Quasi-static load bearing behaviour of hybrid grouted joints

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Abstract

In offshore applications, high-strength grout is used to connect tubular steel sections. Grouted connections rely on welded shear keys to ensure sufficient interlocking of the grout-steel interface. These shear keys lead to stress concentrations, which in turn lead to fatigue cracks, and local damage of the grout. The hybrid grouted joint is a newly developed connection that is characterised by a multi-layered composition. In contrast to state-of-the-art grouted joints, hybrid grouted joints include thin adhesive layers, which are applied on the steel surfaces prior to grouting. The new connection type is in the focus of a recently finished research project. This paper presents selected results concerning the quasi-static load-bearing capacity under axial loading. The experimental campaign aimed at identifying and quantifying various aspects that influence the connection's performance. Different adherent combinations, varying overlap lengths, load directions and systematically induced imperfections were evaluated.

Keywords: Joining technology; grouted joint; hollow sections; adhesive; hybrid joint.

1 Introduction

Circular hollow sections (CHS) are used in numerous fields in steel construction. Up to now, CHS are mostly joined by welding. Both butt weld joints and butt plate joints are very limited in the capability to compensate imperfections. Additionally, due to geometrical and metallurgical notches welded joints possess limited fatigue strength. Demountable joints of hollow sections can be realised by bolting. Yet, this joining method in general faces similar problems as the welded joints.

Besides the classical welded and bolted connections, for overlap joints two further joining methods exist. Adhesive bonding of tubular hollow sections is not yet state-of-the-art, but is in the focus of recent research activity [1]–[5]. In the offshore industry, grouting is a standardized joining method [6]–[8]. Both methods are able to compensate imperfections due to their specific joint gap between the CHS and allow for a continuous load transfer.

1.1 Grouted joint

Two CHS of different size are slid into one another. This results in a tubular gap in the overlap area. This gap allows tilting of the tubes and can be used to compensate geometrical imperfections. The gap is filled with a high strength grout, which, after curing, is able to transfer loads by mechanical interlocking. This is enabled by the minor factory-made imperfections of the tubes. Artificially increasing the roughness of the adherents by welding shear keys on the surface increases the performance of the connection decisively. [9]

1.2 Problems

In the recent past, these shear keys turned out to be the reason for damages occurring at several