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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for In Situ Measurement of Masonry Deformability Properties Using the Flatjack Method[1]

This standard is issued under the fixed designation C 1197; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method describes an in situ method for determining the deformation properties of existing unreinforced solid-unit[2] masonry. This test method concerns the measurement of in-situ masonry deformability properties in existing masonry by use of thin, bladder-like flatjack devices that are installed in saw cut mortar joints in the masonry wall. This test method provides a relatively non-destructive means of determining masonry properties.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 74 Practice for Calibration of Force Measuring Instruments for Verifying the Load Indication of Testing Machines[3]

3. Summary of Test Method

3.1 Two flatjacks inserted into parallel slots, one above the other, in a solid-unit masonry wall are pressurized thus inducing compressive stress on the masonry between them. The installation is shown in Fig. 1. By gradually increasing the flatjack pressure and measuring the deformation of the masonry between the flatjacks, load-deformation (stress-strain) properties may be obtained. Maximum compressive strengths may be measured in certain cases.

4. Significance and Use

4.1 Deformation and strength properties are measured only on the masonry between flatjacks. Boundary effects of the collar joint behind the wythe tested and adjacent masonry are neglected. In the case of multi-wythe masonry, deformability is estimated only in the wythe in which the flatjack is inserted. Deformability of other wythes may be different.

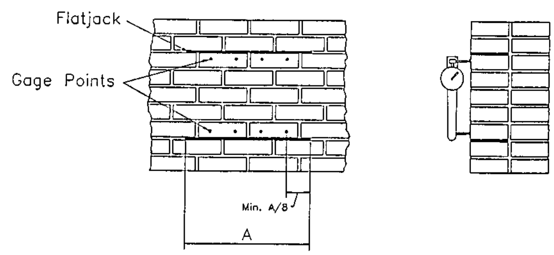

FIG. 1 Deformation Properties Using Two Flatjacks

5. Apparatus

5.1 *Flatjack*:

5.1.1 A flatjack is a thin envelope-like bladder with inlet and outlet ports which may be pressurized with hydraulic oil. Flatjacks may be of any shape in plan, and are designed to be compatible with the masonry being tested. For determining load-deformation properties of masonry, flatjacks are typically rectangular or semi-rectangular as shown in Fig. 2.

5.1.2 For determination of masonry deformability properties, dimension A (see Fig. 2) should be equal to or greater than the length of two masonry units. Dimension B should be equal to or greater than the thickness of one wythe and not less than three in. (76 mm). The radius, *R*, for circular and semi-rectangular flatjacks shall be equal to the radius of the circular saw blade used to cut the slot.

5.1.3 Flatjacks shall be made of metal or other material such that the flatjack in a slot in masonry will be capable of applying operating pressures up to 1000 psi (6.9 MPa).[4] Metal flatjacks suitable for this purpose shall be made of type 304 stainless steel sheet of 0.024 to 0.048 in. (0.61 to 1.2 mm) in thickness with welded seams along the edges, and incorporating hydraulic inlet or outlet ports.

5.1.4 Calibrate all flatjacks as described in Section 7 to determine their pressure-applied load characteristics.

5.2 *Hydraulic System*—An electrically or manually operated hydraulic pump with hydraulic hoses is required. Hose

[1] This test method is under the jurisdiction of ASTM Committee C-15 on Manufactured Masonry Units and is the direct responsibility of Subcommittee C15.04 on Research.

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[2] Solid-unit masonry is that built with stone, concrete, or clay units whose net area is equal to or greater than 75 % of the gross area.

[3] *Annual Book of ASTM Standards*, Vol 03.01.

[4] A maximum operating pressure of 1000 psi (6.9 MPa) is adequate for older existing masonry, but flatjacks with higher operating pressures may be required for more recently constructed buildings.

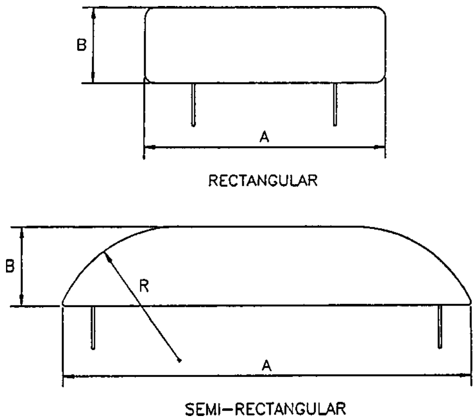

FIG. 2 Flatjack Configurations

connections shall fit the flatjack inlet port. Measure pressure using gages calibrated to a traceable standard having both an accuracy of 1 % of full hydraulic scale and an appropriate operating range. The hydraulic system shall be capable of maintaining constant pressure within 1 % of full scale for at least 5 min.

5.3 *Displacement Measurement*—Measure displacements of the masonry with electronic instrumentation, for example, a Linearly Variable Differential Transformer (LVDT) mounted to the surface of the masonry between the flatjacks, or by a mechanical gage extensometer which measures the distance between fixed gage points on the masonry as shown in Fig. 1. The method or device used to measure deformations shall be capable of deformation measurements up to 3⁄16 in. (5 mm). Deformation measurements shall have an accuracy of at least ±0.005 % of gage length. Record measurements manually at discrete intervals, or continuously by automatic data recording.

5.4 *Attachment of Measurement Devices*—Attach brackets for mounting electrical displacement measuring devices or gage points to be used with mechanical devices securely to the surface of the masonry to prevent movement and ensure the required measurement accuracy. Use rigid adhesive for discs and brackets and cementitious grout for plugs. If gage points are used, the gage points shall have a conical depression at their center, compatible with the pointed elements of the extensometer. The angles of the depression of the cone and the extensometer points shall be the same.

6. Preparation of Slots

6.1 Slots in masonry are normally prepared by removing the mortar from masonry bed joints to avoid disfiguring the masonry. Remove all mortar in the bed joint, that is, pressure exerted by a flatjack shall be directly against the cleaned surfaces of the masonry units.

6.2 The plan geometry of the slot shall be similar to that of the flatjack being used. Plan dimensions of the prepared slot shall not exceed those of the flatjack by more than ½ in. (12 mm). Slots shall be parallel and aligned vertically, and shall be separated by not more than 1.5 times the length of the flatjack.

6.3 Prepare rectangular slots into which rectangular flatjacks are to be inserted by drilling adjacent or overlapping holes (stitch drilling) and subsequently using a drill, bar, or tool to remove mortar and produce a slot of desired dimensions with smooth upper and lower surfaces.

6.4 Prepare slots for circular and semi-rectangular flatjacks using circular saws of sufficient radius to provide the depth required (Fig. 2, dimension B). Use carbide or diamond tipped blades to remove all mortar from the slot.

7. Calibration

7.1 A flatjack has an inherent stiffness which resists expansion when the jack is pressurized. Therefore, the fluid pressure in the flatjack is greater than the stress the flatjack applies to masonry. A flatjack must be calibrated to provide a conversion factor, K_m, to relate internal fluid pressure to applied stress.

7.2 Calibrate flatjacks in a compression machine of at least 100 kip capacity which has been calibrated according to Practice E 74.

7.3 Place a 2 in. (50 mm) thick steel bearing plate on the lower platen of the compression machine. The bearing plate shall be of sufficient size to completely cover the flatjack being calibrated. Place the flatjack on the lower bearing plate such that the edge of the flatjack with the inlet/outlet ports is coincident with the edge of the bearing plate. Place steel spacers around the other edges of the flatjack. The thickness of the spacers shall be equal to approximately 1⅓ times the combined thickness of the two steel sheets used in fabrication of the flatjack. Place the upper 2 in. (50 mm) thick bearing plate on top of the shims and flatjack, and align it to be directly above the lower bearing plate. Position the bearing plate/flatjack/shim assembly on the lower platen such that the centroid of the area of the flatjack is within ¼ in. (6 mm) of the axis of thrust of the test machine. The calibration setup is illustrated in Fig. 3.

7.4 Raise the moveable platen such that the non-moveable platen is in contact with the top bearing plate. Apply a pre-load sufficient to provide full contact between the bearing plates and the spacers, equivalent to 10 psi over the gross area of the flatjack.

7.5 The distance between platens must be held constant during the calibration procedure. Fix the displacement of the test machine at this point if using a displacement controllable machine. If not, attach displacement gages (mechanical or electrical) such that the distance between platens established by the procedures of paragraph 7.4 can be held constant when using a force-control test machine.

7.6 Pressurize and depressurize the flatjack three cycles with the maximum pressure in the flatjack not to exceed 1000 psi (2.069 MN/m^2) nor the stress applied to the flatjack by the compression machine to exceed 1000 psi (2.069 MN/m^2) based on the gross area of the flatjack.

7.7 Increase the pressure in the flatjack in 50 to 100 psi (344.8 to 689.5 KN/m^2) increments up to 1000 ± 50 psi (6.895 MN/m^2 ± 344.8 KN/m^2) while holding the distance between platens constant. At each increment, record flatjack hydraulic pressure and force measured by the test machine.

7.8 Calculate the load applied by the flatjack as internal pressure times gross flatjack area. Plot flatjack load versus load measured by the test machine with the flatjack load on the horizontal axis of the plot. The slope of the line equals the flatjack constant, that is, the conversion factor:

$$K_m = P_{\text{machine}} \div P_{\text{flatjack}} \tag{1}$$