
Izvedba posebnih geotehničnih del - Temeljenje z globinsko vibracijo

Execution of special geotechnical works - Ground treatment by deep vibration

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

Exécution de travaux géotechniques spéciaux - Amélioration de sol par vibration en
profondeur

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**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

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prEN 14731:2026 (E)**European foreword**

This document (prEN 14731:2026) has been prepared by Technical Committee CEN/TC 288 “Execution of special geotechnical works”, the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 14731:2005.

This document includes the following significant technical changes with respect to EN 14731:2005:

- amendment of the code reflecting current practice and evolved equipment;
- amendment of the code in line with the 2nd generation of the EN 1997 series;
- introduction of rigid columns, installed with deep vibration technology and equipment.

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1 Scope

This document establishes general principles for the execution of soil treatment by deep vibration.

The following types of treatment are covered by this document:

- deep vibratory compaction to densify the ground as mentioned in EN 1997-3:2025, Annex I, Table I.1;
- vibrated columns formed by inserted granular material laterally/radially compacted against the surrounding ground to form a stiff composite column-soil structure (vibrated compacted granular columns) as mentioned in EN 1997-3:2025, Annex I, Table I.2;
- vibrated columns formed by inserted material developing unconfined compressive strength comprising a composite of binder and granular material (rigid columns) as mentioned in EN 1997-3:2025, Annex I, Table I.2.

The following treatment methods are covered by this document:

- 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 above ground surface, and which oscillates in a vertical mode.

Treatment methods are outlined in Annexes A, B, C and D.

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

- dynamic compaction, dynamic replacement and other methods in which some form of treatment is applied to the ground surface;
- uncompacted granular columns primarily used as drains;
- explosive compaction.

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 206 (all parts), *Concrete — Specification, performance, production and conformity*

EN 1990 (all parts), *Eurocode — Basis of structural and geotechnical design*

EN 1997 (all parts), *Eurocode 7 — Geotechnical design*

EN 1997-1:2024, *Eurocode 7 — Geotechnical design - Part 1: General rules*

EN 16228 (all parts), *Drilling and foundation equipment — Safety*

3 Terms and definitions

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

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

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

3.1

deep vibratory compaction

type of ground treatment by deep vibration in which the main purpose is to increase the soil's relative density

Note 1 to entry: The treatment is applicable mainly to coarse grained and normally results in increased strength and stiffness, reduced permeability and reduced susceptibility to liquefaction.

Note 2 to entry: Deep vibratory compaction is also termed as vibro floatation, vibro compaction or vibro densification.

3.2

vibrated compacted granular columns

type of soil treatment by deep vibration in which a vibrating tool is used to form continuous compacted granular columns from the maximum depth of penetration up to the top of the treatment zone, forming a composite column-soil structure with an increased composite stiffness compared to the untreated state

Note 1 to entry: Depending on the inserted material, vibrated compacted granular columns are also termed stone columns, gravel columns or sand columns.

Note 2 to entry: The treatment is applicable to a wide range of soils and in coarse grained materials some densification may also be achieved. Two installation processes, the top-feed process and the bottom-feed process are described in Annex C.

Note 3 to entry: Uncompacted granular columns primarily used as drains are covered in EN 15237 and not in this document.

3.3

rigid columns

type of soil treatment by deep vibration in which a vibrating tool is used to form continuous columns with an unconfined compressive strength comprising a composite of binder and granular material or concrete

Note 1 to entry: Rigid columns can be designed as class BII ground improvement according to EN 1997-3.

3.4

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 above ground surface

3.5

depth vibrator

ground treatment equipment used in the installation of vibrated columns and for vibro compaction, which vibrates horizontally by means of an eccentric weight rotating around its longitudinal axis, and is inserted into the ground, which can be assisted by air or water flushing

Note 1 to entry: Penetration can also be preceded by predrilling.

3.6

top vibrator

vibrator which remains above the ground surface and is connected to a compaction probe

3.7

compaction probe

tool for installation of vibrated columns and vibro compaction, which is inserted into the ground to transmit vibrations from a top vibrator which remains above the ground surface; wings, drainage or water flushing can be provided to facilitate the compaction process

3.8

top-feed process

method of constructing vibrated compacted granular columns in which the hole formed by the vibrating tool remains open and allows specified granular material to be fed directly into the top of the hole and which is then compacted by the vibrator or the compaction probe in stages

Note 1 to entry: The penetration can be assisted by flushing with air and/or water and/or pre-drilling.

Note 2 to entry: The process is described in Annex C.

3.9

bottom-feed process

method of constructing vibrated compacted granular columns in which specified granular material is delivered directly to the base of the vibrating tool via a feed pipe attached to the depth vibrator or through the hollow compaction probe, the vibrating tool remains in the soil during the construction of the column to maintain the stability of the hole and to compact the inserted material

Note 1 to entry: The penetration can be assisted by flushing with air and/or water and/or pre-drilling.

Note 2 to entry: The process is described in Annex C.

4 Information needed for the execution of the works

4.1 General

4.1.1 Prior to the execution of the work, all necessary information shall be made available.

4.1.2 The information shall include but is not limited to:

- any legal or statutory restrictions;
- location of main grid lines or reference points for setting out treatment or column positions;
- location and condition of structures, roads, services, etc. on or adjacent to the works, including any necessary surveys;
- minimum requirements for a quality management system, including supervision, inspection and monitoring;
- site geometry (boundaries, topography, access points, slopes, etc.);
- available space for storage of materials, treatment and/or disposal of spoil or waste materials;

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- location of existing underground structures, services and archaeological constraints, known contaminants and potential presence of unexploded ordnance and its location;
- site constraints (environmental restrictions including noise, vibration, displacements, pollution) and potential seasonal weather impacts (e.g. frozen surface layers, storms or flooding);
- above ground lines, services and headroom restrictions.
- future or ongoing activities such as dewatering, tunnelling, deep excavations and raising of site levels.

4.2 Specific requirements

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 meet;

NOTE These objectives typically include provisions of increased bearing capacity, reduced compressibility, reduced liquefaction potential, reduced collapse potential; change of hydraulic conductivity or other requirements;
- water supply and slurry disposal constraints for the wet process of installing vibrated compacted granular columns or deep vibratory compaction.

5 Geotechnical investigation**5.1 General**

5.1.1 All site and ground investigation shall be executed in accordance with the EN 1997 series and the design requirements of the project.

5.1.2 Ground level at any point of investigation or testing shall be given relative to the recognized national datum or to a fixed reference chart datum or agreed project site datum.

5.1.3 The extent and depth of the site and ground investigation shall cover the full treatment zone and its zone of influence and shall be sufficient to determine the characteristic ground conditions and topography of the site and to identify and locate all ground formations, layers for the definition of geotechnical units, other geological features and ground water levels affecting the execution of the works.

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

5.1.5 Some existing or planned man-made fills may be heterogeneous, and further examination may be required to determine representative geotechnical descriptions.

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

5.1.7 The presence of ground conditions which could affect the performance of treatment shall be identified including, but not limited to:

- very stiff, very dense or cemented layers;
- very soft, very loose layers or singular local areas;

- presence, extent and thickness of any strata that might be sensitive to water infiltration or to change of their stress state caused by vibrating tools;
- soils with potential for collapse or excessive settlement; soils with liquefaction potential;
- layers currently subject to ongoing or future consolidation and/or creep movements;
- presence of pre-treated soil, which might have an adverse effect during penetration;
- mining beneath the site;
- site stability problems (e.g. slope stability).

5.1.8 Piezometric levels of all water-tables and permeability of the soils.

5.1.9 Particular attention shall be paid to artesian conditions.

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

5.2 Specific requirements for deep vibratory compaction

5.2.1 Special consideration shall be given to the geometric extent of compactable granular soils and the location and extent of any layers restricting the efficiency of the treatment process or preventing it outright like clay, silt and organic layers and layers impeding drainage.

NOTE Some methods of field investigation might produce data that result in an inconclusive determination of boundaries between geotechnical units under certain conditions like highly laminated soil or dense layers above very soft layers.

5.2.2 Where clay, silt or organic soils are present, some or all of the properties mentioned in 5.2.3 may require clarification.

5.2.3 The following geotechnical properties of coarse-grained soils are relevant to the design and execution of ground treatment by deep vibratory compaction:

- Type of grain material (silica, carbonite, volcanic, etc.);
- particle size distribution and fines content (silt and clay);
- *in situ* density index (relative density);
- drained and undrained shear parameters;
- compactibility;
- hydraulic conductivity;
- hardness of the grain and carbonate content;
- inter-particle bonding caused by cementation, suction or cohesion.

5.3 Specific requirements for vibrated compacted granular columns

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

- compressibility;
- compactibility;
- consistency limits;
- plasticity;
- drained and undrained shear parameters;
- sensitivity;
- hydraulic conductivity.

5.3.2 Certain ground conditions that may result in a loss of lateral support need particular consideration, including, but not limited to:

- presence and extent of peat and organic soil;
- presence of biodegradable fill including domestic waste;
- insufficient shear strength.

5.4 Specific requirements for rigid columns

5.4.1 Particular attention shall be paid to the following aspects, which are relevant to the execution of rigid columns:

- presence of coarse, highly permeable soils or cavities (natural or artificial), which can cause a sudden loss of concrete, mortar or grout during placement, and thus can require special measures;
- presence, strength and deformation characteristics of soft highly compressible soils, such as very low strength clay or peat, which can cause problems during the extraction of the tool and the placing of concrete or other mixtures (deformation or instability);
- underground strata with the potential for high groundwater flows or seepages;
- unfavourable chemistry of groundwater and ground and water temperatures, if required;
- detrimental chemistry of waste materials;
- thickness and characteristics of bearing strata.

5.4.2 The piezometric levels of all water-tables within the zone of influence shall be monitored separately and over a sufficient period of time to estimate the highest piezometric levels which can occur during construction of the rigid columns following the requirements of the EN 1997 series.

5.4.3 When rigid columns are required to reach bedrock, the rock surface level shall be determined.