Upgrading Railway Bridges in Sydney, Australia

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Summary

There is an ongoing programme of upgrading railway bridges on the Sydney metropolitan railway network in Australia. This paper outlines the superstructures types used, substructure re-use through strengthening and associated construction issues.

Keywords: bridges; railways; upgrading; strengthening.

1. Introduction

The railway network in Sydney, Australia is an extensive system that was constructed in the staggered stages 1855 to 1895 and 1912 to 1942.

Many of the railway bridge superstructures were constructed in steel, either twin girder deck spans or half-through girder spans.

Ongoing and expensive maintenance associated with these steel bridges has lead to the development of a bridge renewal programme, with the aim of superstructure replacement and improvement of vertical clearance to roads below, where applicable.

2. Superstructure Replacement Types

For the replacement of a railway bridge's superstructure, the preference is for a ballast-top deck system. However, if a ballast-top structure would mean a reduction in existing vertical clearance above a road, and track lifting is not a feasible option, then direct rail fixation to a concrete deck is an acceptable alternative.

2.1 Pretensioned concrete girders

This superstructure type comprises side-by-side prestressed concrete (PSC) girders. These were developed to allow rapid installation during a limited track closure period, typically associated with railway bridge upgrading.

Standard PSC girders are available for spans ranging from 6,6 metres to 15,6 metres, in 1 metre increments, and they are a popular type of superstructure replacement for ballast-top conversion projects.

2.2 Composite steel box girder and concrete slab deck units

Composite steel box girder deck units comprise a fully precast/prefabricated unit per track. Each deck unit typically comprises three (3) steel box girders topped with a composite concrete slab. There is no lateral structural connection between adjacent deck units.

These deck units are particularly suited to direct rail fixation, as the entire track is supported by a monolithic spanning element.

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2.3 Filler beam deck units

This form of construction uses steel sections embedded within a reinforced concrete slab unit.

Filler beam deck units are most suited where it is imperative to minimise the depth from rail level to underside of superstructure.

Filler beam bridge decks are classified as a shallow deck system, however, they possess high stiffness.

2.4 Through girders

This type of superstructure provides a shallow construction depth (rail level to underside of main girder) that remains constant irrespective of span length.

The critical element in terms of determining construction depth is the transversely spanning deck slab.

Direct rail fixation allows the construction depth to be further reduced.

3. Substructure Underpinning

It has been preferred policy to re-use substructures, if possible, when the bridge superstructure is to be renewed.

The additional dead load due to a heavier superstructure requires a check of the vertical load-carrying capacity of the existing substructures.

3.1 Micropiles

In order to upgrade the load-bearing capacity of existing structures, micropiles provide a suitable form of underpinning.

Essentially, a micropile is a small-diameter (typically less than 300 mm) drilled and grouted replacement pile that is reinforced with a centralised steel bar.

3.2 Jet grouting

Jet grouting is a ground improvement technique that represents a form of underpinning, such that it increases the vertical load-carrying capacity of existing piers and abutments.

A small diameter hole is drilled through the existing footing outstand and continues until reaching the desired founding level.

Cement grout, under high pressure, is sprayed from the bottom of the drilling tube as it is rotated and raised, creating a void filled with a cement grout/soil mix.

4. Abutment Stabilisation

Old brick abutments have been shown to be theoretically unstable, particularly when the existing bridge superstructure is removed during replacement.

Temporary propping may be required during upgrading construction and permanent steel propping struts are sometimes incorporated into the final upgrading work. These usually comprise galvanised steel square hollow sections, and can be conveniently located between steel box girders, for instance.