BRITISH STANDARD

BS EN
447:2007

Grout for prestressing tendons — Basic requirements

The European Standard EN 447:2007 has the status of a British Standard

ICS 91.100.10; 91.100.30

National foreword

This British Standard is the UK implementation of EN 447:2007. It supersedes BS EN 447:1997 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee B/525, Building and civil engineering structures, to Subcommittee B/525/2, Structural use of concrete.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 November 2007

ISBN 978 0 580 55814 6

Amendments issued since publication

Amd. No.	Date	Comments

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 447

October 2007

ICS 91.100.30

Supersedes EN 447:1996

English Version

Grout for prestressing tendons - Basic requirements

Coulis pour câble de précontrainte - Prescriptions pour les coulis courants

Einpressmörtel für Spannglieder - Allgemeine Anforderungen

This European Standard was approved by CEN on 21 June 2007.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 447:2007: E

Contents

Page

Foreword

This document (EN 447:2007) 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 2008, and conflicting national standards shall be withdrawn at the latest by April 2008.

This document supersedes EN 447:1996.

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, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

In post-tensioned prestressed concrete construction, the grouting of tendons is an important operation. The intention of this European Standard is to provide basic requirements for the approval of cement grouts, compliance with which will satisfy the requirements in prEN 13670.

The main function of grouting is to:

- Provide protection to the prestressing steel against corrosion;
- Provide a bond between the prestressing steel and the ducts where required for the design of the structure;
- Allow transfer of compressive stresses in the structure in a direction transverse to internal tendons;
- Fill all voids where water may accumulate and cause frost damage.

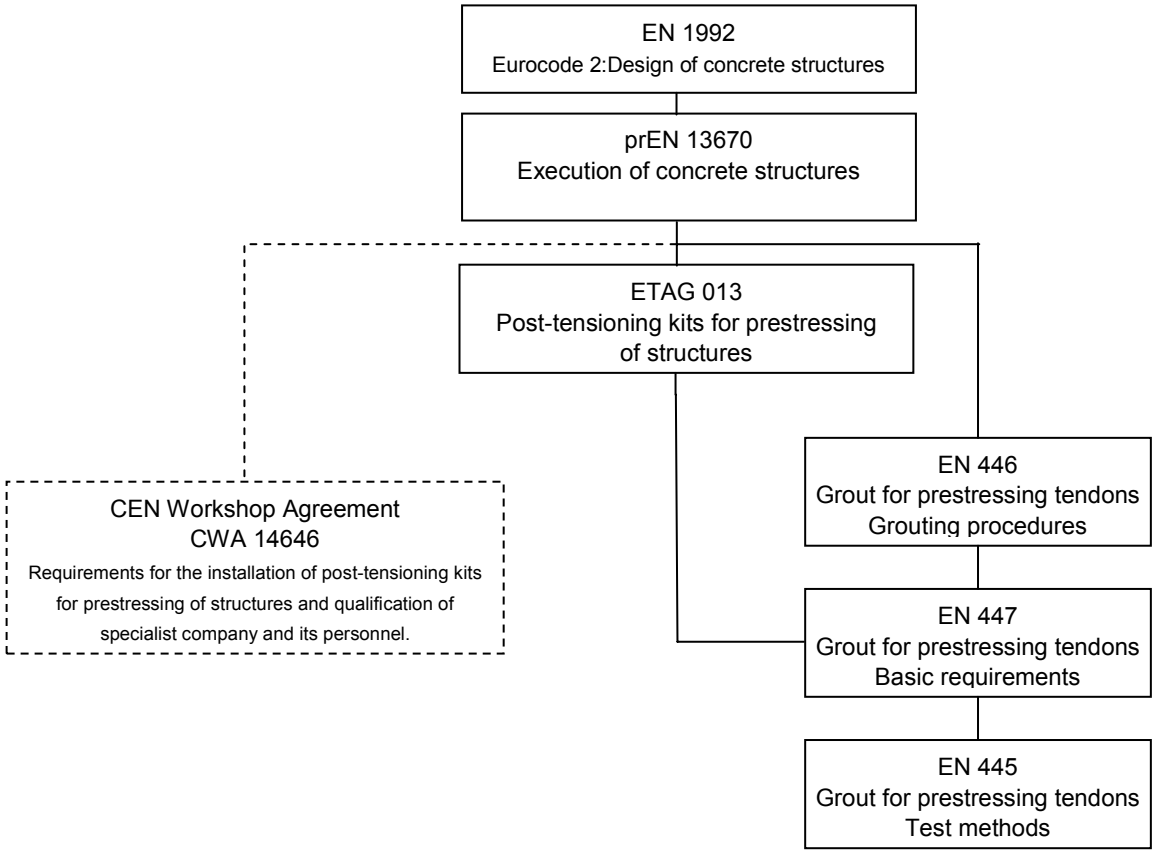
The testing regimes anticipated by this European Standard include three levels:

(1) Initial type and audit testing in accordance with this European standard;

(2) Suitability testing for confirmation of the selected grout for a specific project in accordance with EN 446;

(3) Inspection during grouting works on a specific project in accordance with EN 446.

The test methods for each of the regimes are given in EN 445.



System of CEN and EOTA documents as basis for design, execution and materials selection for protective measures of prestressing systems (only main modules).

1 Scope

This European Standard covers the materials that may be used in the manufacture of cement grouts and the required properties and composition of the grout. It is applicable to grouting of tendons in all types of structures including bridges and buildings.

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.

EN 196-3, *Methods of testing cement – Part 3: Determination of setting times and soundness*

EN 197-1, *Cement – Part 1: Composition, specifications and conformity criteria for common cements*

EN 206-1:2000, *Concrete – Part 1: Specification, performance, production and conformity*

EN 445, *Grout for prestressing tendons – Test methods*

EN 446, *Grout for prestressing tendons – Grouting procedures*

EN 934-2, *Admixtures for concrete, mortar and grout – Part 2: Concrete admixtures - Definitions, requirements, conformity, marking and labelling*

EN 934-4, *Admixtures for concrete, mortar and grout – Part 4: Admixtures for grout for prestressing tendons – Definitions, requirements, conformity, marking and labelling*

EN 1008, *Mixing water for concrete – Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete*

EN 13263 (all parts), *Silica fume for concrete*

3 Terms and definitions

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

3.1
grout
homogeneous mixture of cement and water, it may contain admixtures and additions

3.2
tendon
assembly of prestressing steel and sheath with anchorages and all necessary auxiliary components to permit grouting, either placed internally or externally to the concrete structure

4 Materials

4.1 Cement

Cement shall comply with EN 197-1 type CEM I (portland cement) or any other type of cement permitted for grouting of tendons in the place of use of the grout. The cement type shall be declared.

4.2 Water

Water shall comply with EN 1008.

4.3 Admixtures

Admixtures shall comply with EN 934-4 or EN 934-2. It shall be permissible to use admixtures singly or in combination. Admixtures shall only be used according to the admixture manufacturer's instructions.

4.4 Additions

Grout complying with this standard may contain silica fume. The silica fume shall comply with EN 13263.

If permitted in the place of use grout may contain other additions intended for the use in concrete in accordance with section 5 of EN 206-1:2000. The type and amount of additions shall be declared.

5 Batching and mixing of grout

Materials may be batched and mixed on site to fabricate grout. Alternatively, the dry materials may be batched in a factory for ready-mixed grout and mixed with the liquid materials on site to fabricate grout.

All materials shall be batched by mass except the mixing water and liquid admixtures which may be batched by mass or volume. The accuracy of batching shall be

— ± 2 % for cement, dry admixtures and additions,

— ± 1 % for water and liquid admixtures,

of the quantities specified.

Water contained in liquid admixtures shall be included in the calculation of w/c ratio.

All pozzolanic materials used as separate ingredients shall be included in the calculation of w/c ratio in accordance with the procedures in EN 206-1.

Mixing shall be carried out mechanically with suitable equipment to obtain a homogeneous and stable grout with the plastic properties given in Clause 6.

For any grout fabricated in accordance with this European standard the following information shall be declared by the grout manufacturer:

— mix proportions of materials:

— w/c ratio and its acceptable tolerance;

— sequence of introducing the materials, type of mixer and mixing time;

— range of temperature for which the grout complies with this European standard.

NOTE 1 Grouts complying with this standard will normally have a w/c ratio below 0,4.

NOTE 2 EN 446 requires suitability testing to be carried out using the same type of mixing equipment as to be used for the actual project operations. Hence, it is preferable to also use the same type of equipment for all testing as far as possible.

6 Properties of grout

6.1 General

The grout shall not contain more than:

— Chloride (Cl^-) ≤ 0,10 % by weight of cement;

— Sulfate (SO_3^{2-}) ≤ 4,5 % by weight of cement;

— Sulfide-ions (S^{2-}) ≤ 0,01 % by weight of cement.

These values are the summation of the chloride, sulfates, sulfites and sulfurs occurring in the constituent materials. Deliberate addition of chloride or sulfate is not permitted.

Grout shall comply with the requirements given in 6.2 to 6.8 for:

— sieve test;

— fluidity;

— bleeding;

— volume change;

— strength;

— setting time;

— fluid density.

Testing shall be in accordance with EN 445.

Other test methods may be used if the correlation or safe relationship between the results of these test methods and the reference methods of EN 445 have been established.

The performance requirements of 6.2 to 6.8 shall be satisfied for the range of conditions of temperature as declared by the grout manufacturer.

For pre-bagged grout, the range of temperature shall be stated on the package or accompanying records.

6.2 Sieve test

Grout shall be tested according to EN 445 and no lump shall remain in the sieve.

6.3 Fluidity

The fluidity of the grout during the injection period shall be measured by either one of the methods given in EN 445 and the grout shall have the values given in Table 1.

Fluidity should not change by more than 20 % from immediately after mixing to 30 min after mixing or any later time specified by the grout manufacturer.

Table 1 – Fluidity test requirements

Test method given in EN 445		Immediately after mixing	30 min after mixing [1] or at the time specified by the grout manufacturer
Cone	Time (in s)	$t_0 \leq 25$ s	$1{,}2\ t_0 \geq t_{30} \geq 0{,}8\ t_0$ and $t_{30} \leq 25$ s
Grout spread	a = average spread (in mm)	$a_0 \geq 140$ mm	$1{,}2\ a_0 \geq a_{30} \geq 0{,}8\ a_0$ and $a_{30} \geq 140$ mm
[1] Mixing time shall be measured from the time when all materials are in the mixer.			

NOTE Fluidity measurements immediately after mixing are denominated t_0 (cone method) and a_0 (grout spread method), fluidity measurements made 30 minutes after mixing, i.e. 30 minutes after the first measurements, are denominated t_{30} and a_{30}. Grout shall be kept constantly in motion until sampling for measurement of t_{30} and a_{30}.

6.4 Bleeding

The bleeding of the grout shall be sufficiently low to prevent excessive segregation and sedimentation of the grout materials.

When tested by the wick induced method given in EN 445 for the average of three results the bleeding shall not exceed 0,3 % of the initial volume of the grout after 3 h kept at rest.

When tested by the inclined tube test method given in EN 445 the bleeding shall not exceed 0,3 % of the initial volume of the grout after 3 h kept at rest.

6.5 Volume change

The volume change assessed may be either an increase or decrease. When tested in accordance with the method given in EN 445 the volume change of the grout at rest for 24 h shall be within the range of - 1 % and + 5 %.

6.6 Strength

The compressive strength of grout assessed according to EN 445 shall be not less than 30 N/mm^2 at 28 days or 27 N/mm^2 at 7 days if it is proposed to estimate the likely 28 day strength at 7 days.

6.7 Setting time

Setting time of grout shall be measured according to EN 196-3 and shall comply with the following:

— Initial set of the grout; ≥ 3 h.

— Final set of the grout; ≤ 24 h.

6.8 Density

Fluid density shall be measured in accordance with the method given in EN 445 and shall be declared.

7 Evaluation of conformity

7.1 Production control

The grout manufacturer shall exercise internal control of the grout fabrication. The requirements shall be documented. This requirement applies to grout dry-batched in a factory and to grout batched on site. Type and frequency of checks shall be considered as a function of the production process.

Incoming materials shall be checked for compliance with the specification. CE marked materials shall be assumed satisfactory and need, except in case of justified doubt, no further checking.

Products, which are considered as not conforming, shall be immediately marked and separated from such products, which comply.

7.2 Initial type testing

Initial type testing shall be performed for any grout well before any use on a project under the following conditions:

— for each new grout mix design;

— when there is a change in the materials used for the grout which is likely to have a significant effect on the performance of the grout;

— if the grout is intended to be used in a temperature range for which no prior initial testing has been performed.

The properties, test methods and the minimum number of tests for the initial type testing are specified in Table 2.

Table 2 – Extent of initial type testing

Property	Test Method [1)]	Minimum number of tests
Homogeneity	Sieve test	1 test
Fluidity	Cone method	1 test immediately after mixing
	Grout Spread	2 tests 30 min after mixing
Bleeding	Wick Induced [2)]	3 tests
	Inclined Tube	1 test (two tubes)
Volume Change	Wick Induced [2)]	3 tests
Compressive strength	Broken halves of prisms	1 test (two halves)
Setting time	EN 196-3	1 test
Density	Weight to volume	1 test immediately after mixing

[1)] Testing shall be in accordance with EN 445. Other test methods may be used if the correlation or safe relationship between the results of these test methods and the reference methods of EN 445 have been established.

[2)] Tests for bleeding and volume change are performed on the same sample.

Fluidity, wick-induced bleeding, setting time and density shall be tested for the minimum and maximum temperature of the declared temperature range, and for the reference temperature of (20 ± 3) °C. However, if the minimum and maximum are within 15 °C or less and centred approximately around 20 °C, then testing at the reference temperature of (20 ± 3) °C shall be considered sufficient. Other tests are carried out only at the reference temperature.

7.3 Audit testing

During ongoing fabrication of a particular grout, audit testing shall be performed in regular intervals to confirm the validity of the results of the initial type testing. Audit testing of grout at the reference temperature of (20 ± 3) °C shall be considered acceptable.

Results of suitability testing of the same grout on projects in accordance with EN 446 may be considered as part of the audit testing.

The properties, test methods and the minimum test frequencies for the audit testing are specified in Table 3.

Table 3 – Extent of audit testing

Property	**Test Method** [1)]	**Minimum test frequency** **Number of tests per year** [3)]
Homogeneity	Sieve test	4 tests
Fluidity	Cone method	4 tests immediately after mixing
	Grout Spread	8 tests 30 min after mixing
Bleeding	Wick Induced [2)]	6 tests
	Inclined Tube	1 test (two tubes)
Volume Change	Wick Induced [2)]	6 tests
Compressive strength	Broken halves of prisms	3 tests (two halves)
Setting time	EN 196-3	1 test
Density	Weight to volume	4 tests immediately after mixing

[1)] Testing shall be in accordance with EN 445. Other test methods may be used if the correlation or safe relationship between the results of these test methods and the reference methods of EN 445 have been established.

[2)] Tests for bleeding and volume change are performed on the same sample.

[3)] Tests shall be done at reasonably regular intervals during the year.

Bibliography

[1] prEN 13670, Execution of concrete structures

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001. Fax: +44 (0)20 8996 7001. Email: orders@bsi-global.com. Standards are also available from the BSI website at http://www.bsi-global.com.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: info@bsi-global.com.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001. Email: membership@bsi-global.com.

Information regarding online access to British Standards via British Standards Online can be found at http://www.bsi-global.com/bsonline.

Further information about BSI is available on the BSI website at http://www.bsi-global.com.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL