Prototype of no-projected and Sandglass-shaped Bolt with High-Strength and Durability for Efficient Steel Structures Maintenance

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Abstract

High-strength frictional bolted joints in civil engineering structures are corroded due to the thin coating thickness at the corners of the bolts and the nuts. A sandglass-shaped bolt composed of a countersunk head bolt and countersunk sleeve nut is being developed to secure the constant coating thickness and prevent corrosion. As its thread diameter is smaller than the usual one by the mechanism, an ultra-high-strength material must be applied to require the same fastening capacity as conventional bolts while considering stress concentration related to hydrogen embrittlement. This paper proposes a novel thread shape for the prototype of the sandglass-shaped bolt, whose stress concentration factor can be reduced by more than 30% current standard thread in Japan, focused on the magnitude of stress concentration. Moreover, FE analysis reveals the general fastening performance by comparing with or without the proposed thread.

Keywords: Corrosions, High-strength bolts, Countersunk bolts, Sleeve nuts, Maintenance

1 Introduction

High-strength bolted joints are widely used as in-site connections in terms of productivity and constructability. However, corrosion damage of hexagon head bolt occurs quickly due to thin coating thickness at the corners of the bolt head and nut, and become a burden on the maintenance system of conventional steel structures like steel bridges. One way to solve the problem is to eliminate any projections by adopting a countersunk head [1]. Figure 1 shows a high-strength countersunk head bolt gradually adopted in Japan as a corrosion countermeasure. The countersunk head secures a constant coating thickness prolonging the service life of rust preventive coating and reducing a maintenance effort tremendously. However, corrosion of the nut continues to occur due to the hexagonal shape. Therefore, our research group are developing a no-projected and sandglass-shaped bolt with high strength and durability. Figure 2 shows the prototype called “Double Spindle Fastener (DSF)”, composed of a countersunk head bolt and countersunk sleeve nut. This paper discusses the stress concentration of threads and countersunk heads with axisymmetric numerical analysis, which is deeply related to the yielding and hydrogen embrittlement failure.