SLOVENSKI STANDARD
SIST EN 14731:2006

01-februar-2006

Izvedba posebnih geotehniļ nih del ï Temeljenje z globinsko vibracijo

Execution of special geotechnical works - Ground treatment by deep vibration

Ausfürung von besonderen geotechnischen Arbeiten (Spezialtiefbau) - Baugrundverbesserung durch Tiefenrüttelverfahren

Exécution de travaux géotechniques spéciaux - Amélioration des massifs de sol par vibration

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Ta slovenski standard je istoveten z: EN 14731:2005

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ICS:

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

SIST EN 14731:2006 **en**

2003-01.Slovenski inštitut za standardizacijo. Razmnoževanje celote ali delov tega standarda ni dovoljeno.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14731

September 2005

ICS 93.020

English Version

Execution of special geotechnical works - Ground treatment by deep vibration

Exécution de travaux géotechniques spéciaux - Amélioration des massifs de sol par vibration

Ausführung von besonderen geotechnischen Arbeiten (Spezialtiefbau) - Baugrundverbesserung durch Tiefenrüttelverfahren

This European Standard was approved by CEN on 8 August 2005.

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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 Central Secretariat has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Ref. No. EN 14731:2005: E

Contents

page

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SIST EN 14731:2006
https://standards.iteh.ai/catalog/standards/sist/9849a111-7ccb-4d2d-bec4-ce3e8260b7ea/sist-en-14731-2006

iTeh STANDARD PREVIEW
(standards.iteh.ai)
SIST EN 14731:2006
https://standards.iteh.ai/catalog/standards/sist/9849a111-7ccb-4d2d-bec4-ce3e8260b7ea/sist-en-14731-2006

Foreword

This European Standard (EN 14731:2005) 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 March 2006, and conflicting national standards shall be withdrawn at the latest by March 2006.

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, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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SIST EN 14731:2006
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1 Scope

This European Standard is applicable to the planning, execution, testing and monitoring of ground treatment by deep vibration achieved by depth vibrators and compaction probes.

The following types of treatment are covered by this European Standard:

— deep vibratory compaction to densify the existing ground;

— vibrated stone columns to form a stiffened composite ground structure by the insertion of granular material which itself shall be densified. Generally, stone columns have a diameter greater than 0,6 m and lower than 1,2 m.

The following treatment methods are covered by this European Standard:

— methods in which depth vibrators, containing oscillating weights which cause horizontal vibrations, are inserted into the ground;

— methods in which compaction probes are inserted into the ground using a vibrator which remains at the ground surface and which in most cases oscillates in a vertical mode.

Treatment methods are outlined in Annexes A and B.

The following treatment methods, among others, are not included in this European Standard:

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— methods in which sand or stone columns are installed by means of impact or top vibratory driven casing;

— methods in which very stiff columns are formed either by the addition of cement to granular material or by the use of concrete or any other binder;

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— dynamic compaction and other methods in which some form of treatment is applied to the ground surface;

— explosive compaction.

2 Normative references

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

EN 791, *Drill rigs – Safety*

EN 996, *Piling equipment – Safety requirements*

EN 1990, *Eurocode: Basis of structural design*

EN 1997-1:2004, *Eurocode 7: Geotechnical design – Part 1: General rules*

prEN 1997-2, *Eurocode 7: Geotechnical design – Part 2: Ground investigation and testing*

3 Terms and definitions

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

Additional descriptions of some of the ground treatment methods are given in Annexes A and B.

3.1
deep vibratory compaction
type of ground treatment by deep vibration in which the main purpose is to densify the soil. The treatment is applicable to many granular soils and normally results in increased strength and stiffness, reduced permeability and reduced susceptibility to liquefaction

3.2
vibrated stone columns[1)]
type of ground treatment by deep vibration in which a depth vibrator is used to form continuous stone columns from the maximum depth of penetration up to the ground surface, and hence to form a stone column/soil structure which should have an increased strength and stiffness compared with the ground in an untreated state. The treatment is applicable to a wide range of soils and in granular soils some densification may also be achieved. Three installation processes, the dry top-feed process, the wet process and the dry bottom-feed process are described in Annex B

3.3
vibrating tool
item of equipment which is inserted into the ground to cause vibration at depth; commonly a depth vibrator containing oscillating weights or a compaction probe inserted into the ground using a top vibrator which remains at the ground surface

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3.4
depth vibrator
basic component of ground treatment equipment used in the installation of vibrated stone columns and in vibro compaction, which vibrates horizontally by means of an eccentric weight rotating about its longitudinal axis, and penetrates into the ground. The penetration in the ground can be made easier by air or water flushing

SIST EN 14731:2006
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3.5
top vibrator
vibrator which remains above the ground surface

3.6
compaction probe
tool for deep vibratory compaction which is inserted into the ground to transmit vibrations from a top vibrator which remains at the ground surface; wings, drainage or water flushing can be provided to facilitate the compaction process

3.7
deep vibro compaction
technique in which a depth vibrator is used to compact granular soil with or without the formation of stone columns

3.8
dry top-feed process
method of installing vibrated stone columns in which the hole formed by the depth vibrator remains open and specified granular material is fed directly into the top of the hole and compacted by the vibrator in stages (the process is described in Annex B)

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1) Commonly termed vibro stone columns.

3.9
wet process
method of installing vibrated stone columns in which flushing water removes soft material, stabilises the hole and allows specified granular material to reach the tip of the depth vibrator where it is compacted (the process is described in Annex B)

3.10
dry bottom-feed process
method of installing vibrated stone columns in which specified granular material is delivered directly to the tip of the vibrator via a feed pipe attached to the vibrator, with the vibrator remaining in the ground during the construction of the column to maintain the stability of the hole (the process is described in Annex B)

4 Information needed for the execution of the work

4.1 General

4.1.1 Prior to the execution of the work, all necessary information shall be provided

4.1.2 The information should include:

a) any legal or statutory restrictions;

b) location of main grid lines or reference points for setting out;

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c) condition of structures, roads and services adjacent to the work;

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d) suitable quality management system, including supervision, monitoring and testing.

SIST EN 14731:2006
https://standards.iteh.ai/catalog/standards/sist/9b19a1f1-7ce0-4d2d-8e04-ce3e8260b7ea/sist-en-14731-2006

4.1.3 The information regarding the site conditions shall cover, where relevant:

a) geometry of the site including boundary conditions, topography, access, slopes and headroom restrictions;

b) existing underground structures, services, known contaminants and archaeological constraints;

c) environmental restrictions including noise, vibration, displacements, pollution and effects of seasonal variations in weather including frozen surface layers;

d) future or ongoing activities such as dewatering, tunnelling, deep excavations and raising of site levels.

4.1.4 Other information which will be required is described in Clauses 5, 6, 7 and 8.

4.2 Special features for ground treatment by deep vibration

The information required in relation to the practical aspects of the execution of ground treatment shall include:

— specific project design objectives which the execution of the ground treatment is intended to fulfil;

— water supply and slurry disposal requirements for the wet process of installing vibrated stone columns.

5 Geotechnical investigation

5.1 General

5.1.1 All site investigation shall be undertaken in accordance with EN 1997-1 and prEN 1997-2, and the design of the project.

5.1.2 The extent and depth of the site investigation shall be sufficient to determine the characteristic ground conditions and topography of the site and to identify and locate all ground formations, layers, other geological features and ground water levels affecting the execution of the works.

5.1.3 All information from site investigations shall be made available in accordance with the requirements of Clause 4.

5.1.4 Some fills may be heterogeneous and examination in trial pits may be required for a representative geotechnical description.

5.1.5 Obstructions, hard layers and cobbles and boulders within the ground which would influence or prevent the insertion of the vibrating tool should be identified.

5.1.6 The presence of ground conditions which will affect the performance of treatment shall be identified including:

— hard layers;

— soils sensitive to disturbance;

— soils with potential for collapse settlement on wetting;

— soils with liquefaction potential;

— fills currently settling under self-weight.

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SIST EN 14731:2006
https://standards.iteh.ai/catalog/standards/sist/9849a111-7ccb-4d2d-bec4-ce3e8260b7ea/sist-en-14731-2006

5.1.7 Any contaminants and pollutants in the soil or the groundwater should be identified.

5.2 Specific aspects for deep vibratory compaction

5.2.1 Special consideration shall be given to the extent of the treatable granular soils and the location and extent of any layers which restrict or reduce the efficiency of the treatment process including clay, silt and organic layers and layers preventing drainage.

5.2.2 Where clay, silt or organic soils are present, some or all the properties mentioned in 5.3 may be needed.

5.2.3 The following geotechnical properties of the granular soil may be relevant to the design and execution of ground treatment by deep vibratory compaction:

— particle size distribution and fines content;

— *in situ* density index (relative density);

— permeability;

— crushability of particles;

— inter-particle bonding caused by cementation, suction or cohesion.

5.3 Specific aspects for vibrated stone columns

5.3.1 Particular attention should be given to the determination of physical and geotechnical properties required for the design and execution of the ground treatment by vibrated stone columns, for example:

— compressibility;

— consistency limits;

— undrained shear strength;

— sensitivity.

5.3.2 Certain ground conditions need particular consideration, including:

— location and extent of peat and organic soil;

— presence of biodegradable fill including domestic waste.

6 Materials and products

6.1 General

Imported materials may be naturally occurring sands and gravels, crushed rock or recycled materials such as crushed brick or concrete. Quality control testing is described in 9.2.4.

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6.2 Materials for deep vibratory compaction

SIST EN 14731:2006
https://standards.iteh.ai/catalog/standards/sist/...-sist-en-14731-2006

6.2.1 Material may be added during deep vibratory compaction. This may be the natural granular material being compacted at the site or imported material.

6.2.2 Added materials shall be sufficiently hard and chemically inert so as to remain stable during the treatment process and subsequent working life in the anticipated soil and groundwater conditions.

6.3 Materials for vibrated stone columns

Material used to form stone columns shall be:

— sufficiently hard and chemically inert so as to remain stable during column construction and subsequent working life in the anticipated soil and groundwater conditions;

— graded appropriately for compaction to form a dense column fully interlocked with the surrounding ground and in compliance with other requirements such as drainage;

— compatible with the plant used and flow freely within bottom-feed and through-feed delivery systems without arching which may block these systems.

Gradings typically used with the different processes are given in the following table.

Process	Grading in mm
Dry top-feed process	40 to 75
Wet process	25 to 75
Dry bottom-feed process	8 to 50