IMPROVE TECHNIFICATION AND LCA QUALIFICATION OF WORKERS IN CERAMIC SECTOR WITH THE SUPPORT OF BIM APPLICATIONS

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REPORT 1.2.7

REPORT ON BEST PRACTICES ON METHODS, SKILLS AND COMPETENCES IN RELATION TO CLAY PRODUCTS

CERAMIC FLOOR LAYING PROCESS

Consortium members: Associação Portuguesa da Indústria de Cerâmica (APICER), Centro Tecnologico da Cerâmica e do Vidro (CTCV), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), Asociación Española de Fabricantes (Hispalyt), Institute of Entrepreneurship Development (iED).

Content

1. INTRODUCTION

1. Background

The BIMclay project was born with the purpose of producing and developing didactic materials based on the BIM methodology, which address the challenges related to Life Cycle Analysis (LCA) of clay products, to serve as a training base for professionals in the ceramic sector. To this end, it is necessary to define and compile the most suitable execution systems and tile installation methods for clay and ceramic products.

The first task of the BIMclay project "O1. Establishment of common learning outcomes on clay placing methods, Life Cycle Analysis (LCA) and relative regulations" encompasses a series of specific tasks among which we find the elaboration of this report.

This good practice report addresses the establishment of skills and competencies, as well as the definition of the most sustainable and environmentally friendly implementation processes.

The present report "Ceramic Floor Laying Process" deals with the constructive process of laying ceramic tiles on the substrate.

2. Definition and type of grouting of ceramic tiles

The tile installation by direct adhesion is conditioned by two characteristics:

The water absorption capacity (E in % according to EN14411) since the anchorage of cement hydrates in cement mortars or cement and lime, as well as cementitious adhesives with a low polymer resin content, depend on it and the surface microroughness. In very porous tiles, the adhesion may also be compromised by incomplete hydration of the cement, as the ceramic body absorbs the water necessary for maturing the mortar or the cementitious adhesive without water retainers (the so-called "adhesive cements" or cementitious adhesives suitable only for interiors).

The surface of the tile, deducted from the format, due to shear stresses that may be generated after the hardening of the bonding material, due to thermal and/or humidity oscillations in the tiles or due to dimensional instability of the substrate. In cement mortars and adhesives with a low content of polymer resins, these shear stresses can lead to the breakage of the adhesive bond. The larger the surface, the greater the stresses on the perimeter of the tile. In addition, in thin-bed tile installation with dispersion resin adhesives (D1 and D2 of EN 12004 standard), large-surface tiles make it difficult for water and/or solvent to evaporate, making it impossible for the adhesive to fully mature in the time foreseen by the manufacturer.

The selection of the tile installation technique depends on these two characteristics: thick layer with cement mortar and/or lime or thin layer with adhesive, in the latter case conditioning the selection of the type of adhesive.

Other characteristics of the tile must also be taken into account, in relation to its intended use, in order to ensure its durability and avoid the loss of appearance through the correct selection of materials and tile installation techniques:

The coefficient of moisture expansion, especially in very porous and glazed tiles (BIII GL or AIII GL according to EN 14411), with respect to the appearance of deferred cracking if the glaze is subjected to tensile stress by compression of the substrate due to the overlapping shrinkage of the cement conglomerates and the increase in the volume of the tile due to water and humidity. In this situation, the use of deformable cementitious adhesives can be a good preventive measure.

The formation of efflorescence by the addition of soluble salts to the surface of the unglazed porous tile or the destruction of the support/glazing interface if these salts crystallise on it, in tiles that are also porous and glazed, in coatings subjected to the action of water and humidity from the substrates. In this case, waterproofing the fixing surface and fixing with adhesive are preventive solutions.

In this respect, the UNE-EN ISO 10545-7 "PEI Standard" refers to the wear resistance of materials and is mainly indicated for flooring. In this standard, we can find the following guide table of resistance values and types of traffic for which a specific material is recommended, but it is always necessary to follow the manufacturer's specifications.

STANDARD	TRAFFIC	TARGET AREAS
PEI I	Lightweight	Bedrooms, bathrooms
PEI II	Lightweight-Medium	The whole house excepted the kitchen
PEI III	Medium	The whole house
PEI IV	Medium-Heavy	Entrances, terraces
PEI V	Heavy	Restaurants, hotels, public places

Source: UNE.

On the other hand, depending on the size of the tile, the tile installation system may be:

Thin-bed tile installation, with a toothed trowel and adhesive cements of at least type C1, for small formats, i.e. tiles with a side greater than 40 cm).

Tile installation with double grouting, with application both on the support and on the back of the ceramic tile, in tiles with a surface area greater than 1000 cm2.

2. ENVIRONMENTAL CONSIDERATIONS

Ceramic tiles, like other ceramic products, respect the environment, as 96% of them are composed of supporting raw materials (clay, waste from ceramic pieces and other minority materials such as kaolins, sands and feldspars) and 4% of raw materials for enamel (feldspars, carbonaros, quartz, borates, silicates, kaolins, zirconium oxides, clays, alumina, zinc oxide...).

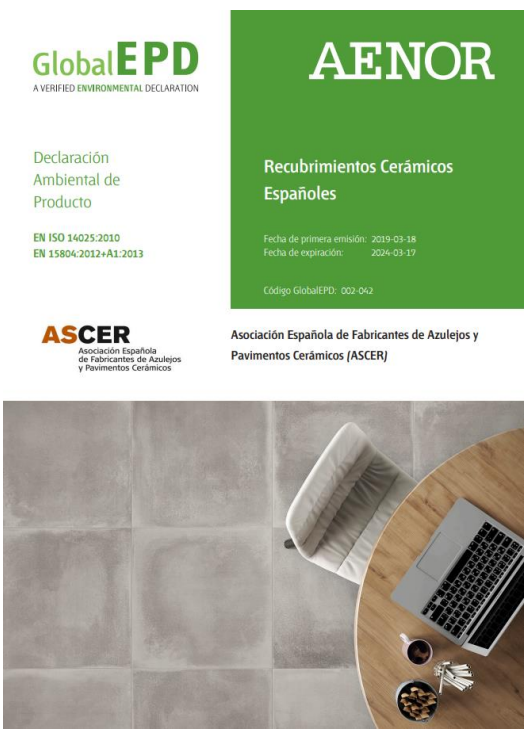
For this type of product, a useful life of equal reference to that of the building where they are installed is considered, provided that it is installed correctly, since it is a long-lasting product that does not require replacement. Therefore, the environmental product declarations (EPD) of ceramic tiles have assumed a useful life of 50 years and these considerations make the useful life shorter.

An example of this is the case of ceramic tilings, which have a type III environmental label, known as the Environmental Product Declaration (EPD) for their entire life cycle (cradle to grave), owned by the Spanish Association of Manufacturers of Ceramic Tiles and Flooring (ASCER).

Ceramic coverings, being totally inert products, do not emit any compounds to soil or water at their use stage, i.e. they do not undergo any physical, chemical or biological transformation, they are not soluble or combustible, they do not react physically, chemically or in any way, they are not biodegradable, they do not adversely affect other materials with which they may come into contact in such a way as to lead to pollution of the environment or harm human health. It is a product that does not leach and therefore does not pose a risk to the quality of surface water or groundwater.

The results of the Life Cycle Analysis (LCA) of this DAP are based on the data provided by the manufacturers of 40% of the national production of ceramic tilings, so it is a representative study of this sector at a national level.

GlobalEPD 002-042. Recubrimientos Cerámicos Españoles



		A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
CO_2	GWP	10,7	3,8E-01	5,2E-01		3,9E-02							8,8E-02	0	6,1E-02	-2,7E-01
	ODP	5,9E-08	1,0E-14	2,6E-13		1,3E-10							2,4E-15	0	6,2E-14	-4,6E-09
	AP	1,7E-02	3,3E-04	8,0E-04		4,1E-05							6,7E-05	0	3,6E-04	-10,0E-04
	EP	2,8E-03	7,0E-05	1,7E-04	NR	2,0E-05	NR	NR	NR	NR	NR	NR	1,6E-05	0	4,9E-05	-1,1E-04
O_3	POCP	1,5E-03	4,3E-05	7,0E-05		3,6E-06							9,7E-06	0	2,8E-05	-1,1E-04
	ADPE	2,5E-05	3,1E-08	7,3E-07		6,9E-09							7,2E-09	0	2,2E-08	-5,3E-08
	ADPF	148,1	5,1	2,5		2,2E-01							1,2	0	7,9E-01	-6,3

GWP [kg CO_2 eq] Potencial de calentamiento global
ODP [kg CFC-11 eq] Potencial de agotamiento de la capa de ozono estratosférico
AP [kg SO_2 eq] Potencial de acidificación del suelo y de los recursos de agua
EP [kg $(PO_4)^{3-}$ eq] Potencial de eutrofización
POCP [kg etileno eq] Potencial de formación de ozono troposférico
ADPE [kg Sb eq] Potencial de agotamiento de recursos abióticos para recursos no fósiles (ADP-elementos)
ADPF [MJ] Potencial de agotamiento de recursos abióticos para recursos fósiles (ADP-combustibles fósiles)

Tabla 10. Parámetros que describen los impactos ambientales definidos en la Norma UNE-EN 15804

Source: AENOR.

3. CONSTRUCTIVE CONSIDERATIONS

In Spain, standard UNE 138002:2017 "General rules for the installation of ceramic tiles by adhesion" defines the quality of ceramic tiles and aims to establish the general rules and associated processes for the design, selection of materials, preparation, installation, delivery and maintenance of the use of ceramic systems that must be considered to guarantee their quality and durability as well as their technical and aesthetic performance.

In addition, the Basic Requirements for each requirement of the Technical Building Code (CTE) must be fulfilled.

In terms of design and execution of coatings with ceramic tiles with adhesives, the provisions of the following sections of the Technical Code must be complied with:

- Structural safety. DB SE.
- Fire Safety DB SI.
- Healthiness. DB HS.
- Protection against noise. DB HR.
- Energy saving DB HE.

4. EXECUTION PROCESS

1. Preparation of the substrate.

In order to begin the construction process of laying ceramic tile flooring and obtain a satisfactory result, it is essential to check that the substrate has matured and is perfectly dry and hardened, i.e. that all the shrinkage due to setting has taken place, in order to avoid the appearance of the pathologies associated with this phenomenon, such as tile lifting or cracking due to lack of stability.

Subsequently, it is necessary to check that the floor is level and clean the surface, leaving it free of dust and loose residues.

Source: YouTube.

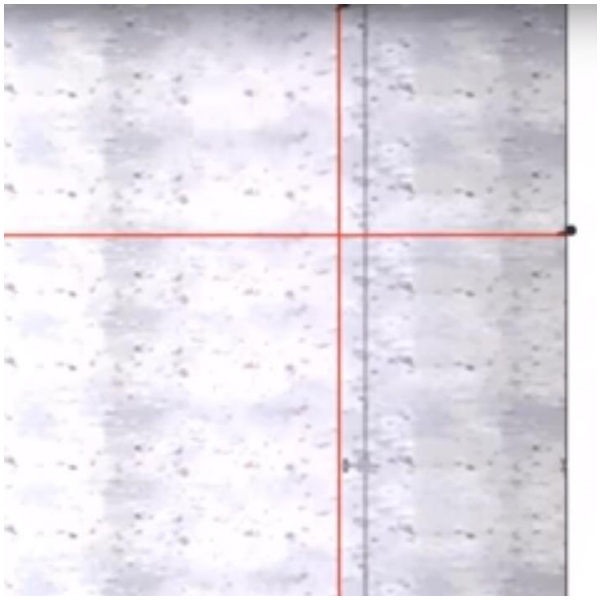
2. Frame of the stay.

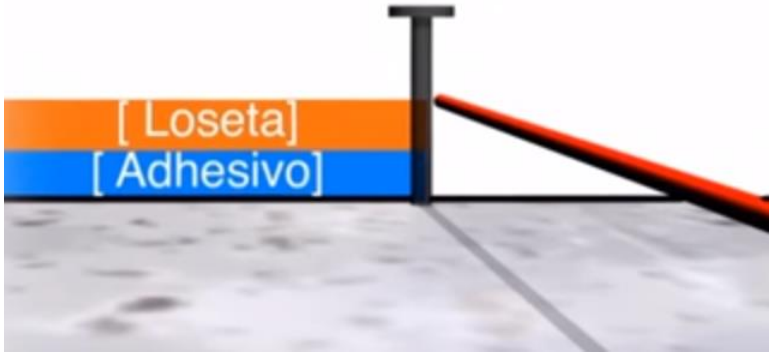
In order to ensure that the final result of the work carried out is satisfactory, the centre of the front wall of the room will be established as the origin of coordinates, from which it will be paved until it covers the entire surface.

With the help of wooden slats fixed to the floor with mortar and wooden blocks that will serve to maintain a regular distance around the perimeter of the room, the surface will be framed. Next, nylon threads will be placed to mark the final height that will reach the top face of the tiles once they have been laid. Therefore, the height that the threads must have will be equal to the thickness of the tile to be installed plus 1 cm of adhesive that will extend between the surface and the tile.

Fuente: YouTube.

The threads will be placed at an equal distance to the side of the tile to be laid. Proper levelling of the nylon threads with a bubble level will be ensured.





Source: YouTube.

3. Adhesive application.

For correct tile installation, a regular 1 cm layer of mortar should be laid with a notched trowel in the longitudinal direction of the first row of tiles to be laid. Since the tiles to be used for paving the room are small in size, i.e. less than 40 cm on each side, they should be laid using the simple gluing method. That is, only the bonding material is applied to the surface on which the selected tiles are to be installed.

Source: YouTube.

4. Laying the tiles.

The tiles are then carefully laid while the adhesive is still soft, by pressing them with your hands, as well as by tapping with a rubber mallet and checking that the back is completely covered by

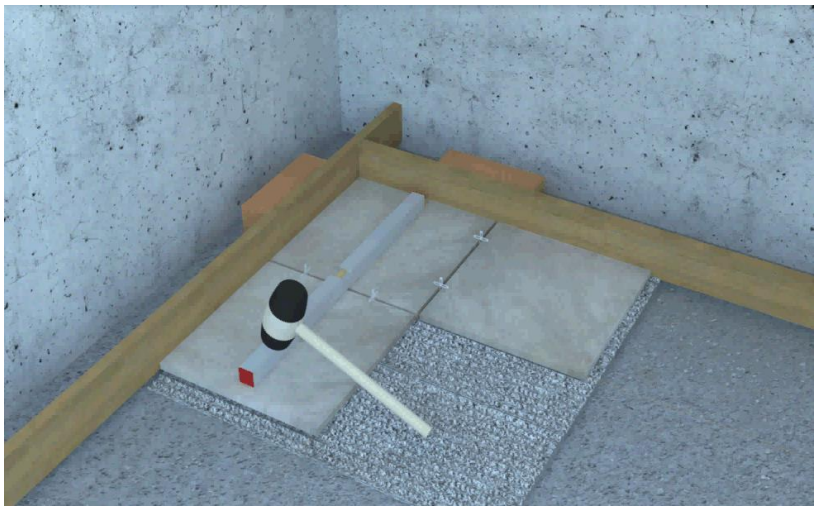
the adhesive. This ensures that no air bubbles form under the tile and prevents the tile from breaking.

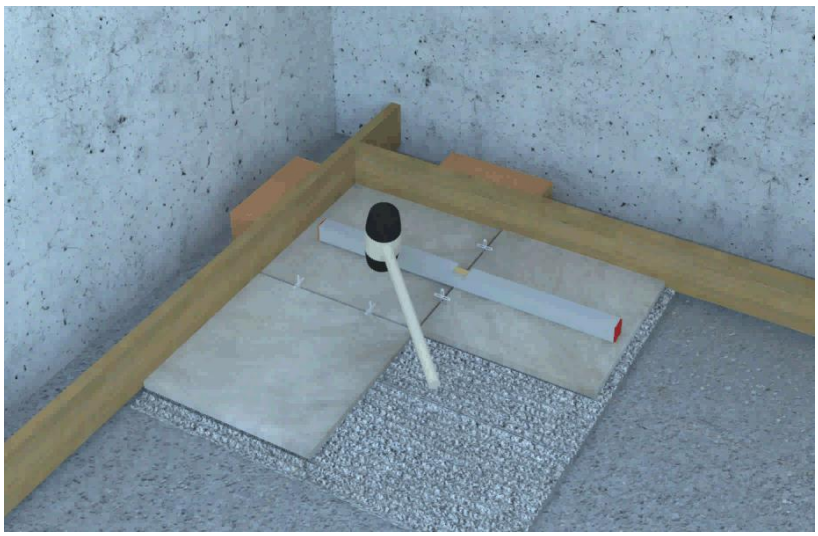
In order to maintain the uniformity of the joints over the entire surface, crossarms must be used.

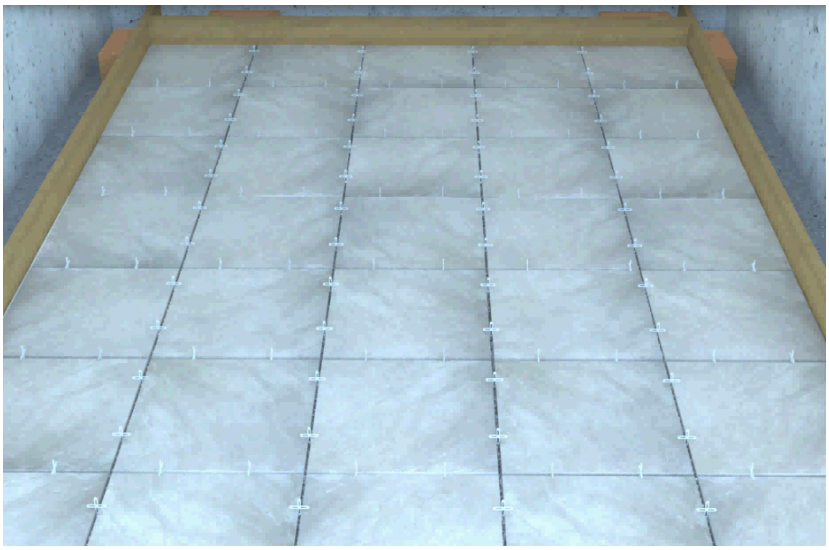
Source: YouTube.

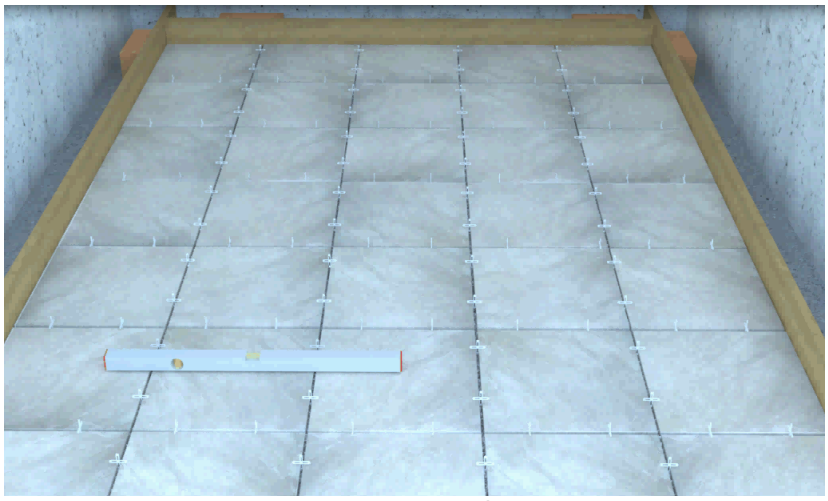
5. Levelling of the tiles.

Check that all tiles are level with the spirit level. In the case of those tiles that are not perfectly level, they should be tapped gently with the rubber mallet until they adjust to the height of the rest of the surface.





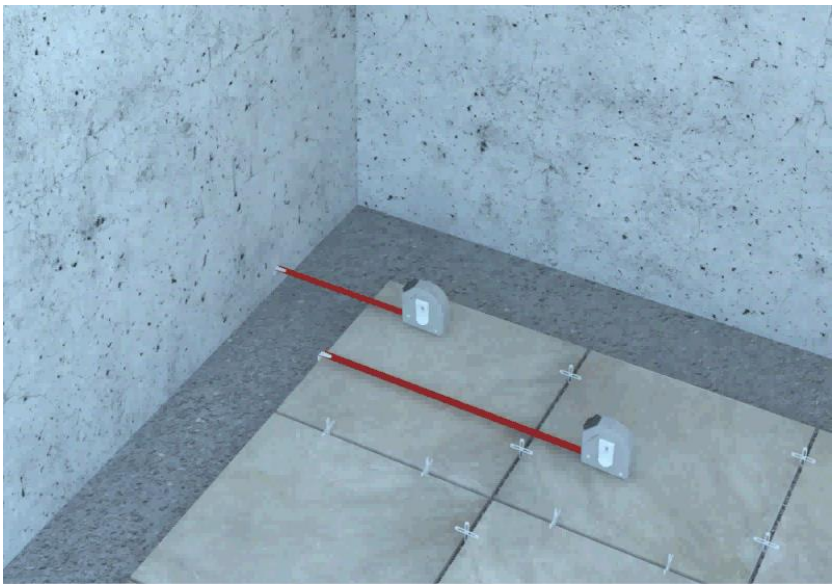




Source: YouTube.

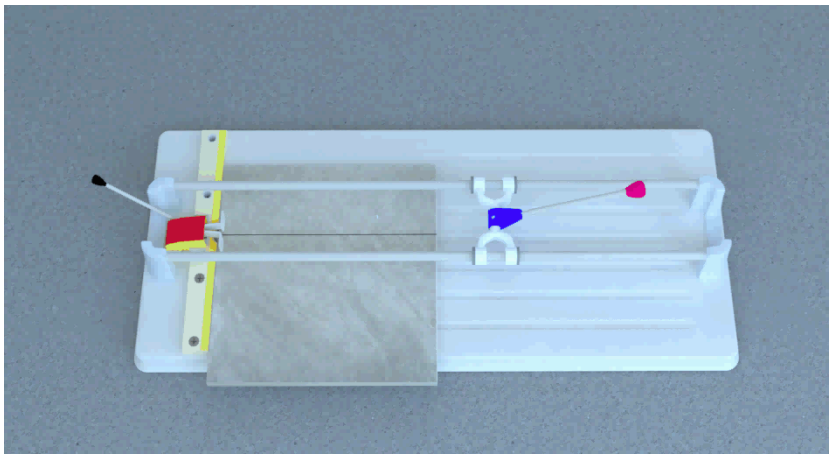
6. Finishing the surface contour.

Once all the surface inside the wooden slats has been completed, they are removed and the rest of the passenger compartment is completed. To do this, the distance between the already laid tile and the wall is measured.



Fuente: YouTube.

The tile is then marked and cut to the dimensions of the measurements made with the help of a machine for cutting ceramic products.



Fuente: YouTube.

The following steps are the same as those carried out with the rest of the surface (adhesive extension, tile installation and leveling).

Fuente: YouTube.

7. Grouting of the tiles.

Once the entire surface of the room has been covered, the remains of the room will be cleaned to avoid the insertion of these remains in the joints.

With the help of a cutter, the adhesive residues in the joints of the tiles are removed, thus leaving the joint clean and ready to proceed with the spreading of the grout material.

After the time necessary for the glue cement recommended by the manufacturer to dry correctly, the tiles will be grouted. To extend this grout, use a smooth rubber trowel and check that all the joints are perfectly filled.

Source: YouTube.

With the cement-joint fluid paste still fresh, the joints will be shaped so that they are at the same height as the tile surface.

8. Cleaning the tiles.

Next, remove the remaining surface paste with a glass cleaner and a wet sponge. To do this, press diagonally to lose the gasket material.

Fuente: YouTube.

9. Pavement Completion.

Wait for the grout to dry for the time specified by the manufacturer and the flooring will be finished.

Source: YouTube.

5. SUMMARY OF STEPS TO BE FOLLOWED IN THE CONSTRUCTION PROCESS

CERAMIC FLOOR LAYING PROCESS:

1. Preparation of the substrate.
2. Frame of the stay.
3. Adhesive application.
4. Laying the tiles.
5. Levelling of the tiles.
6. Finishing the surface contour.
7. Grouting of the tiles.
8. Cleaning the tiles.
9. Pavement completion.

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