BLAXLAND'S CROSSING BRIDGE, WALLACIA NSW – BEARING REPLACEMENT

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Outline of Presentation

• Existing bridge details.
• Load rating.
• Bearing replacement issues and constraints.
• Tender design – bearing replacement support system.
• Alternative design – bearing replacement support system.
Bridge Arrangement
Bridge Configuration

- Major river crossing.
- Twisted pier configuration.
Existing Pier Bearings

Existing Bearing

Neoprene Pad
Existing Superstructure Restraint
Load Rating

- Bridge would likely had been designed for HS20 truck loading, being a 32.7 tonne semi-trailer, or the separate HS20 lane loading. These load configurations were adopted from the US for the design of bridges in Australia from 1947 up to 1976.
- Design loading appreciably lower than the maximum current vehicle configuration that is allowed unrestricted access on public roads in NSW, being the 42.5 tonne semi-trailer.
- Bearing replacement design to be governed by the theoretical load-carrying capacity of the bridge.
- Following rigorous structural analysis, it was found that the existing superstructure could theoretically carry the proposed Higher Mass Limits (HML) traffic loadings, being the 45.5 tonne semi-trailer and 68 tonne B-Double vehicle load configurations.
- Older bridges often have reserve strength, as structural analysis was typically conservative 50 years ago – more difficult then to model/simulate true load distribution behaviour in a relatively complex superstructure arrangement.
- Design of the replacement bearing system proceeded on the basis of these HML traffic loadings.
Bearing Replacement (Piers) – Constraints

- Continuous superstructure across 5 spans – checking of separate jacking events.
- Minimal vertical clearance between underside of headstock and top of pier (≈ 90 mm).
- Final deck level to be maintained.
- Laminated elastomeric bearings only feasible option.
- Limited design bearing stress at concrete surface (top of pier).
Bearing Stress on Existing Concrete Surface

- No proprietary nor specially-designed bearing were found to satisfy requirements.
- Only feasible option to be new bearing supports extending off existing piers.

Limiting design bearing stress at a concrete surface (lower of the two values) (clause 12.9, AS 5100.5 – 2017)

\[ \phi 0.9 f'_c \sqrt{ \frac{A_2}{A_1} } \text{ or } \phi 1.8 f'_c \]
Tender Design – Concrete Bearing Support

- Cored holes into and through the piers for reinforcement attachment.
- High-tensile bars.
- Insitu concrete construction.
Tender Design – Concrete Bearing Support

- Basis of design: Strut-and-tie structural behaviour.
Tender Design – Concrete Bearing Support

- High-tensile tie bars carefully modelled to clear ‘twisted’ pier.
Tender Design – Superstructure Restraint

• Designed to prevent dislodgement of superstructure during flood event or earthquake.
Alternative Design – Steel Brackets

- High-tensile bars external to pier.
- Frictional restraint at pier/bracket interface.

\[ \mu (2F_x + V_x^\prime) \]

(Frictional resistance at bracket/pier interface to counteract \( V_y^\prime - 2F_y \))

\[ \mu = \text{Co-efficient of friction at steel/grout interface} \]

\[ V^\prime = \text{Vertical bearing load} \]
Jacking of Superstructure

- Construct new bearing support (tender design) or install new bearing brackets (alternative design).
- Install new superstructure restraints.
- Sever existing superstructure restraint (interlocking ‘hairpin’ bars) by cutting legs of upper ‘hairpin’ bars.
- Install flat jacks and jack up superstructure, initially decompressing existing neoprene bearing pads and then removing vertical loads from existing bearings.
- To prevent uplift at one of the jacks at the piers, single-lane contraflow traffic is required on the bridge during the jacking operation only (until new superstructure restraints are engaged). Traffic lane to be centralised within existing carriageway width.
- Install replacement elastomeric bearings, shim base plate (or use levelling bolts) to snug fit beneath pier headstock.
- Lower bridge onto new bearing supports and remove jacks.
- Repeat above process at next pier.
Jacking of Superstructure

≈ 90 mm

Proposed Flat Jack Locations
Proposed Abutment Bearing Restraint
Proposed Abutment Bearing Restraint

- Frame designed to prevent bearing ‘crawl’.
- Specially-designed elastomeric bearing pads.
Comparison – Bearing Support Systems

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<thead>
<tr>
<th></th>
<th>Tender Design</th>
<th>Alternative Design</th>
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<tbody>
<tr>
<td>Ongoing maintenance *</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Flood impact vulnerability</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Construction cost</td>
<td>Higher</td>
<td>Lower</td>
</tr>
<tr>
<td>Construction duration</td>
<td>Longer</td>
<td>Shorter</td>
</tr>
<tr>
<td>Prefabricated elements *</td>
<td>No</td>
<td>Yes</td>
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* In relation to bearing support system.
Conclusions

• The Council-accepted alternative design represents an economical scheme, without the need to core numerous holes into and through the piers.

• However, the following long-term issues should be considered with this ‘alternative design’ type of system:
  ➢ Blaxland’s Crossing Bridge is often inundated in flood events. The exposed (thereby vulnerable) high-tensile clamping bars are primary structural elements and cannot tolerate any damage due to floating debris.
  ➢ Post-tensioning force in the high-tensile bars shall be maintained over the design life, as a minimum clamping force is required to provide the frictional resistance to the applied loading, thereby preventing slippage of the brackets.

• The tender design prepared by Arcadis, while requiring extensive work at the piers, represents a feasible bearing replacement solution. Once constructed, there would have been very little maintenance intervention required by Council over its life cycle.
Thank you for your attention