Widening of the Existing Bridge over Reservoir Road on the M4 Smart Motorway Project, Sydney

KENNY LUU, PRINCIPAL CIVIL ENGINEER – BRIDGES, AMEY
CHANG LIU, SENIOR BRIDGE ENGINEER, ARUP
AMELIA AGNEW, BRIDGE ENGINEER, ARUP
Presentation Outline

❖ Project background
❖ Existing Bridge
❖ Design Criteria and Challenges
❖ Final Design
❖ Conclusions
Project Background
Project Background

- Westbound Entry Ramp is to be widened
- Provision for Hard Shoulder Running
- Existing Bridge to be widened by 7.47m minimum to 8.75m maximum
Existing Bridge

- Constructed in 1991
- The bridge carries both Eastbound and Westbound Carriageways
- Bridge is approximately 34.5m wide x 25m span
- The bridge is fixed at the western abutment in the longitudinal direction
Existing Bridge

- Superstructure comprises 1200mm deep prestressed trough girders at 2800 mm nom.
- The girder ends are at 40° skew to the alignment and were meant for the Twin Bridges over Powells Creek
- Substructure comprises shallow sill beam supported on an RSW
- The existing bridge was designed to T44 loading
Existing Bridge

- The RSW is 5.25m high
- Rehas galvanised steel straps at 250mm -750mm horizontal centres and 750mm vertical centres
- The straps are 7.0m long under the bridge abutment reduced to 6.0m at the wingwall
Existing Bridge

• The bridge girders are rated for T44 but not rated for SM1600 or HLP400
• Due to end skew of the girders, the end detailing of the girders was found not compliant to the anchorage requirement of AS5100.5
• The sill beam are rated to T44 but not rated for SM1600 or HLP400
• The RSW was assessed against the current RMS specification R57
  • Not compliant under T44 loadings (load rating factor ~0.7-0.8)
  • Not compliant under SM1600 loadings (load rating factor 0.54)
Widening Design Criteria

- **Design Loadings**
  - 2 Design Lanes of SM1600
  - HLP400

- Widening to be made structurally connected to existing deck via a stitch pour

- **Design standards**
  - Design Brief
  - RMS publications
  - AS5100
Challenges

• Minimise the transverse load transfer from the widening section into the existing bridge as the widening section is designed to the heavier SM1600 and HLP400 loading

• Differential settlement in between the new widening section and the existing bridge

• Risks to the existing bridge and motorway during construction

• Uncertainties in the existing bridge geometry and levels to make connection

• Timeframe
Final design
Final Design

• 1200 deep Super T girders were arranged to minimise load transfer

• Flange width was kept to 2500mm max to utilise standard formwork

• A 200mm min cast insitu deck

• The girders are fully utilised
Final Design

• A stitch pour width varying 650mm-1250mm allows for the connection of the two bridges at deck level

• Existing deck is cut back at the edge of the existing girders to avoid loss of composite action during construction

• The stitch pour is to be constructed after the initial elastic settlement due to dead weight of the new bridge has taken place
Final Design

• Stitch pour reinforcement detailing to allow for variation in the wearing surface as well as uncertainties in the existing deck level

• Proposed reinforcement is spliced through non contact laps and welding to existing reinforcement

• Traffic on the existing bridge will be restricted in accordance with RMS specification during the construction of the stitch pour
Final Design

• Shallow sill beam foundation was selected over piled foundation
  • Emulate the existing bridge structural behaviour
  • Simpler and quicker construction sequence

• The sill beam was sized to satisfy
  • Stability under braking force and other transverse restraint requirements
  • Satisfy eccentricity and bearing criteria requirements of R57

• The widening section articulation also emulates the existing bridge condition i.e fixed at the western abutment
Final Design

• The new sill beam is connected with the existing sill beam via a dowelled connection.

• Dowelled action is achieved via 8 No. 30 dia. stainless steel dowels.

• The dowels are sleeved to allow the initial settlement due to dead weight of the new widening to take place in the RSW.

• Sleeves will be fully grouted at the completion of the deck.
Final Design

- The RSW is founded directly on class IV-III shale \( \rightarrow \) differential settlement is due to the deformation of the RSW block
- A Plaxis model was developed to predict the settlement under live load
- Construction stages were also considered to isolate the settlement components
- Settlement due to the traffic live load was predicted to be 6.0mm
Final Design

• The predicted settlement was then applied in the structural model as a displacement induced load case

• The existing RSW will be partially demolished for the widening work

• RSW extension block will have 8.0m straps

• Due to the potential risks to the existing bridge, a monitoring regime for vertical and lateral movements of the bridge and the RSW are proposed

• The movements are to be recorded 12 hourly during the demolition and construction of the RSW extension, relaxed to weekly and monthly at the completion of the substructure and the bridge, respectively
Conclusions

- The widening design of the existing bridge over the Reservoir Road has achieved an effective solution, sufficiently addressing all the identified constraints and challenges.

- The design carefully considered and minimised the impacts on the existing bridge through:
  - Emulating the same structural behaviour
  - Minimising load transfer by achieving the right deck stiffness using a suitable girder layout
  - Utilising detailing and construction staging to minimise differential settlement
  - Offering flexibility to account for uncertainties in the existing bridge

- The proposed monitoring regime is to provide a mechanism to validate the design and to identify and mitigate risks.
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Questions?