

**norm****NEN-EN 16907-5**

## Grondwerken - Deel 5: Kwaliteitscontrole

Publicatie uitsluitend voor commentaar

Earthworks - Part 5: Quality control

december 2015

ICS 93.020

Commentaar vóór 2016-01-19

Als Europees normontwerp is gepubliceerd: prEN 16907-5:2015 ,IDT

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Preview

EUROPEAN STANDARD  
NORME EUROPÉENNE  
EUROPÄISCHE NORM

**DRAFT**  
**prEN 16907-5**

November 2015

ICS 93.020

English Version

**Earthworks - Part 5: Quality control**

Erdarbeiten - Teil 5: Qualitätskontrolle und  
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## European foreword

This document (prEN 16907-5:2015) has been prepared by Technical Committee CEN/TC 396 "Earthworks", the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

This document is one of the product European Standards within the framework series of EN 16907 on *Earthworks*, as follows:

- *Part 1: Principles and general rules;*
- *Part 2: Classification of materials;*
- *Part 3: Construction procedures;*
- *Part 4: Soil treatment with lime and/or hydraulic binders;*
- *Part 5: Quality control (this document);*
- *Part 6: Land reclamation with dredged hydraulic fill;*
- *Part 7: Hydraulic placement of mineral waste.*

Preview  
prEN 16907-5

## 1 Scope

This European Standard provides recommendations and guidance on the quality assurance and quality control of earthworks construction forming part of general civil engineering and building works. It provides guidance on the techniques to be used to give clients, contractors and designers confidence that the earthworks have been constructed in accordance with their requirements.

## 2 Normative references

Not applicable.

## 3 Terms and definitions

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

### 3.1 quality assurance

all those planned and systematic actions necessary to provide confidence that the earth-structure will perform satisfactorily in service i.e. that it has been constructed to the specified requirements

### 3.2 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

## 4 Quality Assurance Programme

Quality Assurance [QA] refers to the overall system for assuring project quality with Quality Control [QC] being one element of a comprehensive QA programme.

A comprehensive construction QA programme consists of the following core elements:

- i) QC: See Definition in 3.2;
- ii) acceptance, finally by the Client: All factors [i.e. sampling, testing and inspection] to evaluate the degree of compliance with contract requirements;
- iii) dispute Resolution: A dispute resolution process should be unbiased and timely. To address disputes related to testing, use of retained samples used in the acceptance decision, alternate or third party laboratories, and a well-defined decision process to determine the outcome of the dispute are advisable.

NOTE The contract may also require independent quality assurance - i.e. an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance programme.

## 5 Quality Control Plan

A Quality Control Plan for earthworks shall as a minimum include:

- 1) sampling and test procedures including:
  - test locations;
  - frequency of testing;
  - test methods and standards to be adopted;

- extent of data to be collected and storage requirements thereafter;
  - methods and criteria for acceptance;
- 2) an organization chart identifying all relevant personnel and key tasks; Who is responsible for quality overall and for individual elements such as testing;
  - 3) procedures for reviewing samples, certificates etc.;
  - 4) visual observations and inspections;
  - 5) document control procedures;
  - 6) procedures for recording non-conformance and what corrective actions are to be undertaken.

A plan should take cognisance of the risk of non-compliance and the potential effects of any consequential (structural) failure if such non-compliance is either not identified or not corrected having been identified.

Information should be collected for each non-conformance and prompt action taken to identify the reasons behind such an event and to identify appropriate corrective action(s) to prevent a recurrence.

All works specified for the project should be checked, tested and monitored as appropriate with records being fully documented and maintained throughout the construction period and afterwards if required.

## 6 Material checking

Prior to any bulk earthworks being undertaken, materials characterization should be carried out in accordance with prEN 16907-2 to ensure that the design assumptions are still valid and the excavation, transportation and compaction requirements in the contract documents/specification are appropriate.

Compliance sampling and testing should be carried out at the point of excavation for on-site materials unless the character of the material is likely to change between excavation and deposition, in which case further sampling and testing should be carried out at deposition.

Imported materials should be sampled and tested for compliance at the point of deposition where practical and may also be tested at source, especially for initial approval.

All material testing should be carried out in accordance with the test procedures agreed in the QC plan.

Where specified in the contract, the results of the classification testing shall be submitted for review/approval prior to the start of filling.

Testing and recording of materials should be continuously reviewed as excavation and filling progresses. Test results should be made available before permanent deposition and compaction, as far as is practicable.

Additional chemical testing may be required when manufactured or recycled materials are incorporated within the earthworks.

Guidance on the appropriate testing for stabilized soils can be found in prEN 16907-4.

Further information on a number of the common tests used across Europe can be found in EN 1997-2 Section 5 and associated Annexes and in prEN 16907-2.

Routine chemical testing in earthworks is usually limited to organic content, carbonate content, sulfate content, pH value and chloride content and further information is found in EN 1997-2 Section 5.6.

## 7 Approaches to Compaction Control

### 7.1 General

Two main approaches of specifying compaction exist across Europe, which are Method specification and End product specification, as described below and in prEN 16907-3 and as summarized in prEN 16907-1.

Land reclamation by dredged hydraulic fill shall always be specified by end product specifications.

NOTE This clause gives a brief summary of each specification approach and provides recommendations for aspects that are specifically relevant to QC.

### 7.2 Method Specification

Method Specifications require the Contractor to produce and place earthworks using specified materials, specific types of equipment and methods stated in the contract.

If a method specification is used, acceptance shall be controlled by one or a combination of the following:

- checking visually and manually recording the conformity of the execution with the method specifications (ie number of passes, layer thickness, acceptability of fill material, type and weight of compactor, speed of compactor, and frequency of vibration (where required));
- checking and recording the compacted volume ( $Q$ ) and the total compacted surface covered by the compactor to compact that volume ( $S$ , controlled by a tachograph) – see  $Q/S$  method in Annex B;
- checking and recording the number of compacted passes, layer thickness and speed of compactor using a compactor equipped with full Global Navigation Satellite System recording and documentation systems (see NEN/TS XXXX “Earthworks — Continuous Compaction Control”).

It is often beneficial to construct a trial embankment at an early stage in the earthworks to demonstrate that with the proposed materials, methods and equipment the specified criteria (if any) can be achieved. The trial embankment should also be used to validate the effectiveness of the proposed recording regime specifically and quality control procedures generally and refinements made where necessary.

NOTE Method Specifications have been used for many years both with or without selected checking in a number of countries and the practice is well developed and understood. They are based on extensive research and practice into compaction methods and soils.

### 7.3 End product Specification

End product Specifications require earthworks to be constructed to achieve specified engineering criteria. In this form of specification the Contractor has responsibility and latitude in determining the materials, procedures and equipment used to produce the product.

NOTE The QC sampling and testing requirements often depend on the form of contract. Commonly the Client will set a minimum level of testing. In some cases the QC testing regime is at the discretion of the Contractor and acceptance by the Client is based on sampling and testing of the final in-place product. Normally in end product the compliance testing is undertaken as the embankment is constructed (e.g. on each layer of placed fill).

It is often beneficial to construct a trial embankment at an early stage in the earthworks to demonstrate that the proposed materials, methods and equipment are capable of achieving the specified criteria, prior to implementation of the routine rate of testing in the QA system.



Compliance can be demonstrated by various means, including insitu density testing, bearing capacity testing, or Continuous Compaction Control, all of which should be supported by contemporary records maintained by the contractor to provide evidence that the specified requirement(s) have been achieved in each layer of the embankment. The contractor would usually need to comply with the required densities and ranges of moisture content in each layer, but plate bearing tests would usually not be undertaken on each layer. The type and extent of the contemporary records and the responsibility for their production should be an integral part of the Quality Control Plan.

See also 12.2 in prEN 16907-1.

## 8 Compliance testing

### 8.1 General

Fill should be inspected and/or tested to ensure that the material, compaction procedures and procedures of construction comply with the specification (see EN 1997-1:2004, 5.3.4).

The selection of material properties should consider the feasibility of performing compliance testing relative to the selected acceptability criteria and the constraints imposed by the contract and construction operations.

**NOTE** It is important to understand that earthworks testing needs to produce rapid results in order that construction/execution is not delayed. On the majority of civil engineering projects, the rate of earthworks construction is a critical activity. Related to this is the need for rapid turnaround of the results from the compliance testing as any delays will increase the volume of material placed and compacted for which compliance is unproven. When assessing the appropriate form of compliance testing the earthworks practitioner should be aware of these testing limitations.

Where appropriate relationship testing should be used to determine the correlation between compliance tests that will be used to control the earthworks and the fundamental soil properties upon which the earthworks design is based. Such testing should be carried out in advance of the main earthworks programme. See also 6.3.3 in prEN 16907-1.

Compliance testing at the point of deposition generally falls into two main classes i.e.:

- tests for insitu density;
- stiffness and bearing capacity tests.

### 8.2 Insitu density testing

*In situ* density testing may be required for the compacted fill to ensure that the specification requirements have been achieved. The density testing can be carried out using one of the methods set out below:

- nuclear density testing;
- sand replacement;
- core cutter;
- rubber balloon;
- liquid replacement;
- gypsum replacement.

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