Mechanical Behavior of Assembled Deck Plates for Temporary Bridges Under Medium-Term to Long-Term Service

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How Does Eccentric Loading Affect PJP-Welded Deck Plates: Deflection and Reaction Forces?

BACKGROUND

Temporary bridges, originally designed for short-term use, are increasingly being utilized for medium-term to long-term service due to prolonged bridge rehabilitation and disaster recovery projects. However, knowledge regarding their structural performance and durability has not yet been fully accumulated.

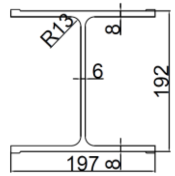

Fig. 1 Checkered H-beam section(mm)

This study focuses on deck plates composed of five checkered H-beams connected in parallel by partial joint penetration (PJP) welds. Although this structure directly supports vehicular loads, its mechanical behavior remains not fully understood. Therefore, this study aims to clarify its fundamental structural responses.

This introduces numerical analysis results to clarify the influence of loading positions on deflection and reaction force distribution using finite element analysis.

Fig. 2 Deck Plate

METHOD

Analysis Solver: Abaqus/Standard 2023

Analysis Cases: Combinations of loading positions (as shown in **Fig.3**)

Load: 140 kN wheel load
(T-load, impact coefficient 0.4)

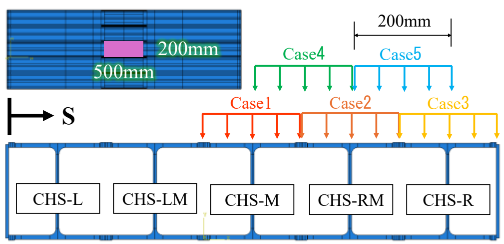

Fig. 3 Analysis Cases

Element Type: Reduced-integration solid elements with 8-nodes

Meshing: Fine meshes are applied to grasp local behavior around the weld joints and loading positions.

Flange thickness: 3 divisions
Vicinity of loading position: 10 divisions

Welding Interface: Considering the characteristics of partial joint penetration (PJP) welds.

Welded zones: Tie constraint
Unwelded zones: Contact (μ=0.01)

KEYWORDS

☐ Deck Plate, Reaction Force Distribution, PJP welding

RESULTS

Deflection Characteristics

Deflection increases as the loading position moves from the center to the end. Specifically, Case 5 (loading directly above the end-joint weld) records a maximum displacement of 5.02 mm, a 46% increase compared to the center-loading cases.

This is attributed to the lack of load distribution when loading at the ends and the high displacement gradient at the weld boundary.

Reaction Force Distribution Ratio

The member directly loaded bears 60% to 85% of the total reaction force regard less of loading positions. Distribution ratio of members two or more rows away was extremely limited, at less than 8%. In Case 3, the member “CHS-R” bears 85.3% of the loaded.

This unevenness distribution promotes additional bending deformation in the member directly under the load, which is a primary factor increasing the maximum displacement.

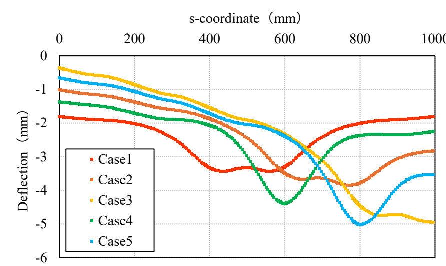

Fig. 4 Deflection distribution

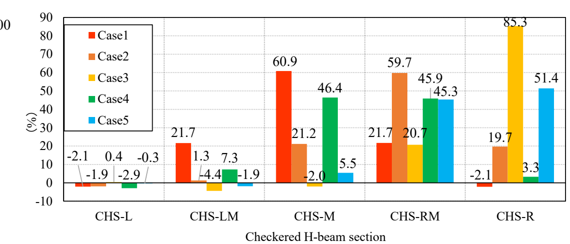

Fig. 5 Reaction Force Distribution Ratio

SUMMARY

- Maximum vertical displacement and reaction force distribution depend heavily on loading position.
- Loading the end-joint-result in unevenness reaction force distribution to adjacent beams result in significant and localized deflection and localized deformation.