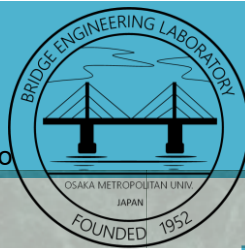


Effect of Surface Treatment on the Slip Coefficient of High-Strength Bolted Joints with Adhesive

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How Do Power-Tooled Roughness Levels Affect the Shear Strength?

BACKGROUND

Corrosion is common damage in steel bridges. To repair corroded steel members, the doubler plate with **high-strength bolted joints with adhesive** (hereafter called **combined joints**) is widely adopted as shown in **Fig. 1**. In this method, epoxy resin (adhesive) for surface leveling is applied to ensure proper contact between the doubler plate and the base material.

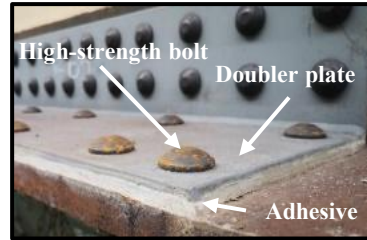


Fig. 1 Repair by combined Joints

Due to in-situ restrictions, power tools are commonly used for the surface treatment of corroded steel plates, and the resulting **surface roughness varies** depending on the type of tool used, significantly affecting the slip coefficient of combined joints. In this study, small-scale slip tests were conducted to compare the slip coefficients obtained by **a bristle blaster and a disc grinder** for the surface treatment.

METHOD

Experimental Setup (Fig. 2)

Contact pressure introduced (vertical load: N_v): 64.9 N/mm²
(Corresponding to F10T-M22 bolt design pre-tension)
Horizontal load (P_h) were measured to calculate slip coefficient (μ)

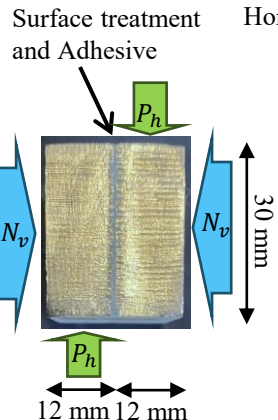


Fig. 2 Specimen



Fig. 3 Surface treatment by power tools

Materials

Adhesive: E258RS
(Shear strength: 28.0 N/mm²)
Primer: E205
(Shear strength: 19.0 N/mm²)

Surface Treatment (Fig. 3)

Inorganic zinc-rich paint (I),
Avg. coating Thk.: 89.1 μ m
Bristle blaster (B), Ra: 2.0 μ m
Disc grinder (D), Ra: 7.7 μ m } ISO St3

RESULTS

Slip Coefficient (Average) (Fig. 4)

ID (0.52) < IB (0.70) < DD (0.72) < BD (0.77) < BB (0.79)

$$\mu = \frac{P_h}{N_v}$$

Effect of Surface treatment (Fig. 5)

Surface roughness Ra: B>D
More **pronounced roughness** increased the contact area between the adhesive and the surface, thereby enhancing the **mechanical interlocking effect**.

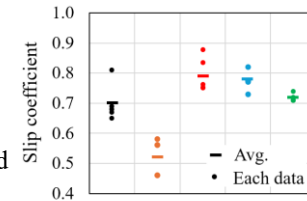


Fig. 4 Slip coefficient

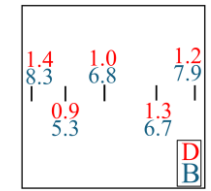


Fig. 5 Roughness at different locations of surface

Failure Modes (Fig. 6, Fig. 7)

For IB, ID:
Failure types: SF1, SF2, CF1
For BB, BD, DD:
Failure types: SF2, CF1

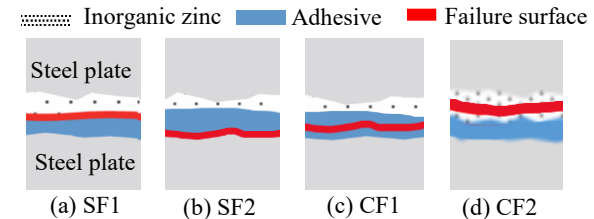


Fig. 6 Classification of failure modes

Failure Characteristics (Fig. 6, Fig. 7)

Uneven surface profiles lead to mixed failure modes and variations in local bonding strength.

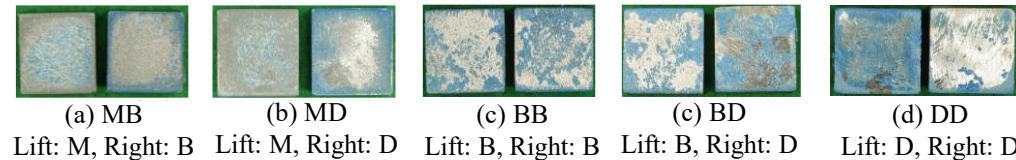


Fig. 7 Contact surface after loading

SUMMARY

- Slip coefficients: ID (0.52) < IB (0.70) < DD (0.72) < BD (0.77) < BB (0.79). Combined joints with both side St3 surfaces show higher slip coefficients than that of one side St3 surfaces, and higher surface roughness leads to higher slip coefficients.
- Non-uniform surface roughness leads to mixed failure modes: adhesive–zinc interfacial failure (SF1), adhesive–rough interfacial failure (SF2), and adhesive cohesive failure (CF1).

KEYWORDS

High-strength bolt, Adhesive, Slip coefficient