Seismic Performance of Masonry Structure with Geogrid Reinforcement

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ABSTRACT

Masonry is the primary form of building structures for habitation in developing countries. It has innumerable advantages, including thermal insulation, sound resistivity, the option of addition and alteration after construction, less formwork, easy and low-cost repair, use of local and eco-friendly materials, need of less-skilled labor, and less engineering intervention over construction. However, such heavy and un-reinforced brittle structures are usually not strong enough for resisting lateral thrust generated due to earthquake ground motion; hence, they cause significant hindrances in seismically active regions. Therefore, these buildings need straitening against lateral forces.

Most of the earlier researchers tried strengthening masonry buildings or the walls to wall-surface strengthening. Surface strengthening needs good surface preparation, which is essential for wall strengthening, as unfilled cracks or unsmoothed irregularities can cause premature debonding and delamination. Also, external surface strengthening affects the aesthetic appearance of the buildings. Hence, in this research, an attempt has been made to observe the performances of geogrid reinforcement embedded in brick mortar, viz., geogrid reinforcement at the bed as well as at the bed and head joints experimentally in the laboratory of Civil Engineering Department, National Institute of Technology Durgapur. A summary of these studies and observations are as follows:

The performances of brick prisms constructed with and without strengthening measures were investigated under compression testing. It was observed that Geogrid-reinforced masonry prisms capable of distributing forces everywhere make the mortar joints stiffer and have high strength endowing the masonry wall panels with more strength. Un-reinforced panels exhibited a sudden failure with cracks along the mortar bed joint, while joints cracked, followed by the crushing of bricks marked with geogrid reinforced panels, reflecting an increase in the strength of embedded mortar.

During an earthquake, masonry fails mainly due to in-plane shear and out-of-plane bending. Nine single-leaf masonry panels having dimensions of 600 mm × 600 mm × 125 mm were

cast to observe the in-plane shear strengthening the performance of brick masonry panels. For this, two patterns of geogrid reinforcement embedded in brick mortar, namely, geogrid reinforcement at the bed as well as at the bed and head joints, were used to three wallets unit, respectively. It was observed that geogrid-reinforced brick panels exhibited better crushing load, in-plane shear strength, lateral strength, ductility, etc., then un-reinforced masonry with the highest in-case of bed joint reinforcement. The economy index of geogrid-embedded reinforcement is found to be more than that of un-reinforced masonry panels with better performances for bed joint reinforcement. The cost analysis estimates that the unit cost of URM and strengthened walls are very close and can be a valid alternative to URM walls for new constructions and a low-cost strengthening technique for earthquake disaster mitigation of brick masonry.

To observe the in-plane and corner failure of brick masonry buildings using geogrid bed-joint reinforcement, such a technique was applied to masonry buildings too. One-fourth scale building model of dimensions 850mm×850mm×760mm was constructed on a plyboard plank with one corner wall (adjacent walls) reinforced with geogrid at bed joint and another corner wall without geogrid reinforcement. Experimentation was done in the laboratory of NIT Durgapur with a high pay-load unidirectional vibration shaker. Sinusoidal load with incremental frequencies was applied for a constant duration of 30sec to a building. No sign of damages up to 0.31g (2.1Hz,12.5mm displacement) was observed initially to any of the walls. However, corner wall building without reinforcement showed crack initiation at 0.45g and complete collapse with over toppling of the transverse wall at 0.90g. No sign of damages for the corner walls strengthened with geogrid reinforcement for any level of shaking was observed, showing a low-cost strengthening technique for earthquake disaster mitigation of brick masonry buildings.