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Metals in old bridges in Sri Lanka – a review

C.S. Bandara[1*], J.A.S.C. Jayasinghe[1], P.A.K. Karunananda[2], U.I. Dissanayake[1] and P.B.R. Dissanayake[1]

[1]Department of Civil Engineering, Faculty of Engineering, University of Peradeniya, Sri Lanka, [2]Department of Civil Engineering, The Open University, Sri Lanka
[*]bandara@civil.pdn.ac.lk

Metal bridges were introduced to Sri Lanka in the 19th century with the development of the road network and the railways. Most of these metal bridges are still in use. However, the collapse of several old iron and steel road bridges has been reported in the recent past highlighting the need for assessing these old bridges in the country. The usual assessment process of existing metal bridges needs a clear identification of metals used to build them and their mechanical properties. Material identification and the determination of mechanical properties of metals is usually done in laboratories. However, some of the tests such as fatigue testing and testing for the combined effects of fatigue and corrosion are expensive and time-consuming. Therefore, empirical and numerical methods are used to determine the material properties based on the results of simple and monotonic tests, such as, tensile and hardness tests.

Even though material properties are the most important data for assessing old structures, very few studies have been conducted with this regard. The present study consists of experiments, reviewing literature and applying empirical and numerical methods to identify typical properties of materials of old metal bridges in the country. This data can be used effectively in the assessment of existing old metal bridges in the country.

The study shows three types of metals used in old metal bridges: cast iron, wrought iron and steel. Cast iron was mostly used for bridge piers. Wrought iron was the common metal used for the superstructure at the beginning and was replaced by mild steel in the late 19th century. The present study proposes strength properties for old metal bridges. The typical ultimate tensile strengths of wrought iron and mild steel are between the ranges of 284 - 343 N/mm^2 and 372 – 450 N/mm^2 respectively. The yield strengths of wrought iron and mild steel are between the ranges of 191 – 241 N/mm^2 and 233 – 280 N/mm^2 respectively. The surface hardness of wrought iron and mild steel are between the ranges of 57 – 63 and 65 – 68 (Rockwell HRB) respectively. The fatigue strength at 10^7 cycles of wrought iron and mild steel are 160 – 165 N/mm^2 and 200 – 260 N/mm^2 respectively. The study also shows that the fatigue strength of wrought iron and mild steel can be predicted using empirical formulae: i.e. the rotary bending fatigue strengths of wrought iron and mild steel at 10^7 cycles are 0.47 times the ultimate tensile strength. However, the usual relationship between the ultimate tensile strength and Brinell hardness of wrought iron and mild steel was not observed in the test data.

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