



TILE FIXING

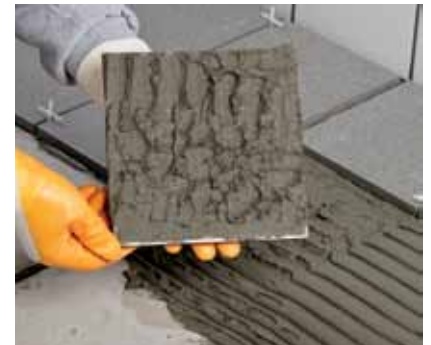
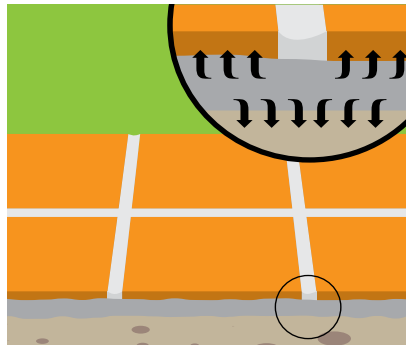
BONDING MECHANISM OF A TILE ON THE SUBSTRATE

The adherence of a tile adhesive on the substrate and back of tile are subject to two types of bonding mechanisms:

Mechanical bonding.

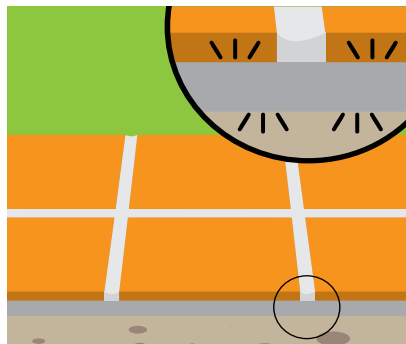
■ Standard type adhesives, applied when mixed with water (cement as mineral binding content) or ready mixed as a dispersion (acrylic as mineral binding content), engages physically with small irregularities, pores (absorbed by the substrate and tile with capillary forces) etc. in the surface and forms a strong bond when adhesive sets in those pores, resulting in a mechanical keying action to bond.

(Tile is referred to covering materials; ceramic wall and floor tiles, porcelain tiles, glass mosaics and tiles, natural stones and marbles, and etc.)



Physical bonding.

■ When the tile or substrate has an impervious surface, then the hydraulic adhesives cannot be absorbed into the material and there is no allowance for a mechanical bonding. The bonding should be provided only by the surface itself. Thus, organic polymers binding agents are added into the adhesive content (polymer modified adhesives) to provide a strong bonding of the adhesive on the tile or substrate surface (polymer binder is referred to reactive resins or thermoplastic dispersions which adhere by chemical bonding, Van der Waals forces and etc.).



EN 12004 STANDARDS

EN 12004 Standard identifies the test and performance criteria to classify tile adhesives. According to the standard, the adhesives are classified by their performances.

Tile adhesives are categorized according to their chemistry and these categories are abbreviated by letters of the alphabet:

C

Cement Based

Cement based powder adhesive is mixed with a specific amount of water or some other liquid to use.

D

Acrylic Dispersion Based

Water emulsion based paste adhesive with synthetic polymer additive. It is ready for use.

R

Reactive Resin Based

Two or more components (including one component as the resin and one another as the hardener) are mixed in specific amounts to use.

The adhesive in one of the adhesive chemistry categories is classified into one the two performance classes according its performance level in defined tests:

Class 1

(Normal) **Standard Performance** adhesive. It validates the minimum required performance level in tests. It is suitable for standard applications requiring no special performance.

Class 2

(Improved) **High Performance** adhesive. It validates higher performance levels in comparison to standard performance adhesives. It is suitable for applications with types of works subject to coercive environmental forces requiring special performance.

Tensile Strength	C1	D1	C2	D2
After 28 days	$\geq 0,5 \text{ N/mm}^2$		$\geq 1 \text{ N/mm}^2$	
Aging with heat	$\geq 0,5 \text{ N/mm}^2$		$\geq 1 \text{ N/mm}^2$	
Aging with water	$\geq 0,5 \text{ N/mm}^2$		$\geq 1 \text{ N/mm}^2$	
Freeze-thaw cycle	$\geq 0,5 \text{ N/mm}^2$		$\geq 1 \text{ N/mm}^2$	
Open time (20 minutes)	$\geq 0,5 \text{ N/mm}^2$		$\geq 0,5 \text{ N/mm}^2$	

Standard defines three optional characteristics for a class1 or class 2 adhesive:

F Fast Setting

Tensile strength (after 24 hours) $\geq 0,5 \text{ N/mm}^2$
Ideal for tiling applications when short drying time is required, particularly for renovation works, and for cold and high humidity conditions that extends drying time.

T Reduced Slip

Slip $\leq 0,5 \text{ mm}$
Ideal for tiling applications of large and heavy tiles on walls.

E Extended Open Time

Tensile Strength (fixing at the 30th minutes of open time) $\geq 0,5 \text{ N/mm}^2$
Ideal for tiling applications when long working time is required, particularly for large areas, and for hot and dry conditions that shortens drying time.



EN 12002 STANDARDS

Standard, in addition to EN 12004 Standard, classifies the adhesive according to the deformability performance:

According to its deformability level the adhesive is classified into one of the two performance classes:

Deformability features are required for tiling applications such as for pools, industrial floors subject to heavy loads, facades affected by severe temperature fluctuations.

S1 Deformable Adhesive

Deformation $> 2,5 \text{ mm}$ but $< 5,0 \text{ mm}$

S2 Highly Deformable Adhesive

Deformation $> 5,0 \text{ mm}$



REQUIRED-ESSENTIAL FEATURES FOR A TILE ADHESIVE

Below are the features of a tile adhesive when it is wet, during application and before it hardens:

- **Workability** (easy application and good spreading performance of the adhesive).
- **Water retention capacity** (for sufficient hydration and bonding performance of the cement based adhesive even on high porosity surfaces).
- **Reduced slip** (non-slipping of the tiles in the new adhesive bed and ensuring fast and efficient wall tiling).
- **Wetness capability** (on the substrate and tile back).
- **Sufficient open and adjustment time.**

Below are the features of a tile adhesive after it hardens and completes its curing:

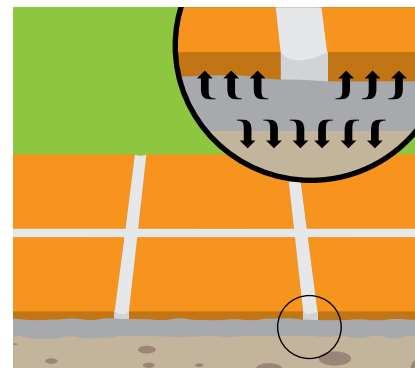
- **High bonding performance** (between the tile and the substrate).
- **High deformability** (the adhesive should absorb the stresses forming between the substrate and the tiling layer in fluctuating thermal conditions).
- **Reduced water absorption** (hydrophobic dispersion additives providing water repellency).

FACTORS AFFECTING ADHESIVE SELECTION

Surface absorptivity of the tile (water permeability).

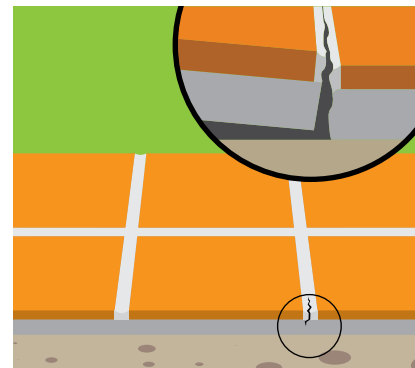
When the adhesive contacts with tile back, it engages physically with small irregularities, pores (absorbed by the substrate and tile with capillary forces) etc. in the surface and forms a strong bond when adhesive sets in those pores, resulting in a mechanical keying action to bond.

- Tiles with different formats such as glass, marble, ceramic or porcelain may have different surface absorptivities (water permeability).



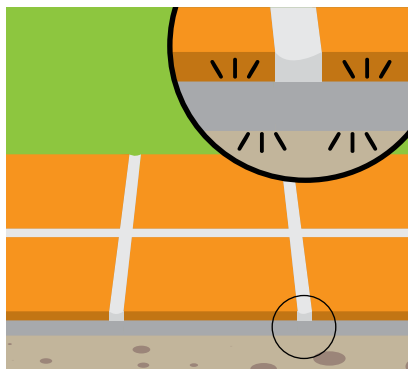
When tiling is done with a standard performance adhesive onto an impervious substrate, the adherence is much weaker resulting in tiles de-bonding from the substrate.

- When the covering materials has very low or no absorptivity (such as porcelain or glass), then the standard type adhesives cannot be absorbed into the material and there is no allowance for a mechanical bonding.
- Impervious substrates may have no irregularities or pores where the adhesive would engage.



- Bonding of the adhesive onto impervious surfaces (of the substrate or tile back) with a sufficient adherence performance is yielded by chemical additives named polymers (organic resins). Polymers provide the physical bonding of the adhesive.

- To provide improved fixing, tile may be produced with irregularities, pores or roughness on the back.



- According to definitions above, standard performance adhesive is suitable for fixing tiles with water absorption rate $\geq 3\%$ (wall and floor tiles, marble and etc.), whereas high performance adhesive is required for fixing tiles with water absorption rate $< 3\%$ (glass mosaics, porcelain tiles and etc.). However; if coercive environment forces are subjected after tiling, high performance adhesive should be chosen.

Surface absorptivity of the substrate (water permeability).

■ Substrates with different formats may have different surface absorptivities (water permeability). Gypsum (board, panel and plaster), wooden (board, panel and OSB), cement (board, plaster and screed) based substrates have high surface absorptivity (water absorption rate ~ 5-30 %). Surface absorptivity for concrete substrate is very low, where glazed tiles or painted surfaces have almost any (water absorption rate ~ 0-1 %).

■ Sealing with appropriate primers; the high absorptivity of surfaces should be reduced and balanced to enhance bonding capability of the substrate.



■ When tiling onto substrates with low porosity (water absorption rate < 3%), high performance adhesive should be chosen.

Acrylic dispersion based ready-mixed adhesives are dispersions of polymers and fillings in water and harden and do gain strength by losing the excessive water retained in its form and dry out. On highly absorptive substrates, these adhesives can be applied without priming the substrate.

■ The adhesive performance class should be chosen according to the tile format and technical requirements.



Flexible substrates.

Wooden floors and panels, gypsum boards may move or flex when exposed to loading (stepped on or pressed), which will cause instability of the covering leading to disbonding and cracking problems. Before tiling application, the loose boards or parts should be replaced, panels laid on joists or battens should be reinforced and fixed to stabilize.

■ When tiling onto flexible substrates, covering and substrate should deflect in conformity according to the load applied. The adhesive should be flexible to absorb the amount of movement or in mismatch the tiles will either delaminate or crack.



■ High performance and deformable adhesives have flexible character.

Covering material size and weight.

When the adhesive contacts with tile back, it engages physically with small irregularities, pores (absorbed by the substrate and tile with capillary forces) etc. in the surface and forms a strong bond when adhesive sets in those pores, resulting in a mechanical keying action to bond.

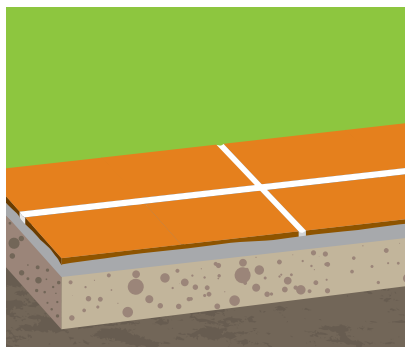
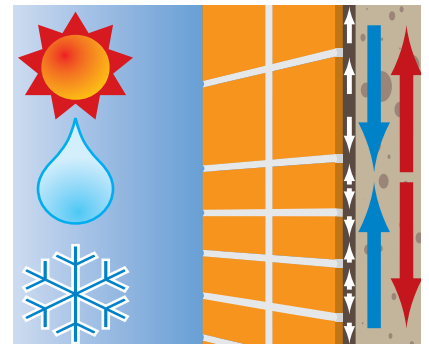
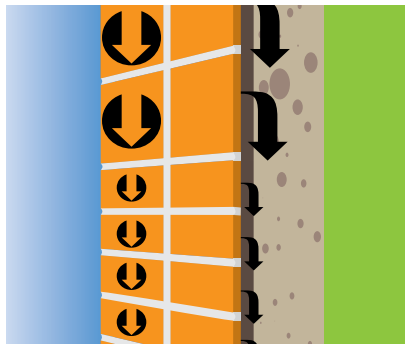
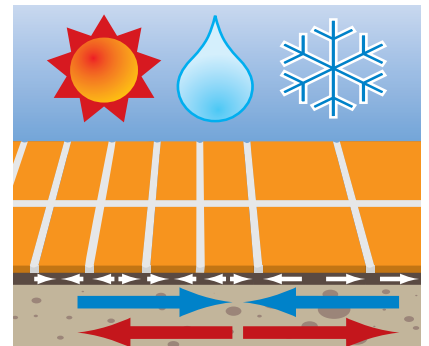
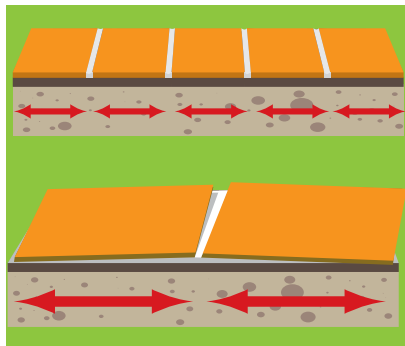
■ Tiles with different formats such as glass, marble, ceramic or porcelain may have different surface absorptivities (water permeability).

In vertical tiling applications, tile weight per m^2 is critical.

■ Heavy tiles may sag by gravity effect and squeeze the underlying tile. The underlying tile may not resist the sagging load of the upper tile and delaminate from the substrate.

■ Large tiles have less joint area to absorb the movements occurring on the covering.

In fixing tiles and natural stones with irregularities on the back or inconstant thickness, selection of a thick bed adhesive will provide an easier and efficient application as the adhesive will perform the leveling to some extent.

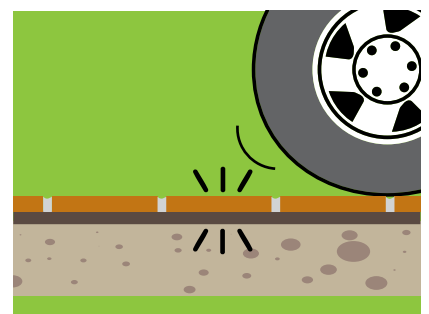
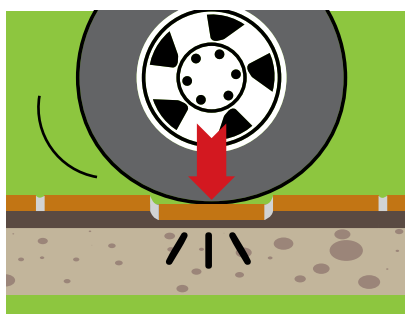
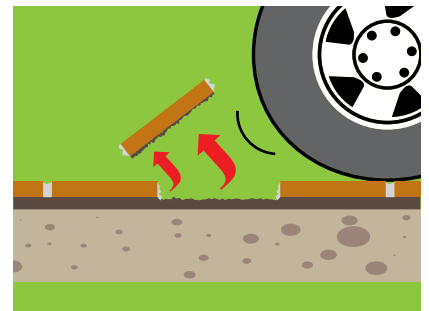
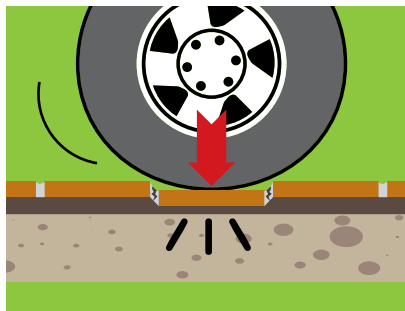


Area of use.

For areas exposed to light pedestrian traffic, standard performance adhesives provide the required technical performance.

The floors of public places (hospitals, malls, public buildings) and industrial areas (factories, warehouses) are exposed to heavy loads such as pedestrian or vehicle traffic. Loads will create pressure and vibration on the covering.

■ The adhesive must be high performance and deformable class to bear the expected loads the area is subject to.



Any area of the tile that has no contact on the substrate and has voids is vulnerable when subjected to a localized load. These fragile points will let cracks and crashes of the covering.

■ For the tile to correspond the loading homogeneously on all tile area, full contact of the adhesive on the substrate is required. For even distribution of the adhesive on the substrate with a full contact (for full spreading of the adhesive on tile back) performance, adhesive should have good workability features (easy spread and applied) when applied with a suitable notched trowel.

■ Adhesive with a fluidic form is required for the adhesive to easily spread and fully cover the tile back. When loaded heavily, in order not to smash the adhesive should be thick bed and deformable (flexible).

All substrates and covering systems will shrink and expand naturally due to temperature fluctuations and humidity. Particularly, when seasonal temperature changes are severe, shrinkage and expansion will exacerbate. In case of outdoor pool and terraces; the water seeped under the covering may freeze in cold weathers. This will cause volume expansion and therefore tension under the covering. Tension may cause delaminating, cracking or deformations of the covering.

■ The adhesive should be flexible type to absorb the amount of movements with a high performance adhering ability. Additionally, the adhesive should have water repellent property in order to resist the corrosive effects of water.

Coverings on external facades are subject to wind loads. The tiles are sucked outwards from its substrate with forces occurring due to the blowing of the wind with varying amplitude.

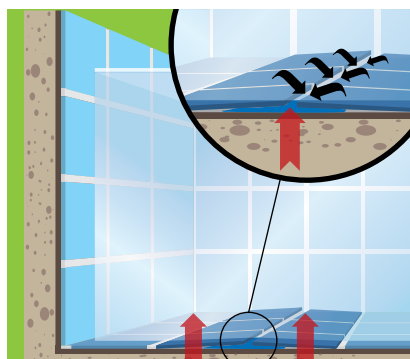
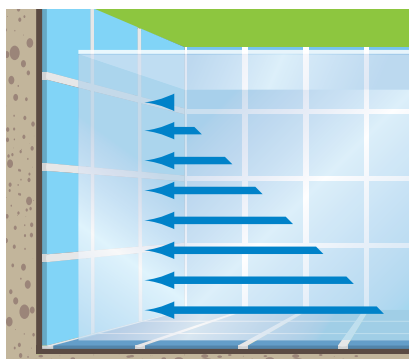
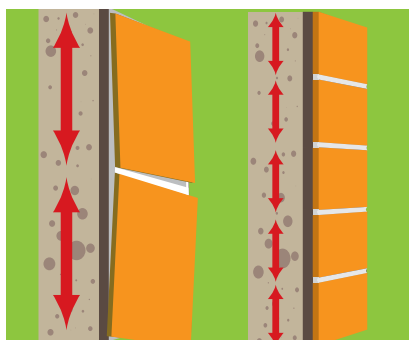
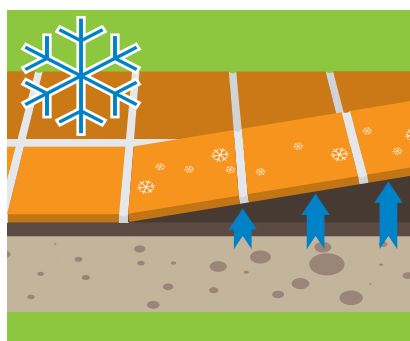
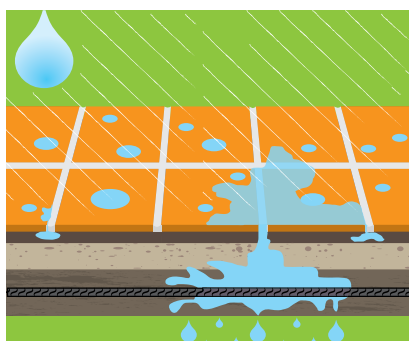
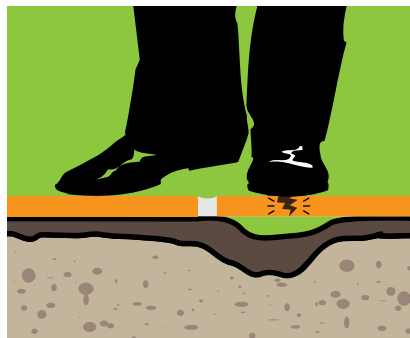
■ Deflection and the tension forming between the substrate and covering will be exacerbated across each tile's width for large tiles when wind loads and thermal loads are subjected.

■ In external facade tiling, the adhesive must be high performance and deformable class to bear the expected wind and thermal loads the area is subject to, while ensuring that enough fixing strength is provided to resist gravity loads of tiles.

In pools and water tanks movements occur due to water pressure varying with weight water.

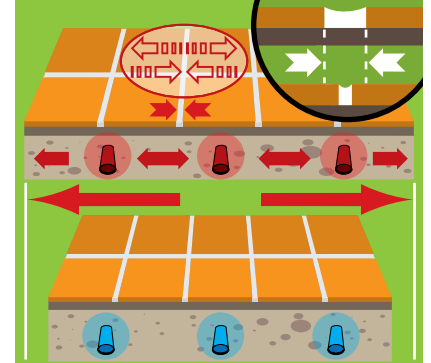
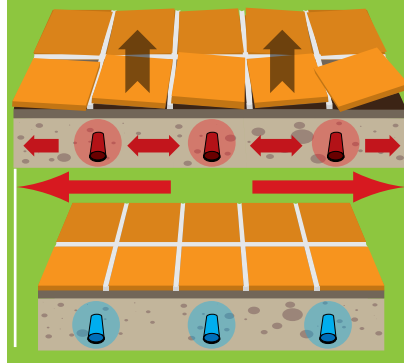
■ Once the pool or water tank is filled, there will be some movement due to the effect of water pressure on the walls and the overall weight of water in the pool. When the pool is emptied inertial forces will be formed on the pool walls and base. These movements will cause tension in the covering system. If tiles crack or blow away from their base under tension, the pool shell will be exposed to the corrosive effects of water.

■ The bonding strength of the adhesive must not be affected by the movements caused by opposite forces. High performance, flexible and water resistant adhesives should be selected particularly developed for pool tiling.



Tiling onto under floor heated systems; the tiles usually have a lower coefficient of thermal expansion. For a given temperature rise tiles will expand less than the substrate and stresses will be formed at the interface between the tile and the adhesive. At weak bonded parts, the tiles may delaminate or blow away from their base. Same rule applies for the substrates on heat transmitting systems and insulation applications.

■ In these typical applications, the adhesive should be high performance class providing flexibility enough to work compatible to the movements occurring in the substrate.



Colour and porosity of the tile.

In fixing transparent and light colored tiles and natural stones, particularly when they are highly porous, the covering material may absorb the adhesive. This causes the formation of stain and shades visible on the covering surface.

■ A sample application should be carried to observe the possibility of the formation of stain and shades. In case, white coloured adhesive should be used.



Time to put into service.

In case of renovation and repair works, tiling may be aimed to be completed in fast.

■ Fast setting adhesives provide set times as low as 3 hours compared minimum set time of 24 hours in regular adhesives.

■ The adhesive performance class should be chosen according to the tile format and technical requirements.



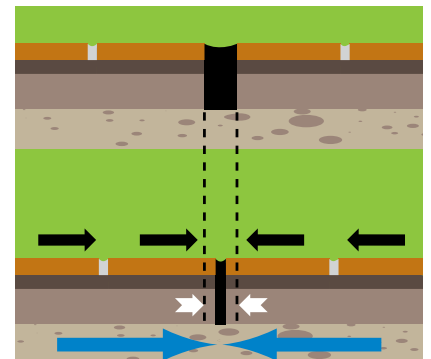
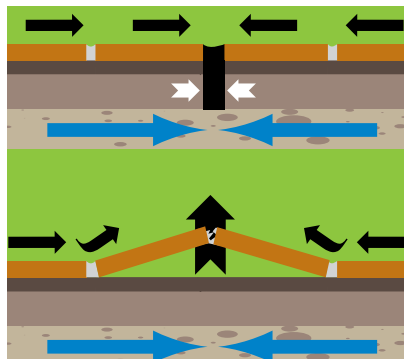
Use of expansion joints.

The tension formed between the covering and the substrate due to thermal and mechanical loads should be absorbed by use of deformable and flexible type adhesives.

■ When tiling on large areas (area > 6m x 6m), the adhesive may not be sufficient to absorb the tension singly. The continuity of the covering should be interrupted by using expansion joints to allow for slight movements and yet to release the tension formed on the covering system.

■ Expansion joints should be laid where tiling meets other materials, along all internal corners (wall and floor intersections). Skirting should be fixed upon to the completion of tiling.

■ No coatings or coverings should be applied on the existing dilatation zones and structural expansion joints in buildings. These zones should be insulated by using proper profiles or mastics.



Expansion joints should have minimum width of 6-10 mm. Expansion joints should be insulated by using proper profiles or mastics. Cementitious grouting materials are not appropriate for expansion joints.

- The profiles or mastics should be resistant to bacteria and fungi formation and to the chemicals the area will be exposed to.

- In use of mastics; to save in the amount of mastics to use, the expansion joints are recommended to be first filled with polyethylene elastic filaments with suitable sizes. Then, the mastic should be applied into the joint as well as leveled to the covering.



APPLICATION

Mixing of the adhesive.

C class - cement based powder adhesive is mixed with a specific amount of water or some other liquid to use.

- Do not add more or less water into the mixture than it is specified on the technical legends on the product packaging or technical data sheets.

- Two components adhesive (including one component as the powder and one another as the liquid) is mixed in amounts of the components as specified on the technical legends on the product packaging or technical data sheets.

- The components are mixed (gradually add powder to the clean water or liquid component) to a smooth and homogenous paste in a bin.

D class - acrylic dispersion based paste adhesive is ready for use. Do not add any of water or other additives into the paste.



- For a smooth and homogenous paste, it is recommended to use a low cycled electrical drill-mixer for mixing.
- For adhesives with T – reduced slip, the paste should be in a consistence such that it does not flow when handled with a trowel.
- The paste should rest for 5 minutes prior to application and should be applied after remixing.

Fixing tiles.

Apply the adhesive on the substrate with a suitable notched trowel to achieve the required bed thickness.

- Use of notched trowel provides even spreading of the adhesive on tile back ensuring the required bed thickness.

- The type and size of the notched trowel to be selected varies according to the tiling purpose and tile format. In general, when fixing large sized tiles and the tiled area will be exposed to heavy loads, large sized notched trowel should be selected.



According to the size of the tiles, fix tiles with either single buttering method (the adhesive is buttered on the substrate) or double buttering method (for tile sizes $> 33 \times 33$ cm, adhesive should be buttered onto the tile back as well). The tiles must be fixed within the open time of adhesive and pressed on with a twisting and sliding action to achieve a good contact.

- Double buttering method provides full contact of the tile on the substrate.

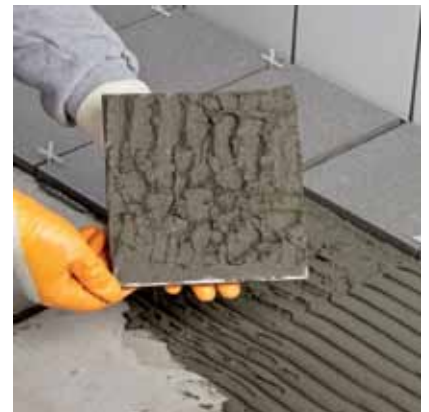
- Glass tiles, natural stones and marbles should be fixed with double buttering method.

The tile should be gently hammered with a rubber hammer in order to provide the stability of bonding and the adhesive to spread and fully cover the tile back.

- Any area of the tile that has no contact on the substrate and has voids is vulnerable when subjected to a localized load. These fragile points will let cracks and crashes of the covering.

- Lift an occasional tile after fixing to verify that the required contact is being achieved.

- The irregularities, pores or roughness on tile back should be completely filled with adhesive when applied with double buttering method.



Precautions.

- In fixing transparent and light colored tiles and natural stones, a sample application should be carried to observe the possibility of the formation of stain and shades. In case, white coloured adhesives should be used.

The tiles should be fixed within the specified open time of the adhesive.

- The open time will be shortened for applications with inconvenient conditions (due to high ambient temperatures, dry air and strong wind and fixing onto high porosity substrates). The open time may extend in lower temperatures and/or high humidity conditions, or when tiling onto impervious or sealed surfaces.

- Fixing after wetting the dried adhesive surface is not applicable. The dried adhesive must be removed from the substrate and new adhesive should be re-applied.



- Wetness on the surface of the adhesive should be tested by touching in case of early setting. If the adhesive does not get on the fingers, it means that the open time has expired.

- The adhesive has a specified pot life. Dried adhesive should be disposed and new adhesive should be mixed. Do not add more water into the dried adhesive to provide a consistent paste, it is not applicable.

- Grouting must be done after the adhesive fully completes its initial set. Setting time may change due to application conditions, adhesive characteristics and application area. During setting phase, the covering should be protected from loadings, direct sun light, frost and rain.

- Application on hot surfaces and during sunny and/or windy weather is not recommended. The substrate should have no risk of freezing.



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