



Designation: D3880/D3880M – 90 (Reapproved 2017)

Standard Test Method for Asbestos Strength Units¹

This standard is issued under the fixed designation D3880/D3880M; 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 gives a procedure for the evaluation of the strength-giving properties of asbestos fibers used to reinforce asbestos-cement products.

1.2 The purpose of this test method is to determine the number of strength units that may be assigned to the sample tested.

1.3 Asbestos fiber possesses the ability to impart strength to an asbestos-cement product. Every fiber grade may be regarded as possessing a certain quantity of strength-giving units. The quantity of fiber required in an asbestos-cement composition varies inversely with the number of strength units it possesses. For example, if an amount, designated by X , of a fiber possessing 100 strength units produces a product of a given strength, $2X$ would be required to produce a product of equivalent strength from fiber possessing only 50 strength units.

1.4 The following definition is the basis for the strength unit test: An asbestos fiber that gives the standard strength at the standard density when used as 10 % of the furnish is defined as having 100 strength units. Therefore, by knowing the percent fiber required in the mix to give standard strength at the standard density, it is possible to calculate the strength units of a sample of asbestos.

1.5 This procedure is intended primarily for chrysotile asbestos; it has not been verified whether or not it is applicable to other types.

1.6 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.7 **Warning**—Breathing of asbestos dust is hazardous. Asbestos and asbestos products present demonstrated health

risks for users and for those with whom they come into contact. In addition to other precautions, when working with asbestos-cement products, minimize the dust that results. For information on the safe use of chrysotile asbestos, refer to “Safe Use of Chrysotile Asbestos: A Manual on Preventive and Control Measures.”²

1.8 *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.* For specific precautionary statements see 6.7.2, 7.5, 9.2.2, and 1.7.

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*³

C150 Specification for Portland Cement

C184 Test Method for Fineness of Hydraulic Cement by the 150- μ m (No. 100) and 75- μ m (No. 200) Sieves (Withdrawn 2002)⁴

C204 Test Methods for Fineness of Hydraulic Cement by Air-Permeability Apparatus

C430 Test Method for Fineness of Hydraulic Cement by the 45- μ m (No. 325) Sieve

C1120 Test Method for Wash Test of Asbestos

C1121 Test Method for Turner and Newall (T and N) Wet-Length Classification of Asbestos

C1162 Test Method for Loose Density of Asbestos

D1193 Specification for Reagent Water

D1655 Specification for Aviation Turbine Fuels

D2590 Test Method for Sampling Chrysotile Asbestos

² Available from The Asbestos Institute, http://www.chrysotile.com/en/sr_use/manual.htm.

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

⁴ The last approved version of this historical standard is referenced on www.astm.org.

¹ This test method is under the jurisdiction of ASTM Committee C17 on Fiber-Reinforced Cement Products and is the direct responsibility of C17.03 on Asbestos - Cement Sheet Products and Accessories.

Current edition approved June 1, 2017. Published July 2017. Originally approved in 1980. Last previous edition approved in 2009 as D3880/D3880M – 90(2009) ^{ϵ 1}. DOI: 10.1520/D3880_D3880M-90R17.

- D2946** Terminology for Asbestos and Asbestos–Cement Products
- D2589** Test Method for McNett Wet Classification of Dual Asbestos Fiber
- D3639** Test Method for Classification of Asbestos by Quebec Standard Test
- D3752** Test Method for Strength Imparted by Asbestos to a Cementitious Matrix
- E11** Specification for Woven Wire Test Sieve Cloth and Test Sieves

2.2 Other Standards:

Quebec Asbestos Mining Association (QAMA) Standard, Designation for Chrysotile Asbestos Grades⁵

3. Terminology

3.1 Definitions:

3.1.1 *point value, n*—in asbestos, an index of commercial value of asbestos fiber used in asbestos-cement products. Point value = (SU-10)/1.39 where SU stands for strength units.

3.1.2 *strength unit, n*—in asbestos, unit of reinforcing potential of asbestos fiber in asbestos-cement products. An asbestos fiber that yields a flexural modulus of rupture of 27 MPa at a product density of 1.6 g/cm³ when used as 10 % of the furnish (dry ingredients) is defined as having 100 strength units. Therefore, the number of strength units of a given asbestos is equal to 1000/(% fiber required in the dry mix to yield 27 MPa at 1.6 g/cm³).

3.1.3 Refer to Terminology **D2946** for other terms relating to asbestos.

4. Summary of Test Method

4.1 This test method covers the fabrication and flexural testing of asbestos-cement test specimens that contain asbestos fiber from the sample being evaluated. The calculation of strength units of the asbestos, based upon the flexural strength, density and composition of the test specimens, is also described.

4.2 The specimen fabrication process includes the following steps:

4.2.1 *Asbestos fiber preparation*, including ball milling, fiberizing, and blending.

4.2.2 *Compounding*, including dry mixing, the preparation of saturated water, and wet mixing.

4.2.3 *Test specimen formation*, including the pressing of asbestos-cement cakes in a semi-automatic press.

4.2.4 *Specimen curing*, including a stage in a humidity cabinet, autoclaving, air cooling, and saturating in a water bath.

4.3 *Specimen testing*, including the determination of immersed mass, saturated mass, flexural strength, specimen thickness and width, and dry mass.

4.4 *Calculations*, involving the determination of specimen volume, modulus of rupture, density, modulus of rupture

adjusted for density, asbestos fiber content required to attain standard strength, fiber ratio required, point value, and strength units.

5. Significance and Use

5.1 This test method facilitates the comparison of different types and grades of chrysotile asbestos by the property most pertinent to its use in asbestos-cement, namely, the strength or reinforcing value it imparts to the product.

5.2 While similar comparative results could be obtained on any given production equipment, this method allows the testing of small samples, avoids costly interruptions in production for numerous trial runs, and allows test values to be obtained by a single standard method so that results can be compared among different locations.

5.3 Strength Unit (SU) value of a fiber blend used in asbestos-cement products may be estimated by taking the proportionate SU value of each component of the fiber blend.

5.4 If the fiber blend is formulated with the aim to optimize another fiber property such as filterability, the SU calculation will assure that the blend will not fall below an acceptable strength level.

5.5 This test method is restricted to grades of asbestos used in asbestos-cement products. Very long (Group 3) fibers are difficult to evaluate by this method because the test specimens produced may not be sufficiently homogeneous. Similarly, very short (Group 7) grades may not be retained satisfactorily in the mold during the pressing of test specimens or may not provide sufficient strength to meet the test requirements.

NOTE 1—The term Group 3 or 7 refers to the standard designation for chrysotile asbestos grades established by the Quebec Asbestos Mining Association, See **2.2**.

5.6 Because of certain differences between this method and the many variations in plant production procedure commonly used in asbestos-cement manufacture, it is emphasized that the strength values obtained by this standardized procedure will not necessarily give exactly the same strength values as obtained at any one specific manufacturing plant.

6. Apparatus

6.1 Ball Milling:

6.1.1 *Porcelain Ball Mill Jars*,⁶ meeting the following specifications:

Capacity	11 000 cm ³ [671 in. ³]
External diameter	280 mm [11.02 in.]
Internal diameter	230 mm [9.06 in.]
Internal height	210 mm [8.27 in.]

⁶ The sole source of supply of the apparatus (Type KU5a ball mill jars, and machine-made balls, manufactured by Staatliche Porzellan Manufaktur, Berlin Werk Seld, Selb/afr. Hartmannstrasse 1–3, German Federal Republic (West Germany)) known to the committee at this time is Fish-Schurman, 70 Portman Road, New Rochelle, NY. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,¹ which you may attend.

⁵ Available from Asbestos Institute, 1130 Sherbrooke St. West, Montreal, Q.C., H3A2 M8.

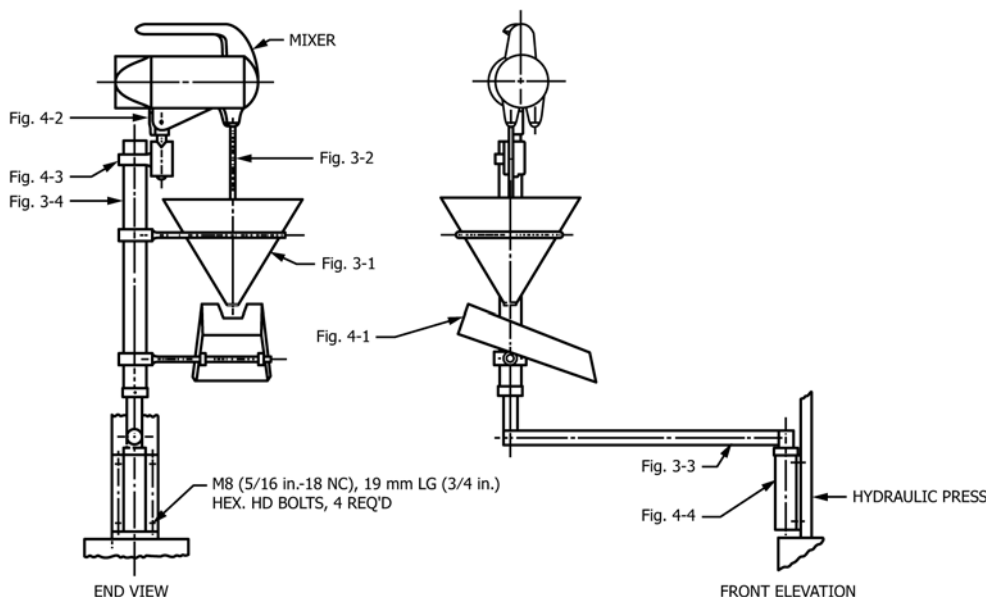


FIG. 1 Wet-Mixer Assembly

6.1.2 *Porcelain Balls*,⁷ machine made, meeting the following specifications:

Diameter	40 mm [1.575 in.]
Mass (each)	74 to 75 g [0.163 to 0.165 lb]
Specific activity	2.3 ± 0.1 (The manufacturer specifies a nominal specific gravity of 2.22.)

Alternatively, handmade balls approaching these specifications may be used.

6.1.2.1 Discard balls when their diameter is 35 mm [1.38 in.] or less.

6.1.3 *Roll Table*, to rotate the ball mill jars at 6.81 ± 0.21 rad/s [65 ± 2 r/min]. See **Note 2**.

6.2 Fiberizing:

6.2.1 *Disintegrator*,⁸ B.O.P. (Ball, Opener, Penmen) Type O, driven at 565 ± 21 rad/s [5400 ± 200 r/min] by a squirrel-cage induction motor rated at no less than 1.492 kW [2 hp].

6.2.2 *Perforated Steel Discharge Plates*, for the fiberizer. One each of the following opening diameters: 3, 5, 7 and 10 mm, ± 3 %. Holes must be on an equilateral triangular pitch with wire edges pointing outward.

6.2.3 *Cardboard Drum*, approximately 410 mm [16 in.] in diameter by 400 mm [15 in.] in height with removable ring clamp on top, and canvas dust cover (transition piece) to serve as a receiver for the fiberizer discharge. Other arrangements for receiving the fiberizer discharge that are satisfactory with

respect to relief of static pressure generated by the fiberizer rotor and with respect to the prevention of sample losses and contamination are acceptable. The free area of cloth while in operating position must be within the limits from 1300 to 4500 cm², and the cloth must be square weave, unbleached cotton duck weighing 0.41 ± 0.02 kg/m² [12 oz/yd²], or a cloth of equivalent permeability.

6.3 Blending:

6.3.1 *Polyethylene Jar with Cover*,⁹ meeting the following specifications:

Inside diameter	311 mm [12.25 in.]
Outside diameter	327 mm [12.875 in.] (wall thickness 8 mm [0.3 in.])
Inside height	311 mm [12.25 in.]

Other containers, such as stainless steel blenders, with similar internal dimensions may be used.

6.3.1.1 The jar may be fitted with a circumferential rubber tension band 100 mm [3.94 in.] wide by 3 mm [0.125 in.] thick to retain the cover. This band may be rolled down, turtleneck fashion, when the cover must be opened. Alternatively, the cover may be retained by mechanical clamps. In that case, the use of a gasket to seal the cover may be necessary.

6.3.1.2 The jar must be fitted with tires around the outer diameter to allow it to roll on a roll table in a horizontal attitude and to allow any clamps or projections to clear the rolls.

6.3.2 *Roll-Table*, to rotate the blending jar at a speed of 5.87 ± 0.21 rad/s [56 ± 2 r/min]. See **Note 2**.

6.3.3 *Rolling Sheet*, 1 m² [1 yd²] or larger, made of rubber, plastic, or some other flexible elastomer.

6.4 Dry Mixing:

⁷ The sole source of supply of the apparatus known to the committee at this time is Ateliers de Lessines S.A., Division BOP, 55 rue de Wauthier 1020, Bruxelles, Belgium. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,¹ which you may attend.

⁸ The sole source of supply of the apparatus known to the committee at this time is Canadian Laboratory Supplies Limited, Box 2090 Stn. St. Laurent, Montreal 307, P. Q., Canada. Specify dimensions required, request a design similar to Catalog No. J3028, and refer to Canlab Quotation No. 2713 (1969). If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,¹ which you may attend.

⁹ The sole source of supply of the apparatus known to the committee at this time is Canadian Laboratory Supplies Limited, Box 2090, Stn. St. Laurent, Montreal 307, P. Q., Canada, (Catalog No. J3028-14). These must be fitted with suitable vanes. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,¹ which you may attend.

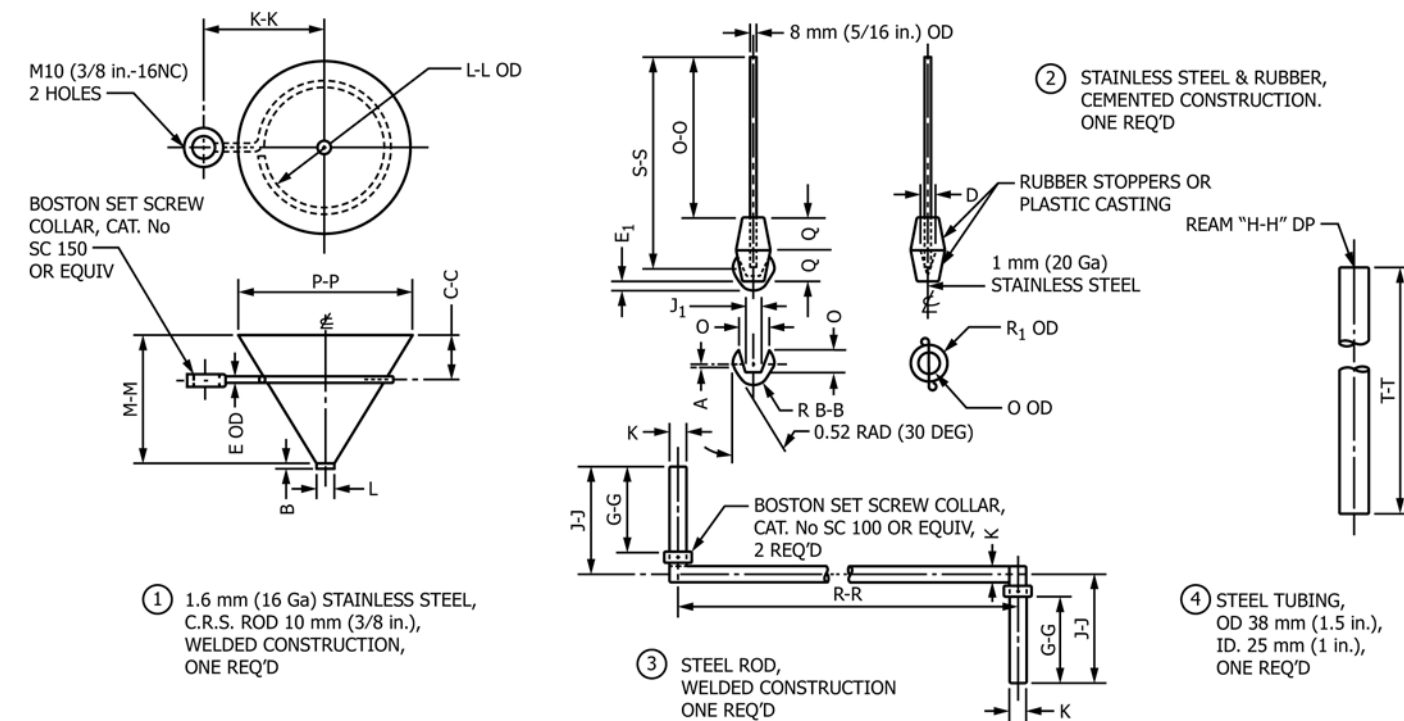


FIG. 2 Wet-Mixer Details

6.4.1 *Polyethylene Jar with Cover*,⁹ meeting the following specifications:

Inside diameter	248 mm [9.75 in.]
Outside diameter	257 mm [10.125 in.]
Inside height	273 mm [10.75 in.]
Capacity	13 200 cm ³

Other containers, such as stainless steel mixers, with similar internal dimensions may be used.

6.4.1.1 The jar must be fitted with a rubber band as described in 6.3.1.1.

6.4.1.2 The exterior of the jar must be fitted with tires as described in 6.3.1.2.

6.4.1.3 The interior of the jar must be fitted with three mixing vanes located 2.09 rad [120°] apart, along the full length of the jar and projecting 38.1 mm [1.5 in.] from the inside wall. The vanes may be fastened to the wall by smooth head rivets or an adhesive. The corners of the vanes at the jar opening should be rounded to a radius of 12.7 mm [0.5 in.]. The vanes may be fabricated from aluminum or any other corrosion-resistant sheet metal 1 mm [0.04 in.] thick.

6.4.2 *Roll-Table*, to rotate the blending jar at a speed of 8.17 ± 0.21 rad/s [78 ± 2 r/min].

NOTE 2—If a judicious choice of drive roll diameter and speed is chosen for the roll table, together with suitable tire dimensions for containers

mentioned in 6.1.1, 6.3.1 and 6.4.1, it is possible to use the same roll table for the three containers. For example, if the drive roll has a diameter of 125 mm [4.93 in.] and a speed of 17.3 rad/s [165 r/min], then the appropriate speed would be obtained for each container if tires were adjusted to bring the effective outer diameters to 311 mm [12.25 in.] for the ball mill jars, 361 mm [14.21 in.] for the blending jars, and 259 mm [10.2 in.] for the dry-mixing jars.

6.5 Wet Mixing:

6.5.1 *Wet Mixer*, as described in Fig. 1, Fig. 2, Fig. 3 and Fig. 4 and mounted on the press. The drive motor must be able to maintain a speed of 62.83 ± 2.62 rad/s [600 ± 25 r/min] under load.

6.5.1.1 The Sunbeam Mix Master (trademark) motor suggested in Fig. 1 may be replaced for heavier duty by another motor, such as the Bodine motor¹⁰ with one shaft at motor speed and another shaft driven through a right-angle gear with a speed reduction of 6:1 or 10:1. This motor may be operated

¹⁰ The sole source of supply of the apparatus known to the committee at this time is Catalog No. 134-1, distributed by Sepor Laboratory Supply, Box 4245, Long Beach, CA 90804. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,¹ which you may attend.



② STEEL, ONE REQ'D

FIG. 3 Additional Wet-Mixer Details

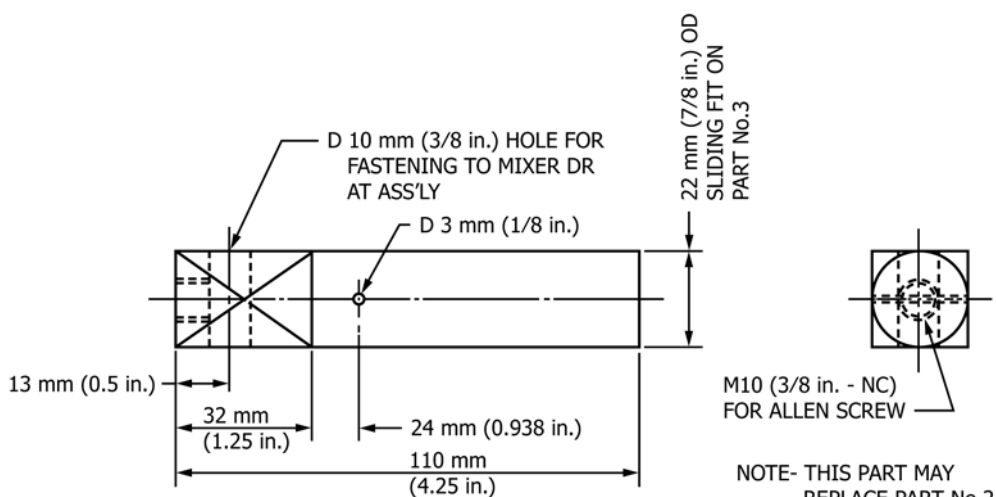


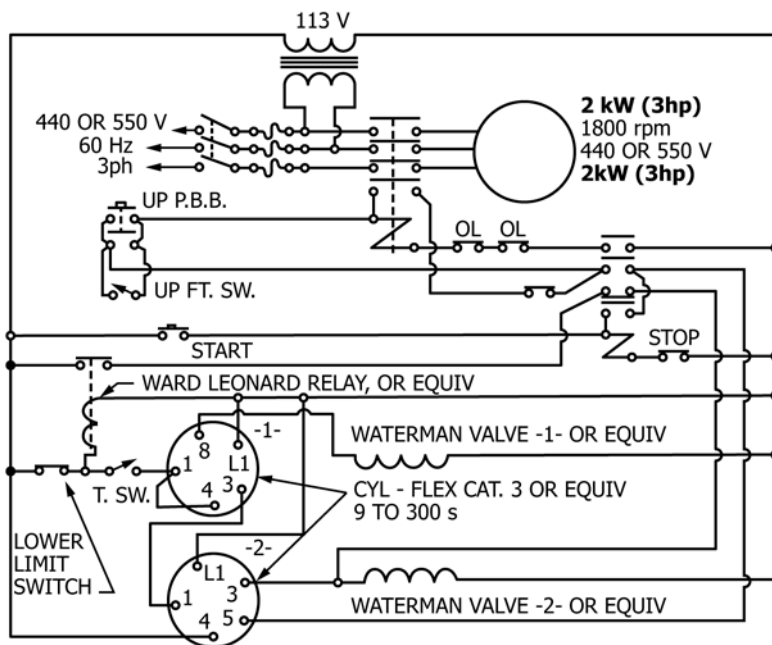
FIG. 4 Modified Motor Mount for Alternative Wet Mixer

with a rheostat speed control, but more satisfactory performance is achieved by means of an autotransformer.

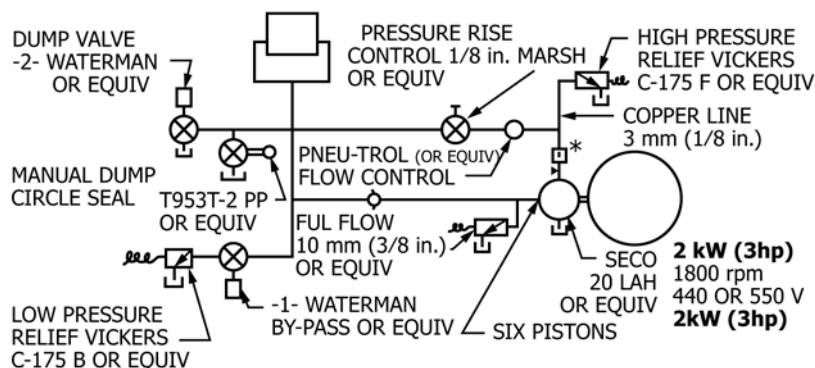
6.5.1.2 The Bodine motor has an additional advantage. If a strobe card is mounted on the higher speed shaft while the impeller is mounted on the other shaft, then the strobe card

(consisting of two black and two white alternating segments) will rotate at 377 rad/s [3600 r/min] when the impeller is at 62.8 rad/s [600 r/min], and the strobe card will appear stationary when illuminated with standard fluorescent lamps operating on 60 Hz alternating current.





(a) ELECTRIC CONTROL CIRCUIT FOR MODIFIED
P.H.I. PRESS



* STEEL COUPLING 19 (3/4 in.)
► ONE PISTON

NOTE: ALL RELIEF VALVES TO
RESERVOIR THROUGH
No 200-8 ROSS HEAT
EXCHANGER OR EQIV

(b) HYDRAULIC CONTROL CIRCUIT

FIG. 6 Control Circuit for P.H.I. Press as Modified for F.S.U. Testing

Thickness	1.24 to 1.68 mm [0.049 to 0.066 in.]
Diameter of perforations	3.18 mm [0.125 in.] $\pm$ 5 %
Width of metal between holes	2.38 mm [$\frac{3}{32}$ in.] [0.09375 in.] $\pm$ 20 %
Pitch of holes	triangular (equilateral)

6.6.10 *Settling Tank*, 130 mm [5 in.] wide by 640 mm [25 in.] long by 500 mm [20 in.] deep, made of galvanized sheet steel, with an overflow drainage system.

6.6.11 *Asbestos Cement, Plastic, or Stainless Steel Plates*, measuring approximately 90 by 220 by 6 mm [3.5 by 8.5 by 0.25 in.]. Ensure that the plates have not become bowed from previous usage nor become bowed under load while in use. See 9.8.2.1.

6.7 *Curing*:

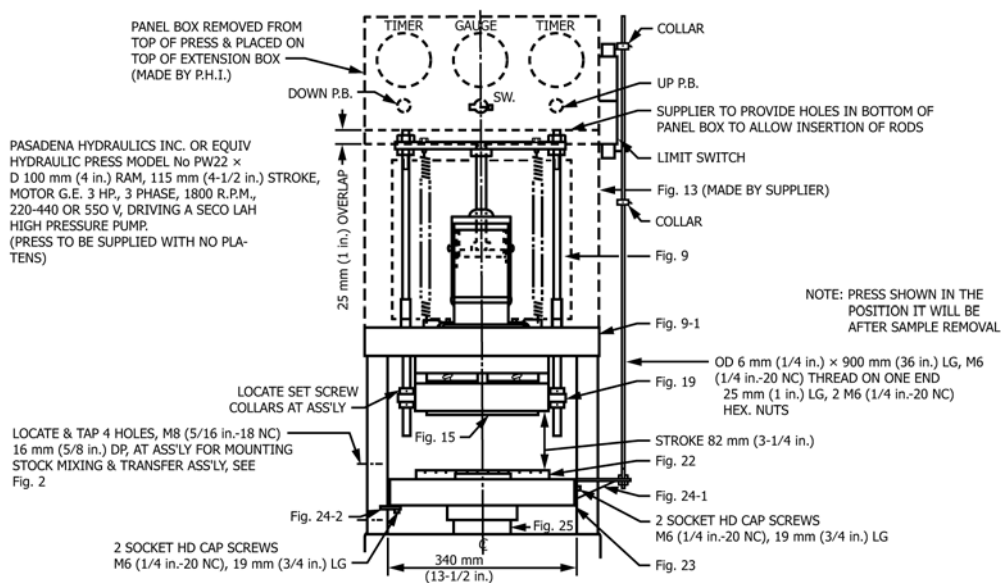


FIG. 7 General Press Assembly (Front Elevation)

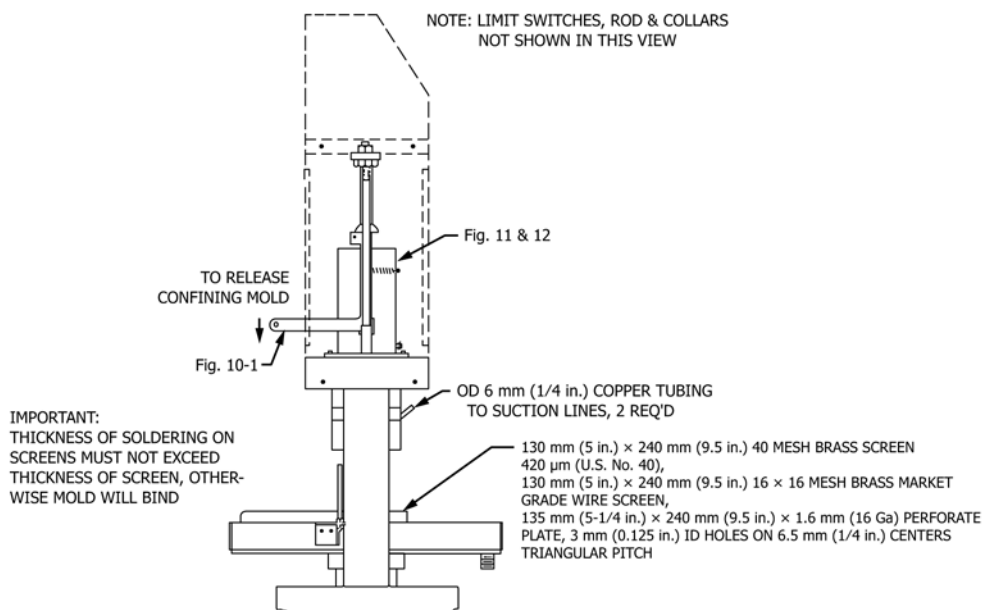


FIG. 8 General Press Assembly (Right Elevation)

6.7.1 *Humidity Cabinet*, capable of maintaining relative humidity between 90 and 100 % at room temperature (15 to 32°C) [60 to 90°F].

6.7.2 *Autoclave*, approximately 460 mm [18 in.] in internal diameter and 760 mm [30 in.] long, capable of maintaining 689.5 kPa [100 psig] gage pressure of saturated steam (not superheated) at 170°C [338°F] for a period of 20 h. **(Warning—**The autoclave must be rated at a gage pressure higher than 689.5 kPa [100 psi] in order to permit this pressure to be maintained. Refer to local government regulations for pressure vessels prior to purchase and installation of an autoclave.)

6.7.2.1 *Autoclave Trays*, steel plate, 610 by 355 by 6 mm [24 by 14 by 0.25 in.], with a handle at one end.

6.7.2.2 *Autoclave Baskets*, as described in Fig. 23.

6.7.2.3 *Asbestos-Cement Cover Sheets*, approximately 360 by 610 by 6 mm [14 by 24 by 0.25 in.].

6.7.3 *Saturating Tank*, large enough to saturate one day's production of test specimens, each measuring approximately 75 by 200 by 6 mm [3 by 8 by 0.25 in.]. One press produces up to 90 test specimens each 8-h shift.

6.8 Testing and Measuring:

6.8.1 *Flexural Testing Machine*, capable of applying a load of 730 N at the rate of 5.88 ± 0.29 N/s. For testing machines with a constant rate of extension, as opposed to a constant rate of loading, these must be capable of extending at the rate of 0.1 mm/s [3.93×10^{-3} in./s]. The dynamometer must read to 1 N [0.2 lbf] and must be equipped with a trailing needle or other mechanism to record maximum load at time of failure.