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Quality Control of Clay Bricks

by J.H. Kung and J.P. Storer-Folt

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RÉSUMÉ

On peut, à l'aide du procédé d'absorption d'eau froide en une minute ou en une heure, réduire la durée de l'essai de contrôle de qualité basé sur les coefficients de saturation et visant à déterminer la durabilité des briques d'argile. La précision des essais actuels de contrôle de qualité peut être améliorée si on utilise à la fois le coefficient d'absorption et le coefficient de saturation.

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Quality Control of Clay Bricks

J. H. KUNG and J. P. STORER-FOLT

National Research Council of Canada
M-20 Montreal Rd., Ottawa K1A 0R6, Canada

The quality control test for the durability of clay bricks based on saturation coefficients can be shortened using a one-min or one-h cold water absorption. The accuracy of current quality control procedures can be improved if both absorption and saturation coefficients are used together.

Introduction

Despite the inadequacy of the standards on frost durability of clay bricks,¹ absorption and saturation coefficients continue to be used as quality control criteria in the production of clay bricks. This may be due to the lack of an alternative method; also, because these procedures are simple, manufacturers have established by experience the maximum allowable and the optimum values for each of their products. However, quality control procedures based on absorption and saturation coefficients have other limitations. They are time consuming, typically requiring 48 h to obtain the saturation coefficient, and the values do not take into account the variations of raw material composition. This paper describes an approach to shorten the experimental time and improve the accuracy of obtained results.

Short-Term Absorption Tests

The 48 h required to obtain the saturation coefficient make this an impractical quality control method in the present production of clay bricks. This lengthy period is especially undesirable in the case of continuous tunnel kiln operations, where advanced technologies are constantly increasing the push rate. By the time the saturation coefficient has been determined, hundreds of thousands of clay bricks have already been fired. Thus, the saturation coefficient in this case is only an index of the quality of bricks already produced; it is not a test that can be used as a corrective measure to adjust production in process.

Many quick tests have been proposed and are used in production plants. The most common test is to measure the shrinkage of the size of the fired bricks, but this only represents a rough estimate of how well bricks were fired and cannot be used as an accurate quality control test for frost durability. The use of firechek keys* is another alternative, but the shrinkage obtained represents a direct measurement of the heat work and not a direct indication of the property of the fired brick. The most promising tests are the extended initial rate of absorption test² and the abbreviated cold-water absorption tests.^{3,4} These tests still require hours and, in some cases, the validity of their application is unknown.

During the Industrial Research Fellowship Program sponsored jointly by the Clay Brick Association of Canada and the Division of Building Research,

National Research Council Canada, the possibility of using one-min or one-h cold water absorption as a quality control test was explored for nine different commercially marketed Canadian clay bricks. The experimental procedure is the same as the standard 24-h cold absorption test specified by ASTM C67. It was found that there was a correlation between the saturation coefficient and short-term cold absorption of laboratory-fired samples, as shown in Figs. 1 and 2. Subsequently, the one-h cold absorption was used as part of the routine quality control test in eight brick plants for further investigation. The results of this investigation confirmed that the short-term cold absorptions can be used as a substitute for the saturation coefficient; the degree of correlation was found to be a function of the mixing or the homogeneity of the raw materials. The correlation is best where one single source of raw material is used (Figs. 3 and 4) and poorest when different materials are blended (Fig. 5); the degree of correlation appears to reveal the homogeneity of the mix. In order to ensure the best correlation, short-term absorption tests should be done with half bricks or a fraction of a whole brick in order to avoid the "tight-skin effect" which increases the scatter of data. Although the initial rate of absorption could be measured in minutes, it proved to have a poorer correlation than the one-min or the one-h cold absorption tests and is more affected by surface texture.

If this test is to be used for quality control purposes, both the short-term cold absorption and the regular saturation coefficient should be measured initially for each type of brick. Once a proper correlation has been established, the short-term absorption test can be used as a quick and simple quality control test provided the same raw materials and the same kiln are used.

Composite Use of Cold Absorption and Saturation Coefficient for Durability

Cold absorption or saturation coefficients have been used separately for quality control, but their values vary depending on the raw material as well as the kiln-firing condition. The inadequacy of using either one for accurate quality control can be seen from Fig. 6. In a production plant, bricks of similar saturation coefficient but different absorption, and similar absorption but different saturation coefficient are both produced. These bricks have different properties. Thus, it is recommended that absorption and saturation coefficients be used in conjunction, because the composite relation is like a fingerprint of the brick.⁵ This relationship between saturation coefficient and absorption not only reveals the quality of the particular brick produced but also indicates the history of the brick, such as the starting raw material composition and the firing condition, as shown by Fig. 7 where the results for bricks of known compositions and firing conditions are plotted. For each raw material a proper index of durability should be defined in terms of the absorption and saturation coefficient and, as the raw material changes, the appropriate index must be determined for quality control.

Conclusion

Current quality control tests for clay bricks based on saturation coefficient can be shortened by the use of one-min or one-h cold absorption tests. The accuracy of the quality control test can be improved further if both the absorption and saturation coefficient are used together, since this composite relationship reveals both the material composition and the firing condition.

Acknowledgments

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*Bell Research Inc., Chester, WV.

Fig. 1. Correlation between 1-min cold absorption and saturation coefficient for burned bricks from Project R.

Fig. 2. Correlation between 1-h cold absorption and saturation coefficient for burned bricks from Project R.

Fig. 3. Relationship between saturation coefficient and absorption of bricks made from a single source of raw material.

Fig. 4. Relationship between saturation coefficient and absorption of bricks made with additives introduced in slurry.

Fig. 5. Relationship between saturation coefficient and absorption of bricks made from blending a shale and a clay.

Fig. 6. Properties of bricks produced in a plant over a period of three months.

Fig. 7. Effect of raw materials elucidated by plotting cold absorption vs saturation coefficient.

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