



SLOVENSKI STANDARD
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Injekcijska masa za prednapete kable - Postopki injektiranja

Grout for prestressing tendons - Grouting procedures

Einpreßmörtel für Spannglieder - Einpreßverfahren

Coulis pour câble de précontrainte - Procédures d'injection de coulis

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English version

Grout for prestressing tendons - Grouting procedures

Coulis pour câble de précontraintes -
Procédures d'injection de coulis

Einpreßmörtel für Spannglieder -
Einpreßverfahren

This European Standard was approved by CEN on 1994-10-28. 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 Central Secretariat or to any CEN member.

The European Standards exist 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 Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Foreword

This European Standard has been prepared by the 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of an identical text or by endorsement, at the latest by September 1996, and conflicting national standards shall be withdrawn at the latest by September 1996.

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

0 Introduction

In post-tensioned prestressed concrete construction, the grouting of tendons is an important operation. The intention of this European Standard is to provide a specification for grouting, compliance with which will satisfy the recommendations in ENV 1992-1-1.

The main function of grouting is to fill the sheaths or cable ducts as fully as possible with grout in order to provide protection to the tendons against corrosion and to provide bond between the tendons and the sheaths.

1 Scope

This European Standard gives the procedures to be used in grouting of post-tensioned prestressed concrete with common grout. Other more specialised grouts may require additional specification to that given herein.

This Standard also covers preliminary assessment, suitability assessment and quality control procedures for grouts and their component materials.

In this Standard values are specified which are marked (+). These values may be varied depending upon circumstances on site, provided that all the other requirements of this Standard are met.

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.

EN 445

Grout for prestressing tendons – Methods of test ¹⁾

EN 447

Grout for prestressing tendons – Specification for common grouts ¹⁾

ENV 1992-1-1 : 1992

EUROCODE 2: Design of concrete structures – Part 1: General rules and rules for buildings

3 Definitions

3.1 Grouting

The injection into sheaths or tendon ducts with grout in a continuous operation.

3.2 Post injection

Complementary operation to grouting in order to replace air or water voids by grout in the ducts before the stiffening of the original grout.

¹⁾ At present at the draft stage.

3.3 Post grouting

Complementary operation to grouting in order to replace air or water voids by grout in the ducts after the stiffening of the original grout.

4 Preliminary assessment

When undertaking this assessment care shall be taken to ensure that the materials used shall be those which are proposed for use. The materials shall be assessed in a laboratory both separately and in the combinations proposed for use.

NOTE 1: The combination for cement and admixture(s) is sensitive and requires to be verified by preliminary assessment.

5 Suitability assessment

5.1 General

Prior to the start of a job a proposal covering materials, equipment, grouting procedures and quality control shall be assessed by the competent authority. In certain circumstances, grouting trials on sheaths in representative forms of a construction may be required, e. g. when there is doubt about the ability to grout particular sheath successfully.

The properties of the grout, made with the materials, and using the plant and personnel proposed for use on site, shall be assessed for suitability for the intended purpose sufficiently in advance of grouting operations, to enable adjustments to be made in the use of the materials or plant or personnel.

5.2 Materials assessment

The materials assessment shall consist of the preparation of the grout, made with the materials, and using the plant and personnel proposed for use on site, and the testing of it in accordance with clause 5 of EN 447 and EN 445. The preparation shall be carried out under the conditions of temperature given in 7.5 of this Standard or expected on site.

The above requirement may be waived where the results of earlier tests on grout made with materials and on plant sensibly identical to that proposed for use, are satisfactory. These test results shall date from not more than 2 months before grouting.

6 Equipment

6.1 General

Grouting equipment shall consist of a mixer, a storage reservoir and a pump with all the necessary connection hoses, valves, measuring devices for water, cement and admixtures and testing equipment.

The mixing equipment shall be capable of producing grout which possesses an even distribution of cement, an even dispersal of admixtures and a minimum presence of cement lumps and accords with the requirements of clause 5 of EN 447.

6.2 Screen

The grouting equipment shall contain a screen the openings of which shall be 2 mm maximum, through which the grout passes prior to its introduction into the storage reservoir.

6.3 Storage reservoir

The mixer shall have an additional storage reservoir with an agitator to keep the grout moving continually before it is pumped into the duct. During interruptions in pumping, the grout shall be recirculated.

The capacity of the mixer and the storage reservoir shall be such that the duct can be filled without interruption and at the required speed.

6.4 Pump

The pump shall provide a continuous flow of grout and shall maintain a pressure of at least 1 MPa; it shall be equipped with a pressure gauge.

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A pressure relief valve shall be incorporated to prevent pressures above 2 MPa, or above any other value determined by the chosen grouting procedure.

Limiting the grout pressure serves to:

- prevent blow-outs of hoses, inlets and outlets
- prevent damage to the concrete structure
- protect the equipment and valves from damage
- protect the operators
- prevent segregation
- control the grout flow.

The use of compressed air for pumping shall not be allowed. The pump shall be constructed in such a way as to prevent introduction of air, oil or other foreign substances into the grout. The capacity of the pump shall be such that the duct can be adequately grouted. The use of a pump with a variable output gives the advantage that it can be adapted to the requirements of ducts of different diameters.

6.5 Hoses

The diameter and rated pressure capacity of the grout hoses shall be compatible with the pump output, the assumed maximum pressure and the length needed. Hoses connectors shall normally not reduce the inside clear diameter available in the hoses.

6.6 Inlet connections

The grout hoses shall be tightly connected to the inlets of the duct. Clamps, bayonet or similar connections are recommended. Narrow openings, through which the grout must pass, shall be avoided, as the resulting pressure build-up can lead to danger of blockage.

A pressure gauge shall normally be mounted at the grout inlet.

NOTE 2: This should apply only where the hose length is greater than 30 m ((+) see clause 1).

In the event of sudden and abnormal pressure increases, an additional pressure gauge located at the grout inlet will indicate whether the reason for the pressure build up lies within the tendon duct or in the grout hoses.

6.7 Stand-by equipment

The arrangements for the provision of stand-by equipment shall be decided in each case.

7 Grouting procedure

7.1 General

Prior to the start of grouting operations a proposal concerning grouting procedure shall be provided by the contractor and be assessed by the competent authority. The procedure shall ensure that the sheaths are properly filled with grout. In certain circumstances grouting trials on sheaths in representative forms of construction may be required, e. g. when there is a doubt about the ability to grout a particular sheath successfully.

NOTE 3: In some countries there are special requirements based on the current knowledge and experience gained with particular grouts, equipment and grouting procedures.

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7.2 Personnel

Grouting operations shall be under the charge of a person with appropriate knowledge, training and experience in production, testing and control systems who shall be responsible for the production and injection of the grout. That person, or an appropriately trained representative, shall be present during all grouting procedures and shall be responsible for all safety precautions relating to the preparatory and grouting operations.

NOTE 4: In some countries there are special requirements regarding standards of knowledge, training and experience for the different tasks.

7.3 Inlets and outlets

The position of the inlets and outlets is related to the type and geometry of the tendons as well as to the procedure for grouting and post grouting the ducts.

Inlets and outlets are normally placed at the following locations:

- inlets or outlets at the anchorages and couplers
- outlets at or near the high points of the duct if the difference between the highest and lowest point is more than 0,5 ((+) see clause 1)
- inlets at the lowest points of strongly inclined, vertical or loop tendons and at specific points when grouting is to be carried out in stages.

7.4 Precautions before grouting

NOTE 5: Sheaths should be grouted as soon as possible after the steel is tensioned. If the delay between inserting the tendons and grouting the sheaths is likely to permit corrosion of the tendons, consideration should be given to the possible use of protective soluble oils on the steel or dry air in the sheath. These operations should only proceed in accordance with the recommendations of the supplier of the system and it should be verified that their use will not have an adverse effect upon the tendons or the properties of the grout or its bond with the tendons. Some countries require the permission of authority for the use of some of these procedures.

Depending upon the tendon installation method, it may be necessary to ensure that the sheath, vents, inlets and outlets are capable of accepting injection of the grout. This shall be done by blowing through the system with dry air.

Where there is water in the duct it shall be removed. Outlets at the lowest points and compressed air may be used for this purpose. The consequences of water remaining in the duct must be considered in order to choose the appropriate grouting procedure.

The injection procedure shall ensure that sheaths are completely filled. Sheaths shall be grouted at a continuous and steady rate which shall be slow enough to prevent the segregation of the water from the grout at points where flow is restricted.

Undulating ducts shall be grouted from the lowest point if the maximum deflection is more than 1,5 m ((+) see clause 1).

7.5 Temperature at grouting

Records shall be kept of the maximum and minimum air temperatures and the temperatures of the members to be grouted.

Grout shall normally be injected when the air temperature and the temperature of the members to be grouted and the grout within the ranges given in table 1.

Table 1: Temperatures at grouting

Temperature °C	Air	Member	Grout
Minimum	5	5	10
Maximum	30	25	25

When any of the temperature are less than the minimum or greater than the maximum given in table 1 special precautions valid in the place of grouting may be necessary which ensure that the sheaths can be grouted successfully.

Tendons shall not be heated unless the general temperature of the members to be grouted is also raised by heating. Materials and equipment shall be completely free of snow, frost and ice.

Notwithstanding the above requirements the temperature of freshly mixed grout shall not exceed 35 °C.

7.6 Grouting operations

Non-retarded grout shall be used within 30 minutes after mixing. The time limit is particularly important when the grout includes an expanding admixture.

NOTE 6: The maximum length grouted in one operation should be not more than 50 m ((+) see clause 1) unless additional injection points are provided.

Normally the rate of grouting will vary from 5 to 15 ((+) see clause 1) metres per minute. In general the ducts shall be grouted from the lowest inlet.

Grouting shall continue until the fluidity of the grout flowing from the outlets is the same as the grout being injected to within the limits specified in 5.2 of EN 447. The outlets shall be successively closed as the filling of the duct progresses.

After completion of grouting the unintended loss of grout from the duct from the duct shall be prevented.

NOTE 7: This may be facilitated by maintaining a pressure of 0,5 MPa for one minute.

The outlets at high points shall be opened shortly after grouting to allow bleed water to be displaced from the ducts. Vertical ducts shall be grouted from the lowest point using appropriate procedures.

Attention shall be given to anchorages, couplers and high points especially in undulating tendons with difference in level more than 0,5 m ((+) see clause 1) and in strongly inclined or vertical tendons.

7.7 Precautions after grouting

Anchorages, vents and other metallic items that are to remain permanently in place shall be protected against corrosion and the ingress of water or other aggressive agents prevented.

7.8 Post injection

Post injection shall normally be carried out with freshly mixed grout.

NOTE 8: If tendons consist of prestressing strands, pressure grouting may be applied. Directly after grouting, the post injection of grout into the duct should be continued at gradually increasing pressure to a maximum of not greater than 1 MPa. The anchorages should be sealed in such a way that the ends of strands protrude from the anchorages.

If tendons consist of prestressing bars, wires or strands the post injection of grout may be carried out when most of the bleed water is separated in the duct and just before the grout stiffens. Pumping grout through inlets at various points may be needed in order to expel bleed water through outlets.

7.9 Post grouting

When the grout in ducts is already stiffened and control procedures at inlets and outlets shown that water or air voids are formed, post grouting shall be carried out. These voids shall be filled with freshly mixed grout. In some cases vacuum grouting may be required.

8 Quality control

8.1 General

Quality control consists of:

- internal control conducted by the contractor according to rules established by the client or by the competent authority
- external control carried out by an independent organisation to verify the results of internal control. Additional checking procedures may be required by the client or the competent authority.

8.2 Materials

It has to be checked that only constituent materials are used which comply with European Standards (see EN 447, clause 4) or with European Technical Approvals.

8.3 Equipment

The equipment shall be assessed as follows:

- checking and approving grouting equipment and qualifications of personal by the competent authority,
- inspecting and approving grouting installations by the competent authority.