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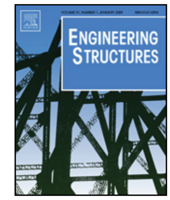

Experimental investigation on shear behaviour of riveted connections in steel structures

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ABSTRACT

The results of an experimental study based on lap-shear tests on riveted connections are presented in this paper. Experimental specimens were manufactured with materials and techniques used in aged metal structures and different dimensions and configurations were considered. The results of the experimental investigation allowed the influence of various parameters on the response of the connections to be assessed, such as load eccentricity, variation in net area, plate width and number of rivets. The experimental results and predicted shear strengths were compared in order to evaluate the reliability of the provisions of EN 1993:1-8. On the basis of the results obtained, modifications are proposed to the design equations given by EN 1993:1-8 for the rivet shear strength and the ultimate resistance of the net cross-section.

1. Introduction

Hot-driven rivets were extensively used in iron and steel structures in the past. Nowadays, these constructions represent an important part of the architectural and cultural heritage that needs to be preserved.

Historic metal structures include several typologies, such as large span roofing of urban passages, gasholders and railway structures.

Railway structures represent a considerable part of construction heritage in many European countries. In Italy, the railway network includes approximately 3500 steel bridges and 14 000 lattice roof structures. The main part of these constructions were built in the period 1910–1960 and were assembled by riveting, although high-strength bolts started to be used in the 1930s [1].

Riveted connections are still used to build new structures and to repair damaged connections in existing railway constructions (see Fig. 1). In particular, driven rivets are commonly used to replace damaged or missing fasteners because high strength bolts do not allow a good fit with the original elements unless the holes are reamed in situ.

The majority of historic steel structures are still in service and are exposed to loads that are larger than was expected. The reliability of these structures is also affected by deterioration and the poor quality of the materials that were used. A recent research project [2] has shown that aged steels do not usually fulfil the requirements of EN 10025 [3] for standardized materials. Thus, there is an urgent need to check the compliance of historic steel structures with current standards and to assess their residual lifetime.

The evaluation of shear strength in riveted connections is a key issue in the assessment of existing steel structures. Many studies have investigated the behaviour of riveted connections [4–11]. However, considering the sensitivity of the connection response to the manufacturing process [6,7,9], it is necessary to extend the results that have been obtained to different materials, geometries and configurations.

Moreover, the compliance of existing results with the predicted response according to modern codes should be checked. Despite the different manufacturing processes, the strength of riveted and bolted lap shear splices are treated in a similar manner in EN 1993:1-8 [12], with the exception of slip-resistance. Indeed, EN 1993:1-8 does not allow riveted connections to be regarded as a slip-resistant type. Rather, they are regarded as a bearing type, owing to the variability and low average value of clamping force.

The capacity of hot-driven connections is affected by several factors, such as loading conditions, geometric and mechanical parameters and manufacturing procedures.

The installation of hot-driven rivets involves many variables, including the driving and finishing temperature, driving time and pressure. Indeed, after the rivets have been heated to a high temperature, the manufacturing procedure requires that the plain end of the fastener be forged into a head by means of a pneumatic hammer. Then, when the hot rivet cools, it shrinks and pulls the parts tightly together. Thus, a residual clamping force and a pre-stressing in the rivet, with a partial slip resistance of the

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