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Study about Prism Test Method and evaluation of Flexural tensile strength by testing small-scale prisms

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Abstract : A masonry prism is an assemblage of masonry units and mortar that is constructed to serve as a test specimen for determining properties of masonry assemblages. Prisms are constructed for compressive strength testing in accordance with ASTM A 447 Standard Test Methods for Compressive Strength of Masonry Prisms. Prisms also are constructed to measure flexural bond strength either by ASTM E 518 Standard Test Methods for Flexural Bond Strength of Masonry or C 1072 Standard Test Method for Measurement of Masonry Flexural Bond Strength.

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Existing test methods to characterize ASR potential of aggregates and mitigation ability of supplementary cementing materials such as the Accelerated Mortar Bar Test (AMBT) and the Concrete Prism Test (CPT) are widely accepted in the industry. Although, the AMBT is a rapid test, the results from this test can be unreliable, particularly with certain types of aggregates. The CPT is considered as a more reliable test; however, the duration of this test method renders it impractical for routine usage in the industry to screen deleterious materials or inefficient ASR mitigation measures. This research presents a new test method-Miniature Concrete Prism Test (MCPT) that overcomes the deficiencies of the AMBT and the CPT.

Key Words : Prism testing, Bricks, Clay etc.

Introduction : Prism testing of brick or structural clay tile masonry provides a number of advantages over constituent material testing alone. The primary benefit of prism testing is a more accurate estimation of the compressive strength of the masonry assemblage. Another benefit of prism testing is that it provides a method of measuring the quality of workmanship throughout

the course of a project. Low prism strengths may indicate mortar mixing error or poor quality grout. The MSJC Specifications permit testing of masonry prisms to show conformance with the specified compressive strength of masonry, fc. In addition, the material components must meet the appropriate standards of quality. Masonry prisms are tested in accordance with ASTM E 447 Test Methods for Compressive Strength of Masonry Prisms, Method B as modified by the MSJC Specifications. At least three prisms are required by the MSJC Specifications for each combination of materials. The average of the three tests must exceed f_c.

A benefit of verifying compliance of the compressive strength of masonry by unit, mortar and grout properties is the elimination of prism testing. Each of the materials in the masonry assemblage must conform to ASTM material standards. For compliance with these material standards, the compressive strength of the unit and the proportions or properties of the mortar and grout must be evaluated. Not surprisingly, there have been attempts by numerous researchers to accurately correlate the assemblage compressive strength with unit, mortar and grout compressive strengths. Testing an assemblage of three materials produces a large scatter of compressive strengths covering all possible combinations of materials. Therefore, estimates of the masonry assemblage compressive strength based on unit, mortar and grout properties are necessarily conservative. The correlations provided in the MSJC Specifications, shown in Table 5, between unit compressive strength, mortar type and the masonry assemblage compressive strength represent a lower-bound to experimental data. In addition, the MSJC Specifications unit strength method does not directly address variable grout strength, multi-wythe construction or the influence of joint reinforcement on the compressive strength of the masonry assemblage. Consequently, compliance with the specified compressive strength of masonry by prism testing will always produce a more accurate and optimum use of brick or structural clay tile masonry's compressive strength than the unit strength method. The conservative nature of Table 2.1 should not be overlooked by the designer. A comparison of the predicted assemblage compressive strength by the unit strength method in the MSJC Specifications and a data base of actual brick masonry prism test results reveal this conservatism. The average compressive strength of prisms of solid brick units was found to be about 1.7 times the masonry compressive strength predicted by Table 1.2. The average compressive strength of prisms of hollow units ungrouted and grouted was found to be 1.9 and 1.4 times the compressive strengths predicted by Table 1.2, respectively.

Net Area Unit Compressive Strength, Psi(Mpa)		Net Area Assemblage Compressive Strength, Psi(Mpa)
Type M or S Mortar	Type N Mortar	
2400 (16.6)	3000 (20.7)	1000 (6.9)
4400 (30.3)	5500 (37.9)	1500 (10.3)
6400 (44.1)	8000 (55.2)	2000 (13.8)
8400 (57.9)	10500 (72.4)	2500 (17.2)
10400 (71.7)	13000 (89.7)	3000 (20.7)
12400 (85.5)	……	3500 (24.1)
14400 (99.3)	……...	4000 (27.6)

Flexural Tensile Strength

Flexural tensile strength may be evaluated by testing small-scale prisms in accordance with ASTM E 518 Test Method for Flexural Bond Strength of Masonry or ASTM C 1072 Test Method for Measurement of Masonry Flexural Bond Strength, but these results may not directly correlate to the allowable flexural tensile stresses in the MSJC Code.

Reinforced brick and structural clay tile masonry is considered cracked under service loads and the flexural tensile strength of the masonry is neglected in design. However, cracking of an unreinforced brick or structural clay tile masonry member constitutes failure and must be avoided. Thus, flexural tensile strength is an important design consideration for unreinforced masonry. Flexural tensile strength is the bond strength of masonry in flexure. It is a function of

the type of unit, type of mortar, mortar materials, percentage of grouting of hollow units and the direction of loading. Workmanship is also very important for flexural tensile strength, as unfilled mortar joints or dislodged units have no mortar-to-unit bond strength. The allowable flexural tensile stresses for portland cement-lime mortars are based on full-size wall tests in accordance with ASTM E 72 Method of Conducting Strength Tests of Panels for Building Construction. Values for masonry cement and air-entrained portland cement-lime mortars are based on reductions obtained with comparative testing.

Masonry walls subjected to lateral load either due to wind, earthquake or eccentric vertical external load/ or self-weight produce bending about the vertical axis/ horizontal axis or both the axis, depending upon its support condition and geometry.Bending about vertical axis produces flexure tension normal to its bed joints (ftn) and bending about horizontal axis produces flexural tension parallel to bed joint (ftp). The flexural tensile strength (modulus of rupture is of course different in bending in a plane normal to bed joints than for the bending in a plane parallel to bed joint in the wall. The ratio of (ftp) to (ftn) is referred to as orthogonal strength ratio R which is affected by many factors. It is a major of the degree of anisotropy of the material and is set at 2.0 in masonry codes. However the ratio ranges from 1.5 to 8 in clay masonry.

ASTM E 72 has defined the method and tested the procedure for determining the flexural tensile strength, which is referred as wall test. ASTM E 518 provides two methods for performing the tets on flexure beams knows as beam test. Method A uses concentrated loads at 1/3 points of the span and method B uses a uniform loading over the entire span.

Experimental setup

For conducting flexural tensile strength we conducted method A. We construct nine samples of same mortar grades used in above tests. To check flexural tensile strength we made samples of seven bricks of dimensions according to ASTM E 72 and ASTM E 518 as shown in fig. and check their strength after 7 and 28 days. Also we place three samples in water for 24 and noted the effect on strength after having sample submerged. For checking flexural tensile strength we apply three point loading in such a way so that each parts lenth is L/3 and rested the samples on end supports with some bearings as shown in fig 3.24.

Results :

Flexural tensile strength (modulus of rupture) of brick masonry is a function of tensile bond strength of mortar to brick, mortar cement content, mortar bed joint thickness and orientation of mortar bed joint with respect to span either normal to joint or parallel to joint

Experimental results, which were obtained in this experimental campaign, showed that some specimens show perfectly tensile failure but usually the samples of 1:6 mortar grade fails due to its own weight. The samples which we tested after 7 days , almost all samples fail due to its own weight except sample of 1:2 mortar.

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