STUDY OF THE MECHANICAL PROPERTIES OF THIN LARGE-SIZED CERAMIC TILES

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At the moment, the ceramic products that have gained prominence in the international market, which are a trend in room decoration are thin large-sized tiles, also known as "slims". This type of ceramic tile has been widely used in façades and building refurbishment, mainly because it allows installation on already existing floorings, so that it is particularly appealing for renovating residential or business areas. Its thickness is in the range of 4 mm. In addition to the advantage of being easier to cut or to drill, these tiles reduce the working load of the building, as well as being a product that allows a great diversity of design applications, while it also provides ecological benefits, because it uses less raw materials and energy in manufacture.

Owing to the low thickness of the product, it has certain characteristics such as flatness, modulus of rupture, and breaking load, which are difficult to measure, because when it is placed on a support to carry out the flatness measurement, or when it is under the action of a force, a vertical displacement takes place that prevents proper measurement of these characteristics, as shown in Figure 1.

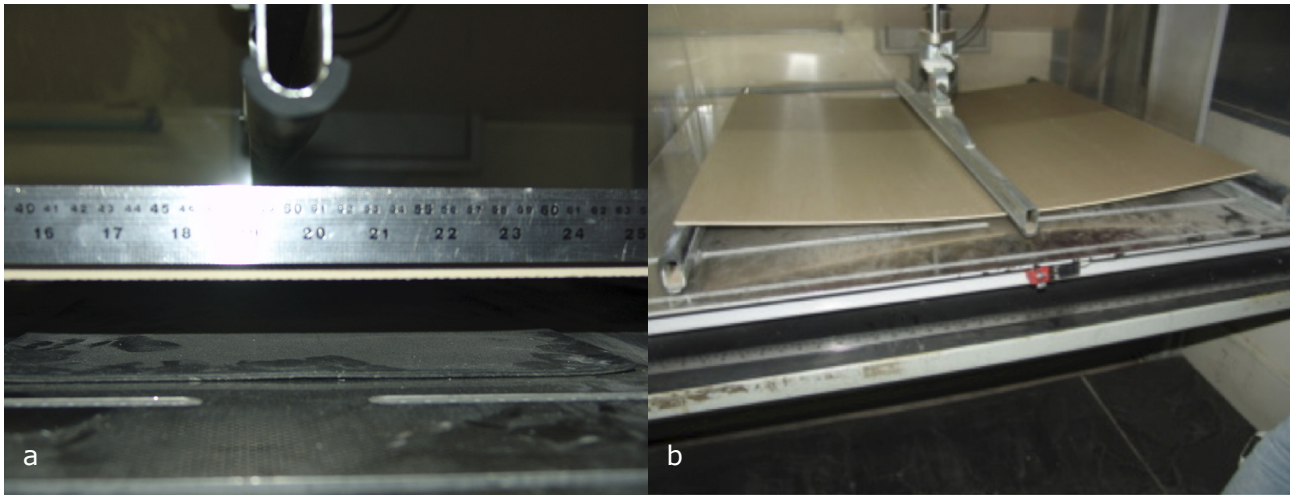

Figure 1. Vertical displacement that prevents proper measurement of the modulus of rupture and breaking load. (a) without load application, (b) with load application.

As the mechanical properties of a tile are important for their specification with regard to intended use, this study analysed the difference in the results of the breaking load and modulus of rupture of the tiles in their original dimensions and in the test pieces extracted from different regions of the same work piece. The tested tiles in their original size and with their edges and the centre cut out belong to the same lot.

The measurement of the breaking load (BL) and of the modulus rupture (MOR) was performed on pieces with a side length of 60 cm or more, and with a thickness of less than 12 mm, using a CROMETRO tester. The tiles exhibited water absorption values of 3% or less.

For the products with thickness < 4 mm, the breaking load and modulus of rupture of the whole pieces were measured, and when it was not possible to carry out the measurement in its original size, the size was reduced until rupture became possible, as shown in Table 1.

Size (cm)	Product 1		Product 2		Product 3	
	BL (N)	MOR (MPa)	BL (N)	MOR (MPa)	BL (N)	MOR (MPa)
100x100	---	---	---	---	298.99 ± 2.72	36.61 ± 0.33
90x90	298.22	36.52	314.54 ± 20.32	38.51 ± 2.49	---	---
80x80	430.41	52.7	---	---	---	---
20x20	917.90 ± 108.22	134.81 ±19.66	857.99 ± 183.36	122.60 ± 39.32	883.30 ± 67.24	128.39 ± 12.28

Table 1. BL (breaking load) and MOR (modulus of rupture) results for sheets with thickness < 4 mm.

Tables 2 and 3 detail the BL and MOR measurement results for ceramic tiles with thickness greater than 4 mm, which were measured in their original size and cut into sizes of 20 cm x 20 cm.

Size (cm)	P4	P5	P6	P7	P8
Original	963.80 ± 144.40	1466.24 ± 44.99	1337.62 ± 60.23	1318.70 ± 75.40	2727.5 ± 73.54
20 x 20	983.71 ± 145.86	1638.48 ± 128.36	1307.09 ± 92.06	1413.07 ± 167.57	2816.96 ± 304.25

Size (cm)	P9	P10	P11	P12
Original	2719.88 ± 216.83	654.77 ± 16.46	3847.14 ± 68.24	3792.15 ± 143.78
20 x 20	2779.82 ± 188.54	685.03 ± 47.53	3858.35 ± 691.70	4140.0 ± 405.91

Table 2. BL (breaking load) results for sheets with thickness > 4 mm.

Size (cm)	P4	P5	P6	P7	P8
Original	35.63 ± 4.23	40.07 ± 1.18	36.05 ± 1.42	37.66 ± 2.31	35.10 ± 1.00
20 x 20	37.05 ± 4.53	42.89 ± 2.91	35.40 ± 2.68	41.10 ± 4.27	35.89 ± 3.44

Size (cm)	P9	P10	P11	P12
Original	37.01 ± 1.88	37.24 ± 1.47	45.94 ± 1.29	46.67 ± 1.89
20 x 20	39.48 ± 2.70	37.20 ± 2.71	44.64 ± 6.69	53.03 ± 4.70

Table 3. MOR (modulus of rupture) results for sheets with thickness > 4 mm.

Samples were also taken and tested from different regions of the tiles (edges and centre), which were cut to a size of 20 cm x 20 cm, after which their BL (breaking load) and MOR (modulus of rupture) were measured.

In this study, it was observed that:

- The sheets with thickness > 4 mm displayed a different behaviour from the others.
- The average MOR (modulus of rupture) and BL (breaking load) values were very close together, but the standard deviation found was very high, indicating that there was a great range of values in the same piece.

Taking into account the above, more studies are required to define an appropriate test methodology for this type of product, in particular for products with a thickness below 4 mm.