Draft Finalized by Technical Committee

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नेपाल गुणस्तर

NEPAL STANDARD

METHOD OF PHYSICAL TEST FOR HYDRAULIC CEMENT

PART 7 DETERMINATION OF COMPRESSIVE STRENGTH OF MASONRY CEMENT

Government of Nepal

Ministry of Industry, Commerce and Supplies

Nepal Bureau of Standards and Metrology (NBSM)

Kathmandu, Nepal

www.nbsm.gov.np

1. SCOPE

1.1 This standard (Part 7) covers the procedure for determining the strength of masonry cement as represented by compressive strength tests on 50 mm mortar cubes.

2. SAMPLING AND SELECTION OF TEST SPECIMENS

2.1 The samples of the cement shall be taken in accordance with the requirements of NS 386 and the relevant standard specification for the type of cement being tested. The representative sample of the cement selected as above shall be thoroughly mixed before testing.

3. TEMPERATURE AND HUMIDITY

3.1 The temperature of moulding room, dry materials and water shall be maintained at 27 ± 2ºC. The relative humidity of the laboratory shall be 65 ± 5 percent.

3.2 The moist closet or moist room shall be maintained at 27 ± 2ºC and at a relative humidity of not less than 90 percent.

4. GENERAL

4.1 The standard sand to be used in the preparation of mortar cubes shall conform to NS 51**.**

5. APPARATUS

5.1 Balance - The balance shall conform to the following requirements:

On balance in use, the permissible variation at a load of 1000 g shall be plus or minus 1.0 g. The permissible variation on new balance shall be one half of this value. The sensibility reciprocal shall be not greater than twice the permissible variation.

Note 1 - The sensibility reciprocal is generally defined as the change in load required to change the position of rest of the indicating element or elements of a non-automatic indicating scale a definite amount at any load.

Note 2 - Self Indicating balance with equivalent accuracy may also be used.

5.2 Standard Weights - The permissible variations on weights in use in weighing the cement shall be as prescribed in Table 1.

TABLE 1 PERMISSIBLE VARIATION ON WEIGHTS

WEIGHT	PERMISSIBLE VARIATION ON WEIGHTS IN USE
g (1)	g (2)
500	±0.35
300	±0.30
250	±0.25
200	±0.20
100	±0.15
50	±0.10
20	±0.05
10	±0.04
5	±0.03
2	±0.02
1	±0.01

5.3 Cube Moulds - Cube mould of 50 mm size and accessories conforming to NS ***.

5.4 Planetary Mixer - Planetary mixer conforming to Annex A.

5.5 Flow Table and Accessories - Flow table and accessories conforming to Annex B.

5.6 Tamping Rod - Tamping rod conforming to NS *** .

6. PREPARATION OF MOULDS

6.1 The interior faces of the specimen moulds shall be thinly covered with mineral oil or light cup grease. After assembling the moulds, excessive oil or grease shall be removed from the interior faces and the top and bottom surfaces of each mould. Moulds shall then be set on plane, non-absorbent base plates that have been thinly coated with the mineral oil, petrolatum or light cup grease.

7. PREPARATION OF MORTAR

7.1 Clean appliances shall be used for mixing. Temperature of water and that of the test room at the time when these operations are being performed shall be 27 ± 2°C. Potable/distilled water shall be used in preparing the cubes.

7.2 The material for each set of three specimens shall be mixed separately and shall be as follows:

Masonry cement	420 g
Standard sand	1440 g

7.2.1 The amount of water used for gauging shall be such as to produce a flow of 110 ± 5 percent with 25 drops in 15s as determined in **7.3**.

7.3 Determination of Flow

7.3.1 Trial Mixing - With dry material as specified in **7.2**, make trial mortars with different percentages of water until specified flow is obtained. Make each trial flow test with fresh mortar. The mixing shall be done mechanically by means of mixing apparatus as specified in **5.4**. Place the dry paddle and the dry bowl in the mixing position in the mixer, then introduce the materials for batch into the bowl and mix in the following manner:

a) Place all the mixing water in the bowl;

b) Add the masonry cement to the water, then start the mixer and mix at the slow speed (140 ± 5 rev/min) for 30 s;

c) Add the entire quantity of sand slowly over a period of 30 s, while mixing at slow speed (140 ± 5 rev/min);

d) Stop the mixer, change to medium speed (285 ± 10 rev/min), and mix for 30 s;

e) Stop the mixer, and let the mortar stand for one and a half minutes. During the first 15 s of this interval, quickly scrap down into the batch any mortar that may have collected on the side of the bowl, then for the remainder of this interval, cover the bowl with the lid;

f) Finish by mixing for one minute at medium speed (285 ± 10 rev/min); and

g) In cases requiring further remixing, any mortar adhering to the side of the bowl shall be quickly scraped down into the batch with the scraper prior to remixing which is to be continued till a uniform mortar is obtained.

Upon the completion of mixing. The mixing paddle shall be shaken to remove excess- mortar into the mixing bowl.

7.3.2 Carefully wipe the flow-table top clean, and dry and place the mould at the centre, Place about 25 mm thick layer of mortar mixed in accordance with **7.3.1** in the mould and tamp 20 times with the tamping rod. The tamping pressure shall be just sufficient to ensure uniform filling of the mould. Then fill the mould with mortar and tamp as specified for the first layer. Cut off the excess mortar to a plane surface flush with the top of the mould by drawing the straight edge of a trowel (held nearly perpendicular to the mould) with a sawing motion across the top of the mould. Wipe the table top clean and dry, particularly taking care to remove any water from around the edge of the flow mould. Lift the mould away from the mortar one minute after completion of the mixing operation. Immediately drop the table through a height of 12.5 mm, 25 times in 15 s. The flow is the resulting increase in average base diameter of the mortar mass, measured on at least four diameters at approximately equi-spaced intervals expressed as a percentage of the original base diameter.

7.4 The material for moulding each batch of test specimens shall be mixed separately using the quantities of dry materials, conforming to the proportions specified in **7.2** and the quantity of water as determined in **7.3**. Mixing of mortar shall be done mechanically as described in **7.3.1**.

8. MOULDING OF SPECIMENS

8.1 Immediately following completion of the flow test, return the mortar from the flow mould to the mixing bowl, quickly scrape down into the batch the mortar that may have collected on the side of the bowl and give the entire batch a 15 s mixing at medium speed (285 ± 10 rev / min). Start moulding the specimens within a total elapsed time of not more than 2 min and 15 s after completion of the original mixing of the mortar batch. Place a layer of mortar about 25 mm in thickness in all the cube compartments. Tamp the mortar in each cube compartment 32 times in about 10s in four rounds, each round to be at right angles to the other and consisting of eight adjoining strokes over the surface of the specimen as illustrated in Fig. 1. The tamping pressure shall be just sufficient to ensure uniform filling of the moulds.

The four rounds of tamping (32 strokes) of the mortar shall be completed in one cube before going to the next. When the tamping of the first layer in all of the cube compartments is completed, fill the compartments with the remaining mortar and then tamp as specified for the first layer. During tamping of the second layer, bring in the mortar forced out on to the tops of the moulds after each round of tamping by means of the gloved fingers and the tamper upon completion of each round

and before starting the next round of tamping. On completion of the tamping, the tops of all cubes should extend slightly above the tops of the moulds. Bring in the mortar that has been forced out on to the tops of the moulds with a trowel and smooth off the cubes by drawing the flat side of the trowel (with the leading edge slightly raised) once across the top of each cube at right angles to the length of the mould. Then for the purpose of levelling the mortar and making the mortar that protrudes above the top of the mould of more uniform thickness, draw the flat side of the trowel (with the leading edge slightly raised) lightly once along the length of the mould. Cut off the mortar to a plane surface flush with the top of the mould by drawing the straight edge of the trowel (held nearly perpendicular to the mould) with a sawing motion over the length of the mould.

NOTE: - When a duplicate batch is to be made immediately for additional specimens the repetition of flow test may be omitted and the mortar allowed to stand in the mixing bowl for 90 s and then remixed for 15s at medium speed before starting the moulding of the specimens.

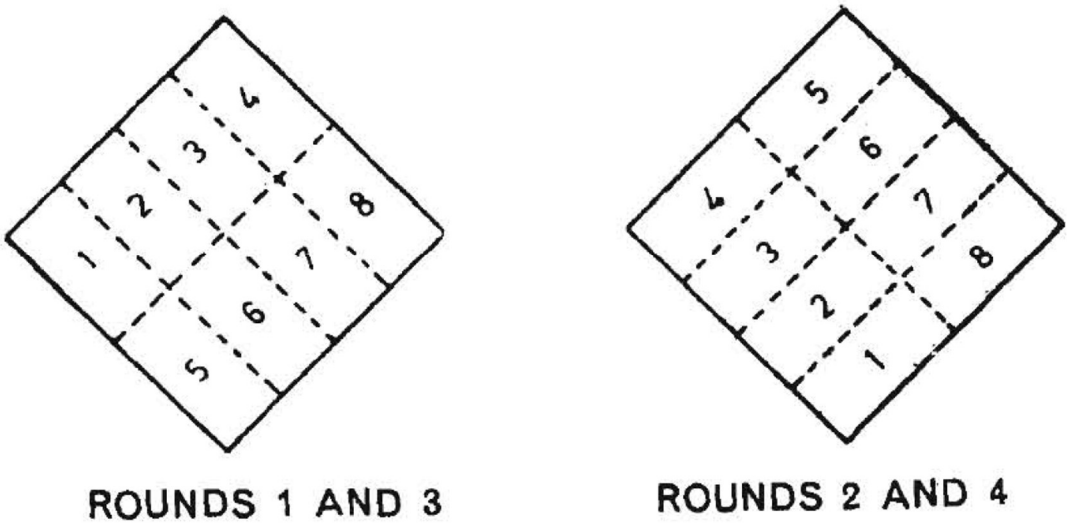


Fig. 1 Order of Tamping For Moulding Test Specimens

9. STORAGE AND CURING OF SPECIMENS

9.1 All test specimens, immediately after moulding and compaction, shall be kept in the moulds on plane plates in a moist cabinet, maintained at a temperature of 27 ± 2°C and a relative humidity of 90 percent or more, from 48 to 52 h in such a manner that the upper surfaces shall be exposed to the moist air. The cubes shall then be removed from the moulds and placed in the moist cabinet for five days in such a manner as to allow free circulation of air around at least five faces of the specimens. After five days curing in moist cabinet, the cubes for 7-day compressive strength shall be removed for testing whereas the cubes for 28-day compressive strength test shall be immersed in clean water for another twenty-one days in storage tanks of non-corrosive materials.

10. TESTING

10.1 Test not less than three cubes for compressive strength for each of the curing periods of 7 and 28 days as indicated in **9.1**, the periods being reckoned from the completion of moulding and compaction.

10.2 Testing of the cube specimens shall be carried out immediately after their removal from the moist cabinet for 7-day specimens, and from storage water for all other specimens if more than one specimen at a time is removed from the moist cabinet for 7-day tests, these cubes shall be covered with a damp cloth until the time of testing. If more than one specimen at a time is removed from storage water for testing, these cubes shall be placed in a pan of water at a temperature of 27 ± 2°C and of sufficient depth to completely immerse each cube until the time of testing.

10.2.1 The cubes shall be tested on their sides without any packing between the cube and the steel plattens of the electrically operated testing machine. One of the plattens shall be carried on a base and shall be self-adjusting. An initial loading up to one-half of the expected maximum load for specimens having expected maximum loads of more than 13500 N may be applied at any convenient rate. Apply no initial loading to specimens having expected maximum loads of less than 13500 N. Adjust the rate of load without interruption so that the breaking strength of the cube is reached in not less than 20 sec and not more than 80 sec. Make no adjustment in the control of the testing machine while a specimen is yielding rapidly immediately before failure.

11. CALCULATION

11.1 The measured compressive strength of the cubes shall be calculated by dividing the maximum load applied to the cubes during the test by the cross-sectional area, calculated from the mean dimensions of the section and shall be expressed to the nearest 0.5 N/mm^2. In determining the compressive strength, do not consider specimens that are manifestly faulty, or that give strengths differing by more than 10 percent from the average value of all test specimens. After discarding specimens or strength values, if less than two strength values are left for determining the compressive strength at any given period, a retest shall be made.

ANNEX A

Mixer and Paddle - Specification

A.1. MATERIALS

A.1.1 Materials for construction of different component parts of mixer shall be as given in Table A.1.

TABLE A.1 MATERIALS FOR CONSTRUCTION OF DIFFERENT COMPONENT OF MIXER

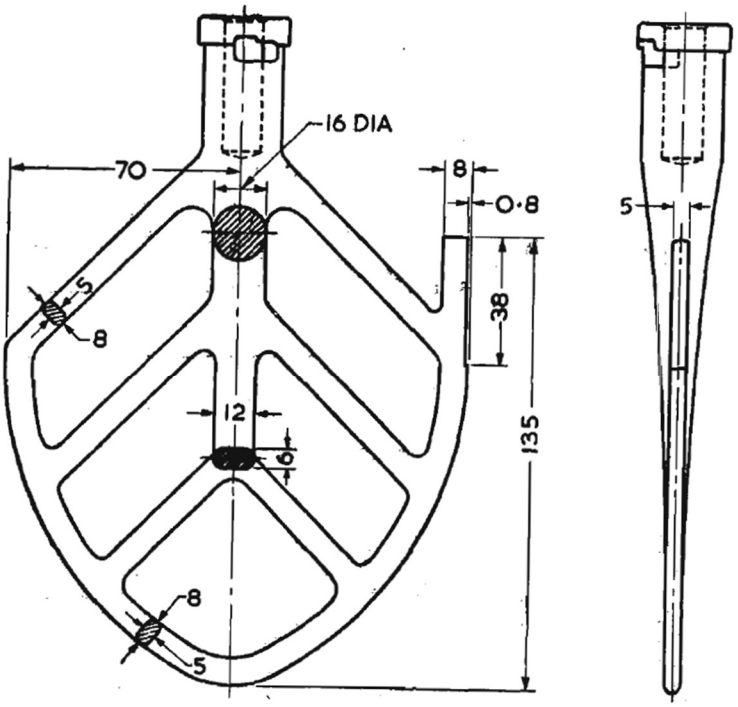
S.No.	Parts	Material	Ref to Nepal Standard
(1)	(2)	(3)	(4)
i)	Mixing bowl	Stainless steel or other suitable material	NS ***
ii)	Paddle	Stainless steel or other suitable material	NS***
iii)	Scraper	Rubber	-

A.2. CONSTRUCTION

A.2.1 Mixer - It shall be an electrically driven mechanical mixer of the epicyclic type, which imparts both a planetary and a revolving motion to the mixer paddle. The relative motions of axial and planetary revolutions of the blade should be opposite to each other. The mixer shall have at least two speeds, controlled by positive mechanical means. (Rheostat adjustment of speed shall not be acceptable). The first or slow speed shall revolve the paddle at a rate of 140 ± 5 rev/min, with a planetary motion of approximately 62 rev/min. The second speed shall revolve the paddle at a rate of 285±10 rev/min with a planetary motion of approximately 125 ± 10 rev/min. The mixer shall be capable of adjustment so that when the bowl is in the mixing position the clearance between the lower end of the paddle and the bottom of the bowl shall be approximately 2.5 mm but not less than the approximate diameter of a grain of the standard sand.

A.2.2 Paddle - The paddle shall be readily removable, made of stainless steel or any other equivalent material not attacked by cement, masonry cement, cement-pozzolana mixture or lime-pozzolana mixture and of hardness to prevent being abraded by silica sand, and shall conform to

the basic design shown in Fig A.1(A). The dimensions of the paddle shall be such that when it is in the mixing position the paddle outline conforms to the contour of the bowl used with the mixer, and the clearance between corresponding points on the edge of the paddle and the side of the bowl in the position of closest approach shall be approximately 4 mm but not less than 0.85 mm.



All dimensions in millimetres.
1A Mixing Paddle

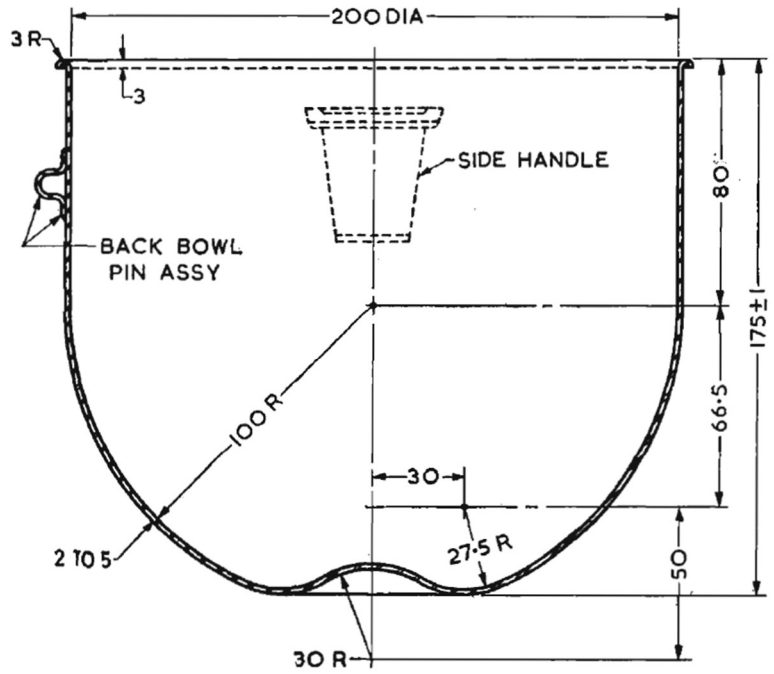


Fig.A.1 Paddle and Mixing Bowl.

A.2.3 Mixing Bowl - The mixing bowl shall be removable and shall have a nominal capacity of 4.75 litres. It shall be of the general shape shown in Fig. A.1(B). It shall comply with the limiting dimensions shown in Fig. A.1(A) and shall be made of stainless steel or any other equivalent material not attacked by cement, masonry cement, cement-pozzolana mixture or lime-pozzolana mixture and of hardness to prevent being abraded by silica sand. The bowl shall be so equipped that it will be positively held in the mixing apparatus in a fixed position during the mixing procedure. It shall be provided with a lid made of non-absorbing material and not attacked by cement, masonry cement, cement-pozzolana mixture or lime-pozzolana mixture.

A.2.4 Scraper – The scraper shall consist of a semi rigid rubber blade attached to a handle about 150 mm long. The blade shall be about 75 mm long and 50 mm wide and tapered to a thin edge about 1.5 mm thick.

ANNEX B

Flow Table and Accessories - Specification

B.1. MATERIALS

B.1.1 Materials for construction of different component parts of flow table apparatus shall be as given in Table B.1.

TABLE B.1 MATERIALS FOR CONSTRUCTION OF DIFFERENT COMPONENT PARTS OF FLOW TABLE

S.No.	Parts	Material	Special Requirements, If any
(1)	(2)	(3)	(4)
i)	Table	Cast brass	Hardness, 25 HRB (220 HV), Min
ii)	Supporting Frame	Cast iron	Not less than grade 20
iii)	Mould	Cast brass	Hardness, 25 HRB (220 HV), Min
iv)	Cam	Mild steel, case-hardened	Cam tip hardness, 50 to 55 HRC (510 to 600 HV)
v)	Cam shaft	Mild steel	-
vi)	Vertical shaft	Mild steel, case-hardened	Wearing surface hardness, 50 to 55 HRC, (510 to 600 HV)
vii)	Base plate	Cast iron or steel	-

B.2. DIMENSIONS

B.2.1 Dimensions with tolerance of different component parts of flow table apparatus shall be as detailed in Fig. B.1. Except where other tolerances are specifically indicated against the dimensions in Fig. B.1, all dimensions shall be taken as nominal dimensions.

NOTE - The allowable deviations for nominal dimensions shall be as laid down for coarse class of deviation in ISO 2768 (PART 1&2).

Table 1 — Permissible deviations for linear dimensions except for broken edges
(external radii and chamfer heights, see table 2)

Values in millimetres

Tolerance class		Permissible deviations for basic size range							
Designation	Description	0,5[1] up to 3	over 3 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 400	over 400 up to 1 000	over 1 000 up to 2 000	over 2 000 up to 4 000
f	fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	+0,5	–
m	medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2
c	coarse	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±4
v	very coarse	–	±0,5	±1	+1,5	+2,5	±4	±6	±8

1) For nominal sizes below 0,5 mm, the deviations shall be indicated adjacent to the relevant nominal size(s).

Table 2 — Permissible deviations for broken edges (external radii and chamfer heights)

Values in millimetres

Tolerance class		Permissible deviations for basic size range		
Designation	Description	0,5[1] up to 3	over 3 up to 6	over 6
f	fine	±0,2	±0,5	±1
m	medium			
c	coarse	±0,4	±1	±2
v	very coarse			

1) For nominal sizes below 0,5 mm, the deviations shall be indicated adjacent to the relevant nominal size(s).

Table 3 — Permissible deviations of angular dimensions

Tolerance class		Permissible deviations for ranges of lengths, in millimetres, of the shorter side of the angle concerned				
Designation	Description	up to 10	over 10 up to 50	over 50 up to 120	over 120 up to 400	over 400
f	fine	±1°	±0°30′	±0°20′	±0°10′	±0°5′
m	medium					
c	coarse	±1°30′	±1°	±0°30′	±0°15′	±0°10′
v	very coarse	±3°	±2°	±1°	±0°30′	±0°20′

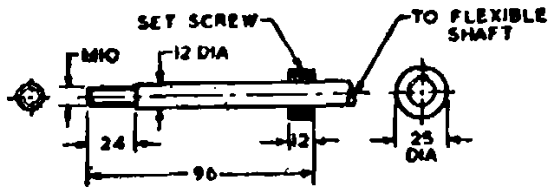
B.3. CONSTRUCTION

B.3.1 Flow Table and Frame - The flow table apparatus shall be constructed in accordance with Fig. B.1A to B.1G. The apparatus shall consist of an integrally cast rigid iron frame and a circular rigid table top 250 ± 2.5 mm.in diameter, with a shaft attached perpendicular to the table top by means of a screw thread. The table top, to which the shaft with its integral contact shoulder is attached, shall be mounted on a frame in such a manner that it can be raised and dropped vertically through 12 mm height with a tolerance in height of ±0.1 mm for new table and ± 0.4 mm for table in use, by means of a rotated cam.

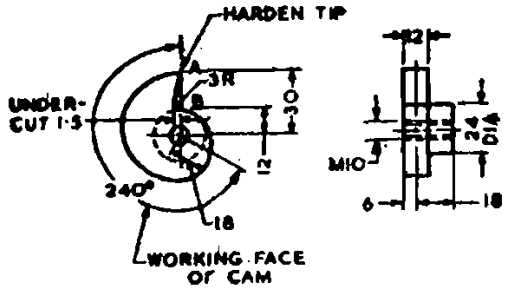
B.3.1.1 Table - The table top shall have a fine machined plane surface free from surface defects, and shall be scribed as shown in Fig. B.1E. The table top shall not vary by more than 0.05 mm

from a true plane surface. The table shall have an edge thickness of 7.5 mm and shall have six integral radial stiffening ribs. The mass of table and attached shaft shall be 4.00 ± 0.05 kg and shall be symmetrical around the centre of the shaft.

B.3.1.2 Cam and Vertical Shaft - The wearing surfaces of cam tip and vertical shaft shall be case hardened, where indicated in Fig. B.1B and B.1C. The shaft shall be straight and the difference between the diameter of the shaft and the diameter of the bore of the frame shall not be less than 0.05 mm and not more than 0.075 mm for new tables and shall be maintained at value from 0.05 to 0.125 mm for tables in use. The end of the shaft shall not fall upon the cam at the end of the drop, but shall make contact with the cam not less than 120^0 from the point of drop. The face of the cam shall be a smooth spiraled curve of uniformly increasing radius from 12 to 30 mm in 360^0 -and there shall be no appreciable jar as the shaft comes into contact with the cam. The cam shall be recovered and the contact faces of the cam and the shaft shall be such that the table does not rotate more than one revolution in 25 drops. The surfaces of the frame and of the table which comes into contact at the end of the drop shall be maintained smooth, plane and horizontal, and parallel with the upper surface of the table and shall make continuous contact over a full 360^0 rotation.

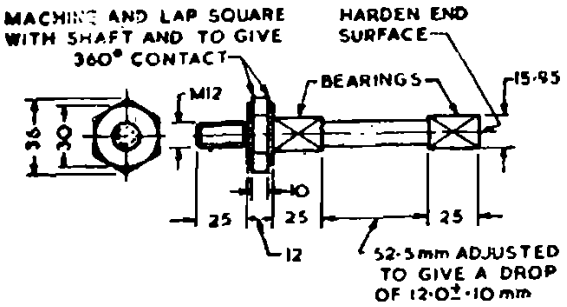


IA CAM SHAFT

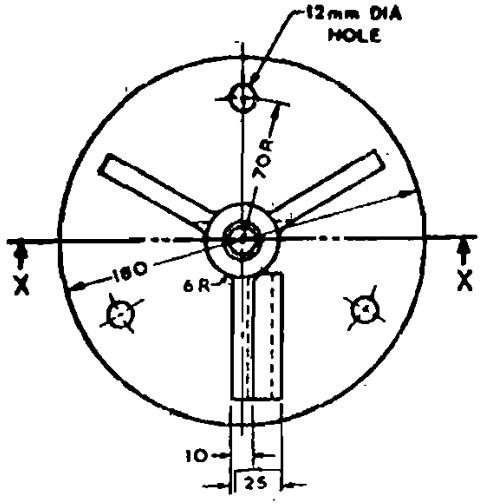


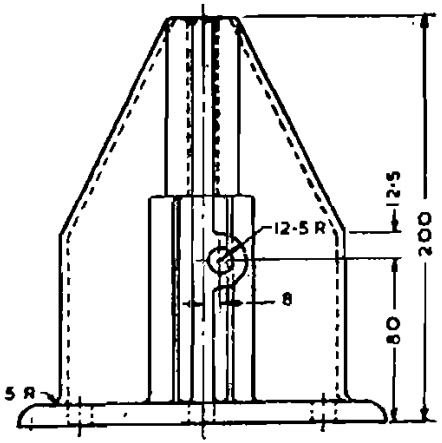
NOTE—CURVE FROM B TO A TO BE A SMOOTH SPIRAL OF UNIFORMLY INCREASING RADIUS FROM 12 mm TO 30 mm IN 360°

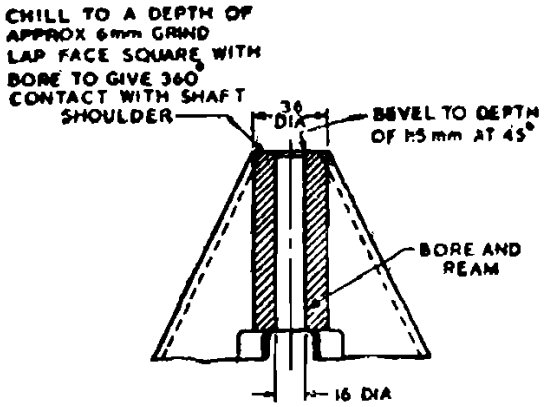
IB CAM



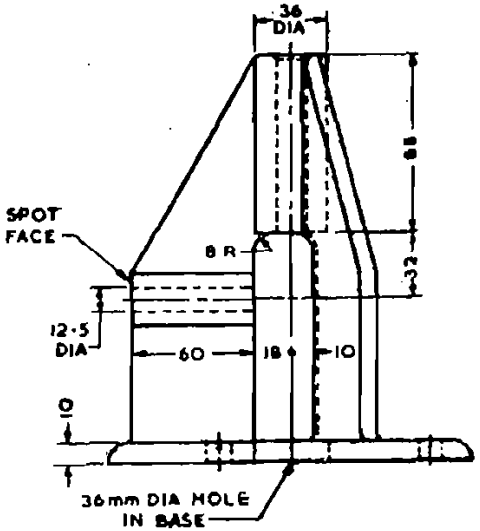
IC VERTICAL SHAFT





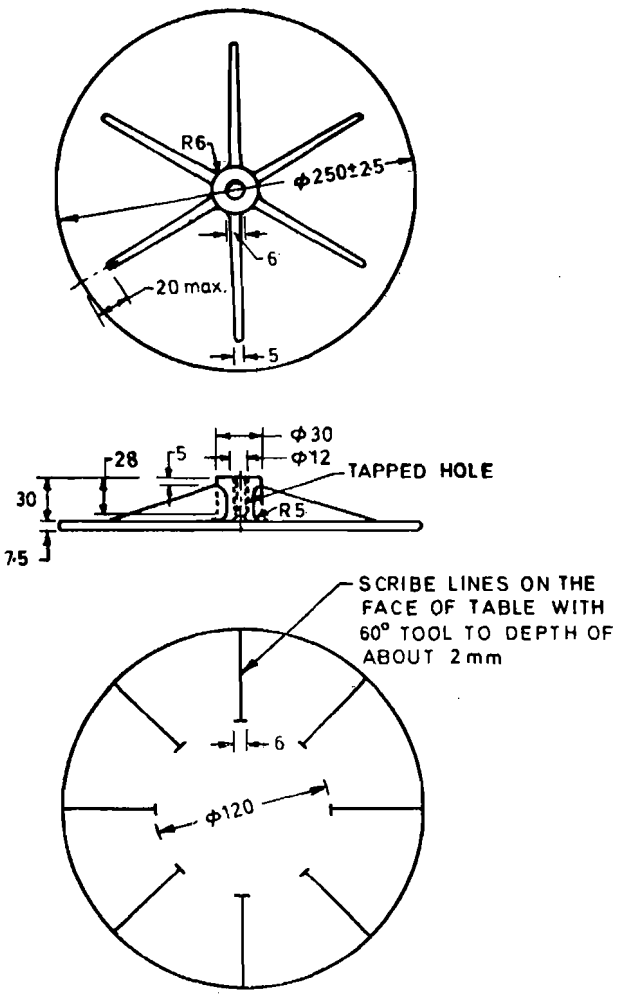


SECTION XX



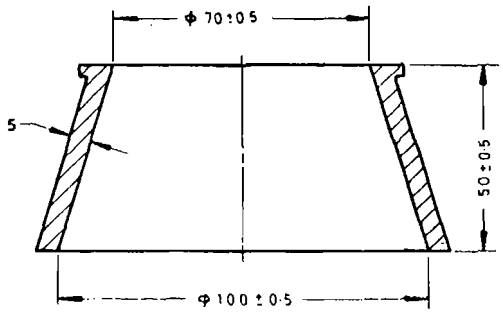
ID SUPPORTING FRAME

All dimensions in millimetres.

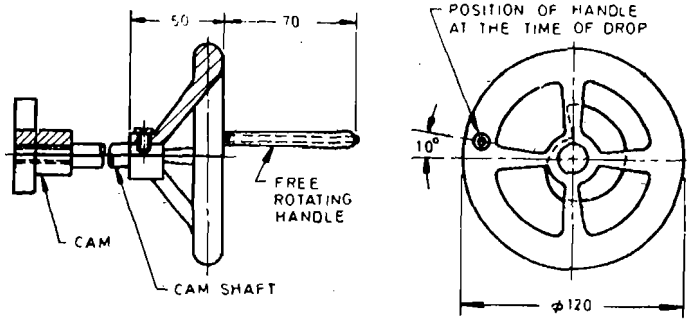


1E TABLE TOP

All dimensions in millimetres.



IF MOULD



IG DETAILS OF MANUAL DRIVE

All dimensions in millimetres.

FIG. B.1 FLOW TABLE AND ACCESSORY APPARATUS

B.3.1.2.1 The cam shall be screwed on to the cam-shaft and additionally secured in position with a suitable taper-pin.

B.3.1.3 Supporting Frame - The frame casting shall have three integral stiffening ribs extending the full height of the frame and located 120° apart. The top of the frame shall he chilled to a depth of approximately 6 mm and the face ground and lapped square with the bore and to give 360^0 contact with the shaft shoulder. The underside of the base of the frame shall be ground to secure a complete contact with the steel plate beneath.

B.3.1.4 Drive - The flow table may be operated either manually by a hand wheel mounted on the cam shaft or by a motor connected to the cam shaft through an enclosed worm gear speed reducer and flexible coup ling (*see* Fig B.1G). The speed of the cam shaft shall be approximately 100 rev/min. The motor driven mechanism, where provided, shall not be fastened or mounted on the table base plate or frame.

NOTE 1 - A 40 W motor has been found suitable for a power driven flow table.

NOTE 2 - If required by the purchaser, for motor-driven equipment a suitable counter for recording the number of drops may be provided; a suitable device for switching off the motor after a specified number of drops may also be provided.

B.3.2 FLOW TABLE MOUNTING

B.3.2.1 The flow table frame shall be securely bolted to a cast iron or steel plate at least 25 mm thick and 250 mm square. The top surface of this plate shall be machined to a smooth plane surface. The plate shall be anchored to the top of a concrete pedestal by four 12 mm bolts passing through the plate and embedded at least 150 mm in the pedestal. Positive contact at all points between the plate and the pedestal shall be ensured, preferably by casting the pedestal inverted on the plate. No nuts or other levelling devices shall be used between the plate and the pedestal. Levelling shall be affected by suitable means under the base of the pedestal.

B.3.2.2 The concrete pedestal shall weigh not less than 200 kg. A stable gasket cork pad, 12 mm thick and approximately 100 mm square, shall be inserted under each corner of the pedestal. The

flow table shall be checked frequently to ensure that the table top is level, that the pedestal is stable, and that the nuts and bolts in the table base and pedestal plate are tight.

NOTE - A torque of 27 Nm is recommended when tightening the fastenings.

B.3.2.3 The table top, after the frame has been mounted on the pedestal, shall be level along two diameters at right angles to each other, in both the raised and lowered positions.

B.3.3 Accessory Apparatus

B.3.3.1 Mould **-** The surfaces of the base and top of the mould for casting the flow specimens shall be parallel and at right angles to the vertical axis of the cone.

B.3.3.1.1 The mould shall have a minimum wall thickness of 5 mm. The outside of the top edge of the mould shall be shaped so as to provide an integral collar for convenient lifting of the mould. All surfaces shall be machined to a smooth finish. A circular shield, approximately 250 mm in diameter, with a centre opening approximately 100 mm in diameter, made of non-absorbing material not attacked by the cement, shall be used with the flow mould to prevent mortar from spilling on the table top.

B.3.3.2 A suitable firm joint outside caliper shall be provided for measuring the diameter of the mortar after it has been spread by the operation of the table.

B.3.3.3 A tamping bar of steel, 12.5 mm in diameter and 125 to 150 mm long with a rounded working end shall be provided.