METHODOLOGY FOR CONTROL OF THE EXECUTION OF CERAMIC TILE COVERINGS

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ABSTRACT

The evolution in recent years of ceramic materials, involving products with low water absorption and larger sizes, as well as the development and appearance of new ceramic tile adhesives and, where appropriate, the need to incorporate layers with various functions, such as insulation, watertightness, etc., together with a lack of regulation of the tile fixer trade, have led to inadequate knowledge for the appropriate execution of ceramic tile coverings.

On the other hand, the few regulations on tile installation, as well as the new regulations grounded in performance-based criteria, together with greater quality demands by users with respect to end product quality, make it necessary to highlight quality control of the materials and of the installation processes and, of course, of the finished tiling.

This paper seeks to provide a methodology for the control of the execution of ceramic tile coverings in accordance with the system laid down in article 7 of Royal Decree 314/2006, of 17 March, by which the Technical Building Code was passed into law, which structures control in three differentiated phases: reception on the building site of products, equipment, and systems; control of the execution of the building work, and control of the finished work.

The technical methodology and procedures for verifying the quality of the building work unit, ceramic tile covering, are based on the requirements laid down by the applicable building construction regulations, as well as by the recommendations set out in quality guides (in this case the Ceramic Tile Guide) and, where appropriate, on the specifications detailed by the project specifications writer or ordered by the executive management.

The proposed controls to be conducted on site (checklist) have already have been tested on site in different assignments performed by students in the Ceramics Classroom of Universitat Jaume I.

Once the control methodology presented in this paper has been adequately tried and proven with actual on-site applications, it is intended to draw up a control guide for the execution of ceramic tile coverings that will facilitate the work of technicians responsible for their installation, as well as the builder or tile fixer performing these tile installations.

1. INTRODUCTION

The purpose of this paper is to put forward a methodology for the control of the execution of ceramic tile coverings in accordance with the system laid down in article 7 of Royal Decree 314/2006, of 17 March, by which the Technical Building Code1, hereafter termed TBC, was passed into law.

In the building process, two different phases may be distinguished: one involving the project design and the other the execution of the building work. Both phases may be subject to quality control, thus yielding:

- Quality control of building project design.
- Quality control of the execution of the work.

The regulations on building construction, and in particular the TBC, do not make control of building design compulsory. However, the Developer can voluntarily decide to perform building design control by means of an organisation for building construction quality control (ECCE). This organisation will verify, totally or partly, depending on the assignment, whether the solutions proposed in the project design conform to the basic requirements of the TBC and other applicable regulations. The methodology and procedures for design control lie beyond the scope of this paper.

In contrast, the TBC makes quality control of the execution of the building work compulsory; in particular in article 7 it states:

"During the construction of building works the works manager and the site manager shall perform, according to their respective competences, the following controls:

a) *On-site reception control of products, equipment and systems that are supplied to the work.*

b) *Control of the execution of the work.*

c) *Control of the finished work."*

Therefore, according to the TBC, the control of building work execution is compulsory, this being a function that must be performed by the works manager and the site manager, according to their respective competences.

As a result, there are two types of control of the execution of the work: **self-controlled** installation by the builder/installer, and **external control** by the works manager and the site manager (executive management).

The following sections describe the methodology for controlling the execution of the building work unit ceramic tile covering. The order of the method is, first, to draw up a control programme based on the project design control plan, which contains the specifications of the products, of the execution, and of the finished tile covering and, secondly, to perform the installation controls that allow conformity of the tile covering to be verified.

In the external control, the responsibility of writing up the **control programme** in building construction lies with the site manager, as already noted. The control programme develops the control plan, taking into account the means and circumstances of the work Contractor or tile installer and their work plan.

In self-controlled installation, the responsibility of the planning and programming lies with the builder/installer. This self-controlled installation can be assured by a conformity certification; in this case external control can be reduced or even suppressed.

2. PRELIMINARY CONSIDERATIONS

During the execution of the building work unit ceramic tile coverings, the works manager and the site manager shall perform, according to their respective competences, the following controls:

- Control of on-site reception of products, equipment, and systems.
- Control of tile covering execution.
- Control of the finished tile covering.

These controls serve to verify that the products, processes, and activities involved in the execution and in the finished tile covering conform to what has been set out in the project design, applicable legislation, standards of good construction practice, and executive management instructions.

Before initiating on-site control activities, the site manager shall write up a control programme that sets out the control plan and, where appropriate, the document of particular specifications of the design, and shall take into account the means and circumstances of the works builder or tiling installer and their work plan.

The control programme shall include:

- The identification of products and execution processes subject to control.
- Where appropriate, the establishment of control weighting factors to better match the singularities of the tile covering, with a view to modifying the control planning.
- Definition of the control lots and inspection units, for each case describing the checks to be made and, where appropriate, the acceptance and rejection criteria.
- The necessary control documentation.
- The controls to be performed for product reception, for the execution of the building work unit and of the tiled finish.

The programmed control activities shall include the three control phases described below.

3. ON-SITE PRODUCT RECEPTION CONTROL

The system to be followed for product reception is the system set out in the TBC:

a) Control of the documentation of the supplies that arrive on site (see table 3).

b) Where appropriate, control by means of quality marks or technical suitability evaluations.

c) Where appropriate, control by testing.

The conformity of the products, equipment, or system received on site is obtained when:

- They correspond to those specified in the control plan or, where appropriate, in the design document of conditions.
- They are accompanied by the required documentation.
- They are characterised by the required properties, and the declared values in the documents that accompany the CE mark, or compliance of the required characteristics can be deduced from the declaration of the technical characteristics.
- They have been tested, when this is established in the control program, and

their conformity can be deduced from the results obtained.

IDENTIFICATION	REQUIRED PROPERTIES. (SPECIFICATION)	CONTROL OF DOCUMENTATION OF SUPPLIES	CONTROL BY MEANS OF QUALITY MARKS	CONTROL BY TESTS
The identification of the product, equipment, or system received shall be verified: • product type. • • where appropriate, dimensions and shape. • • where appropriate, finish. • • where appropriate, tile code.	When, in the project design, the product, equipment, or system is characterised by a series of required properties (specifications), it shall be verified that the values declared in the documents that accompany the CE mark or in the declaration of technical characteristics allow compliance with these specifications to be deduced.	The following documents shall at least be provided: <u>Before supply</u>: • Documentation accrediting the CE mark (CE label with declaration of technical characteristics + CE conformity declaration. • Where appropriate, declaration of product technical characteristics. <u>During supply:</u> • Supply sheet and CE label. Check that the product identification and characteristics match those required by the design. <u>After supply</u>: Certificate of guarantee; certificate of supply.	When the product, equipment, or system has a quality mark or a DITE (document of the evaluation of technical suitability) and this guarantees the required characteristics, the product shall be immediately accepted by the accreditation of its mark or evaluation of technical suitability.	When in the project design certain specifications are required for the product, equipment, or system and their conformity cannot be deduced by documentary check, tests shall be performed of the corresponding characteristics

Table 3. Actions for the reception of products, equipment, or systems.

Of all the products involved in a ceramic tile covering, it is recommended that at least those with the greatest repercussion on the final tiling quality should be subjected to reception control, that is: ceramic tile, ceramic tile adhesive, grout and, where appropriate, cement mortar, screed mortar or self-levelling compound and insulation membrane.

The requirement of the TBC is to be noted for floorings in floors of buildings with Sanitary, Educational, Commercial, Administrative, Parking and Public Traffic

Uses, in relation to slip risk. The floorings shall conform to the requirable slip resistance class for floors as a function of their location defined in table 1.2 of the DB SU1 of the TBC, determined according to UNE-ENV 12633:2003.

In the particular case of ventilated façades, it shall be verified that the documentation provided by the supplier of the mechanical anchoring systems shall at least include:

- Manufacturer's certificate of guarantee, signed by a natural person, relating to compliance of the technical specifications required of the system by the project design.
- The documentation of conformity corresponding to the CE mark when this is pertinent.
- Where appropriate, when the project design requires this, the DIT or evaluations of technical suitability of the system accredited by authorised organisations.

When the project envisages this or if the conditions of the previous paragraph are not met, reception control shall be performed by testing to determine the characteristics at issue (for example, by determination of the breaking strength for fastening systems according to UNE-EN 13364; adhesion of the fastener to the substrate; resistance to external impacts, etc.) and the distribution of the supply shall be programmed in sampling batches and lots, which shall be subject to the conditions of acceptance or rejection.

The requirement of the TBC is to be noted for floorings in floors of buildings with Sanitary, Educational, Commercial, Administrative, Parking and Public Traffic Uses, in relation to slip risk. The floorings shall conform to the requirable slip resistance class for the floors as a function of their location defined in table 1.2 of the DB SU1 of the TBC, determined according to UNE-ENV 12633:2003.

The site manager shall be in charge of managing the control documentation.

EXAMPLE OF RECEPTION CONTROL OF PRODUCTS FOR FLOORING IN A PUBLICLY TRAFFICKED BUILDING

IDENTIFICATION	REQUIRED PROPERTIES. (SPECIFICATION)	CONTROL OF DOCUMENTATION OF SUPPLIES	CONTROL BY MEANS OF QUALITY MARKS	CONTROL BY TESTS
Glazed stoneware tile, • size. 40x40cm. • grey colour. • rough matt finish.	In this example the design specifies a tile code [(1)]: **4/1/H/-** Therefore, the tile shall conform to the following specifications: • Breaking strength > 900N. • Abrasion resist. >2100 rev. • Mohs hardness ≥ 4. • Slip resist. class ≥ 1 (15<Rd<35). • Resist. to acids and alkalis: min. class LA at low concentration and class HB at high concentration.	The following documents shall at least be provided: Before supply: • Documentation accrediting the CE mark (CE label with declaration of technical characteristics + CE conformity declaration. • Manufacturer's declaration of tile technical characteristics. (It shall be verified that the values declared match the specifications). During supply: • Supply sheet and EC label. • After supply: • Certificate of guarantee; supply certificate.	Not applicable.	In this example, in the manufacturer's declaration of characteristics, no slip resistance value is declared. Therefore, the executive management shall request performance of the test: • Slip resistance, according to UNE-EN 12633:2003.
Ceramic tile adhesive: • type C2E	In this example, the design specifies the use of an adhesive, **C2E.** Therefore, it shall be verified that the adhesive received matches that designation.	The following documents shall at least be provided: Before supply: • Documentation accrediting the CE mark (CE label with declaration of technical characteristics + CE conformity declaration. During supply: • Supply sheet and EC label. After supply: • Certificate of guarantee; supply certificate.	Not applicable.	No tests are planned or programmed.

Grout: • type CG2 • grey colour	In this example, the design specifies the use of grout CG2. Therefore, it shall be verified that the grout received matches that designation.	The following documents shall at least be provided: Before supply: • Documentation accrediting conformity with standard UNE-EN 13888. • Manufacturer's declaration of the technical characteristics of the product. During supply: • Supply sheet with product identification. After supply: • Certificate of guarantee; supply certificate.	Not applicable.	No tests are planned or programmed.

[(1)] *In accordance with the Ceramic Tile Guide [2].*

4. CONTROL OF THE EXECUTION OF THE CERAMIC TILE COVERING

As has already been indicated, the control programming needs to identify the processes and activities to be controlled, the installation lots (inspection units), the checks to be made and their frequency and, where appropriate, the acceptance criteria.

The executive management will be able to reduce outside control when the builder or, where appropriate, the professional installer has a documented production control or that person's trade is registered.

In order to programme and control each tile covering unit (floor tiling, wall tiling, and ventilated façade) in the building work, these shall be divided into installation lots that shall be subject to acceptance or rejection. In each installation lot, the processes and activities liable to inspection (control) shall then be identified and the check frequencies defined.

Optionally it shall also be possible to be take into account control weighting factors that graduate control intensity as a function, for example, of the use to which the tile covering is going to be subjected, the dimensions of the tile covering, environmental aggressiveness, climate, the use of innovative or complex systems, or other factors that deserve to be considered.

4.1. Control of floor tiling and wall tiling installation.

4.1.1. Installation lots and installation processes and activities.

In order to control the execution, the ceramic tiling shall be divided into installation parts or lots, which shall be individually subject to acceptance or rejection.

The proposed maximum dimensions or size of the installation batch is orientational: depending on the singularity, complexity or development of the tiling installation, the executive management can establish the size it considers most advisable.

Tilings of different types shall not be mixed in the same lot, such as floor tilings and wall tilings, or those in which the tile installation system is different, for example thin-bed or thick-bed tile fixing.

INSTALLATION LOT (SIZE)	
interiors residential use	exteriors and use by public traffic (1)
400 m² ór 4 dwellings	200 m²

(1) By extension, sanitary, educational, commercial, administrative, and parking uses are included.
Table 4.1.1.a. Installation lots.

In each installation lot, the processes and activities liable to inspection shall be identified. Table 4.1.1.b identifies a basic set of processes and activities, which could vary, depending on the singularities of the tiling to be controlled.

INSTALLATION PHASE	INSTALLATION PROCESSES AND ACTIVITIES	EXECUTION CONTROL TABLE
Management of stockpiles	Control of the management of stockpiles of tiles, adhesive, etc.	R1
Installation of the base substrate	Control of dimensional stability of the base substrate	R2
Installation of the intermediate layers	Preparation of the substrate and installation, where appropriate, of intermediate layers.	R3
	Preparation and control of the fixing surface.	
Tile installation and grouting	Product reception.	R4
	Thick bed: application of the cement mortar.	
	Thin bed: application of the adhesive.	
	Tile installation	
	Layout of the movement joints	
	Installation of the grout	

Table 4.1.1.b. Installation processes and activities.

In each of the processes or activities included in an installation lot, the builder or, where appropriate, the installer shall self control the installation and the executive management shall perform an external control, by check inspections. The following section proposes check frequencies, which will vary depending on the control agent, and the assigned level of control, as set out below.

4.1.2. Check frequencies.

As indicated, the number of inspections to be performed in each process or activity depends on the agent and the adopted level of control.

Two levels of control are defined: a normal level, which is that of usual applications, and an intense level of control for tilings affected by control weighting factors (particularly demanding uses, climate, innovation, complexity, etc.), which require a more thorough control, or for tilings in which the builder/installer has no documented self-controlled installation.

As noted above, the executive management can reduce the external control when the builder or, where appropriate, the professional installer has documented production control, or their trade is registered.

The following installation control tables describe, for exclusively orientational purposes, the checks to be performed in each of the processes or activities, indicating the number of checks per installation lot as a function of the agent conducting the control and of the adopted level of control. The list does not seek to be exhaustive, though it includes the most significant checks, based on the Ceramic Tile Guide.

INSTALLATION CONTROL TABLES

Installation processes and activities	Check/observation point	Number of checks per lot			
		Normal control		Intense control	
		Self controlled by builder	External control	Self controlled by builder	External control
Control of stockpile management	Ceramic tile: • Check correct storage according to manufacturer's specification. • In general stockpiles, identification and separation of lots, avoiding mixtures of different grades in the same building area. Adhesive: • Check storage under cover.	1	-	2	-

Table R1. Stockpile management.

Control of substrate dimensional stability	Check waiting times after fabrication of the substrate: • Concrete floors and decks (two, three months). • Brick partitions: 1 month • Levelling bases or regularising layers: one week per cm thickness	2	1	4	2

Table R2. Installation of the base substrate.

Preparation of the substrate and installation, where appropriate, of intermediate layers.	Base substrate: • Check absence of dust, rubble, adhered material, grease, oils, etc. (1)	2	1	4	2
	Types of layers and preparation: • Check in the design: type, specifications, thickness and arrangement. • Check setting-out	2	1	4	2
	Layer of gravel/stabilised sand (2): • Check thickness (≤ 2cm) and that the material is dry.	2	1	4	2
	Insulation layer (soundproofing, etc.) (2): • Check that the manufacturer's installation instructions are followed. • Check proper arrangement on the surface and around abutting elements (partitions, columns, building envelopes, etc.).	4	1	8	2
	Levelling and/or strengthening layer (2): • Industrial mortars: Identification of type and manufacturer's recommendations for use • Semi-processed mortars (silo): Check type and consistency. • Self-levelling compounds: Identification of type and manufacturer's recommendations for use • Mortar made on site: Check proportioning, consistency and, where appropriate, strength. • Where appropriate, check arrangement of the reinforcement (lath). • Check spreading and levelling.	4	1	8	2
	Structural joints, types and preparation: • Check specifications in the design (arrangement, compressible materials and sealants, installation, etc.)	2	1	4	2

Installation processes and activities	Check/observation point	Number of checks per lot			
		Normal control		Intense control	
		Self controlled by builder	External control	Self controlled by builder	External control
Preparation of the substrate and installation, where appropriate, of intermediate layers.	State of the fixing surface: • Moisture content: Check that the surface is dry and that waiting times have been observed. • Flatness in adhesive tile installation: Check that the maximum deviation measured with a 2m straightedge is< 3mm • Cleanness: Check absence of dust, work rests, grease stains, etc.	4	1	8	2

Table R3. Installation of intermediate layers.

Tile installation and grouting	Ceramic tile: • Check the type and that reception control has been performed. • Check visually for absence of surface defects. • Check visually if there are dimensional deviations. • Where appropriate, check wetting of the tiles in installation with cement mortar.	4	1	8	2
	Adhesive: • Check the type to be used. • Check that it is mixed and used according to the manufacturer's instructions.	2	1	4	2
	Thick-bed tile fixing with mortar: • Check level of the fresh mortar bed (straightedge and level) • Check that a cement grout slurry is applied or cement dusting on fresh mortar. • Check that white cement is used for tiles with a light colour • Check alignment and thickness of tile-to-tile joints (spacing between tiles). • Check for the absence of voids and tile bonding by lifting up a tile.	4	1	8	2

Tile installation and grouting	Thin-bed tile fixing with adhesive: • Check spreading, combing with an appropriate notched trowel and thickness of the adhesive application. • Check that adhesive open time is not exceeded. • Check alignment and thickness of tile-to-tile joints (spacing between tiles). • Check that the buttering-and-floating method is used when foreseen. • Check for the absence of voids and tile bonding by lifting up a tile.	4	1	8	2
	Structural joints: • Check that they are not covered and that an appropriate sealant is used.)	1	1	2	1
	Perimeter joints and partition joints • Check their layout, that they are not covered, and that an appropriate filling material is used (width > 5mm)	4	1	8	2
	Tile-to-tile joints: • Check the type to be used according to the design. • Check that at least 24 hours have passed since the tile installation. • Check the elimination and cleaning of the surplus material	2	1	4	2
	Spare material: • Check that about 1% of each type of material has been kept as spare material.	1	-	1	-
	Installed and grouted tiling: • Check that the floorings are protected	1	1	2	1
	Skirting in floorings: • Check that the type and colour match the tiles. • Check the arrangement of the ribbon between the skirting and flooring. • Check the linearity of the skirting with partition walls. • Check proper grouting of the skirting.	2	1	4	2

(1) On some fixing surfaces, such as pre-existing substrates in renovation work for example, it may be necessary to perform additional checks of the finish and state of the surface (roughness, porosity, surface hardness, presence of hollow areas, etc.).
(2) Only in those cases in which the arrangement of these layers is foreseen (Project Design Document of Specifications).

Table R4. Tile installation and grouting.

4.2. Control of the installation of ventilated façades with ceramic cladding.

The action system is the same as that set out in section 4.1.

Size of the installation lot: 200 m^2.

Tables FV1, FV2, FV3, and FV4 on installation control describe, just for orientational purposes, the checks to be performed in each of the installation processes or activities, indicating the number of checks per installation lot as a function of the agent conducting the control. In this case, no control levels are defined.

INSTALLATION CONTROL TABLES

Installation processes and activities	Check/observation point	Number of checks per lot	
		Self controlled by installer	External control
Control of stockpile management	Ceramic tile: • Check correct storage according to manufacturer's specification. System of fastenings: • According to the manufacturer's instructions.	2	-

Table FV1. Stockpile management.

Control of the state of the substrate	• Check that the out of plumb or deviation from flatness of the substrate can be offset by the play of joints in the brackets and, where appropriate, in the profiles.	4	1

Table FV2. Installation of the base substrate.

Installation of the anchoring system	Installation of brackets: • Check that according to the type and state of the substrate the appropriate anchorings are used for the brackets in accordance with the design calculations • Check the setting out and position according to the module layout and specifications of the design. • Check that they are installed in a staggered arrangement. • Check that measures are taken to avoid the electrochemical phenomenon of galvanic corrosion between metals with different voltage; contact between two metals with different activity will be avoided with an insulation joint or another system.	8	2
	Installation of vertical profiles (studs): • Check the distance between profiles, flatness, alignment (tolerance ± 1mm/m) and horizontal joint (> 2mm per m) • Check that the required space is reserved to achieve the thickness of the ventilation chamber specified in the design.	8	2

Installation of the insulation	• Check that it covers the entire external face of the bearing wall and the resistant structure of the building. • Check thickness. • Where appropriate, protection of the profile channels.	2	1

Table FV3. Installation of the anchoring system.

Installation of the mounting elements and tiles	• Check the installation in accordance with construction details of the design or of the system.	4	2
Joints	• Check that the width of the horizontal and vertical joints between the tiles conforms to the tolerance established in the design. • Check that the expansion joints of the building match a vertical joint of the façade system by means of a double profile.	2	1
Singular points	• Check the installation in accordance with the construction details of the design or of the system (watertightness, water evacuation, etc.)	4	2

Table FV4. Installation of the tiles.

5. CONTROL OF THE FINISHED TILE COVERING

The control of the finished tile covering will consist of verifying that the specifications in the design are conformed to, both dimensionally and of any other nature.

It may be noted that the TBC, in the Basic Document on Safety of Use, DB SU1, contains the following requirements for floorings:

- Floorings shall satisfy the requirement that the requirable slip resistance class of the floor, defined as a function of their location in table 1.2 of the DB SU1 of the TBC, matches the slip resistance value of the tiles.
- If there are irregularities in the flooring, they must be smaller than 6mm.
- Differences in level of 50 mm shall be resolved with a slope of 25 %.
- In internal pedestrian area, the floor shall exhibit no holes into which a sphere of 15 mm in diameter can be introduced.

If a façade service trial is programmed to verify façade impermeability to water by the combined action of water and foreseeable wind in the area where the building is located, the executive management shall define the inspection unit that is to be subjected to the trial (in general, one per façade typology).

The trial shall be conducted in accordance with the procedure of the Valencian Institute for Housing: *Service trial of the watertightness of building façades*, Recognized Document of the Autonomous Government of Valencia with code DRC0609.

The result of the trials on the façade inspection unit shall be considered satisfactory, when, after 30 minutes have passed after its conclusion, no water infiltration in the form of dripping or damp stains at any point on the inner surface of the façade are to be observed, either in the trial area or in adjacent areas, especially at the juncture with the deck.

For orientational purposes, tables RT1 and RT2 detail the checks to be made per installation lot in order to verify the dimensional regularity of the tile covering, in addition to its appearance, cleanness, and final protection.

Installation processes and activities	Check/observation point	Number of checks per lot			
		Normal control		Intense control	
		Self controlled by builder	External control	Self controlled by builder	External control
Control of deviation from flatness of the tile covering (1)	• Check that the maximum deviation measured with a 2m straightedge does not exceed the limit of: ▪ ± 3mm in floorings and ▪ ± 2mm in facings	4	2	8	4
Control of deviation from level between adjacent tiles (1)	• Check that the deviation between two adjacent tiles (lipping) does not exceed the limit of: ▪ Joint < 6mm: ± 1mm ▪ Joint > 6mm: ± 2mm	4	2	8	4
Control of tile-to-tile joint alignment (2)	• Check that the difference in joint alignment, measured with a 1m straightedge, does not exceed the limit of: ▪ ± 2mm in floorings ▪ ± 1mm in facings	4	2	8	4
Control of flooring horizontality (1)	• Check that the deviation from the tolerance is not exceeded: ± L/600, where L is the distance in mm between fixed points. (Method: use any type of level: water, optical, laser level, etc.)	4	2	8	4

(1) The reference values have been obtained from standard UNE-CEN/TR 13548:2007 IN "General Rules for the design and the installation of ceramic tiles".
(2) The reference value has been obtained from the Spanish Technological Building Standard, NTE RSR.
Table RT1. Check of dimensional regularity.

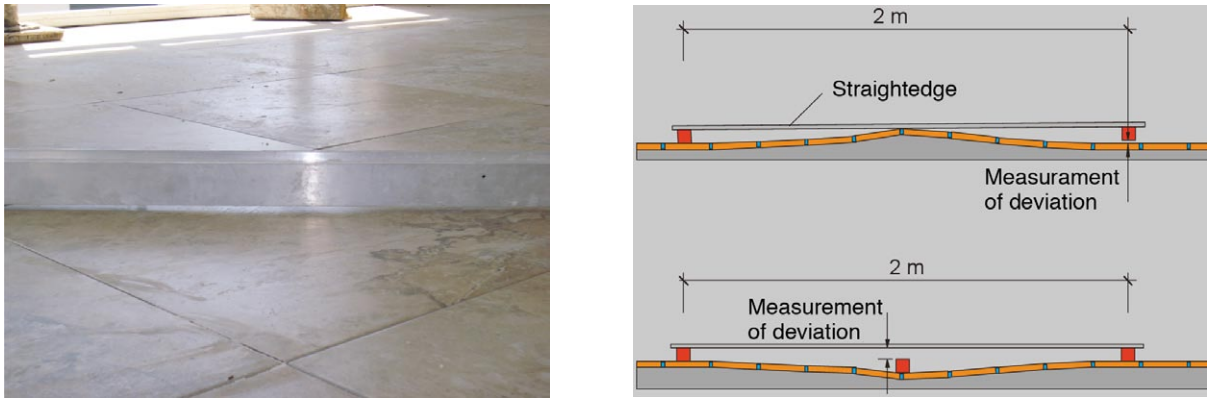

Figure 1. Check of flooring flatness.

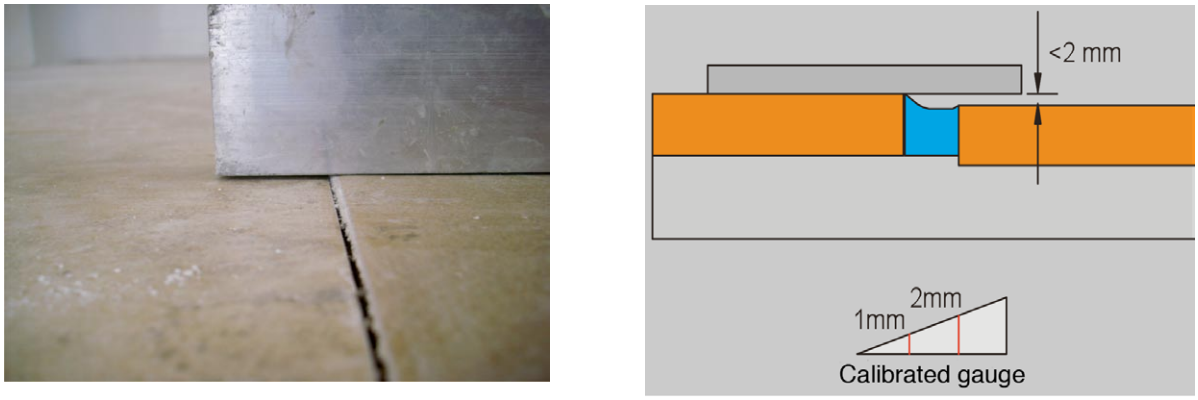

Figure 2. Check of the deviation from level of adjacent tiles.

Installation processes and activities	Check/observation point	Number of checks per lot			
		Normal control		Intense control	
		Self controlled by builder	External control	Self controlled by builder	External control
Surface appearance	Check that no defects are observed such as changes of colour, stains, pitting, or cracks.	4	1	8	2
Final cleanness and protection	Check that there are no stains (gypsum, paint, etc.) and, where appropriate, protection measures	4	1	8	2

Table RT2. Check of the surface appearance, cleanness, and protection of the tile covering.

REFERENCES

[1] [1] Royal Decree 314/2006, of 17 March, by which the Technical Building Code is passed into law. Ministry of Housing. www.codigotecnico.org

[2] Guía de la Baldosa Cerámica. Recognised Document DRB 01/06 by the Autonomous Government of Valencia. Published by Instituto Valenciano de la Edificación. www.five.es