Evaluation of longitudinal forces on substructure of railway bridges due to increased axle loading and speed through full scale field investigations

B.Arun Sundaram, Voggu Srinivas, S.Parivallal and Saptarshi Sasmal

Scientists, CSIR-Structural Engineering Research Centre, CSIR Campus, Taramani, Chennai 600013, India

Contact: arunsundaram@serc.res.in

Abstract

Bridges are the vital link for the highway and railway networks. There has been much progress in bridge design in recent years with increasing use of advanced analytical design methods, use of new materials and new bridge concepts. The new generation of locomotives produce approximately twice the tractive effort of older locomotives due to which the bridge substructures are subjected to greater longitudinal forces than the design load. Instrumentation and field testing has to be carried out in a comprehensive manner to get the distribution of these longitudinal forces at different levels starting from the coupler level to the substructure level. The existing codal provisions on the evaluation of longitudinal force is initially discussed in this paper. Details of the instrumentation adopted and the experimental investigations carried out on a typical bridge is presented. The percentage of force being transmitted to the substructure was evaluated and compared with the codal provisions.

Keywords: Prestressed concrete slab bridge; railway bridges; longitudinal force; instrumentation; experimental investigations; codal provisions

1 Introduction

We are dependent on the civil infrastructures like bridges, building, offshore structures etc for our various essential needs. Most of the civil infrastructures existing in India have been built earlier and are in service for a longer period of time. These structures are in service despite their aging and accumulation of damage. The condition of these structures needs to be assessed and the performance of these structures under present loading conditions needs to be studied to decide upon the safety and the necessary maintenance to be carried out. Instrumentation and response measurement offers the potential for continuous and periodic assessment of these structures. Based on the knowledge of the condition of the structure, the maintenance strategies can be worked out and the service life of the structures can be extended [1-2]. Indian Railways (IR) has about 1,27,768 bridges on a network route of 63,500 kilometres. Out of these, about 11,090 bridges are classified as Important / Major bridges [3-4]. Most of the major/important bridges are of steel plate girder, open web type truss and masonry arch type bridges built as per old loading standards. Age-wise profile of the in-service bridges reflects that: 42% bridges are over 100 years old, 62% bridges are over 80 years old and 75% bridges are over 60 years old.

With present growth of economy and increased demand for transportation of goods and people, there is huge requirement for increasing the speed, frequency, loading in the trains. Heavy haulage locomotives are introduced in the railways which exerts additional traction on the bridges along with the increased axle loadings. These longitudinal forces are being considered presently during the design stage itself. But in the case of in-service bridges, these forces have not been accounted for during the design. The sub

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