Analytical Study on Reinforcement Effect of High-Strength Bolted Frictional Patch Plate Joints for Steel I-Girders Web Panel Focusing on Cross-Section and Slip Span

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The influence of the girder and angle section geometries, as well as the slip range, on the length of the transition region was clarified.

BACKGROUND

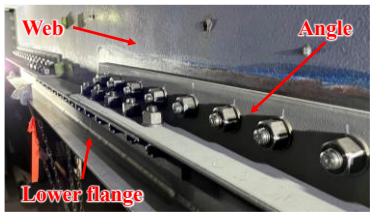

Fig.1 Example of reinforcement by bolt

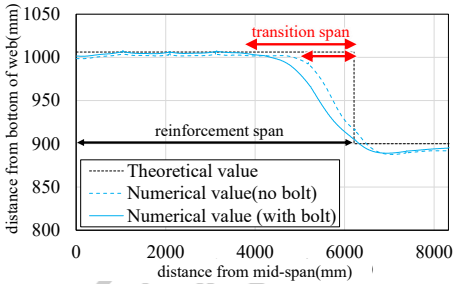

Fig.2 neutral axis

1. As show in Fig.1, when angle sections are attached to the web panel, there exists transition span where the neutral axis position and axial stress deviate from theoretical values.
2. As show in Fig.2, modeling the bolts with friction revealed that slip occurs at the bolt positions near the ends of the angle sections due to local changes in cross-section between the reinforced and unreinforced span, resulting in an extended transition span.

METHOD

FEA

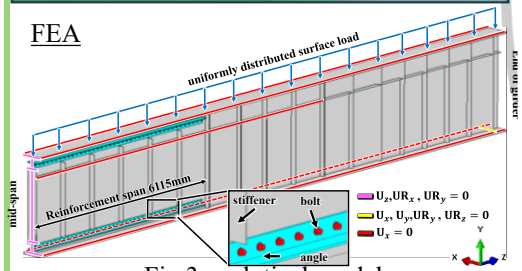

Fig.3 analytical model

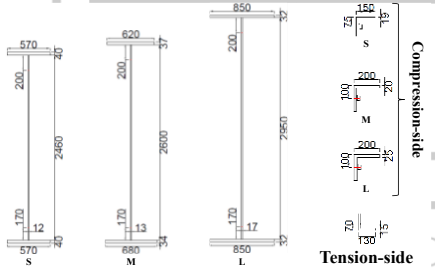

Fig.4 analytical case

- As show in Fig.3, half-span model of longitudinally symmetric I-girder was developed.
- As show in Fig.4, four angle sections were installed on both sides of the web at mid-span using M22 high-strength.
- parameters include the presence or absence of bolt modeling, three types of girder and angle cross-sections, resulting in a total of 18 cases.

KEYWORDS

patch plate transition span cross-section

RESULTS

- As show in Fig.5, the distance required for the axial stress ratio(analytical / theoretical) in angle section to converge to approximately 1.00, as well as the slip span, was found to be longer on the compression-side angle than on the tension-side one.
- As show in Fig.6, transition span of axial stress ratio in the angle section extended beyond that of the neutral axis shift.
- Effect of slip varied with the cross-sectional properties, resulting in the transition span increasing by up to approximately 1.6 times

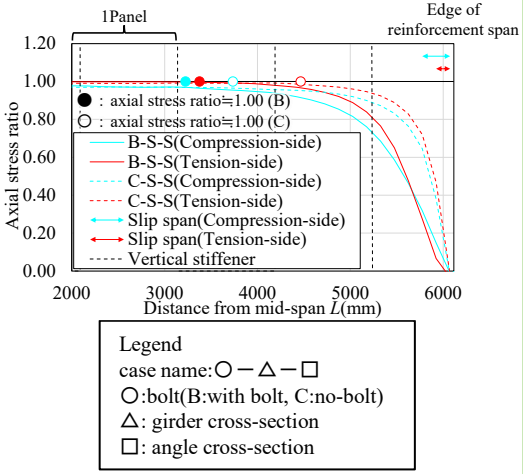

Fig.5 axial stress ratio

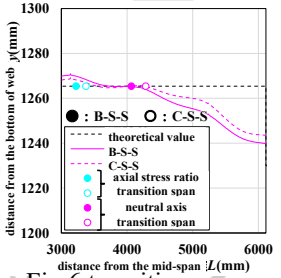

Fig.6 transition span

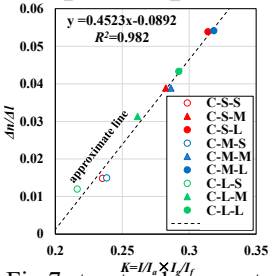

Fig.7 structural parameter K

- As shown in Fig. 7, there is a strong correlation between the cross-sectional properties and the neutral axis difference(reinforced – unreinforced) / transition span.

Δn : Difference in the theoretical neutral axis position between the reinforced and non-reinforced sections
I : Second moment* of area of the entire reinforced section
I_a : Second moment* of area of the angle section
I_g : Second moment* of area of the girder section only
I_f : Second moment* of area of the flange
*Second moment of area about the neutral axis after reinforcement

SUMMARY

- Larger cross-sections of angle sections resulted in a longer slip span and transition span. Additionally, transition span may increase by up to approximately 1.6 times due to slip.
- It is preferable to define the transition span of the axial stress ratio in angle sections as the transition span of the reinforced cross-section.
- A structural parameter was identified that enables evaluation of the transition span excluding the effect of slip.