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ISO

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ISO RECOMMENDATION
R 679

METHOD OF TESTING STRENGTH OF CEMENTS

COMPRESSIVE AND FLEXURAL STRENGTHS OF PLASTIC MORTAR (RILEM-CEMBUREAU METHOD)

1st EDITION
March 1968

For each individual country the only valid standard is the national standard of that country.

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BRIEF HISTORY

The ISO Recommendation R 679, *Method of testing strength of cements – Compressive and flexural strengths of plastic mortar (Rilem-Cembureau method)*, was drawn up by Technical Committee ISO/TC 74, *Hydraulic binders*, the Secretariat of which is held by the Institut Belge de Normalisation (IBN).

Work on this question by the Technical Committee began in 1952 and led, in 1964, to the adoption of a Draft ISO Recommendation.

In January 1965, the Draft ISO Recommendation (No. 772) was circulated to all the ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Argentina	Ireland	Romania
Austria	Israel	Sweden
Belgium	Italy	Turkey
Czechoslovakia	Japan	U.A.R.
Denmark	Korea, Rep. of	United Kingdom
France	Netherlands	U.S.S.R.
Germany	Norway	Yugoslavia
Hungary	Poland	
India	Portugal	

Two Member Bodies opposed the approval of the Draft :

New Zealand
U.S.A.

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council which decided, in March 1968, to accept it as an ISO RECOMMENDATION.

ISO Recommendation R 679 March 1968

METHOD OF TESTING STRENGTH OF CEMENTS

COMPRESSIVE AND FLEXURAL STRENGTHS OF PLASTIC MORTAR

(RILEM-CEMBUREAU METHOD)

1. SCOPE

This ISO Recommendation describes the *Rilem-Cembureau* method of testing the compressive and flexural strength of plastic mortar.

2. PREPARATION OF MORTAR

2.1 Standard sand

The standard sand should be a natural, rounded, siliceous sand (with the maximum possible amount of quartz, particularly in its fine fraction). The Belgian standard sand* should be the standard reference sand.

The sand should be subdivided into three fractions : fine, medium and coarse, separated by 0.5 mm and 1 mm sieves.

The particle size distribution of the coarse, medium and fine fractions should be such that by mixing equal masses of the fractions, a sand grading is obtained which falls within the limits defined by Table 1.

If the available sands make it necessary, any other subdivision into fractions is permissible provided that the combined grading complies with the limits given in Table 1. However, sand fractions having too wide a range of particle sizes should be avoided as they may cause segregation of the mixed materials.

Each country should use those of its own current standard sieves whose aperture sizes are nearest to the six apertures specified in Table 1.

TABLE 1

Sieve aperture Square mesh mm	Cumulative retained %	Sand fraction
0.08 0.15	98 ± 2 88 ± 5	fine
0.50	67 ± 5	medium
1.00 1.70 2.00	33 ± 5 5 ± 5 0	coarse

* As defined in the Belgian Standard NBN 715 – *Standard sand.*

The sieve analysis of the sand should be made on a representative 100 g sample. Both the sand and the test sieves should be perfectly dry. Sieving should be continued until the amount of sand passing through each sieve is less than 0.5 g per minute.

The results obtained should be reported in the form of a curve, such as that shown in Figure 1, the aperture sizes of the sieves used being plotted on the x-axis to a logarithmic scale.

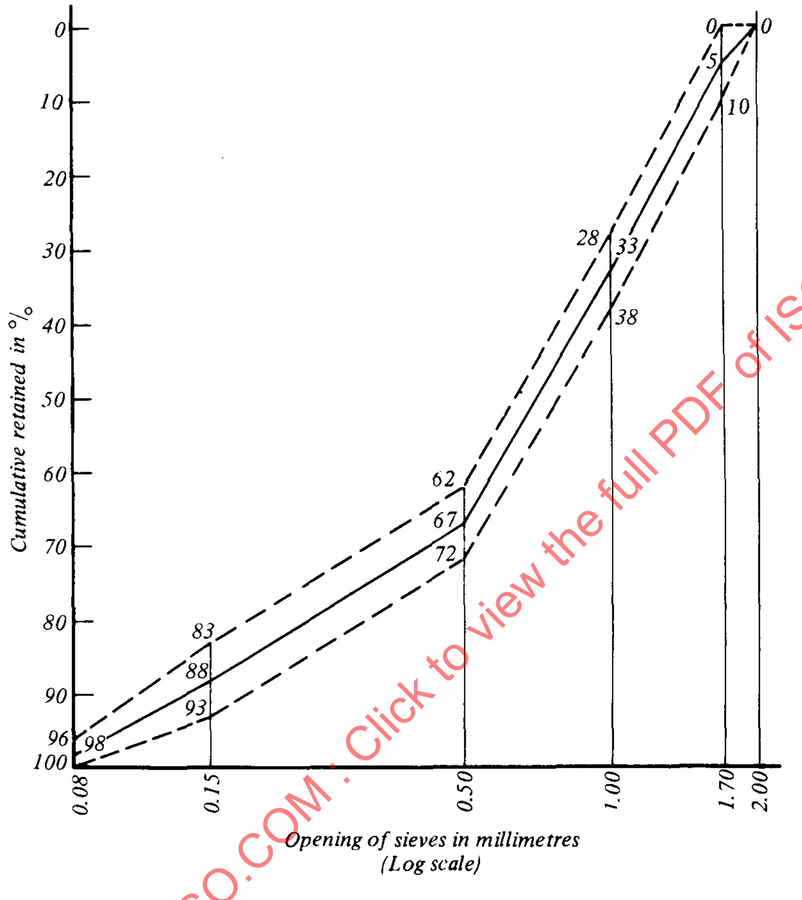

FIG. 1 – **Standard sand – Particle size distribution**

2.2 Composition of mortar

The proportions by mass should be one part of the cement under test, three parts of perfectly dry standard sand and one-half part drinking water (water/cement ratio = 0.50).

2.3 Preparation of mortar

Each batch should be sufficient for three test specimens, i.e. 450 g of cement, 1350 g of sand and 225 g of water. If the sand is subdivided into three equal parts, weigh in succession 450 g of the cement and 450 g of each of the coarse, medium and fine sand fractions. Weighing should be carried out by means of a balance accurate to ± 0.5 %. Mixing should be done mechanically by means of the mixer shown in Figure 2. For the preparation of the mortar, the cement, sand, water, gauging room and apparatus should be at a temperature of 20 ± 2 °C. The relative humidity of the air in the gauging room should be not less than 65 %.

2.3.1 *Mixer.* The electrically-driven mixer should consist essentially of

– a stainless steel mixing bowl with a capacity of about 4.7 litres and of the shape and dimensions shown in Figure 2, and provided with means by which it can be securely fixed to the mixer frame during mixing;

– a mixer blade of the form and dimensions shown in Figure 2, revolving about its axis as it is driven in a planetary movement around the bowl by an electric motor at controlled speeds. The two directions of rotation should be opposite and the ratio between the two speeds should not be a whole number.

Dimensions in millimetres

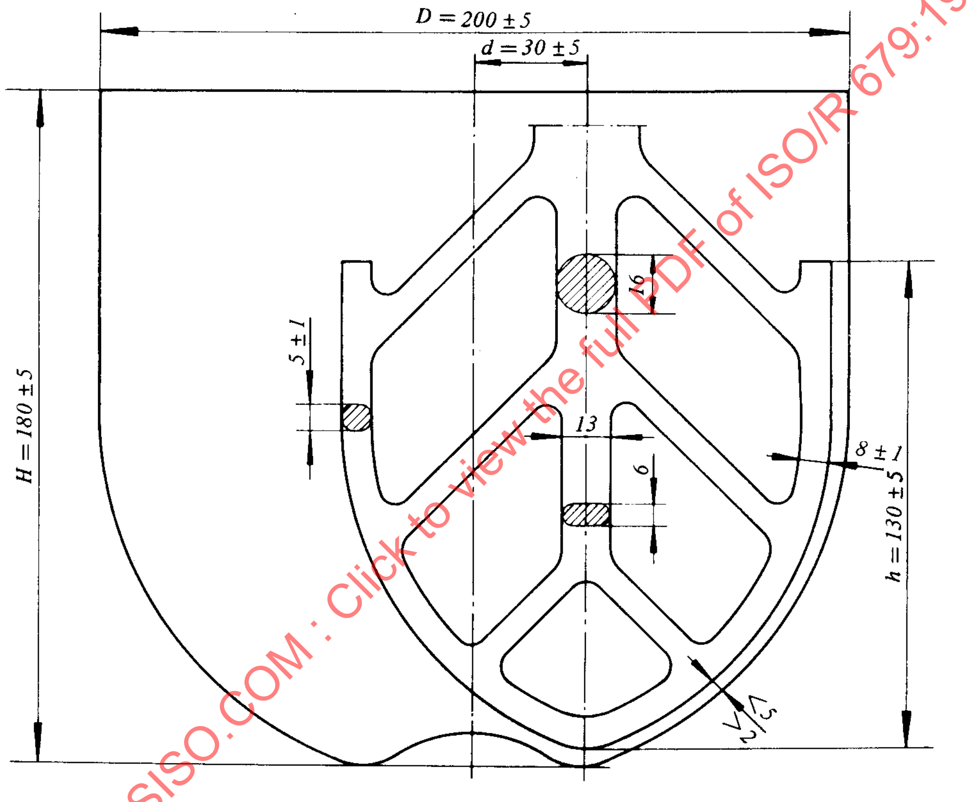

FIG. 2 – **Type of mortar mixer**

The following speeds should be observed during mixing.

TABLE 2

	Mixer blade revolutions per minute	Planetary movement revolutions per minute
Low speed	140 ± 5	62 ± 5
High speed	285 ± 10	125 ± 10

2.3.2 *Mixing*. With the mixer in the operating position

– pour the water into the bowl and add the cement;

– start the mixer at the low speed and, after 30 seconds, add steadily during the next 30 seconds, the fine, medium and coarse sand fractions – in that order if they are separated. Switch the mixer to the higher speed and continue the mixing for an additional 30 seconds.

stop the mixer for 1 minute 30 seconds. During the first 15 seconds, remove by means of a rubber scraper all the mortar adhering to the wall of the bowl and place in the middle of the bowl. Cover the bowl during the remaining 1 minute 15 seconds;

– continue the mixing at the higher speed for 1 minute.

3. PREPARATION AND CONSERVATION OF TEST SPECIMENS

3.1 Description of test specimens

The test specimens should be prisms, 40 mm × 40 mm × 160 mm in dimensions.

3.2 Moulds

Moulds should be made from hard steel (minimum recommended Vickers hardness : 400), and should consist of three compartments to enable three specimens to be prepared simultaneously. A typical design is illustrated in Figure 3.

Their internal dimensions, in millimetres, should be the following :

length : 160 ± 0.4

width : 40 ± 0.1

height : 40 ± 0.1

The mould walls should be at least 10 mm thick; the two internal opposite ("side") faces of 40 mm × 160 mm should be plane to within 0.01 mm; the angle between them and the base of the mould should be 90 ± 0.5 °.

Moulds should be replaced when their dimensions and form differ from the specified mean by twice the permitted tolerance in any respect.

The mould should rest on a machined steel base plate to which it should be securely clamped.

The mould should be surmounted by a metal hopper with vertical walls 20 to 40 mm in height. When viewed in plan these walls should not overlap the internal walls of the mould by more than 1 mm.

Dimensions in millimetres

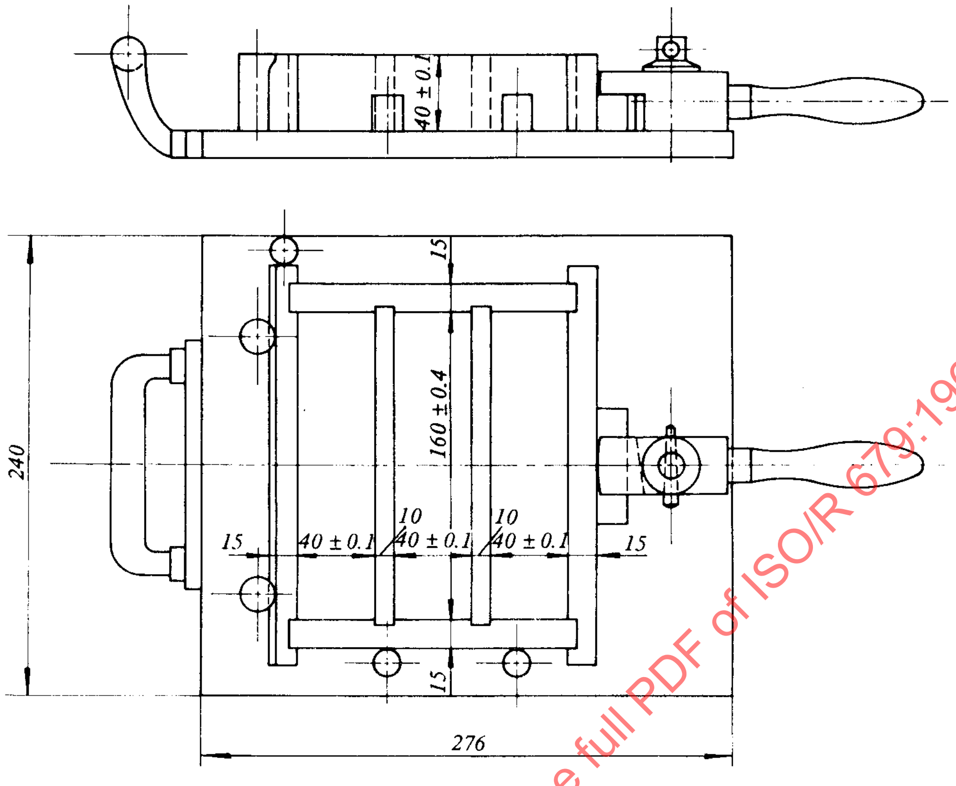

FIG. 3 – **Type of mould for three prisms**

3.3 Moulding of test specimens

Immediately after the preparation of the mortar the specimens should be moulded mechanically by means of a jolting apparatus as described below.

3.3.1 *Jolting apparatus.* The jolting apparatus should conform to the following requirements :

(1) The apparatus consists essentially of a rectangular table rigidly connected by two light arms to a spindle at a horizontal distance of 80 cm from the centre of the table. The mass of the arms holding the table should be 1 ± 0.3 kg. The table should incorporate on its lower face a projecting lug with a plane face, beneath which is a small stop with a rounded upper surface. When the projecting lug rests on the stop its plane face and that of the table should be horizontal.

(2) By means of a cam made of hard steel (Vickers hardness = 400) or of case-hardened steel, the table should be raised and then allowed to fall freely from a height of 15 mm before the lug strikes the stop.

(3) By means of an electric motor of about 250 W and a reduction gear, the cam should be driven at a speed of one revolution per second. It is recommended that the motor be provided with a device which automatically stops it after sixty jolts.

(4) The mould should be placed on the table in such a way that the length of the compartments is perpendicular to the axis of rotation of the cam. The mould should be located on the table with the aid of suitable reference marks so that the centre of the central compartment be directly above the point of impact. The mould surmounted by its hopper should be clamped rigidly to the table, e.g. by means of wing nuts.

(5) The combined mass of the table, mould, hopper and clamps should be 20 ± 1 kg.

(6) The apparatus should be fixed on a concrete base 1 m long, 30 cm wide and 80 cm high. The base plates of the two frames carrying the cam and the spindle about which the table rotates should 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.

(7) To reduce noise, the concrete base should be placed on four rubber pads 10 × 10 cm and 1 cm thick. The table should be horizontal when at rest, and the common normal through the point of contact of the lug and stop should be vertical. The lug striking face and the stop should be replaced as soon as the above condition is no longer satisfied. Ball bearings should be employed for the spindles about which the table and the cam rotate. If plain bearings are used, the play of the spindles in them should not exceed 0.1 mm.

Figure 4 shows a typical design of jolting apparatus.

Dimensions in millimetres

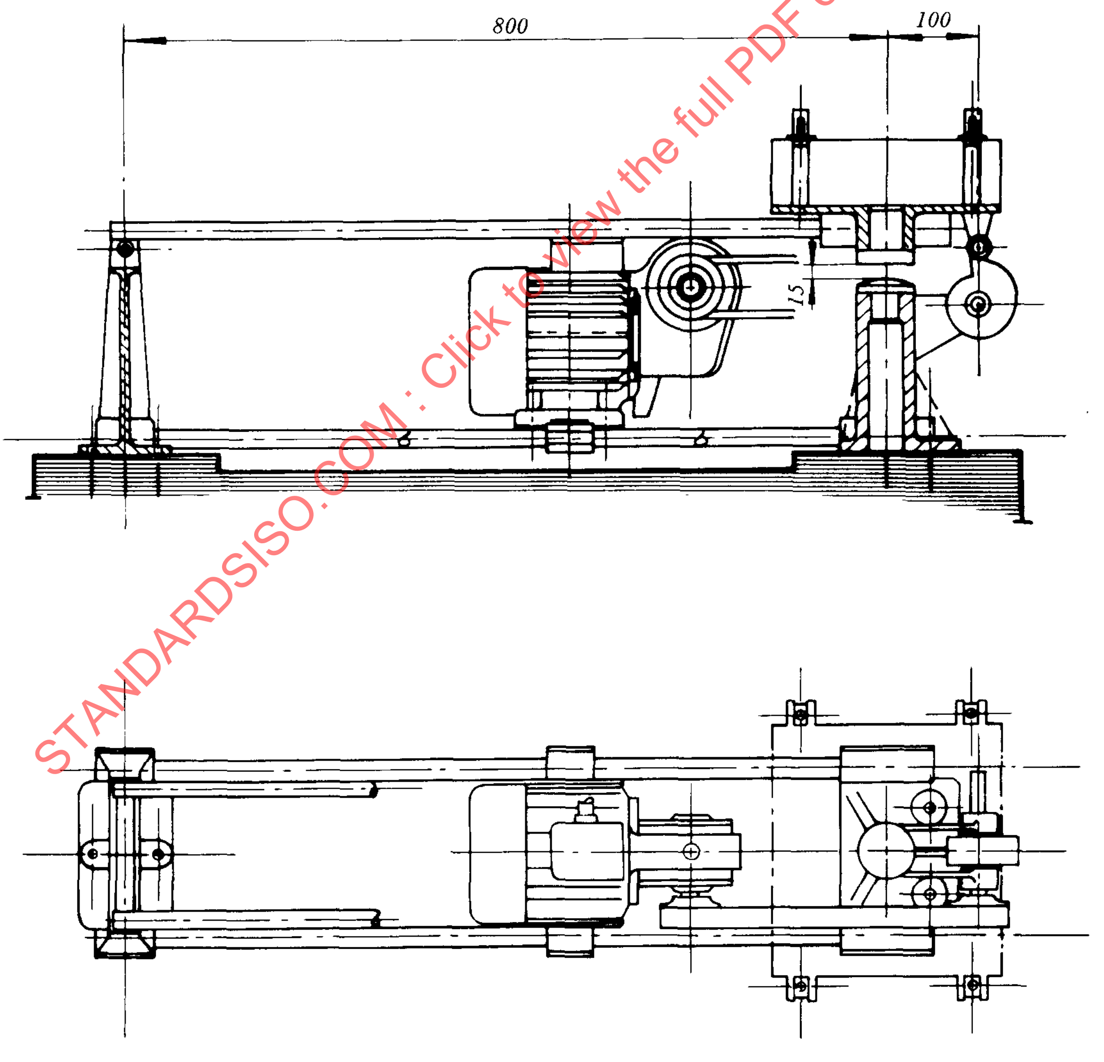

FIG. 4 – **Type of jolting apparatus**

3.3.2 *Moulding the test specimens.* Oil the moulds lightly inside and seal their external joints (using for example a mixture of three parts of paraffin wax to one part rosin (colophony)).

The mould and its hopper being fixed on the jolting table, introduce the first layer of mortar of about 320 g directly from the mixer into each of the mould compartments (e.g. by using a spoon of a known capacity). Spread this layer by means of a spatula of flat steel tool which is drawn twice forwards and backwards along the mould while pressing its edges against the top of the hopper. Give sixty jolts to the first mortar layer in 60 seconds. Then introduce a second identical layer of mortar levelled and trans-compacted as previously.

Lift the mould from the jolting table and remove its hopper. Strike off the excess mortar with a metal straight edge held nearly vertically and moved slowly along the length of the mould with a transverse sawing motion.

Then smooth the surface lightly using the same straight edge held almost flat.

Make marks identifying the specimens on the moulds.

3.4 Conservation of test specimens

Cover the moulds (e.g. by a steel or rubber sheet) in order to prevent evaporation of water and place until demoulding in a storing room or cabinet which should be maintained at a temperature of 20 ± 1 °C and a relative humidity of not less than 90 %.

For tests on 24 hours old samples, demoulding should be carried out 15 to 20 minutes before the test is due.

For tests on samples other than 24 hours old, the demoulding should be carried out between 20 and 24 hours after moulding.

Demoulding may be delayed by a further 24 hours if the mortar has not acquired sufficient strength after 24 hours to be handled without danger of damage, but the fact should be mentioned in the test report.

Demoulding should be done with due precautions, preferably with the device shown in Figure 5.

Each demoulded test specimen should be weighed and the mass marked on its bottom face. This mass is a check on the procedure.

After demoulding, the specimens should be stored at 20 ± 1 °C in still tap water, until the time for testing. Vertical faces as cast should remain vertical during storage. The specimens should be kept apart from each other, allowing free access of water to all their faces. The water should be replaced every 15 days.

Dimensions in millimetres

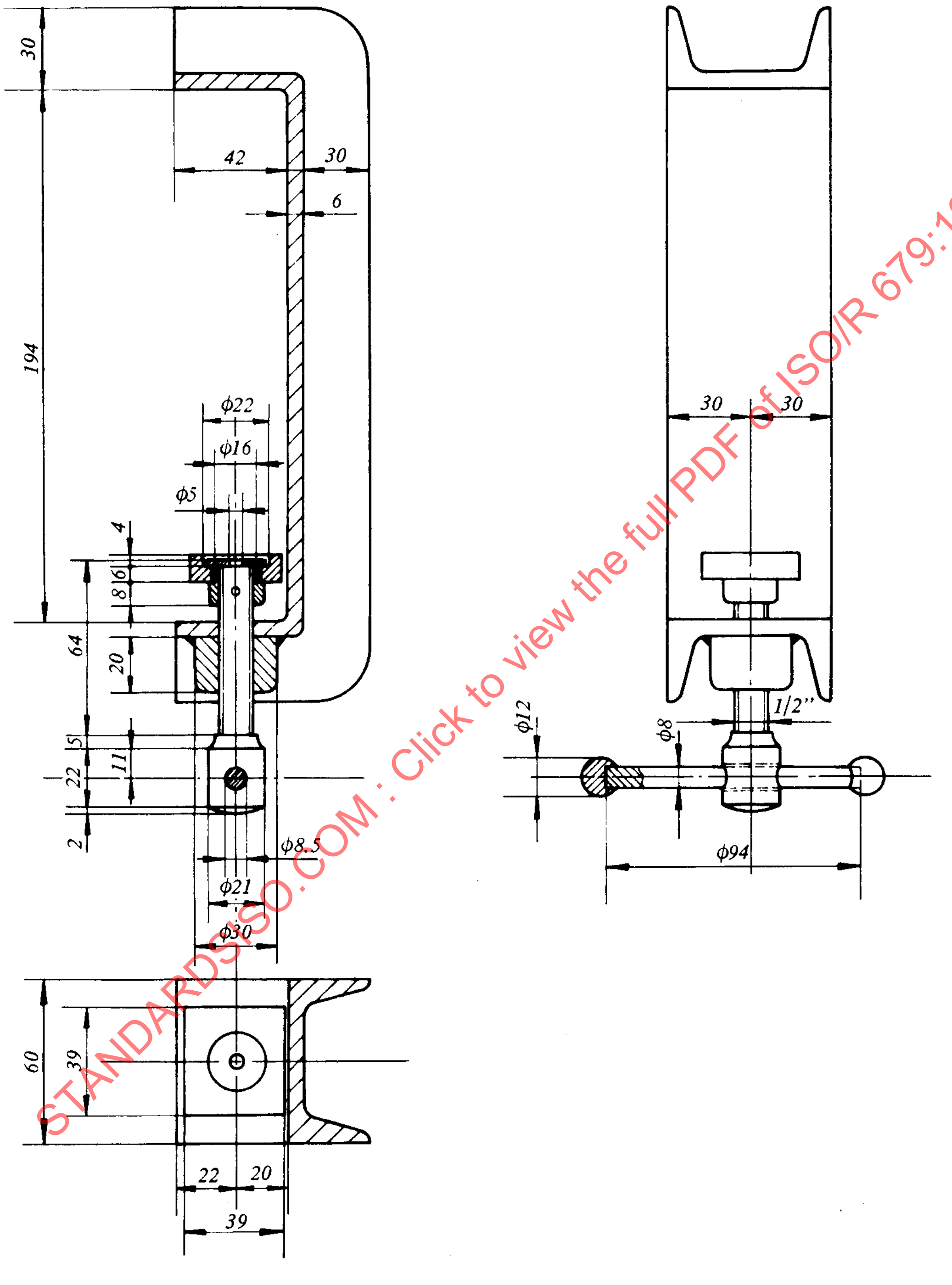

FIG. 5 – **Apparatus for demoulding specimens**

The specimens should be taken from the water less than 15 minutes before test. In order to satisfy this condition they should be transported to the test machine in a container full of water. They should then be wiped with a clean cloth, so that any deposit that might have accumulated on them is removed.

4. TESTING THE SPECIMENS

4.1 Bending strength

The testing machine for bending strength should be capable of applying loads less than 10 kN (or 1000/kgf) with a precision of 1 % for the upper 4/5 of its range. The machine should be provided with a bending device carrying two supporting rollers of 10 mm diameter spaced 100 mm or 106.7 mm apart and a third loading roller of the same diameter placed centrally between the other two.

The three vertical planes through the axes of the three rollers should be parallel and remain parallel and equidistant during the test. One of the supporting rollers and the loading roller should be capable of swinging slightly in relation to their centres in elevation to allow a uniform distribution of the load on the width of the prism without subjecting the specimen to any torsional stresses.

The prism should be placed in the bending device with one lateral moulded face on the supporting rollers and with its longitudinal axis perpendicular to the support.

The load P should be applied vertically by the loading roller on the opposite lateral face of the prism and should be increased progressively at 50 ± 10 N/s (or 5 ± 1 kgf/s).
The modulus of rupture R is given by the following formula :

$$R = \frac{6M}{b^3} = 1.5\frac{Pl}{b^3}$$

where

M is the bending moment, $M = \frac{Pl}{4}$;

b is the side of the square section of the prism;

P is the load applied to the middle of the prism;

l is the distance between the supports.

Expressing l and b in centimetres, the formula becomes :

$$R = 0.234P \text{ for } l = 10 \text{ cm}$$

$$l = 0.250P \text{ for } l = 10.67 \text{ cm}$$

R is in kilonewton per square centimetre (kN/cm^2), when P is in kilonewton (kN), or in kilogrammes-force per square centimetre (kgf/cm^2), when P is in kilogrammes-force (kgf).

4.2 Compressive strength

After testing in flexure, the half-prisms should be damp stored until the crushing test. Each half-prism should be tested in compression on the lateral moulded faces on a section of 40 × 40 mm between two plates of hard metal at least 10 mm thick, 40 ± 0.1 mm wide, of a length greater than 40 mm and plane to within 0.01 mm.

These plates should be of hard steel with a Vickers hardness of at least 600 or, preferably, of tungsten carbide.

The crushing machine should have a precision of at least 1.5 % for the smallest loads used in the tests. It should be provided with at least two ranges of loading, one from 4 to 5 tonne, the other from 15 to 25 tonne. Its upper platen should bear a spherical seating whose centre is situated in the plane of the lower platen.

When the crushing machine is provided with platens whose diameter is not greater than 10 cm and with a spherical seating of diameter not greater than 6 cm, the compression plates may be simply fixed to the platens of the machine and centred on these and on the axis of the test piece.

The plates should be guided without appreciable friction during the test so that they maintain the same horizontal projection. One of them may be slightly inclined in order to allow perfect contact with the test piece.

These conditions can be advantageously attained by a special compression jig placed between the platens of the compression machine.

When the platens and spherical seating of the compression machine are larger than those stated above, a jig should be placed between the platens of the machine to transmit the load of the machine to the compression surfaces of the mortar specimens. In this jig the lower plate can be embodied in the lower platen. The upper plate receives the load from the opposing upper platen through an intermediate ball seating and the assembly should be able to slide vertically without appreciable friction in the jig which guides its movement. After crushing of the test piece it is desirable that the assembly should return automatically to its initial position (see Fig. 6).