

BEDDING ADHESIVES FOR STONES AND TILES 5



## 5 BEDDING ADHESIVES FOR STONES AND TILES

Before starting stone or tiling works, it is important to select the correct bedding adhesive to ensure its performance. No one single formula adhesive can be used with all stones/tiles and substrates. The first step in choosing a tile adhesive is to consider the location of the installation e.g. whether the stones/tiles are to be installed inside or outside the building, to the wall or on the floor, in a wet or dry area, and the type of receiving substrate e.g. concrete, render, screed drywall, etc.

### ***Polymer-modified cementitious adhesives***

Polymer-modified adhesives are widely accepted in the industry and often referred to as thin-set mortars. The blended polymers interact with cement components to improve the physical and mechanical properties such as increased adhesion, reduced shrinkage and lower water absorption. In most cases it is suitable for wet or dry installations. The polymer additives add strength and flexibility to the mortar, without which the bedding can crack easily.

The polymer modified adhesives are commonly available in two types. One comes with powdered polymer as pre-mix. Hence, during the application, only water is required to be added to make a bed. The other type requires addition of liquid latex additive rather than water. The second type is generally used for natural stones which are prone to moisture ingress and also for a fast setting installation. It also reduces the effect of back staining on natural stones and gives better shear bond strength to the bed.

### 5.1 CLASSIFICATION OF ADHESIVES

Based on ISO 13007 -1:2004, tile adhesives fall into three major categories:

**Type C (Cementitious):** Mixture of hydraulic binding agents, aggregates and additives; to be mixed with water or other liquid just before use.

**Type D (Dispersion):** Ready -for-use mixture of binding agents in the form of polymer dispersion, additives and other mineral fillers.

**Type R (Reaction Resin):** Single or multi-component mixture of synthetic resin, mineral fillers and other additives in which the curing occurs by chemical reaction.

The above categories can be further divided into the following classes:

- (i) Normal adhesive (Tensile strength  $> 0.5 \text{ N/mm}^2$ ) : **Class 1**
- (ii) Improved adhesive (Tensile strength  $> 1.0 \text{ N/mm}^2$ ) : **Class 2**

They can be categorized according to the following characteristics:

- (i) Fast-setting with early tensile strength adhesive : **F**
- (ii) Slip-resistant adhesive : **T**
- (iii) Adhesive with extended open time : **E**
- (iv) Special deformable characteristic (Type C only) : **S**

*Classification and performance criteria for cementitious adhesive based on EN 12004/12002 and ISO 13007-1*

CLASSIFICATION	CHARACTERISTICS	REQUIREMENT
C1 – Normal	Tensile strength @ 28 days ( Open time @ 20 minutes)	≥ 0.5 N/mm <sup>2</sup>
C2 – Improved	High tensile strength @ 28 days. (Open time @ 20 minutes)	≥ 1.0 N/mm <sup>2</sup>
F – Fast setting	Early tensile strength @ 6 hours.	≥ 0.5 N/mm <sup>2</sup>
T – Slip (Non sag)	Downward movement of a tile on a vertical surface.	≤ 0.5 mm
S1 – Deformable	Capacity of a hardened adhesive to be deformed	< 5 mm ≥ 2.5 mm
S2 – Highly Deformable	Capacity of a hardened adhesive to be deformed	≥ 5 mm
E – Extended open time	Extended open time @ 30 minutes with the tensile adhesion strength	≥ 0.5 N/mm <sup>2</sup>

## 5.2 QUICK REFERENCE GUIDE FOR COMBINATIONS OF FINISHES, LOCATIONS, AND SUBSTRATES

TYPE OF FINISH	LOCATION	SUBSTRATE	SUGGESTED ADHESIVE CLASSIFICATION IN COMPLIANCE WITH ISO 13007-1 EN 12004/12002
Natural Marble & Granite	Wall & Floor (Internal/External)	Concrete/Cement render/Screed	C2 TE
Natural/Agglomerated Stones (prone to moisture and staining)	Wall & Floor (Internal)	Concrete/Cement render/Screed	C2 F/S1 2-Component
Natural/Agglomerated Stones with size 600x600 mm or more	Wall & Floor (Internal)	Concrete/Cement render/Screed	C2 FTE /S1
		Deformable substrates such as drywall, board and plywood	C2 FTE /S2
Homogeneous tile/ Ceramic tile with low water absorption	Wall & Floor (Internal)	Concrete/Cement render/Screed	C2TE 1-Component
Ceramic tile with high water absorption	Wall & Floor (Internal/External)	Concrete/Cement render/Screed	C2TE 2-Component
Glass & ceramic mosaic	Wall & Floor (Internal/External)	Concrete/Cement render	C2TE
Ceramic / Homogeneous/Mosaic	Wall (Internal)	Deformable substrates such as drywall, board and plywood	C2FTE/S2
1.Tiles 2.Glass mosaics 3.Rapid installation	Wall & Floor (Swimming pool)	Concrete/Cement render/Screed	1. C2 T 2. C2 TE/S1 3. C2F/S1 (2-Component)



Fig. 5.1 – Less-absorbent stones with a substrate of cement render or concrete.

#### a. For less-absorbent natural & agglomerated stones and tiles

Improved high tensile strength adhesive is suitable for less-absorbent natural stones and glass mosaics for both internal and external applications. The adhesive is a mixture of cement, selected sand aggregates with additives and synthetic resin. The latex (polymer) added into it can be a separate liquid or integrated into the powder. The special feature of the adhesive is that it hardens without undergoing noticeable shrinkage. However the C2TE type may not be compatible with deformable substrates that may be subject to movement and vibration e.g. drywall, chip-board, etc.

#### b. For moisture sensitive natural & agglomerated stones

High performance fast-setting with early tensile strength and deformable adhesive is compatible for installation of stones which are prone to moisture ingress and requires rapid drying. Because of its improved bonding strength and fast setting properties, it is also suitable for floors which are subject to heavy traffic and places that require rapid re-flooring or retrofitting such as supermarkets, hospitals, airports, etc. The use of epoxy material (R type adhesive) is an alternative choice for moisture sensitive tiles or stones. However the cost of epoxy based adhesive is often higher than cementitious adhesives.



Fig. 5.2 – Porous natural stones with a substrate of cement render or concrete.

#### c. For stones and tiles on deformable substrates

The downward movement on a vertical surface is generally high in deformable substrates such as plywood or board partitions. These substrates require the adhesive to be fast setting, deformable and slip resistant for better performance.



Fig. 5.3 – Installation of tiles and stones on partition board substrate.

#### d. Ceramic tiles with high water absorption

High performance fast setting with early tensile strength 2-component adhesive is compatible for ceramic tiles with high water absorption. The addition of latex liquid instead of water prevents possible back staining on tiles.



Fig. 5.4 – High water absorbent tiles with a substrate of cement render.

### e. Ceramic tiles with low water absorption



C2TE 1-Component

Fig. 5.5 – Tiles with low water absorption on a rendered substrate.

High performance, deformable cementitious adhesive is suitable for tiles and stones which are less prone to moisture absorption. The bedding thickness can range from 3 mm to 10 mm for thin-bed adhesives or up to 15 mm for medium bed adhesives. As the polymers are integrated into the mortar, it does not require separate latex liquid for mixing other than water.

### f. Swimming pool mosaics

Latex fortified 2-component adhesive is preferable for mosaics with continuous water submersion and water pressure. The latex mortars reduce the effect of chemical reactions, improve adhesion and flexibility to withstand expansion due to stress and differential movement.



C2TE/S1 2-Component



C2TE/S1 2-Component

Fig. 5.6 – For swimming pool mosaics.

## 5.3 1-COMPONENT VS. 2-COMPONENT ADHESIVES

1-component adhesive mortar is in powder form with premixed modified polymers. Generally, they are suitable for stones and tiles with low water absorption and laid on cement sand screed or rendered substrate. Only water is required to be added during application since the polymer is already integrated into the powder. Thus, it is easier to control the mixing ratio when it is used extensively in a large project.



Fig. 5.7 – 1-component adhesive: Add powder + clean potable water.

2-component adhesives consist of a mixture of cement-based powder mortar (component A) and separate latex liquid (component B). They are appropriate for tiles and stones which are prone to moisture ingress and back staining hence requiring a rapid setting adhesive. They are also more suitable for special applications like water features and swimming pools. However both systems also can have the additional properties of fast setting and deformability.



Fig. 5.8 – 2-component adhesive: Add powder + latex liquid.

## 5.4 SCREED-LESS BEDDING ADHESIVE

The conventional cement-sand floor screed comprises a layer of mortar of Portland cement and concreting sand which is cast in situ on to a concrete slab. The screed thickness can range from 20 to 30 mm and it needs to be cured for a minimum of 14 days before laying of tiles. Failure to observe this requirement can lead to cracks or debonding of tiles due to inadequate surface preparation.



Fig. 5.9 – A typical conventional floor screeding process using cement-sand mortar.

To avoid the inconvenience of prolonged curing, a medium-bed mortar can be considered. Instead of laying a cement-sand screed, the adhesive up to 15 mm thick can be laid directly onto the concrete substrate followed by the tile. However, the substrate should be reasonably level with good surface preparation, otherwise excessive thick-bed mortar may be required to correct the differences in levels, leading to additional time and cost.

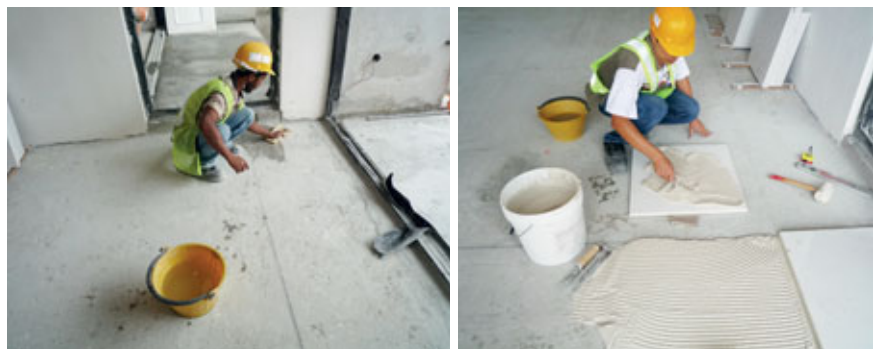


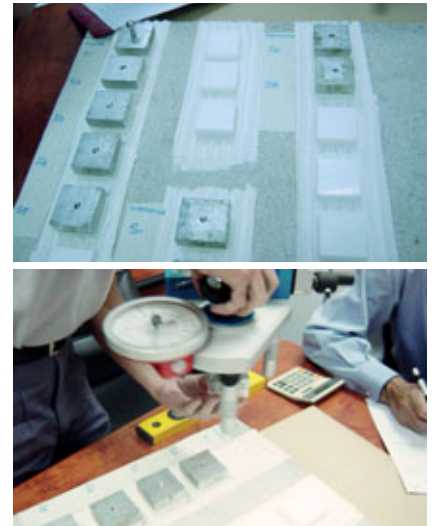
Fig. 5.10 – Screed-less bedding adhesive for laying marble floor.

## 5.5 COMPATIBILITY TESTS

The adhesive's function is to provide cohesion between the substrate and tile. A weak bond between tile and adhesive or adhesive and substrate are the most common causes of failure. To prevent such failures, a tensile adhesion strength test should be conducted to check the compatibility of the materials. Other trial checks such as water absorption rate and the effect of impregnator on stone surface should also be considered otherwise rectification works may be necessary after installation. As technology advances, new testing procedures like in-situ shear bond testing can be employed to test shear forces closely similar to actual situations after installation.

## 5.6 CONSIDERATIONS IN SELECTING ADHESIVES

Although there are established criteria for selecting adhesives for different types of finishes, substrates and locations, it is good practice to confirm the selection by testing it on site before actual installation. More care should also be taken for moisture sensitive and light coloured natural stones. It would be better to choose white coloured bedding adhesives for light coloured natural stones to avoid back staining. Apart from selecting the appropriate bedding adhesive, the manufacturer's guidelines on using the material such as mixing ratio and open time should be strictly observed to obtain optimum performance. When in doubt, it is always advisable to consult the manufacturer for technical support on the product and its suitability for the intended use.



*Fig. 5.11 – Compatibility tests to ensure adhesive's performance.*