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Shear and out of plane strength design of reinforced adobe walls

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Extended Abstract

In spite of being earth the most common construction material in the world, from the technical point of view is ranked as a non engineering material. The almost null tensile strength and the fact that it is very difficult to supervise its fabrication and therefore its mechanical properties, makes this material not suitable to apply the usual techniques of analysis and design. Between the many construction techniques using earth as building material, the masonry adobe blocks is one of the most popular around the world and whose behaviour to applied loads is in many senses similar to other types of masonry.

In the search for a reinforcing material that is compatible, have standard mechanical properties and easy to install, the biaxial geogrids appears as the most appropriate reinforcing material for both, new and existing earthen constructions.

Recent and extensive dynamic and static testing have demonstrated that the geogrid embedded in the plaster mud mortar conforms with the adobe wall a composite material where the grid takes the tensile stresses and the adobe the compression forces in the same way that steel bars are the reinforcing material for concrete. In the post elastic range, this material shows a ductile behavior with a great capacity for energy dissipation, an important feature for a good seismic performance.

In the cyclic horizontal shear test performed in I shape adobe walls, substantial energy dissipation was obtained, as is shown in figure1.

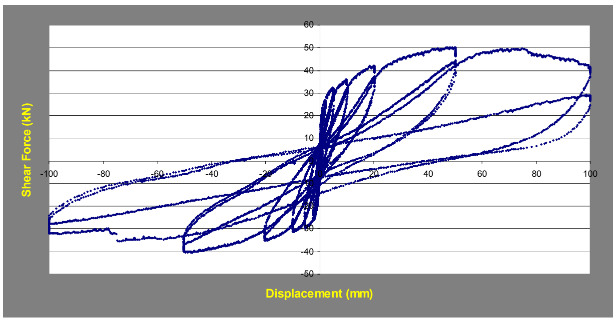
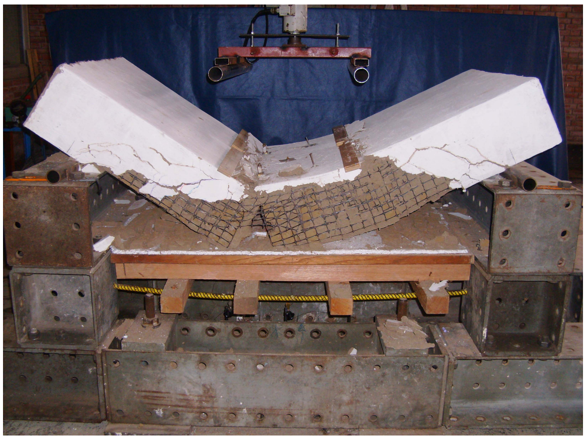


Figure 1. Cyclic horizontal shear test on adobe walls.

It was found a maximun value of 0.04Mpa for shear strength after which the earthen material degradates inside the wall but mantaining integrity and deformation capacity because it is confined with the geogrid. In order to obtain a inelastic behaviour, the reinforcing material has to take the maximum shear force computed as follow: **fg = (S) (vu) (t) (1/N) (**eq. 1**),** where **fg** is the tensile strength of the grid; **vu** is the maximum shear force for a wall with mud plaster (0.04MPa); **t** is the thickness of the wall including the plaster; **N** is the number of grid layers in both faces of the wall; and **S** is the factor that assure the inelastic behaviour because the grid is elastic until failure (S=1.3).

For the bending tests, a portion of wall was tested horizontally with two vertical loads applied symetrically. The test was taken to the final state with the failure of the grid in tension as is shonw in figure 2.



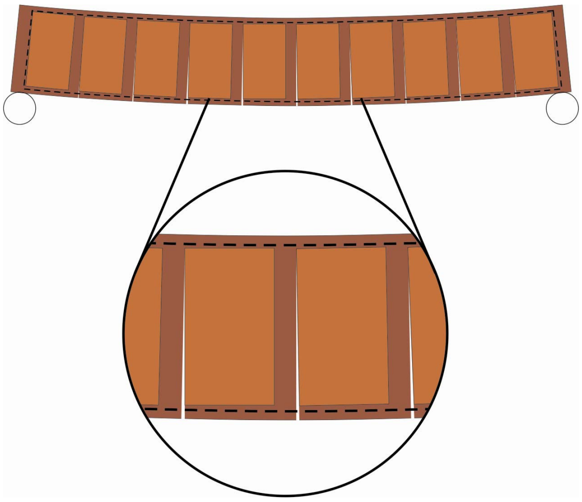


Figure 2. Flexural test of adobe wall.

The flexural test shows that the tensile crack propagates through the plane between the mortar and block (figure 2). It can be stated that the flexural out of plane strength is governed by the tensile strength of the grid and can be computed as follows: **Φ Mn = (Φ) (fg) (d)** (eq. 2), where **Mn** is the moment capacity of the section; **Φ,** is the strength reduction factor in bending (Φ =0.9); **fg** is the tensile strength of the grid; and **d** is the distance from the tensile reinforcement to the compressive resultant force, equivalent to the thickness of the wall without including the plaster.

These tests have shown that it is possible to reinforce an existing or new adobe house using analytical tools commonly accepted by the engineering community, being therefore the first step to include the adobe construction as an engineering material.

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