Title: Design of Approach Spans to Second Gateway Bridge - Brisbane

The Second Gateway Bridge is part of a $1.88b upgrade of the Gateway Motorway in Brisbane, Australia. The upgrade project comprises over 20 km of new and upgraded motorway including 27 bridges and a second Gateway Bridge over the Brisbane River. The Gateway Upgrade Project is being delivered as a design, construct and maintain contract by the Leighton Abigroup Joint Venture for Queensland Motorways. The design and construction of the Second Gateway Bridge is under the control of the Gateway Bridge Alliance comprising the Leighton Abigroup Joint Venture and VSL Australia. The design of the Second Gateway Bridge was delivered by an integrated design team of Maunsell Australia and Cardno for the Maunsell SMEC Joint Venture.

The Second Gateway Bridge is 1627m long with a main span of 260m. The three river spans are constructed by the cast in-situ balanced cantilever method. The approach spans are constructed by match cast segmental construction with epoxy joints and with asymmetrical twin segments forming two spines that are stitched together after cantilevering. Approach spans are typically 71m and the box section is 3.3m deep.

This paper describes the design of the approach spans that comprise over 1100m of the bridge. The paper covers the philosophy of the bridge form and articulation which is of particular interest because, in pursuit of long life and low maintenance, there are no bridge bearings other than at three halving joint segments, and the design has balanced the flexibility of the substructure and foundations with the provision of just three sets of bearings and expansion joints. The bridge comprises two separated box girder spines, erected in balanced cantilever from each pier. These are later connected to the adjacent span and also joined together with a longitudinal stitch pour. The sections are subject to large shears and significant torsion and the shear centre and principal axes of the cross sections change between the balanced cantilevering and the final joined form. The design approach to this complex construction sequence and the treatment of large shears and torsion, which resorted to AASHTO and a review of several other codes, is explained.
Title: Design of Main Spans - Second Gateway Bridge – Brisbane

The Second Gateway Bridge is part of a $1.88b upgrade of the Gateway Motorway in Brisbane, Australia. The upgrade project comprises over 20 km of new and upgraded motorway including 27 bridges and a second Gateway Bridge over the Brisbane River. The Gateway Upgrade Project is being delivered as a design, construct and maintain contract by the Leighton Abigroup Joint Venture for Queensland Motorways. The design and construction of the Second Gateway Bridge is under the control of the Gateway Bridge Alliance comprising the Leighton Abigroup Joint Venture and VSL Australia.

The Second Gateway Bridge is 1627m long with a main span of 260m over the Brisbane River and side spans of 162m. The main spans are constructed by the cast in-situ balanced cantilever method with segments varying from 15m to 5m deep and 3m to 5m long. The main spans connect the approach spans within the two side spans with a closure segment that connects the twin cell single box section of the main spans to the twin box precast form of the approach spans.

The bridge was designed with a target design life of 300 years with particular attention directed at durability planning, materials selection and detailing to ensure a very long life for this landmark bridge. The design of the Second Gateway Bridge was delivered by an integrated design team of Maunsell Australia and Cardno for the Maunsell SMEC Joint Venture.

This paper will provide an insight to the design of this major bridge covering the selection of the cross section and its complementary relationship to the existing Gateway Bridge which is just 50m upstream. Also covered will be the design of the bridge substructure which comprises compact pile caps that are each supported on groups of 1.8m diameter bored piles in clusters below each pier column, the testing of superstructure concrete for creep and shrinkage parameters, the treatments for the control of peak temperatures and thermal gradients in large concrete pours for heat of hydration effects, ship impact protection using arrestor islands, and of course the design of the superstructure of the main spans.
Construction of Brisbane's Second Gateway Bridge

The Gateway Upgrade Project is a State Government initiative delivered by Queensland Motorways and the Leighton Abigroup Joint Venture. The project involves the upgrade of 20 kilometres of Brisbane’s Gateway Motorway, with its signature feature comprising duplication of the 1.6km-long Gateway Bridge.

Constructed using a balanced cantilever method, the second Gateway Bridge will join its twin in the top 10 of its kind in the world. With design of the second bridge differing markedly from that of the first, so too have construction methods differed. For example, among other considerable differences, while construction of the two main river piers was undertaken using cofferdams over a period of two years, river piers for the second bridge were constructed with a land-based operation over a significantly shorter period.

Practical challenges encountered prior and during construction include:

- Soft ground conditions, with much of construction taking place in the flood-plain of the Brisbane River
- Dredging and environmental approvals
- Maintaining positive relations with an operating premier golf club, upon which construction needed to take place
- Procurement of resources, from machinery to personnel
- Fostering a cultural shift conducive to reaching stringent quality standards in construction (i.e. 300 year design life) and a relatively rigid construction program
- Establishment and operation of a Pre-cast Manufacturing Facility to produce piles, match-cast segments and halving joint segments.

This paper will outline key features and benefits of the completed second Gateway Bridge, challenges and innovations used in construction, and a detailed construction methodology.
Title: Thermal Movements of the Existing Gateway Bridge

The Gateway Bridge, opened in 1986, is a post tensioned concrete box girder bridge crossing the Brisbane River, with a main span of 260 metres and approach spans ranging from 60 metres to 145 metres. The approach spans are twin-cell segmental box girders with wet joints and the main spans are cast in-situ box girders. The main spans were built by the balanced cantilever method and the Approach Spans were built span-by-span. The approach spans have bearings at the tops and base of all piers. The twin blade piers that support the main span are integral with the superstructure.

The bridge has two internal expansion joints and is tied into each abutment, preventing longitudinal movement at these locations. On the south side, the expansion joint is 373 m from the abutment. On the north side, the expansion joint is 728 metres from the abutment. The distance between the two expansion joints, including the main span, is 526 metres. The joint consists of a needle-beam type halving joint and modular expansion joint at deck level.

The modular expansion joints on the existing Gateway Bridge have reached the end of their useful life, and will be replaced as part of the Gateway Upgrade Project. As creep and shrinkage movements of the existing bridge have effectively ceased, the movement range of the replacement expansion joints will be largely determined by the thermal movements. In order to obtain a more accurate estimate of the thermal movement range, the movements at both of the existing modular expansion joints on the Gateway Bridge have been continuously recorded since September 2007. Ambient temperature inside the bridge has also been recorded at both expansion joint locations.

The paper will summarise the thermal movements, and relate these to both the bridge ambient temperature, and the shade air temperature near the site as recorded by the Bureau of Meteorology. The results will be compared to the provisions of the Australian Bridge Design Code.