Basal reinforced embankments spanning voids:

Roadway embankment, Bad Wünnenberg Bypass, North Rhine-Westphalia, Germany

Bad Wünnenberg is a town in the state of North Rhine-Westphalia, Germany. It is situated on the river Aabach, approximately 20 km south of Paderborn. The new section of the road B480n links to the Aftetal bridge, an 800 m long steel composite structure, which spans the Afte Valley at a height of almost 70 m and is the central feature of the Bad Wünnenberg bypass.

To withstand high traffic loads, Federal German roads require good quality foundations. This requirement was not achieved on a section of the B480n Bad Wünnenberg Bypass between the Rhenish Slate Mountains and the Münsterländer Chalk Basin, where the B480n passes over a wide chalk karst area. The underground cavities can rise to the ground surface, especially in cuttings, resulting in local deformations and subsidence.

Since ground subsidence could not be completely ruled out along the planned route, the application of basal geotextile reinforcement was applied as a form of insurance against possible future subsidence. If foundation voids were to arise in the future beneath the road structure then the geotextile reinforcement would be required to span across any formed depressions thus maintaining the road in a serviceable condition.

Along the planned route of the road bypass its alignment changes from cuttings to embankment fills up to 7 m in height. In the cuttings where most subsidence problems are expected to occur fill heights of 1.1 m were used.

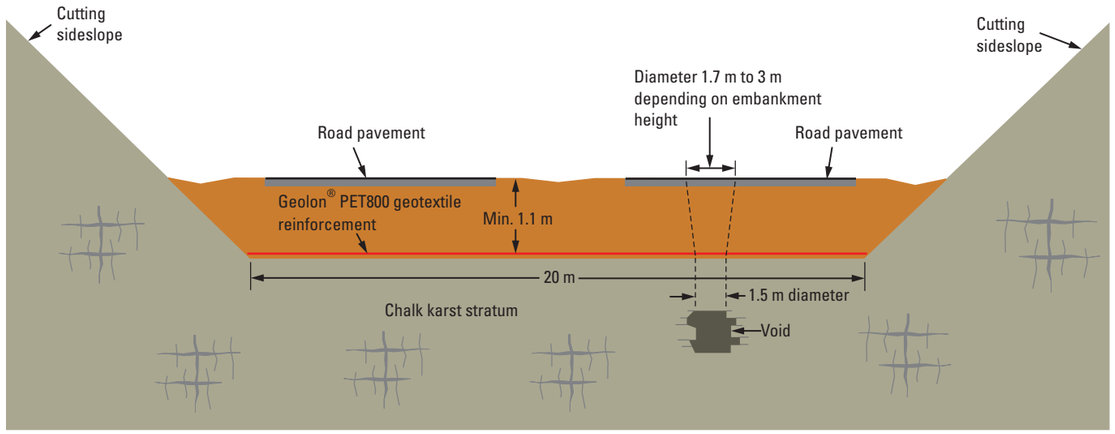
Based on the results of the ground survey and geotechnical analysis, it was found that initial void diameters of 1.5 m could be expected in the fissured foundation stratum beneath the roadway alignment. These voids would result in potential vertical subsidence beneath the earth fills.

In the cutting sections where 1.1 m of earth fill was used an analysis using the RAFAEL subsidence method showed that the expected subsidence diameter at pavement surface would be 1.7 m. In the embankment sections the same analysis showed the expected subsidence diameter at pavement surface to range up to 3 m depending on embankment height. The resulting maximum allowable geotextile reinforcement strains ranged from 2% to 6% depending on the height of earth fill on the basal geotextile reinforcement.

The required basal reinforcement properties were determined in accordance with EBGEO (2011). This resulted in a design tensile strength of at least 300 kN/m over a 100 year design life at the required strain levels. Geolon® PET800 geotextile reinforcement, with an initial tensile strength of 800 kN/m, fulfilled the long term design requirements and was subsequently used for the basal reinforcement.

The subgrade surface was first prepared by smoothing and compacting the ground surface. Next the layer of Geolon® PET800 geotextile reinforcement was installed in the direction along the length of the roadway. On top of the geotextile reinforcement granular fill material, having good dilatancy properties, was placed and compacted. Further lifts of granular fill were placed and compacted until the level for the pavement subgrade was achieved. Finally, the roadway pavements were constructed on top.

Site preparation works



Cross section through the cutting section of the road structure

Client: Landesbetrieb Strassenbau Nordrhein County, Germany.

Consultant: Dr Spang GmbH, Witten, Germany.

Contractor: Amand GmbH & Co. KG, Germany.

EBGEO (2011) Recommendations for design and analysis of earth structures using geosynthetic reinforcements, Wilhelm Ernst and Sohn, Germany.

Compacting embankment fill

Placing and compacting granular fill over Geolon® PET800 geotextile reinforcement