MICROPILES FOR THE REPLACEMENT OF TIMBER RAILWAY BRIDGES

Lukasz Gawlik, Design Engineer, Keller, Sydney, lukasz.gawlik@keller.com.au
Introduction
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• Geotechnical Conditions
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Scope of Work #1

Rosewood Railway Bridge

Sadliers Crossing Railway Bridge
Scope of Work #2

Rosewood Railway Bridge

Sadliers Crossing Railway Bridge
Geotechnical Conditions

Rosewood Railway Bridge
• 2No. Boreholes for 5 piers
• Consistent soil and rock conditions
• Medium to high strength sandstone

Sadliers Crossing Bridge
• 5No. Boreholes for 6 piers
• Highly variable soil and rock conditions
• Low to medium strength sandstone
Design Approach

• Large lateral loads up to 1.2MN due to flood (water flow)
• Scour effect up to 2m with consequent potential buckling of the micropiles
• Optimized (minimized) number of high capacity micropiles under single pier
• Micropile inclination and rotation (micropile layout)
• Micropiles embedded in low to medium to high strength sandstone
• Structural capacity provided by central bar and curricular hollow section (CHS)
Micropile Configuration

- Micropiles closely spaced
- Micropiles inclined and rotated
- Lateral loads resulting in large compression and tension
- Three-dimensional global stability assessed for each pier
Geotechnical Capacity and Testing

- Geotechnical reduction factor $\Phi_{g+} = 0.40$ and $\Phi_{g-} = 0.32$
- Design socket in low to medium to high strength rock

<table>
<thead>
<tr>
<th>Bridge</th>
<th>Production Micropiles</th>
<th>Design Compression Load (MN)</th>
<th>Design Tensile Load (MN)</th>
<th>Design Rock Socket (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rosewood</td>
<td>50</td>
<td>2.3</td>
<td>0.9</td>
<td>2.3 - 2.8</td>
</tr>
<tr>
<td>Sadliers Crossing</td>
<td>56</td>
<td>1.5</td>
<td>0.3</td>
<td>1.5 - 4.0</td>
</tr>
</tbody>
</table>

- 5No. sacrificial test micropiles over 50No. production micropiles at Rosewood
- Sacrificial micropiles tested to validate rock skin friction
- 6No. test micropiles over 56No. production micropiles at Sadliers Crossing
Structural Capacity #1

- Structural capacity relied on steel only
- No grout contribution to structural capacity in compression considered
- Strain compatibility for different steel grades (central bar and circular hollow section)
- Steel section splicing (circular hollow section)
- Compression and bending moment reduced capacity due to threaded connections (sacrificial casing)
Structural Capacity #2

ROSEWOOD

MICROPILE TYPE A
X-SECTION WITHIN SOIL

CEMENT GROUT
40MPa

GEWI BAR
Ø63.5mm

STEEL TUBE
CHS 139.7x5.4mm

CASING
CHS 273x8.8mm

MICROPILE TYPE B
X-SECTION WITHIN SOIL

CEMENT GROUT
40MPa

GEWI BAR
Ø63.5mm

CASING
CHS 273x8.8mm

SADLIERS CROSSING

MICROPILE
X-SECTION WITHIN SOIL

CEMENT GROUT
40MPa

GEWI BAR
Ø63.5mm

BOREHOLE
Ø219mm

MICROPILE TYPE A
X-SECTION WITHIN ROCK

CEMENT GROUT
40MPa

GEWI BAR
Ø63.5mm

STEEL TUBE
CHS 139.7x5.4mm

ROCK SOCKET
Ø240mm

MICROPILE TYPE B
X-SECTION WITHIN ROCK

CEMENT GROUT
40MPa

GEWI Bar
Ø63.5mm

Rock Socket
Ø240mm

MICROPILE
X-SECTION WITHIN SOIL

CEMENT GROUT
40MPa

GEWI BAR
Ø63.5mm

ROCK SOCKET
Ø190mm
Drilling System

- Cased bored micropile system with casing and PCD (Polycrystalline Diamond) bit

- PCD bit sizes used:

<table>
<thead>
<tr>
<th>Bridge</th>
<th>Micropiles</th>
<th>Casing OD (mm)</th>
<th>PCD Bit Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rosewood</td>
<td>Production</td>
<td>273</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>Test</td>
<td>152</td>
<td>127</td>
</tr>
<tr>
<td>Sadliers Crossing</td>
<td>Production / Test</td>
<td>219</td>
<td>190</td>
</tr>
</tbody>
</table>
Construction Limitations – Rosewood
Construction Limitations – Sadliers Crossing
Summary and Conclusions

• Complexity of foundation design and construction under live bridges
• Design and construction team’s capability of resolving site issues
• Works completion with only minimal delays despite unforeseen problems
Thank you for your attention

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