# Analytical Study on Shear Resisting Mechanism of Headed Studs in Push-Out Testing Considering Thin Mortar Layer

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## Collapse Mechanism and Estimation of Shear force per stud Considering Thin mortar layer thickness

## BACKGROUND

RC decks, which are one of the superstructures of steel bridges, are replaced when they are severely damaged. When using PCaPC slabs during replacement, a box cutout is made and headed studs are used to prevent slippage with the existing steel girders. As shown in the **Fig.1**, a thin mortar layer is used to adjust the height to avoid interference between the bolts and splice plates on the steel girders and the PCaPC slabs.

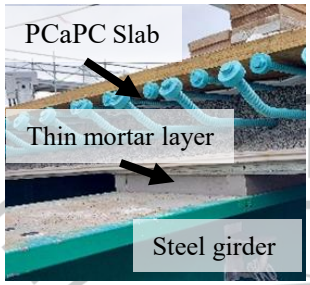


**Fig. 1 Slab replacement status**

However, the current stud design shear strength formula does not take into account the effects of thin mortar layer, a structural detail specific to deck replacement, and there is a demand for the proposal of a stud design shear strength formula that can be applied when replacing slabs.

Purpose **Proposal for shear strength formula for studs applied to slab replacement**

## METHOD

***1.Collapse mechanism in push-out tests considering thin mortar layer***

FE analysis was conducted to understand the cracking and stress properties inside the test specimen, which could not be obtained by push-out testing.

***2. Evaluation of the effect of Thin mortar layer thickness on Shear force per stud***

- ✓ Relationship between stud shear force per stud and relative displacement between H-beam and concrete block
- ✓ Relationship between Thin mortar layer thickness and Shear force per stud at serviceability/ ultimate limit state

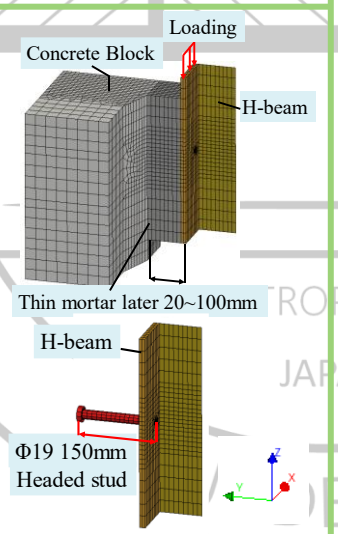


**Fig. 2 1/4FE model**

## KEYWORDS

Thin mortar layer Collapse mechanism Shear force per stud

## RESULTS

***1.Collapse mechanism***

- ➢ Cracks in thin mortar layers develop in the following order:

(1) Initial cracking at the stud base and at the boundary between the mortar layer and the thin mortar layer and the box-cutout;

(2) As the load is applied, the initial cracks are connected in the thickness direction, which reduces the misalignment stiffness;

(3) Cracking damage becomes more pronounced, which reduces the restraint force at the stud base.

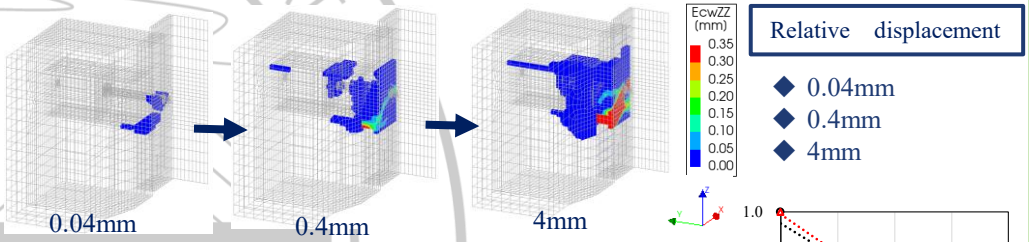


**Fig. 3 Crack development**

***2. Estimation of Shear force per stud Considering Thin mortar layer thickness***

- ➢ There is a strong linear correlation between mortar thickness and reduction ratio at the serviceability/ ultimate limit state
- ➢ The slope of the reduction ratio between the analytical and experimental values is similar.

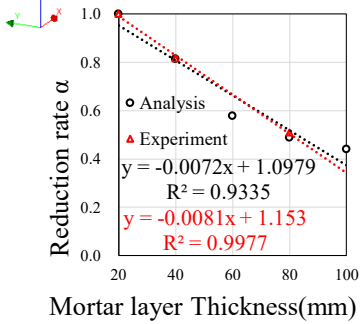


**Fig. 4 Comparison of the slope of the reduction rate between experiment and analysis (serviceability limit state)**

## SUMMARY

- ✓ Collapse mechanism was clarified based on the crack propagation in Thin mortar layer.
- ✓ Crack initiation is caused by the discontinuity between the fill mortar and the concrete block.
- ✓ The push-out testing specimens considering thin mortar layer can be evaluated based on the stud shear force per stud based on the minimum mortar layer thickness of 20 mm.