

Testing hardened concrete —

Part 6: Tensile splitting strength of test specimens

The European Standard EN 12390-6:2000 has the status of a
British Standard

ICS 91.100.30

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National foreword

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 10, an inside back cover and a back cover.

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This British Standard, having been prepared under the direction of the Sector Committee for Building and Civil Engineering, was published under the authority of the Standards Committee and comes into effect on 15 December 2000

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ISBN 0 590 36606 5

Amendments issued since publication

Amd. No.	Date	Comments

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 12390-6

October 2000

ICS 91.100.30

English version

Testing hardened concrete - Part 6: Tensile splitting strength of test specimens

Essai pour béton durci - Partie 6: Résistance en traction par fendage d'éprouvettes

Prüfung von Festbeton - Teil 6: Spaltzugfestigkeit von Probekörpern

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Ref. No. EN 12390-6:2000 E

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 104, Concrete (performance, production, placing and compliance criteria), the Secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2001, and conflicting national standards shall be withdrawn at the latest by December 2003.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

This standard is one of a series concerned with testing concrete.

It is based on the International Standard ISO 4108 – Concrete Determination of tensile splitting strength of test specimens.

As this number of standard together with several other standards for test methods for concrete which are referred to in EN 206 are not easy to number it has been decided.

It is recognized good practice to include measurement of density prior to the determination of tensile splitting strength, as a check on compaction.

This test method was one of a number examined in a Laboratory inter-comparison part-funded by the EC under Measurement and Testing programme, contract MAT1-CT94-0043. The programme and other references showed the following:

- a) Tensile splitting strengths measured between the normal plane platens of testing machines, gave the same results as those using the special curved platens, originally described in ISO 4018. Although, therefore these curved platens have been optionally retained in this standard, they are not necessary for the measurement.
- b) The material used for the packing strips affects the apparent tensile strength measured. This has led to the decision to standardize on hardboard strips, since they provided the lowest standard deviations.
- c) The apparent tensile strength measured depends upon the shape and size of the test specimen used:
 - cubes gave higher measured tensile strengths than cylinders, by approximately 10 %;
 - 150 mm cubes gave lower measured tensile strengths than 100 mm cubes;
 - the effect of cylinder size on measured tensile strength was not found to be significant, possibly due to the variability of the data.

As a result of these conclusions from the laboratory programme, this standard restricts the measurement of tensile splitting strength to cylindrical specimens used with hardboard packing strips, which is the reference method. However, as some countries still test cubical or prismatic specimens, their use has been retained in a normative annex. In cases of dispute, the reference method is the use of cylinders of 150 mm diameter and 300 mm length.

A draft for this standard was published in 1996 for CEN enquiry as prEN 12362. It was one of a series of individually numbered test methods for fresh or hardened concrete. For convenience it has now been decided to combine these separate draft standards into three new standards with separate parts for each method, as follows:

- Testing fresh concrete (EN 12350)
- Testing hardened concrete (EN 12390)
- Testing concrete in structures (EN 12504)

The series EN 12390 includes the following parts where the brackets give the numbers under which particular test methods were published for CEN enquiry:

EN 12390 Testing hardened concrete -

- Part 1: Shape, dimensions and other requirements of specimens and moulds (former prEN 12356:1996)
- Part 2: Making and curing specimens for strength tests (former prEN 12379:1996)
- Part 3: Compressive strength of test specimens (former prEN 12394:1996)
- Part 4: Compressive strength - Specification for testing machines (former prEN 12390:1996)
- Part 5: Flexural strength of test specimens (former prEN 12359:1996)
- Part 6: Tensile splitting strength of test specimens (former prEN 12362:1996)
- Part 7: Density of hardened concrete (former prEN 12363:1996)
- Part 8: Depth of penetration of water under pressure (former prEN 12364:1996)

1 Scope

This standard specifies a method for the determination of the tensile splitting strength of cylindrical test specimens of hardened concrete. A method using cubic or prismatic specimens is included in annex A (normative).

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 12350-1, *Testing fresh concrete – Part 1: Sampling.*

EN 12390-1, *Testing hardened concrete – Part 1: Shape, dimensions and other requirements of specimens and moulds.*

EN 12390-2, *Testing hardened concrete – Part 2: Making and curing specimens for strength tests.*

EN 12390-4, *Testing hardened concrete – Part 4: Compressive strength – Specification for testing machines.*

EN 316, *Wood fibreboards - Definition, classification and symbols.*

3 Principle

A cylindrical specimen is subjected to a compressive force applied to a narrow region along its length. The resulting orthogonal tensile force causes the specimen to fail in tension.

4 Apparatus

4.1 Testing machine, of EN 12390-4.

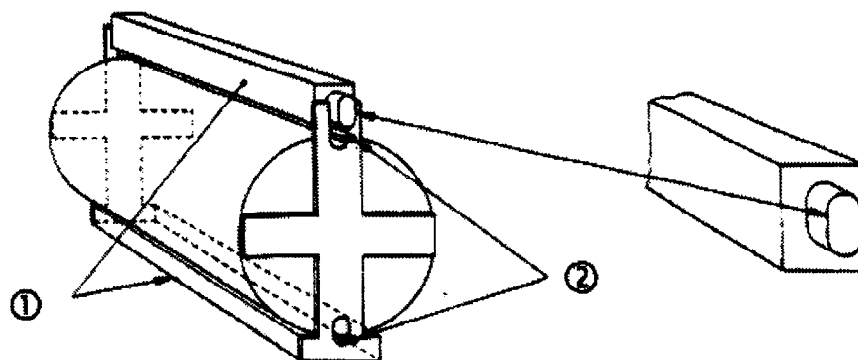
Curved steel loading pieces may be used in place of conventional plane platens, when tests are carried out on cubic or prismatic specimen.

4.2 Jig (optional), for positioning the specimen and the packing strips. The jig shall not restrict the deformation of the specimen during the test.

NOTE A suitable jig for cylindrical specimens is shown in figure 1.

4.3 Packing strips, conforming to EN 316, made of hardboard, of density $> 900 \text{ kg/m}^3$ and dimensions, width $(a) = (10 \pm 1) \text{ mm}$; thickness $(t) = (4 \pm 1) \text{ mm}$ and a length greater than the length of the line of contact of the test specimen. Hardboard packing strips shall be used only once.

Dimensions in millimetres



Key

- 1 Steel loading piece
- 2 Hardboard packing strips

Figure 1 - Jig for testing cylindrical specimens

5 Test specimens

5.1 General

The test specimens shall be cylindrical, conforming to EN 12390-1, but a length/diameter ratio as low as 1 shall be acceptable for cores. Specimens cast in moulds shall conform to EN 12350-1 and EN 12390-2.

The specimens shall be examined and any abnormalities observed shall be reported.

5.2 Adjustment of test specimens

Where the dimensions or shapes of test specimens do not conform to EN 12390-1, because they exceed the respective tolerances, they shall be rejected or adjusted as follows:

- uneven surfaces shall be levelled by grinding;
- the deviation of angles shall be corrected by cutting and/or grinding.

5.3 Marking

Unless a centring jig is used, two lines shall be marked along which to apply the load. These lines shall be opposite each other in an axial plane and the extremities of the two lines shall be connected over each end of the specimen, to define clearly the plane of loading.

6 Procedures

6.1 Specimen preparation

For specimens stored in water, wipe any excess moisture from the surface of the specimen before placing in the testing machine.

Wipe the bearing surfaces of the jig, packing strips, loading pieces and platens. Clean and remove any loose grit or other extraneous material from the surface of the specimen that will be in contact with the packing strips.

6.2 Specimen positioning

Place the test specimen centrally in the testing machine, optionally using a jig. Carefully position packing strips and, if required, loading pieces, along the top and bottom of the plane of loading of the specimen.

Ensure that the upper platen is parallel with the lower platen, during loading.

6.3 Loading

Ensure that the specimen remains centred when the load is first applied, either by means of a jig or by temporary supports.

Select a constant rate of loading within the range 0,04 MPa/s (N/mm² x s) to 0,06 MPa/s (N/mm² x s). Apply the load without shock and increase continuously, at the selected constant rate ± 1 %, until no greater load can be sustained.

NOTE The required loading rate on the testing machine is given by the formula:

$$R = \frac{s \times \pi}{2 \times L \times d}$$

where:

R is the rate of increase of load, in newtons per second;

L is the length of the specimen, in millimetres (see Figure 2);

d is the designated dimension of the specimen, in millimetres;

s is the increase in rate of stress, in megapascals per second, or newtons per square millimetre per second.

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

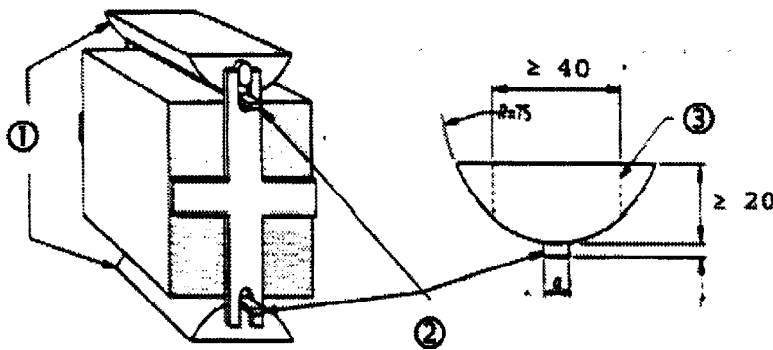
When using automatically controlled testing machines, check the rate of loading periodically, to ensure that the rate is constant.

Record the maximum load indicated.

6.4 Examination of specimen

Examine the fractured specimen and the appearance of the concrete and record, if unusual.

Dimensions in millimetres



Key

- 1 Steel loading piece
- 2 Hardboard packing strips
- 3 Segment may be trimmed

Figure 2 - Curved loading piece

7 Expression of results

The tensile splitting strength is given by the formula:

$$f_{ct} = \frac{2xF}{\pi \times L \times d}$$

where

- f_{ct} is the tensile splitting strength, in megapascals or newtons per square millimetre;
- F is the maximum load, in newtons;
- L is the length of the line of contact of the specimen, in millimetres;
- d is the designated cross-sectional dimension, in millimetres.

NOTE For deviations from the standard method in respect of the dimensions of the specimen, the strength calculation may be based on the actual dimensions of the test specimen.

Express the tensile splitting strength to the nearest 0,05 MPa (N/mm²).

8 Test report

The test report shall include:

- a) identification of the test specimen;
- b) details of adjustment (if appropriate);
- c) surface moisture condition at time of test;
- d) date of test;
- e) appearance of concrete and type of fracture (if unusual);
- f) tensile splitting strength of specimen (to nearest 0,05 MPa or 0,05 N/mm²);
- g) deviations from the standard method of testing;
- h) a declaration from the person technically responsible for the test that the testing was carried out in accordance with this standard except as detailed in item g).

9 Precision

There is currently no precision data for this test.

Annex A

(normative)

Determination of tensile splitting strength using cubic or prismatic specimens

A.1 Scope

This annex specifies a method for the determination of the tensile splitting strength of cubic and prismatic test specimens of hardened concrete.

A.2 Normative references

See clause 2

A.3 Principle

A prismatic specimen is subjected to a compressive force applied to a narrow region. The resulting orthogonal tensile force causes the specimen to fail in tension.

A.4 Apparatus

A.4.1 Testing Machine EN 12390-4.

Curved steel loading pieces may be used in place of or in addition to conventional plane platens (see figure 2).

A.4.2 Jig (optional)

A jig may be used for positioning the specimen and the packing strips. The jig shall not restrict the deformation of the specimen during the test.

A.4.3 Packing strips

See 4.3

A.5 Test specimens

A.5.1 Requirements

The test specimens shall be cubic or prismatic, conforming to EN 12350-1, EN 12390-1 and EN 12390-2.

The specimens shall be examined and any abnormalities observed shall be reported.

A.5.2 Adjustment of test specimens

See 5.2

A.5.3 Marking

See 5.3

A.6 Procedures

The requirements of 6.1 apply.

The plane of loading shall be perpendicular to the trowelled surface.

A.7 Expression of results

See clause 7

NOTE The result obtained from testing a prismatic specimen of concrete is likely to be some 10 % higher than that obtained from testing a cylindrical specimen of the same concrete.

A.8 Test report

The test report shall include the items listed in clause 8 and in addition it shall be stated that the specimen was cubic or prismatic and the dimensions of the specimen shall be reported.

A.9 Precision

There is currently no precision data for this test.

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