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Structural adequacy assessment of a disused flat bottom rail wagon as road bridge deck

Manicka Dhanasekar [a,*], Wirtu L. Bayissa [b,1]

[a] Faculty of Built Environment & Engineering, Queensland University of Technology, Brisbane, QLD 4001, Australia

[b] School of Urban Development, Faculty of Built Environment & Engineering, Queensland University of Technology, Brisbane, QLD 4001, Australia

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ABSTRACT

This paper presents half of a full scale experimental testing technique for assessing the structural adequacy of a disused flat bottom rail wagon (FBW) for low volume, heavy axle load road bridge applications. The aim of this ongoing research project is to develop sufficient knowledge required for achieving significant economy and safety of the heavy axle transportation system in regional government council roads. In the absence of such knowledge, the viability of replacing/rehabilitating the ageing bridges could not be economically justified, mainly due to low volume traffic and the costs of alternate solutions using new materials for heavy axle load demands.

This study describes a comprehensive laboratory testing of half of a single lane, single span bridge deck and an associated three dimensional finite element modeling. The novel idea in the paper is to enforce the transverse continuity conditions along the longitudinal edge of the half of full scale bridge so that the single FBW tested will mimic the behaviour of a double FBW deck for a single lane road bridge under heavy axle design loads. Several serviceability and ultimate load tests, conforming to the Australian bridge design traffic loads applied at critical locations of the FBW system are reported in the paper. The test results demonstrate that the FBW possesses sufficient structural strength and can service the required design traffic loads.

1. Introduction

1.1. Motivation

In the last few decades, due to concern for the safety, integrity and serviceability of existing bridge infrastructures and the economy of their rehabilitation/replacement, interest in the usage of disused structural systems have emerged; such solutions also exhibit better environmental credentials compared to other solutions of utilising new materials. In particular, bridge structures located on low volume road networks that are under the control of local government councils are reported to be more likely subjected to severe deterioration, mainly due to inadequate technical capacity and funding to conduct routine inspection, timely repair and replacement of such large stocks of deteriorating bridges. In comparison with the conventional bridge options, the research presented in this paper has the potential to exhibit shorter construction and commissioning time, and significantly lower initial costs due to the availability of disused rail wagons from local rail companies at scrap cost. With the advent of large volume, high axle road trains/trucks, and their forecasted increase in throughput due to the resource boom, the need for rehabilitating ageing bridges to resist heavy axle load, albeit at low frequency is more pressing than ever before.

Local government bodies in Australia are responsible for maintenance and operations of over 20,000 Bridges [1]. The majority of these bridges are reported to have ageing timber decks with widespread deficiencies requiring urgent attention. Similar reports from the Iowa state university's bridge engineering center also indicate that about 81% of Iowa's 25,000 bridges are located on secondary roads, for which the responsibility of maintaining safe operations rests with the county government authorities [2]. Similar poor states of bridges on low volume roads confronted with high axle loads exist in other regions [3].

With a view to alleviating the difficulties associated with these low volume high axle load road bridges, a cost-effective bridge solution is being developed at Queensland University of Technology (QUT). As part of this development, a disused flat bottom rail wagon (FBW) is identified and tested in the structural laboratory and a 3D finite element model has also been developed; a demonstration bridge is constructed and its performance is being assessed using extensive datasets obtained from field testing.

* Corresponding author. Tel.: +61 7 3138 6666; fax: +61 7 3138 1170.
E-mail addresses: m.dhanasekar@qut.edu.au (M. Dhanasekar), wirtu.bayissa@qut.edu.au (W.L. Bayissa).
[1] Tel.: +61 7 3138 1244; fax: +61 7 3138 1170.

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