

Monitoring of Impact Damaged Bridge

Queensland Rail and
EngAnalysis



Background

Bridge strikes (2009, 2024)

Inspections and repair undertaken early 2025

Strain gauging and load testing for design verification

On-going monitoring

Bridge strike detection and measurement – informed response

Periodic reporting

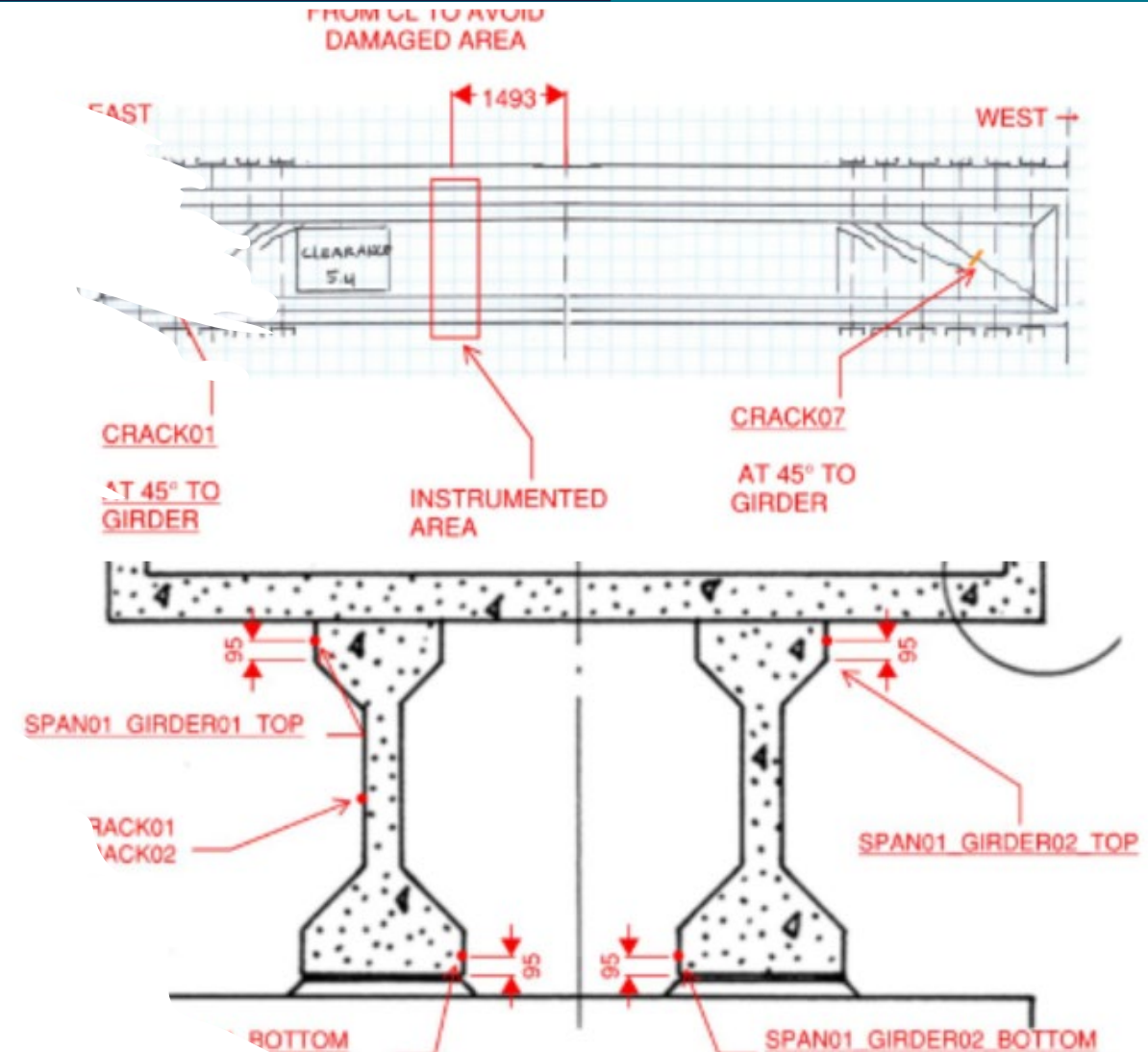
Repair Overview

- From recorded asset history, the most impactful (w.r.t kinetic energy)
- Immediate concern
- Site complexity
- Immediate response
- Engineering intervention



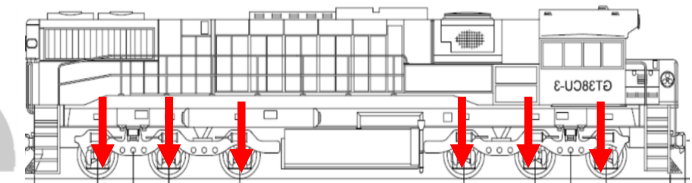
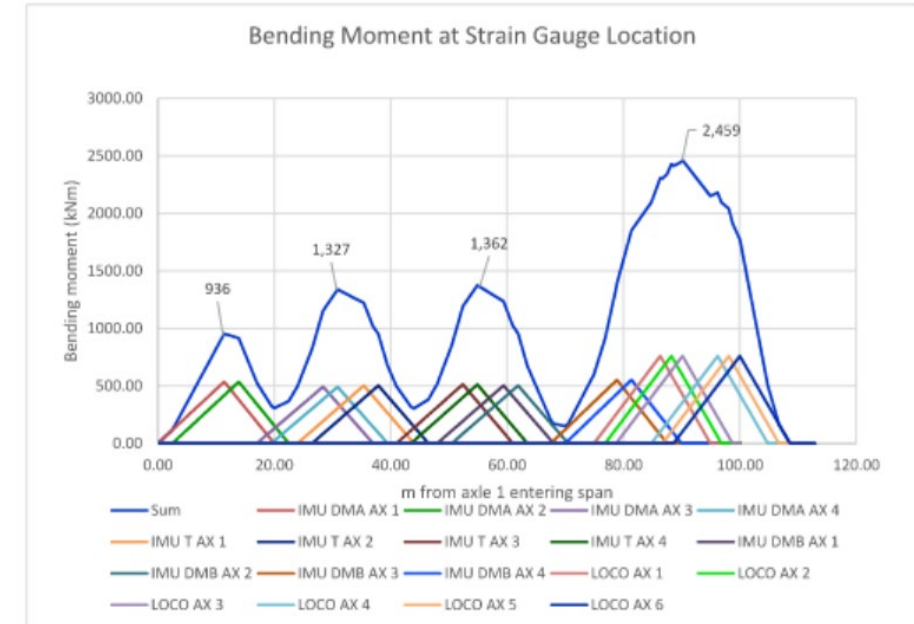
Instrumentation

- Data acquisition, remote communications, solar and battery
- Strain gauges:
 - Mid-span top and bottom of girders on span 1 and span 2
 - Crack opening - over the repaired cracks
 - Ratios
- Triggered system + long term trends



Load Testing

- Controlled load testing
- Acceptance Criteria
 - Designer specified limits on crack opening displacement
 - Repeatable and linear relationship with loading
 - Neutral axis compared to estimate, and damaged vs non damaged girder
- Method/approach
 - Site team focus on safe testing operation
 - Remote support, live viewing of data and review, immediate data for stop / go decisions



Load Testing cont...

- Process

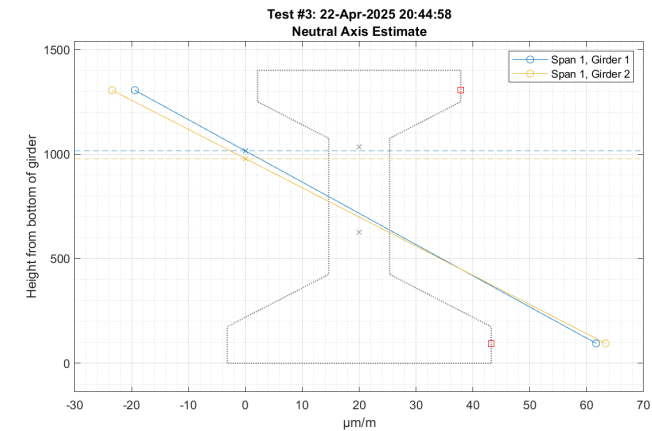
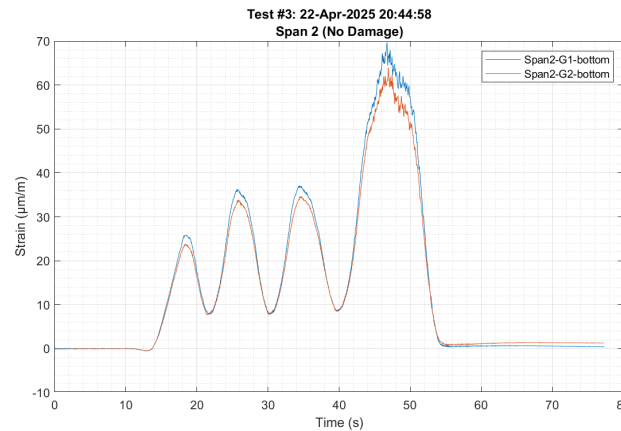
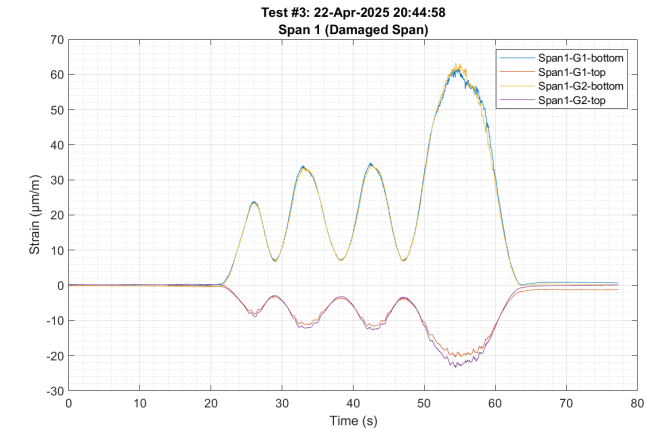
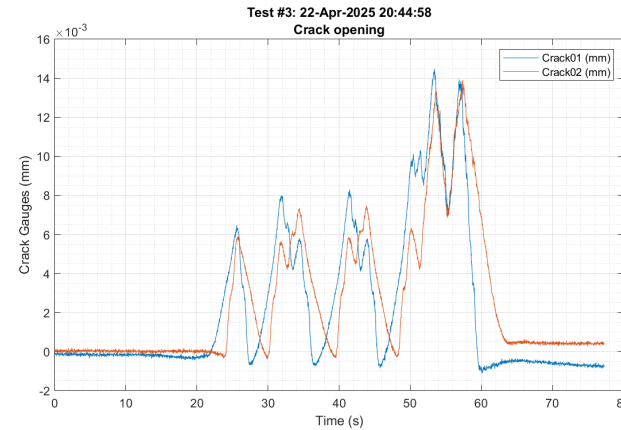
- Test run
- Review data
- Decide: proceed with next test OR stop

- Result

- 6 tests completed
- Crack opening < threshold
- Stable results with loading change
- NA consistent and close to expected

- Outcomes

- Immediate answers (go/stop decision) and data access
- Bridge re-opened the following morning



Analysis and Reporting

- Metrics
 - Peak strains
 - Neutral axis
 - Crack opening
 - Ratios (Span 1 / Span 2, Girder 1 / Girder 2)
 - Speed
- Dashboard
- Anomaly detection – notification (Figure-6)
- Monthly Summary



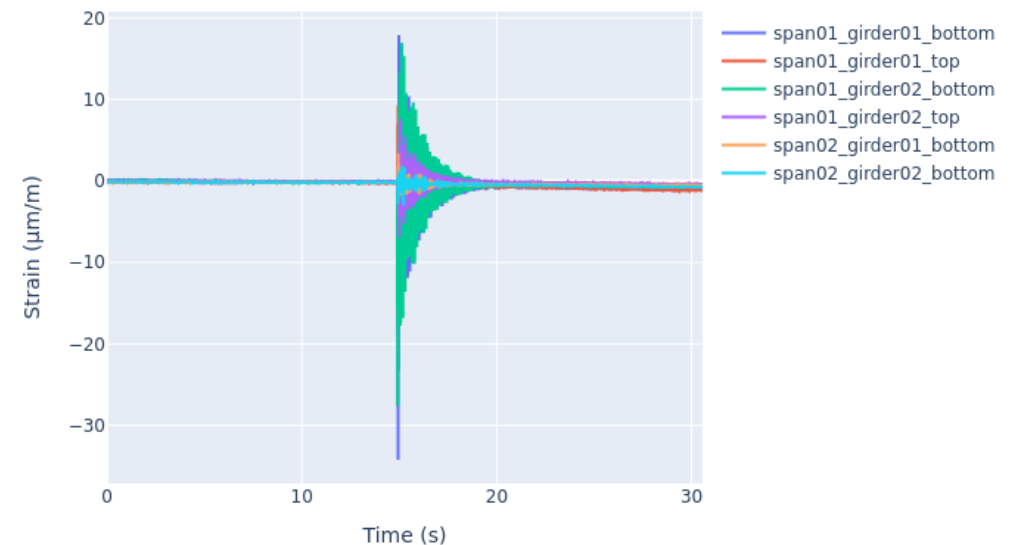
Bridge Strike Response

Case Study: Bridge strike August 2025

- Immediate response – system captured and alerted the project team
- Standard response per Queensland Rail's asset management+ **decision to install strain gauges**
- Analysis of monitoring data from test runs of lighter loads (Hi -rail vehicles) to confirm neutral axis's location
- Peak strains compared to a train loading

Week following incident

- Site inspection same day to check track misalignment and damage
- Hi-rail inspection using maintenance vehicle
- Track resurfacing consist to travel over bridge
- Normal weekly hi-rail inspection
- Locos + 3 car unit



Conclusion and Success Factors

- **Load testing**
 - Defined acceptance criteria
 - Site + remote support team
 - Collaborative and immediate review of data
- **On-going monitoring**
 - Data for verifying engineered design and visual inspection
 - Initial frequent reporting while behaviour is understood
 - Periodic reporting + anomaly detection



What's next...

- Instrumentation focused on gathering critical data for bridge strikes

Figure - 1

Installed strain gauges (*Queensland Rail*)



Figure – 2
Diagonal crack locations
(*Queensland Rail*)



Figure - 3

Night works to secure catching
membrane (*Queensland Rail*)





Figure - 4

Looking at the impact along the direction of travel, this one shows the shear cracks (*Queensland Rail*)

Figure – 6

Example of monitoring data triggered by traffic movement

EN-210-0751 Train Pass Event: 2025-09-22 09:32



EngAnalysis Reports
To  Henry Griscti - EngAnalysis

 20250922_093206_maryborough_event_data.csv
245 KB

 2025-09-22 0932.pdf
3 MB



9:06 AM



EN-210-0751 QR Maryborough Bridge: Train Pass Data

Dashboard: <https://qr.enganalysis.com.au>

Event Time: 2025-09-22 09:32:06

Event Details:

Metric	Event Value AEST	Median
Crack 01 Opening (mm)	0.014	0.014
Crack 02 Opening (mm)	0.012	0.012
Span 01 Girder 01 Bottom Strain (Damaged) (µε)	52.0	49.5
Span 01 Girder 01 Top Strain (µε)	-17.5	-16.9
Span 01 Girder 02 Bottom Strain (µε)	53.8	52.8
Span 01 Girder 02 Top Strain (µε)	-20.7	-19.6
Span 02 Girder 01 Bottom Strain (µε)	57.1	56.8
Span 02 Girder 02 Bottom Strain (µε)	53.0	52.3
Span 01 Girder 01 Neutral Axis (mm)	1039.5	1038.7
Span 01 Girder 02 Neutral Axis (mm)	998.0	1009.5
Span 01 Bending Moment (N.m)	1083.4	1064.1
Train Speed (km/h)	19.0	18.2