ROCKLEA TO DARRA
Ipswich Motorway Upgrade
- Little Doris Creek Bridge

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All Photos, Images, and BIM views are courtesy of TMR / BCC, Bielby Hull & Albem and BG&E/Cardno JV.
Project Overview

- Upgrade of Ipswich Motorway Rocklea to Darra stage 1 between Grannard Rd to Oxley Roundabout. Approximately 3km of Mwy upgrade from 4 to 6 lanes
- Design and Construct Team - BG&E/Cardno with Bielby Hull & Albem (BHA)
- Client - TMR (Motorway upgrade) / (BCC Service Road Upgrade)
- Project cost is approximately $400M which is a 50:50 joint funded project between the Australian and Queensland Government
- 3 bridge crossings over creeks with a total of 12 bridges for the Project
- Oxley Creek Bridges - 2 Motorway Bridges and 2 Service Rd Bridges
- Oxley Creek Overflow Bridges - 2 Motorway Bridges and 2 Service Rd Bridges
- Little Doris Creek - 2 Motorway Bridges and 3 Service Rd Bridges/Ramps
- Randolph Street Culverts replacement
- 8 retaining walls (RC cantilever, mass block wall & soldier pile wall)
- All Structural Design delivered as a Building Information Model (BIM) using Revit
Typical Bridge Structural Form

- **Bridge Superstructure Form**
  - Standard QLD 20 TO 25m long Deck Unit bridges with in-situ deck (Motorway Bridges for TMR)
  - Modified 20m long deck unit bridges (winged planks) for Service Rd bridges for BCC
- **Bridge substructure Form**
  - Driven PSC Piles (550 octagonal)
  - Driven steel tubes filed with RC concrete with precast concrete driving shoe. (supplementary Specification developed based off MRTS64.)
- 1 new 5 cell RCBC culvert crossing at Randolph street (constructed in stages)
- 2 existing culvert widenings at Little Doris Creek
Oxley Creek Overflow Bridge - Winged Planks with PSC Driven Piles

Little Doris Creek Bridge - Std TMR Deck Unit Bridge with in-situ RC deck founded on Steel Driven Tube Piles filled with RC
Wall structures

- 8 Retaining Wall designs including one Early Works Design package
- Reinforced Concrete Cantilever Walls up to 3m high
- RC walls with integral road barriers
- Soldier pile wall with in-situ concrete facing
- Mass block walls
- Temporary sheet pile walls at Little Doris Creek Bridges
Walls

RC Wall with Integrated barrier

Soldier Pile Wall

Mass Block Wall

Mass Concrete Block Wall
Little Doris Creek Bridge - Features

- Single 25m span Std TMR Deck Unit Bridge with composite RC Deck
- Top down construction method
- Abutments supported on non standard Steel driven tube piles (filled with RC) at 1.75m c/c with a precast concrete driving shoe
- Temporary tie back system incorporating steel tie rods connected to a sheet pile wall
- Rock filled concrete lined berm (looks like spill through but it’s not)
- Staged construction over existing 8 cell box culvert structure
- Staged demolition of existing culverts
Little Doris Creek Bridge -
Isometric View
Aerial View
Project to Date
Little Doris Creek Site
Little Doris Creek Site
Little Doris Existing Culverts

- 6 / 2135 x 2135 precast culverts and a twin cell culvert 2400 x 2400 on the western most side
- Culverts were constructed over two stages between the late 1980s and early 1990s and were a replacement of the original 6 / 7’ x 7’ culverts which were constructed in the 1960s.
- 200mm thick reinforced concrete base slab, 305mm thick unreinforced concrete walls and simply supported reinforced concrete roof slabs
- Determined that the existing six cell culverts have sufficient structural capacity to support the increased fill heights of 2.0m
Existing Culverts Level 2 Inspections
Existing Culvert widening
BR08 - Blunder Rd Exit Ramp

Culvert Apron Slab

Culvert Wingwall / Headwall Construction
Retention and Strengthening Options

- Option developed to strengthen and retain existing culverts
- Insert pipes and fill annulus with flowable fill
- Rehabilitate to ensure a 100 year design life
- Enhance hydraulic capacity with construction of additional row of culverts on top of the existing culverts
Bridge Option Comparison

Replace Culverts with Bridge

Retain Culverts Option
Final Bridge Option

- Single Span 25m 1050mm deep Deck Unit
- 200mm Min RC Deck
- Twin bridges separated by 40mm
- Top down Construction supported by abutment piles and shotcrete facing
- Propped bridge (Fixed each end)
- Steel tube piles filled with RC
- Constructed in stages. EB Constructed first followed by WB. Existing culverts demolished in stages
- Temporary tie back system during construction
- RC berm to aid water flow and temporary stability
Final Bridge Layout

BR08 - WB culvert widening
BR09 Ipswich Motorway WB & EB
BR10 EB Entry Ramp
Typical Berm Details

Typical berm detail under Motorway

Berm detail filled with mass concrete at tie in to existing culverts
Design Journey

- **Substructure Pile Options**
  - 1050 Dia. CIP Bored Piles - with Permanent Liner
  - 550 PSC Driven Piles - with Soil Nail retention
  - 1050 Dia. CIP Bored Piles with Polymer and temporary Liner
  - 750 Dia. Driven Closed end Steel tube filled with Reinforced Concrete (Precast concrete Driving Shoe)

- **Temporary works Options**
  - Soil Nail Wall in front of PSC Piles
  - Prop bridge prior to excavation. (would involve demolition below superstructure with limited headroom)
  - Temporary tie backs to sheet pile wall & remove culverts prior to placing deck
# Pile Multi Criteria Analysis

<table>
<thead>
<tr>
<th>Option</th>
<th>Pile Type</th>
<th>Vertical Loading</th>
<th>Lateral Loading</th>
<th>Construction</th>
<th>Risk</th>
<th>Cost</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CIP Bored Pier with Permanent Liner</td>
<td>4 Long Socket</td>
<td>1</td>
<td>4 Socket collapse Shotcrete bond to steel liner</td>
<td>4 Socket collapse and extension Tremie pour</td>
<td>3 Liner plus Long socket</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Driven PSC pile with soil nail retention(^1)</td>
<td>1 High founding level. Piles tested for capacity</td>
<td>4 Separate retention system</td>
<td>3 Separate system for vertical and lateral load</td>
<td>3 Soil-structure interaction between PCS and soil nails</td>
<td>4 Two systems</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>CIP drilled with polymer and temporarily liner(^2)</td>
<td>3 Longer pile length compared to driven options</td>
<td>1</td>
<td>2 Polymer management</td>
<td>2 Option 1 with reduced risk of socket collapse</td>
<td>1 Polymer with no liner</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Driven, closed end steel tube(^2)</td>
<td>1 High founding level. Piles tested for capacity</td>
<td>1</td>
<td>1 Shotcrete bond to steel liner for temporary works</td>
<td>1 Relatively low construction risk. Needs appropriate design for durability.</td>
<td>2</td>
<td>1</td>
</tr>
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**Note:**

1. PSC and other combinations may also apply such as CFA or other ground stiffening options
2. Not currently approved by TMR
FILL

ALLUVIUM - Soft to Firm silty Clay

RESIDUAL
Very Stiff to Hard Silty Clay

SILTSTONE - XW
Closed End Steel Driven Pile Detail

- Top of Pile RL 4.7m
- Level of No Corrosion RL -3.0m
- Shear Transfer Zone
- Precast concrete driving shoe with shear transfer zone
- Toe of Pile RL -12m
Precast Pile Driving Shoe

Design Details

- Pile Driving Analysis prepared by geotechnical designers FSG
- Loads during driving used to check Pile Driving Shoe (load up to 7 times higher than ULS loads)
- A strand 7 model was analysed using the loads during driving to assess the stresses
Temporary Tie Back System

- Install Piles
- Construct Abutment Headstocks
- Install Temporary steel sheet piling & Tie back System
- Install Pile Deflection Monitoring
- Excavate to top of existing culvert base slab in 1.0m lifts while installing a sacrificial shotcrete support between piles
- Remove existing culverts
Typical Tie Back Details

Pile / Shotcrete wall interface

Tie back connection to Piles Detail
WALLAP Analysis of Permanent System
Construction Sequence and Traffic Staging
Construction Stage 1 & 2

1. Maintain existing Motorway traffic.
2. Extend existing culverts below Blunder Road Exit Ramp (BR08) under local traffic controls
3. Construct RC wall MR 16 and temporary reinforced soil slope and widen existing westbound carriageway embankment.
4. Install temporary PCB’s
Construction Stage 3

1. Shift existing Ipswich Motorway Westbound and Ipswich Motorway Eastbound traffic to widened embankment.
2. Construct substructure BR09 EB and BR10.
4. Install temporary works tie back anchor system.
5. Excavate to base slab level, remove culvert units, place rock filled berms.
6. Construct temporary reinforced soil slope in median and temporary batter over existing culverts to stabilize the westbound carriageway.
7. Construct bridge superstructure BR09 EB and BR10.
8. Construct approach embankment evenly from both sides.
Construction Stage 4

1. Shift Ipswich Motorway Eastbound onto BR09 EB
2. Construct temporary reinforced soil slope to facilitate completion of BR09 EB approaches
Construction Stage 5

1. Construct bridge substructure for Ipswich Motorway Westbound BR09 WB.
2. Install temporary works anchor system.
3. Demolish temporary retaining wall and remove fill over existing culvert units.
4. Remove remaining culvert units up to the limit of demolition required to build Ipswich Motorway Westbound.
5. Place rock filled berms.
6. Construct bridge superstructure BR09 WB.
7. Construct maintenance path and concrete lining layer on rock filled berms.
8. Complete Blunder Road Exit Ramp and associated culvert and maintenance path works.
Construction Stage 6
1. Shift Motorway traffic to configuration shown and complete earthworks to approaches.
Conclusion & Final Remarks

- Use of non standard piles - **Best Solution** for the situation
- **Communication** with CJV / TMR to achieve the best solution for the project
- **Collaboration** with TMR to develop acceptable piling solution and appropriate Supplementary Specification
- **Communication** with CJV to determine best construction sequence
- **Collaboration** with Geotechnical designers to ensure design models and geotechnical models are in sync.
QUESTIONS???