Reinforced Embankments on Piles for Railroads: German Experience

Remblai renforcé sur des pieux pour des voies de chemin de fer: Expérience Allemande

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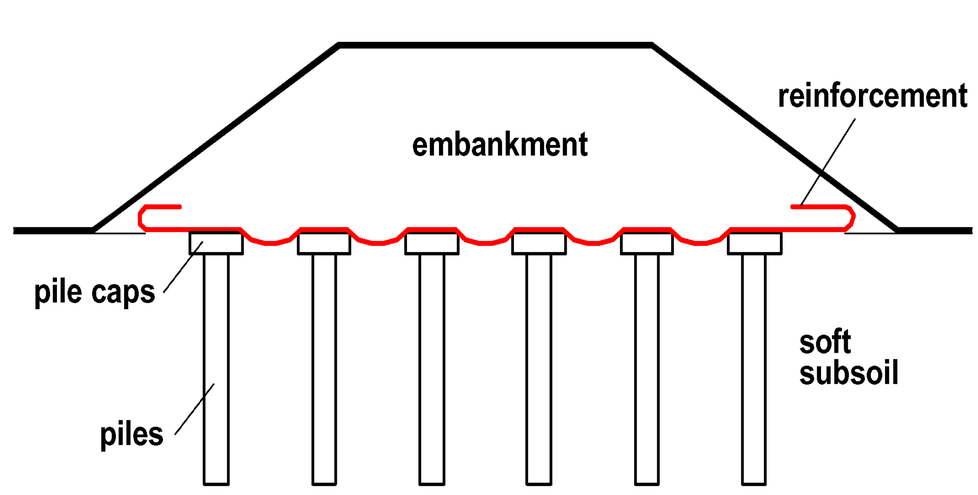
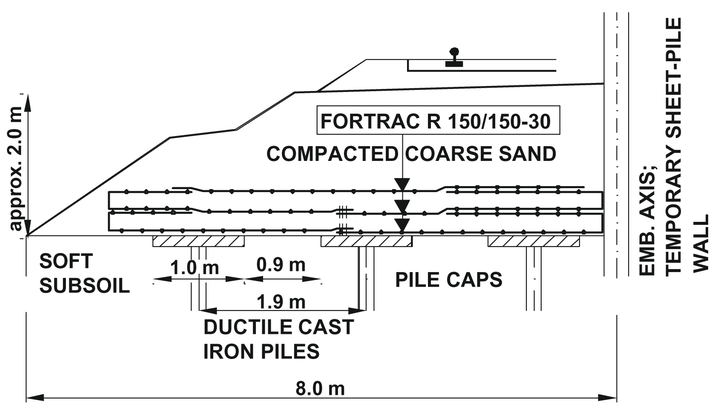
Embankments on soft subsoil supported by piles/columns and geogrid reinforcement on top of them have important advantages compared to „conventional“ embankment foundation: no consolidation time is required (traffic can start immediately after construction), there is no import/export of additional soil, settlement under traffic is strongly reduced, etc. The use of this solution is growing recently in Germany. The most important projects being „a step forward“ of this type of the German Railways (Deutsche Bahn, DB) with high-strength geogrids are presented, demonstrating the development of experience, materials and acceptance. The development started for trains with 160 km/h and went successfully up to 300 km/h with extremely high-strength geogrids. The last project combines for the first time reinforced embankment on columns with geogrid-reinforced slopes. All structures have been approved by the German Supervising Authorities. Long-term measurement results for the „oldest“ project Werder-Brandenburg (under traffic since 6 years) are presented also.

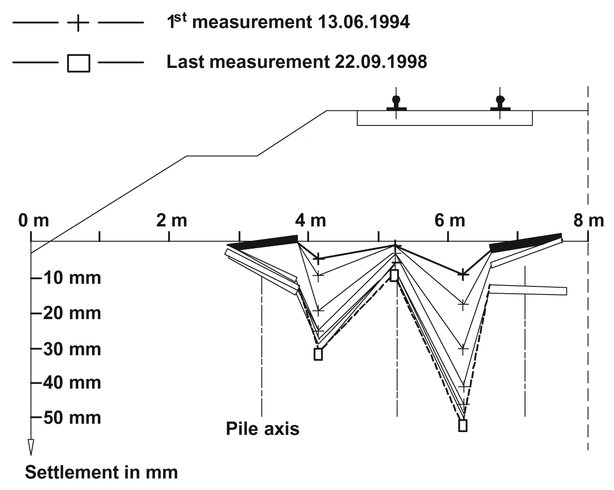


General principles of geosynthetic reinforced embankments on piles/columns

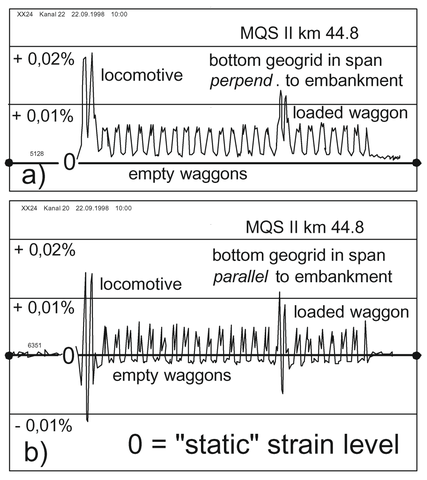


Project Werder-Brandenburg (1994, traffic since 1995): typical cross-section

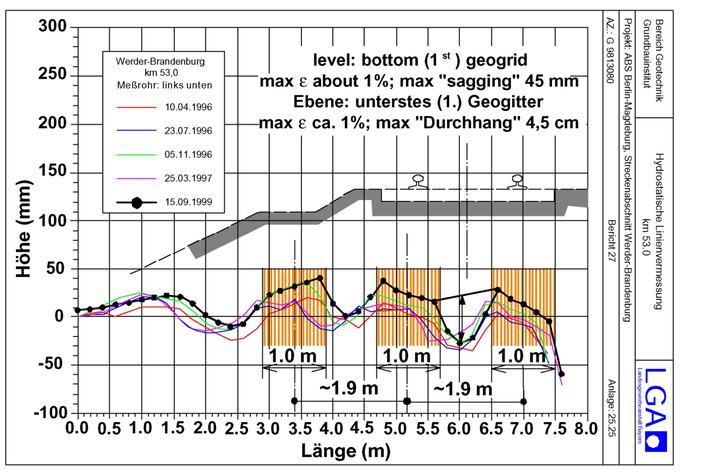
Project Werder-Brandenburg: pile caps before geogrid installation



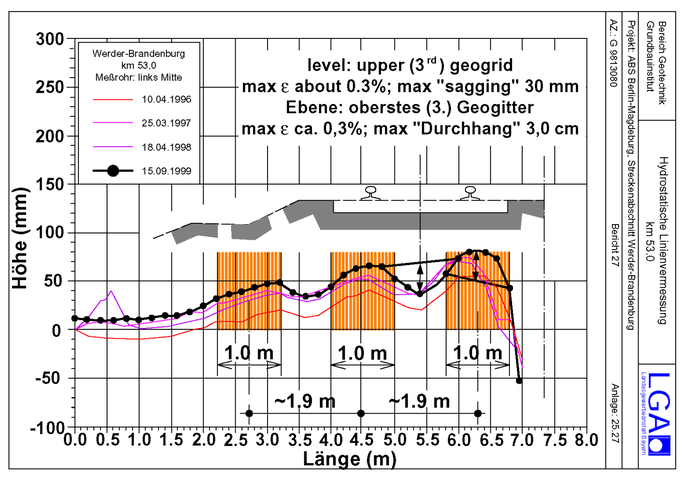
Project Werder-Brandenburg: typical settlements of pile caps and geogrids after 6 years in operation; note the different scales! Simplified graph: real shape is smooth (see below)!



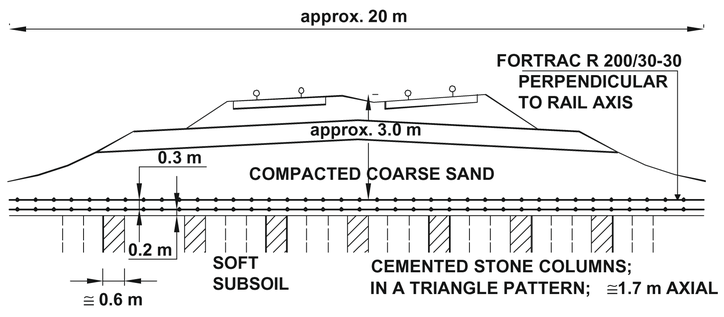
Project Werder-Brandenburg: typical dynamic strains of geogrid; low values for the geogrids used.



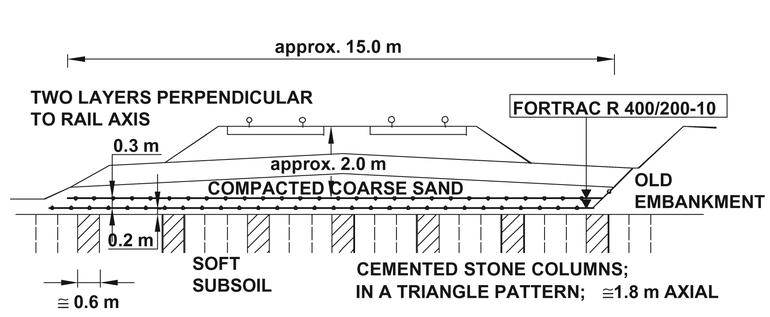
Project Werder-Brandenburg: typical shape of 1st geogrid (directly on the caps) after about 5 years of traffic. Attention: different scales!



Project Werder-Brandenburg: typical shape of 3rd geogrid about 0.5 m above the 1st one. Attention: different scales!

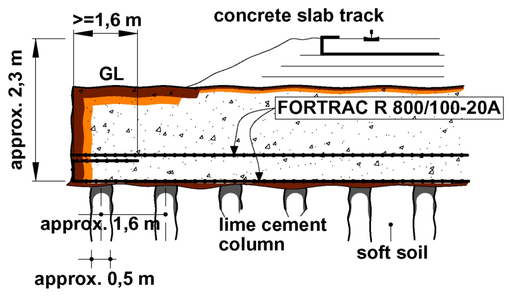


Project Southern Bypass Stendal (1995, traffic since 1998): typical cross-section of segment “PfA 4.3”



Project Southern Bypass Stendal (1995, traffic since 1998): typical cross-section of segment “PfA 4.6”

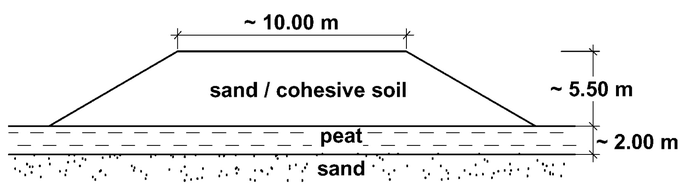
ICE high-speed line between Hannover and Berlin, Körgraben region, aramid geogrid over lime cement columns



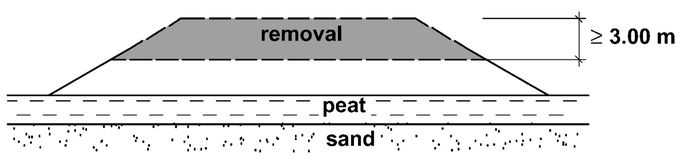
build up from top to bottom:
superstructure:
concrete slab track
sand/gravelly sand
B2 material 0.7 m
geogrid lengthwise
B2 material 0.3 m
geogrid crosswise
sand 0.1 m

Project Körgraben (Station rathenow) (1997, traffic since 1998): typical cross-section

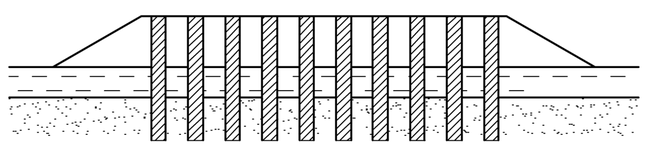
1. Existing embankment



2. Removing of the top part of the embankment

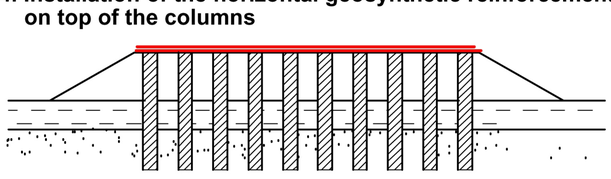


3. Installation of the mortar cemented stone columns

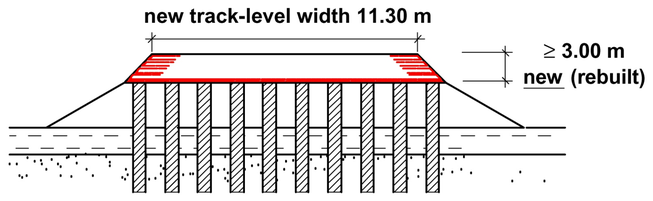


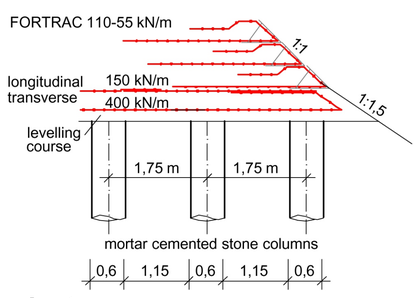
mortar-cemented stone columns

4. Installation of the horizontal geosynthetic reinforcement on top of the columns



5. Construction of the reinforced oversteep slopes





Project Harper Mühlenbach (1999, traffic since 1999): concept, stages, components; first project combining geogrid-reinforcement on columns with geogrid reinforced slopes