Seismic Capacity Evaluation of URM Infill Built in RC Frame
Part 1: Outline of Experiment

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URM Infill RC Frame
Seismic Capacity Evaluation Cyclic Test
Turkish Building

1. Introduction

The authors have studied the in-plane seismic performance of unreinforced masonry (URM) infilled RC frames, and investigated the failure mechanism forming a diagonal strut in the walls. They discussed a simple approach to evaluate the lateral resistances of infill walls [1, 2].

The objectives of this study are to clarify the in-plane and out-of-plane behavior of URM infill, and to propose a reinforcing system to prevent the infill from the out-of-plane failure. Parts 1 to 3 of this paper report a series of in-plane cyclic static tests on five specimens and their results, particularly the shear strengths.

2. Experimental Program

2.1 Prototype Building and Scaled Specimens

To improve the seismic performance of URM infill walls, a research project was initiated in collaboration between European and Japanese universities, under JST Concert-Japan project. A building in Turkey was selected as a reference building and 1/4-scale models were prepared. Figure 1 shows the outline of the reference building. The building is a 5-story RC building in Turkey, with the plan dimensions of 23m by 16m and each story height of 3m. As shown in Figure 1, the interior middle frame in the longitudinal direction in the first story was focused in this research. The 1/4-scale models included Bare Frame (BF) and infilled frames: 1-Bay 1-Story with Horizontally stacked blocks (1B-1S-H), 1-Bay 1-Story with Vertically stacked blocks (1B-1S-V), 2-Bay 1-Story with Horizontally stacked blocks (2B-1S-H) and 1-Bay 2-Story with Horizontally stacked blocks (1B-2S-H), as shown in Figure 2.

Figure 3 shows the cross-sectional details of the column and beam of the specimens. The area ratios of longitudinal reinforcement and shear reinforcement to the cross-sectional area were designed to be approximately equal to those of the reference building. The upper beam with a T-shape section, considering an effective slab width, was designed to fail in flexure, where the shear-to-flexural strength ratio (Q_{SU} / Q_{MU}) and the flexural stiffness were equivalent to those of the reference building. The concrete block (CB) unit was also scaled by 1/4. The cement-to-sand ratio was adjusted so that the strength and stiffness of three layered CB prism specimens corresponded to those of the full-scale.

2.2 Material Characteristics

Table 1 through Table 3 show the material test results, where the values present the mean value of 3 samples from each test. Although the design compressive strength of concrete was 18 N/mm^2, the value of test cylinders exceeded it, as shown in Table 1. The yield stresses of reinforcements showed higher values by 35% than the nominal yield stress, as shown in Table 3. The compressive strength and Young's modulus from the three layered CB prism tests were 6.7 N/mm^2 and 9.6×10^3 N/mm^2, respectively, as shown in Table 2. The results obtained from the material tests were used in estimating the section capacities.

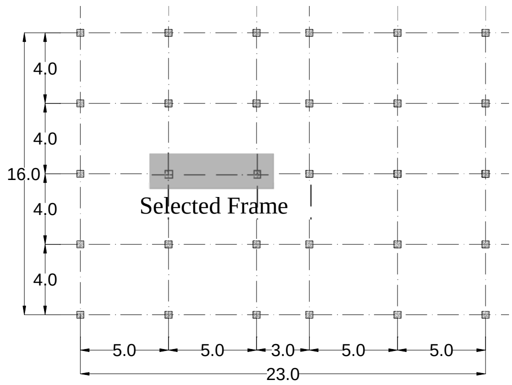

Figure 1. Outline of the reference building

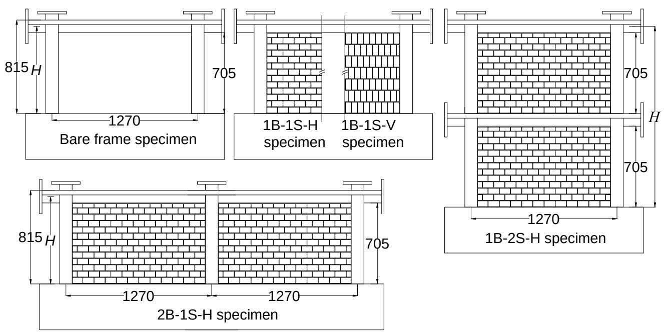

Figure 2. Elevations of the specimens (unit: mm)

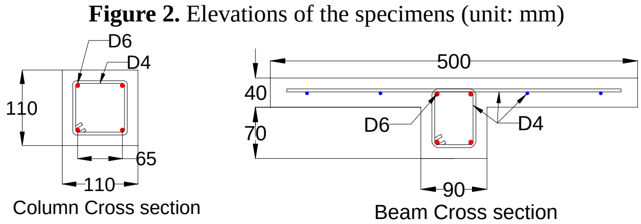

Figure 3. Cross-section of the column and beam (unit: mm)

RC フレームに内蔵される無補強組積造壁の耐震性能評価
（その 1）実験概要

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Table 1. Mechanical properties of concrete

Compressive strength	Young's modulus	Tensile strength
24.1 N/mm^2	2.1x 10^4 N/mm^2	1.71 N/mm^2

Table 2. Mechanical properties of concrete block

Compressive strength	Young's modulus
6.7 N/mm^2	9.6x10^3 N/mm^2

Table 3. Mechanical properties of reinforcements

Bar	Use / Member	Yield stress	Tensile strength	Young's modulus
D4 rebar (SD295)	Hoop / Beam and column	401 N/mm^2	574 N/mm^2	2.1x10^5 N/mm^2
D6 rebar (SD295)	Main bar / Beam and column	407 N/mm^2	543 N/mm^2	2.0x10^5 N/mm^2

2.3 Test Setup and Loading Protocol

A loading system for the in-plane cyclic static tests is shown in Figure 4. Lateral loads in the positive and negative directions were applied from the left and right ends of the beam with hydraulic actuators, respectively. Two vertical actuators were installed to apply a constant axial load of 35 kN (2.9 N/mm^2) on the top of each column, and a distributed load of 5.9 kN/m (in total 7.5 kN) was also applied considering a design dead load. Two pantagraphs were used to provide out-of-plane stability during the tests. Figure 5 shows a lateral loading protocol, which was controlled by a drift angle R, which was defined as a lateral drift Δ at the center of the uppermost beam divided by the height from the bottom of the first story column to the uppermost beam's center, H, as shown in Figure 2.

2.4 Instrumentation Plan

A key objective of the tests was to capture three-axis strain gauge data for all the blocks in 1B-1S-H and 1B-1S-V specimens. However, due to limitations in the measurement equipment, it was not possible to measure three-axis strain data for all the blocks of 2B-1S-H and 1B-2S-H specimens; therefore, approximately a half number of blocks were selected to evaluate the strut mechanism in the positive loading direction according to the method proposed in the previous study[1], which is described in Part 3. Figure 6 shows strain gauge arrangements for all specimens. In addition, to measure the curvature distributions along the column and beam, displacement transducers were attached on both side faces of the column and beam.

3. Conclusion

An experimental program was outlined in Part 1. The results are described in Parts 2 and 3.

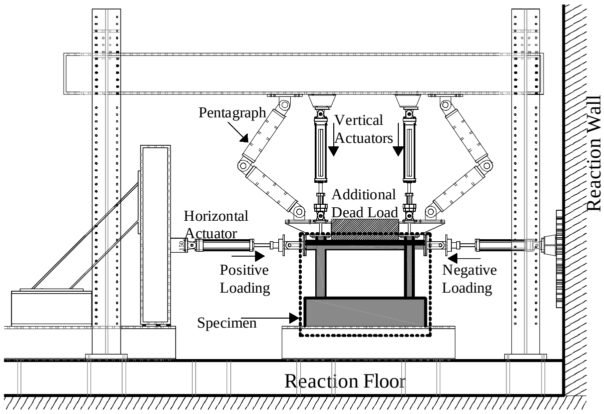

Figure 4. Test setup

Figure 5. Loading protocol

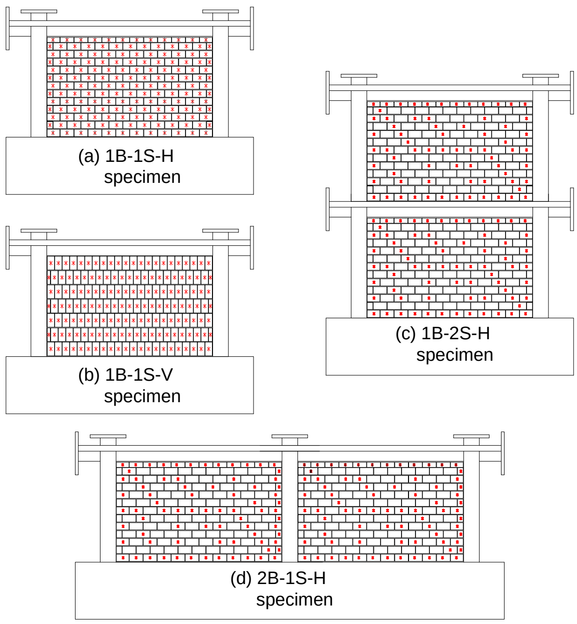

Figure 6. Strain gauge arrangements

[Reference]

[1] Jin, K., Choi, H., Takahashi, N., Nakano, Y. (2012). "Failure Mechanism and Seismic Capacity of RC Frames with URM Wall considering Its Diagonal Strut". *Proc. 15th World Conference of Earthquake Engineering (WCEE), International Association of Earthquake Engineering.*

[2] Maidiawati, Oo, T., Sanada, Y. (2012) "A Simple Approach for Determining Contact Length between Frame and Infill of Brick Masonry Infilled R/C Frames". *Proc. 15th World Conference of Earthquake Engineering (WCEE), International Association of Earthquake Engineering.*

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