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NEPAL STANDARD

METHOD OF PHYSICAL TEST FOR HYDRAULIC CEMENT

PART 8 DETERMINATION OF TRANSVERSE AND COMPRESSIVE STRENGTH OF PLASTIC MORTAR USING PRISM

Government of Nepal

Ministry of Industry, Commerce and Supplies

Nepal Bureau of Standards and Metrology (NBSM)

Kathmandu, Nepal

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1. SCOPE

1.1 This standard (Part 8) covers the procedure for determining the transverse and compressive strength of plastic mortar using prism.

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±2°C. The relative humidity of the laboratory shall be 65±5 percent.

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

4. APPARATUS

4.1 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 or a non-automatic indicating scale a definite amount at any load.

Note 2 – Self indicating balance with equivalent accuracy may also be used.

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

4.3 Planetary Mixer - Planetary mixer conforming to NS 123 (Part 7).

4.4 Moulds - Moulds conforming to Annex A.

4.5 Jolting Apparatus - Jolting apparatus conforming to Annex A.

4.6 Scraper - The scraper shall consist of a semi rigid rubber blade attached to a handle about 150 mm long. The blade shall be about 150 mm long, 50 mm wide and tapered to a thin edge about 2 mm thick.

TABLE 1 PERMISSIBLE VARIATION ON WEIGHTS
(Clause 4.3)

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

4.7 Demoulding Device - Demoulding device as shown in Fig. 1.

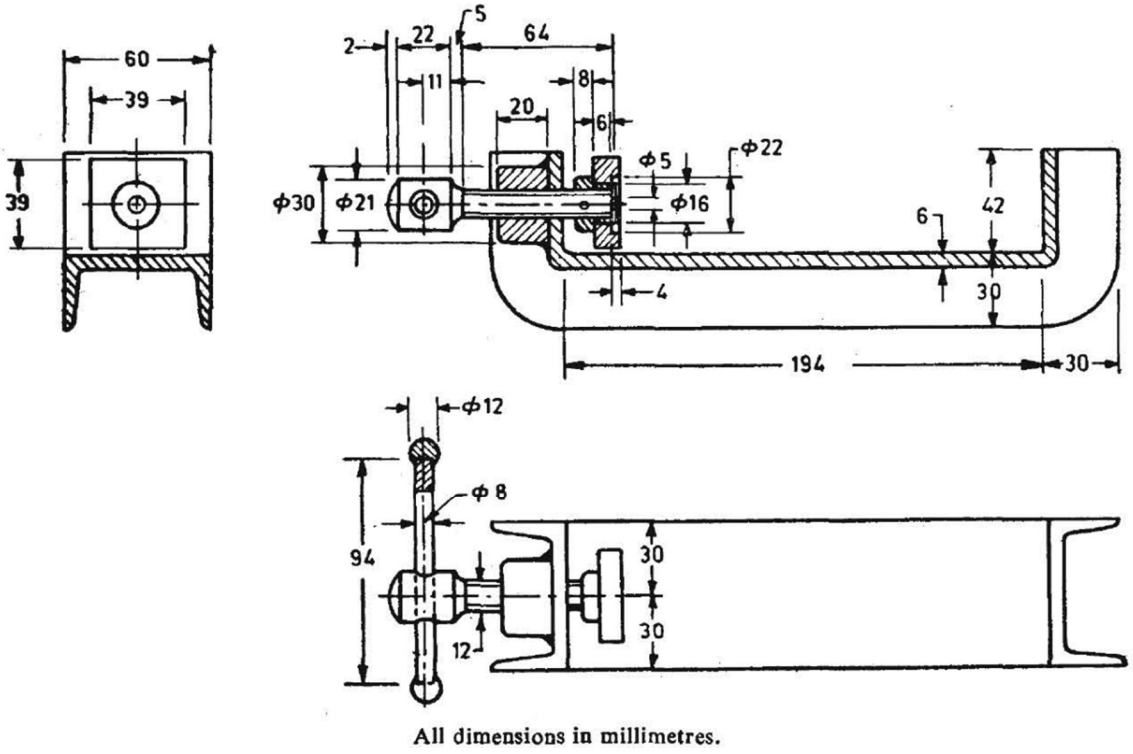


Fig 1. Apparatus for demoulding specimens

5. COMPOSITION OF MORTAR

5.1 The proportions by mass shall be one part of the cement under test, three parts of perfectly dry standard sand and 1/2 part of water (water cement ratio =0.50). The standard sand shall conform to NS 51: 2082. Potable/distilled water shall be used in the test.

6. PREPARATION OF MORTAR

6.1 Each mix shall be sufficient for three test specimens, that is, 450 g of cement, 1350 g of sand and 225 g of water. Since the three sand fractions are usually of equal mass, 450 g amounts are weighed successively for the cement and for each of the coarse, medium and fine sand fractions. Mixing shall be done mechanically by means of the mixer specified in **4.3**.

6.1.1 Mixing Operation - The mixture being in the operation position, the water shall be poured into the bowl and the cement added. The mixer shall be started at low speed 140± 5 rev/min and after 30 s, the fine, medium and coarse sand fractions in that order shall be added steadily during

the next 30 s. The mixer shall be switched to medium speed (285±10 rev/min) and mixing continued for an additional 30 s.

The mixer shall then be stopped for 1 min 30 s. During the first 15 s, all the mortar adhering to the wall of the bowl shall be removed by means of a rubber scraper and thrown into the middle of the bowl. The bowl shall be covered during the remaining 1 min 15 s. Mixing shall then be continued at medium speed (285±10 rev/min) for one minute.

7. PREPARATION AND CURING OF TEST SPECIMENS

7.1 Moulding of Test Specimens

7.1.1 The specimens shall be made in a laboratory of which the temperature shall be 27±2°C and the relative humidity shall be 65±5 percent. The moulds and all accessories shall be at this specified temperature. The moulds shall be lightly oiled inside and their external joints sealed (using, for example, a mixture of 3 parts of paraffin wax to 1 part of rosin). The mould and its hopper being fixed on the jolting table, the first layer of mortar of about 320 g shall be introduced directly from the mixer into each of the mould compartments (that is, by using a spoon of a known capacity). This layer shall be spread by means of steel plate levelling tool which is drawn twice forward and backward along the mould while processing its flanges against the top of the hopper. Sixty jolts shall be given to the first mortar layer in 60 s.

A second identical layer of mortar is then introduced, levelled and compacted as previously. The mould shall then be lifted from the jolting table and its hopper removed. The excess mortar shall be struck off with a metal straight edge held nearly vertical and moved slowly along the length of the mould with a transverse sawing motion. The surface shall subsequently be lightly smoothed, using the same straight edge held almost flat.

7.1.2 Marks identifying the specimens shall be made on the moulds.

7.2 Curing of Test Specimens

7.2.1 In order to prevent evaporation of water, the moulds shall be covered by a steel or rubber sheet and placed until demoulding in a moist room or cabinet which shall be at a temperature of 27 ± 2°C and a relative humidity of not less than 90 percent.

7.2.2 In the case of tests at 24 h, demoulding shall be carried out 15 to 20 min before the test is due. For tests at other ages, the demoulding shall be carried out between 20 and 24 h after moulding. If the mortar has not acquired sufficient strength after 24 h to be handled without danger of deterioration, demoulding may be delayed by 24 h, but the fact shall be mentioned in the test report. Demoulding shall be done with due precautions using the demoulding device. Each demoulded test specimen shall be weighed and marked on its bottom surface. This weight is a check on the procedure.

7.2.3 After demoulding, the specimens shall be cured at 27±2°C by immersing in water, until the time for testing. Vertical faces as cast shall remain vertical during storage. The specimens shall be kept apart from each other, allowing free access of water to all their faces. It is convenient to replace the water every 14 days. The specimens shall be taken from the water less than 15 min before test. In order to satisfy this condition, they shall he transported to the test machine in a container full of water. They shall then be wiped with a clean cloth. So that any deposit that might have accumulated on them is removed.

8. TESTING

8.1 Bending Strength - The apparatus for bending strength tests shall consist of two supports in the form of rollers of 10 mm dia. and spaced 100 or 106.7 mm apart, on which the test prism is placed on a side face and of a third roller of the same diameter, equidistant from the first two and transmitting the load P to the opposite side face of the prism. Two of the rollers should be free to rock about their centres in order to permit uniform distribution of loads over the specimen. The prism and rollers shall be placed in electrically operated testing machine which is capable of applying and measuring small loads (less than 10 kN) with an accuracy of 1 percent in the upper 4/5 of its range. The applied load P shall be increased progressively at the rate of 50±10 N/s. The breaking stress R, in N/mm^2 is 0.00234 P or 0.00254 P, P in N, depending on whether the distance between supports is 100 or 106.7 mm. This follows from the formula:

$$R = \frac{6\,M}{b^3}$$

where M = bending moment. and

b = side of the square cross-section of the prism.

8.2 Compressive Strength - After the bending strength tests, the half prisms shall be kept moist until the compressive strength tests are made. Each prism shall be tested for compressive strength on its side faces of which an area 40 x 40 mm shall be placed between two hard metal plates. These shall be at least 10 mm thick, 40.0±0.1 mm wide, more than 40 mm long and their surfaces shall be plane to within 0.02 mm. The plates shall preferably be of tungsten carbide or of steel, with a Vickers hardness index of at least 600 (HV 600). During the test, the plate shall be guided without friction in such a way that the upper is maintained vertically above the lower. One of the plates may be slightly inclined to permit perfect contact between it and the face of the test specimen. A typical jig used for compressive strength test is shown in Fig. 2.

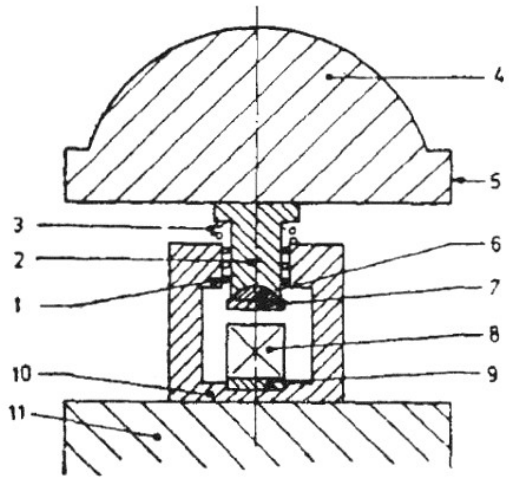
The plates, test specimen and suitable guides shall be placed in a compression machine, the upper platten of which shall be mounted on a freely moving ball seating centered on the axis of compression. The side or diameter of this platten shall be not larger than 100 mm on account of the small size of the test specimens. The machine shall have an accuracy of 1 ± 1 to 1.5 percent of the smallest loads used in the tests.

8.2.1 The load shall be increased at the rate of N/mm^2 per second up to about half the expected crushing load, a higher rate may be used, however, the duration of the test shall not be less than 10 s.

9. CALCULATIONS

9.1 Flexural and compressive strength shall be expressed in N/mm^2 and shall be determined on at least 3 prisms for each age. It is advisable, as far as possible, to avoid having at each age more than two prisms from the same batch of mortar.

9.2 The test report shall give all the results but the arithmetic means from 3 bending strength tests and from 6 compressive strength test. At each age shall be taken as the bending and compressive strengths of the mortar.



Key

1. Ball bearings
2. Sliding assembly
3. Return spring
4. Spherical seating of machine
5. Upper platen of machine
6. Spherical seating of the jig
7. Upper platen of the jig
8. Specimen
9. Lower plate
10. Lower platen of the jig
11. Lower platen of machine

Fig 2. Typical Jig for the compressive strength test

ANNEX A

JOLTING APPARATUS - SPECIFICATION

A.1. MATERIALS

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

TABLE A1 MATERIALS FOR CONSTRUCTION OF DIFFERENT COMPONENTS OF JOLTING APPARATUS

S.No.	Parts	Material	Special Requirements, If any
(1)	(2)	(3)	(4)
i)	Table	Mild steel	-
ii)	Supporting Frame	Aluminium	-
iii)	Spindle	Mild steel	Striking Face
iv)	Projecting lug	Do	Hardened to not less than 650 VH or equivalent
v)	Stop	Do	Wearing face hardened to not less than 650 VH or equivalent
vi)	Cam	Do	Hardened to not less than 650 VH or equivalent
vii)	Stand	Cast iron	Smooth surface
viii)	Bracket	Do	Smooth surface
ix)	Mould	Mild steel	

A.2. DIMENSIONS

A.2.1 The dimensions of the jolting apparatus with mould shall be generally as given in **Fig.A.1 and A.2.** Where tolerances for dimensions are not specifically mentioned dimensions shall be considered nominal.

Note – Allowable deviation for nominal dimensions shall be as laid down for coarse class of deviation in **Annex B.**

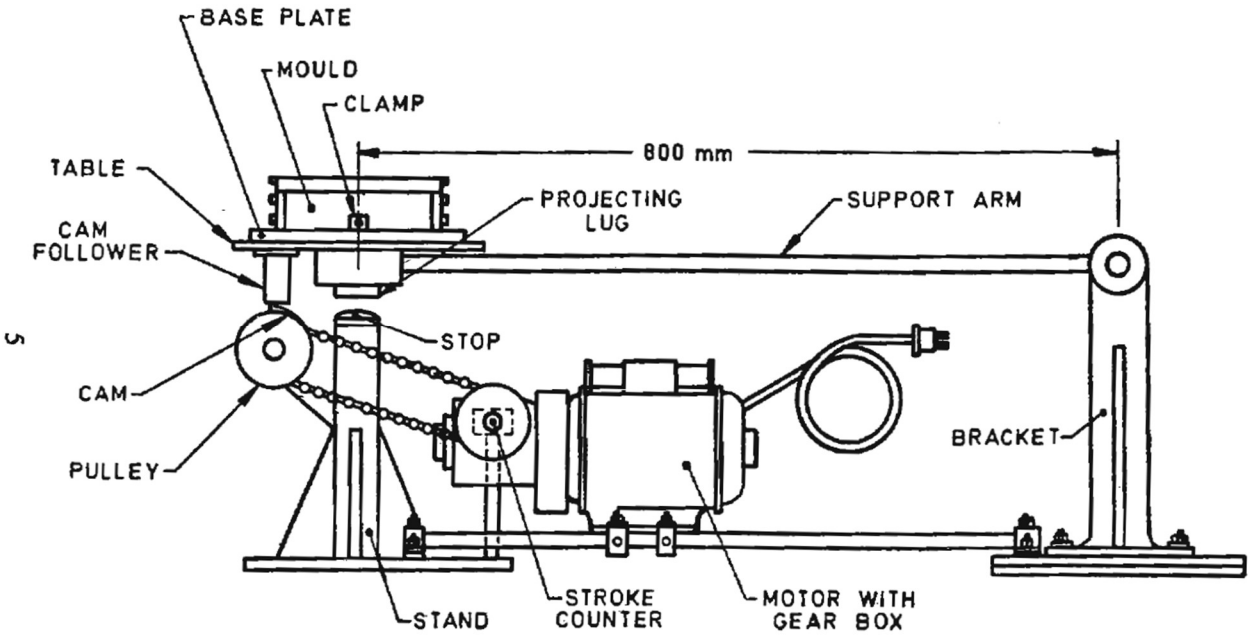
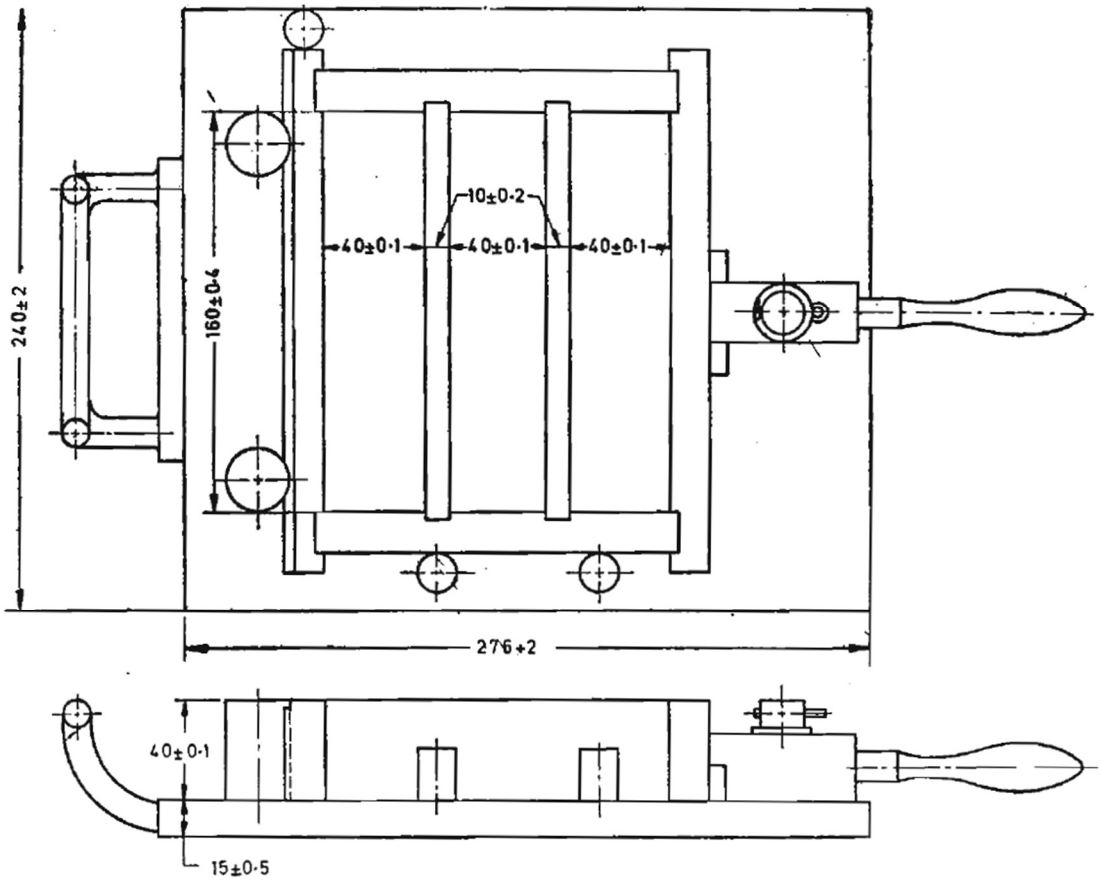


Fig.A.1 Typical jolting Machine



All dimensions in millimetres.

Fig A.2. Typical Mould 40 x 40 x 160 mm size

A.3. CONSTRUCTION

A.3.1 Jolting apparatus shall be constructed as shown in Fig. A.1 and shall consist of a table which is raised and allowed to fall through a height of 15 ± 0.1 mm for new apparatus and 150.4 mm for the apparatus in use by the rotation of a ram.

A.3.1.1 Table - The table shall be machined and shall have on the underside a projecting lug with plane face hardened. At the end, a cam follower shall be fixed. Guide pieces as shown in Fig. 1 shall be provided so that the centre of the central compartment of the mould is directly above the points of percussion. It shall be provided with an arrangement to rigidly fix the mould. The table shall be rigidly fixed to the supporting arms.

NOTE - The combined mass of the table together with mould, hopper and clamps shall be 20±1 kg.

A.3.1.2 Supporting Arms - The supporting arms carrying the table shall be fixed to a spindle mounted on a bracket. The mass of the supporting arms shall be 1.0±0.3 kg.

A.3.1.3 Stand - The stand shall carry a stop having a rounded upper surface, and shall be positioned in such a way that the stop is right beneath the projecting lug of the table. When the projecting lug rests on the stop, its plane face and that of the table shall be horizontal. The common normal through the point of contact of the lug and stop shall be vertical; the lug striking face and the stop shall be replaced as soon as this condition is no longer met.

A.3.1.4 Cam - The cam shall be mounted on the stand as shown in Fig. 1. When the cam is rotated, it shall operate the cam follower raising the table and allowing it to drop. The cam shall be driven at a speed of 60 ± 1 rpm.

A.3.1.5 Drive - The cam shall be driven by means of an electric motor and a reduction gear. Electric motor of 1/3 hp is found suitable. recommended that a device be provided which stops the drive automatically after 60 jolts.

A.3.1.6 Bracket - The bracket shall be fixed to a mild steel plate having holes for bolting down to a concrete base. The bracket shall be rigidly connected to a stand with two arms.

A.3.2 Mould (see Fig. A.2) - The dimensions of the mould with tolerances shall be as specified in Table 2. The general requirements of construction of the mould shall be as laid down in NS***.

A.3.2.1 The mould shall embody three compartments and shall rest on a machined steel base plate to which it shall be clamped securely. The mould shall be surmounted by a hopper made of steel or a non-ferrous metal with vertical walls of 20 mm to 40 mm height. Viewed in plan, the interior vertical surfaces of the hopper shall be within those of the compartment by a distance not exceeding 1 mm. The mass of the mould together with hopper and base shall be 13±10.25 kg.

A.4. JOLTING APPARATUS MOUNTING

A.4.1 The apparatus shall be fixed on a concrete base 1 m long, 30 cm wide and 80 cm high. The base plates of the stand carrying the cam and bracket about which the table rotates shall each be fixed to the concrete base by means of four anchor bolts, and when fixing them a thin layer of rich mortar should be placed between the base plates and the concrete base in order to ensure perfect contact.

A.4.2 To reduce the noise, the concrete base shall be placed on four rubber pads of 100 x 100 x 10 mm size.

Annex B

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′