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The contribution of shear stress in the modulus of rupture of ceramic tiles

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The modulus of rupture (MOR) of ceramic tiles, is determined by following the method reported in the Standard EN ISO 10545-4, (Ceramic tiles - Determination of modulus of rupture and breaking strength), in which the parameters and the procedure, in performing the test and the relative calculations, are specified.
In the Standard, the tiles, building components having two prevailing dimensions (x and y) in comparison with the thickness (z axis), considered negligible, are dealt and solved as beams, in other words as slender structures, in which its length widely exceeds both width and thickness. This assumption, to shift from a plate to a beam, allows to simplify the problem.
By considering tiles like beams, the Standard provides the determination of MOR by means the 3-point method, with the classical formula to calculate the tensile stress due to the flexural moment. In fact, the contribution of the shear stress, that arises in the beam during its loading, is directly included as tensile stress. It is well known as the shear stress can be independently evaluated, providing its contribution to the total stress field.
In this context, the beam theory provides in the calculation of the stress field a contribution of the shear stress, τ, to the total stress field in terms of tensile stress, σ. In the case of a simple symmetric and isostatic beam, symmetrically loaded, the resulting stress involves a twofold contribution due to σ and τ. As regards, the Standard EN ISO 105454-4 considers in the calculation of MOR, the effect of the shear stress directly incorporated as tensile stress.
To clarify the role of the shear stress, during a 3-point flexural test, and to determine its contribution in the calculation of MOR, a commercial product was tested, more in detail, porcelain stoneware tiles, having nominal dimensions 65x18x7mm. The samples, comprehending a significant number of specimens, were tested subjecting them to 3-point bending test. By using as test parameters, three outer spans, i.e. 60, 40, 20mm, and adopting for each sample two different crosshead velocity, in detail 0.5 and 5.0mmmin^{-1}. The results, average of at least twenty valid tests for each loading configuration and crosshead speed, were obtained applying at first the recommendations reported in the Standard EN ISO 105454-4. Using the theory of the simple beam, a more accurate analysis was performed separating the contribution of the shearing stress from that due to the bending stress. In this way, it has been

possible to quantify the contribution of shear stress. Since, the Young's modulus was also evaluated by means an extensometric apparatus, it was possible to separately calculate the two different contributions (bending and shearing stress) to the deformation.

The investigation allowed to quantify the different contributions, by evaluating also their impact on the final results.