Load Transfer Mechanism of Single-sided frictional joints with high strength countersunk head bolts

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Abstract

This study analyzes the load transfer mechanism in single-sided frictional joints, with high-strength countersunk head bolts. Numerical analysis on coupon-type joints explores the bearing force on the counterbore, the friction force ratio to bearing force, and the slip resistance difference between countersunk head bolts and conventional bolts. The findings revealed that high-strength countersunk head bolted single-sided frictional joints employ a bearing force on the counterbore part by a bolt tightening. Since the stress occurs in the thickness direction of the main plate/the splice plate in the case of high-strength countersunk bolts, yielding of the main plate/the splice plate is limited and the reduction of the bolt axial force is not significant. Consequently, a single-sided frictional joint with high-strength countersunk bolts demonstrated higher slip strength.

Keywords: high strength countersunk head bolt, single-sided friction joints, slip coefficient, splice plate arrangement, countersinking bolt hole

1 Introduction

A countersunk head high-strength bolt, simply referred to as a countersunk bolt, features a smooth bolt head, as shown in Figure 1. This design, when applied to frictional joints for bridge deck plates, eliminates bolt head protrusion, thereby ensuring uniform base asphalt thickness [1]. The objective of this study is to develop countersunk bolted single-sided friction joints, simply referred to as CBJ, and counterbore processing in the main plates to achieve a completely flat steel deck surface [2], as shown in Figure 2.

In a previous study [1], slip tests were performed on both single- and double-sided frictional joints using 90° countersunk bolts. It was observed that the axially parallel part of the counterbore, marked by the red circle in Figure 3, undergoes plastic deformation. This leads to a lower axial force than that in a high-strength hexagon bolt (referred to as a hexagon bolt) when the tensile load is applied. In single-sided frictional joints, the slip coefficient decreased by approximately 6%, and in double-sided joints, it decreased by approximately 10% with countersunk bolts compared to hexagon bolts.

To suppress the plasticity of the axially parallel part, the bolt head opening angle was adjusted to 92° [3],

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