PREDICTION OF CERAMIC TILE PRONENESS TO CRAZING

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1. INTRODUCTION

Crazing is defined as a hairline fissure at the glazed tile surface [1]. This defect arises as the result of tensile stress in a certain part of the glaze coating, which exceeds its mechanical strength, giving rise to a fissure at the surface.

Two types of crazing may be distinguished: immediate and delayed crazing. The former arises when the glaze is subjected to tensile stress by the body at room temperature. The latter occurs when the expansion that the body undergoes owing to moisture absorption (moisture expansion), transforms the initial compressive stress to which the glaze was subject into tensile stress.

The relationship that exists between the stress to which the glaze is subjected by the body and the properties that both materials exhibit (glaze and body), may be defined by the following equation [3]:

$$\sigma_t = E_V \cdot K_V \cdot \Delta C \quad (1)$$

where σ_t is the stress to which the glaze is subjected by the body, E_V is the modulus of elasticity of the glaze, K_R is a constant that depends on the thickness of glaze and body and on their moduli of elasticity, and ΔC is the difference in shrinkage between the glaze and the body, after reaching the effective fit temperature (mm/mm).

On the other hand, the tensile stress to which the glaze is subjected as a result of the body's moisture expansion, can be expressed by the equation:

$$\sigma_t = H \cdot E_V \quad (2)$$

where H is the moisture expansion of the body (mm/mm).

In view of these relationships, a crazing resistance parameter R_C may be defined as the quotient:

$$R_C = \frac{\sigma_V}{\Delta S \cdot E_V} \quad (3)$$

where σ_V is the tensile strength of the glaze and $\Delta S = \Delta C + EH$ (mm/mm).

The higher this quotient, the less will a glaze be prone to craze.

2. EXPERIMENTAL PROCEDURE

2.1. Materials

A pressing powder and different glazes were used, of the types usually employed in redware floor tile manufacture, as well as industrially fabricated porous wall tile.

2.2. Experimental

The pressing powder was used to form prism-shaped test specimens sized 3x8x1 cm^3 and 7x7x1 cm^3. A glaze suspension was applied by microspray gunning to the larger specimens. Finally, two types of test specimens were fired at different schedules in an electric laboratory kiln.

The industrially fabricated tiles and the test specimens obtained in the laboratory underwent crazing tests and/or moisture expansion testing in an autoclave.

3. RESULTS AND DISCUSSION

3.1. Setting of probability intervals for the appearance of crazing

The test specimens that had been prepared in the laboratory underwent successive treatment cycles in an autoclave, during which pressure and/or dwell time were modified. After completing each cycle, the expansion was determined of the unglazed specimens, while inspecting the surface of the glazed specimens with a view to detecting possible crazing. This procedure was repeated for each of the tested cycles until the specimens crazed, which was when testing was stopped. The resulting data allowed setting the following intervals:

- $R_C<2$. High probability of crazing arising.
- $2<R_C<5$. Moderate probability of crazing arising, becoming higher as R_C approaches 2.
- $R_C>5$. Low probability of crazing arising.

3.2. Confirmation testing of the set intervals.

The industrial specimens were subjected to the conditions laid down in standard ASTM C370. On completing the test, the parameter R_c was determined and the specimen was inspected for signs of crazing. An analysis of the outcomes showed that:

- 100% of the tiles with a value of R_c below 2 had crazed.
- 45% of the tiles with a value in the range 2 to 5 had crazed, of which 100% of the tiles having values below 3 crazed.
- 100% of the tiles with a value of R_c above 5 withstood the cycles without crazing.

4. CONCLUSIONS

In the present study, three probability intervals have been established for the appearance of crazing (high, moderate, and low), as a function of a defined parameter, called crazing resistance. The validity of these intervals was confirmed in crazing resistance testing on industrially manufactured tile. In view of the results, this parameter may be of great use when it comes to formulating body and glaze compositions that yield glazed tile with high crazing resistance.

5. REFERENCES

[1] UNE 67-105-83: 1983. Determination of crazing resistance.

[2] ENRIQUE, J.; BELTRÁN, V.; NEGRE, F.;FELÍU, C. Técnica Cerámica, 183, 183-297, 1990.

[3] AMORÓS, J.L.; NEGRE, F.; BELDA, A.; SÁNCHEZ, E. Técnica Cerámica, 178, 582-592, 1989.