Structural Performance and Design Method for GFRP Inspection Walkway Bracket Bases

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Clarifying the Influence of Structural Parameters on the Behavior of Bracket Bases for Rational Design

BACKGROUND

In areas with severe corrosive environments, corrosion of bridge inspection walkways has become a significant issue (Fig. 1).

Fig. 1 Example of corrosion in inspection walkways *)

Fig. 2 Application example of GFRP inspection walkway *)

*) Miyaji Engineering Ltd.,: FRP inspection walkways

Therefore, GFRP inspection walkways (Fig. 2) are applied.

Although the pull-out force governs design its estimation method may be inappropriate. In addition, the analytical slip moment was 3 times the design value, indicating the current design method has room for improvement.

Objective Proposing the more rational bracket base joint structures

METHOD

1. Experimental Method and Parameters

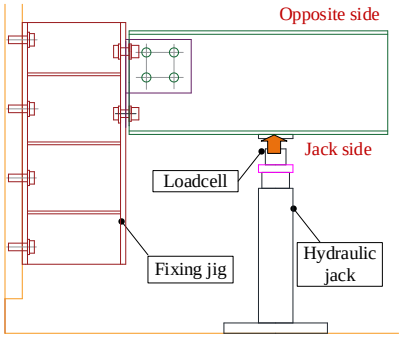


Fig. 3 Overall view of specimen setup

Friction-type joint Tension-type joint

F(ax205-h250)-T(b4-h250)-R10-G300

- h_g (300 or 200 mm)
- r (10 or 20 mm)
- h_t (250 or 150 mm)
- Number of bolts (4 or 8)
- Bolt axial force (205 or 85kN)

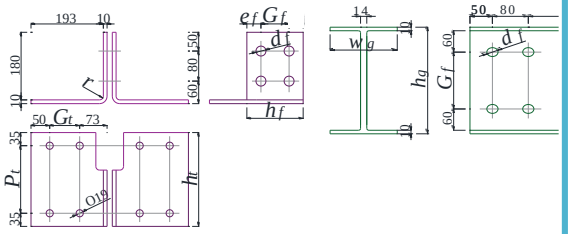


Fig. 4 Overall view of specimen setup

2. Viewpoints

- Bolt pre-tension reduction in frictional bolted joints
- Variation of pull-out force and comparison with design values
- Load-displacement relationship at the loading point

KEYWORDS

GFRP bracket, Pull-out force, CFS(Cold-Formed Steel) geometry

RESULTS

1. Reduction rate of bolt axial force

- Bolt axial force reduction (≈ 1 week) : 16%
- Similar reduction trend to previous single-row arrangement, even in bolt group configuration

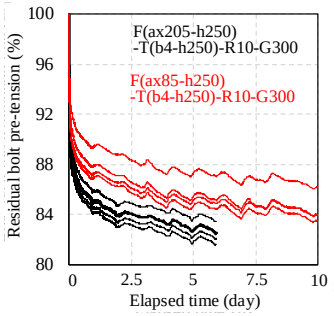
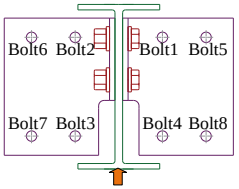


Fig. 5 Residual bolt pre-tension

2. Pull-out force

- The pull-out force of F(h150) exceeds the design value at the design load due to differences between assumed and actual CFS load-resisting positions

Bolt position



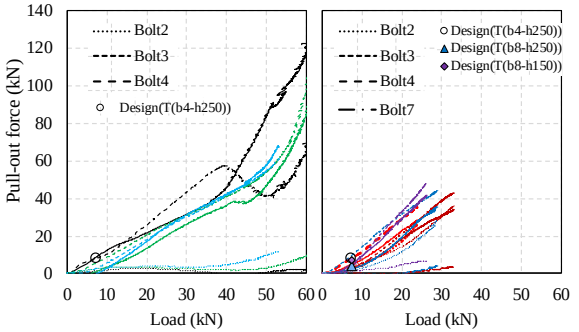


Fig. 6 Pull-out force

3. Load-disp. relationship

- Behavior of both side (Opposite and Jack side (Fig.3)) is generally consist → GFRP deformation is negligible
- Effect of CFS height on stiffness is smaller than predicted by theory (Tab.1)
  →Different rotation centers: F(h250) resists mainly with 2 bolts, while F(h150) distributes load over 4 bolts (Fig.6), reducing CFS deformation

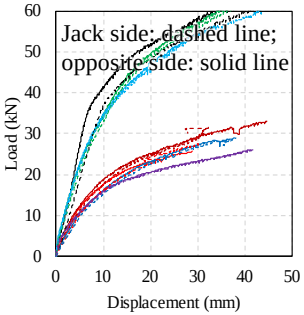


Fig. 7 Load-disp. relationship

Tab.1 Comparison of stiffness

	$\frac{k_{Theo.F(h)}}{k_{Theo.F(h150)}}$	$\frac{k_{Exp.F(h)}}{k_{Exp.F(h150)}}$
F(h150)	1	1
F(h250)	4.6	2.2

- F(ax205-h250)-T(b4-h250)-R10-G300
- F(ax205-h250)-(Tb4-h250)-R20-G300
- F(ax85-h250)-(Tb4-h250)-R10-G300
- F(ax205-h150)-(Tb4-h250)-R10-G300
- F(ax205-h150)-T(b8-h250)-R10-G300
- F(ax205-h150)-(Tb8-h250)-R10-G200
- F(ax205-h150)-(Tb8-h150)-R10-G300

SUMMARY

1. Height of the friction-jointed region of the CFS strongly influences the stiffness due to increased flexural rigidity and reduced separation at the bent region.
2. Specimens with different friction joint heights showed larger pull-out forces than design values, assuming the CFS neutral axis acts as the rotation center.