

**BASIC PRINCIPLES OF EARTHWORKS DESIGN AND EXECUTION IN
BULGARIA ACCORDING THE STANDARD БДС EN 16907-1**

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***Abstract:** This paper aims to present informative the basic principles of earthwork design and execution in Bulgaria according the new standard БДС EN 16907-1, that became effective on 16.05.2019. This standard gives basic principles and general rules for the planning, design and specification of earthworks as a main engineering process.*

***Keywords:** earthworks, principles, general rules, standard*

1. INTRODUCTION

In the field of transport infrastructure in Bulgaria the main emphasis is placed on the pavement design, the components of road pavements, the reducing of the environmental impact of the road construction, the use of recycled materials in the road pavements and others [1][2][3].

Earthworks, however, are a main engineering process and require very accurate planning, design, construction and maintenance [4]. CEN/TC 396 prepared a set of European earthworks standards and divided them into seven distinct parts. Each separate part corresponds to a different stage of the planning, execution and control of earthworks. The main recommendation is that the full set of standards should be considered collectively as a group for execution of earthworks.

The series of the earthworks standards includes:

- 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;

- EN 16907-7 Earthworks - Part 7: Hydraulic placement of extractive waste.

The above-mentioned standards apply to the design of materials for earthworks, execution, monitoring and checking of earthworks construction processes to guarantee that the completed earth-structure satisfies the geotechnical design [5]. It is important to note, that these standards should not be used for geotechnical design (e.g. determining of the required form of the earth-structure, its properties and others) and for environmental planning.

The European standard EN 16907-1:2018 is the first one of the set earthworks standards and has the status of a Bulgarian standard БДС EN 16907-1: 2019 from 16.05.2019. This standard gives basic principles and general rules for the planning, design and

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specification of earthworks. The conflicting national standards hat to be withdrawn at the latest by June 2019.

The field of application of earthworks covers: transport infrastructures (roads, railways, waterways, airports); platforms for industrial, commercial and residential buildings; hydraulic engineering, flood defense and coastal protection works; harbors and airport areas, including the construction of embankments in water; river dykes and marine embankments for land reclamation; earth and rock fill dams; onshore embankments made of hydraulically placed fill; noise barriers, visual barrier, and other non-load bearing earthworks; landscaping embankments; backfilling of open mines and quarries; tailings dams [5].

The standard БДС EN 16907-1: 2019 is applicable to almost all types of earth-structures, except dykes, dams, ground improvement (piling, jet grouting, deep soil mixing, vertical drains or stone columns) beneath an earth-structure and some other specific types of works.

Within the scope of the standard is written, that in several European countries some national sets of rules have been established could not be harmonized within a short period by a European Standard. The main reasons are the climate conditions, the different types of subsoils etc. It is important to emphasize that the standard [5] gives therefore basic rules to reach the aims described above. Seven informative Annexes from B to H of the same document give examples of national practices following the main rules.

The Eurocode 7 (EN 1997-1, Part 1 and Part 2) and the earthworks standards (EN 16907, from Part 2 to Part 6) are referred to in the text of the standard and some or all of their content constitutes requirements of it.

2. PRINCIPLES OF EARTHWORKS DESIGN AND EXECUTION

The standard [5] gives the most important principles regarding to the structure of earthworks projects and their planning and design. Clearly and thoroughly are described the two main stages of each earthworks project: pre-construction studies and execution of works (construction).

The pre-construction studies covers the basic processes such as: planning of the earth-structures; site investigations and classification of materials, assessment of the compatibility of these materials with the required properties of the earth structure, selection of a construction procedure, optimization of earthworks at the scale of the whole project and specifications for executing the works (construction procedure, monitoring, quality control).

The execution of works consists in: construction of earth structure on site, checking the design assumptions, execution of works as specified, monitoring of the ground (e.g. slope stability), quality control / quality assurance and checking the characteristics of the completed earth-structure versus the requirements, leading to the acceptance of the results of the earthworks.

The design process of earth-structures should produce comprehensive guidelines to be satisfied during the construction. For example, the site preparation, the materials, the quality control and quality assurance requirements, the temporary and permanent protection measures or the logistical aspects may be generated as part of the earthworks design process and the instructions should be determined to suit the particular project[6][7].

Four basic aspects are also taken into account:

- relationship between earthworks and earth-structure design;
- sustainable development and environmental considerations for earthworks;
- risk management;
- types of earthwork processes.

It is important to note that Eurocode 7 and other relevant standards regulate the geotechnical and structural design of earth-structures (stability, deformations etc.). The design of earthworks relates to the selections of fill material properties and specification of the requirements for the earthworks construction process. The set of earthworks standards assume that the earth-structure has been properly designed.

The designer of earthworks should prepare different technical earthworks specifications with all requirements that are to be satisfied during construction (e.g. quality control and monitoring procedures, the mechanical process used for extraction, transport, layering, and compaction, the schedule of operations etc.).

In the earthwork standards sustainable development is defined as “*an enduring, balanced approach to economic activity, environmental responsibility and social progress*” [5]. The set of earthworks standards deal with the effects of earthworks only. All environmental questions should be cleared in accordance with the existing laws and standards.

Risk management should be a key aspect of complex projects involving earthworks as in all construction activities. The areas of risk to be managed comprise: programme, quality and financial risks to guarantee the successful completion of the project; health and safety, along with environmental risks to satisfy statutory requirements.

Earthworks include large range of activities, which cannot be covered by a universally set of rules. This standard [5] provides guidance and requirements for four groups of following earthwork activities: construction of fills, execution of cuts and excavations, hydraulic placement of dredged material and hydraulic placement of soils and mineral waste.

CONCLUSIONS

This paper presents some information on the basic principles of earthwork design and execution in Bulgaria according the new standard БДС EN 16907-1, that became effective on 16.05.2019. This standard gives important basic principles and general rules for the planning, design and specification of earthworks as a main engineering process.

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