Short–Span Bridges – Leading Australian Innovations

Frank Rapattoni
Technical Executive - Bridges
Parsons Brinckerhoff
Melbourne, Australia
frapattoni@pb.com.au

Frank Rapattoni, born 1950, received his Bachelor of Civil Engineering from Swinburne Institute of Technology. He joined Parsons Brinckerhoff after extensive experience in the design, construction and development of bridges in VicRoads, BHP Steel and Cardno.

Summary

Australia has one of the most extensive road networks in the world with some 37,000 bridges. The bridges have relatively short spans by comparison with other continents.

Bridge engineering has undergone a significant evolution in the past decade. New developments have led to reduction in costs, improvements in safety and lower environmental impact. The development of the prestressed concrete Super T-beam system has made the greatest impact capturing a large market share in a short time. Advances in the design and construction of steel bridges have also made these more competitive. Perhaps the most significant innovation is the “pier-redundant” bridge, a concept with unmatched safety in the event of pier collapse. These developments have potential application in the USA and around the world.

Keywords: Precast beams, prestressing, standardisation, safety, pier redundancy, surface coating, deck formwork, composite steel bridges.

1. Introduction

Australia is a vast country with a largely flat topography. It has one of the most extensive road networks in the world with more than 800,000 km of public roads and some 37,000 bridges [15].

Developments of short-span bridges in the last decade have led to reduction in costs, improvements in safety and lower environmental impact. Some of these are considered to be at the leading edge of short-span bridge engineering.

The development of the prestressed concrete Super T-beam system has made the greatest impact. Advances in the design and construction of steel bridges have made these more competitive. One of the most significant innovations is the “pier-redundant” bridge concept which provides an unmatched level of safety by avoiding total bridge collapse in the event of pier failure.

In this paper I will discuss the background to the developments and their key benefits, their use both in Australasia and their potential application in the USA and world-wide.

2. Overview of Australian Bridges

The number of road bridges on National highways, freeways and arterial roads is around 14,000. Based on deck area, 77% have superstructures in concrete, 18% in steel and 5% in timber [15]. For the overall road network, the respective percentages are 55% in concrete, 15% in steel and 30% in timber. Most timber bridges were constructed in the early 1900’s and are now to be found mostly on local roads.

Australian bridges have relatively short spans with 95% of all bridges having spans less than 40m and more than 80% less than 20m.

The bridge industry is relatively small by comparison with other continents. State Road Authorities played a leading role in some of the developments aiming to achieve a high level of standardisation. The steel industry played a significant role in the advancement of steel bridge engineering.

https://doi.org/10.2749/222137908796293820

3. Leading Innovations

3.1 Prestressed Concrete Super T-Beams

Prestressed concrete Super T-beams are by far the most popular bridge system used in Australia for bridge spans ranging from 10 to 38m. Their development began with the inception of T-slabs, similar beams developed for spans up to 19m [1].

- The success of the T-slab concept was the catalyst for the development of the Super T-beams which were developed to span up to 38m [3].
- Based on the T-slab concept [1], Super T-beams can span up to 32m as a simply supported span or 38m when continuous over three spans or more with SM1600 live loading [12]. It should be noted that these design loads are among the highest in the world.
- Super T-beams have now effectively replaced T-slabs and most of the other beam types used across Australia and New Zealand. A single fixed steel form is used to manufacture these beams for spans ranging from 6 to 38metres.

3.2 Developments in Steel Bridges

Steel bridges have steadily lost market share since the 1950's as concrete bridges provided cheaper alternatives. The following developments in the last decade have increased the attractiveness of steel bridges and have led to resurgence in their use:

3.2.1 Transfloor™ precast decking system

The development and details of the Transfloor™ system were outlined in an earlier paper [3]. In brief, this precast decking comprises lattice trusses. Its major feature is the ability to cantilever beyond the external beams enabling deck slab construction without any formwork.

3.2.2 Design aids

A number of design aids have been developed by Bluescope Steel and Onesteel (formerly BHP Steel) to assist engineers in designing economical, state-of-the-art bridges [5] [6]. These were discussed in details in an earlier paper by the author [7].

3.2.3 Coatings guide for new steel bridges

This guide [5] is considered to be of particular importance as it assists designers in the selection of appropriate coatings in different environments on the basis of lowest initial and life-cycle costs.

3.2.4 Pier-redundant bridges

The pier-redundant bridge concept is such that the bridge superstructure is designed to avoid its collapse with any one pier removed. This concept was outlined in earlier papers by the author [7] [8]. It leads to bridges which are virtually indestructible and is perhaps the most significant development in safety.

4. Conclusions

- Australian bridges have relatively short spans by comparison with other continents. Approximately 80% of bridges have spans less than 20m.
- Bridge engineering for short-span bridges has undergone a significant evolution in the past decade. Developments have led to reduction in costs, improvements in safety and lower environmental impact.
- The development of the prestressed concrete Super T-beam system reshaped the industry and captured a large market share in a short time. Advances in the design of steel bridges have also made these more competitive, especially for spans in excess of 38m.
- It is considered that the above developments for short-span bridges have the potential to be adopted in the USA and around the world.