M-LOCK – THE SOLUTION FOR SHORT-SPAN BRIDGES
ADAPTABLE MODULAR PRECAST BRIDGE COMPONENTS

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Abstract

Precast concrete components have been utilised for many years for standard short span bridges with simple alignments. Now with additional requirements for bridges being introduced into simple structures, such as footways, provision of service ducts within the deck, skewed superstructures and varying pile types, it is becoming increasingly difficult to justify the use of a precast system.

This paper describes the development of the M-Lock bridging system, the design criteria adopted and the emphasis in the design on ease of construction. Recent developments to the bridging system to extend its application to highway bridges are outlined. Examples of recent M-Lock bridges are described to illustrate the adaptability of this modular precast bridging system.

Key Words: modular bridges, precast concrete, highway bridges, M-Lock bridging system

Introduction

Precast concrete components have been utilised for many years for standard short span bridges with simple alignments. With increases in the mass of vehicle loads, higher volumes of traffic and various geometric constraints it is becoming increasingly economically difficult to justify the use of a precast system.

The M-Lock precast modular bridging system is based on a precast bridging system first introduced by Rocla in the USA in 1952. In the mid 1990's, Cardno MBK, in conjunction with Rocla, designed and detailed a similar product to comply with the Australian Bridge Design Code requirements. The M-Lock bridging 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 Department of Transport, VicRoads, RTA NSW and Queensland Main Roads for use in highway bridge applications.

The M-Lock bridging system is adaptable to suit all the clients needs and is now an economic and sustainable construction solution for short span bridging on both rural and highway roads.

The M-Lock Bridging System

Cardno MBK in conjunction with Rocla has designed and detailed the modular bridging system to comply with the Australian Bridge Code requirements. The M-Lock system is currently designed for both T44/HLP320 and

the recently introduced M1600/S1600 vehicle live loads. Span lengths are standardised at 7m, 9m, 10m and 12m.

The precast components include:

- Precast straight and skewed planks deck units
- Precast headstocks designed to suit either driven or socketed piles
- Precast piles
- Precast Level 2 traffic barriers
- Precast wingwalls
- Precast approach slabs
- Precast end protection beams

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 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.

Recent Design Developments to the M-Lock Bridging System

RTA NSW 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, following inspection of a sample of these bridges by Cardno MBK engineers. Although this aproach was unsuccessful, the 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.

The M-Lock bridging system was thus modified to incorporate transverse and longitudinal stressing. In March 2001, the RTA gave approval to the widespread use of this transversely stressed bridging 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.

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 barriers on the approaches and precast approach slabs.

The Bella Vista Twin Bridges, Sydney, completed this year, was the first project constructed that incorporated the new developments to the system.

Current M-Lock Bridging Systems

Two versions of the M-Lock bridging system are currently in place:

- local roads system; and
- highways road system

The two systems are aimed at different markets and ensure the M-Lock system is applicable for all roads.

In keeping with the approvals obtained from each state road authority, the Highways system is used on roads with traffic volumes greater than 1000 AADT. Notwithstanding this delineation, it has become clear that the RTA prefers the use of the Highways system on all Main Roads regardless of AADT values.

Local Road M-Lock System

The Local Road system encompasses the originally developed M-Lock system, which is also referred to as the "bolted" system by Rocla. This system incorporates longitudinal shear keys between deck units that are also interconnected by bolts through the deck unit webs. Level 3 (Thrie beam) traffic barriers are connected to the outside webs of the external deck units. The deck units are placed on a slope to match the deck crossfall (typically 2% one way or two way) and generally no wearing surface is provided. Transverse restraint is provided by the upturned ends of the headstocks that also prevent spreading of the deck units.

The Local Road system is currently designed for either T44/HLP320 live loading (Australian Bridge Design Code 1996) or for the SM1600 live loading.

Highways System

The Highways system incorporates the recent developments of transverse bar stressing of deck units and longitudinal stressing over the piers, precast Level 2 Type F traffic barriers, precast wingwalls to allow transition to Thrie beam on approaches and precast approach slabs. Deck crossfalls are accommodated by variable thickness asphaltic concrete wearing surface.

The Highways system is currently designed for the SM1600 live loading.

Carriageway Widths

A number of standard carriageway widths have been chosen to comply with Austroads and state highway road authority recommendations.

For the local road system, these carriageway widths are 4.4m (one lane), 6.8m (two lanes narrow), 8.0m (two lanes standard), 9.2m (two lanes wide) and 10.4m (3 lanes).

For the highways system, the corresponding carriageway widths are 4.8m, 7.2m, 8.4m, 9.6m and 10.8m.

Advantages of the M-Lock Bridging System

The M-Lock bridging system comprises entirely of precast reinforced concrete components. This system is a rapid, economic construction solution to bridges on both the rural and the highway road systems.

The use of the M-Lock bridging system also minimises environmental impact on the bridge sites. Disturbance to bridge sites are limited to the drilling of holes for precast socketed piles or the driving of precast piling. All other components are erected using mobile cranes.

The advantages with using the M-Lock bridging system are the following:

- Rapid construction time
- Small construction crew required
- Simple construction enabling utilising of shire day labour
- High quality product
- Cost effective
- No in-situ concrete used, unless a footway is required
- No deck slab is required
- Suitable for both Level 3 and Level 2 traffic barriers
- The deck acts as an orthotropic plate to assist distribution of wheel loadings

Examples of M-Lock Bridges

The following examples demonstrate the versatility of the M-Lock bridging system:

Bridge over Davies Creek, Evans Shire, NSW – 2 x 12m spans, square, driven 400mm square reinforced concrete piles, 8m between Level 3 barriers;

Bridge over Wollan Lagoon, Inverell, NSW – 3 x 9m spans, square, driven 585mm dia, reinforced concrete spun piles, 4.4m between Level 3 barriers;

Bridge over O'Connell River, Bloomsbury, Qld – 5 x 12m spans, square, socketted 500mm octagonal prestressed piles, 4.5m between castellated kerbs;

Bridge over Darling Anabranch, Wentworth, NSW – 9 x 12m spans, 15 degree skew, transversely stressed, driven 400mm square or 585mm dia reinforced concrete piles, 8.4m between Level 2 precast kerbs;

Bridge over Drainage Reserve, Blair Athol, NSW – 1 x 12m span, 30 degree skew, socketted 585mm dia reinforced concrete spun piles, 15.6m overall width, with two cast-in-place footways and combined pedestrian/traffic barriers with multiple services;

Bella Vista twin bridges, Sydney – 3 x 10m spans, square, socketted 585mm dia reinforced concrete spun piles, transversely stressed, cast-in-place footway and modified New jersey barrier with two rails.

Conclusion

The M-Lock bridging system is a modular precast concrete bridging system that provides a low cost short span bridge suitable for both rural and highway conditions.

Through innovative design and good construction techniques, construction of the M-Lock bridges achieves minimum construction cost combined with minimal site works.

The recent modification to the system is considered to be a suitable sustainable solution to the highway system.

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 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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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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