NEW CHALLENGES FOR CERAMIC FLOORING WITH RESPECT TO THE USE OF ANTI-IMPACT SHEETS (TBC DB HR) AND THE CURRENT USE OF DECK SCREEDS WITH SELF-LEVELLING MORTARS

[1] J. Pérez Navarro, [2] G. Martínez Sánchez, [3] Flor de Liz Ramos Gomariz

[1] Technical Architect. Official College of Quantity Surveyors and Technical Architects of the Murcia Region (Spain)

julian@coaatmu.es

[2] Technical Architect. Algescon Levante S.L. (Spain)

[3] Technical Architect. Algescon Levante S.L. (Spain)

ABSTRACT

This paper seeks to explain two issues now facing ceramic flooring.

On the one hand, since April, 2009, it has been compulsory to comply with the Basic Document on Protection against Noise (DB-HR) of the Spanish Technical Building Code (TBC). This new regulation means that, in order to comply with this insulation requirement, anti-impact sheets have to be installed in the multi-layer flooring system, which have a certain influence on the system's performance, which we wish to analyse.

On the other hand, in order to optimize execution times, the use of self-levelling mortars for screeds on decks has currently become standard practice, since this is a product that can be pumped and that dries quickly, on which the adhesive and the tiles are directly applied. These mortars offer new performance parameters for the system, since the shrinkage factor is decisive here due to the water loss produced while they are setting. In this sense, industrial formulations with reinforced fibreglass and the influence of the final thicknesses of these screeds are analysed here for the sector's general information.

1. BACKGROUND

Analysis of floating floor construction systems at three sites:

1) A building with 81 houses in Pobla de Farnals, Valencia.
2) A building with 11 houses in Valencia.
3) An apartment building in Almenara, Castellon.

These buildings were constructed between the years 2005 and 2008.

2. MATERIALS USED

In the three buildings, based on the project specifications, a floating floor construction system was designed, made up of: a thermal, acoustic and impact noise absorption insulation sheet + a self-levelling floor + ceramic flooring.

In the first case 1), the products used were as follows:

A self-levelling mortar made by Hormigones Conbo, S.L., at the Puerto de Sagunto plant in Valencia, installed in the building by PAHORVAL, was used for making the ceramic floor base.

This material was installed directly on the building decks or on soundproofing sheets, previously laid out on the decks.

The components of the self-levelling mortar used were as follows:

CEM II/B-V 42.5R cement manufactured by LAFARGE ASLAND, S.A., according to supply certificates for Hormigones Conbo, S.L., dated March 29th and May 3rd, 2005.

Crushed sand, with particle size analysis and determination of the signature modulus performed at the Hormigones Conbo. S.L. laboratories.

POZZOLITH 390N plasticiser of the company BETTOR.

Water. No information was provided, but since the mortar was made at the central facility, it is assumed that it complied with the requirements established in the EHE (Structural Concrete Instruction).

A report was also provided on the compressive strength of the self-levelling mortar made by Hormigones Conbo, S.L., issued by the quality control laboratory, CIVITUM, in which an average compressive strength of Rcm28=18.9 N/mm^2 at 28 days was determined. This strength is considered suitable for withstanding perfectly well the mechanical stresses to which the base made with this self-levelling mortar was going to be subjected.

2.1. Soundproofing sheet.

In order to obtain the sound reduction of the impact noise between houses established in the project, the soundproofing sheet manufactured by TROCELLIN IBERICA, S.A., called Type C classic AISLAFON NEGRO BASICO with a thickness of 3 mm, made with closed cell cross-linked polyolefin foam, was laid on the decks that separated the houses.

2.2. Construction system.

The mortar was installed by pumping it onto the deck or onto the soundproofing sheet. It was then spread manually with a long-handled tool and levelled using gauges previously levelled with a laser level.

In both cases, a 5 mm-thick strip of porexpan was laid vertically next to the structural elements or the brick envelopes to create a joint that insulated the self-levelling mortar of these elements. The surface of each slab of mortar thus coincided with that of the house.

Figure 1. Installation of the soundpoofing sheet.

Figure 2. Level gauges.

Figure 3. Pouring of the self-levelling mortar.

3. PATHOLOGIES DETECTED

There was no cracking caused by any notable shrinkage in the mortar base installed directly on the deck. The cracks that appeared were of little significance and when they developed, they were very different from one another. Therefore, there

was no risk whatsoever for the ceramic flooring to be installed on the substrate at a later stage. The on-site moving of materials and the normal construction process caused no damage at all to the mortar base; nor did it increase the slight cracking found due to shrinkage.

Self-levelling mortar bases behaved similarly at other sites directed by this technical building management.

When the self-levelling mortar base was installed on the noise reduction sheet, the cracking due to shrinkage came to reach unacceptable levels, with the mortar slabs breaking and the phenomenon getting worse when the mechanical actions typical of the movement of site materials occurred at the cracks, especially when the thickness of the mortar layer in the area did not exceed 3 cm, and so-called "spider web" cracks appeared that evidenced complete fracture of the affected area.

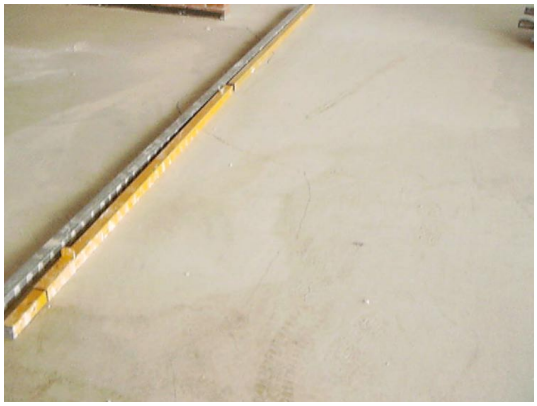

Figure 4. Finished and set mortar base.

Figure 5. Cracking. Crack width >3mm.

Figure 6. "Spider web" cracks.

4. RESEARCH

In which the cause → effect relationship was obvious: self-levelling mortar + noise reduction sheet → uncontrolled cracking.

The research into the pathology, the tests carried out, and the recommendations for repair are described below.

4.1. Research.

- With the small thicknesses of the self-levelling mortars and the mechanical movement of site materials, in some houses, the cracking worsened and "spider webs" formed that caused the slab to break.
- The cracks reached and easily exceeded widths of 3 mm. This caused lipping between both sides of the crack, which also exceeded this magnitude.
- Shrinkage is intrinsic to the setting of mortars made with cement. This was more pronounced in this case due to the high water-cement ratio required to make the mortar fluid, to facilitate pumping and help mortar levelling. Also, when it was poured onto the closed cell noise reduction sheet, which insulated the mortar substrate from the deck and completely prevented the mortar base from adhering to it, all the rapid water loss of the mortar during setting occurred at the surface, and this effect was not controlled sufficiently by the plasticiser addition that was incorporated into the mortar.
- It was observed that cracking appeared about 10 days after the cement mortar had been poured, and that it worsened as time went by. This is a phenomenon that continues with time, since it is intrinsic to cement mortars.

4.2. Tests carried out and recommendations.

As a first preventive measure, shrinkage joints were ordered to be made by radial cuts of the mortar layer in order to control the shrinkage.

Figure 7.

As the above photograph shows, the result was not satisfactory.

- In order to resolve the pathology, and with a view to repairing the self-levelling mortar without completely breaking it up, in contact with the company MAPEI, the following tests were carried out:
  - Demolition of the mortar layer in two houses for a TOPCEM PRONTO floating cement screed to be applied, according to the procedure by this commercial company. In one of the houses, the screed was reinforced with lath and in the other it was not.

Figure 8.

- Repair of the mortar layer in one house according to this commercial company's procedure, sealing cracks with EPORIT and then preparing the flooring substrate and way of installing it. This testing of this procedure was carried out in its entirety.

Figure 9.

5. REPAIR PROCEDURE

Once the conclusions of the research had been drawn and the option for repairing the self-levelling mortar used in the building had been decided on, following the logical construction order, a TECHNICAL PROCEDURE was drawn up for repairing the mortar substrate for the installation of the ceramic flooring, according to the process detailed below.

5.1. Crack repair.

1. The cracks must be opened with radial cuts, cleaned and vacuumed before being sealed.

2. The areas affected by "spider web" cracking shall be demolished and the resulting area filled with TOPCEM PRONTO. Sealing shall then follow.

3. With respect to the cracks with 3-mm lipping between their top sides, a minimum width of 36 cm of the flooring shall be demolished along the whole length of the crack, and the resulting strip filled with TOPCEM PRONTO. Sealing shall then follow.

4. Sealing of the cracks by pouring EPORIT.

Figure 10.

5. Sprinkling the surface of the fresh resin with sand and then vacuuming it once it has hardened.

Figure 11.

6. Execution of the construction process corresponding to the compartmentalization, installations, and the cladding of the houses.

7. Verification of the extent to which the construction process has affected the repaired self-levelling mortar base. If new cracks appear, actions shall be taken in accordance with the description given in points 1.1 to 1.5 of the procedure.

5.2. Installling the ceramic flooring.

1. Gluing the MAPETEX felt with KERABOND adhesive with 100% ISOLASTIC added.

Figure 12.

2. Installation of the ceramic flooring on the MAPETEX felt with the KERABOND adhesive with 100% ISOLASTIC added, using the buttering and floating technique (substrate and back of the tiles). The tile-to-tile joints shall be 3 mm wide.

Figure 13.

Given the size of the rooms in the houses, the configuration of the flooring stretches is considered adequate for the room dimensions, while the perimeters of the rooms are left as movement joints. In the event of the flooring model changing between rooms, a movement joint shall be made between both.

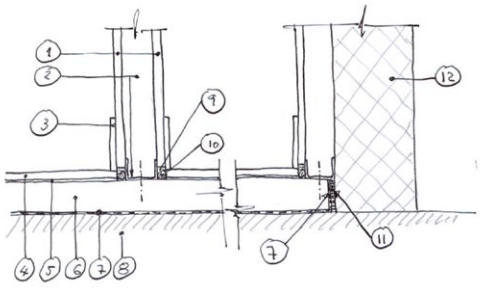

Figure 14. 1. Gypsum wallboard e=15 mm. 2. Gypsum wallboard structure. 3. Ceramic skirting. 4. Ceramic flooring. 5. MAPETEX felt and KERABOND adhesive. 6. Repaired self-levelling mortar. 7. Noise reduction sheet. 8. Deck. 9. Joint sealing with MAPESIL AC. 10. MAPEFOAM for joint bottom. 11. Porexpan e=5mm. 12. Structural element or building envelope.

3. ULTRACOLOR filling of the tile-to-tile joints.

Figura 15.

4. Sealing of movement joints with MAPESIL AC before installing MAPEFOAM for the bottom of the joint.

With respect to the products, their characteristics and specification sheets, the indications in the recommendations for use of Annexes 3 and 4 shall be followed, as well as the contents of the official catalogues of the company MAPEI.

In the second case 2), the materials that made up the system were as follows:

- Self-levelling mortar:

  Mortar prepared at the central facility, made up of Readynivel cement by Lafarge.

- Impact noise reduction sheet:

  Sheet made of high-quality polyethylene through a direct extrusion and physical expansion process, with closed cells. Chovaimpact Plus of 5 mm thickness. Installed in a roll, overlaps joined with adhesive tape.

- Ceramic flooring.

Installation:

The anti-impact sheet was laid on the deck and raised onto all the vertical faces, creating absorption points of possible movements due to the expansion of the materials with respect to the mortar.

A corrugated steel lath measuring 150x150x5mm was then laid.

The installation was performed with the external cladding leaf of the facade completed, without installation of the external woodwork. Due to the building's location and orientation, the damage caused by excessive shrinkage due to mortar drying was minimal.

Pathologies:

- Not very significant cracking was noticed approximately one week after the pouring. No intervention was required for crack sealing.
- Areas where the lath showed through by default in the installation were observed, which remained in the upper part of the floor.
- The ceramic flooring was installed using adhesive without any previous preparation.

Figure 16.

In the third case 3), the materials of which the system consisted were as follows:

- Self-levelling mortar:

  Mortar prepared at the central facility, made up of Readynivel cement by Lafarge.

- Impact noise reduction sheet:

  Sheet made with 5 mm-thick Trosinter 25/5 closed cell cross-linked polyethylene. Installed in a roll, overlaps joined by an air diffuser or adhesive tape.

- Ceramic flooring.

Installation:

The anti-impact sheet was laid on the deck and raised onto all the vertical faces, creating absorption points of possible movements due to the expansion of the materials with respect to the mortar.

The installation was performed with the external cladding leaf of the facade completed, without installation of the external woodwork.

The building location and orientation favoured cracking of the floor due to the uncontrolled shrinkage of the mortar as a result of excessive airing.

Figure 17.

Pathologies:

- Cracking, in some cases +up to 2 mm, was noticed two or three days after pouring. These were 45º tracks in spider form that ran through the rooms and that began at particular points, such as false openings and pillar linings. In other cases, cracks were involved that coincided with areas where the mortar thickness was less than 5 cm.

In these cases, the intervention was demolition of the floor.

Figure 18.

In cases of smaller cracks, the sealing option was chosen using a cement grout and Sikaflex polyurethane sealant, following the manufacturer's recommendations, the grout completely penetrating into the crack.

Figure 19.

5.3. Recommendations for the installation.

Adequate thickness of the self-levelling mortar (a minimum of 5 cm and observance of the manufacturer's specifications).

The use of floor reinforcement with lath or polypropylene fibres, according to the manufacturer's recommendations.

Correct mortar proportioning, depending on the results and following the manufacturer's indications.

Making cuts in the hardened mortar at flooring changes.

Covering facade openings during the installation to prevent airing.

Preventing the formation of air pockets in the anti-impact sheet during the mortar pouring process.

Chipping away excess concrete from the decks in the compression layer to ensure the thickness (> 5 cm) of the mortar across the entire surface.

6. CONCLUSIONS AND FINAL RECOMMENDATIONS

In short, for the deck system to comply with the requirements of the Technical Building Code (DB-HR) and also for it to be compatible with a ceramic system, we recommend that the deck system be made up of a 10 mm-thick anti-impact sheet (Impactodan type by DANOSA) onto which a MALLATEX type lath is installed as reinforcement, using mortars with polypropylene fibres proportioned at the central facility with a minimum thickness of 5 cm. The results obtained are optimum. Cracking becomes very occasional, one or two cracks of no more than one metre in length on the surface of an entire house.

The techniques used respect and improve those indicated in the Guide for installing ceramic floorings, and they more than comply with the TBC requirements.

With respect to the TBC and the thermal insulation of the floor of a house with a garage, we are currently analysing several techniques. The one that is giving us the best result is as follows:

- Install the thermal insulation on the deck (extruded polystyrene does not absorb water from the mortar and it works better. Spraying polyurethane is horrible. It dries the mortar).
- Installation of the self-levelling mortar with a minimum thickness of 8 cm (10 cm being recommendable) reinforced with MALLATEX. (Reinforcement with lath creates problems when pouring the self-levelling mortar through the undulations that are typical of the lath, which end up appearing at the surface). The minimum thickness is to provide the base mortar on the thermal insulation with rigidity and weight. Otherwise, the floating effect of the flooring appears once it has been installed and it is easy for a thinner mortar layer to fail, leading to fractures in the flooring once it has been installed.
- Installation of ceramic flooring with adhesive, always using the buttering and floating technique (substrate and tile).

Figure 20.

REFERENCES

[1] Technical Building Code. Basic Document on Protection against Noise. TBC DB-HR

[2] Guide for applying the DB HR. Protection against Noise.

[3] New solutions of the TBC catalogue of construction elements.

[4] UNE 29052-1 Acústica. Determinación de la rigidez dinámica. Parte 1: Materiales utilizados bajo suelos flotantes en viviendas.

[5] UNE-ISO 1817. Caucho, vulcanizado. Determinación del efecto de los líquidos.