Joint UK-IGS EGGS Meeting London
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National Road N210 –
Construction Experience and
Monitoring Results
Dipl.-Ing. H. Hangen, HUESKER
Geotechnical Situation

8 – 12 m soft soils
Peat, $E_s = 500$ kN/m$^2$
Clay, $E_s = 1000$ kN/m$^2$
Existing Situation

- Construction in 1941 (Prof. Buismann)
- Sand filled RC caisson on wooden piles
  \( s = 1.5m \)
Existing Situation

Structure failed because of:

- insufficient durability and length of piles
- Erosion of sand through the joints of the concrete sections (should have used nonwoven...)
- Increased traffic load
- Construction of parallel road

⇒ Yearly repair, tremendous traffic problems, tremendous cost
## New N 210: Trade Off Matrix / DCM

### Classification

<table>
<thead>
<tr>
<th>Construction scheme</th>
<th>Feasibility (technical)</th>
<th>Construction cost</th>
<th>Construction time</th>
<th>Environmental impact</th>
<th>maintenance / Risk</th>
<th>Reliability / references</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft soil replacement</td>
<td>+</td>
<td>o</td>
<td>--</td>
<td>--</td>
<td>+</td>
<td>++</td>
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<tr>
<td>Preload embankment</td>
<td>+</td>
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<td>+</td>
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<tr>
<td>EPS</td>
<td>-</td>
<td>o</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Stone columns</td>
<td>o</td>
<td>o</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>GEC</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>+</td>
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<tr>
<td>Concrete piles + concrete plate</td>
<td>+</td>
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<tr>
<td>Pref. concrete piles + GSY</td>
<td>+</td>
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</tbody>
</table>
Design Section of the new N 210

- Friction Ratio, Rf [%]
- Local Friction, fs [MPa]
- Cone Resistance, qc [MPa]

N210 geofabric Stabilenka® 350/50 (2 layers)

pile cap

uncompacted peat 0.15 m

concrete pile L = 14.00 m

geogrid Fortrac® R 600/50-30 T (1 layer)

- 2.90 mm
- 2.28

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Key questions of design

- Spreading
- Arching
- Pile efficiency
- Support of subsoil
Design calculations / arching

BS 8006:1996
- Only “real“ standard
- Long (positive) experience
- Allows for shallow embankments

- EBGEO (new):
  \[(s_x^2 + s_y^2)^{1/2} = s = (1.41 \times 2.35m)\]
  \[h > 1.0 \ (s - d) \implies h > (3.32 - 0.84) = 2.48 \text{ m}\]

- BS 8006:
  \[s = s_x = s_y\]
  \[h > 0.7 \ (s - a) \implies h > 0.7 \ (2.35 - 0.75) = 1.12 \text{ m}\]

- CUR 159B:
  \[h > 0.66 \ (s - d) \implies h > 0.66 \ (3.32 - 0.84) = 1.64 \text{ m}\]
Design calculations / others

- Arching model / pile efficiency
- Arching stability / dynamic loading (Heitz / Kassel)
- Differential stiffness (column / soft-soil)
- Number of geogrid layers
- Triangular pile pattern
Test Embankment

- Optimise construction sequence
- Verify design calculations
- Quality assurance (20 years)

- Trial embankment as part of the final stretch
  Length of test section: L = 50 m
  part 1: without preloading
  part 2: with add. preloading

- Detailed instrumentation
Construction

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Section of new N 210

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Section MV 2 / preloading

- settlement plate
- NAP 0.00
- preloading h = 2.00 m

- earth- and pore water pressure
- displacement transducer
- earth pressure
- settlement plate
- load cell
Section MV 2 / preloading
Section MV 2 / arching
Section MV2 / arching

Pfahlkraft L009
Erddruck G006

\[ s = 2,35 \text{ m} \]
\[ a = 0,75 \text{ m} \]
\[ (s - a) = 1,60 \text{ m} \]

\[ H = 1,15 \text{ m} \]

\[ H = 0,70 \text{ m} \]
\[ = 0,4…0,5 (s-a) \]

Preload

(2 x 1.0m)
Section MV 2 / loadspreding

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Section MV 1 / reinforcement strains

Kraftmessdose

Erd- und Porenwasserdruckgeber

Setzungspegel

Wegaufnehmer

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Section MV 1 / reinforcement strains

Loadcell L005
strain midspan
strain on pile
strain midspan

H = 1.15 m

Forces [kN]

Strain [%]

Date


traffic load: 50 t

Christmas happy new year…
Summary / Conclusion

- Cost effective construction method
- Good performance even for extremely shallow embankments
- Arching build-up is very good
- Arching re-arranges partly after first traffic load
- Arching remains stable for “road traffic”
- To be analysed: Sensitivity with regard to lateral pressures (not shown here)
- Long term performance
… no risk no fun…

Thank you!