

# Designing reinforced embankments on piles: publications in Osaka

M. Nods  
Huesker Synthetic

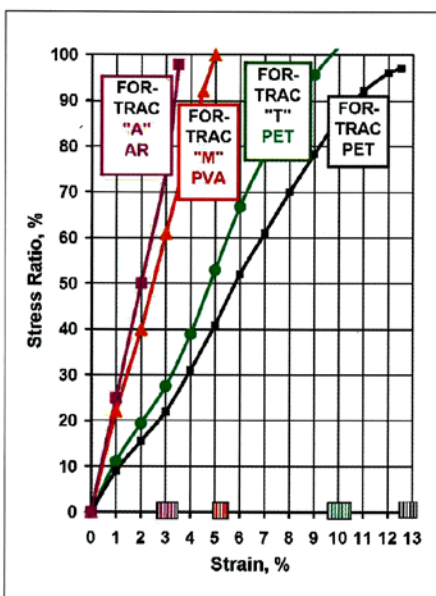
## HUESKER

HUESKER  
P.O. Box 1262  
D-48705 Gescher  
Germany  
Tel. 0049 2542 7010  
E-mail: info@huesker.de  
Internet: www.huesker.com

### PUBLICATIONS IN OSAKA

Two important papers related to reinforced embankments on piles and design methods were published at the 16<sup>th</sup> International Conference on Soil Mechanics and Geotechnical Engineering (ICSMGE) in Osaka (2005):

1. Piled embankments: Overview of Methods and Significant Case Studies, by Alexiew;
2. Embankment project on soft subsoil with grouted stone columns and geogrids, by Heitz, Kempfert and Alexiew.



↑ Figure 1 Influence of the polymer used on the tensile force-strain behavior of Fortrac® geogrid "families"

### ABSTRACT

Two important papers were published at the Osaka conference addressing design and application of geosynthetic reinforced embankments on piles. The availability of design procedures and reference embankments for high speed trains indicate that the system of piled embankments has reached the stage of maturity. The availability of high strength geogrids with different polymers allows for project optimisations.

The first paper (Alexiew) is reporting on different analytical design procedures which are in use in various countries world-wide, while the second paper (Heitz a.o.) is addressing a specific railway embankment project.

Also in Holland the discussion on design procedures is ongoing, as can be read in the regular edition in the Dutch language of Geotechniek No 3, 2005 (page 17). A CUR working group is planning to address the issue of design methods and arching effects, and to develop design guidelines. Alexiew's publication can be an interesting contribution to the discussions in the CUR working group.

### ADVANTAGES OF PILED EMBANKMENTS

Important advantages of piled embankments as compared to "conventional" embankment foundations directly on the soft soil are:

- No consolidation time required, direct use is possible;
- No settlements, no maintenance costs;
- No import/export of additional embankment fill for soil improvement, settlement compensation, etc;
- No major influences on existing underground structures (foundations, cables, sewage systems etc.) and geohydrology.

Despite the ongoing discussions on design procedures Alexiew concludes that reinforced embankments on piles as a system have reached the stage of maturity. A lot of experience is available in design procedures, construction and (registered) behaviour. A range of geosyn-

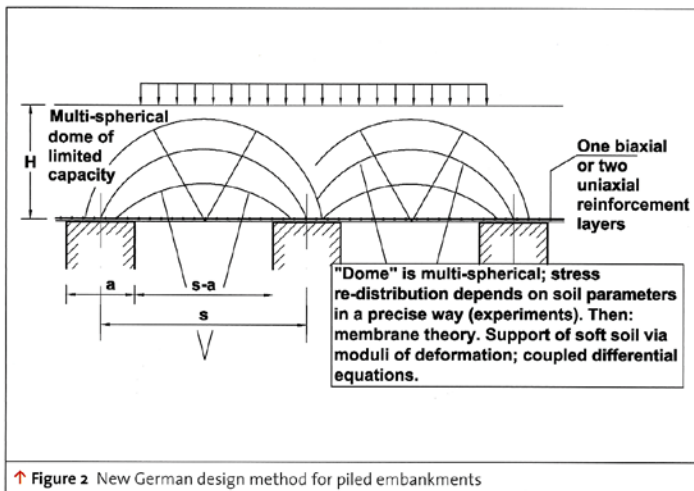
thetic reinforcements with different polymers (see figure 1) is available today, which eliminates any limitation for their use in such systems. Efficiencies are possible by maximising pile spacing and using stronger reinforcements in one or two layers. Fortrac® geogrids with strengths up to 2000 kN/m are possible these days.

Typically the additional costs for stronger reinforcements are negligible in relation to possible reconstruction costs, therefore it is recommended that in case of any doubts regarding bearing capacity or serviceability in the stage of design, to use stronger reinforcements. Some failed or highly deformed structures are known, which were due to optimistic design assumptions.

Alexiew also presented some specific project examples.

### NEW GERMAN DESIGN METHOD IN EBGEO

The development of the new German design method started in 1995. Focal points were to improve the stress redistribution model for the embankment body and to find a way for a reasonable consideration of a possible upward soft soil counter pressure between the piles. The draft for a new chapter in EBGEO (Empfehlungen für Bewehrungen aus Geokunststoffen - DGGT) is ready. It includes a new "multi-shell arching" theory and a strain-related counter pressure. Only one or maximum two strong reinforcement layers directly over the piles are recommended. Because the soft soil counter pressure is of great influence on the results (reinforcement tension), caution is advised in



↑ Figure 3 Paulinenaue section. Three layers of PVA Fortrac® geogrid were placed at 300 mm vertical spacings

the actual use of counter pressure in design calculations. Lowering the ground water level could already eliminate all counter pressure.

#### PROJECTS EXAMPLES

Recent project examples presented in Alexiew's paper include a motorway embankment in the UK (A63 Selby Bypass, 2003) and a railway embankment in Germany (Büchen, 2003, high speed rail link Berlin-Hamburg). Both projects are examples of optimisations via creative engineering with non-standard Fortrac® geogrids (individual custom-made product solutions with different polymers) which are unique possibilities offered by Huesker Synthetic.

#### ICE RAILWAY EMBANKMENT PAULINENAUE: A SITE OF SUPERLATIVES

The second paper by Heitz a.o. is presenting a specific railway embankment project in the section Berlin-Hamburg (13 km section near Paulinenaue). In *Geokunst* of April 2005 (Supplement in the regular edition in the Dutch language of *Geotechniek* No 2, 2005) this project was presented in more detail.

It concerned upgrading of the 150 year old railway line between Berlin and Hamburg for the ICE high speed trains with maximum speeds of 230 km/h.

An earlier reconstruction at the end of the 90s resulted into allowed train speeds of 160 km/h. In terms of construction, the greatest challenges to overcome were on a section between Paulinenaue and Friesack.

The boggy ground there is capable of taking very little load. In the earlier construction stage, the rail embankment had been founded

on 40,000 partially injected vibro columns (PIVC) and geogrid reinforcement. During the planning phase, DB Projektbau GmbH was at first in favour of a partial closure with single track operation, as had been adopted in other sections. In order to ensure that this demanding and high quality project was executed in the best possible manner, a decision in favour of a specified period of full closure was made in consultation with the joint venture partners. Exactly 76 days were allowed for this to take place in summer 2003. A seven-day week, three-shift working system was introduced so that the Herculean task could proceed smoothly all around the clock. The job was planned down to the smallest detail before construction began. Work on the section started simultaneously at several sites. First the existing track bed, along with the associated groundworks was completely removed. The original boggy ground was then replaced to the level of the groundwater table. Approximately 1 m of the partially injected vibro columns forming the piled foundations was then exposed and cut off to existing ground level. Their condition was recorded and repairs carried out where necessary.

The new embankment was then constructed on this foundation. The first geogrid layer was placed over a 200 mm layer of graded aggregate. Then followed three layers of Fortrac® PVA geogrid type R 200/200-30 M placed at intervals of 300 mm.

The 14 m wide rolls of geogrid were placed transversely to the track and overlapped by one metre. Each layer of geogrid was precisely installed to laser accuracy and tolerances of less than 10 mm, in accordance with the manufacturer's recommendations. Huesker

manufactured the custom-made geogrid in 210 m long rolls.

This kept waste to a minimum. For the critical construction phase – the time of full closure – Huesker had reserved additional capacity at its production plants to ensure that extra geogrid could be supplied very quickly if required.

Both papers can be requested via [info@huesker.de](mailto:info@huesker.de).

#### HUESKER SYNTHETIC: ONE OF THE WORLDS LEADING MANUFACTURERS OF CUSTOM-MADE REINFORCING GEOSYNTHETICS

Over the past 40 years, Huesker has developed a wide range of products for use in the construction industry. The high quality products are manufactured and certified in accordance with ISO 9001 and are CE compliant. Ongoing liaison with contractors, consultant engineers and research institutions enables Huesker to continually modify and improve products to meet the growing and varied needs of worldwide customers.

Huesker's highly qualified and experienced technical team can offer design advice and engineering solutions on a variety of construction applications including:

- Road, Rail and Airport infrastructure
- Hydraulics in river, marine and port engineering
- Ground improvement and foundation engineering
- Waste disposal and contaminated land reclamation

Further information can be found at [www.huesker.com](http://www.huesker.com).