BS EN 14227-15:2015

BSI Standards Publication

Hydraulically bound mixtures — Specifications

Part 15: Hydraulically stabilized soils

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National foreword

This British Standard is the UK implementation of EN 14227-15:2015. It supersedes BS EN 14227-12:2006, BS EN 14227-13:2006, BS EN 14227-14:2006 and BS EN 14227-10:2006 which are withdrawn. It partially supersedes BS EN 14227-11:2006.

The UK participation in its preparation was entrusted to Technical Committee B/510/4, Cementitious bound materials, unbound granular materials, waste materials and marginal materials.

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.

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Mélanges traités aux liants hydrauliques - Spécifications - Partie 15: Sols traités aux liants hydrauliques

Hydraulisch gebundene Gemische - Anforderungen - Teil 15: Bodenverfestigung mit hydraulischen Bindemitteln

This European Standard was approved by CEN on 5 September 2015.

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CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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European foreword

This document (EN 14227-15:2015) has been prepared by Technical Committee CEN/TC 227 "Road materials", 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of an identical text or by endorsement, at the latest by May 2016, and conflicting national standards shall be withdrawn at the latest by May 2016.

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.

This document supersedes EN 14227-10:2006, EN 14227-11:2006 (only the sections that cover stabilization), EN 14227-12:2006, EN 14227-13:2006 and EN 14227-14:2006.

This European Standard is one of a series of standards for hydraulically bound mixtures, which includes:

EN 14227-1, *Hydraulically bound mixtures — Specifications — Part 1: Cement bound granular mixtures;*

EN 14227-2, *Hydraulically bound mixtures — Specifications — Part 2: Slag bound granular mixtures;*

EN 14227-3, *Hydraulically bound mixtures — Specifications — Part 3: Fly ash bound granular mixtures;*

EN 14227-4, *Hydraulically bound mixtures — Specifications — Part 4: Fly ash for hydraulically bound mixtures;*

EN 14227-5, *Hydraulically bound mixtures — Specifications — Part 5: Hydraulic road binder bound granular mixtures;*

EN 14227-15, *Hydraulically bound mixtures — Specifications — Part 15: Hydraulically stabilized soils.*

Compared with EN 14227-10:2006 to EN 14227-14:2006, the following change has been made:

— These parts have been merged.

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 hydraulically stabilized soils for roads, airfields and other trafficked areas and specifies the requirements for their constituents, composition and laboratory performance classification.

This European Standard covers the stabilization of soils using one or a combination of: cement, fly ash, hydraulic road binder, lime and blast-furnace slag.

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

EN 459-1, *Building lime — Part 1: Definitions, specifications and conformity criteria*

EN 933-1, *Tests for geometrical properties of aggregates — Part 1: Determination of particle size distribution — Sieving method*

EN 13282 (all parts), *Hydraulic road binders*

EN 13286-2, *Unbound and hydraulically bound mixtures — Part 2: Test methods for laboratory reference density and water content — Proctor compaction*

EN 13286-3, *Unbound and hydraulically bound mixtures — Part 3: Test methods for laboratory reference density and water content — Vibrocompression with controlled parameters*

EN 13286-4, *Unbound and hydraulically bound mixtures — Part 4: Test methods for laboratory reference density and water content — Vibrating hammer*

EN 13286-5, *Unbound and hydraulically bound mixtures — Part 5: Test methods for laboratory reference density and water content — Vibrating table*

EN 13286-40, *Unbound and hydraulically bound mixtures — Part 40: Test method for the determination of the direct tensile strength of hydraulically bound mixtures*

EN 13286-41, *Unbound and hydraulically bound mixtures — Part 41: Test method for the determination of the compressive strength of hydraulically bound mixtures*

EN 13286-42, *Unbound and hydraulically bound mixtures — Part 42: Test method for the determination of the indirect tensile strength of hydraulically bound mixtures*

EN 13286-43, *Unbound and hydraulically bound mixtures — Part 43: Test method for the determination of the modulus of elasticity of hydraulically bound mixtures*

EN 13286-45, *Unbound and hydraulically bound mixtures — Part 45: Test method for the determination of the workability period of hydraulically bound mixtures*

EN 13286-46, *Unbound and hydraulically bound mixtures — Part 46: Test method for the determination of the moisture condition value*

EN 13286-47, *Unbound and hydraulically bound mixtures — Part 47: Test method for the determination of California bearing ratio, immediate bearing index and linear swelling*

EN 13286-48, *Unbound and hydraulically bound mixtures — Part 48: Test method for the determination of degree of pulverisation*

EN 13286-49, *Unbound and hydraulically bound mixtures — Part 49: Accelerated swelling test for soil treated by lime and/or hydraulic binder*

EN 13286-50, *Unbound and hydraulically bound mixtures — Part 50: Method for the manufacture of test specimens of hydraulically bound mixtures using Proctor equipment or vibrating table compaction*

EN 13286-51, *Unbound and hydraulically bound mixtures — Part 51: Method for the manufacture of test specimens of hydraulically bound mixtures using vibrating hammer compaction*

EN 13286-52, *Unbound and hydraulically bound mixtures — Part 52: Method for the manufacture of test specimens of hydraulically bound mixtures using vibrocompression*

EN 13286-53, *Unbound and hydraulically bound mixtures — Part 53: Methods for the manufacture of test specimens of hydraulically bound mixtures using axial compression*

EN 14227-2, *Hydraulically bound mixtures — Specifications — Part 2: Slag bound granular mixtures*

EN 14227-4, *Hydraulically bound mixtures — Specifications — Part 4: Fly ash for hydraulically bound mixtures*

EN 15167-1, *Ground granulated blast furnace slag for use in concrete, mortar and grout — Part 1: Definitions, specifications and conformity criteria*

3 Terms and definitions

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

3.1
hydraulically stabilized soil
stabilized mixture of soil and water that sets and hardens by hydraulic reaction

3.2
soil
natural, artificial or recycled material or any combination of these

3.3
slenderness ratio
height to diameter ratio of the specimen

4 Symbols and abbreviated terms

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

W is the water content;

P is the pulverization;

IPI is the immediate bearing index;

MCV is the moisture condition value;

CBR is the California bearing ratio, expressed in percent (%);

R is the compressive or tensile strength, expressed in megapascals (MPa);

R_c is the compressive strength, expressed in megapascals (MPa);

R_t is the direct tensile strength, expressed in megapascals (MPa);

R_{it} is the indirect tensile strength, expressed in megapascals (MPa);

R_i is the compressive or tensile strength after immersion in water, expressed in megapascals (MPa);

E is the modulus of elasticity, expressed in megapascals (MPa);

E_c is the modulus of elasticity E determined in compression, expressed in megapascals (MPa);

E_t is the modulus of elasticity E determined in direct tension, expressed in megapascals (MPa);

E_{it} is E determined in indirect tension, expressed in megapascals (MPa);

I is the 'strength after immersion' ratio;

LS is the linear swelling of a CBR specimen, expressed in millimetres (mm);

G_v is the volumetric swelling of a specimen, expressed in percent (%).

5 Constituents

5.1 Cement

Cement shall conform to EN 197-1 or to a European Assessment Document.

5.2 Fly ash

Fly ash shall be siliceous or calcareous fly ash conforming to EN 14227-4.

NOTE Siliceous fly ash is a pozzolan and requires lime or a source of lime (e.g. cement) to produce a hydraulic reaction.

5.3 Blast-furnace slag

Blast-furnace slag shall be either ground granulated blast-furnace slag conforming to EN 15167-1 or partially-ground granulated blast-furnace slag conforming to EN 14227-2.

NOTE Other constituents are normally necessary to enhance the hydraulic reactivity of slag.

5.4 Hydraulic road binder

Hydraulic road binder shall conform to EN 13282 (all parts) or to a European Assessment Document.

5.5 Lime

Lime shall be air lime conforming to EN 459-1, in form of quick lime or hydrated lime or lime slurry.

5.6 Soil

Not less than 95 % of the soil shall pass the selected sieve from Table 1 when tested using wet sieving to EN 933-1.

Table 1 — Selected sieve

Sieve mm	**Category**
6,3	$S_{6,3}$
20	S_{20}
31,5	$S_{31,5}$
63	S_{63}
Declared Value	S_{DV}
No Requirement	S_{NR}

The soil shall conform to classification and homogeneity requirements at the place of use.

NOTE 1 Some type of soils may be pre-treated to adjust moisture content and/or flocculate clays, for example with lime.

NOTE 2 Organic matter can reduce or prevent the setting and hardening process. Laboratory mixture design work will determine whether soil containing organic matter can be accommodated. The amount of organic matter that can be accommodated depends on the type of organic matter.

NOTE 3 Soil containing or suspected of containing sulfur, sulfide or sulfate can result in expansion of the mixture. Laboratory mixture design work including 'resistance to water testing' in accordance with this European Standard will determine if material with the potential to cause swelling can be accommodated.

5.7 Water

Water shall not adversely affect the setting, hardening and performance of the mixture.

5.8 Other constituents

Other constituents include aggregate, gypsum or other materials that are either necessary for or improve hydraulic reaction and or improve workability, traffickability or performance.

6 Mixture

6.1 General

The mixture shall comprise constituents specified in Clause 5.

In the case of constituents added at different times to the soils (for example treatment with lime followed by the addition of another constituent), the time interval in the laboratory between the respective additions shall be reported.

6.2 Proportioning and dry density

The proportioning of the constituents including water content, expressed as percentages by dry mass of the total dry mass of the mixture, and the dry density of the mixture, shall be declared.

The declared proportions shall be based on the laboratory mixture design.

7 Requirements for the fresh mixture

7.1 Water content

When required, the water content of the mixture shall comply with the selected category from Table 2.

The water content shall be selected to permit compaction on site by rolling and to optimize the mechanical performance of the mixture. The water content shall be determined by a method in conformity with EN 13286-2, EN 13286-3, EN 13286-4 and EN 13286-5 and limits set that give a workable range on site compatible with the compaction and desired performance of the mixture.

Table 2 — Minimum water content categories

Minimum water content	Category
0,9 optimum water content of the mixture determined in accordance with the selected method of compaction from EN 13286-2, EN 13286-3, EN 13286-4 and EN 13286-5	$W_{0,9}$
0,95 optimum water content of the mixture determined in accordance with the selected method of compaction from EN 13286-2, EN 13286-3 , EN 13286-4 and EN 13286-5	$W_{0,95}$
The optimum water content of the mixture determined in accordance with the selected method of compaction from EN 13286-2, EN 13286-3, EN 13286-4 and EN 13286-5	$W_{1,0}$
1,05 optimum water content of the mixture determined in accordance with the selected method of compaction from EN 13286-2, EN 13286-3, EN 13286-4 and EN 13286-5	$W_{1,05}$
Declared value	W_{DV}

7.2 Degree of pulverization

When required, the degree of pulverization of the mixture, determined in accordance with EN 13286-48, shall conform to one of the categories in Table 3.

Table 3 — Degree of pulverization

Degree of pulverization	Category
≥ 30 %	P_{30}
≥ 40 %	P_{40}
≥ 50 %	P_{50}
≥ 60 %	P_{60}
Declared value	P_{DV}

7.3 Immediate bearing index

When required, the immediate bearing index of the mixture at the declared water content, determined in accordance with EN 13286-47, shall conform to one of the categories in Table 4.

Table 4 — Immediate bearing index

Immediate bearing index	Category
≥ 10	IPI_{10}
≥ 15	IPI_{15}
≥ 20	IPI_{20}
≥ 25	IPI_{25}
≥ 30	IPI_{30}
≥ 40	IPI_{40}
≥ 50	IPI_{50}
Declared value	IPI_{DV}

7.4 Moisture condition value

When required, the moisture condition value of the mixture, determined in accordance with EN 13286-46, shall conform to one of the categories in Table 5.

Table 5 — Moisture condition value

Moisture condition value	Category
6 minimum, 10 maximum	$MCV_{6/10}$
7 minimum, 11 maximum	$MCV_{7/11}$
8 minimum, 12 maximum	$MCV_{8/12}$
9 minimum, 13 maximum	$MCV_{9/13}$
Declared values	MCV_{DV}

7.5 Workability period

When required for the intended use and the weather conditions, the workability period, determined in accordance with EN 13286-45, shall be declared.

8 Laboratory mechanical performance classification

8.1 General

The laboratory mechanical performance of the mixture shall be characterized and classified by one of the following three methods:

— by California bearing ratio CBR;

— by compressive strength R_c;

— by the combination R_t, E of tensile strength R_t and modulus of elasticity E.

NOTE No correlation is intended nor should be assumed between the three methods of characterization.

8.2 California bearing ratio

The CBR of the mixture, determined in accordance with EN 13286-47 with a surcharge of (4,5 ± 0,2) kg shall conform to the selected class from Table 6 and the following:

a) After manufacture, the specimens shall be subjected to a conditioning period of either 1 h, 3 d, or other selected period, during which the specimens shall be prevented from drying out and shall be maintained at a temperature of (20 ± 2) °C or other specified temperature.

b) After conditioning, the specimens shall undergo a soaking period of either 4 d or other longer period before testing, during which they shall be maintained at a temperature of (20 ± 2) °C or other specified temperature.

c) The time of conditioning and soaking periods shall be noted in the test report.

Table 6 — California bearing ratio

CBR requirement after 4 d soaking (or other longer specified period)	Category
≥ 5	CBR_5
≥ 10	CBR_{10}
≥ 12	CBR_{12}
≥ 15 and the immediate bearing index	CBR_{15}
≥ 20 and the immediate bearing index	CBR_{20}
≥ 30 and the immediate bearing index	CBR_{30}
≥ 40 and the immediate bearing index	CBR_{40}
≥ 50 and the immediate bearing index	CBR_{50}
Declared Value	CBR_{DV}
No Requirement	CBR_{NR}

8.3 Classification by compressive strength

— Mixtures shall be classified by compressive strength determined in accordance with EN 13286-41 carried out on specimens manufactured in accordance with EN 13286-50, EN 13286-51, EN 13286-52 and EN 13286-53.

— The class of compressive strength shall be selected from Table 7 in combination with the selected method of specimen manufacture.

— The age of classification and curing conditions employed for the specimens before test shall be specified in accordance with practice at the place of use.

— For characterization or mixture design testing in the laboratory, compressive strength shall be the average result from at least three specimens. If one value varies by more than 20 % of the average, it shall be discarded and compressive strength taken as the average of the other values.

NOTE 1 Annex A gives examples of age of classification and specimen curing regimes.

If employed as the curing regime, freeze thaw cycling of specimens shall be carried out in accordance with regulation at the place of use. The type, extent and duration of conditioning shall be reported.

There is currently insufficient experience to define a method of freeze thaw conditioning that can be used in all parts of Europe.

NOTE 2 The permitted methods of specimen manufacture produce different specimen shapes and density, and thus for the same mixture, different strengths. Hence, it is important, on the basis of experience and utilization, not to separate strength from the method of specimen manufacture.

Table 7 — Compressive strength classification

Minimum R_c in MPa **for cylinders of slenderness ratio 2**[a]	**Minimum** R_c in MPa **for cylinders of slenderness ratio 1**[a] **and cubes**	R_c **Category**
0,15	0,2	$C_{0,15/0,2}$
0,4	0,5	$C_{0,4/0,5}$
0,8	1	$C_{0,8/1}$
1,2	1,5	$C_{1,2/1,5}$
1,5	2	$C_{1,5/2}$
2	2,5	$C_{2/2,5}$
2,3	3	$C_{2,3/3}$
3	4	$C_{3/4}$
4	5	$C_{4/5}$
5	6	$C_{5/6}$
6	8	$C_{6/8}$
8	10	$C_{8/10}$
9	12	$C_{9/12}$
Declared value	Declared value	C_{DV}

[a] If cylinders with slenderness ratios other than 1 or 2 are used, then the correlation with cylinders of either slenderness ratio 1 or 2 shall be established before use, except for Proctor cylinders of slenderness ratio 1,2 and 0,83, which shall be considered equal to slenderness ratio 1.

8.4 Classification by tensile strength and modulus of elasticity (R_t, E)

8.4.1 General

— The class of R_t, E shall be selected from Figure 1.

— The age of classification and curing conditions for the specimens shall be specified in accordance with practice at the place of use.

— For characterization or mixture design testing in the laboratory, R_t and E shall be the average result from at least three specimens. If one value varies by more than 20 % of the average, it shall be discarded and R_t and E taken as the average of the other values.

— R_t and E shall be established using one of the equivalent methods described in 8.4.2 to 8.4.4.

NOTE For information, Annex A gives examples of age of classification and curing regimes.

8.4.2 Method by direct tensile testing

R_t shall be determined in accordance with EN 13286-40.

E shall be determined in direct tension E_t in accordance with EN 13286-43.

Specimens shall be manufactured using vibrocompression in accordance with EN 13286-52.

8.4.3 Method by indirect tensile testing

— R_t shall be derived from R_{it} determined in accordance with EN 13286-42 using the relationship $R_t = 0{,}8\ R_{it}$.

— E shall be derived from E_{it} (E measured in indirect tension) determined in accordance with EN 13286-43 using the relationship $E = E_{it}$.

— Specimens shall be manufactured using:

  — Proctor compaction for both in accordance with EN 13286-50, or

  — vibrating hammer for both in accordance with EN 13286-51, or

  — vibrocompression for both in accordance with EN 13286-52, or

  — axial compression for both in accordance with EN 13286-53.

NOTE The permitted methods of specimen manufacture produce different specimen shapes and density, and thus for the same mixture, different strengths. Hence, it is important, on the basis of experience and utilization, not to separate strength from the method of specimen manufacture.

8.4.4 Method by indirect tensile and compression testing

— R_t shall be derived from R_{it} determined in accordance with EN 13286-42 using the relationship $R_t = 0{,}8\ R_{it}$.

— E shall be derived from E_c (E measured in compression) determined in accordance with EN 13286-43 using the relationship $E = E_c$.

— Specimens shall be manufactured using:

  — Proctor compaction for both in accordance with EN 13286-50, or

  — vibrating hammer for both in accordance with EN 13286-51, or

  — vibrocompression for both in accordance with EN 13286-52, or

  — axial compression for both in accordance with EN 13286-53.

NOTE The permitted methods of specimen manufacture produce different specimen shapes and density, and thus for the same mixture, different strengths. Hence, it is important, on the basis of experience and utilization, not to separate strength from the method of specimen manufacture.

9 Resistance to water and other requirements for the mixture

9.1 Resistance to water

9.1.1 General

When required, resistance to water shall be examined in accordance with 9.1.2, 9.1.3 or 9.1.4, whichever is appropriate.

9.1.2 Strength after immersion in water

The mixture shall satisfy the selected category for immersion from Table 8.

In Table 8, R_i shall mean the average strength of not less than 3 specimens after Z days sealed curing followed by Q days full immersion curing of unsealed specimens in aerated water, and R shall mean the average strength of not less than 3 specimens after ($Z + Q$) days sealed curing. All the specimens shall be manufactured from the same batch of mixture, using the same method of manufacture, and shall be cured at the same temperature. Z and Q shall be specified in accordance with the practice and requirements at the place of use.

NOTE 1 It is important that the selected category reflect the nature of the main constituent, in particular materials containing sulfates or other potentially expansive material, the intended use of the mixture, the climate and weather conditions during construction.

NOTE 2 Annex A gives examples of Z and Q.

Table 8 — Strength after immersion

R_i/R **ratio**	**Category**
≥ 0,6	$I_{0,6}$
≥ 0,7	$I_{0,7}$
≥ 0,8	$I_{0,8}$
Declared value	I_{DV}

9.1.3 Linear swelling after soaking in water

Linear swelling, determined on at least 3 fully soaked (immersed) CBR specimens in accordance with EN 13286-47, using water that is continuously aerated, shall conform to the selected category from Table 9. The soaking shall follow a conditioning period. The swelling shall be examined for at least 28 d or until swelling ceases if longer. The specimens shall be manufactured from the same batch of mixture.

NOTE The conditioning period will usually be the same as that selected for the determination of CBR in 8.2.

Table 9 — Linear swelling

Average maximum swelling of the specimens mm	**Maximum swelling of any individual specimen** mm	**Category**
5	10	LS_5
1	2	LS_1
Declared value	Declared value	LS_{DV}

9.1.4 Volumetric swelling after immersion in water

Volumetric swelling G_v shall not exceed 5 % when tested in accordance with EN 13286-49.

NOTE Where the volumetric swelling is greater than 5 % but does not exceed 10 %, the use of the mixture is generally not possible; however a complementary study can be made according to experience at the place of use.

9.2 Strength for direct construction trafficking

'Strength for direct construction trafficking' shall be specified in accordance with provisions valid at the place of use.

NOTE Depending on the aggressiveness of the construction traffic, a minimum compressive strength of 1 MPa or 1,2 MPa or 1,5 MPa at the age of trafficking might support construction traffic.

9.3 Resistance to frost

Frost resistance shall be examined in accordance with provisions valid at the place of use.

10 Production control

See Annex B (informative).

11 Designation and description

11.1 The product shall be designated by:

a) producer, place of production and producer code;

b) reference to this European Standard, i.e. EN 14227-15;

c) mechanical performance characterization and category (e.g. hydraulically stabilized soil S_{20}– T2);

d) description of the constituents.

11.2 In addition, the product shall be described by:

a) if applicable, the characteristics and homogeneity of the soil;

b) mixture proportions including water content;

c) selected fresh mixture categories (e.g. W, P, IPI, MCV) including the compaction energy used to determine W and IPI;

d) laboratory mechanical performance values together with the method of manufacture (including if appropriate the time interval between the additions of constituents to the soil), curing conditions, curing period, dry density and water content of the mechanical performance specimens;

e) 'resistance to water' category (e.g. I, LS or G_v)

f) appropriate 'other requirements' from Clause 9.

12 Labelling

When appropriate, the delivery ticket shall contain at least the following:

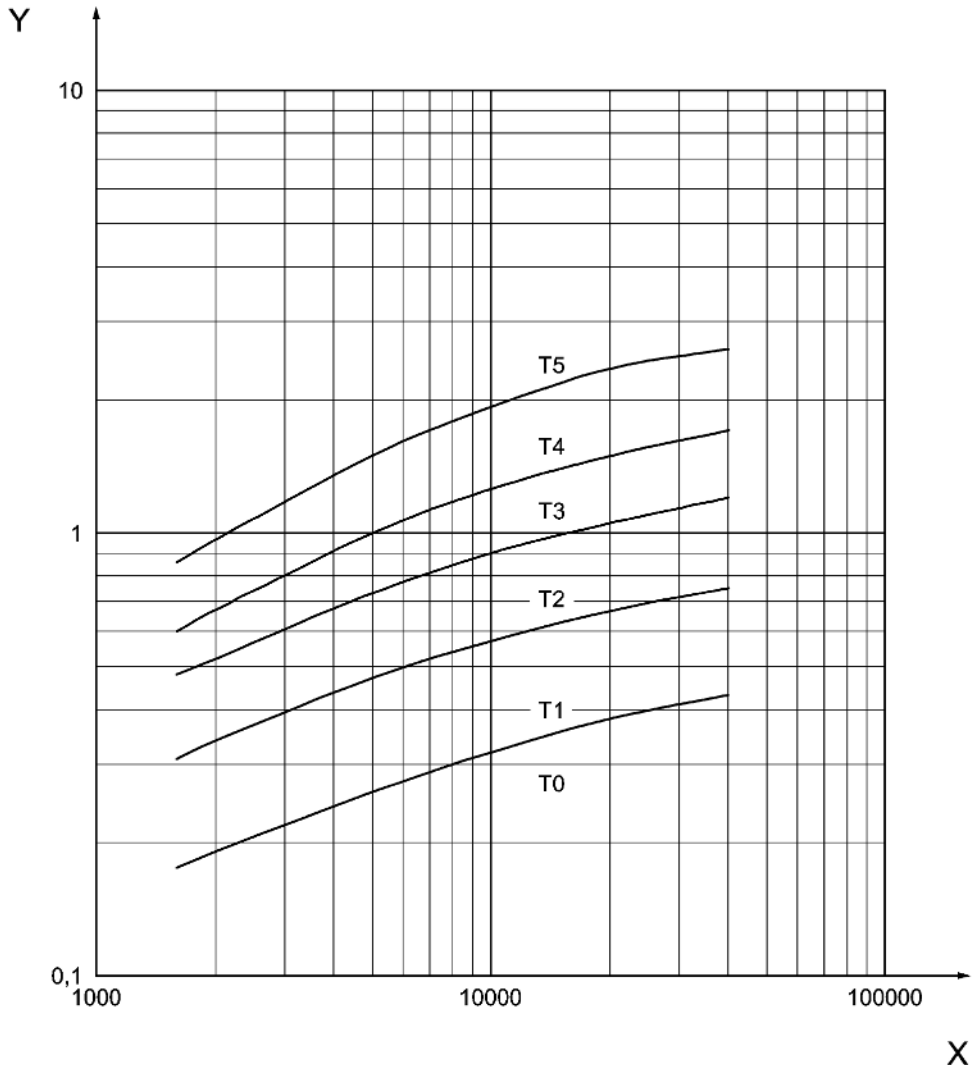
a) designation (e.g. soil treated with cement S_{20}– T2);

b) reference to this European Standard;

c) date of dispatch;

d) quantity;

e) serial number.



Key

Y direct tensile strength R_t, in MPa

X elastic modulus E, in MPa

E MPa	**2 000**	**5 000**	**10 000**	**20 000**	**40 000**
Low limit of category	R_t MPa				
T5	0,97	1,50	1,93	2,35	2,60
T4	0,67	1,00	1,26	1,49	1,70
T3	0,52	0,73	0,90	1,05	1,20
T2	0,34	0,47	0,57	0,67	0,75
T1	0,19	0,26	0,32	0,38	0,43
NOTE The table gives the values of R_t and E used to draw the curves limiting the categories T5, T4, T3, T2 and T1.					

Figure 1 — Classification by R_t, E

Annex A
(informative)

Examples of 'age of classification' and curing regimes for R_c, R_t and E testing of treated soils including resistance to water testing

Sealed curing (days) [a] (Z in 9.1.2)	**Immersion in water curing (days)** [b] (Q in 9.1.2)	**Total (days)**
0	4	4
3	4	7
7	–	7
7	7	14
14	–	14
21	7	28
28	–	28
28	28	56
56	–	56
28	63	91
91	–	91
182	–	182
364	–	364

[a] Sealed curing, which is generally used for classification purposes, designates a condition that prevents loss or gain of water and applies to the time in the mould also.

[b] Temperature during sealed or immersion curing is typically (20 ± 2) °C or (40 ± 2) °C.

Annex B
(informative)

Production control for hydraulically stabilized soils

B.1 General

This annex describes recommendations for a production control system for producers of hydraulically treated mixtures (e.g. aggregates and soils treated by lime, hydraulic binders or hydraulic combinations).

The objective of production control is to give assurance that the mixture conforms to the specification.

B.2 Quality Manual

The producer should establish and maintain his policy and procedures for production control in a Quality Manual that should include:

— producer's organizational structure relating to quality;

— control of constituents and mixtures;

— process control, calibration and maintenance;

— requirements for handling and storage of the mixture when appropriate;

— inspection, calibration and control of the measuring equipment in the process, and laboratory testing equipment for the mixture;

— procedures for handling non-conforming mixture.

B.3 Organization

B.3.1 Responsibility and authority

The responsibility, authority and interrelation of all personnel who manage, perform and verify work affecting quality should be defined in the Quality Manual, particularly personnel who have authority to identify, record and rectify any mixture quality problems.

B.3.2 Management representative

The producer should appoint a person with appropriate authority, knowledge and experience of production control to ensure that the requirements of the Quality Manual are implemented and maintained.

B.3.3 Internal audits

The producer should carry out internal quality audits to verify compliance with the planned arrangements and the effectiveness of the quality system. Audits should be scheduled on the basis of the status and importance of the activity. The audits and follow up action should be carried out in

accordance with documented procedures. The results of the audits should be documented and brought to the attention of the personnel having responsibility in the area audited. The management personnel responsible for the area should take timely corrective action on the deficiencies found by the audit and should keep a record of the action taken.

B.3.4 Management review

The production control system should be reviewed at appropriate intervals by management to ensure its continuing suitability and effectiveness. Records of such reviews should be maintained.

B.3.5 Sub-contract services

Where any services are supplied from outside the producer's resources, means of control should be established.

B.3.6 Records

The production control system should contain adequately documented procedures and instructions.

The intended frequencies of tests and inspections by the producer should be documented and the results of tests and inspections recorded.

Sampling location, date and time, as well as details of the mixture or constituents tested, should be recorded together with any other relevant information.

Where the constituent or mixture examined does not satisfy the requirements of the appropriate specification and this European Standard, records should be kept of corrective actions taken to ensure the quality of the mixture is maintained.

Records should be kept in such a way that they are retrievable and be retained for the period stated in the Quality Manual, usually a minimum of 3 years or longer if legally required.

B.3.7 Training

The producer should establish and maintain procedures for the training of all personnel involved in activities affecting quality. Personnel performing specific assigned tasks should be suitably qualified on the basis of appropriate education, training or experience, as required. Training records should be kept.

B.4 Control procedures

B.4.1 Production management

The production control system should contain the following:

a) composition of the mixture to be produced;

b) procedures to adjust mixture composition;

c) procedures to ensure that constituents comply with requirements;

d) procedures to ensure that production equipment, including mixture storage facilities, maintain the composition, homogeneity, and consistency of the mixture;

e) procedures for:

   1) calibrating, maintaining and adjusting the process and testing equipment;

   2) sampling the constituents and mixture;

3) data recording during processing;

4) adjusting the process according to weather conditions;

f) instructions so that the mixture is identifiable up to the point of delivery as regards source and type.

B.4.2 Composition of the mixture

The composition of the mixtures should be established from a laboratory mixture design procedure intended to ensure the mixture will have properties conforming to the relevant standard.

Where applicable, the composition of regularly produced mixtures should be included in a catalogue of mixtures compositions and considered as the mixture base line or target composition.

The compositions should be re-established in case of significant change in constituents and should be reviewed periodically to ensure the mixture conforms to requirements taking account any change in properties of constituents.

B.4.3 Constituents

Documentation should detail the source and type of each constituent of the mixture for use at the production location.

Adequate supplies of constituent should be available to ensure that the planned rates of production and delivery can be maintained.

The specifications for incoming constituents should be established and communicated to suppliers by means of written orders.

The control procedures should check that constituents are capable of providing the required quality.

Constituents should be transported and stored in such a manner as to avoid intermingling, contamination or deterioration that may affect the quality of the product.

B.4.4 Process control

The Quality Manual should include:

— description of equipment and installation;

— description of the flow of constituents and the processes carried out on them. If appropriate, this should incorporate a flow diagram;

— schedule for monitoring the performance of the process, (manual or automatic systems), including a record of equipment performance against the stated tolerances.

B.4.5 Inspection, calibration and control of process equipment

The Quality Manual should identify items of measuring devices that require calibration and the frequency of such calibration.

Calibration procedures should be provided, including the permitted tolerances for the devices to remain in service. The Quality Manual should state the required accuracy of all calibrations.

The equipment should be adequately maintained to ensure that it continues to be capable of producing mixture to the required specifications and tolerances.

B.4.6 Handling and delivery

The Quality Manual should contain procedures to ensure that the mixture is handled and (where appropriate) delivered with the minimum of segregation or degradation and within the permitted water content range and time limit.

At the point of delivery, the mixture should be identifiable and traceable with regard to its production data. The producer should maintain records of relevant data of production, which can be referenced from information when appropriate on the delivery ticket.

If appropriate, the producer's Quality Manual should describe the characteristics of any mixture storage system and define its mode of operation. The producer should ensure through checks, inspections and records that such systems are used correctly and that mixtures maintain their suitability for use.

B.5 Inspection and testing of constituents and mixtures during production

B.5.1 General

At the start of the production process, the homogeneity of the mixture should be considered with regard to the specification, the type and quality of the production plant and the quality and homogeneity of the constituents. This can be appreciated either from past production experience or by undertaking specific tests.

The Quality Manual should specify the frequency and nature of regular tests/checks/inspections that should be carried out during production. The producer should prepare a schedule of frequencies considering:

— test frequencies in relation to periods of actual production of each mixture;

— test frequency where automated surveillance and monitoring of the production process exists;

— statistical approach for testing.

Reasons for changing the test frequencies and analysis should be stated in the Quality Manual.

If appropriate, long-term experience of the consistency of a particular property as well as mixtures with an established record for conformity should be taken into account.

B.5.2 Characteristics that require control during production

These may include:

— properties of the constituents including water content (before production);

— proportioning of the constituents including added water;

— grading of the fresh mixture;

— water content of the fresh mixture.

The above characteristics should comply with the requirements of the target composition of the mixture (see B.4.2).

B.5.3 Frequency of sampling the mixture

During the regular production of the mixture, the sample frequency may be as follows:

— In the case of plants with a validated and accepted automated surveillance and data collection system giving computerized composition for every truck or every batch, one sample should be taken every 2 000 t or 1 000 m^3 or one per day for lesser quantities.

— In any other case, one sample should be taken every 300 t or 150 m^3, with a minimum of 1 sample per day.

— Alternatively and independent of the type of mixing plant, the frequency of sampling can be on a time related rather than a quantity related basis such as a minimum of 1 sample per week or 1 sample per day depending on the characteristic being measured.

In the case of occasional production of a standard mixture, the production should be assessed cumulatively with previous production with the same or similar criteria. The frequency of sampling can be adjusted on a contract-by-contract basis according to the overall quantity of production required.

B.6 Inspection and testing equipment

B.6.1 General

All necessary facilities, equipment and personnel should be available to carry out the required inspections and tests.

Normally the testing should be performed according to the specified test methods given in the relevant standard.

Other test methods may be used, if correlations or safe relationships between the results of these test methods and the reference methods have been established.

B.6.2 Measuring and testing equipment

The producer should be responsible for the control, calibration and maintenance of his inspection, measuring and testing equipment.

B.6.3 Measuring and testing equipment in the process

The points in the process where measuring equipment needs to be deployed should be stated in the Quality Manual.

The Quality Manual should indicate when control is carried out automatically or manually. There should be a description of how equipment is maintained and calibrated.

B.6.4 Measuring and testing equipment in laboratory

The testing equipment should be in a known state of calibration and accuracy, consistent with the required measurement capability.

The following points should be addressed:

— accuracy and frequency of calibration, which should be in accordance with the relevant tests standard;

— equipment to be used in accordance with documented procedures;

— equipment to be uniquely identified and calibration records should be retained;

— keeping of calibration records.

B.7 Non-conformity

B.7.1 General

Non-conformity can arise at the following stages:

— constituent delivery;

— constituent in storage;

— mixture production;

— handling, storage and delivery of the mixture if appropriate.

In the event that a non-conforming constituent, process or mixture is identified, investigations should be initiated to determine the reasons for non-conformity and effective corrective action should be implemented to prevent recurrence in accordance with procedures documented in the Quality Manual.

B.7.2 Non-conformity of constituents

In the case of non-conforming constituents, corrective action may involve:

— reclassifying the constituent;

— reprocessing;

— adjusting process control to allow for constituent non-conformity;

— rejection and disposal of the non-conforming constituent.

B.7.3 Non-conformity of the mixture

Non-conforming mixture should be evaluated and procedures for taking action should be followed.

The Quality Manual should identify the action to be taken when a non-conforming product is identified and should state the circumstances under which the customer will be notified of non-conforming results.

Such action may involve:

— corrective action (for example modification of the mixture and/or adjustment of equipment);

— acceptance of the mixture following the agreement of the customer to accept a non-conforming mixture;

— if the mixture produced is incorrect it can be redirected to an alternative customer if appropriate;

— rejection of the mixture.

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BSI Group Headquarters

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