SLOVENSKI STANDARD
SIST EN 12390-13:2014

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Preskušanje strjenega betona - 13. del: Določanje sekantnega modula elastičnosti pri tlačni obremenitvi

Testing hardened concrete - Part 13: Determination of secant modulus of elasticity in compression

Prüfung von Festbeton - Teil 13: Bestimmung des Elastizitätsmoduls unter Druckbelastung (Sekantenmodul)

Essai pour béton durci - Partie 13: Détermination du module sécant d'élasticité en compression

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Testing hardened concrete - Part 13: Determination of secant modulus of elasticity in compression

Essais pour béton durci - Partie 13: Détermination du module sécant d'élasticité en compression

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 12390-13:2013) has been prepared by Technical Committee CEN/TC 104 “Concrete and related products”, 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of an identical text or by endorsement, at the latest by April 2014, and conflicting national standards shall be withdrawn at the latest by April 2014.

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

It is based on an extensive investigation and comparison of existing National Standards: ASTM, BS, DIN, ISO, NORD TEST and UNI followed by the analysis of a test programme involving five laboratories carried out by UNI.

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

The series EN 12390, *Testing hardened concrete,* consists of the following parts:

— *Part 1: Shape, dimensions and other requirements of specimens and moulds*

— *Part 2: Making and curing specimens for strength tests*

— *Part 3: Compressive strength of test specimens*

— *Part 4: Compressive strength - Specification for testing machines*

— *Part 5: Flexural strength of test specimens*

— *Part 6: Tensile splitting strength of test specimens*

— *Part 7: Density of hardened concrete*

— *Part 8: Depth of penetration of water under pressure*

— *Part 13: Determination of secant modulus of elasticity in compression*

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies the method for the determination of the secant modulus of elasticity in compression of hardened concrete on test specimens which may be cast or taken from a structure.

The test method allows the determination of two secant moduli of elasticity: the *initial modulus*, $E_{C,0}$ measured at first loading and the *stabilized modulus*, $E_{C,S}$ measured after three loading cycles.

Two different test methods are given. The first (method A) is for determination of both initial and stabilized moduli, the second (method B) is for determination of stabilized modulus only.

2 Normative references

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

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 12390-3, *Testing hardened concrete — Part 3: Compressive strength of test specimens*

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

EN 12504-1:2009, *Testing concrete in structures — Part 1: Cored specimens – Taking, examining and testing in compression*

EN ISO 9513, *Metallic materials — Calibration of extensometer systems used in uniaxial testing (ISO 9513)*

3 Terms and definitions, symbols and scripts

3.1 Terms and definitions

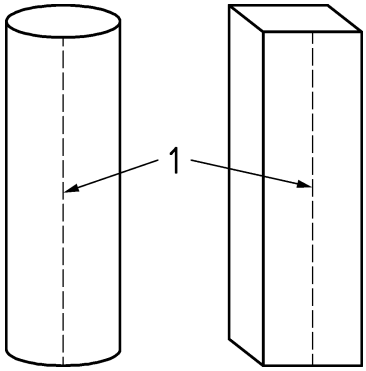
For the purposes of this document, the following terms and definitions apply.

3.1.1
initial secant modulus of elasticity
$E_{C,0}$
secant slope of the stress strain curve at first loading

3.1.2
stabilized secant modulus of elasticity
$E_{C,S}$
secant slope of the stress strain curve after three loading cycles

3.1.3
base or gauge length
length used as reference base for strain measurement

3.1.4
measuring line
straight line laying on the lateral surface of the specimen and parallel to the vertical axis (see Figure 1)



Key

1 measuring line

Figure 1 — Measuring line on cylinder and prismatic specimens

3.2 Symbols and scripts

For the purposes of this European Standard, the symbols and scripts in Table 1 apply.

Table 1 — Symbols and scripts (1 of 2)

Symbol	Explanation
$E_{C,0}$	Initial secant modulus of elasticity
$E_{C,S}$	Stabilized secant modulus of elasticity
ε	Measured strain
ΔL	Change in measured length
L_0	Initial gauge length of instrument
L	Specimen length
d	Specimen diameter or width
D	Upper sieve size (for definition of aggregates size, see EN 12620)
D_{max}	Declared value of D of the coarsest fraction of aggregates actually used in the concrete
f_c	Compressive strength of concrete determined by testing companion specimens – cylinders, prisms, cubes or cores – or estimated from non-destructive tests
σ_a	Nominal upper stress = f_c / 3
σ_b	Nominal lower stress – arbitrary value between 10 % and 15 % of f_c
σ_p	Nominal preload stress – arbitrary value between 0,5 MPa and σ_b
ε_a	Strain along each measuring line at upper stress
ε_b	Strain along each measuring line at lower stress
ε_p	Strain along each measuring line at preload stress
$\varepsilon_{a,\,n}$	Average strain at upper stress on loading cycle n
$\varepsilon_{b,\,n}$	Average strain at lower stress on loading cycle n

Table 1 (2 of 2)

Symbol	Explanation
$\varepsilon_{p,\,n}$	Average strain at preload stress on loading cycle n
σ_a^m	Measured stress corresponding to nominal upper stress, σ_a
σ_b^m	Measured stress corresponding to nominal lower stress, σ_b
σ_p^m	Measured stress corresponding to nominal preload stress, σ_p
$\Delta\sigma$	Difference between measured stresses σ_a^m and σ_b^m (Method A) or σ_a^m and σ_p^m (Method B)
$\Delta\varepsilon_0$	Strain difference during first loading cycle
$\Delta\varepsilon_s$	Strain difference during third loading cycle

4 Principle

A test specimen is loaded under axial compression, the stresses and strains are recorded and the slope of the secant to the stress-strain curve is determined at first loading (Method A only) and after three loading cycles (Methods A and B).

The secant slope is known as the secant modulus of elasticity in compression.

The test specimens may be either cast or taken from an existing structure.

5 Apparatus

5.1 Test machine

Compression testing machine conforming to EN 12390-4 with following additional requirements:

a) suitable for execution of programmable loading cycles;

b) able to increase and decrease the load at a constant rate within a given tolerance (see 7.3.1 and 7.3.2);

c) able to maintain a constant load at selectable nominal values with a maximum variation within ± 5 %;

d) calibrated as Class 1 to EN 12390-4 over the working range from the lower stress to the upper stress as defined in 7.3.1 and 7.3.2 .

NOTE The test lends itself to the use of automatic control test machines. However, if manual control test machines can be shown to comply with b), c) and d) above, they can be used.

5.2 Instrumentation

Instrumentation measuring the strain of the specimen under axial compression along a measuring line shall be Class 2 as determined in accordance with EN ISO 9513 in the range from 0 μm/m to 1 000 μm/m.

The instrumentation can measure strain directly (e.g. resistive strain gauges) or take the form of measuring length change from which the strain, ε, is calculated with the formula:

$$\varepsilon = \frac{\Delta L}{L_0} \qquad (1)$$

5.3 Base or gauge length

The base or gauge length of the strain measuring instrument shall be between two-thirds of the specimen diameter (or section width) and one-half of the specimen length and not less than $3D_{max}$.

NOTE For specimens where L/d is between 3,5 and 4,0, the gauge length can be increased to up to 2/3 of the specimen length.

6 Test specimens

6.1 Shape and dimensions of specimens

The test specimens shall be moulded (cylinder or prism) or drilled cores complying with the requirements of EN 12390-1 or EN 12504-1. The dimension d (diameter or width) shall be at least 3,5 times D_{max}. The ratio between the specimen length L and the dimension d shall be in the range $2 \leq L/d \leq 4$.

The recommended test specimen shall be cylinders of diameter 150 mm and height 300 mm (reference specimen). Alternatively, other test specimens generally complying with the requirements of EN 12390-1 may be used, provided that the specimen complies with the dimensions and aggregate size to diameter or width stated above. In the case of specimens drilled or cut from a structure, this requirement sometimes cannot be fulfilled; in such cases, this shall be stated in the test report.

NOTE The size of the test specimen can have an influence on the result.

If relevant, the adjustment of test specimen shall comply with EN 12390-3.

Companion specimens should be available for the determination of compressive strength as described in 7.2 and shall be made from the same batch of concrete in the case of cast specimens, or shall be drilled from the same zone in the case of drilled specimens.

6.2 Curing, storage and conditioning

Moulded specimens shall be cured or stored in accordance with EN 12390-2, cored specimen in accordance with EN 12504-1. Before testing they shall be maintained at (20 ± 2) °C for sufficient time for strain measuring instruments to be securely fixed but not longer than 24 h out of water. During the time out of water, precautions shall be taken to ensure the specimen remains moist.

7 Method

7.1 Specimen instrumentation and positioning

The strain measuring instruments shall be positioned in such a way that the measuring base is at equivalent distance from the end faces of the specimen.

At least two strain measuring instruments shall be symmetrically arranged with respect to the central axis of the specimen.

The specimen shall be centred on the lower platen.

7.2 Determination of compressive strength

The compressive strength of concrete f_c shall be determined in accordance with EN 12390-3 on companion specimen(s) preferably having the same size and shape of those specimens used for secant modulus of elasticity determination.