

Review of existing techniques and fibre reinforced polymers used for strengthening tubular joints

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Abstract. Fibre reinforced polymers (FRP) are widely used to strengthen steel structures and retrofitting of existing structures due to its excellent properties. This paper reviews the use of carbon fibre reinforced polymer (CFRP) and glass fibre reinforced polymer (GFRP) in strengthening steel and concrete structures. The paper discusses the use of FRP in strengthening of steel bridges, uses of FRP in repairing of corroded structures and the behaviour of different adhesives. The paper then deals with the FRP strengthened hollow sections and the different failure experienced. The paper then reviewed the current state of art used in strengthening tubular structures and focusing on FRP in strengthening of joints.

Keywords: steel structure; FRP, tubular joints; strengthening; repairing; retrofit

1. Introduction

Tubular structures are used in the construction of offshore structures, bridges and other superstructures due to its ease of fabrication and light weight. The tubular joints used in offshore structures are subjected to reverse cyclic loading by waves which arise in high stress concentration. Strengthening and retrofitting is needed for these joints to increase their lifespan and fatigue life. Conventional methods of strengthening tubular joints are, by adding external gusset plates or by using ring stiffeners. By welding gusset plates and stiffener to the tubular joint, the joint experiences high stress concentration at the intersection and is more prone to failure Ahmadi *et al.* (2012, 2013b), Zhu *et al.* (2014, 2016).

An alternative technique for strengthening the tubular joints with Glass Fibre Reinforced Polymer (GFRP) revealed that the ovalization, chord surface displacement and stresses got reduced Lesani *et al.* (2013, 2014, 2015). Deshpande (2006) had shown that Carbon Fibre Reinforced Polymer (CFRP) and Glass Fibre Reinforced Polymer (GFRP) can be generally used to strengthen steel structures. Haedir and Zhao (2011) in the design and evaluation of externally bonded CFRP sheets for strengthening circular steel tubular short columns had shown that usage of CFRP for the strengthening of steel tube increased the yield capacity.

Ghafoori and Motavalli (2015) had developed an innovative retrofit system to prestress CFRP

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