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Grout for prestressing tendons —

Part 1: Basic requirements

Coulis pour câbles de précontrainte —

Partie 1: Exigences essentielles

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Contents

Page

Foreword ..... **iv**
Introduction ..... **v**
1 Scope **1**
2 Normative references **1**
3 Terms and definitions **1**
4 Materials **1**
4.1 General 1
4.2 Cement 1
4.3 Water 2
4.4 Admixtures 2
4.5 Additions 2
5 Batching and mixing of grout **2**
6 Properties of grout **3**
6.1 General 3
6.2 Sieve test 3
6.3 Fluidity 4
6.4 Bleeding 4
6.5 Volume change 4
6.6 Strength 4
6.7 Setting time 4
6.8 Density 5
7 Evaluation of conformity **5**
7.1 Production control 5
7.2 Initial type testing 5
7.3 Audit testing 6
Bibliography **7**

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 14824-1 was prepared by Technical Committee ISO/TC 71, *Concrete, reinforced concrete and pre-stressed concrete*, Subcommittee SC 3, *Concrete production and execution of concrete structures*.

ISO 14824 consists of the following parts, under the general title *Grout for prestressing tendons:*

— *Part 1: Basic requirements*

— *Part 2: Grouting procedures*

— *Part 3: Test methods*

Introduction

In post-tensioned prestressed concrete construction, the grouting of tendons is an important operation. The intention of this part of ISO 14824 is to provide basic requirements for the approval of cement grouts, compliance with which will satisfy the requirements in ISO 22966.

The main function of grouting is to:

— protect 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 part of ISO 14824 include three levels:

(1) initial type and audit testing in accordance with this part of ISO 14824;

(2) suitability testing for confirmation of the selected grout for a specific project in accordance with ISO 14824-2;

(3) inspection during grouting works on a specific project in accordance with ISO 14824-2.

The test methods for each of the regimes are given in ISO 14824-3.

In some countries requirements exist for independent third-party certification of grout and grouting procedures which should be set out in national requirements to supplement ISO 22966.

Certain special structures or tendon configurations can require grouts with enhanced performance. Any resulting necessary amendment of the requirements of this part of ISO 14824 needs to be included in the execution specification.

Grout for prestressing tendons —

Part 1:
Basic requirements

1 Scope

This part of ISO 14824 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.

ISO 9597, *Methods of testing cement — Determination of setting times and soundness*

ISO 22965-2, *Concrete — Part 2: Specification of constituent materials, production of concrete and compliance of concrete*

ISO 14824-3, *Grout for prestressing tendons — Part 3: Test methods*

ISO 12439, *Mixing water 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, which 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 General

Materials shall have a general suitability in accordance with ISO 22965-2.

4.2 Cement

Cement shall be Portland cement or any other type of cement permitted for grouting of tendons which complies with national standards in the place of use of the grout. The cement type shall be declared.

4.3 Water

Water shall comply with ISO 12439.

4.4 Admixtures

Admixtures shall have an established suitability for use in grouts. It shall be permissible to use admixtures singly or in combination. Admixtures shall only be used according to the admixture manufacturer's instructions unless any variation is proven satisfactory by testing and approved by the manufacturer.

4.5 Additions

Grout complying with this part of ISO 14824 may contain silica fume.

If permitted in the place of use, grout may contain other additions intended for use in concrete in accordance with ISO 22965-2. 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 declared and it shall be stated whether it is included in the calculation of water/cement (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 ISO 22965-2.

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 part of ISO 14824 the following information shall be declared by the grout manufacturer:

— mix proportions of materials;

— w/c ratio and its acceptable variation;

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

— range of temperature for which the grout complies with this part of ISO 14824.

NOTE 1 Grouts complying with this part of ISO 14824 normally have a w/c ratio below 0,45.

NOTE 2 ISO 14824-2 requires suitability testing to be carried out using the same type of mixing equipment as is 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 mass of cement;

— sulfate (as SO_3) ≤ 4,5 % by mass of cement;

— sulfide (S^{2-}) ≤ 0,04 % by mass of cement where ordinary Portland cement is used. Where other cements are permitted the sulfide limit shall be according to national requirements and described in the Execution Specification.

These values are the summation of the chloride, sulfates, sulfites and sulfides occurring in the constituent materials.

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 ISO 14824-3.

Other test methods may be used if the correlation or safe relationship between the results of these test methods and the reference methods of ISO 14824-3 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.

Grout shall be tested as specified in this part of ISO 14824 or in the project specification at the following ambient temperatures:

— reference temperature (20 ± 2) °C or (27 ± 2) °C for hot/tropical climates;

— lowest temperature declared by the manufacturer (−1/+3) °C;

— highest temperature declared by the manufacturer (−3/+3) °C.

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

In the absence of specified maximum and minimum ambient temperatures, it is recommended to use 15 °C above and below the reference temperature

6.2 Sieve test

Grout shall be tested according to ISO 14824-3 and no lumps 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 ISO 14824-3 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.

Where grout for special applications is required to remain fluid for significantly longer periods prior to injection the grout manufacturer shall declare the applicable time and limits (1,2 and 0,8) for the later test.

Where the suitability of high viscosity grout is proven by full-scale trials, alternative limits to those in Table 1 shall be declared by the grout manufacturer.

Table 1 — Fluidity test requirements

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

NOTE Fluidity measurements immediately after mixing are denominated t_0 (cone method) and a_0 (grout spread method), fluidity measurements made 30 min after mixing, i.e. 30 min after the first measurements, are denominated 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 ISO 14824-3, 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 ISO 14824-3, 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 ISO 14824-3 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 ISO 14824-3 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.

NOTE The 7-day strength requirement is not mandatory if the 28-day strength requirement is met.

6.7 Setting time

Setting time of grout shall be measured according to ISO 9597 and shall comply with the following:

— initial set of the grout, ≥ 3 h;

— final set of the grout, ≤ 24 h.

For special applications a longer period to final set may be required in which case the time shall be declared by the manufacturer.

6.8 Density

Fluid density shall be measured in accordance with the method given in ISO 14824-3 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.

Products that are considered as not conforming shall be immediately marked and separated from those products that 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 [a]	Minimum number of tests
Homogeneity	Sieve test	1 test
Fluidity	Cone method	1 test immediately after mixing 2 tests 30 min after mixing
	Grout spread	
Bleeding	Wick induced [b]	3 tests
	Inclined tube	1 test (two tubes)
Volume change	Wick induced [b]	3 tests
Compressive strength	Broken halves of prisms	1 test (two halves)
Setting time	ISO 9597	1 test
Density	Mass to volume	1 test immediately after mixing

[a] Testing shall be in accordance with ISO 14824-3. Other test methods may be used if the correlation or safe relationship between the results of these test methods and the reference methods of ISO 14824-3 have been established.

[b] 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. However, if the difference between minimum and maximum is 15 °C or less and centred approximately around the reference temperature, then testing at the reference temperature shall be considered sufficient. Other tests are carried out only at the reference temperature.

The temperature of the individual constituents of the grout should be recorded and taken into account.

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 shall be considered acceptable.

Results of suitability testing of the same grout on projects in accordance with ISO 14824-2 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 [a]	Minimum test frequency Number of tests per year [c]
Homogeneity	Sieve test	4 tests
Fluidity	Cone method	4 tests immediately after mixing 8 tests 30 min after mixing
	Grout spread	
Bleeding	Wick induced [b]	6 tests
	Inclined tube	1 test (two tubes)
Volume change	Wick induced [b]	6 tests
Compressive strength	Broken halves of prisms	3 tests (two halves)
Setting time	ISO 9597	1 test
Density	Weight to volume	4 tests immediately after mixing

[a] Testing shall be in accordance with ISO 14824-3. Other test methods may be used if the correlation or safe relationship between the results of these test methods and the reference methods of ISO 14824-3 have been established.

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

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

Bibliography

[1] ISO 14824-2, *Grout for prestressing tendons — Part 2: Grouting procedures*

[2] ISO 22965-1, *Concrete — Part 1: Methods of specifying and guidance for the specifier*

[3] ISO 22966, *Execution of concrete structures*

[4] EN 445*, Grout for prestressing tendons — Test methods*

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