

Preliminary approach for a prototype of sustainable anti seismic dwelling in Nepal based upon the historic vernacular tradition

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ABSTRACT

The effects of the 2015 Ghoroka earthquake in Nepal revealed deficiencies both in the most recent vernacular architecture, lacking in the use of wooden reinforcements due to national laws against deforestation, and in reinforced concrete architecture, generally undersized and poorly reinforced due to the high import cost of construction steel. The geography of Nepal has led to the development of a wide variety of vernacular architecture using local materials such as stone, brick or earth in the form of rammed earth and adobe walls (CBS 2014). Moreover, although its tradition in the construction of vaults is not as prominent as in the adjacent regions of India, Nepal has developed its own tradition in the construction of vaults and domes, which are generally self-supporting and made of brick or adobe with lime mortar.

The design of a prototype of a seismic house in Nepal aims to use a modular housing unit with rammed earth walls and/or walls made of materials and tiled vaults recycled from previous earthquakes, and with bamboo elements and vegetable fibre grids respectively. These avoid the use of imported materials, preferring km0 and sustainable materials following local tradition.

Through the application of linear and non-linear seismic analysis on finite element models, several housing units have been analysed, with variations in planimetric layout and types of tile vault, from the simpler barrel vault to the sail vault. Both are analysed assuming different values of springer height, rise and thickness, searching for the best shape in terms of seismic efficiency, evaluating stress and strain state.

The results obtained from this preliminary study clearly show that, under seismic actions, the construction system using depressed sail vaults and rammed earth walls with bamboo reinforcements responds more efficiently and homogeneously in terms of tensions and deformations. This is due to the geometric symmetry that determines the same response in several directions, as opposed to vaults with a characteristically strong directionality (barrel vault).

This research involves the study of the mechanical characteristics (tensile strength, Young's modulus, etc.) of local natural fibres (jute, hemp), found on site, and the reinforcement mesh design to compensate loss of tensile strength and provide robustness, aiming to improve the global and local seismic response of the above-mentioned construction system. Laboratory tests will be crucial in determining the values of the characteristics of local fibres, as the values found in literature are highly variable and depend on the material geometry and chemical composition.

Finally, the HouSe-Nepal project proposes and offers knowledge of a more sustainable and less seismically vulnerable architecture, continuing the local tradition.