THE FROST RESISTANCE OF CERAMIC FLOOR TILES IN COMPARISON WITH CLIMATIC CONDITIONS IN POLAND

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ABSTRACT

The frost resistance of ceramic floor tiles in Poland is determined in accordance with the ISO 10545-12 standard, for testing floor tile behaviour over 100 freeze-thaw cycles in a temperature range of–5 to +5 °C. The present paper presents the influence of the number of freeze-thaw cycles on the properties of tiles (porosity, abrasion resistance) In addition, the authors discuss the defect susceptibility of tiles under Polish climatic conditions.

INTRODUCTION

Materials used for floor coverings must meet very stringent requirements in terms of:

- physical properties (*bending strength, compression strength, scratch resistance, abrasion resistance and impact strength*);

- chemical properties (*chemical resistance to: acids salts used in swimming pools and household chemical agents as well as stain resistance and discolouration resistance*).

In the case of outdoor applications of covering materials, additional requirements are obligatory, especially resistance to weather conditions (*water, sunlight, variable temperatures and rapid changes in temperature).* In its life cycle, the floor covering should not be damaged in any way by changes in its appearance or gaps in its surface. Obviously, the same requirements apply to ceramic floor tiles.

TESTING METHODOLOGY

The most recent modification of the frost resistance standard (Polish Standardization Committee introduced the standard PN ISO 10545-12 from 1999) adjusted it to international standards. The present standard describes in detail testing conditions, setting the number of temperature changes at 100 cycles and the temperature range between +5 and -5°C. The standard also comprehensively presents the appearance of tiles after the completion of testing and details which changes should not occur.

In this paper samples *(glazed floor tiles of the 3rd abrasion resistance class according to PN ISO 10545-7 of the average absorption capability 3.95 %, mechanical bending strength above 40 MPa and rated frost resistant in accordance with the standard's requirements)* were tested for their frost resistance:

1) according to requirements of the standard PN ISO 10545-12;

2) by changing testing parameters, i.e. introduction of extra heating of the tile surface in the thaw cycle and cyclic extra soaking with water;

3) the measurement was carried out for a different number of freeze-thaw cycles, i.e. 50, 100, 200, 500 and 1000 cycles.

After testing the frost resistance, the tiles were inspected by means of a stereoscopic microscope and an analysis of basic physicochemical properties was performed, including their absorption capability, abrasion resistance, bending strength and inspection of fractures of tile samples and surfaces with the use of a scanning electron microscope. The following figures present selected results of tests.

SUMMARY OF RESULTS

On observing the changes registered by means of a microscope, it may be noticed that with the increasing number of freeze-thaw cycles of the tile, its abrasion resistance

deteriorates; it can be also observed that pores exposed during abrading become larger during the testing of frost resistance. The interaction of these two destructive factors leads to a significant decline in both abrasion resistance and frost resistance of ceramic tiles as well reduction of other mechanical properties.

The photos presenting fractures surface of samples show effects of repeated freezing and thawing on the material microstructure – enlarged pores and their higher number are proportional to the number of freeze-thaw cycles. Increased porosity results in a faster destructive process of the material, thus significantly deteriorating its service performance.

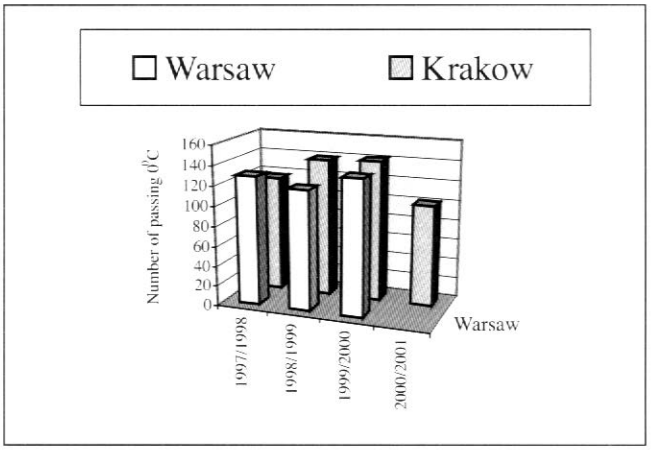

Fig. 1. The number of fluctuations of temperatures within a year.

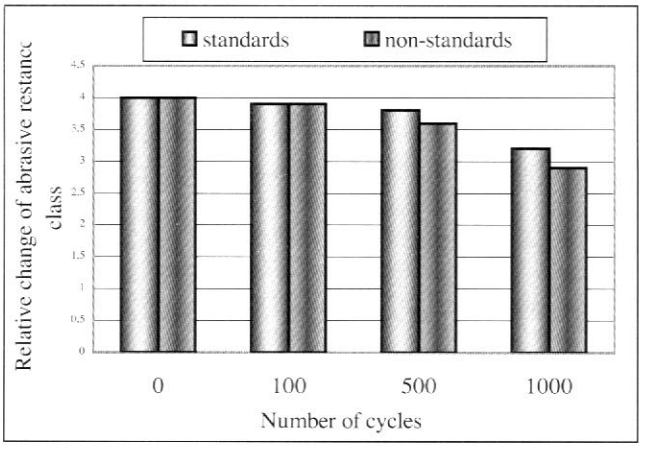

Fig. 2. . Relative changes in abrasion classes of tiles.

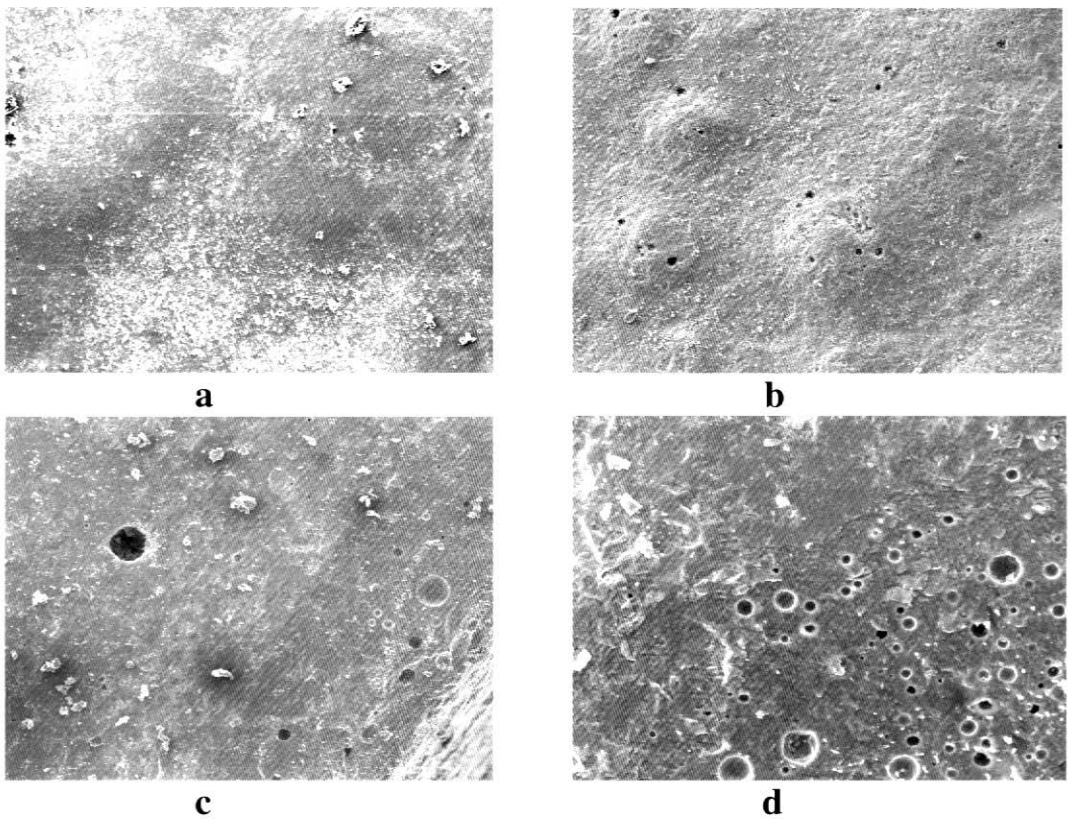

Fig. 3. Image of the surface of glazed tiles after testing their abrasion resistance (2100 abrasion cycles):

a. tile not tested for frost resistance.

b. tile after 100 freeze-thaw cycles.

c. tile after 500 freeze-thaw cycles.

d. tile after 1000 freeze-thaw cycles.

The number of freeze-thaw cycles required by this standard (100 cycles) has no significant impact on the properties of tiles. Increasing (adequate for climatic conditions in Poland) the number of these cycles, above 500, leads to a marked decrease in ceramic floor tile technical parameters.

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