A2 Maydown to City of Derry Airport – Construction over Soft Ground
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• The general design approach adopted for treatment of soft ground areas by staged construction and surcharge
• Detailed design of two specific surcharge areas
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A2 Maydown to City of Derry Airport
The Project

A2 Maydown to City of Derry Airport
The A2 is part of the Northern Key Transport Corridor connecting Belfast to Londonderry via Coleraine.

The section of the A2 described in this paper provides links to the local Maydown and Campsey industrial zones scheme and the City of Derry Airport (CODA), the key transport hub in the Northwest Province.
Brief Summary of the A2 Scheme

- 6.4km long new main-line dual carriageway
- Embankments typically 1 to 2m height, maximum 4.2m
- Two significant river crossings (River Faughan and River Muff)
- 4 new river bridges (1 at River Faughan, 3 at River Muff)
- Two other major structures - Campsey Underpass and Broadbridge Footbridge
- Crossing of former sludge lagoons east of the River Faughan

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Employers Requirements

Settlement prevented or largely complete before pavement construction

Within the 12 month maintenance period

• <25mm differential settlement within 10m of structure
• <0.1% change in gradient within 50m of structure
• <0.5% change in gradient at all other locations
Specific Areas of Interest

Although treatment of other soft ground areas was undertaken, the presentation will focus on the adoption of PVD’s, staged construction and surcharge at

- Faughan West – staged construction & surcharge
- Campsey WTW – construction over slurry lagoons, staged construction and surcharge
General Design
Approach to
Deep Soft
Ground Areas
General Design Approach to Staged Construction & Surcharging

- Band drains to accelerate consolidation and pwp dissipation
- 1m Lifts where possible
- Effective applied embankment loading $c_u/p_o'$ ratio of 0.25
- Min Global FoS $>1.35$ (1.5 target) for undrained analysis

- For surcharge loading FoS $>1.0$
- Secondary Compression Ratio $C_\alpha=0.00018 \times mc$ (%)
  (Simons 1974)
- Surcharge OCR $>1.35$ to reduce secondary compression (Ladd)

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Surcharging to Remove Secondary Settlement
Observational Approach to Construction

<table>
<thead>
<tr>
<th>Description (activity)</th>
<th>Loading Stress (kPa)</th>
<th>Excess Pore Water Pressures (kPa)</th>
<th>Degree of Consolidation (%)</th>
<th>Approx. Total Settlement (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raise embankment by 1m (1m total)</td>
<td>19</td>
<td>19</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>Wait 3 weeks for dissipation of pwp</td>
<td>19</td>
<td>5</td>
<td>75</td>
<td>100</td>
</tr>
<tr>
<td>Raise embankment by 1m (2m total)</td>
<td>38</td>
<td>24</td>
<td>40</td>
<td>225</td>
</tr>
<tr>
<td>Wait 3 weeks for dissipation of pwp</td>
<td>38</td>
<td>5.5</td>
<td>85</td>
<td>225</td>
</tr>
<tr>
<td>Raise embankment by 1m (3m total)</td>
<td>57</td>
<td>24</td>
<td>60</td>
<td>335</td>
</tr>
<tr>
<td>Wait 15 days for dissipation of pwp</td>
<td>57</td>
<td>8</td>
<td>86</td>
<td>335</td>
</tr>
<tr>
<td>Raise embankment by 1m (4m total)</td>
<td>76</td>
<td>26</td>
<td>86</td>
<td>335</td>
</tr>
<tr>
<td>Wait 15 days for dissipation of pwp</td>
<td>76</td>
<td>9</td>
<td>88</td>
<td>460</td>
</tr>
<tr>
<td>Raise embankment by 0.5m to full height (4.5m)</td>
<td>85.5</td>
<td>18</td>
<td>80</td>
<td>460</td>
</tr>
</tbody>
</table>

Embankment filling cannot progress until the excess pore water pressures have dissipated to the required values given above at the end of each construction phase. The readings of the inclinometers should be +/- 10% of the previous reading.

- Maintain stability and limit post-construction settlement by control of pwp
- Back analysis of settlement data
- Target lateral movement/vertical settlement ratio (Deformation Ratio) <0.3
- Full time geotechnical specialist on DSR team
- I&M - settlement plates, vibrating wire piezometers, precise levelling points & inclinometers

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Detailed Design
For Faughan West
and Campsey
WTW
Faughan West

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Faughan West

A2 Maydown to City of Derry Airport
Faughan West - Design

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Campsey WTW- Location of Ground Treatment

A2 Maydown to City of Derry Airport
Campsey WTW - Design

A2 Maydown to City of Derry Airport
Campsey WTW- Design

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Monitoring and Control of Surcharge Areas
Successful implementation of a staged construction/surcharge technique relies on adopting an observational approach to control the works. This requires

- A clear understanding of the program of works, height of lifts, trigger levels and length of hold points between lifts
- Sufficient instrumentation to understand whether the ground is responding as expected to the applied loadings and to provide built-in redundancy in the instrumentation arrays
- The ability to respond at short notice to any contraindications and react in an informed manner to address developing problems
Faughan West – Lift height, settlement and Deformation Ratio
Faughan West – Lift height, and pwp response
Campsey WTW Lagoon Treatment

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Campsey WTW Lagoon Treatment

A2 Maydown to City of Derry Airport
Campsey WTW—Lift height, and pwp response.
Post Construction Performance

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Back Analysis of $C_{vh}$

**Faughan West**
- Design 3 m$^2$/year, actual 1.4 to 1.9 m$^2$/year

**Campsey STW**
- Design 5 m$^2$/year, actual 1.2 to 2.5 m$^2$/year

**Muff Central**
- Design 3 m$^2$/year, actual 5.5 to 6.6 m$^2$/year

*Mitigation – increased duration of hold points & surcharge heights*
Settlement Monitoring Faughan West

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Lessons Learnt

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Lessons Learnt

• Selection of Deformation Ratio (DR) of 0.3 as a trigger appears appropriate – stability issues identified with a DR >0.6
• pwp back-analysis was complex – potential interface with band drains?
• Post-construction settlement may still occur – issues with approach to piled structures
• For complex ground treatment process, allow for full time supervision by a geotechnical specialist
• Contingency in the programme
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