SLOVENSKI STANDARD
SIST EN 16907-6:2019

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Zemeljska dela - 6. del: Pridobivanje novih zemljišč s hidravličnim nasipanjem sedimentov, izkopanih pod vodo

Earthworks - Part 6: Land reclamation earthworks using dredged hydraulic fill

Erdarbeiten - Teil 6: Landgewinnung mit nassgebaggertem Einbaumaterial

Terrassements - Partie 6 : Terre-plein en remblai hydraulique dragué

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Earthworks - Part 6: Land reclamation earthworks using dredged hydraulic fill

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

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

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European foreword

This document (EN 16907-6:2018) 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of an identical text or by endorsement, at the latest by June 2019, and conflicting national standards shall be withdrawn at the latest by June 2019.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.* The set of standards prepared by CEN/TC 396 is divided into several parts, which correspond to different steps of the planning, execution and control of earthworks and should be considered collectively as a group of standards for executing earthworks. The full set of Parts is as follows:

— EN 16907-1 *Earthworks — Part 1: Principles and general rules;*

— EN 16907-2 *Earthworks — Part 2: Classification of materials;*

— EN 16907-3 *Earthworks — Part 3: Construction procedures;*

— EN 16907-4 *Earthworks — Part 4: Soil treatment with lime and/or hydraulic binders;*

— EN 16907-5 *Earthworks — Part 5: Quality control;*

— EN 16907-6 *Earthworks — Part 6: Land reclamation earthworks using dredged hydraulic fill* (this document);

— EN 16907-7 *Earthworks — Part 7: Hydraulic placement of extractive waste.*

Within this standard references to specific parts of the standard are written by the full reference (e.g. "EN 16907-2").

These "Earthworks standards" do not apply to the environmental planning and geotechnical design that determines the required form and properties of the earth-structure that is to be constructed. They apply to the design of the earthworks materials, execution, monitoring and checking of earthworks construction processes to ensure that the completed earth-structure satisfies the geotechnical design.

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

Dredging and land reclamation projects generally have three main stages: Pre-construction (Initiative, Initiation, Earth-structure Design and Procurement), Construction (including the earthworks design of a dredged hydraulic fill project) and Post-construction (Use and End of life).

This standard covers the execution stage of land reclamation with dredged hydraulic fill and the associated design of the works. The design of a land reclamation itself is not covered in detail in this standard. For the geotechnical design aspects of land reclamation works, reference is made to EN 1997-1, *Eurocode 7: Geotechnical design - Part 1: General rules* and the relevant parts of the EN 1998 series *Eurocode 8: Design of structures for earthquake resistance*.

The principles of dredging and hydraulic fill equipment are discussed in outline. For more detail reference is made to textbooks such as the *Hydraulic Fill Manual* [1].

1 Scope

This European Standard deals with underwater excavation and hydraulic placement of fill material for land reclamation projects.

The scope is limited to soils that exhibit free-draining behaviour during and after placement.

The main purpose of this European Standard is to ensure that functional requirements and specifications for such projects are in harmony with site boundary conditions and construction methods.

This European Standard specifies minimum requirements for site related data to be acquired before the procurement and execution stage of a dredging and land reclamation project.

This European Standard gives guidance on how the selection of the dredging equipment shall be undertaken. It also gives guidance on the selection of a borrow area and on the judgement regarding the suitability of the fill material for the project.

This European Standard offers the general principles on how to design the actual execution of a dredged hydraulic fill project and offers guidelines for monitoring and quality control of that execution in order to guarantee that the fill mass exhibits the behaviour as intended by the designer of the land reclamation.

This European Standard does not cover dredging and/or placement of rock, mine tailings, mineral wastes and contaminated soils.

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 933-7, *Tests for geometrical properties of aggregates — Part 7: Determination of shell content — Percentage of shells in coarse aggregates*

EN 1997-1, *Eurocode 7: Geotechnical design — Part 1: General rules*

EN 1997-2, *Eurocode 7 — Geotechnical design — Part 2: Ground investigation and testing*

EN 1998 (all parts), *Eurocode 8 — Design of structures for earthquake resistance*

EN 13137, *Characterization of waste — Determination of total organic carbon (TOC) in waste, sludges and sediments*

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 ISO 10693, *Soil quality — Determination of carbonate content — Volumetric method (ISO 10693)*

EN ISO 14688-1, *Geotechnical investigation and testing — Identification and classification of soil — Part 1: Identification and description (ISO 14688-1)*

EN ISO 17892-1, *Geotechnical investigation and testing — Laboratory testing of soil — Part 1: Determination of water content (ISO 17892-1)*

EN ISO 17892-3, *Geotechnical investigation and testing — Laboratory testing of soil — Part 3: Determination of particle density (ISO 17892-3)*

EN ISO 17892-4, *Geotechnical investigation and testing — Laboratory testing of soil — Part 4: Determination of particle size distribution (ISO 17892-4)*

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

CEN ISO/TS 17892-8, *Geotechnical investigation and testing — Laboratory testing of soil — Part 8: Unconsolidated undrained triaxial test (ISO/TS 17892-8)*

CEN ISO/TS 17892-9, *Geotechnical investigation and testing — Laboratory testing of soil — Part 9: Consolidated triaxial compression tests on water saturated soil (ISO/TS 17892-9)*

CEN ISO/TS 17892-10, *Geotechnical investigation and testing — Laboratory testing of soil — Part 10: Direct shear tests (ISO/TS 17892-10)*

CEN ISO/TS 17892-11, *Geotechnical investigation and testing — Laboratory testing of soil — Part 11: Determination of permeability by constant and falling head (ISO/TS 17892-11)*

CEN ISO/TS 17892-12, *Geotechnical investigation and testing — Laboratory testing of soil — Part 12: Determination of Atterberg limits (ISO/TS 17892-12)*

EN ISO 18674-2, *Geotechnical investigation and testing — Geotechnical monitoring by field instrumentation — Part 2: Measurement of displacements along a line: Extensometers (ISO 18674-2)*

EN ISO 22282-2, *Geotechnical investigation and testing — Geohydraulic testing — Part 2: Water permeability tests in a borehole using open systems (ISO 22282-2)*

EN ISO 22476-1, *Geotechnical investigation and testing — Field testing — Part 1: Electrical cone and piezocone penetration test (ISO 22476-1)*

EN ISO 22476-2, *Geotechnical investigation and testing — Field testing — Part 2: Dynamic probing (ISO 22476-2)*

EN ISO 22476-3, *Geotechnical investigation and testing — Field testing — Part 3: Standard penetration test (ISO 22476-3)*

EN ISO 22476-4, *Geotechnical investigation and testing — Field testing — Part 4: Ménard pressuremeter test (ISO 22476-4)*

EN ISO 5814, *Water quality — Determination of dissolved oxygen — Electrochemical probe method (ISO 5814)*

EN ISO 7027-1, *Water quality — Determination of turbidity — Part 1: Quantitative methods (ISO 7027-1)*

ISO 11923, *Water quality — Determination of suspended solids by filtration through glass-fibre filters*

ISO 11048, *Soil quality — Determination of water-soluble and acid-soluble sulfate*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
basis of design (of the works)
document with information on, among other subjects, the overall objectives of the project, the scope of the works, the location of the land reclamation and the borrow area on which the design is to be based

3.2
borrow area
source of the fill material

Note 1 to entry: A dedicated borrow area is a borrow area which is solely used for the extraction of suitable fill material.

Note 2 to entry: The fill material can result from capital dredging or maintenance dredging. In this case the borrow area is defined by the design of these dredging works.

3.3
bulking
volume change of a soil mass due to handling

Note 1 to entry: Positive is a volume increase.

3.4
bund
wall or bank of earth or stone to retain soil and/or fluid

3.5
capital dredging
activity of creating new civil engineering works by means of dredging, such as, for instance, harbour basins and canals and the deepening and/or widening of existing waterways and approach channels

3.6
degree of compaction (of natural ground or fill)
ratio between in-situ dry density and maximum dry density obtained from a standard laboratory compaction test

3.7
density index (of non-cohesive soil)
index which relates the void ratio, or dry density, of a soil sample, or of the soil in-situ, to the limiting void ratios, or dry densities

3.8
design of the earth-structure
design of the land reclamation
defining the civil engineering structure under EN 1997-1 to meet the functional requirements for future use

[SOURCE: EN 16907-1:2018, [11]]

3.9
design of the earthworks
design of the execution of the works

defining the construction process to produce a specified earth-structure that also covers the design of the supporting works

[SOURCE: EN 16907-1:2018, [11], adapted]

3.10
disposal area
area where dredged material is placed without any direct function, with the sole purpose being to dispose

3.11
dredging

excavation activity or operation from a floating plant usually carried out at least partly underwater, in shallow seas or fresh water areas with the purpose of gathering up bottom sediments and placing them at a different location

3.12
dredge
device, machine, or vessel that is used to excavate and remove bed material from the bottom of a body of water

3.13
dredged hydraulic fill
mixture of dredged fill material and process water in the land reclamation area

Note 1 to entry: Process water in dredging and land reclamation works is, in principle, clean water used as a medium to transport the sediment.

3.14
earth-structure
civil engineering structure made of soils, rocks, by-products or recycled materials resulting from earthworks

[SOURCE: EN 16907-1:2018, [11], adapted]

3.15
earthworks
civil engineering process that modifies the geometry of ground surface by creating stable and durable earth-structures

[SOURCE: EN 16907-1:2018, [11]]

3.16
fill mass
body (volume) of fill material after placement

3.17
fill material
material that is used for the land reclamation

Note 1 to entry: Within the scope of this standard 'fill material' is the material that ultimately will form the earth structure and that is part of the 'dredged hydraulic fill' during the execution of the works.

3.18
fines content
dry weight percentage of soil particles (silt and clay) with particle size smaller than 0,063 mm

3.19
functional requirement
requirement regarding the future function of the land reclamation

Note 1 to entry: For example, the reclamation will be used as a container stacking area.

3.20
land reclamation
earth structure constructed with hydraulic fill or dry fill

Note 1 to entry: This standard deals with dredged hydraulic fill.

3.21
losses

3.21.1
material losses
in-situ material dredged but not incorporated in the land reclamation or disposal area

Note 1 to entry: Example: material placed outside the boundary of the land reclamation or material carried out of a land reclamation by the outflow of dredge process water.

3.21.2
volume losses
reduction in volume due to handling, placing, compaction and settlement

3.22
maintenance dredging
activity of keeping, for instance, previously dredged areas, existing watercourses and harbour basins at the required nautical and/or hydrological depth by removing siltation

3.23
mechanical dredging
dredging that removes material by mechanical action, without the use of pumps

3.24
minimum and maximum dry densities
densities corresponding to the extreme states of particle packing (loosest and densest) at which the particles of a dry granular soil can be placed according to a standardized laboratory test

3.25
overflow
device on a dredge or barge that returns the surplus process water

3.26
performance requirement
requirement regarding the behaviour of the land reclamation in order to fulfil its function as designed

Note 1 to entry: For example maximum residual settlement or minimum bearing capacity foundations.

3.27
quality control
system used to monitor, assess and adjust construction/execution processes to ensure that the final product will meet the specified level of quality

[SOURCE: EN 16907-5:2018, [12]]

3.28
rainbowing
placing fill material in a land reclamation area by spraying the material via a nozzle in an arc through the air

Note 1 to entry: The name is derived from the appearance of the mixture arc, which closely resembles a rainbow, especially in sunny weather when the water particles break the light.

3.29
settling pond
basin or pond used to promote settling of suspended solids and to achieve acceptable desiltation of process water discharge

3.30
suction dredging
dredging that removes material by hydraulic suction action

3.31
suitable fill material
material able to meet the design specifications with or without compaction

3.32
turbidity
reduction of transparency of a liquid caused by the presence of undissolved matter

[SOURCE: EN-ISO 7027-1]

4 Symbols and abbreviations

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

BHD BackHoe Dredge

CPT Static Cone Penetrometer Test

CSD Cutter Suction Dredge

HSE Health, Safety and Environment

PLT Plate Loading Test

SD (plain) Suction Dredge

SPT Standard Penetration Test

TSHD Trailing Suction Hopper Dredge

TSS Total Suspended Solids

5 Stages of land reclamation projects

This standard covers the design of the earthworks for the execution of land reclamation projects using dredged hydraulic fill and is applicable after scheme identification, business case assessment and design of the earth-structure according to EN 1997-1, *Eurocode 7: Geotechnical design - Part 1: General rules*.

The typical sequence for the design and construction of land reclamation projects shall follow the stages indicated below:

— Pre-construction stage;

— Execution (construction) stage;

— Post-construction stage.

NOTE For the first two stages reference is made to 4.2 of EN 16907-1 [11]. The Post-construction stage typically comprises: operation and maintenance, updating and de-commissioning.

The design of the land reclamation during the Pre-construction stage shall be based on a sequence and method of construction to suit the contractor's expected approach and equipment. However, this may not always match the contractor's capability, plant and preferred method. For this reason, the contractor shall undertake further design for the execution of the project.

The Execution (construction) stage shall not proceed until the design of the land reclamation prepared during the Pre-construction stage is developed in sufficient detail to demonstrate that the earth-structure is constructible with the materials available within the borrow area dedicated to the project, while meeting the user's engineering and environmental performance requirements.

The requirements for regulatory approvals run through all stages, with the final approvals at the end of the Execution (construction) stage.