

STN	Zemné práce Časť 6: Rekultivácia územia naplavovanými zemnými konštrukciami	STN EN 16907-6 73 3000
------------	--	--

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

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 04/19

Obsahuje: EN 16907-6:2018

128467

EUROPEAN STANDARD**EN 16907-6****NORME EUROPÉENNE****EUROPÄISCHE NORM**

December 2018

ICS 93.020

English Version

**Earthworks - Part 6: Land reclamation earthworks using
dredged hydraulic fill**Terrassements - Partie 6 : Terre-plein en remblai
hydraulique draguéErdarbeiten - Teil 6: Landgewinnung mit
nassgebagertem Einbaumaterial

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

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of 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 United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG**CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels**

Contents	Page
European foreword	5
Introduction.....	6
1 Scope	7
2 Normative references	7
3 Terms and definitions.....	9
4 Symbols and abbreviations.....	13
5 Stages of land reclamation projects.....	13
6 Design aspects for earthworks with dredged hydraulic fill.....	14
6.1 Introduction.....	14
6.2 Basis of Design	14
6.2.1 General	14
6.2.2 Scope of Work	15
6.2.3 The project site.....	15
6.2.4 Standards and Codes of Practice	15
6.2.5 Functional requirements	15
6.2.6 Boundary conditions and constraints.....	15
6.2.7 Performance requirements	16
6.2.8 Site data.....	16
6.2.9 Borrow area.....	16
6.2.10 Environmental constraints	17
6.2.11 Regulations, permits and licenses.....	17
6.3 General design aspects	17
6.3.1 Earth-structure design aspects.....	17
6.3.2 Morphological and environmental aspects.....	17
6.4 Boundary conditions affecting the execution.....	18
6.4.1 General	18
6.4.2 Locations of land reclamation area, borrow area and disposal site	18
6.4.3 Soil conditions at the land reclamation area.....	18
6.4.4 Soil conditions at the borrow area	18
6.4.5 Suitable fill material properties.....	19
6.4.6 Dredging close to existing structures.....	19
6.4.7 Construction tolerances	19
6.4.8 Return of process water	19
6.4.9 Ground improvement of the fill mass and the subsoil	19
6.4.10 Project execution time and milestones	19
6.5 Earthworks design considerations	20
6.5.1 Introduction.....	20
6.5.2 Land reclamation area.....	20
6.5.3 Borrow area.....	20
6.5.4 Available quantity of suitable fill material.....	21
6.6 Design considerations in relation to dredging equipment.....	22
7 Technical specifications for earthworks with dredged hydraulic fill	22
7.1 Introduction.....	22

7.2	Technical specifications for the subsoil	22
7.3	Technical specifications for the fill mass	22
7.4	Technical specifications for the fill material	23
8	Data collection	23
8.1	General	23
8.2	Bathymetrical and topographical data	24
8.3	Geotechnical and geophysical data	24
8.3.1	General	24
8.3.2	Geotechnical and geophysical data in the borrow area.....	24
8.3.3	Geotechnical and geophysical data in the land reclamation area.....	26
8.4	Hydrological and meteorological data.....	26
8.5	Seismic data	27
8.6	Morphological and environmental data.....	27
8.6.1	General	27
8.6.2	Sediment transport.....	27
8.6.3	Total Suspended Solids (TSS) and turbidity	28
8.6.4	Organic matter and gas.....	28
8.6.5	Contaminants	28
8.6.6	Underwater sound.....	28
8.7	Seabed features	28
8.8	Site constraints	29
9	Equipment.....	30
9.1	Selection of the dredging equipment.....	30
9.1.1	General	30
9.1.2	Selection of the dredging equipment based on the capabilities of the equipment	30
9.1.3	Selection of the dredging equipment based on hydraulic and meteorological conditions.....	30
9.1.4	Selection of the dredging equipment based on the presence of shipping.....	31
9.1.5	Selection of the dredging equipment based on environmental restrictions	31
9.2	Typical dredging equipment	31
9.3	Accuracy and tolerances	32
9.4	Minimal vessel requirements for monitoring and data logging.....	32
10	Design of the execution of earthworks with dredged hydraulic fill.....	33
10.1	Construction	33
10.1.1	General	33
10.1.2	Preparation phase.....	33
10.1.3	Construction phase	34
10.1.4	Post-construction phase.....	35
10.2	Selection of placement method	35
10.3	Preparation of the seabed for dredging and for the land reclamation works.....	37
10.4	Containment bunds.....	38
10.5	Process water management.....	39
10.6	Water table in the land reclamation area.....	39
10.7	Use of cohesive or fine grained materials.....	39
10.8	Ground improvement.....	39
11	Quality control.....	40
11.1	General	40
11.2	Quality Control Plan.....	40
11.3	Monitoring and testing	41
11.4	Dimensions and boundary conditions	41

EN 16907-6:2018 (E)

11.4.1 Borrow area	41
11.4.2 Land reclamation area	42
11.5 Quality of the fill material	42
11.5.1 Source material in borrow area	42
11.5.2 Fill material in land reclamation area	42
11.6 Fill mass	42
11.6.1 Bearing capacity	42
11.6.2 Slope stability	43
11.6.3 Consolidation and deformations	43
11.6.4 <i>In situ</i> density and density index	43
11.6.5 Permeability	45
11.6.6 Frequency of testing	45
11.6.7 Environmental monitoring	46
11.7 Handover documentation	47
Annex A (informative) Non EN and non ISO test and monitoring methods	48
A.1 General	48
A.2 Electrical piezometer	49
A.3 Inclinomometer	49
A.4 Rod and plate settlement gauges	49
A.5 Settlement profiling tube	50
A.6 Trial embankment	50
A.7 Zone Loading Test	51
Annex B (informative) Determination of minimum and maximum dry densities and density index	52
B.1 General	52
B.2 British Standard procedures	52
B.2.1 General	52
B.2.2 Minimum dry density of sands	52
B.2.3 Minimum dry density of gravelly soils	53
B.2.4 Maximum dry density of sands	53
B.2.5 Maximum dry density of gravelly soils	53
B.3 ASTM procedures	53
B.3.1 General	53
B.3.2 Minimum index dry density	53
B.3.3 Maximum index dry density	54
B.4 Density index	54
Bibliography	55

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.

EN 16907-6:2018 (E)**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 16907-6:2018 (E)

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*