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Impact Resistance of Porcelain Stoneware Tiles: A PhenomenologicalApproach

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Abstract

The impact resistance of floor tiles is an important technical requirement, especially for large size and/or low thickness porcelain stoneware slabs. The standard test for ceramic tiles (ISO 10545-5) is non-destructive: it determines the coefficient of restitution of a small sample (75x75 mm^2) assembled on a concrete substrate under a weak impact energy (0.27 J). This method does not provide neither an impact strength nor information on the way a ceramic tile is broken by impact. In order to fill this gap, an investigation was undertaken to describe, by a phenomenological approach, how porcelain stoneware breaks under different conditions of impact. For this purpose, unglazedtiles with different size (12x12, 25x25, 60x60 cm^2) andthickness (3.5, 5 and 8 mm)were assembled on a concrete basement and tested for the coefficient of restitution (ISO 10545-5) and impact strength, whichwas measured by falling steel balls (50, 200, 500 g) with increasing energy (from 0.2 to 6 J) and with different speed (from 1.9 to 5.5 m/s). The effects caused by impact were visually inspected, revealing theformationof a set of distinctive features: an impact ring, radial cracks, one or two concentric Hertzian cone fractures, and a highly fractured inner zone.Such damages were quantified by measuring the impact ring diameter andthe numberand length of radial and conical cracksas well as estimatingthe new surface formedandthe Roesler index. A nearly linear dependence on the impact energy was found for crack length and surface, while the ring diameter and crack number seem to follow a cubic law.The impact strength depends not linearly on the tile thickness, but also the sample size may somehow affect the mechanical behavior under impact. A map of 7 levels of damage was drawn by contrasting increasing impact energywith tile thickness: it can help to predict the tile behavior in operation and to address the correct tile type for each application.

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