Fundamentals

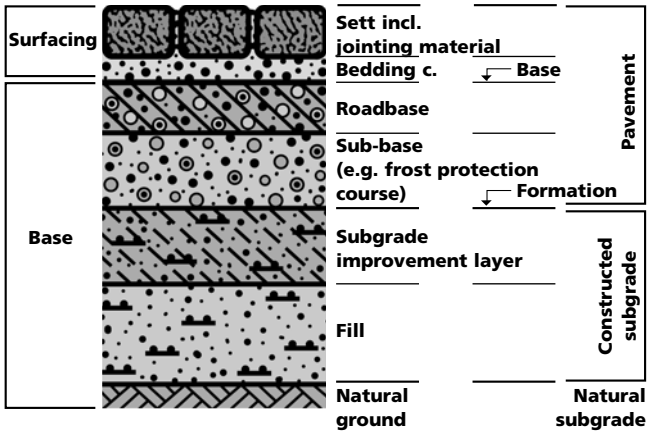
The use of segmental units (setts, pavers and flags) to pave roads, paths and squares is one of the oldest forms of construction. Today, this method is employed for both vehicular and pedestrian areas in the public realm and hard landscaping in private gardens.

One of two general construction types – the **bound** or the **unbound pavement – is adopted depending on the type of hard surface and its use (traffic loads, roadsweepers etc.).**. Whereas bound pavements entail the incorporation of binders in the roadbase, bedding and grouting materials, unbound constructions employ binder-free granular materials.

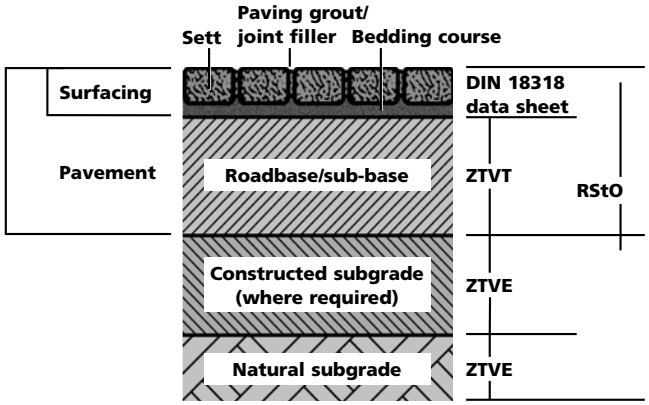
A combination of bound and unbound constructions is frequently adopted for privately used pavement areas (which are generally subject to low traffic loads). In such cases, the roadbase/sub-base and bedding course are unbound and only the paving grout is bound. This solution is preferred by private clients as the resulting pavement is largely maintenance-free (no regular weeding necessary), and no sand or stones are trampled into the house. Yet, due to the "springiness", i.e. up-and-down movement, of unbound pavements, this construction necessitates the use of flexibly formulated reaction resin-bound grouts (see Section 13.2 "Reaction resin-bound paving grouts").

In Germany, the design and construction of bound roads, pathways and squares are primarily governed by the following standards, regulations and manuals:

- **ZTVP – StB 06 (FGSV/German Research Association for Highway and Traffic Engineering)**
  Special technical conditions and guidelines for construction of segmental pavements and kerbs
- **DIN 18318 (VOB/German construction contract procedures, Part C)**
  Construction works for traffic lines – unbound sett, paver and flag pavements, kerbs
- **DIN EN 1338**
  Concrete paving blocks
- **DIN EN 1339**
  Concrete paving flags
- **DIN EN 1342, DIN EN 1343**
  Natural stone flag paving, natural stone setts
- **DIN EN 1344, DIN EN 1345**
  Clay pavers in sand bed, clay pavers in mortar bed
- **DIN EN 18503**
  Clay pavers



Pavement construction to RStO



Applicable standards/regulations

- **DNV (German Natural Stone Association) data sheet**
  Natural stone sett and flag pavements for vehicular areas
- **FGSV – German Research Association for Highway and Traffic Engineering**
  Working paper on segmental pavements of bound construction
- **RStO 12 (FGSV)**
  Guidelines for standardization of vehicular pavements
- **WTA (International Association for Science and Technology of Building Maintenance and Monuments Preservation) data sheet**
  Bound pavement construction – historic pavements
- **FGSV**
  Pervious concrete roadbase/sub-base data sheet
- **ZTV-Wegebau**
  Special technical conditions for construction of pathways and public squares outside vehicular areas
- **Handbuch gebundene Bauweise**
  German-language manual on bound construction

Fundamentals

With **bound constructions**, the setts, pavers or flags are rigidly installed in a hydraulically setting mortar bed (bedding mortar) on a bound roadbase. Both the bedding course and the hydraulically bound roadbase/sub-base are made of pervious mortars which, once set, allow adequate drainage. The same applies to bituminous-bound porous asphalt courses. Paving grouts, on the other hand, take the form of an impervious mortar matrix: this is to ensure that water, as far as possible, runs off the surface rather than infiltrating into the pavement construction. The paving units should be laid with adequate, uniform joint widths. Some concrete pavers are provided with special spacer nibs to facilitate laying with a regular joint pattern.

The joints are normally finished using a hydraulically setting, bound paving grout. The combination of bound base and bound grout produces an overall construction, capable of withstanding exceptionally high loads.

Depending on the duty, bound constructions are able to accommodate a limited amount of deformation.

Expansion is subject to very narrow limits due to the extremely low elongation at fracture (between 0.1 and 0.2 mm/m) of paving grouts and bedding mortars.

Cracking is inevitable given the fluctuating loads (traffic, temperature action), heterogeneous pavement composition, varying shrinkage behaviour and consequent internal stresses within the construction. Yet, these in themselves do not result in damage to the pavement, nor do they constitute a defect.

Unbound pavements involve the laying of segmental units in a loose chippings bed with subsequent vibration. In the past, any joints within the pavement were filled with sand or finely graded quality chippings. These loose jointing fillings have, however, proved vulnerable to modern-day suction roadsweepers and the resulting material loss allows displacement of paving units and rutting upon exposure to sufficiently high traffic loads. A satisfactory solution to this problem may, under certain circumstances, be offered by the use of reaction resin paving grouts (see Section 13.2).

Granite setts laid in pervious bedding mortar on pervious, coarse-aggregate, bound roadbase.

Concrete pavers placed on concrete foundation to form drainage channel.

Setts laid on unbound base in sand/gravel bed.

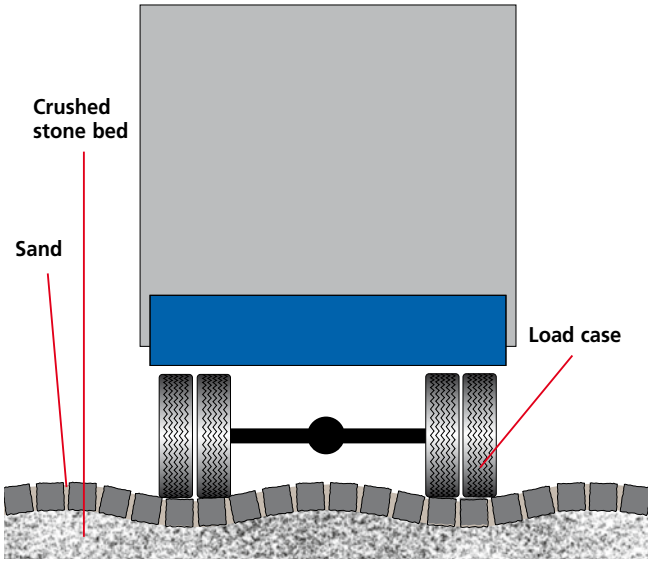
Failures and their causes

As the situation in many towns and cities shows, rising traffic volumes and higher loads (e.g. through heavy-goods vehicles and buses) now pose a stiff test for traditional unbound segmental pavings in public areas. The use of suction roadsweepers, which pick up the loose jointing material (sand, chippings etc.) and thereby empty the joints, encourages water infiltration into the pavement, causing long-term damage to the overall construction. This may manifest itself through rutting, settlement and the loosening, tipping or displacement of paving units. To avert such failures, pavements subject to high traffic loads should be bedded on a bound roadbase. Likewise, a high-strength, hydraulically setting paving grout or reaction resin mortar should be used for jointing.

Material sucked and rinsed out of joints by roadsweeping equipment and rainwater.

Paving units displaced due to lack of jointing material in conjunction with high traffic loads.

Unbound pavement



Rutting and displacement of unbound pavement caused by excessive traffic loads.

Remedial stabilization of unbound pavements using high-strength, hydraulically setting paving grouts is not feasible. These are too brittle and cannot accommodate the "springy" movement of the pavement, with failure of the grouted joints as the upshot (see photo on right). Hydraulically setting paving grouts should therefore not be used for unbound segmental pavements!

Failure of joints due to combination of hydraulically setting, bound paving grout with unbound base and exposure to high traffic loads.

Fundamentals

Paving materials

A wide range of segmental paving materials – including concrete, natural stone, clay and, more recently, thick ceramic units (see Section 13.3) – are used for public and private vehicular areas. The paving units are available in a diversity of formats, sizes and thicknesses. Recently, there has been a trend towards large-format units with substantial thicknesses (8–16 cm).

Concrete pavers

Concrete units, in a bewildering variety of shapes and colours, now find widespread use in segmental paving. Their manufacture is subject to the standardized provisions of DIN EN 1338 and DIN EN 1339.

Natural stone units

As historical evidence shows, natural stone setts boast the longest tradition among segmental paving materials. Weather-resistant stone should be specified for sett pavements. The advice of a natural stone consultant (geologist) should be sought on such projects.

Heavy-duty stone setts for heavily trafficked road section.

Clay pavers

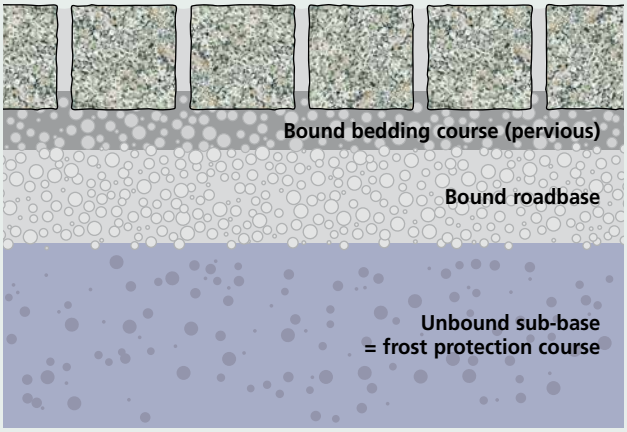
Clay pavers, normally laid in a mortar bed, have been successfully used for vehicular pavements in some regions.

Compressive strengths for natural stone units

Stone groups	Compressive strength to DIN 52 105 (N/mm²)
A. Igneous rock	
1. Granite, syenite	160–240
2. Diorite, gabbro	170–300
3. Quartz porphyry, keratophyre, porphyrite, andesite	180–300
4. Basalt, melaphyre	250–400
Basaltic lava	280–150
5. Diabase	180–250
B. Sedimentary rock	
6. Siliceous rock	120–300
a) Vein quartz, quartzite, greywacke	
b) Quartzitic sandstones	
c) Other quartz sandstones	
7. Limestones	280–180
a) Compact (solid) limestones and dolomites (including marbles)	
b) Other limestones including limestone conglomerates	
c) Travertine	
C. Metamorphic rock	
8. Gneisses, granulite	160–280

Fundamentals

Load-dependent pavement composition to RStO



Specification to RStO

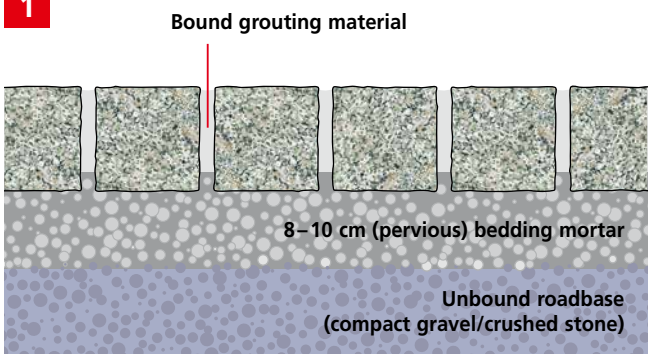
Composition:

- 8–16 cm Natural stone setts/concrete pavers
- 3– 5 cm Bedding mortar
- 12–20 cm Bound roadbase (pervious)
  Frost protection course

Although the present version of the RStO (Guidelines for standardization of vehicular pavements) is still geared to unbound construction, it can also serve as a basis for designing bound-construction pavements. Unbound constructions exhibit a certain flexibility or even "springiness". As this is lacking in bound pavements, these should be designed a few centimetres thicker.

System solutions depending on duty

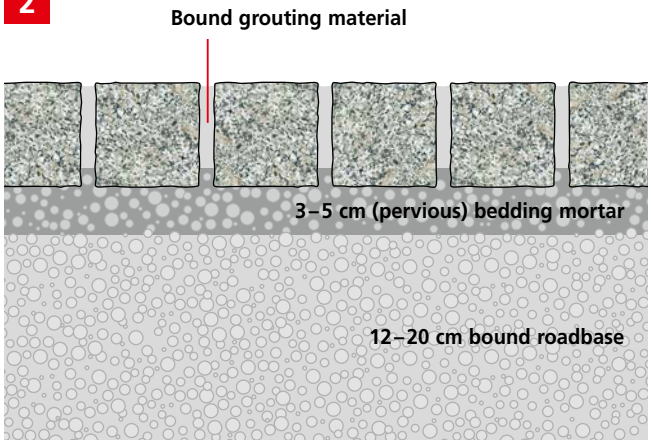
1



Light to medium duty.

- Courtyards and driveways
- Garden and parkland paths
- Car park surfaces
- Pedestrian precincts with light-duty delivery traffic

2



Medium-heavy to heavy duty.

- For car, bus and heavy-goods vehicle traffic
- Turning areas
- Roads
- Roundabouts and traffic islands

Fundamentals

Drainage channels

Regardless of pavement type (i.e. for bituminous, concrete and segmental pavements), roads and other hard-landscaped areas require channels (formed with concrete or stone units) to carry rainwater run-off to drainage gullies. From a technical viewpoint, channels take the form of slender, in some cases even filigree, linear constructions. The narrower they are, the more vulnerable they become to shear movement and surface loads.
To maximize durability, drainage channels require a stable base (including, where necessary, a reinforced, in-situ concrete foundation), wet-on-wet laying of the paving units with appropriate bonding layers, and the complete filling of joints between the units with a suitable paving grout (Sopro BSF 611, Sopro PFM).

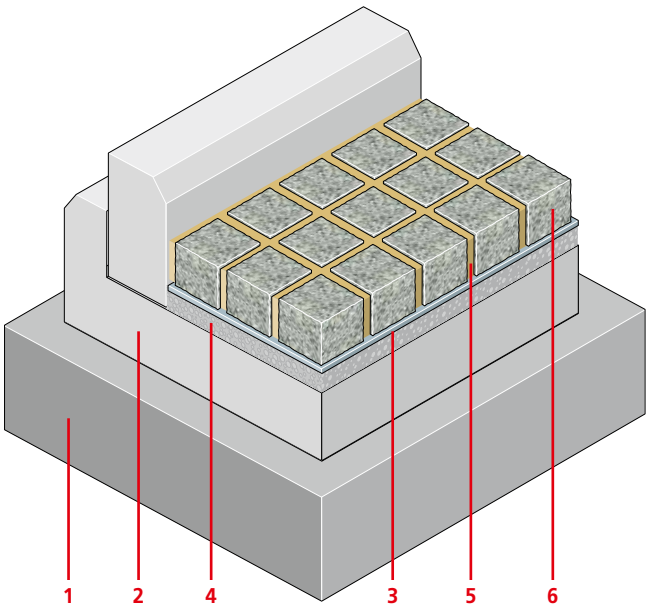
Concreted and reinforced drainage channel foundation in road.

Natural stone setts laid in coursed, broken bond pattern on strip foundation.

Nowadays, concrete specials are often used to form drainage channels in vehicular pavements.

Concrete allows channels to be manufactured in a wide range of shapes, as Rinn product illustrates.

Drainage channel composition



1 Base layer

2 Concrete foundation

3 Bonding layer (Sopro HS 448 bonding slurry with trass)

4 Bedding mortar (Sopro DM 610 drainage mortar)

5 Bound grouting material (Sopro PFM high-strength paving grout or Sopro BSF 611 paving grout for concrete units)

6 Paving unit (concrete or natural stone)

Pavement surfacing

Segmental units, i.e. setts, pavers and flags, are used for large-area pavements in a wide variety of public areas.

These include roads, streets, marketplaces, pedestrian precincts and special traffic-related structures (e.g. bus stops and roundabouts).

Where required by the projected loads, bound constructions may be needed in such areas. Here, particular attention should be paid to the design of adequately sized roadbases/ sub-bases and the wet-on-wet laying of units with applied bonding layer in the bedding mortar.

Alongside the standard paving unit formats, increasingly large flags (e.g. 60 x 120 x 14 cm) are now specified for public squares. The use of a bound construction is essential in such cases given that the leverage action under load conditions may cause vertical displacement of the flags and create trip hazards.

Stone pavement in road area.

Large-format concrete units are nowadays used as an alternative to stone flags in public squares.

Natural stone flags laid using bound-construction method.

For large flags, in particular, application of bonding layer (e.g. Sopro's No.1 flexible tile adhesive) and wet-on-wet laying in bedding mortar is essential for durable performance.

Natural stone flag laid in suitably thick mortar bed.

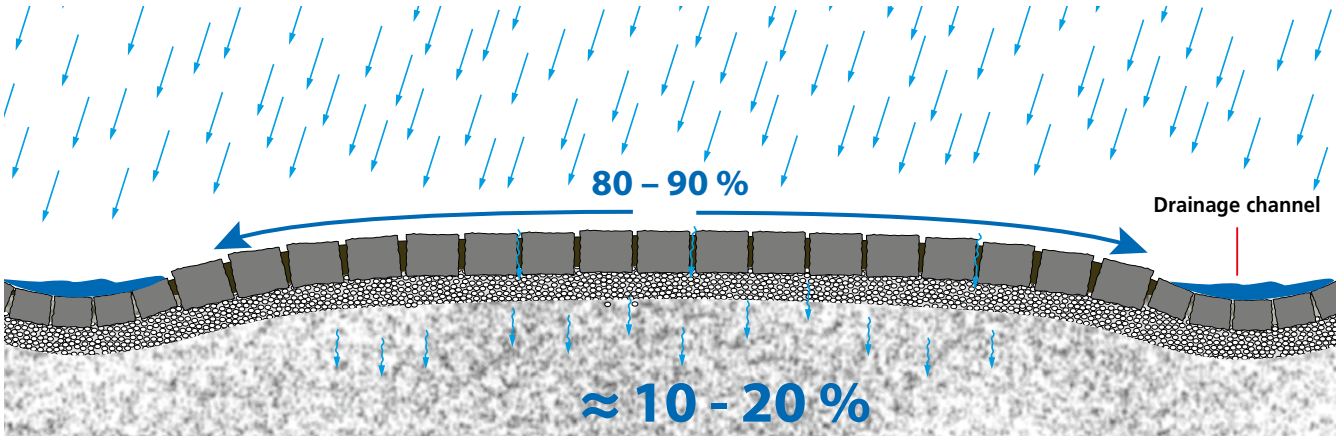
Fundamentals

Special features of bound pavements

Even where pavements are of bound construction and are deemed impervious*, a certain amount of moisture will still infiltrate into the structure. This is attributable both to the open-pored texture of the units and possible hairline cracks in the pavement.

Such cracks may form sporadically as a result of temperature action or even shrinkage in the base construction. Hairline cracking does not, however, constitute a defect, nor does it impair the durability of the pavement.

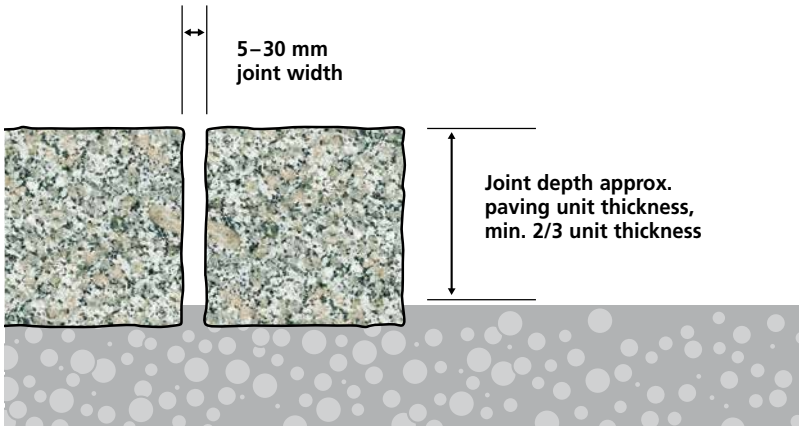
Given the inevitable infiltration of moisture into the structure, the guiding principle should be to increase the water permeability of the pavement construction from the top downwards. In other words, the roadbase/sub-base and bedding course should be constructed using a single-sized aggregate concrete/mortar (Sopro DM 610 drainage mortar). This does not store the water, but allows it to percolate easily, thereby creating a self-draining pavement that is durably frost-resistant.



Pavement cross-section illustrating principle of increasing water permeability from top downwards.

*** Note: Drainage channels and gullies are needed to accommodate the surface run-off from bound-construction pavements!**

Joint width and depth



To ensure the long-term strength and performance of the pavement, provision should be made for adequate joint widths and depths (2/3 of paving unit thickness).

Minimum joint width should be observed to ensure that joints are properly filled with bound paving grout.

Fundamentals

Pavement composition

Unbound roadbase (frost protection course)

Gravel/crushed stone course compacted for light to medium duty.

Bound roadbase (concrete or asphalt)

Bound (concrete) roadbase compacted for medium-heavy to heavy duty.

Bedding course

Preparation of pervious bedding mortar using mechanical stirrer or forced-action mixer.

Sopro DM 610
Trass cement-bound premixed dry mortar for outdoor laying of natural stone units and other types of flag, paver and tile. The specially graded material produces a highly pervious mortar bed virtually free from capillary suction. This provides reliable protection against water-induced damage, e.g. efflorescence and microstructural failure through frost action, on pavements, patios, steps/stairways, landings and other outdoor surfaces. Coverings are generally laid wet on wet using Sopro HSF 748 flexible bonding slurry with trass.

Preparation of bedding mortar course:
4–5 cm for laying on bound roadbase;
8–10 cm for laying on gravel/crushed stone course for light to medium duty

Fundamentals

Pavement composition
Bonding layer

Application of bonding layer (Sopro HSF 748) by trowelling onto rear face of paving unit.

Sopro HSF 748
flexible bonding slurry with trass

Application of bonding layer by dipping paving unit into Sopro HSF 748.

Wet-on-wet laying of paving unit pretreated with bonding material in prepared Sopro DM 610 drainage mortar bed.

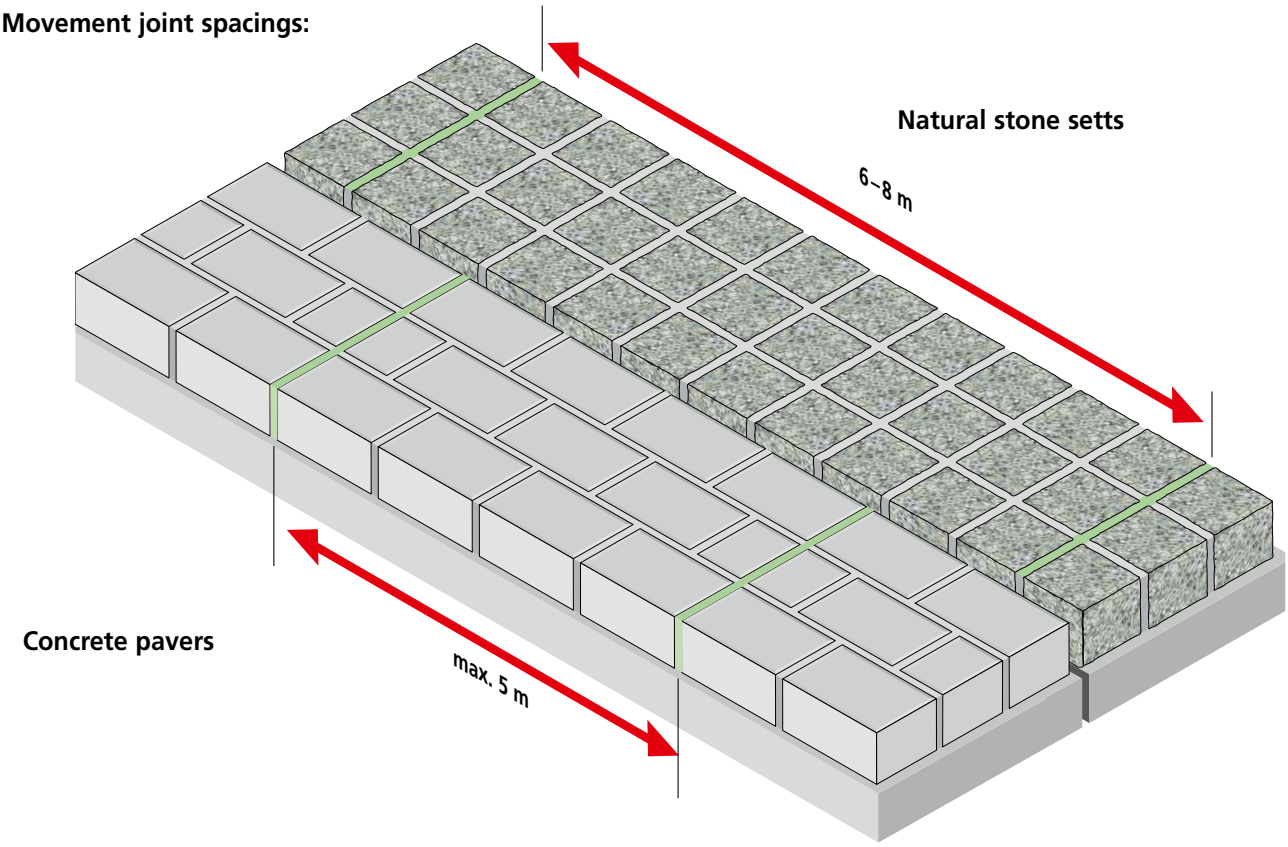
Paving unit properly aligned using stringline, then firmly tapped into place with hammer.

Use of Sopro HSF 748 ensures strong bond between bedding mortar (Sopro DM 610) and paving unit.

Special features of bound pavements (movement joints)

The thermal expansion and internal stresses acting within monolithic pavement constructions necessitate the incorporation of movement joints.

Movement joint spacings:



The provision of movement joints in pavements and drainage channels constructed from concrete/clay pavers or natural stone setts is governed by the FGSV (German Research Association for Highway and Traffic Engineering) **"Data sheet for segmental pavements"**. Depending on the paving material, movement joints are required at between 5 and 8 m centres.

A **maximum spacing of 5 m** should be adopted for concrete pavers – particularly with linear constructions – to accommodate, alongside thermal movement, the shrinkage typical of concrete.

Natural stone sett pavements may be laid with movement joints at up to max. 8 m centres.

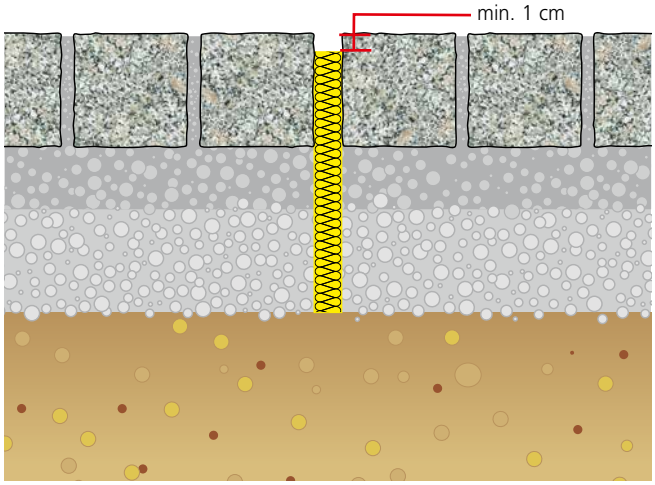
Movement joints can be incorporated by installing elastic materials in the joint prior to grouting or by making cuts in the freshly placed grout. Solutions with a proven track record include rubber expansion discs for drainage channels and the later cutting of movement joints for road surfaces.

The provision of movement joints is particularly important for linear constructions (e.g. roads, channels etc.).

Cementitious paving grouts

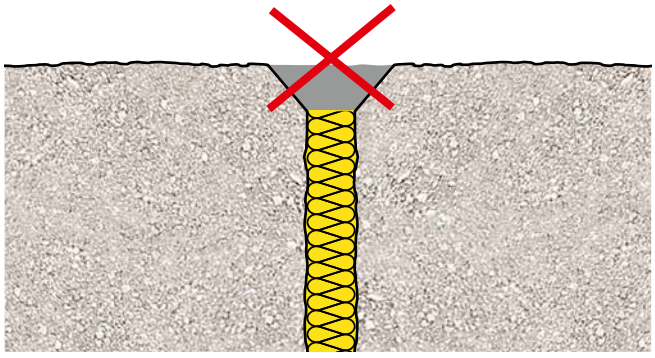
Special features of bound pavements (movement joints)

Installation of elastic materials



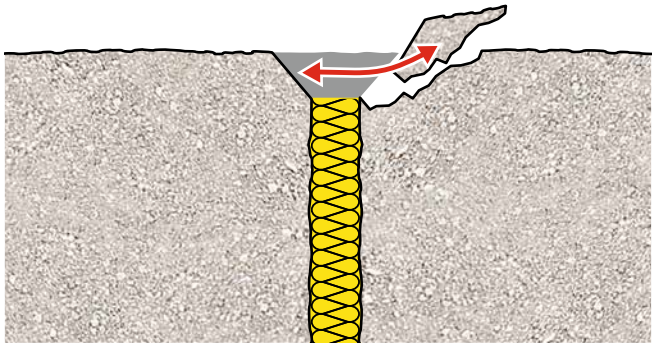
Movement joint design incorporating elastic material (rubber expansion disc), e.g. for drainage channel. Due to thermal stress-induced contraction of expansion disc, this should be installed 1 cm below pavement surface.

Rubber unit incorporated in concrete block pavement to accommodate movement.



Movement joints should not be grouted over as this will render them useless.

Grouted movement joint, preventing stress transmission and potentially causing damage to entire pavement.

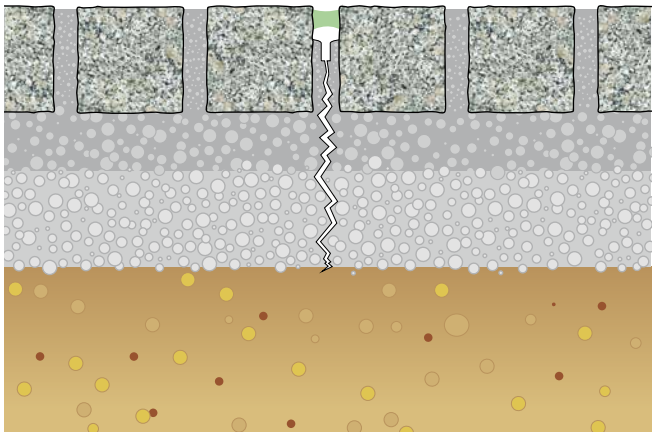


Cracking and spalling caused by covering over of movement joints.

Spalling of paving units.

Special features of bound pavements (movement joints)

Cutting of movement joints after pavement laying



One proven solution for segmental pavements subject to high loads, e.g. on roads, involves the cutting of movement joints in the finished surface. The abutting faces left in the joints by the cutting process prevent the paving units from tipping under shear loads caused by braking and accelerating vehicles.

Joints can be cut to required width by choosing suitably sized cutting discs.

Cutting of movement joint in road surface several days after laying and grouting.

Movement joint formed in road surface using angle grinder.

Cut filled with Sopro PUD 682 polyurethane sealant or Sopro TDS 823 two-component turbo sealing slurry.

Cementitious paving grouts

Specification of paving grout

The aforementioned differences between the properties of natural stone and concrete units – notably in terms of compressive strength and coefficient of expansion – necessitate the use of different grouts for the two pavement types. Most importantly, the final strength of the grout should always be significantly below that of the installed paving units. Failure to ensure this will result in damage to the pavement in the form of cracked units or surface deformation.

Natural stone units

Sopro PFM paving grout – tailored to strengths of natural stone units.

Sopro PFM, 5–30 mm

High-strength, hydraulically setting grout for finishing joints in heavy-duty natural stone pavements.

Concrete pavers

Sopro BSF 611 paving grout, through its strength and other properties, is geared to particular features of concrete pavers.

Sopro BSF 611, 5–30 mm

Rapid-set, trass-bearing, cementitious paving grout, particularly suitable for grouting joints in concrete segmental pavements in gardens/ landscaped areas and in medium- to heavy-duty vehicular pavements, including areas exposed to frost and dew.
Specially tailored to properties of concrete pavers (e.g. in respect of strength and temperature behaviour). Suitable for linear structures, e.g. roads and drainage channels, for roundabouts and for hard landscaped areas, e.g. marketplaces. Contains Rhenish trass.

Cementitious paving grouts

Application with natural stone setts (road surface)

Natural stone setts with varying joint widths – this poses no problems where Sopro PFM 575 high-strength paving grout is used.

Preparation of paving grout using stirrer.

Straightforward filling of joints due to excellent flow properties of paving grout.

Large-scale cleaning using special equipment.

Cleaning with spray lance.

Small-scale cleaning using sponge float.

Sopro PFM, 5–30 mm

High-strength, rapid-set, trass-bearing, cementitious paving grout for medium- to heavy-duty natural stone and concrete block pavements, meeting CG2 WA requirements to DIN EN 13888. Low-chromate to Regulation (EC) No 1907/2006, Annex XVII.

- For 5–30 mm joint widths
- Compressive strengths ≥ 68 N/mm²
- Resistant to suction sweeper loads
- High-strength microstructure
- High abrasion resistance
- Reduces efflorescence
- Early walkability and loadability
- Resistant to frost and de-icing salts

Cementitious paving grouts

Application with concrete pavers

40 x 40 cm concrete flags laid in thick bed on roadbase.

Even large-format concrete units can be used for bound pavements and grouted with a cementitious material.

Thorough pre-wetting of concrete segmental pavement.

Sopro BSF 611 paving grout for concrete units can be prepared within a matter of seconds.

By virtue of its workable consistency, Sopro BSF 611 allows smooth application and grouting of joints.

Addition of pigments allows preparation of grout in a variety of colours.

By adding pigments to Sopro BSF 611 on site, grout colour can be made to match concrete pavers.

Straightforward cleaning of surface by sponge roller machine.

Cleaning of surface with spray lance after initial set of paving grout.

Cementitious paving grouts

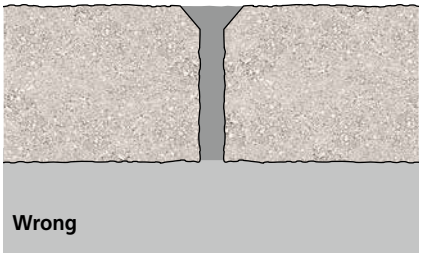
Application with concrete pavers

Note:
On account of their strength and geometry (chamfer), concrete pavers must not be grouted flush with the pavement surface. Otherwise, thermal stresses due to temperature fluctuation may lead to spalling and damage to the pavers.

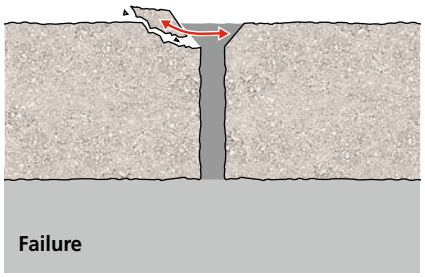
Exposed chamfer at joints, with grout colour matching concrete pavers through addition of pigment.

Properly grouted concrete pavers with exposed chamfer.

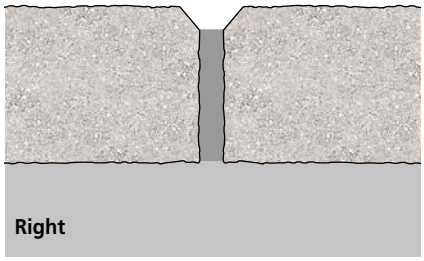
Proper grouting also ensures durable joints between large-format units.



Note: Concrete pavers must not be flush-jointed, i.e. grout should be washed out down to bottom of chamfer to prevent later spalling.



Spalling at top edge of paver due to flush jointing.



Grout washed out down to bottom of chamfer.

Sopro BSF 611, 5–30 mm

Rapid-set, trass-bearing, cementitious paving grout, particularly suitable for grouting joints in concrete segmental pavements in road, garden and landscaped areas and in medium- to heavy-duty vehicular pavements. Specially tailored to properties of concrete pavers (e.g. in respect of strength and temperature behaviour). Suitable for linear structures, e.g. roads and drainage channels, for roundabouts and for hard landscaped areas, e.g. marketplaces.

Reaction resin-bound paving grouts

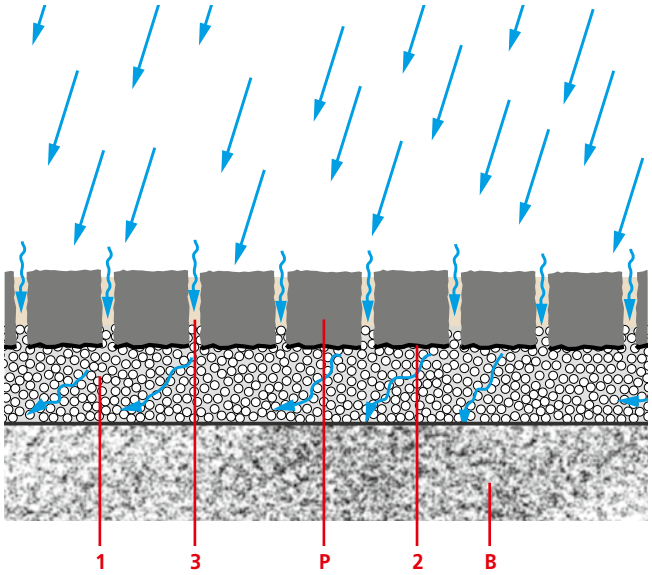
Pervious segmental paving

Sopro EPF is recommended as a bound grouting material for pervious segmental pavements. Bound materials are frequently preferred for privately used pavement areas (low maintenance).

The use of single-size silica sand aggregate ensures that the grout is water-permeable after setting. Subject to a minimum joint-to-pavement ratio, the construction can thus be deemed pervious.

This, combined with the pervious materials used for bedding course and roadbase, ensures the free drainage of rainwater from the pavement surface down to the subgrade. As described earlier in this section under "Fundamentals", the specification of bedding material and roadbase depends upon the traffic loads.

The combination of Sopro EPF two-component epoxy paving grout with Sopro DM 610, laid on a suitable roadbase material, produces an integral, pervious, bound pavement system that is also capable of withstanding high loads.



Segmental paving on Sopro DM 610 drainage mortar, grouted with Sopro EPF

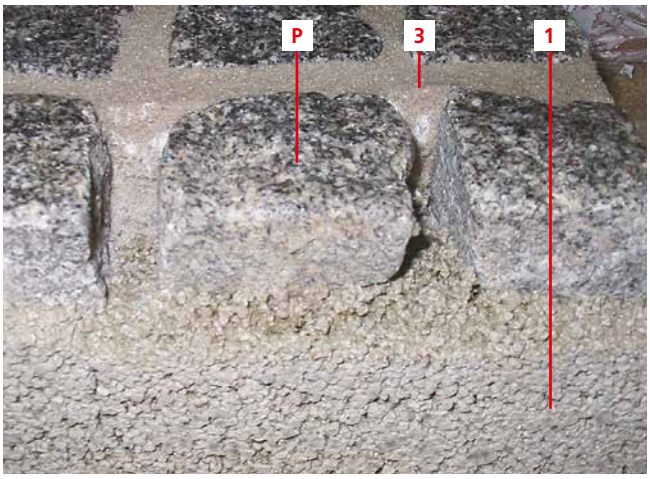
1 Sopro DM 610 drainage mortar

2 Sopro HSF 748 flexible bonding slurry with trass

3 Sopro EPF two-component epoxy paving grout/Sopro Solitär® F20 pervious grout

B Pervious concrete or crushed stone bed (roadbase)

P Paving unit



Cross-section through pervious segmental pavement.

Product recommendation

Sopro EPF two-component epoxy paving grout
for higher live loads (vehicles)

Sopro Solitär® F20 pervious grout
for low to medium live loads

Sopro DM 610 drainage mortar

Reaction resin-bound paving grouts

Bound grouts for older chippings- and sand-jointed segmental pavements

Most segmental pavements are of unbound construction. Yet, there is a growing demand among both public- and private-sector clients for bound grouting materials that produce compact, solid joints. The resanding of joints or replacement of displaced pavers, for example, is placing an increasing financial burden on municipal budgets. The problem is compounded by complaints of paved areas with deep, wide joints being difficult to walk over or negotiate with prams, wheelchairs and walking aids.

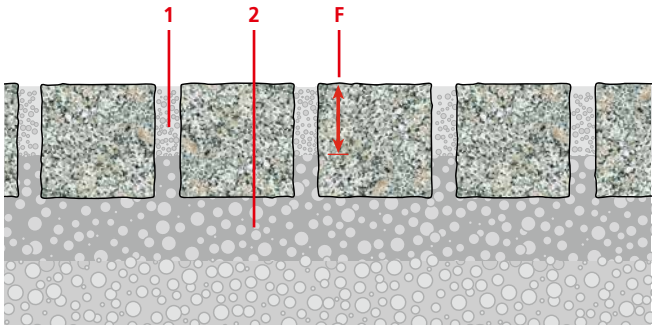
Jointing material in old segmental pavement has been washed out to considerable depth, making it difficult to walk over.

Depending on their footwear, pedestrians may catch their feet in open joints or even stumble.

Given that unbound sett, block and flag pavements are constantly subject to movement, cementitious paving grouts can be ruled out as a long-term solution! The elongation at fracture of cementitious systems is too low to accommodate the loads imposed by traffic or thermal movement. These loads would lead to severe cracking followed by dislodgement of the grout.

Reaction resin-bound paving grouts as solution

Reaction resin-bound paving grouts, which offer greater elasticity than cementitious products, represent the solution to the above problems. Their use necessitates careful preparation of the surface to be grouted. The grouted joints should be min. 4–5 cm deep and at least 6–8 mm wide. The joint faces should be clean and free from clayey material, adhesion-impairing substances and vegetation residue.



1 Bound paving grout (Sopro HFE epoxy paving grout)

2 Sand/chippings bed

F Filling depth ⅓ of paving unit thickness, though min. 4–5 cm

Sopro HFE epoxy paving grout

Easily workable, water-emulsifiable, resin-bound grout for filling top few centimetres of joints.

Reaction resin-bound paving grouts

Water-emulsifiable, two-component systems (e.g. Sopro HFE epoxy paving grout) are particularly suitable as they can be slurry-applied and achieve a good to very good level of compactness with relatively little effort. Given its water compatibility, the grout can also be applied in slightly inferior weather conditions. Depending on the product type, the joints are compacted by metal jointer, tamping or machine. The resulting surface is relatively impervious, permitting little to no drainage. The specific product guidelines must be observed.

Good flow properties of paving grout are clearly visible.

Note:

There is a growing demand for bound paving grouts to be used on inner-city paving schemes. These segmental pavements are often of unbound construction and are usually trafficked by cars and delivery vehicles. Where the settlement of such pavements has ceased, with no signs of deformation (rutting), grouting with a resin-bound product is an option. Feedback from numerous projects that have adopted this solution suggests that the relevant pavements perform well in practice. Trial application on a sample area is recommended as this may supply useful information for decision-making.

Preliminary works

After assessment and testing of the relevant pavement (possibly through trial application on a sample area), cleaning of the joints is the most important precondition for successful grouting. This means that the joints should be emptied/cleaned using high-pressure equipment/compressed air in conjunction with suitable tools or attachments. Proper adhesion of the applied paving grout to the clean faces of the paving units is essential.

Cleaning with high-pressure water jet or special compressed-air equipment.

Joints have been emptied and paving unit faces are free from adhesion-impairing substances.

Reaction resin-bound paving grouts

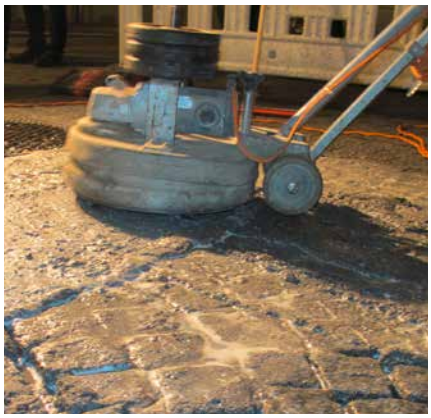
Application

Bound grouts for older segmental pavements in sand or chippings bed

Paving grouts can be applied in various ways: either by normal slurry application (with liquid grout flowing or being worked into open joints) or mechanically with the single-disc machine.

Preparation of Sopro HFE high-strength, two-component, resin-bound (epoxy) paving grout.

Smooth, easily workable Sopro HFE poured onto pavement and pushed into open joints with rubber squeegee.



Mechanical application ensures particularly good compaction of grout.

After short setting time for grout, surplus material is swept off pavement surface.

Finished pavement.

After grouting, pavement has compact, flush joints with low maintenance requirement and is comfortable to walk over.

Different grout colours cater for wide range of design options.

Even wide joints, when finished with Sopro HFE epoxy paving grout, will offer lasting visual appeal.

Reaction resin-bound paving grouts

Laying and grouting of pervious segmental pavements

Base

- **Bound roadbase (pervious) ➡ high traffic loads**
- **Compacted gravel/crushed stone bed ➡ low to medium traffic loads**

Bedding mortar

Sopro DM 610

Sopro HSF 748

Grouting

Sopro Solitär® F20

For low to medium traffic loads

Sopro EPF

For low to medium traffic loads on gravel and crushed stone bed and bound roadbases

Sopro HFE

May be used for high traffic loads on bound roadbase, though without drainage capability. Also suitable for filling joints in pavements of unbound construction, subject to examination of project-specific situation.

Reaction resin-bound paving grouts

Application
Sopro EPF two-component epoxy paving grout for pervious segmental pavements

Pre-wetting of cleaned pavement to be grouted.

Curing agent added to sand/resin mix.

Mixing of Sopro EPF with addition of water.

Workable Sopro EPF.

Joints filled with grout.

Cleaning of grouted pavement.

Sopro EPF

Water-emulsifiable, two-component, solvent-free epoxy resin grout for natural stone, concrete and clay paving units in areas subject to light to medium duty.

- For joint widths upwards of 5 mm
- Pervious
- Resistant to suction sweeper loads
- Straightforward application
- May be slurry-applied
- Resistant to frost and de-icing salts

Thick, large-format ceramics for outdoors

An expanding range of thick, large-format ceramic units is now available for the design of outdoor pavements. The new-generation ceramic paving flags are available in practically any size and with a near-limitless variety of finishes.

The key feature of these flags is their thickness, which ranges between 2 and 3 cm. Various installation options are possible, depending on the envisaged use of the area – the projected live loads being the decisive factor.

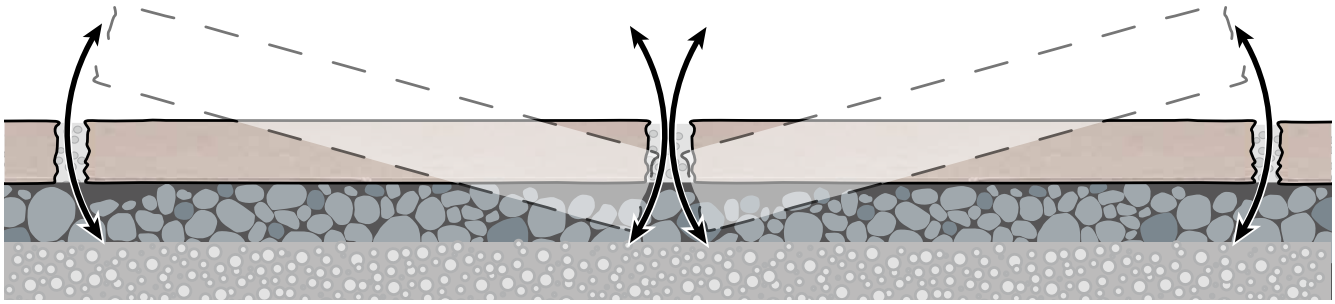
Rigid installation on a concrete ground slab or suitably thick pervious mortar bed has, of course, established itself as the best solution. Unfortunately, this is not always feasible or proves to be too elaborate. A partially bound assembly may, however, be possible in such cases.

Complete loose laying of the units is not recommended. One of the reasons is that, despite their 2 cm thickness, the flags are prone to "rocking" and vertical displacement when loaded at the edges due to leverage action and inadequate interlock between the flags at their joint faces. This may lead to the formation of "steps", i.e. trip hazards.

The above-mentioned bound or partially bound constructions are a useful option for laying flags or tiles, particularly on patios, terraces or footpaths with the associated live loads. Clients are thus provided with a continuous paved surface that is easy to maintain and remains perfectly level throughout its service life.

New-generation ceramic flags in various formats for patios and terraces.

2 – 3 cm paving units in various sizes.



Ceramic flags loose laid on gravel bed, with "rocking" or vertical displacement as upshot.

Thick, large-format ceramics for outdoors

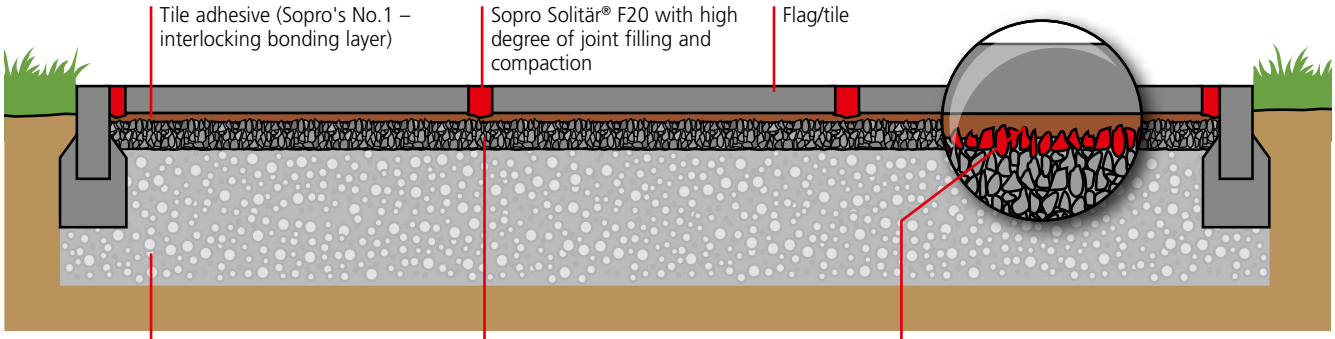
Partially bound construction on patios or footpaths with Solitär system

A partially bound construction may be adopted as long as it is known that the patio will only be subject to pedestrian traffic. To ensure the proper performance of this solution, certain parameters need to be considered.

Composition:

- Properly compacted and suitably sized frost protection course.
- Chippings bed – crushed, angular aggregate, compacted.
- Perimeter edging to area (lawn kerbing etc.).
- Units laid with tile adhesive (e.g. Sopro's No.1, min. 10 mm serration) combed onto rear face to achieve interlock between units and chippings.
- Joints filled with Sopro Solitär® F20 using water hose to wash in grout.
- Once Sopro Solitär® F20 has cured, it will remain pervious and tough-elastic.

Sopro Solitär® F20



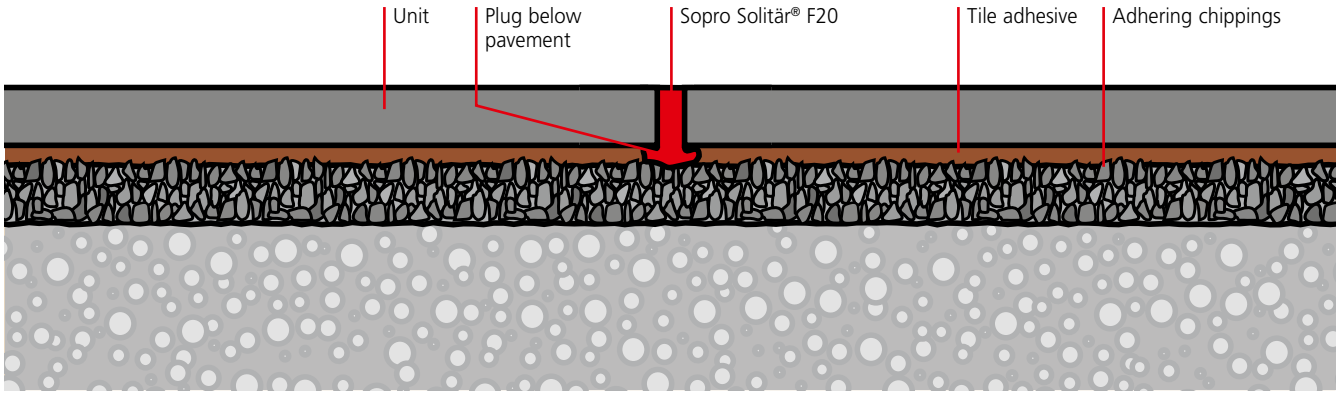
Adhesive (e.g. Sopro's No.1) applied to rear face of units.

Embedded chippings on rear face are clearly visible.

Straightforward grouting with Sopro Solitär® F20 using water hose and rubber squeegee.

Thick, large-format ceramics for outdoors

Note
A strong interlock is created between the tile adhesive applied to the rear face of the paving units and the compacted chippings. When the adhesive has cured, the units are able to accommodate lateral shear forces without displacement. The adhesive and adhering chippings also add mass to the pavement and thus provide further stability against movement. The applied Sopro Solitär® F20 grout flows into the joints and forms a "plug" in the lower pavement zone that holds together the units. As the grout remains pervious and tough-elastic, it exhibits a certain springiness when the pavement is loaded while also performing a drainage function. This solution can also be adopted for concrete and natural stone units. (With natural stone, a trial application may be advisable to rule out the risk of discoloration in response to the specific mineralogical composition.)



Composite action between tile adhesive and Sopro Solitär® F20 grout.

Application of Sopro Solitär® F20

Grout easily washed into joint with water hose and rubber squeegee.

Filled joints combine with paving units to create an appealing finish.

Thick, large-format ceramics for outdoors

Installation of bound-construction patio with 2 cm ceramic flags

Placement of unbound frost protection course.

Compaction of unbound base and frost protection course.

Preparation of Sopro DM 610 drainage mortar for bedding layer using screed pump.

Compaction and striking off of pervious mortar bed at required level.

Sopro MEG 665 megaFlex S2 highly flexible tile adhesive combed onto rear face of flag for laying by buttering method.

Installed flag paving, ready for finishing with Sopro FL plus flexible tile grout.

Cold-applied asphalt for small areas and repairs

Roads and other vehicular pavements are constantly exposed to weather action in conjunction with often high traffic loads. This inevitably leads to regular instances of damage that may permanently affect or disrupt traffic flows.

Such damage often amounts to no more than minor defects (e.g. potholes) in the road surface that can be promptly repaired by road and municipal works units. Given the need to reopen roads and other paved areas as soon as possible, the adopted solutions must allow rapid application and early trafficking after a minimum period of interruption.

In addition to the repair of road damage, bituminous materials are also commonly required for diverse small-scale applications. With only small quantities of material needed, the use of hot-mix asphalt is hardly viable if only on account of the disproportionate logistical effort this would involve.

Sopro KA 655 cold-applied asphalt offers the ideal solution for the efficient handling of minor repairs and small areas, even at cold temperatures.

Cold-applied asphalt for filling damaged areas in segmental paving.

Typical road damage after a long winter or heavy traffic loads.

Sopro KA 655
cold-applied asphalt

Cold-applied asphalt for small areas and repairs

Construction of access ramp.

Sopro KA 655 is cold-applied ...

... and spread across the area to slightly above required level.

Area is dampened with water prior to compaction.

Sopro KA 655 is then compacted by plate compactor.

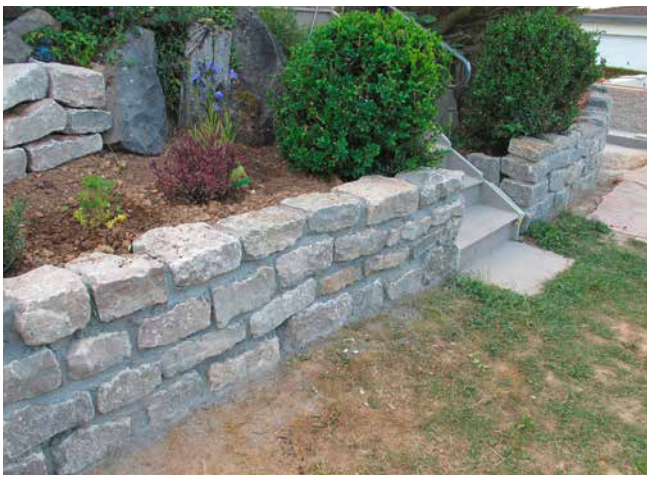
Finished area is walkable immediately after compaction.

Garden walls

Given the irregular topographies of many development sites, houses and other buildings often have to be constructed on sloping terrain.

The creation of horizontal surfaces, e.g. patios, around the house necessitates the placement of fill. Naturally enough, the garden walls built to retain these areas are required to double up as design features to embellish the building surrounds. Concrete and natural stone are the common choice for constructing such walls.

Due to their dimensional accuracy, concrete blocks (e.g. for the RINN Toskana wall) can be bonded using the thin-bed method.



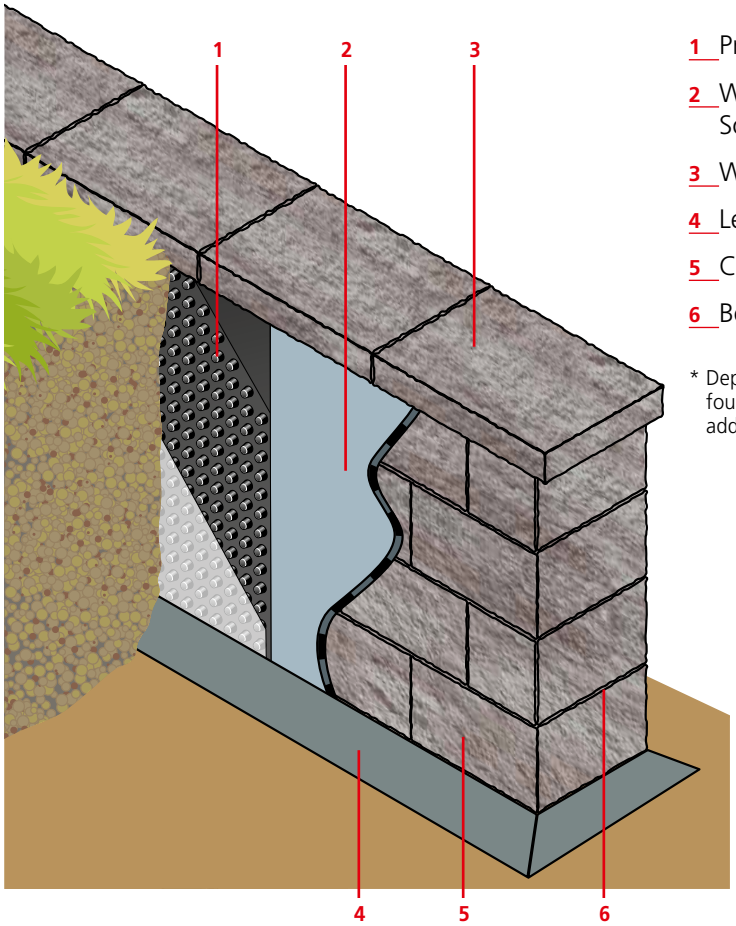
Natural stone blocks are laid with Sopro TVM 858 thick-bed mortar with trass, which accommodates required joint widths and compensates for different block thicknesses.

Construction

Regardless of the selected material, the walls need either a lean-concrete footing or, for greater heights and loads (e.g. where a garage entrance lies above the wall), a reinforced-concrete foundation with starter bars. All relevant criteria, including soil quality, wall height and loads to be accommodated, thus need to be clarified by the designer in advance and factored into the wall and foundation detailing. Here, the masonry block manufacturers are glad to provide support with the design and structural calculations.

Prepared foundations.

Garden walls



1 Protective Sopro KDS 663 basement drainage mat

2 Waterproof membrane installed with Sopro TDS 823, Sopro ZR 618 or Sopro DSF 623

3 Wall coping with drip

4 Lean-concrete foundation*

5 Concrete masonry block (e.g. RINN Toskana)

6 Bonding with Sopro DBE 500 epoxy tile adhesive

* Depending on wall height and loads imposed by retained areas, foundation may need to be reinforced or concrete backing provided for additional support.

To prevent migration through the wall of water accumulating at the rear (rainwater, perched water in slope) – which would impair both its strength and visual appeal (through staining and efflorescence) – a waterproof membrane is required on the rear face. This is particularly important for concrete walls given that concrete blocks are prone to efflorescence when exposed to permanent moisture migration.

Waterproof membrane applied to rear wall face by thick/block brush. Sopro ZR 618 Turbo MAXX should be used for this purpose.

Garden walls

With concrete block walls, the high dimensional accuracy of the individual units allows them to be laid in a thin adhesive bed. The foundation must be built to extremely tight tolerances as thin adhesive layers offer little scope for correction when the blocks are laid.

Foundation for wall construction.

Adhesive (Sopro DBE 500 epoxy tile adhesive) applied with notched trowel.

Block laying.

Application of (Sopro DBE 500) adhesive: front zone (1–1.5 cm) left free so as to prevent soiling of block face.

Wall with coping.

Note
Where walls, whether concrete or natural stone, are topped by a coping – which serves to improve the durability of the wall – it is important to provide for elastic joints between the individual coping units. These units are subject to high stresses from thermal action. To prevent any build-up of these stresses due to "rigid" joints and consequent adhesion failure, the provision of such elastic joints is essential.

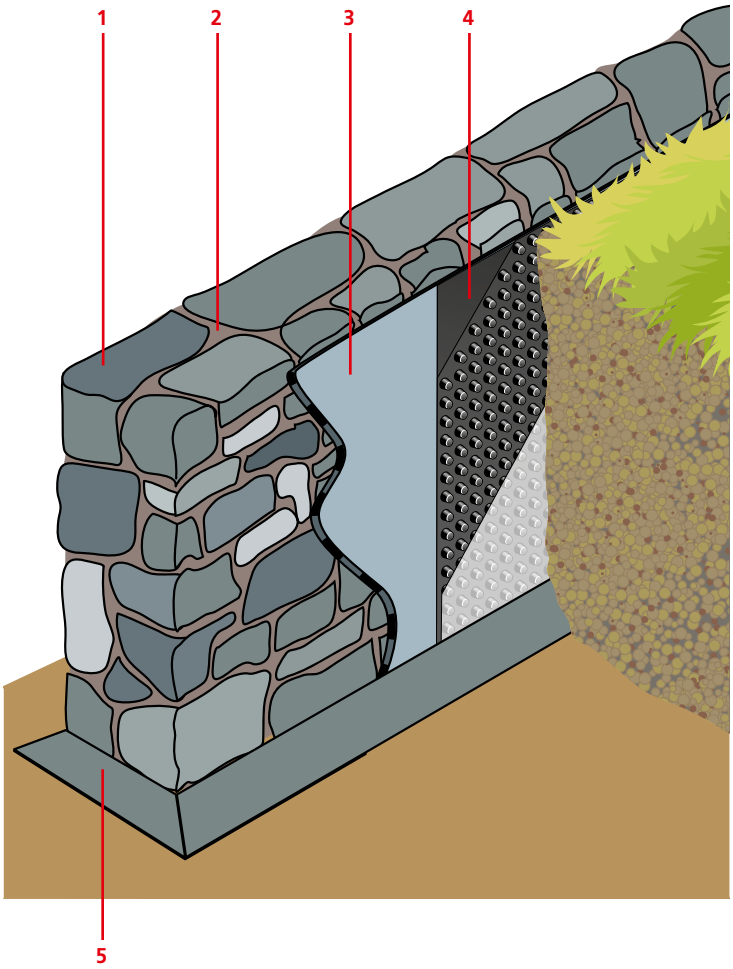
When masonry joints have cured, rear wall face requires waterproofing (Sopro ZR 618). Sopro KDS 663 basement drainage mat should be incorporated as protective layer prior to backfilling.

Garden walls

The thin-bed method cannot normally be adopted for natural stone walls due to the irregularity of the blocks. Consequently, the mortars used for laying natural stone units must be designed to accommodate their large dimensional tolerances. Here, Sopro TVM 858 thick-bed mortar with trass is the ideal solution.

Dressed units for garden wall construction.

Large and varying joint widths are the result.



Natural stone wall

1 Natural stone unit

2 Sopro TVM 858 thick-bed mortar with trass

3 Waterproof membrane installed with Sopro TDS 823, Sopro ZR 618 or Sopro DSF 623

4 Protective Sopro KDS 663 basement drainage mat

5 Lean-concrete foundation*

* Depending on wall height and loads imposed by retained areas, foundation may need to be reinforced or concrete backing provided for additional support.

Garden walls

Bedding mortar is mixed to stiff, plastic consistency.

High adhesive strength and sag resistance of pictured mortar allows it to support sometimes very heavy blocks.

Trass mortar is easy to lay and mould with trowel or metal jointer.

Depending on wall height and pressure from retained earth, concrete backing may be needed to strengthen wall. A waterproof membrane must also be installed using Sopro ZR 618 Turbo MAXX prior to backfilling.

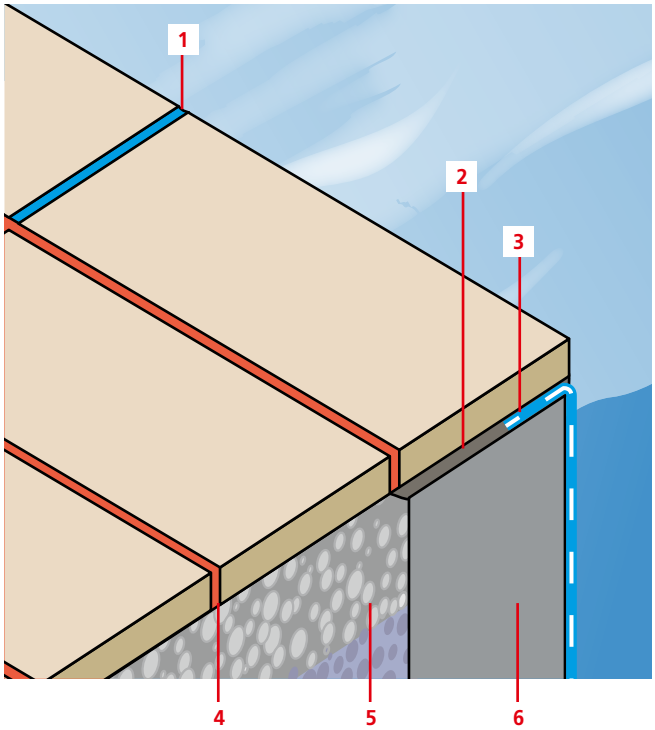
Swimming pool surrounds

Outdoor pools should normally be provided with paved surrounds. Not only does this enhance the aesthetic impact and visual appeal, it also facilitates access to and prevents soiling of the pool.

Pool constructions can vary widely: they may comprise reinforced-concrete structures lined with tiles or sheet membranes, or be made from glassfibre-reinforced plastics (GRP) or stainless steel. Yet, virtually all require a pool edge assembly incorporating natural stone, cast stone or ceramic units.

Bonding such units to concrete surfaces normally poses no problems. With GRP, sheet linings or stainless steel, however, special adhesives are needed to achieve a strong bond.

Natural stone or ceramic covering as surrounds to membrane-lined or GRP pool.



1 Elastic jointing material

2 Reaction resin adhesive (Sopro DBE 500/Sopro PUK 503/Sopro MEG 666)

3 Swimming pool sheet membrane

4 Sopro Solitär® F20 pervious grout

5 Chippings bed or drainage mortar construction

6 Concrete

Membrane-lined pool with natural stone units.

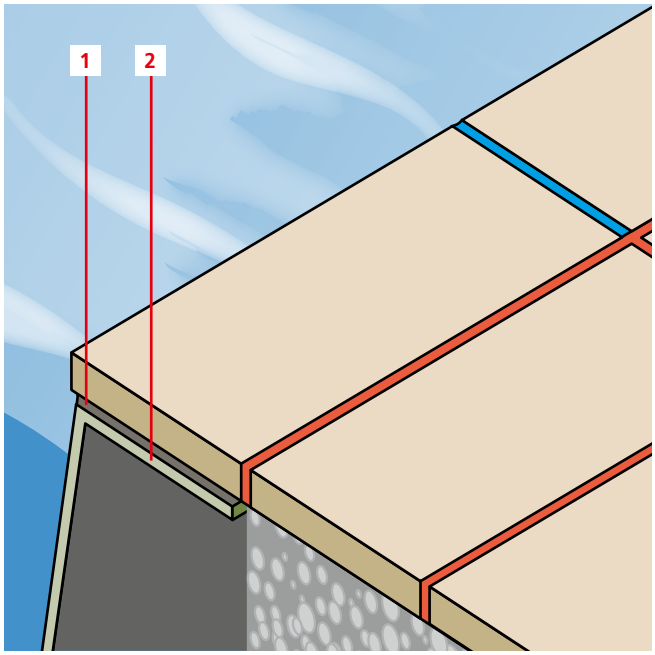
Paving units (made by Rinn) are bonded to lining and concrete with Sopro DBE 500 epoxy tile adhesive. Lining is bonded to concrete with Sopro PUK 503 PU adhesive.

Swimming pool surrounds

Glassfibre-reinforced plastics (GRP) pool

1 Reaction resin adhesive (Sopro PUK 503)

2 GRP shell



Thermal action

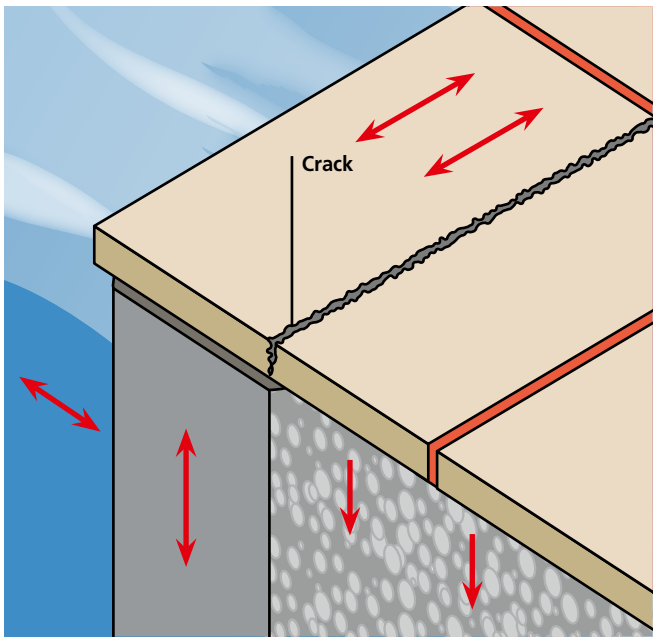
Pool edge waterproofings are exposed to fluctuating temperatures and thermal action. Due to the coefficients of thermal expansion of their constituent materials, they may expand and contract. Depending on the length of the units, all joints must be sealed with an elastic sealant (e.g. Sopro Marble Silicone). This prevents the accumulation of thermal stresses and consequent risk of adhesion failures.

Provision is required for elastic joints at the ends of the pool edge units.

Note
Sopro's Technical Service and Project Consulting teams will be glad to provide support with the detailing and product selection for the specific pool edge construction and deployed materials.

Sopro PUK 503

Sopro DBE 500



Due to the varying behaviour (settlement and expansion) of pool and pool edge area, the pool edge units should not extend into the pool deck areas as this would result in cracking and fracturing.