Proceedings of The Annual Research Sessions, University of Peradeniya, Sri Lanka. Vol. 7. October 30, 2002

ENGINEERING ANALYSIS AND FATIGUE EVALUATION OF ANCIENT RIVETED WROUGHT IRON RAILWAY BRIDGES

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Evaluation of load carrying capacity and remaining service life of railway bridges in Sri Lanka has become of primary importance since most of the major bridges in the country are more than 50 to 100 years old. The task of dealing with these old bridges has become complex as many codes of practice do not provide necessary guidelines for identification of the condition and for evaluating the remaining service life. The analysis of a railway bridge was carried out as a case study. The method adopted in evaluating the remaining service life of the bridge was the Miner-Palmgren cumulative damage rule.

The bridge considered was a semi-through bridge having eight double system Warren girders supported by cylindrical piers. Several member sets were used in the analysis of the structure considering various cross-sectional properties. The most highly stressed member, i.e. the critical member of each of the member sets was taken into consideration for life evaluation. The aim of this exercise was to find out the remaining service life of each set of members.

Out of the various forms of structural failures applicable to bridges the bridge considered was most likely to fail due to the effect of fatigue. The service stresses in the bridge were evaluated using a validated 3D finite element model and the stress cycle distribution of the service conditions were found from the analyses and as well as from the field tests. An impact factor based on the measured strains in dynamic field tests was used for this evaluation. The Miner's summation rule was used in the prediction of the fatigue life of the bridge.

Elements of a structure may be subjected to many forms of stress cycles varying both in range and in magnitude. Each element of the structure should be designed considering the number of cycles of different magnitude to which the element is likely to be subjected during the expected life of the structure. The number of cycles of each magnitude must be estimated by the designer in the light of available data, considering the probable frequency of occurrence of each type of loading.

Due to fatigue under current loadings, speeds, and frequencies of operation, the lowest remaining life found for a member under the investigation was found to be 20 years. Thus, it may be concluded that the Bridge deck can be used for another 20 years provided that the speed, frequency, and the weight of the trains are not increased from the present value. If proper maintenance work is carried out and critical members are replaced by new members having longer life, the bridge may be able to provide service for a further period.