ANNERLEY ROAD BRIDGE
STRIKE PROTECTION BEAMS

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Presentation Outline

- Risk and Consequence of Bridge Strikes
- Annerley Road Bridges
- Design of Protection Beams
- Construction of Protection Beams
- Strike Protection
Consequence of bridge strikes

- Low clearance bridges in Queensland have been struck by over-height vehicles
- Bridge strikes may cause severe damages to bridge structures
- Bridge strikes may cause traffic delays to both rail and road users
- Bridge strikes may cause injuries and fatalities to road users

The M20 miracle! Motorway bridge which collapsed in heavy Bank Holiday traffic after being hit by a lorry leaves just one motorcyclist injured

(Bus Headline - Courtesy of The Daily Mail)

Brisbane traffic: Rail and road delays at Rocklea station as truck hits crossing

(Bus Headline - Courtesy of The Courier Mail)
Annerley Road Bridges

- Dual rail bridges; concrete arch bridge and steel truss bridge
- Bridges are single span and 60° skewed to Annerley Road
- They carry Brisbane suburban train services
- 3.85m (from survey) road clearance under the bridges
- There have been 23 strikes between 2002 and 2013
- Tragic death of a 40-year-old cyclist happened in early 2013 due to an over-height truck being deflected sideway after it hit the bridge
Annerley Road Bridges

- Queensland Rail initiated an engineering solution, to install protection beams to protect Annerley Road Bridges
- Annerley Road Bridge site was prioritized in the $3.6M program
- Queensland Rail engaged JF Hull Pty Ltd (JFH) for design and construction
- JFH contracted KBR to be the engineer
- Site constraints: bridge skew, overhead and underground services and private lands
Design of Protection beams

Design Criteria:

• Design loads as per Clause 10.3, AS 5100.2-2004
  - 1000kN horizontal load toward the bridge
  - 750kN horizontal load away from the bridge
  - 500kN vertical upward load
  Increase the loads by 25% for connections and supports

• Less maintenance after multiple strikes

• 20mm below bridge soffit

• No skew to roadways

• Clear visibility of protection beams to road users

• Minimisation of existing service relocation

• Minimisation of Annerley Road closure for construction

(Courtesy of Brisbane City Council)
Design of Protection Beams

Design Optimisation:

• Option 1: New protection structures immediately adjacent to existing bridges
  
  Advantages: Low cost, no clash with existing services  
  Disadvantage: Skew to roadways, long span

• Option 2: Modification of existing height gauge supporting structures
  
  Advantages: Low cost, no clash with existing services, no skew  
  Disadvantage: Insufficient capacity of existing foundation

• Option 3: Replacement of existing height gauge structures with new protection structures
  
  Advantages: No clash with existing services, no skew  
  Disadvantage: High cost for removal of existing piles and underground structures
Design of Protection Beams

• Option 4: New protection structures spanning across roadways with no skew
  Advantages: No skew, close to existing bridges
  Disadvantage: Geotechnical investigation, search for underground services
  This option was the most acceptable solution and it was adopted for detailed design

• Option 5: New protection structures spanning on side of roadways (use of existing road median)
  Advantages: Low cost, no skew
  Disadvantage: Extended road closure for construction, geotechnical investigation, search for underground services
Design of Protection Beams

Searching for existing underground services
Design of Protection Beams

**ALTERNATIVE 1:** 1500 DIA x 16 THICK
WEIGHT ≈ 620 kg/m

**ALTERNATIVE 2:** 2/1000 WB 215
WITH 200x200x13 GA BRACING
WEIGHT ≈ 750 kg/m

REQUIREMENTS FOR STIFFENERS IN SECTION TO BE CONFIRMED

ADOPT ALTERNATIVE 1 ON THE BASIS OF REDUCED WEIGHT AND FABRICATION REQUIREMENT

**ALTERNATIVE 3:** 1100x1100 BOX

TYPICAL BEAM SECTION
SCALE 1:10
Design of Protection Beams

Welded splice

Beam bolted to column

1500x1200 pile cap

3x900 dia piles

Welded splice

Beam bolted to column
Design of Protection Beams

Finite element model

High concentrated stress (410 MPa)

Local stiffeners

Reduced stress (< 350 MPa)
Construction of Protection Beams
Construction of Protection Beams
Strike Protection

• Protection beams have been struck several times
• A garbage truck hit the southern protection beam on 20/01/16
• A refrigerating truck hit the northern protection beam on 23/11/16
• Expensive consequence to the trucks but not to rail infrastructure and users
Conclusion

• Proactive liaison between all involved parties
• Solutions to challenges due to bridge geometry and site conditions
• Clear visibility of the protection beam
• Potholing and survey of existing underground services
• Optional and optimisation design
• Investigation of local stresses
• 2015 Queensland CCF Earth Awards in Category 1