World Academy of Science, Engineering and Technology
International Journal of Structural and Construction Engineering
Vol:10, No:05, 2016

Strengthening by Assessment: A Case Study of Rail Bridges

Authors : Evangelos G. Ilias, Panagiotis G. Ilias, Vasileios T. Popotas

Abstract : The United Kingdom has one of the oldest railway networks in the world dating back to 1825 when the world's first passenger railway was opened. The network has some 40,000 bridges of various construction types using a wide range of materials including masonry, steel, cast iron, wrought iron, concrete and timber. It is commonly accepted that the successful operation of the network is vital for the economy of the United Kingdom, consequently the cost effective maintenance of the existing infrastructure is a high priority to maintain the operability of the network, prevent deterioration and to extend the life of the assets. Every bridge on the railway network is required to be assessed every eighteen years and a structured approach to assessments is adopted with three main types of progressively more detailed assessments used. These assessment types include Level 0 (standardized spreadsheet assessment tools), Level 1 (analytical hand calculations) and Level 2 (generally finite element analyses). There is a degree of conservatism in the first two types of assessment dictated to some extent by the relevant standards which can lead to some structures not achieving the required load rating. In these situations, a Level 2 Assessment is often carried out using finite element analysis to uncover 'latent strength' and improve the load rating. If successful, the more sophisticated analysis can save on costly strengthening or replacement works and avoid disruption to the operational railway. This paper presents the 'strengthening by assessment' achieved by Level 2 analyses. The use of more accurate analysis assumptions and the implementation of non-linear modelling and functions (material, geometric and support) to better understand buckling modes and the structural behaviour of historic construction details that are not specifically covered by assessment codes are outlined. Metallic bridges which are susceptible to loss of section size through corrosion have largest scope for improvement by the Level 2 Assessment methodology. Three case studies are presented, demonstrating the effectiveness of the sophisticated Level 2 Assessment methodology using finite element analysis against the conservative approaches employed for Level 0 and Level 1 Assessments. One rail overbridge and two rail underbridges that did not achieve the required load rating by means of a Level 1 Assessment due to the inadequate restraint provided by U-Frame action are examined and the increase in assessed capacity given by the Level 2 Assessment is outlined.

Keywords : assessment, bridges, buckling, finite element analysis, non-linear modelling, strengthening
Conference Title : ICSE 2016 : International Conference on Structural Engineering
Conference Location : Rome, Italy
Conference Dates : May 02-03, 2016