PUSH-OFF TEST OF LOOP BAR SHEAR CONNECTORS OF PRECAST CONCRETE WALLS

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1. INTRODUCTION

In Thailand, precast concrete wall structural systems are gaining significant traction in the construction industry. A comprehensive examination of Bangkok and its peripheral regions revealed a strong preference among engineers to use this structural system when building medium-rise residential buildings. One of the prevalent vertical connection types of precast concrete walls is known as a loop bar joint [1-3]. This type of joint provides simplicity in the construction and installation process and is widely used in Thailand.

Presently, Thailand has established design standards for precast wall systems, with a primary focus on vertical load-bearing capacity and resistance to wind forces. While most research typically emphasizes the study of developing joint configurations of the precast wall systems to enhance their seismic resistance [4-6], the understanding of the behavior of existing buildings using the precast wall systems and those to be constructed remains relatively underexplored.

2. METHODOLOGY

Six vertical loop bar joint specimens with different joint configurations were tested. The specimens were divided into two groups as per the joint face configuration (Table 1). For the first group (Loop bar, L), a 1-RB6 loop bar, a 2-RB6 loop bar, and a 1-wire rope were used as transverse joint reinforcement with a plane joint face. The second group (Loop bar + Shear key, LS) had transverse joint reinforcement detailing the same as the first group but had a shear key on the joint face, as shown in Figure 1. The test setup used in the present study was a push-off test which conducted of single shear type (Figure 2). The shear force, panel deformation, shear deformation of the joint, and strain in the transverse reinforcements were recorded.

Table 1. Overview of test specimens

Specimen Group	Specimen Designation	Transverse joint reinforcement
Loop bar	L-1-R6	1-RB 6 mm
	L-2-R6	2-RB 6 mm
	L-1-W5	1-wire rope 5 mm
Loop bar + Shear key	LS-1-R6	1-RB 6 mm
	LS-2-R6	2-RB 6 mm
	LS-1-W5	1-wire rope 5 mm

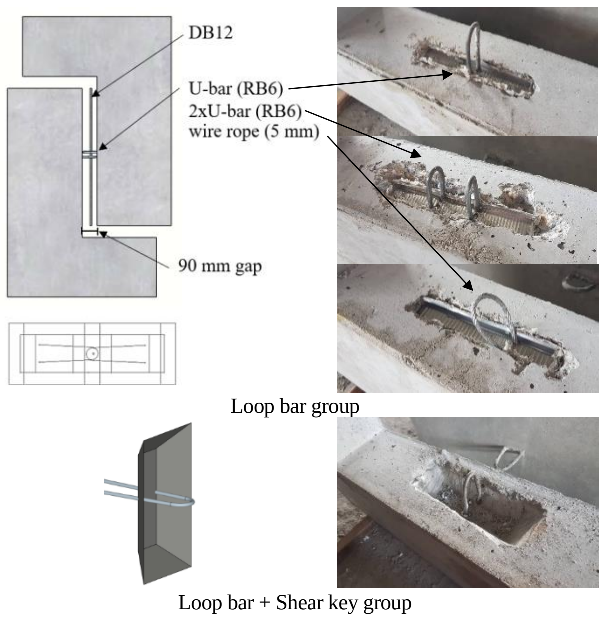


Figure 1. The joint face configuration

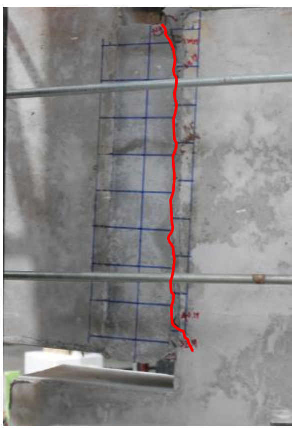
Figure 2. Push-off test setup configuration.

3. RESULTS

The shear strength of the vertical joints of precast reinforced concrete was illustrated, as shown in Table 2. For the loop bar group, the ultimate load capacity of the connection significantly increased from 43 kN to 82 kN when the number of RB 6 mm loop bars increased from 1 to 2. However, the cracking load is not different at 32 kN. The L-1-W5 specimen, where the wire rope was used as the transverse reinforcement, had the lowest cracking load and ultimate load. The shear key increased the joint shear strength, as seen in the specimens in the LS group. The shear key has an obvious effect on the cracking load. In LS-1-R6 and LS-2-R6 specimens, where the transverse reinforcement was RB 6 mm loop bars, the cracking load increased up to 200% compared with those of the L group specimens. Furthermore, the cracking load increased up to 400% in LS-1-W5. The joint failure mode changed from shear slip to diagonal crack when a shear key was added to the joint face, as shown in Figure 3. The interesting point was found in the failure mode of L-2-R6, which was shear slip and diagonal crack, while L-1-R6 was shear slip. Consequently, increasing the RB 6 mm loop bar from 1 to 2 can significantly improve the shear strength of the vertical plane joints of precast reinforced concrete.

Table 2. Failure mode and direct shear strength of vertical connections

Specimen	Failure mode	Cracking Load (kN)	Ultimate Load (kN)
L-1-R6	Shear slip	32.33	43.83
L-2-R6	Shear slip and Diagonal crack	32.00	82.16
L-1-W5	Shear slip	11.00	32.17
LS-1-R6	Diagonal crack	63.00	63.00
LS-2-R6	Diagonal crack	61.66	98.00
LS-1-W5	Diagonal crack	44.17	56.17


Shear slip


Diagonal crack

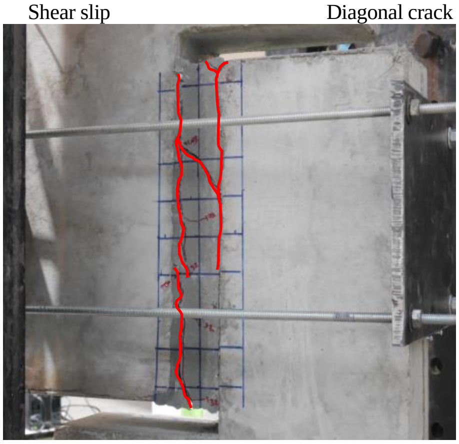

Shear slip and Diagonal crack (L-2-R6))

Figure 3. Failure mode

4. CONCLUSIONS

The direct shear performance of six vertical joints of precast reinforced concrete specimens was studied through the implementation of push-off tests. The specimen was divided into two groups, namely the loop bar group and the loop bar with shear keys group. The direct shear capacity of the joint was recorded, and the failure mode was observed. The following conclusions were drawn from this study:

- Increasing the number of RB 6 mm loop bars from 1 to 2 results in an increase in the shear strength of the vertical plane joints, but it does not enhance the inhibitory effect on the development of shear cracks.
- Adding shear keys significantly increases the shear strength and cracking strength of the RB 6 mm loop bar connections by 45% and 95%, respectively.
- The joint failure mode changes from shear slip to diagonal crack when adding shear keys to the joint face.
- When switching from RB 6 mm to 5 mm wire rope for the loop joints, the shear capacity of the joints dropped dramatically.

5. REFERENCE

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