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STRUCTURAL APPRAISAL OF A WROUGHT IRON TRUSS RAILWAY BRIDGE

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Abstract: A study for estimating load carrying capacity and remaining fatigue life of a wrought iron truss railway bridge is presented. The task is perused through static and dynamic field measurements and a numerical analysis. The dynamic factors obtained from the field testing were compared with those given by empirical formulae. For the numerical study, a three dimensional finite element model was prepared using SAP2000. Static responses obtained from the field load tests were used to validate the numerical model. A linear multi-step moving load case was introduced to the validated numerical model to determine member forces of the bridge under live loads. Based on the numerical solutions, along with dynamic and load factors for different type of engines and carriages, working stresses, factors of safety against yielding and fracture and remaining fatigue life were obtained and reported. The suitability of the bridge for anticipated increase of loading is verified. A bracing system for the bridge deck is suggested in order to reduce the lateral vibrations due to high speed trains.

Keywords: Wrought-iron railway bridge; moving load; dynamic factor; vibration; load testing; fatigue analysis

1. Introduction

In the latter part of the 19th century, many wrought iron railway bridges were built in many countries. Most of these railway bridges are still in use with some strengthening to accommodate increase in train schedules and loading. Sri Lanka also was fortunate to get a railway network which connected country's north to south, east to west and also the central upcountry to the coastal belt, under British authorities (Gribble,1952, Hyatt, 2000) during this period. Most of the bridges were made of wrought iron and are around 30 m in span and semi-through double lattice truss type. After more than a century these bridges are still in operation and well maintained. Even though these bridges were initially designed to accommodate a fewer number of trains with steam engines, with the passage of time, number of trains were increased and the steam engines were replaced by diesel engines.

Due to ever increasing demands of carrying capacities of these trains, heavier engines were added gradually. Presently the Sri Lanka Railways (SLR) is considering to add engines with axle loads of 20 tons. This called for an estimation of factors of safety and remaining fatigue lives of some selected bridges and this study was initiated to fulfill those requirements.

This work presents herein is a condition survey and a linear moving load analysis for a wrought iron truss railway bridge built in 1880. Dynamic loading to bridge structures are treated by introducing a dynamic factor, a constant increment to static live loads (Spyrakos et al. 2004, Thambirathnam et al. 2000). This factor takes into account the effect of bridge-vehicular interaction, impact loads, etc. Remaining fatigue life analysis was