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Piled Embankment or a Traditional Sand Construction: How to Decide? A Case Study

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Abstract
A 3.5 km bypass road was constructed around the village Reeuwijk in the Netherlands on very soft and compressible soil. Two construction methods were considered: (i) a traditional solution using a sand embankment, vertical drainage and a temporary surcharge load and (ii) a basal reinforced piled embankment. This paper describes the decision process to select the best construction method. The process included considering the design, the performance, the whole life costs and the risks of each of the considered construction types.
It was concluded that the whole life costs were comparable for both construction types: the piled embankments and the traditional sand solution using vertical drainage and temporary surcharge load. However, the risks were much smaller for the piled embankment. In particular, excessive post-construction settlements of the traditional solution were considered to be a major risk. Therefore, the principal chose for a piled embankment. The road was opened in January 2016.

Keywords: Piled embankments, Whole life costs, Road construction methods, Soft soil, decision support systems

1 Introduction

Reeuwijk is a peaceful small village in the central peat area (Figure 1a) of the Netherlands. Because the capacity of the existing road through the village was insufficient and traffic was found to be disturbing, a 3.5 km bypass road was constructed around the village (Figure 1b). The subsoil consists of 8 m very soft and compressible peat and organic clay deposits. The groundwater table is as high as 0.2 to 0.5 m below ground surface. A careful decision process helped selecting the best construction method in these very poor ground conditions. The process included risk management, meticulous communication with the village community and analyses of whole life costs. The new bypass road was opened in January 2016.

This paper presents the comparison between two construction methods: (i) a tradition solution using a sand embankment, vertical drainage and a temporary surcharge load, (ii) a basal reinforced piled embankment with piles driven into the firm substratum. This paper describes the design, performance, costs and risks of these solutions. The following issues were taken into consideration: construction time, post-construction settlements, construction costs, maintenance costs over the service life and geotechnical risks.

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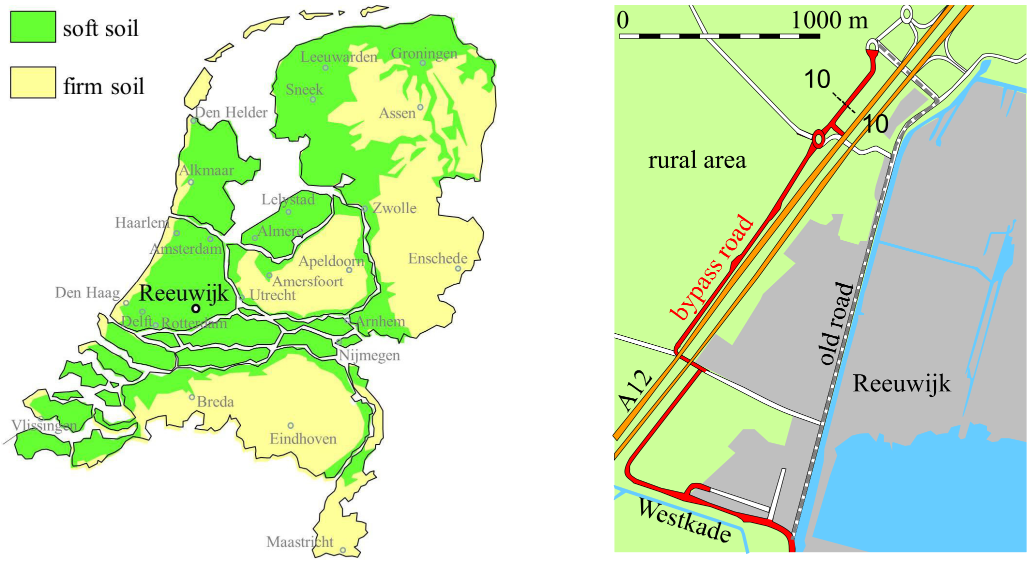

Figure 1: (a) Location of Reeuwijk in the Netherlands; (b) the new bypass road (in red).

2 Decision Process

2.1 Site Conditions

The location of the bypass road is given in Figure 1b. The length of the road is 3500 m; it has one lane in each direction, with extra lanes at junctions. The design traffic volume is 19,000 vehicles per day in 2025, including 5% heavy goods vehicles. The annual traffic growth is anticipated to be 2%. The service life of the pavement is 20 years. The height of the pavement is 0.5 m above the surrounding ground surface. A bicycle path was constructed along the road. The subsoil is extremely soft and compressible; soil characteristics are given in Table 1. The groundwater table is 0.2 to 0.5 m below ground surface.

Soil description	Top of layer m GL	Unit weight kN/m^3	Water Content %	C_c -	$C_{\alpha;e}$ -	c_v m^2/s
Clay	0.0	17.0	40	0.35	0.021	$5{\cdot}10^{-8}$
Peat / organic clay	-0.6	10.4 / 13.6	370 / 90	3.7 / 0.85	0.22 / 0.051	$1{\cdot}10^{-7}$ / $5{\cdot}10^{-8}$
Sand	-8.4	-	-	-	-	-

Table 1: Soil characteristics. C_c = compression index; $C_{\alpha;e}$ = coefficient of secondary compression in terms of void ratio; c_v = coefficient of consolidation

2.2 Methodology

The methodology of the decision process consisted of:

1. selecting characteristic road sections (this Chapter);
2. selecting potential suitable construction methods (this Chapter);
3. making a geotechnical design for these methods (Chapters 2.3 and 2.4);
4. calculating their construction and maintenance costs (Chapter 3.1);
5. assessing geotechnical risks associated with the construction methods (Chapter 3.2);
6. selecting the method with the most acceptable whole life costs and risks (Chapter 3.3).

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