Exfoliation prevention functions of outer walls with tile finishing on reinforced concrete building during earthquakes

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(Keywords) Outer walls with tile finishing, exfoliation prevention functions, earthquake-proof safety, large size specimen

1. Foreword

Examinations into damages caused by earthquake vibrations, such as the exfoliation of tile finishing have been ongoing since last year. This year, a horizontal pressing experiment was conducted on a wet process reinforced concrete construction wall specimen to investigate among various structures with tile finishing; exfoliation resistance against large shear deformations, many existing buildings with tile finishing over mortar beddings, the rapidly widespread use of mortar in direct tension and organic adhesives. These were the results we acquired.

2. Experiment overview

Five reinforced concrete wall specimens were created with pillars and beams, of which each wall surface was constructed using one of the eight tile constructions shown in Table 1. For the two test bodies No.1 and No3, one surface was of tile finishing, while its reverse side was used to observe damage to the concrete. For test bodies No.2, No.4, and No.5, tile finishing was arranged on both sides, with one side featuring a standard joint filled with mortar, and the other in a deep joint construction without filling. The 50mm×100mm mosaic tiles that were used were positioned in the same pattern on both sides. The lower part of the concrete was fixed and pressure was statically applied alternately on the upper part of the beam. As the drift angle of the apex interlayer was controlled, cracking and tile detachment/exfoliation was observed until the concrete fractured.

3. Results and conclusion

Photos 1 to 3 show the state of: the concrete at a drift angle of 1/100 (Photo 1), a standard joint with mortar in direct tension and organic adhesives (Photo 2) and a standard joint and deep joint construction with a two-level mortar base tile finishing (Photo 3). Cracking consistent to that of the concrete occurred on tile finishing grounded in mortar, however, with adhesives, cracks were centered on the joints and hardly noticeable on the tiles. As well, on two-level mortar bases in both standard and deep joints, cracking began at a drift angle of 1/1600 and exfoliation began to occur at a deformation angle of 1/250. Furthermore, all detachments occurred on the boundary surfaces of the tile and bonding mortar. Exfoliation occurred mostly on deep joint constructions, reinforcing the known risks of exfoliation with regards to deep joints. Cracking was observed at a drift angle of 1/1600 for both adhesive and direct joints. However, exfoliation did not occur until there was damage to the concrete at 1/100 for adhesives, and was not observed for direct joints until there was considerable deformation at 1/200. In the future, using small test bodies, we will consider conducting simple test methods to evaluate the seismic safety of tile finishing construction methods.

Table 1: Tile finishing construction method

№	Joint	Finishing construction
1	Standard	Uneven adjustment mortar + organic adhesives
	—	None
2	Standard	Organic adhesives (common name adhesive joint)
	Deep	Organic adhesives (common name adhesive joint)
3	Standard	Thickly applied 5cm premixed mortar foundation
	—	None
4	Standard	Mortar in direct tension (common name: direct joint)
	Deep	Mortar in direct tension (common name: direct joint)
5	Standard	2 layer mortar coating foundation
	Deep	2 layer mortar coating foundation

(Drift angle 1/100)

Photo 1: Concrete

(Standard joint/organic adhesives)

(Standard joint/mortar in direct tension)

Photo 2: Drift angle 1/100

(Standard joint)

(Deep joint)

Photo 3: Drift angle 1/100 two-level mortar base tile finishing