Paper ID:4863 Improvement of Stiffener Configuration to Strengthen Tensile Type Joints with Long Bolts Applied to Bridge Main Tower

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ABSTRACT

Long-tightening joints, despite their ability to be assembled quickly, have been found to have complexities in structure and difficulties in welding during fabrication of joint components in suspension bridge main towers and wind power generation towers. In this study, a method was investigated to simplify the fabrication of long-tightening joints by reducing the welding length of joint members and improving the joint geometry through FE analysis. Additionally, a composite joint structure with concrete was studied to reduce stress concentration near the welds, which are potential weak points for fatigue cracks. The results showed that the welding length could be reduced while maintaining the strength and deformation performance of the joint by changing the stiffener geometry. The stress concentration near the welds was also improved by incorporating concrete into the joint.

Keywords: Long type tensile bolted joints, Main tower connection, FE analysis.

1 INTRODUCTION

Long type tensile bolted joints (Long-tightening joints) have been utilized in the main towers of suspension bridges (Chen and Duan, 2014) such as the Second Bosphorus Bridge in Turkey (Figure 1 (a)) and the Kurushima Ohashi Bridge in Japan (Figure 1 (b)). One of the benefits of long-tightening joints is the ease and speed of assembly compared to welded joints, making it a viable option for use in tower joints for offshore wind turbines, which have seen a rise in popularity in recent years. The basic structure of a long-tight joint is illustrated in Figure 2. The joint consists of various components such as bolts, rib plates, end plates, anchor plates, and shear plates in addition to the main plate. Despite its benefits, the long-tightening joint has a complex structure and its assembly, particularly through welding in a factory, is challenging. In Japan, the design method and specifications for long-tightening joints have remained unchanged since 2004 (Nishiwaki et al., 2004). In order to make the implementation of long-tightening joints more feasible, it is necessary to simplify the structure shown in Figure 2 by reducing the number of components or shortening the welding length. With the recent improvements in FE analysis and computer performance, the author considered that the disadvantage of long-tightening joints could be solved by eliminating members and decreasing weld lengths while still preserving the joint's performance such as configuration optimizations for short tensile type bolted joint (Sugimoto et al., 2018; Sugimoto and Yamaguchi, 2022). Furthermore, long-tightening joints have multiple welds of steel members which are prone to fatigue cracks, thus the development of new joint structures that can reduce stress concentrations near welds is essential.

In this study, the joint geometry is improved through FE analysis by shortening the weld length of joint members to facilitate fabrication in a factory. Additionally, a composite joint structure

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