CityLink Tulla Widening
– Bulla Road to Power Street

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Introduction | Presentation outline

• Project Background

• New bridges:
  – Bulla Road southbound entry ramp over the Collector Distributor
  – Pascoe Vale Road over Western Link
  – Mt Alexander Road over Moonee Ponds Creek

• Widening or modification of existing bridges:
  – Bulla Road Bridge North Abutment Modification (Separate Paper)
  – Western Link over Pascoe Vale Road
  – Moonee Ponds Creek Bridges 1,2,4 and 6 (Separate Paper)
  – Citylink southbound ramp to power street and Burnley tunnel (Ramp Z)
  – West Gate Freeway eastbound elevated structure

• Conclusions
Introduction | Project Background

- 2 packages of work
  - Melbourne Airport to Bulla Road
    - Funded by Federal and State Government
    - Delivered by VicRoads
    - Approx. length of 8 km
  - Bulla Road to Power Street (CTW - this project)
    - Funded and delivered by Transurban
    - Approx. length of 16 km

- One extra lane in each direction
- Contract Awarded May 2015
- Expected Completion by end 2017
- Total capital cost ~$1.28 billion for both packages
Introduction | Project Background

- Client: Transurban
- Contractor: CPB – Design & Construct Partner
- Main Consultants: Aurecon-GHD Joint Venture (AGJV)
- Other Consultants: Doulgas Partners (geotechnical), SLR (Noise Modelling), KBR (Proof Engineering), PowerPlant (Lighting Design), Hassel (Urban and Architectural), Visionstream (ITS), Davis Langdon & AECOM (IR)
Total 36 Design Packages, over 4000 Structural Drawings

- 3 New Bridges (total 400 m length)
- 10 Existing Bridge Widening (total 1800 m length)
- 7 Gantry Packages (70 New, 30 Existing)
- 3 Noise Wall Packages (40 Noise Walls)
- 5 Retaining Wall Packages (10 Retaining Walls)
- 7 Pier protection Packages (17 Pier Protection)
- 1 Existing Bridge Strengthening package
Introduction | Project Background

Major Design Challenges

➢ Large Number of Design Packages
➢ True Brown Field Site
➢ Coordination/Integration between three design offices and four verification offices
➢ Semi-Alliance Environment for D&C
➢ Very tight delivery timeline & Penalty
➢ Stakeholders & IR Approval
New Bridges | Bulla Road southbound entry ramp
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New Bridges | Bulla Road southbound entry ramp

Major Design Constraints

➢ Existing ground profile require one abutment to be top down with Soil Nail and another bottom up construction with RE Wall

➢ High bridge skew requiring an in-situ diaphragm at abutment

➢ Construction staging including limited access for crane positioning.

➢ Heavy beams due to high skew and long span resulting in onerous crane requirements.
New Bridges | Bulla Road southbound entry ramp
New Bridges | Bulla Road southbound entry ramp

Design Details-Girder End
New Bridges | Bulla Road southbound entry ramp

Design Details-Approach Slab
New Bridges | Pascoe vale Rd Bridge over Western Link

- Also Called Bell Street Interchange
- Existing Bridge → 1 lane for Tullamarine Fwy on Ramp and 1 for Pascoe Vale Rd bound traffic
- New bridge → Connecting Bell St to Pascoe Vale Rd traffic
  - Free up an additional lane on existing bridge
  - Eliminate dangerous left hand merging
New Bridges | Pascoe vale Rd Bridge over Western Link

- Complex site requiring the bridge to span over:
  - Entire CityLink carriageway (11 lanes)
  - Existing Pascoe Vale Rd exit ramp bridge
  - Moonee Ponds Creek channel
  - Craigieburn Railway line (2 tracks)
  - Close proximity to Strathmore Secondary College
New Bridges | Pascoe vale Rd Bridge over Western Link

- 269m long structure with maximum span of 62m
  - Spans 1 to 4 → Continuous steel box girders
  - Spans 5 to 6 → Simply supported Super-T girders
  - Piers skewed up to 29 degrees to suit site geometry
  - Curve radius of up to 165m

Span Arrangement
New Bridges | Pascoe vale Rd Bridge over Western Link

Superstructure
New Bridges | Pascoe vale Rd Bridge over Western Link

Substructure

Abutment A

Abutment B

Steel Box Pier

Transition Pier
New Bridges | Pascoe vale Rd Bridge over Western Link

Analysis and Design

- 3D “spine” grillage deck model using Spacegass
  - Steel box modelled as single beam elements
  - Rigid outriggers pinned to webs
- Response spectrum analysis for earthquake design due to complex geometry

3D Spacegass Grillage Model
New Bridges | Pascoe vale Rd Bridge over Western Link

Analysis and Design

- Local steel Finite Element Models in MIDAS Civil
- Skew diaphragms beyond “hand calculation” in AS5100.6

Local MIDAS Civil FE Plate Model for Diaphragms
Construction Challenges

- Complex site required close co-ordination between design and construction teams:
  - Construction sequence
  - Crane positioning in constrained site critical
    - Steel splice locations
    - Maximum lifting weights
  - Temporary towers
  - All major girder lifts to be completed under night road and rail closures
New Bridges | Mt Alexander Road over Moonee Ponds Creek

Major Constraints

- Close proximity to the existing bridge
- Requires partial removal of the existing north east approach embankment
- New bridge piers/columns are to line up with existing
- Soffit level to be no lower than existing
- Pedestrian Path under below 1 in 10 ARI
New Bridges | Mt Alexander Road over Moonee Ponds Creek
New Bridges | Mt Alexander Road over Moonee Ponds Creek
Existing Bridges Widening | Western Link Bridge over Pascoe Vale Road

1. For general notes refer to drawings CTW-001-005-053-500-381: BOS 540 & 114.
2. Prior to construction existing asphalt to be removed along face of R3 barrier to expose deck to confirm existing deck levels and thickness of ex. asphalt. Asphalt thickness may vary across width of bridge widening due to the possibility of the asphalt depth varying from core depth to the existing bridge. Top of new deck and existing deck must match the minimum deck and deck trolley thickness of 110 mm must be maintained at all locations.
3. For its conduits and junction boxes refer GHD 3441 & 5447.

For Construction
• Live running traffic on CityLink north and southbound lanes
• The existing noise wall is also to be retained during construction
• Depth of structure to achieve existing clearance to Pascoe Vale Rd.
• Pier strengthening works require
• Existing underground utilities in close proximity to or running below new substructure
• Driven piles will require pre boring to minimise vibration effects on gas main
Existing Bridges Widening | Western Link Bridge over Pascoe Vale Road
- Deck Cast in 2 stage
- Partial Road Closure
- Limit of Deflection and Vibration during deck casting
- High strength Low shrink low slump concrete for stitch
Existing Bridges Widening | Ramp Z-Southbound Ramp Bolte to Power St.
Existing Bridges Widening | Ramp Z-Southbound Ramp Bolte to Power St.

- Existing ramp constructed in 2009/2010
- 420 m of elevated structure in 14 spans
- Existing Pier 9 Crosshead spans over West Gate Freeway
Existing Bridges Widening | Ramp Z-Southbound Ramp Bolte to Power St.

- Existing Span 1 and 2 are 42m long 2.3m deep composite steel I-Girders, connected to existing CityLink segmental concrete box girders.
- Existing Span 3 to 14 Super-T beams are 26-32m long.
Design Challenges - Span 1 Widening

- Risk of additional load transferred to Ramp L due to Span 1 widening
- No reserved capacity for Ramp L
- Avoid deck strengthening due to location of first pier
Existing Bridges Widening | Ramp Z - Southbound Ramp Bolte to Power St.

Design Solution - Span 1 Widening

- Pier location selected to maintain an optimized stiffness of girder
- Flexible enough to allow deflection of deck at start of widening and hence no need for deck strengthening
- Stiff enough to eliminate additional load transfer to Ramp L
- Girder extended under the existing deck, made non-composite for 25% of its length
- Pier1B located under existing deck at 1/3 span
Existing Bridges Widening | Ramp Z-Southbound Ramp Bolte to Power St.

Design Challenges - Span 2 Widening

- Two steel I-girders connected to the existing
- Kinked in plan to suit the curved geometry
- Excessive twist of girders under girder and deck SW
- Unbalanced reactions of girders

Span 2 FE Model - Twisted Girders (SAP2000)
Design Solution - Span 2 Widening

- Both girders are required to be assembled together on site
- Torsional restraint provided by pair of cross bracings at the ‘kinked’ points
- Supported on a temporary tower at mid-span till composite action achieved
- Minimized the amount of permanent twist
Existing Bridges Widening | Ramp Z-Southbound Ramp Bolte to Power St.

**Design Challenges – Pier 9 Crosshead**

- Existing crosshead is a precast post-tensioned beam
- Existing Super-T beams are supported on a concrete corbel
- Crosshead was not designed for future widening
- Assessment showed that crosshead suspension reinforcement is not adequate for the new beam loads
- Anchoring into crosshead was also impossible due to presence of post-tensioning
- Extending existing concrete corbel was not a solution

![Existing concrete corbel](image)

![Existing Post-Tensioning Profile](image)
Existing Bridges Widening | Ramp Z-Southbound Ramp Bolte to Power St.

Design Solution – Pier 9 Crosshead

- Steel fabricated saddle with 100mm thick top plates
- Transfer loads from bearings to top of crosshead
- All components checked for fatigue
- Simple structural form and ease of installation achieved
**Existing Bridges Widening** | Ramp Z-Southbound Ramp Bolte to Power St.

**Pier 10 Crosshead**

**Design Challenges**

- Limited structural depth available
- Casting crosshead over live traffic
- Possible West Gate Freeway traffic disruption

**Design Solution**

- Independent new concrete column
- Two fabricated steel I-girders cantilever over the West Gate Freeway
- Crosshead held to the top of the new column by cast-in stress bars
- Shallow structural depth achieved
- Easy installation
Existing Bridges Widening
Westgate Freeway Eastbound Elevated Structure

- Total length of widening 1010 m
- Total 24 span. Span length varies from 31 m to 56 m
- Existing structure is constructed in the mid 1980’s
- Existing structure is continuous up to 300 m
- Segmental Box Girder balanced cantilever construction.
- Widening width varies from 0 to 3.5 m
Existing Bridges Widening | Westgate Freeway Eastbound Elevated Structure

Design Constraints

- The widening work is to be constructed adjacent to live traffic
- The widening work crosses a number of existing access roads and tram routes
- Existing 3.8 m x 3.8 m Melbourne Water storm water drain close to pier.
- Low piling headroom under existing Deck
- Piling adjacent and close proximity to existing Westgate Elevated Structure substructures
Existing Bridges Widening | Westgate Freeway Eastbound Elevated Structure

Design Solutions - Superstructure

• For Widening up to 0.8 m
Existing Bridges Widening | Westgate Freeway Eastbound Elevated Structure

Design Solutions - Superstructure

- For Widening up from 0.8 m to 2.4 m
Existing Bridges Widening | Westgate Freeway Eastbound Elevated Structure

Design Solutions - Superstructure

• For Widening up from 2.4 m to 3.2 m
Existing Bridges Widening | Westgate Freeway Eastbound Elevated Structure

Design Solutions - Superstructure

- Transition from I Girder to Box Girder
Existing Bridges Widening | Westgate Freeway Eastbound Elevated Structure

Design Solutions - Substructure
Existing Bridges Widening | Westgate Freeway Eastbound Elevated Structure

Design Solutions - Substructure
Existing Bridges Widening | Westgate Freeway Eastbound Elevated Structure

Design Solutions - Articulation
Conclusions

• An excellent example of fitting new works within a busy existing road corridor

• Design decisions were heavily influenced by the need to accommodate the existing traffic and associated highway works, and to suit construction staging under operating live traffic

• Major bridgeworks successfully completed and Road open for traffic months ahead

• Close co-ordination with design and construction teams was critical for successful completion
Acknowledgments and Questions

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