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Second edition
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Cement — Test methods — Determination of strength

Ciments — Méthodes d'essai — Détermination de la résistance mécanique

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 679 was prepared by Technical Committee ISO/TC 74, *Cement and lime*.

This second edition cancels and replaces the first edition (ISO 679:1989), which has been technically revised as follows, based on comments received by the Secretariat.

a) The testing procedure has been revised with respect to hardness and surface texture of moulds (4.6.3) and compression strength testing machine platens (4.6.6) as supplied; suitability of mould oil (4.6.3); frequency of operation of jolting apparatus (4.6.4); and the inclusion and accuracy of a balance (4.6.8); deionized water (5.3) is now permitted; procedures for mixing mortar (6.2) and the moulding (Clause 7) and conditioning (Clause 8) of test specimens have been revised to reflect current best practice.

b) Test results (Clause 10) are now reported in megapascals, replacing newtons per square millimetre. (One megapascal is equivalent to one newton per square millimetre.)

c) The use of a flexural strength testing machine (4.6.5) is now optional.

d) Estimates of the precision for compressive strength testing (10.2.3) have been revised to include both short- and long-term repeatability together with reproducibility data for laboratories of “normal” performance and an indication of precision data for “expert” laboratories.

e) The procedure for validation testing of ISO standard sand (11.2) includes initial qualification testing, validation criteria, verification testing and annual confirmation testing.

f) The procedure for validation testing of alternative compaction equipment (11.3) has been revised and a normative annex (Annex A) has been introduced detailing two alternative vibration compaction equipments which have been validated.

Cement — Test methods — Determination of strength

1 Scope

This International Standard specifies a method of determining the compressive and, optionally, the flexural strength of cement mortar containing one part by mass of cement, three parts by mass of ISO standard sand and one half part of water. The method applies to common cements and to other cements and materials, the standards for which call up this method. It might not apply to other cement types that have, for example, a very short initial setting time.

This International Standard describes the reference equipment and procedure, and specifies the method used for validation testing of ISO standard sands and of alternative equipment and procedures.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1101, *Geometrical Product Specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

ISO 1302, *Geometrical Product Specifications (GPS) — Indication of surface texture in technical product documentation*

ISO 3310-1, *Test sieves — Technical requirements and testing — Part 1: Test sieves of metal wire cloth*

ISO 4200, *Plain end steel tubes, welded and seamless — General tables of dimensions and masses per unit length*

ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

3 Principle

The method is comprised of a determination of the compressive, and optionally the flexural, strength of a prismatic test specimen 40 mm × 40 mm × 160 mm in size.

These specimens are cast from a batch of plastic mortar containing one part by mass of cement, three parts by mass of ISO standard sand and one half part of water (water/cement ratio of 0,50). ISO standard sands from various sources and countries may be used, provided that they have been shown to give cement strength results that do not differ significantly from those obtained using the ISO reference sand (see Clause 11).

In the reference procedure, the mortar is prepared by mechanical mixing and is compacted in a mould using a jolting apparatus. Alternative compaction equipment and procedures may be used provided that they have been shown to give cement strength results that do not differ significantly from those obtained using the reference jolting apparatus and procedure (see Clause 11 and Annex A). In the event of a dispute, only the reference equipment and procedure shall be used.

The specimens are stored in the mould in a moist atmosphere for 24 h and, after demoulding, specimens are stored under water until strength testing.

At the required age, the specimens are taken from their wet storage, broken in flexure, determining the flexural strength where required, or broken using other suitable means that do not subject the prism halves to harmful stresses, and each half is tested for strength in compression.

4 Apparatus

4.1 Laboratory, for the preparation of specimens, maintained at a temperature of (20 ± 2) °C and a relative humidity of not less than 50 %.

A laboratory temperature of (25 ± 2) °C or (27 ± 2) °C may be maintained in warm countries, provided the temperature is stated in the test report.

The temperature and relative humidity of the air in the laboratory shall be recorded at least once a day during working hours.

Laboratories testing in accordance with this International Standard should consider the enhanced confidence for test results engendered by conformity to the requirements of ISO/IEC 17025.

4.2 Moist-air room or **large cabinet**, for storage of the specimens in the mould, maintained at a temperature of (20,0 ± 1,0) °C and a relative humidity of not less than 90 %.

The temperature of the moist-air room or the large cabinet for storage may be maintained at (25 ± 1) °C or (27 ± 1) °C in warm countries, provided the temperature is stated in the test report.

The temperature and relative humidity of the moist-air room or cabinet shall be recorded at least every 4 h.

4.3 Storage containers, for curing the specimens in water, with fitted grates, of material that does not react with cement.

The temperature of the water shall be maintained at (20,0 ± 1,0) °C.

The temperature of the water in the storage containers may be maintained at (25 ± 1) °C or (27 ± 1) °C in warm countries, provided the temperature is stated in the test report.

The temperature of the water in the storage containers shall be recorded at least once a day during working hours.

4.4 Cement, **ISO standard sand** (see 5.1.3), and **water**, used to make test specimens, at the laboratory temperature.

4.5 Test sieves, wire cloth, in accordance with ISO 3310-1, of the sizes in accordance with Table 1.

Table 1 — Aperture of test sieves

Square mesh size [a] mm					
2,00	1,60	1,00	0,50	0,16	0,08

[a] Taken from ISO 565:1990, series R 20.

4.6 Equipment

4.6.1 General requirements

Apparatus used to make and test the specimens shall be at the laboratory temperature. Where temperature ranges are given, the target temperature at which the controls are set shall be the middle value of the range.

The tolerances shown in Figures 1 to 5 are important for correct operation of the equipment in the testing procedure. When regular control measurements show that the tolerances are not met, the equipment shall be rejected, adjusted or repaired. Records of control measurements shall be kept.

Acceptance measurements on new equipment shall cover mass, volume and dimensions to the extent that these are indicated in this International Standard, paying particular attention to those critical dimensions for which tolerances are specified.

In those cases where the material of the equipment can influence the results, the material is specified and shall be used.

The approximate dimensions shown in the figures are provided as guidance to equipment manufacturers or operators. Dimensions that include tolerances are obligatory.

4.6.2 Mixer, consisting essentially of the following:

a) stainless steel bowl, with a capacity of about 5 l, of the typical shape and size shown in Figure 1, provided with a means by which it can be fixed securely to the mixer frame during mixing and by which the height of the bowl in relation to the blade and, to some extent, the gap between blade and bowl can be finely adjusted and fixed;

b) stainless steel blade, of the typical shape, size and tolerances shown in Figure 1, revolving about its own axis as it is driven in a planetary movement around the axis of the bowl at controlled speeds by an electric motor. The two directions of rotation shall be opposite and the ratio between the two speeds shall not be a whole number.

Blades and bowls shall form sets which shall always be used together.

The gap between blade and bowl shown in Figure 1 shall be checked regularly. The gap of (3 ± 1) mm refers to the situation when the blade in the empty bowl is brought as close as possible to the wall. Simple tolerance gauges (“feeler gauges”) are useful where direct measurement is difficult.

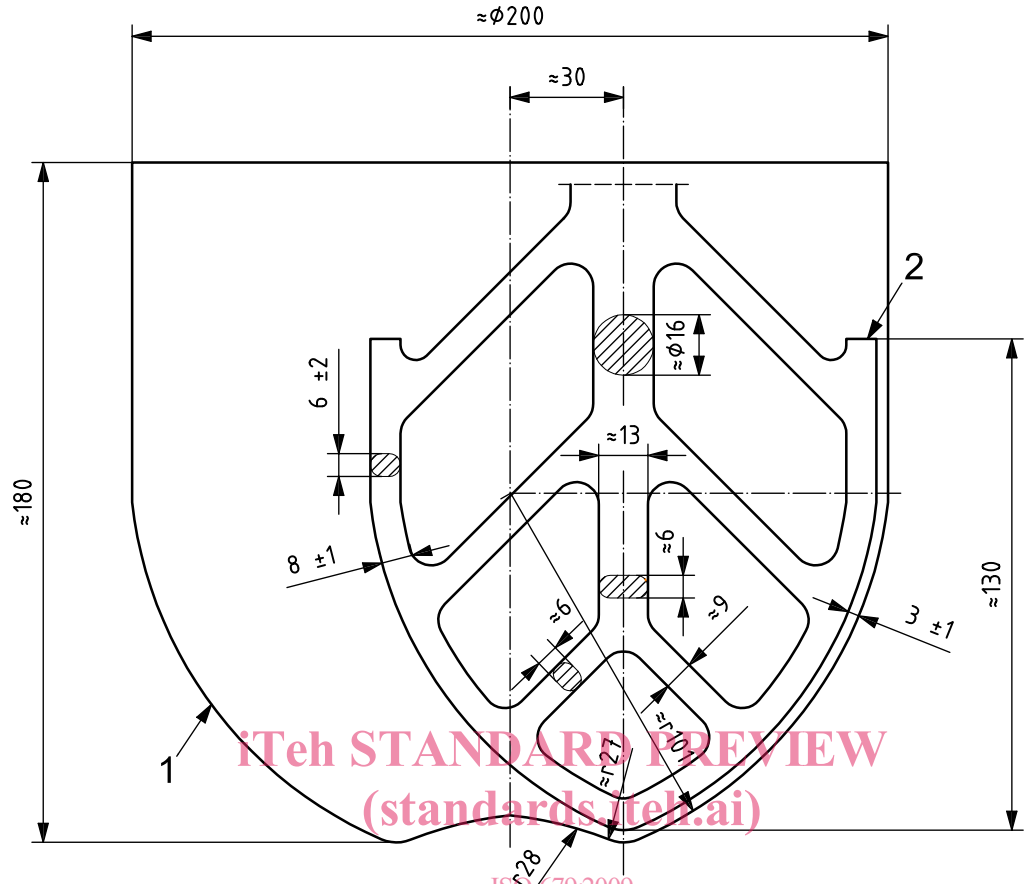
NOTE The dimensions marked as approximate on Figure 1 are for the guidance of manufacturers.

The mixer shall operate at the speeds given in Table 2 when mixing the mortar.

Table 2 — Speeds of mixer blade

Speed	Rotation min^{-1}	Planetary movement min^{-1}
Low	140 ± 5	62 ± 5
High	285 ± 10	125 ± 10

Dimensions in millimetres



Key

1 bowl
2 blade

Figure 1 — Typical bowl and blade

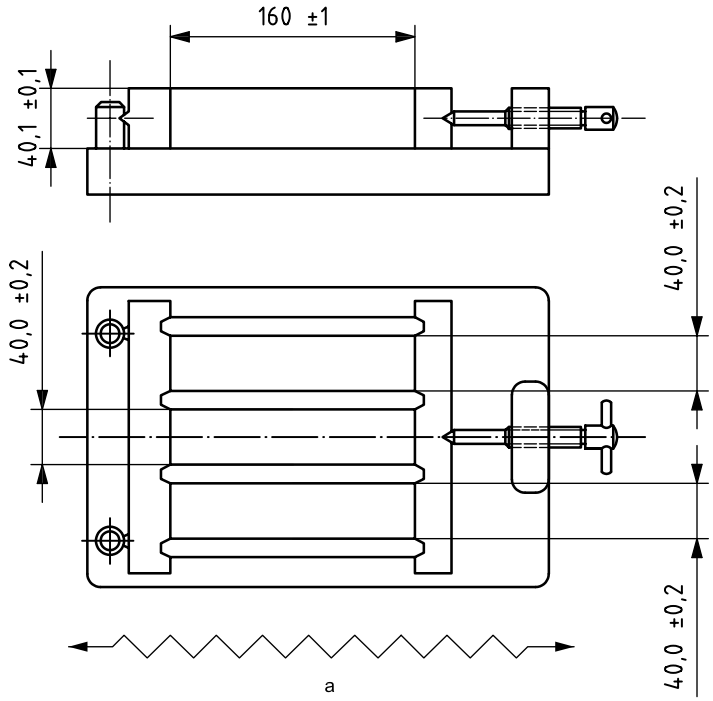
4.6.3 Moulds, consisting of three horizontal compartments so that three prismatic specimens 40 mm × 40 mm in cross-section and 160 mm in length can be prepared simultaneously. A typical design is shown in Figure 2.

The mould shall be made of steel with walls approximately 10 mm thick. Each internal side face of the mould shall be case hardened to a Vickers hardness of at least HV 200, as supplied. However, a minimum Vickers hardness value of HV 400 is recommended.

The mould shall be constructed in such a manner as to facilitate the removal of moulded specimens without damage. Each mould shall be provided with a machined steel or cast iron baseplate. The mould, when assembled, shall be positively and rigidly held together and fixed to the baseplate.

The assembly shall be such that there is no distortion or visible leakage during operation. The baseplate shall make adequate contact with the table of the compacting apparatus and be rigid enough not to induce secondary vibrations.

Dimensions in millimetres



a Striking off direction with sawing motion.

Figure 2 — Typical mould

Moulds and jolting apparatus from different manufacturers may have unrelated external dimensions and masses, so their compatibility needs to be ensured by the purchaser.

Each part of the mould shall be stamped with identifying marks to facilitate assembly and to ensure conformity to the specified tolerances. Similar parts of separate mould assemblies shall not be interchanged.

The assembled mould shall conform to the following requirements.

a) The internal dimensions and tolerances of each mould compartment shall be as follows:

   — length: (160 ± 1) mm;

   — width: (40,0 ± 0,2) mm;

   — depth: (40,1 ± 0,1) mm.

b) The flatness tolerance (see ISO 1101) over the whole of each internal side face shall be not greater than 0,03 mm.

c) The perpendicularity tolerance (see ISO 1101) for each internal face with respect to the bottom surface of the mould and the adjacent internal face as datum faces shall be not greater than 0,2 mm.

d) The surface texture (see ISO 1302) of each internal side face shall be not rougher than N8, as supplied.

Moulds shall be replaced when any one of the specified tolerances is exceeded. The mass of the mould shall comply with the requirement for the combined mass in 4.6.4.

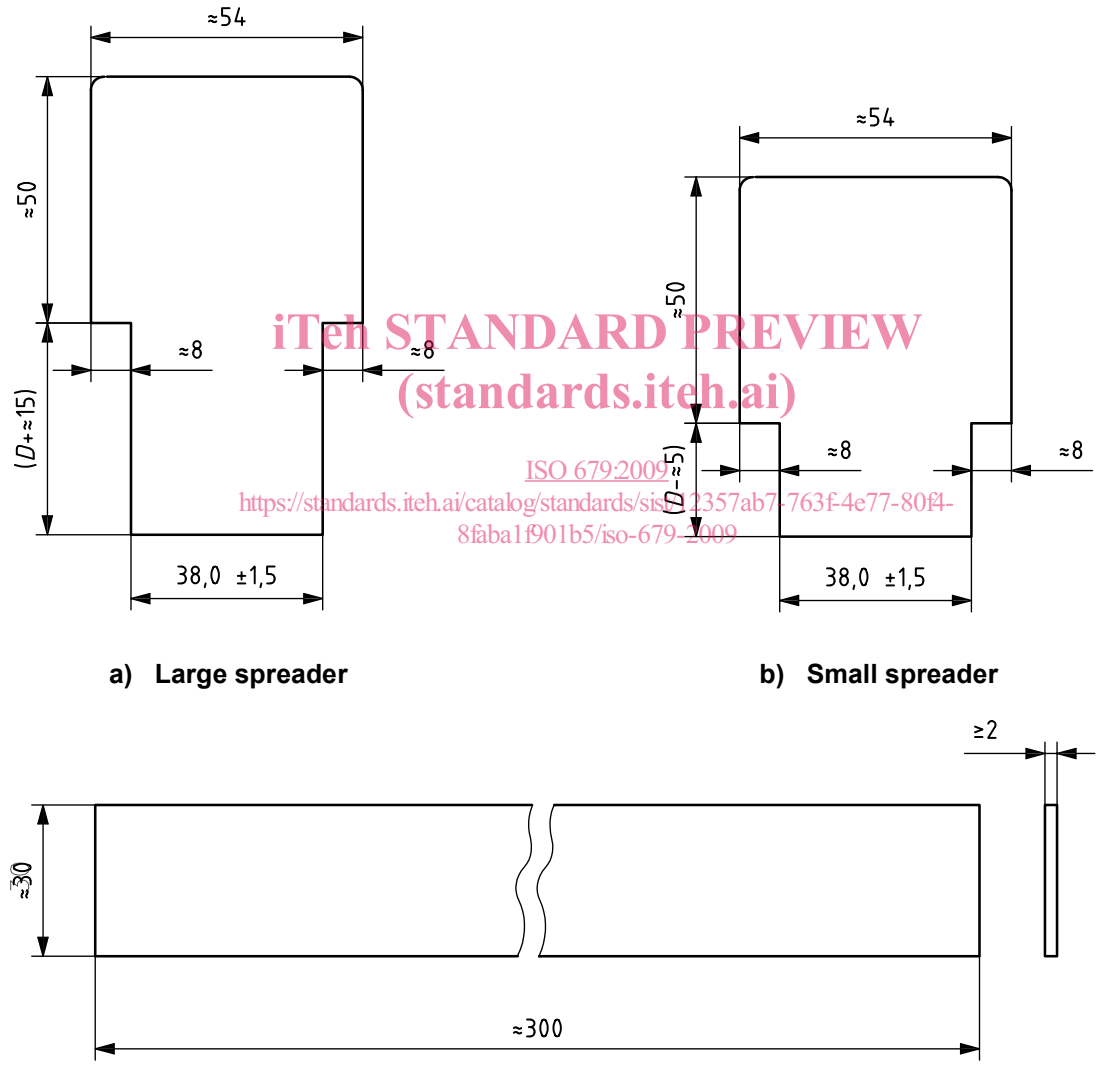
After assembling the cleaned mould ready for use, a suitable material shall be used to coat the outer joints of the mould. A thin film of mould oil shall be applied to the internal faces of the mould.

NOTE Some oils have been found to affect the setting of cement; mineral-based oils have been found to be suitable.

To facilitate the filling of the mould, a tightly fitting metal hopper with vertical walls 20 mm to 40 mm high shall be provided. When viewed in plan, the hopper walls shall overlap the internal walls of the mould by not more than 1 mm. The outer walls of the hopper shall be provided with a means of location to ensure correct positioning over the mould.

For spreading and striking off the mortar, two spreaders and a metal straight-edge of the type shown in Figure 3 shall be provided.

Dimensions in millimetres



a) Large spreader

b) Small spreader

c) Straight-edge

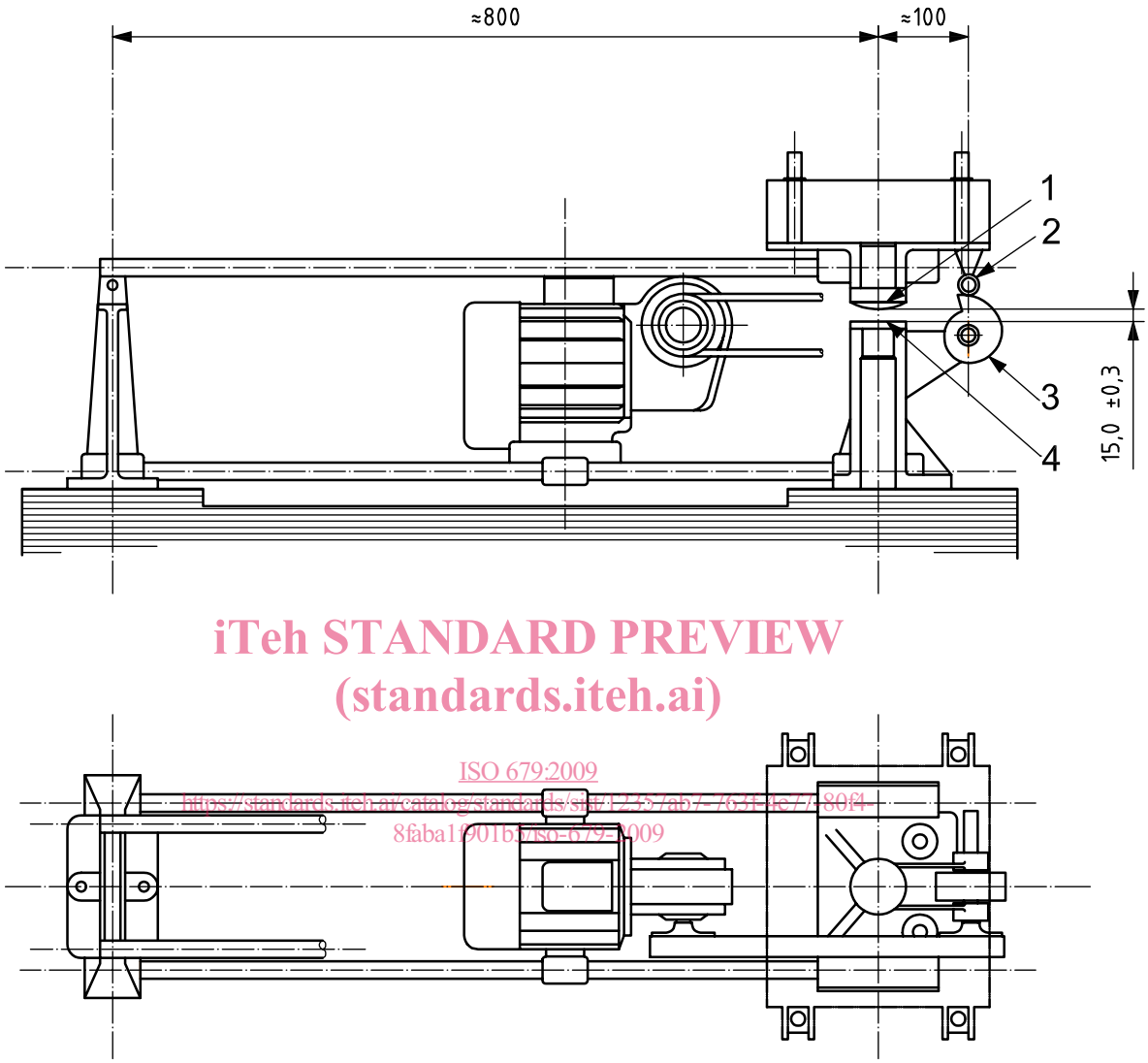
Key

D height of the hopper

Figure 3 — Typical spreaders and metal straight-edge

4.6.4 Jolting apparatus, consisting of a rectangular table rigidly connected by two light arms to a pivot at nominally 800 mm from the centre of the table. A typical design is shown in Figure 4.

Dimensions in millimetres



Key

1 lug
2 cam follower
3 cam
4 stop

Figure 4 — Typical jolting apparatus

The table shall incorporate at the centre of its lower face a projecting lug with a rounded face. Beneath the projecting lug shall be a small stop with a plane upper surface. In the rest position, the common normal through the point of contact of the lug and the stop shall be vertical. When the lug rests on the stop, the top face of the table shall be horizontal so that the level of any of the four corners does not deviate from the mean level by more than 1,0 mm. The table shall have dimensions equal to or greater than those of the mould baseplate, and a plane, machined upper surface. Clamps shall be provided for firm attachment of the mould to the table.

The combined mass of the table, including arms, empty mould, hopper and clamps shall be (20,0 ± 0,5) kg.

The arms connecting the table assembly to the pivot shall be rigid and constructed of round tubing with an outside diameter lying in the range 17 mm to 22 mm selected from tube sizes in accordance with ISO 4200. The total mass of the two arms, including any cross bracing, shall be (2,25 ± 0,25) kg. The pivot bearings shall be of the ball or roller type and protected from ingress of grit or dust. The horizontal displacement of the centre of the table as caused by the play of the pivot shall not exceed 1,0 mm.

The lug and the stop shall be made of through-hardened steel of at least HV 500 Vickers hardness value. The curvature of the lug shall be about 0,01 mm^{-1}.

In operation, the table is raised by a cam and allowed to fall freely from a height of (15,0 ± 0,3) mm before the lug strikes the stop.

The cam shall be made of through-hardened steel of at least HV 400 Vickers hardness value and its shaft shall be mounted in ball bearings of such construction that the free fall is always (15,0 ± 0,3) mm. The cam follower shall be of a construction that ensures minimal wear of the cam. The cam shall be driven by an electric motor of about 250 W through a reduction gear at a uniform speed of one revolution per second. A control mechanism and a counter shall be provided which ensures that during one period of jolting of (60 ± 3) s exactly 60 jolts are given.

The position of the mould on the table shall be such that the longitudinal dimension of the compartments is in line with the direction of the arms and perpendicular to the axis of rotation of the cam. Suitable reference marks shall be provided to facilitate the positioning of the mould in such a way that the centre of the central compartment is directly above the point of impact.

The apparatus shall be firmly mounted on a concrete block with a mass of about 600 kg and volume of about 0,25 m^3 and of dimensions giving a suitable working height for the mould. The entire base of the concrete block shall stand on an elastic pad, e.g. natural rubber, having a sufficient isolation efficiency to prevent external vibrations from affecting the compaction.

The base of the apparatus shall be fixed level to the concrete base by anchor bolts, and a thin layer of mortar shall be placed between the base of the apparatus and the concrete base to ensure overall and vibration-free contact.

4.6.5 Flexural strength testing apparatus (optional), capable of applying loads up to 10 kN with an accuracy of ± 1,0 % of the recorded load in the upper four-fifths of the range being used, at a rate of loading of (50 ± 10) N/s.

NOTE 1 The provision of this apparatus is optional. If only the compressive strength is to be measured, prisms can be broken using other suitable means which do not subject the prism halves to harmful stresses.

NOTE 2 The flexural strength can be measured by using a flexural strength testing machine or by using a suitable device in a compression testing machine.

The apparatus shall be provided with a flexure device incorporating two steel supporting rollers of (10,0 ± 0,5) mm diameter spaced (100,0 ± 0,5) mm apart and a third steel loading roller of the same diameter placed centrally between the other two. The length of these rollers shall be between 45 mm and 50 mm. The loading arrangement is shown in Figure 5.