Study on Hybrid Joints with Frictional and Bearing type High-Strength Bolts
摩擦用—支圧用高力ボルトを用いたハイブリッド継手に関する研究

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To propose a design method for Frictional-Bearing hybrid bolted joint

BACKGROUND

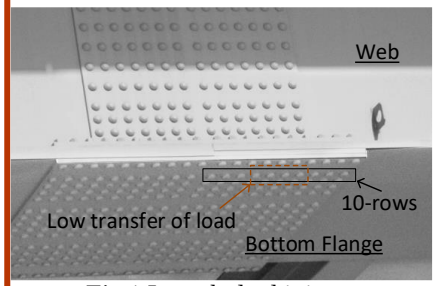


*Fig.*1 Long bolted joint

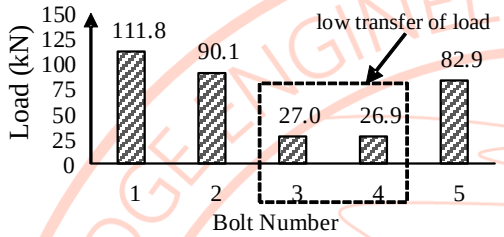


*Fig.*2 Load sharing of joints (when slip occurred)

In recent years, there has been a tendency for High-strength bolt frictional joints to become larger and longer, as shown in Fig.1. In contrast, as the length of the joint increases, the actual **force that can be withstood is less than the design strength** because the load sharing of bolts within the joint becomes **uneven**, as shown in Fig.2. On the other hand, due to the presence of the secondary member in steel structure, there are many cases where **the bolted joint splice plates are too long and cannot be installed**.

Purpose: To resolve this problem, we propose a method to improve the slip strength of a long friction-bolted joint by combining it with a bearing-type joint (hybrid joint).

1>. Ultimate limit state design method 2>. Miniaturization of bolted joint

3>. Strength improvement of long bolted joint

KEYWORDS

High-strength bolt Bearing-type bolt Hybrid joint

METHOD

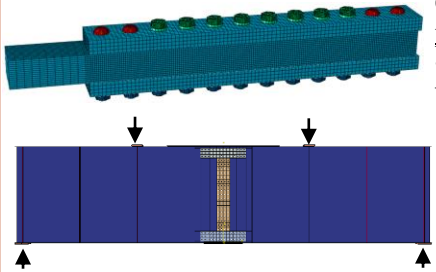


*Fig.*3 Finite element method model

1. Mechanical behavior of hybrid joint

• Finite element analysis was performed to clarify the slip strength and the influence parameter of mechanical behavior for hybrid joint.

• Conduct experiments to verify the FE method's Validity and the feasibility of hybrid joint.

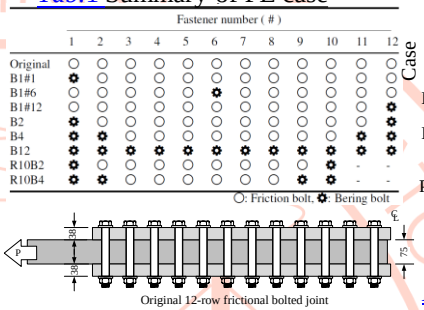
2. Generality of hybrid joint

Consider multi bolted joints (chain & zig-zag) and their application on girder to verify their generality.

3. Propose ultimate limit state strength design method

RESULT

*Tab.*1 Summary of FE case



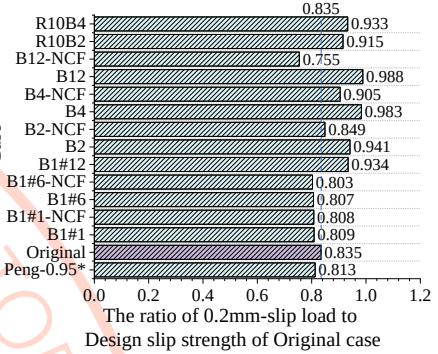


*Fig.*4 Ratio of slip load and designed slip strength of each case

Slip strength of hybrid joint: Fig.4 shows the results of the present analysis, all cases of hybrid joints, except B1, improved the slip load of the original case, which is a long-bolted friction joint. Among them, the R10B2 case, which shortens the joint length to 10 rows, also has a 10% higher slip load than the long frictional bolted joint (Original) due to the load transmit mechanism is friction-bearing hybrid, and the local slip would not occur.

Mechanical behavior of hybrid joint: Fig.5 shows the original case experienced load decrease (1858 kN) before it reached the designed slip strength (1968 kN), and the slip load of original case was 1594 kN when the relative displacement was 0.2mm. However, the hybrid joint (B2 to R10B4 case) did not experience load decrease, and the nonlinear change in the curve occurred at approximately 2387 kN.

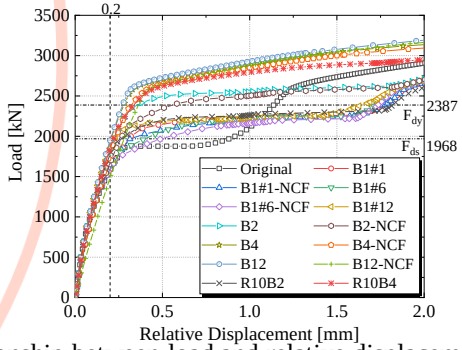


*Fig.*5 Relationship between load and relative displacement

SUMMARY

➢ The hybrid joint which was installed bearing-type bolts at each end of the joint would **not occur slip locally**, therefore the **hybrid joint has a higher slip load than the long frictional bolted joint.**

➢ Due to the friction-bearing hybrid load transmit, the hybrid joint has a 10% higher slip load than the long bolted frictional bolted joint. It can be concluded that **the shortening of the long bolted joint length can be realized by installing the bearing-type bolts.**