SLOVENSKI STANDARD
SIST EN 14475:2006

01-junij-2006

Izvedba posebnih geotehniļ nih del ï Armirano polnilo

Execution of special geotechnical works - Reinforced fill

Ausführung von besonderen technischen Arbeiten (Spezialtiefbau) - Bewehrte Schüttkörper

Exécution de travaux géotechniques spéciaux - Remblais renforcés

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ICS:

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

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Execution of special geotechnical works - Reinforced fill

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Ausführung von besonderen technischen Arbeiten (Spezialtiefbau) - Bewehrte Schüttkörper

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

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Contents

Foreword

This document (EN 14475:2006) has been prepared by Technical Committee CEN/TC 288 “Execution of special geotechnical works”, 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of an identical text or by endorsement, at the latest by July 2006, and conflicting national standards shall be withdrawn at the latest by July 2006.

The design of reinforced fill structures is currently carried out using national standards such as BS 8006 (1995) and NF P 94-220 (1998) and other standards. As a matter of fact EN 1997-1, Eurocode 7 (Geotechnical design) does not currently cover the detailed design of reinforced fill structures. The values of partial factors and load factors given in EN 1997-1 have not been calibrated for reinforced fill structures.

Whilst many common features exist between the design methods that have been developed and established in the various member countries of CEN, there are also differences reflecting different working practices, as well as such matters as geological and climatic variations.

In view of these differences, and of the time required to develop a common design method that would fully reflect the various considerations identified in particular national methods, a two stage approach has been adopted for the development of standards for reinforced fill.

In accordance with this two stage approach Working Group 9 was mandated by TC 288 for first producing an EN giving guidance on the Execution of reinforced fill, before working towards a common method of design. This standard represents the implementation of the first part of that mandate.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

1.1 This European Standard establishes general principles for the construction of reinforced fill.

1.2 This European Standard covers engineered fills that are reinforced by the inclusion of horizontal or sub-horizontal reinforcement placed between layers of fill during construction.

1.3 The scope of reinforced fill applications considered in this European Standard includes (Figure 1):

— earth retaining structures, (vertical, battered or inclined walls, bridge abutments, bulk storage facilities), with a facing to retain fill placed between the reinforcing layers;

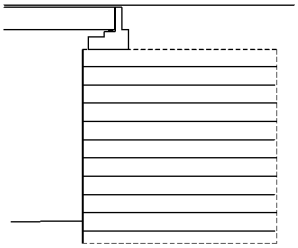
— reinforced steep slopes with a facing, either built-in or added or wrap-around, reinforced shallow slopes without a facing, but covered by some form of erosion protection without a facing, reinstatement of failed slopes;

— embankments with basal reinforcement and embankments with reinforcement against frost heave in the upper part.

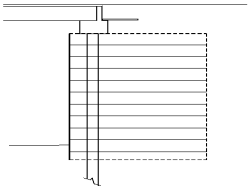
Principles for the execution of other special geotechnical works using soil nails, bored piles, displacement piles, micro piles, sheet pile walls, diaphragm walls, grouting or jet grouting are established in other European Standards.

Reinforcement of road pavements is not covered by this Standard.

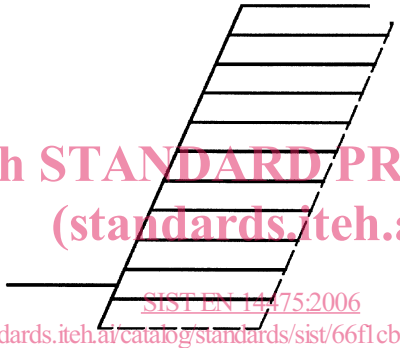
a) Walls



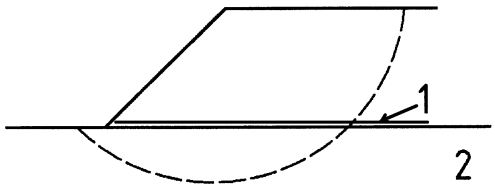
b) Abutments



c) Mixed abutments



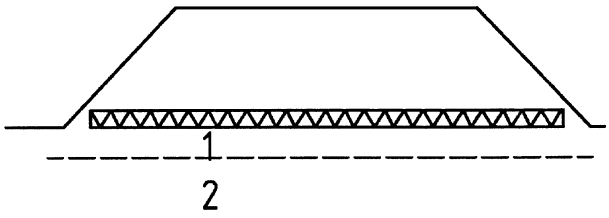
d) Reinforced slopes



e) Basal reinforcement

Key

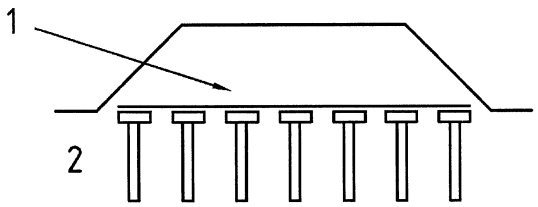
1 Reinforcement
2 Soft deposit



f) Basal mattress

Key

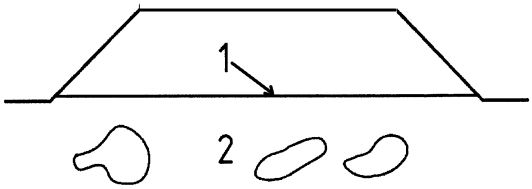
1 Thin soft layer
2 Firm layer



g) Piled embankments with basal reinforcement

Key

1 Reinforcement
2 Piles



h) Reinforcement over areas prone to subsidence

Key

1 Reinforcement
2 Potential weak zones or voids

i) Reinforcement in areas prone to frost heave

Key

1 Reinforcement
2 Ice lenses

j) Offshore Basal Reinforcement

Key

1 Reinforcement
2 Lake or sea
3 Soft seabed

Figure 1 — Some reinforced fill applications

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 206-1, *Concrete – Part 1: Specification, performance, production and conformity.*

EN 1990, *Eurocode – Basis of structural design.*

EN 1991, *Eurocode 1 : Actions on structures.*

EN 1992-1-1, *Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings*

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

EN 10025-2, *Hot rolled products of structural steels – Part 2: Technical delivery conditions for non-alloy structural steels*.

EN 10025-4, *Hot rolled products of structural steels – Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels.*

EN 10079, *Definition of steel products.*

EN 10080, *Steel for the reinforcement of concrete - Weldable reinforcing steel - General*

EN 10218-1, *Steel wire and wire products – General - Part 1 : Test methods*.

EN 10218-2, *Steel wire and wire products - General - Part 2 : Wire dimensions and tolerances*.

EN 10223-3, *Steel wire and wire products for fences - Part 3 : Hexagonal steel wire netting for engineering purposes.*

EN 10223-4, *Steel wire and wire products for fences - Part 4 : Steel wire welded mesh facing.*

EN 10244-1, *Steel wire and wire products - Non-ferrous metallic coatings on steel wire - Part 1: General principles.*

EN 10244-2, *Steel wire and wire products - Non-ferrous metallic coatings on steel wire - Part 2: Zinc or zinc alloy coatings.*

EN 10245-1, *Steel wire and wire products - Organic coatings on steel wire – Part 1: General rules.*

EN 10245-2, *Steel wire and wire products - Organic coatings on steel wire – Part 2: PVC finished wire.*

EN 10245-3, *Steel wire and wire products - Organic coatings on steel wire – Part 3: PE coated wire.*

EN 10326, *Continuously hot-dip coated strip and sheet of structural steels – Technical delivery conditions.*

EN 12224, *Geotextiles and geotextile-related products – Determination of the resistance to weathering.*

EN 12225, *Geotextiles and geotextile-related products – Method for determining the microbiological resistance by a soil burial test.*

EN 13251, *Geotextiles and geotextile-related products - Characteristics required for use in earthworks, foundations and retaining structures*.

EN ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs (ISO 898-1:1999)*

EN ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods (ISO 1461:1999)*

EN ISO 2063, *Thermal spraying - Metallic and other inorganic coatings - Zinc, aluminium and their alloys (ISO 2063:2005)*

EN ISO 10320, *Geotextiles and geotextile-related products – identification on site (ISO 10320:1999).*

ENV ISO 10722-1, *Geotextiles and geotextile-related products - Procedure for simulating damage during installation - Part 1: Installation in granular materials (ISO 10722-1:1998)*

EN ISO 12957-1, *Geosynthetics - Determination of friction characteristics - Part 1: Direct shear test (ISO 12957-1:2005)*

EN ISO 13431, *Geotextiles and geotextile-related products - Determination of tensile creep and creep rupture behaviour (ISO 13431:1999)*

3 Terms and definitions

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

3.1
fill
natural or man made material formed of solid particles, including certain rocks, used to construct engineered fill

3.2
reinforcement
generic term for reinforcing inclusions placed within fill

3.3
engineered fill
fill which is placed and compacted under controlled conditions

3.4
reinforced fill
engineered fill incorporating discrete layers of soil reinforcement, generally placed horizontally, which are arranged between successive layers of fill during construction

3.5
fill reinforcement
reinforcement which enhances stability of the reinforced fill mass by mobilising the axial tensile strength of the fill reinforcement by soil interaction over its total length

NOTE It is typically in the form of a strip, sheet, rod, grid or mesh and is usually placed in discrete layers.

3.6
geosynthetics
for the purpose of this European standard “geosynthetics” stands for “geotextiles and geotextile related products”

3.7
facing
covering to the exposed face of a reinforced fill structure which retains the fill between layers of reinforcement and protects the fill against erosion

3.8
foundation
foundation of a reinforced fill structure is the total area of the surface upon which the lowest layer of reinforcement is installed

3.9
discrete facing unit
partial height facing unit used to construct incrementally a reinforced fill structure

3.10
full height facing unit
facing unit equal to the height of the face of the structure

3.11
hard facing unit
panel or block usually of precast concrete with intrinsically low vertical compressibility and high bending stiffness. (See C.2.1 for guidance)

3.12
deformable facing unit
preformed steel grid section, a preformed solid steel section or a rock filled gabion with intrinsically vertical compressibility and low bending stiffness. (See C.2.2 for guidance)

3.13
soft facing unit
soil fill encapsulated in a geogrid or a geotextile facing with no bending stiffness. (See C.2.3 for guidance)

3.14
facing system
assemblage of facing units used to produce a finished reinforced fill structure

3.15
rigid facing system
facing system with no capacity to accommodate vertical differential settlement between fill and facing. (See Annex C for guidance)

3.16
semi-flexible facing system
facing system with some capacity to accommodate differential settlement between fill and facing

3.17
flexible facing system
pliant, articulated, facing system with capacity to accommodate differential settlement between fill and facing

3.18
green facing
vegetative cover or infill used without facing units or as an adjunct to reinforced fill structures constructed using facing units

3.19
cladding
false facing added in front of the facing to improve the aesthetics of a finished reinforced fill structure

3.20
design life
service life, in years, required by the design

3.21
temporary structures
structures with a design life of 1 - 5 years (Class 1)

3.22
permanent structures
structures with a design life of more than 5 years (Class 2 – 5)

4 Information needed for construction

4.1 Prior to commencement of any construction work all information necessary for the construction of the works in compliance with the design and contract documents shall be provided.

4.2 Information shall include definition of the reporting procedure to deal with unforeseen circumstances, or with any conditions revealed or considered during construction which appear to be worse than those assumed in the design.

4.3 Information shall include definition of the reporting procedure if an observational method of design is adopted or monitoring is required.

4.4 Notice of any restrictions such as any construction phasing required by the design, any restrictions on site access, any environmental restrictions or any statutory restrictions on the site shall be provided.

4.5 For works to be constructed to specified levels, co-ordinates and tolerances these shall be shown on plans, or in the specification, together with the positions, levels of and co-ordinates of fixed reference points at or near the works construction site.

4.6 When relevant a schedule of any testing and acceptance procedures for materials incorporated in the works shall be provided.

4.7 When samples of reinforcements are to be installed for the assessment of their long term degradation, or pull-out capacity, detailed instructions with regard to their location, identification and installation shall be provided.

4.8 To avoid damage to existing or proposed services the accurate location of all services such as electricity, telephone, water, gas, drains and sewers shall be ascertained.

4.9 If the site is subject to tidal working or flooding, cold climate conditions or allied restrictions, details of such restrictions shall be ascertained.

5 Geotechnical investigations

5.1 The extent of any site investigation shall be sufficient to allow determination of ground conditions at the site in accordance with the requirements of EN 1997-1 and to enable construction of the works in compliance with the contract documents and design.

5.2 Geotechnical, hydrogeological and hydrological information should be provided to enable the constructor to design any temporary works or accesses needed for construction (e.g. earthworks, embankments, stabilization of excavations or cuttings near the structure, construction of cofferdams.)

5.3 Relevant geotechnical investigation shall be provided to determine the properties of the fill material related to:

— workability, in accordance with 6.2.2;

— aggressiveness against the reinforcements or the facing, in accordance with 6.2.8;

— internal friction and cohesion, in accordance with 6.2.10.

5.4 A geotechnical investigation, in accordance with 6.2.8.1 to 6.2.8.3, shall be provided, when relevant, to determine the aggressiveness of:

— foundation material which can be in contact with the reinforcement or facing;

— ground water which can soak the selected fill and affect its own aggressiveness.

6 Materials and products

6.1 General

6.1.1 Construction of reinforced fill involves the use of the following major components:

— fill material;

— fill reinforcement, and if required;

— facing system.

All materials and products shall conform to the specifications of the design and with the technical requirements of the suppliers if proprietary systems are used. All materials used shall be mutually compatible.

6.1.2 The source of supply of all materials, fill, reinforcements, facing etc... shall be documented. The source of materials shall not be changed without prior notice.

6.2 Fill materials

6.2.1 General

6.2.1.1 The fill used within the reinforced zone shall be selected to meet the properties required by the design and the project specification.

6.2.1.2 The suitability of a reinforced fill material is dependent on a number of factors that shall be considered when selecting the material:

— fill workability;

— function and environment of the structure and long term behaviour;

— fill layer thickness and maximum particle size;

— facing technology;

— vegetation;

— drainage properties;

— aggressivity of the fill;

— fill – reinforcement interaction;

— fill – internal friction and cohesion;

— frost susceptibility.

6.2.2 Fill workability

6.2.2.1 The fill workability shall be such that it can be placed and compacted to produce the properties required by the design.

6.2.2.2 The selection of the fill shall take into account the climatic conditions under which the fill will be placed, the compaction plant and local practice and experience. See Annex A for guidance.

6.2.2.3 Any relevant local experience in the construction of unreinforced embankments shall be considered in the fill selection for reinforced fill structures.

6.2.2.4 Any additives used to improve the workability of some fill materials, e.g. lime, cement, shall be considered with regard to construction limitations. i.e. presence of reinforcement layers within the fill, chemical durability.

6.2.2.5 The fill material shall be free from snow and ice. Frost susceptible materials shall not be placed in sub-zero conditions

6.2.3 Function and environment of the structure and long term behaviour

6.2.3.1 Some types of structure have a critical function where post construction settlement is very important. e.g. bridge abutments, walls supporting railway tracks and buildings, or high earth retaining structures etc. In these cases fill material which is easy to compact and which will have subsequent low compressibility shall be selected. (see Annex A for guidance).

6.2.3.2 Where a structure is exposed to flooding and subsequent rapid drawdown the drainage properties of the fill shall be checked for compatibility with the design assumptions.

6.2.3.3 The behaviour of some fine grained soils, shall be considered with regard to the design life, long term performance and function of the reinforced soil structure. Degradable fill materials and friable soils shall not be used unless specific studies are carried out to validate their use. In particular the properties of materials which are susceptible to break down shall be assessed from trial tests, or tests performed on the material after compaction.

6.2.4 Fill layer thickness and maximum particle size

6.2.4.1 The maximum particle size should allow an acceptably even surface to be formed and be compatible with the compacted layer thickness. The maximum particle size can also be a function of the spacing of the layers of reinforcement and, where relevant, of the size of the facing units.

6.2.4.2 The maximum particle size will also be determined by the choice of reinforcement in order to keep the construction damage within the specified design limits. See 6.2.8.4.

6.2.4.3 The compaction equipment used close to the facing of the structure is generally required to be lighter than within the body of the fill (unless specified otherwise by the soil reinforcement system). This may result in thinner compacted layers, to achieve the required fill density.

6.2.4.4 Unsuitable fills such as organic soils, soluble materials and strongly swelling materials shall not be used.

6.2.5 Facing technology

6.2.5.1 The compatibility of compaction induced settlement and post construction settlement with the facing system used shall be considered when the fill is selected. See Annex A and C for guidance.

6.2.6 Vegetation

6.2.6.1 When a vegetative cover on the facing (greened surface) is planned, the fill material placed near the front of the construction shall meet specified requirements for vegetative cover.

6.2.7 Drainage properties

6.2.7.1 When using drainage geosynthetics the drainage and filtration properties of the geosynthetic shall be compatible with the selected fill.

6.2.8 Aggressivity of the fill

6.2.8.1 The electro-chemical, chemical and biological aggressivity of the fill materials shall be considered to ensure that these properties do not have a detrimental effect on the performance of the reinforcement or the facing.

6.2.8.2 The assessment of the electrochemical, chemical or biological suitability of the selected fill in regard to the reinforcements shall be based on previous relevant experience, e.g. established correlation between the soil characteristics and the long term strength losses of the reinforcements.

6.2.8.3 The mechanical aggressivity of the fill materials with regard to the reinforcement or facing shall be considered to assess compatibility with the design assumptions.

6.2.8.4 The assessment of mechanical damage of the reinforcements, or their coatings, caused by the selected backfill during construction shall be based on previous relevant experience where available, or on specific site testing where necessary. This is particularly important where crushed, angular, fill is used.

6.2.9 Fill reinforcement interaction

6.2.9.1 The interaction between the fill and the reinforcement shall be considered to assess compatibility with the design assumptions.

6.2.9.2 The assessment of the fill reinforcement interaction should be based on testing such as shear box or pull-out testing, and/or previous relevant experience where available.

6.2.10 Fill internal friction and cohesion

6.2.10.1 The compatibility of the internal friction and cohesion of the selected fill with the design assumptions shall be considered.

6.2.10.2 The assessment of the internal friction and cohesion of the fill shall be representative of the conditions in which it is used (e.g. density, moisture content, stress level).

6.2.10.3 The assessment of the frictional properties of free draining or granular fill materials (as defined in Annex A for guidance) may be based on previous relevant experience and related to the particle size distribution of the material.

6.2.11 Frost susceptibility

6.2.11.1 Where relevant, non frost susceptible material shall be used to a thickness of the frost depth from any surface exposed to sub-zero temperatures unless an insulating layer is used.

6.2.12 Guidance

Some typical combinations of fill, reinforcement and facing units are considered in Annex A. The electrochemical properties of fills used with metallic reinforcement are considered in Annex B.