness of the exterior wall and thus form a structural thermal bridge through which heat escapes to the outside more quickly than through the rest of the building envelope. Up to 6% of heating energy can escape through this weak point alone. It is possible to close these niches during building renovation work.

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Multipor telescopic tool carrier on the bare wall

44



Once installed

, walling up with Ytong flat blocks to improve the energy efficiency. The new radiators can then be attached immediately to the solid Ytong flat blocks using suitable dowels. If this is not done, it is advisable to insulate the radiator recesses with Multipor interior insulation systems to the required thickness

and to work them into the rest of the wall surface.

If the niches are closed with Multipor interior insulation systems, the radiators are fastened through the insulation material to the load-bearing substrate. There are several options for this:

- The existing brackets are extended by the thickness of the insulation material.
- Brackets are attached to the interior insulation and doweled through the insulation into the load-bearing substrate using appropriately sized fasteners.
- New telescopic brackets are attached to the existing wall and then finished.
- The radiators are placed on feet.

In cases of increased stress, for example in schools or discotheques, we recommend using angle brackets or placing the radiators on feet.

Further information on this topic, depending on the applicable requirement classes, can be found in VDI Guideline 6036 "Fastening of Radiators." The respective fastening solutions and types should be selected based on this guideline. Well-known radiator manufacturers provide excellent assistance in this regard.

Guideline values for processing times

Depending on practical experience, it takes 10 to 15 minutes to bond 1.0 m² of Multipor mineral insulation boards
15 minutes to bond 1.0 m² of Multipor mineral insulation boards. Plastering and other possible preparatory work, such as removing separating layers, are not included in this calculation. The insulation of reveals, flashings, etc. is not taken into account here. Other allowances (e.g., for plaster profiles) must be taken into account if necessary. Please also compare the current tender texts. Risk and profit must be included in the calculation. The spread is very high: from 0 to approx. 12%. Direct transport to the construction site and scaffolding times must also be taken into account.

Multipor interior insulation systems

Multipor interior insulation systems consist of coordinated, specially developed, and material-compatible system components. They offer solutions for every insulation project and every energy-efficient renovation measure. Please refer to the current Multipor price list for the complete product range.

You can find your local contact person in the contact section at www.multipor.de.

Table 4: Material consumption of the basic components

Material	Consumption
Basic positions	
Multipor mineral insulation board WI	4.3 boards/m²
Multipor mineral insulation board WI compact plus	5.2 boards/m²
Multipor lightweight mortar (adhesive)	approx. 3.5 kg/m² , with max. 5 mm layer thickness
Multipor lightweight mortar (reinforcement)	approx. 3.5 kg/m² , with max. 5 mm layer thickness
Multipor reinforcement fabric	Approx. 1.1 m²/m²
Alternative positions	
Multipor lightweight mortar (top coat)	Approx. 2.5 kg/m² , with a maximum layer thickness of 3 mm
Multipor screw anchors	4.3 pieces/m²
Multipor soffit panels	1.66 pieces/linear meter
Multipor insulation wedge	2.56 pieces/linear meter
Multipor lime plaster	Approx. 2.0 kg/m², with a maximum layer thickness of 2 mm
Multipor lime fine plaster	Approx. 5.0 kg/m², with a maximum layer thickness of 3 mm
Multipor interior silicate paint	approx. 0.3 l/m²

4.5 Processing Multipor interior insulation system WI with clay mortar

Ecological, healthy living, and climate-regulating: Environmentally friendly solutions should be considered, especially when modernizing—Multipor clay mortar and the matching Multipor clay paint are particularly well suited for this purpose.

The Multipor interior insulation system WI clay enables healthy modernization measures both for energy-efficient renovation as interior wall insulation and for interior plaster systems on masonry types such as Ytong aerated concrete and Silka sand-lime brick.

Multipor clay mortar, with its mixture of clay powder and natural sands, complies with current clay building regulations and DIN 18947
"Clay plaster mortar" (see Table 1).

Its purely mechanical drying and reusability, as well as the absence of chemical additives, make the mortar healthy for living. And: Due to its high capillary conductivity, it absorbs moisture, distributes it, and thus accelerates drying.

Multipor clay mortar can be used in a variety of ways:

- Single or multi-layer leveling plaster up to 40 mm thick for uneven substrates
- Adhesive mortar for Multipor mineral insulation board WI in accordance with the currently valid processing instructions
- Reinforcement plaster with fabric insert on Multipor mineral insulation board WI
- Interior plaster on Multipor mineral insulation board WI, on Ytong aerated concrete masonry, and on Silka sand-lime brick masonry
- Wall heating plaster according to manufacturer's instructions

It is extremely easy to use and, as a 100% natural material, can be remixed again and again: if the material has set prematurely, simply remix it with water to restore its working consistency.
Any leftovers can therefore be stored indefinitely or completely composted.

Half-timbered renovation

Another important area of application for Multipor clay mortar is half-timbered house renovation. Combined with Multipor WI mineral insulation boards, both materials complement each other perfectly in terms of their structural properties when it comes to achieving the best indoor climate and optimum protection for historic wall structures that are worth preserving. In historic half-timbered buildings, clay plaster was used in the past to protect wooden components by quickly removing moisture.
Additional processing instructions and data sheets are available for download at www.multipor.de to ensure professional application.

Multipor clay mortar can also be used as interior plaster (both in new construction and renovation) on numerous surfaces. Applied 3 to 5 mm thick to dry substrates, the clay mortar can be textured with a trowel or sponge board to create the finished surface. With good ventilation, the material hardens within 3 to
5 days to the point where a surface finish can be applied.



Multipor clay mortar

Natural clay

Multipor clay paint is the perfect and ecological complement to Multipor clay mortar.

As it is a solvent-free, natural, and decorative clay-based wall paint, it is suitable for painting both walls and ceilings in the

4.5 Processing Multipor interior insulation system WI with clay mortar

interior areas, where it is applied with a roller, brush, or paintbrush – after two to three coats, it creates white, diffusion-open, and thus moisture-regulating wall surfaces. Mineral tinting materials or pigment additives offer a range of color and structural design options.

Special living value

The Multipor WI Lehm interior insulation system thus offers an ecological and environmentally friendly solution for surface design and energy-efficient renovation. Healthy living products – also suitable for allergy sufferers – can be applied to a wide variety of substrates and significantly increase the quality and comfort of living.

Multipor reinforcement fabric 7 x 7 mm

The Multipor reinforcement fabric 7 x 7 mm (see Table 2) was specially developed for use in the Multipor WI interior insulation system with clay and can be embedded in the upper third of the freshly applied Multipor clay mortar with light pressure. It should overlap by at least 10 cm in the joint area. The requirement is 1.10 m²/m². Rolls 1 m wide and 50 m long are generally available.

Bonding Multipor mineral insulation boards WI in clay mortar Before bonding, the Multipor

Thermal conductivity	λ = 1.0 W/(mK)
Vapor diffusion resistance factor	≤ 11
Heat capacity	1.0 KJ/kgK
Bulk density	2,042 kg/m³
Shrinkage	1.9
Flexural strength	0.70 N/mm²
Compressive strength	1.5 N/mm²
Equilibrium moisture content, weight %	2.0 – 4.5
Building material class	A1; non-combustible
Processing temperature	≥ 5 to +30 °C
Storage	dry on pallet, unlimited storage life
Delivery form	25 kg per bag 48 bags per pallet
Regulations	DIN 18947 (LPM-0/0.8m-S II-2.0)

Table 2: Technical data for Multipor reinforcement mesh 7 x 7 mm

Alkali-resistant glass mesh for interior use	
Weight	105 +/– 5 g/m²
Mesh size	7 x 7 mm
Strength – Delivery condition – After aging	 ≥ 1,750 N/5 cm ≥ 50% and ≥ 1,000 N/5 cm
Roll dimensions – Width – Length	 1 m 50 m
Requirements	Approx. 1.1 m²/m²



Mix Multipor clay mortar

Mix the clay mortar with approx. 6.0 l of water per bag (25 kg) using a suitable mixer until it has a uniform and lump-free consistency



Comb through Multipor clay mortar

[1]. The Multipor WI mineral insulation boards are bonded to the substrate over the entire surface with Multipor clay mortar, with the joints offset substrate with staggered joints. To do this, apply the clay mortar over the entire surface of the back of the Multipor


Apply Multipor to the wall …


… and pressed


Apply reinforcement layer

Apply mineral insulation boards WI and comb through [2].

The ridge height of the clay mortar must be at least 10 mm after combing. In addition, the existing wall surface can be freshly coated with clay mortar up to a maximum of 10 mm with a smoothing trowel. After applying the clay mortar, the Multipor mineral insulation boards WI must be floated onto the wall surface with pressure [3].

This ensures that the adhesive layer is as thin as possible and covers the entire surface. The butt joints and bed joints of the Multipor mineral insulation boards WI are not bonded, but are butted together tightly [4].

The first row must be laid with particular care, ensuring that it is plumb and level, paying attention to any differences in height in the floor structure. If constructions are expected to exhibit different expansion behavior or settlement, the Multipor hemp felt insulation strips be used as a decoupling strip to the adjacent components. Fitting pieces of Multipor mineral insulation boards WI can be cut to any size using the fine-toothed Multipor handsaw.

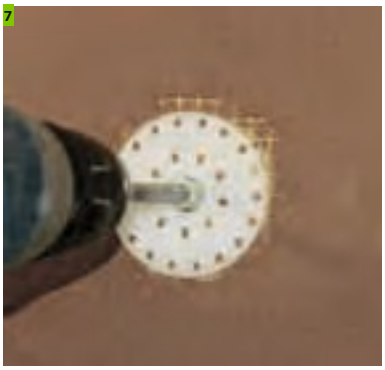
Practical tip: Dried Multipor clay mortar can be mixed again and again with water until it reaches the required consistency.

Reinforcement plaster/base coat

For the reinforcement layer, mix the Multipor clay mortar to a workable consistency. Please note that the amount of water added per bag is reduced to approx. 4.5 to 5l compared to when used as an adhesive. The Multipor clay mortar is then combed onto the surface of the insulation boards using a notched trowel (12 mm teeth) [5].

The average ridge height is 10 mm. Next, embed the reinforcement fabric with a mesh size of 7 x 7 mm in the upper third of the reinforcement plaster layer.


Embedding the fabric


Setting the screw dowel

layer. When smoothed, this results in an average layer thickness of 5 mm [6].

Use of dowels In principle, Multipor WI mineral insulation boards are doweled with Multipor clay mortar as an adhesive during
energy-efficient renovation with Multipor clay mortar as an adhesive. The mechanical processing

4.5 Processing Multipor interior insulation system WI with clay mortar



Applying the top coat



Texturing with a trowel



Applying paint using a roller, brush, or paintbrush

Securing with thermally decoupled screw fasteners with plate heads (minimum diameter 60 mm). In half-timbered buildings, this should primarily be done on the wooden structure to avoid damage to the infill. At least four Multipor screw anchors per m^2 must be used. On free edges (e.g., window recesses), we recommend one dowel per panel at free edges (e.g., window recesses). Corner connections are made by interlocking the insulation panels.

Inserting the dowels

- Normally, the screw anchors are placed in the center of the panel.
- For plaster thicknesses > 10 mm (reinforcement and top coat plaster), doweling is carried out through the reinforcement mesh fresh into fresh [7]. The reinforcement mesh must be cut with a knife before inserting the dowels.
- If wall heating is also to be installed on walls insulated with Multipor mineral insulation boards WI, the dowels are inserted after the heating pipes have been plastered, also through the reinforcement layer

Please also refer to the additional information in our technical information sheet "Wall heating," which can be found in the download area at www.multipor.de.

Multipor clay mortar as top coat
Multipor clay mortar is used as a finishing plaster for decorative design on prepared and dry substrates. To do this, comb the Multipor clay mortar onto the existing reinforcement layer with a notched trowel to a thickness of 3 to 5 mm [8] and then texture the finished surface with a plastic trowel or sponge board [9].

Surface finish/paint Once the finishing plaster is dry, the paint coating can be applied [10] – for this, we recommend our Multipor clay paint as a dry paint, which is available in white and in 2 or 8 kg containers. It is mixed on site with the required amount of water and is then ready for immediate use. It should be mixed well with a stirrer before application and can be adjusted to the substrate with a maximum of 10% added water to improve its spreadability. This makes the paint easy to apply with a roller, brush, or paintbrush. Two to three coats are required for complete color coverage, with a drying time of approximately three hours after each coat under normal ambient conditions.

Practical tip: Due to the nature of the material, shrinkage or drying cracks may appear on the clay plaster surface. These emphasize the natural character of Multipor clay mortar. They do not constitute a defect and can be closed again by lightly moistening (e.g., with a spray bottle) and using a sponge board.

Any desired color can be achieved using commercially available mineral tinting materials or pigment additives.

Table 3: Approximate consumption values

Multipor clay mortar according to DIN 18947	
Delivery form	25 kg/bag
Yield per bag	Approx. 15 l fresh mortar with a layer thickness of 10 mm sufficient for approx. 1.5 m²
Amount of water per bag	Approx. 6.0 l for bonding, approx. 4.5–5 l for reinforcement
Bonding	Approx. 7–8 kg/m²
Reinforcement	Approx. 7–8 kg/m²
Top coat	Approx. 5 kg/m² (for 3 mm) to approx. 8 kg/m² (for 5 mm)
Multipor clay paint (dry powder)	
Delivery form	2 or 8 kg/bag
Required amount of water	1.5 l/kg dry powder
Material requirement per coat	Approx. 90 g/m² per coat
Drying time	Approx. 2 hours at normal indoor temperatures (20 °C, 50% relative humidity)

Color tone for our Multipor clay paint.

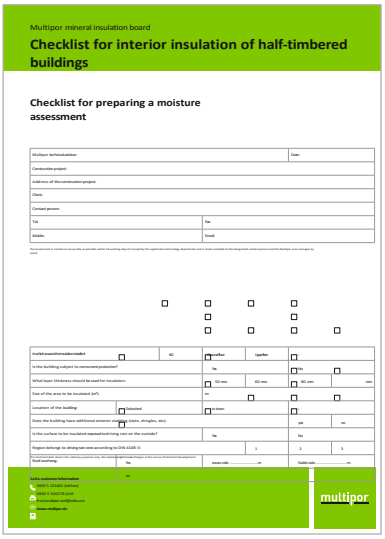
Additional information When improving the energy efficiency of buildings, it is essential to consider and evaluate the thermal bridge effect of integrated components (e.g., ceilings, walls) – a planning task that must be carried out in advance. Corresponding Supplementary products (such as Multipor soffit panels or Multipor insulation wedges) are available in the Multipor WI Lehm interior insulation system range.

Building physics in half-timbered construction

The energy retrofitting of half-timbered buildings often presents planners and builders with a major hurdle, as it requires a great deal of expertise and specialist knowledge, particularly when it comes to assessing moisture conditions. Multipor offers a "Checklist for interior insulation in half-timbered buildings" in the download area at www.multipor.de.

Once completed and returned to us, it provides the basis for realistic verification of moisture-related issues in the construction.




Multipor mineral insulation board

Checklist for interior insulation of half-timbered buildings

Checklist for preparing a moisture assessment

multipor

Property and reference report





Half-timbered building, Soest

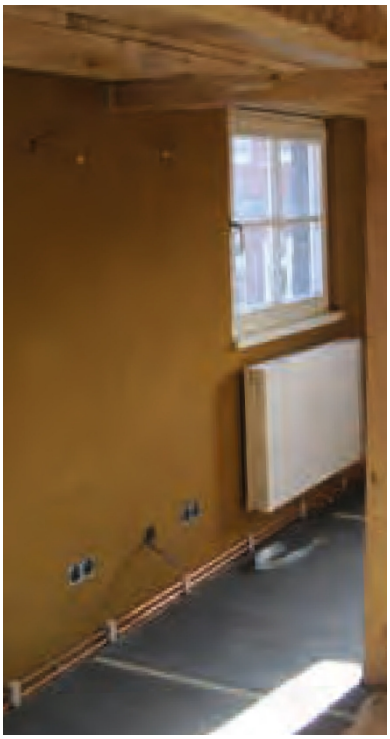
- Complete energy-efficient renovation of a gutted half-timbered building
- Complete use of the Multipor interior insulation system WI clay
- Multipor clay mortar as leveling plaster, adhesive and reinforcement layer, and as finishing plaster
- Multipor clay paint as a high-quality surface finish
- Highest standards of ecology and health-friendliness were met

Property data

Building type	Half-timbered house
Location	Soest
Application	Interior insulation with clay
Products	■ Multipor mineral insulation board WI, d = 80 mm ■ Multipor clay mortar ■ Multipor clay paint

Project and reference report





Half-timbered building, Warendorf

- Preservation of the listed facade
- Complete use of the Multipor interior insulation system WI clay
- Multipor clay mortar as leveling plaster, adhesive and reinforcement layer, and as finishing plaster
- KfW Efficiency House Standard "Monument" achieved
- Highest requirements for ecology and health friendliness were met

Property data	
Building type	Half-timbered house
Location	Warendorf
Application	Interior insulation with clay
Products	Multipor mineral insulation board WI Multipor clay mortar

4.6 Fastening loads with Multipor interior insulation systems



Depending on the type of load, different loads can be fastened directly into the Multipor mineral insulation board WI/WI compact plus or through the insulation into the load-bearing substrate. Dowels, anchors, and screws are standard items in everyday construction practice. Multipor also offers professional fastening solutions in its tool shop at www.multipor-werkzeugshop.de. In day-to-day business, specialist knowledge of the anchor base, fastening systems, and connecting elements plays an important role in ensuring safety and security.

Experience has shown that the greatest challenge lies in correctly assessing the requirements and selection of fasteners. It therefore makes sense and is expedient to coordinate the various trades. The following aspects must be taken into account when selecting fasteners:

- What is the substrate (building material, strength class)?
- What are the dimensions of the components? Can the required drill hole depths and edge and center distances be maintained?
- How should the static system of the structure to be connected be assessed? What forces are transmitted?
- What is the stress state in the substrate (tension or compression zone)?
- Are there any special requirements with regard to corrosion and Fire protection or temperature resistance?
- Is approval of the fastener as a structurally relevant fastening necessary?
- Can the necessary manufacturer-specific installation conditions be met?

Anchoring types and their operating principles

Three types of anchors are suitable for anchoring components in Multipor mineral insulation boards or in load-bearing substrates:

- Expansion anchors made of steel or plastic
- Adhesive anchors with cement or synthetic resin-based composite
- Undercut anchors with form closure

The following operating principles differ:

- Friction lock: This is created by friction between the dowel and the anchoring surface, with the expansion of segments ensuring anchoring. The



Spreading element can be made of plastic or steel. A distinction must also be made between force-controlled anchors (maximum load capacity after applying a specified torque) and displacement-controlled anchors (wedged into the substrate by driving a cone over a defined distance).

- Material bond: How an adhesive anchor works. A composite material allows the anchor to be installed in the anchoring base without spreading pressure. The connecting effect leads to the term "composite anchor."
- Form lock: This requires undercut drill holes or suitable cavities. The dowel must be fastened in such a way that it can be supported in the anchoring base without spreading pressure.

Dowel installation

The Multipor fastening accessories provide you with coordinated fastening materials. The product descriptions explain how to set the dowels, but depending on the dowel type, a specified insertion depth or torque must be applied. For functional dowels, the product descriptions or technical information sheets provide information on the necessary boundary conditions such as setting depth, axis distances, and edge distances.

A drill hole perpendicular to the surface can be easily made with a hammer drill, for example.

Here, too, the information on the required drill hole depths and diameters can be found in the data sheets of the respective dowel manufacturers. The choice of drill bit and machine settings depend on the anchor base.
For example:

- Ytong aerated concrete: 3-piece set of impact tools (6 mm, 8 mm, 10 mm)
- Silka sand-lime brick: rotary and hammer drilling
- Vertical perforated bricks and lightweight construction materials: rotary drilling
- Other anchor bases: rotary and hammer drilling

The drill hole is cleaned with a brush or blown out, as the drill dust greatly influences the friction behavior of force-fit dowels and the penetration behavior of composite dowels into the surface.

Fastening

The fastening of loads depends on the expected load and stress. The choice of fastener and its position is also based on this.

Types of fastening:

- Panel fastening for non-load-bearing substrates
- Mechanical fastening of light loads in Multipor mineral insulation boards
- Mechanical fastening of heavy or dynamic loads through the Multipor mineral insulation board in the substrate

A selection of possible fasteners can be found as technical information on the Internet at www.multipor.de.

Panel fastening Wall

For substrates that do not allow secure bonding of Multipor mineral insulation boards, and for tiled interior insulated walls, the mineral insulation boards are fastened to the wall with Multipor screw anchors.

1



Multipor screw anchors

2



Setting the Multipor screw anchor

4.6 Fastening loads with Multipor interior insulation systems



Multipor flat dowel



Driving in the flat dowel



Anchoring the flat dowel

Fastening on non-load-bearing substrates and tile coverings, etc.

- Not possible with Multipor WI compact plus
- Interior wall insulation WI with Multipor screw dowel [1]
- Dowel length from 115 to 60 mm Internal insulation
- Dowel length from 135 to 80 mm Internal insulation
- Dowel length in 155 to 100 mm interior insulation

Multipor mineral insulation boards WI can be plastered over the entire surface of the wall. This is followed by additional doweling with Multipor screw dowels through the fresh reinforcement layer (Multipor screw dowels, plate diameter ≥ 60 mm fresh in fresh) and the fabric into the load-bearing substrate [2].

Fastening of light static loads for interior insulation of exterior walls (≤ 3 kg)

- Multipor flat dowels:
  Fixings in Multipor mineral insulation board WI or
  WI compact plus for light loads up to 3 kg for interior wall insulation

Light loads can be fastened directly into the Multipor mineral insulation board using the Multipor flat dowel. To do this, drive the flat dowel completely into the Multipor mineral insulation board horizontally with the open side facing forward (recognizable by the bevelled corners) and screw the supplied screw into the center of the waves [3] [4] [5].

Fastening light static loads for interior insulation of exterior walls (≤ 6 kg)

- Multipor spiral dowels: Fastening in the Multipor mineral insulation board WI for light loads up to 6 kg (lengths: 50 mm, 85 mm, 120 mm) [6]. This is not permitted for Multipor WI com-pact plus.

Before carefully screwing in the spiral dowel (50 mm, 85 mm, 120 mm) with a Torx bit T 40, make a slit in the plaster shell including the reinforcement fabric with a cutter knife [7] [8].



Multipor spiral dowel



Preparing the Multipor mineral insulation board



Inserting the Multipor spiral dowel

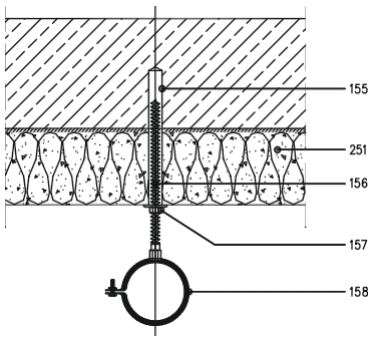
Fastening heavy loads

(≥ 6 kg) and dynamic loads Loads over 6 kg and dynamically stressed loads are not fastened to the Multipor mineral insulation board WI or WI compact plus, but to the substrate.

- Fastening individual loads: For lamps and cables, dowels are inserted through the Multipor mineral insulation boards WI or WI compact plus into the load-bearing substrate. The point loads are distributed with the aid of a 30 mm washer [9].

- Fastening objects with Multipor device carriers: Multipor device carriers, which are fastened to the substrate before the Multipor mineral insulation boards are bonded, are also suitable for easy fastening of objects. Objects such as e.g., wall lights can be attached to them [10–13].

9



155 Drive-in anchors / compact dowels
156 Threaded rod
157 Nut with washer ∅ 30 mm
158 Pipe clamp
251 Multipor ceiling insulation DI

Fastening connection through the Multipor mineral insulation board

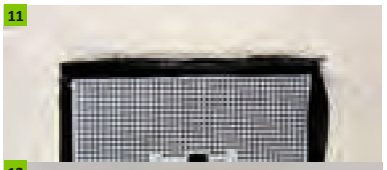
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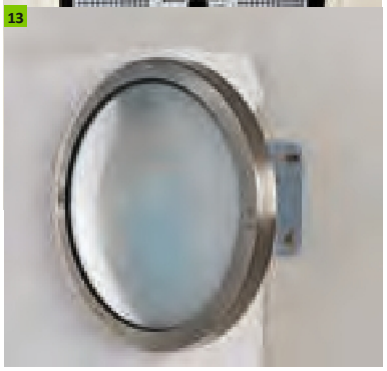
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Multipor device carrier with light attachment

11



13



Multipor device carrier with light

4

4.7 Air shaft insulation with Multipor interior insulation system WI

- Fast, economical adhesive installation
- Non-combustible, building material class A1 according to DIN EN 13501-1
- No smoke development, no dripping, no toxic gases in case of fire
- Purely mineral, fiber-free and free of harmful substances
- Pressure-resistant and practically non-compressible
- Dimensionally stable, no warping or shrinkage
- Ecologically certified and harmless in terms of building biology

Modern buildings are increasingly being equipped with intelligent ventilation and air conditioning technology. The fresh air required for this is usually drawn in through appropriately dimensioned air shafts and fed into the rooms after being treated. The residual heat is extracted from the stale air and the air volumes are discharged outside through additional air shafts.

In large buildings (office complexes, hospitals, event venues), the air ducts take on considerable dimensions. Heat losses from adjacent rooms are eliminated or reduced to an uncritical level through the use of air duct insulation.

Due to its ecological properties, the Multipor WI interior insulation system (see Table 1) is ideally suited for this area of application: in addition to its existing pest resistance, the high alkalinity of the product provides a significant inhibitory effect against mold growth. Furthermore, Multipor is biologically safe and solvent-free.

In the current certificate from the eco-INSTITUT in Cologne, the structure with Multipor mineral insulation board and

Table 1: Technical data for Multipor mineral insulation board WI and Multipor lightweight mortar

	Multipor mineral insulation board WI	Multipor lightweight mortar
Regulations	European Technical Assessment ETA-05/0093	Lightweight mortar LW according to EN 998-1
Dry bulk density	85–95 kg/m³	approx. 770 kg/m³
Compressive strength	≥ 200 kPa	CS II; 1.50–5.0 N/mm²
Thermal conductivity	λ = 0.042 W/(mK) (rated value)	$\lambda_{10,dry}$ = 0.18 W/(mK)
Water vapor diffusion resistance factor	μ = 2	μ ≤ 10
Building material class	A1; non-combustible Melting point > 1,200 °C	A2-s1, d0; non-combustible
Dimensions / Delivery quantity	600 x 390 mm d = 60–300 mm (in 20 mm increments) Special format d = 50 mm with λ = 0.045 W/(mK) and μ = 3	20 kg/bag

Alkali-resistant glass mesh fabric for indoor and outdoor use, white	
Weight	160 +/– 5 g/m²
Mesh size	4 x 4 mm
Strength – Delivery condition – After aging (ETAG 004)	 ≥ 1,750 N/5 cm ≥ 50% and ≥ 1,000 N/5 cm
Roll dimensions – Width – Length	 1 m 25 or 50 m
Requirements	Approx. 1.1 m²/m²

Multipor lightweight mortar certified: The indoor air does not contain any VOC concentrations that are harmful to health (VOC stands for volatile organic compounds).

If there are special hygiene requirements for ventilation and air conditioning systems, the VDI 6022 guideline must be observed. Sheet 3 formulates the structural, technical, and organizational measures that are necessary for the planning, manufacture, execution, operation, and maintenance of ventilation and air conditioning systems (HVAC systems).

The maximum air velocity in the air duct is decisive for the surface design. This can be up to 30 m/s (108 km/h) and must be taken into account by means of certain measures. Table 3 lists the air velocities with the corresponding implementation instructions.

Processing Multipor interior insulation system WI for air duct insulation
As a general rule, the applicable installation and processing regulations for the Multipor interior insulation system WI and Multipor ceiling insulation system DI must be observed.

The Multipor interior insulation system WI for air shaft insulation is functionally coordinated, ensuring maximum system reliability while at the same time being easy to process and install.

This logically structured system makes it possible to eliminate thermal bridges to adjacent components/rooms or minimize them to an uncritical level.

The substrate of the supply and exhaust air shafts to be insulated must be load-bearing and suitable for bonding. Formwork oil residues or other adhesion-reducing components must be removed properly beforehand.

To achieve full-surface bonding, any rough unevenness on the surface to be insulated must first be leveled.
Unevenness
Irregularities up to 3 mm are leveled using the comb bed method.

The adhesive is always applied to the Multipor WI mineral insulation boards. The buttering-floating method can be used to level out unevenness in the substrate up to a maximum of 5 mm – here,
The adhesive is applied to the Multipor WI mineral insulation boards and to the substrate to be insulated.

The Multipor lightweight mortar must be applied over the entire surface of the back of the board using a 12 mm notched trowel (for insulation thicknesses of 160 mm boards or more, use a 15 mm notched trowel). The board coated with mortar is floated onto the surface to be insulated.

Any unevenness in the insulated surface can be easily sanded down with the Multipor sanding board.

Additional information for air shaft insulation applications For air flow speeds of up to 10 m/s in air shafts, the surface of Multipor mineral insulation boards WI must also be coated with Multipor interior silicate paint as a final coat. The paint can be applied to the insulation surface (in two coats) with a roller or by spraying.

4.7 Air duct insulation with Multipor interior insulation system WI

Table 3: Air duct insulation with Multipor mineral insulation board WI

Air flow velocity	Design/surface	Comments
up to 10 m/s	■ Multipor mineral insulation board WI bonded over the entire surface ■ Surface coating using Multipor interior silicate paint	■ Paint application using a roller or airless spray ■ Paint application usually in two steps
up to 20 m/s	■ Multipor mineral insulation board WI bonded over the entire surface ■ Additionally fill surface with Multipor lightweight mortar ■ Optionally, apply Multipor interior silicate paint as an optional final coat	■ Layer thickness approx. 3 mm (hairline cracks in the joints of the insulation boards cannot be ruled out) ■ Additional fabric reinforcement increases surface strength and minimizes hairline cracking crack formation
up to max. 30 m/s	■ Multipor mineral insulation board WI bonded over the entire surface ■ Multipor mineral insulation boards WI are additionally doweled "fresh on fresh" through the reinforcement layer ■ As reinforcement, always use Multipor lightweight mortar ■ Finishing plaster made from Multipor lightweight mortar, Multipor fine lime plaster, or Multipor lime smooth finish ■ Additionally, Multipor interior silicate paint is optional as a final coating/ surface finish	■ Multipor screw anchors with a plate diameter of at least 60 mm are generally used as anchors ■ Fabric must always be embedded in the reinforcement layer ■ Fastening is carried out with one fastener per Multipor mineral insulation board WI ■ The type of fastener must be selected according to the fire protection requirements for the specific project

For air flow speeds of up to 20 m/s, a system coating of approx. 3 mm with Multipor lightweight mortar is recommended as the final coating. Fabric reinforcement is not absolutely necessary in this case, but it does increase resistance. For air flow speeds of up to 30 m/s, the Multipor mineral insulation boards WI must also be doweled into the load-bearing substrate through the reinforcement layer (fresh on fresh) and the dowel plates must be filled with filler. The layer structure is as follows:

- Bonding of the Multipor mineral insulation board WI to a load-bearing substrate with Multipor lightweight mortar
- Reinforce the surface of the insulation boards with Multipor lightweight mortar and reinforcement fabric, including doweling "fresh in fresh" using Multipor screw dowels. The fabric is cut beforehand with a sharp blade.
- Application of the final coat as required (either Multipor lightweight mortar or Multipor lime fine plaster or Multipor lime smooth finish for a smooth surface)
- Multipor interior silicate paint can be applied as an option.

Surface design of the air shaft insulation
Multipor lightweight mortar and Multipor lime fine plaster on the reinforcement layer made of Multipor lightweight mortar meet the requirements for a Q2 surface.

With Multipor lime finish (see Table 4) on the reinforcement layer of Multipor lightweight mortar, the requirements for a Q3 surface can be met.

The maximum plaster thickness (reinforcement and finishing plaster) is 8 mm.
If structural requirements call for greater plaster thicknesses, Multipor screw anchors must be used to secure the reinforcement layer while it is still fresh. The maximum surface load must be agreed with the Multipor consultant.

If the insulation board surfaces are sanded, they must be cleaned of dust and loose particles before further coating work (e.g., sweeping with a fine broom). However, additional priming before applying Multipor lightweight mortar is not necessary. Multipor interior silicate paint can also be applied without further substrate preparation.

Weathering
Areas indirectly exposed to weathering (in transition to the outside air) must be protected, e.g., by means of a cover plate or similar. Areas directly exposed to weathering are designed in accordance with the Multipor WAP composite thermal insulation system, i.e., Multipor mineral insulation boards of type WAP are fully bonded with one screw anchor per insulation board under the fabric in the load-bearing substrate. At air speeds of 20 to 30 m/s, the anchoring is carried out through the fabric. The surface coating always consists of fabric-reinforced base coat and top coat with a coat of paint.

Practical tip: If there are special hygiene requirements for ventilation and air conditioning systems, the VDI 6022 guideline must be observed.

Walkable areas (floor areas of inspection areas) If air ducts must be walked on, the insulation boards must be protected with suitable additional cladding and fitted to the flanking insulation. The suitable drywall panel Fermacell Powerpanel H_2O (a cement-bonded lightweight panel with a sandwich structure) is laid out over the entire horizontal area. It is bonded over the entire surface with Multipor lightweight mortar. The Fermacell Powerpanel H_2O panels are butted together. Any joints between the individual panels can be filled with Multipor lightweight mortar.
Panels are cut to size using a standard circular saw with extraction. The minimum insulation panel thickness of Multipor mineral insulation panels WI in accessible areas with additional planking is 120 mm.

Insulation of overhead areas: When insulating overhead areas, each insulation panel must be at least

> 140 mm, each insulation panel, regardless of depending on the air flow velocity, each insulation board must be doweled with one fastener per board. At air velocities of ≥ 20 m/s, all insulation boards that are installed overhead
be doweled.

Smoke extraction shafts
The use of Multipor WI mineral insulation boards in smoke shafts is generally possible. Due to varying air temperatures and velocities, an individual, project-specific assessment is required here.

necessary. Our Multipor consultants will be happy to advise you as part of the services we offer.

Services offered
- Project-specific advice
- Support with tendering
- On-site training of the contractor at the construction site
- If necessary, preparation of building physics calculations for the functionality of the structure

Table 4: Technical data for Multipor lime plaster

Compressive strength	> 1.0 N/mm²
Vapor diffusion resistance factor	μ ≤ 25
Bulk density	984 kg/t
Building material class	A1; non-combustible
Air and ambient temperature	≥ 5 °C to +30 °C
Processing time	Approx. 120 min.
Delivery form	20 kg/bag, 48 bags per pallet
Storage	dry, approx. 6 months
Amount of water per bag	approx. 8–9 l/bag
Yield per bag	with a layer thickness of 2 mm approx. 10 m²
Consumption per m²	approx. 2.0 kg/m² for a layer thickness of 2 mm

Project and reference report





Tower 185 high-rise building, Frankfurt

- Compliance with thermal insulation and hygiene requirements
- Compliance with existing fire protection regulations
- Dimensionally stable, pressure-resistant panel
- Simple, easy-to-handle processing

Project data	
Building type	New
Use	Office and commercial building
Location	Frankfurt
Completion	2011
Products	23,000 m² Multipor mineral insulation boards 50/60/120/200 mm
Special	Building material class A1 Ecologically certified and harmless in terms of building biology Dimensional stability and compressive strength



Multipor ExSal Therm

The solution for salt-contaminated and damp masonry

Product highlights:

- Desalination and insulation in one system
- No need to dry out masonry
- Faster restoration and longer renovation cycles than with conventional restoration plasters

Further advantages:

- Optimal thermal insulation with $\lambda = 0.047$ W/(mK)
- Diffusion-open and capillary-active
- Building material class A, non-combustible
- Ecological and sustainable

For further information, please click here:

www.multipor.de/exsaltherm

multipor

4.8 Multipor ExSal Therm

Interior insulation systems

- Masonry desalination and thermal insulation in one system
- Simple system design – no vapor barrier
- Longer renovation cycles than with conventional renovation plaster systems
- No need to dry out the masonry beforehand
- Cost savings due to uncomplicated and quick renovation and work steps
- Preservation of listed and historic facades and building fabric
- Ideal for converting former agricultural farms, stables, and industrial wastelands into residential buildings – gaining additional living and usable space
- Useful when boundary constructions or external exposure of the masonry are not possible
- Ecological, healthy for living, and sustainable
- Non-combustible

Old and historic buildings are rarely adequately protected against rising damp. A problem often arises that can only be permanently solved with a great deal of effort: damp and salt-contaminated walls. Salts not only manifest themselves in aesthetically unattractive efflorescence on wall surfaces, they can also cause lasting damage to the building fabric.

If the building site is contaminated with salt, salts penetrate the masonry with rising moisture and leave a visible white, crystalline, and fluffy coating on the interior. This results in cracks in the masonry and various types of plaster damage. The risk of mold growth increases.

Until now, special renovation plasters were often considered the solution, but these frequently need to be renewed after a few months or years. Multipor ExSal Therm is an innovative and economical solution solution is now available that has a long-lasting effect after installation and also provides additional insulation. The key advantage is that the masonry does not have to be dried out beforehand, which can be costly.

Installed on the inside, the system is particularly suitable for listed, historic, or older buildings, where the focus is usually not only on masonry renovation but also on improving the energy efficiency of the property.

How salts get into the masonry

In the construction industry, moisture is known to be one of the most common causes for necessary renovations. But it is not only moisture that affects masonry – salt deposits can also cause considerable damage. These two problems are often linked. Unlike older buildings, newer properties are well protected against rising or penetrating moisture from the ground by horizontal and vertical moisture barriers. In older buildings, these barriers are often missing or have lost their effectiveness over time. With rising moisture from the ground , salts dissolved in the water can penetrate the masonry structure over time. These crystallize on the surface, forming unsightly efflorescence and destroying the plaster or even the entire masonry in the medium to long term.

The salts in masonry are mostly sulfates, nitrates, and chlorides in varying concentrations.

The causes of salts in masonry can be very different. These include, for example, salt-contaminated substrates or bodies of water, road salt, or fungicides.



Example of surface efflorescence



4.8 Multipor ExSal Therm



Why are salts harmful? Damp walls can have far-reaching consequences: from unsightly stains to mold, an unhealthy indoor climate, and significantly reduced thermal insulation.

If the masonry is also contaminated with salts, these dissolve in the moisture in the masonry and migrate to outer or higher areas with lower humidity, where conditions are favorable for crystallization. There, the salts gradually close the pores in the masonry. The result: diffusion capacity is reduced, making it difficult for the wall to dry. In winter, there is an additional risk of frost damage.

As the salts dry, they crystallize with a significant increase in volume. This significant increase in volume creates strong crystallization or explosive pressure on the surface of the masonry, leading to the destruction of the masonry/plaster. This process can then continue in the outer wall zones.

Many salts also attract even more moisture – they are hygroscopic. The associated damage to the building fabric continues to increase. This means that the more salts accumulate, the more moisture is stored.

Whether salt contamination leads to damage depends, on the one hand, on the properties and concentration of the salt or salt mixture and, on the other hand, on how much moisture is present in the environment that can be absorbed by the masonry.



Example of surface efflorescence

Multipor ExSal Therm – the system components

The Multipor ExSal Therm system is the innovative and economical solution for masonry renovation and simultaneous interior insulation.

The system was developed specifically for the renovation of damp and salt-laden masonry, such as that found in basements, vaults, listed buildings, and historic structures. In addition, its good thermal insulation properties increase the interior surface temperature of the exterior wall, enhancing comfort and preventing mold growth. Unlike renovation plasters, the ExSal Therm system can also be used on damp masonry, increasing the interior surface temperature of the exterior wall, enhancing comfort, and preventing mold growth. Unlike renovation plasters, the ExSal Therm system can also be used on damp masonry, increasing the interior surface temperature of the exterior wall, enhancing comfort, and preventing mold growth. Unlike renovation plasters, the ExSal properties, it increases the interior surface temperature of the exterior wall, enhances comfort, and prevents mold growth. Unlike renovation plasters, the ExSal Therm System can also be used on masonry that is still damp. This means that the masonry does not necessarily have to be sealed and dried out, but the substrate must be suitable or prepared for full-surface bonding.

Multipor ExSal Therm consists of four coordinated system components: a mineral desalination board with product properties tailored to the application, a mineral, sulfate-resistant lightweight mortar for bonding, reinforcement, and as a finishing plaster, a reinforcement fabric, and other mineral finishing plasters. Thanks to the simple system design, renovations with the Multipor ExSal Therm system are uncomplicated, time-saving, and economical.

The core component—the Multipor ExSal Therm desalination panel—is a

4.8 Multipor ExSal Therm

Mineral insulation material based on sand, lime, cement, and water. Thanks to its special material structure, the ExSal Therm panel offers an optimal combination of important properties: it is highly porous, dimensionally stable, vapor-permeable, reduces capillary action, and is non-combustible (building material class A1). In addition, the desalination panel is designed to absorb many times its own weight in salts and is therefore significantly more durable than conventional renovation systems. Due to its chemical composition, it has a high pH value of > 11. This high alkalinity inhibits the growth of mold.

The accompanying Multipor ExSal Therm lightweight mortar supports the transport of moisture and the salts dissolved in it from the masonry into the ExSal Therm panel thanks to its high (capillary) absorbency. There, these crystallize and are thus kept away from the inside of the room.
The moisture evaporates on the surface of the insulation panel, while the salts remain in the panel through deposits in pores and pore channels. The system thus remains intact in the long term.
Multipor ExSal Therm lightweight mortar serves not only as an adhesive, but also as a reinforcing mortar, thus contributing to the simplicity of the system. Together with

Multipor reinforcement fabric 4 x 4 mm, it forms the basis for the final coating of the
ExSal Therm system consisting of Multipor ExSal Therm lightweight mortar, Multipor lime fine plaster, or Multipor lime smoothing compound.

The Multipor ExSal Therm system can also be combined with the Multipor WI interior insulation system. This allows salt-contaminated and vulnerable areas to be insulated with ExSal Therm, while other areas can be insulated with our conventional interior insulation system.

For further information, please contact our Multipor application technology department.

Table 1: Product data Multipor ExSal Therm

	Multipor ExSal Therm panel	Multipor ExSal Therm lightweight mortar
Approval/Regulations	European Technical Assessment ETA-05/0093	according to DIN EN 998-1
Dry bulk density	115 kg/m³	≤ 800 kg/m³
Compressive strength	≥ 350 kPa	CS II; 1.5–5.0 N/mm²
Rated thermal conductivity	λ = 0.047 W/(mK) [λ = 0.060 W/(mK)*]	$\lambda_{10,dry}$ = 0.18 W/mK
Water vapor diffusion resistance	Diffusion open, μ = 3	μ ≈ 10
Building material class/melting point	A1, non-combustible according to DIN EN 13501-1/ ≥ 1,200°C	A2-s1, d0, non-combustible according to DIN EN 13501-1
Dimensions/delivery quantity	600 x 390 mm d = 60/80/100 mm	20 kg per bag 40 bags/pallet
Consumption per m²	4.3 panels/m²	Bonding (5 mm): approx. 4.0 kg/m² (12 mm trowel) Approx. 6.5 kg/m² (15 mm trowel) Reinforcement (5 mm): approx. 4.0 kg/m² Top coat (2–3 mm): approx. 3.0 kg/m²
Amount of water per bag	–	approx. 6.0 l
Yield per bag	–	approx. 5 m²with a layer thickness of 5 mm
Processing time	–	2 hours
Storage	Dry on pallet	dry on pallet, approx. 12 months

* incl. safety margin for permanent moisture ingress into the desalination plate

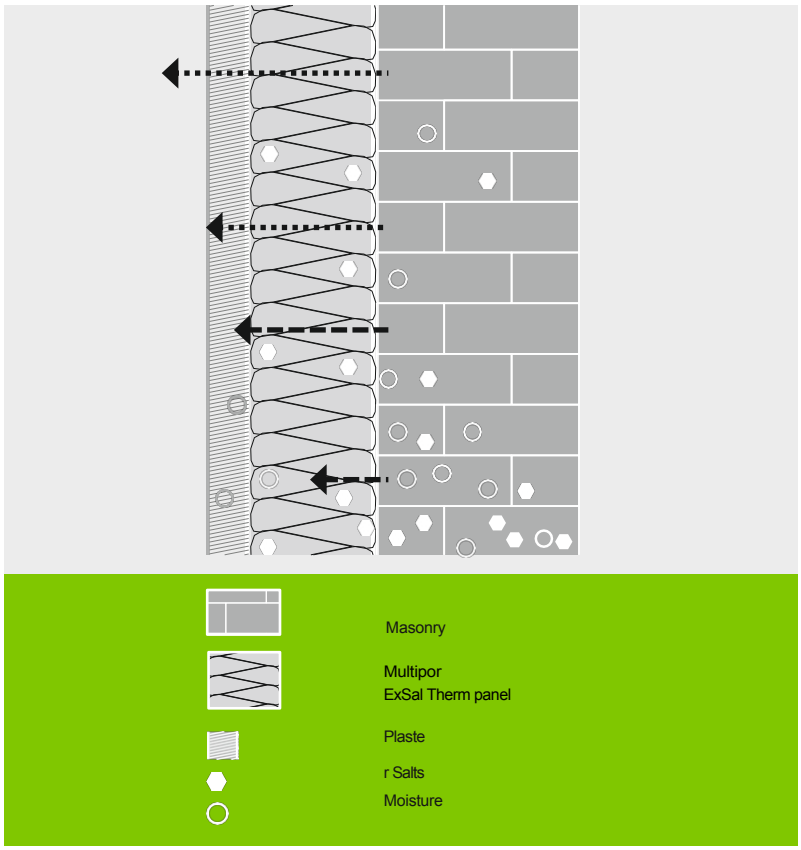
Function

Salts are transported in dissolved form from the existing masonry into the Multipor ExSal Therm system by means of moisture. Salt transport is linked to the capillary transport of water, following the capillary pressure and thus the moisture content gradient – from wet to dry.

Since ExSal Therm mortar has a higher liquid conductivity than the desalination panel, the moisture with the salts dissolved in it does not remain in the mortar, but is transferred to the ExSal Therm plate.

To prevent the salts from reaching the surface of the desalination plate and crystallizing there, its capillary conductivity has been reduced. At the same time, the plate has high water vapor permeability.
As the moisture evaporates but the salts cannot reach the surface so quickly, they crystallize where they are not visible – inside the desalination plate.

Schematic diagram



4.8 Multipor ExSal Therm

Processing

With Multipor ExSal Therm, you can renovate damp, salt-contaminated masonry and make it significantly more durable than with conventional renovation plaster systems. At the same time, the wall is upgraded in terms of energy efficiency. This saves time, effort, and costs.

The Multipor ExSal Therm system is primarily used where building components are contaminated with salts of various types and concentrations, or where damp walls are difficult to access from the outside and it is difficult to achieve a permanent seal against moisture penetration.

Steps to take before renovating your masonry with Multipor ExSal Therm:

- Assessment of the overall condition of the building component/property and the resulting scope of renovation
- Assess the moisture situation of the building component
- Analyze salt deposits
- Assess the substrate of the component to be renovated/insulated
- Identify existing thermal bridges – influence of flanking/connecting components
- Determination of the future use of the space and the energy requirements
- Planning a combination with the classic Multipor interior insulation system
- Any further work that plays a role in the renovation measure (e.g., electrical installations)

Practical tip

In constructions such as damp and salt-contaminated solid walls in combination with wooden floors and/or wooden beam ceilings, the causes of moisture ingress must first be eliminated before installing the ExSal Therm System. Wooden components must be inspected for any (pre-existing) damage and repaired if necessary.

Substrate

Similar to the classic Multipor interior insulation system, Multipor ExSal Therm also requires a sufficiently level substrate to ensure full-surface bonding of the ExSal Therm panel and to guarantee the long-term structural functionality of the system.

To do this, proceed as follows:

- Remove old, crumbly, and/or loose plaster.
- Sweep salt deposits/salt efflorescence ("saltpetre") from the substrate
- If necessary, scrape out masonry joints to a depth of 2 cm and fill with ExSal Therm lightweight mortar

Uneven substrates can be leveled using ExSal Therm lightweight mortar – in a single layer (up to 20 mm) or in multiple layers. ExSal Therm lightweight mortar is based on sulfate-resistant cement and is specially designed for this type of substrate and application. Alternatively, a so-called "porous base coat" according to WTA can also be used as a leveling plaster. Classic Multipor lightweight mortar is not suitable for this purpose. The corresponding drying times for the leveling plaster layer must be taken into account in the work schedule.

Table 2: Substrate assessment for ExSal Therm interior insulation

Existing substrate	Measure	Recommendation
Dry, level, fully jointed masonry without salt contamination	None	Use classic Multipor interior insulation system – if necessary, remove dust, dirt, and paint
Uneven or loose old plaster	Level or remove	Level the substrate with ExSal Therm lightweight mortar or a sulfate-resistant porous base plaster
Lime or lime-cement plaster	None (if still firmly adhering)	If necessary, remove dust, dirt, and loose particles; renew selectively if necessary
Damp gypsum plaster	Remove	Remove plaster completely, level substrate with ExSal Therm lightweight mortar or a sulfate-resistant porous base plaster
Old paint (on damp substrate)	Remove	Remove paint completely (e.g., milling, sandblasting) – level substrate with ExSal Therm lightweight mortar or a sulfate-resistant porous base coat
Saturated masonry	Seal, dry out (to the next floor)	Install horizontal or vertical waterproofing – temporarily dry wall surfaces to be insulated with ExSal Therm so that ExSal Therm mortar can set hydraulically
Damaged building drainage	Repair	Renew or repair gutters, downpipes, and sluices
Salt-contaminated masonry	Remove salts	Sweep wall surfaces, remove damaged, crumbling plaster, scrape out joints and fill with ExSal Therm lightweight mortar, level surfaces with M-ExSal Therm lightweight mortar
Lightweight/drywall constructions	Not a suitable substrate	Not suitable for insulation with Multipor ExSal Therm
Existing old insulation & salts/moisture (e.g., HWL panels or similar)	Remove (case-by-case assessment)	Consult with Multipor application technology Remove old insulation materials, level the substrate with ExSal Therm lightweight mortar or sulfate-resistant porous base plaster if necessary
Half-timbered construction with interior plaster and salt contamination	Consider each case individually	Consult with Multipor application technology

Adjacent components

In order to limit salts or moisture locally, it is advantageous to seal connections to adjacent ceilings or walls using suitable means and methods. This can be done, for example, using suitable injection methods.

Mixing Multipor ExSal Therm lightweight mortar

Multipor ExSal Therm lightweight mortar (20 kg/bag) is mixed with the amount of water specified on the container. To achieve the right consistency, use a mixer with a slow-running agitator and a robust mixing paddle with long spirals. The mixing time for one bag is approx. 2 to 3 minutes. The mixed lightweight mortar should be left to mature for approx. 5 minutes and then stirred again. 20 kg of ExSal Therm lightweight mortar combined with the required amount of mixing water yields approx. 29 liters of fresh mortar.

Thorough cleaning of tools and mixing equipment immediately after use or during longer work interruptions ensures optimum mixing and processing results.

4.8 Multipor ExSal Therm



Webs made of Multipor ExSal Therm lightweight mortar



Bridges smear when inserted to ...



... full-surface bonding



Cutting fitting plates



Working on curves

Bonding the Multipor ExSal Therm mineral insulation board

The Multipor ExSal Therm lightweight mortar is applied over the entire surface of the back of the ExSal Therm desalination board with a 12 mm notched trowel and combed across the direction of application. The insulation board is then pressed against the wall and floated in place professionally, ensuring optimum adhesion. Butt joints and bearing joints remain free of mortar. This also allows slight unevenness in the substrate to be compensated for. Freshly laid Multipor ExSal Therm mineral insulation boards using the buttering-floating method (adhesive mortar applied to the wall and insulation board) compensate for additional unevenness if necessary.

Full-surface bonding prevents warm, humid room air from flowing behind the insulation layer, thus ensuring moisture exchange and the long-term structural functionality of this special type of interior insulation.

The first row of boards must be laid particularly carefully, ensuring that they are plumb and level, taking into account any differences in height to the adjacent floor structure. ExSal Therm panels are laid with a joint offset of at least 15 cm. It is not necessary to interlock the insulation panels with the inner wall corners; instead, they are simply pushed tightly together.

Cutting and adjusting

The ExSal Therm mineral insulation board can be quickly and easily adapted to local conditions, and even custom pieces can be quickly cut to the required size using a standard handsaw (e.g., Multipor handsaw). Panel offsets are sanded flat using a Multipor sanding board to ensure an optimal surface structure for subsequent plastering work. Any sanding dust produced must be removed from the insulation board surface before applying the reinforcement plaster; if necessary, the sanded surface must be re-primed.

Connection to adjacent components
Multipor ExSal Therm panels are tightly butted against connecting components such as interior walls or solid ceilings and decoupled by means of a saw cut.
The connection area of these components often represents a thermal bridge and must also be insulated. The depth and possible thickness of the required flank insulation can be calculated using suitable thermal bridge programs. The necessary supplementary products, such as insulation wedges or soffit insulation boards, are included in our product range. We will be happy to assist you with any questions you may have.

Combination of Multipor ExSal Therm and conventional Multipor interior insulation system
The ExSal Therm renovation system can be optimally combined with the Multipor interior insulation system. It is often the case that only parts of the surface need to be reinforced.
If old existing walls show signs of moisture, including possible salt contamination, the ExSal Therm system is installed at least one insulation board width (39 cm) beyond the contaminated area. The adjacent wall surface can be insulated with the standard Multipor interior insulation system. The respective mineral insulation boards are bonded using the system adhesive provided for this purpose. It is also possible, both in terms of building physics and practical construction, to bond and reinforce classic Multipor mineral insulation boards with ExSal Therm lightweight mortar.

insulation board surface To reinforce the Multipor ExSal Therm boards, apply the Multipor ExSal Therm lightweight mortar as a reinforcing plaster over the entire surface in a medium layer thickness of
5 mm and using a 10 mm or 12 mm notched trowel. Then press the alkali-resistant Multipor reinforcement fabric into the plaster and carefully work it into the upper third of the reinforcement layer. When reinforcing interior corners, the reinforcement fabric is inserted into the corner and not pulled around the corner.

In interior wall areas exposed to impact, additional alkali-resistant reinforced mesh (additional reinforcement) increases the compressive strength of the surface. It is embedded in the Multipor ExSal Therm lightweight mortar as an additional mesh layer below the normal reinforcement layer, butted and not overlapping in the Multipor ExSal Therm lightweight mortar. The reinforced reinforcement must be dry before applying the full-surface system reinforcement. It must also be carried out before installing edge protection and expansion joint profiles.

Finishing plasters on the reinforcement layer
The following can be used as final, thin-layer finishing plasters:

- Multipor ExSal Therm lightweight mortar
- Multipor lime fine plaster
- Multipor lime smoothing compound

The final coat of ExSal Therm lightweight mortar or Multipor lime fine plaster is applied in a layer thickness of 2 to a maximum of 3 mm and promptly brushed and/or textured. Multipor lime smooth finish

Table 3: Product data Multipor lime fine plaster/lime smooth finish

	Multipor fine lime plaster	Multipor lime smooth finish
Compressive strength	CS II; 1.5 – 5.0 N/mm²	CS I; > 1.0 N/mm²
Vapor diffusion resistance factor	μ ≤ 13	μ ≤ 9
Building material class	A1; non-combustible	A1; non-combustible
Processing temperature	≥ 5 °C to +30 °C	≥ 5°C to +30 °C
Processing time	Approx. 70–110 min.	Approx. 120 min.
Delivery form	25 kg per bag 48 bags per pallet	20 kg per bag, 36 bags per pallet
Storage	dry on pallet, approx. 12 months	dry on pallet, approx. 12 months
Water quantity per bag	Approx. 5.5–6.0 l	approx. 10 l
Yield per bag	with a layer thickness of 3 mm for approx. 5.0 m²	with a layer thickness of 2 mm approx. 10 m²
Consumption per m²	with a layer thickness of 3 mm approx. 5.0 kg/m²	with a layer thickness of 2 mm approx. 2.0 kg/m²

is applied in a layer thickness of 2 mm and is suitable for creating very high-quality surfaces.

When combining ExSal Therm and the Multipor interior insulation system, it is recommended to reinforce the entire wall surface with ExSal Therm lightweight mortar and plaster it with one of the finishing plasters mentioned above.

Color coating
The colored final coating is applied using Multipor interior silicate paint.

Alternative surface designs Drywall panels/pre-wall installations, wallpaper, tile coverings, and classic emulsion paints are not suitable as final surface designs on Multipor ExSal Therm.
Furnishings should not be placed directly against the internally insulated wall, but at a distance of at least 50 mm. Air circulation must be ensured. Ideally, furniture should be avoided in front of internally insulated surfaces.

Installations and fixings Electrical installations must be carried out as pre-wall installations (e.g., in suitable skirting boards or cable ducts). The skirting boards can be fixed to the insulation material using appropriate spiral dowels (available as accessories).

Radiators must be placed on feet and not attached to the wall through the insulation.

Wall surface heating and ExSal Therm
Wall surface heating systems can be installed on Multipor ExSal Therm and fastened through the insulation into the load-bearing substrate. Wall surface heating can also have a positive effect on the moisture balance of the wall and is recommended by us. Further information on this can be found in our technical information "Wall heating."

Our service for you
Every construction project that is to be upgraded in terms of energy efficiency with interior insulation requires careful planning and preparation. This is no different for a renovation project using the Multipor ExSal Therm system. In order to ensure long-term functional reliability in terms of moisture and salt exposure, building physics considerations of the planned system structure must be carried out in advance of the construction work and form part of the project planning. The structure must be evaluated using numerical simulation methods (e.g., WUFI(*)). In addition, the assessment and optimization of thermal bridges is part of the planning process for any interior insulation. We are happy to offer you the corresponding services. The relevant checklists can be found at www.multipor.de.

Table 4: Material consumption of system components

Material	Consumption
Multipor Ex Sal Therm mineral insulation board	4.3 boards/m²
Multipor ExSal Therm lightweight mortar (adhesive)	for 5 mm layer thickness: approx. 4.0 kg/m² with 12 mm notched trowel approx. 6.5 kg/m² with 15 mm notched trowel
Multipor ExSal Therm lightweight mortar (reinforcement)	for 5 mm layer thickness: approx. 4.0 kg/m² with 12 mm notched trowel
Multipor reinforcement mesh 4x4 mm	approx. 1.1 m²/m²
Multipor ExSal Therm lightweight mortar (top coat)	approx. 3.0 kg/m² with max. 3 mm layer thickness
Multipor lime finish	approx. 2.0 kg/m² , with max. 2 mm layer thickness
Multipor lime fine plaster	approx. 5.0 kg/m² , with a maximum layer thickness of 3 mm
Multipor interior silicate paint	approx. 0.3 l/m²

Project and reference report



Former stable converted into workspace and living space

Multipor ExSal Therm was used for the energy-efficient renovation of the former stable building into high-quality living and working spaces. This eliminated the need to install or replace the essential horizontal and vertical masonry barriers. The innovative Multipor ExSal Therm system reliably removes moisture from the damp and heavily salt-damaged former stable walls and stores the dissolved salts in the numerous pores of ExSal Therm. The moisture is released into the room air and ventilated away. At the same time, the system has excellent insulating properties, which previous systems did not offer in such applications.

The loss of space is marginal when renovating the interior of the listed building. The renovation and insulation of the brick walls is carried out in a single step.

- Even partial areas or hard-to-reach places can be covered quite easily with this insulation and renovation system. The panels are easy to cut to size and are available in various thicknesses. This means they can be used anywhere within the renovation project.

The advantages of ExSal Therm are particularly evident in listed buildings, which often have many hard-to-reach corners. Even in challenging areas, such as around windows, the panels can be glued to the wall surfaces in need of renovation. Multipor ExSal Therm is ideal for damp walls with heavy salt contamination, has excellent insulating properties, and creates a pleasant indoor climate in renovated rooms.

Property data	
Building type	Listed cattle barn
Use	Office
Completion	2021
Products	Approx. 65 m² Multipor ExSal Therm
Special	Walls particularly affected by moisture and salt Hard-to-reach corners Optimal insulation properties required due to change in use

FAST ECONOMICAL NON-COMBUSTIBLE VARIABLE KEL SURFACE DESIGN UNDERGROUND GARAGES ECOLOGICAL MASSIVE DIMENSIONALLY STABLE WOODPECKING-PROOF BASEMENT ENERGY-SAVING ACCORDING TO 100% RECYCLABLE EASY TO PROCESS IMPLEMENTATION GARAGES MOISTURE PROTECTION FIRE PROTECTION OPTIMIZATION NAT PURE MINERAL BASEMENT WOODPECKER-PROOF SUSTAINABLE NON-COMBUSTIBLE IMPLEMENTATION SAFETY SURFACE DESIGN ECOLOGICAL VARIABLE SHAPEFAST GARAGES DEPTH

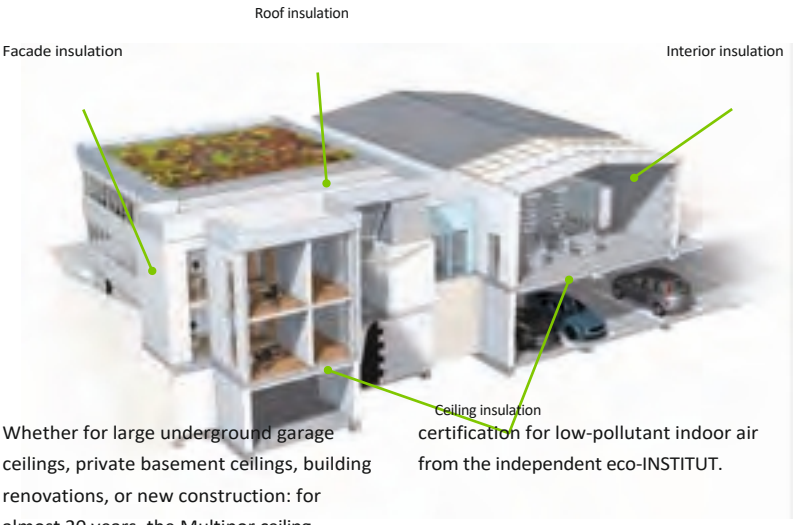


5.0 Multipor ceiling insulation system DI

Ceiling insulation
System DI

5.1 General introduction and Planning

- Fast, economical adhesive installation
- Bright, friendly panel surface
- Non-combustible, building material class A1, improvement of fire protection class (depending on construction)
- Purely mineral, fiber-free and free of harmful substances
- Simple adhesive installation with no risk of air pockets
- Variable surface design
- Insulation including sound absorption



Whether for large underground garage ceilings, private basement ceilings, building renovations, or new construction: for almost 20 years, the Multipor ceiling insulation system DI has been reliably meeting energy and fire protection requirements in large-scale projects and residential buildings alike. In addition, it is an ecologically safe insulation material that has been awarded and certified as ecological by both the Institut Bauen und Umwelt e. V. (Institute for Construction and the Environment) and natureplus. Furthermore, the product has the highest A+ certification

certification for low-pollutant indoor air from the independent eco-INSTITUT.

Underground garage ceiling insulation A new building or an inner-city development of office and

Commercial buildings are hardly conceivable without (insulated) underground parking garages. The Multipor DI ceiling insulation system reduces construction time and costs in this area because it is quick and safe to install and does not require dowels. The open-cell structure of the mineral insulation board surface also absorbs sound in the underground parking garage.

In renovation projects, it ensures fire safety compliance. The light-colored panel surface also creates a friendly atmosphere in the underground car park. The ceiling application area is shown in



basement ceilings and underground car park ceilings

Table 1: Product data Multipor ceiling insulation system DI

	Multipor mineral insulation board DI	Multipor lightweight mortar
Regulations	European Technical Assessment ETA-05/0093	Lightweight plaster mortar LW in accordance with EN 998-1
Dry bulk density	85–95 kg/m³	approx. 770 kg/m³
Compressive strength	≥ 200 kPa	CS II; 1.50–5.0 N/mm²
Thermal conductivity	λ = 0.042 W/(mK) (rated value)	$\lambda_{10,dry}$ = 0.18 W/(mK)
Water vapor diffusion resistance factor	μ = 2	μ ≤ 10
Building material class	A1; non-combustible Melting point >1,200 °C	A2-s1, d0; non-combustible
Dimensions/delivery quantity	600 x 390 mm d = 60–300 mm (in 20 mm increments) Special format d = 50 mm with λ = 0.045 W/(mK) and =β	20 kg/bag

explicitly named in European Technical Assessment ETA-05/0093.

Basement ceiling insulation

In existing buildings in particular, many basement ceilings are not insulated or are inadequately insulated and, in addition, do not meet current fire protection requirements. This is a situation that can be remedied with the Multipor ceiling insulation system DI. The system can be optimally adapted to any situation, increases safety, and saves heating costs as an economical insulation system.



Simple adhesive installation on an existing ceiling

Residents often complain about cold floors in their living spaces, which greatly impair their comfort.
At the same time, heating costs are too high because a lot of energy is lost from the living space to the basement. The Multipor mineral insulation board DI system, which is eligible for KfW funding, is an ideal solution for both creating comfort and saving heating costs. Heating costs can be significantly reduced even with thin layers of
Multipor mineral insulation boards DI – simply glued under the ceiling.
Both professional tradespeople and



skilled homeowners are able to install and work with Multipor mineral insulation boards DI quickly, easily, and economically. With Multipor mineral insulation boards DI, it is possible to insulate and finish a wide variety of ceiling shapes and geometries easily and effectively from below. The handy format of the Multipor mineral insulation board DI, measuring 600 x 390 mm, guarantees quick processing in combination with the easy-to-use and economical Multipor lightweight mortar.

The Multipor sanding board can be used to sand down any remaining unevenness. The insulated ceiling surface can be left untreated, primed or painted at a later date, or filled or plastered with Multipor lightweight mortar to protect the panel surface from mechanical damage.

5.1 General introduction and planning

Fire protection requirements

The non-combustible Multipor ceiling insulation DI, in combination with Multipor lightweight mortar, it provides absolute safety for underground garage and basement ceilings as well as passageways. Even in the event of a fire at the highest temperatures, the Multipor ceiling insulation system DI does not emit any toxic fumes or smoke. There is also no

dangerous dripping of hot material. Since Multipor mineral insulation boards DI are non-combustible, they do not represent an additional fire load in the event of a fire – ideal for insulating escape routes.

Multipor mineral insulation boards DI are non-combustible building materials of building material class A1 in accordance with DIN EN 13501-1 and are therefore harmless in terms of smoke gas toxicology in the event of a fire. Since the associated Multipor lightweight mortar is classified as building material class A2-s1, d0, the entire system meets all requirements of the building regulations for non-combustible building materials (building material class A).

Fire protection in garages

The fire protection requirements for garages in Germany are regulated in the so-called garage regulations of the federal states. In some cases, there are also follow-up regulations in individual states, e.g., in North Rhine-Westphalia. The Technical Commission for Building Supervision also continues to issue the model garage regulation.

The following paragraph is included in almost all



Economical ceiling insulation for high fire protection requirements

regulations (excerpt from the Model Garage Regulation M-GarVO § 6 (6)):

Cladding and insulation layers under ceilings and roofs must

1. be made of non-combustible materials in large garages (over 1,000 m²),
2. and in medium-sized garages (100–1,000 m²) of at least flame-retardant building materials.

Because the Multipor ceiling insulation system DI is made of non-combustible materials, it meets all requirements in this regard, regardless of which regulation applies. According to the test certificate, Multipor protects the structure for 90 to 120 minutes, depending on the thickness of the insulation material and the structure.

Fire protection optimization in renovation projects

Multipor mineral insulation boards DI are also ideally suited for fire protection upgrades of "old" concrete or various types of solid ceilings and increase fire protection in both new and existing buildings. If the existing load-bearing ceiling structures have insufficient fire protection, e.g., due to insufficient concrete cover of the steel reinforcement, Multipor offers the solution.

Ceiling insulation made of Multipor mineral insulation boards DI may be used to supplement the concrete cover required for fire protection in accordance with DIN EN 13501. The relevant certificates are available and can be requested from our sales representatives if required. Multipor thus contributes to the classification of the respective ceiling slabs in the corresponding fire resistance class according to DIN 13501-2.
Together with the existing concrete cover and the improvement provided by the Multipor ceiling insulation system DI, a better fire protection classification that meets current requirements can be achieved.

Moisture protection

Moisture exposure during the shell construction phase due to the construction site does not have a long-term adverse effect on the Multipor mineral insulation system DI. In underground garages in high-risk areas,

even greater environmental influences (e.g., flooding) can occur. In order to test the moisture exposure in such extreme situations, a practical test was carried out: A Multipor mineral insulation board DI was glued to a concrete ceiling element and completely submerged in water for several days. The result was convincing: the boards remained dimensionally stable and mechanically undamaged, the adhesive bond held completely, and a few days after subsequent air drying, the full insulating function of the Multipor mineral insulation board DI on the ceiling and wall was restored thanks to its diffusion-open properties.

Energy requirements From an energy perspective and in accordance with legal requirements (EnEV), ceilings must be insulated towards the heated area. In addition, the U-values must be complied with in accordance with the current EnEV and the requirements of DIN 4108-2 "Reduction of thermal bridges in open garages." The Multipor ceiling insulation system

DI consists of 100% homogeneous material and thus has a good and homogeneous thermal conductivity value of λ = 0.042 W/(mK)

. Thermal bridges, which often in rail or dowel systems or multi-layer panels, are prevented by the full-surface bonding and homogeneity of the panel.

The direct, full-surface bonding of the insulation boards to the ceiling also has the advantage that backflow of the insulation layer is prevented, thus avoiding system-related heat losses as with "loose" insulation layers.

Working on beams and walls
In addition to the Multipor DI mineral insulation panel, the Multipor insulation wedge is an optimal solution for connecting areas of beams or integrating components. The dimensional stability of the insulation panel

a finishing profile

. Multipor mineral insulation boards DI can be adapted precisely to round or square penetrations to avoid thermal bridges.

Bright and friendly atmosphere Lighting in underground garages is essential for their use, but also has energy implications. The Multipor mineral insulation board DI has a bright, friendly surface which, thanks to the homogeneity of the insulation material, is retained even when the surface of the insulation board is sanded. Of course, it is possible to add color using silicate paints.

The surface quality can be further enhanced visually by applying a colorless silicate primer, a coat of Multipor interior silicate paint, a thin layer of filler, or, after doweling, a layer of reinforcement with a final coat of finishing plaster. This means that the insulation measure is not only economically sensible, but can also be adapted to the design of the property and its use.



Installation of Multipor mineral insulation board DI



Clean wall connection



Adapting the board to round and square shapes

Project and reference report





Underground car park insulation Forum, Duisburg

- Insulation of the underside of the visitor underground car park
- Full compliance with fire safety requirements
- Quick and easy processing
- Highest standards for appearance and acoustics

Project data	
Building type	Underground car park
Location	Duisburg
Application	Ceiling insulation
Products	Multipor mineral insulation board DI, d = 60 mm Multipor lightweight mortar

Project and reference report





Underground car park insulation Parkend residential complex, Frankfurt am Main

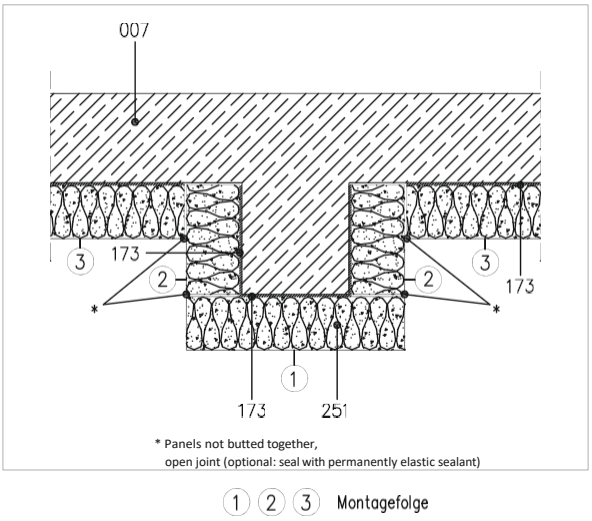
- Insulation of the underside of the underground car park
- Quick adaptation to the existing geometry
- Visually appealing solution
- Sound-absorbing properties ensure quiet living above the underground car park

Project data	
Building type	Underground car park
Location	Frankfurt am Main
Application	Ceiling insulation
Products	Multipor mineral insulation board DI, d = 160 mm Multipor lightweight mortar

5.2 Construction examples for DI ceiling insulation

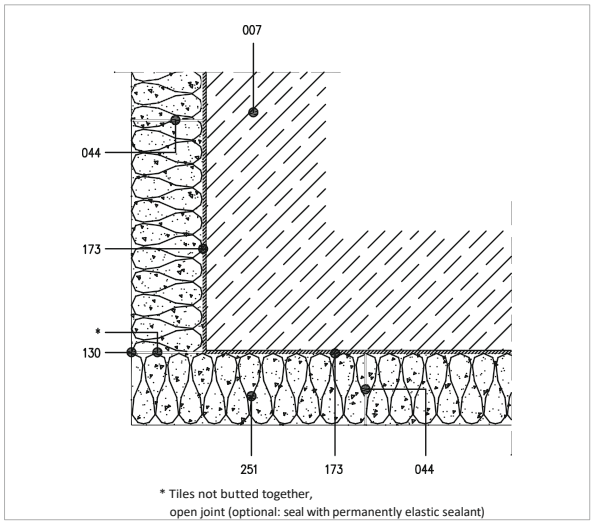
Construction examples of DI ceiling insulation: Basement and underground garage ceilings

Joist cladding



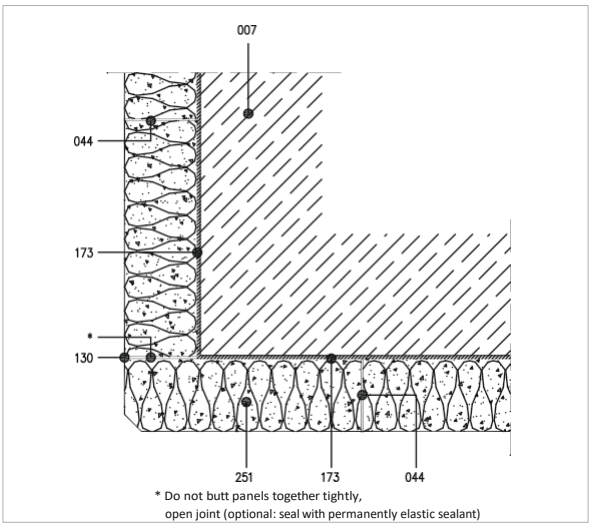
Ceiling insulation 17-001

Ceiling offset



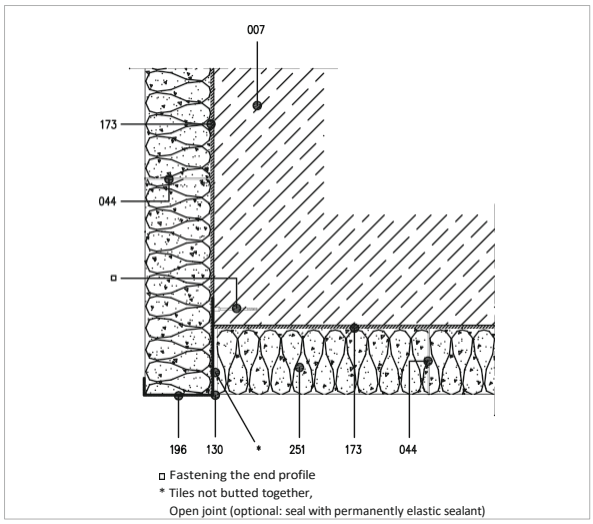
Ceiling insulation 17-002

Ceiling offset with edge profile



Ceiling insulation 17-003

Ceiling offset with end profile



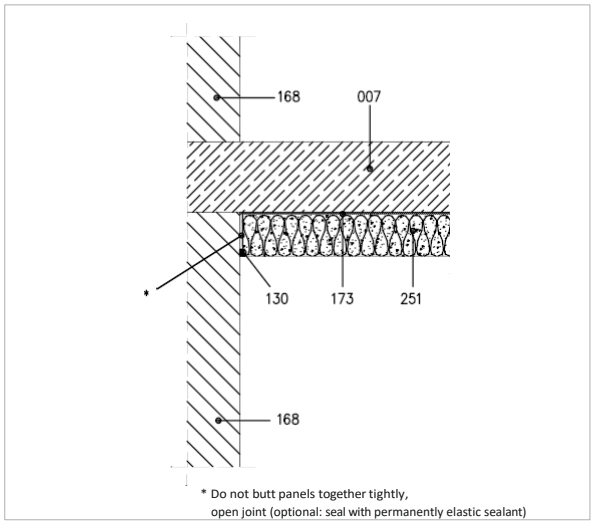
Ceiling insulation 17-004

007 Reinforced concrete ceiling
044 Butt joint (mortar-free)
130 Elastic jointing (optional)
173 Multipor lightweight mortar
196 End profile
251 Multipor ceiling insulation DI

These and other construction examples can be found at www.multipor.de/konstruktionsbeispiele

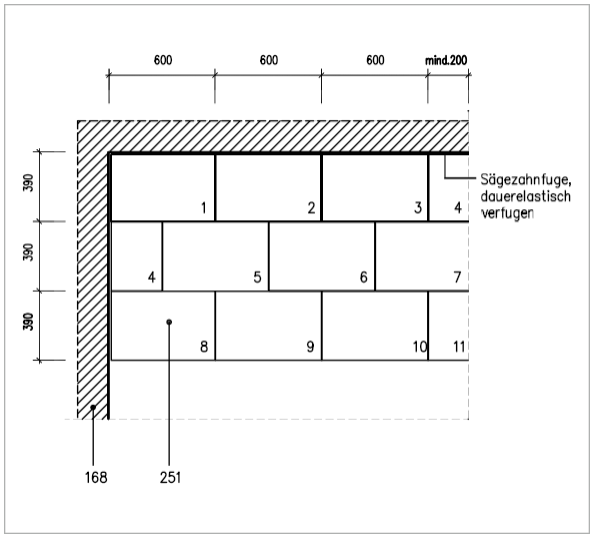
Construction examples for ceiling insulation DI: Basement and underground garage ceilings

Ceiling cladding



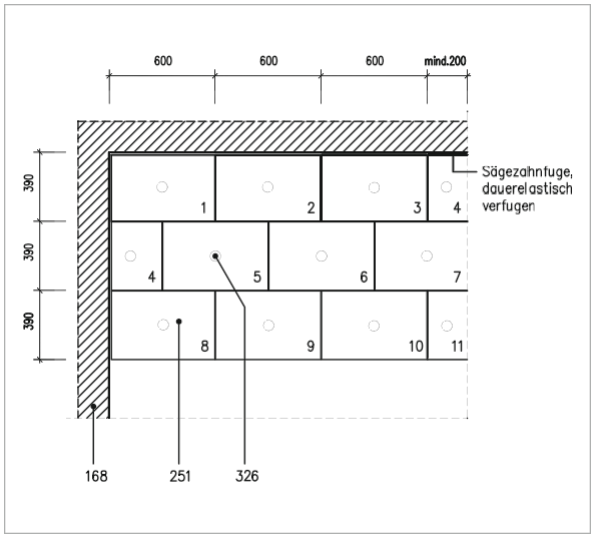
Ceiling insulation 17-005

Installation example (without dowels)



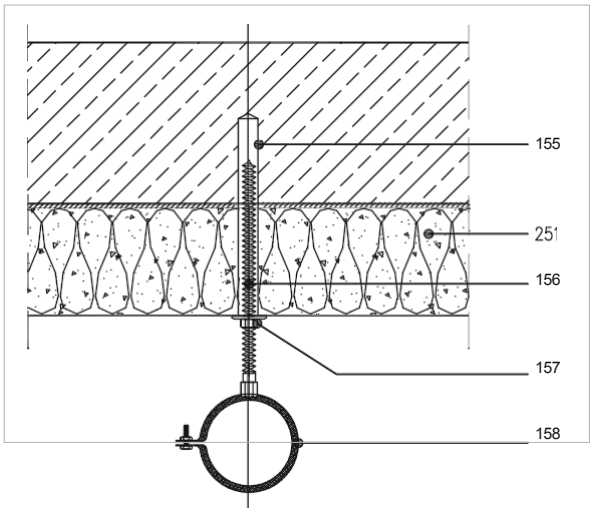
Ceiling insulation 17-010

Installation example (with dowels)



Ceiling insulation 17-011

Fastening connection



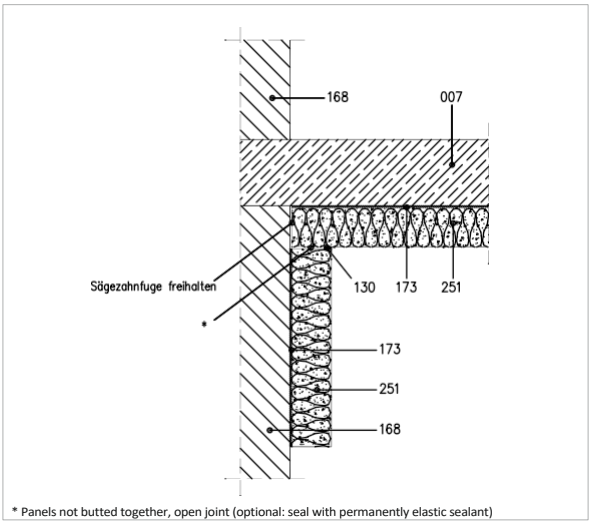
Ceiling insulation 17-012

007 Reinforced concrete ceiling
130 Elastic jointing (optional)
155 Drive-in anchors/compact dowels
156 Threaded rod
157 Nut with washer ∅ 30 mm
158 Pipe clamp
168 Existing masonry
173 Multipor lightweight mortar
251 Multipor ceiling insulation DI
326 Multipor screw anchor

5.2 Construction examples for DI ceiling insulation

Construction examples for ceiling insulation DI: Basement and underground garage ceilings

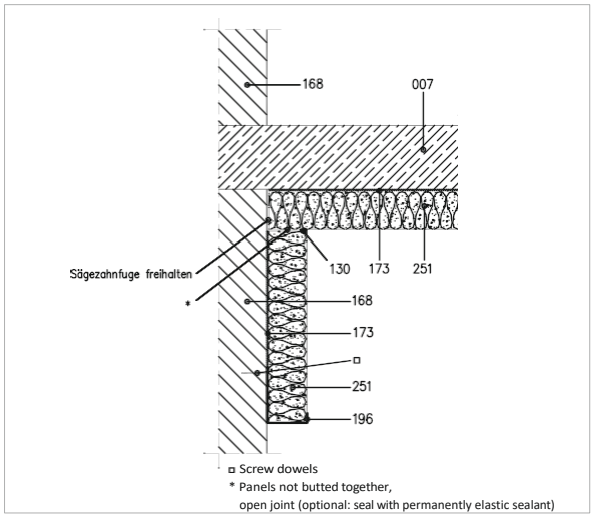
Side insulation



* Panels not butted together, open joint (optional: seal with permanently elastic sealant)

Ceiling insulation 17-006

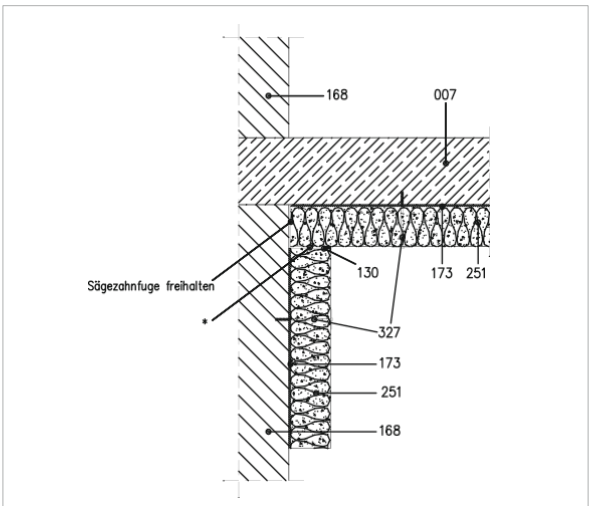
Side insulation with finishing profile



▫ Screw dowels
* Panels not butted together, open joint (optional: seal with permanently elastic sealant)

Ceiling insulation 17-008

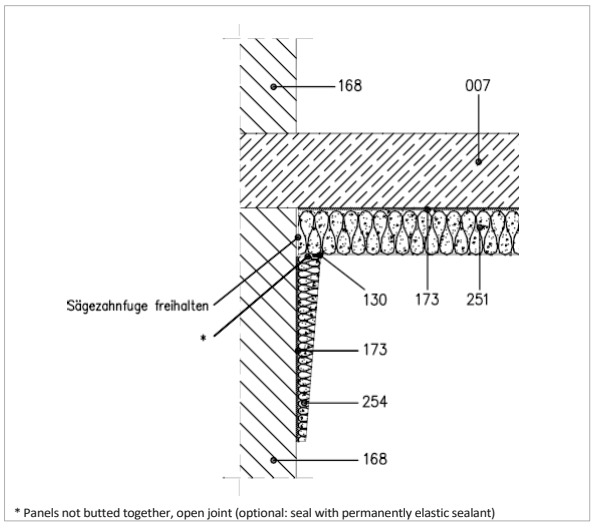
Side insulation with ceiling fasteners



* Panels not butted together, open joint (optional: seal with permanently elastic sealant)

Ceiling insulation 17-007

Side insulation with insulation wedge



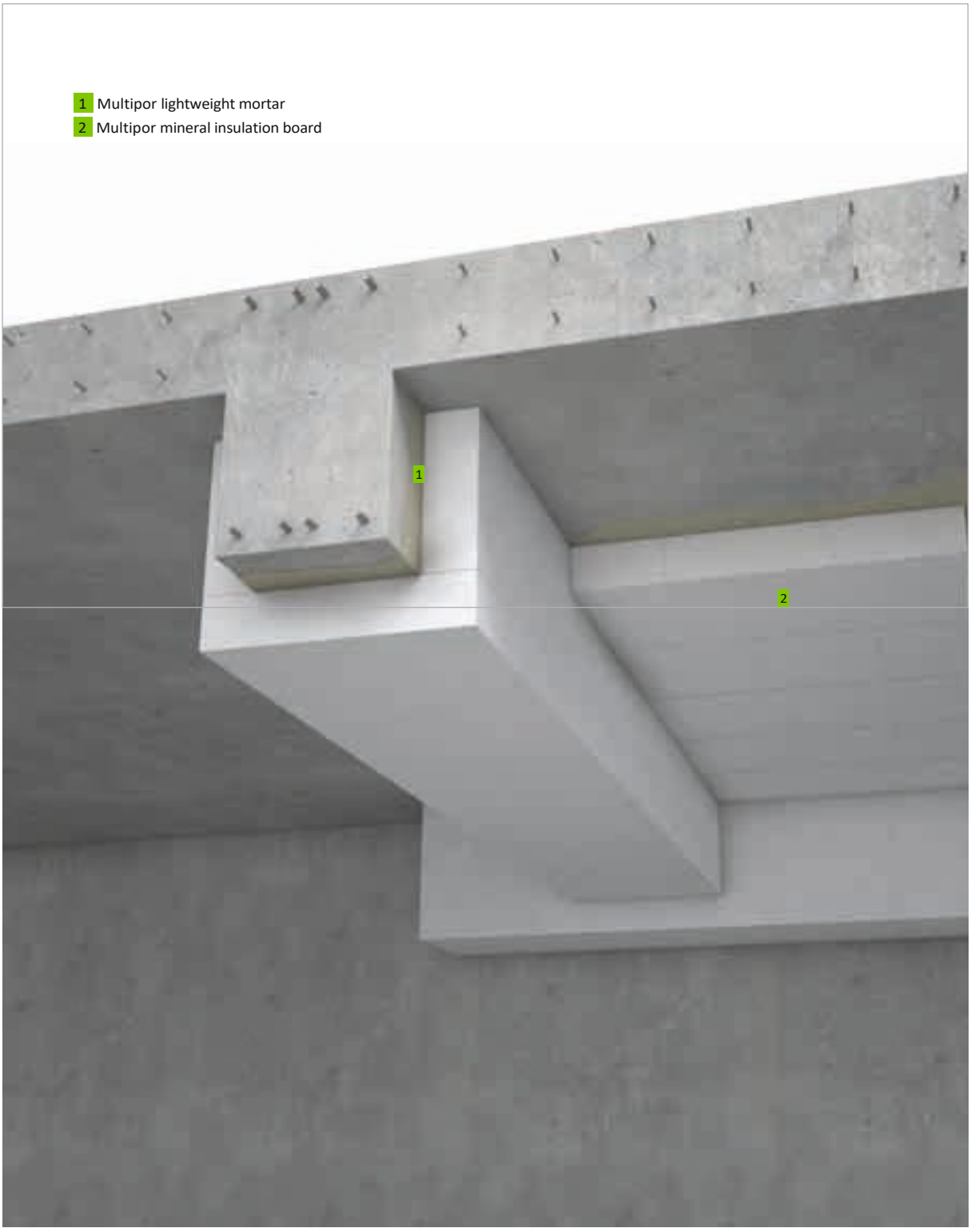
* Panels not butted together, open joint (optional: seal with permanently elastic sealant)

Ceiling insulation 17-009

007 Reinforced concrete ceiling
130 Elastic jointing (optional)
168 Existing masonry
173 Multipor lightweight mortar
196 End profile
251 Multipor ceiling insulation DI
254 Multipor insulation wedge
32 Multipor ceiling fasteners (as required)

These and other construction examples can be found at www.multipor.de/konstruktionsbeispiele

Processing Multipor ceiling insulation system DI 5.3



5.3 Processing Multipor ceiling insulation system DI

Typical areas of application:

- Underground garages and basement ceilings
- Thermal bridge-optimizing flank insulation on walls
- Air shaft insulation (see section 4.7)

Advantages

- Easy and quick overhead installation
- Low panel weight
- Easy to work on supports and walls
- Easy adhesive installation
- Bright, attractive surface
- High yield of Multipor lightweight mortar of approx. 30 liters/bag
- Multi-layer installation possible
- Improvement of fire protection for solid existing ceilings



Substrate preparation and substrate assessment

For both new construction and existing ceiling insulation, the substrate must be checked in advance for suitability and load-bearing capacity (see Table 1). In order to be bonded, it must be clean, dry, and free of residues that reduce adhesion, e.g., formwork oil. Strength development, formwork removal times, and concrete drying must be taken into account.

. Multipor lightweight mortar has a very high water retention capacity, so that no additional primer is required for substrates that are otherwise load-bearing. Particularly in the case of sandy and highly absorbent substrates, which are often found in existing buildings, it is necessary to prime the existing surface or pre-treat the substrate, e.g. with a

Adhesive filling with Multipor lightweight mortar is required. Particularly in the case of in-situ concrete ceilings, the corresponding formwork removal times and strength development of the concrete must be observed.

Paint, dirt, and non-load-bearing plaster must be removed, and any imperfections in the plaster must then be repaired with a standard lime-cement plaster or Multipor lightweight mortar. Existing concrete burrs must be removed, whereby it is often sufficient to cut off the burrs with a trowel [1] and then sweep the surface with a broom [2]. Concrete surfaces treated with release agents must be pretreated or cleaned using suitable measures. For freshly plastered substrates, the drying time of the plaster must be observed.

Table 1: Substrate preparations

Existing substrate	Measure	Recommendation
Grease, formwork oil residues, other release agents	Remove	High-pressure water jets with suitable cleaning agents, rinse with clean water, allow to dry
Dust, dirt, diesel soot	Remove	Sweep, brush, wash off
Non-load-bearing, sanding plaster	Remove	Remove mechanically, if necessary additionally dowel mineral insulation board
Old paint or unknown paint coatings	Remove	Remove paint completely using suitable methods (e.g., milling)
Wallpaper	Remove	Remove wallpaper completely using suitable methods (e.g., milling)
Unknown substrates	Check adhesion	Remove coating, create adhesive substrate or additionally dowel mineral insulation board

Timing of insulation work

The timing of the start of insulation work on the underside of the ceiling depends on several factors and must be agreed in advance with the client or confirmed in writing by the client.

- For in-situ concrete ceilings, the required formwork removal times must be observed and the corresponding drying times for the concrete must be planned into the construction schedule. A minimum drying time of 60 days for the concrete (also depending on the respective concrete quality) must be planned before starting the installation of Multipor.
- For filigree ceilings, the necessary structural reinforcement must be installed and the concrete overlay applied. A drying time of at least 30 days must be allowed for here.
- In the case of both Orbeton and filigree ceilings, further static loads that could cause the ceilings to deform must be ruled out.
- Extreme dynamic loads on the underside of the ceiling surfaces to be insulated, e.g., due to heavy traffic directly above during and after the insulation work, must be excluded.
- Depending on the season, care must be taken to ensure that the component and ambient temperature during installation of the insulation does not fall below 5 °C or exceed 30 °C (including the setting time of the mineral adhesive over a period of 24 hours).
- As expansion joints in building structures/ceiling levels are increasingly being dispensed with, but there are often individual concreting sections in in-situ concrete ceilings, these sections must be incorporated into the insulation level as joints (saw cuts).

1



Knock off any protruding concrete ...

2



...and remove dust

3



Mix mortar to make it easy to work with

5.3 Processing Multipor ceiling insulation system DI

Table 2: Technical data for Multipor lightweight mortar

Lightweight mortar	LW Lightweight plaster mortar according to EN 998-1
Compressive strength class	CS II; 1.5–5.0 N/mm²
Diffusion resistance factor	$\mu \leq 10$
Water absorption	W2, $c \leq 0.2$ kg/(m² $\min^{0.5}$)
Thermal conductivity	$\lambda_{10,dry}$ = 0.18 W/(mK)
Building material class	A2-s1, d0; non-combustible
Weight per bag	20 kg
Pallet contents	40 bags



Apply light mortar with a minimum 12 mm notched trowel

Mixing the lightweight mortar

Multipor lightweight mortar – see Table 2 for technical data – is mixed with the specified amount of water in accordance with the processing and safety instructions and may be processed at air, material, and component temperatures between +5 °C and +30 °C. Multipor lightweight mortar (20 kg/bag) for filling, bonding, and reinforcing Multipor mineral insulation boards DI is easy to mix. A slow-speed mixer and a robust mixing paddle with long blades are suitable for achieving a consistency that is easy to work with [3]. Depending on the weather, the mortar should be left to mature for about 5 minutes, mixed again, and then applied. Clean the tools immediately after use. Thoroughly cleaned mixing paddles always ensure optimal mixing results.

- Approx. 8 l water required per 20 kg bag of lightweight mortar when mixing with a mixer paddle
- Processing time: approx. 1.5 hours, depending on weather conditions
- Due to the high yield of Multipor lightweight mortar, 30 l of fresh mortar per bag is sufficient for approx. 6 m²of bonding or approx. 6 m²of reinforcement layer, depending on the substrate condition.
- Multipor lightweight mortar can also be processed using standard plastering machines.

Multipor lightweight mortar can be stored dry on pallets for 12 months from the date of manufacture. As with any product, the processing and safety instructions on the container apply.

Applying the lightweight mortar to the Multipor mineral insulation board DI

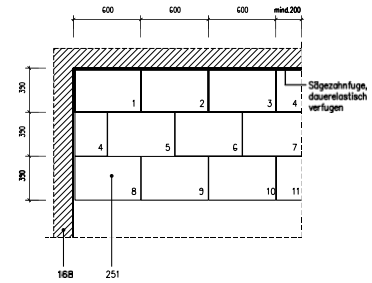
The lightweight mortar is applied to the entire surface of the back of the insulation boards with a notched trowel and combed through to create an optimal bond between the lightweight mortar and the insulation board [4].

Depending on the thickness of the insulation material to be processed, different notched trowels should be used for the corresponding web heights of the lightweight mortar:

- 12 mm trowel for insulation thicknesses up to 140 mm
- 15 mm trowel for insulation thicknesses from 160 mm (up to 200 mm in a single layer)

This also allows slight unevenness in the substrate to be better compensated. Freshly laid Multipor DI mineral insulation boards (buttering-floating method) additionally compensate for larger unevenness if necessary.

5



Installation diagram

6



Bonding the mineral insulation board

7



Floating

8



Swim in and press down perpendicular to the mortar application

Bonding the Multipor mineral insulation board DI

The Multipor mineral insulation boards DI must be bonded over the entire surface with Multipor lightweight mortar in a staggered pattern with a joint offset of ≥ 15 cm [5]. An installation board makes laying easier and ensures more even pressing. The butt joints of the insulation boards are laid with a tight fit and are not mortared. For full-surface bonding, both the surfaces should be checked for squareness before installation begins and the alignments should be marked with a chalk line or laser.

Bonding, floating, and pressing are carried out by hand or with the aid of a mounting board. The floating of the insulation boards, which is necessary for optimum bonding, is always carried out across the direction of the mortar teeth. [6 – 7]. Floating Multipor mineral insulation boards on the substrate to be insulated ensures an optimal bond between the mineral insulation board, adhesive, and solid ceiling.

For insulation thicknesses > 200 mm, the Multipor mineral insulation boards DI are bonded to the ceiling in two layers (Table 3). The first layer is applied as described above, while the second, thinner or equally thick layer of insulation is applied with offset joints and is also bonded to the entire surface of the first layer using Multipor lightweight mortar. A 10 mm notched trowel is usually sufficient for the intermediate adhesive layer. Regardless of whether a single or double layer is applied, the insulation layers must be doweled to the substrate if the total insulation thickness exceeds 140 mm or if the underside is fully plastered with Multipor mineral insulation boards DI.

Due to the joint offset of the insulation layers, the two-layer application automatically has a thermal bridge-optimizing effect. In addition, any irregularities in the substrate that are transferred to the first layer can be concealed seamlessly by simply sanding them down before bonding the second layer. Sanded surfaces must generally be dusted (swept).

Dealing with movement and expansion joints, component connections, insulation fields

In large underground garages and associated large structures in particular, static and thermal influences can generate such strong stresses that cracks occur in the structure. To prevent this, the components are separated from each other by means of movement joints, often referred to as expansion joints. These joints must be incorporated into the insulation layer in both new and existing buildings. Under no circumstances should the existing joints be insulated, as otherwise the movements of the building structure can cause damage to the insulation layer.

5.3 Processing Multipor ceiling insulation system DI

Table 3: Mechanical fastening

Insulation thickness	Measure
Up to 140 mm, single and double layer	Full-surface bonding (Multipor lightweight mortar)
> 140 mm, single layer	Full-surface bonding and mechanical fastening*
> 140 mm, two layers	Full-surface bonding and mechanical fastening* (fastening can be carried out through the first layer if the second layer of Multipor remains max. 140 mm thick)
– Car park decks (underfloor insulation with Multipor) – for unknown substrates – For fabric-reinforced plaster layers (regardless of panel thickness)	In general: full-surface bonding and mechanical fastening* required

* At least one fastener per panel

9



Easy cutting

Multipor ceiling insulation DI can be laid without joints up to a contiguous area of 35 m², whereby the side lengths must not exceed 7.5 m.
If the adhesive substrate consists of element ceilings (filigree ceilings), every second component joint must be transferred to the insulation layer. In the case of filigree ceilings, the flat support of the panel elements must also be checked in advance. If there is an offset in the joint area, the recessed areas must be leveled using Multipor lightweight mortar.

Even in smaller buildings that do not have movement joints in the existing structure, Multipor DI mineral insulation boards must be installed in such a way that movements in the building or between the insulation and the building do not cause any damage. For example, when bonding full-surface ceiling insulation [8] to the underside, a joint must be formed around the perimeter, for example by means of a saw cut.

Newer underground garages are often constructed as precast concrete structures. As a statically determined structure, movements can occur, especially on beams that have a support designed with a sliding bearing. The beams undergo length changes due to temperature stresses and time-dependent material behavior. Furthermore, they bend under their own weight and vertical loads. This deflection is greatest in the middle of the beam when the load is uniform. At the same time, the deflection causes a twist, which in turn is greatest at the supports. To avoid forced stresses between Multipor mineral insulation board DI and the existing structure, sufficient freedom of movement must therefore be provided.

In particular, the connections between the joist and the existing wall must be designed in such a way that these movements can be absorbed

. For the reasons described above, it is clear that the connection area between the wall and ceiling must also be designed to allow for movement. Open joints can optionally be sealed with permanently elastic sealant on the room side. For guidance, see Chapter 5.2 Construction examples for DI ceiling insulation.

Cutting and adjusting the Multipor mineral insulation board DI The boards and required fittings can be easily cut to any size using a fine-toothed Multipor handsaw [9].

Multipor mineral insulation boards DI can also be quickly adapted to existing electrical cables or recesses in walls or ceilings, thus ensuring a homogeneous insulation layer [10] [11].

The Multipor sanding board helps with adjustment so that the panels can be easily and quickly connected to round or square shapes [12] [13].
, the Multipor sanding board helps with the adjustment [12] [13].


10

Prepare the panel for notching


11

Notching the panel where pipes are present


12

Grind the panel

Additionally dowel Multipor mineral insulation board DI

For insulation thicknesses greater than 140 mm, each insulation panel must be doweled with one dowel per panel. In many cases, the load-bearing capacity of solid existing ceilings in combination with a bonded insulation system can only be assessed to a limited extent. If the insulation thickness is > 140 mm or the substrate can only be assessed to a limited extent, the Multipor mineral insulation boards DI are additionally doweled in the center of the board
with a dowel [14] [15] [16]. If the floor slab bonded with Multipor mineral insulation boards is exposed to permanent dynamic loads, such as in production facilities or stadium stands, the Multipor mineral insulation boards DI must be doweled regardless of their thickness. Please contact our application engineering department for more information. Suitable ceiling dowels approved for this purpose must be used.
Suitable anchors can be found in the current price list or in the technical information "Fasteners" in the download area at www.multipor.de.


13

Adapting panels to round and square shapes

Practical tip: If Multipor is laid in two layers, only the first layer of insulation is doweled. The second layer of insulation, with a maximum thickness of 140 mm, is rotated by 90° and the joints are offset, and is only glued to the first layer. This saves costs due to shorter dowel lengths and also creates an attractive appearance.


14


15

Suspensions and loads in the ceiling

Cables and cable trays are often retrofitted under the ceiling. The insulation material does not need to be removed for this; instead, the load can be fastened to the substrate using a threaded rod and washer through the Multipor mineral insulation board DI (see page 173; example 17-012). A selection of fasteners can be found in the following chapter 5.4.

5.3 Processing Multipor ceiling insulation system DI

Light sanding

If the ceiling surface is uneven, the panel surface can be easily sanded using the Multipor sanding board [17]. Thanks to the homogeneous material structure, the sanded surface matches the structure and color of the unsanded Multipor mineral insulation panel DI.

The ceiling surface can be insulated quickly and cleanly. The light-colored Multipor mineral insulation boards DI do not require any additional treatment. Ceiling soffits that have been sanded over a large area can be coated with Multipor plaster primer, Multipor interior silicate paint, or a colorless silicate primer after sanding to achieve a uniform appearance. Loose particles and/or dust particles must be removed from the surface beforehand.

Material particles present on the board surface due to the manufacturing process may fall off. To prevent this, the insulation board can be coated with Multipor plaster primer, Multipor interior silicate paint, or a colorless silicate primer. This binds dust and loose particles and at the same time strengthens the surface without changing the material properties.

Optional coating – surface treatment

The individual finish is applied according to requirements and specifications.
Whether paint, filler, or plaster: the design possibilities are endless.

Optional paint options for the panel surface

For color design options, we recommend Multipor interior silicate paint in accordance with DIN 18363. This can be applied to the dust-free surface by brushing, rolling, or spraying.

Optional full-surface filling

For fully filled Multipor mineral insulation boards DI, Multipor lightweight mortar must be applied thinly in grain thickness – maximum 3.0 mm – to the surface and felted in good time [18]. This is particularly recommended for rooms with lower surface quality requirements, as hairline cracks cannot be ruled out in the area of the board joints. 2 to 2.5 kg/m² of Multipor lightweight mortar is sufficient for a layer thickness of 2 to 3 mm (10 to 12 m²/bag).

Optional full-surface plastering

To plaster the entire surface of Multipor mineral insulation boards DI, a reinforcement layer of Multipor lightweight mortar is first required – with an average layer thickness of 5 mm including reinforcement fabric [19].

16



17



Easy sanding

18



Applying Multipor lightweight mortar

19



Applying Multipor lightweight mortar …

20



... and embed the Multipor reinforcement mesh

21



Carefully slit crosswise

22



Slightly adjust to round shapes ...

23



... and square, clean wall finish

24



Connection between wall and ceiling

25



Installation procedure 1, 2, 3

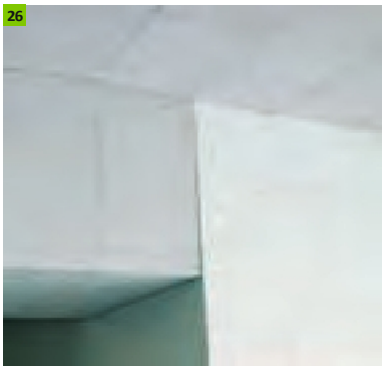
[20]. Then, additional fastening is carried out with Multipor screw anchors or Multipor ceiling fasteners (depending on requirements) through the fresh layer and the fabric into the load-bearing substrate (fresh on fresh). Before installing the fasteners, the reinforcement fabric at the drill hole should be carefully slashed crosswise with a utility knife [21]. This allows the dowels to be screwed in without changing the position of the embedded fabric. If necessary, the dowel area should be plastered after the dowel has been set. Four dowels per square meter should be provided for the surface. Product data sheets with technical specifications for our Multipor screw dowels and Multipor ceiling fasteners, as well as an overview of other fasteners, can be found in the download area at www.multipor.de

Depending on the selected coating, the following application instructions must be observed.

Thin plasters and surface fillers:

- Apply a 2 to 3 mm thick final coat of Multipor lightweight mortar, which can be felted in good time.
- Multipor lime fine plaster or Multipor lime smoothing compound for thin-layer filling and smoothing of the reinforcement layer

26



Support detail

5.3 Processing Multipor ceiling insulation system DI

The total plaster thickness of the reinforcement layer and top coat must not exceed 8 mm. The top coat thickness is approximately 3 mm, and correspondingly less for Multipor lime fine plaster and Multipor lime smooth finish (see processing guidelines).

Insulation of beams and components

A wide variety of connection details illustrate how easy it is to install and work with Multipor mineral insulation boards DI. Connections to round or angular shapes can be easily made without additional tools or profiles, and it is not necessary to finish the insulation with metal profiles (to prevent detachment or damage) [22–24].

When insulating beams, it is important to insulate the underside of the beam first and then the side surfaces [25–27].
If the adhesive for the underside of the joist is applied to the mineral insulation board, the protruding areas remain free. This prevents the horizontal and vertical Multipor mineral insulation boards DI from sticking together and the mineral insulation board from tearing off when the joist deflects. The insulated ceiling surface runs against the lateral insulation of the joists [28]. This is also tension-free and must be connected in a permanently elastic manner, depending on the fire protection requirements. When connecting the joist insulation to the walls, the application rules for dealing with expansion and movement joints must be observed.

27



28



Insulate joists [1], [2],

Table 3: Calculation aid

Material	Consumption	Approximate time	Comments
Basic positions			
Multipor mineral insulation board DI	4.3 boards/m²	Approx. 15 min/m²	For bonding
Multipor lightweight mortar	approx. 3.5 kg/m²	Approx. 15 min/m²	For bonding
Alternative positions			
Multipor lightweight mortar	Approx. 3.5 kg/m²	Approx. 10 min/m²	For reinforcement
Multipor screw anchors without fire protection requirements	4.3 pcs/m²	Approx. 8–10 min/m²	Place the dowels in the center of the panel or evenly distributed in the plaster layer in the surface
Multipor lightweight mortar	Approx. 2.5 kg/m²	Approx. 10 min/m²	For final coating as top coat
Multipor screw anchors with fire protection requirements	4.3 pcs/m²	Approx. 8–10 min/m²	Place the dowels in the center of the panel or evenly distributed for plaster layers across the surface
Multipor insulation wedge	5.2 pcs/m²	Approx. 15 min/m²	For bonding

The following assumptions form the basis of the sample calculation:
– The area to be insulated has no large openings, projections, reveals, or similar features.
– Plaster leveling and similar preparatory work are not included in the calculation.
– Other allowances (e.g., for plaster profiles, etc.) must be taken into account if necessary – see also the current tender texts.
– Multipor screw anchors with or without fire protection requirements
– Direct transport to the construction site or scaffolding times must also be taken into account.

29



Aestuver expansion joint M

30



Aestuver Expansion Joint M

31



Aestuver Expansion Joint M

Rigid connections between walls and ceilings must be avoided. In such cases, a permanently elastic connection must be made, for example with Aestuver joint flex tape [29]. Any areas that may have become firmly bonded during processing must be subsequently separated using a handsaw or similar tool.

Fixtures
Lamps must be mounted on a load-bearing substrate that provides a stable support surface with mineral insulation board and plaster. Fire protection regulations must always be observed.

Expansion joints with fire protection requirements
Expansion joints must always be incorporated and formed in the insulation layer. Unprotected openings in building components do not meet fire protection requirements and are not permitted. This applies, among other things, to component joints for movement absorption. Aestuver Expansion Joint M, which is used between solid ceilings or walls, is considered to be a fire protection-effective and permanently elastic sealant for joints ≤ 30 mm wide is Aestuver expansion joint M, which is used between solid ceilings or walls. Thanks to its fire resistance class F90 in accordance with DIN 4102-2, it prevents the spread of fire and smoke for 90 minutes and can also accommodate joint movements of up to +/- 15% of the joint width [29–31].

Calculation aid
The material quantities and working times to be calculated for the work steps can be taken as guidelines from Table 3.

Work safety on the construction site To avoid accidents, the regulations of the employers' liability insurance association must always be observed.

In addition to general construction site safety measures, the installation of Multipor insulation systems involves further requirements in the area of work and protective scaffolding. Here too, regulations from a technical and trade association perspective apply that ensure smooth construction site operations.

The generally applicable safety and hygiene measures as well as the regulations of the employers' liability insurance associations always apply, such as the wearing of safety goggles and dust masks during grinding work, especially when working overhead.

5.4 Fastening loads to Multipor ceiling insulation systems DI

The fastening of loads depends on the expected load size and type of stress. The choice of fastening material and its position is also based on this.

Types of fastening:

- Mechanical fastening of light loads in Multipor mineral insulation board DI
- Mechanical fastening of heavy loads through the Multipor mineral insulation board DI in the substrate

A selection of possible fasteners can be found as technical information on the Internet at www.multipor.de in the download area.

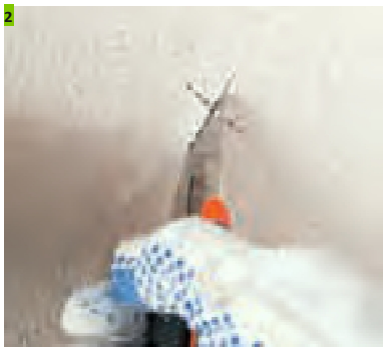
Fastening of light, stationary loads
Light, stationary loads up to 6 kg pull-out load at a hole spacing of 600 mm can be fastened directly into the Multipor mineral insulation board DI using the Multipor spiral dowel [1]. Before the spiral dowel (50 mm,
85 mm, 120 mm) is screwed in, carefully make a slit in the plaster layer with a utility knife [2].

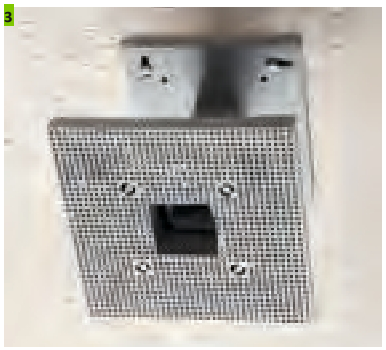
Practical tip: In public and freely accessible underground garages, all loads should be fastened to a load-bearing substrate to prevent vandalism.

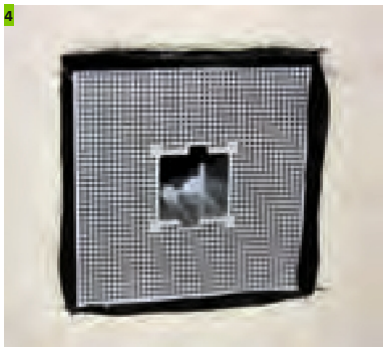
Multipor telescopic device carrier This carrier can be used for dowel-free mounting of lights, motion detectors, and other devices.

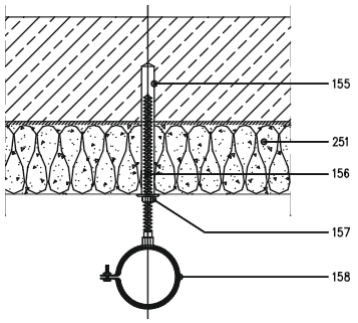
1

Multipor spiral dowel

2

Preparing the Multipor mineral insulation board DI

3

Multipor telescopic tool carrier

4

Built-in Multipor telescopic device carrier

5


155 Drive-in anchors / compact dowels
156 Threaded rod
157 Nut with washer ∅ 30 mm
158 Pipe clamp
251 Multipor ceiling insulation DI

Fastening connection through the Multipor mineral insulation board DI

It can be combined as desired with a minimum center distance of 120 mm. Installation takes place before the insulation work. The integrated cable routing allows convenient and secure connection to the electrical cable. The Multipor telescopic device carrier can be loaded with up to 5 kg [3] [4].

Fastening heavy and dynamic loads Loads over 6 kg and all dynamic loads are not fastened to the Multipor mineral insulation board DI, but to the load-bearing substrate.

Fastening of individual loads For hangers of cable and conduit routes, dowels are inserted through the Multipor Mineral Insulation Board DI into the load-bearing substrate. The point loads are distributed with the aid of a washer [5].

6



Fastening a light strip

7



Attaching a sprinkler system

8



Fastening a cable tray

MAXIMUM STABILITY PRESSURE-RESISTANT NON-COMBUSTIBLE FIBER-FREE PURE MINERAL DIFFUSION-OPEN AGING-RESISTANT DIMENSIONALLY STABLE EASY TO PROCESS VOLUME-STABLE ECONOMICAL SUSTAINABLE SAFE TO USE FL SLOPELED roofs 100% RECYCLABLE ECONOMICAL APPLICATION FIBER-FREE VOLUME STABLE FLAT ROOF DIFFUSION OPEN APPLICATION SAFETY PURE MINERAL ECONOMICAL SAFETY OF EXECUTION SLOPED ROOFS NON-COMBUSTIBLE

6 Multipor roof systems DAA/DAD



6.0 Multipor Roof Systems DAA/DAD

Roof systems DAA/DAD

6.1 General introduction and Planning

- Maximum stability and compressive strength (300 kPa/350 kPa)
- Practical for construction, no compression
- Non-combustible, building material class A1 according to DIN EN 13501-1
- Approved according to ETA-05/0093
- Diffusion-open
- Purely mineral, fiber-free
- Resistant to aging, deformation, and volume change
- Easy to process
- Ecologically certified by natureplus, IBU, and eco-INSTITUT

Multipor mineral insulation boards are suitable for insulating pitched and flat roofs in cold and warm roof constructions. Chapter 6.8 describes the processing of the Multipor mineral insulation board DAD in pitched roof insulation, including all planning and construction examples. The following chapter 6.2 describes the application of the Multipor mineral insulation board DAA in flat roof insulation.

Function of roof constructions Roofs primarily protect the building, its occupants, and its contents from external influences. Flat roof insulation in particular
enormous temperature fluctuations – approx. 80 °C to approx. - 20 °C – and must therefore meet special requirements. Mechanical stress, moisture, wind suction and, increasingly, fire protection play a major role. If, for example, insulation material ignites during insulation and sealing work in the roof area, smoldering fires can have far-reaching consequences. Every roof construction is therefore a complex building task and requires professional and expert planning.

Roof use

The following types of flat roofs can be distinguished in terms of their use:

- Unused roof areas (roofs exposed to the elements, covered with gravel and/or extensively greened), which are only rarely accessed, e.g., for maintenance purposes
- Used roof areas (intensively greened roofs as well as balconies, terraces, and parking decks)

Multipor mineral insulation boards DAA optimally meet the requirements for both types of roof.

Flat roof shapes

The term "flat roof" does not define the shape of a roof structure, as is often assumed, but rather the arrangement of the roof layers: Flat roofs are generally constructed with a flat, homogeneous, membrane-like roof waterproofing that is laid over the entire surface on a continuous and jointless substructure (e.g., insulation).
Flat roofs are possible in any shape and pitch.

Roof pitch

- The roof pitch should be decided during the planning phase, as standing water significantly reduces the life expectancy of a roof waterproofing system. DIN 18531-1 therefore divides flat roof structures into two application categories:

- Application category K2 (higher-quality roof construction): This defines constructions with a longer service life and lower maintenance costs. The standard roof pitch for this application category is at least 2% in the waterproofing layer. In addition, the roof pitch in valley areas must be at least 1%. Only high-quality waterproofing products that are regulated as such in DIN 18531-1 may be used. Unevenness of the substrate and execution tolerances must also be taken into account during planning.

- Application category K1 (standard roof construction): This represents the minimum requirements for a roof construction. K1 roof waterproofing may also be used here. However, if the roof slopes fall below those specified for application category K2, high-quality K2 roofing membranes must be installed here, even if the result is only a K1 roof.

- The current flat roof guideline completely dispenses with the K1 and K2 categorization.

Multipor sloping panels allow for any roof pitch, so that, at the planner's request, perfectly functioning sloping roofs with almost any pitch can be designed.

The U-value for sloped insulation is determined in accordance with DIN EN ISO 6946. The outdated method of calculating the U-value for an average insulation thickness is no longer used.

Table 1: Product data for Multipor mineral insulation board DAA/DAD

Designation	Unit	Description		
		DAA	DAA	DAD
Rated thermal conductivity (λ)	W/(mK)	0.045	0.047	0.045
Compressive strength	kPa	≥ 300	≥ 350	≥ 300
Tensile strength	kPa	≥ 80		
Deformation		≤ 1 mm at 1,000 N point load		
Modulus of elasticity E	N/mm	20		
Bulk density	kg/m³	approx. 115		
Water vapor diffusion resistance factor ( ) μ		3		
Specific heat capacity (c)	J/(kgK)	1,300		
Thermal expansion coefficient (α_t)	1/K	$1*10^{-5}$		
Water absorption (short term) according to DIN EN 1609	kg/m	≤ 2		
Water absorption (long-term) according to DIN EN 12087	kg/m	≤ 3		
Panel format (L x W)	mm	600 x 390		
Fire protection/building material class according to DIN EN 13501-1		A1, non-combustible		
Melting point	°C	> 1200		

Table 2: Areas of application for Multipor mineral insulation boards according to DIN 4108-10

Article	Type of application[1)]	Compressive load[1)]	Building material class (fire class)	Areas of application	Deformation
Multipor 300 kPa λ = 0.045 W/(mK)	DAA	dh (high load)	A1	Roofs in use, terraces	Practically non-compressible in construction
Multipor 350 kPa λ = 0.047 W/(mK)	DAA	ds (very high load)	A1	Parking decks, industrial floors, etc.	Practically non-compressible in construction

[1]According to DIN 4108-10, Table 2 (see page 32) or building authority approval

6.1 General introduction and planning

Permissible. As part of the services offered (see Multipor price list), the required insulation thicknesses and complex roof layouts are calculated.

Positioning safety Flat roof constructions must generally be secured against lifting by wind suction, regardless of the type of construction. Since July 2012, wind suction forces have been determined in accordance with DIN EN 1991-1-4; among other things, the location of the construction project (wind zone), the terrain category, the building height, and the internal pressure conditions are taken into account. The resulting wind suction forces are then taken into account when planning the roof construction package.

The stability of flat roof constructions can be achieved in various ways:

- Sufficiently dimensioned ballast for loosely laid roof layers (e.g., gravel, greenery, plating)
- Friction-locked bonding of all roof layers
- Mechanical fastening of the roof waterproofing in the substructure

Regardless of the type of installation, however, the edge fixing of the roof waterproofing prescribed by the flat roof guidelines is mandatory. This absorbs horizontal forces (e.g., from wind suction, roof membrane shrinkage, vibrations of the supporting structure, etc.) and thus prevents damage in connection areas.



calculations are prepared for roof structures with ballast as well as for bonded structures. Wind load calculations for mechanical fastening, on the other hand, must be requested from the roof waterproofing manufacturers, as additional special features apply here, such as roofing membrane widths and/or product-specific fastening types (hem fastening, field fastening, line fastening). You can find more information about the services we offer in our current price list in the download area at www.multipor.de.

Cost-effectiveness

Roofs generally have a life expectancy of several decades. However, hastily selected building products and workmanship errors can lead to structural damage with high repair costs. High-quality roof constructions with a high-quality combination of insulation and waterproofing—such as Multipor mineral insulation boards with tested waterproofing systems – are therefore a worthwhile safety.

Multipor mineral insulation boards DAA/DAD are ideal for use in fire protection due to their optimal properties in this regard.

- fire protection
- compressive strength
- compression resistance
- ecology
- thermal insulation

One of the most economical flat roof insulation materials on the market.



protection requirements need a non-combustible roof insulation material. As a high-performance insulation material in building material class A1, Multipor mineral insulation boards DAA/DAD are an absolutely safe solution in this regard. Unlike conventional insulation materials, roofs insulated with Multipor meet the high requirements for non-combustibility, compressive strength, and resistance to deformation. And all this with just one material.

boards DAA/DAD allow for numerous safe roof construction variants – from unloaded, unused roofs to heavily loaded parking roof structures or roof terraces. These first-class properties ensure material approvals and technical certifications. The relevant certifications are available for download at www.multipor.de.

Ecology/sustainability Multipor mineral insulation boards DAA/DAD are an ecologically recommended alternative to common plastic, mineral fiber, or foam glass insulation materials.
Made from natural raw materials, they are completely harmless in terms of building biology and health, both during processing and throughout their entire service life.

The IBU declaration certifies that Multipor is manufactured in a resource- and environmentally-friendly manner and that its ingredients are of mineral origin. Roof insulation made from durable Multipor DAA/DAD mineral insulation boards is therefore ideal for environmentally and health-conscious customers and builders. With the Multipor Big Bag, single-type processing residues can be easily returned to our plant in Stulln for recycling. Of course, safe disposal in a landfill is also possible.

Project and reference report





GHOTEL hotel & living, Würzburg

- Complex and challenging sloped roof construction
- Individual slope plan
- Lens-shaped roof geometry requiring an adaptable insulation material
- Quick and easy adaptation of the insulation material
- Particularly high requirements for wind loads and fire protection

Project data

Building type	Hotel
Location	Würzburg
Application	Roof insulation
Products	■ Multipor mineral insulation board DAA as a project-specific pitched roof with a 2% slope ■ Multipor lightweight mortar

Project and reference report



Photo: Kö-Bogen



Photo: Kö-Bogen/Friedhelm Krischer

Kö-Bogen, Düsseldorf

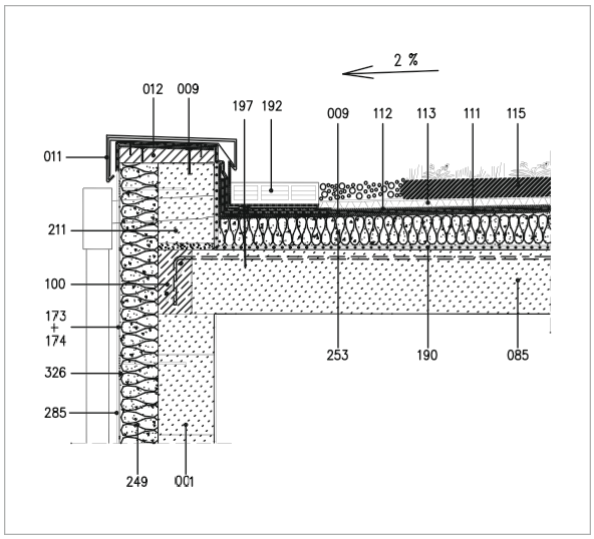
- Challenging adaptation to amorphous building geometry
- Project-specific sloping roof construction
- Green roof construction on reinforced concrete ceiling
- High requirements for compressive strength and fire protection
- LEED-certified building

Project data	
Building type	Shopping center and office
Location	Düsseldorf
Application	Roof insulation
Products	■ Multipor mineral insulation board DAA as a project-specific pitched roof with a 2% slope ■ Multipor lightweight mortar

6.2 Construction examples Flat roof insulation DAA

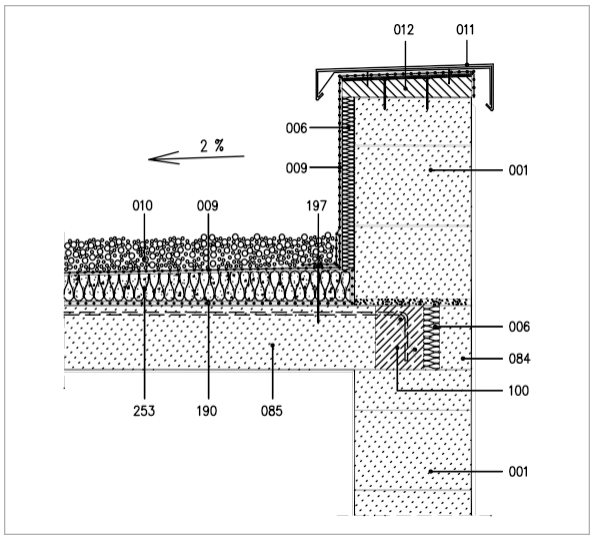
Construction examples of flat roof insulation DAA

Parapet, green roof



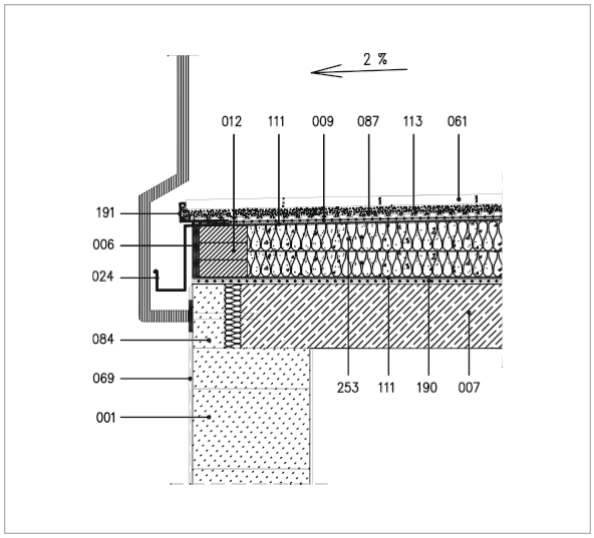
Roof insulation 09-001

Parapet connection, gravel support



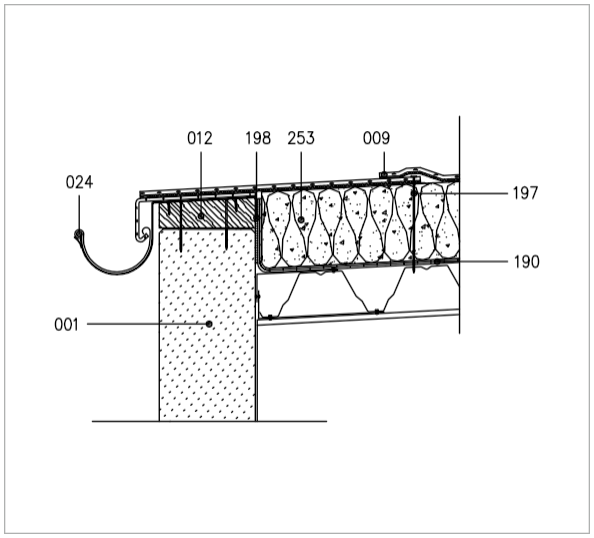
Roof insulation 09-002

Railing detail



Roof insulation 09-003

Drainage with gutter



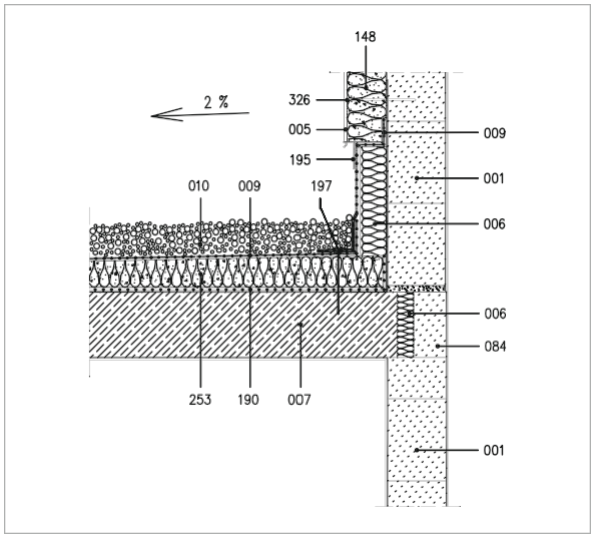
Roof insulation 09-004

001	Ytong masonry	06	Balcony flooring	112	Root protection layer	197	Roof screw
006	Thermal insulation	069	Plaster, lime-cement mortar	113	Drainage layer	198	Bonding
007	Reinforced concrete ceiling	084	Ytong ceiling block, laminated	115	Vegetation layer	211	Ytong flat construction panel
009	Roof waterproofing			173	Multipor lightweight mortar	249	Multipor mineral insulation board WAP
010	Gravel fill	08	Ytong ceiling	174	Multipor reinforcement mesh	253	Multipor flat roof Insulation DAA
011	Cover plate	087	Drainage	190	Vapor barrier		
012	Wooden plank	10	Ring anchor	191	Gravel trap	285	System-compliant finishing plaster
024	Rain gutter	11	Separation or protective layer	192	Roof inlet	326	Multipor screw anchor

These and other design examples can be found at www.multipor.de/konstruktionsbeispiele

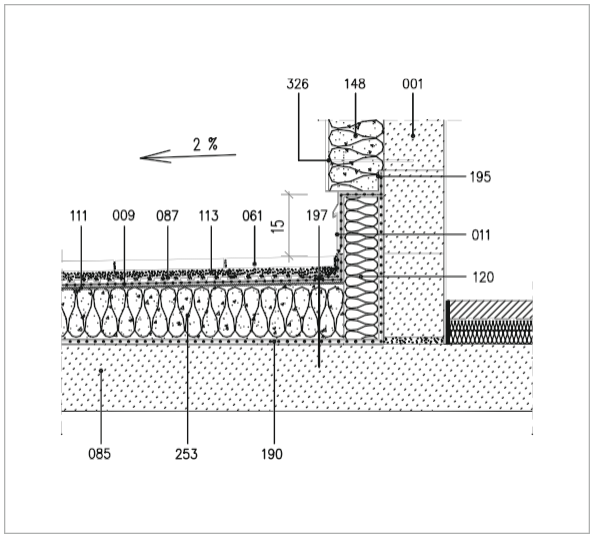
Construction examples Flat roof insulation DAA

Wall connection, roof with flashing



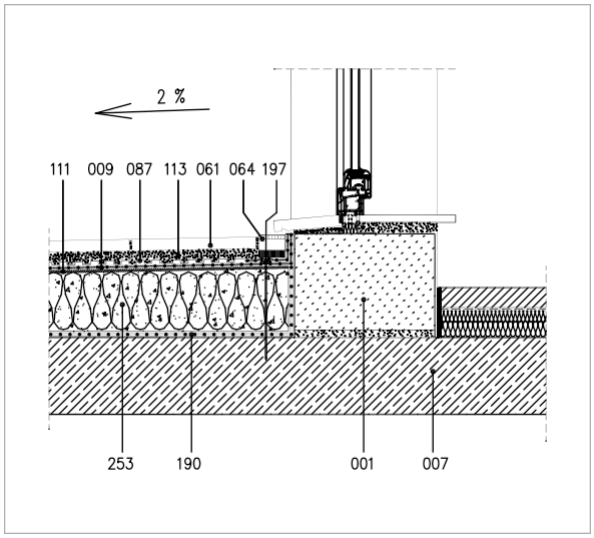
Roof insulation 09-005

Wall connection, terrace



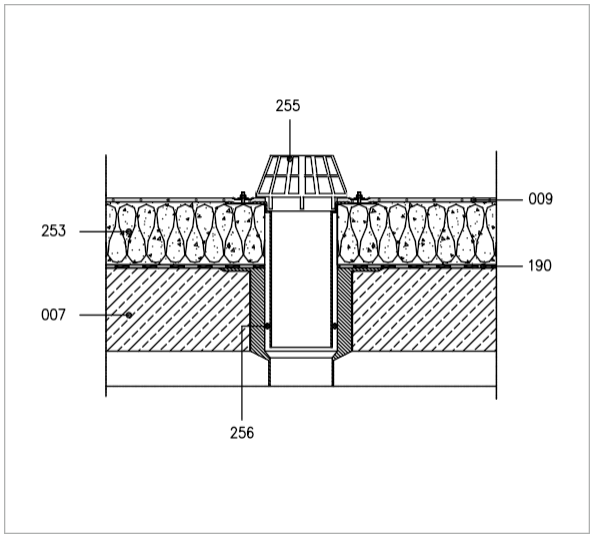
Roof insulation 09-006

Wall connection / balcony above living areas



Roof insulation 09-007

Drainage with flat roof drain



Roof insulation 09-008

001	Ytong masonry	06	Drainage channel with grating		
005	Ytong exterior plaster	08	Ytong ceiling storage block	190	Vapor barrier
006	Thermal insulation	08	Ytong ceiling element	195	Connection profile
007	Reinforced concrete ceiling	087	Drainage	197	Roof screw
009	Roof sealing	111	Separating or protective layer	253	Multipor flat roof insulation DAA
01	Gravel fill	113	Drainage layer	25	Gravel trap
011	Cover plate	120	Perimeter insulation	256	Roll ring
061	Balcony flooring	148	Multipor mineral insulation board	326	Multipor screw anchor

6.3 Flat roof structure loosely laid with Auffast

In this roof structure, all layers are loosely laid. The subsequent ballast then secures the position.

Substructure:

- Reinforced concrete
- Aerated concrete
- Wooden formwork with tongue and groove
- Wood-based panels
- Trapezoidal sheets
- Generally all flat, load-bearing substrates without open gaps and joints

Vapor barrier:

- PE vapor barriers/barriers suitable for the sealing system
- Aluminum composite films in accordance with DIN 18234 (industrial construction guideline)
- Bitumen vapor barriers
- Liquid vapor barriers

Thermal insulation Multipor mineral insulation board DAA, loosely laid:

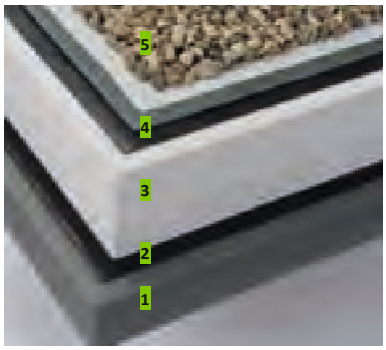
- Minimum thickness 120 mm
- Single-layer installation up to 240 mm
- Multi-layer installation, also as sloped insulation
- Installation with insulation adhesive foam on uneven substrates
- For trapezoidal sheet metal, installation is carried out on insulation supports (e.g., cement-bonded lightwood panels or OSB panels).
  For trapezoidal sheet metal with smaller clear opening widths, the insulation support is not required.
  Our Multipor technical advisors will be happy to answer any questions you may have.
- For reinforced concrete substrates, installation on a leveling layer of quartz sand is possible. Please contact our Multipor technical advisors for more information.

Roof waterproofing:

- Bitumen and polymer bitumen membranes
- Plastic and elastomer membranes
- The arrangement of separating and protective layers between the insulation board and the waterproofing is carried out in accordance with the processing guidelines
  of the roofing membrane manufacturer.

Ballast:

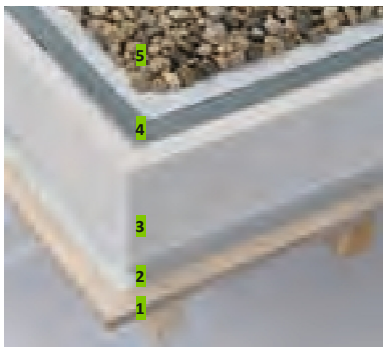
- Gravel
- Greening
- Terrace coverings in fine gravel
- The arrangement of separating, drainage, storage, and protective layers is carried out in accordance with the processing guidelines of the roofing membrane manufacturers and the flat roof guidelines.
- The ballast must be dimensioned in accordance with DIN EN 1991-1-4 and installed in accordance with wind load calculations.
- For greening, the dry weight of the substrate is used as the required ballast.



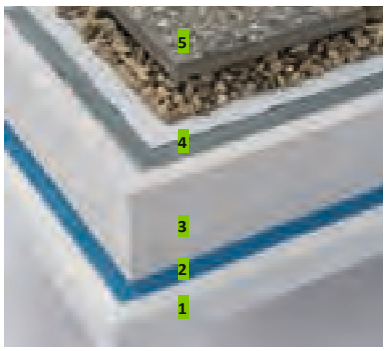
1 Reinforced concrete ceiling
2 Vapor barrier, bitumen
3 Multipor mineral insulation board DAA
4 Bitumen sheets, multi-layered
5 Gravel ballast on protective layer



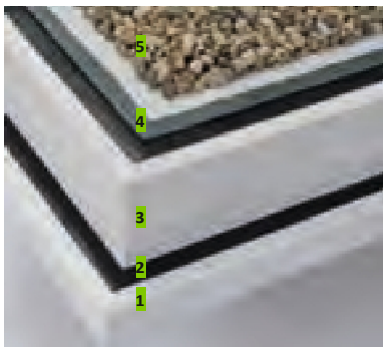
1 Trapezoidal sheet metal
2 PE vapor barrier
3 Insulation support
4 Multipor mineral insulation board DAA
5 Plastic roofing membrane
6 Gravel load on protective layer



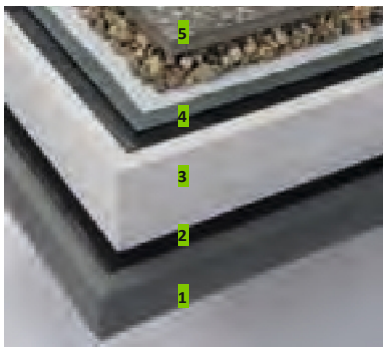
1 Wooden substructure
2 Vapor barrier, aluminum composite foil
3 Multipor mineral insulation board DAA
4 Plastic roofing membrane
5 Gravel ballast on protective layer



1 Aerated concrete roof element
2 PE vapor barrier
3 Multipor mineral insulation board DAA
4 Plastic roofing membrane
5 Plating on protective layer



1 Aerated concrete roof element
2 Vapor barrier, bitumen
3 Multipor mineral insulation board DAA
4 Bitumen sheets, multi-layered
5 Gravel ballast on protective layer



1 Reinforced concrete ceiling
2 Vapor barrier, bitumen
3 Multipor mineral insulation board DAA
4 Bitumen membranes, multi-layered
5 Plating on protective layer

6.4 Flat roof structure bonded

All layers are bonded or welded together with a strong bond.

Substructure:

- Reinforced concrete
- Aerated concrete
- Wooden formwork with tongue and groove
- Wood-based panels
- Trapezoidal sheets
- Generally all flat, load-bearing substrates without open gaps and joints

Vapor barrier:

- Bitumen vapor barriers – suitable for the respective substrate and for bonded construction, including substrate preparation (e.g., bitumen primer)
- Liquid vapor barriers (suitable for bonded construction)

Thermal insulation Multipor mineral insulation board DAA, bonded installation:

- Minimum thickness 120 mm
- Single-layer installation up to 240 mm
- Multi-layer installation, also as sloped insulation
- In the case of trapezoidal sheet metal, installation is carried out on insulation supports (e.g., cement-bonded lightweight board or OSB board).

Bonding in the lower layer:

- Hot bitumen
- Using thermally activatable vapor barriers on the upper side
- Insulation adhesive foam
- Liquid vapor barrier
- Multipor lightweight mortar (when laying on Ytong roof elements)

Bonding of additional layers (for multi-layer installation):

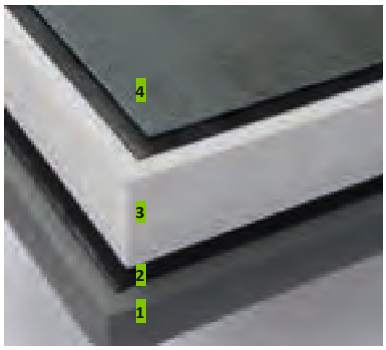
- Hot bitumen
- Insulation adhesive foam
- Multipor lightweight mortar

A wind load calculation in accordance with DIN EN 1991-1-4 provides the wind suction forces specific to the property. Our application technology then determines the type and quantity of adhesive required.

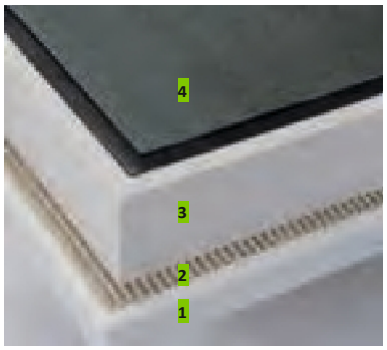
Roof waterproofing:

- Bitumen and polymer bitumen membranes
- Plastic and elastomer membranes
- Liquid waterproofing

Multipor consultants will be happy to advise you on the most suitable waterproofing products for the bonded structure.

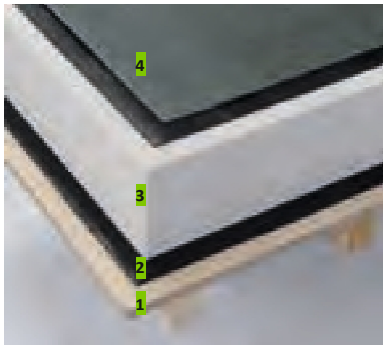


1 Reinforced concrete ceiling
2 Bitumen vapor barrier with primer
3 Multipor mineral insulation board DAA, bonded
4 Bitumen sheets, welded

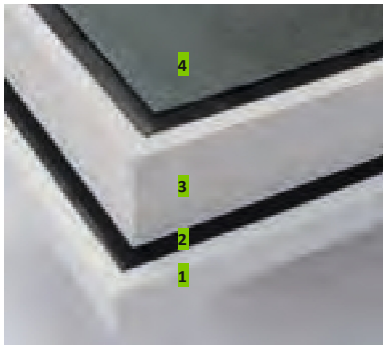


1 Aerated concrete roof element
2 Multipor lightweight mortar
3 Multipor mineral insulation board DAA, bonded
4 Bitumen membranes, welded

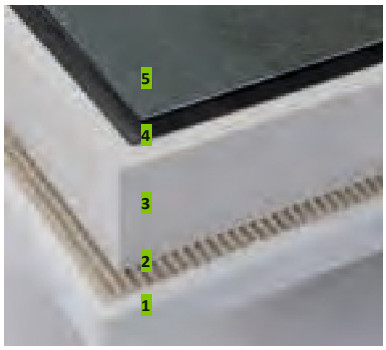
Note: Regardless of the static wind load verification, a base load of either at least 40 mm of 16/32 gravel or at least 80 mm of extensive greenery is required for bonded flat roof structures.
The installation of the ballast layer and the appropriate protective layers must be carried out in accordance with generally accepted technical rules.



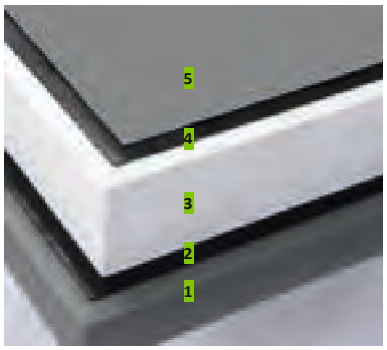
1 Wooden substructure
2 Bitumen vapor barrier with primer
3 Multipor mineral insulation board DAA, glued
4 Bitumen sheets, welded



1 Aerated concrete roof element
2 Bitumen vapor barrier with primer coat
3 Multipor mineral insulation board DAA, bonded
4 Bitumen sheets, welded



1 Aerated concrete roof element
2 Multipor lightweight mortar
3 Multipor mineral insulation board DAA, bonded
4 Bitumen roofing membrane, 1st layer, welded
5 Plastic roofing membrane, bonded



1 Reinforced concrete ceiling
2 Bitumen vapor barrier with primer coat
3 Multipor mineral insulation board DAA, bonded
4 Bitumen roofing membrane, 1st layer, welded
5 Plastic roofing membrane, bonded

6.5 Flat roof structure mechanically fastened

In this roof structure, the waterproofing layer is fixed to the load-bearing substructure using suitable fasteners.

Substructure:

- Reinforced concrete
- Aerated concrete
- Wooden formwork with tongue and groove
- Wood-based panels
- Trapezoidal sheets
- Generally all flat, load-bearing substrates without open gaps and joints

Vapor barrier:

- PE vapor barriers/barriers suitable for the sealing system
- Aluminum composite films in accordance with DIN 18234 (industrial construction guideline)
- Bitumen vapor barriers
- Liquid vapor barriers

Thermal insulation Multipor mineral insulation board DAA, loosely laid:

- Minimum thickness 120 mm
- Single-layer installation up to 240 mm
- Multi-layer installation, also as sloped insulation
- Installation with insulation adhesive foam on uneven substrates
- For trapezoidal sheet metal, installation is carried out on insulation support (e.g., cement-bonded lightweight board or OSB board). For trapezoidal sheet metal with smaller clear opening widths, the insulation support is not required. Our Multipor technical advisors will be happy to answer any questions you may have.
- Insulation boards that are not covered by fasteners for the roof waterproofing are either glued or fixed with additional fasteners in accordance with flat roof guidelines.

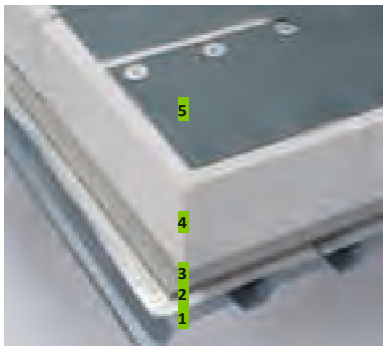
Roof waterproofing:

- Bitumen and polymer bitumen membranes
- Plastic and elastomer membranes

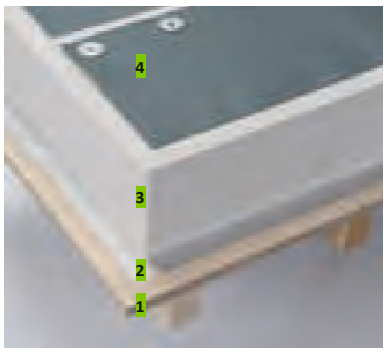
Separation and fire protection layers are arranged in accordance with the processing guidelines of the roofing membrane manufacturers. With regard to wind load calculations for mechanical fastenings, please contact the manufacturers of roof waterproofing directly, as additional factors such as e.g., roofing membrane widths and/or product-specific fastening types (e.g., hem fastening, field fastening, line fastening) are important.



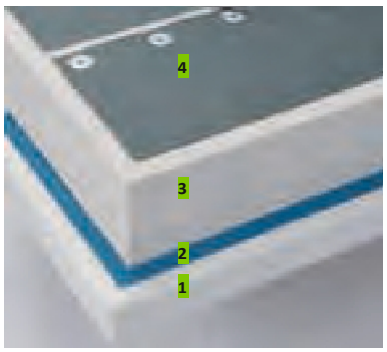
1 Trapezoidal sheet metal
2 Vapor barrier, aluminum composite foil
3 Multipor mineral insulation board DAA
4 Plastic roofing membrane, mechanically fastened



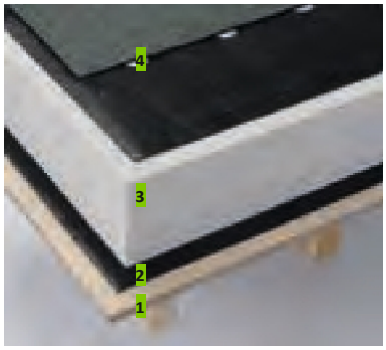
1 Trapezoidal sheet metal
2 Vapor barrier, aluminum composite foil
3 Insulation support
4 Multipor mineral insulation board DAA
5 Plastic roofing membrane, mechanically fastened



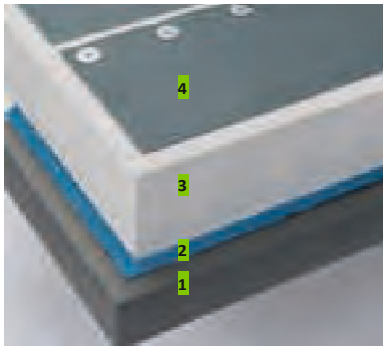
1 Wooden substructure
2 Vapor barrier, aluminum composite foil
3 Multipor mineral insulation board DAA
4 Plastic roofing membrane, mechanically fastened



1 Aerated concrete roof element
2 PE vapor barrier
3 Multipor mineral insulation board DAA
4 Plastic roofing membrane, mechanically fastened



1 Wooden substructure
2 Vapor barrier, bitumen
3 Multipor mineral insulation board DAA
4 Bitumen sheets, multi-layered, mechanically fastened



1 Reinforced concrete ceiling
2 PE vapor barrier
3 Multipor mineral insulation board DAA
4 Plastic roofing membrane, mechanically fastened

6.6 Flat roof structure for parking deck

Parking deck constructions pose a particular challenge due to the static load: the structural layers must be able to bear extremely high vertical loads. In addition, the horizontal load (braking and acceleration forces) must be safely dissipated from the roof structure.

For this reason, reinforced concrete is the only suitable material for the substructure.

Vapor barrier:

- Bitumen vapor barriers – suitable for the respective substrate and bonded structure, including substrate preparation (e.g., bitumen primer)
- Liquid vapor barriers, suitable for bonded structures

Thermal insulation Multipor mineral insulation board DAA, bonded installation:

- Minimum thickness 120 mm
- Single-layer installation up to 240 mm
- Multi-layer installation, also as sloped insulation

Bonding in lower level:

- Hot bitumen
- Liquid vapor barrier

Bonding of additional layers (for multi-layer installation):

- Hot bitumen
- Multipor lightweight mortar

Roof waterproofing:

- Bitumen and polymer bitumen membranes
- Plastic and elastomer membranes

Wearing course/road surface:

- Concrete pressure distribution plate according to static calculation
- To prevent stress cracks, pressure distribution slabs must be divided by joints.
- Composite paving on a gravel or sand bed, according to static calculation
- Concrete composite paving at least 10 cm thick
- With regard to separating, sliding, and protective layers, the processing guidelines of the roofing membrane manufacturers apply.

Tables 2 and 3 contain reference values for the static design of the wearing course/roadway. The final static design is carried out by the structural engineer involved in the respective construction project.

Table 1: Parameters for the dimensioning of the pressure distribution plate WLG 047

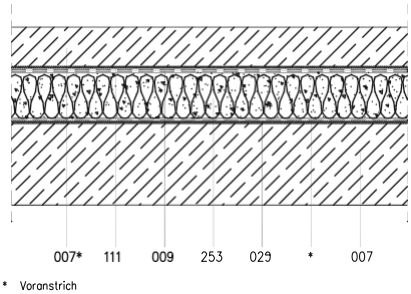
Compressive strength	350 kPa
Modulus of elasticity E	200 N/mm^2
Bedding index C_D (3 mm adhesive bitumen + 10 cm Multipor + 12 mm bitumen waterproofing)	270 MN/m^3
Pressure distribution plate	2.5 x 2.5 m

Table 2: Reference values for the design of the pressure distribution plate

Wheel load [KN]	Required thickness of pressure distribution plate [cm]	Reinforcement*
5.0	12	Q188 in the center of the field
7.5	12	Q188 in the middle of the field
10	12	Q188 in the middle of the field
15	18	Q257 A top and bottom
20	24	Q335 A top and bottom

Concrete grade of the pressure distribution plate: C35/45 XC4 XD 3 XF4 XM1
Reinforcing steel grade: B500A
* Reinforcement allowances in corner or edge areas may be necessary according to punching shear verification

Design example with reinforced concrete pressure distribution slab

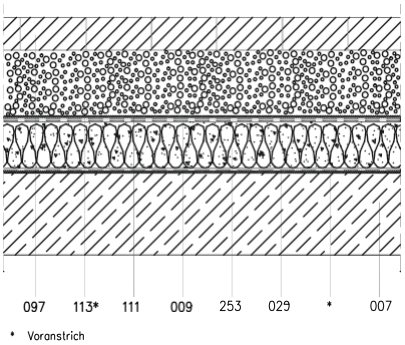


007 Reinforced concrete ceiling
007* Concrete pressure distribution slab
009 Roof waterproofing, 2-layer
029 Roof membrane, diffusion-resistant
11 Separation or protective layer
25 Multipor flat roof insulation DAA

Table 3: Reference values for the design height of the paving bed (sand, grit, etc.)

Bridge class	Fill height without vibration coefficient [cm]	Fill height with vibration coefficient [cm]
60	40	48
30/30	28	34
16/16	28	34
12/12	25	31
9/9	22	26
6/6	17	21
3/3	11	14

Construction example with composite stone paving on a gravel bed



007 Reinforced concrete ceiling
009 Roof waterproofing, 2 layers
029 Roof membrane, diffusion-resistant
097 Concrete block (interlocking paving stones)
11 Separation or protective layer
113* Drainage layer (gravel or sand bed according to structural analysis)
253 Multipor flat roof insulation DAA, laid in hot bitumen

6.7 Processing Multipor flat roof insulation DAA



The high-quality Multipor flat roof insulation DAA meets all requirements for modern construction. It is subject to permanent internal and external quality control. Careful handling during processing and in subsequent work rounds off the product quality.

Product features:

- High fire protection with building material class A1 according to DIN EN 13501-1
- Compressive strength of 300 kPa or 350 kPa
- Monolithic, mineral, fiber- and binder-free
- Practical for construction, no compression
- Resistant to aging, deformation, and volume change
- Insect and rodent proof
- Approved according to ETA-05/0093
- Ecologically certified by natureplus, IBU, and eco-INSTITUT

Advantages

- High installation performance
- Low panel weight, easy handling
- All common installation methods possible
- Fiber-free, therefore no itching
- Easy to cut to size with a handsaw
- Height differences can be easily and simply sanded down
- Excellent adaptability to building geometry

Flat roof insulation

The Multipor mineral insulation board DAA is available as a flat and sloped board – with identical product properties in terms of thermal and fire protection, compressive strength, and ecology in accordance with European Technical Assessment ETA-05/0093.

Flat boards

If the load-bearing roof structure has already been constructed with a slope, the Multipor mineral insulation board DAA is used as a flat board.

In general, roof structures can be constructed with single or multiple layers of insulation. For single-layer installation, insulation board thicknesses from 120 to 240 mm (in 20 mm increments) are available. On request, we also offer panels up to 300 mm on request. For insulation panel thicknesses < 120 mm, please contact our Multipor technical advisors. For multi-layer installation, each layer must be at least 120 mm thick.

Slope panels

We also offer the Multipor DAA mineral insulation board with factory-made slopes, which eliminates the need for costly and time-consuming sloped screeds or slopes in the substructure [1].

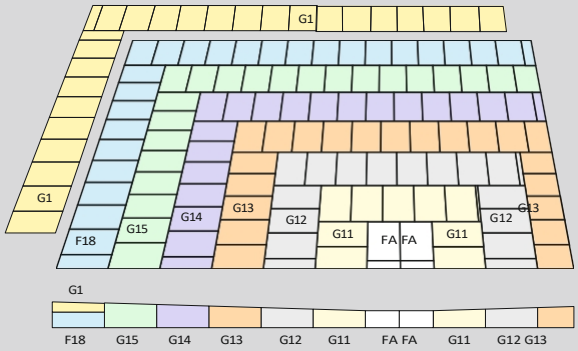
6.7 Processing Multipor flat roof insulation DAA

In order to achieve the required thermal insulation, the slope insulation usually consists of at least one flat panel as a base panel (at least 120 mm) and one layer of slope panels. Depending on the thickness of the insulation material, the installation system is structured as follows according to Table 1:

1



Table 1: Multipor sloped roof system (example for 2% slope)

Insulation material thickness [mm]	Article		Sloped roof system
	Underlay plate [mm] Flat plate	Sloped plate [mm]	
70–250	Not applicable	70–250	
250–430	180	70–250	
430–610	2 x 180	70–250	

The slope plates are manufactured in various slope variants as standard: 1.0%, 1.7%,
2.0%, 2.5%, 3.0%, and 5.0% are common. Other slopes can also be realized depending on the project. The applicable flat roof guidelines stipulate a minimum slope of 2.0%. If a lower slope is planned, the measures and specifications of the currently applicable flat roof guidelines must be observed.

Multipor connection wedge

Multi-layer bitumen roof waterproofing requires connection wedges on rising building parts to enable problem-free, "kink-free" roof membrane routing. If the Multipor connection wedge is used, it runs along the rising building components (wall connection, parapet, etc.) and is bonded over the entire surface to the previously laid flat or sloped panels using Multipor lightweight mortar, PU insulation adhesive, or hot bitumen [2].

Such connection wedges are neither necessary nor desirable for plastic and elastomer roofing membranes. Most accessory system parts (inner and outer corners, connection collars, parapet drains, etc.) are designed to match right-angled angled connections.

Apply primer

To bond bituminous vapor barriers securely – i.e., in a bonded

2



Multipor connection wedge

roof structure – on the substrate, a bitumen primer coat in accordance with DIN 18195 and
DIN 18531 is necessary. A primer coat is not necessary for loosely laid roof structures with ballast or mechanical fastening.

Apply vapor barrier

For all vapor barriers/retarders, the installation instructions in the ZVDH flat roof guidelines and the current processing instructions or product data sheets of the respective manufacturers apply. In the case of a bonded roof structure, the vapor barriers with aluminum inserts are welded over the entire surface and force-fit as welding strips of grade V60 S4 + AL or G200 S4 + AL [3]. Alternatively, polymer bitumen vapor barriers of type PYE V60 S4 + AL or PYE G200
S4 + AL, as well as vapor barriers cast using hot bitumen
(e.g., 100/25) can be used [4].

In the case of loosely laid roof structures with ballast and mechanical fastening, vapor barriers do not have to be welded over the entire surface and force-fit – loose laying or point fixing is sufficient. For such applications, more cost-effective vapor barriers made of polyethylene [5] and aluminum composite films, which are also laid loosely, are also suitable. In both cases, however, closed seams and a vapor-tight connection to rising components are mandatory.
Any differences in height can be compensated for with technical granulates or quartz sand.

Liquid vapor barriers based on polyurethane resin combine three properties: primer, vapor barrier, and adhesive for Multipor mineral insulation boards DAA. To do this, the two-component material can be mixed according to the manufacturer's instructions and then spread over the entire surface with a rubber squeegee at a consumption rate of at least 2 kg/m², depending on the substrate [6].

Insulation board installation

Multipor DAA mineral insulation boards must be laid with the joints offset. Longitudinal and transverse joints are not bonded. Height differences at the insulation board joints caused by the construction site can be quickly removed with the Multipor sanding board [7]; the abrasion should then be removed with a broom.

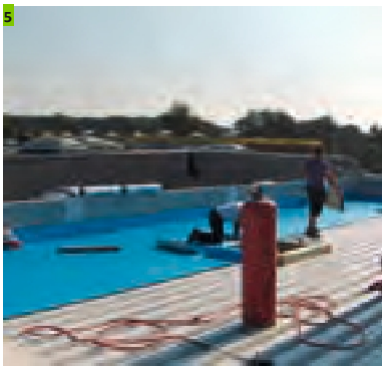
- Installation in bonded roof structures: Multipor DAA mineral insulation boards can be connected to the substrate in various ways, as shown in Table 2.
- Installation on roofs with ballast and mechanical fastening: On loosely laid roof structures with ballast, Multipor mineral insulation boards DAA are laid loosely. On mechanically fastened roof structures, loose insulation boards that are not secured by fasteners in the roof waterproofing must be fixed in place by gluing or additional fasteners. To level uneven substrates, the use of PU cartridge adhesive is recommended.

3

Vapor barrier with aluminum insert as welding sheet

4

Vapor barrier with aluminum insert, laid in hot bitumen

5

Polyethylene vapor barrier

6

Liquid vapor barrier

6.7 Processing Multipor flat roof insulation DAA

Table 2: Installation options for Multipor mineral insulation boards DAA

Installation variant	Description
Hot bitumen	Multipor mineral insulation boards DAA must be laid over the entire surface in hot bitumen [8] (e.g., 100/25) that has been applied beforehand using a pouring process, so that a full-surface bond with the vapor barrier is created. The consumption of hot bitumen mass is approximately 3 $^{kg/m^2}$ [9].
Thermally activatable vapor barrier on the upper side	Thermally activatable adhesive strips are located on the upper side of the installed vapor barrier, which are liquefied (activated) by heating/flaming with a burner. The Multipor mineral insulation boards DAA are then laid directly into these liquefied bitumen strips [10].
Liquid vapor barrier	Once the liquid vapor barrier has been applied, the Multipor DAA mineral insulation boards [11] are laid – in the same way as when using hot bitumen. The processing time of the previously applied liquid vapor barrier and the respective manufacturer's instructions must be observed.
PU insulation adhesive	Taking into account the wind suction load, the PU insulation adhesive foam must be applied to the vapor barrier in accordance with the manufacturer's instructions. The adhesive consumption is based on the manufacturer's specifications the manufacturer's specifications. The Multipor mineral insulation boards DAA can then be laid in it. We recommend a PU cartridge adhesive [12].


7

Grind down excess teeth


8

Applying hot bitumen


9

Laying insulation boards in hot bitumen


10

Insulation board installation on top of a thermally activatable vapor barrier


11

Laying insulation boards in liquid vapor barrier


12

Laying insulation boards in PU insulation adhesive foam, here as installation fixing

Table 3: Bonding of the second layer of insulation

Installation variant	Description
Multipor lightweight mortar	To do this, the Multipor lightweight mortar is combed over the entire surface of the upper side of the lower layer of insulation boards using a notched trowel (12 mm teeth) [13]. The panels of the second layer are then floated into the adhesive bed with light pressure and pressed together without bonding the longitudinal or transverse joints [14]. Further layers of insulation material are to be installed in the same way as the second layer. The consumption of lightweight mortar with a 12 mm notched trowel is approximately 3.5 kg/m(²).
PU insulation adhesive foam	The PU insulation adhesive foam is applied taking into account the wind suction load and in accordance with the manufacturer's instructions. The second layer of mineral insulation boards is then laid in the fresh adhesive. The insulation boards should be pressed together without bonding the longitudinal or transverse joints. Further layers of insulation material are to be installed in the same way as the second layer, with the adhesive consumption being based on the manufacturer's specifications [15].
Hot bitumen	The Multipor DAA mineral insulation boards must be laid into the hot bitumen (e.g., 100/25) previously applied by pouring [16] in such a way that a full-surface bond with the first layer of boards is created. The insulation boards must be pressed together without any glued longitudinal or transverse joints. Further layers of insulation material follow in the same way as the second layer. The consumption of hot bitumen mass is approximately 2.5 kg/m² [17].

If the installation is carried out in two layers or in conjunction with sloped panels, there are also several options available (see Table 3). Care must always be taken to ensure that the layers are offset.

If insulation support is necessary due to the trapezoidal sheet metal geometry, it must be laid directly on the trapezoidal sheets and fastened in accordance with the wind load calculation. The vapor barrier is then welded to the insulation support.

13



14



15



Laying insulation boards with PU adhesive, here as a mounting fixative

16



Applying hot bitumen

17



Laying insulation boards in hot bitumen

6.7 Processing Multipor flat roof insulation DAA

Roof waterproofing

Waterproofing layers must always be laid in accordance with the manufacturer's, processing, and flat roof guidelines. The following tables show examples of different designs, whereby all roof layers of bonded roof structures must be connected to each other in a force-fit manner. In the case of loose laying with ballast and mechanically fastened roof structures, the waterproofing layers are usually laid loosely.

Table 4: Bituminous waterproofing layers

Waterproofing layer	Description
First layer of cold self-adhesive membrane, thermally activated on the underside	The waterproofing membrane is rolled out step by step and the protective film applied to the underside is removed. The now exposed bitumen adhesive layer is thermally activated with a burner and the roofing membrane is then bonded over the entire surface to the Multipor mineral insulation boards DAA [18].
First layer of roof waterproofing membrane, bonded with hot bitumen	The roof waterproofing membrane (PYE-PV 200 DD) is applied over the entire surface and without voids using approximately 3 kg/m² hot bitumen (e.g., 100/25) in a pouring and rolling process onto the Multipor mineral insulation boards DAA [19].
Second layer of polymer bitumen welding membrane in accordance with DIN EN 13707	The second waterproofing layer consists of a polymer bitumen welding membrane in accordance with DIN EN 13707, which is matched to the first layer. It is welded onto the first layer over the entire surface, parallel to and offset from the first waterproofing layer [20].


18

First sealing layer as thermally activated cold self-adhesive membrane


19

Apply hot bitumen


20

Second waterproofing layer


21

Plastic sealing membrane loosely laid with ballast


22

Plastic roofing membranes bonded


23

Plastic roofing membranes mechanically fastened

Table 5: High-polymer sealing membranes

Installation method	Description
Loose installation with ballast	Plastic roofing membranes are laid loosely, if necessary on a separating layer specified by the manufacturer. The longitudinal and transverse seams are closed according to the manufacturer's instructions using a hot air welding device or solvent welding agent. A separating layer with a minimum weight of 300 g/m² (e.g., geotextile) must be applied under the gravel ballast on plastic roofing membranes. Further installation is carried out in accordance with the manufacturer's instructions and requires ballast dimensioned according to wind load requirements [21].
Bonded installation	The bonded use of plastic roofing membranes on Multipor must be tested and approved for the specific application. Bonding is carried out over the entire surface using the roofing membrane manufacturer's system adhesive or as a self-adhesive membrane on a suitable primer on the insulation surface. The longitudinal and transverse seams are closed according to the manufacturer's instructions using a hot air welding device or solvent welding agent. Roofs with a bonded structure usually remain exposed to the weather [22].
Mechanical fastening	Plastic roofing membranes are laid on a separating layer specified by the manufacturer, if necessary. Mechanical fastening is concealed in the hem area of the overlapping roofing membranes or via line or field fastening with separate reinforcement strips. Screws with washers matched to the load-bearing substructure are used as fasteners; their number and arrangement must be specified by the roofing membrane manufacturer and verified by a wind load calculation. The longitudinal and transverse seams are closed according to the manufacturer's instructions using a hot air welding device or solvent welding agent. Mechanically fastened roofs usually remain exposed to the weather [23].

Further roof structure / Further fastening

Mechanically fastened roof structures do not require any additional ballast and remain exposed to the elements. Loosely laid roof structures, on the other hand, require ballast dimensioned according to the wind suction load. Depending on the planned use, this can be carried out as follows:

- Gravel 16/32 for unused roof areas [24]
- Fine gravel 8/16 for terraces and balconies
- Green roofs including all functional layers [25]
- Walkways and driveways made of concrete paving stones on a gravel subbase or reinforced concrete slabs [26]

For bonded roof constructions, the comments on page 201 of this insulation book must be observed.

The arrangement of appropriate separating and protective layers must be carried out in accordance with the applicable manufacturer's specifications. Green roofs can also be equipped with storage and drainage layers.

24



Roof surface with gravel 16/32

25



Surface protection/ballast

26



Parking roof with reinforced concrete slabs

6.8 Processing Multipor steep roof insulation DAD

For maximum thermal insulation in summer and winter, a combination of solidly constructed pitched roofs with Multipor pitched roof insulation DAD is ideal. The kit (Ytong combination roof) consists of custom-made Ytong aerated concrete roof elements and Multipor pitched roof insulation DAD (Table 1). Additional system components include Multipor lightweight mortar and roof screws for fastening the further structure to the roof elements. All wooden components (support battens and counter battens), including the necessary fasteners, must be supplied by the customer. The underlay and roof covering complete the combination roof on site. Its basic version (160 mm Multipor DAD) already meets the specifications of the reference building according to EnEV. For high-quality energy-efficient designs in the area of KfW efficiency and passive houses, a further variant (260 mm Multipor DAD) of the combination roof with a U-value of 0.15 W/(m²K) is available. If you would like to use other combinations of roof elements with Multipor mineral insulation boards DAD for your building project, our Multipor consultants will be happy to provide you with an individual quote.

The solid roof with Multipor mineral insulation boards DAD is installed in several steps, with the necessary curing times again requiring several working days. In single-family homes, Ytong aerated concrete roof elements can be used to create a closed roof surface in a single day. In the following days, the structurally necessary reinforcement of the ring anchor and the concrete grouting are then carried out. Further work is then required to install wooden frames for roof overhangs overhangs and the Multipor mineral insulation boards DAD, before the roofer finally carries out the roofing.

Installation of Multipor DAD pitched roof insulation

The Multipor mineral insulation boards DAD for the pitched roof, the Multipor lightweight mortar, and the appropriate accessories are delivered to the construction site on time upon request. Packaged Multipor mineral insulation boards DAD and their accessories are temporarily stored on a level surface.

Multipor steep roof insulation DAD is always packed under a recyclable and weather-resistant film to protect it from the elements, which is only removed shortly before processing. The Multipor mineral insulation boards DAD are packed in handy small packages with separate film on the Euro pallet and can therefore be easily transported to the installation site.

Table 1: Product data for Ytong roof elements with Multipor steep roof insulation DAD

Item Compressive strength/bulk density class	Regulated by	U-value [W/(m² K)]	Dimensions L x W x H [mm	
AAC 4.5-550	DIN EN 12602	0.20 0.15	(2,250–6,000) x 625 x 200 (2,250–6,000) x 625 x 200	+ 160 + 260





Multipor mineral insulation board DAD bonded to cleaned surface



Multipor lightweight mortar

Substrate preparation
Before applying Multipor steep roof insulation DAD, ensure that the substrate is level, clean, and dry [1]. Concrete residues from grouting work and protrusions in the joints should be leveled as much as possible. This allows the mortar consumption quantities for subsequent bonding
the Multipor mineral insulation boards DAD.

Mixing Multipor lightweight mortar
Multipor lightweight mortar is mixed with the amount of water specified on the bag [2].

The processing and safety instructions are described in detail on the bag. The lightweight mortar can be processed at air, material, and component temperatures between 5 °C and 30 °C. Multipor lightweight mortar (20 kg/bag) can be easily mixed in the Multipor bucket [3] [4].

Using a slow-running mixer and a robust mixing paddle with long blades, the mortar mixture is mixed intensively a workable consistency. After a short curing time of approx. 5 minutes – depending on weather conditions – the lightweight mortar is mixed again and is now ready for use. Clean the mixing paddles thoroughly immediately after use to ensure optimum mixing results every time.

The water requirement is 8 l per 20 kg bag. The processing time is approx. 1.5 hours, depending on weather conditions. Multipor lightweight mortar is very economical: 30 liters of fresh mortar per bag is sufficient to bond approx. 6 m² of Multipor DAD mineral insulation board. The mortar is mixed by hand or using a mixer
(e.g., G4 plastering machine with re-mixer, processing: screw conveyor at half power, hose length max. 20 m, hose diameter 35 mm). If another adhesive mortar is used, damage-free and permanent bonding cannot be guaranteed.



Multipor bucket with fill level indicator



Mixing Multipor lightweight mortar

Bonding Multipor steep roof insulation DAD
F o r a permanent bond, the Multipor lightweight mortar is applied over the entire surface of the Multipor mineral insulation board DAD and

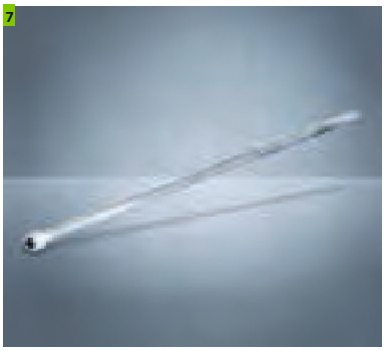
6.8 Processing Multipor steep roof insulation DAD



Full-surface application of Multipor lightweight mortar



Cutting Multipor steep roof insulation DAD



Ytong roof screw to fasten the support battens

Combed through [5]. The lightweight mortar consumption is approx. 3.5 kg/m², which also allows slight unevenness on the roof to be leveled out.

The butt joints must not be bonded. After applying the adhesive mortar, the Multipor steep roof insulation DAD must be laid with butt joints and without gaps. No adhesive must get into the butt joints of the panels to prevent open joints (thermal bridges) from forming.

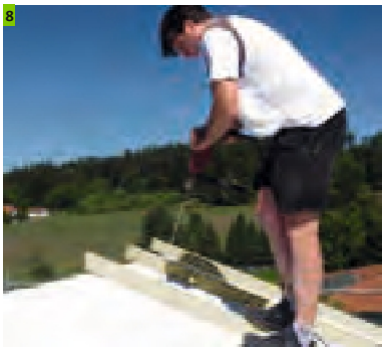
The panels are laid in a grid pattern, glued crosswise to the direction of travel with offset joints. For steep roofs, laying the mineral insulation panels in strips (starting from the bottom) has proven to be effective.

Cutting and adjusting Multipor DAD mineral insulation boards The fine-toothed Multipor foxtail allows Multipor DAD mineral insulation boards to be cut easily and precisely to size. Notches in the board can also be made quickly with this tool [6].

Two-layer installation for large insulation thicknesses
Multipor steep roof insulation DAD is available in insulation thicknesses from 120 to 300 mm in increments of 20 mm, thus meeting the various energy standards – from EnEV reference house to the KfW efficiency house to the passive house.

As non-compressible insulation, Multipor mineral insulation boards DAD can also be installed in two layers, thus achieving insulation levels of up to 600 mm. A further layer of Multipor steep roof insulation DAD is then applied in an offset pattern to the first layer already installed using Multipor lightweight mortar.

Fastening the following wooden structure to the Ytong roof elements
The first counter-battens must be made of at least softwood of sorting class S10 according to DIN 4074-1 and strength class C24 according to DIN 1052. If necessary, pre-drill the wooden battens with the minimum



Screwing the Ytong roof screw into the Ytong combination roof



Completely sink the Ytong roof screw into the battens

Dimension 40/60 mm is anchored directly into the Ytong roof elements using the Ytong roof screw or other approved fasteners through the Multipor mineral insulation board DAD [7] [8] [9].

The required number of roof screws/fasteners is determined by the structural analysis.

Installation of the underlay membrane with counter battens
Once the first counter battens have been fastened, the underlay membrane ($s_d \leq$ 0.2 m) is installed and connected in accordance with the relevant technical rules
for penetrations and in connection areas. With the second counter-battens applied by the roofer, two ventilation levels are created below and above the underlay, which further improve summer heat protection.

Fastening the roof battens The battens are professionally fastened to the counter battens in accordance with the roof covering. The roof covering forms the finish of the combination roof. If additional measures for the thermal and/or photovoltaic use of solar energy [10], additional battens and fasteners may be required.

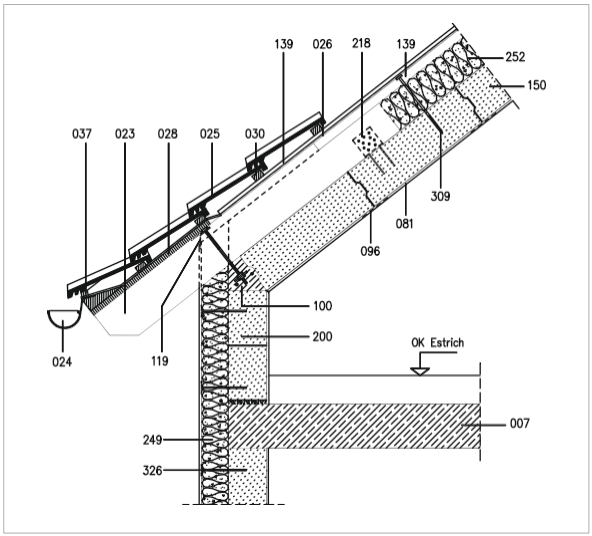
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6.8 Construction examples Ytong roof elements with Multipor pitched roof insulation DAD

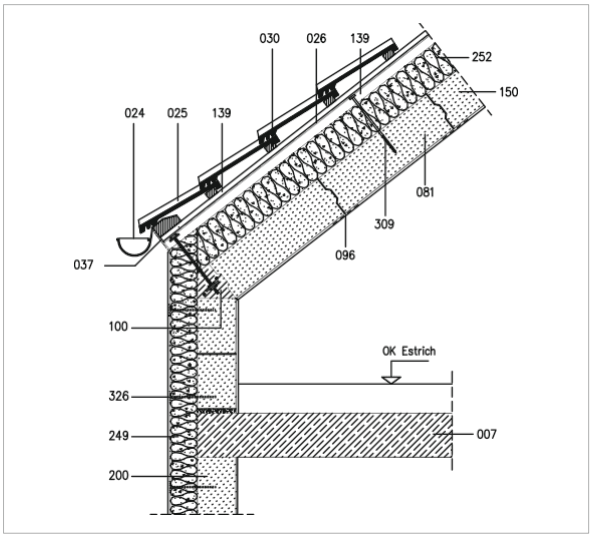
Construction examples Ytong roof elements with Multipor pitched roof insulation DAD

Eaves area



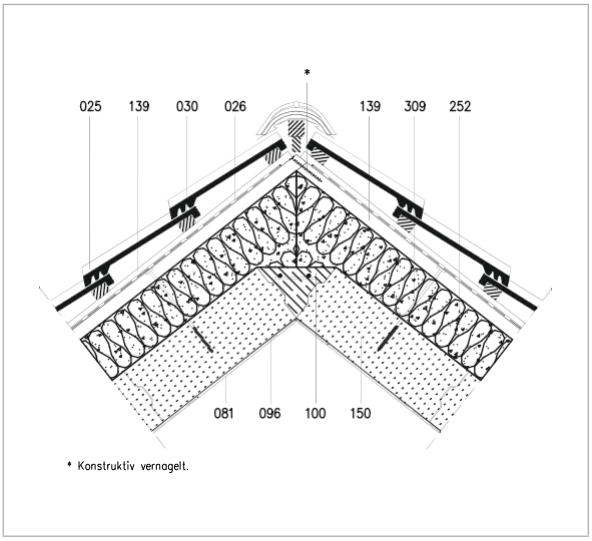
Functional wall 08-002

Eaves area, without overhang



Functional wall 08-015

Ridge area



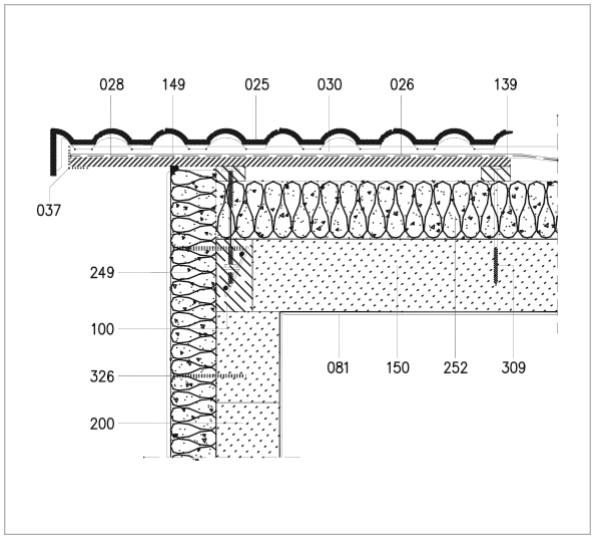
Regulated detail ridge 08-009

007	Reinforced concrete ceiling
023	Rafters
024	Rain gutter
025	Roof tiles
026	Underlay membrane, diffusion-open
028	Wooden formwork
030	Roof battens
037	Insect screen
081	Interior plaster
096	Fabric insert
100	Ring anchor
119	Plaster finishing profile
139	Lathing
150	Ytong roof element
200	Ytong/Silka masonry
21	Galvanized steel sheet angle bracket
249	Multipor mineral insulation board WAP
252	Multipor pitched roof insulation DAD
309	Ytong roof screw
326	Multipor screw anchor

These and other design examples can be found at www.multipor.de/konstruktionsbeispiele

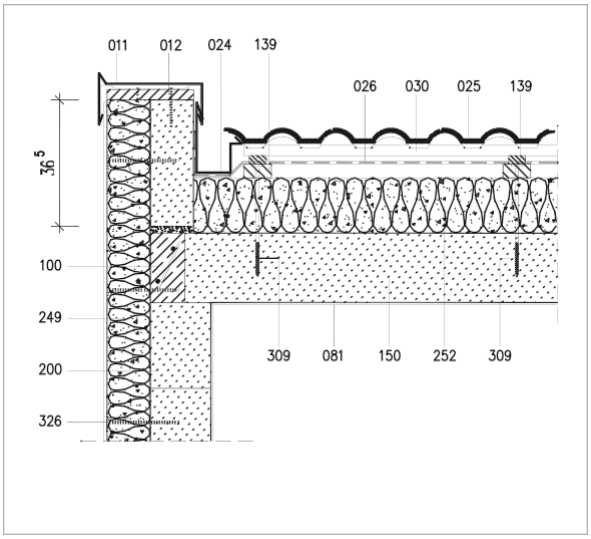
Construction examples Ytong roof elements with Multipor pitched roof insulation DAD

Eaves area, with roof overhang



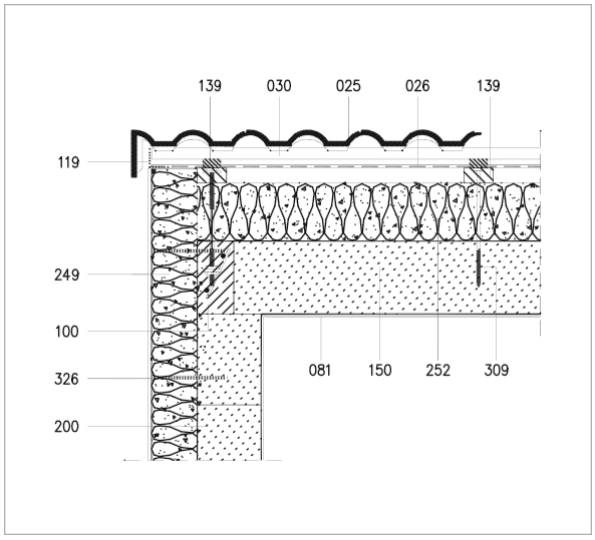
Functional wall 08-006

Eaves area, with parapet



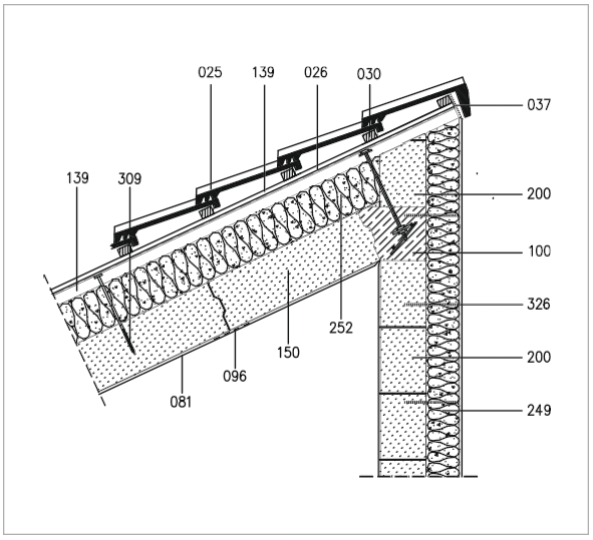
Functional wall 08-02

Eaves area, without roof overhang



Functional wall 08-01

Ridge area, without roof overhang



Functional wall 08-019

011	Cover plate	037	Insect screen		
012	Wooden plank	081	Interior plaster	150	Ytong roof element
024	Rain gutter	09	Fabric insert	200	Ytong/Silka masonry
02	Roof tiles	10	Ring anchor	249	Multipor mineral insulation board WAP
026	Underlay membrane, diffusion-open	11	Plaster finishing profile	25	Multipor steep roof insulation DAD
02	Wooden formwork	13	Lathing	309	Ytong Roof screw
03	Roof battens	14	Pre-compressed sealing tape	32	Multipor screw anchors

Tools and accessories for
bricklaying and insulation

Xella

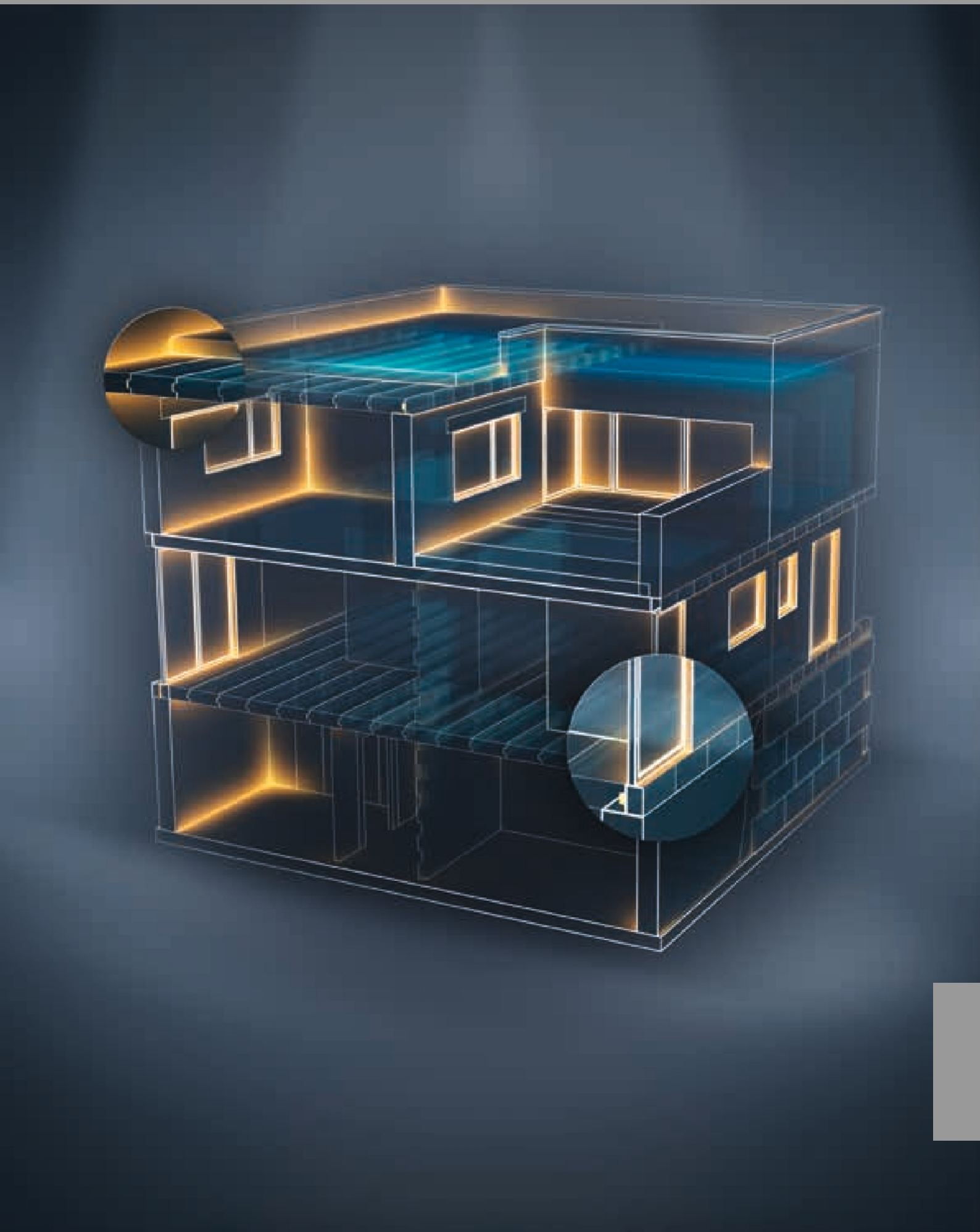


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7 Building physics



7.0 Building physics

Building physics

The classic focal points of building physics are thermal and moisture protection as well as fire and sound insulation. Other important topics such as building lighting, ventilation, climate protection, ecology, and room acoustics have only been added in the course of the development of the field.

The areas of building physics that are essentially relevant to the use of Multipor mineral insulation boards are thermal and moisture protection, which are interdependent in certain technical and physical respects and are described in more detail in the following chapters. Important explanations and clarifications on other topics such as sound and fire protection can be found in the relevant sections of the respective chapters of the insulation book. After explaining the basic terms, the content relevant to the use of Multipor mineral insulation boards is discussed in more detail. For more in-depth technical information, please refer to the relevant technical literature. Of course, Multipor technical advisors are available to answer any further questions you may have.

Thermal insulation

In our latitudes, living and utility rooms must be heated during the winter. In summer, excessive indoor temperatures caused by solar radiation should be avoided. This task divides thermal insulation into summer and winter thermal insulation.

The main objectives of summer and winter thermal insulation are:

- Providing a healthy living environment
- Saving energy required for the proper use of a building
- Ensuring sufficient interior surface temperatures of the heat-transferring building envelope through thermal insulation measures, thereby also preventing condensation and mold growth

In building physics, thermal insulation is also indirectly moisture protection.

Moisture protection

Moisture protection describes the different storage and transport mechanisms of water in its liquid and gaseous states.

The main objectives of moisture protection are:

- Prevention of uncontrolled moisture effects from inside and outside in order to ensure the usability of rooms
- Preventing moisture penetration into building materials and insulation materials
  Moisture-laden building materials have poorer thermal insulation properties than dry ones, which is why it is important to ensure that building structures do not become damp.
- Preserving the building fabric
  One of the main accelerators of the deterioration of buildings is water. It enables many biological, chemical, and physical processes that cannot occur in dry conditions.
- Provision of a healthy living environment

Effective moisture protection can only work if the effects are known, the transport mechanisms are understood, and well-planned measures are implemented. In this context, moisture protection is also indirectly thermal protection.

Fire protection

Fire protection refers to all measures that prevent the outbreak of a fire or the spread of a fire through fire or smoke (preventive fire protection) and that enable the rescue of people and animals as well as effective firefighting in the event of a fire (defensive fire protection).

Fire protection in the context of building physics deals on the one hand with the behavior of a fire—such as temperature and smoke development—and on the other hand with the material behavior of various building materials and components under the influence of fire.
In this respect, Multipor mineral insulation boards are an excellent insulating material, as evidenced by their classification in building material class A according to DIN EN 13501 and their smoke-free and drip-free fire behavior.

The main objectives of fire protection are:

- Preventing fires from starting
- Preventing the spread of fire
- Effective firefighting

Sound insulation

Physically, sound is a wave-like deformation propagating through a medium. The tasks of building physics consist of recording sound and developing measurement methods and sound insulation measures.

Sound insulation refers to all measures that reduce the transmission of sound from a source to a receiver. Appropriate measures should primarily be taken to prevent or reduce the transmission of sound. In this context, sound insulation refers to the prevention of airborne or structure-borne sound propagation. The sound insulation index R, measured in decibels [dB], is a key physical quantity in this context.

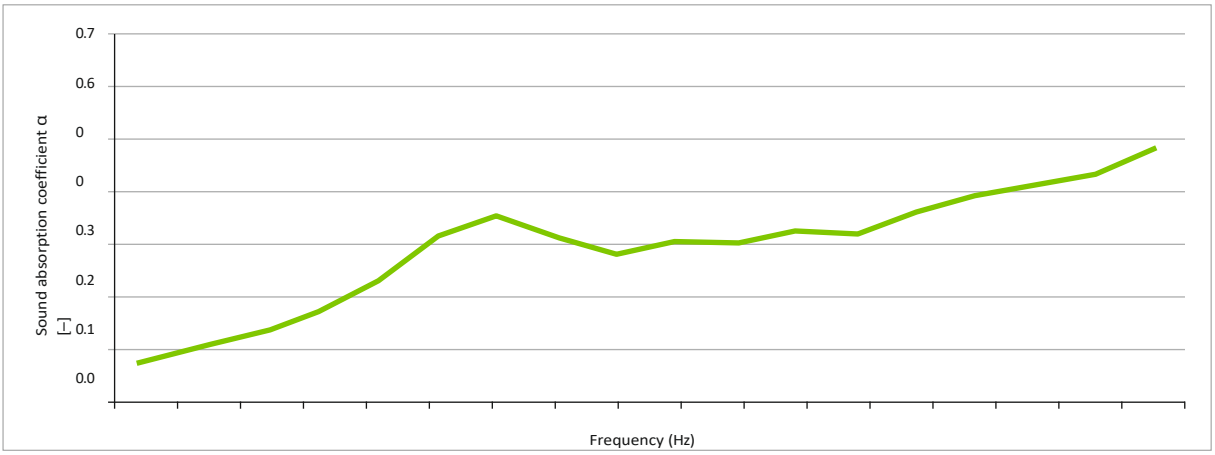
The main objectives of sound insulation are:

- To reduce sound transmission
- Preventing sound transmission
- Impeding the propagation of airborne or structure-borne noise

Sound absorption

When Multipor mineral insulation boards are installed without plaster, the material's good sound absorption reduces the sound pressure level in the room while simultaneously improving the acoustic situation. Based on the measured (echo chamber of the MPA Lower Saxony) frequency-dependent sound absorption values, a rated sound absorption coefficient α_{w} = 0.35 is obtained in accordance with DIN EN ISO 11654:1997.

Fig. 1: Sound absorption coefficient of unplastered Multipor mineral insulation boards



	100	125	16	20	25	315	400	500	630	800	1,000	1,250	1,600	2,000	2,500	3,150	4,000	5,000
f [Hz]	100	125	160	200	250	315	400	500	630	800	1,000	1,250	1,600	2,000	2,500	3,150	4,000	5,000
α_s	0.08	0.10	0.13	0.16	0.23	0.31	0.34	0.31	0.28	0.30	0.30	0.32	0.32	0.36	0.39	0.41	0.43	0.47

Note: The statements in the chapters refer to the state of the art at the time of printing. Current changes in standards and approvals must be taken into account in planning, as must the applicable provisions for technical verification in each individual case.

7.1 Thermal insulation

Building physics

Today, structural thermal insulation fulfills several tasks: In addition to the well-known requirements for minimum thermal insulation to ensure condensation- and mold-free component surfaces, thermal insulation should also ensure comfort and a pleasant indoor climate in every season. From an energy perspective, however, the most important requirement is to reduce transmission heat loss – which automatically makes structural thermal insulation an important environmental issue. The combustion of fossil fuels contributes to the greenhouse effect through emissions, including those from heating. Less heating energy therefore means lower pollutant emissions, which conserves energy and fuel resources and also reduces heating costs.

7.1.1 Fundamentals of thermal insulation

The transport mechanism relevant to structural thermal insulation is heat conduction. It follows the temperature gradient: heat flows from warm to cold. How much heat flows depends on the size of the temperature difference and on the thermal conductivity of the building materials involved. The most important terms and definitions are explained below.

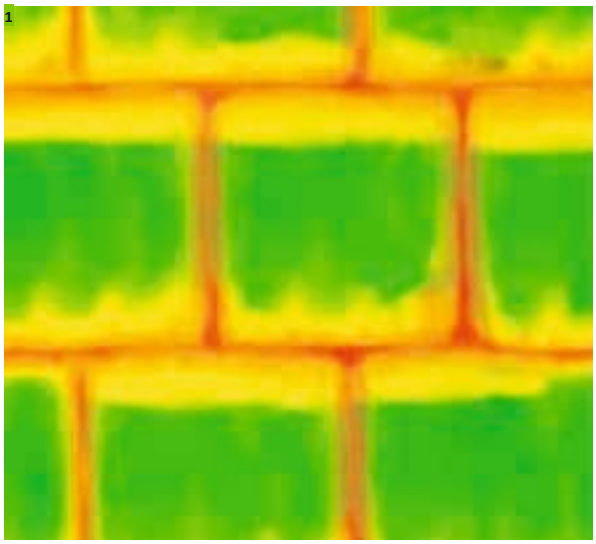
Thermal conductivity

Thermal conductivity λ is a material property for homogeneous substances. It has the unit [W/(mK)] and indicates the amount of energy (Ws) that flows through 1 m² of a 1 m thick building material within one second when there is a temperature difference of 1 K (Kelvin). Low thermal conductivity means low heat permeability of a material and thus good thermal insulation. The thermal conductivity of homogeneous building materials depends largely on their bulk density and moisture content: lower bulk density reduces thermal conductivity, while increasing moisture content increases it. For application and thermal design, the so-called design value of thermal conductivity λ is therefore used, based on the equilibrium moisture content that occurs under normal use. For common insulation materials, the design values of thermal conductivity λ are specified in Table 1 of DIN 4108-4:2017-03.

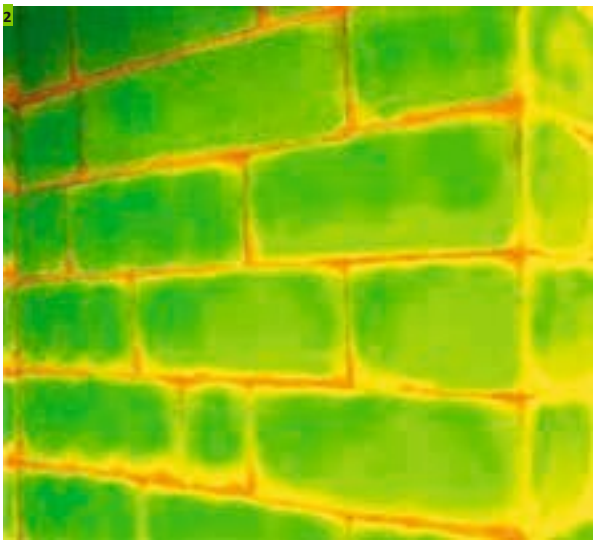
The values in Table 1 below illustrate not only the basic relationship between bulk density and thermal conductivity for homogeneous materials, but also the basic principle behind the development of Multipor based on Ytong aerated concrete. By further reducing the bulk densities below the previously known limits for aerated concrete, a homogeneous insulation material has been created. The relationship at these low bulk densities is no longer strictly linear, which is why the thermal conductivities of Multipor mineral insulation boards are regulated by building authorities.

Article	Bulk density ρ [kg/m³]	Compressive strength [kPa]	Thermal conductivity λ [W/(mK)] (rated value)	Reference value for water vapor diffusion resistance coefficient μ –
Multipor mineral insulation board, according to approvals (material/systems)	approx. 85 – 90	≥ 200	0.042	2
	approx. 100–115	≥ 300	0.045	3
	approx. 100–115	≥ 350	0.047	
Ytong PP2-0.35	approx. 300–331	2,000	0.080	5

In the case of inhomogeneous building materials, thermal conductivity can only be determined by measurement. These values then usually apply to an optimal arrangement of the individual building material components, which, however, cannot be achieved in practice at all construction sites. In fact, the thermal conductivities of individual components within an overall construction can vary considerably. In masonry, the mortar used—which often has a higher thermal conductivity than the wall building material—can therefore play a relevant role in thermal insulation. It is therefore not only important to consider



Temperature curves with thick-bed mortar



Temperature curves with thin-bed mortar

the pure wall building material, but also the overall construction (including mortar quality and masonry method). This effect is taken into account in the design values for thermal conductivity according to DIN 4108-4. Masonry constructed using the thin-bed mortar method is virtually jointless and even offers thermal insulation advantages over types of masonry that have standard mortar joints approximately 10 mm thick. For masonry blocks with general building authority approval, the corresponding thermal conductivity rating can be found in the approvals. A comparison of the thermal images [1–3] clearly shows the influence of the joints on heat transfer and the difference between the individual masonry components. Since the butt joints and bed joints in Multipor are butt-jointed and Multipor is a homogeneous insulating material in all directions, such influences do not need to be taken into account.



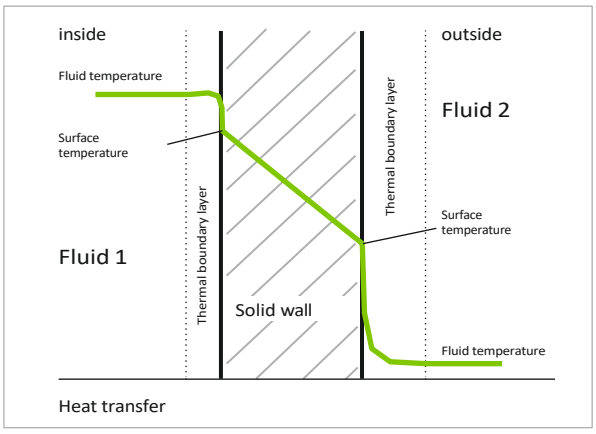
Temperature curves for full-surface insulation with Multipor

Heat transfer

Heat transfer describes how much heat a building component emits from the interior of a room to the outside. It depends on both the temperature difference and the individual thermal resistances of the building component.

From a physical point of view, heat transfer (see Fig. 1) is the transfer of heat from one fluid through a wall to another fluid. It comprises three individual processes: first, the transfer of heat from the indoor air (fluid 1) to the surface of the wall on the inside, then the conduction of heat through the wall, and finally the transfer of heat from the surface of the wall to the outside air (fluid 2).

Fig. 1: Schematic representation of heat transfer



7.1.1 Fundamentals of thermal insulation

The heat transfer coefficient (U-value) describes the heat transfer of a component normalized to a temperature difference of 1 K in [W/(m²K)] and thus how much energy in W flows to the outside over 1 m² of wall surface when there is a temperature difference of 1 K between the inside and outside. The U-value is an important comparative value for evaluating the thermal properties of a building component and also helps to assess transmission heat losses. It is the reciprocal of the total thermal resistance (heat transfer resistance R_{T}) and can be calculated for homogeneous components according to
DIN EN ISO 6946 as follows:

$$U = \frac{1}{R_T}$$

The thermal resistance R_T is composed of the thermal resistances of the individual layers R_i and the two transition resistances R_s (inside and outside). The thermal resistance R of a material layer is calculated from the layer thickness d in m and the thermal conductivity λ of a material as follows:

$$R = \frac{d}{\lambda}$$

This thermal resistance R is also referred to as thermal transmittance and has the unit [m²K/W]. If a component is composed of several homogeneous material layers, the thermal transmittance is calculated from the sum of the resistances of the individual layers.

$$\sum_{i=1}^{n} R_i = \sum_{i=1}^{n} \frac{d_i}{\lambda_i} = \frac{d_1}{\lambda(1)} + \frac{d_2}{\lambda(2)} + \ldots + \frac{d_n}{\lambda_n}$$

In order to calculate the thermal resistance required for the U-value from the thermal transmittance resistance, the transition resistances for the interior and exterior are also required.

The heat transfer from the air to a building component consists of a radiation component and a convection component. Since the air flow is generally much greater outside than inside, the convection component of the heat transfer is greater outside – accordingly, the heat transfer resistance outside is significantly lower than inside. DIN EN ISO 6946 specifies heat transfer resistances R_{si} for the interior and R_{se} for the exterior (see Table 2). The heat transfer resistance R_{si} for the interior distinguishes between the direction of heat flow as horizontal (walls), upward (ceilings), and downward (floors).

The thermal transmittance R_T can be calculated from the thermal resistance of the component and the heat transfer resistances as follows:

For single-layer, homogeneous components:

$$R_T = R_{si} + R + R_{se}$$

For multi-layer, homogeneous components:

$$R_T = R_{si} + \sum_{i=1}^{n} R_i + R_{se} = R_{si} + \sum_{i=1}^{n} \frac{d_i}{\lambda_i} + R_{se}$$

Table 2: Heat transfer resistances

Heat transfer resistance	Direction of heat flow		
	Upward [m²K/W]	Horizontal [m²K/W]	Downward [m²K/W]
R_{si}	0.10	0.13	0.17
R_{se}	0.04	0.04	0.04

Example of U-value calculation

The U-value is calculated for the wall described below as an example (wall structure from outside to inside):

Table 3: Example wall structure

	Material	Thickness [mm]	λ [W/mK]
1	Finishing plaster and reinforcement layer	8	0.21
2	Multipor WAP	180	0.045
3	Adhesive layer	5	0.21
4	Silka sand-lime brick 2.0	175	1.1
5	Gypsum plaster	15	0.51

This results in the following thermal resistance and total values:

Table 4: Calculation of thermal resistance

	[m/(W/mK]	[m/(W/mK]	[m²K/W]
Rse=			0.04
R_1 =	d_1 / λ_1	0.008/0.21	0.038
R_2 =	d_2 / λ_2	0.18 /0.045	4.0
R_3 =	d_3 / λ_3	0.005/0.21	0.024
R_4 =	d_4 / λ_4	0.175/1.1	0.159
R_5 =	d_5 / λ_5	0.015/0.51	0.029
R_{si} =			0.13
R_T			4.420

To determine the U-value, all that remains is to calculate the reciprocal of R_T.

$$U = \frac{1}{R_T} = \frac{1}{4.420} = 0.23 \text{ W/m}^2\text{K}$$

Special features of air layers

When calculating thermal resistance, a special feature must be taken into account if the component has air layers. The following applies: Stationary air layers contribute to thermal insulation and are considered stationary if the following specifications are met for their opening to the outside environment:

- No air flow through the layer is possible.
- Openings have a maximum area of 500 mm² per m length (in the horizontal direction) for vertical air layers.
- Openings have a maximum area of 500 mm² per m² of surface area for horizontal air layers.

The applicable thermal resistance values for "quiescent air layers" can be found in Table 5. The thermal resistance of these air layers depends on their thickness on the one hand and on the direction of the heat flow on the other.

Thickness of the air layer [mm]	Thermal resistance R / Direction of heat flow		
	Upward [m²K/W]	Horizontal[1)] [m²K/W]	Downward [m²K/W]
0	0	0	0
5	0.11	0.11	0.11
7	0.13	0.13	0.13
10	0.15	0.15	0.15
15	0.16	0.17	0.17
25	0.16	0.18	0.19
50	0.16	0.18	0.21
100	0.16	0.18	0.22
300	0.16	0.18	0.23

[1]Horizontal means that the deviation from the horizontal does not exceed +/- 30°.

7.1.1 Basics of thermal insulation

An air layer is considered to be "poorly ventilated" if the following applies to its opening:

- over 500 mm² to 1,500 mm² per m length (in the horizontal direction) for vertical air layers
- over 500 mm² to 1,500 mm² per m² of surface area for horizontal air layers

The thermal resistance of a "poorly ventilated" air layer is calculated using the following formula:

$$R_T = \frac{1500 - A_v}{\frac{1000}{R_{T,u}} + \frac{A_v - 500}{1000}} R_{T,v}$$

Where

$R_{T,u}$ is the thermal resistance with a stationary air layer

$R_{T,v}$ is the thermal resistance with a strongly ventilated air layer A_v Ventilation opening size in m²

An air layer is considered "well ventilated" if the ventilation opening size is greater than:

- ≥ 1,500 mm² per m length (in the horizontal direction) for vertical air layers
- ≥ 1,500 mm² per m² surface area for horizontal air layers

If a highly ventilated air layer is present, the thermal resistance of all layers between the air layer and the outside environment is neglected. In this case, the external heat transfer resistance is replaced by the internal heat transfer resistance of the same component [$R_{se} = R_{si}$].

Thermal properties of insulated component constructions with Multipor mineral insulation boards 7.1.2

The thermal properties of wall, ceiling, and roof constructions are also becoming increasingly important in new buildings and renovations due to the energy performance certificate in accordance with the current Energy Saving Ordinance. Energy performance certificates show the energy performance of a house using a color scale from green to red, as well as in so-called efficiency classes. Similar to the labeling of electrical and household appliances, the efficiency classes range from A+ (low energy consumption) to H (high energy consumption). The energy performance certificate must be presented to buyers or tenants during the viewing or handed over when purchasing a property. Basic energy data must already be stated in the property advertisement. In this context, the
U-value is an important factor in assessing the quality of thermal properties.

For guidance, the following pages list the U-values of different component structures in combination with Multipor insulation material.

Wall constructions with Multipor mineral insulation boards WAP
Wall constructions with Multipor mineral insulation boards WAP easily meet the current requirements of the EnEV. Functional walls with Ytong aerated concrete and Silka sand-lime bricks as well as other wall components are listed below as examples (see Table 1 and Table 2).

Load-bearing masonry	Ytong aerated concrete				Silka sand-lime brick			
λ [W/(mK)] Brick width B [mm]	0.09 30	0.09 365	0.12 175	0.12 240	0.70 175	0.70 240	1.10 175	1.10 240
Multipor λ [W/(mK)]	0.045							
Insulation thickness [mm]	U-values [W/(m²K)]							
80	0.19	0.16	0.29	0.25	0.44	0.42	0.46	0.45
100	0.17	0.15	0.26	0.22	0.37	0.36	0.38	0.37
120	0.16	0.14	0.23	0.20	0.32	0.31	0.33	0.32
140	0.15	0.14	0.21	0.19	0.28	0.27	0.29	0.28
160	0.14	0.13	0.19	0.17	0.25	0.24	0.25	0.25
180	0.13	0.12	0.18	0.16	0.22	0.22	0.23	0.22
200	0.12	0.11	0.16	0.15	0.20	0.20	0.21	0.20
220	0.12	0.11	0.15	0.14	0.19	0.18	0.19	0.19
240	0.11	0.10	0.14	0.13	0.17	0.17	0.17	0.17
260	0.11	0.10	0.13	0.12	0.16	0.16	0.16	0.16
280	0.10	0.10	0.13	0.12	0.15	0.15	0.15	0.15
300	0.10	0.09	0.12	0.11	0.14	0.14	0.14	0.14

Assumptions: Exterior plaster: $\lambda_{10,dry}$ = 0.18 W/(mK), d = 10 mm; Interior plaster: λ = 0.51 W/(mK), d = 10 mm; Heat transfer resistances: R_{si} = 0.13 m²K/W, R_{se} = 0.04 m²K/W

7.1.2 Thermal properties of insulated building component constructions with Multipor mineral insulation boards

Table 2: U-values of double-shell masonry made of Ytong aerated concrete and Silka sand-lime brick with Multipor thermal insulation composite system WAP

Load-bearing masonry	Ytong aerated concrete						Silka sand-lime brick			
λ [W/(mK)] Brick width B [mm]	0.10 175	0.10 240	0.14 175	0.14 240	0.16 150	0.16 240	0.99 175	0.99 240	1.1 175	1.1 240
Multipor λ [W/(mK)]	0.045									
Insulation thickness [mm]	U-values [W/(m²K)]									
60	0.28	0.24	0.33	0.29	0.37	0.30	0.51	0.49	0.51	0.50
80	0.25	0.22	0.29	0.25	0.32	0.27	0.42	0.34	0.42	0.41
100	0.23	0.20	0.25	0.23	0.28	0.24	0.35	0.34	0.35	0.35
120	0.21	0.18	0.23	0.21	0.25	0.22	0.30	0.30	0.30	0.30
140	0.19	0.17	0.21	0.19	0.22	0.20	0.27	0.26	0.27	0.26
160	0.17	0.16	0.19	0.17	0.20	0.18	0.24	0.24	0.24	0.24
180	0.16	0.15	0.18	0.16	0.19	0.17	0.22	0.21	0.22	0.21

Assumptions: Silka facing brick 1.8: λ = 0.99 W/(mK), d= 115 mm; Finger gap: $\lambda_{(eq)}$ = 0.067 W/(mK), d = 10 mm; Interior plaster: λ = 0.51 W/(mK), d = 10 mm; Heat transfer resistances: $R_{(si)}$ = 0.13 m²K/W, $R_{(se)}$ = 0.04 m²K/W

Energy-oriented modernization of existing exterior walls with Multipor interior insulation system WI Interior insulation with diffusion-open Multipor mineral insulation board WI transforms existing buildings with poor energy ratings into high-quality insulated buildings. System-compatible insulation for facades worth preserving is also an economically optimized solution for upgrading the energy efficiency of building structures. T h e following sample structures have been tested under the following conditions and can be used without further verification:

Sample structures under the following conditions

Exterior:
Central German climate with temperature, relative humidity, direct and indirect solar radiation, and driving rain
Interior:
Indoor climate – in accordance with DIN 4108 – with a constant air temperature of 20 °C and 50% relative humidity

In individual cases, the thermal influences on the side and top edges, windows, and door connections must be taken into account in the planning.

Thermal properties of insulated building component constructions with Multipor mineral insulation boards 7.1.2

Table 3: Improvement of the U-values of monolithic existing walls through Multipor wall interior insulation WI

Wall structure before	Thickness d [mm]	U-values [W/(m² K)]	Wall structure with Multipor WI compact plus λ = 0.045 W/(mK)		Wall construction with Multipor WI λ = 0.042 W/(mK)				
			30 [mm]	40 [mm]	60 [mm]	80 [mm]	100 [mm]	120 [mm]	140 [mm]
Brick λ = 0.86 W/(mK)	115	U-value before	2.76	2.76	2.76	2.76	2.76	2.76	2.76
		U-value after	0.97	0.80	0.56	0.44	0.36	0.31	0.27
	175	U-value before	2.31	2.31	2.31	2.31	2.31	2.31	2.31
		U-value after	0.91	0.76	0.54	0.43	0.36	0.30	0.27
	240	U-value before	1.97	1.97	1.97	1.97	1.97	1.97	1.97
		U-value after	0.85	0.72	0.52	0.41	0.35	0.30	0.26
	300	U-value before	1.73	1.73	1.73	1.73	1.73	1.73	1.73
		U-value after	0.80	0.68	0.50	0.40	0.34	0.29	0.26
	365	U-value before	1.53	1.53	1.53	1.53	1.53	1.53	1.53
		U-value after	0.76	0.65	0.48	0.39	0.33	0.28	0.25
Calcium silicate brick λ = 0.99 W/(mK)	115	U-value before	2.9	2.90	2.90	2.90	2.90	2.90	2.90
		U-value after	0.99	0.81	0.56	0.44	0.37	0.31	0.27
	175	U-value before	2.46	2.46	2.46	2.46	2.46	2.46	2.46
		U-value after	0.93	0.77	0.55	0.43	0.36	0.31	0.27
	240	U-value before	2.12	2.12	2.12	2.12	2.12	2.12	2.12
		U-value after	0.88	0.74	0.53	0.42	0.35	0.30	0.26
	300	U-value before	1.88	1.88	1.88	1.88	1.88	1.88	1.88
		U-value after	0.83	0.70	0.51	0.41	0.34	0.30	0.26
Aerated concrete λ = 0.21 W/(mK)	115	U-value before	1.29	1.29	1.29	1.29	1.29	1.29	1.29
		U-value after	0.69	0.60	0.45	0.37	0.32	0.28	0.24
	240	U-value before	0.73	0.73	0.73	0.73	0.73	0.73	0.73
		U-value after	0.49	0.44	0.36	0.31	0.27	0.24	0.21
	300	U-value before	0.60	0.60	0.60	0.60	0.60	0.60	0.60
		U-value after	0.43	0.39	0.32	0.28	0.25	0.22	0.20
Aerated concrete assembly component λ = 0.14 W/(mK)	150	U-value before	0.77	0.77	0.77	0.77	0.77	0.77	0.77
		U-value after	0.51	0.46	0.37	0.31	0.27	0.24	0.22
	200	U-value before	0.60	0.60	0.60	0.60	0.60	0.60	0.60
		U-value after	0.43	0.39	0.32	0.28	0.25	0.22	0.2
	250	U-value before	0.32	0.32	0.32	0.32	0.32	0.32	0.32
		U-value after	0.37	0.34	0.29	0.26	0.23	0.21	0.19
Concrete λ = 2.1 W/(mK)	200	U-value before	3.08	3.08	3.08	3.08	3.08	3.08	3.08
		U-value after	1.01	0.82	0.57	0.45	0.37	0.31	0.27
	250	U-value before	2.87	2.87	2.87	2.87	2.87	2.87	2.87
		U-value after	0.99	0.81	0.56	0.44	0.37	0.31	0.27
	300	U-value before	2.69	2.69	2.69	2.69	2.69	2.69	2.69
		U-value after	0.96	0.79	0.56	0.44	0.36	0.31	0.27

Assumptions: Masonry according to table, interior plaster: λ = 0.51 W/(mK), d = 20 mm; exterior plaster: λ = 1.0 W/(mK), d = 20 mm; heat transfer resistances: R_{si} = 0.13 m^2K/W, R_{se} = 0.04 m^2K/W

7.1.2 Thermal properties of insulated building component constructions with Multipor mineral insulation boards

Table 4: Improvement in the U-values of double-shell walls through Multipor interior wall insulation WI

Wall structure before	Thickness d [mm]	U-values [W/(m² K)]	Wall structure with Multipor WI compact plus λ = 0.045 W/(mK)		Wall construction with Multipor WI λ = 0.042 W/(mK)				
			30 [mm]	40 [mm]	60 [mm]	80 [mm]	100 [mm]	120 [mm]	140 [mm]
Calcium silicate brick λ = 0.99 W/(mK)	115	U-value before	2.43	2.43	2.43	2.43	2.43	2.43	2.43
		U-value after	0.92	0.76	0.54	0.43	0.36	0.30	0.27
	240	U-value before	1.86	1.86	1.86	1.86	1.86	1.86	1.86
		U-value after	0.82	0.69	0.50	0.41	0.34	0.29	0.26
	300	U-value before	1.67	1.67	1.67	1.67	1.67	1.67	1.67
		U-value after	0.78	0.66	0.49	0.40	0.33	0.29	0.25

Assumptions: Solid brick: λ = 1.2 W/(mK), d = 11.5 cm, no air layer, masonry according to table, interior plaster: λ = 0.51 W/(mK), d = 15 mm, After renovation: Lightweight mortar: $\lambda_{(10,dry)\ =\ 0}$ .18 W/(mK), d = 10 mm, heat transfer resistances: R(si$_{)\ =\ 0}$ .13 m(2) $^{K/W}$, R(se$_{)\ =\ 0}$ .04 m(2) $^{K/W}$

Improve the energy efficiency of basement ceilings with Multipor ceiling insulation DI

If heated rooms are separated from unheated rooms below, thermal insulation measures are also advisable here. Multipor mineral insulation board DI is suitable for improving the energy efficiency of both new and existing buildings. Since it is particularly difficult and costly to improve the energy efficiency of floor structures in existing buildings, the non-combustible and, in the event of fire, drip-proof mineral Multipor ceiling insulation DI offers a safe and simple solution. Even a thin layer of insulation raises the energy efficiency to a modern standard (Table 5).

Wall structure before	Thickness d [mm]	U-values [W/(m²K)]	Additional insulation on the underside with Multipor DI λ = 0.042 W/(mK)					
			60 [mm	80 [mm]	100 [mm]	120 [mm]	140 [mm]	160 [mm]
Aerated concrete assembly component λ = 0.14 W/(mK)	150	U-value before	0.78	0.78	0.78	0.78	0.78	0.78
		U-value after	0.37	0.31	0.27	0.24	0.22	0.20
	200	U-value before	0.61	0.61	0.61	0.61	0.61	0.61
		U-value after	0.33	0.28	0.25	0.22	0.20	0.18
	250	U-value before	0.50	0.50	0.50	0.5	0.5	0.50
		U-value after	0.29	0.26	0.23	0.21	0.19	0.17
Concrete λ = 2.10 W/(mK)	150	U-value before	3.55	3.55	3.55	3.55	3.55	3.55
		U-value after	0.58	0.46	0.38	0.32	0.28	0.24
	200	U-value before	3.28	3.28	3.28	3.28	3.28	3.28
		U-value after	0.58	0.45	0.37	0.32	0.27	0.24
	250	U-value before	3.04	3.04	3.04	3.04	3.04	3.04
		U-value after	0.57	0.45	0.37	0.31	0.27	0.24
Brick ceilings λ = 0.58 W/(mK)	210	U-value before	1.75	1.75	1.75	1.75	1.75	1.75
		U-value after	0.50	0.40	0.34	0.29	0.26	0.23
Brick ceilings λ = 0.67 W/(mK)	220	U-value before	1.86	1.86	1.86	1.86	1.86	1.86
		U-value after	0.51	0.41	0.34	0.29	0.26	0.23
Brick ceilings λ = 0.66 W/(mK)	250	U-value before	1.70	1.70	1.70	1.70	1.70	1.70
		U-value after	0.50	0.40	0.34	0.29	0.25	0.23

Assumptions: Without taking floor structures into account, heat transfer resistances: R_{si} = 0.17 m²K/W, R_{se} = 0.04 m²K/W

Thermal properties of insulated building component constructions with Multipor mineral insulation boards 7.1.2

Roof constructions in new buildings with Multipor mineral insulation boards DAD and Ytong aerated concrete assembly components Solid roofs made of Ytong aerated concrete assembly components can be very well insulated with the mineral insulation material Multipor. However, it is important to pay attention not only to thermal insulation but also to moisture protection, fire safety, and ease of installation. Depending on the insulation standard, Multipor mineral insulation boards DAD in various thicknesses can be applied to Ytong roof elements of different thicknesses. The solid roof elements provide additional thermal insulation, as they already have good insulation values due to the enclosed air pores (Table 6).

Roof elements	Ytong aerated concrete AAC 4.5-550					
λ [W/(mK)]	0.14					
Panel height H [mm]	20	240	200	240	200	240
Rafter share	0		Up to 6		up to 10	
Multipor λ [W/(mK)]	0.045					
Insulation thickness [mm]	U-values [W/(m²K)]					
140	0.21	0.20	0.23	0.21	0.23	0.22
160	0.19	0.18	0.21	0.20	0.21	0.20
180	0.18	0.17	0.19	0.18	0.20	0.19
20	0.17	0.16	0.18	0.17	0.18	0.18
220	0.15	0.15	0.17	0.16	0.17	0.16
240	0.14	0.14	0.16	0.15	0.16	0.15

Assumptions: Interior plaster λ = 0.51 W/(mK), d = 10 mm; heat transfer resistances R_{si}= 0.10 m²K/W, R_{se}= 0.04 m²K/W

Improve the thermal performance of flat roof constructions during renovation with Multipor DAA roof insulation Flat roof constructions often have to meet higher thermal and fire protection requirements. Multipor DAA mineral insulation boards meet both requirements in a single material. The non-combustible boards are particularly suitable for renovating old aerated concrete and reinforced concrete flat roofs. Insulation thicknesses between 120 and 220 mm perfectly meet all legal thermal insulation requirements. Energy solutions that go beyond this can also be achieved with even greater insulation thicknesses as non-compressible insulation (Table 7).

Wall structure before	Thickness d [mm]	U-values [W/(m²K)]	Additional structure on the roof with Multipor DAA λ = 0.045 W/(mK)					
			120 [mm]	140 [mm]	160 [mm]	180 [mm]	200 [mm]	220 [mm]
Aerated concrete assembly component λ = 0.14 W/(mK)	150	U-value before	0.83	0.83	0.83	0.83	0.83	0.83
		U-value after	0.26	0.23	0.21	0.19	0.18	0.16
	200	U-value before	0.64	0.64	0.64	0.64	0.64	0.64
		U-value after	0.24	0.21	0.20	0.18	0.17	0.15
	250	U-value before	0.52	0.52	0.52	0.52	0.52	0.52
		U-value after	0.22	0.20	0.18	0.17	0.16	0.15
Concrete λ = 2.10 W/(mK)	150	U-value before	4.73	4.73	4.73	4.73	4.73	4.73
		U-value after	0.35	0.30	0.27	0.24	0.21	0.20
	200	U-value before	4.25	4.25	4.25	4.25	4.25	4.25
		U-value after	0.34	0.30	0.26	0.24	0.21	0.20
	250	U-value before	3.86	3.86	3.86	3.86	3.86	3.86
		U-value after	0.34	0.30	0.26	0.23	0.21	0.19

Assumptions: Without taking into account plaster and roof structures, heat transfer resistances: R_{si}= 0.10 m²K/W, R_{se}= 0.04 m²K/W

7.1.3 Thermal bridges

The thermal insulation of a building is influenced not only by the construction and insulation materials used in the building envelope, but also by component connections and the changes in material that occur within them. The additional heat losses that occur in these areas compared to the heat losses of undisturbed components are referred to as thermal bridge losses.

A thermal bridge can be either geometric, material-related, or both.

Geometric thermal bridges are, for example, building corners: here, two walls with the same thermal properties meet, whereby more heat can be dissipated via the large outer surface than flows into the wall on the inside.
Material-related thermal bridges are caused by changes in material within a component, for example, reinforced concrete columns in a wall. A combination of these can be found, for example, in walls and columns integrated into the exterior wall or continuous ceiling or balcony slabs.

Since heat dissipation via thermal bridges is generally greater (there are also negative thermal bridges) than for the undisturbed component, the internal surface temperature in the area of a thermal bridge is usually significantly lower in winter than on the adjacent component surface in the area without thermal bridges. This increases the risk of condensation and mold growth, which is why DIN 4108-2: 2013-02 requires a minimum surface temperature of 12.6 °C in the area of the thermal bridge (this temperature must be maintained on all interior surfaces).

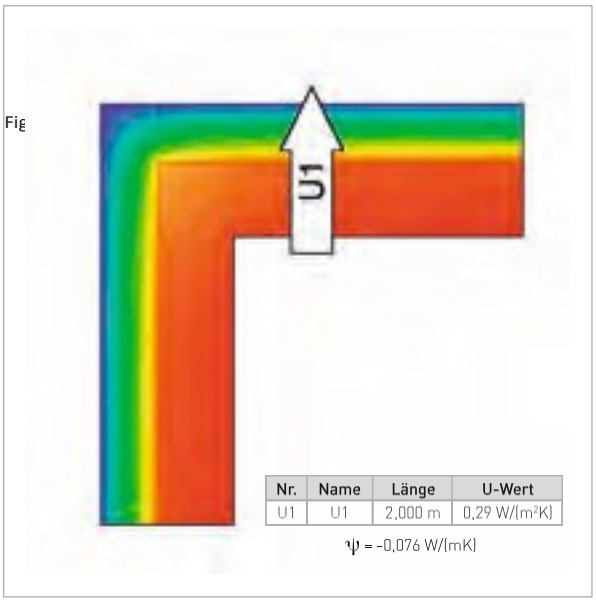
The additional heat loss caused by the thermal bridge can be quantified using the so-called length-related heat transfer coefficient Ψ [W/(mK)] in accordance with DIN EN ISO 10211. It indicates how much heat in W per m of thermal bridge length is emitted in addition to the undisturbed component at a temperature difference of 1 K. Since it basically refers to the undisturbed component, we are talking about a relative value here.

The Ψ values of construction details can either be calculated according to DIN EN ISO 10211 or taken from thermal bridge catalogs (e.g., New Thermal Bridge Catalog, Examples and Explanations according to DIN 4108, Supplement 2).

Practical tip: The Psi-Therm software family is a calculation tool that can be used to calculate the values of all types of construction. With an individual thermal bridge catalog derived from this, buildings can then be easily verified. As part of our services, we are happy to offer you the calculation and recording of object-related thermal bridges for your construction project.

Thanks to generally improved thermal insulation, transmission heat losses through the building envelope are significantly lower today than in the past – however, this means that linear thermal bridge losses account for a higher percentage of the total heat consumption. This is evident from the Ψ values, which are higher for better insulated constructions. This significantly reduces the transmission heat loss of an exterior wall that is retrofitted with a composite thermal insulation system. At the same time, the thermal bridge effect of the existing window connection becomes greater in the window area if the window is not replaced and the reveal can only be insulated to a limited extent. Compared to the previous condition, the insulation measures save heat energy. In relative terms, however, the heat losses in the reveal area are greater after the insulation measure. There are calculation programs or thermal bridge catalogs available to take these thermal bridges into account in calculations.

Negative thermal bridges – positive for your building
Thermal bridges are localized areas in building components that have an increased heat flow compared to the standard construction. This can be caused by geometric conditions or material-related disturbances. The increased heat flow means a higher heat dissipation and is therefore also a heat loss compared to the undisturbed area of a building component – a so-called positive thermal bridge.



Fig

Thermal bridges can take on a negative numerical value. This is explained using the example of an outside corner. An outside corner is a so-called geometric thermal bridge. The length-related heat transfer coefficient refers to the outside dimension. An external corner with an edge length of 1 m is better insulated than a straight wall because the internal dimension of the external corner is shorter than that of the straight wall. In comparison, the external corner is therefore better insulated than the straight wall of the same length, which is reflected in a negative value for the thermal bridge coefficient. Compared to the undisturbed area, this is then equivalent to an energy saving. A thermal bridge coefficient with a negative value is equivalent to a thermal bridge credit.

The determination of the length-related heat transfer coefficient can be illustrated using Figure 1 "Excerpt from thermal bridge calculation with Psi-Therm 2D". A calculation program determines the heat flow through the building corner shown with an edge length of at least 1 m. This value is compared with the heat flow through an undisturbed component with the same external length.
If the difference between the calculated heat flow minus the heat flow of the undisturbed area is positive, the result indicates the additional heat losses to be taken into account. If the result is negative – as in the case of the exterior corner shown – this means a thermal bridge credit and energy savings.

Thermal bridges always influence the overall energy requirement of a building – more precise planning and calculation of the individual thermal bridges enables significant savings compared to the flat-rate values according to DIN 4108.

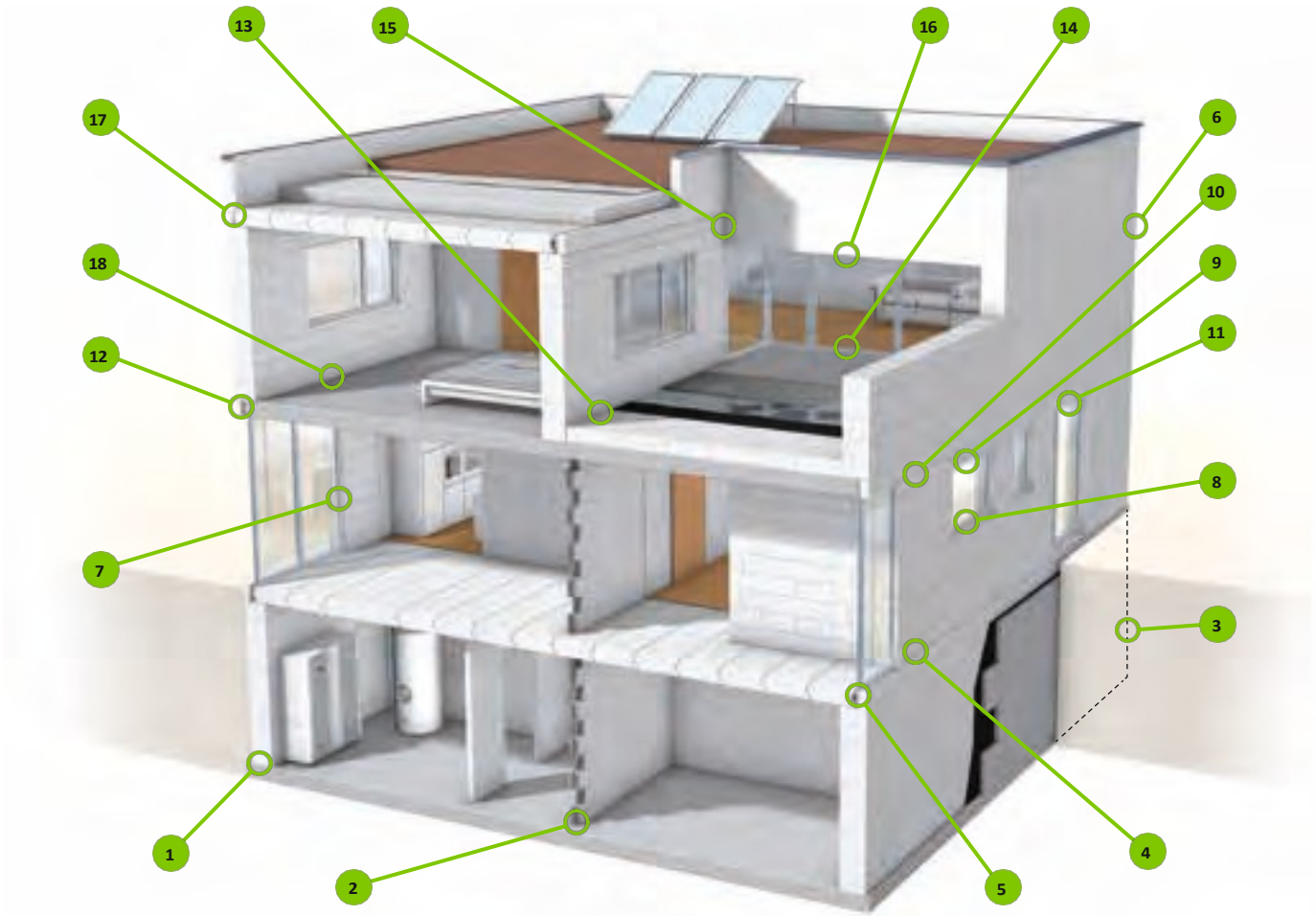
The sum of the thermal bridge calculations on the following page is negative. The reason for this is that the thermal bridges in this example have been carefully planned and optimized so that the thermal bridges have no negative impact on the energy balance of the building. Particularly in well-insulated buildings, it can be seen that the thermal bridge calculation can deliver better values than the flat-rate values according to DIN 4108.

With consistent and well-thought-out planning, in which the sum of all thermal bridges is negative, one can also speak of a so-called thermal bridge-free building envelope, since the thermal bridges do not need to be taken into account in the calculations. According to EnEV 2014, the influence of thermal bridges can be taken into account without mathematical proof by applying a surcharge of ΔU_{WB} = 0.10 W/(m²K). If DIN 4108, Supplement 2 is complied with, this surcharge can be reduced to ΔU_{WB}= 0.05 W/(m²K). It is clear that well-planned thermal bridges make a significant contribution to reducing transmission heat losses and that good thermal bridge planning pays off in the long term.

ΔU_{WB} = 0.10 W/(m² K) means, as a rule of thumb, an additional heating requirement of 1 m³ of gas per square meter of living space per year. For a residential building with a living space of 150 m², this means an additional consumption of 150 l of gas per year if the connection details are poorly designed. It is clear that reducing thermal bridge losses and performing the appropriate calculations pays off and saves energy in the long term.

7.1.3 Thermal bridges

Example of a detailed thermal bridge calculation



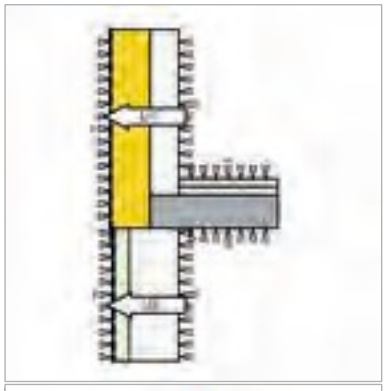
No.	Designation	Length [m]	ψ Value [W/(mK)]	Total [W/K]
1	Transition between floor slab and basement wall	40.40	-0.076	-3.07
2	Interior wall on floor slab	19.45	0.053	1.03
3	External corner in the ground	10.60	-0.106	-1.12
4	Ceiling connection via basement with wall	27.38	-0.002	-0.05
5	Ceiling connection via basement with window	13.02	0.009	0.12
6	Outside corner above ground level	18.90	-0.118	-2.23
7	Window/door reveal	58.30	0.016	0.93
8	Window sill	13.92	0.014	0.19
9	Window lintel with roller shutter box	3.55	0.052	0.18

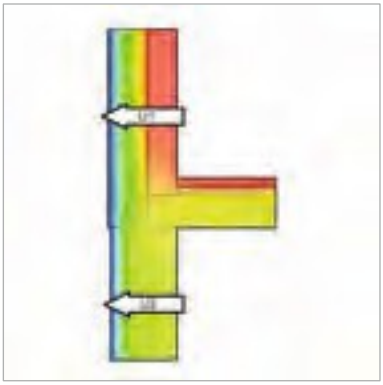
No	Designation	Length [m]	ψ Value [W/(mK)]	Total [W/K]
10	Ceiling connection via ground floor to roof terrace	2.1	0.022	0.05
11	Door lintel with roller shutter box	9.26	0.14	1.33
12	Ceiling integration above ground floor with window	7.26	0.106	0.77
13	Roof terrace wall connection	4.15	0.045	0.19
14	Roof terrace Window connection	4.35	0.001	0.0
15	Inner corner above ground level	2.80	0.047	0.13
16	Parapet with roller shutter box	16.50	-0.075	-1.24
17	Parapet with wall	23.90	-0.060	-1.43
18	Ceiling integration above ground floor with wall	18.23	0.076	1.39

Total losses via thermal bridges: -2.8 W/K; calculated area of the outer shell: 542 $^{m^2}$; calculated ΔU_{WB}= -0.01 W/(m²K); planned ΔU_{WB}= 0.00 W/(m² K)

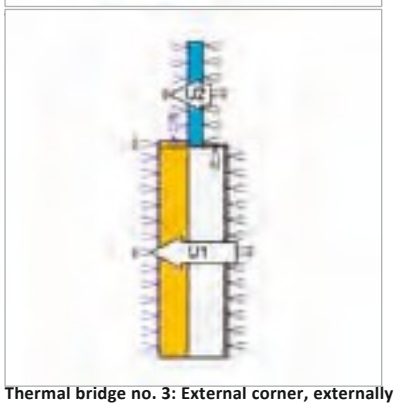
Thermal bridges with Multipor

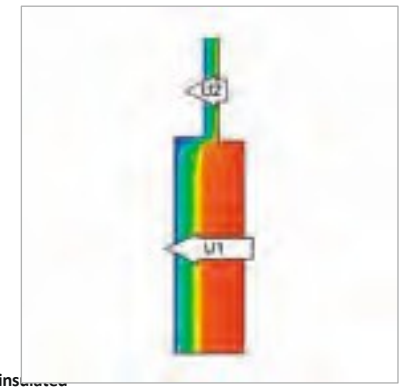
Thermal bridge no. 1: Ceiling connection above basement with wall





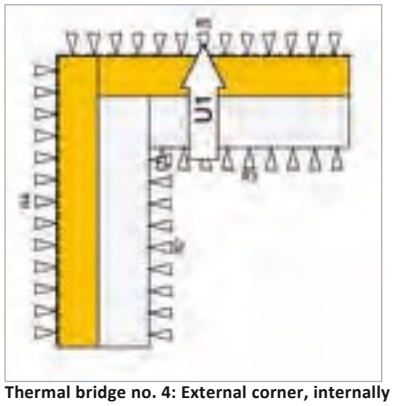
Description:	Ceiling connection Unheated basement
Basement wall	Calcium silicate brick, d = 30 cm λ = 0.99 W/(mK)
Ceiling	Reinforced concrete ceiling, d = 20 cm λ = 2.1 W/(mK)
Ground floor wall	Sand-lime brick, d = 17.5 cm λ = 0.99 W/(mK)
Base	Foam glass, d = 10 cm λ = 0.045 W/(mK)
ETICS	Multipor WAP, d = 24 cm λ = 0.045 W/(mK)
Uninterrupted U-values:	
U1	0.18 W/(m²K)
U2	0.37 W/(m²K)
Length-related heat transfer coefficient:	
y	0.015 W/(mK)

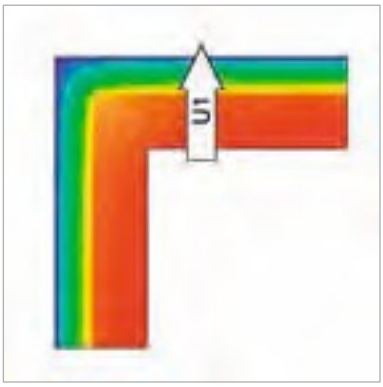




Description:	Window sill
Window	d = 8 cm U = 1.00 W/(m²K)
Masonry	Calcium silicate brick, d = 17.5 cm λ = 0.99 W/(mK)
ETICS	Multipor WAP, d = 14 cm λ = 0.045 W/(mK)
Uninterrupted U-values:	
U1	0.29 W/(m²K)
U2	1.00 W/(m²K)
Length-related heat transfer coefficient:	
y	0.052 W/(mK)

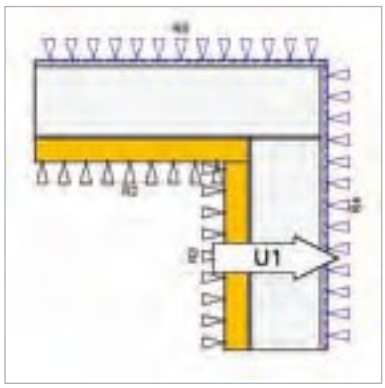
Thermal bridge no. 3: External corner, externally insulated

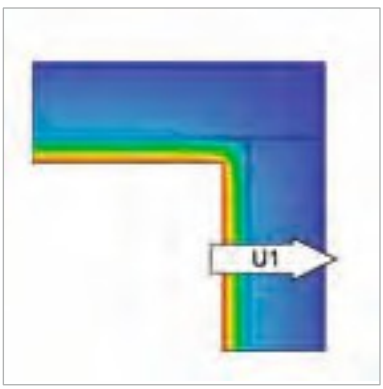




Description:	External corner insulated on the outside
Masonry	Calcium silicate brick, d = 17.5 cm λ = 0.99 W/(mK)
ETICS	Multipor WAP, d = 14 cm λ = 0.045 W/(mK)
Uninterrupted U-values:	
U1	0.29 W/(m² K)
Length-related heat transfer coefficient:	
y	-0.076 W/(mK)

Thermal bridge no. 4: External corner, internally insulated





Description:	Outside corner insulated on the inside
Masonry	Calcium silicate brick, d = 17.5 cm λ = 0.99 W/(mK)
WI	Multipor WI, d = 12 cm λ = 0.042 W/(mK)
Uninterrupted U-values:	
U1	0.31 W/(m² K)
Length-related heat transfer coefficient:	
y	0.156 W/(mK)

7.1.4 Minimum thermal insulation

In order to ensure that the interior surfaces of building components remain free of condensation and mold, the minimum thermal insulation requirements specified in DIN 4108-2:2013-02 must be observed, which depend on the type and respective temperature conditions on both sides of the component (see Table 1). Building components with a surface-related mass of at least 100 kg/m² must meet the minimum requirements for thermal resistance defined in DIN 4108-2:2013-02, Table 3. For components with a surface-related mass of less than 100 kg/m², a thermal resistance of $R \geq 1.75$ m²K/W must be maintained.

Table 1: Minimum values for thermal resistance of components according to DIN 4108-2:2013-02

Component		Minimum value for thermal resistance R in [m²K/W]
Walls of heated rooms	against outside air, ground, underground garages, unheated rooms (including unheated attic rooms or unheated basement rooms outside the heat-transferring envelope)	1.2
	For rooms with low heating	0.5
Roof slopes of heated rooms	against outside air	1.2
Ceilings of heated rooms facing upwards and flat roofs	against outside air	1.2
	To ventilated rooms Between roof slopes and side walls in converted attic spaces	0.9
	To unheated rooms, crawl spaces, or even lower rooms	0.9
	To rooms between insulated roof slopes and side walls in converted attic spaces	0.3
Ceilings of heated rooms facing downwards	against outside air, against underground garages, against garages (including heated ones), driveways (including lockable ones), and ventilated crawl spaces	1.75
	against unheated basement rooms	0.9
	Lower closure (e.g., base plate) of recreation rooms directly adjacent to the ground up to a room depth of 5 m	
	Above an unventilated cavity, e.g., crawl space, bordering on the ground	
Building components in stairwells	Walls between heated rooms and directly heated stairwells, walls between heated rooms and indirectly heated stairwells, provided that the other components of the stairwell meet the requirements of the table	0.07
	Walls between heated rooms and indirectly heated stairwells, if not all other components of the stairwell meet the requirements of the table	0.25
	Upper and lower closure of a heated or indirectly heated stairwell	Same as components of heated rooms
Components between heated rooms	Apartment and building partition walls between heated rooms	0.07
	Apartment partition ceilings, ceilings between rooms with different uses	0.3

Table 1: Minimum values for thermal resistance of components according to DIN 4108-2:2013-02

Thermal bridge areas must also comply with the required minimum thermal insulation: A temperature factor of $f_{Rsi} \geq 0.7$ applies to the coldest interior surface. The $f_{(Rsi)}$ value is a measure of the safety of a building structure with regard to mold growth. This is based on stationary boundary conditions. The $f_{(Rsi)}$ value describes the ratio of the temperature differences between the interior wall surface and the outside temperature to the difference between the interior and exterior temperatures.

Assuming an indoor temperature of 20 °C and a relative humidity of 50 %, compliance with the f_{Rsi} value ≥ 0.7, the relative humidity on the inner wall surface remains < 80% and thus no mold can form. An $f_{(Rsi)}$ value of 0.7 corresponds to a temperature of $\theta_{(si)} \approx 12.6$ °C and applies when $\theta_{(i)=}$ 20 °C is assumed indoors and $\theta_{(e)=}$ -5 °C outdoors. This verification requires heat transfer resistances that deviate from the minimum values in Table 1. The temperature factor f_{Rsi} is calculated as follows:

$$f_{Rsi} = \frac{\theta_{si} - \theta_e}{\theta_i - \theta_e}$$

θ_i	Indoor air temperature
θ_e	Outdoor air temperature
θ_{si}	Internal surface temperature of the component

All planning and implementation examples listed in DIN 4108, Supplement 2 meet the minimum thermal insulation requirements, meaning that no separate verification is necessary. The same applies to building corners whose individual components meet the minimum thermal insulation requirements according to Table 1.

7.1.5 Indoor climate in winter and summer

Living and working spaces should have an indoor climate that is suited to human life processes and thermal regulation. Whether a person feels comfortable and at ease depends on numerous external factors, which are determined by lighting conditions and psychological factors as well as thermal and hygienic conditions. The key factors are:

- the room air temperature
- the surface temperatures of the surfaces enclosing the room
- heat dissipation through floor surfaces
- the air velocity
- the relative humidity of the room air

At a normal room air temperature of 18 to 22 °C, humidity has little effect on comfort, and warm room air velocities below 0.2 m/s also have no significant effect on thermal comfort. The same applies to floor surface temperatures of 18 to 26 °C.

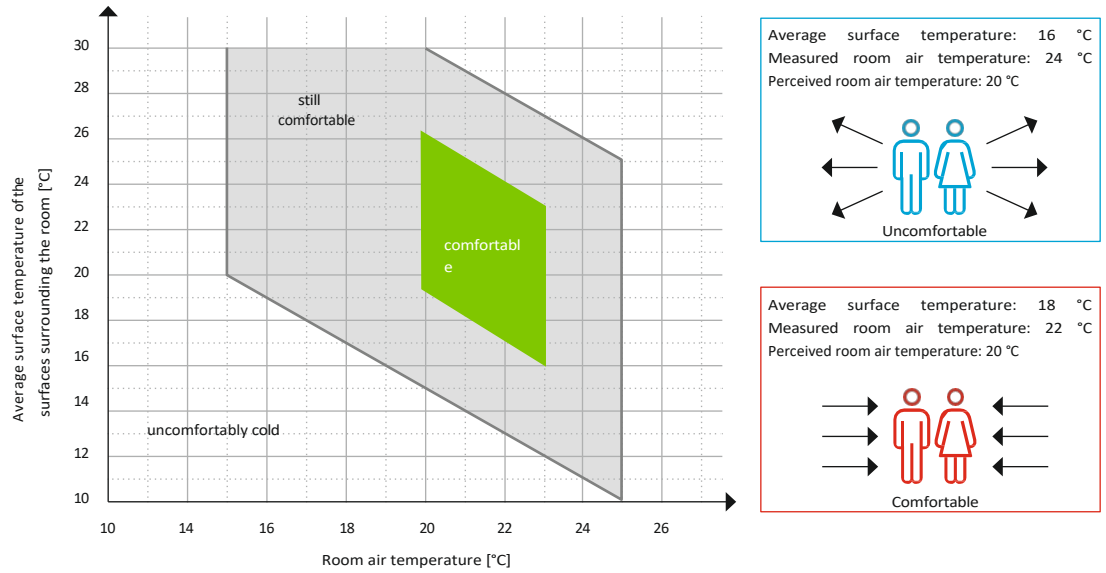
The room air temperature and the average internal surface temperature of the surfaces enclosing the room have a decisive influence on this. A comfortable room climate is generally achieved when the average value of these variables is between 19 and 20 °C and their difference does not exceed 2 to 3 K (°C).

The surfaces enclosing the room include the exterior and interior walls of a room, its floor and ceiling surfaces, as well as furniture, radiators, and window surfaces. Their respective surface temperatures are added to the average surface temperature of the surfaces enclosing the room in proportion to their surface area.

Comfortable indoor climate and energy savings
Room air temperatures can be lowered without any loss of thermal comfort by raising the internal surface temperatures of the surfaces enclosing the room using Multipor insulation systems. Regardless of whether it is implemented as a composite thermal insulation system, wall or ceiling insulation, an increase in the internal surface temperatures is achieved. Important for comfort: improved thermal insulation of exterior and window surfaces and minimized thermal bridges as far as possible.

In our latitudes, the annual average outdoor temperature is around +5 °C. Lowering the room air temperature by just 1 K (°C) during the heating period can save around 5 to 6% in heating energy – and thus costs. In addition, improved thermal insulation of exterior walls also allows for lower room air temperatures due to increased surface temperatures on the room side of the exterior walls – without compromising comfort, but with high energy-saving potential. The room air temperature has a significant influence on heating energy consumption, so it is advisable to exploit all possibilities to increase the surface temperature of the surfaces enclosing the room by means of passive measures such as interior or exterior wall insulation, thereby reducing the interior room temperature required for a comfortable indoor climate.

Fig. 1: Thermal comfort during sedentary work, moderate activity, and appropriately adjusted clothing as a function of the average surface temperature of the surfaces enclosing the room and the room air temperature



According to W. Frank: "Indoor climate and thermal comfort," Reports from Building Research, Issue 104, Berlin (1975)

Heat storage

In addition to thermal insulation, the heat storage capacity and cooling behavior of a building component are also relevant for energy-efficient and climate-adapted construction. While thermal insulation determines the transmission heat loss of a house, heat storage behavior has a particular influence on the stability of the indoor climate, which is extremely important for summer heat protection in particular.

According to DIN V 4108-6:2003-06, the effective heat storage capacity C_{eff} of building materials and components is the product of their specific heat capacity c, bulk density ρ, component surface area A, and effective component thickness d_{eff}. It has a significant influence on the heating and cooling behavior of rooms. The greater the heat storage capacity of the components enclosing the room, the slower they heat up or cool down.

$C_{eff} = c \cdot \rho \cdot {}_{d(eff)} \cdot A$

c specific heat capacity
ρ Bulk density
d_{actual} Effective component thickness A Component area

An important mathematical variable for this is the heat penetration coefficient b. It is the square root of the product of thermal conductivity λ, specific heat capacity c, and bulk density ρ. The smaller the heat penetration coefficient b of the room boundary surfaces, the faster the room heats up.

$b = \sqrt{c \cdot \lambda \cdot \rho}$

c specific heat capacity
λ Rated thermal conductivity
ρ Bulk density

Table 1 shows the heat storage capacity C and heat penetration coefficient b for Multipor mineral insulation boards depending on their bulk density. The higher the heat penetration coefficient b, the slower the room reacts to temperature fluctuations.

7.1.5 Indoor climate in winter and summer

Table 1: Room climate characteristics of common insulation materials

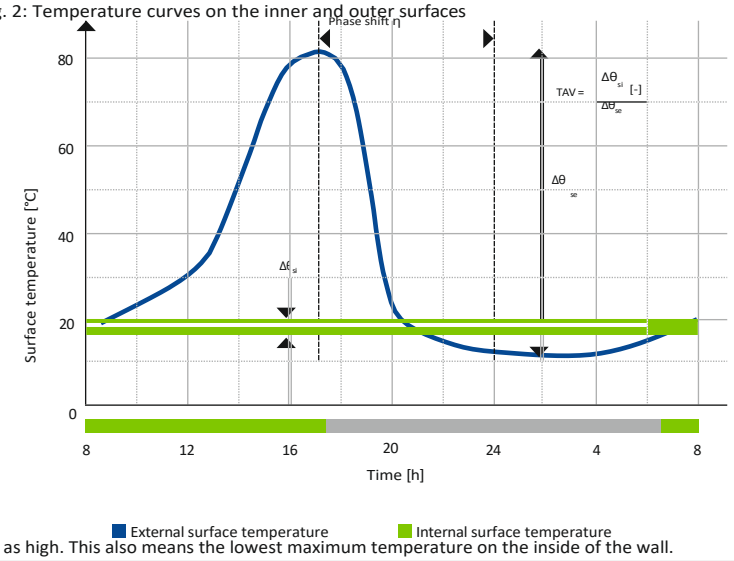
Table 1: Room climate characteristics of common insulation materials

	Bulk density [kg/m³]	Thermal conductivity λ [W/(mK)]	Specific heat capacity c [J/(kgK)]	Heat storage capacity C (layer thickness 200 mm) [J/(m²K)]	Heat penetration factor b [J/(m²K$^{0.5}$)]
Multipor mineral insulation board	90 115 115	0.042 0.045 0.047	1,300	23,400 29,900 29,900	70 82 84
EPS slightly	15	0.040	1,500	4,500	30
EPS heavy	30	0.040	1,500	9,000	32
Mineral fiber	60	0.040	850	10,200	45
Foam glass	120	0.045	850	20,400	68
Lightweight wood fiber insulation	45	0.040	2100	18,900	61

The heat storage capacity and heat penetration index are therefore indicators of the thermal inertia of building materials and room enclosure surfaces. This plays a role not only in cooling and heating times (for example, with interrupted or intermittent heating in winter), but also, and above all, in summer heat protection.

Multipor mineral insulation boards stand out from other insulation materials in terms of summer heat protection because they have a high dead weight for an insulation material (see Table 1).
This also applies to the specific heat capacity. A comparative calculation based on a 17.5 cm thick sand-lime brick wall and 2 cm thick exterior plaster shows that Multipor h a s the longest
phase shift and a maximum amplitude ratio that is half as high. This also means the lowest maximum temperature on the inside of the wall.

Fig. 2: Temperature curves on the inner and outer surfaces



Summer indoor climate

The summer indoor climate is influenced by the incoming heat, the storage capacity of the building components enclosing the room, and night ventilation. The incoming heat depends on the size and orientation of the window areas, possible shading, and the thermal permeability of opaque exterior components. Heat entering from outside (due to solar radiation or increased outside air temperature) can have an unpleasant effect on the indoor climate. Solar energy entering through windows in particular can be effectively limited with sun protection devices.

In summer, exterior components are exposed to particularly high temperature fluctuations – in extreme cases, the surface temperature can reach up to 70 °C. To ensure a pleasant indoor climate, it is therefore necessary to reduce large fluctuations in outside temperature to a lower level of fluctuation inside the building.

The EnEV takes this requirement into account by requiring proof of summer heat protection in accordance with DIN 4108-2:2013-02, depending on the type of building construction. Positive periodic temperature fluctuations continue as oscillations through the component, whereby the temperature amplitude is attenuated. The temperature amplitude ratio TAV is defined as the ratio of the maximum temperature fluctuation on the inner surface to the maximum fluctuation on the outer surface of the component. The time delay of the wave movement through the component—i.e., the time span in which a temperature wave from outside passes through a component into the interior of the room—is referred to as phase shift or delay η (Fig. 2).

The smaller the temperature amplitude ratio TAV, the greater the temperature attenuation by the component. A small TAV value therefore promotes summer heat protection. The phase shift is closely related to the temperature amplitude ratio: If the temperature amplitude ratio is small, the phase shift is usually large, but the thermal load is hardly noticeable. If, on the other hand, the TAV value is relatively large (0.70 to 1.00), the phase shift is only short, which usually results in an uncomfortable indoor climate.

Multipor insulation systems help improve the indoor climate in summer. As underfloor ceiling insulation, upper roof insulation, or exterior composite thermal insulation systems, they insulate against heat input from the outside and increase the buffering effect of solid ceiling and wall components. They can also contribute to improving the indoor climate as interior insulation, making full use of their heat storage capacity. Especially in combination with Multipor clay plaster, temperature and humidity are regulated easily and naturally.

Proof of summer heat protection

Proof of summer heat protection is evidence of comfort for residents or users and an important planning task. It is required as part of the energy assessment of a building in accordance with the Energy Saving Ordinance. The room in which the effects of summer temperatures are greatest must be identified. The DIN 4108-2 standard stipulates that proof must be provided for this room at least. Proof is provided in accordance with the standard for regional summer climate regions, which distinguishes between three different methods:

- No verification required if limit values are complied with
- Simplified verification procedure using table values
- Dynamic thermal simulation method

If proof of summer heat protection is not required, the following planning procedure must be followed: The floor area-related window area ratio f_{WG} as a quotient of the window area A_W must be selected in relation to the net floor area A_G of the room so that it falls below the respective limit values according to Table 2. Verification is carried out depending on the orientation and inclination of the windows.

Table 2: Limit values for waiving proof of summer heat protection

Inclination of the windows relative to the horizontal	Orientation of the windows[1)]	Floor area-related window area ratio[2)] f_{WG} [%]
Over 60° to 90°	Northwest over south to northeast All other north orientations	10 15
From 0° to 60	All orientations	7

[1)] If the room in question has windows facing in several directions, the lower limit value for f_{WG} applies.

[2)] The window area ratio f_{WG} is calculated from the ratio of the window area to the floor area of the room or group of rooms in question. If there are several facades or, for example, bay windows, f_{WG} is calculated from the sum of all window areas in relation to the floor area.

Table 2: Limit values for waiving the requirement to provide evidence of summer heat protection

7.1.5 Indoor climate in winter and summer

Within DIN 4108-2, there is a special regulation for residential buildings regarding the verification procedure for summer heat protection.
Provided that the floor area-related window area ratio of the room to be examined does not exceed 35% and windows facing east, west, and south have a normatively verified external sun protection system, verification is not required. Normatively certified sun protection is defined as sun protection glazing ($g \leq 0.40$) with a reduction factor ($F_{c)} \leq 0.35$) and, for standard glazing ($g > 0.40$), sun protection devices with $F_{c)} \leq 0.30$. In many cases, this makes it quite easy to provide proof for residential buildings.

For commercial buildings and modern glass architecture in residential buildings, which quickly exceed the limit values in Table 2, at least the simplified verification according to DIN 4108-2 is required. This proves that the existing solar heat gain coefficient $S_{vorh)}$ is less than the permissible $S_{zul)}$, whereby the existing solar heat gain coefficient $S_{vorh)}$ depends on the following five factors:

- Window area fraction A_w
- Total energy transmittance g of the window areas
- Net floor area A_G of the room in question
- Types of glazing (double glazing and triple glazing)
- Sun protection devices (external, intermediate, and internal)

The existing solar heat gain coefficient S_{vorh} is derived from the table data on the effectiveness of the latter two factors. The window area fraction is determined on the assumption of a 30% frame fraction with the clear shell opening dimensions as the outer frame dimensions without plaster. For window elements with opaque parts, only the glazed window area is used.

To determine the permissible solar heat gain coefficient S_{zul}, the tables in DIN 4108-2 are also required, as well as seven additional factors:

- Climate zones A / B / C in Germany according to the climate map from DIN 4108-2
- Amount of air exchange during night ventilation
- Influences from the building design
- Use of solar control glass
- Orientation of the windows
- Window inclination
- Use of passive cooling (e.g., through cooling ceilings)

The building design in particular influences the permissible solar heat gain coefficient, with solid buildings having a medium to heavy design and thus reducing the required solar protection in mathematical terms. We refer to a light design when there is no evidence of effective heat storage capacity and none of the simplified properties for medium or heavy designs have been proven.

- Medium construction type:
  - Reinforced concrete ceiling
  - Solid interior and exterior components (average bulk density ≥ 600 kg/m³)
  - No internal thermal insulation on the exterior components
  - No suspended or thermally covered ceiling
  - No high rooms (> 4.5 m) such as gyms, museums, etc.
- Heavy construction:
  - Reinforced concrete ceiling
  - Solid interior and exterior components (average bulk density ≥ 1,600 kg/m³)
  - No internal thermal insulation on the external components
  - No suspended or thermally covered ceiling
  - No high rooms (> 4.5 m) such as gyms, museums, etc.

If the effective heat storage capacity has been verified in accordance with DIN V 4108-6 and related to the net floor area of the room in question, the following limit values apply for the classification of the various building construction classes:

- Lightweight construction: $C_{effective} / A_G < 50$ Wh/(Km²)
- Medium construction type: 50 Wh/(Km²) ≤ $C_{eff} / A_G \leq 130$ Wh/(Km²)
- Heavy construction: $C_{actual} / A_G > 130$ Wh/(Km²)

Once both values have been determined, verification can be provided – provided that the solar gain coefficient $S_{actual} \leq S_{permitted}$.

If it is not possible to use the simplified method or if the structural situation does not lead to satisfactory results, verification can also be carried out using thermal building simulation. Here, a distinction is made between the type of use as a residential or non-residential building and the normatively defined summer climate regions. The indoor climate conditions are determined hourly with the aid of software and compared with the reference value of the normatively recommended indoor temperature. By adding up the excess temperature hours, it is possible to assess whether a building meets the requirements for summer heat protection. It should be noted here that in the case of non-residential buildings, no assessment of the permissible room temperatures is carried out in accordance with workplace guidelines.

7.1.6 Energy Saving Ordinance EnEV 2014

Since May 1, 2014, buildings must be designed in accordance with the Energy Saving Ordinance 2014 (EnEV 2014), which was further tightened on January 1, 2016. It continues the Energy Saving Ordinance 2009 and emphasizes the approach that final energy consumption in the building sector should be further reduced.

EnEV history

The 2009 Energy Saving Ordinance continued the steady tightening of requirements for the energy consumption of buildings. Since 2002, the requirements with regard to transmission heat loss through the building envelope and ventilation heat loss have been gradually increased. The same applied to the energy efficiency of building services (heating, hot water supply, ventilation, and cooling).

With the introduction of the energy performance certificate for new and existing buildings, it became possible for the first time to compare buildings efficiently with each other, also in terms of transparency for users/buyers. In addition, inspection reports during construction and operation optimized the energy quality of buildings.

Objectives of the EnEV 2014

Discussions and guidelines at the European level led to the need to adapt the Energy Saving Ordinance in Germany. With the current EnEV 2014, this has been done in an exemplary manner. Compared to the previous EnEV 2009, the current EnEV 2014 essentially pursues four objectives in residential construction:

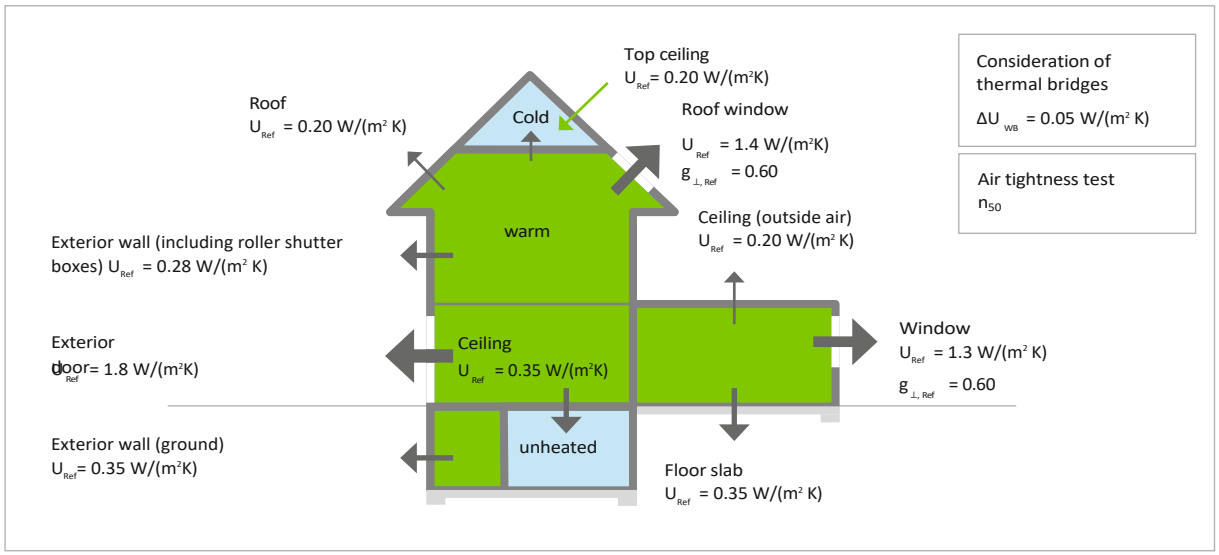
1. Transparent documentation of the energy quality of a building with the energy performance certificate
   - The final energy demand represents the total amount of energy required to ensure both the heating and domestic hot water supply of the building.
   - The primary energy demand also takes into account the generation and provision of the required energy.
   - The transmission heat loss characterizes the quality of the building envelope and the resulting heat losses through separating components with different temperatures on both sides.
   - Energy efficiency classes are introduced for the purpose of comparing individual buildings.
   - The use of renewable energies to cover heating and cooling requirements is documented in order to save fossil resources.
   - There are regulations governing the issuance, display, and content of energy performance certificates. This allows users to directly recognize the energy quality of a building and the costs they can expect.
2. Tightening of requirements from January 1, 2016
   - The annual primary energy demand Q_p has been reduced by 25% compared to the reference building.
   - The transmission heat loss H'_T for residential buildings has been limited to the value of the comparable reference building.
3. Adaptation of the certificates to the current standards
   - The current EnEV 2014 takes into account the fact that the key verification standards in the field of energy assessment of buildings have been adjusted since 2009.
   - On May 1, 2014, the primary energy factor for electricity was reduced from 2.6 to 2.4. From January 1, 2016, there was a further reduction to 1.8.
   - Summer heat protection must be calculated using various verification methods in accordance with the new DIN 4108-2 standard from 2013.
4. Increased control options
   - The EnEV 2014 introduces an effective control mechanism for the first time, which enables random checks of energy quality and is thus intended to contribute to an increase in the quality of execution.
   - Successively adjusted escalation levels check the information from the calculation against the actual building constructed. This can range from checking the input data to an on-site inspection of the property.
   - This is made possible by recording energy performance certificates using the new registration numbers and by requiring planners to retain all calculation documents for two calendar years.

The proven reference building method for residential buildings

The reference building method can be used to calculate the energy performance of all types of residential and non-residential buildings. For residential buildings, the reference building method according to DIN V 4108-6 in conjunction with DIN V 4701-10 is suitable, as it requires less effort than the data basis from DIN V 18599.

The energy quality of the building envelope is determined by the transmission heat loss. This value balances the components of the building envelope in such a way that the average insulation effect across all exterior components (e.g., walls, roof, windows, etc.) can be determined. The reference building makes corresponding suggestions for the heat transfer coefficients (U-values) of the individual components. These can be either exceeded or fallen short of. This enables the planner to create appropriate economical solutions for the building envelope. In addition, the EnEV continues to take thermal bridges into account and assigns the planner the task of avoiding them in an economical manner.

Fig. 1: Reference standard for residential buildings – reference building method

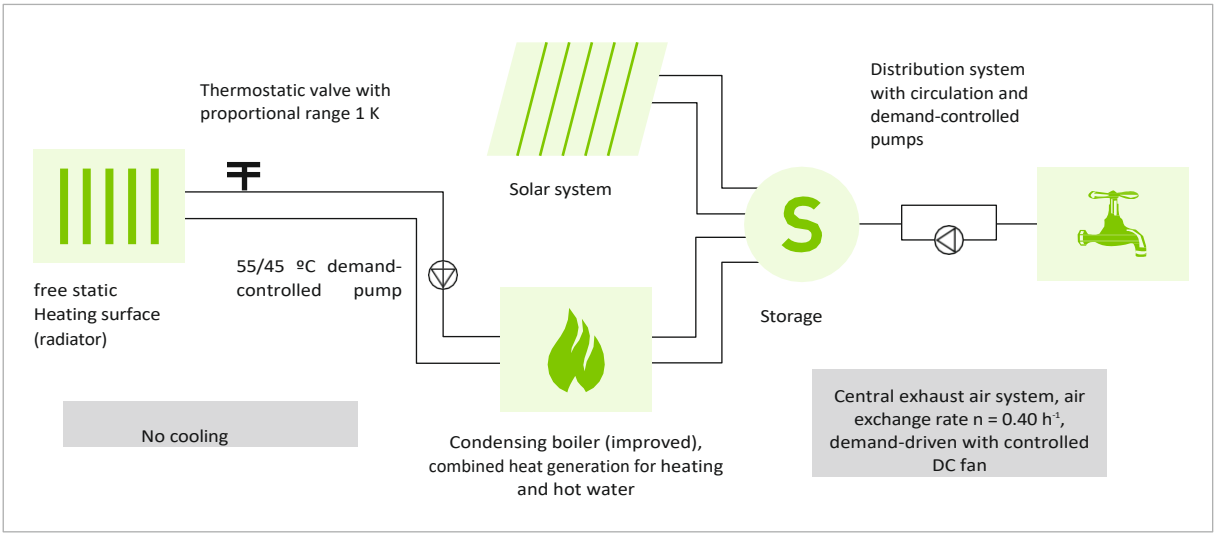


The energy consumption of a building continues to be determined by the combination of component quality, the heat-transferring building envelope, and the system technology used for heating, domestic hot water, and ventilation. The reference building method also allows for a wide variety of combinations in building services engineering and is compared with a reference standard. As part of the verification process, the building services engineering can then be further optimized using manufacturer specifications and exact pipe lengths. This allows significant savings in the calculated annual primary energy requirement to be achieved compared to the standard values.

With the interplay between the individual components, the current EnEV does not describe rigid limit values, but rather enables a balanced relationship between the building envelope and the building services engineering in order to comply with the energy requirements. In the reference building, specifications for component and system parameters are used to determine the maximum permissible annual primary energy requirement. These parameters and the geometry of the actual building are used to calculate the energy standard. The sum of all values counts, not the individual values.

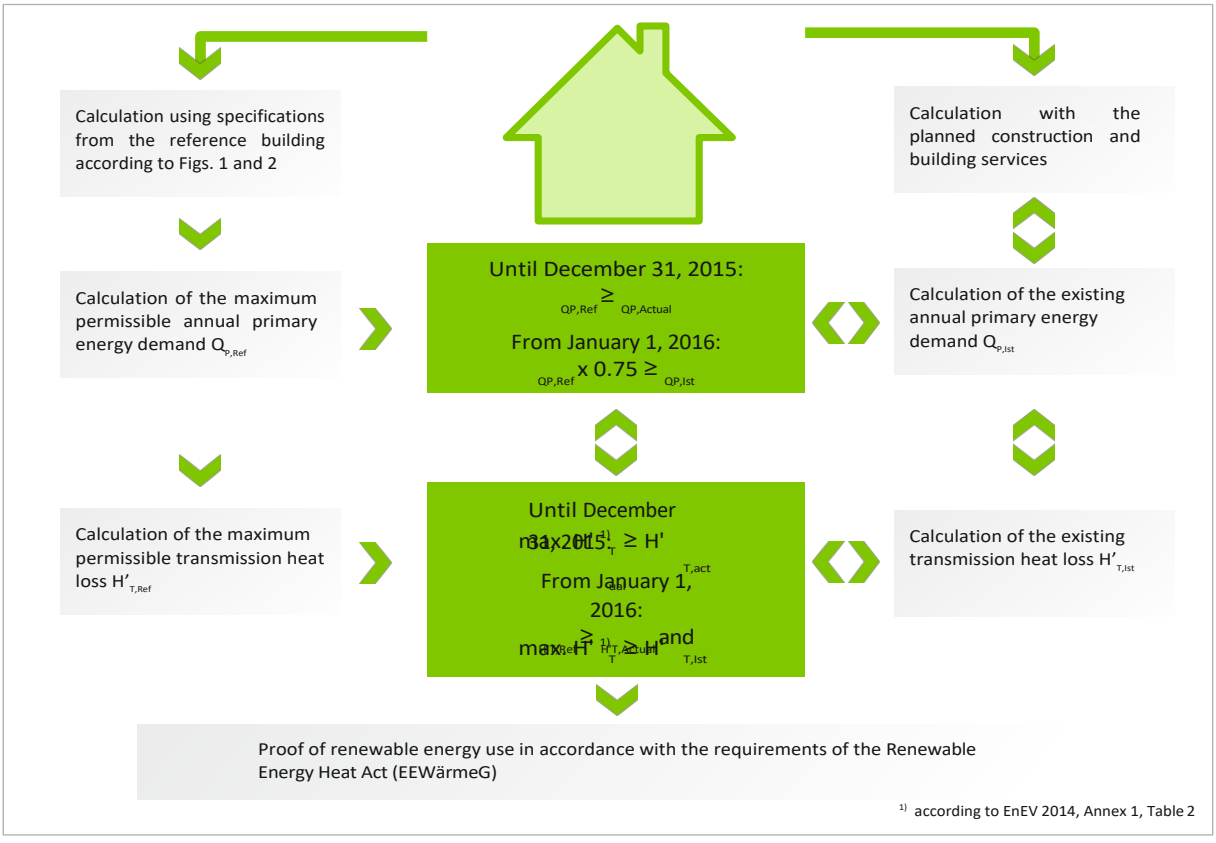
7.1.6 Energy Saving Ordinance EnEV 2014

Fig. 2: Reference standard for building services – reference building method



The requirement value from the reference building shows the maximum permissible annual primary energy demand and the transmission heat loss that the planned building must comply with or fall below in the energy performance certificate. Any deviations in the individual components and system technology are possible as long as they do not exceed the specified limit values. The lower the actual values are compared to the requirements, the lower the energy consumption and thus also the operating costs of the building.

Fig. 3: Calculation process of the EnEV 2014 – reference building method



Verification for non-residential buildings

Non-residential buildings are verified using the reference building method in accordance with DIN V 18599. To calculate non-residential buildings, they are divided into zones based on the indoor temperature and differences in use. Zones with indoor temperatures greater than or equal to 19 °C are subject to stricter requirements for the U-values of the individual components than those with indoor temperatures between 12 and less than 19 °C. The different temperatures in the individual zones result in zone-specific primary energy requirements, which together represent the total energy requirement of the non-residential building.

The current DIN V 18599 standard takes into account energy flows for air conditioning and hot water as well as the energy requirements for lighting – detailed in the energy performance certificate. Commercial sales and rental advertisements must specify the energy performance of the building. Unlike residential buildings, the final energy demand for heat and electricity must be specified.

Summer heat protection in accordance with DIN 4108-2 is also a necessary component of energy-efficient building design. In many cases, both the regulations on lighting for work areas and modern architecture require building certification with a dynamic thermal simulation calculation. The following applies: In non-residential buildings, the number of hours with temperatures above the degree temperature is significantly lower at 500 h/a than in residential buildings. Additional sun protection measures are therefore often necessary to ensure a comfortable indoor climate in offices and workplaces. These are easier and more economical to install than active cooling systems and air conditioning systems. This is because cooling a building generally consumes more energy than heating it, which in turn has an impact on operating costs.

With the tightening of the EnEV on January 1, 2016, the requirements for non-residential buildings have also increased. The aim is to reduce the respective energy requirements from an economic point of view in line with the types of use. In fact, the tightening of the regulations increased the energy requirements for office buildings to the same extent as for residential buildings, while, for example, the building envelope for hall structures was adapted to the intended use.

The right Multipor insulation system for every requirement

With the Multipor WAP composite thermal insulation system, current and future energy standards can be easily achieved. The system is ideal for the perfect and ecological insulation of functional walls made of Ytong aerated concrete and Silka sand-lime bricks. This fact is expressly underlined by the certifications from natureplus, IBU, and eco-INSTITUT. I f , for example, an exterior wall consists of a 17.5 cm thick Ytong aerated concrete load-bearing shell and a Multipor mineral insulation board WAP that is only 14 cm thick as a composite thermal insulation system, the U-value requirements of the reference building in EnEV 2014 are already exceeded by 25%.

If the masonry has to meet higher structural requirements, the load-bearing shell can be replaced with Silka sand-lime brick and the insulation thickness increased to 20 cm. The insulating effect remains the same, but the load-bearing shell of the masonry can now easily withstand high loads (multi-story buildings).

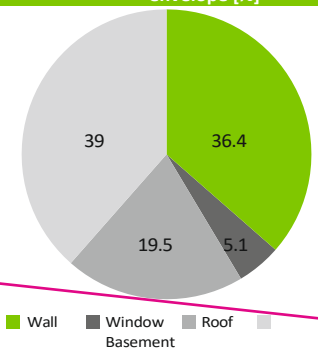
Due to the versatility of Multipor mineral insulation boards, they can also be used in a modified form for basement ceiling or roof insulation. Their non-combustibility and ease of processing in the system also ensure the best results in these areas. In this way, around 8 m³ of finished mineral insulation material can be obtained from 1 m ³ of raw materials in a certified and resource-saving manufacturing process.

7.1.6 Energy Saving Ordinance EnEV 2014

Examples of various energy standards

Is the "smaller" sign here Correct?

Area proportions of the building envelope [%]



Requirements

Reference values: Single-family home A_N = approx. 195 m² Volume approx. 610 m³

Wall structures / examples

Functional exterior wall

YTONG + multipor

silka + multipor

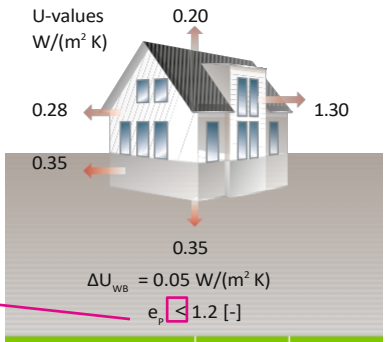
Roof structures / examples

Ytong combination roof

YTONG + multipor

Reference building according to EnEV 2014

(including stricter requirements in 2016)



	Target	Actua
Q_p [%]	100	100
Q_p [kWh/(m²a)]	70.5	70.5
H'_T [%]	100	80
H'_T [W/(m²K)]	0.400	0.319

U = 0.28 W/(m²K)

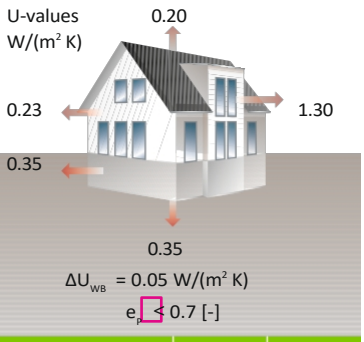
20.0 cm **Ytong PP 4-0.50** λ = 0.12 W/(mK)
8.0 cm **Multipor WAP** λ = 0.045 W/(mK)

17.5 cm **Silka 20-2.0** λ = 1.1 W/(mK) 14.0 cm **Multipor WAP** λ = 0.045 W/(mK)

U = 0.20 W/(m²K)

20.0 cm **Ytong AAC 4.5-550** λ = 0.14 W/(mK)
16.0 cm **Multipor DAD** λ = 0.045 W/(mK)

Xella standard 2016



	Target	Actual
Q_p [%]	100	78
Q_p [kWh/(m²a)]	50.8	39.7
H'_T [%]	100	76
H'_T [W/(m²K)]	0.319	0.304

U = 0.23 W/(m²K)

17.5 cm **Ytong PP 4-0.50** λ = 0.12 W/(mK)
12.0 cm **Multipor WAP** λ = 0.045 W/(mK)

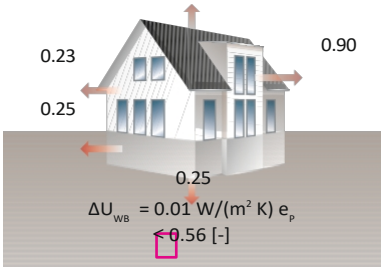
17.5 cm **Silka 20-2.0** λ = 1.1 W/(mK) 18.0 cm **Multipor WAP** λ = 0.045 W/(mK)

U = 0.20 W/(m²K)

20.0 cm **Ytong AAC 4.5-550** λ = 0.14 W/(mK)
16.0 cm **Multipor DAD** λ = 0.045 W/(mK)

KfW Efficiency House 55
(variant 1)

U-values W/(m² K) 0.17



ΔU_{WB} = 0.01 W/(m² K) e_p < 0.56 [-]

Q_p [%]	Target 55	Actual 40
Q_p [kWh/(m²a)]	37.3	26.2
H'_T [%]	70	70
H'_T [W/(m²K)] [1]	0.223	0.221

U = 0.23 W/(m²K)

17.5 cm **Ytong PP 4-0.50** λ = 0.12 W/(mK)
12.0 cm **Multipor WAP** λ = 0.045 W/(mK)

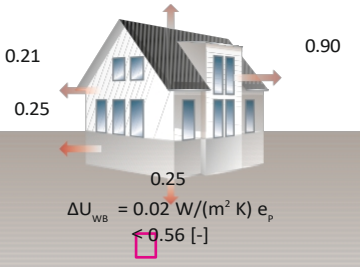
17.5 cm **Silka 20-2.0** λ = 1.1 W/(mK) 18.0 cm **Multipor WAP** λ = 0.045 W/(mK)

U = 0.17 W/(m²K)

20.0 cm **Ytong AAC 4.5-550** λ = 0.14 W/(mK)
20.0 cm **Multipor DAD** λ = 0.045 W/(mK)

KfW Efficiency House 55
(Variant 2)

U-values W/(m² K) 0.17



ΔU_{WB} = 0.02 W/(m² K) e_p < 0.56 [-]

Q_p [%]	Target 55	Actual 40
Q_p [kWh/(m²a)]	37.3	26.0
H'_T [%]	70	69
H'_T [W/(m²K)] [1]	0.223	0.219

U = 0.21 W/(m²K)

17.5 cm **Ytong PP 4-0.50** λ = 0.12 W/(mK)
14.0 cm **Multipor WAP** λ = 0.045 W/(mK)

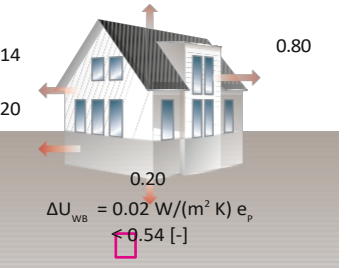
17.5 cm **Silka 20-2.0** λ = 1.1 W/(mK) 20.0 cm **Multipor WAP** λ = 0.045 W/(mK)

U = 0.17 W/(m²K)

20.0 cm **Ytong AAC 4.5-550** λ = 0.14 W/(mK)
20.0 cm **Multipor DAD** λ = 0.045 W/(mK)

KfW Efficiency House 40
(Also known as KfW Efficiency House 40 Plus)[2]

U-values W/(m² K) 0.15



ΔU_{WB} = 0.02 W/(m² K) e_p < 0.54 [-]

Q_p [%]	Target 40	Actual 39
Q_p [kWh/(m²a)]	28.2	21.9
H'_T [%]	55	55
H'_T [W/(m²K)] [1]	0.176	0.176

U = 0.14 W/(m²K)

17.5 cm **Ytong PP 4-0.50** λ = 0.12 W/(mK)
24.0 cm **Multipor WAP** λ = 0.045 W/(mK)

17.5 cm **Silka 20-2.0** λ = 1.1 W/(mK) 28.0 cm **Multipor WAP** λ = 0.045 W/(mK)

U = 0.15 W/(m²K)

20.0 cm **Ytong AAC 4.5 550** λ = 0.14 W/(mK)
24.0 cm **Multipor DAD** λ = 0.045 W/(mK)

[1] Based on the reference building EnEV 2014, according to Annex 1, Table 1, excluding line 1.0; here Qp = 67.76 kWh/m² a

[2] Plus package consisting of: Electricity generation system based on renewable energies + stationary battery storage system + ventilation system with heat recovery + user interface with visualization of electricity generation and consumption

7.1.6 Energy Saving Ordinance EnEV 2014

Modernization of residential buildings

In Germany, there is an above-average number of residential units that, due to their date of construction, have poor to inadequate thermal insulation and outdated building services equipment. The result: increased energy costs in winter and sometimes unbearable living conditions in hot summer months, which can only be improved by energy-intensive cooling measures.

The current EnEV specifies both the requirements for alterations and extensions to buildings and the obligations for retrofitting them. Any type of energy-efficient renovation of a building—whether to the heat-transferring envelope or the building services—reduces heating costs, optimizes climate protection, and increases the current market value.
Every modernization also contributes to greater living comfort and makes existing buildings attractive again – both for owners and potential tenants.

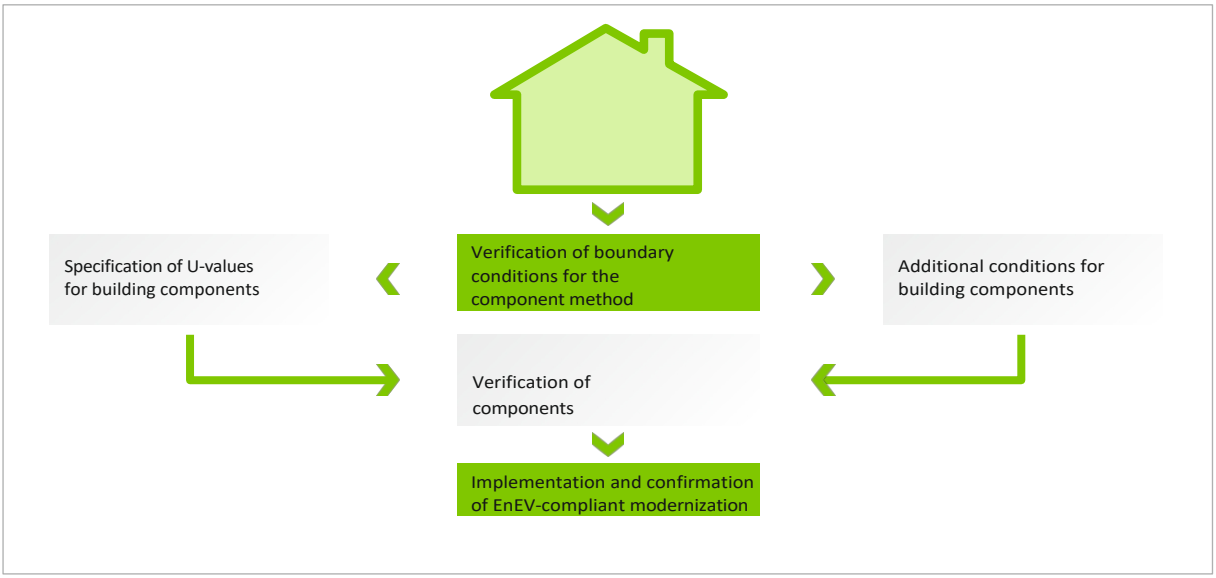
The EnEV 2014 gives planners more certainty when planning energy measures in the field of building renovation, as the amendment finally clarifies numerous details that have been interpreted differently since 2009. Planners must now therefore deal intensively with the current EnEV within the scope of modernization, as the combination of individual measures and overall measures must be described in the energy performance certificate and evaluated from an economic perspective. A distinction can be made between retrofitting obligations and economically justifiable renovation measures.

Planners can choose between the relatively simple component method or the more complex detailed verification method for modernization projects. If the modernization also involves an extension with more than 50 m² of additional usable space, it must be checked whether a new heat generator is being installed. Only then do the new building requirements apply. Otherwise, verification for the modernization can also be provided using the component or reference building method.

The component-related approach sets requirements for the individual components according to the table values in Appendix 3, Table 1 of the EnEV. The values contained therein always apply in combination with further provisions from Appendix 3 of the EnEV 2014.

The second calculation variant in the modernization area goes much deeper, as it recalculates the entire building according to the rules of the current EnEV for residential buildings. As a result, residential buildings may exceed the limit values for annual primary energy demand and transmission heat loss according to the reference building method by a maximum of 40%. It is therefore clear that this assessment method is more suitable for complete renovation than for component modernization.

Fig. 4: Calculation process for the component method for modernization



Outlook and development of the Energy Saving Ordinance

The EnEV 2014 set the course for the future. In Germany, the European framework conditions from Directive 2010/31/EU and the accompanying regulations are thus being implemented in an exemplary manner. At the same time, efforts are being made to make new buildings as nearly zero-energy houses or nearly zero-energy buildings the standard in the public sector from 2019 and in the private sector from 2021. With a 25% reduction in primary energy demand, the EnEV 2014 provides clear guidelines for those involved in construction for residential and non-residential buildings from January 1, 2016. The current version of the Energy Saving Ordinance has established the former Efficiency House 70 standard of the Kreditanstalt für Wiederaufbau (KfW) as the new standard.

But the accompanying decisions on the current EnEV go even further:
Section 1 "Purpose and Scope" of the Energy Saving Ordinance sets out a clear development mandate for future energy savings. In addition to the national target of low-energy buildings, the goal of a climate-neutral building stock by 2050 will continue to be pursued. As a result, further efforts and tightening of regulations will also be required in the area of modernization in the future. Homeowners will then also have to consider whether a new construction project is not easier to implement than a modernization project from an economic point of view. Accompanying modernization programs to promote measures in existing buildings slightly cushion the cost burden for building owners, but the modernization recommendations now also focus on a cost-effectiveness analysis for each property.

To simplify energy-saving regulations, the previously separate laws and ordinances are to be merged into a single set of rules. This will result in a body of law that facilitates the energy and economic optimization of buildings, combining the previous Energy Saving Act (EnEG), the Act on the Use of Renewable Energies in the Heating Sector (EEWarmeG), and the Energy Saving Ordinance (EnEV). The Building Energy Act (GEG) was developed to standardize energy saving legislation for buildings and to take into account the implementation of the amendment to the EU Buildings Directive of June 2018. The new EU Buildings Directive 2018 requires that public buildings from 2019 and all other new buildings from 2021 comply with a "nearly zero energy" or low energy standard. The first draft of the GEG got stuck in parliament in 2017 before it could be submitted to the federal cabinet. The federal ministries are currently preparing a new draft that takes the amended EU directive into account. The draft was not yet available at the time of going to press.

EnEV 2014:

Stay up to date with the brochure "EnEV 2014 – Requirements, Changes, Outlook," available online at: **www.multipor.de/enev**



7.2 Moisture protection

Building physics

For the effective planning and long-term implementation of insulation measures in new buildings, but especially for the interior insulation of existing buildings, it is essential to be familiar with basic building physics concepts and terminology in order to take appropriate precautions for moisture protection.

To begin with, here are some relevant moisture-related basics for planning insulation measures in new and existing buildings.

Chapter 7.2.5 contains an in-depth discussion on the topic of interior insulation, which is often the subject of controversy due to improper planning and execution, especially when moisture problems and their visible consequences—such as mold and rot—are the result of poor planning or execution. Here, the Multipor WI interior insulation system represents a durable solution for interior insulation systems without a vapor barrier that has been proven over decades.

At the end of chapter 7.2.5, not only are the currently common designs of interior insulation systems explained and compared, but the possible mathematical verification methods for the safe planning of interior insulation with the Multipor WI interior insulation system are also explained.

7.2.1 Basics of moisture protection

Absolute and relative humidity Air can absorb moisture in the form of water vapor, with the maximum amount of water vapor that can be absorbed increasing as the temperature rises. The relationship is exponential and can be plotted as a saturation vapor pressure curve (Fig. 2) or as a saturation quantity curve (Fig. 1) over temperature.

For many practical purposes, absolute humidity is less important than the relative value of absolute humidity in relation to the maximum possible humidity at the same temperature. This is the relative humidity, often denoted by Φ and expressed as a percentage.

Fig. 1: Diagram of relative humidity as a function of temperature and water vapor saturation concentration

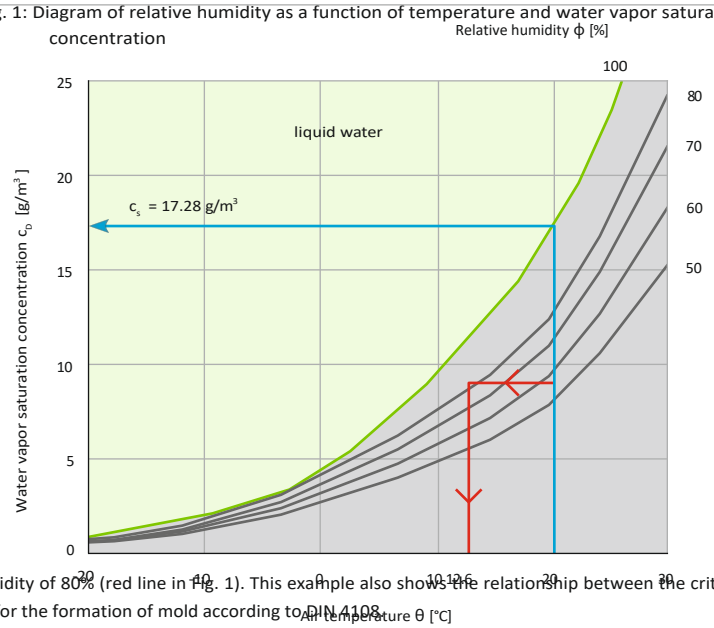


Figure 1 clearly shows that relative humidity increases as the temperature decreases. Air with a relative humidity of 50% at 20°C has cooling to a temperature of 12.6 °C has a relative humidity of 80% (red line in Fig. 1). This example also shows the relationship between the critical surface temperature and the critical relative humidity for the formation of mold according to DIN 4108.

In principle, mold can form at a relative humidity of ≥ 80%. Under standard climatic conditions of 50% relative humidity and 20 °C in a residential building, the internal surface temperature must therefore not fall below 12.6 °C at any point.

Table 1: Maximum possible water content, depending on temperature

Temperature [°C]	Amount of water vapor [g/m³]	Temperature [°C]	Amount of water vapor [g/m³]
-	2.36	13	11.34
-5	3.41	14	12.06
-4	3.66	15	12.82
-3	3.93	16	13.63
-2	4.22	17	14.47
-1	4.52	18	15.36
0	4.85	19	16.30
1	5.19	20	17.28
2	5.56	21	18.32
3	5.95	22	19.41
4	6.36	23	20.56
5	6.80	24	21.76
6	7.26	25	23.03
7	7.75	26	24.36
8	8.27	27	25.75
9	8.82	28	27.21
10	9.40	29	28.74
11	10.01	30	30.34
12	10.66		

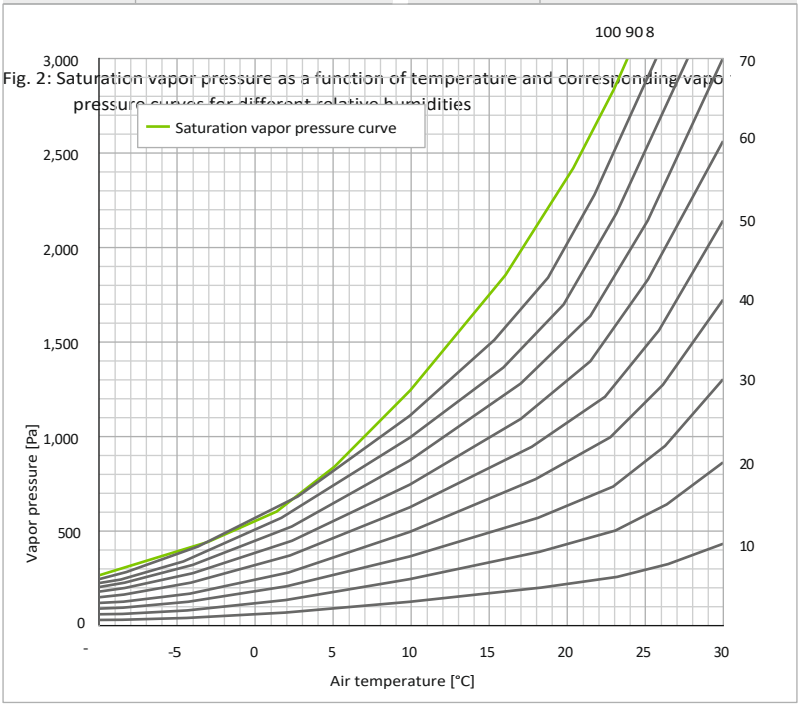


Fig. 2: Saturation vapor pressure as a function of temperature and corresponding vapor pressure curves for different relative humidities

Condensate, condensation

As the temperature rises, the amount of water that can be absorbed increases exponentially (see also Figure 1 and Table 1). When warm air cools down, the maximum amount of water that can be absorbed decreases. If the amount of water in the air remains constant, the relative humidity increases in this case. When the relative humidity reaches a value of 100%, the air contains exactly the amount of water (vapor) that it can absorb. The air is saturated with vapor.
Further cooling leads to supersaturation, as a result of which the air must release water.

The terms dew water and condensate are used synonymously for the separated liquid water.

Examples:
On clear nights, the Earth's surface cools significantly as a result of heat radiation. This cools the passing air to such an extent that it becomes supersaturated, whereupon the excess water condenses on cold surfaces. These cold surfaces can be plants and grasses as well as roads and facades.

Single-glazed windows with low thermal resistance are so cold on the inside surface of the pane that the warmer room air cools down at the interface and becomes supersaturated, resulting in water droplets (condensation) forming on the pane.

7.2.1 Basics of moisture protection







Dew point
The term dew point temperature – or dew point for short – refers to the temperature at which the air reaches water saturation and the process of condensation begins.

The dew point or dew point temperature depends on the air temperature and relative humidity. If both boundary conditions are known, the dew point temperature can be determined mathematically or graphically using diagrams such as those shown in Figure 1.

For example, the dew point at 20 °C and 50 % humidity can be read from Figure 1 by drawing a horizontal line from this point in the diagram to the left until water vapor saturation is reached. The temperature that can be read at this intersection on the x-axis corresponds to the dew point temperature for the selected combination (20 °C and 50%). In this example, this is approximately 9.3 °C.

In building construction, the term dew point is often used synonymously with dew level.

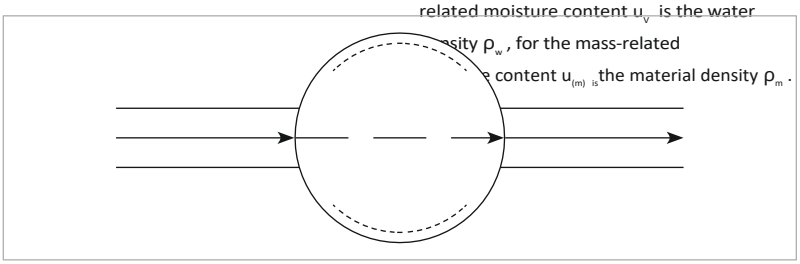
Condensation level/dew level
The term condensation level or dew level refers to a layer or component above which there is a temperature difference. The imaginary level within this layer or component at which the dew point temperature occurs is the dew level.

Like the dew point temperature, the exact position of the dew line depends only partly on the temperature and relative humidity of the air on the warm side. No less relevant are the temperature on the cold side, the thermal conductivity, the vapor diffusion resistance, and the layer thickness of the layer in question or the various layers of the component in question.

The terms "condensation level" and "dew point" are always linked to a model concept in discussions about interior insulation systems. This is the Glaser model, which can be used to describe and visualize steady-state vapor diffusion in a simplified manner. Since the simplifying assumptions underlying this model only apply in very few cases, the concept of the condensation or dew point is misleading in most cases.

A classification of the method and an evaluation of the reliability of the results in connection with

Fig. 3: Capillary condensation



with today's systems for interior insulation is provided in more detail in Chapter 7.2.5.

Moisture content
The amount of water in a building material can be determined by its moisture content. Both the volume and the mass of the building material are commonly used as reference values, so that the moisture content can be expressed, for example, in kg of water (M_w) per m^3 of building material (V_m).

$u = M_w / V_m$ [kg/m³]

The following specifications are also common: m³ water per m³ building material or kg water per kg building material, or these multiplied by 100 to record the percentage by volume or mass.

$u_v = u/\rho_w \cdot 100$ [%] u_m
$= u/\rho_m \cdot 100$ [%]

The conversion factor for the volume-related moisture content u_v is the water density ρ_w, for the mass-related moisture content $u_{(m)}$ is the material density ρ_m.

Moisture storage and equilibrium moisture content

Building materials can absorb moisture and store it on the inner surfaces of the pore structure (sorption or moisture storage). If the relative humidity of the ambient air increases, building materials absorb moisture more readily and store it.

Capillary condensation (Fig. 3) of the water plays a decisive role here, as it begins even before the actual saturation vapor pressure is reached, whereupon the inner surfaces of the pores are wetted with water. The smaller the pores, the sooner this condensation begins.

Due to capillary condensation, salt-free building materials never dry out completely under normal conditions, but always retain a certain amount of residual moisture.

Table 2: Moisture content at different relative humidity levels

	Moisture content at 23 °C and 50% relative humidity	Moisture content at 23 °C and 80% relative humidity
Multipor	2.8 kg/m	3.2 kg/m³
Lightweight mortar	2.5 kg/m	10.4 kg/m³
Clay mortar	15 kg/m	28.2 kg/m³
Lime-cement plaster	30 kg/m	45 kg/m³
Gypsum plaster	3.6 kg/m	6.3 kg/m³
EPS	0.0 kg/m³	0.0 kg/m
Mineral wool	0.0 kg/m³	0.0 kg/m
Foam glass	0.0 kg/m³	0.0 kg/m
Calcium silicate brick	12 kg/m	24 kg/m
Solid brick	7 kg/m	12 kg/m
Aerated concrete	13 kg/m³	22.5 kg/m³
Concrete	25 kg/m	40 kg/m

(Source: DIN EN ISO 10456:2010-05, excerpts from Table 4)

This so-called equilibrium moisture content describes the moisture content of a building material that adjusts itself depending on a given air humidity. This process results in the moisture storage function or sorption isotherm – a material property that indicates the equilibrium moisture content as a function of relative air humidity (Table 2). This relationship is reflected in the so-called moisture buffer effect. Building materials that can store a lot of moisture in the normal humidity range therefore also have a good moisture buffer effect. When humidity levels rise – for example, when many people gather in a meeting room – they can absorb and store the resulting moisture. When the load decreases again, the building materials release the stored moisture back into the room air and can thus regulate the indoor climate. However, even under normal conditions, the moisture storage function of wall building materials has a beneficial effect on the indoor climate.

Equilibrium moisture

More than 40 years of practical experience have shown that the equilibrium moisture content and the associated moisture content are reached when the building material is stored at 80% relative humidity. It is therefore often referred to by the formula symbol u_{80}.

Moisture transport

We distinguish between two mechanisms of moisture transport: water vapor transport, which takes place in the air or the air-filled pore space, and capillary or liquid transport, which takes place within the pore structure of a building material and depends on the moisture content.

Water vapor transport Water transport in the gas phase occurs when there is a concentration gradient of water vapor within the air. Gas molecules always strive to equalize an existing concentration gradient, so that molecules move from areas of high concentration to areas of lower concentration. The associated transport process is called diffusion. In the case of water vapor transport, this is therefore also referred to as vapor diffusion. It takes place in the air-filled pore space of the porous medium. Its speed depends on the size of the concentration or vapor pressure difference, the temperature, and the permeability of the medium.

μ value

The vapor permeability of building materials is described by the water vapor diffusion resistance factor (μ value). This indicates how much worse the water vapor permeability of the building material is compared to a layer of still air. It is dimensionless and therefore has no units [–]. The μ value is a material parameter that is determined by measurement for various products.

s_d value

For thin building or coating materials, however, the water vapor diffusion resistance is often specified as an s_d value rather than a μ value.

7.2.1 Basics of moisture protection

This describes the water vapor diffusion equivalent air layer thickness and is specified in [m].

$s_d = \mu \cdot d$ [m]

It is the product of the µ value and the layer thickness d of the building material and indicates how thick a stationary air layer would have to be in order to have the same diffusion resistance as the building material layer in question.

Water absorption, w-value or water absorption coefficient

The w-value and the v-value, which will be explained later, are used for the practical assessment of the moisture absorption of a building material and to calculate the drying time.

Water absorption is a physical parameter of a material. The water absorption property depends on the surface texture and porosity. Certain materials with high water absorption capacity may therefore only be suitable for indoor use in order to help regulate a comfortable room humidity level.

Water absorption is measured using the so-called w-value. This indicates how much water a building material absorbs in liquid form within a certain period of time.
The w-value has the unit [kg/(m²h$^{0.5}$)]. The unit root of time can be explained by the fact that a material needs four times as long to absorb twice the mass
four times as long. If the time is plotted as a root function on the abscissa and the amount of water absorbed on the ordinate, a straight line is formed whose slope represents the value of the water absorption coefficient – the w-value (Fig. 5).

The v-value

The v-value describes the so-called water vapor diffusion flux density. The classification is given in DIN EN 1062-1

Fig. 4: Comparative representation of the s_d values of selected building materials – the figure clearly shows the different vapor-retarding properties of selected building materials

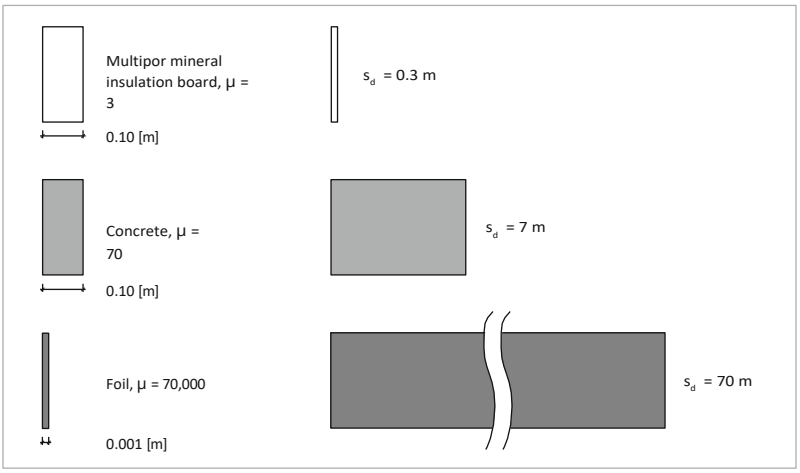
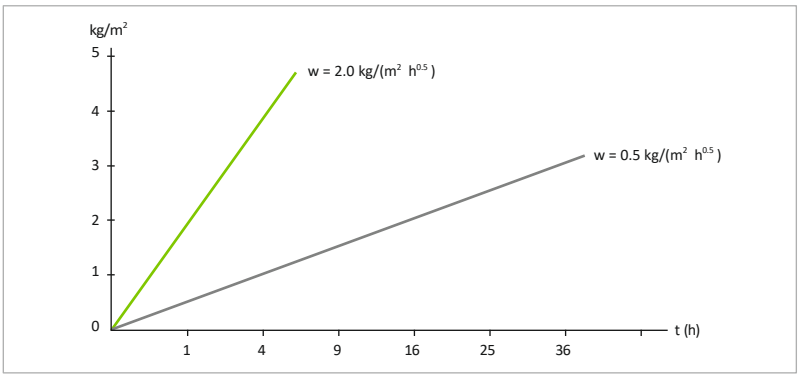


Fig. 5: Graphical representation of the water absorption coefficient (w)



regulated. The value indicates how much water vapor diffuses through a surface in a given time. The v-value is measured at a temperature of 23 °C and has the unit [g/(m² d)].

The conversion factor 21 between the s_d and v values is a value measured at 23 °C when a sample has a relative humidity of 100% in the damp area and a relative humidity of 50% outside the diffusion layer.

The v-value is considered high if more than 150 g of water vapor per m² per day diffuses through a layer. It is directly proportional to the s_d value:

Formula:

$s_d = 21/v$ [m]

$v = 21/s_d$ [g/(m² d)]

The v-value is highly dependent on temperature. According to the laws of thermodynamics, the drying time doubles at a temperature 10 °C lower. At a temperature of 3 °C, it is therefore only 25% of the value determined at 23 °C.

The dependence of the v value and the s_d value clearly shows that a high v value is always associated with a low s_d value. Conversely, a high s_d value means that the drying capacity is low.

The following numerical example illustrates the relationship between water absorption, s_d value, and v value (Fig. 6):

Numerical example: Relationship between s_d value and v-value

Initial situation:
A material with a w value of 0.2 [kg/(m²h$^{0.5}$)] and an s_d value of 0.2 m is exposed to driving rain on the outside for one day. This results in the following calculated amount of water being absorbed:

$w = 0.2\ kg/(m^2h^{0.5}) \cdot (24\ h)^{0.5} = 0.2 \cdot 4.9\ kg/m^2 = 0.98\ kg/(m^2d)$

Within 24 hours, an insulation material with the above-mentioned w value absorbs approx. 1 kg/m² of water. The v value can be used

to determine the required drying time.

$v = 21/s_d = 21/0.2\ m = 105\ g/(m^2d)$

The actual v value at an outside temperature of 3 °C is only 25% of the value at 23 °C, and thus only 105 g/(m²d) · 0.25 = approx. 26 g/(m²d) or

0.026 kg/(m²d)

The drying time can now be determined from the ratio of the amount of water absorbed to the amount of drying per day.

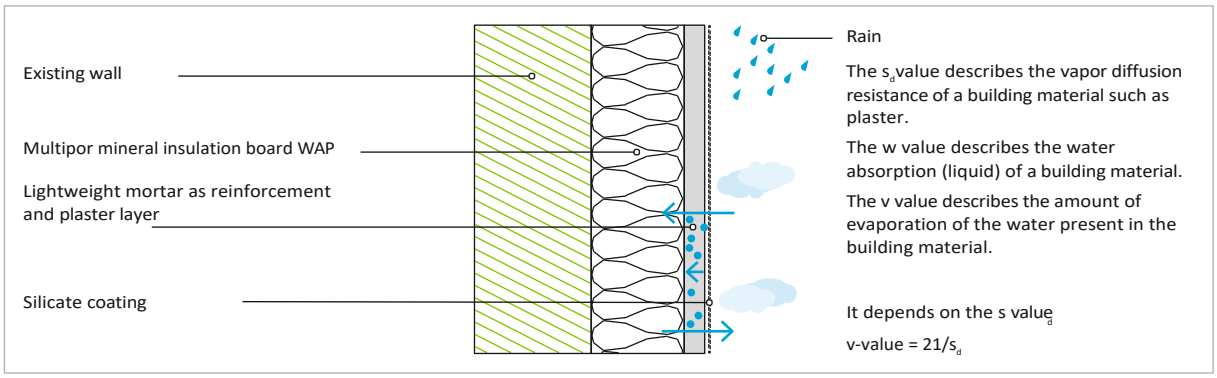
t = 0.98 kg/m² / 0.026 kg/(m²d) = 37.8 d

The re-drying of a facade exposed to such conditions would take approx. 38 days in winter at a temperature of 3 °C. It should be noted that this value is only valid if no further moisture exposure occurs during this period.

This numerical example shows that, in order to ensure sufficient drying capacity, paints and plasters with a low water absorption coefficient (w value), a low water vapor diffusion equivalent air layer thickness (s_d value) and, at the same time, a high water vapor evaporation capacity (v-value).

A facade constructed in this way also has a certain degree of fault tolerance, whereas virtually impermeable constructions have no drying capacity and small errors in construction and/or damage during use can lead to moisture penetration throughout the entire facade.

Fig. 6: Graphic describing s_d -, w- and v-values



7.2.1 Basics of moisture protection

Table 3: Moisture-related material properties

Table 3: Moisture-related material properties

Product	Item	Bulk density ρ [kg/m³]	Thermal conductivity λ [W/(mK)]	Reference value for water vapor diffusion resistance coefficient μ[1] –
Multipor mineral insulation board	WI/DI Compressive strength ≥ 200 kPa	85 to 95	0.042	2
	WAP/DAA/DAD Compressive strength ≥ 300 kPa	100 to 115	0.045	3
	DAA compressive strength ≥ 350 kPa	100 to 115	0.047	
Multipor lightweight mortar		770	0.18	< 10
Multipor clay mortar		2,040	1.0	< 11
Ytong	Aerated concrete	300 – 600	0.07 – 0.18	5
Silka	Calcium silicate brick	1,000 – 1,400	0.5 – 0.7	5
Silka	Calcium silicate brick	1,600 – 2,200	0.79 – 1.3	15
Brick		1,200 – 2,200	0.05 – 1.4	5
Concrete		1,600 – 2,400	1.15 – 2.10	120–150
EPS		15	0.04	20–100
Mineral wool		60	0.04	1
PA film, thickness ≥ 0.05 m		–	–	50,000

[1] According to DIN 4108-4: The value that is less favorable for the building structure must be used in each case.

The relationship between the $s_d$value, v value, and w value also applies to interior insulation and its coating of paint and plaster. However, it should be noted that the moisture load in winter due to vapor diffusion into the structure is almost constant, but in much smaller quantities than driving rain on the outside.

Capillary transport, capillary conduction, capillary activity

Water transport in liquid form takes place in the water-filled pore areas and on the water-wetted inner surfaces of porous media. The driving force for liquid transport is spatial differences in the pressure of the liquid phase. This is also referred to as the suction tension gradient, which causes water in liquid form to be conducted or sucked from areas with higher water content to areas with lower water content.

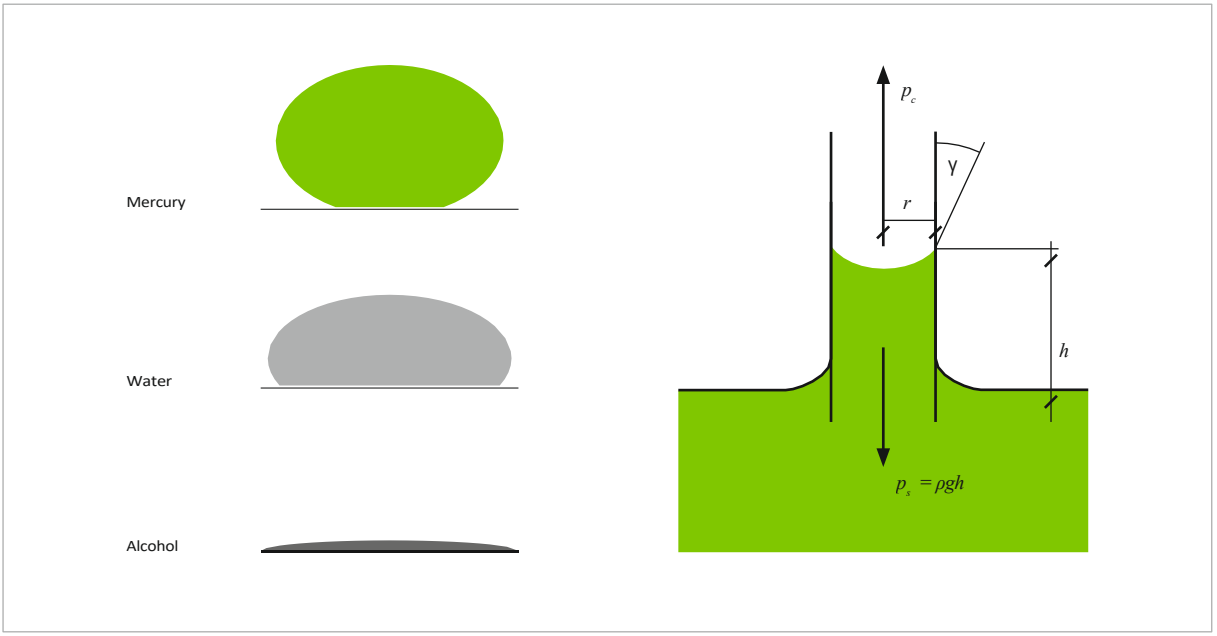
There are several mechanisms that determine liquid transport within porous media. One of these mechanisms is capillary conduction, whose name is derived from the simple but very illustrative model of the capillary. However, it should be noted that, in comparison to water vapor diffusion, the process of capillary conduction only begins at higher humidity levels.

Capillary activity and capillary return transport

Strictly speaking, the term capillary conduction refers to the transport of liquids within capillary tubes. These are circular tubes with a small radius in which the curvature of the water meniscus causes liquid transport (see Figure 7).

This is caused by the surface tension of the water. It ensures that a specific edge curvature, known as the meniscus, forms when water comes into contact with a solid substance. Figure 7 shows a schematic illustration of this for various liquids on the left. The meniscus can no longer form freely within very small capillary tubes. Due to the confined space, the meniscus then assumes a curvature that is more tense. This leads to a negative pressure ($p_{(c)}$), the so-called suction tension, which causes a transport process that is shown in Figure 7 on the right as the capillary rise height. Depending on the radius of the capillaries, the suction forces can become very large, resulting in very efficient liquid transport.

Fig. 7: Surface tension of various liquids (left) and capillary rise height as a function of capillary radius (right)



The term capillary action has become established as a synonym for liquid transport within porous media. In the context of interior insulation, this is misleading insofar as, as a result of the mechanism described for liquid transport in a capillary, the term capillary transport is generally equated with "highly efficient liquid transport."

Under non-isothermal conditions—i.e., when there is a temperature difference across a porous medium—it is possible for water vapor and liquid transport to occur simultaneously in opposite directions. This is due to the different driving forces for both transport mechanisms: the (temperature-dependent) vapor pressure difference for vapor transport and the (water content-dependent) capillary pressure difference for liquid transport.

The term capillary return transport refers to this process. It describes the liquid transport that occurs when water diffuses into a material in vapor form on the warm side, accumulates in the cold area, and is transported back toward the warm side of the material in liquid form as a result of this accumulation.

In fact, this liquid transport does not usually take place in fine capillary tubes, nor are large amounts of moisture transported over long distances in a short time.

This is moisture transport at very low moisture contents. Accordingly, although the inner material surfaces are thinly wetted with water (capillary condensation) and smaller pores or pore areas are certainly also filled with water, it is unlikely that there is a continuous liquid phase over large areas. The transport process consists
of components such as the equalization of minor differences in moisture content through surface transport or liquid conduction in very small pores or pore areas and in pore corners. This liquid transport is always smaller than or at most equal to the inflowing vapor transport.

Further explanations on the subject of capillary activity can be found in the brochure "Capillary Activity." This can be found in the download area at www.multipor.de.

7.2.2 Driving rain protection

Driving rain stress on walls occurs when rain and wind simultaneously strike the facade. Driving rain protection is necessary for the durability of a wall, the prevention of moisture penetration, and the preservation of the building material and thermal insulation properties. Good driving rain protection prevents moisture and structural damage. Effective driving rain protection is essential for the successful and long-lasting implementation of Multipor interior insulation WI.

The driving rain exposure of building facades varies greatly. The decisive factors are the geographical location, the exposure of the building, and the prevailing wind direction.

DIN 4108-3:2014-11 therefore distinguishes between three stress groups based on the average annual precipitation and wind exposure:

- Exposure group I – for low driving rain exposure
- Stress group II – for medium driving rain stress
- Stress group III – for high driving rain stress

Structures can be protected against impermissibly high driving rain exposure either by structural measures (exterior wall cladding, facing brickwork, etc.) or by means of suitable plasters or protective coatings. DIN 4108-3 provides examples of suitable wall structures depending on the driving rain exposure (see Table 1). For plastered exterior walls, a distinction is made between systems with water-retardant and water-repellent exterior plaster, which can be assigned to groups based on their water absorption and drying properties. This ensures a balanced ratio of water absorption and drying. The driving rain protection of a building must also be ensured in the area of joints and connections. These requirements can be met for joints and connections either by using joint sealants or other suitable design measures. In the area of composite thermal insulation systems, some possible measures are described in
Chapters 3.3 and 3.7.

Recommendation: When installing interior insulation, we recommend in all cases that the protection against driving rain be designed to at least meet the requirements of stress group II.

Table 1: Recommendations for wall structures (excerpt from Table 3 DIN 4108-3: 2014-11)

Stress group I Low driving rain stress	Stress group II: Medium driving rain exposure	Stress group III: heavy driving rain exposure
Exterior plaster without special requirements for driving rain protection	Water-repellent exterior plaster according to Table 2 on	
– exterior walls made of masonry, wall panels, concrete, etc. – and plastered external thermal bridge insulation		
Single-shell exposed masonry with a thickness of 31 cm (with interior plaster)	Single-shell exposed masonry with a thickness of 37.5 cm (with interior plaster)	Double-shell facing masonry with air layer and thermal insulation or with core insulation (with interior plaster)
Walls with rear-ventilated exterior wall cladding[1)]		
Walls with external insulation using a thermal insulation plaster system or a building authority-approved composite thermal insulation system		

[1)] Open joints between the cladding panels do not impair rain protection.

Table 2: Criteria for rain protection of plasters and coatings

Criteria for rain protection	Water absorption coefficient W_w [kg/(m² h$^{0.5}$)]	Water vapor diffusion equivalent air layer thickness s_d [m	Product $W_w \cdot s_d$ [kg/(mh$^{0.5}$)]
Water-repellent	$W_w \leq 0.5$	≤ 2.0	≤ 0.2

1



Karsten's test tube can be used to measure the water absorption capacity of a wide variety of building materials and wall components in a non-destructive manner. The lower side opening is attached vertically to the wall structure to be tested using a sealing compound. The test tube is then filled with water up to the upper measuring mark. The measuring scale can then be used to determine the water absorption of the wall per unit of time, usually after 1 minute. The measurement method is used to estimate the water absorption coefficient and can be used as a basis for assessing whether a facade needs to be renovated. The test tube can also be used to check the effectiveness of a renovated and hydrophobic facade [1].

2



Clinker facades are exposed to environmental influences on the outside. The weak point of clinker masonry is usually the grouting, which accounts for 10 to 30% of the facade area, depending on the clinker format. Visible cracks, breakouts, holes, or moss growth are signs that the joints need to be renovated. Crumbling, sanding, and patchy areas must be removed and repointed. If the surface of the bricks is damaged, the entire wall surface can be impregnated to protect it from driving rain [2].

3



There are several renovation methods available for renovating a cracked plaster surface. The simplest renovation is paint renovation, which can only be used for small cracks caused by the plaster. Plaster renovation can be used for larger and deeper cracks. The cause of the cracks should be clarified and eliminated before renovation. The old plaster must be sufficiently stable. The cracks must be exposed and equipped with a separating layer and plaster base before the base coat is applied.
A reinforcement layer and a new top coat of plaster complete the plaster-based restoration [3].

A combination of plaster restoration and energy-efficient renovation is the installation of a composite thermal insulation system on the old plaster. The cause of the cracks and the load-bearing capacity of the old plaster must also be clarified before work begins. Further steps can be found in section 3.7.

7.2.3 Protection against ground moisture

It is advisable to consider the external moisture protection of components in contact with the ground at an early stage in the overall planning and execution of a building project and to coordinate this with all parties involved.

DIN 18533 "Waterproofing of building elements in contact with the ground" was reissued in July 2017. This standard contains three parts:

1. Part 1: Requirements, planning and execution principles, standardized waterproofing materials
2. Part 2: Waterproofing with membrane-type waterproofing materials
3. Part 3: Waterproofing with liquid-applied waterproofing materials

DIN 18533 applies to the planning, selection, and application of waterproofing for water-permeable building components in contact with the ground. If, for example, interior spaces are to be waterproofed, the DIN 18534 series of standards, also newly published in 2017, must be applied.

The specifications for the planning and execution of waterproofing for building components in contact with the ground from the DIN 18195 series of standards, which has since been withdrawn, have been fundamentally revised in some cases in the new series of standards. DIN 18195 now consists of only one standard part, which contains the basic terms for waterproofing buildings.

Based on the principles for the planning and execution of waterproofing for components in contact with the ground, the following procedure is recommended:

Step		Conte nts
1	>	Definition of the area of application (e.g., wall, floor slab, ceilings in contact with the ground, etc.)
2	>	Clarification of the expected water permeability of the soil, if necessary on the basis of a soil survey
3	>	Expected use of the space (requirements for indoor air quality) in accordance with the planning task and after consultation with the client
4	>	Type of water exposure (ground moisture, stagnant seepage water, pressurized water)
5	>	Determination of crack class
6	>	Select a suitable sealing material in accordance with Part 2 or 3.
7	>	Specifications for processing the sealing material

Example:

Ytong basement exterior wall, integration into the ground < 3 m, residential basement, building ground is not very water-permeable ($k < 10^{-4}$ m/s).

Step		Specification according to DIN 18533-1 to 3
1	>	Wall in contact with the ground, wall base
2	>	Slightly impermeable to water
3	>	Standard requirements according to Section 5.5 of DIN 18533-1 (recreation rooms)
4	>	Class: W1.1-E, ground moisture and non-pressurized water
5	>	Crack class R2-E, masonry subjected to earth pressure
6	>	e.g., bitumen and polymer bitumen membranes according to Table 19 of DIN 18533-2
7	>	Follow the processing instructions in Table 19 and the manufacturer's instructions

Appendix B of DIN 18533-1 contains further criteria for the selection of waterproofing types as planning principles.

In contrast to the previous DIN 18195, DIN 18533 contains a great deal of information that must be taken into account and incorporated into the planning process. As this information may change over time, every planner is well advised to document the manufacturer's specifications used in a legally compliant manner.



Insulation of a basement wall



Sealing a base

Good protection against ground moisture is a basic requirement for the successful implementation of thermal insulation measures. Whether for protection against rising damp in interior wall insulation, protection against moisture penetration in underground garage insulation, or the professional construction of a base for a composite thermal insulation system, adequate protection against ground moisture must be taken into account in all cases. When installing Multipor composite thermal insulation systems, waterproofing in accordance with DIN 18533 must generally be carried out before starting the insulation work.

Condensation and mold protection 7.2.4

Preventing condensation on interior building surfaces is one of the key requirements for avoiding mold. Moisture does not only penetrate buildings from the outside – for example, through driving rain – but is also present in the building materials and in the air, and, last but not least, moisture is also generated during the use of the building itself. Therefore, the following applies: Avoid damage caused by condensation within the structure through good planning and execution, and also permanently prevent mold growth as a result of increased moisture on the surfaces of building components.

Building moisture

Construction moisture only needs to be taken into account in the first one to two years after completion of construction, after which it has usually dried out completely. This means that it takes around two years for the wall materials to reach their equilibrium moisture content. Therefore, larger pieces of furniture should always be rear-ventilated and not placed directly against the exterior wall during the corresponding period after completion of construction. In addition, it is particularly beneficial in winter to adjust ventilation to the increased indoor humidity.

Condensation protection

DIN 4108 contains important requirements for condensation protection and, in Part 2, also regulates the corresponding minimum thermal insulation of building components: This ensures that there is no condensation or mold damage on room-side surfaces. Condensation occurs when the dew point of the room air is reached. The dew point is determined by the temperature and relative humidity as well as the surface temperature of the building component. In order to guarantee permanent mold prevention, the humidity on the surface of the building component must not exceed 80%. This corresponds to a surface temperature of at least 12.6 °C under standard climatic conditions (indoor temperature 20 °C, outdoor temperature -5 °C). The standard therefore specifies minimum thermal resistance values for the various components and also requires a minimum surface temperature (12.6 °C) to be maintained, especially in winter, even in the area of thermal bridges. The value required in this context is the temperature factor $f_{(R_{si})}$, which must not be less than 0.7.

7.2.4 Condensation and mold protection

The f_{Rsi} value is a measure to ensure the safety of a building structure with regard to mold growth. This is based on stationary boundary conditions.

The f_{Rsi} value describes the ratio of the temperature differences between the inner wall surface and the outside temperature to the difference between the inside and outside temperatures. Assuming an indoor temperature of 20 °C, a relative humidity of 50%, and an outdoor temperature of -5 °C, compliance with the value ≥ 0.7 ensures that the relative humidity on the inner wall surface remains < 80% and thus no mold can form.

Formula $f_{Rsi} = \frac{\theta_{si} - \theta_e}{\theta_i - \theta_e} \geq 0.7$

Based on the requirements of DIN 4108-3, wall constructions also require moisture protection certification in order to reduce condensation within the construction. However, this certification is not required if certain criteria regarding the thermal resistance of components and the hygric properties of building materials are met: For walls with interior insulation, for example, the thermal resistance of the insulation layer is limited to

$R \leq 1.0$ m²K/W (corresponds to an insulation thickness of approx. 4 to 5 cm). At the same time, it is important to comply with a value of $s_d \geq 0.5$ m with regard to the diffusion resistance of the inner layers (insulation + room-side finish).

The verification method specified in DIN 4108-3 can be used to verify condensation protection. The so-called Glaser method is a simplified calculation method that calculates heat conduction and vapor diffusion under steady-state boundary conditions. This makes it possible to determine whether and where condensation occurs within the structure under stationary winter conditions and how much condensation is produced. According to the standard, this should be limited to 1 kg/m² per year (0.5 kg/m² for moisture-sensitive substrate materials). At the same time, it must be demonstrated that the condensate that has formed in winter can evaporate completely in summer. Due to its simplified approach, the Glaser method neglects building physics properties such as heat absorption, heat emission, and heat storage, as well as moisture absorption, moisture emission, and moisture storage. Changing climatic conditions are also not taken into account. Modern interior insulation measures – for example, with the capillary-active and diffusion-open Multipor WI interior insulation system – cannot therefore be verified using the method described above. Due to the mathematical neglect of the capillary-active properties, verification according to Glaser is not possible.

However, the transport of liquid within the insulation material to the inside of the wall ensures that no condensation occurs within the structure. This has been proven by many years of damage-free practical experience in numerous projects. Numerical transient calculation methods are available for mathematical verification, which take into account the building physics properties described above. Two suitable software solutions are also available: WUFI(*) from IBP Holzkirchen and Delphin from IBK at TU Dresden. The use of hygrothermal component calculations is regulated by DIN EN 15026. Both programs meet the requirements of DIN EN 15026 for transient calculations. The calculation results for installed interior insulation correspond to practical experience (see also Chapter 7.2.5). This means that both programs can be used to verify capillary-active interior insulation systems in accordance with the standard.

Mold protection

Provided that the above-mentioned rules for condensation protection are observed, this represents the best possible prevention against mold growth. The Multipor WI interior insulation system consists exclusively of mineral components that do not provide a breeding ground for mold. Compliance with a sufficient interior surface temperature then ensures perfect mold protection and, at the same time, a pleasant indoor climate. Here, Multipor can absorb air humidity through its pores, transport it capillarily, and, as a diffusion-open building material, release it again. The result is dry component surfaces with high alkalinity that offer mold hardly any living conditions.

Put simply, if the construction on the inside of the wall remains dry – i.e., below the equilibrium moisture content u_{80} – it will also remain mold-free!

How interior insulation systems work 7.2.5

Interior insulation can significantly improve the energy efficiency of an existing property. An important prerequisite for interior insulation to work is adequate protection against driving rain on the exterior wall, as this reduces
regardless of the interior insulation system – the temperature of the existing wall there compared to the uninsulated initial situation. At the same time, the wall's ability to dry out into the room is significantly reduced.

The building physics properties, which are particularly evident in the relationship between temperature and vapor pressure or relative humidity, must be taken into account when installing interior insulation. The difference in vapor pressure is the driving force behind vapor diffusion, with water vapor moving from high to low vapor pressures. When there is a temperature difference, the vapor diffuses from the higher to the lower temperature, even if the relative humidity is the same on both sides, because the warm air contains more moisture in absolute terms than the cold air. In interior insulation, the layer with the greatest temperature difference (the thermal insulation) is on the inside of the wall, so that water vapor diffusion into the wall occurs, especially in winter. Therefore, when planning an interior insulation system, it must be determined whether the unavoidable diffusion flow is either prevented or allowed and absorbed.

Types of interior insulation

There are basically two options for installing interior insulation:

1. Diffusion-retarding systems, such as mineral wool with a vapor barrier foil or virtually diffusion-tight plastic foams. These interior insulation systems prevent the heat flow between the inside and outside from being associated with a high vapor diffusion flow. The air can cool down slowly and is effectively dry (depending on the diffusion resistance of the inner layer used).
2. Diffusion-open, so-called capillary-active interior insulation systems. Here, the interior air is not "dried" when heat flows from the inside to the outside (in principle, of course, heat can also flow from the outside to the inside [summer], but this can be neglected for typical buildings in Germany). Since this type of interior insulation can cause condensation to form within the insulation and/or in the following layers, this insulation "relies" on the fact that this does not cause any problems. And this condensation can a l w a y s be avoided if water does not accumulate inside the insulation because it can be transported, i.e., distributed, within the structure.

Fig. 1: Principle of how diffusion-retardant interior insulation works

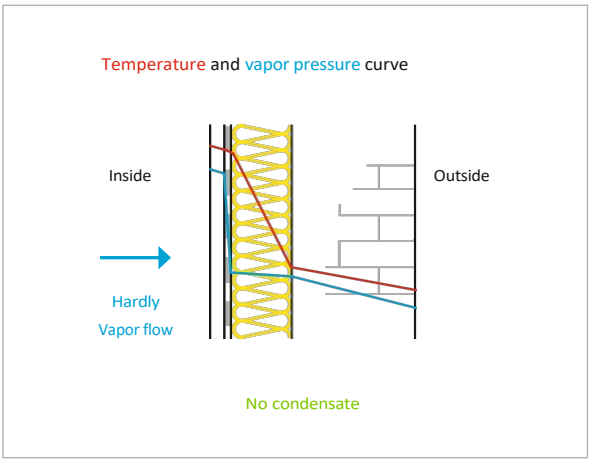
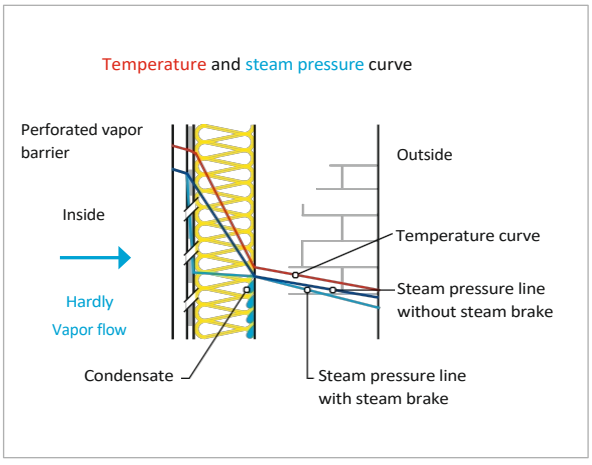


Fig. 2: Diffusion-retardant interior insulation with perforation



7.2.5 How interior insulation systems work

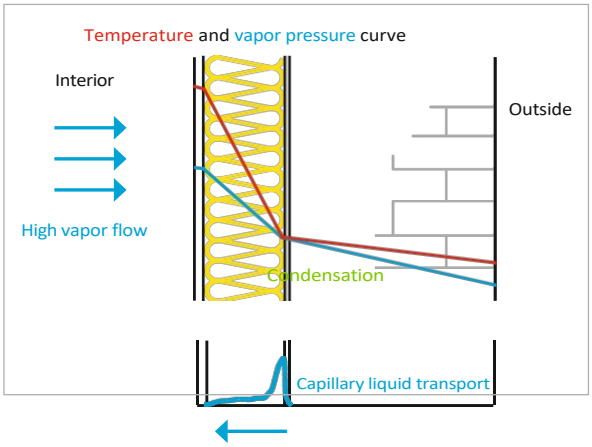
Both variants are briefly presented below with regard to their mechanisms of action.

Diffusion-retarding interior insulation

The principle of diffusion-retarding interior insulation is shown in Figure 1. It shows a masonry wall to which interior insulation, for example mineral wool, has been applied. In order to prevent vapor diffusion into the insulation, such a system must be fitted with a vapor barrier foil on the inside of the room. The room-side finish is usually a layer made of building boards (e.g., gypsum fiber boards), which also protects the membrane from mechanical damage. It is clear that this type of insulation can only work if the water vapor is actually "slowed down." If

there are defects in the installation,

Fig. 3: Principle of how diffusion-open interior insulation works



This situation is comparable to pulling the plug in a bathtub. Due to the pressure difference, large amounts of water vapor enter the structure, condense, and can only dry out to the outside—a rather rare drying direction under winter conditions.

Figure 1 clearly shows that the diffusion resistance of the vapor barrier foil must be sufficiently high to prevent condensation from forming on the cold side of the insulation, which could potentially damage both the existing structure and the insulation material and its insulating effect. In addition, such a system requires great care during installation to avoid "plug drying," especially at foil joints, connections (windows, floors, ceilings), and penetrations (pipes, sockets, etc.).

It should also be remembered that installing foil on the inside of the room means that the adjacent components no longer buffer moisture loads in the rooms. This inevitably leads to longer ventilation times (when ventilating through windows) and/or higher relative humidity in the room if ventilation systems do not allow for humidity-dependent ventilation rates.

Danger of diffusion-retarding interior insulation

Figure 2 clearly shows the risk of diffusion-retarding interior insulation. A damaged vapor barrier—e.g., due to a drill, a retrofitted electrical outlet, or poor workmanship—negates the vapor-retarding effect at that point and also changes the course of the vapor pressure line across the cross-section. Moisture in the form of water vapor is introduced into the structure, which can lead to condensation at the transition between, for example, insulation and wall.

Diffusion-open, capillary-active interior insulation

The principle of diffusion-open, capillary-active interior insulation is shown in Figure 3. An interior insulation system consisting of capillary-active insulation boards (e.g., Multipor) and an adhesive mortar for fixing to the existing structure is applied to an existing or newly constructed masonry wall. The inner wall finish is usually a thin plaster or filler. However, it is also possible to add gypsum fiberboard on the room side (e.g., to accommodate wall tiles).

While diffusion-retarding interior insulation uses either a system (fiber insulation and vapor barrier foil) or a single building material (plastic foam) to provide thermal insulation and diffusion resistance, capillary-active interior insulation always functions as a building material system. This consists of the diffusion-open, capillary-active insulation material and the associated adhesive mortar. Compared to the insulation material, the adhesive mortar must have higher thermal conductivity, greater diffusion resistance, and lower liquid water conductivity.

The reason for this combination of properties is the principle of capillary-active interior insulation. In winter, as explained above, a clear temperature profile develops above the insulation layer. This causes a vapor diffusion flow into the structure. As a result, the relative humidity increases and, in theory, more moisture accumulates within the insulation. The dew point is not reached at all for most capillary-active insulation materials because the moisture accumulates beforehand due to the sorptive material properties, forming a thin film of liquid water on the inner material surfaces. As the water content increases, this film of water enables liquid transport. If condensation does occur within the insulation, the properties of the material enable transport away from this area to dry areas. However, as mentioned above, this is more theory than practice, as condensation does not occur in the first place because the air is already "dehumidified" on its way through the material. Furthermore, as the moisture content increases, so does the resistance to diffusion flow in the material.

How can the phenomena described be incorporated into the planning of interior insulation? Is this even possible, and what tools are available for this purpose?

Calculated verification by Glaser, COND, Delphin, WUFI®

In order to comply with the normative requirements, a mathematical verification is usually required if the requirements for verification-free constructions are not met. The oldest method, which is still used in some cases today, is verification according to the Glaser method.

The Glaser method, standardized in DIN 4108-3, is first and foremost a simplified calculation method based on a very simple model, which can be used to assess most applications with sufficient certainty. This model assumes that for a precisely defined period of time (e.g., 90 days) – the so-called dew period – heat and vapor flow through the construction to the outside under constant boundary conditions. The vapor flow is slowed down by the material-related diffusion resistance, similar to the heat flow, which is slowed down by the thermal resistance
. During this time, the adjacent air has a constant relative humidity (inside and outside). The current edition of DIN 4108-3 is authoritative.

The heat and vapor diffusion flow existing under the specified boundary conditions can lead to condensation inside the structure
. The amount of water is limited. Furthermore, it is specified that in the second period, the so-called evaporation period, the water dries up by evaporating away from the condensation level in both directions via a vapor flow. If water remains despite the vapor flow, the construction cannot function permanently because water is added again in each new dew period until the construction overflows – or becomes damp. In summary, the Glaser method is a model that only considers heat conduction and vapor diffusion and only stationary, i.e., temporally constant climatic boundary conditions. Heat and moisture storage within the material are neglected, as are liquid or capillary transport. The Glaser method model is therefore crude and clearly on the safe side when it comes to assessing interior insulation systems. Only thin insulation materials that reduce the temperature only moderately can be verified using this method. However, the model fails because of the type of insulation, not the type of insulation because of the model. Other, more realistic methods must therefore be used. In principle, the standard itself already indicates that other methods (simulation) can be used whenever the conditions deviate from those in the standard.

The COND calculation method (IBK Dresden) offers a good opportunity to interact between the Glaser method and the simulation methods – in principle a similar approach to the Glaser method, except that the transport of the condensate is not left to the diffusion flow alone. The capillary activity of the building material is already taken into account, but the boundary conditions remain stationary. Dew and evaporation periods alternate after a set time, with the temperature and relative humidity remaining constant during this period. The capillary conduction approach reduces the drying times for the construction, in some cases significantly. Those who are more familiar with the Glaser method as an analytical approach than with simulation will find COND a suitable means of approximating reality. Table 1 shows an example of an internally insulated construction with Multipor WI internal insulation – calculated with COND. Figure 4 documents the areas with the calculated condensation. The calculation results according to COND and Glaser can be seen in Figure 5. The results show that the quasi-stationary approach according to COND reduced the drying time by approximately 50 days. Condensate can be found at the boundary between the interior insulation and the adhesive, in the adhesive itself, in the old interior plaster, and in the masonry.

7.2.5 How interior insulation systems work

Table 1: Calculation of a Multipor interior insulation WI using the COND program (excerpt)

Material	d [mm]	ρ [kg/m³]	λ [W/mk]	μ [–]	w_{80} [m³/m³]	w_{sat} [m³/m³]	A_w [kg/(m² h$^{0.5}$)]
Multipor lightweight mortar	8.0	770	0.1800	10	0.0522	0.6900	0.1860
Multipor WI	120.0	90	0.0420	2.0	0.0053	0.9630	0.3600
Multipor lightweight mortar	5	770	0.1800	10	0.0522	0.6900	0.1860
Cement plaster (interior)	25.0	1,900	0.9100	25	0.0250	0.2420	1.1400
Old building bricks (cluster 4)	365.0	1,710	0.8000	8.3	0.0048	0.3300	16.6800

d = layer thickness, λ = calculated value of thermal conductivity, μ = vapor diffusion resistance factor, w_{80}/w_{sat}= moisture content at 80% relative humidity or saturation, A_w= water absorption coefficient, layers from left to right

can be seen, but COND already assumes water transport, which limits the amount of condensate to some extent and, in particular, accelerates drying.

However, the design is not yet fully verified if the standard's requirements for limiting moisture content and complete re-drying are to be met. Nevertheless, this method shows the person conducting the verification a way to achieve verification. If verification with COND fails, this is mainly due to the fact that COND uses the water absorption value A ($_{w}$) to describe the transport processes within the material. This approach is a simplification and may significantly overestimate this one material property. The behavior of a material at free water saturation does not usually document the behavior inside a material when condensate is to be transferred. In this case, drying tests, for example, are more suitable for determining this property. The planner is therefore well advised not to rely solely on this one material property.

In summary, the COND calculation approach provides a good bridge to the simulation program. COND indicates possible areas with higher condensate and provides an initial realistic overview of the drying times to be expected in a stationary climate. The actual moisture accumulation or the actual expected distribution of the condensate is not represented by COND. Furthermore, 2D designs cannot be calculated with the program; the section planes are set system boundaries or material, moisture, and heat transport.

Numerical simulation offers a more realistic approach to verification. However, it is also the verification method that requires the greatest input and at least solid initial experience on the part of the planner in order to evaluate the results due to the lack of clear boundaries. Moreover, at first glance, the results in most programs are not very conclusive. Is what you see good or bad? There are no clear limits as in the Glaser method, and there is no indication of usability. Nevertheless, there is no alternative to verification by means of numerical simulation when it comes to the question of using capillary-active interior insulation. The Multipor mineral insulation board WI is such a capillary-active insulation material.

The selection of numerical simulation programs is manageable. The reason for this is that the material data required for a simulation necessitates numerous preliminary laboratory tests.

In Germany, the programs Delphin (IBK Dresden) and WUFI® (Fraunhofer Institute for Building Technology) are mainly used today. Both programs have applications for 1D and 2D use. Due to its simplicity, the WUFI® program is certainly very popular with architects and planners. The Delphin program, on the other hand, impresses with its variety of possible applications. With regard to interior insulation systems, both programs can be used to make reliable predictions about the moisture behavior of a structure. However, this requires that the material properties have been determined in accordance with the relevant specifications. Under certain circumstances, the two programs may also produce different results because their material models and calculation approaches do not completely match. However, it is unlikely that the suitability of a structure can be determined using only one program. As a rule, it is unnecessary to switch programs in order to calculate a "healthy" structure. Figure 6 shows an evaluation graph for a beam head connection created using the Delphin program. It shows the relative humidity at the marked points. Similar graphs can also be created with the WUFI(®)program, but the frequently used 1D version does not have the same

functionality as a 2D program, which limits the evaluation options. In any case, it is up to the person responsible for verification to decide when and where a program can be used effectively.
Multipor technical advisors are available to help planners evaluate calculation results correctly.
You can find your local contact in the contact section of the website at www.multipor.de.

Practice and reality

If the frequency of complaints about interior insulation systems using Multipor mineral insulation boards WI is taken as a benchmark, the calculated forecasts are really reliable. Even under more complicated conditions (e.g., a pool in the basement), Multipor interior insulation WI
works perfectly in practice. Only rarely are interior insulation systems thoroughly examined after a period of time and compared with expected values, and then only for scientific purposes. Multipor has been monitoring various construction projects for years in order to use diagnostic and measurement techniques to determine whether the simulation also reflects reality. This was the case, for example, with a construction project in Finsterwalde.
This construction project was insulated internally in 1998 with Multipor mineral insulation boards WI. Insulation boards with a thickness of 50 mm to 80 mm in some cases were used. Figures 1 to 3 show the property before and during the renovation.

In 2013, the property was re-examined. It was found that the interior insulation had retained its full functionality over the last 15 years. The Multipor WI interior insulation was completely intact, showed no damage, and had retained its full adhesion to the substrate. The Multipor mineral insulation boards WI had dried down to an expected equilibrium level.

Fig. 4: Results of the calculation with condensate in three levels

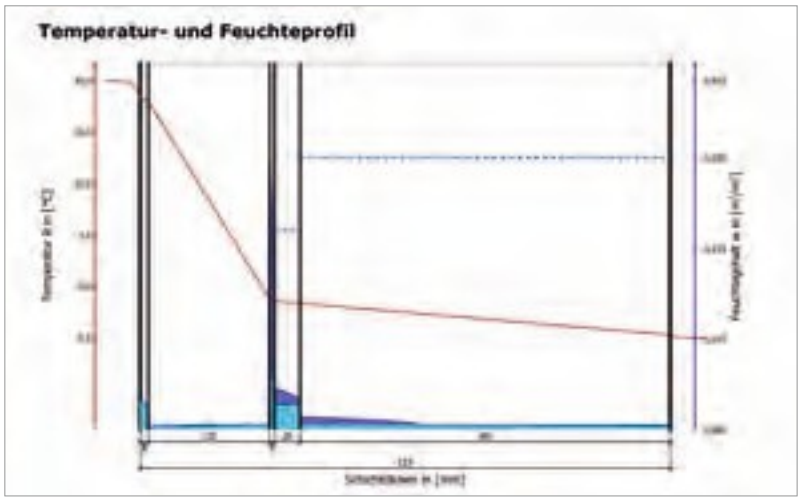
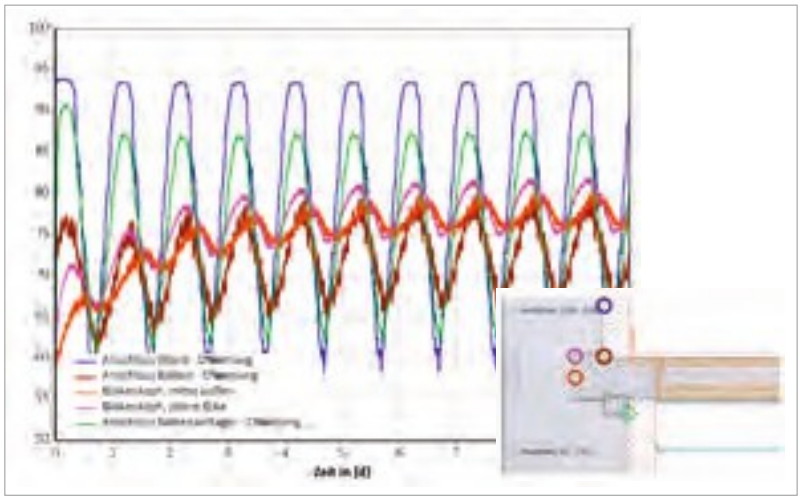


Fig. 5: Summary of results according to Glaser and COND



Fig. 6: Graph after calculation of a beam connection with Delphin



7.2.5 How interior insulation systems work



Exterior view of the renovation project in Finsterwalde, Friedensstraße



Substrate before renovation



Interior insulation in the lintel area

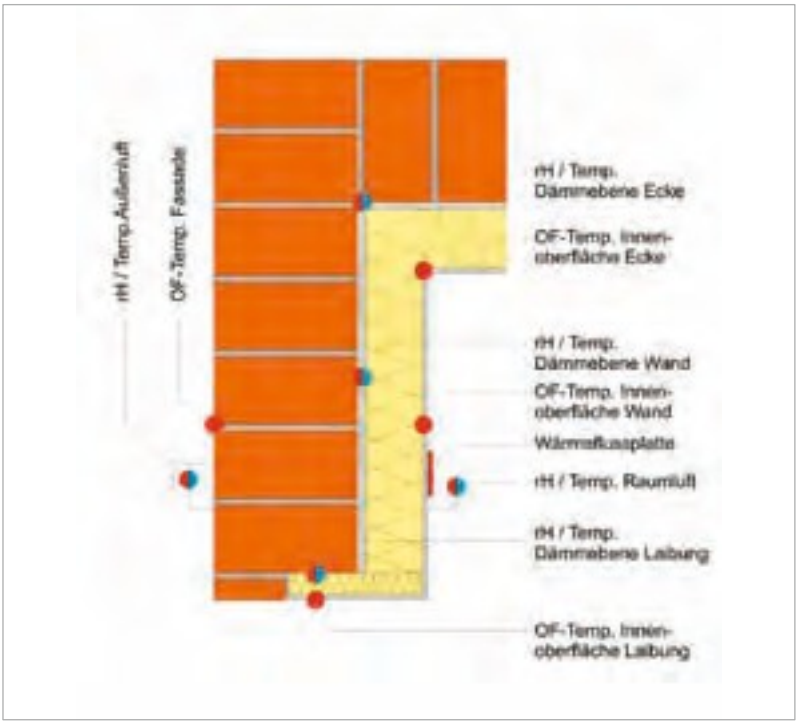
In addition to the measurements taken on the property, extensive material tests were carried out on the insulation boards used at Xella Technology and Research. The results showed that the material properties of the insulation board had not changed in terms of aging. The compressive strength and thermal conductivity guaranteed 15 years ago have remained virtually unchanged. Despite the system-related absorption, storage, and release of water within the insulation, no damage has been observed. The tensile strength, which is decisive for the mechanical stability of the system used, also remained unchanged.

Materials rarely remain at the same technological level after 15 years. The development of the Multipor WI mineral insulation board from an initial foam-based formula has also continued in the meantime. Insulation thicknesses of only 5 cm have become less common today due to energy requirements. It is therefore in our interest to continue to monitor projects over longer periods of time, as we have done at Güterfelde Castle near Potsdam (Fig. 4).

Numerous sensors (temperature, humidity, and heat flow meters) will provide information over the next few years on how the interior insulation used here actually performs (Fig. 7).

In this project, too, the initial results show good agreement with the results of the simulation calculation. The relative humidity and temperatures correspond to expectations, taking into account the recorded climate. Figure 8 shows the measurement record in a soffit area of the building. The temperature at the level of the adhesive is within the predicted range (even in winter) and shows relative humidity levels that do not indicate condensation at this location.

Fig. 7: Measurement points for long-term measurements in the reveal area – Güterfelde Castle

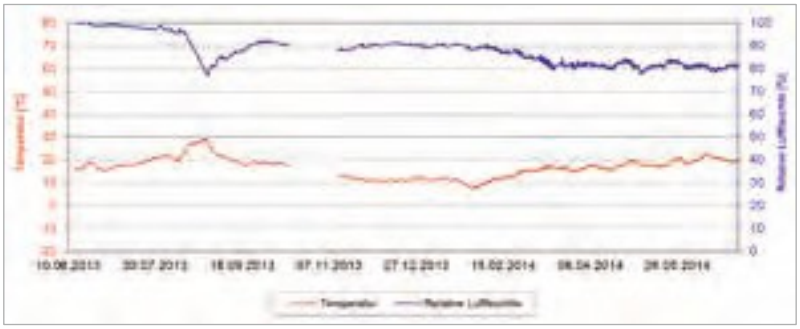


4



Güterfelde Castle

Fig. 8: Temperature and relative humidity at a measuring point in the window reveal



Object-related mathematical verifications

Multipor is happy to provide specialist planners with all the values and information required to carry out a professional transient hygrothermal simulation. This applies to all components that play a significant role in the functioning of the system structure and are supplied by Multipor. The relevant information is available in the download area at www.multipor.de. For members of the Fachverband Wärmedämm-Verbundsysteme e . V. (Professional Association for Thermal Insulation Composite Systems), the values are provided in accordance with the requirements of the "Technical Guideline for the Internal Insulation of Exterior Walls with Internal Insulation Systems." This enables you to use the verification programs

- WUFI® from IBP Holzkirchen (www.wufi.de) and
- Delphin from IBK at TU Dresden (www.bauklimatik-dresden.de/delphin/) to successfully

verify the capillary-active Multipor WI interior insulation systems.

For moisture protection verification of an interior insulation system, apply the hygrothermal simulation in accordance with DIN EN 15026 and observe WTA information sheets 6-1 and 6-2, as they take additional factors influencing the overall construction into account:

- Location-specific climatic conditions and driving rain
- Building moisture
- Heat and moisture storage of the construction
- Liquid water/capillary transport

Successful in terms of verification means: The amount of moisture produced is limited so that accumulated moisture can dry out again. This prevents the construction from "building up" in terms of overall moisture content over the years and the interior insulation from losing its positive properties. In addition, the moisture behavior of adjacent components (e.g., integrated wooden beam ceilings) can be included in the verification process, which creates planning reliability for wall construction and sensitive construction details.

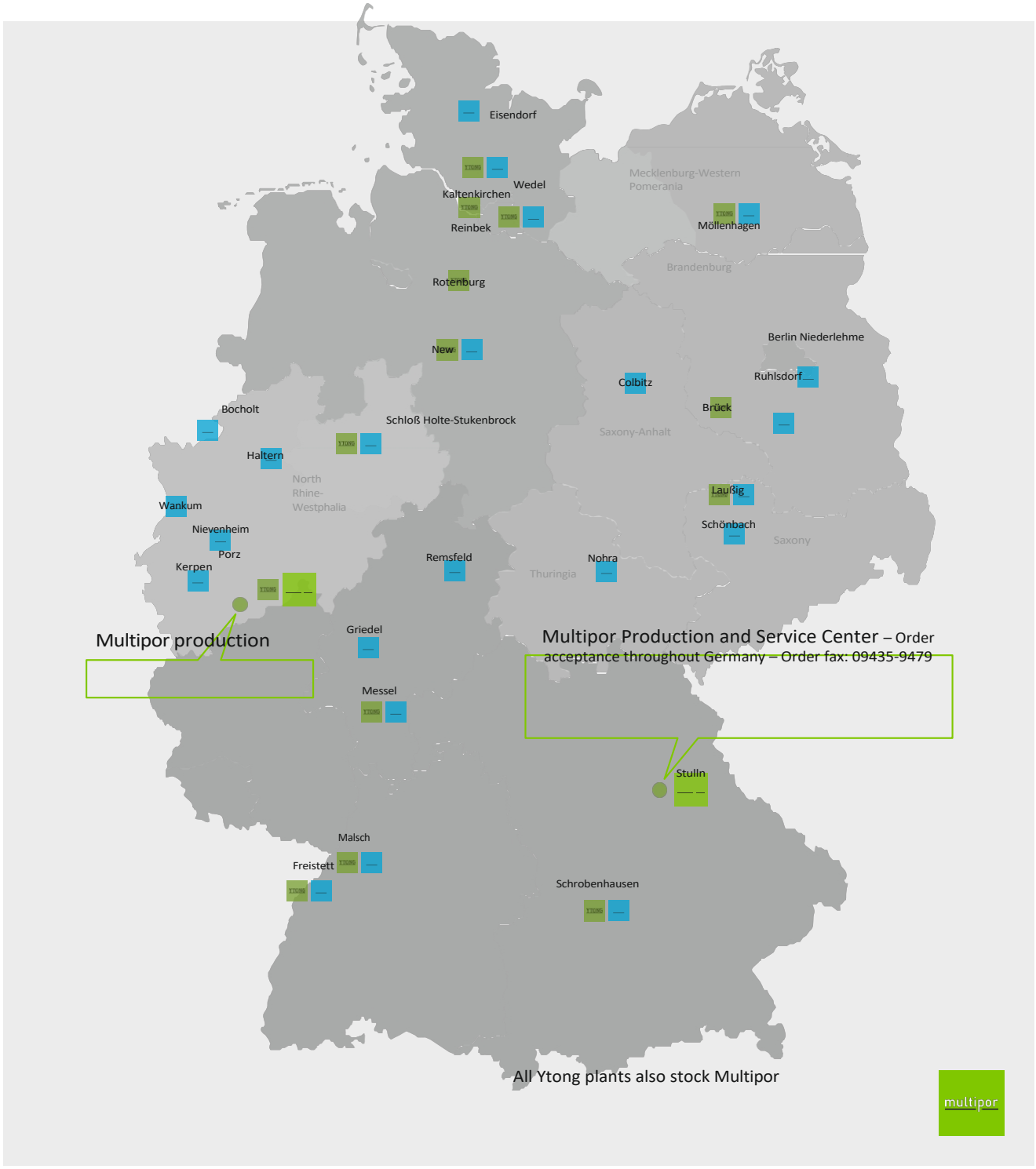
Multipor also offers its customers further moisture-related verifications with transient verification programs for different constructions and structures. This is based on experience gained from many thousands of project-related calculations and evaluations, which enable successful and practical implementation in construction. In addition, a checklist with boundary conditions is available in the download area at www.multipor.de, and Multipor's technical advisors will of course be happy to help you choose the right interior insulation system.

Contact and locations

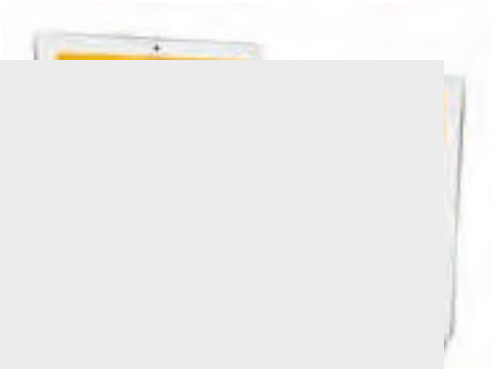
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Multipor Service Center
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Your detailed keyword search – in the online insulation book!

www.multipor.de/daemmbuch

The Multipor insulation book with all the information about our mineral insulation systems is also available online. An optimized search function for all relevant content, such as our construction details, as well as the integration of interactive content make the website an online compendium of knowledge about insulation with Multipor.

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DIN 1055	Effects on structures
DIN 4074	Classification of wood according to load-bearing capacity
DIN 4095	Building ground; drainage for the protection of structures; planning, design, and execution. DIN 4102 Fire behavior of building materials and components
DIN 4108	Thermal insulation and energy saving in buildings
DIN	Thermal insulation and energy economy in buildings – Part 10: Application-related requirements for thermal insulation materials – Factory-made thermal insulation materials
DIN 4109	Sound insulation in building construction; requirements and verification
DIN	Building ground – Examination of soil samples; Determination of the water permeability coefficient. DIN Waterproofing of buildings – Terms
DIN	Tolerances in building construction – Structures
DIN	Structural fire protection for large roofs
DIN	VOB German Construction Contract Procedures – Part C: General Technical Contract Conditions for Construction Work (ATV) – Composite thermal insulation systems
DIN	VOB German Construction Contract Procedures – Part C: General Technical Contract Conditions for Construction Work (ATV) – Plastering and Stucco Work
DIN	VOB German Construction Contract Procedures – Part C: General Technical Contract Conditions for Construction Work (ATV) – Painting and Varnishing Work – Coatings
DIN 18516	Exterior wall cladding, rear-ventilated
DIN	Waterproofing of roofs, balconies, loggias, and pergolas. DIN 18533 Waterproofing for building components in contact with the ground
DIN 18558	Synthetic resin plasters; terms, requirements, execution
DIN 18947	Clay plaster mortar – requirements, testing, and labeling
DIN	Application and processing of external thermal insulation composite systems (ETICS) with insulation materials made of expanded polystyrene hard foam (EPS) or mineral wool (MW)
DIN EN 1052	Test methods for masonry
DIN EN 1062	Coating materials – Coating materials and coating systems for mineral substrates and concrete in exterior areas
DIN EN 12087	Thermal insulation products for buildings – Determination of water absorption during long-term immersion. DIN EN 13501 Classification of construction products and construction types according to their fire behavior
DIN EN 13561	Awnings – Performance and safety requirements
DIN EN 13707	Waterproofing membranes – Bituminous membranes with reinforcing fabric for roof waterproofing – Definitions and characteristics
DIN EN 13914 and DIN	Planning, preparation, and execution of exterior and interior plastering
DIN EN 15026	Thermal and moisture behavior of building components and elements – Evaluation of moisture transfer by numerical simulation
DIN EN 1609	Thermal insulation products for buildings – Determination of water absorption during short-term partial immersion. DIN EN 1991-1 Eurocode 1: Actions on structures
DIN EN 1991-1-4	Eurocode 1: Actions on structures – Part 1-4: General actions – Wind loads
DIN EN 1991-1-4, NA	National Annex – Nationally determined parameters – Eurocode 1: Actions on structures – Part 1-4: General actions – Wind loads
DIN EN 998-1	Specifications for mortar in masonry construction – Part 1: Plaster mortar
DIN EN ISO 10211	Thermal bridges in building construction – Heat flows and surface temperatures – Detailed calculations
DIN EN ISO 10456	Building materials and products – Thermal and moisture properties – Tabulated design values and methods for determining nominal and design values for thermal insulation
DIN EN ISO 6946	Building components – Thermal resistance and thermal transmittance – Calculation methods DIN EN ISO 717 Acoustics – Evaluation of sound insulation in buildings and building elements
DIN EN ISO 7730	Ergonomics of the thermal environment – Analytical determination and interpretation of thermal comfort by calculation of the PMV and PPD indices and criteria for local thermal comfort
DIN V 18599	Energy performance of buildings – Calculation of useful, final, and primary energy demand for heating, cooling, ventilation, domestic hot water, and lighting
DIN V 4701-10	Energy performance of heating and ventilation systems – Part 10: Heating, domestic hot water heating, ventilation

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