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Ground Improvement of the Tank Terminal in Amsterdam, the Netherlands

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Abstract

In the western part of the Port of Amsterdam, a new storage terminal for oil products is being built. The site investigation revealed that underneath a single tank, the thickness of the compressible layers could differ in up to 3 meters. It was concluded by the client that ground improvement was required to avoid excessive differential settlements of the storage tanks and associated maintenance costs. The initial ground improvement design proposed by the client consisted of the application of dynamic replacement (DR). A trial showed that the traditional DR method as well as the CDC technique (Cofra Dynamic Compaction®) did not achieve sufficient improvement. Therefore, a full ground improvement was made, with large excavations of up to a depth of 8 meters below the surface, removing more than 1,000,000 m^3 of material. The excavations were backfilled with sand. This very loose sand was compacted in one phase using the CDC technique. This paper presents an overview of the initial trial results and the final work method with a focus on the method of compaction and the compaction results.

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Keywords: dynamic replacement; dynamic compaction; soft ground; ground improovement.

1. Introduction

In the western part of the Port of Amsterdam, a large new storage terminal for gasoline and related products is being built. An impression of the terminal is given in Figure 1. Before the storage tanks could be built, large ground improvement was required. The ground improvement was required because of the large risk of differential settlements underneath the storage tanks and the high direct and indirect costs involved with the jacking and

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backfilling of differentially settled tanks. During the ground improvement, the highly compressible layers were removed within the zone of influence of the tanks and replaced by sand. This sand was compacted in one phase from the surface using the world largest rapid impact compaction hammers. This paper presents an overview of the ground improvement works with a focus on the method of compaction and the results obtained.

Fig. 1. Artist impression terminal.

2. Geological conditions at place

The extensive site investigation data at the location of the terminal, with numerous CPT tests underneath one single tank, revealed compressible Holocene deposits with varying thicknesses underneath a continuous sand layer of 3 to 5 meters in thickness. The sand layer was placed in the 1960s during a large-scale reclamation of the port of Amsterdam and was placed on top of the agricultural areas. The area was raised further during the dredging operations of the new 'Afrika' harbor at the beginning of this century, adding about 1 meter to the sand thickness. Underneath a single tank, the layer thickness of the compressible material, consisting of a distinct layer of peat on top of a clay layer, could differ a couple of meters. The local thickening of the layer is contributed to an infilled channel, which presumably formed in the underlying clayey sand deposits on top of the Pleistocene sands. Figure 2 presents the interpolated bottom of the compressible layers. The creek is recognizable through the red coloring.

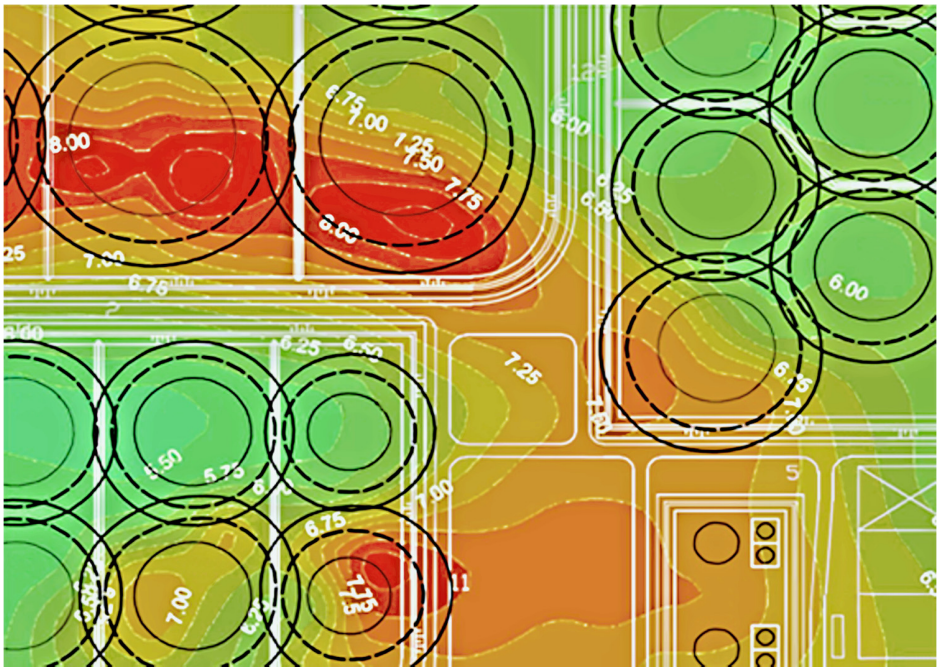

Fig. 2. Interpolated bottom of the compressible peat and clay layer from the CPT information.