PP-BAND RETROFITTING ASSESSMENT
- Double Storey RC Roof Masonry House -
PP-バンド耐震補強法の効果の検証
－二階建てRC屋根付き組積造住宅－

Objective

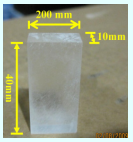
To investigate applicability and effect of PP-band retrofit method to double storey masonry houses with RC roof by shake table test using scaled model.

Test Setup and Loading Condition

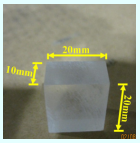
Two 1/12 scaled double storey models were prepared for shake table test. One was non-retrofitted and the other was retrofitted with PP-band meshes. The nominal dimensions of those model houses were 290mm length by 290mm width by 500mm height including thicknesses of the slabs.

For the construction of these masonry model, two sizes of the acryl blocks, 40 x 20 x 10mm^3 and 20 x 20 x 10mm^3, were used. As the surface of the acryl block was very smooth and could not provide sufficient friction, sandpaper was attached to provide required friction. By friction and shear test, sandpaper of Grit#80 was found the most appropriate. After the various trials of shear test with different mixture ratios of mortars, the mortar with mixture ratio of Cement: Lime: Sand: Water = 1:8:30:10 [by weight] were finally selected. PP-band meshes were prepared with PP-band of cross sectional area of approximately 1mm width by 0.3mm thick. The PP-bands were placed at a pitch of 20mm center to center and connected by welder.

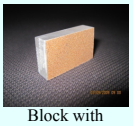
The sinusoidal motion of two amplitudes, 5 and 15mm, with frequencies from 2 to 6 Hz were applied to the shake table. The duration of motion of each frequency applied was 30 Sec.

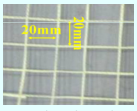


Full acryl block



Half acryl block


Block with Sandpaper

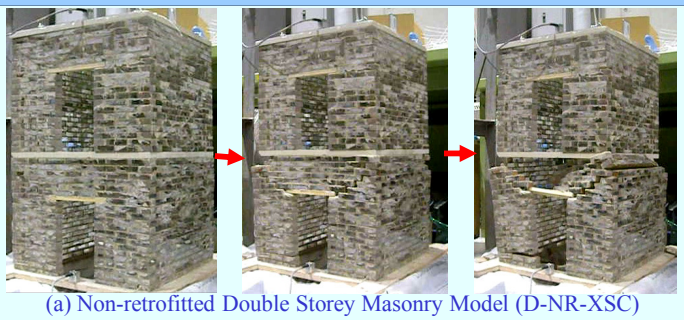


PP-band mesh

Input motion used

Amplitude (mm)	Frequency (Hz)				
5	2	3	4	5	6
15	2	3	4	5	6

Failure Patterns

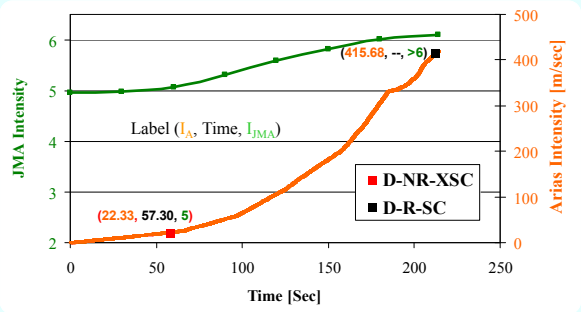

(a) Non-retrofitted Double Storey Masonry Model (D-NR-XSC)


(b) PP-band Retrofitted Double Storey Masonry Model (D-R-SC)

Shake Table Test Results

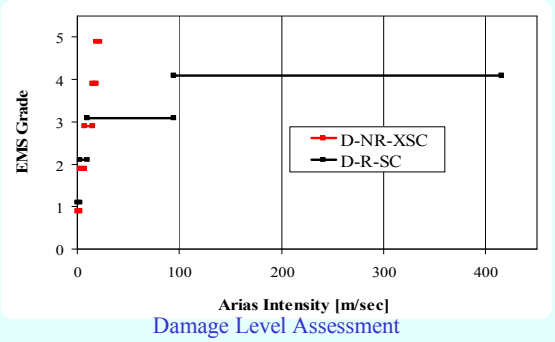
The above photos show the non-retrofitted and retrofitted double storey masonry house models from start to end of the test. In the non-retrofitted case, the first storey walls showed shear cracks as well as bending cracks along with sliding of the second storey as one unit. While in the retrofitted case, although PP-band mesh influence was not observed before initial cracking, after this occurred, crack propagation was prevented due to PP-band and the whole model behaved as one unit under the dynamic load.

Result and Discussion



Comparison of Seismic Capacity

Non-retrofitted model performed well and it did not show any considerable damage until the input acceleration was below 141 gal [I_{JMA} <5]. But when the acceleration was raised to 300 gal, the specimen collapsed suddenly. The Arias Intensity (I_A) at collapse point was recorded 22.33m/sec. On the other hand, retrofitted model behaved as one unit through out the shake table test and it did not collapse even a strong input motion of 1,200 gal was applied and Arias Intensity (I_A) was 415.88m/sec. PP-band retrofitted masonry model showed almost 4 and 18 times greater seismic capacity than the non-retrofitted one in terms of ground acceleration and arias intensity, respectively.



Damage Level Assessment

The above graph shows the damage levels of the masonry house models using European Macro-seismic Scale [EMS] Grades. Both models, non-retrofitted and retrofitted, showed almost the same damage level before occurrence of considerable cracks but after that PP-band became effective in retrofitted model and complete collapse of structure was thwarted. It is important to note that double storey masonry model did not collapse completely and minor distortion of walls occurred at an input acceleration of 1,200gal. Maximum lateral displacement recorded at the second storey slab level was 8.31 and 41.88mm, for non-retrofitted and retrofitted models, respectively.

要約

本研究では，床や屋根に鉄筋コンクリート床版（ＲＣスラブ）を用いた2階建組積造建物へのＰＰバンド補強法の適用性とその効果を検証するために，1/12スケールの縮小建物モデルを用いた振動台実験を行った．振動外力としては，振幅と周波数の異なる10種類（振幅：0.5，1.5cm，振動数：2,3,4,5,6Hz）の水平1方向の正弦波（各30秒間）を用いた．振幅0.5cm周波数6Hzから周波数を低下させ，次に振幅を1.5cmにして同様に周波数を低下させた入力を行い，各段階での被害の様子を観測した．実験結果からは，ＰＰバンド補強建物は，非補強建物に比べて，入力加速度で4倍，エネルギー吸収能力で18倍の性能の向上がはかられた．同じ振動外力に対する被害程度をEMS基準（ヨーロッパ被害評価基準）で比較すると，被害程度が軽微なEMS2までは両者で差はないが、EMS3からはPPバンド補強建物は被害の進展が各段に遅くなり，顕著な耐震補強効果が確認された．

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