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Investigating Low-Cost Base Isolation Strategy to Enhance Seismic Resilience in Rural Masonry Buildings

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ABSTRACT

On April 25, 2015, a 7.6 Magnitude Earthquake struck the Barpak region followed by more than 300 aftershocks above 4 Magnitude and 4 earthquakes greater than 6 Magnitude. The aftermath of these events unveiled that a total of 489,852 houses were completely damaged; among them 474,025 (95%) were low strength masonry, 18,214 (3.6%) were cement mortared masonry and only 6,613 (1.3%) were Reinforced Concrete (RC) buildings. A total of 256,697 houses were partially damaged among which 173,867 (68%) were low strength masonry, 65,859 (25.6%) were cement mortared masonry and only 16,971 (6.6%) were RC buildings [1]. This highlights the vulnerability of masonry structures and the need for developing seismic resilience in rural masonry buildings.

Base isolation has developed as an effective solution to minimize structural damage under severe seismic excitations. Elastomeric isolators, in particular, have been studied extensively in the past. However, their high cost and bulkiness make them unsuitable for rural masonry buildings. Sliding base isolators of the pure-friction (PF) type have emerged as a viable alternative since they adopt a cheap light-weight sliding interface between the superstructure and foundation [2]. They have also been shown to perform well over a wide range of earthquake frequencies and provide a high degree of acceleration isolation.

A simplified mathematical model was formulated to analyze response of masonry building with PF isolation under a wide range of near-fault and far-fault earthquake records. Since Nepal is home to a wide variety of soil types, effect of Soil-Structure Interaction (SSI) was also incorporated. Transient response in terms of Inter-story Drift Ratio (IDR) and Peak Sliding Displacement (PSD) were obtained by direct integration using the Backward Differentiation Formula (BDF). It was found that SSI led to significant increase in base displacement demand, which is crucial for design of base isolation systems. It was also observed that PF isolation effectively reduces structural response under all types of ground motion records, hence it could be a viable solution for short-rise masonry buildings.

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