BELLA VISTA TRANSVERSELY STRESSED

M-LOCK TWIN BRIDGES

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Abstract

The recently constructed Twin Bridges at Bella Vista, Sydney, is the first bridge to be constructed incorporating new developments in the precast M-Lock bridging system.

The M-Lock bridging system has recently been modified to include transverse and longitudinal stressing of the deck units, which has addressed current limitations and restrictions placed on precast modular bridges by the Australian Road Authorities. This modification has made the M-Lock bridging system accepted by the Australian Road Authorities for unrestricted use on highways.

This paper will describe the development of the M-Lock bridging system with specific references to the Bella Vista Twin Bridges.

Introduction

Precast concrete components have been utilised for many years using standard bridging details for simple alignments. With increases in the mass of vehicle loads, higher volume of traffic and various geometric constraints it is becoming increasingly economically difficult to justify the use of a precast system. The recently constructed Twin Bridges at Bella Vista, Sydney, incorporating new developments in the precast M-Lock bridging system, has addressed these issues.

The M-Lock bridging system was based on a Rocla product, which was first introduced 50 years ago in the USA in 1952. Cardno MBK in conjunction with Rocla has designed and detailed the original product to comply with the Australian Bridge Design code requirements. The M-Lock system includes products for T44 / HLP320 vehicle loads and M1600 / S1600 vehicle loads.

The M-Lock bridging system has recently been modified to include transverse and longitudinal stressing of the deck units, which has been accepted by the WA Main Roads, SA Main Roads, VICROADS, RTA NSW and QLD Main Road Authorities in Australia.

History of the M-Lock Bridging System

The M-Lock bridging system that was designed and manufactured for use on rural roads comprises entirely of precast reinforced concrete components including:

- Piles;
- Piers;
- Headstocks;
- Abutments;
- Planks.

The substructure consists of piles that are either precast spun circular reinforced concrete piles or square section reinforced concrete installed as driven piles or placed within pre-drilled sockets. The piles extend up to pier headstock or abutment level.

The superstructure comprises 1200mm wide inverted U-shape reinforced concrete beams bolted down to the headstocks and to each other, and with the longitudinal shear keys between units filled with non-shrink mortar. No deck slab or kerbs are required.

The Traffic barriers comprised Austroads Level 3 steel post and rail barriers, bolted to the outside of the deck units.

Spreading of the deck units transversely is restricted by placement of non-shrink mortar between the outer deck units and the upturned ends of the headstocks, and with the transverse bolts between adjacent deck units.

The bridges are designed to be submersible in accordance with the RTA Technical Services Directorate Direction 90/19 *Guidelines for the Design of Bridges Subject to Submergence*.

Configurations provided to-date generally comprise one and two lane widths and have proved to be very cost effective because of the minimal on-site works.

RTA Chief Bridge Engineer Circular 99/5 dated 14 July 1999 nominated restrictions on the use of multi beam modular bridge decks and specifically for the M-Lock bridge system. These restrictions on the M-Lock system were:

- Not to be used on roads with 30 year projected traffic volumes exceeding 1000 AADT (Annual Average Daily Traffic) total or 300 AADT for heavy vehicles (longitudinal joints restriction);

- Not to be used on roads with 30 year projected traffic volumes exceeding 2000 AADT or 500 AADT for heavy vehicles (transverse joints restriction).

The longitudinal joint restriction was based on the concern over possible breakdown of the grouted longitudinal shear keys with time or under heavy traffic and the need to be repaired at least once during the design life of the bridge (100 years). The 1000 AADT limit corresponds to the upper limit of traffic flow at which joint repairs could be carried out without undue disruption to traffic.

Interest amongst local councils grew considerably in the late 1990's, as councils saw the M-Lock system as an economic form of short span bridging for timber bridge replacements.

In 2000, Cardno MBK carried out further development work for Rocla in revising and standardising the M-Lock bridging system for the new SM1600 live loading.

In late 2000, an approach was made to the RTA to raise the AADT limit from 1000 to 2000 to allow greater use of the bridging system on rural roads. The long term successful use of the system in the USA was presented in support of this proposal. RTA advised that if the system were to incorporate transverse stressing of the deck units, there would be no objection in principle to its use on all roads, regardless of AADT values.

Cardno MBK was subsequently commissioned by Rocla to develop a version of the M-Lock system incorporating transverse and longitudinal stressing. In March 2001, the RTA gave approval to the widespread use of this transversely stressed system. Approaches were then made to other state road authorities and similar approvals were subsequently granted by VicRoads, Queensland Main Roads, South Australia Department of Transport and Western Australia Main Roads.

The Recent Development of the M-Lock Bridging System

With approvals now given by the state authorities to the unrestricted use of the modified modular bridging system, Rocla commissioned Cardno MBK to prepare standard details suitable for construction.

Standard drawings for the modified bridging system were completed in September 2001 encompassing span ranges of 7 metres, 9 metres, 10 metres and 12 metres. This system incorporated transverse bar stressing of the deck units, longitudinal stressing over the piers, precast Level 2 Type F traffic barriers, precast wingwalls to allow transition to Thrie Beam barrier on the approaches and precast approach slabs.

This design development incorporated advice from the RTA Bridge Section, which addressed concerns relating to existing modular bridge systems.

At the same time, efforts were made to identify the first bridge site suitable for its implementation.

The primary objective was to construct a bridge using this newly developed system and demonstrate to potential owners that a low cost modular bridge could be suitable for highway conditions.

The Bella Vista Twin Bridges, Sydney was the first project that incorporated the new modifications to the system.

Bella Vista Twin Bridges Project

The Bella Vista twin bridges are part of a large residential and commercial development owned by Norwest Limited, and project managed by Bowdens Group. The development site is within the Baulkham Hills Shire precinct and is encouraging growth and economic advantages to the Council district. The twin bridges are the gateway into the development, and aesthetics were an important feature to the project.

The Baulkham Hills Shire Council requested that the new development for Norwest Limited be capable of providing for a traffic volume over 1000 AADT.

Each twin bridge structure comprises 3 equal spans of 10 metres length. The carriageway width is 5 metres wide, with one bridge carrying a single lane of eastbound traffic and the other bridge carrying the westbound traffic. Both bridge superstructures incorporate a 3.5 metre wide footpath with provisions for gas, electrical and telstra services.

The barriers on the traffic side are precast concrete modified Type F Level 2 barriers with a twin railing attached to the top of the concrete base. This barrier is connected to the bridge system via the transverse stressing that connects the deck units. The barriers on the footpath are combined grille type pedestrian / traffic railings bolted to the cast-in-place concrete footway.

The substructure comprises standard precast headstocks, with voids included for the protruding precast pile reinforcement. The piles are 585 mm diameter spun precast reinforced concrete piles, which are socketed into the ground at the required depth. The piles are positioned in oversized holes and have grout filling the internal and external socket length in the shale bedrock. The remaining lengths of the piles were backfilled with compacted lean sand/cement mix.

This modular bridge system was ideal for this development, as the aesthetic value is high. The bridge is constructed with high quality surface finish, as the precast elements are manufactured in steel forms. The overall appearance provides smooth clean lines.

Design

Design and documentation of the twin bridges was completed in three weeks, following receipt of site survey and geotechnical information. Construction drawings were issued in October 2001.

Final approval of the design by Council was linked to the approval of the entire development.

Following completion of the design Cardno MBK was approached by the project manager to undertake the site inspections for construction of the twin bridges.

Construction

The bridges were constructed by Hill Bros over a period of six weeks and were completed on the 2 May 2002. The six week construction period encompassed the entire construction phases from the drilling of the holes for the piles to the grouting of the transversely stressed bar anchorages, while working a 5-day week.

Hill Bros had previously constructed one bridge incorporating the standard bolted M-Lock bridging system. Using good construction techniques the contractor was able to construct the bridge within the specified allowable tolerances (± 5 mm).

Based on Hill Bros' performance, Baulkham Hills Shire Council has expressed interest in constructing the next bridge using their own day labour forces.

The construction sequence was as follows:

- Drilling of the oversized holes for the piles;
- Placement of piles including grouting of socketed depth of piles and backfilling around the piles;
- Placement of precast headstocks;
- Grouting the headstock voids with the protruding pile reinforcement to provide a connection between the pile and the headstock;
- Plank assembly – which includes placement of the bearing strip on all headstocks, positioning and placement of all the hold-down bolts for the planks on the headstocks and positioning and placement of all the planks;
- Positioning and placement of all the concrete barrier units;
- Stressing of transverse tendons - includes placement of the grout between the planks, hand-tightening of the tendons, grout in the shear key, stressing of the tendons and grouting of the tendon ducts;
- Longitundal stressing of bars;
- Positioning and placement of the end protection beams;
- Placement of footway reinforcement, services and anchor bolts;
- Placement of the traffic railing and the pedestrian railings;
- Placement of joint sealing;
- Grouting of the transversely stressed tendon anchorages.

Conclusion

The primary objective was to construct a bridge incorporating the newly developed M-Lock bridging system and demonstrate to potential owners that a low cost modular bridge could be suitable for highway conditions.

Through innovative design and good construction techniques, construction of the Bella Vista twin bridges demonstrated that this was achievable at minimum construction cost with minimal site works.

Although precast modular bridges are not considered to be the most suitable bridge type for highways, this project showed that with the modifications nominated by the RTA the Rocla M-Lock system is considered to be a suitable solution for highways.

Construction of these bridges provides a reference for future precast concrete modular bridges for unrestricted use on all main roads.

Author Biography

Irene Scott has been with **Cardno MBK** as a bridge engineer since graduation in 1997, from the University of Sydney with BSc and BE (Hons) and the University Medal in engineering. Irene was named the Institution of Engineers Australia, Sydney Division 2000 Young Engineer of the Year.

Irene has worked on a number of bridge projects including the design and development of the M-Lock Bridging System, and has recently visited the USA to investigate the original Rocla product.

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Ken Wheeler is an Associate Director with **Cardno MBK** with BSc, BE (Hons) and MEngSc degrees from the University of Sydney and is a Fellow of the Institution of Engineers, Australia.

Ken has 25 years experience in the design and construction of highway bridges primarily with the Roads and Traffic Authority, NSW and more recently with Cardno MBK. Ken is the Project Director for the development and production design of Rocla's M-Lock Bridging System.

Ken was AUSTROADS representatives on Standards Australia Committees BD/1 (Steel Structures) and BD/32 (Composite Structures) from 1984 to 1996 and is currently the ACEA Representative on Committee BD/90 (Bridge Design).

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Bob Druitt is the National Product Manager, Bridge & Earth Retention Systems for **Rocla Pipeline Products**.

The main focus of Bob's product portfolio is the M-Lock Bridging System. Over the past 12 months Bob has been promoting the system across Australia and has successfully obtained national Main Roads approval.

Bob has over 22 years experience in the building and civil construction industry including 10 years with the specialist civil engineering company Reinforced Earth.

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