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Seismic Upgrading of URM Walls Using Composite Fibres Laminates

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Introduction

Unreinforced Masonry (URM) is a very widespread construction material. URM walls perform poorly during recent earthquakes. Numerous techniques are available to increase the strength and/or ductility of URM walls. One promising technique consists of using composites as externally bonded plates to enhance the lateral capacity and/or ductility of URM. This article presents a research project to conduct dynamic test on URM walls retrofitted with composites laminates as externally bonded plates.

Literature Review

Fiber Reinforced Plastics (FRP) are now commonly used for structural retrofit applications. Significant research has been conducted around the world to test the seismic behavior of different structural elements strengthened with composite materials. For all these structural elements the use of composite material enhances the member behavior and/or ductility. There are two types of failure for URM walls, either under in-plane forces or out-of-plane forces. Out-of-plane failure has extensively been treated by Ehsani et al. (1993, 1997, and 1999), and Albert et al. (2000). In spite of the in-plane vulnerability of URM, only little research examines the effect of composites in increasing load carrying capacity and ductility enhancement. Schwegler (1995) reported that URM walls strengthened with composites show a ductile behavior and increase in load carrying capacity. Questions remain concerning the behavior and design of URM walls retrofitted with FRP. The goal of this current research is to improve knowledge of the actual behavior of URM walls under dynamic loading, as this will contribute to validate the retrofitting technique and to develop quantitative design models.

Test Design

This research aims to test URM walls strengthened with FRP on the earthquake simulator of IBK, ETH. This installation features are 2×1 m table and can generate a maximum horizontal force of 100 kN. Based on these characteristics it is possible to test half scale specimens. Figure 1 represents the test set-up and specimen. The test specimens are designed to simulate the structural features of the building shown in Figure 2. It is important to note that the normal force is carried by slender columns and bearing walls, while the bearing walls resist all the lateral force. The tributary areas of the floors belonging to the bearing wall for gravity load are different from the areas for horizontal mass inertia forces. To apply the same structural concept the calculated gravity load (due to the reinforced concrete slab, flooring and live load) will be applied directly to the specimen by two external pre-stressed cables, the inertia force will be generated by a 12 ton mass, this mass will be placed on rails mounted on a steel structure. From dynamic response standpoint the test specimen is a single degree of freedom (SDF) system using one of the three available masses of the testing instrumentation. The test walls will simulate the wall at the top floor where, maximum earthquake accelerations will occur.

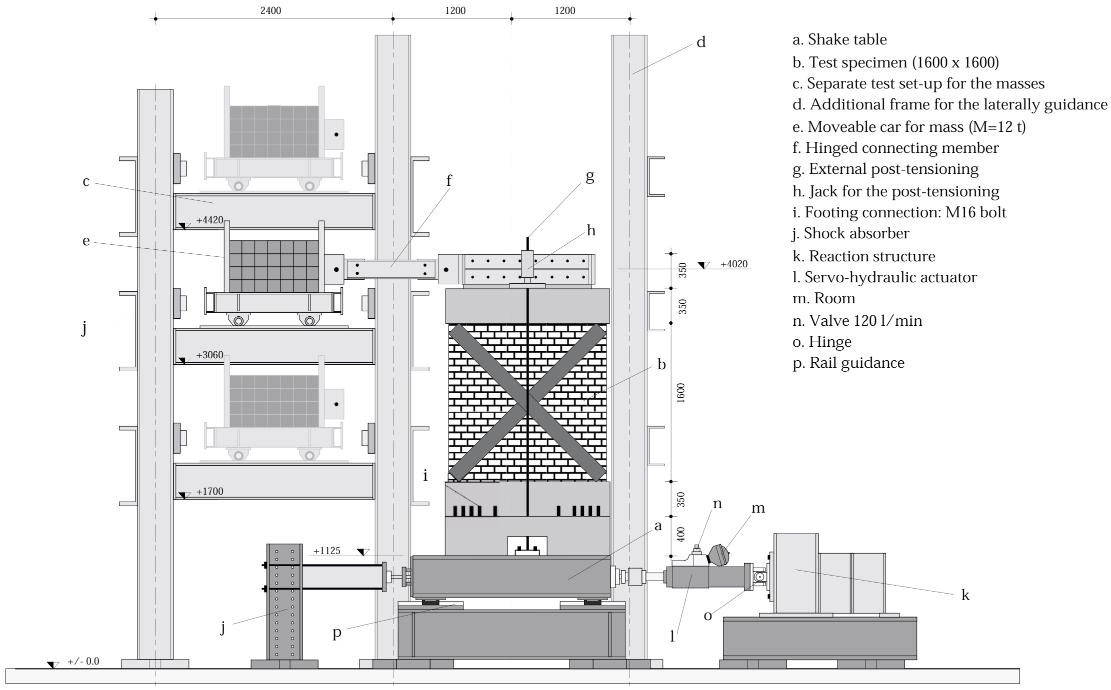

Figure 1: Test set-up and specimen

The planned test parameters are as follows:

- Four square panels (1.60×1.60 × 0.1 m), single wythe will be tested. The first one will be control specimen and the other three specimens will be retrofitted with different configuration of CFRP.
- Hollow Clay Masonry (HCM) will be used to build the specimens. As this building material is widely used in the old building and has been successfully used in other research programs Schwegler (1995).
- Type N, low strength cement mortar will be used, as in the older URM buildings the joints are the weakest part of the wall.
- Synthetic dynamic excitation simulating a design earthquake valid for zone B of the EC8; which is valid for medium stiff soil, will be used.

Reference

Albert, L. Michel; Elwai, E. Alaa; Cheng, J. J. Roger, "Strengthening of Unreinforced Masonry Walls Using FRPs," ASCE Journal of Composites for Construction, May. 2001.

Ehsani, M. R.; Saadatmanesh, H.; Velazquez-Dimas, J. I., "Behaviour of Retrofitted URM Walls Under Simulated Earthquake Loading," ASCE Journal of Composites for Construction, Jan. 1999.

Schwegler, G.," Masonry Construction Strengthened with Fibre Composites in Seismically Endangered Zones," 10th European Conference on Earthquake Engineering, Vienna, Austria, 1995.

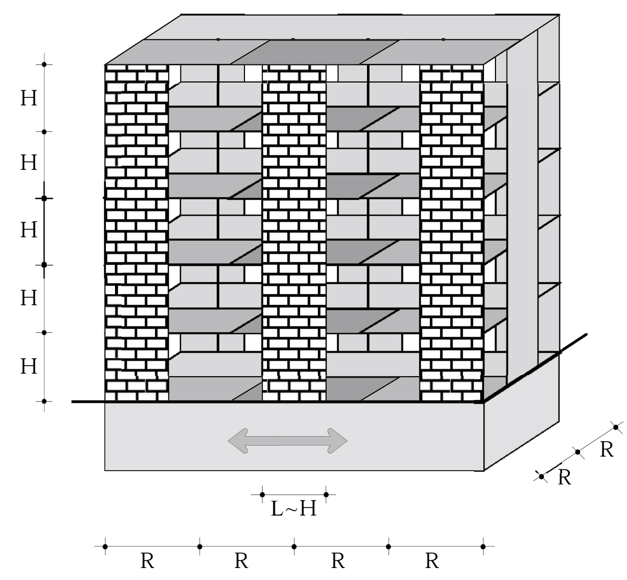

Figure 2: Five-story building with URM walls