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Fundamentals

Today, an immense variety of natural stones from across the globe (well over 6,000 different types) are specified for construction projects throughout Germany. Modern cutting and processing techniques have facilitated production of high-precision natural stone units in practically all sizes and thicknesses, and these products are now available at affordable prices.

The manufacturing techniques employed in the past (splitting and frame sawing) resulted in thickness tolerances which, by and large, could only be offset by the use of thick-bed laying methods. The now widespread calibrated natural stone tiles (precision cut with uniform thickness) readily permit the application of thin-bed techniques.

The mineralogical composition of natural stone lends the material its characteristic properties (colour, texture, compressive strength, bending strength etc.). In some situations, however, it may increase the material's sensitivity, thereby imposing higher demands on the tile-fixing products and associated workmanship.



Stone blocks are cut up into required shapes and sizes.



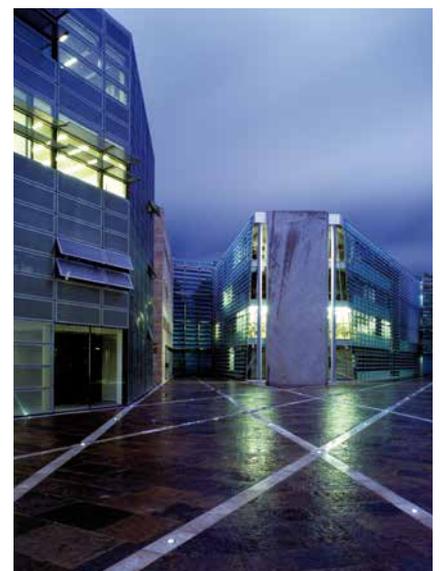
Units cut to required project-specific sizes.



Good-practice guide and reference book for natural stone laying.



Natural stone finish indoors.



Natural stone finish outdoors.

Fundamentals

The sensitivity of natural stone varies according to its mineralogical composition. Moisture (dampness in mortar), liquids, acids and alkalis may bring about significant changes in the material. In other words, any contact between minerals and the above-mentioned substances can trigger a chemical process, which may, for instance, lead to discoloration of the stone.

This makes it all the more vital to eliminate, during the installation process, any risk factors that may bring about such changes.



Scanning electron microscope (SEM) image of a natural stone tile: as the large fissures suggest, some natural stones exhibit a high water absorption capacity.



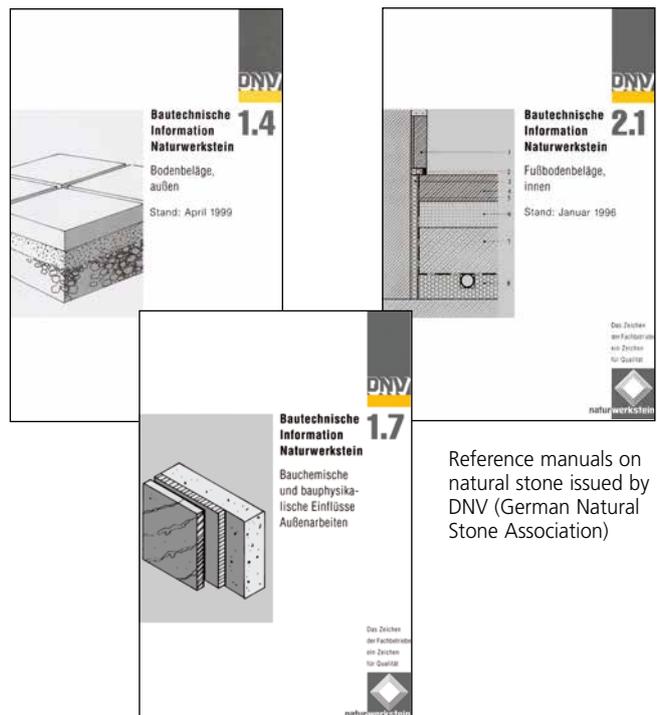
Discoloration of outdoor natural stone caused by moisture migration via joint and surface.

For this reason, natural stone adhesives should always be fast-setting (with crystalline water binding properties), contain trass and, for certain stone types (light-coloured, translucent materials), be based on white Portland cement.

Moisture ingress (e.g. from rain or wash water), once the covering is installed and in use, also plays a major role with regard to visual flaws in the stone. Depending on the open-pored texture of the stone, its surface may darken to a great or lesser extent. These dark patches will normally disappear if the stone is allowed to dry.



Yellowing of natural stone caused by presence of pyrites, which the high moisture capacity of thick-bed adhesive causes to change colour.



Reference manuals on natural stone issued by DNV (German Natural Stone Association)

Fundamentals

Tile thicknesses

Tile thicknesses are specified in function of loading, stone strength, unit size, laying method and substrate. Outdoor installation also necessitates a consideration of weather action, which should likewise have an influence on the specified tile thickness.

Natural stone tiles with up to 40 cm edge length are required to be at least 7 mm, natural stone slips at least 10 mm thick. Solnhofen stone floor tiles, for example, are required to be 10 mm thick for edge lengths up to 35 cm and 15 mm thick for edge lengths exceeding 35 cm.

Depending on the projected loads – in particular, dynamic loads as opposed to static point loads – a special DNV (German Natural Stone Association) dimensioning procedure is applied to determine the required tile thicknesses. As practical experience shows, it is advisable to take the precaution of specifying somewhat greater tile thicknesses than the minimum stated values, particularly for floor coverings, to accommodate unforeseen live loads and microstructural variations in the stone.

Approximate compressive and flexural tensile strengths of natural stone

| Stone groups | 1993 Compressive strengths of dry stone to DIN 52105 N/mm ² | 1993 Flexural tensile strengths of dry stone to DIN 52112 N/mm ² |
|---|---|--|
| A. Igneous rock | | |
| 1. Granite, syenite | 90–270 | 5–22 |
| 2. Diorite, gabbro | 120–300 | 10–20** |
| 3. Quartz porphyry, keratophyre, porphyrite, andesite | 120–300 | 7–20 |
| 4. Basalt, melaphyre, basaltic lava | 250–400* 80–250 | 13–25 |
| 5. Diabase | 180–250* | 15–25** |
| B. Sedimentary rock | | |
| 6. Siliceous rock | | |
| a) Vein quartz, quartzite, greywacke | 150–300* | 11–25 |
| b) Quartzitic sandstones | 120–200* | |
| c) Other quartz sandstones | 20–180 | 1–15 |
| 7. Limestones | | 12–20** |
| a) Compact (solid) limestones and dolomites (incl. marbles) | 75–240 | 3–21 |
| b) Other limestones including limestone conglomerates | 20–160 | 2–15 |
| c) Travertine | 20–100 | 2–13 |
| 8. Volcanic tuffs | 20–30* | 0.5–6 |
| C. Metamorphic rock | | |
| 9. a) Gneisses, granulite | 100–280 | 5–25 |
| b) Amphibolite | 170–280* | |
| c) Serpentine | 140–250* | |
| d) Roofing slate | | 40–80 |

* Compressive strength values dating from 1993 to DIN 52 105

** Flexural tensile strength values dating from 1993 to DIN 52 105

Fundamentals

As hinted above, the market for natural stone is bewilderingly large and offers a wealth of different materials.

To maximize the output from quarries, individual natural stone units may be "resinated", i.e. their surface is treated with reaction resins. This produces a continuous, sealed, stable and sometimes vividly coloured finish. Yet, as a result,

the surface is virtually watertight – which may, in turn, lead to discoloration or edge staining during laying or grouting.

With some units, the rear face is also resin-stabilized. This means that the bedding adhesive has no genuine contact with the stone itself, only with a smooth reaction resin coat.



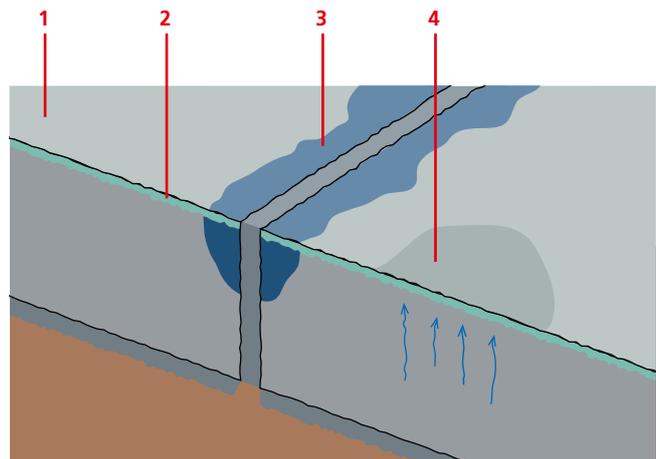
Surfaces treated with resin to repair cracks etc.



Units with resin-treated surface.



Rear face of unit treated with resin and scrim.



During grouting, water accumulates at side faces and cannot diffuse upwardly.

Note:

The installation of natural stone units treated with resin necessitates the use of rapid-set products with crystalline water binding properties.

- 1** Natural stone unit
- 2** Resin coat
- 3** Moisture accumulation due to grouting process
- 4** Staining induced by moisture migrating from substrate

Thin- and medium-bed laying

| Advantages | Disadvantages |
|---|---|
| <ul style="list-style-type: none"> • Low risk of discoloration • Suitable for large areas • Short drying times and downtimes • Only short period prior to joint grouting • Medium bed able to accommodate thickness variations | <ul style="list-style-type: none"> • Two operations required (1 screed/2 laying) • Only calibrated tiles/units suitable or only low dimensional tolerances permissible in covering thickness • Larger substrate irregularities need to be levelled out |

Thick-bed laying

| Advantages | Disadvantages |
|---|--|
| <ul style="list-style-type: none"> • Able to accommodate tile products with large thickness variations • Only one contractor required | <ul style="list-style-type: none"> • Only suitable for small to medium-sized areas • High risk of discoloration • Long waiting time prior to joint grouting due to drying • Only suitable for low live loads when applied to insulation* • No clearly defined compressive and flexural tensile strengths in relation to live loads • Unsuitable in conjunction with calcium sulphate screeds |

Substrate moisture content for thin-, medium- and thick-bed laying based on CM method

| Flooring | Moisture content of cement screed | Moisture content of calcium sulphate screed |
|--|--------------------------------------|--|
| <ul style="list-style-type: none"> • Ceramic and stone coverings in thin/medium bed | 2.0–2.5% CM heated/unheated | 0.5% CM** unheated 0.3% CM, heated |
| <ul style="list-style-type: none"> • Ceramic and stone coverings in thick bed | 3.0% CM, unheated 2.0% CM, heated | Should be avoided*** Should be avoided*** |

Note:

For pervious construction, see Section 6.4

* Structural calculations required to determine screed thickness for heavy-duty coverings (live loads exceeding 1.5 kN/m² and wheel loads). Bedding (thick-bed) adhesives for natural stone tiles are not permissible as a substitute for the screed required under DIN 18560 as load-spreading layer (DNV 2.1, 5.1).

** ZDB (Federation of the German Construction Industry) data sheet "Ceramic tiling, natural and cast stone coverings to calcium sulphate screeds" and Section 7 "Screeds and floor constructions" should be observed.

*** Only possible in conjunction with damp-proofing primer (e.g. Sopro EPG 522 epoxy primer).

Fundamentals

Alongside the traditional thick-bed method, the thin-bed techniques (**DIN 18157***) commonly adopted for ceramic coverings are also being increasingly applied for natural stone finishes.



Installation of natural stone slips on wall using buttering/floating method.

This has the advantage of allowing earlier loading and use of the surfaces. Indeed, given the "dry construction" practices that are widespread today, this is often the only option for the reliable installation of natural stone (see, for example, Section 9 "Tiling in metalwork and shipbuilding").

An **adhesive thickness of approx. 1–5 mm is adopted for the thin-bed method.**

Natural stone is far more susceptible to changes in appearance than ceramic finishes. With natural stone coverings, particular care is required in specifying the correct tile adhesives and grouts so as to eliminate the risk of discoloration, light/dark patchiness (sometimes caused by the laying operation) and deformation.

* with mortars tested to DIN EN 12004



Test with grey and white adhesive. Even white adhesives can induce discoloration if they are not rapid-setting.

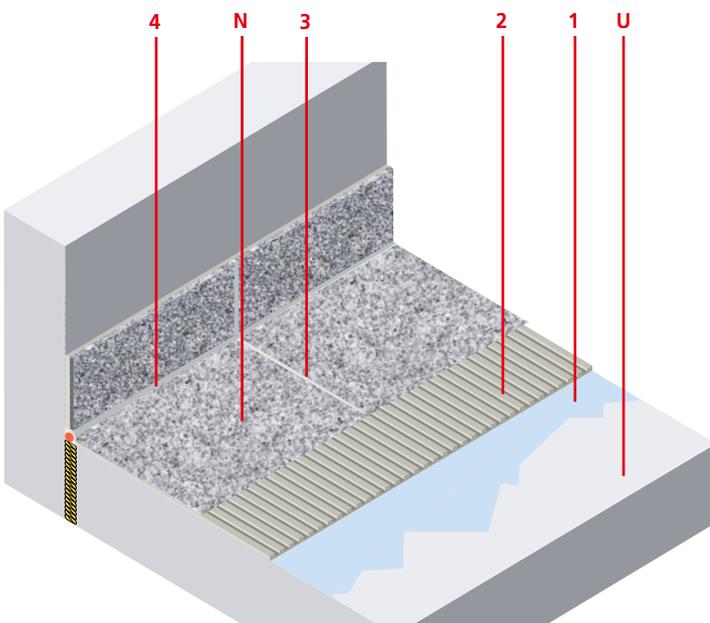
The setting speed of cementitious adhesives is crucial in determining the later appearance of the covering. White cementitious thin-bed adhesives are a popular choice for laying natural stone. If these are normal-setting, however, then they are equally likely to affect the visual impact of the finish – as the above-pictured test demonstrates.

There is an enormous variety of natural stone types. To cater for these, Sopro's Technical Service department offers a range of different laying solutions.

Please contact the team on the following number:



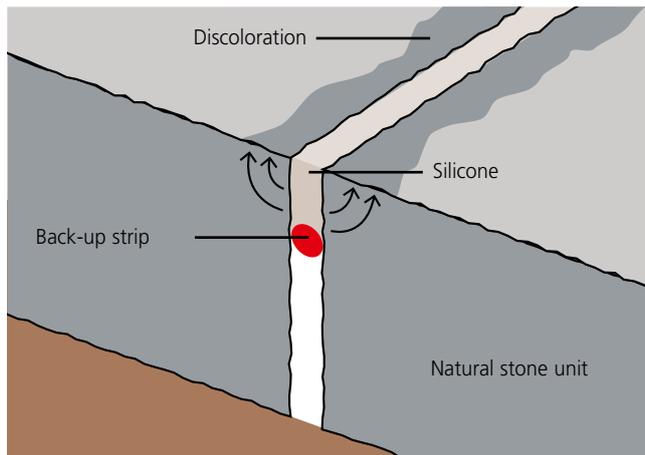
- 1** Sopro GD 749 primer
- 2** Thin-bed adhesive:
Discoloration-sensitive natural stone:
Sopro M&M 446 flexible marble and mosaic adhesive (for walls and floors)
- 3** Grout: Sopro DF 10 flexible designer tile grout
- 4** Elastic joint sealant: Sopro Marble Silicone
- N** Natural stone covering
- U** Concrete/cement screed substrate



Thin-bed laying

Movement joints

Regardless of laying method (thin-, medium- or thick-bed), natural stone coverings, like other finishes, require provision for movement joints. These must not be sealed with standard ceramic or sanitary silicone products. To prevent edge staining of the stone units, a special-purpose, neutral-curing silicone sealant (Sopro Marble Silicone) should be used.



Unsuitable (e.g. acidic-curing) silicone product results in tile edge staining due to plasticizer migration.



Most incidences of edge staining are irreversible and typically necessitate removal of damaged units.

Thin-bed laying

System composition



Product recommendation



Sopro GD 749



Sopro M&M 446
White, rapid-set, flexible tile adhesive, for walls and floors



Sopro's No.1 Silver
Silver-grey, rapid-set flexible tile adhesive with 4-in-1 formulation, for walls and floors



Sopro FKM 600
Silver-grey, multi-purpose flexible tile adhesive, for walls and floors



Sopro VF 419
Silver-grey, flexible, thin-, medium- and floating-bed tile adhesive, for floors



Sopro DF 10*



Sopro FL plus*



Sopro Marble Silicone*

* Treated article under EU Biocides Regulation. Please observe current version of product information, available at www.sopro.com

Natural stone coverings on barrier-free bathroom floors

Natural stone finishes nowadays feature in all areas of residential construction: not only are they installed in the main living areas of houses and apartments, clients are increasingly opting for stone coverings as a stylish element in bathroom design.

Prior to definitively specifying natural stone in wet spaces, clients should seek counselling on its behaviour under exposure to water, soap and different types of cleaner. Among the wide variety of materials available on the market, some stones are excellently suited to installation in damp or wet conditions while others should be avoided under all circumstances.

Regardless of the specified stone type, clients should always bear in mind that stone is a "natural" product that undergoes a certain degree of change over time under the action of water (light/dark patchiness).

In barrier-free bathrooms, natural stone is laid using the thin-bed method on a substrate sealed in advance through installation of a waterproof membrane (see Section 3). In a guidance paper entitled "Natural stone in wet areas in conjunction with waterproof membrane" (BIV data sheet 1.04, as March 2012), the BIV (Association of German Stonemasons) gives a detailed account of the key factors to be considered in the design and construction of natural stone bathrooms.



Moreover, with the issue of the new waterproofing standard DIN 18534 "Waterproofing for indoor applications" in July 2017, membrane plus tile finish solutions now have the status of officially standardized waterproofing systems.

Waterproofing materials used in conjunction with tile coverings:

- Polymer dispersions
- Crack-bridging mineral sealing slurries
- Reaction resins
- Waterproofing materials in sheet form
- Waterproofing materials in panel-shaped form

Natural stone surfaces are easily workable using contemporary mechanical equipment. This is important given that shower facilities are wet-loaded barefoot areas and are consequently required to offer adequate slip resistance for users.

Guidance on specification of falls with due regard to surface treatment

| Fall (%) | Treatment | Stone type |
|-----------|---|----------------------------------|
| 1.0 – 2.0 | Finely ground, finely brushed | Hard stones and dense limestones |
| 1.5 – 2.5 | Finely ground, finely brushed | Limestones, sandstones |
| 1.5 – 2.5 | Coarsely ground, coarsely brushed, milled | Hard and soft stone |
| 1.5 – 2.5 | Flamed and finely brushed, sandblasted and finely brushed | Hard and soft stone |
| 1.5 – 3.0 | Flamed, sandblasted | Hard and soft stone |



Bathroom with natural stone floor covering.

Natural stone coverings on barrier-free bathroom floors

Guidance on the required falls and appropriate surface treatments is provided by the aforementioned data sheet.

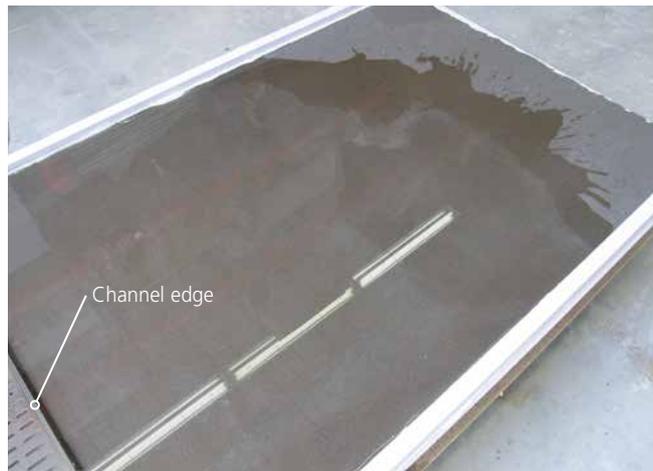
Walk-in showers are an increasingly popular feature of contemporary bathroom design. Here, water runs off from the shower area into a drain or channel. The natural stone coverings in these areas are therefore subject to constant water exposure and saturation. To prevent permanent discoloration of the stone units near the floor drain or channel, designers must take care to specify suitable drainage components.

Floor drains and channels with an edge upstand or watertight frame around the grate should not be used in conjunction with natural stone floor coverings – the reason being that this tends to result in water accumulation on the waterproof membrane up to the top edge of the upstand. This water is then absorbed by the surrounding stone units, which will then remain saturated due to the permanent water exposure on their lower face.

To prevent the darkening of stone floor finishes in barrier-free bathroom floors, it is crucial to specify drainage components that allow water accumulating on the membrane to run off freely. Various systems that make suitable provision for this and have been used successfully in conjunction with Sopro waterproof membranes are shown below.



Shower with edge staining of natural stone near channel after daily use.



Test: water accumulation at channel upstand in shower area.



Test: darkening of installed natural stone units is observed after certain period of exposure.

Natural stone coverings on barrier-free bathroom floors

Schlüter system



Waterproof membrane connected flush with upper edge, thereby allowing water to run off freely.

Dallmer system



Flush connection of waterproof membrane at top edge. Water can run off freely. Different drainage strip systems also create wide variety of design options.

Tece system



Natural stone installation with clearly visible provision for water run-off on waterproof membrane.

Geberit system



Drainage unit is located in wall, thereby simplifying connection to waterproof membrane. Here too, any accumulating water can run off freely.

Proline system



Channel has no upstand and lies flush with screed. Water can run off freely without accumulating.

Gutjahr system



Reliable water run-off guaranteed by perforated frame on top part of channel.

Natural stone coverings on barrier-free bathroom floors

Product solutions for barrier-free bathrooms with floor drains and channels

Waterproof membrane



Sopro FDF

Highly elastic, crack-bridging, solvent-free one-component liquid polymer waterproof coating. Applied to walls and floors as membrane in composite waterproofing systems with tile finish. Used in damp and wet spaces not subject to hydrostatic pressure, e.g. bathrooms, showers, washrooms and sanitary facilities. Suitable for water action classes W0-I and W1-I (wall/floor) as well as W2-I (wall). Contrast colour: Sopro FDF 527



Sopro DSF 623

Reactive, sag-resistant, one-component mineral sealing slurry for production of flexible, crack-bridging waterproof membranes. For waterproofing indoor spaces to DIN 18534, for waterproofing tanks and pools to DIN 18535, for waterproofing normal, recessed and access balconies to DIN 18531 Part 5, and for waterproofing elements in contact with soil to DIN 18533.



Sopro AEB 640

Thin-sheet, crack-bridging waterproofing and separating membrane, faced either side with special nonwoven fabric. Nonwoven fabric ensures strong bond between waterproofing/separating membrane and cementitious tile adhesive. Ideal for trouble-free, flexible waterproofing of wall and floor surfaces below natural stone and ceramic tiling in bathrooms, showers and wet spaces. Laps and joints are bonded and watertightly sealed using Sopro RMK 818 Racofix® universal adhesive, Sopro MKS 819 Racofix® universal adhesive S, Sopro FDK 415 fixing and waterproofing adhesive, Sopro WB 588 Racofix® WaterBlock one-component hybrid membrane or Sopro TDS 823 two-component turbo sealing slurry.

Particularly suitable for fast-track waterproofing on tightly scheduled construction schemes.

Suitable for water action classes W0-I to W2-I to DIN 18534, and solutions based on W3-I to DIN 18534.

Bedding adhesive



Sopro M&M 446

White, rapid-set, trass-bearing, cementitious, flexible natural stone tile adhesive, meeting C2 FT requirements to DIN EN 12004, for installation of light-coloured, calibrated, deformation-resistant **marble and other natural stone coverings,** also underwater. **High protection against efflorescence, discoloration and staining** thanks to original Rhenish trass and white cement. Suitable for use in conjunction with wall and floor heating and waterproof membranes.



Sopro's No.1 Silver

Silver-grey, rapid-set, cementitious, highly polymer-modified flexible tile adhesive. C2 FTE S1 to DIN EN 12004. Multi-purpose product thanks to **4-in-1 formulation:** thin-bed, medium-bed, floating-bed and surface filler consistency. **Rapid set** despite **extended open time,** making it ideal for **laying large-format fully vitrified stoneware units** and deformation-sensitive tiles. Perfect solution for **light-coloured, translucent natural stone units.** With high crystalline water binding capacity and original Rhenish trass. For installation of ceramic wall and floor coverings, also on heated substrates and waterproof membranes.

Grouting



Sopro DF 10 1 – 10 mm

Fine, strong, flexible, rapid-set, cementitious tile grout, meeting CG2 WA requirements to DIN EN 13888, for grouting all types of ceramic and natural stone coverings to produce brilliantly coloured, lime-film-free finish. **Enhanced protection of joint against mould formation* and microorganisms plus lime-film-free finish ensure brilliantly coloured joint pattern with lasting appeal,** for both indoor and outdoor applications, and especially in moisture-exposed areas. Inherent water-beading effect and Hydrodur® technology create water- and dirt-repellent joints with antimicrobial capability. Also suitable for outdoor applications, and for grouting thin tile coverings (≤ 4 mm). Sopro TF+TFb high-strength tile grouts, Sopro DFX designer epoxy tile grout or Sopro FEP 604 three-component epoxy tile grout are recommended for use in swimming pools.

* Treated article under EU Biocides Regulation. Please observe current version of product information, available at www.sopro.com

Medium-bed laying

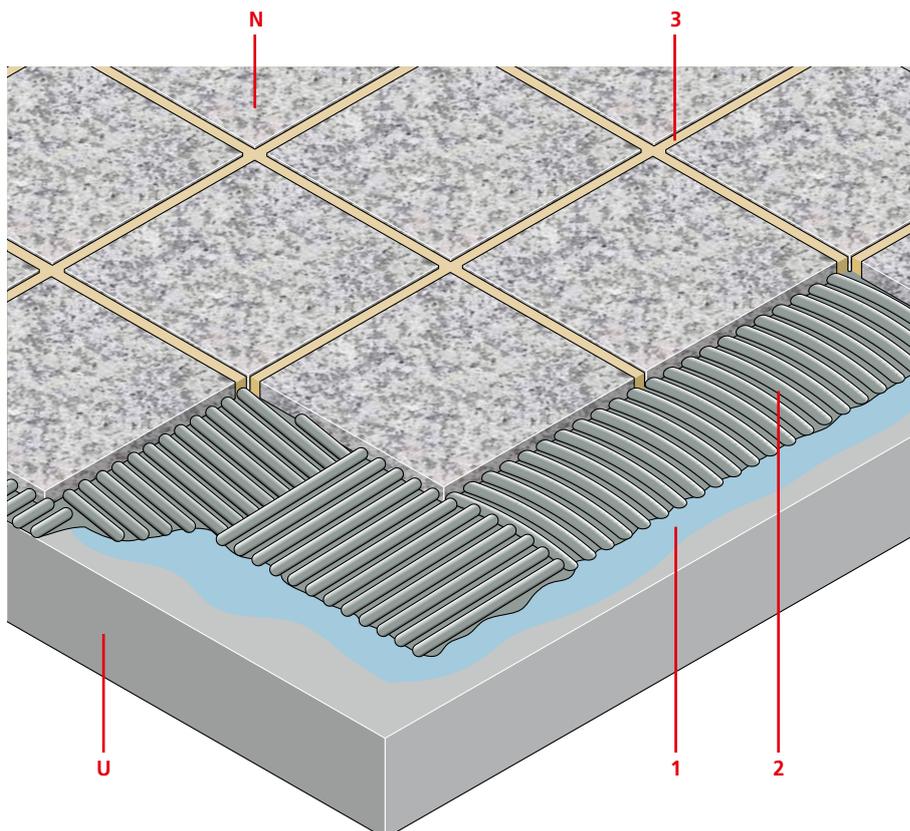


Laying of natural stone with Sopro MDM 888 medium-/thick-bed tile adhesive using medium-bed method.

Alongside the thin-bed laying method (1–5 mm adhesive thicknesses) governed by DIN standards, recent years have also seen the evolution and establishment of medium-bed techniques, specifically for natural stone finishes.

Medium-bed laying (5–20 mm adhesive thicknesses) is particularly useful for installing large-format natural stone units that may be subject to minor thickness tolerances.

The use of varying adhesive formulations allows the reliable laying of practically any natural stone type. Medium-bed adhesives are available as normal-setting, rapid-setting and white cement-based products.



- 1** Sopro GD 749 primer
- 2** Discoloration-sensitive natural stone: Sopro MDM 885 white medium-/thick-bed tile adhesive
- Discoloration-resistant, non-translucent natural stone: Sopro MDM 888 medium-/thick-bed tile adhesive
- 3** Grout: Sopro DF 10 flexible designer tile grout
- N** Natural stone covering
- U** Concrete/cement screed substrate

Medium-bed laying

System composition



Product recommendation



Sopro GD 749



Sopro MDM 888
Flexible, rapid-set,
trass-bearing
medium-bed adhesive



Sopro MDM 885
White, flexible, rapid-set,
trass-bearing
medium-bed adhesive

Grouting



Sopro DF 10*

Heavy duty



Sopro TF+*



Sopro Marble
Silicone*

* Treated article under EU Biocides Regulation.
Please observe current version of product information,
available at www.sopro.com

Pervious bedding systems

Pervious systems for outdoor areas



To protect outdoor coverings from moisture penetration and frost damage, the above guidelines recommend the use of single-sized aggregate bedding mortars. The rapid drainage through the construction thus achieved also minimizes the susceptibility of the covering to efflorescence and discoloration. Use of Sopro DMX 619 drainage mortar eXtra as the bedding material is recommended, particularly for filigree balcony constructions. The product's binder formulation prevents any efflorescence effects. Its high water permeability ensures rapid drainage of water down to the waterproof barrier (e.g. Sopro DSF 623 flexible RS sealing slurry) while the high air void content although guarantees good frost resistance.

Provision should be made for a 1.5–3% fall in outdoor areas. The drainage mortar screed should always be used in conjunction with the Sopro DRM 653 drainage mat.

Greater adhesive bed thicknesses than the 10–30 mm specified by DIN 18322 for thick-bed laying (bonded construction) are recommended for the coarse-aggregate drainage mortar in order to facilitate laying and ensure proper drainage.

Bed thicknesses of 60 mm or more are readily feasible using drainage mortars. Shrinkage and associated deformation are negligible due to the lack of fine aggregate and low water requirement. ZDB (Federation of the German Construction Industry) data sheet "Outdoor coverings, tile coverings outside buildings" (August 2019 version) prescribes a minimum thickness of 50 mm for the load-spreading drainage construction (screed).

* Thicker size to be specified depending on live loads.

In the case of higher live loads, specification of the construction thickness should also take account of DIN 1991 (Eurocode 1) and DIN 18560-2.

Sopro DMX 619 drainage mortar eXtra may be used as a bedding adhesive or, in a suitable coat thickness, for the provision of bonded, unbonded or floating load-spreading layers (screed, min. 50 mm*). Upon subsequent moisture penetration, its special mortar formulation prevents the familiar efflorescence effects caused by the free lime.

Installation

Pervious systems can take the form of coverings laid in a thick bed or of a screed construction used as a base for thin-bed laying of the covering.

Where the thick-bed method is adopted, the drainage mortar should be pre-compacted and struck off. After coating the rear tile face with an adhesion promoter (Sopro HSF 748 flexible bonding slurry with trass, Sopro thin-bed adhesive etc.), the tiles are tapped into the prepared drainage mortar bed.

If the tilayer prefers the thin-bed method, the drainage mortar is used to place a screed with a minimum thickness of 50 mm. This should be allowed to dry and harden for 3–4 days before the tiles are laid. Here, coating ("buttering") of the rear tile face with the thin-bed adhesive (Sopro M&M 446 flexible marble and mosaic adhesive, Sopro's No.1 flexible tile adhesive etc.) is recommended prior to bonding the tiles to the pervious screed. This helps to preserve the open-pored surface texture of the drainage mortar.

Pervious bedding systems

System composition



Product recommendation



Sopro DSF 623



Sopro TDS 823



Sopro DRM 653

Wet-on-wet application



Sopro DMX 619

Installation on load-spreading layer



Sopro DMX 619



Sopro HSF 748, Sopro M&M 446, Sopro MEG 667



Sopro M&M 446, Sopro FKM 600, Sopro MEG 666



Sopro FL plus*



Sopro DF 10*



Sopro Marble Silicone*

* Treated article under EU Biocides Regulation. Please observe current version of product information, available at www.sopro.com

Application of Sopro DMX 619 drainage mortar eXtra

Installation as screed for subsequent thin-bed tiling



1 Preparation of mortar using forced-action mixer or screed pump.



2 Fixing of screed rails.



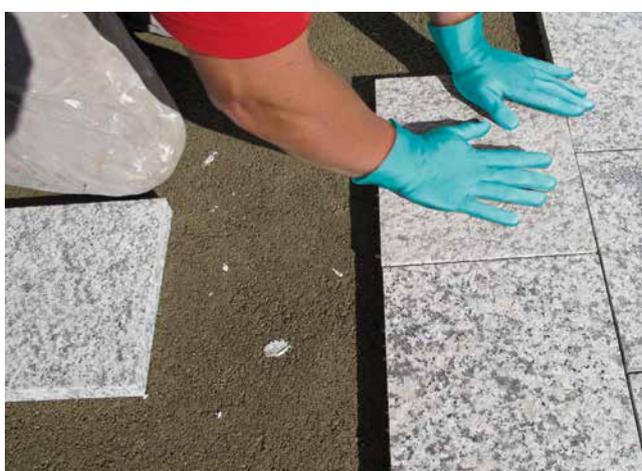
3 Incorporation of load-spreading layer using Sopro DMX 619.



4 Pervious screed after setting, with open-pored, water-permeable texture.



5 Thin-bed adhesive (Sopro M&M 446) combed onto rear face of natural stone tile (buttering method).



6 Bonding of natural stone tile to drainage mortar screed after application of thin-bed adhesive to rear tile face.

Application of Sopro DMX 619 drainage mortar eXtra

Thick-bed method



1 Preparation of Sopro DMX 619 using drum-type mixer.



2 Preparation of thick-bed drainage mortar for wet-on-wet application.



3 Application of adhesion promoter (Sopro HSF 748 flexible bonding slurry with trass) to rear face of natural stone tile.



4 Tapping of natural stone tile into prepared pervious thick-bed mortar.



5 Spreading of Sopro DMX 619 drainage mortar eXtra for installation of large-format units in thick bed.



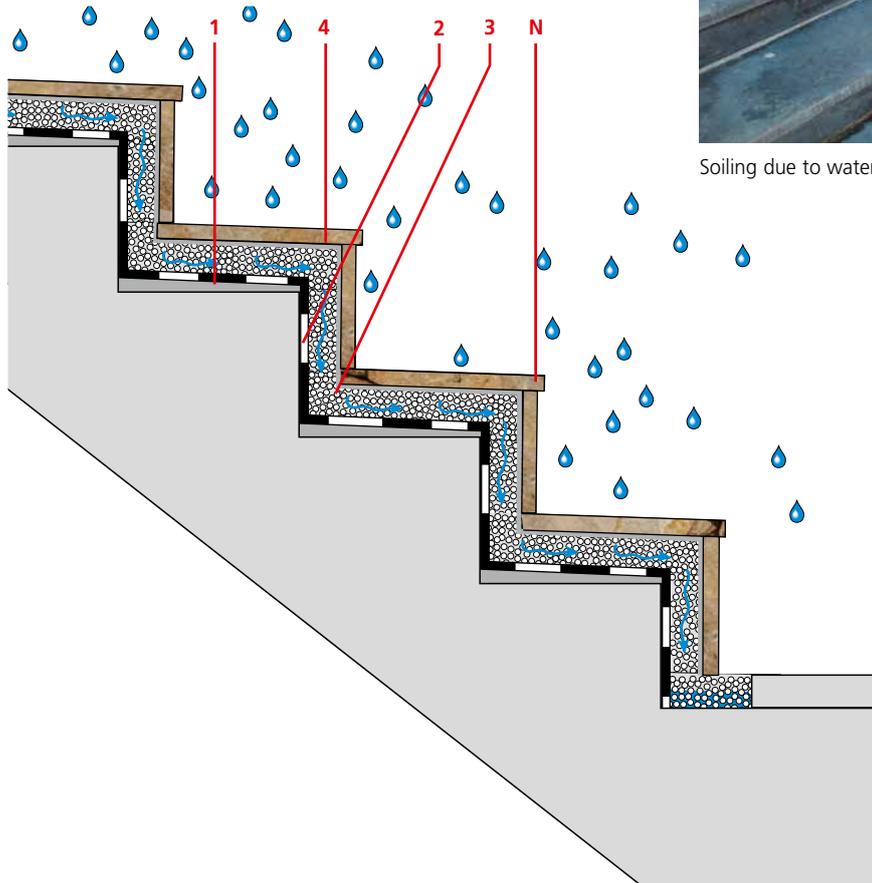
6 Mechanical placing in thick bed of unit pretreated with adhesion promoter (Sopro HSF 748 flexible bonding slurry with trass).

Pervious bedding systems

Outdoor steps

Natural stone coverings on steps and landings are also prone to discoloration and efflorescence caused by infiltrating water. Here too, the use of a pervious mortar (Sopro DMX 619) is recommended for installing the finish.

Large (main or intermediate) landings between stair flights should always have separate provision for drainage (e.g. floor drain or water spout). Water **must not** be allowed simply to run off down the steps.



Soiling due to water run-off from patio areas over steps.

- 1** Levelling coat to falls
Sopro RAM 3 454 renovation and levelling mortar
- 2** Two-coat waterproof membrane, e.g. using Sopro DSF 623 flexible RS sealing slurry or Sopro TDS 823 two-component turbo sealing slurry
- 3** Pervious bedding mortar
Sopro DMX 619 drainage mortar eXtra
- 4** Adhesion promoter e.g. Sopro M&M 446 flexible marble and mosaic adhesive/Sopro HSF 748 flexible bonding slurry with trass
- N** Natural stone covering

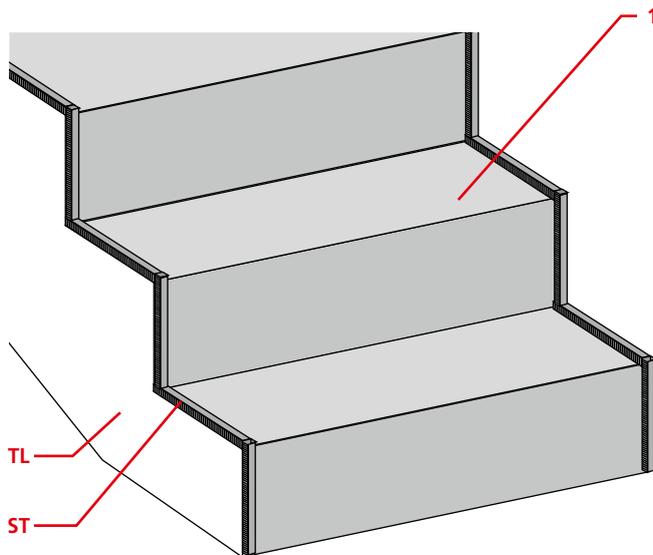
Infiltrating water percolates through pervious mortar and runs off down the membrane. Note: Adequate provision should be made at the bottom step for water to soak away (e.g. gravel strip). The drainage mortar bed should be 3 cm thick to ensure an adequate water flow rate.

Pervious bedding systems

Outdoor steps

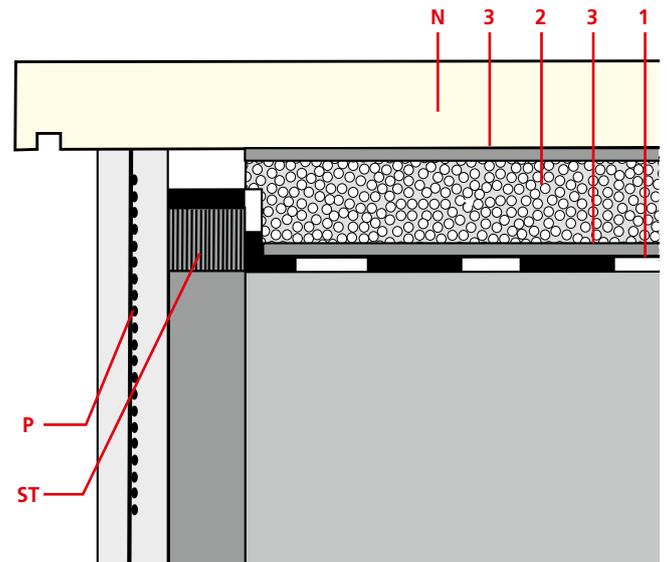
To prevent water run-off over the side string of the stair flight and the attendant risk of soiling, an extruded polystyrene strip, for instance, should be bonded at the sides at a suitable height (around one centimetre lower than later thickness of adhesive bed) prior to installation of

the waterproof membrane. After the adhesive has cured, the polystyrene strip is overcoated with the waterproof membrane (Sopro DSF 623 flexible RS sealing slurry or Sopro TDS 823 two-component turbo sealing slurry). Instead of running off over the sides, the water then drains down the stair flight to the soakaway strip.



Stair flight with lateral upstand.

- 1** Two-coat waterproof membrane, e.g. using Sopro DSF 623 flexible RS sealing slurry or Sopro TDS 823 two-component turbo sealing slurry
- 2** Pervious bedding mortar, Sopro DMX 619 drainage mortar eXtra
- 3** Adhesion promoter e.g. Sopro M&M 446 flexible marble and mosaic adhesive/Sopro's No.1 flexible tile adhesive



Stair covering assembly.

- N** Natural stone covering
- P** Render with scrim (e.g. Sopro PG-X 1188 armour scrim eXtra)
- TL** Stair flight
- ST** Extruded polystyrene strip



Water run-off at side leads to damage and unsightly soiling.



Stair flight provided with lateral upstand.

Application of Sopro DMX 619 drainage mortar eXtra

Wet-on-wet application on stairway



1 Levelling coat to falls using Sopro RAM3 454 renovation and levelling mortar.



2 Application of Sopro HSF 748 flexible bonding slurry with trass to waterproof membrane as contact coat for Sopro DMX 619 drainage mortar eXtra.



3 Covering material prepared by coating rear face with Sopro HSF 748 flexible bonding slurry



4 Stair riser laid using Sopro DMX 619 drainage mortar eXtra.



5 Drainage mortar bed ready to receive stair tread.



6 Finished step, fixed with Sopro DMX 619 drainage mortar eXtra.

Thick-bed laying

The traditional thick-bed laying method for natural and cast stone finishes – to DIN 18332 and DIN 18333 – is employed where, for example, the thickness tolerances of the covering materials necessitate this and the floor covering is to be installed in a single operation. DIN standards specify the use of a trass-bearing binder for the sand/cement mortar mix, nowadays supplied as a premixed dry mortar.

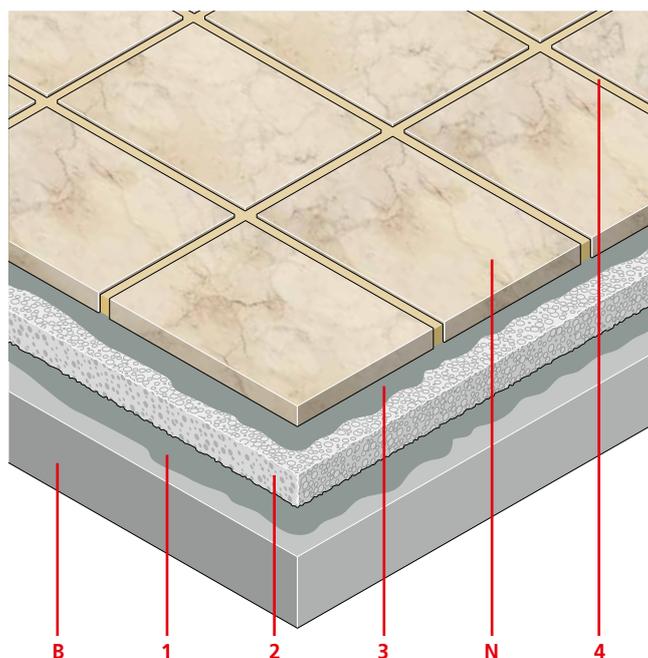
Practical experience has shown that coverings laid by the thick-bed method are prone to adhesion failure (between adhesive bed and substrate or adhesive bed and stone), efflorescence, discoloration and grinning through of adhesive bed. These failures are due, among other things, to the moisture in the thick bed or the lack of bonding layers. In other words, for laying natural stone units in thick beds, special mortar mixes and bonding layers should be used.



Edge staining and discoloration within tile surface due to moisture content of thick-bed adhesive.

System composition for trouble-free thick-bed laying:

- 1** Sopro HSF 748 flexible bonding slurry with trass
Bonding layer applied to substrate
 - 2** Sand/trass cement thick-bed adhesive prepared with Sopro TRB 421 binder with trass
 - 3** Sopro M&M 446 flexible marble and mosaic adhesive as bonding layer for discoloration-sensitive natural stone
Alternative for discoloration-resistant natural stone: Sopro HSF 748 flexible bonding slurry with trass
 - 4** Grouting with Sopro DF 10 flexible designer tile grout/concrete grey (trass-bearing) Sopro MFb tile grout
Alternative for high loads: Sopro TF+ high-strength tile grout
- B** Concrete substrate
- N** Natural stone covering

**Note:**

Special natural stone silicone sealants are required for movement joints in natural stone coverings.

Thick-bed laying

Product recommendations



Light-coloured natural stone laid with thick-bed adhesive. Rapid moisture migration and discoloration may result.



Sopro TVM 858

Thick-bed tile adhesive

Hydraulically setting, trass-bearing, cementitious mortar for laying and bonding of discoloration-sensitive natural stone units (e.g. Solnhofen stone tiles, Jura marble), cast stone units and window sills, using **thick-bed method** to DIN 18352, DIN 18332 and DIN 18333. Application in conjunction with Sopro MAS 418 marble slurry or HSF 748 flexible bonding slurry with trass.

For levelling substrates made from cementitious materials, e.g. screeds and concrete, in 10–40 mm mortar beds.



Sopro TRB 421

Trass-bearing binder

Special **trass-bearing, cementitious binder** for preparation of thick-bed and wall tile adhesives for laying natural stone units. High trass content significantly reduces risk of efflorescence, bloom and discoloration.

Requires on-site mixing with sand (grading selected according to construction height).



Sopro M&M 446

White, flexible natural stone tile adhesive

White, rapid-set, trass-bearing, cementitious, flexible natural stone tile adhesive, meeting C2 FT requirements to DIN EN 12004, for installation of light-coloured, translucent, calibrated, deformation-resistant marble and other natural stone coverings. High protection against efflorescence, discoloration and staining thanks to original Rhenish trass and white cement. Also for installation of suitable glass mosaic in wet and underwater areas, subject to addition of Sopro FD 447 flexibilizing dispersion. Suitable for use in conjunction with wall and floor heating and waterproof membranes.



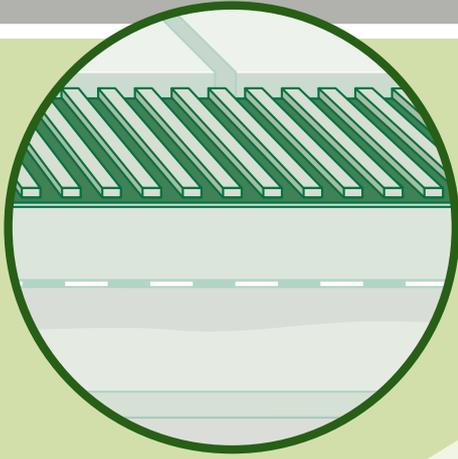
Sopro HSF 748

Grey slurry

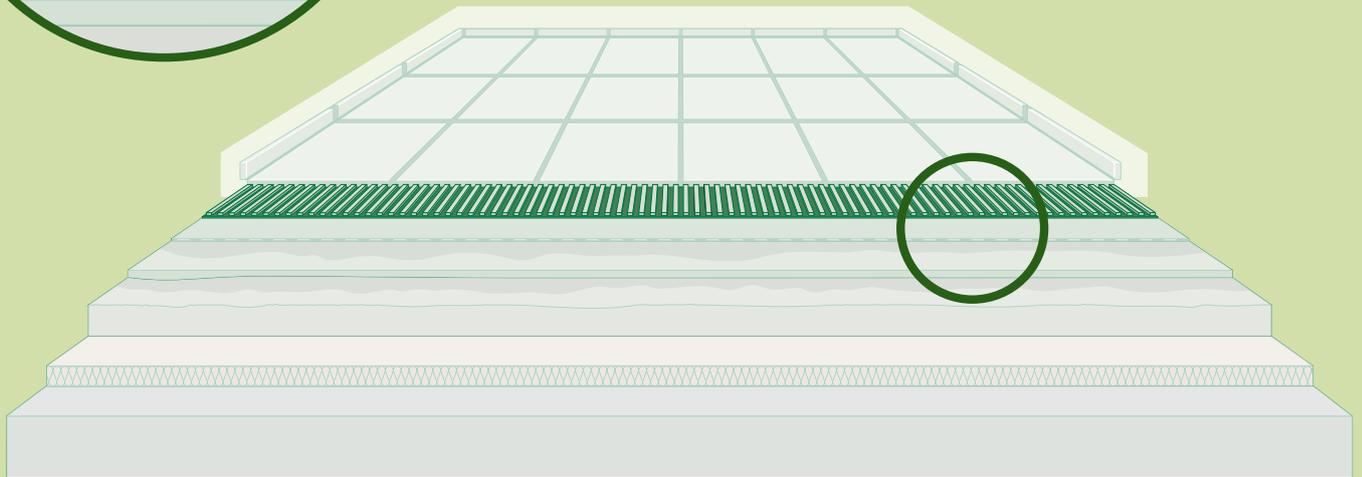
One-component, trass-bearing, polymer-modified **bonding and contact slurry.**

As flexible bonding slurry for optimization of bond between rear face of natural stone unit and thick-bed adhesive. Or as bonding layer between thick-bed adhesive and substrate (concrete floor) for bonded constructions.

Adhesion promoter for bonded screeds.



Sopro product systems for sustainable construction



Schematic system composition

Low-emission tile/bedding adhesives*



Sopro FKM 600 Silver multi-purpose flexible tile adhesive
DGNB: Top quality level 4, Line 8**



Sopro M&M 446 flexible marble and mosaic adhesive
DGNB: Top quality level 4, Line 8**



Sopro VF 419 VarioFlex® Silver flexible tile adhesive
DGNB: Top quality level 4, Line 8**



Sopro MDM 885 white medium-/thick-bed tile adhesive
DGNB: Top quality level 4, Line 8**



Sopro MDM 888 medium-/thick-bed tile adhesive
DGNB: Top quality level 4, Line 8**

* For details of all relevant Sopro products, please consult our sustainability brochure.

** Rating under German Sustainable Building Council (DGNB) quality certification scheme, Criterion "ENV1.2 Local Environmental Impact" (2018 version).