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N242 Bridge Abutments on geogrid reinforced soil near the city of Alkmaar in the Netherlands

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Abstract

The capacity of the provincial road N242 and all the junctions lead to huge traffic problems. To solve these problems the contractor Heijmans Infrastructure BV is constructing two fly-overs including four bridge abutments on geogrid reinforced soil. Designs are in accordance with BS 8006. Varying with the type of fly-over and the bridge abutment there are 7 to 9 layers of geogrid reinforced soil under every bridge foundation. After finishing the reinforced soil is covered with soil for protection. The settlement of the reinforced soil construction after constructing the concrete foundation and placing the bridge deck was less than 10 mm.

Introduction

The provincial road N242 has a crucial role in the attainability and development of the region Heerhugowaard, Alkmaar, Langedijk and Schermer. At this time the limited capacity of the road and all the junctions lead to huge traffic problems. To solve these problems the contractor Heijmans Infrastructure BV is constructing the next items:

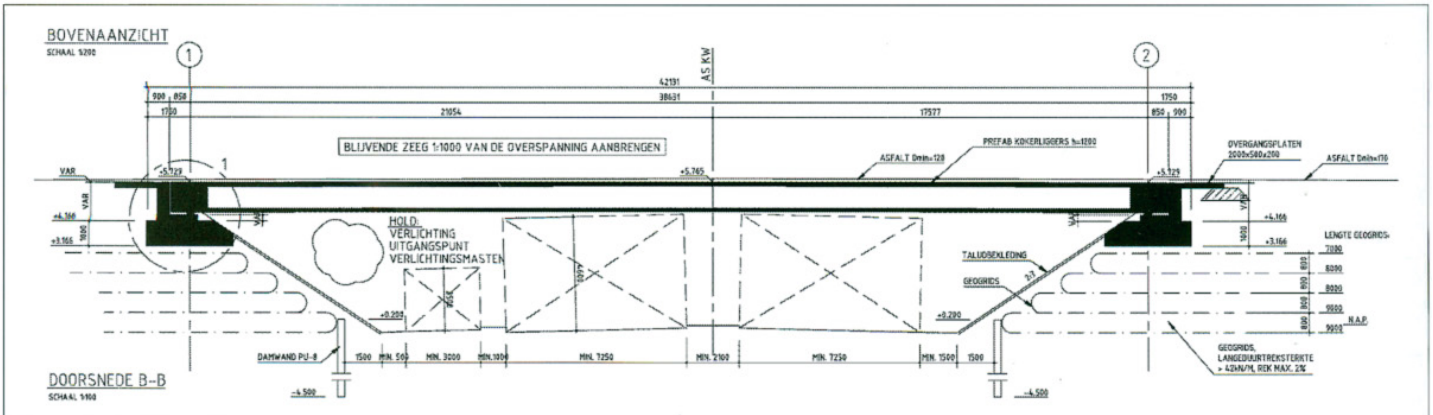
- All the driving lanes of the N242 will be separated;
- Three junctions of roads with the N242 will be combined into one fly-over;
- Two junctions at the same level will be fly-overs;
- Separate bicycle roads and tunnels for bicycles;
- A separate bus lane from Alkmaar to Heerhugowaard for public transportation.

In this project fly-overs KW B and KW O will be constructed including four bridge abutments on geogrid reinforced soil.

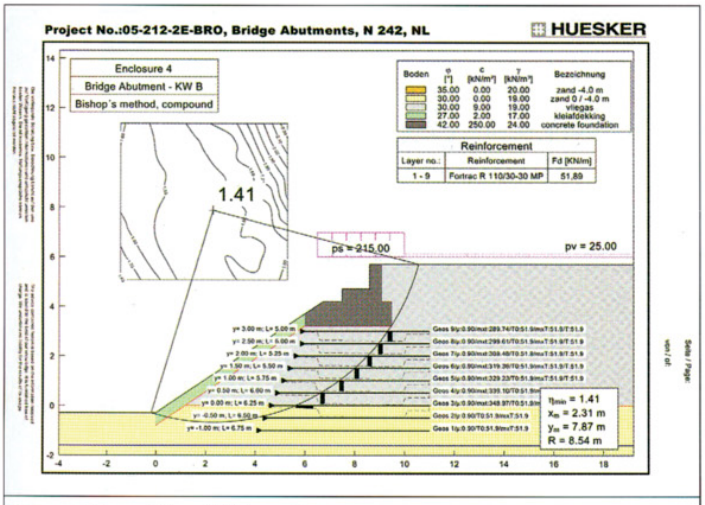
Calculations

Figure 1 shows the principle cross-section of the construction with geogrid reinforced soil. *Figure 3* shows a more detailed drawing as the result of the calculations.
The geogrid reinforced soil structure is built in 0.5 m compacted fill layers reinforced with Fortrac® geogrids. The fill material is sand and at the front facing granular material (0/40) to get better compaction. The construction is built with a gradient 2:1 in order to optimise the Fortrac® geogrids in strength and length. Later the construction is covered with soil at the front so it can be protected against UV-radiation and vandalism.

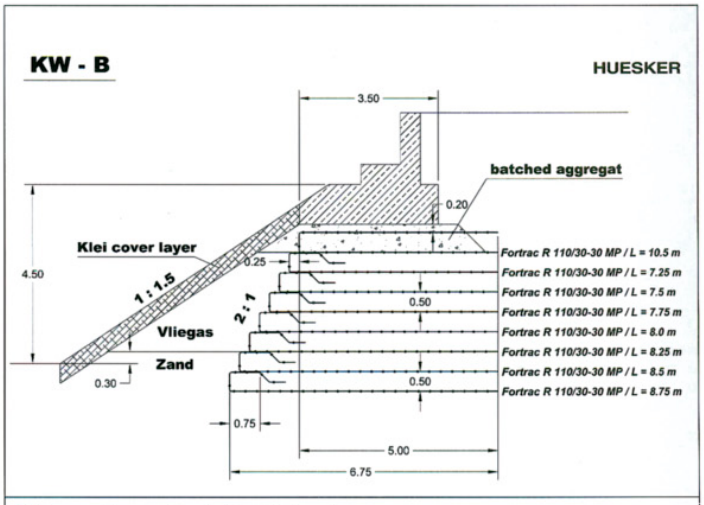
Designs are in accordance with BS 8006. In *figure 2* a graphic presentation of the overall stability is given. Different cross-sections were calculated with different heights and loads in order to optimise the geogrid strengths. Geogrids used are Fortrac R 300/30-30 MP, Fortrac R 150/30-30 MP and Fortrac R 110/25-20/30 MP. Fortrac M (made of PVA yarns) is used because of the high tensile stiffness in combination with the high chemical resistance and very low creep. The high chemical resistance is important since the geogrids may come in contact



↑ **Figure 1** Principle cross-section geogrid reinforced soil of fly-over B



↑ **Figure 2** Presentation stability result



↑ **Figure 3** Cross-section bridge abutment

with the concrete of the bridge foundation, which may imply an environment with pH > 10. Varying with the type of fly-over and the bridge abutment there are 7 to 9 layers of geogrid reinforced soil under every bridge foundation.

Construction of the geogrid reinforced bridge abutment

For this project the contractor Heijmans produced a formwork allowing every layer to be built in one operation. After constructing the layer the formwork was pulled away with a crane and placed on the finished layer. *Figures 4 and 5* show the construction method.
Every layer was compacted to a minimum proctor density of 98 %. At the front side the layer of 0.5 m is compacted in 2 runs of 0.25 m with a plate vibrator. The sand layer behind is compacted in one operation with a heavy roller compactor. When necessary water was added to get optimal compaction. The compaction was measured every 1 or 2 layers with a nuclear device on 3 different places. *Figures 6 and 7* show the activities. Every 3 layers the height is checked so that if necessary the height can be compensated in the next fill layer.

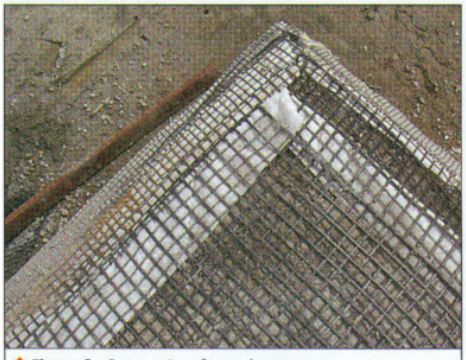
The Fortrac® geogrids are placed with an overlapping of 0.20 m. For each bridge abutment and fill layer an installation plan was made. With this plan everybody on the job site could see which geogrid was needed in length and strength. *Figure 8* gives a corner view from the top of the reinforced bridge abutment after fi-

↑ **Figure 4** The formwork

↑ **Figure 5** Construction of 3rd layer at KW O

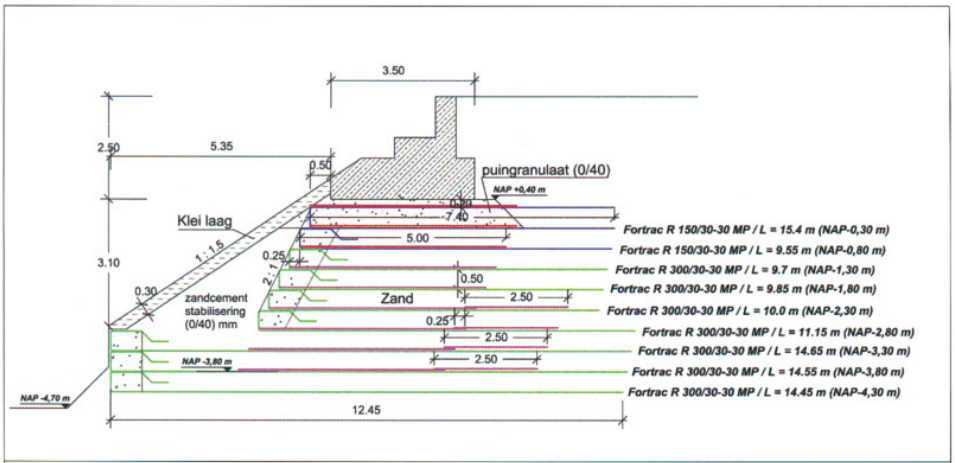
↑ **Figure 6** Heavy rolling compactor

↑ **Figure 7** Wetting the fill



↑ **Figure 8** Corner view from above

↑ **Figure 9** Reinforced soil KW O Westside



↑ **Figure 10** Reinforced soil KW O eastside

nishing. *Figure 9* shows the reinforced bridge abutment from the side after finishing.

Reinforced soil KW O eastside

At the eastside of fly-over KW O a small waterway for recreation was foreseen at the foot of the bridge abutment. It was anticipated to be built with wooden sheet piles but due to the new location it had to be built with steel sheet piles and anchors. By making 3 extra reinforced fill layers just behind the sheet pile construction the wooden sheet piles were made possible again. These extra layers also carry the soil above eliminating ground pressure on the wooden sheet piles (*see figure 10*). *Figure 11* shows the 3rd fill layer just behind the wooden sheet piles.

Fly-over KW B

After finishing the reinforced soil is covered with soil for protection. The concrete construction of the foundation was built and settlements where measured. *Figure 12* shows the bridge foundation after construction. The final slope was made with stabilised sand and stones. After that the bridge deck was placed (see *figure 13*). The settlement of the reinforced soil construction after constructing the concrete foundation and placing the bridge deck was less than 10 mm.

↑ **Figure 11** 3rd layer behind wooden sheet pile

↑ **Figure 12** Bridge foundation KW B

↑ **Figure 13** Fly-over KW B