Effect of plywood retrofit on dynamic response of URM house subjected to forced vibration

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ABSTRACT: The results of non-destructive forced vibration tests on a small-scale unreinforced masonry (URM) house are presented. The main aim of the study was to assess the changes in system level response between the as-built and retrofitted structure. This includes assessment of diaphragm response, wall-diaphragm connection details, in-plane wall response, out-of-plane wall response, and the response of wall corners. Further, the test protocols were designed to investigate two types of retrofit techniques consisting of a plywood diaphragm retrofit and wall-diaphragm connection retrofit. However, this paper only presents the results of plywood retrofit as the experimental study is still in progress. From the results, it was found that the basic dynamic properties (natural frequency and mode shapes) and the force path of the as-built structure were significantly affected after applying the plywood retrofit.

1 INTRODUCTION

Unreinforced masonry (URM) buildings are typically the class of structures with the highest risk of failure during an earthquake, and the requirement to seismically upgrade these earthquake-prone buildings in New Zealand was mandated by The Building Act 2004 (DBH 2004). Importantly, these URM buildings form a significant percentage of New Zealand's building stock and represent the predominant national architectural heritage (Russell and Ingham 2008). Most unreinforced masonry buildings in New Zealand consist of solid URM bearing walls and flexible timber diaphragms (floor and roof). The URM wall thickness configuration over the height of the building was typically reduced by a single leaf at each storey height to support the diaphragm. The most common diaphragm seating method was to bear the joists and transverse beams on a single brick width without embedment. No connections between URM walls and diaphragm were identified in URM buildings constructed before the 1931 Hawke's Bay earthquake and most out-of-plane wall failures were related to the absence of anchorage between the walls and diaphragms. Following the 1931 Hawke's Bay earthquake, most URM buildings were seismically retrofitted, which included the installation of wall-floor and wall-roof connections (Blaikie and Spurr 1992). Most wall-diaphragm connections applied were through-bolt anchor with the use of a steel bearing plate located on the exterior of the building. However, failures of this type of connection were detected in the 2007 Gisborne earthquake (see Figure 1).

(a) Failure of wall-diaphragm tension anchor (b) Pull-of brickwork failure

Figure 1: Connection failures in the 2007 Gisborne earthquake