Experimental Study on the Slip Behavior of Joints in Deformed Flange H-Shaped Steel Beams Coated with Inorganic Zinc-Rich Paint

Osaka Metropolitan University Graduate School of Engineering Bridge Engineering Lab Ren Kigawa

Clarification of the slip behavior at the joint of protruded H-beam with inorganic zinc-rich paint applied to the joint surface

BACKGROUND

In this study, Deformed Flange T-shapes with upper flange protrusions are used in composite slab bridges to improve bonding with concrete(Fig.1). Currently, their joint protrusions are machined for contact, but a non-machined joint is preferred for easier construction (Fig. 2).Loading tests using zinc-rich painted Deformed Flange H-shapes were conducted to investigate slip behavior at these joints.

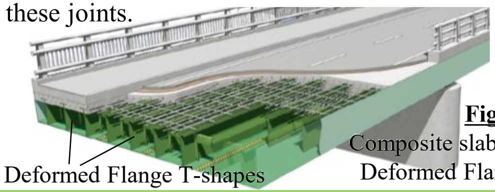


Fig.1
Composite slab bridges using Deformed Flange T-shapes

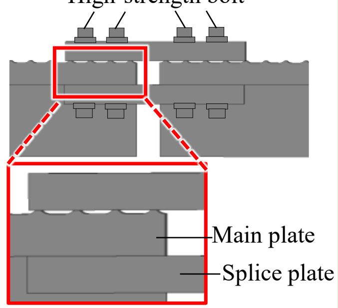


Fig.2
High Strength Bolted Frictional Joints with a One sided-projection on the Base Plate

METHOD

Four-point bending test of Deformed Flange H-beams

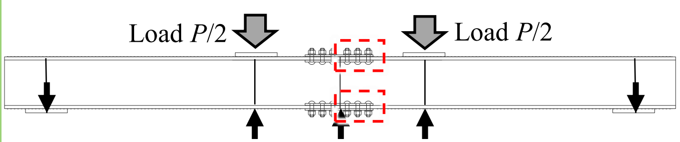
◆ Consideration items 1
Clarification of slip behavior under tensile force

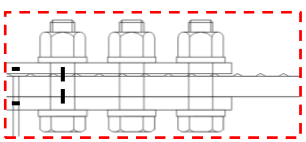
◆ Consideration items 2
Clarification of slip behavior under compressive force

◆ Consideration items 3
Effect of shape error of protrusions in the plate width direction on the slip behavior

Table1 Test cases

	presence or absence of protrusions	focus joint	number of specimens
M-1T	Absence	bottom flange (bottom side)	1
M-2T	Presence	bottom flange (bottom side)	2
M-1C	Absence	top flange (compression side)	1
M-2C	Presence	top side (compression side)	2





❙ : relative displacement
▬ : edge surface strain

Fig.2 Measured parameters

KEYWORDS

☐ High-strength bolted frictional joints ☐ Protuberance

RESULTS

◆ Consideration items 1

From Fig. 4, the relative displacement at the N side of M-2T was larger than at the H side under the same load. As shown in Fig. 5, slip at the N side halted load transfer there and increased load transfer to the H side, inducing slip at the H side and reducing bending strength of M-2T by up to 21% compared to M-1T. No nonlinearity in behavior due to N-side slip was observed, as shown in Fig. 7.

◆ Consideration items 2

For the compression side, similarly to the tension side, slip at the N side occurred early in the case with protrusions, leading to a 32% reduction in bending strength. The larger reduction on the compression side is likely due to the increased axial force reduction during loading, as shown in Fig. 6 and Table 2.

◆ Consideration items 3

As shown in Fig. 5, a difference in transmitted load was observed between edge surface 1 (M-2T-1-1) and edge surface 2 (M-2-1-2).

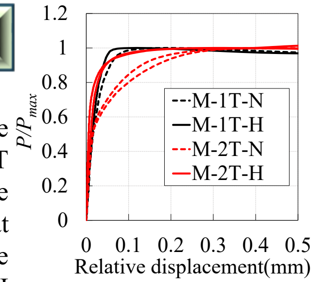


Fig.4 Load-relative displacement relationship

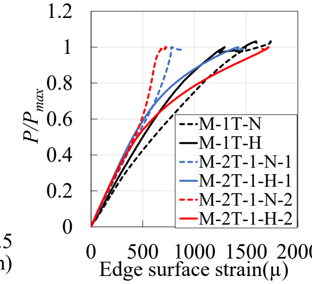


Fig.5 Load-edge surface strain relationship

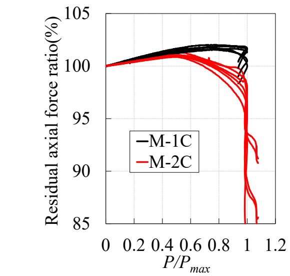


Fig.6 Load–residual axial force ratio relationship

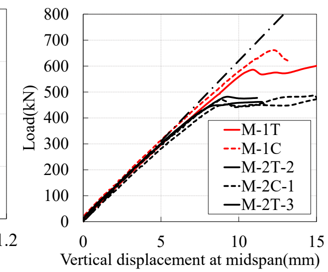


Fig.7 Load–midspan vertical displacement relationship

Table2 Summary of Test Results

	Axial force reduction ratio under loading (%)	Flexural Strength (kN)	slip coefficient ※
M-1T	5.5	586	0.56
M-1C	-1.1	662	0.66
M-2T-1	6.6	462	0.43
M-2T-2	6.3	482	0.44
M-2C-1	4.9	470	0.44
M-2C-2	4.2	452	0.41

※Define the bending strength as the slip load and calculate it

SUMMARY

I. In cases with protrusions, slip occurred earlier on the protrusion side, reducing the joint's bending strength compared to the no-protrusion case. However, no increase in local deflection or load reduction was observed.

II. When protrusions were present on the compression side, the decrease in bolt axial force was greater than on the tension side, leading to a larger reduction.

III. Shape errors of the protrusions in the plate width direction caused different slip behavior.