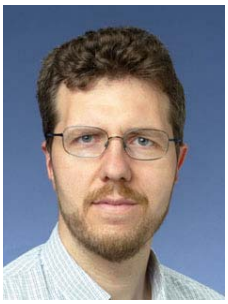
Benefits of Post-Weld Treatment to Improve Tubular Bridge Fatigue Performance

Scott WALBRIDGE
Assistant Professor
University of Waterloo
Waterloo, Ontario, Canada
swalbrid@civmail.uwaterloo. ca

Scott Walbridge, born 1973, received his civil engineering B.Sc. and M.Sc. degrees from the Univ. of Alberta, Edmonton, Canada, in 1996 and 1998, and his Ph.D. from the Swiss Federal Inst. of Technology (EPFL), Lausanne, in 2005.

Alain NUSSBAUMER
Senior Researcher
Steel Structures lab
ICOM-EPFL
Lausanne, CH
Alain.Nussbaumer@epfl.ch



Alain Nussbaumer, born 1964, received his civil engineering degree from the Swiss Federal Inst. of Technology (EPFL), Lausanne, in 1988, and his Ph.D. from Lehigh Univ., PA, USA in 1993.

Summary

In looking for ways of improving the fatigue performance of tubular bridge structures, the use of residual stress based post-weld treatment methods, such as needle peening, has been suggested. To study this possibility, a number of large-scale fatigue tests were performed on untreated and treated tubular bridge joints. Following these tests, a probabilistic fracture mechanics-based treatment model was developed and used to perform a number of studies. In examining the results of these studies, the mean applied stress level was seen to strongly influence the treatment benefit at the various potential crack sites in a typical tubular bridge structure. Based on this observation, the possibility of post-weld treatment in the field (i.e. after the dead load stresses are introduced) is examined herein, and seen to result in a significant increase in the treatment benefit.

Keywords: welded steel joints; fatigue; post-weld treatment; needle peening; probabilistic fracture mechanics; service life extension.

1. Introduction

Tubular bridges, that is bridges consisting of steel tubes welded together to form truss girders (see Figure 1), have seen increasing popularity in recent years [1-3]. This trend has been aided by modern cutting and fabrication techniques, making their construction more feasible and competitive [4]. In the design of tubular bridges, engineers have found the fatigue performance of the joints to be a critical aspect that may have a significant impact on the economic viability of these structures. Historically, research on the fatigue behaviour of tubular joints has been conducted primarily to address the needs of the offshore industry [5]. Recent specialized research on tubular bridge joints has attempted to better characterize the behaviour of these joints in view of the significant differences in loading, scale, and geometry ($\gamma = D/(2 \cdot T) < 12$ typical for bridge joints, see Figure 2) that exist with respect to the tubular joints often used in offshore applications. In looking for ways of improving the fatigue performance of tubular bridge joints, the use of residual stress-based post-weld treatment methods such as needle peening has been suggested. In order to study this possibility, large-scale tests were carried out at ICOM, which demonstrated the potential of these methods in this regard [5].

https://doi.org/10.2749/222137807796120201