Palmerston North City Council

Manawatu Pedestrian / Cycle Bridge Detailed Business Case

Preliminary Bridge Structures Report

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Manawatu Pedestrian/Cycle Bride

Detailed Business Case

Preliminary Bridge Structures Report

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1 Introduction

Opus has been commissioned by the Palmerston North City Council (PNCC) to prepare a Detailed Business Case (DBC) for He Ara Kotahi Manawatu River Pedestrian/Cycle Bridge, Contract 3382, within the City of Palmerston North, as part of the government's Urban Cycleway Fund (UCF) Package.

This Preliminary Bridge Design Report defines the design criteria and explains the basis of the preliminary design of the bridge structure and forms part of the Detailed Business Case.

2 Background

Our Preliminary Structural Options Report was provided in April 2016 for the Indicative Business Case. This report provided a list of options for the bridge form, layout and location. The findings of the Preliminary Structural Options Report have not changed significantly unless modified by this report.

Following consideration of the Indicative Business Case, a bridge consisting of a steel box beam with a reinforced concrete deck was nominated as the preferred option.

3 Factors Influencing Design

3.1 Design Criteria

Design of the bridge will adhere to New Zealand policy and standard requirements including but not limited to the following documents:

- NZ Transport Agency Bridge Manual 3rd Edition, September 2014
- Compliance Document for New Zealand Building Code
- AS/NZS 1170 – Structural Design Actions
- NZS 3404 Parts 1 and 2 – Steel Structures Standard
- NZS 3101 Parts 1 and 2 – Concrete Structures Standard.

3.2 Safety in Design

The preliminary design of the bridge has considered safety aspects for construction, use, maintenance and demolition.

3.3 Foundations

For the preliminary ground conditions and foundation requirements refer to the "Manawatu River Pedestrian/Cycle Bridge Preliminary Geotechnical Appraisal" report. Bored end-bearing reinforced concrete piles are considered an appropriate foundation.

3.4 Hydrology

For the preliminary hydraulic requirements refer to the 'Manawatu River Pedestrian/Cycle Bridge – Preliminary Hydraulic Report' report.

The bridge beam depth has been minimised to provide a larger waterway area. The Bridge Manual requires a 1.2m freeboard from the design water level to the soffit of the bridge beam. Refer to Table 2.4 of the Bridge Manual below.

Table 2.4: Freeboard allowance for the level of serviceability to traffic

Waterway structure	Situation	Freeboard	
		Measurement points	Depth (m)
Bridge	Normal circumstances	From the predicted flood stage to the underside of the superstructure	0.6
	Where the possibility that large trees may be carried down the waterway exists		1.2
Culvert	All situations	From the predicted flood stage to the road surface	0.5

The three piers have been designed as single reinforced concrete cylinders, 1.2m in diameter.

An indicative scour depth at river piers has been provided by the hydraulic engineers based on typical values for New Zealand rivers. A design scour depth of 8m below the current base of the river has been assumed when determining the pile founding depth. This allows for both general and localised scour around the river piles.

3.5 Span Arrangement

The bridge spans 191m between abutments and comprises of three 50m spans and one 41m span at the city end of the bridge. The three piers have been designed as single reinforced concrete cylinders of 1.2m diameter. The abutments are piled.

The bridge deck is a reinforced concrete slab made composite with the bridge beam.

Expansion joints will be required at the bridge abutments.

3.6 Bridge Width / Depth

Two bridge deck widths have been considered a 4.2m and a 5m shared space. The deck widens at each bridge abutment to allow transition to the bridge approaches.

The bridge design allows for the incorporation of a widened viewing platform section in the middle of the bridge located above the bridge pier to minimise the loading on the bridge beams.

The 5m wide deck option will require a bridge box beam of depth 1.5m. The 4.2m wide deck option will require a bridge box beam of depth 1.2m.

3.7 Live Loading

The bridge will be designed for a pedestrian live load of 5 kPa in accordance with the Bridge Manual. Vehicle loads (emergency or maintenance vehicles) will also be applied in accordance with the Bridge Manual. A 5,000kg axle limit has been applied to achieve cost savings. The addition of light vehicle loads within the limits given above does not incur significant cost increases over a pedestrian only bridge.

3.8 Seismic

The bridge will be designed for seismic conditions in accordance with the Bridge Manual. An outcome of the Indicative Business Case was that the bridge will be designed to Importance Level 2 (normal footbridges). Importance Level 2 requires an Ultimate Limit State 1,000-year Average Recurrence Interval (ARI) for earthquake actions. Refer to Bridge Manual table 2.1 below.

We note that a higher Importance Level (3 or 4) would require a 2,500-year ARI.

Table 2.1: Importance level and annual probabilities of exceedance for wind, snow, floodwater and earthquake actions for bridges

Bridge categorisation	Importance level (as per AS/NZS 1170.0[2])	Bridge permanence*	Annual probability of exceedance for the ultimate limit state		Annual probability of exceedance for the serviceability limit state	
			ULS for wind, snow and floodwater actions	ULS for earthquake actions	SLS 1 for wind, snow and floodwater actions	SLS 2 for floodwater actions
Bridges of high importance to post-disaster recovery (eg bridges in major urban areas providing direct access to hospitals and emergency services or to a port or airport from within a 10km radius). Bridges with a construction cost exceeding $15 million (as at December 2012)†.	4	Permanent	1/5000	1/2500	1/25	1/100
		Temporary	1/1000	1/1000	1/25	1/100
Bridges on the primary lifeline routes (or similar new alignments) identified in figures 2.1(a), 2.1(b) and 2.1(c), categorised for the purposes of this manual on the basis of: • volume of traffic carried • route strategic importance (eg interconnection of centres of population) • redundancy of the regional roading network.	3	Permanent	1/2500	1/2500	1/25	1/100
		Temporary	1/500	1/500	1/25	-
Normal bridges, not falling into other levels. Footbridges.	2	Permanent	1/1000	1/1000	1/25	1/50
		Temporary	1/250	1/250	1/25	-
Bridges on no-exit or loop rural roads, not serving a through road function, and serving populations <50.	1	Permanent	1/500	1/500	1/25	1/25
		Temporary	1/50	1/50	-	-

Notes:

* Permanent bridge: design working life = 100 years. Temporary bridge: design working life $\leq$ 5 years.

† Values shall be adjusted to current value. For the relevant cost adjustment factor refer to the NZ Transport Agency's (NZTA) *Procurement manual*, Procurement manual tools, Latest cost index values for infrastructure, table 1 Cost adjustment factors, part 3 - Bridges[3].

3.9 Wind

Wind loading will be considered in the detailed design but we do not anticipate this to be a critical load case as seismic and hydraulic load actions will govern.

3.10 Side Protection Requirements

Side protection is required for a shared cycle/pedestrian bridge to a height of 1.4m. Intermediate rails to comply with the 'Compliance Document for New Zealand Building Code' Clause F4 – Safety from falling are required.

The side protection proposed does not meet the requirements for a vehicle barrier or horses, as defined in the Bridge Manual, Appendix B. This decision has been made to reduce costs and improve aesthetics.

3.11 Service / Utility Requirements

The bridge is required to carry a watermain (375mm internal diameter) and electrical cables (four groups of three 150mm diameter ducts). Electrical cables will be placed within the box culvert (two groups of three ducts in each box) for both the 4.2m and 5m wide options. There is also a water pipe which will be carried on the downstream outside of the 4.2m wide option and within the bridge beam box for the 5m wide option. There are safety in design concerns for either option which are being managed throughout the project.

Any impact on services and relocation/protection strategies shall be assessed and mitigated in consultation with the relevant service authorities. Powerco have indicated that they will not need access to the inside of the bridge box beam to maintain their electrical ducts.

3.12 Constraints on Construction Methods

Segmental steel box construction and long spans will minimise the effect on the waterway during construction. A steel structure will be lighter, thus easier to prefabricate and lift over a concrete structure.

3.13 Access for Inspection and Maintenance

Access inside the steel box will be required through access holes in the bridge deck. If access is required, this will be a confined space environment so special arrangements will be needed.

Drain holes in the bottom flange of the box are required to allow any water that collects inside the box to escape.

Long life (40 year) coating systems are applied to the exterior of the steel bridge beams to reduce the need for maintenance and recoating. The interior of the bridge beams will have at least an 80 year design life to ensure that recoating is not required avoiding the need for internal access. The application of long life coating systems to the bridge beams will reduce the need for maintenance thus providing safety in design and environmental benefits.

The standard inspection regime for a bridge is:

- General inspection every 2 years
- Principal (detailed) inspection every six years requiring special access.

An annual maintenance cost of 0.3% the bridges asset value should be allowed for ongoing maintenance, this is a generalised based on New Zealand practice and incorporates all maintenance works (including painting, joints, bearings, cleaning etc). The bridge will be required to carry maintenance / access vehicles.