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Changes in mechanical parameters of soil, considering the effect of additional compaction of embankment

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Abstract

The paper presents selected test results obtained during construction of multi-layer soil embankments. It also provides the analysis of a new geotechnical approach, used for construction of non-typical soil embankments, which takes into account the effect of additional compaction of individual layers. The tests were conducted in in-situ conditions. The testing area constituted a foundation for a large industrial object, i.e. a clinker storage silo of storage capacity of 200 000 tons. The obtained results allow for the assessment of the influence of compaction of the higher layers on the increased soil compaction of the lower layers.

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Keywords: mechanical parameters; multi-layer earth embankments; compaction of bottom layers by the top layer

1. Introduction

In construction of earth embankments, in particular road embankments with significant thickness, an engineering challenge is an optimal way to achieve the target values of geotechnical parameters of embankment Kumor L.

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(2014), Kumor M.K. et al. (2013). The main geotechnical issues that are essential in rational construction of earth embankment apply usually to the following factors:

- choice of the appropriate fill material,
- determination of the required values of parameters that would allow for a safe work of the earth structure in terms of its stability and deformability,
- construction of the earth structure in accordance with engineering code of practice,
- *in-situ* control of the achieved geotechnical parameters in regard to the design values.

Technology of construction of the multi-layer earth embankments that is used commonly involves meeting some basic technical requirements:

- thickness of each layer should be adjusted to equipment capabilities that would enable achievement of the design parameters,
- successive layers should be built in only when the design values of mechanical parameters of the previous layer have been achieved.

The aforementioned rules lead to a conclusion that every consecutive layer of embankment can only be built in when the final values of parameters of the compacted layer have been achieved. This method requires longer construction period and frequently leads to many uncertainties in terms of determination of quality requirement, which result from the secondary distribution of loosening of the compacted layer. Conducted analytical and field analyses indicate that compaction of the lower layers of backfill increases successively during formation of the upper layers, Kumor L. (2014), Kumor M.K. et al. (2013). As a result, the final effect of compaction of the entire compaction, should consider the impact of additional compaction of every layer that is underneath. Field tests, Kumor L. (2014) confirm that such processes of additional compaction actually take place. In the case of construction of embankments from mineral aggregate, the following statement is correct, *there is no geotechnical need for compaction of each newly built-in layer of material, in order to achieve the full value of the designed compaction level, since each successive layer generates the compaction effect in the previously built-in layer of backfill (bottom of the layer).*

2. Characteristics of the testing area

The tests were conducted in the earth embankment formed as a base for a planned industrial object, a clinker storage silo of storage capacity of 200 thousand tons, which was realized on the premises of a cement factory. A pit for the silo foundations was formed as a result of demolition of the old foundations of the rotary stoves to the level of the virgin soil. The demolition work resulted in the creation of the pit in the spot intended for the construction of the silo. The excavation reached depth of 9 meters below the surface of the plot, and was intended for filling. The earth embankment, which constituted the foundation of the projected silo, was then constructed in the pit. According to the project, the silo was cylindrical with a diameter of about D = 70 m and the height of H = 37 m. The foundation of the silo was designed on drilling pales from the embankment -1.0 m below the surface. The foundation plate of the silo was designed with the monolithic reinforced concrete technology, placed directly on the earth embankment. Simultaneously, the embankment constituted a full-sized testing area. Geometrical dimensions of the pit (fig. 1) of the projected embankment were:

- diameter $D \approx 80.0$ m,
- depth/height $H_1 = -10.0$ m, $H_2 = -4.0$ m,
- volume $V = 26\ 500\ m^3$.