

Shake Table Tests of Traditional Timber Frame Masonry Construction System

Aanisa Gani¹, Durgesh C Rai², and Jan Mohammad Banday³

Abstract:

Past earthquakes established the robustness of the vernacular timber-framed masonry construction systems in earthquake-prone regions. The post-earthquake reconnaissance studies reveal that these building systems possess excellent seismic resilience and can sustain multiple seismic events over their useable life. Such a performance is in contrast to that of many modern contemporary structures. Regardless of all the data available on the exceptional behavior of these structures in earthquakes, the robust quantitative experimental data on their seismic performance is quite limited. This paper reports a series of half-scale shake table tests on an archetypal single-room, single-story timber frame infilled with dry stack masonry. Two models, one a bare timber frame and the other a timber frame infilled with dry stack masonry were investigated in this study. Both the models were subjected to white noise base excitation for dynamic characterization whereas the timber frame with infill was also subjected to a ground motion of increasing intensity in accordance with a single ground motion record incremental dynamic analysis to investigate the seismic behavior of such structures. The dynamic properties were assessed, including natural frequency, damping ratio, mode shapes, and stiffness degradation. The frequency decreased to 30%, and the stiffness degraded to 48% for shake table motions up to PGA of 0.45g. Sensors and instrumentation were placed to capture the dynamic response in terms of peak accelerations at the sill, lintel, and roof levels. The acceleration response from the floor to the roof level is also measured and presented as acceleration amplification factors of both in-plane and out-of-plane walls. The acceleration response was more amplified for out-of-plane walls with an amplification of 250%, while a lower value of 80% was observed for in-plane walls. Experimental results reinforce that these construction systems offer effective seismic resistance and an extensive analysis helps understand the behavior of such systems under seismic loads.

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¹ National Institute of Technology Srinagar, Srinagar, India, dcrai@iitk.ac.in

² Department of Civil Engineering, Indian Institute of Technology Kanpur, Kanpur, India

³ National Institute of Technology Srinagar, Srinagar, India