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EXAMINATION OF SUITABILITY OF THE FREQUENCY INSPECTION TO MONITORING OF CHANGES OF CERAMIC TILES IN THE COURSE OF THE FREEZING AND THAWING CYCLES

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Abstract: *The paper presents some results of our experimental study of the application potential of the frequency inspection method to the non-destructive assessment of long frost resistance condition of ceramic tiles from two different manufacturers (Bohemia Gres and Rako). Verification of the frost resistance period being doubled with respect to standard figures is expected to take place.*

Keywords: ceramic tile, freezing and thawing cycles, dominant frequency

1. Introduction

The analysis was applied to sets of ceramic tiles, which had been fabricated in Bohemia Gres in year 2002 and in Rako in year 2002 too.

To assess the long frost resistance, the ceramic tiles were subject to 300 freezing - thawing tests to ČSN EN ISO 10545-12 [1]. Table 1 presents the ceramic tiles.

Type of ceramic tyles *(Year of production)*	***Specification of ceramic tyles***	***Dimension of ceramic tyles [mm]***	***Average value of water absorption [%]***	***Surfacing of ceramic tyles***
Bohemia Gres (2002)	11, 12, 13, 14, 15, 16	300 x 300 x 9	0,4	glaze
2.Rako (2002)	41, 42, 43, 44, 45, 46	333 x 333 x 8	0,4	

Table 1: Description of ceramic tiles.

2. Test method

Prior to the tests, the ceramic tiles were immersed into a vessel containing water whose temperature was t_1 = 5°C. After having been pulled out from water, the specimen was wiped with a wet rag. Immediately after the removal from water, the ceramic tiles were placed in a refrigerating chamber. The tiles being frozen, the refrigerating chamber temperature was maintained at t_2 = -5°C for 15 minutes.

The freezing cycle being completed, the tiles were immersed into water for 1 to 2 hours in order to thaw out. The ceramic tiles were left lying in water till the test continuation.

A check measurement was carried out prior to stress cycle start and, subsequently, after the completion of 50, 100, 150, 200 and 300 cycles.

A metal hammer of a mass of 169 g, which was hinged in a fixture ensuring a constant release level, h = 2 cm [2], was used to hit the tile.

The tile response to the exciting impulse was picked up by means of a piezoelectric sensor of Sedlák S7 type, whose operating frequencies range from 100 Hz to 50 kHz. The sensor was fitted to the tile surface at a point in the maximum amplitude region.

A points of coordinates:

- Ceramic tiles by type 2.Rako: x = 18 cm, y = 16.5 cm
- Ceramic tiles by type Bohemia Gres: x = 12 cm, y = 18 cm

The response voltage was fed into the input of a Yokogawa DL1540CL digital oscilloscope and further processed by means of a special signal-analysis software package. [3,4].

3. Experiment results and discussion

Fig. 1 shows the power spectral density (in relative units) versus frequency plot for specimen No.41. A dominant frequency f_0 = 6510 Hz may be observed.

Fig. 2 shows the power spectral density (in relative units) versus frequency plot for specimen No.41 after the 150 freezing and thawing cycles. A dominant frequency f_0 = 7190 Hz may be observed.

Fig. 3 shows the power spectral density (in relative units) versus frequency plot for specimen No.203 after the completion of 300 freezing and thawing cycles. A dominant frequency f_0 = 7204 Hz may be observed.

Fig. 4 shows average incremental values of a dominant frequency versus numbers of freezing and thawing cycles for a ceramic tiles (2.Rako, Bohemia Gres).

Mean values of average values of a dominant frequency and the respective variance coefficients are shown in Fig. 5 - after the 150 freezing and thawing cycles and in Fig. 6 - after the completion of 300 freezing and thawing cycles.

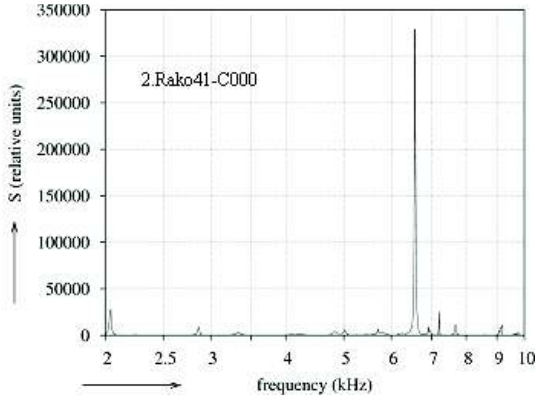

Fig.1 The power spectral density versus frequency plot for a ceramic tile No.41 before degradation.

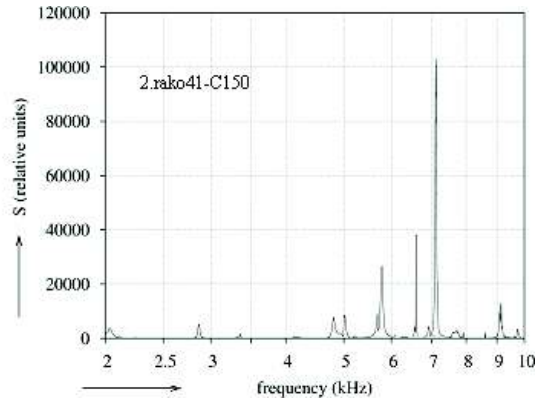

Fig.2 The power spectral density versus frequency plot for a ceramic tile No. 41 after the 150 freezing and thawing cycles.

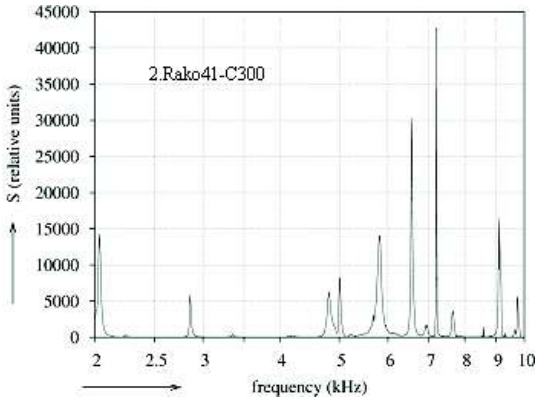

Fig.3 The power spectral density versus frequency plot for a ceramic tile No.41 after the completion of 300 freezing and thawing cycles.

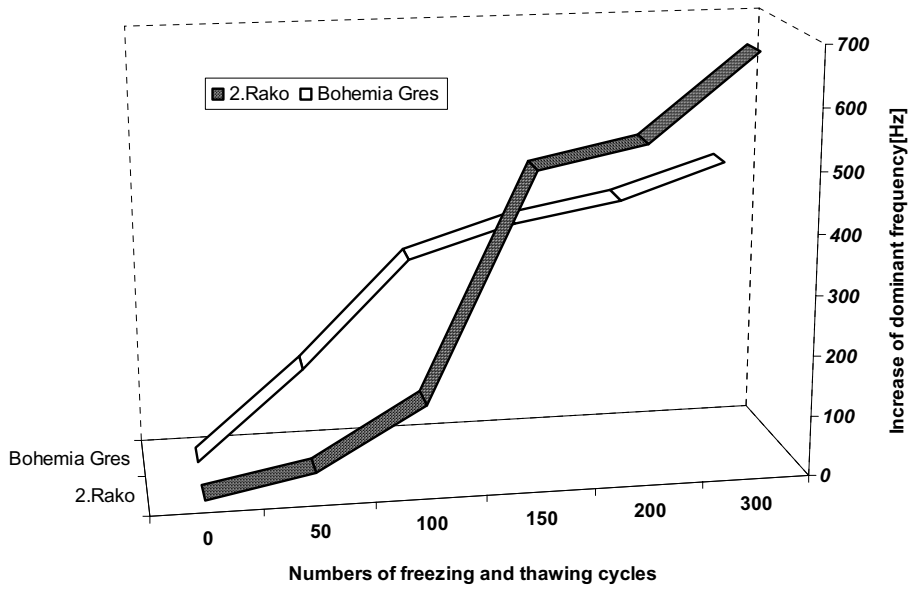

Fig.4 Average incremental values of a dominant frequency versus numbers of freezing and thawing cycles for a ceramic tiles (2. Rako, Bohemia Gres).

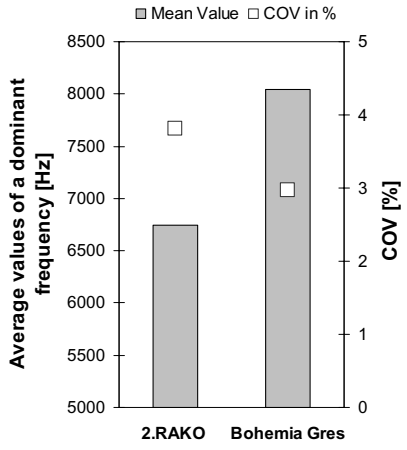

Fig.5: Average values of a dominant frequency after the 150 freezing and thawing cycles: Mean values and variance coefficients

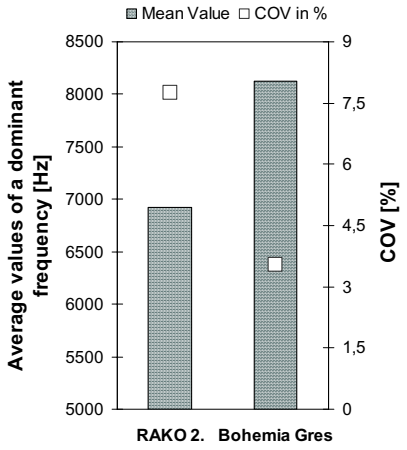

Fig.6: Average values of a dominant frequency after the completion of 300 freezing and thawing cycles: Mean values and variance coefficients

The changes that were observed in the tile may be taken as an indication of certain structure impairment. The structure impairment appeared to be reflected in a change of the resonance frequency distribution.

With the exception of a single ceramic tile, only insignificant resonance frequency changes. Average values of resonance frequency were 682 Hz by type 2.Rako and 467 Hz by type Bohemia Gres in the course of the freezing and thawing cycles. This gives evidence of a very good quality as well as frost resistance of this ceramic tiles types, from which a long service life may therefore be predicted.

4. Conclusion

The analysis was applied to a two sets of ceramic tiles, of a plain tile type, which had been fabricated in Bohemia Gres and Rako in 2002. To assess the long frost resistance, the ceramic tiles were subject to 300 freezing - thawing tests.

With the exception of a ceramic tile, only insignificant resonance frequency changes took place in the course of the freezing and thawing cycles. This gives evidence of a very good quality as well as long frost resistance of this ceramic tile type, from which a long service life may therefore be predicted.

From the results we can also see that the frequency inspection method is a useful non-destructive testing method being applicable to the evaluation of the ceramic tile structure condition and allowing predicting of the frost resistance and service life of these products.

Acknowledgements

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