FOCUS ON
INSTALLING
CERAMIC TILES
ON FACADES
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INTRODUCTION

Installing ceramic tiles on façades, especially at heights over 3 metres, poses difficulties both from a design and application point of view.

One of the main factors that designers have to consider is represented by differential movements that occur between the substrate and the ceramic tiles as a result of daily and seasonal temperature changes. These, in turn, are dependent on the geographical position, exposure to the sun, the colour of the tiles and their format. In view of this, it is evident that, for this type of application, great care must be taken over safety aspects, especially if the project involves the installation of large slabs (tiles with sides > 60 cm are classified as large) and if the building is situated in seismic-risk areas.

In the last few years, developments in the ceramics industry have allowed manufacturers to produce even larger ceramic slabs, measuring up to 160x320 cm. The thickness of these slabs can vary from 3 to 5.5 mm (in this case, they are classified as thin, stoneware slabs, some of which are reinforced on the back with anti-alkaline fibreglass mesh which makes them stronger) up to traditional nominal widths of 10-11 mm.

Generally, three types of substrate can be identified for covering facades.

**Cement-based plaster or concrete**

Italian regulation UNI 11493 states that the substrate must have a cohesive resistance (determined as adhesion to the load-bearing layer) of at least 1 N/mm² and a stress resistance parallel to the laying surface of at least 1.2 N/mm² (Class AA “very high”) measured in accordance with UNI 10827. The verification of the surface resistance can be done empirically by scratching the surface vigorously with a large steel nail to form squares measuring about 2x2 cm. The surface resistance is considered acceptable if deep incisions are not formed and they do not produce a crumbling effect.

In addition to these requirements, the substrates must also meet the following conditions:

- They must have completed their curing cycle and, therefore, must be dimensionally stable.
- They must be dry.

The maximum moisture content allowed for laying ceramic tiles must not exceed 3%. Measurements must be carried out with a carbide hygrometer.

Consequently, it is safe to assume that the dilatometric stresses, combined with the weight of the slabs, require a careful assessment of the characteristics of the substrate.
- They must be flat.
The flatness of the laying surface (floor or wall) is a fundamental requirement because it directly affects the final tiled surface regularity. Moreover, a flat laying surface allows the use of an even thickness of adhesive. The verification of the flatness of the substrates must be carried out using a 2-m metal ruler placed on 2-mm spacers when laying thin slabs or a 3-mm metal ruler when laying thicker tiles, placing it all directions. There should not be any positive or negative variations above +2 mm for thin slabs and above +3 mm for thicker tiles. If these tolerances are not met, appropriate levelling products must be applied.

- They must be clean.
The surface must be free from superficial dust; loose fragments; release oil residue; paint, varnish and old glue residue and anything else which could compromise adhesion.

- The plaster must be reinforced with galvanised wire mesh, in correspondence with the stringcourses and point between the concrete frame and the curtain wall, to limit the formation of cracks due to the differential movements of the various materials.
External Thermal Insulation Composite System (cladding)

Recently, with a view to saving energy and improving the thermal comfort in buildings, thermal cladding insulation has been developed for use in both new buildings and renovations, where ceramic tiles are laid instead of traditional mineral-based finishes. As shown in the image, this is a composite system, featuring layers of various elements. Compared to traditional thermal cladding insulation with mineral-based finishes, this system consists of EPS (expanded polystyrene) or XPS (extruded polystyrene) insulating panels which are fixed with suitable adhesives to the substrate, together with suitable wall plugs and a layer of structural plaster reinforced with anti-alkaline, fibreglass mesh, to form a mechanically resistant surface, with a low elastic module which can support the weight and strain of the tiles. The system allows tiles measuring up to 50x150 cm and 5mm in thickness to be installed, up to a maximum height of 20 metres. Follow the manufacturer’s instructions carefully when installing these insulation systems.

1 - Concrete
2 - Adhesive
3 - Insulating panels
4 - Low module structural plaster
5 - Fibreglass mesh
6 - Wall plugs
7 - Adhesive: Hyperflex K100
8 - Thin porcelain stoneware slab
9 - Elastic separation joints sealed with Ottoseal S70
10 - Litochrom 1-6 or Litochrom 3-15 cementitious grout
In light of the above, it is clear that to plan the installation correctly, the following parameters must be taken in account:

- It is essential to identify the variation or expected temperature range (Δt) to be able to calculate the size variation of the tiles based on their format and the thermal expansion coefficient provided by the manufacturer.
- Choose light-coloured tiles with a reflection index above 20% (assuming that the black has a reflection index \(= 0\%\), while the white has a reflection index = 98%).
- Use deformable or highly deformable cementitious adhesives which allow for the tile-substrate differential movements. Alternatively, two-part reactive adhesives can be used, generally consisting of epoxy-polyurethane resin.
- Prepare joints that match the size of the tiles.
- Create elastic separation joints on the tiling surface, the size of which will depend on the predicted Δt, their distance and the overall deformation allowed for the silicone sealant.
- Installation on top of old tiles, mosaics or natural stone is not allowed for façades.

Let’s take a closer look at each of these aspects.

**How do I calculate the size variation of the tiles?**

Porcelain stoneware is the most suitable tile for this type of application based on its virtually zero water absorption thus, making the tiled surfaces on exteriors extremely durable. The linear thermal expansion coefficient of the tiles (\(\alpha\)) is provided by the manufacturer and measured in accordance with the UNI EN ISO 10545-8 standard. This coefficient gives the increase in thousandths of a millimetre for every initial metre of length to every 1°C increase in temperature. Porcelain stoneware has a linear thermal expansion coefficient which, on average, varies between 4 and 8 \(\times 10^{-6}\) °C⁻¹. The size variation (\(\Delta L\)) affecting a porcelain stoneware tile is calculated by the formula:

\[
\Delta L = \alpha \times \Delta t \times L
\]

where:

- \(\Delta L\) = size variation (mm)
- \(\alpha\) = thermal expansion coefficient
- \(\Delta t\) = variation or predicted range of temperature (°C)
- \(L\) = length of the longest side of the tile (mm)

**What is a deformable or highly deformable adhesive?**

The determination of the deformation for a cementitious adhesive is laid down by the EN 12002 standard. This standard describes a test method which measures the deformation via a flexibility test of an adhesive film subjected to a central load. The higher the deformation of the adhesive, the greater the transverse deformation value measured from the centre of the sample. The standard defines two classes of deformation. Class S1 classifies “deformable adhesives” for which the transverse deformation is between 2.5 and 5 mm while Class S2 classifies “highly deformable adhesives” for which the transverse deformation is ≥ 5 mm.
Litokol offers the following products:

**Superflex K77**
Enhanced cementitious adhesive, deformable, with zero vertical slip and extended open time in Class C2TE-S1 in accordance with the EN 12004 and EN 12002 standards.

**Hyperflex K100**
Enhanced cementitious adhesive, highly deformable, with zero vertical slip and extended open time in Class C2TE-S2 in accordance with the EN 12004 and EN 12002 standards.

**Cementkol K21-K22 + Latexkol**
Grey (K21) or white (K22) cementitious adhesives, in Class C1 according to EN 12004, which when combined (30%) with Latexkol elasticising latex are transformed into highly deformable Class C2S2 adhesives.

**Litoelastic**
High-performance, two-part, white reactive adhesive for zero vertical slip in Class R2T in compliance with EN 12004.
**WARNING**

For tiles with sides measuring more than 30 cm, the project designer must decide whether a mixed fixing system of adhesive/safety withholding hook is required, to be chosen based on the tile format and weight, the tile design/layout, the height of the installation and the environmental conditions. LITOKOL can assist customers in choosing the best safety withholding hook thanks to its partnership with specialised companies operating in this sector.

In the event of projects where the height of the installation exceeds 3 metres, we recommend that the customer contacts our technical support team beforehand.

Safety withholding hook RAI-FIX by Raimondi S.p.A.
## LITOKOL ADHESIVES FOR INSTALLING THIN SLABS WITHOUT REINFORCED MESH ON FACADES
(Substrate: cement-based plaster or concrete)

<table>
<thead>
<tr>
<th>Slab format</th>
<th>Adhesive</th>
<th>EN 12004 Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5.000 cm²</td>
<td>Superflex K77</td>
<td>C2TES1</td>
</tr>
<tr>
<td>Longest side ≤ 100 cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 5.000 cm²</td>
<td>Hyperflex K100 + Cementkol K21/K22 + Latexkol</td>
<td>C2TES2 C2S2</td>
</tr>
</tbody>
</table>

## LITOKOL ADHESIVES FOR INSTALLING THIN SLABS WITH REINFORCED MESH ON FACADES
(Substrate: cement-based plaster or concrete)

<table>
<thead>
<tr>
<th>Slab format</th>
<th>Adhesive</th>
<th>EN 12004 Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5.000 cm²</td>
<td>Hyperflex K100 + Cementkol K21/K22 + Latexkol</td>
<td>C2TES2 C2S2</td>
</tr>
<tr>
<td>Longest side ≤ 100 cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 5.000 cm²</td>
<td>Litoelastic</td>
<td>R2T</td>
</tr>
</tbody>
</table>

## LITOKOL ADHESIVES FOR INSTALLING CERAMIC TILES ON INSULATION CLADDING IN FACADES

<table>
<thead>
<tr>
<th>Slab format</th>
<th>Adhesive</th>
<th>EN 12004 Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max 50X150 cm</td>
<td>Hyperflex K100 + Cementkol K21/K22 + Latexkol</td>
<td>C2TES2 C2S2</td>
</tr>
<tr>
<td>Thickness: 5 mm (without reinforcement mesh)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## LITOKOL ADHESIVES FOR INSTALLING TILES WITH A THICKNESS > 5 mm ON FACADES
(Substrate: cement-based plaster or concrete)

<table>
<thead>
<tr>
<th>Tile format (longest side)</th>
<th>Adhesive</th>
<th>EN 12004 Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 30 cm</td>
<td>Superflex K77</td>
<td>C2TES1</td>
</tr>
<tr>
<td>≤ 60 cm</td>
<td>Superflex K77 Hyperflex K100 + Cementkol K21/K22 + Latexkol</td>
<td>C2TES1 C2TES2 C2S2</td>
</tr>
<tr>
<td>&gt; 60 cm</td>
<td>Hyperflex K100 + Cementkol K21/K22 + Latexkol</td>
<td>C2TES2 C2S2</td>
</tr>
</tbody>
</table>

** Decide whether a mixed adhesive/safety withholding hook fixing system is required for heights over 3 metres.
ADVICE FOR INSTALLATION

Bonding
Having identified the adhesive, we would like to outline a few pointers for its use. Firstly, when installing tiles on a façade, the adhesive must always be applied with the back-buttering method, where the adhesive is applied to both the substrate and the back of the tiles, which are tapped with a rubber mallet, so as to obtain a full layer of adhesive without any air pockets.

Specific electric vibrating machines are available on the market which help tap in the tiles, especially when installing large tiles.

Great care should be taken over the adhesive “open time”, by frequently checking with your finger if a surface has skinned over. If this occurs (open time expired), simply reapply the adhesive by combing on some fresh material and laying the tiles. Checking the open time is even more important in hot or windy conditions.

If the tiles are installed in hot seasons, we recommend working in the early hours of the morning when the temperature is more suitable for installation.

Vice versa, in cold weather, do not start work if a drop in the temperature below +5°C is forecast in the following 24 hours. When laying thin slabs, remove any excess adhesive from the joints while it is still fresh.
Joints

As previously indicated, the tiles must be laid with a wide joint. Butt joints are not allowed. The width must be defined based on the climate conditions and the tile format. Generally, joints for installation on façades should be created with a width between 4 and 8 mm. Any plastic spacers must be removed before grouting. For grouting, use the cement-based grouts Litochrom 1-6 and Litochrom 3-15 (high performance cementitious grout in Class CG2WA according to the EN 13888 standard) or two-component epoxy mortar such as Starlike® or Epoxystuk X90 (Class RG reactive grouts according to EN 13888). Both types of mortar used for joints have lower elasticity modules compared to the tiles and can, therefore, prevent dilatometric tensions from being transferred to the adhesive, which would cause the tiles to come off. Refer to the specific technical data sheets for the correct use of the products mentioned.

Elastic separation joints

Divider joints must be included to absorb the expansion of the ceramic wall tiles. The placement of the joints, which should be decided during the planning phase, must allow for sections of 9 m² (3x3 linear meters). Moreover, these joints must be created in line with the stringcourses, corners, edges, windows and openings. The width of elastic joints, which must not be less than 6 mm, must be calculated based on the following parameters:

- Space between joints (L)
- Maximum temperature variation expected during use (∆t)
- Elongation capacity of silicone sealant (E)
- Linear thermal expansion coefficient of the tile (α)

Based on the following formula:

\[ Ag \text{ (width of joint)} = \frac{(α \times ∆t \times L)}{E} \]

Separation joint

Structural joint generally sealed with appropriate edge protections and joint covers

Joints in line with other elements

Joints with applied elements
The top parts of vertical surfaces must be adequately protected with suitable edge protections or sealants to prevent rain water penetrating under the ceramic tiles. Thanks to our partnership with Otto Chemie, a leading manufacturer of silicone sealants, LITOKOL proposes the neutral, cross-linking silicone sealant, Ottoseal S70, for creating elastic separation joints on façades between ceramic tiles. The product has excellent weathering ageing and UV-resistance and contains fungicides. It is available in a variety of colours and the permitted elongation (E) is 25%.

**Structural joints**

Any structural joints in the building which by law must be sealed with specific edge protections or joint covers must be strictly observed. Litokol can also assist customers in choosing the most suitable product for structural joints, based on the size of the gaps, the expected movement of the structure, the type of wall tiles and installation, and waterproofing.
Note

The information provided in this document has been drafted to the best of our knowledge and experience, and to the best of our technical knowledge on laying ceramic tiles. Given the considerable number of cases and variety of unforeseen conditions that may arise, the information provided should, therefore, be considered as an indication only. So, before starting the installation work, it is essential that the designer in charge of the tile layout and the project manager identify the best design choices.