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Earthquake Resistant Reinforcement for Adobe Structures: Barkal Earthquake Experience

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ABSTRACT

In the developing countries like Bangladesh, a great percentage of the population lives in adobe structures because of their manifold advantages such as, low cost, easy availability, easy construction, low energy requirement, and comfort. In Bangladesh, about 35% of the people still live in such houses. Unfortunately, these houses are very vulnerable to earthquake. Recent seismic activities and the historical seismicity data of Bangladesh and adjoining areas indicate that Bangladesh is at high seismic risk. As Bangladesh is the world's most densely populated area, any future earthquake will affect more people per unit area than other seismically active regions of the world. The last notable earthquake in Bangladesh — the July 27, 2003 Barkal earthquake (M_b= 5.6) caused the collapse of 150 adobe houses and rendered 500 families homeless. A detailed survey of the collapsed houses in the village Kolabunia under Barkal upazilla of Rangamati district was conducted and soil samples were collected from the collapsed houses. Geotechnical characteristics of those collected samples were determined by laboratory tests. Past earthquakes and survey of the collapsed houses in the Barkal earthquake indicated that the failure of adobe structures is mainly due to three reasons, among others: 1). Adobe is a brittle material. It has very low tensile strength and low ductility although it may have large compressive strength. 2). The connection between the bricks and the walls is extremely weak, which causes a partial or total disintegration under a few cycles of moderate shaking. 3). Great inertial forces induced by heavy mass and irregular configuration of the walls make adobe structures very unstable. However, this study deals with the aspect of material improvement only. Recently, it has been observed that by mixing straw with soil, ductility can be increased at the cost of compressive strength. In this study, Carbide lime was selected as the other reinforcing material since it is cheap, easily available and is an industrial waste. Specimens were prepared from the collected soil samples varying the straw content from 0 to 3% while keeping the lime content constant at 5%. It was observed that the failure strain, i.e. the ductility of the material increased significantly with increasing straw content without affecting the compressive strength. The same tests were performed on specimens made of soil collected from other parts of the country. Similar behavior was observed for those samples as well.