Effects of material properties on slipping behavior in high-strength bolted frictional GFRP joints

Toshie Habukawa, Gen Hayashi, Masaki Sekimoto, Takashi Yamaguchi, Hiroaki Kitoh

Osaka Metropolitan University, Osaka, Japan

Contact:a20tr039@st.osaka-cu.ac.jp, hayashi-g@omu.ac.jp

Abstract

This study aims to clarify the influence of the variability in the material properties of Glass Fiber-Reinforced Polymers (GFRP) and the modeling method of GFRP on the slipping behavior of high-strength bolted frictional GFRP joints. Therefore, study conducted a statistical evaluation of the variability in material properties and finite element (FE) analysis. As a result, the initial load-relative displacement relationship in the anisotropic model generally matched the experimental results. Furthermore, it was found that the Poisson's ratio did not have a significant impact on the slipping behavior in any direction. The material property that most influenced the slipping behavior was considered to be the shear modulus in the plate thickness direction.

Keywords: GFRP, high-strength bolted frictional joints, slipping behaviour, material properties, variation

1 Introduction

Glass fiber-reinforced polymers (GFRP) are often applied in civil structures and bridge members in harsh corrosion environments owing to their excellent lightweight properties and weather resistance. In such cases, bolted connections of the bearing type are commonly used as mechanical joining methods between GFRP members. However, these connections face challenges, such as low shear strength and elastic modulus. As a result, the joint resistance was low and the number of bolts increased. Additionally, challenges remain in on-site assembly, including the need to align hole positions. Therefore, to enhance joint strength and improve on-site constructability, high-strength frictional bolted joints, which resist the load through the frictional force generated by introducing axial force to high-strength bolts, have been attracting attention.

In contrast, GFRP underwent creep deformation. In practice, when applied to high-strength bolted frictional joints, the critical axial force in the frictional joint continues to decrease over time owing to the creep deformation [1]. Therefore, the current situation is that there are few applications of high-strength bolted frictional joints with GFRP. Hashimoto et al. [2] experimentally demonstrated that using steel in the connecting plate can mitigate the decrease in bolt axial force, focusing on thick hand lay-up molded materials used in civil structures. Therefore, our research team has experimentally shown that the reduction of the bolt axial force can be suppressed by using steel as the splice plates for thin GFRP joints and clarified the practical feasibility of bolted joints used in

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