

Simple Strength Test for Masonry Units

TECHNICAL PAPER

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SYNOPSIS

This Paper describes a test of the corners of masonry blocks which uses inexpensive equipment and can be carried out by hand, making it useful for on-site tests and at small manufacturing operations. It is suggested that this test's result is more valuable as a measure of the necessary strength of a block than the standard overall crushing test.

1. INTRODUCTION

The relative ease of manufacture of concrete masonry units has enabled small manufacturing operations to be an important part of the industry worldwide, particularly in developing countries. However a frequent problem with small manufacturers is lack of quality control.

Although for low-rise structures the strength of the unit is generally not critical to its performance in the wall, wide variance leading to low strength can cause unacceptable damage to occur during transport from mould to final position in the structure.

The South African standard test for masonry units SABS 1215[1] is to crush the whole unit, with preparatory flat facings cast on it first, calling for skilled people and large expensive equipment. A need exists for a strength test that is simple and inexpensive so that small scale manufacturing operations and their customers can have quality control checks. Not only would this ensure that the end user receives an adequate product, but it could also reduce materials cost.

A review of published literature on concrete testing yielded only one test [2] that could possibly be adapted for use on concrete blocks, but the size and proportions of the blocks made it impractical. From these considerations the test described in this paper was developed.

2. DESCRIPTION OF TEST

The manner of applying the force to the specimen is similar to the Brazilian test for the tensile strength of concrete, in that a small local zone of compression under the steel round-bar acts like a wedge which induces horizontal tension. (Refer figure 3.) An inclined failure plane develops in the concrete, breaking off a wedge from the block's corner. This inclined direction of the fracture line indicates the influence of shear stress within the material and therefore a greater similarity to the stress conditions that induce failure in a standard compression test than those in the Brazilian tension test.

3. INTERPRETATION OF THE TEST RESULTS

The stress pattern induced in the material by this test is complex and not amenable to interpretation by simple theory. Despite the inclined fracture line, the failure is probably dominated by the tensile stress induced as shown in figure 3. This is believed to be desirable, because the test may then be a good indication of the resistance of masonry units to the most common damage during transport, i.e. impact-induced tension breaking either a corner or the whole block.

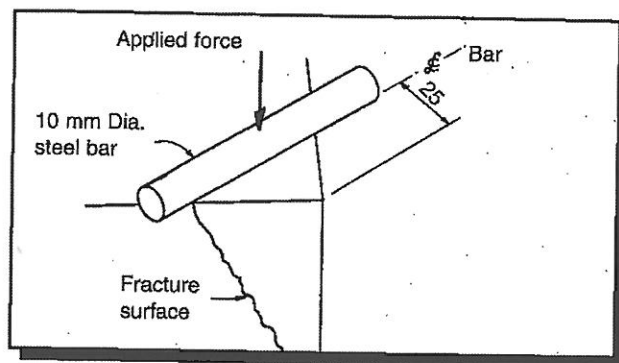


Figure 1. Detail of the manner of test of one corner of masonry unit

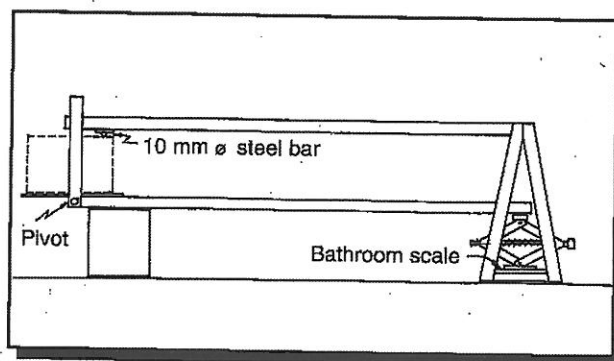


Figure 2. Lever system to apply measured force to 10mm dia. roundbar.

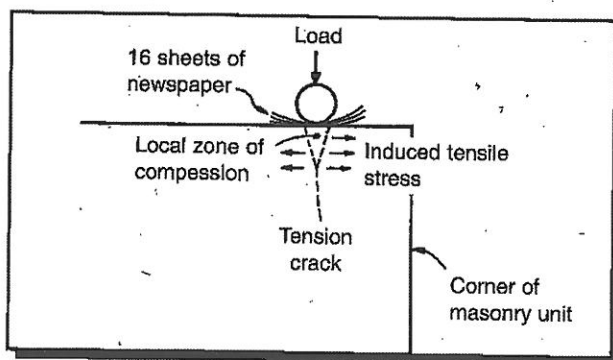


Figure 3. Production of tensile stresses from manner of load application

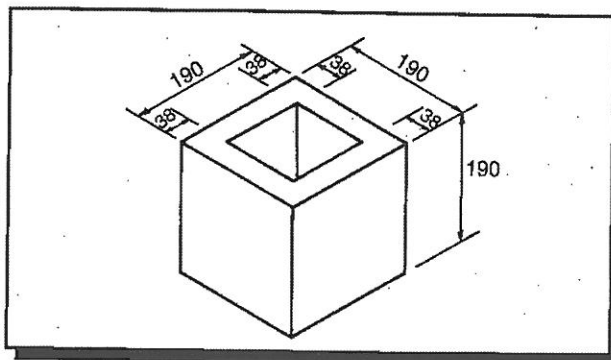


Figure 4. Hollow block used in correlation test

The present test used to classify the strength of concrete blocks is to crush the whole block. The nominal strength is given by the maximum force carried divided by the gross area, including any hollow voids. Although this strength's use is most often simply to indicate the probability of the blocks reaching their place in a wall without unsightly breakage, it is well established in the construction industry. Therefore it was felt desirable to be able to interpret the corner strength test described in this paper into a value of that overall crushing strength. However it is suggested that the corner strength test has the potential to replace the overall crushing strength for all situations except where there are high stresses from, for example, multistorey loads on blocks.

4. CORRELATION BETWEEN THE CORNER STRENGTH TEST AND THE OVERALL CRUSHING STRENGTH

Blocks of four different nominal strengths and with the dimensions shown in figure 4 were used. Four specimens of each strength were available. Previous tests on the variance of the overall strength of blocks from the same manufactured batch and the variance of the value of the corner strengths within a single block led to the conclusion that an SABS 1215 test on one block would adequately represent the batch, and the remaining three should be used for the corner strength test. Figure 5 shows the overall crushing strength plotted against "the block corner strength", i.e. the mean of tests on four corners of

a block. The correlation shown in figure 5 is clearly not as linear as could be desired, but is usable.

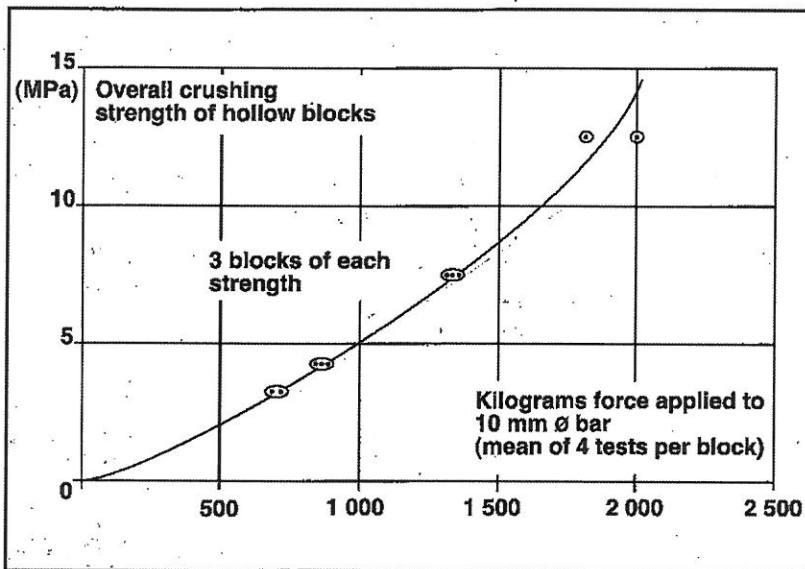


Figure 5. Correlation between corner strength test and overall crushing strength of one type of hollow block

However figure 5 can only be used for one type of hollow block, because other manufacturers' moulds will have different ratios of concrete area to overall area. Figure 6 shows the results of the same tests presented in figure 5 but the crushing strength values plotted are from taking the crushing load of the block and dividing by the net area of concrete. Also shown in figure 6 are the results of corner strength and crushing strength tests on solid 100 mm cubes of sand and cement mortar. Ideally the graph lines on figure 6 would be close together, then the corner strength test could be interpreted into the strength of the solid concrete and using the ratio of net area to gross area of a hollow block its overall crushing strength could be estimated. However the graph lines are far apart, probably because of the structural weakness of the slender walls of a hollow block compared to a solid cube.

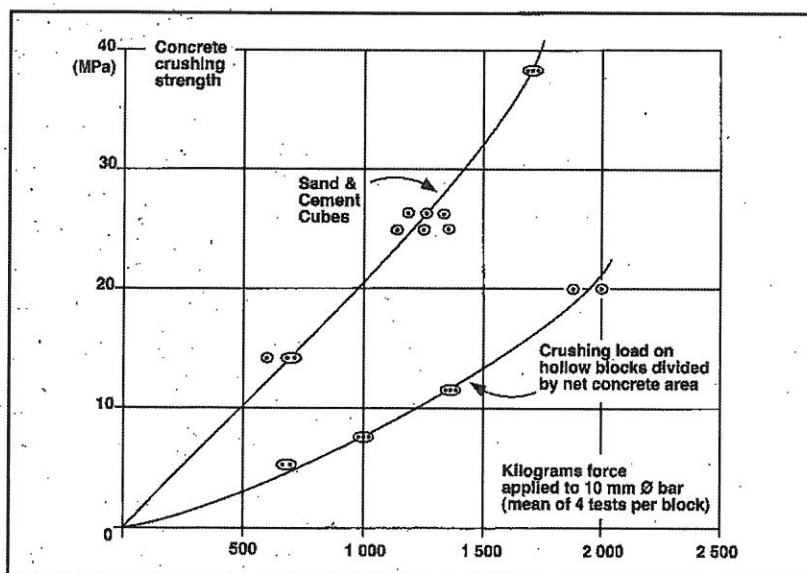


Figure 6. Correlation between corner strength test and concrete crushing strength

5. EXPERIENCE OF USE OF THE CORNER STRENGTH TEST

Three corner strength testers have been made so far: for the Lesotho Highlands Scheme, the Eastern Cape Appropriate Technology Unit, and a manufacturer of interlocking dry-stack concrete wall blocks. A correlation with crushing strength (similar to figure 5) of the product of the main block supplier to the Lesotho Highlands Scheme has been established, and clear user instructions illustrated with photographs have been prepared. However, possibly because of the entrenched use of the overall crushing strength, little practical experience with the test has yet accumulated, except that it is quick and easy to carry out.

6. CONCLUSIONS

1. It has been found that the corner strength test is simple enough to be carried out by relatively unskilled people and the apparatus is cheap.
2. The corner strength test may be more appropriate than the nominal overall crushing strength, because: a) a masonry unit's resistance to damage during its movement from mould to wall is usually the most critical aspect of its strength;
b) it tests the parts most vulnerable to damage in the manner in which they are likely to be damaged;
c) the overall crushing strength, (being calculated on the gross area which includes voids), is less closely related to the strength of the actual concrete.
3. The industry is presently familiar with expressing the quality of masonry in terms of overall crushing strength, so further correlations between that strength and the corner

strength of different block shapes and sizes will probably be necessary until the corner strength is better known in the building industry.

4. The desirability of small scale masonry manufacture and the quality control of it could lead to widespread use of the corner strength test, if it is properly promoted.

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1. South African Bureau of Standards. "Standard specification for concrete masonry units", SABS 1215-1984.
2. N Richardson "Point-load test for estimating concrete compressive strength", *ACI Materials Journal*, July-August 1989, pp 409-416.

1998 POSTGRADUATE STUDENT RESEARCH REPORTS IN CEMENT AND CONCRETE TECHNOLOGY,

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