Determination of the tensile and shear bond strength of two assemblies of adhesive and tile and of the tensile bond strength of a construction solution

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CERÁMICA KERSA, S.L.
Castellón, 11 June 2013
1. Introduction
On 25 April 2013, the Instituto de Tecnología Cerámica (ITC) received three samples, supplied by the company CERÁMICA KERSA, S.L., identified with the following references:
- Adhesive and porcelain tile assembly
- Adhesive and wall tile assembly
- Construction solution

2. Tests conducted
The determination of the shear and tensile bond strength of the porcelain tiles and of the wall tiles to the adhesive, and the determination of the tensile bond strength of the construction solution were requested.

The methods used to perform these tests are briefly described below.

**Determination of the shear bond strength**

The test consisted of the determination of the shear force required to debond a known area of two porcelain tiles and of two wall tiles, respectively, joined at their fair faces with an adhesive. The adhesive was a double-sided adhesive tape with a polymer substrate.

The pieces used in testing consisted of two fragments of tile, measuring about 6.8 x 4.8 cm, stuck together at their fair faces with the adhesive tape, the contact area being about 5.0 x 4.8 cm. As shown in Figure 1, the force was applied using a steel wedge with a 1-mm-thick flat edge that rested on one of the tile fragments, as close as possible to the side where the adhesive tape was stuck. The tests were performed in a universal testing machine at a speed of 0.5 mm/min.

Shear bond strength was expressed as follows:

\[ \sigma = \frac{F_{\text{max}}}{A} \]  

(1)

\[ A = b \cdot e \]  

(2)

where:

- \( F_{\text{max}} \) = Maximum force (N)
- \( A \) = Contact area (mm\(^2\))
- \( b \) = Piece width (mm)
- \( e \) = Height of the fitted fragment (mm)
- \( \sigma \) = Shear bond strength (N/mm\(^2\))
Determination of the tensile bond strength

The test consisted of the determination of the force required to debond a known area of two porcelain tiles and of two wall tiles, respectively, joined at their fair faces with an adhesive. The adhesive was a double-sided adhesive tape with a polymer substrate.

The test consisted of subjecting to tensile force the adhesive layer between the two porcelain tiles and the two wall tiles, respectively, joined at their fair faces with an adhesive. To do this, as shown in Figure 2, the assembly of the two pieces, stuck together as described previously, was placed on two bottom support points, the upper piece resting on these supports. Two top support points were then set on the lower piece, which was suspended transverse to the two bottom supports. The tests were performed in a mechanical testing machine (Instron) at a constant deformation speed of 0.5 mm/min.
Determination of the tensile bond strength in the construction solutions

The tensile strength of the construction solutions was determined by applying the tensile force as illustrated in Figure 3.

The construction solutions were made up of a gypsum backing on which mesh-backed ceramic pieces were stuck by means of the adhesive tape. The tensile method consisted of adhering a steel block on the fair face of nine of the mesh-backed ceramic pieces, using an epoxy adhesive that was assumed to have a greater strength than the test adhesive, on which a force could be applied at right angles to the adhering surface.

### 3. Results

The results obtained are detailed below.

Table 1 details the results of the shear force required to debond the adhesive tape or to break the tape’s polymer substrate. It shows the calculated average value and the scatter, as well as the maximum and minimum values obtained in the ten tests.
Table 1. Results of the shear bond strength test (N/mm²).

<table>
<thead>
<tr>
<th></th>
<th>Adhesive and porcelain tile assembly</th>
<th>Adhesive and wall tile assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>0.37 ± 0.02</td>
<td>0.29 ± 0.02</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.40</td>
<td>0.32</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.33</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Table 2 details the results of the tensile force required to debond the adhesive tape or to break the tape's polymer substrate. It shows the calculated average value and the scatter, as well as the maximum and minimum values obtained in the ten tests.

Table 2. Results of the tensile bond strength test (N/mm²).

<table>
<thead>
<tr>
<th></th>
<th>Adhesive and porcelain tile assembly</th>
<th>Adhesive and wall tile assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>0.45 ± 0.02</td>
<td>0.39 ± 0.02</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.40</td>
<td>0.35</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.50</td>
<td>0.42</td>
</tr>
</tbody>
</table>

1 Most of the tested pieces exhibited failure in the ceramic body, so that the tensile bond strength was greater than the values obtained.

Table 3 details the results of the tensile force required to debond the adhesive tape or to break the tape’s polymer substrate. In this case, since only 3 pieces were tested for each type of tile, the table presents the results of the three tests together with the calculated average value and the scatter.

Table 3. Results of the tensile bond strength test (N/mm²).

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.14</td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
</tr>
<tr>
<td>2</td>
<td>0.16</td>
<td>0.07</td>
<td>0.11</td>
<td>0.08</td>
</tr>
<tr>
<td>3</td>
<td>0.16</td>
<td>0.07</td>
<td>0.12</td>
<td>0.09</td>
</tr>
<tr>
<td>Average</td>
<td>0.15 ± 0.02</td>
<td>0.07 ± 0.03</td>
<td>0.11 ± 0.04</td>
<td>0.09 ± 0.01</td>
</tr>
</tbody>
</table>

In the case of sample A (Figure 4), the separation occurred between the paper lining the gypsum backing and the gypsum backing. On the other hand, in some of the test pieces, the gypsum backing exhibited defects before the test, particularly in this sample (Figure 5). In the other three samples, the separation occurred between the adhesive tape and the mesh backer of the pieces.
Figure 4. Sample: A, B, C, and D respectively

Figure 5: Detail of the gypsum backing of a test piece of sample A.
Report no. C131632, issued at the request of the company CERÁMICA KERSA, S.L., consists of a title page and 6 pages.

Castellón, 11 June 2013

Dra. Francisca Quereda Vázquez
Responsable del Laboratorio de Composiciones
Cerámicas

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