Experimental study on the ultimate strength and mechanism of stress transfer of column members reinforced by using cover plate

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Monotonic compression loading tests of column models focusing on arrangement of bolts

BACKGROUND

It is widely adopted to reinforce chord members in a steel truss bridge by using cover plates with high-strength blind bolts that can be constructed from one-side to improve the resistance of members as shown in **Fig.1**. However, regarding this reinforcement, it isn't clearly regulated by Japanese Specifications for Highway Bridges, and the mechanism of stress transfer between the base plate and the cover plate under the compression force isn't obvious enough.

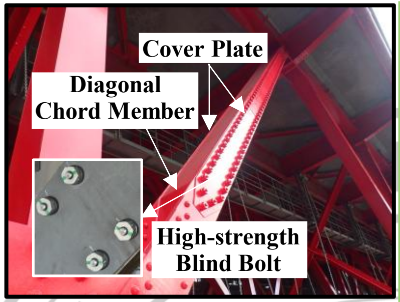


Fig. 1 Application of reinforcement using cover plate

In this study, it is defined that the required number of bolts to transmit the stress at the base plate to the cover plate and arrangement of bolts as the design conditions, carried out are static loading tests of box-section steel column members with reinforcement using cover plates subjected to a gradually increasing axial pure compression load. Then investigated are the ultimate strength, the mechanism of stress transfer between base and cover plates.

METHOD

Monotonic Compression Loading test

Due to confirm the validity of 2 arrangement types as shown in **Fig.2**, fabricated 2 types of specimens are in this experiment, the first one is the conventional arrangement of bolts (Type A), the second one is the arrangement of bolts based on the design policy (Type B).

End Section (Stress Transfer Area)

The section is where bolts are placed to transmit the stress at the base plate to the cover plate.

The number of bolts in the stress transfer area is calculated by using **Eqn. (1)**.

Intermediate Section

The section is where bolts are placed as a part of edge to enhance the degree of resistance between the base and the cover plate.

$$N_{req} = \sigma_y \times A_{cn} / \rho_a \quad \text{…Eqn.(1)}$$

Where σ_y is a yield stress, A_{cn} is a net cross-section area of a cover plate (=(b_c-d_c × 3) × t_c, ρ_a is an allowable force per friction surface of a M24 high-strength blind bolt (=41.6kN).

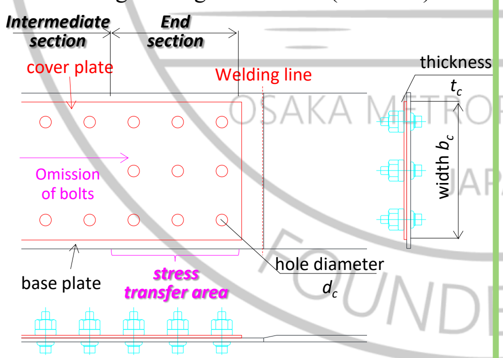


Fig. 2 Arrangement policy of bolts

KEYWORDS

- ☐ Compression force
- ☐ Mechanism of stress transfer
- ☐ Reinforcement using cover plate

RESULTS

Load vs. axial displacement

Fig. 3 shows the load-axial displacement curve at the top of the specimen. As shown in **Fig.3**, its relationship of Type A corresponds with its relationship of Type B. The ultimate strength of Type A is 3,841 kN and its load of Type B is 3,845 kN, the two values are equivalent. However, both relationships became non-linear at nearly P/P_{by} = 0.3.

→ the load-axial displacement relationship isn't influenced by the arrangement of bolts after stress transfer area.

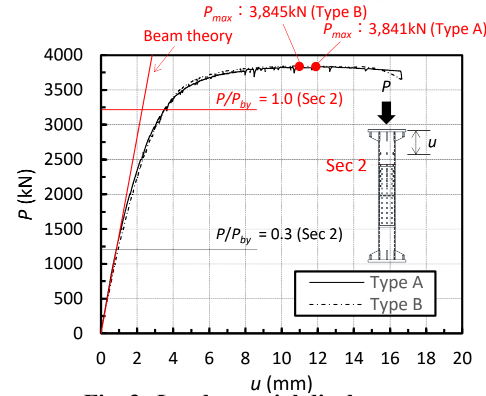


Fig. 3 Load vs. axial displacement

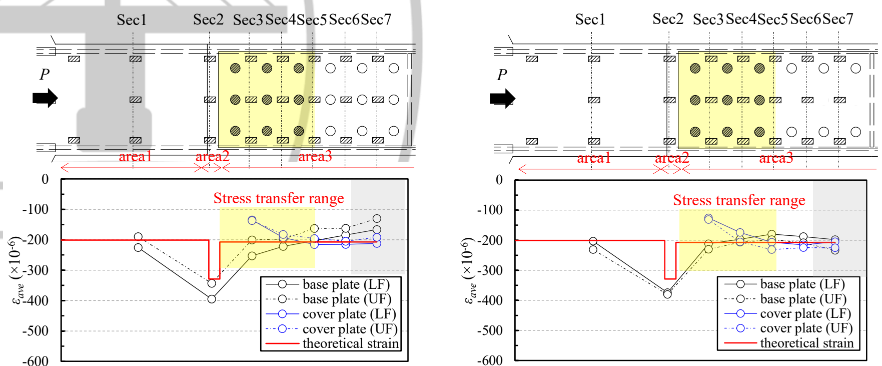
Mechanism of stress transfer

Fig.4 shows the strain values of cross-section at the load level (P/P_{by}=0.2). As shown in **Fig.4**, it can be confirmed that the flange's and cover plate's strains tend to be constant.

→ It isn't confirmed that there is significant difference in the strain distribution between Type A and Type B.

What is P_{by} ?

P_{by} is the design resistance of Sec 2 calculated based on mechanical properties (=3,245kN).



(a) Type A (b) Type B

Fig. 4 The strain values of cross-section at the load level "P/P_{by}=0.2"

SUMMARY

Because the influence on the arrangement of bolts can't be investigated as noted in *RESULTS*, it can be suggested that the area where the required number of bolts calculated by **Eqn. (1)** is sufficient for the stress transfer area. Therefore, it can be possible to omit the number of bolts after the stress transfer area.