Numerical study of a blind bolted connection between an aluminum bridge deck and steel girders

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Abstract

This article concerns the behaviour of two blind bolt types, Ajax One side and Blind Oversize Mechanically (BOM), used to connect a multi-void aluminum bridge deck on its supporting steel girders. An extensive numerical simulation by FEM was performed to evaluate the connection behaviour against the Canadian Highway Bridge Design standard CSA S6-19. The main objective was to examine the assembly against fretting and quantify its impact at the contact zone over several load cycles. A special numerical model was developed for the prediction of fretting, and validated with analytical results and other observations reported in the literature. The model was used to analyze the fretting for each bolt at the surface of contact between the bolt head and the aluminum plate. Results of the study revealed that the blind bolts will lead to a few micrometers of wear, while for the standard bolt, a probable crack developments associated with minor wear may occur at the contact area.

Keywords: Highway bridge; Extruded aluminum deck; Blinded bolt; Fretting; Ajax Oneside bolt; BOM bolt.

1 Introduction

In 2005, the cost of modernizing, bridges and urban roads in Canada was estimated at 66 billion $. Bridge infrastructure in many parts of the world continues to suffer from deterioration caused by severe climatic conditions and the use of de-icing salts in wintery conditions. These factors generally accelerate the corrosion of steel, the disintegration of concrete or the deterioration of wood when these materials are used for construction. Bridge owners are constantly looking for competitive and innovative materials and solutions to help extend the useful life of their infrastuctures and to minimize costs of maintenance over the life of the structure.

The use of structural aluminium alloys offers considerable promise for the construction of modern roadway bridges and for the rehabilitation of the large inventory of deficient bridges [1].

This is due to the material's superior strength-to-weight ratio and durability (i.e. resistance to atmospheric corrosion), and low maintenance requirements compared to traditional construction material such as reinforced concrete or steel [2]. In addition, the material's extrudability property provides designers with the ability to optimise structural sections.

Aluminum was first used on highway bridges in 1933 when a bridge deck replacement was carried out at the "Smithfield Street" bridge in Pittsburgh, USA [3]. In 1950, the first bridge in the world made entirely of aluminum alloy (2014-T6) was built; the Arvida Bridge is an arch bridge crossing the Saguenay River in Québec, Canada [4].The first applications of aluminum bridges in Europe were

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