

# Analytical Study on Methods for Crack Suppression in push-out Specimens with Thin-Layer Mortar

Osaka Metropolitan University Graduate School of Engineering  
Bridge Engineering Lab Otoy Narazaki



## - A Tapered-Base Approach for Crack Suppression and Capacity Enhancement -

### BACKGROUND

When using PCa-PC slabs in deck replacement work, headed studs are used at block-out parts to prevent misalignment with the existing steel girders. A thin layer of mortar is used to adjust the height to avoid interference between the PCa-PC slabs and bolt heads or splices. Our previous studies revealed that **cracks in thin-layer mortar reduce the shear resisting performance of the studs**. However, it has also been known that increasing compressive and tensile strengths of mortar can suppress cracks.

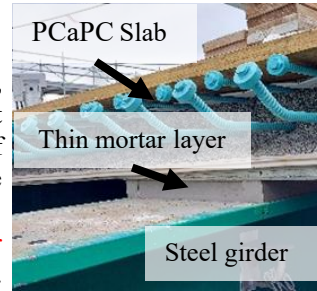


Fig. 1 Slab replacement status

### Purpose

Exploration of a crack suppression method based on block-out slab shape modification

### METHOD

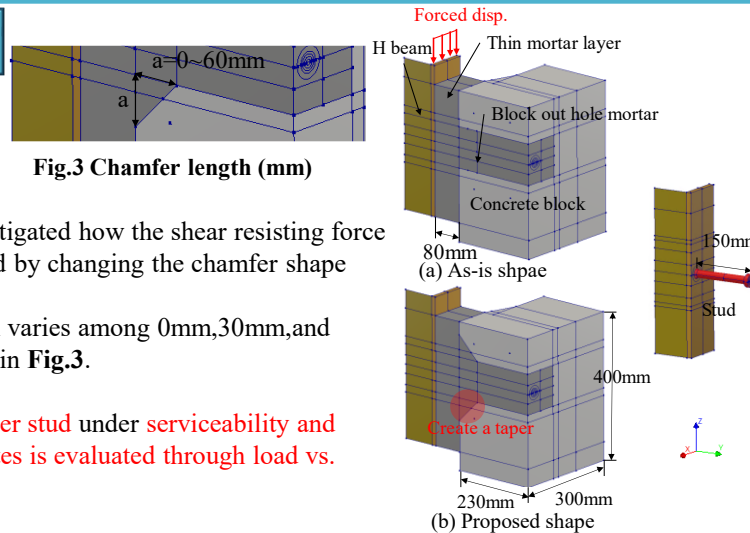


Fig. 2 3D-FEM model

- ✓ **FE analysis** investigated how the shear resisting force can be maintained by changing the chamfer shape
- ✓ C-chamfer length varies among 0mm, 30mm, and 60mm, as shown in Fig.3.
- ✓ The **shear force per stud** under **serviceability and ultimate limit states** is evaluated through **load vs. displacement**.

Fig.3 Chamfer length (mm)

### KEYWORDS

□ shear force per stud, crack suppression, shape modification

### RESULTS

#### □ Initial stiffness remained unaffected

The initial stiffness up to the Initial shear force was approximately constant (approx. 300 kN/mm) regardless of the taper length (Fig.4)

#### □ Significant increase in shear capacity

The Initial shear and maximum load significantly increased by up to 2.00 times and 1.92 times, respectively (for  $a=60$ ), compared to the as is model ( $a=0$ ). (Fig.4)

#### □ Delay in crack penetration

The taper increased the distance between the stud base and the mortar boundary, effectively delaying the penetration of cracks. (Fig.5)

#### □ Expansion of compressive struts

Compressive stress area expanded with increasing  $a$ , widening the compressive strut from the stud base, which maintained stud's shear resisting force.

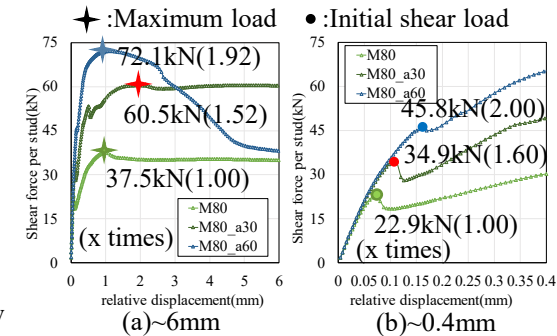


Fig. 4 Load-displacement relationship

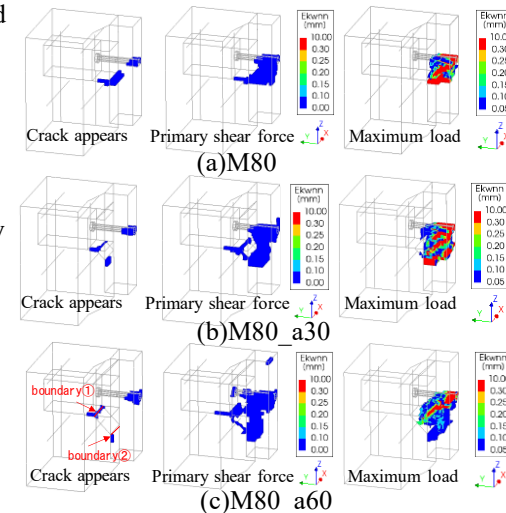


Fig. 5 Crack Progression Diagram

### SUMMARY

**Comprehensive performance improvement:** Providing a taper maintains the initial stiffness (approx. 300 kN/mm) while significantly increasing the shear capacity (up to 2.00x for primary shear force and 1.92x for maximum load) **by expanding the compressive strut area and delaying crack penetration.**