MEASUREMENT OF DIMENSIONAL DEVIATIONS ACCORDING TO ISO 10545-2

►► Length and width

Definition

Measurement of the lengths (longer sides) and widths (shorter sides) in rectangular tiles, and of the four equal sides in square tiles, at 5 mm from each corner, with a precision of 0.1 mm. Sampling takes place on 10 whole tiles. This method is applied to ceramic tiles with a surface area of 4 cm² or larger.

A gauge (slide calliper) or other similar instrument that assures a precision of 0.1 mm is used.

If the tile fixer has no gauge, dimensional control shall be performed on site with a tape measure, length and width being measured at the tile back, between the sharp edges of the sides, the result being expressed in millimetres or, at best, in approximations of half a millimetre. Though the results obtained will not have the accuracy required by the standard, they will provide an approximation of the real deviations of the tile dimensions.

Procedure

In square tiles, the average measurement of each tile is the arithmetic mean of the four measurements of its sides. The average measurement of the sample is the arithmetic mean of 40 measurements (10 tiles x 4 sides = 40 sides).

In rectangular tiles, the arithmetic mean of the measurements of each pair of parallel sides gives the corresponding average measurement of the length and width of the tile; i.e. the resulting measurement is given by two average measurements. Therefore, the average length measurement will be the arithmetic mean of 20 length measurements (10 tiles x 2 sides/tile = 20 length measurements). The same shall be done for width.
Expression of results

In addition to tile identification (manufacturer, series, model, W size and, where appropriate, calibre), the following results shall be stated:

► All individual length and width measurements in rectangular tiles
► All individual measurements of the four sides in square tiles
► The average length and width measurement in each rectangular tile
► The average of the four side measurements in square tiles
► The average length and width measurement of the ten tiles in the sample in rectangular tiles (arithmetic means of 20 lengths and 20 widths, respectively)
► The average measurement of the 40 sides in the sample (10 tiles) in square tiles

Remarks

The greater or lesser uniformity in the results of the side measurement of a ceramic tile will have a direct effect on tile installation. As a result, the tile fixer should always perform the control on site, as a preliminary operation prior to the actual setting out, whether the installation is to take place with an open joint or a minimum joint.

Since particular attention is to be paid to this necessary control, in terms of product type, we have:

► Extruded tiles A, especially if they have not been rectified (termed natural)
► Pressed tiles of groups BI_a, BI_b, and BI_IIa, especially if they have not been calibrated in-factory
► Tiles of any type that are to be fixed with a minimum joint, particularly in wall tiling

The tile fixer should have a slide calliper (or gauge) to carry out the measurements with a precision of 0.1 mm However, given the price of this instrument, in order to be able to reach up to 60 cm, verifications may be made with a metric tape measure, taking the precaution to round off the measurements and the calculations in millimetres, since it is inconsistent to express the results in tenths of a millimetre when the tape measure only provides millimetre readings. As noted previously, dimensional control is done at the tile back, between the sharp edges of the sides, it being possible to discern about half millimetres. In length and width control, the tile fixer shall follow the procedure set out below:

1 The tile fixer shall verify that all the boxes or packing units bear the same nominal size, the same work size W and, where appropriate, the same calibre code. The tiler shall simultaneously also verify other essential data (manufacturer, series, model, colour, and explicit references to first quality).

2 The tiler shall check that the work size W does not depart from the nominal size further than allowed in standard EN 14411; i.e.:
For extruded tiles \( W - N \leq \pm 3 \text{ mm} \) (where \( N \) is the nominal size)

- For pressed tiles, except BIII, \( W - N \leq 2 \% \), with a maximum of \( \pm 5 \text{ mm} \)

- For BIII tiles, \( W - N \leq 2 \text{ mm} \)

3 The tiler shall select at least 10 tiles from 10 different boxes.

4 The tiler shall make the measurements as described in the *procedure* section, and calculate the arithmetic means.

5 The tiler shall compare the results with the maximum tolerances envisaged in European standard EN 14411 for each product group. If the deviation exceeds the maximum tolerance envisaged in EN 14411, the tile shall not be considered first quality and it will be necessary to ask the manufacturer to replace the lot.

6 The tiler shall size the tile-to-tile joint on the basis of the maximum deviations found, where (even though within the standard and first quality) dimensional variations may still occur, making tile installation difficult and penalising output.

It has already been noted that the manufacturing process decidedly conditions the final dimensions of the fired ceramic tile. This is the result of the raw materials used and particularly of the forming, drying, and firing processes.

The manufacturers agreed to design certain product standards *based on product limitations in the manufacturing process*, without considering other critical factors in defining the concept of first quality. A historical analysis of the approved standards clearly endorses the foregoing statement: improvement of the manufacturing process and achievement of great command of this process have led the manufacturers to allow smaller tolerances for their products. However, contradictions still exist at the present time between what *is tolerated* in ceramic tile and what *is required* in other standards on tile installation, such as the Technological Standards for Building Construction (Spain) on wall tilings and floorings, set out in **Chart 1**.
What should the tile fixer do?

The tiler should, if possible, select first-quality ceramic tile from manufacturers who assure minimum dimensional tolerances in their products.

In pressed tiles with intermediate and high vitrification (groups BIa, BIb, and BIIa according to standard EN 14411), the highest level of quality in the calibration is set at a calibre precision of ±0.5 mm. That is, one should value the manufacturers or sellers that supply calibrated tiles with the greatest possible precision and which are closest to the foregoing value.

In regard to extruded tiles, it is advisable to select those that bear the term precision on the label, since this is synonymous with smaller dimensional tolerances. In any event, these tolerances are much larger than in pressed tiles, which is why in all cases it will be necessary to install tile with an open joint of sufficient width to allow the maximum dimensional deviations detected in the control panel to be absorbed. In this sense, it should be borne in mind here that it is necessary to carry out a dry tile installation of at least 2 m² surface in order fully to check the dimensional deviations.

Thickness measurement

Definition

Longitudinal measurement of a tile cross-section, where that cross-section is greatest.
**Equipment**

Micrometer with pick-ups 5 to 10 mm in diameter or other appropriate instrument. The tile fixer will be able to conduct this control on site with sufficient precision (0.1 mm) if a gauge is used.

On site, the tiles can be placed with their fair faces together, and the distance can be measured from a level set on the top tile to the surface on which the tiles rest.

**Procedure**

First, 10 whole tiles are to be taken from the sample. If the tiles have no relief on their fair faces or irregular surfaces, two diagonals shall be drawn and the thickness at each of the four sections in which these diagonals divide the tile (whether square or rectangular) shall be measured. The thickness measurement shall take place in each section at a point in which the thickness is greatest, and shall include the rib or rear profile and the overall thickness of the tile. This measurement shall be made with an approximation of a tenth of a millimetre. For tiles with reliefs on their fair face or irregular surfaces (for example, rustic effects), the test method consists of drawing four lines at right angles to one of the sides of the tile, located at 0.125, 0.375, 0.625, and 0.875 times the length of that side of the tile. The thickness measurements are made at the points of those lines at which that thickness is greatest.

**Expression of results**

The average thickness of each tile is the arithmetic mean of the four measurements made on the tile. The average thickness of the sample of 10 tiles is the average of the 40 measurements.

**Comments**

As stated, it is difficult accurately to verify the thickness deviations unless one has a gauge. This is a dimensional characteristic for which considerable tolerance is allowed in standard EN 14411: 10% for all extruded tiles and for pressed tiles with a surface area below 190 cm² (approximately for nominal size 14x14 cm); and 5% for the rest, as set out in Chart 3.

In a very tight thin-bed tile installation, problems of lack of flatness could occur, or adhesion might be jeopardised if the variations in thickness are superimposed on the variations in flatness of the fixing surface. For example:

- **AIₐ o AIₐ natural**, with W 300x300x18 mm: ±10% of 18 mm = ±1.8 mm → 3.6 mm maximum variation between adjacent tiles in the most unfavourable case
- **BIₐ**, with W 1200x600x14 mm: ±5% of 14 mm = ±0.7 mm → 1.4 mm maximum variation between adjacent tiles in the most unfavourable case.
**Straightness of sides**

**Definition**

This is the measurement of the deviation of the tile centre from the straight line that joins the tile corners in the tile plane.

The measurement is only made on the straight sides of the tile and is calculated as a percentage from the formula:

\[
\frac{C}{L} \times 100 \quad \text{where} \quad C: \text{is the deviation from straightness in the centre of the measured side} \\
L: \text{is the length of the measured side.}
\]

**Equipment**

Laboratory apparatus, like the one shown in the figure, with a standard calibrating plate. The test method envisaged in this standard requires a precision of 0.1 mm, which is why, in principle, the measurements can only be made in the laboratory, unless a gauge is used on site.

On site, the corners of two tiles that display the defect may be joined and the distance between the two tiles can be measured with a tape measure at the middle point of the edge, expressing the result in millimetres or with a maximum precision of half a millimetre. This will allow application of the foregoing formula, where \( C \) is half the measured value.

**Procedure**

When the measuring apparatus has been calibrated with the standard plate, the tiles are positioned and the deviations from straightness of each side are measured for both square and rectangular tiles. The result of the measurement shall be stated with a precision of a tenth of a millimetre. The average value of the deviation is calculated for each tile as well as the average value of the average deviations of 10 tiles, though the test result always refers to the maximum deviation of one side with regard to the length of the adjacent side.

**Expression of results**

The calculation is made for each measurement on the basis of the above formula and the result is stated as a per cent of the quotient of this deviation by the length of the corresponding side expressed in the work size \( W \). For example, a tile of work size \( W \) 600x300x7.5 mm, which has a maximum deviation from straightness at its longest side (600 mm) of 4 mm will have, as a percentage, a deviation of \((4/600) \times 100 = 0.67\%\). If this were a Bla porcelain tile, it would lie outside the allowable tolerance of the standard, according to Chart 3.
Comments

As already indicated, it is difficult to carry out the control on site if there is no gauge or slide calliper. The tile fixer may approximate this control when faced with a so-called *lens* effect, as shown in the figures. When the two sides of tiles with the defect are placed face to face, it will be possible to measure the gap between the tiles relatively reliably, expressing this in millimetres if a tape measure is used or in tenths of a millimetre if the measurement is made with a slide calliper. The measurement is made at the centre of the controlled side and, following the same calculation procedure as in the previous example, the deviation is obtained as a percentage, which shall be compared with the maximum allowable deviation for the corresponding product group, according to standard EN 14411 (Chart 3).

![Straightness of sides](image)

Lack of straightness is the result of non-uniform compaction in pressing or the result of the drying and firing processes, especially in products that undergo greater dimensional variations with regard to the dimensions of the green piece. Therefore, the tile fixer should pay particular attention to ceramic tiles of groups BIa, BIb, and BIIa, in addition to the extruded products. Mechanical rectification of the sides eliminates this defect, but it may generate another, equally important one, namely departures from rectangularity, as set out further below.
Rectangularity

Definition

Rectangularity refers to how closely the adjacent edges of a square or rectangular tile form right angles; i.e. that these angles are orthogonal (the tile is squared). The deviation from rectangularity is obtained by comparing the angle formed by (consecutive) adjacent edges of a ceramic tile with the angle of an appropriate standard plate, calculated as a percentage from the formula:

$$\frac{\delta}{L} \times 100$$

where

$\delta$: is the deviation of a tile side (measured at 5 mm from the corner of the contiguous angle) with respect to the internal side of the standard plate.

$L$: is the length of the adjacent tile side.

Equipment

Laboratory apparatus like the one shown in the figure, with a standard calibrating plate. The test method envisaged in this standard requires a precision of 0.1 mm, which is why, in principle, the measurements can only be performed in the laboratory, unless a gauge is used on site. Dial gauge $B$ measures the deviation from rectangularity.

Procedure

Once the apparatus has been calibrated with the standard plate, the deviation from rectangularity of each side is measured, in both square and rectangular tiles, noting the results for the four sides. This procedure is repeated for the 10 tiles of the sample. The tiles are placed fair face downwards, on the locating studs of the apparatus.

Expression of results

The maximum deviation from rectangularity with respect to the actual tile dimensions are obtained from the foregoing formula, expressed as a percentage. For example, a tile of work size W 600x300x7.5 mm, for which in the laboratory a $\delta$ of 3 mm with respect to the long side (600 mm) is found, will have a deviation from rectangularity of $(3/600) \times 100 = 0.5\%$, which would lie be within the standard tolerances for all product groups, shown in Chart 3.
Comments

On site it is only possible to establish limited indications of defective rectangularity in the tiles, when the following is observed:

- The measured or calculated diagonals are not equal.
- Measurement of the four sides in square tiles yields different values; or in rectangular tiles, these differences correspond to the same opposite sides.

This defect may be verified by placing two tiles, on a rule (if necessary, rotating them 90º) until a gap is observed between the corners opposite the rule. Measurement of the gap corresponding to the two faulty tiles will provide an approximate deviation from rectangularity, dividing the result by two and applying the foregoing formula.

With the proliferation of mechanical rectification on all types of tiles, this defect (previously a minor one, resulting from pressing, drying and firing processes) has reappeared, owing to uncoupling of the stops that guide the tile in the rectification process.

Rectification consists of the longitudinal cutting of the tile, first of two parallel sides and then, after a 90º turn, of the cutting of the other two parallel sides at right angles to the two previously cut sides.

In the cutting operation, which may be complemented by bevelling of the sharp edges (to better protect the glazes), it is vital that the guides that lead the tile through the grinding tools should be parallel, and that the turn mentioned should be 90º.

If this 90º turn is not exact, though machining of the sides will produce two parallel edges, they will not form a square or a rectangle, but a rhombus. This defect is to be considered very serious, since it makes it impossible to fix tiles with aligned joints, especially if the tile fixer is obliged to install the tile with a minimum joint, which is what usually happens with rectified tiles.

If this defect is detected, the tile fixer can act in quite a precise way, calculating the departure from rectangularity from the measurement of the diagonals, as set out below:

- First, the two diagonals of the tile are measured with the tape measure; these will be equal in a rectangular or square tile when the corners are at right angles (90º)

- If this measurement yields two different values, the larger value shall be chosen and this shall be compared with the calculated maximum value according to the mathematical formula that is provided as complementary information.
If the larger measured diagonal yields a value exceeding the calculated maximum diameter for the product group and corresponding size, the tile clearly lies outside the allowable standard tolerances and a claim can be lodged with the manufacturer.

Those interested in understanding the origin of the value of this maximum diagonal, and who are familiar with Pythagoras’s theorem, will be able to follow the following development:

A square or rectangular tile with equal diagonals \( D_1 = D_2 = \sqrt{L^2 + A^2} \) will display perfect rectangularity. However, in a tile like the drawn one in red in the foregoing figure, \( D_1 \neq D_2 \), where \( D_1 > D_2 \). If that difference between the diagonals provides a deviation that corresponds to the maximum deviation tolerated by the standard, referenced \( \delta \), then according to the definition of rectangularity:

\[
\delta \times 100 = y(\%) \quad \text{so that} \quad \delta = \frac{y}{100} A
\]

Pythagoras’s theorem gives the maximum diameter \( D_{\text{max}} \), which corresponds to the maximum deviation \( \delta \) tolerated by the standard for a given type of tile.

\[
D_{\text{max}} = \sqrt{(L + \delta)^2 + A^2} = \sqrt{L + \frac{y \cdot A}{100}}^2 + A^2 = \sqrt{L^2 + 2 \cdot L \cdot \frac{y \cdot A}{100} + \frac{y^2 \cdot A^2}{10000} + A^2} = \sqrt{L^2 + A^2 + \frac{y \cdot A \cdot L}{50} + \frac{y^2 \cdot A^2}{10000}}
\]

For extruded tiles and pressed tiles with a surface area \( S \leq 90 \text{ cm}^2 \) (except BIII GL), the maximum allowable tolerance for rectangularity is 1% \((y=1)\).

For pressed tiles with \( S > 90 \text{ cm}^2 \) (except BIII GL), the maximum allowable tolerance for rectangularity is 0.6 % \((y=0.6)\).

For BIII GL pressed tiles, without spacer lugs, the maximum allowable tolerance for rectangularity is 0.5 % \((y=0.5)\).

These data enable the maximum diameter for a given size and a given type of product to be calculated.
Let us assume a Bla tile of work size W 600x300x9 mm. In this case, application of the foregoing formula gives:

\[
D_{\text{max}} = \sqrt{L^2 + A^2 + \frac{y \cdot A \cdot L}{50} + \frac{y^2 \cdot A^2}{10000}} = \sqrt{600^2 + 300^2 + 0.6 \cdot 300 \cdot 600 \cdot \frac{10000}{50} + 0.6^2 \cdot 300^2} =
\]

\[
= 672.43 \text{ mm} \text{ (note that if } D_1 = D_2 = \sqrt{L^2 + A^2} = \sqrt{600^2 + 300^2} = 670.8\text{mm)}
\]

Any diagonal that exceeds this value goes beyond the allowable maximum tolerance in the standard for the rectangularity of Bla tiles with a surface area S>90 cm² and size indicated above.

►► Flatness

Definition

Surface flatness is defined as a function of the measurements obtained at three points of the tile surface. If the tile displays reliefs made by forming or by application of glazes on the fair face, flatness shall be measured, if possible, at the tile back.

The deviations from flatness of a tile with respect to the plane defined by three points, chosen at random on the surface, are measured through three parameters:

► Centre curvature: deviation of the centre of a tile from the plane defined by three of the four tile corners.
► Side curvature: deviation of the centre of one of the tile sides from the plane defined by three of the four tile corners.
► Warpage: deviation of the fourth tile corner from the plane defined by the other three corners.

Equipment

Laboratory apparatus with a standard plate, as shown in the figure. The measurements of the previously defined parameters can only be controlled in the laboratory by means of the equipment described in the standard. This equipment is applied to tiles with sides larger than 40x40 mm.
**Procedure**

Tiles larger than 40x40 mm are placed face downwards on the base of the apparatus after adjustment of the devices for measuring the deviation with the standard plate. The maximum values of the centre curvature, side curvature, and warpage of each tile are noted, measured with a precision of 0.1 mm.

For tiles smaller than 40x40 mm, a metallic rule is used that is located along each edge and also along the diagonals. Warpage is not measured for these small sizes.

**Expression of results**

- Centre curvature is expressed as a percentage of the length of the diagonal; i.e. the deviation as an absolute value expressed in tenths of a millimetre (in the case of BIII tiles, the sign must be considered, since the tolerances differ depending on whether the curvature is positive or negative), divided by the length of the diagonal, also expressed in tenths of a millimetre, and the result is multiplied by one hundred.

- Side curvature is expressed in the same way, but with respect to the length of the side at which the curvature is observed.

- Warpage is expressed as a percentage with respect to the diagonal in the same way as that described for centre curvature.
Flatness defects can occur in any type of ceramic tile made by current processes, though it is most common in more or less vitrified products made by the single-firing process. All flatness defects produce an undesired optical effect in the ceramic tiling, especially with lateral or zenithal light, forming an angle with the ceramic surface. In large sizes, side curvature is one of the most frequent defects. It may be noted that the optimisation of the pressing and firing processes has led to a substantial decrease in deviations from flatness in ceramic tiles: for example, warpage has gone from being a very common defect in the past to an infrequent one or one with small deviations. The tile fixer can verify the lack of flatness by making a stack of consecutive tiles from the same box, placing them with their fair faces together. In the case of a considerable deviation from flatness, an accordion effect will occur, with evident instability. Each tile can also be turned 90º in regard to the preceding one (always with the fair faces together), especially to detect warpage problems. This verification may then be extended to 180º turns in alternate tiles, stacking them in pairs.
Thin-bed fixing affords few possibilities for the correction of flatness defects, which may cause very pronounced optical effects, particularly in wall tilings with tangential light. Faced with warpage problems, the tile fixer has few options for correction, since one corner of the tile will always be sunken or raised in regard to the other three, causing an effect known as lipping. But the flatness parameter has perhaps an even greater importance if the specifications envisaged in the Spanish Technological Standards for Building Construction dedicated to wall tilings and floorings are considered, as shown in Chart 2.

<table>
<thead>
<tr>
<th>TECHNOLOGICAL STANDARD FOR BUILDING CONSTRUCTION</th>
<th>Specifications for flatness and lipping</th>
<th>MAXIMUM TOLERANCES IN EN 14411</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTE-RPA/1973 Coverings for facings. Wall cladding</td>
<td>It is a condition for automatic non-acceptance when there are variations in flatness exceeding 2 mm in any direction, measured with a 2-m rule.</td>
<td>SIDE CURVATURE: ± 1.5% ± 4.5 mm ± 0.5% ± 3 mm</td>
</tr>
<tr>
<td>NTE-RSB/1975 Coverings for floors and stairs. Tiles</td>
<td>It is a condition for automatic non-acceptance when there are variations in flatness exceeding 4 mm, measured by overlapping with a 2-m rule. It is a condition for automatic non-acceptance when there is lipping exceeding 2 mm.</td>
<td>SIDE CURVATURE: ± 1.5% ± 4.5 mm ± 0.5% ± 3 mm</td>
</tr>
</tbody>
</table>

According to these Spanish standards of 1973 and 1975, it is a condition for automatic non-acceptance of wall claddings when there are variations in flatness exceeding 2 mm in any direction, measured with a 2-m rule, and 4 mm in floorings. In floorings it is necessary to add the maximum tolerance of 2 mm for lipping, whether stemming from the tile installation process or inherent to the lack of flatness or planarity of the tile itself.

Chart 2 presents two examples that clearly illustrate the existing contradiction between the quality requirements of the Technological Standards for Building Construction and the allowable maximum tolerances in standard EN 14411 for ceramic tiles. The tile fixer shall carry out the flatness controls on a sampling of tiles and shall compare the calculated maximum tolerances with the proposed values in the standard, given in Chart 3, in order at least to be able to lodge a claim with the manufacturer if the tiles fail to conform to the standard. Faced with side curvatures like the ones presented in the example in this table, the tile fixer will be able to do little to avoid undesired optical effects. Once again, the only possible advice is to choose ceramic tiles whose manufacturer assures dimensional tolerances (in this case for flatness) below the maximum values advanced in EN 14411.
# Maximum Deviations of Thickness, Straightness of Sides, Rectangularity, and Surface Flatness According to EN 14411

<table>
<thead>
<tr>
<th>Type of product</th>
<th>Thickness</th>
<th>Straightness of sides</th>
<th>Rectangularity</th>
<th>Surface Flatness</th>
<th>Curvature</th>
<th>Warpage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al P, Alb P</td>
<td>± 10 %</td>
<td>± 0.5 %</td>
<td>± 1 %</td>
<td>± 0.5 %</td>
<td>± 0.5 %</td>
<td>± 0.8 %</td>
</tr>
<tr>
<td>Al N, Alb N</td>
<td>± 10 %</td>
<td>± 0.6 %</td>
<td>± 1 %</td>
<td>± 1.5 %</td>
<td>± 0.5 %</td>
<td>± 0.8 %</td>
</tr>
<tr>
<td>AIIa1 P</td>
<td>± 10 %</td>
<td>± 0.5 %</td>
<td>± 1 %</td>
<td>± 1.5 %</td>
<td>± 0.5 %</td>
<td>± 0.8 %</td>
</tr>
<tr>
<td>AIIa1 N</td>
<td>± 10 %</td>
<td>± 0.6 %</td>
<td>± 1 %</td>
<td>± 1.5 %</td>
<td>± 1.5 %</td>
<td>± 1.5 %</td>
</tr>
<tr>
<td>AIIa2 P</td>
<td>± 10 %</td>
<td>± 1 %</td>
<td>± 1 %</td>
<td>± 1 %</td>
<td>± 1 %</td>
<td>± 1.5 %</td>
</tr>
<tr>
<td>AIIa2 N</td>
<td>± 10 %</td>
<td>± 1 %</td>
<td>± 1 %</td>
<td>± 1.5 %</td>
<td>± 1.5 %</td>
<td>± 1.5 %</td>
</tr>
<tr>
<td>AIIb1 P</td>
<td>± 10 %</td>
<td>± 1 %</td>
<td>± 1 %</td>
<td>± 1 %</td>
<td>± 1 %</td>
<td>± 1.5 %</td>
</tr>
<tr>
<td>AIIb2 P</td>
<td>± 10 %</td>
<td>± 1 %</td>
<td>± 1 %</td>
<td>± 1 %</td>
<td>± 1 %</td>
<td>± 1.5 %</td>
</tr>
<tr>
<td>AIII P</td>
<td>± 10 %</td>
<td>± 1 %</td>
<td>± 1 %</td>
<td>± 1.5 %</td>
<td>± 1.5 %</td>
<td>± 1.5 %</td>
</tr>
<tr>
<td>AIIb1 N</td>
<td>± 10 %</td>
<td>± 1 %</td>
<td>± 1 %</td>
<td>± 1.5 %</td>
<td>± 1.5 %</td>
<td>± 1.5 %</td>
</tr>
<tr>
<td>AIIb2 N</td>
<td>± 10 %</td>
<td>± 1 %</td>
<td>± 1 %</td>
<td>± 1.5 %</td>
<td>± 1.5 %</td>
<td>± 1.5 %</td>
</tr>
<tr>
<td>BIIa</td>
<td>S&lt;90&lt;90</td>
<td>± 10 %</td>
<td>± 0.75 %</td>
<td>± 1 %</td>
<td>± 1 %</td>
<td>± 1 %</td>
</tr>
<tr>
<td>BIIb</td>
<td>90&lt;90 ≤190</td>
<td>± 10 %</td>
<td>± 0.5 %</td>
<td>± 0.6 %</td>
<td>± 0.5 %</td>
<td>± 0.5 %</td>
</tr>
<tr>
<td>BIIa</td>
<td>190&lt;190≤410</td>
<td>± 5 %</td>
<td>± 0.5 %</td>
<td>± 0.6 %</td>
<td>± 0.5 %</td>
<td>± 0.5 %</td>
</tr>
<tr>
<td>BIIb</td>
<td>S&gt;410</td>
<td>± 5 %</td>
<td>± 0.5 %</td>
<td>± 0.6 %</td>
<td>± 0.5 %</td>
<td>± 0.5 %</td>
</tr>
<tr>
<td>BIII (2) WITHOUT SPACER LUGS</td>
<td>± 10 %</td>
<td>± 0.3 %</td>
<td>± 0.5 %</td>
<td>+0.5%</td>
<td>+0.3%</td>
<td>± 0.5%</td>
</tr>
<tr>
<td>BIII (2) S ≤250 WITH SPACER LUGS</td>
<td>± 10 %</td>
<td>± 0.3 %</td>
<td>± 0.3 %</td>
<td>+0.8%</td>
<td>-0.2%</td>
<td>+0.8 mm</td>
</tr>
<tr>
<td>BIII (2) S &gt;250 WITH SPACER LUGS</td>
<td>± 10 %</td>
<td>± 0.3 %</td>
<td>± 0.3 %</td>
<td>+0.8%</td>
<td>-0.2%</td>
<td>+0.8 mm</td>
</tr>
</tbody>
</table>

(1) S: tile surface area in cm²
(2) Only for GL tiles

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**Chart 3**

Physico-chemical characteristics · Dimensional quality
The measurement of dimensional deviations ISO 10545-2
Examples of labels and dimensional qualities

This example of a label reproduces all the marking information required by EN 14411. It only lacks the unit of measure in the nominal size (30x30 cm). However, other important information not required by the standard is also lacking:

- The calibre code, since a stoneware tile is involved
- The colour code, which assures the degree of uniformity of appearance

This example of a label contains all the dimensional data on the tile, as well as the colour and calibre codes. In addition, the manufacturer provides the calibres that he markets and coordination size C for calibre 3. Coordination size C is work size W plus the tile installation joint width in millimetres.

Further examples follow of information on the dimensional characteristics of a ceramic tile as they appear in trade catalogues, as well as the deviations that would be obtained for the considered size.

**RUSTIC STONEWARE AI Precision GL**

<table>
<thead>
<tr>
<th>Model Vylma 25 cm x 25 cm</th>
<th>Tolerances in the standard</th>
<th>Absolute values</th>
</tr>
</thead>
<tbody>
<tr>
<td>W (248 mm x 248 mm x 11 mm)</td>
<td>Length and width</td>
<td>± 1 %</td>
</tr>
<tr>
<td></td>
<td>Length and width (average)</td>
<td>± 1 %</td>
</tr>
<tr>
<td></td>
<td>Thickness</td>
<td>± 10%</td>
</tr>
<tr>
<td></td>
<td>Straightness of sides</td>
<td>± 0.5 %</td>
</tr>
<tr>
<td></td>
<td>Rectangularity</td>
<td>± 1 %</td>
</tr>
<tr>
<td></td>
<td>Centre curvature</td>
<td>± 0.5 %</td>
</tr>
<tr>
<td></td>
<td>Side curvature</td>
<td>± 0.5 %</td>
</tr>
<tr>
<td></td>
<td>Warpage</td>
<td>± 0.8 %</td>
</tr>
</tbody>
</table>

Requires using a tile installation with a very generous open joint (at least 8 mm) in order to be able to accommodate the positive or negative deviations. There may be problems of lack of parallelism in the joints. There may be problems of lipping in regard to the NTE standards.
### PORCELAIN TILE BIa UGL

Model Guardarrama 60 cm x 30 cm W (596 mm x 298 mm x 7 mm)

<table>
<thead>
<tr>
<th>Dimensional Quality</th>
<th>Tolerances in the standard</th>
<th>Absolute values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length and width</td>
<td>± 0.6 %</td>
<td>± 3.6 mm/± 1.8 mm</td>
</tr>
<tr>
<td>Length and width (average)</td>
<td>± 0.5 %</td>
<td>± 3 mm/± 1.5 mm</td>
</tr>
<tr>
<td>Thickness</td>
<td>± 5%</td>
<td>± 0.35 mm</td>
</tr>
<tr>
<td>Straightness of sides</td>
<td>± 0.5 %</td>
<td>± 3 mm/± 1.5 mm</td>
</tr>
<tr>
<td>Rectangularity</td>
<td>± 0.6 %</td>
<td>± 3.6 mm/± 1.8 mm</td>
</tr>
<tr>
<td>Centre curvature</td>
<td>± 0.5 %</td>
<td>± 3.3 mm</td>
</tr>
<tr>
<td>Side curvature</td>
<td>± 0.5 %</td>
<td>± 3 mm/± 1.5 mm</td>
</tr>
<tr>
<td>Warpage</td>
<td>± 0.5 %</td>
<td>± 3.3 mm</td>
</tr>
</tbody>
</table>

The Spanish Technological Standards for Building Construction relative to wall cladding and flooring, NTE-RPA/1973 and NTE-RSB/1915, respectively, establish conditions for automatic non-acceptance of a wall cladding or flooring when:

- Deviations from parallelism in the tile-to-tile joints exceed ±1 mm, measured with a 1-m rule
- Deviations from flatness exceed 2 mm in wall claddings and 4 mm in flooring coverings, measured in all directions with a 2-m rule
- ‘Lipping’ (projecting edges or differences in height between contiguous tiles) occurs, exceeding 2 mm in floor coverings, skirtings, and stair steps

When those building construction requirements are compared with the allowable maximum tolerances in standard EN 14411, an evident contradiction becomes apparent in large and intermediate sizes.