



SLOVENSKI STANDARD

SIST EN 16907-4:2019

01-april-2019

Zemeljska dela - 4. del: Tretiranje zemljin z apnom in/ali hidravličnimi vezivi

Earthworks - Part 4: Soil treatment with lime and/or hydraulic binders

Erdarbeiten - Teil 4: Bodenbehandlung mit Kalk und/oder hydraulischen Bindemitteln

Terrassements - Partie 4: Traitement des sols à la chaux et/ou aux liants hydrauliques

Ta slovenski standard je istoveten z: **EN 16907-4:2018**

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ICS:

93.020	Zemeljska dela. Izkopavanja.	Earthworks. Excavations.
	Gradnja temeljev. Dela pod	Foundation construction.
	zemljo	Underground works

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en,fr,de

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 16907-4

December 2018

ICS 93.020

English Version

Earthworks - Part 4: Soil treatment with lime and/or hydraulic binders

Terrassements - Partie 4: Traitement des sols à la chaux et/ou aux liants hydrauliques

Erdarbeiten - Teil 4: Bodenbehandlung mit Kalk und/oder hydraulischen Bindemitteln

This European Standard was approved by CEN on 14 May 2018.

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EUROPÄISCHES KOMITEE FÜR NORMUNG

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EN 16907-4:2018 (E)**European foreword**

This document (EN 16907-4:2018) has been prepared by Technical Committee CEN/TC 396 “Earthworks”, the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by June 2019, and conflicting national standards shall be withdrawn at the latest by June 2019.

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

This document is one of the European Standards within the framework series of EN 16907 on *Earthworks*, as follows:

- *Part 1: Principles and general rules;*
- *Part 2: Classification of materials;*
- *Part 3: Construction procedures;*
- *Part 4: Soil treatment with lime and/or hydraulic binders (this document);*
- *Part 5: Quality control;*
- *Part 6: Land reclamation earthworks using dredged hydraulic fill;*
- *Part 7: Hydraulic placement of extractive waste;*

According to the CEN-CENELEC Internal Regulations, the national standards organisations 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, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

In the context of the present standard, the treatment of a material designates the operation which consists of mixing, to an agreed specification, the material with a binder, for example lime, or hydraulic binder, or both of them, and optionally with additional water. The objective is to enhance the properties of materials with poor characteristics for use in earth structures. It can also be to enhance properties of materials to enable their use in specific applications (like capping layers, abutment fills, foundations, etc.).

Although the technique has been used for a long time, its application at a large scale, for the construction of earth structures, started in the 1960s. Since then, the technique has seen a substantial increase thanks to its many benefits, among which are:

- enhancement of the mechanical properties of material;
- elimination of lorry movements for disposal of site material;
- reduced lorry movements for importation of construction material;
- reduced noise and nuisance to local residents;
- less wear and tear on the local road network;
- no tipping charges or landfill tax;
- maintained landfill capacity;
- no waste of valuable non-renewable aggregate resources;
- generally reduced construction time and cost.

Once treated properly, the material can be used in embankment, capping layer or any part of the structure, provided it meets the specification of the project.

The treatment products considered in this standard are limited to the following standardized products: cement, fly ash, granulated blast furnace slag, hydraulic road binder and lime.

For the purpose of this standard, these treatment products will be designated as binders.

For the purpose of this standard, cement, granulated blast furnace slag and hydraulic road binder will be designated as hydraulic binders.

Fly ash includes siliceous fly ash and calcareous fly ash. Siliceous fly ash is a material which requires a source of calcium oxide, e.g. lime or cement, to produce a hydraulic reaction. Calcareous fly ash contains calcium oxide and is comparable to a hydraulic binder. For the purpose of this standard, both types of fly ash will be designated as hydraulic binders.

Lime is air lime and has no hydraulic property. For the purpose of this standard, it will be designated as a binder.

Typical uses of the binders are as follows:

- lime is generally used to dry up wet materials, and/or to enhance the performance of cohesive materials;
- hydraulic binders are mainly used to quickly and significantly increase the mechanical performance of non-cohesive materials;

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- in presence of cohesive material and depending on the application, lime and hydraulic binder may be used together, in two steps on site, or through a pre-blended form like a hydraulic road binder.

The materials considered in this standard are: soils, weak rocks, intermediate rocks, chalk, recycled materials, artificial materials. They can also be mixes of these different types.

The success of a treatment operation relies upon the respect of specifications as well as of good practices that closely depend on local geological and climatic conditions. Thus, in addition to the requirements of this standard, reference may be made to the guidelines of good practices valid in the place of use. Some of them are included as notes in the standard or in the annexes at the end of this document.

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1 Scope

This European Standard applies to the treatment with binders of natural soils, weak rocks, intermediate rocks, chalk, recycled materials and artificial materials for the execution of earthworks during the construction and maintenance of roads, railways, airfields, platforms, dykes, ponds and any other types of earth structure.

It relates only to the treatment in layers, produced for earthworks in situ or from a mixing plant, as opposed to the treatment by columns for example.

The standard specifies the requirements for the constituents of the mixtures, the preliminary laboratory testing methodology, the laboratory performance classification, the execution and control.

NOTE 1 The informative annexes also give example of good practices for execution and control.

The laboratory performance classification specified in this European Standard covers the two types of treatment: improvement and stabilization.

For improvement, the classification relates to the short term performance.

For stabilization, the classification relates to the medium to long term performance.

NOTE 2 EN 16907-4 prepared by CEN/TC 396 "Earthworks" is for improvement and stabilization in earthworks applications. EN 14227-15 prepared by CEN/TC 227 "Road materials" is for stabilization only in pavement applications.

NOTE 3 For stabilization, the performance classification specified in EN 16907-4 uses generally the same laboratory performance classification specified in EN 14227-15, except for the performance classification diagram according to " R_t and E " specific to pavements in EN 14227-15, which has been replaced in EN 16907-4 by a performance classification diagram according to " R_t and E " specific to earthworks (Figure 1).

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2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 197-1, *Cement - Part 1: Composition, specifications and conformity criteria for common cements*

EN 450-1, *Fly ash for concrete - Part 1: Definition, specifications and conformity criteria*

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

EN 13282-1, *Hydraulic road binders - Part 1: Rapid hardening hydraulic road binders - Composition, specifications and conformity criteria*

EN 13282-2, *Hydraulic road binders - Part 2: Normal hardening hydraulic road binders - Composition, specifications and conformity criteria*

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*

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

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

EN ISO 17892-7, *Geotechnical investigation and testing - Laboratory testing of soil - Part 7: Unconfined compression test (ISO/FDIS 17892-7)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 16907-1 and EN 16907-2 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

air lime

lime which combines and hardens with carbon dioxide present in air

3.2

binder

product or combination of products which, when mixed with a material, provides either a short term or a long term enhancement of the properties of the material

Note 1 to entry: The binders covered by this standard are limited to the following standardized products: cement, fly ash, blast furnace slag, hydraulic road binder and building lime.

3.3

binder spreading unit

equipment used to distribute the binder uniformly on the soil to be treated

Note 1 to entry: These include spreaders that are capable of applying binders under the form of powder or suspension into water.

3.4

cement

hydraulic binder, i.e. a finely ground inorganic material which, when mixed with water, forms a paste which sets and hardens by means of hydration reactions and processes and which, after hardening, retains its strength and stability even under water

3.5

curing period

period of time during which a treated mixture is left undisturbed after final compaction, in prescribed conditions to limit evaporation, to allow stabilization processes to continue

3.6

in situ soil mixing plant

equipment used to thoroughly mix the binders with the soil

Note 1 to entry: This equipment comes in various sizes and includes mainly two types of plants: stationary tool mixers (plough) and moving tool mixers (rotovators, soil pulverisers, etc.).

3.7

fly ash

fine powder produced by the combustion of pulverized coal or lignite with or without co-combustion materials in energy generating plants and captured by mechanical or electrostatic precipitators

Note 1 to entry: Fly ash may be:

- siliceous, where the essential chemical components are silicates, aluminates and iron oxides;
- calcareous, where the essential chemical components are silicates, aluminates, calcium oxide and sulphates.

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Note 2 to entry: Siliceous fly ash is a pozzolanic material and requires a source of calcium oxide, e.g. lime or cement, to produce a hydraulic reaction.

3.8 hydraulic binder

binder which, when mixed with water, hardens both in the air and under water and remains solid, even under water

3.9 hydraulic road binder

factory produced hydraulic binder, supplied ready for use, having properties specifically suitable for treatment of materials for bases, sub-bases and capping layers as well as earthworks, in road, railway, airport and other types of infrastructures

3.10 lime

calcium oxide and/or hydroxide, and calcium-magnesium oxide and/or hydroxide produced by the thermal decomposition (calcination) of naturally occurring calcium carbonate (for example limestone, chalk, shells) or naturally occurring calcium magnesium carbonate (for example dolomitic limestone, dolomite)

Note 1 to entry: Lime may be under the form of quicklime, hydrated lime, or lime slurry.

Note 2 to entry: All references to lime in this standard are for Building lime according to EN 459-1.

3.11 lime slurry

suspension of hydrated lime into water which is produced from either quicklime or hydrated lime, in a specific device, at the lime plant or at the jobsite

3.12 mix-in-place or in-situ treatment

method of treatment which is carried out with mobile equipment (spreader and mixer)

3.13 mellowing period

period of time when a cohesive material and lime mixture is left undisturbed after light compaction to allow the migration of lime through the material clods created during mixing and for improvement processes to take place

3.14 mixture

combination of materials with binder(s) and water, and possibly other constituents

3.15 pozzolanic material

material which does not harden by itself when mixed with water but which reacts at normal ambient temperature with dissolved calcium to form strength-developing cementitious compounds

3.16 silo

horizontal or vertical storage unit, often cylindrical in shape, in which binders are stored

Note 1 to entry: They can be mobile or fixed.

3.17**slag**

all reference to slag in this standard are for granulated blast furnace slag

3.18**slenderness ratio**

height to diameter ratio of the specimen

3.19**soil improvement**

operation which modifies the physical properties of a material - such as water content, plasticity, water and frost susceptibility, compactibility and swelling potential - by the addition of a binder

Note 1 to entry: The quantity of binder added may not be sufficient to induce significant permanent properties.

3.20**soil stabilization**

operation consisting in obtaining an homogeneous mixture of soil with binder(s), and optionally with water, which properly compacted significantly changes (generally in the medium or long term) the characteristics of the soil in a way that renders it stable, particularly with respect to the action of water and frost

Note 1 to entry: Soil stabilization gives a permanent characteristic that can be measured by methods typical of solid materials.

3.21**soil treatment**

general term to indicate a process aimed at modifying a given soil so that the mixture resulting from the addition of binder or a combination of binders to a soil can fulfill the purpose intended

Note 1 to entry: Treatment encompasses both improvement and stabilization.

3.22**treatment in plant**

method of treatment in which stationary plants are employed

Note 1 to entry: The plant can be semi-mobile.

Note 2 to entry: The materials and binders are mixed through a pugmill. The mixture is then discharged into a truck or to a stockpile.

3.23**workability period**

duration of time calculated from the end of the mixing, during which the binder setting remains nil or very low, and within which all placement operations must be completed, including compaction and trimming

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