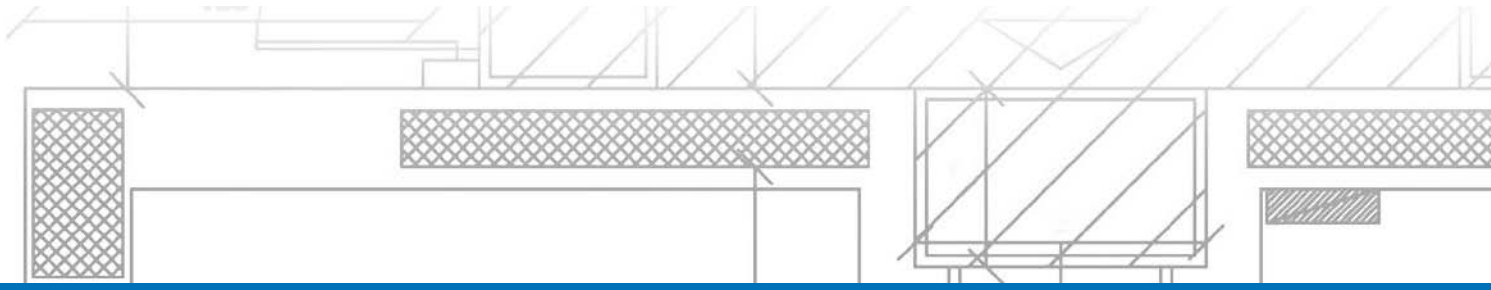
Technical Notebook

INSTALLATION OF HEATED SCREEDS AND SUBSTRATES FOR LAYING FLOORS



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Technical Notebook

INSTALLATION OF HEATED SCREEDS AND SUBSTRATES FOR LAYING FLOORS

1. INTRODUCTION

The aim of this Technical Notebook is to define the fundamental criteria to be considered when designing and laying screeds, and to highlight the products available from MAPEI for laying durable screeds.

The service life and functionality of any type of flooring, whether the material used is ceramic, stone, textile, resilient or wood, are highly dependent on the physical and elastic-mechanical characteristics of the substrate on which it is installed. These properties must be defined according to a number of factors, such as the final use of the flooring, which basically means the loads acting on its surface, environmental conditions, the type of flooring to be installed, the compressibility of the underlying layers and any deflections in the concrete floor slab.

REFERENCE STANDARDS

UNI EN 13813

Screeds materials and floor screeds – Screeds materials – properties and requirements.

UNI EN 1264-4

Water-based surface embedded heating and cooling systems – Part 4: Installation.

UNI EN 10329

Floor covering laying – Measurement of humidity into the concrete or similar floor screeds.

2. WHAT IS A SCREED?

A screed is a construction element laid in a range of thicknesses, and its purpose is to bring the installation surface for the flooring to the design height and to provide a surface suitable for installing the specified flooring. Screeds are usually made from pre-blended mortar mixed with cementitious binders or anhydrite-based binders. Depending on whether it is laid directly on a supporting structure (for example a reinforced concrete floor slab), on an isolating layer (for example a vapour barrier) or on a layer of thermal insulation and/or soundproofing material, it is known as a “bonded”, “unbonded” or “floating” screed. A screed may also have an underfloor heating/cooling system incorporated within its structure and, in such cases, is known as a “heated” screed.

When a screed is laid, it must mainly guarantee the following:

- that it forms a substrate suitable for installing the specified flooring;
- that it is laid on schedule;
- that its durability under various service conditions (laid internally or externally, for civil, commercial or industrial flooring, etc.) is not compromised.

The durability of flooring, therefore, is influenced by the characteristics of its substrate, which means the type of product selected to make the substrate, the quality of preparation work, how it is laid and the compactness and curing of the mix.

To sum up, when choosing which product to use to make the screed, be it a special binder, a pre-blended mortar or traditional site-prepared mortar, you must take into consideration the final use of the screed, site conditions (internal or external, the thickness to be laid, etc.), the type of flooring to be installed, the time to wait before installing the flooring and the time required before putting the flooring into service.

3. TECHNICAL AND PERFORMANCE CHARACTERISTICS OF SCREEDS

To be suitable for installing flooring, the screed must have the following characteristics:

- **SUFFICIENT THICKNESS**: its thickness depends on the type of screed to be laid (see Section 4 “Types of screed”), and must be sufficient for the type of flooring to be installed and the type/intensity of traffic acting on it when in service.

- **MECHANICALLY RESISTANT**: its mechanical strength, as with thickness, must be sufficient for the final use of the floor and for the type of flooring to be installed. As a general rule, the mechanical strength of a screed suitable for installing any type of flooring for domestic use must be at least 20 MPa, while for industrial use it must be at least 30 MPa.

- **COMPACT**: the screed must be compact and homogeneous on the surface and through the whole thickness. The presence of layers or areas of crumbling lower density material is a sign of poor mechanical characteristics which could cause breakage or detachment of the flooring. These areas must be carefully assessed and, according to the seriousness and extent of the defect, they must be removed and repaired or consolidated with suitable products.

- **CURED AND DIMENSIONALLY STABLE**: before installing any type of flooring, it is absolutely essential that the screed is cured and that most of the shrinkage is completed. In fact, during the curing cycle, screeds are prone to hygrometric shrinkage due to part of the mixing water evaporating or drying off. This may cause curling or cracking (Fig. 3.1 and Fig. 3.2). If cracks develop after installing the flooring (Fig. 3.3), the floor covering could be damaged and/or become detached.

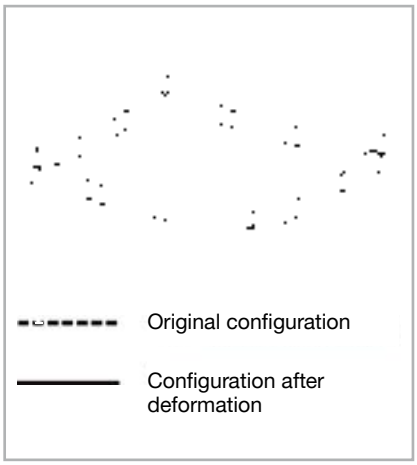


Fig. 3.1 - Typical “sail” type deformation of an area of flooring subject to curling

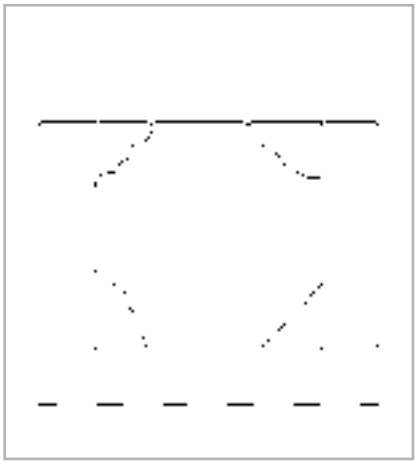


Fig. 3.2 - Schematic diagram of cracks generated by curling in a square area

The curing time for a traditional sand-cement screed is around 7-10 days per centimetre of thickness in good weather. Turnaround times for a screed made from traditional cementitious mortar, therefore, can be particularly long (more than 1 month). However, it is possible to reduce curing times considerably by using special admixtures, or by using special binders (such as **MAPECEM** or **TOPCEM**) or pre-blended, controlled-shrinkage, rapid-drying and setting mortar (such as **MAPECEM PRONTO** or **TOPCEM PRONTO**) in the mix.

- **CRACK-FREE**: there are a number of causes of cracks in screeds, such as hygrometric shrinkage, too much water in the mix, the use of aggregates which are too fine or too much cement. Before installing flooring, all cracks must be monolithically sealed by filling them with epoxy resin, such as **EPORIP** or **EPOJET**. If there are hairline cracks on the surface of the screed, or if ceramic or stone flooring is to be installed, it is possible to lay an anti-fracture membrane such as **MAPETEX** on the screed.

Fig. 3.3 - Serious damage caused by "curling" at an advanced state

- **CLEAN**: The surface of the screed must be perfectly clean. Dust, dirt, detached areas, rubble and any other material or substance on the surface of the screed must be removed before installing the flooring to prevent compromising adhesion between the flooring and the screed (Fig. 3.4).

Fig. 3.4 - Ceramic tile detached from a crumbly screed

- **DRY**: The level of residual humidity in the screed must be checked. It must conform to the maximum level for that type of floor covering and must be uniform through the whole thickness of the screed, especially when installing flooring sensitive to humidity. For cementitious-based screeds, levels of less than 2% for wooden floors and less than 2.5-3% for PVC, rubber and linoleum are considered acceptable. For anhydrite screeds, the level of residual humidity must be less than 0.5%, whatever type of floor covering is installed.

The level of residual moisture in a screed is measured using an electric or carbide hygrometer (Fig. 3.5).

- **FLAT**: flatness is checked by laying a straightedge at least 2 metres long in all directions on the surface of the screed (Fig. 3.6). The maximum acceptable tolerance with this particular straightedge is 2 mm, although the acceptable tolerance varies according to the length of the straightedge used to check for flatness. If the flatness is not in tolerance, the surface must be levelled off using a suitable product before installing the flooring.

- **SMOOTH**: the suitability of the grade of finish of the surface and, therefore, its level of roughness, depends on the type of flooring to be installed. For example, a rough surface with open pores helps the screed dry out and improves adhesion of skimming coats and adhesives. If, on the other hand, a perfectly smooth, reflective finish is required, for example when installing resilient flooring, it is advisable to apply a skimming product designed specifically for this kind of use on the surface of the screed.

Fig. 3.5 - The most reliable instrument to measure residual moisture in a screed is a carbide hygrometer

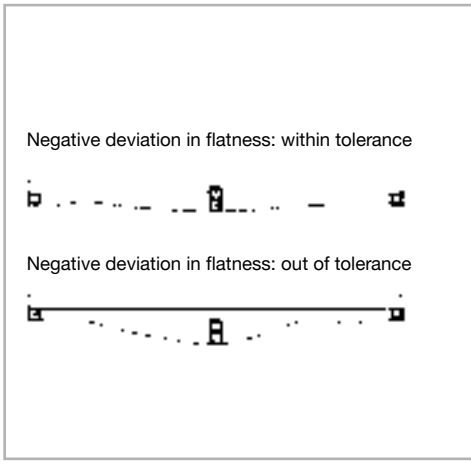


Fig. 3.6 - Method used to check the flatness of flooring

4. TYPES OF SCREED

Screeds may be divided into the following types, depending on their stratigraphic layout:

- UNBONDED

- FLOATING

- BONDED

- HEATED

4.1 UNBONDED SCREED

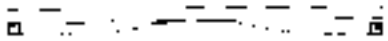
An unbonded screed (Fig. 4.1) is formed by laying a horizontal separation layer (for example polyethylene or PVC sheets) between the screed and substrate (for example a reinforced concrete capping layer), and positioning compressible material, such as 10 mm thick polystyrene or **MAPESILENT BAND R**, around the perimeter of the walls and around pillars. The sheets must overlap each other by at least 200 mm and be taped together, while the edges and ends are folded upwards by 100 mm onto the pillars and walls. For foot traffic, this type of screed must be at least 35 mm thick. The advantages of an unbonded screed (Fig. 4.3) are as follows:

- Flooring is not in contact with the main structure and is less affected, therefore, by deformations in the structure (e.g. settling, hygrometric shrinkage, thermal expansion, small amounts of give in the foundations, etc.).

- Thick screeds may be laid without having to worry about excessive drying times or the formation of cracks caused by shrinkage in lightened sub-layers. In this case, a layer of lightened concrete to embed pipe-work is laid on the reinforced concrete floor slab, followed by the separation layer (which also acts as a vapour barrier) (Fig. 4.2).

Positive deviation in flatness: within tolerance

Positive deviation in flatness: out of tolerance



- The polythene or PVC sheets are thick enough to create an efficient vapour barrier to prevent damp rising from the substrate.

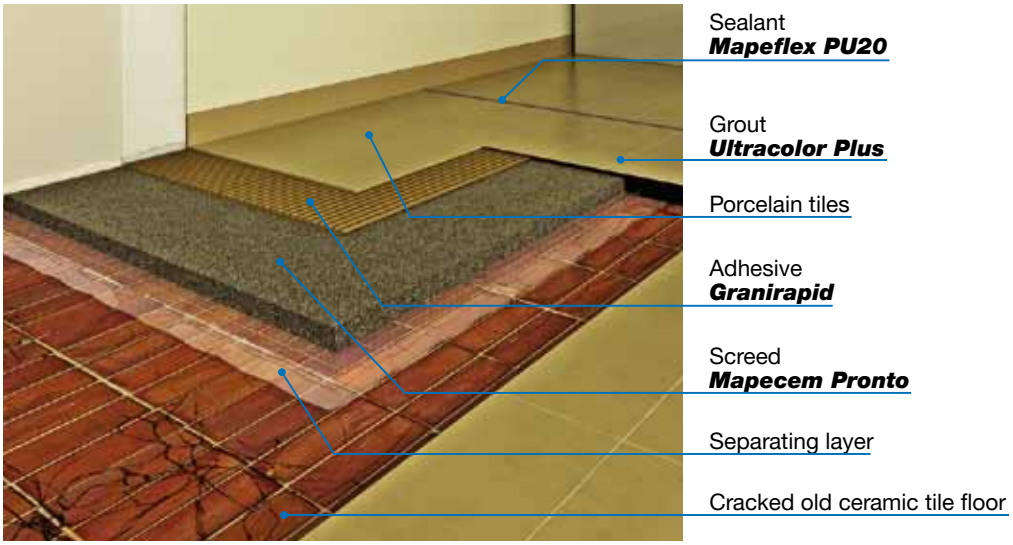


Fig. 4.1 - Example of an isolated screed with sheets of polyethylene installed over old, cracked ceramic flooring

This type of screed, especially when it is not very thick, is more prone to curling. To prevent this type of problem, it is very important that the minimum specified thickness for unbonded screeds is strictly adhered to, and it is preferable to make the screed using products with low rates of shrinkage and high mechanical characteristics (such as **MAPECEM**, **MAPECEM PRONTO**, **TOPCEM** or **TOPCEM PRONTO**).

4.2 FLOATING SCREED

A “floating” screed is an unbonded screed applied over a layer of thermal insulating material, such as expanded polystyrene or polyurethane panels (Fig. 4.3.1), or soundproofing material (Fig. 4.3.2). The aim of this type of solution is to comply with the limits set by local laws, which define the minimum performance requirements of soundproofing systems in buildings according to their final use.

Fig. 4.2 - Laying an unbonded screed on polyethylene sheets

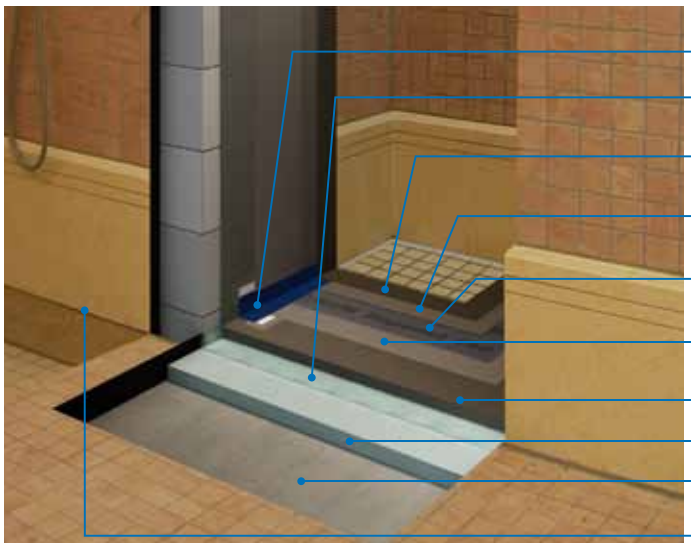


Fig. 4.3.1 - Example of an isolated screed installed over a layer of thermal insulating panels

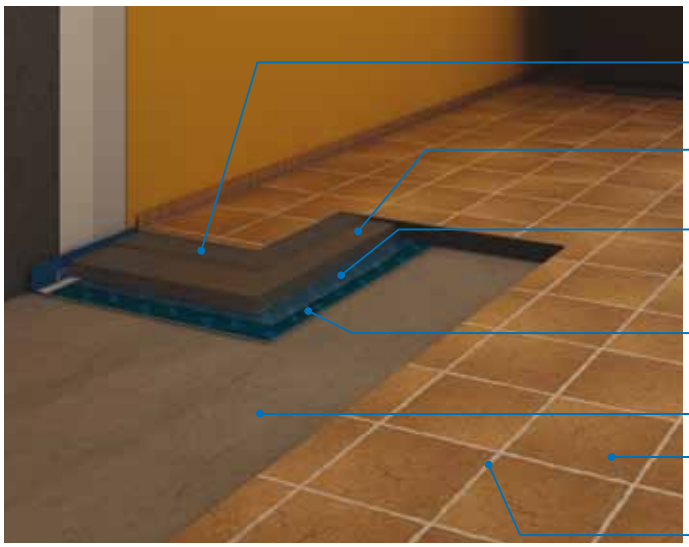


Fig. 4.3.2 - Floating screed soundproofed with MAPESILENT SYSTEM

The minimum thickness of a floating screed is calculated by considering the intrinsic characteristics of the material used to make the screed and the mechanical stresses to which it will be subjected under normal conditions of use (Table 1).

	THICKNESS OF SCREED	REINFORCEMENT
I: Thickness <3 mm	4 cm	Reinforcement not required
I: Crushing* <0.5 mm and thickness >3 mm	4 cm 5 cm	50x50 mm mesh, ø = 2mm Reinforcement not required
II: Crushing* >0.5 mm and ≤ 3mm	4 cm 5 cm	50x50 mm mesh, ø = 2mm Reinforcement not required
III: Crushing* >3 mm and <12 mm	4 cm 5 cm	100x100 mm mesh, ø = 5mm 50x50 mm mesh, ø = 2mm

*Crushing refers to the reduction in thickness of the insulating layer following the compressive force from a "standard" load

Table 1: Minimum thickness of floating screeds and characteristics of reinforcement according to the compressibility class of the isolating layer.

Traditional cementitious-based substrates must be at least 40 mm thick, and the thickness must be increased accordingly if the loads when in service are high. Electro-welded reinforcement mesh should be inserted at the mid-point of the screed to distribute loads and prevent depressions, especially when the screed is not particularly thick (40-50 mm).

Products from the **MAPESILENT** range may be used to make a floating screed designed for soundproofing from the noise of footsteps.
The system is made up of **MAPESILENT ROLL**, **MAPESILENT PANEL**, **MAPESILENT BAND R**, **MAPESILENT TAPE** and **MAPESILENT UNDERWALL**, and is a simple, efficient way to create a floating screed which is perfectly isolated from the structure, and on which it is possible to install any type of flooring such as ceramic, stone, parquet, PVC, linoleum, etc. (Fig. 4.4).

The specific products which make up the system allow the limits set by D.P.C.M. 5-12-97 to be complied with, and the most demanding acoustic efficiency classes (Class I and Class II) in the new technical standard UNI 11367 - *"Acoustic classification of buildings"*- to be reached.
The excellent performance of the **MAPESILENT** system is illustrated in the readings taken on site by *qualified Environmental Acoustics technicians*, who have registered reductions in the noise of footsteps (ΔL_w) of more than 30 dB, in full compliance with the requirements of D.P.C.M. 5-12-97 and the most demanding acoustic efficiency classes (soundproofing from footsteps) according to UNI 11367.

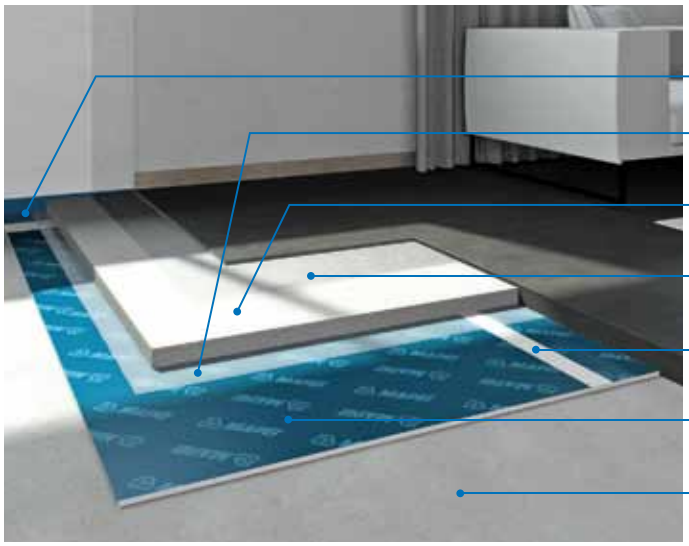


Fig. 4.4 - Floating screed soundproofed with MAPESILENT SYSTEM

Apart from its excellent soundproofing performance and ease of application, the **MAPESILENT** system is also noteworthy for its high resistance to foot traffic and impact during site operations, often the cause of damage in the continuity of the layer and, therefore, its soundproofing capacity (a typical problem with expanded polyethylene systems).

4.3 BONDED SCREED

If there is not enough space available (less than 35 mm) to lay an unbonded screed, a bonded screed which bonds to the underlying slab must be laid (Fig. 4.5) by taking the following measures:

- Make sure that the floor slab is well cured, sufficiently resistant, that there are no traces of dust or crumbling portions and that it has a rough surface.

- If flooring sensitive to humidity is to be installed (for example wood, PVC, etc.), before laying the screed make sure the level of humidity in the floor slab is within the limits specified for this type of flooring and that there is no rising damp.

- To guarantee that the screed bonds perfectly, spread a layer of bonding slurry made from **PLANICRETE**, water and the same binder

used to make the screed according to the dosage rates in Table 2 on the substrate.

- When a thickness of only a few centimetres is laid over concrete flooring, or if the screed is laid in areas subjected to high mechanical stresses, use **EPORIP** epoxy adhesive instead of **PLANICRETE**-based bonding slurry.

- Whatever type of adhesion promoter is used, the new mix must be applied using the “wet on wet” technique.

- Perimeter joints must be made around the room and around pillars by inserting 10 mm thick compressible material, such as expanded polystyrene. Also, joints must be made in correspondence with those in the floor slab.

	CEMENT	TOPCEM	MAPECEM
PLANICRETE (parts in weight)	1	1	1
WATER (parts in weight)	1	1	1
BINDER OR PRE-BLENDED MORTAR (parts in weight)	2	3	2

Tab. 2 - Recommended doses for PLANICRETE-based bonding slurry

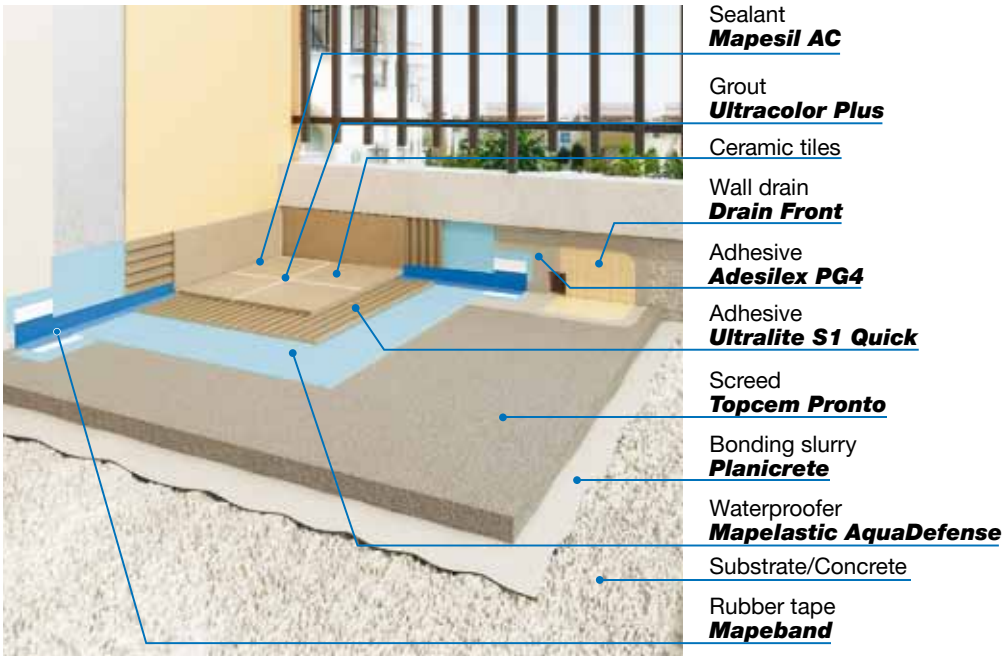


Fig. 4.5 - Bonded screed made using PLANICRETE-based bonding slurry

Fig. 4.6 - Layout of heated elements for an underfloor heating system

Fig. 4.7 - Laying a screed with embedded heated elements for an underfloor heating system.

4.4 HEATED SCREED

A heated screed is a floating screed with elements (pipe-work in plastic or composite material) embedded in the screed in a spiral or coil pattern (Fig. 4.6 - 4.7) and, depending on the time of year, has hot or cold water flowing through the elements. The water is usually at a temperature of between +30°C and +40°C when rooms require heating, and between +15°C and +18°C to cool rooms down. The elements are inserted above insulating panels (Fig. 4.8) so that heat propagates only in the direction of the room to be heated or cooled down. When designing this type of screed, the thickness of screed above the elements must be at least 30 mm according to UNI 1264-4 standards and metallic reinforcement mesh must be inserted in the screed. The size of the mesh will depend on the total thickness and design loads. Also, the pipe-work which passes through the joints must be protected by a slip-on sheath or sleeve. The screed must only be laid after the pipe-work has been tested for leaks. Around the perimeter of the room and the pillars, insert 10 mm compressible material such as expanded polystyrene. Only in the case of residential environments, where due to design or site requirements or to reduce the thermal inertia of the screed made from **MAPECEM PRONTO**, the thickness of the screed above the heated elements may be reduced to a minimum of 15 mm and reinforced with galvanized mesh.

Please note, however, that even though under these specific conditions the screed is suitable for any type of flooring, it does not meet the requirements of UNI 1264-4 standards.

To reduce the thickness to the minimum possible, we recommend using cementitious or special binders with low shrinkage and high mechanical strength (such as **TOPCEM**, **TOPCEM PRONTO**, **MAPECEM** or **MAPECEM PRONTO**). **MAPECEM**, **MAPECEM PRONTO**, **TOPCEM** and **TOPCEM PRONTO** may be used to make heated screeds without the need for other admixtures.

It is worth mentioning that **TOPCEM PRONTO** has an excellent, certified thermal conductivity λ value of 1.62 $\frac{W}{mk}$.
With traditional send-cement screeds mixed on site, a super-plasticising admixture such as **MAPESCREED 740** should be added to guarantee relatively high thermal conductivity and that the pipe-work is completely embedded. By adding this special admixture at a rate of 1-1.5% of the weight of the cement, the water/cement ratio may be reduced and both its workability and thermal diffusion efficiency are improved.
When the curing cycle has been completed, which varies according to the type of binder used, switch the heating system on to check that it functions correctly and to complete the curing cycle of the screed.

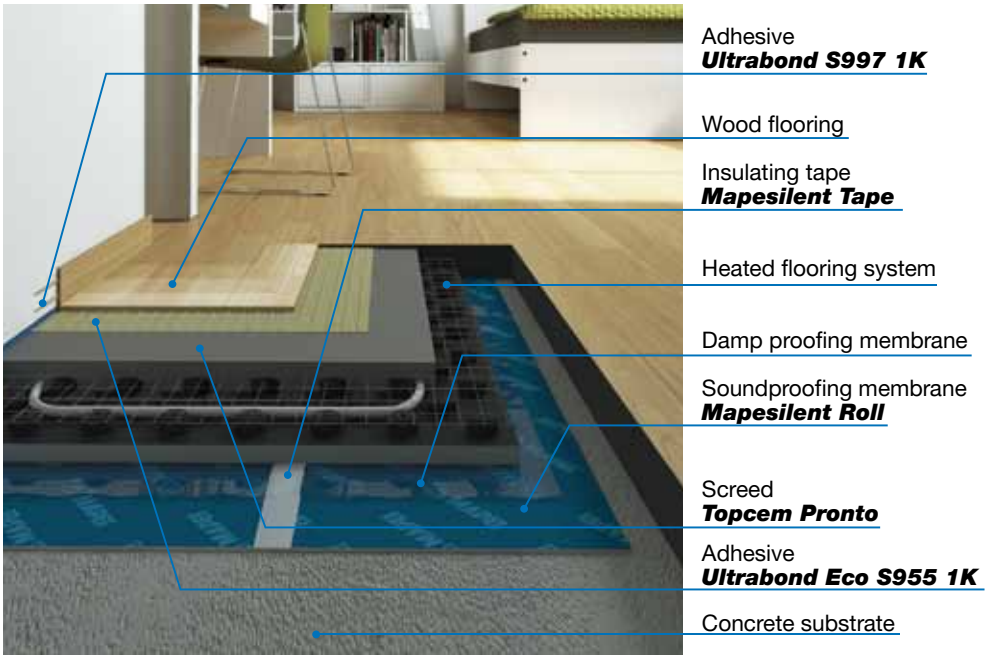


Fig. 4.8 - Heated screed with both hot and cold water flowing through the heating elements

Fig. 4.9 - Floor slab isolated acoustically by laying MAPESILENT ROLL, MAPESILENT BAND R and MAPESILENT TAPE.

Fig. 4.10 - Floor slab isolated acoustically by laying MAPESILENT PANEL, MAPESILENT BAND R and MAPESILENT TAPE.

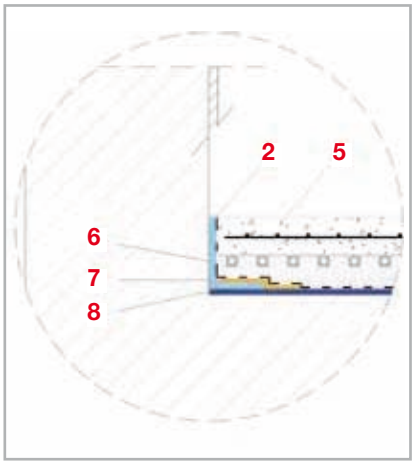


Fig. 4.11 - Various steps in applying MAPESILENT BAND R

	TOPCEM	TOPCEM PRONTO	MAPECEM	MAPECEM PRONTO
Recommended dose (kg/m^3)	200-250	-	350-450	-
Residual moisture* (%) – after 24 hours – after 3 days – after 4 days	 <3.5 - <2	 <3.5 - <2	 <2 <1.6 -	 <2 <1.6 -
Waiting time before skimming	1-4 days	1-4 days	4 hours	4 hours
Waiting time before installing: – ceramic – marble – wood**	 24 hours+ 2 days+ 4 days+	 24 hours+ 2 days+ 4 days+	 3-4 hours+ 3-4 hours+ 24 hours+	 3-4 hours+ 3-4 hours+ 24 hours+
Compressive/flexural strength (MPa) – after 24 hours – after 3 days – after 4 days – after 7 days – after 28 days	 >8/3 - >15/4 >22/5 >30/6	 >8/3 - >15/4 >22/5 >30/6	 >30/5 >40/6,5 - - >45/7	 >40/6 >50/7 - - >62/10

* At +23°C and 50% R.H.
+ These times may be longer if aggregates smaller than the specified size (0-8 mm) are used or if too much mixing water is used.
** When laying wooden floors, measure the level of residual humidity with a carbide hygrometer to make sure it is lower than the level specified for installing wood.

Tab. 3 - Performance characteristics* of screeds made with mapei special binders and mortars

Table 3 illustrates the waiting times before testing the system according to the type of binder used to make the screed. The testing cycle is carried out by switching on the system at the lowest temperature, and then increasing the temperature by 5°C per day until it reaches the maximum operating temperature. The system is then left running at the maximum operating temperature for 3 days, and then the temperature is reduced by 5°C per day until it reaches room temperature. The screed may be subjected to thermal shock during the test cycle and cracks often appear. If cracks do form, they must be sealed with **EPORIP** before installing the floor covering. If the installation of ceramic or stone flooring is specified, use a cementitious adhesive from at least class C2 according to EN 12004.

To soundproof the screed in compliance with the minimum requirements of DPCM 5/12/97 (see Section 4.2), products from the **MAPESILENT** system may be used (Fig. 4.9, 4.10 and 4.11).

To guarantee sufficient soundproofing from impact noise, position the **MAPESILENT** system below the thermal insulation, and replace the compressible material around the perimeter of the room with

MAPESILENT BAND R to prevent the formation of acoustic bridges (Fig. 4.12).

Also, to prevent the transmission of vibrations, it is important that any pipe-work from the heating system which comes out of the screed is lagged with elastic material. These elements, including manifolds, must be isolated with **MAPESILENT BAND R** or **MAPESILENT TAPE**. In this case too, once the screed has been completed, and after waiting according to the times specified in Table 4, the system must be switched on and tested.

COMPOSITION	CEMENT + AGGREGATES + WATER + MAPEFLUID N200	CEMENT + AGGREGATES + WATER + MAPEFLUID PZ500	TOPCEM PRONTO + WATER	TOPCEM + AGGREGATES + WATER	MAPECEM PRONTO + WATER	MAPECEM + AGGREGATES + WATER
Waiting time	21 days	14 days	4 days	4 days	1 day	1 day

Tab. 4 - Waiting times before carrying out the testing cycle of an underfloor heating system according to the binder used for the screed (for a screed around 40 mm thick).

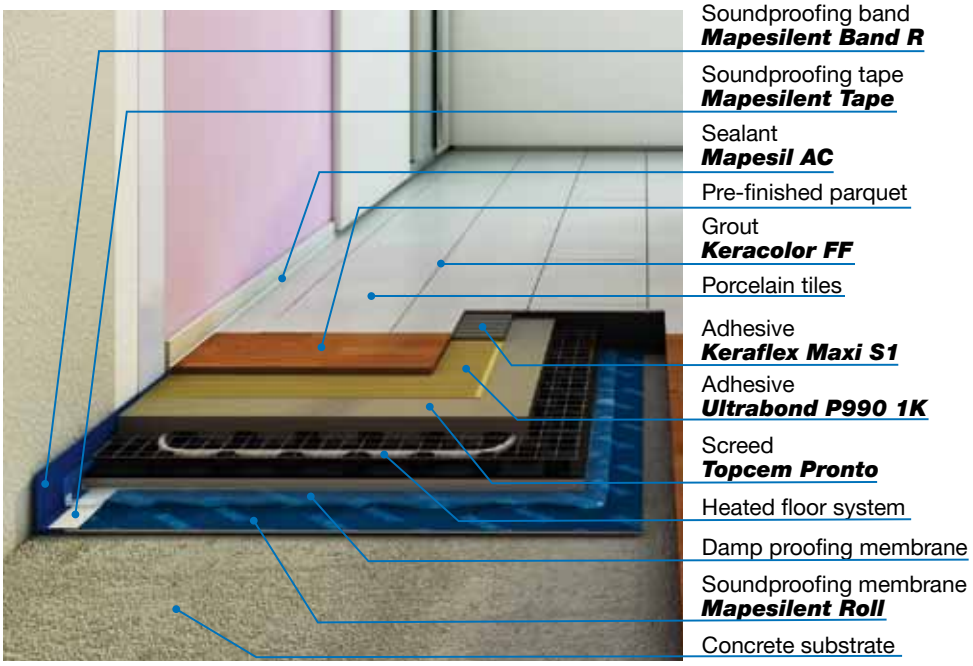


Fig. 4.12 - Example of a heated screed soundproofed with MAPESILENT SYSTEM

5. COMPACT HEATED SCREEDS

The restoration and renovation of residential buildings is becoming increasingly widespread and, thanks to the advent of new technology, it is now possible to install compact heated screeds suitable for any type of floor covering, as long as it does not have to be polished in situ (such as parquet and natural stone).

Unlike traditional heating systems (illustrated in the previous paragraph) that require a screed at least 70 to 80 mm thick, it is possible to install compact heating systems even if the thickness available is as low as 1.5 to 20 mm.

As well as the advantages of traditional heated screeds, compact systems also have other characteristics:

- They may be applied and bonded over existing flooring, thus avoiding having to demolish it;
- They have lower thermal inertia;
- Heated floors can be installed in areas where a minimum thickness of 70 mm normally required for traditional systems is not available;
- The temperature of the water flowing through the system is slightly lower;
- Less time is required for installation;
- Less waiting is required before installing flooring.

The most widely used slim systems currently available consist of pre-formed plastic panels, generally self-adhesive, or fibre cement/gypsum fibreboard panels with slots machined in them where the pipe-work is positioned.

The difference with these systems is how they are installed. For both systems the substrate must have the following characteristics:

1. Flat.
2. Clean with no trace of release agents.
3. Dry with no rising damp.

4. Strong.

5. No cracks that could lead to the panels fracturing.

6. Stable.

7. Well anchored to the substrate in the case of existing flooring.

5.1 PRE-FORMED PLASTIC PANEL SYSTEM

Before installing the panels, apply a coat of **ECOPRIM T** primer on the substrate to improve adhesion. When the primer is dry (minimum 2-4 hours), install the panels and pipe-work according to the specified layout (Fig. 5.1).

Within 4 days of applying **ECO PRIM T**, fill all the gaps and cavities in the plastic panels with **ULTRAPLAN MAXI** to a level at least 3 mm above the dimples in the panels. The maximum overall thickness is 30 mm.

24-36 hours after applying **ULTRAPLAN MAXI** the system may be started up for the first time by following the procedure in the previous section.

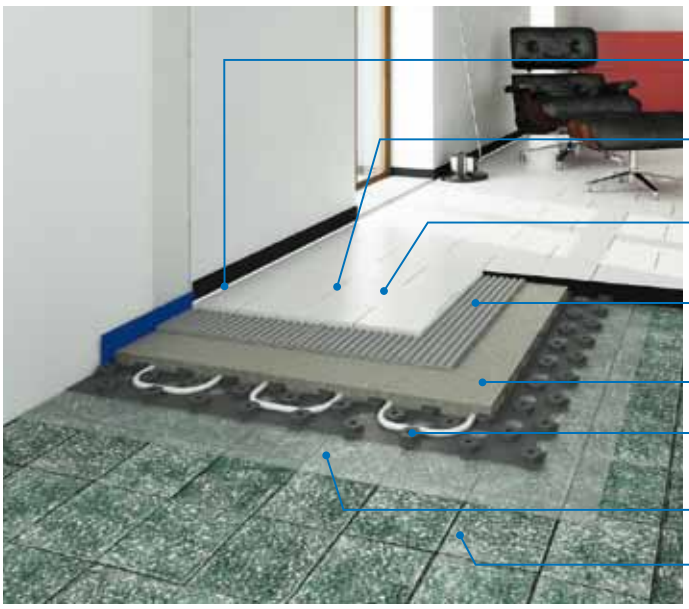


Fig. 5.1 - System for laying ceramic on a slim heated system with pre-formed plastic panels

5.2 FIBRE CEMENT PANEL SYSTEM

Bond the fibre cement or gypsum fibreboard panels (Fig. 5.2) to the existing substrate with **ULTRABOND MS RAPID** applied in beads around 20-30 cm apart on the back of the panels.

12-24 hours after bonding the panels, position the pipe-work in the slots in the panels according to the specified layout. After positioning the pipe-work, apply a coat of **ECOPRIM T** primer to improve adhesion, making sure that all traces of dust from the machining operations in the panels is completely removed.

When the primer is dry (minimum 2-4 hours), level off the surface of the panels with a layer of **ULTRAPLAN MAXI** to a level of at least 3 mm over the surface of the panels.

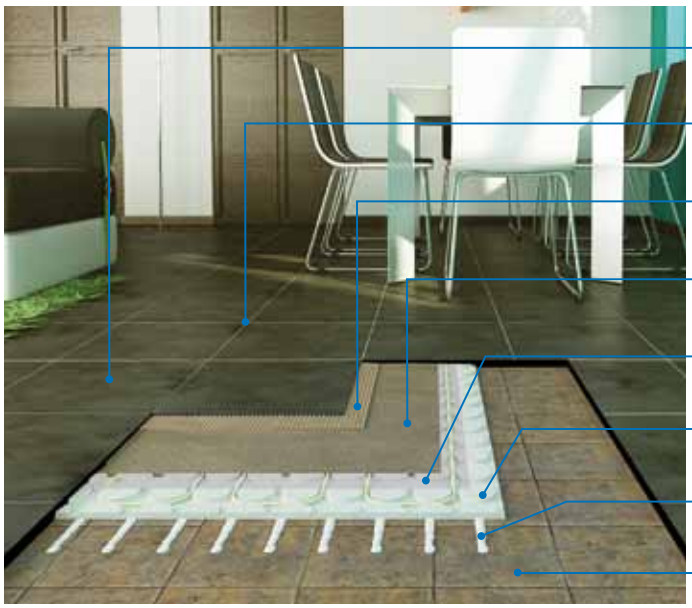


Fig. 5.2 - System for laying ceramic on a slim heated system with gypsum fibreboard panels

6. COMPOSITION OF SCREEDS

To make the types of screed described in the previous section with the performance characteristics mentioned in Section 3, MAPEI has a wide selection of products available for its clients, including:

1) liquid and powdered super-plasticising admixtures for mixing with water, cement and suitable aggregates;
2) special binders for mixing with water and suitable aggregates;
3) mixes of aggregates in a granulometric curve to make screeds, also in combination with MAPEI special binders;
4) special pre-blended mortars for mixing with water.

This section contains a description of the properties and application methods of these products, together with the performance characteristics of the screeds made from them.

Fig. 6.1 - TOPCEM and TOPCEM PRONTO

6.1 SPECIAL PRODUCTS FOR NORMAL-SETTING, RAPID-DRYING SCREEDS

The use of super-plasticisers allows waiting times to be reduced compared with the times required for screeds made using traditional materials. These waiting times, however, could still be too long and incompatible with the site schedule, especially in those cases where floors have to be put into service relatively quickly. Binders are required, therefore, which allow mortar with long workability times and which are easy to apply to be used for the substrate, while at the same time allow floor coverings to be installed after just a few days. To meet the requirements of those clients who require a finished floor in a very short time, MAPEI Research & Development laboratories have developed pre-blended mortars for mixing only with water and special hydraulic binders which, when prepared on site with assorted aggregates, allow screeds to be laid with very little shrinkage, high mechanical strength, very short drying times and, therefore, very short turnaround times.


Fig. 6.2 - Batching a TOPCEM/TOPCEM PRONTO mix

Fig. 6.3 - Levelling off the surface of TOPCEM/TOPCEM PRONTO mix

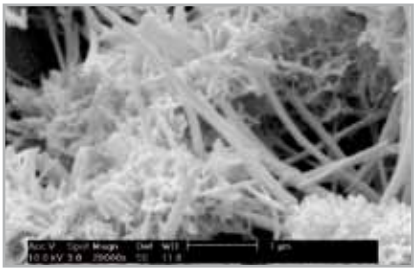


Fig. 6.4 - The structure of a traditional sand-cement screed viewed through an electron microscope

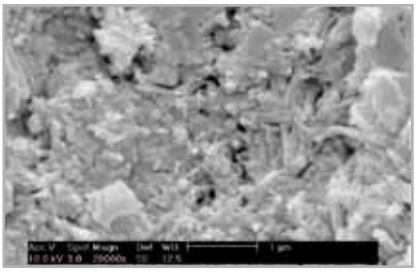


Fig. 6.5 - The structure of a screed made with TOPCEM/TOPCEM PRONTO viewed through an electron microscope: note how the special composition of these products allow a much more compact structure to form compared with a traditional screed

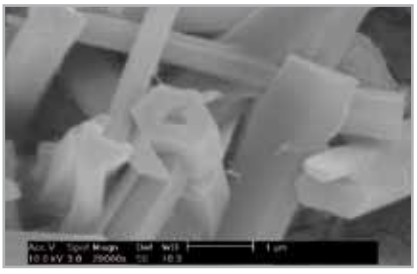


Fig. 6.6 - A screed made with MAPECEM/MAPECEM PRONTO viewed through an electron microscope: this image shows the particular crystalline structure generated by the hydration of the special binders

The solutions offered by MAPEI to make normal-setting, rapid-drying screeds (4 days) are **TOPCEM** and **TOPCEM PRONTO**.

TOPCEM binder and **TOPCEM PRONTO** pre-blended mortar are products offered by MAPEI as a solution for normal-setting, rapid-drying (4 days), controlled-shrinkage screeds. Screeds made from **TOPCEM** and **TOPCEM PRONTO** are suitable for installing ceramic tiles after just 24 hours of curing, stone sensitive to humidity after 2 days and wood, PVC, rubber and linoleum flooring after 4 days.

Thanks to their ease of application, including by pumping (Fig. 6.2), the workability and setting times are similar to those for traditional cementitious mortar (Fig. 6.3) and make **TOPCEM** and **TOPCEM PRONTO** particularly suitable for screeds laid over very large areas when there is very little time available before the flooring needs to be put into service.

TOPCEM and **TOPCEM PRONTO** may also be used to make heated screeds without the need for other admixtures.

To make a screed using **TOPCEM**, suitable clean, dry aggregates (from 0 to 8 mm) must be added on site. **GRAVEL 0-8** may be used in this case, a mixture of aggregates in a granulometric curve of 0 to 8 mm.

If the screed is made from **TOPCEM PRONTO**, it just requires mixing with water. **TOPCEM PRONTO** has CE marking and is classified CT-C30-F6 A1fl according to UNI EN 13813 European Standards.

Compared with a traditional screed or a screed made from **TOPCEM**, **TOPCEM PRONTO** has the following advantages:

- There is no longer the problem of having to source good quality aggregates with the right grain size, which are often hard to find in many areas.
- Dosage errors and problems due to poor workmanship are avoided.
- It is the ideal solution when the storage of raw materials (inerts, cement, etc.) is a problem, for example when carrying out renovation work in ancient town centres.
- Guarantees shorter drying and curing times, does not depend on the quality or type of inerts available on site, on the risk of

dosage errors or on the quality of workmanship, and is particularly recommended for installing flooring sensitive to moisture (wood, PVC, linoleum, etc.).

6.2 SPECIAL PRODUCTS FOR RAPID-SETTING, RAPID-DRYING SCREEDS

If the time available on site is extremely low, **MAPECEM** binder and **MAPECEM PRONTO** pre-blended mortar may be used to make rapid-setting, rapid-drying screeds (1 day).

At normal temperatures, screeds made from **MAPECEM** and **MAPECEM PRONTO** are suitable for installing ceramic 3-4 hours after laying and are dry (residual moisture less than 2%) and suitable, therefore, for installing flooring sensitive to moisture, after 24 hours. Mortar made from **MAPECEM** and **MAPECEM PRONTO** may also be applied with a pump. Thanks to these characteristics and their very high mechanical strength, **MAPECEM** and **MAPECEM PRONTO** are particularly recommended for repairs to flooring in supermarkets, shops, shopping centres, airports and any other structure where it would be impossible or too costly to interrupt normal activities. **MAPECEM** and **MAPECEM PRONTO** may be used to make heated screeds without the need for other admixtures. To make a screed using **MAPECEM**, suitable clean, dry aggregates (from 0 to 8 mm) must be added on site. **GRAVEL 0-8** may be used in this case, a mixture of aggregates in a granulometric curve of 0 to 8 mm. If the screed is made from **MAPECEM PRONTO**, it just requires mixing with water. **MAPECEM PRONTO** has CE marking and is classified CT-C60-F10-A1fl according to EN 13813 European standards. The advantages of using **MAPECEM PRONTO** are the same as above for **TOPCEM PRONTO**, to which there is the added advantage that it is rapid-setting and rapid-drying. Table 3 shows the compressive strength, levels of residual humidity and waiting times before installing flooring for screeds made from **TOPCEM**, **TOPCEM PRONTO**, **MAPECEM** and **MAPECEM PRONTO**.

Fig. 6.7 - MAPECEM and MAPECEM PRONTO

6.3 ADVANTAGES OF SCREEDS MADE WITH MAPEI SPECIAL BINDERS AND PRE-BLENDED MORTARS COMPARED WITH TRADITIONAL SCREEDS

The advantages of using **TOPCEM**, **TOPCEM PRONTO**, **MAPECEM** and **MAPECEM PRONTO** for screeds compared with traditional sand-cement mortar mixed on site are shown in Table 5.

	TOPCEM AND **TOPCEM PRONTO**-BASED SCREEDS	**MAPECEM** AND **MAPECEM PRONTO**-BASED SCREEDS	TRADITIONAL SCREEDS	ADVANTAGES WHEN USING MAPEI PRODUCTS
Drying time	4 days	1 day	7-10 days per mm of thickness	- Shorter waiting times when installing flooring sensitive to moisture (wood, resilients) and epoxy floor coverings - Lower risk of detachment of parquet or blistering of rubber, linoleum and PVC flooring - Less hygrometric shrinkage due to less mixing water and the amount of shrinkage is controlled, therefore lower risk of crack formation and, as a result, lower risk of breakage or detachment of ceramic or stone flooring after installation
Hygrometric shrinkage	Controlled	Controlled	Varies according to the amount of water and cement and the size of the aggregates in the mix	- Because these products have controlled shrinkage, the frequency and, therefore, the number of control joints may be reduced by increasing the pitch areas the screed is divided into - Lower risk of cracking
Compressive strength	> 30 MPa	>45 MPa (MAPECEM) > 60 MPa (MAPECEM PRONTO)	Varies according to the composition of the mix (often less than 10 MPa)	- Higher resistance to abrasion - Lower risk of collapse or breakage under concentrated loads - Better guarantee when laying screeds in environments subject to intense loads
Suitability for laying screeds with embedded heating/cooling elements	Suitable, no need for admixture	Suitable, no need for admixture	Suitable ONLY if a super-plasticising admixture is used	- The use of TOPCEM PRONTO in particular allows screeds to be made with certified thermal conductivity (λ), equal to 1.27 W/(m•K)
Site logistics				Pre-blended products such as TOPCEM PRONTO and MAPECEM PRONTO offer a solution to various problems often encountered on site: - dosage errors when mixing mortar - the difficulty in sourcing quality aggregates with the right size - storage areas are required for raw materials - defects due to poor workmanship

Tab. 5 - The advantages of using MAPECEM, MAPECEM PRONTO, TOPCEM and TOPCEM PRONTO

COMPARISON BETWEEN A TRADITIONAL MIX AND A MIX WITH DIFFERENT DOSES OF **MAPESCREED 704** (1-1.5%)			
Portland Cement PC 32.5	230 kg	230 kg	230 kg
Aggregates particle size 0-6 mm	1700 kg	1700 kg	1700 kg
Mapescreed 704	0	1%	1.50%
Mixing Water	152 l	125 l	116 l
Compressive Strength after 7 days MPa	13	19	22
Compressive Strength after 28 days MPa	16	24,5	28
Residual Moisture after 14 days	≥ 4%	≥ 2.6%	≥ 2.4%
Residual Moisture after 21 days	≥ 3.5%	≥ 1.9%	≥ 1.8%

6.4 HEATED SCREED MIXED ON SITE WITH A SUPER-PLASTICISING ADMIXTURE

To make heated screeds (see Section 4.4), if they are made from sand-cement mortar mixed on site in various ratios (from 200 to 350 kg/m^3, depending on the performance required), a super-plasticising admixture may be added such as **MAPESCREED 704**.

MAPESCREED 704 is a special plasticising and water-reducing admix for cementitious screeds, including heated and cooling screeds.

7. GENERAL GUIDELINES FOR LAYING SCREEDS

To make a defect-free screed, the following fundamental guidelines must be followed, irrespective of the type of mortar or binder used.

- The choice of which type of aggregate to use is important. It must be clean, contain no impurities and have the correct grain size for the thickness of screed to be laid (for example, for **TOPCEM** and **MAPECEM** assorted aggregates from 0 to 8 mm for a screed 4 to

Fig. 7.1 - Forming levelling strips

Fig. 7.2 - A screed cut perpendicularly at the point where laying has been interrupted

Fig. 7.3 - Sealing a chase in existing flooring by applying bonding slurry on the contact surfaces between the existing and repaired surfaces

Fig. 7.4 - Reinforcing a screed by bridging fine electro-welded mesh over pipe-work

8 cm thick). If the aggregates are too fine, more mixing water will be required and surface porosity of the screed will be reduced. As a result, drying times for the mortar will be longer and there is a higher risk of shrinkage cracks.

- The levelling strips (Fig. 7.1) must be made from the same binder as for the screed. Also, when the mortar to make the screeds is laid and levelled off, the levelling strips must not have hardened.

- When fresh mortar has to be “welded” to a set surface (for example, when screed laying is interrupted for more than an hour or if the levelling strips have hardened), cold joints must be made by applying bonding slurry, made from **PLANICRETE**, water and binder, or **EPORIP** on the hardened part of the screed (cut cleanly and perpendicularly to the substrate) (Fig. 7.2). When filling a chase in a screed that has already been laid (Fig. 7.3), the same type of bonding slurry must also be applied on the contact surfaces between the existing screed and the filler material.

- If there is pipe-work in the screed, make sure there is a layer of mortar at least 30 mm thick above it. We also recommend reinforcing this thinner section to prevent the formation of cracks by bridging metallic reinforcement mesh made from 2 mm diameter wire over the pipe-work (Fig. 7.4).

- To improve the screeds resistance to cracking, for example when there is compressible material under the screed, position zinc-plated metallic reinforcement mesh at the mid-point of the screed (Fig. 7.5). The mesh limits the amount shrinkage cracks and cracks in correspondence with check joints open up. In so doing, cohesion between the grains of inert is maintained, which

is indispensible to transfer loads correctly between the two edges of the cracked joint.

- Finish off the surface of the screed by hand with a float (Fig. 7.6), with a power float or by helicopter (Fig. 7.7). Particularly when **TOPCEM**, **TOPCEM PRONTO**, **MAPECEM** or **MAPECEM** binders and special mortars have been used, take care not to wet the surface too much or to smooth over the same point for too much time, otherwise water from the mix will collect on the surface and cause bleeding, which will then cause a reduction in surface porosity and longer drying times.

- While the screed is still wet, as soon as it is consistent enough to be cut without breaching the inerts, form a series of check joints (Fig. 7.8). They must be made in correspondence with sills, between pillars and every 20-25 m^2 on internal screeds and every 16 m^2 on external substrates. Cut the screed to a depth of one third its thickness, taking care not to cut through any electro-welded mesh present. If the screed is made from **TOPCEM**, **TOPCEM PRONTO**, **MAPECEM** or **MAPECEM PRONTO** special binder or mortar, the pitch of the joints may be increased. If a bonded screed is laid, the position of the joints must match those in the bonded substrate.

- Once the curing cycle is complete (especially when installing floor coverings sensitive to humidity, such as wood, resilients and epoxy paints), check the residual moisture in the screed with a suitable instrument, such as a carbide or electric hygrometer.

- Any cracks which form in the screed after completing the curing cycle must be monolithically sealed with **EPORIP** before installing the flooring.


Fig. 7.5 - Placing zinc-plated metallic mesh at the mid-point of the screed


Fig. 7.6 - Float-finishing the surface of a screed


Fig. 7.7 - Finishing the surface of a screed with a power float

Fig. 7.8 - Forming check joints in a screed

- In most cases, the surface of screeds finished by float, power-float or helicopter are suitable for installing ceramic or stone flooring. If the surface is not smooth or flat enough for tiles, or when the installation surface is too low compared with the final height required, a smoothing layer must be applied. Also, when installing resilient flooring (linoleum, PVC, rubber, etc.), the installation surfaces always have to be finished off with a finishing layer, which must have mechanical strength characteristics compatible with the final use of the floor and the strength of the substrate. To finish and smooth off installation surfaces for ceramic, stone and resilient flooring, MAPEI has a wide range of thixotropic and self-levelling skimming compounds available. For example, the following products are recommended:

• **ULTRAPLAN**: self-levelling, ultra rapid-hardening smoothing compound for thicknesses from 1 to 10 mm.

• **ULTRAPLAN MAXI**: self-levelling, ultra rapid-hardening smoothing compound for thicknesses from 3 to 30 mm.

• **PLANIPATCH**: fine-grained, ultra rapid-drying, thixotropic cementitious skimming compound for thicknesses from 0 to 10 mm.

• **NIVORAPID**: ultra rapid-drying, thixotropic cementitious skimming compound for thicknesses from 3 to 20 mm. These smoothing compounds are also suitable for use when installing wooden floors as long as they are applied in layers at least 3 mm thick.

8. TYPICAL SCREED DEFECTS AND REPAIR PROCEDURES

This section contains a description of the most common defects in screeds, their main causes and relative repair procedures to eliminate them.

- **CRACKS**

Main causes: the main causes of cracks in screeds (Fig. 8.1) are hygrometric shrinkage, too much water in the mix, the use of aggregates which are too fine, too much binder in the mix, no control joints or second pours without applying bonding slurry beforehand between the hardened screed and the new, fresh mortar.

Repair procedure:

• ***Solution 1:*** Open up the cracks with an angle grinder to form a "V" shape (Fig. 8.2) so it is easier to seal them, and vacuum off all traces of dust in the cracks. The cracks may then be sealed with epoxy resin such as **EPORIP**, **EPORIP TURBO** or **EPOJET**, depending on the size of the cracks (Fig. 8.3). Sprinkle fine sand on the surface of the resin while it is still fresh (Fig. 8.4). Any excess sand which is not anchored in the resin may be removed when the **EPORIP** has dried.

• ***Solution 2:*** For hairline surface cracks, after thoroughly cleaning the surface, apply a layer of anti-crack isolating material such as **MAPETEX** directly on the surface of the cracked screed. The flooring may then be installed directly on this layer.

- **FRACTURES AROUND PIPE-WORK**

Main causes: this type of defect occurs when the thickness of the screed over the pipe-work is too low (less than 30 mm) and when metallic reinforcement mesh has not been positioned correctly in these areas (Fig. 8.5).


Fig. 8.1 - Cracked screed


Fig. 8.2 - Opening cracks in a screed with an angle grinder

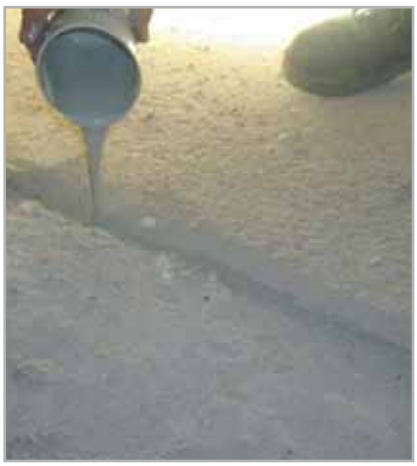


Fig. 8.3 - Sealing fractures with EPORIP

Fig. 8.4 - Sprinkling sand on the surface of fresh EPORIP

Fig. 8.5 - A depression in an underfloor screed in correspondence with pipe-work

Fig. 8.6 - The thickness of the screed over pipe-work is insufficient (< 30 mm)

The problem is more evident if the pipe-work has been lagged with compressible material which weakens that section (Fig. 8.6).

Repair procedure:

• ***Solution 1:*** Remove at least 250 mm of screed along each side of the fracture and apply **EPORIP** or bonding slurry made from **PLANICRETE**, water and binder on the cold joint. Then bridge fine metallic mesh (Ø 2 mm) over the pipe-work and rebuild the removed part of the screed by applying a mix rich in binder on the slurry.

• ***Solution 2:*** If the screed above the pipe-work is too thin and it is not possible to repair the fracture as described in solution 1, remove the area as described above and rebuild the section with **MAPEFLOOR EP19** after applying a coat of **PRIMER MF** (Figs. 8.7 and 8.8).

- **BLEEDING OR SURFACE DUST**

Main causes: the factors which can cause partial segregation of the screed mix, which results in surface bleeding, are too much water in the mix, excessive tamping or excessive wetting of the surface during finishing operations (Fig. 8.9). If a smoothing layer or flooring is applied over a surface with bleeding that has not been removed correctly, it could provoke detachment (Fig. 8.10).

Repair procedure: Mechanically remove the layer with bleeding, vacuum off all traces of dust from the surface of the screed and apply a coat of **PRIMER G** diluted 1:2-1:3 with water or **LIVIGUM** diluted 1:4-1:5 with water. This primer is also an efficient remedy when there is no surface bleeding but dust forms constantly on the surface. If the surface of the screed is particularly dusty or crumbly after removing the layer with bleeding, we recommend applying a consolidating primer such as **PRIMER MF**.

- **CRUMBLING SURFACE**

Main causes: a crumbly surface is caused by the mixing water in the screed evaporating off too quickly due to exposure to direct sunlight or currents of air. Other causes of a crumbly surface are poor compacting or finishing, a sudden drop in temperature below 0°C before the screed has set or leaching by rainwater.

Repair procedure:

• ***Solution 1:*** Remove the crumbly areas on the surface of the screed by shot-blasting or scarifying and then apply a coat of **PRIMER G** diluted 1:2-1:3 with water. When the **PRIMER G** has dried, smooth over the surface with **ADESILEX P4** (for external screeds) or **NIVORAPID**.

• ***Solution 2:*** consolidate the surface directly with **PRIMER MF** impregnator.


Fig. 8.7 - Applying bonding slurry made from epoxy resin (PRIMER MF)

- **CRUMBLY SURFACE LOCALISED IN CERTAIN AREAS ONLY**

Main causes: when this type of problem appears on new screeds, it is usually due to incorrect mixing of the screed mortar or insufficient compacting.

Repair procedure:

• ***Solution 1:*** Remove the deteriorated areas, apply a coat of bonding slurry made from **PLANICRETE**, water and binder and then pour new mix over the slurry.

• ***Solution 2:*** When the crumbly portions are confined to small areas only, localised consolidation may be carried out using **PRIMER MF**, **ECO PRIM PU 1K**, **PRIMER EP** or another suitable consolidating primer (Fig. 8.11). Immediately after applying the primer, sprinkle the treated area with sand (Fig. 8.12). Any excess sand may then be removed when the primer has dried.


Fig. 8.8 - Filling fractures with MAPEFLOOR EP19

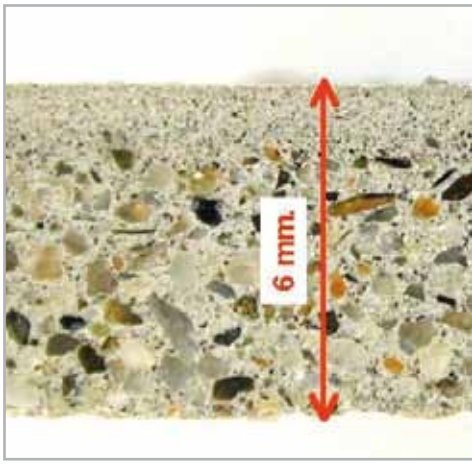
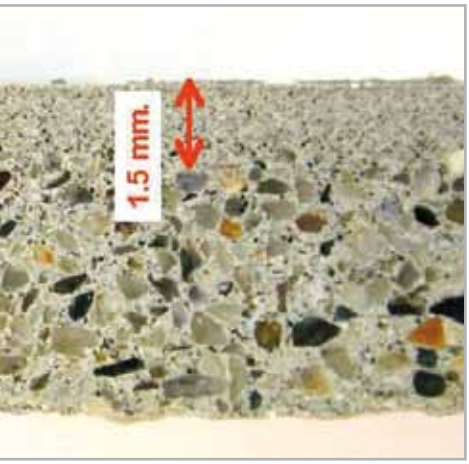


Fig. 8.9 - Sectional view of a screed with surface bleeding

Fig. 8.10 - ULTRAPLAN detached from a screed with surface bleeding

Fig. 8.11 - Applying PRIMER MF on the surface of a screed



N.B. Do not use PRIMER EP to consolidate screeds with embedded heating elements.

- **CRUMBLY STRUCTURE THROUGH THE ENTIRE THICKNESS OF THE SCREED**

Main causes: when this type of problem is more widespread in the screed, the possible causes are a low binder content, insufficient compacting of the screed mix, frosts during the night before the screed has hardened correctly or the cement has been hydrated properly, too little water in the mix or a rapid loss of the mixing water due to high temperatures or the substrate being too absorbent.

Repair procedure:

• ***Solution 1:*** Completely remove the screed and re-lay a new one.

• ***Solution 2:*** (to be assessed, and depending on how much of the screed has the problem): consolidate the screed by impregnating it with a consolidating primer such as **PRIMER MF**, **ECO PRIM PU 1K**, **PROSFAS** or **PRIMER EP**. Immediately after applying the primer, sprinkle sand on the treated areas. Remove any excess sand when the primer has dried.

N.B. Do not use PRIMER EP to consolidate screeds with embedded heating elements.

- **HIGH LEVEL OF RESIDUAL MOISTURE**

Main causes: in certain cases, even after waiting the time required for the screed to dry out, the level of residual moisture is still high. There are a number of causes to this problem, such as too much water in the mix, the aggregates used are too fine, no vapour barrier under the screed, water accidentally spilt on the screed after it has been completed or excessive wetting of the surface during finishing operations and tamping which, apart from increasing the amount of water, clogs the pores in the surface and slows down the drying process.

- **TO BE USED ONLY WHEN THERE IS NO RISING DAMP**

Repair procedure:

• ***Solution 1:*** If you are sure there is a suitable vapour barrier and there is still enough time to let the screed dry out, simply sand the surface to open the pores and accelerate the drying process using de-humidifiers.

• ***Solution 2:*** If you are sure there is a suitable vapour barrier and there is very little time left before the flooring is installed, especially if it is sensitive to humidity, a water proofing primer may be applied. This type of primer may be used if the level of residual moisture in a screed around 60 mm thick is no higher than 5%. In these cases, saturate the screed with **PRIMER MF** (Fig. 8.11), **PRIMER EP**, **ECO PRIM PU 1K** or another suitable waterproofing primer and sprinkle sand on the treated area (Fig. 8.12). Any excess sand may then be removed when the primer has dried. For non-absorbent screeds, **TRIBLOCK P** may be used.

Fig. 8.12 - Dusting the surface of a screed with sand after applying a coat of PRIMER MF

- **CONTINUOUS RISING DAMP**

Main causes: this phenomenon occurs when a vapour barrier for the screed has not been laid directly on the ground.

Repair procedure: when there is continuous rising damp, the only solution is to lay a new screed on a suitable vapour barrier. Depending on the amount of space available, this screed may either be overlaid on the existing one or re-laid after removing the existing one.

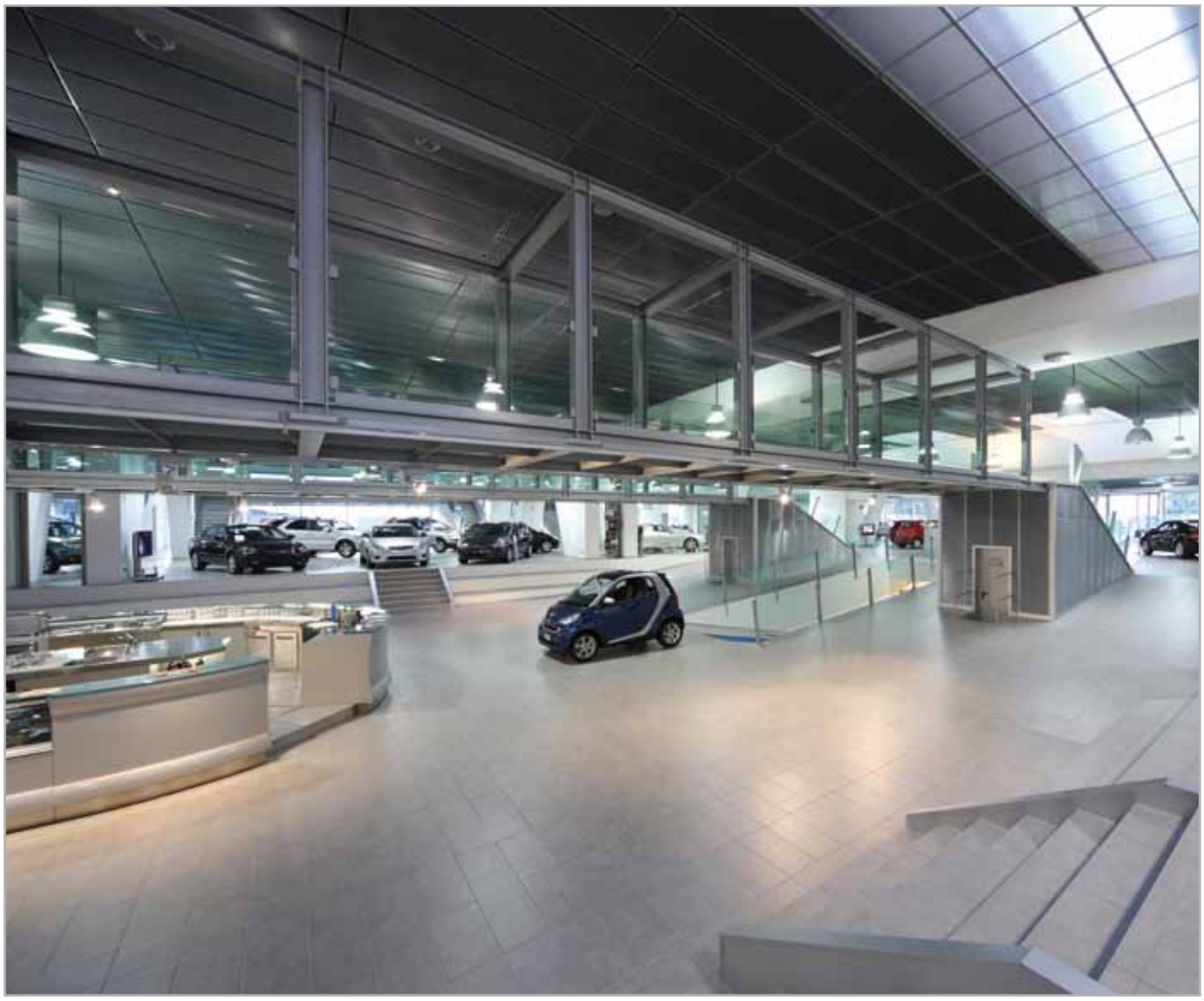
- **INSUFFICIENT FLATNESS**

Main causes: if suitable levelling strips have not been made or the screed has not been flattened off correctly, the surface may be uneven with hollows which take it out of the specified tolerance for flatness.

Fig. 8.13 - Brush-applying PRIMER G diluted with water on the surface of a screed

Fig. 8.14 - Creating a flat surface on a screed by applying a layer of ULTRAPLAN

Repair procedure: repair the screed by applying **PRIMER G** (Fig. 8.13) diluted 1:2-1:3 with water on the surface and then level off the surface by applying a coat of suitable skimming mortar such as **NIVORAPID**, **ADESILEX P4**, **ULTRAPLAN** (Fig. 8.14), etc.



AUTOTORINO DI CURNO
Bergamo - Italy

Screeds laid and ceramic tiles installed using:
EPORIP, **TOPCEM**, **KERAFLEX**, **KERAFLEX MAXI** and **KERACOLOR GG**

NIGUARDA HOSPITAL
Milan - Italy

Screeds laid and PVC flooring installed using: **TOPCEM**, **PRIMER G**, **ULTRAPLAN ECO** and **ULTRABOND ECO V4 SP**

INSTALLATION OF HEATED SCREEDS AND SUBSTRATES FOR LAYING FLOORS

WIMBLEDON COURT CENTRE
London - England

Screeds laid and ceramic tiling installed using: **TOPCEM**, **ULTRAPLAN ECO**, **KERAQUICK** + **LATEX PLUS** and **ULTRACOLOR PLUS**

UNION SQUARE MALL SHOPPING CENTRE
Aberdeen - Scotland

Screeds laid and materials installed with: **TOPCEM**, **KERAQUICK**, **ULTRACOLOR PLUS** and **MAPESIL AC**

"COOP" SHOPPING CENTRE
Lido di Camaiore - Italy

Screeds laid and ceramic tiles installed using:
TOPCEM PRONTO and
GRANIRAPID

NOTES

NOTES

Technical Notebook

INSTALLATION OF HEATED SCREEDS AND SUBSTRATES FOR LAYING FLOORS

C.P. MK 838130 - (GB) 09/13

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