2015 Small Bridges Conference

Case Study: Composite Steel Box Girder Bridges

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Agenda

Case Study Bridges

- Auburn Station Rail Overbridge
- Lily St Rail Overbridge
- Northern Area Precinct (NAP) Bridge at Sydney Airport

Advantages of Composite Steel Box Girder Bridges

Design Considerations

Station Rd Rail Overbridge

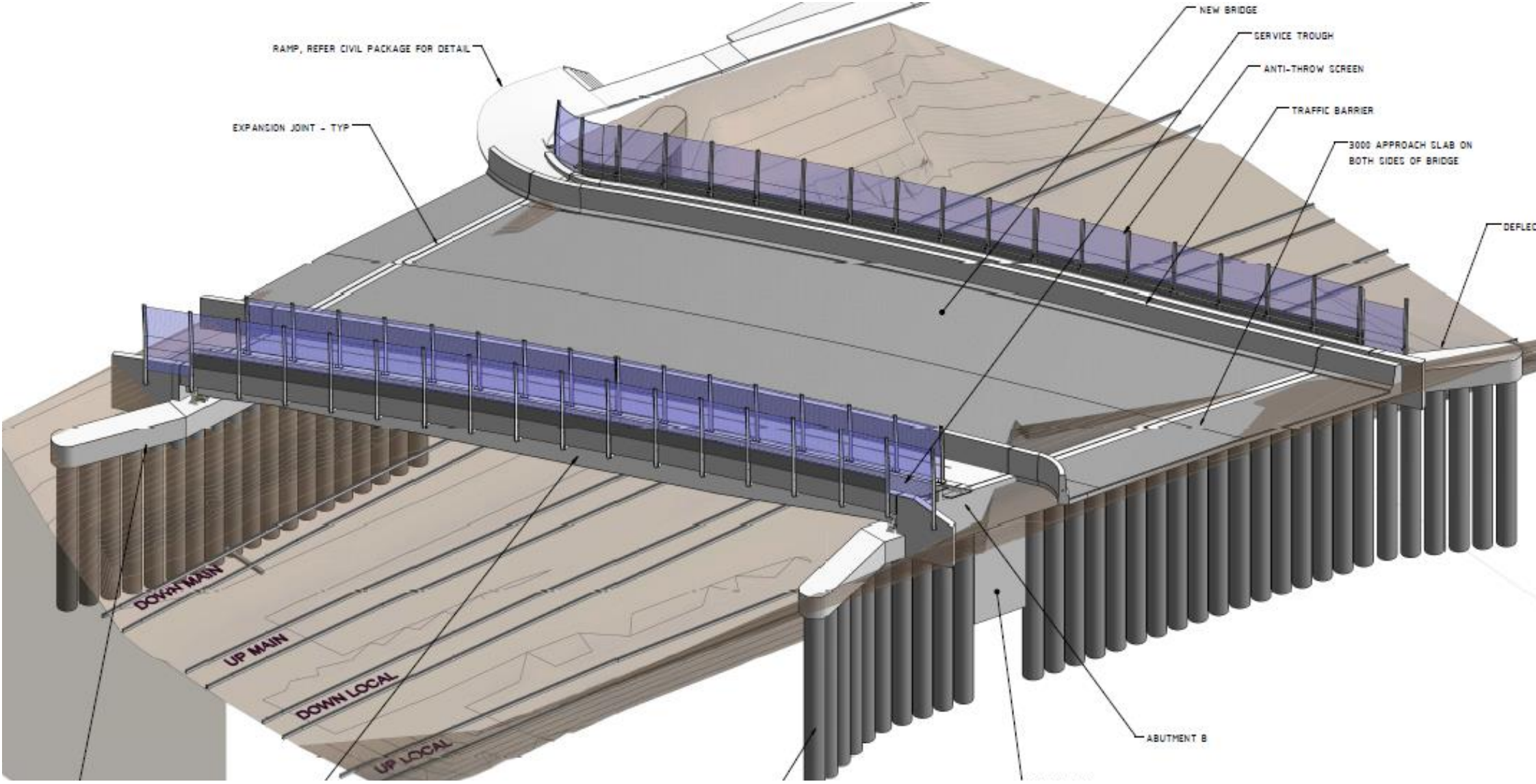
Station Rd Rail Overbridge - Scope

Works included the demolition and replacement of the existing composite concrete and steel I-girder, three-span, two lane road bridge over the Railway corridor, with a new wider single span four traffic lane bridge in the same location. This new bridge includes two pedestrian walkways, one on each side with one serving as a shared pedestrian and cycleway.

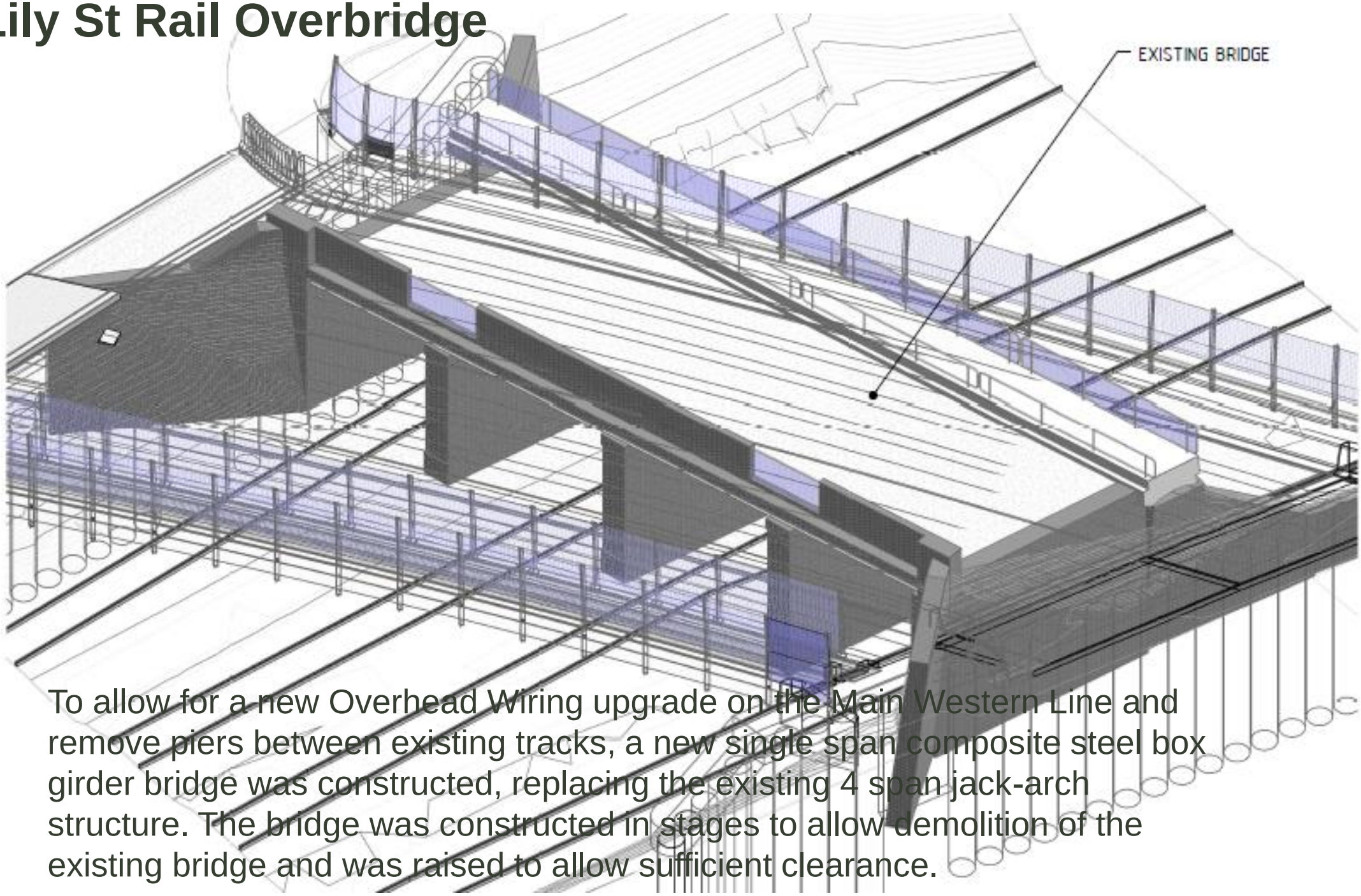
Station Rd Rail Overbridge – New Bridge Details

The Station Road Overbridge crosses the rail tracks in a single span of 32 m and has a complex geometrical set-out and construction staging. The bridge comprises eight steel trough girders with a composite concrete deck slab. Each girder varies in depth to accommodate the complex geometrical road alignment and to achieve a minimum 5.2 m clearance to the rail tracks underneath.

Lily St Rail Overbridge

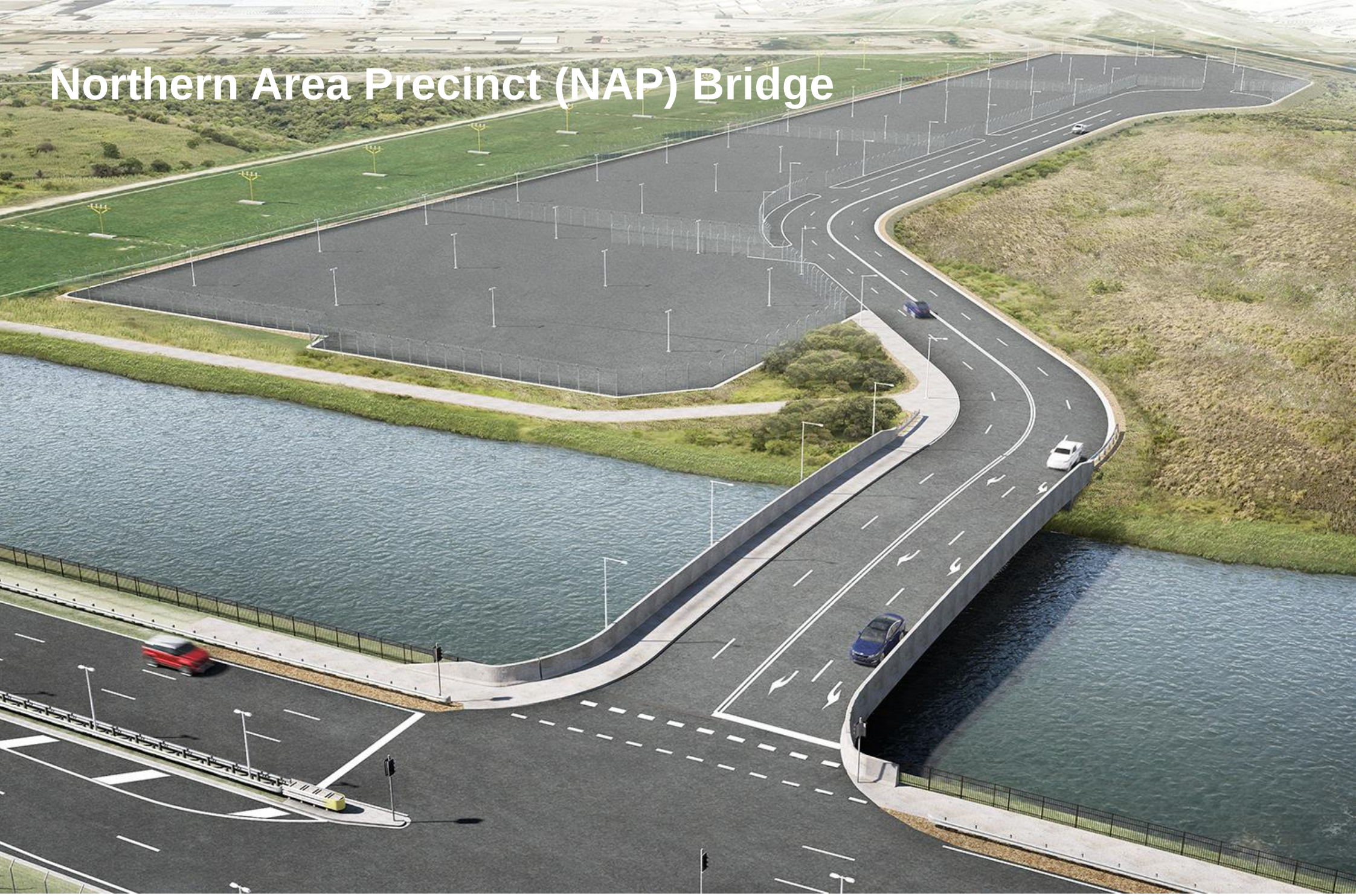


Lily St Rail Overbridge



To allow for a new Overhead Wiring upgrade on the Main Western Line and remove piers between existing tracks, a new single span composite steel box girder bridge was constructed, replacing the existing 4 span jack-arch structure. The bridge was constructed in stages to allow demolition of the existing bridge and was raised to allow sufficient clearance.

Northern Area Precinct (NAP) Bridge



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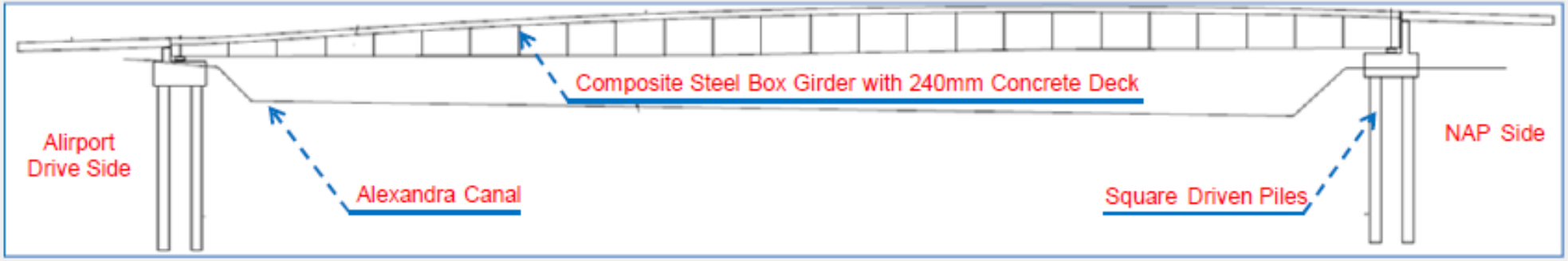
Northern Area Precinct (NAP) Bridge – Bridge Details

- **Bridge Type:** Simply supported concrete-steel Composite Box Girder
- **Number of girder:** 5
- **Bridge Span Length:** 50m.
- **Bridge Depth:** Vary 0.7m to 1.8m (Concrete Toping 0.24m. Thk.)
  The girder profiles vary in depth to accommodate the geometrical road alignment and airspace rights over Alexandra canal.
- **Supported at each end :** Abutment beams which is in turn supported by a precast driven piled foundations (0.4x0.4m. Dia.)

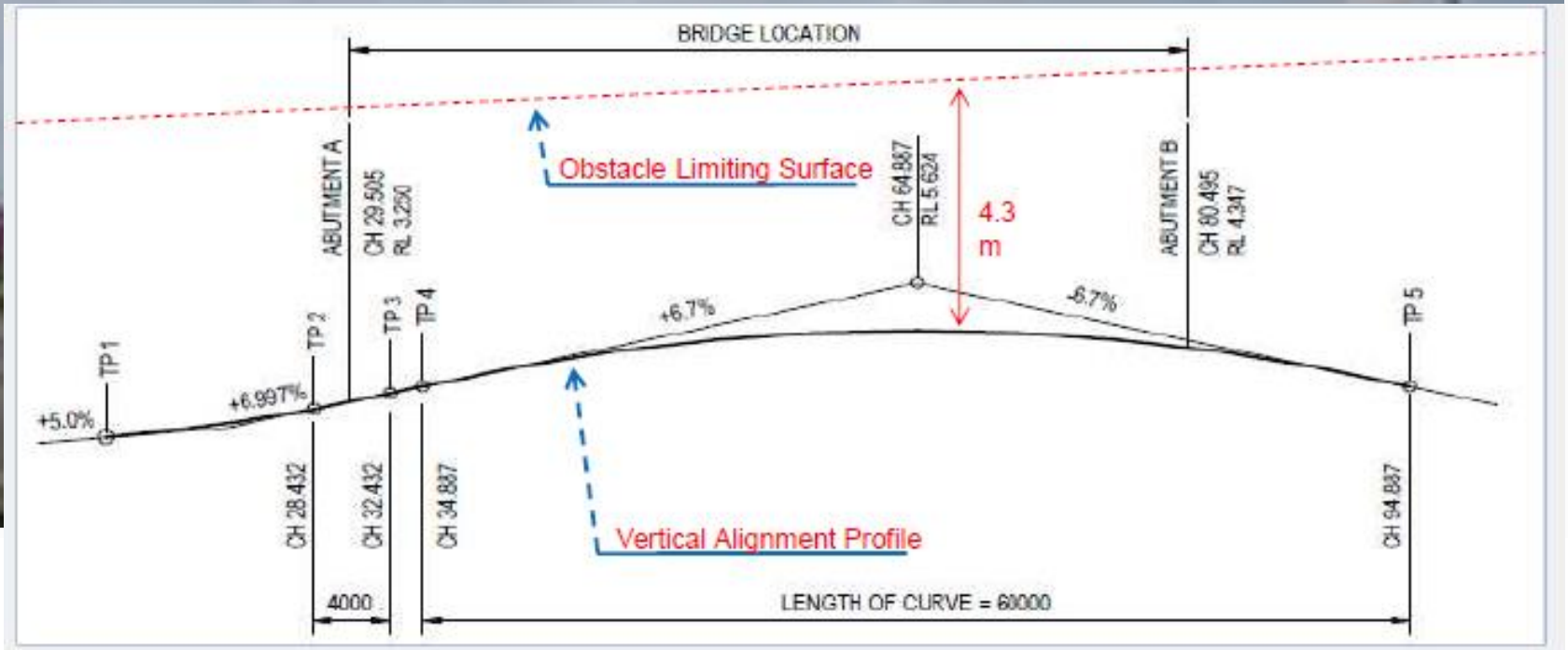


Girder 's depth was controled by OLS requirements and flood levels.

Northern Area Precinct (NAP) Bridge - Constraints

Above - SACL requires that all permanent and transient structures must remain below the Obstacle Limiting Surface (OLS)

Below - The soffit of the bridge is to provide 2.0m freeboard above the Mean High Water Spring (MHWS) tide mark over a significant portion of the canal's 10.5 metre approximate width.



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Advantages of Composite Steel Box Girder Bridges

Common to each of these three case study bridges were the following 5 key advantages;

- **Span to Depth Ratio**
- **Geometry Flexibility**
- **Efficiency in erection**
- **Flexibility in Staging**
- **Safety during Construction**

Span to Depth Ratio

Bridge	Span (m)	Girder Depth (m)	Loading	Ratio
Station Rd Rail Overbridge	31.7	1.4	SM1600	23
Lily St Rail Overbridge	37.7	1.5	SM1600	25
NAP Bridge	51	1.8	T44	28
Typical Super T PSC Girder	32	1.7	SM1600	19
Typical PSC Plank	21	0.9	SM1600	23

Geometry Flexibility

Webs profiled to provide a variable vertical geometry, to suit;

- VC on the bridge
- Clearance over railways
- Clearance over navigation channels

This flexibility is a key advantage over precast concrete girders.

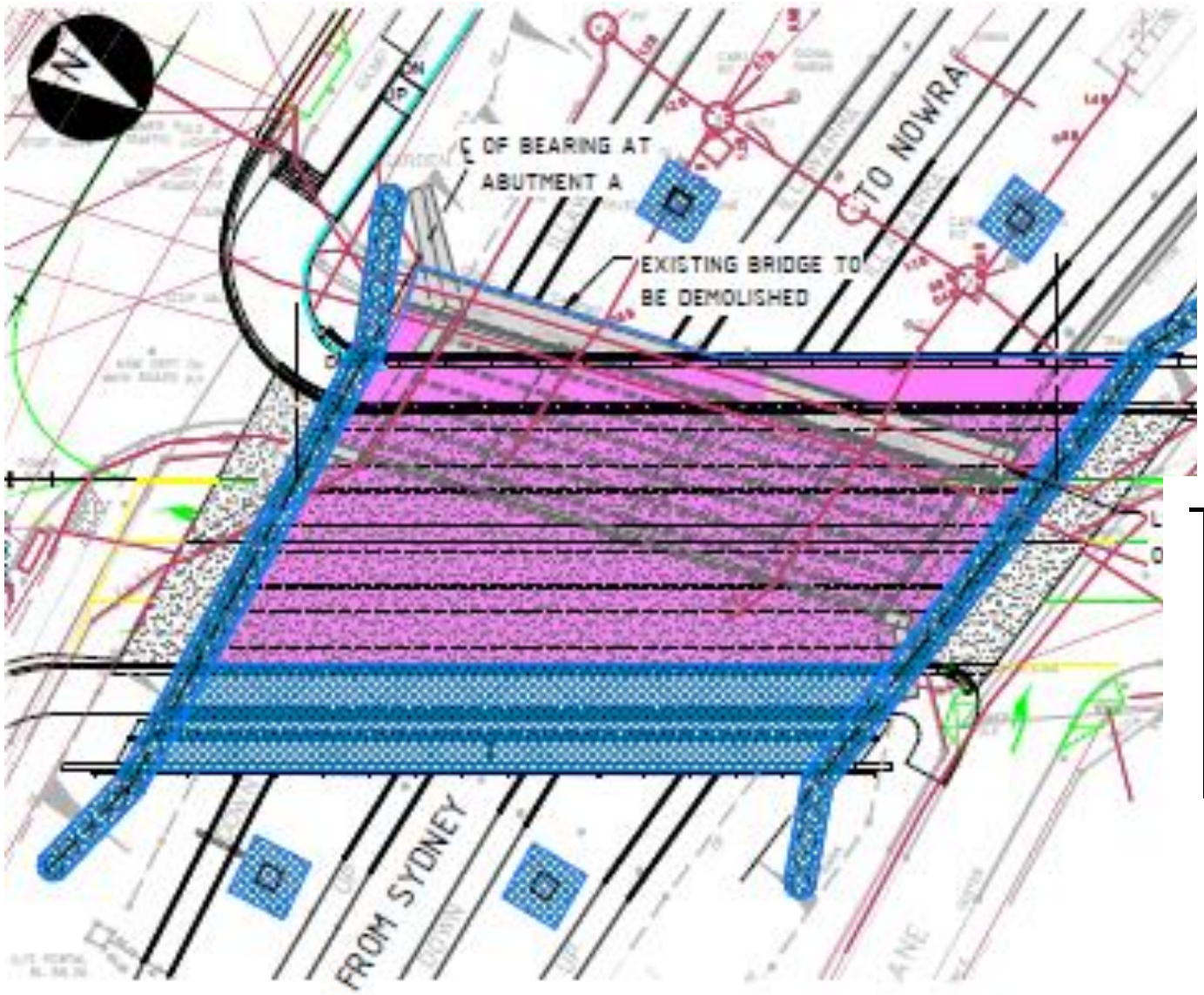
Girders can be easily varied in cross section to suit cross falls and account for lesser loading of non-trafficked areas of the bridge deck.

Erection efficiency

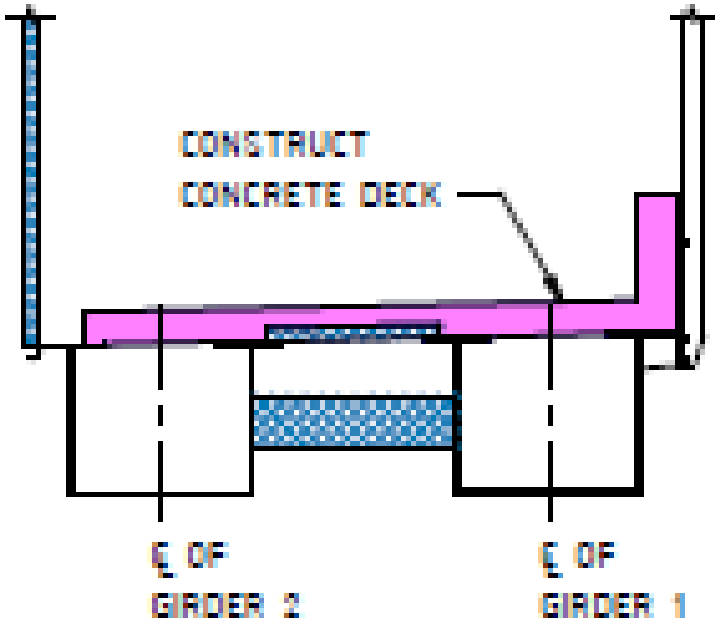
Crane position key
Strength to weight ratio maximised
Build greater bridge deck faster, single spans up to 51m

Flexibility in Staging

For bridge replacements on-alignment, composite steel box girder bridges can be easily staged to allow partial completion to facilitate a traffic switch or demolition. Station Rd and Lily St overbridge took advantage of these staging benefits. Greater deflection control to facilitate staging.



CONSTRUCTION STAGE 3



Safety in Construction

By detailing a closed box with a 6mm closure plate and erecting with handrails, there is an immediate safe working platform to place permanent formwork. Permanent formwork between each girder provides a safe working platform for deck construction.

Design Considerations

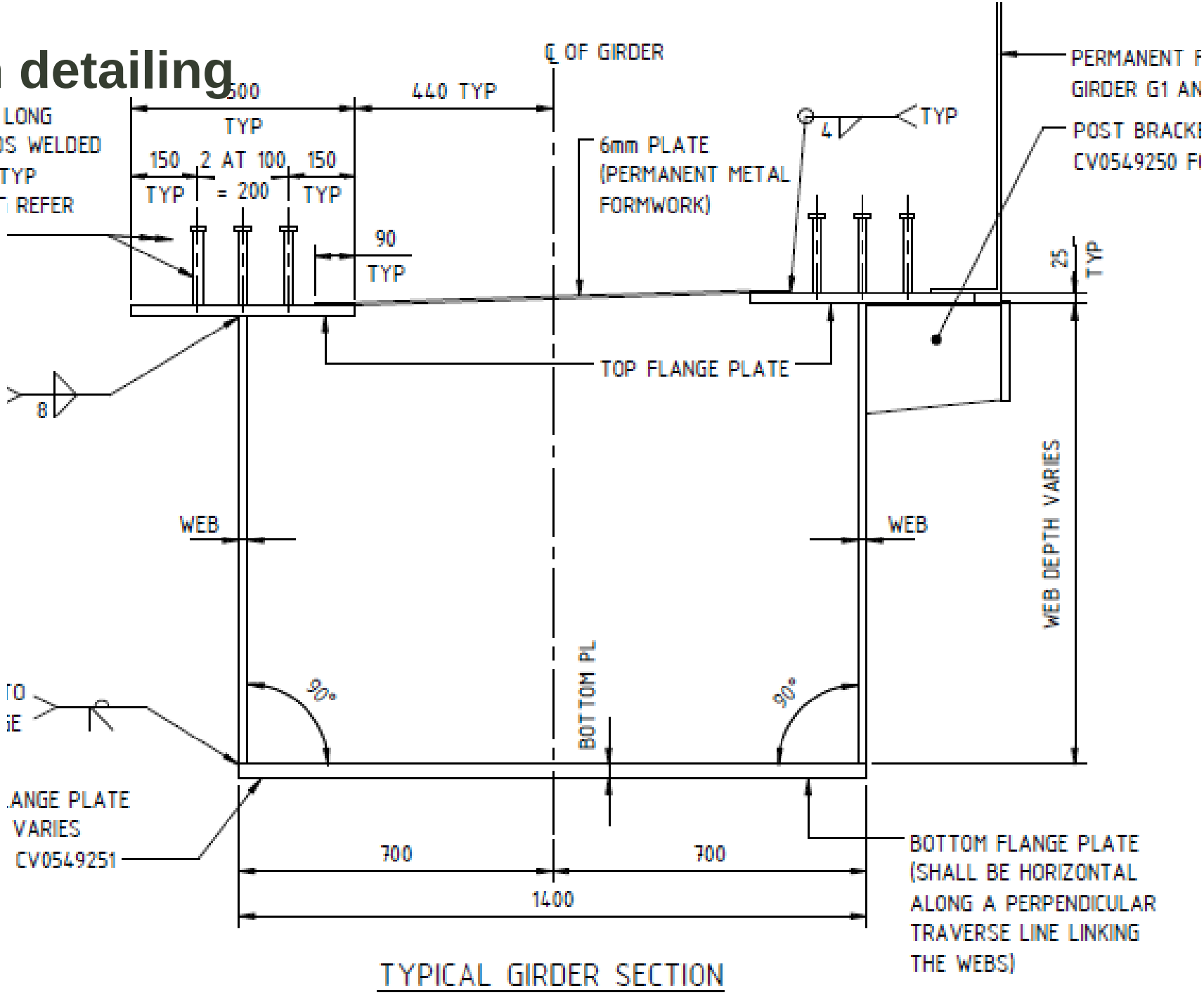
Based on these case studies, special design consideration should be given to the following aspects;

- **Fabrication detailing**
- **Temporary Stability during Erection**
- **Prediction of Deflections**
- **Bracing and making use of the composite action early**
- **Dual composite option for continuous applications**
- **Design for maintenance**

Fabrication detailing

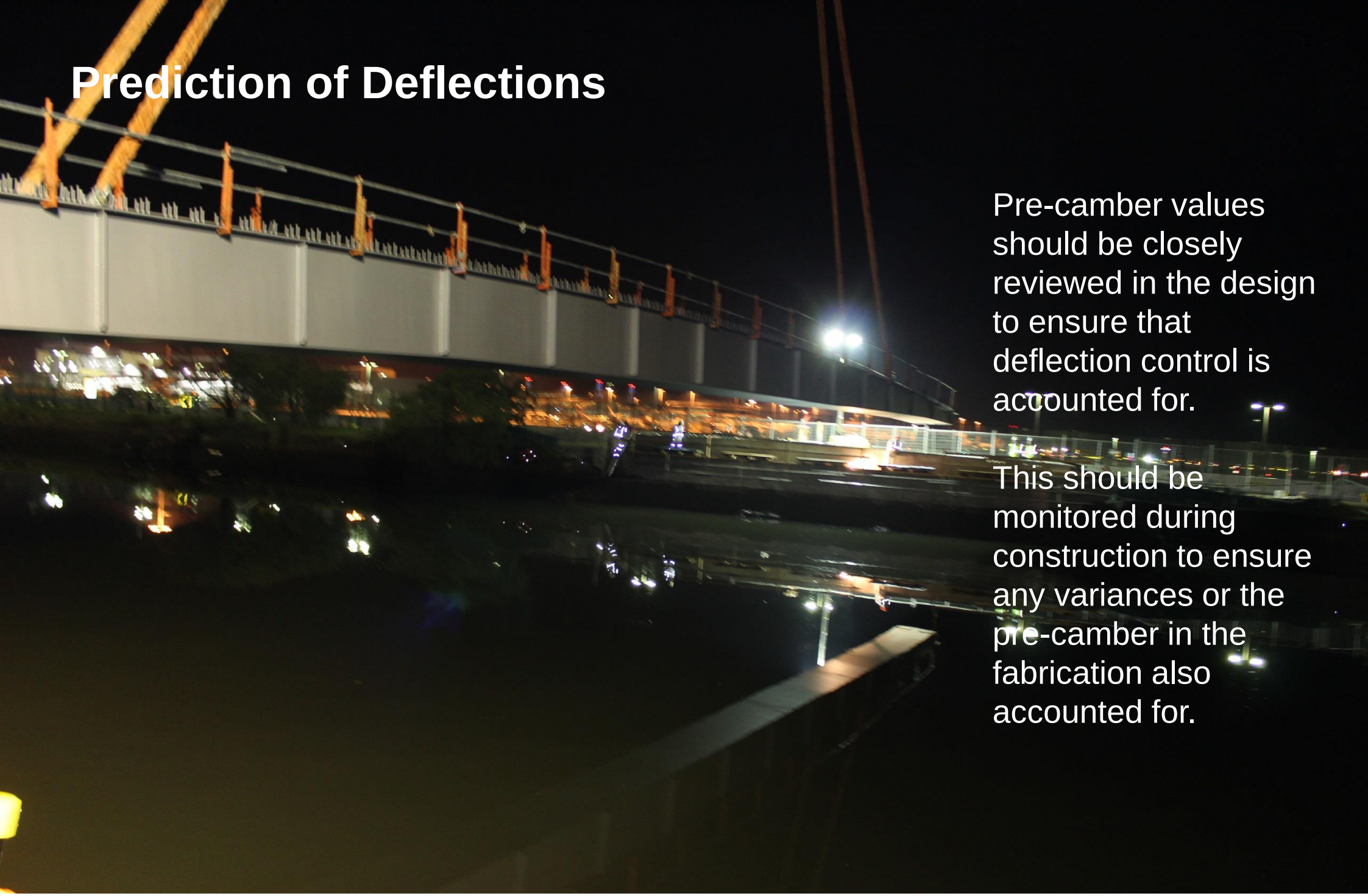
Key items to consider include;

1. Web to flange weld detail
2. Permanent formwork
3. Internal bracing
4. Dual composite to reduce the bottom flange or for continuity
5. Closed box allowing for 1 coat primer



TYPICAL GIRDER SECTION

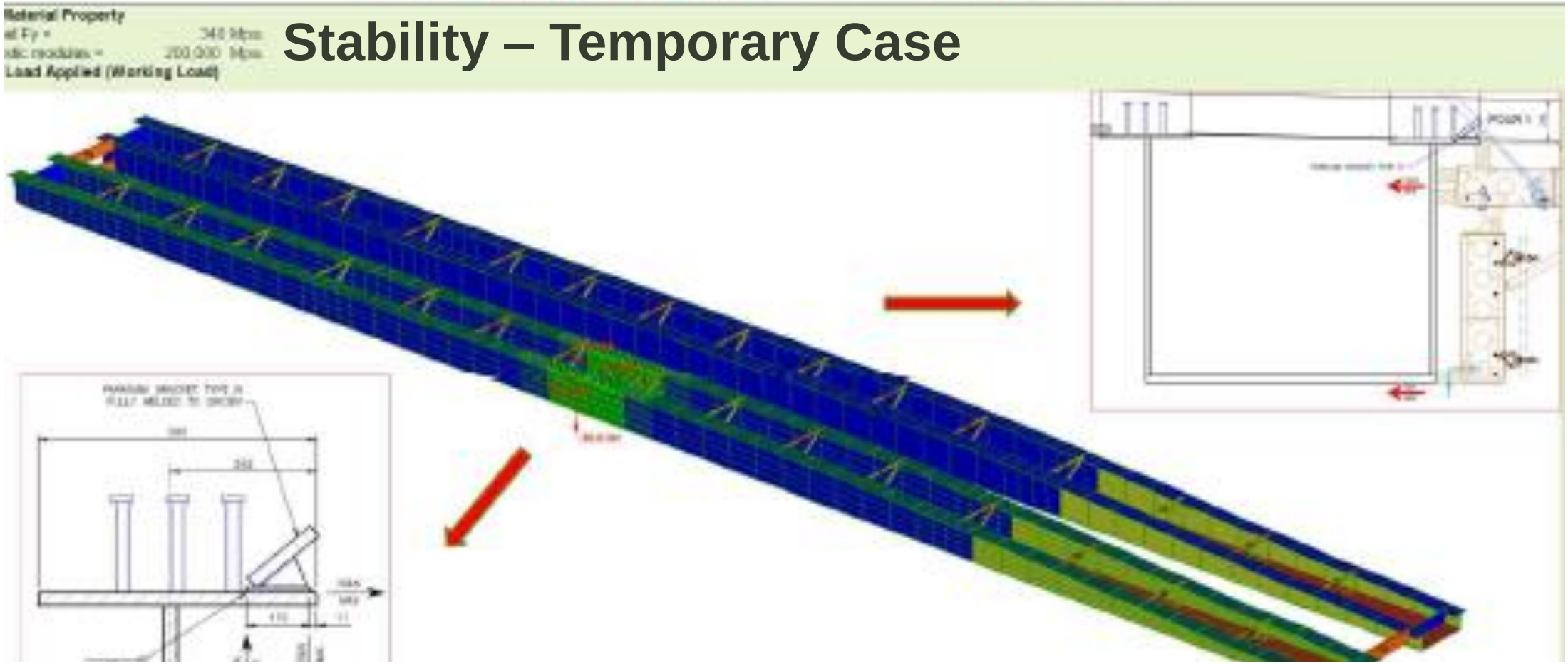
Prediction of Deflections



Pre-camber values should be closely reviewed in the design to ensure that deflection control is accounted for.

This should be monitored during construction to ensure any variances or the pre-camber in the fabrication also accounted for.

Stability – Temporary Case



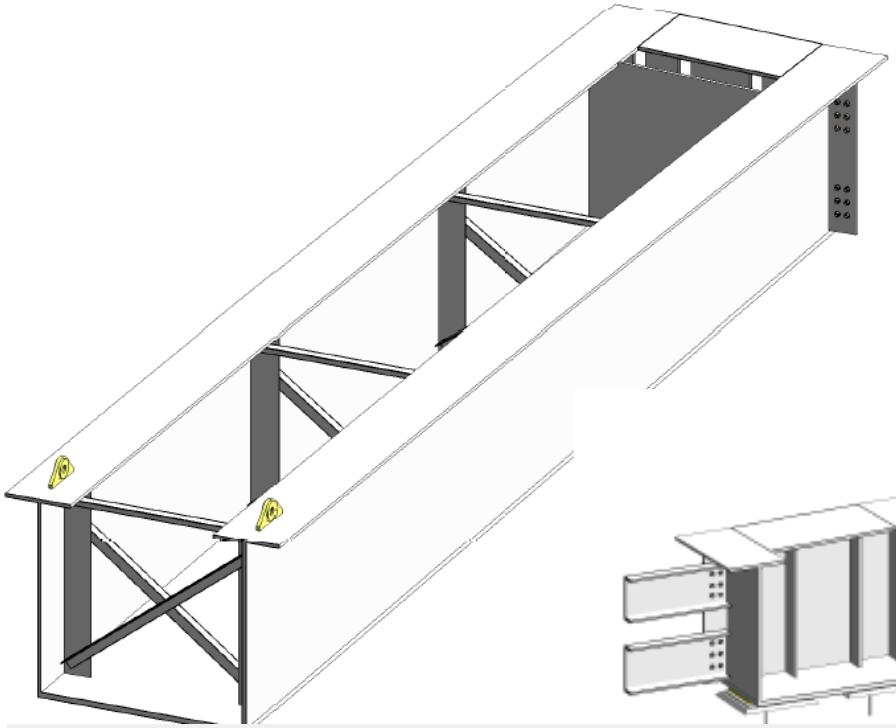
Key consideration the stability include;

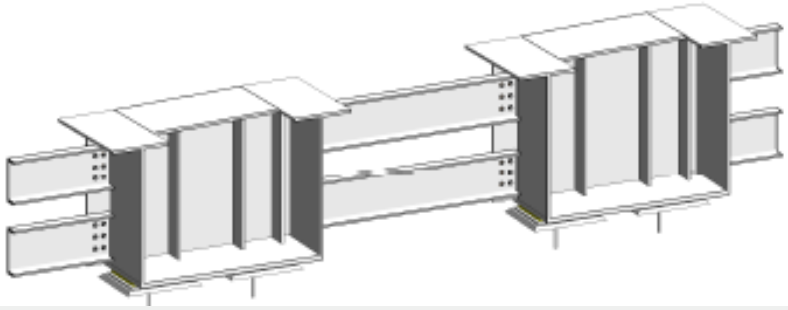
1. Eccentric temporary loading causing lateral sway – these can be overcome by having a strongback beam distributing loads to the adjacent girder.
2. Longitudinal translation of the girder at the bearing assembly during final erection – this can be overcome by placement on timbers and jacking up to position bearing assembly girder deflections have occurred.
3. Permanent and temporary stability can be achieved with twin bearings

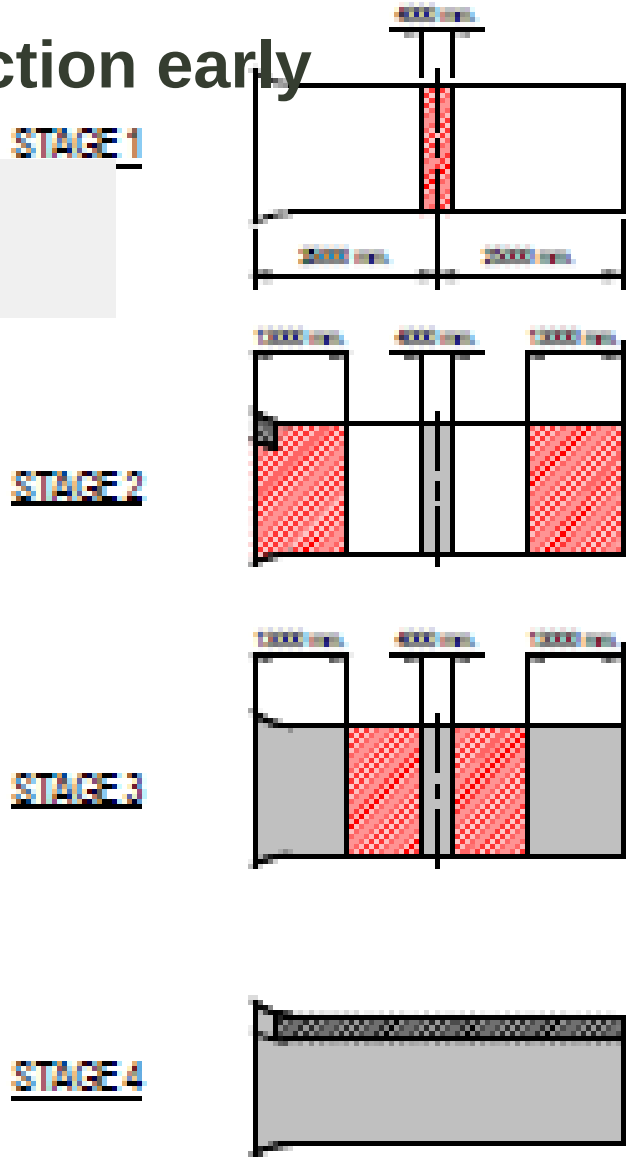
Bracing and making use of the composite action early

Reduce the effective length of the member.

Increase the member moment capacity.







Difficult to installation at construction site when the girders have massive vertical deflection. ?

Effect of differential movement between the girders will be increase the force in bracing.

Design for Maintenance

Sealing the box to avoid the need for future maintenance.

Case Study Conclusions

Based on the case studies presented the key advantages of the composite steel box girder bridges were determined to be;

- Superior Span to Depth Ratio compared to the PSC girder equivalent bridges
- Flexibility in the Geometry compared to other bridge forms
- Flexibility in Staging when construction is on the existing road alignment