The Innovative Design of Piled Through Mass Gravity Stone® Strong Wall Homestead Gully Bridge Rehabilitation

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# 1. Project Team

<table>
<thead>
<tr>
<th>Role</th>
<th>Company Name</th>
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</thead>
<tbody>
<tr>
<td>Client</td>
<td>Queensland Government</td>
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<tr>
<td>Geotechnical Investigations &amp; Principal Designer</td>
<td>GHD</td>
</tr>
<tr>
<td>Retaining Wall Designer</td>
<td>GEOINVENTIONS CONSULTING SERVICES</td>
</tr>
<tr>
<td>Precast SS Block Supplier</td>
<td>CONCRIB</td>
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<tr>
<td>Contractor</td>
<td>RoadTek</td>
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</tbody>
</table>
2. **General Information**

The Location of Homestead Gully Bridge

Approximate 520km North of Brisbane Near Town Of Moonford
Existing Timber Bridge

Three-span bridge supported on driven timber piles, which was constructed in the 1960s.
Many timber bridges which were constructed have come to the end of their design lives and requires replacement OR upgrades.

These bridges do not conform to current design standards & safety requirements.
3. Geological and Geotechnical Information

The Critical Borehole (BH01)
3. Geological and Geotechnical Information

Geology:

Quaternary Flood Plain (Qa)
- Alluvium - Clay, Silt and Gravel
- Rocks of the Jurassic Evergreen - Ironstone, Sandstone, and Siltstone.

Geotechnical Profile (BH01):
- 0.0-5.0m firm to stiff Sandy CLAY (alluvium)
- 5.0-14.0m very stiff
- CLAY / Silty CLAY (alluvium)
- 14.0-19.0m residual soil;
- 19.0-21.0m moderately weathered,
- low strength Argillaceous SANDSTONE.
4. Challenges - Design & Construction

Original Design - RC Retaining Wall
New Plan Layout
GCS Alternative Design & Objective – Stone Strong precast retaining wall which was isolated from the bridge.
Original Design
RC Retaining Wall

GCS Alternative Design
Pile Through Stone Strong Wall
5. The Innovative Solution

Two Separate Structures were combined into Piled Through Stone® Strong System

Typical Stone® Strong Block for Backfill Retaining

No Filling at the location of H-steel Piles

H-Steel Pile for Bridge Support
6. **ULS and SLS Check**

**Ultimate Limit State (ULS)**

**Hypothesis:**
- Norminal surcharge of 20kPa adopted in the retaining wall design and was assumed to be at the top of the embankment;
- Retaining wall designed to account for active soil pressure behind wall only;
- Soil pressure behind the bridge headstock is not transferred to the retaining walls;
- Passive soil resistance is not considered according to Clause 13.3.1 of AS5100.3 – 2004.
- All bending moments are transferred to the bored piers beneath the concrete footing;
- Bore piers have spacing of 2.44m.

![Earth Pressure Behind The Retaining Wall Diagram]
6. **ULS and SLS Check**

**Ultimate Limit State (ULS)**

Load transferred to each bored pile: $F_V=175.0\text{kN}; F_H=111.0\text{kN}; M=179.0\text{kNm}$

Based On 2.44m Bored Pile Spacing

**Adopted Soil Parameters**

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>$\gamma$ (kN/m$^3$)</th>
<th>$E$ (MPa)</th>
<th>Poisson’s Ratio</th>
<th>$c'$ (kPa)</th>
<th>$\varphi'$ (°)</th>
<th>$c_u$ (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-St CLAY</td>
<td>18</td>
<td>10</td>
<td>0.4</td>
<td>3</td>
<td>25</td>
<td>66</td>
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<tr>
<td>VSt CLAY</td>
<td>19</td>
<td>20</td>
<td>0.3</td>
<td>5</td>
<td>27</td>
<td>96</td>
</tr>
<tr>
<td>Backfill</td>
<td>20</td>
<td>30</td>
<td>0.3</td>
<td>0</td>
<td>30</td>
<td>-</td>
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</tbody>
</table>
Serviceability Limit State (SLS)

The Allowable Displacement: 70mm

Maximum Displacement = 26mm
7. Construction Methodology

dynamic engineering through innovation
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Boring Of 5.0m Deep Bored Piers At Precise Locations
Installation Of Steel Liners At Bored Pier Locations
Installation Of Reinforcing For Bored Piers - 8N20 Bars
Delivery Of Stone Strong Blocks – 24SF, 6SF and Corner Blocks
Reinforcement Cage Through 400mm Concrete Footing and Stone Strong Block
Reinforcement Cage & H Steel Pile Through Stone Strong Block
Completed Rehabilitated Bridge
8. The Advantages & Limitations

Advantages

❖ Stone Strong System provides degree of flexibility to accommodate hybrid solutions
❖ Minimise the space required for abutments to achieve the optimum cost
❖ A better option compared to conventional spill through wall
❖ Accelerated construction program with large precast blocks
❖ Aesthetic chisel sandstone facade

Limitations

❖ Fixed spacing at 2.44m or 1.22m for piled foundation
❖ Required accurate pile position & verticality control to sleeve through the blocks
If you can’t reduce a difficult engineering problem to just one 8 ½ x 11-inch sheet of paper, you will probably never understand it

Ralph B. Peck

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