INTERNATIONAL STANDARD

ISO 1920-4

First edition
2005-07-15

Testing of concrete —

Part 4:
Strength of hardened concrete

Essais du béton —

Partie 4: Résistance du béton durci

Reference number
ISO 1920-4:2005(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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 1920-4 was prepared by Technical Committee ISO/TC 71, *Concrete, reinforced concrete and pre-stressed concrete*, Subcommittee SC 1, *Test methods for concrete*.

This first edition of ISO 1920-4:2005 cancels and replaces the first editions of ISO 4012:1978, ISO 4013:1978 and ISO 4108:1980, which have been technically revised.

ISO 1920 consists of the following parts, under the general title *Testing of concrete*:

- *Part 1: Sampling of fresh concrete*
- *Part 2: Properties of fresh concrete* [1)]
- *Part 3: Making and curing test specimens*
- *Part 4: Strength of hardened concrete*
- *Part 5: Properties of hardened concrete other than strength*
- *Part 6: Sampling, preparing and testing of concrete cores*
- *Part 7: Non-destructive tests on hardened concrete*

The following parts are under preparation:

- *Part 8: Determination of drying shrinkage of concrete*
- *Part 9: Determination of creep of concrete*

This series of Draft International standards was based on existing and draft ISO standards and on draft CEN standards dealing with testing concrete.

1) To be published.

Testing of concrete —

Part 4:
Strength of hardened concrete

1 Scope

This part of ISO 1920 specifies procedures for testing the strength of hardened concrete.

2 Normative references

The following referenced documents are essential 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 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 679, *Methods of testing cement — Determination of strength*

ISO 1920-3, *Testing of concrete — Part 3: Making and curing test specimens*

ISO 2781, *Rubber, vulcanized — Determination of density*

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

ISO 4662, *Rubber — Determination of rebound resilience of vulcanizates*

EN 316:1999, *Wood Fiberboards — Definition, Classification and Symbols*

EN 12390-4:2000, *Testing Hardened Concrete — Part 4: Compressive Strength — Specification for Testing Machines*

3 Determination of compressive strength

3.1 Test specimens

The test specimen shall be a cube or a cylinder meeting the requirements of ISO 1920-3 or cores meeting the requirements of ISO 1920-6.

Damaged specimens shall not be tested.

Specimens that are badly honeycombed shall not be regarded as being representative of the quality of concrete supplied. In general, standard cube and cylinder specimens should not be tested if they are badly honeycombed as this is an indication of poor specimen making. When such specimens are tested, the test report shall include the fact that the specimen was honeycombed.

Where the designated size, l_1 or l_2, of the cross-section is outside the tolerances, the specimens may be used for testing by using the actual dimensions; see 3.4.

Where the dimensions or shape of a test specimen exceed the respective tolerances given in ISO 1920-3, the specimen shall be rejected or adjusted (if feasible) by one or more of the following methods:

— uneven surfaces levelled by grinding or by capping;

— the deviation of angles corrected by cutting and/or grinding.

The procedures given in Annex B shall be used to adjust the specimen.

Adjustment by grinding shall be the reference method.

3.2 Apparatus

The test shall be carried out using a compression-testing machine conforming to EN 12390-4 or to a national standard valid in the place of testing. The test machine shall be in calibration at the time of test. The calibration shall be carried out at least once per year.

3.3 Procedure

3.3.1 Preparation and positioning of specimens

For specimens stored in water, excess moisture shall be wiped from the surface of the specimen before placing in the testing machine.

The time between the extraction of the specimen from the humidity chamber or the water tank until the test shall be as short as possible and not more than 3 h. During the time the specimen is outside the humidity chamber or water tank, it shall be protected from drying, e.g. by covering with wet burlap.

All testing-machine bearing surfaces shall be wiped clean and any loose grit or other extraneous material removed from the surfaces of the specimen that will be in contact with the platens.

Do not use packing, other than auxiliary platens or spacing blocks, between the specimen and the platens of the testing machine.

Cube specimens shall be compressed perpendicularly to the direction of casting.

The specimen shall be centred on the lower platen to an accuracy of 1 % of the designated size of cubic, or diameter of cylindrical specimens.

Where physical means of ensuring centring are provided on the testing machine and they are in calibration, these shall be deemed to satisfy the requirements for accuracy of centring.

If auxiliary platens are used, the top auxiliary platen shall be aligned with the top of the specimen.

With two-column testing machines, cubic specimens should be placed with the trowelled surface facing a column.

3.3.2 Loading

The load shall be applied without shock and shall be increased continuously at a constant rate until no greater load can be sustained. Select a rate of stress not less than 0,15 MPa/s and not greater than 1,0 MPa/s.

When using manually controlled testing machines, any tendency for the selected rate of loading to decrease as specimen failure is approached shall be corrected by appropriate adjustment of the controls.

When using automatically controlled testing machines, the rate of loading whilst testing concrete specimens in compression shall be periodically checked to ensure that the rate is constant.

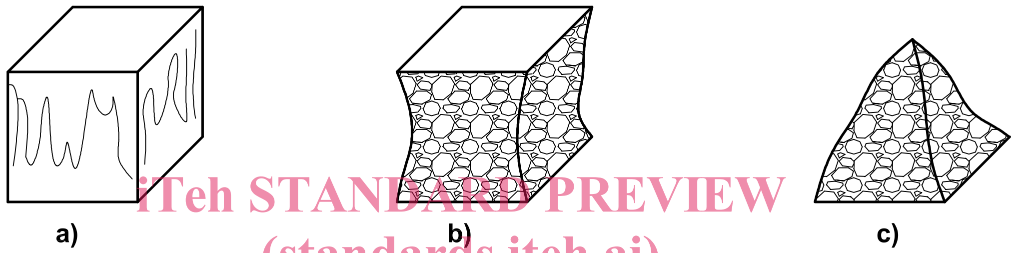
The maximum load indicated shall be recorded.

3.3.3 Assessment of type of failure

For cubic specimens, if the failure is satisfactory (see Figure 1), this fact shall be recorded. If the failure pattern is unsatisfactory, this fact shall be recorded and the type of failure recorded using the pattern number in Figure 2 closest to that observed.

For cylindrical specimens, if the failure is satisfactory (see Figure 3), this fact shall be recorded. If the failure pattern is unsatisfactory, this fact shall be recorded and the type of failure recorded using the pattern letter in Figure 4 closest to that observed.

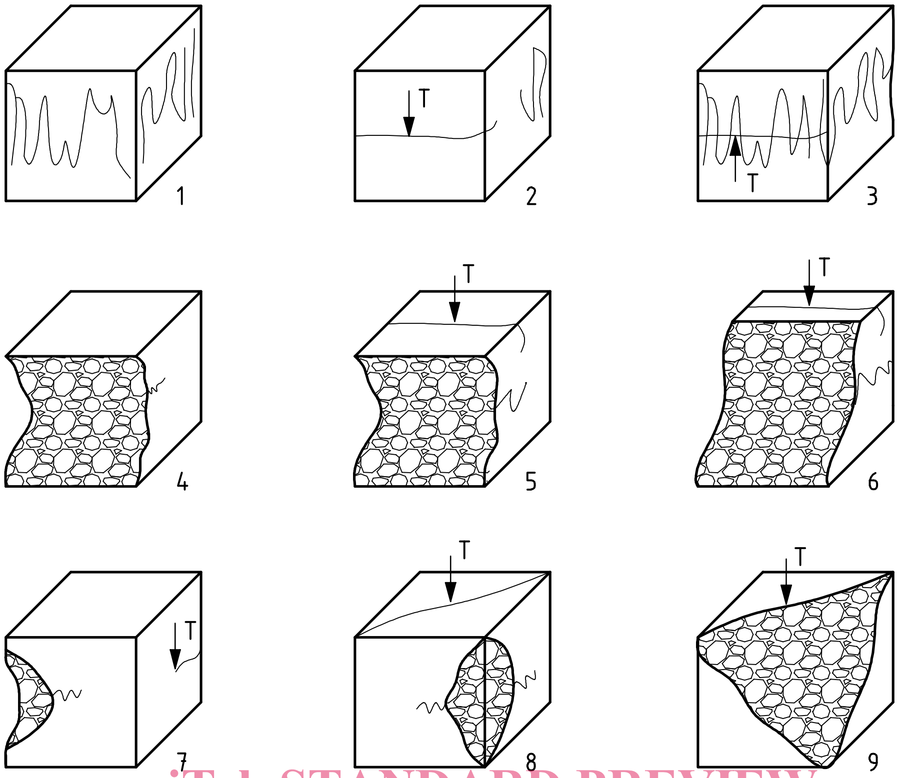
NOTE Unsatisfactory failures can be caused by insufficient attention to the detailed procedures for making, capping and testing specimens or by a machine fault.



NOTE 1 All four exposed faces are cracked approximately equally, generally with little damage to faces in contact with the platens.

NOTE 2 Figure 1 c) demonstrates explosive failure.

Figure 1 — Satisfactory failures of cube specimens



Key

T indicates a tensile crack

Figure 2 — Some unsatisfactory failures due to unequal cracking of the exposed faces of cube specimens

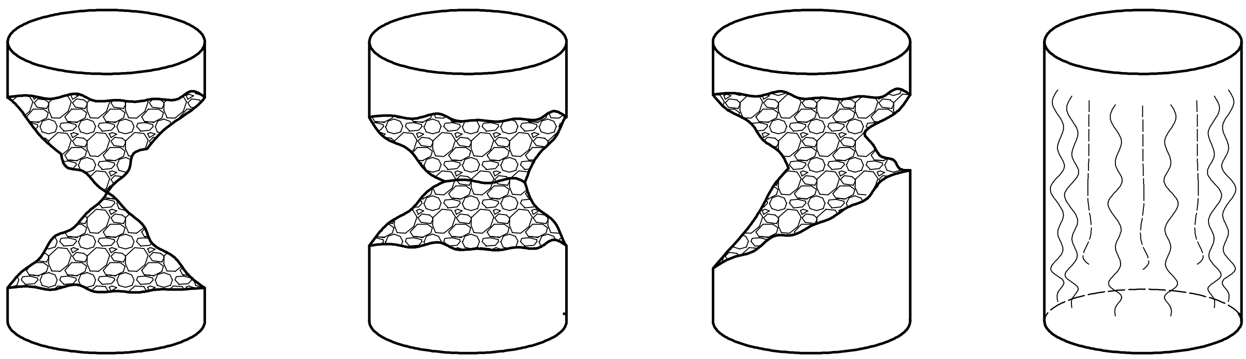


Figure 3 — Satisfactory failure of cylinder specimen

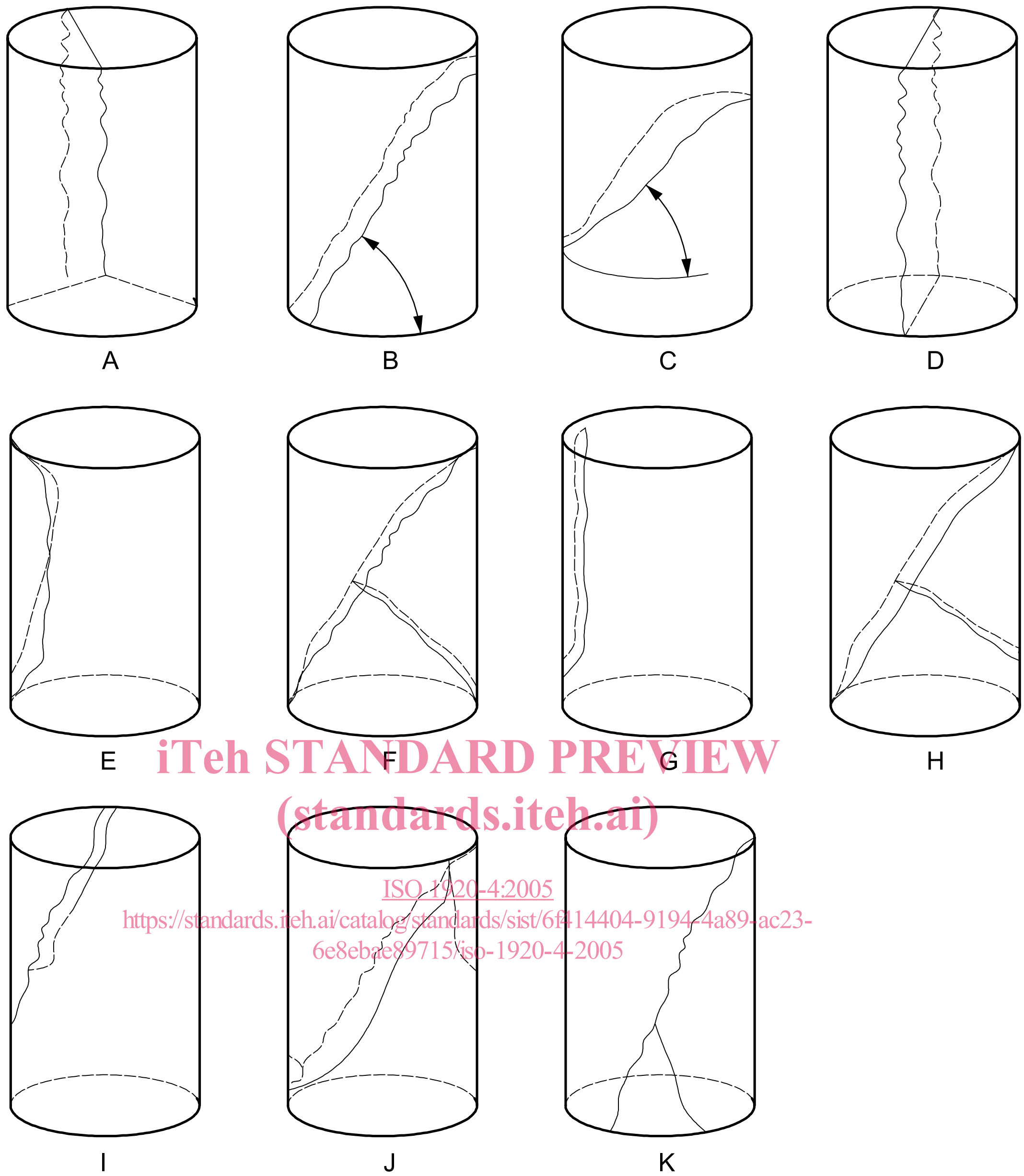


Figure 4 — Some unsatisfactory failures of cylinder specimens

3.4 Test results

The compressive strength is given by the equation:

$$f_c = \frac{F}{A_c} \tag{1}$$

where

f_c is the compressive strength, expressed in megapascals;

F is the maximum load, expressed in newtons

A_c is the cross-sectional area, expressed in square millimetres, of the specimen on which the compressive force acts.

If the actual dimensions of the test specimen are within ± 0,5 % of the designated size, the strength may be calculated on the basis of the designated size. If the actual dimensions are outside this tolerance, the strength calculation shall be based on the actual dimensions of the test specimen, determined in accordance with ISO 1920-3.

The compressive strength shall be expressed to the nearest 0,5 MPa.

3.5 Test report

In addition to the requirements in Clause 6, the test report shall include the following:

— type of specimen: cube, cylinder or core;

— method of adjustment, if relevant;

— compressive strength of specimen (to the nearest 0,5 MPa);

— type of failure (satisfactory or unsatisfactory, and, if unsatisfactory, the nearest type).

4 Determination of flexural strength

4.1 Test specimens

The test specimen shall be a prism conforming to ISO 1920-3.

Sawn specimens of nominal width, l, of 100 mm or 150 mm with a square cross-section and overall length of between $4l$ and $5l$ may also be tested to this part of ISO 1920. The ratio of l to the maximum size of aggregate shall be not less than four, except for specimens with a nominal width of 150 mm and a maximum size of aggregate of 40 mm, which may also be tested.

The direction of casting shall be identified on the specimen.

4.2 Apparatus

4.2.1 Testing machine

The test shall be carried out using a testing machine conforming to EN 12390-4:2000, 4.2 and 4.3, or to a national standard valid in the place of testing.

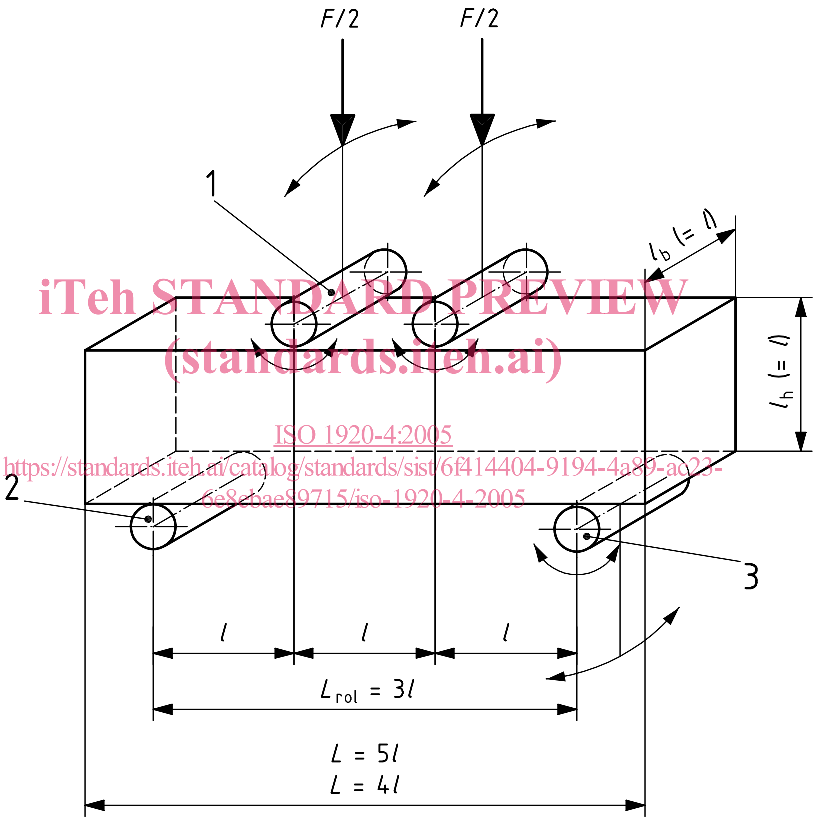
4.2.2 Force application

The device for applying loads shall consist of two upper rollers and two lower rollers (see Figure 5).

All rollers shall be manufactured from steel and shall have a circular cross-section with a diameter between 20 mm and 40 mm and shall be at least 10 mm longer than the width of the test specimen.

Each roller, except one of the lower ones, shall be capable of rotating around its axis and of being inclined in a plane normal to the longitudinal axis of the test specimen.

The distance, L_{rol}, between the lower (outer) rollers (i.e. the span) shall be equal to $3l$, where l is the width of the specimen. The distance between the upper (inner) rollers shall be equal to l. The inner rollers shall be equally spaced between the outer rollers as shown in Figure 5. All rollers shall be adjusted in the positions illustrated in Figure 5 to an accuracy of ± 2 mm.



Key

1 loading roller (capable of rotation and of being inclined)

2 supporting roller

3 supporting roller (capable of rotation and of being inclined)

Figure 5 — Arrangement for loading a test specimen (two-point loading)

4.3 Procedures

4.3.1 Preparation and positioning of specimens

The specimen shall be examined and any abnormalities shall be reported.

For specimens stored in water, excess moisture shall be wiped from the surface of the specimen before placing in the testing machine.

The time between the extraction of the specimen from the humidity chamber or the water tank until the test shall be as short as possible and not more than 3 h. During the time the specimen is outside the humidity chamber or water tank, it shall be protected from drying, e.g. by covering with wet burlap.

All testing-machine bearing surfaces shall be wiped clean and any loose grit or other extraneous material removed from the surfaces of the specimen that will be in contact with the rollers.

The test specimen shall be placed in the machine, correctly centred with the longitudinal axis of the specimen at right angles to the longitudinal axis of the upper and lower rollers.

The reference direction of loading shall be perpendicular to the direction of casting of the specimen.

The test result may be affected by the direction of loading with respect to the direction of casting.

4.3.2 Loading

Do not apply the load until all loading and supporting rollers are resting evenly against the test specimen.

The load shall be applied without shock and shall be increased continuously at a constant rate until no greater load can be sustained. Select a constant rate of stress of not less than 0,04 MPa/sec and not greater than 0,06 MPa/sec.

NOTE The required loading rate on the testing machine is given by Equation (2):

$$F_{\mathrm{R}} = \frac{s \times l_{\mathrm{b}} \times l_{\mathrm{h}}^{2}}{l_{\mathrm{rol}}} \tag{2}$$

where

F_{R} is the required loading rate, expressed in newtons per second;

s is stress rate, expressed in megapascals per second;

l_{b}, l_{h} are the lateral dimensions (breadth and height), expressed in millimetres, of the specimen;

l_{rol} is the spacing, expressed in millimetres, of the lower rollers.

When using manually controlled testing machines, any tendency for the selected rate of loading to decrease, as specimen failure is approached, shall be corrected by appropriate adjustment of the controls.

When using automatically controlled testing machines, the rate of loading shall be periodically checked to ensure that the rate is constant.

The maximum load indicated shall be recorded.

