A New Improved Type of Friction Connection – An Experimental Study

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Abstract

Indenters in the slip planes of a bolted lap joint increase its load bearing capacity. In an experimental study, conducted at the Luleå University of Technology, Sweden, a part of the European R&D project PROLIFE, RFCS 2015-00025, indenters between two plates a) were loaded in compression and b) shear loaded in a lap joint. The load to press a 2.5 mm diameter stainless steel indenter 2.3 mm into the plates was 11 kN and the effective friction of the joint was improved. In a reference test with two shear planes and plain as rolled plates, no indenters and an M30 bolt pre-loaded to 320 kN, the joint slip resistance force was 54.5 kN and the effective friction coefficient μ_{eff}=0.09. For an identical arrangement but with 29 indenters per shear plane, the slip resistance was close to 250 kN and μ_{eff} was increased to 0.40, at the current Eurocode acceptable joint slip of 0.15 mm.

Keywords: Friction connection; hardness; indenter; slip resistance; pre-loading.

1 Introduction

This article is a part of the European research project "Prolonging life time of old steel and steel-concrete bridges" or simply "PROLIFE" and deals with the development and testing of a new innovative friction joint, aimed at being used to connect trusses with the bottom flanges of bridge beams in order to make two or more adjacent beams act like a steel box girder.

When tightening a friction joint bolt, only 10 % [1] of the applied moment generates clamping force and the remainder is lost in friction. The friction coefficients for different surface conditions according to the current Eurocode are equal or lower than μ=0.5, see *Table 1*, leaving space for improvement in the opinion of the authors. Since the friction coefficients rely on such parameters as paint layers and blasting treatment and thus may vary considerably in practice, a desire to obtain well-defined friction conditions resulted in the idea of using indenters.

From a practical point of view it is not reasonable to ask steel contractors to handle small steel indenters at the construction site. One way of avoiding this difficulty is to attach indenters in a matrix pattern on cardboard or the like, leaving a bolt hole, for application in friction joints. If the idea permits leaving behind old corrosion protection and also decreasing the total pre-tension force to around one third of the present value, the concept would be a very important contribution in a rather new area. Friction joint corrosion can be avoided by applying an extra protective layer before mounting or sealing the joint edges with suitable material. Further, the concept could also be used in e.g. indoor or other corrosion-free climates (e.g. desert environment).

The research was initiated with the idea of using aluminium oxide ceramic indenters, because of their hardness. The problem with ceramics as indenter material is their brittleness as a small deformation may induce failure through crushing.

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