EXPERIMENTAL STUDY OF VERNACULAR STRUCTURES SUBJECTED TO VARIOUS PROPORTIONS OF CONTAINMENT REINFORCEMENT

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ABSTRACT

Vernacular structures referred as non-engineered structures are made from locally available materials, they can be more vulnerable to damage during earthquake. According to the location, weather, material availability, etc. vernacular houses varying vastly, so focus of the study is made only for masonry type vernacular housing structures made from the adobe bricks with various proportion of containment reinforcement. The main objective of the study is to understand the effect of earthquake resistant features on the behavior and damage or failure pattern of adobe masonry structure under earthquake or dynamic force. To achieve this goal 4 reduced scaled models were created with varying proportions of containment reinforcement, and then the shake table taste performed, and the failure damage pattern observe.

Keyword: - *adobe material, containment reinforcement, vernacular houses, scaled mode etc.*

1. INTODUCTION

Lots of research and study is going on the structures made from the R.C.C. and steel. Compare to that very few has been done on vernacular housing structure. As vernacular structures also referred as NON-ENGINEERED STRUCTURES are made from locally available materials, they can be more vulnerable to damage during earthquake. So, the behavior of those structures under dynamic loading should also studied. There are so many earthquakes resisting R.C.C and steel structure exists on this planet and more will be in future but what about those people who lives in vernacular structure in villages. So many people loss their life in villages during earthquake due to lake of earthquake resisting structures. The main problem here is how can we make earthquake resisting vernacular houses with low cost for poor people who lives in villages. Adobe bricks are a non-toxic, fire-resistant, durable yet biodegradable building material that provides enough thermal mass to assure outstanding thermal performance. Low sound transmission levels through walls and a general sense of solidity and security are also advantages.

1.1 Detail plan and geometry of structure

At a scale of 1:5, total of 4 reduced scaled models of adobe masonry structures were made. Five of the models were made out of scaled adobe bricks. Details plan and elevation of structures are shown in figure 1.1.

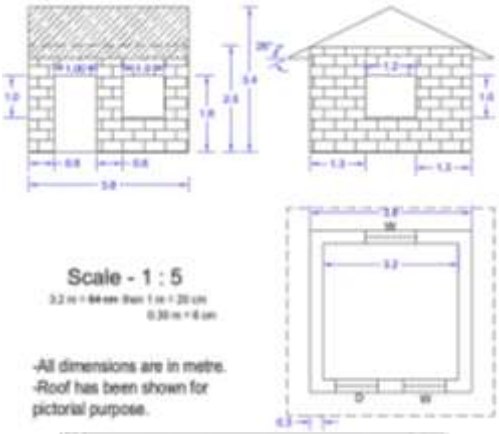


Fig -1.1 plan of structure

1.2 Material Specification

Soil.	Bulk Density of soil. (gm/cm3)	Sand Content in %	Silt conte nt in %	Clay content in %	Salinity of soil in ppm	ph Value of soil
Adobe soil	**1.276**	**35**	**20**	**45**	**181**	**8.35**

Table -1.1 Soil properties

Table – 1.2 Adobe brick dimension

Brick Dimensions	**Full Scaled (In CM)**			**Reduced (1:5) scaled (In CM)**		
	L	B	H	L	B	H
Adobe Bricks	25	30	8	5	6	1.6

Al (Aluminum) wire was used as vertical containment reinforcement in both prototype and modelled structures. For stimulation purpose diameter of Al wire considered for modelled structure was approximately 1 mm to 2mm. Wires on the external side of the wall and internal side of the wall must be linked with Al or Fe wire after every 3 courses of the brick masonry. Generally vertical containment reinforcement is provided near the junction of walls and openings in walls on the both sides of the wall.

For containment reinforcement K.S. JAGADISH SIR'S book STRUCTURAL MASONRY referred & in that book he researched on masonry structure with containment reinforcement and gave percentage of containment reinforcement range between 0.015% to 0.053%.

2. MATERIAL TESTING

Adobe material had to be tested for minimum strength requirement according to their respective codes. Both prototype (full scaled) and modelled (reduced scale at 1:5) material should satisfy minimum strength requirements.

2.1 Adobe cube testing

5 Nos. of 20cm × 20cm × 20cm cubes to be casted and tested for compressive strength for adobe material according to NZS: 4298:1998.

Fig -2.1 casting of adobe brick and block for testing **Fig -2.2 adobe cube testing**

According Table: 2.1 from NZS:4298:1998 required compressive strength for adobe brick material is 13.5 kg/cm2. Test results shows that average compressive strength of adobe material cubes is 14.3 kg/cm2, hence material is suitable for casting of adobe bricks. As material satisfy minimum requirement of code, same material is used for both prototype and modelled adobe bricks.

2.2 Adobe brick prism

After finalization of material proportion for prototype and model bricks, brick prism is to be made from the bricks of finalized proportion. According to ASTM E447- 74 height of the prism should be twice the largest lateral dimension of the prism.

For adobe bricks, same material which was used for brick making was used as 1 cm thick mortar for prototype brick prism. While for model brick prism adobe material which was passing through 400 µm used as 2 mm thick mortar.

Fig -2.3 Prototype adobe brick prism

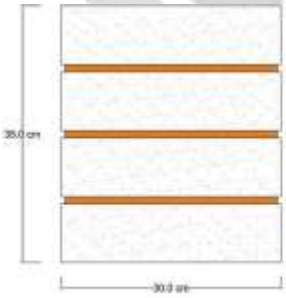
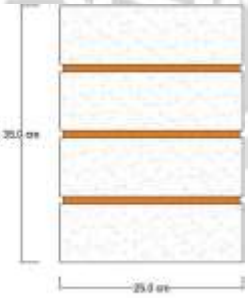
Fig -2.4 modelled adobe brick prism **Fig -2.5 testing of adobe brick prism**

Both prototype and model brick prism have approximately same Avg. compressive strength around 11.30 kg/cm^2. Hence, proposed material can be used as mortar for modelled adobe masonry structures.

3. TEST ON MODEL STRUCTURE

There are 5 scaled model made from adobe bricks which are shown as in table 3.1.

Table -3.1 Percentage range of containment reinforcement

Scaled model	Diameter of containment reinforcement	Percentage of reinforcement (%)
 Front View	 Side View	
Model A1	1.00mm	0.0167
Model A2	1.30mm	0.02830
Model A3	1.60mm	0.4278
Model A4	1.80mm	0.05425

3.1 Test results from impact hammer and shake table

Fig -3.1 BSC vs Drift ratio (%) curve for adobe model

From the above graph following observations are made,

- Seismic resistance of model A4 is significantly larger than the other models.
- Model A1 has highest drift ratio 0.043% while other models like A2 and A3 has around 0.037% and 0.033% model A4 has 0.029%
- Capacity curve for model A2 and A3 is nearly equal up to the drift ratio 0.035%.
- Model A4 shows high BSC value before failure.
- Capacity curve of model A1 shows competitively lesser values of BSC for corresponding drift ratio compared to other models. Which shows very low energy absorption for model A1.
- So as per this graph model A4 performs better.

4. CONCLUSIONS

The results clearly reveal the mechanism by which a large curvature ductility is achieved. When the steel percentage is low and when the yield strain of steel is also low, the steel starts yielding even when the compressive strain in masonry is low.

As we can see from results from Model A1 to A4 increasing the percentage of containment reinforcement drift ratio (%) decreases to almost 60-70 % and base shear coefficient increases.

As percentage 0.0167% is become too low and 0.05425% is high so for adobe material structure containment reinforcement range should be between 0.02830% to 0.05425%.

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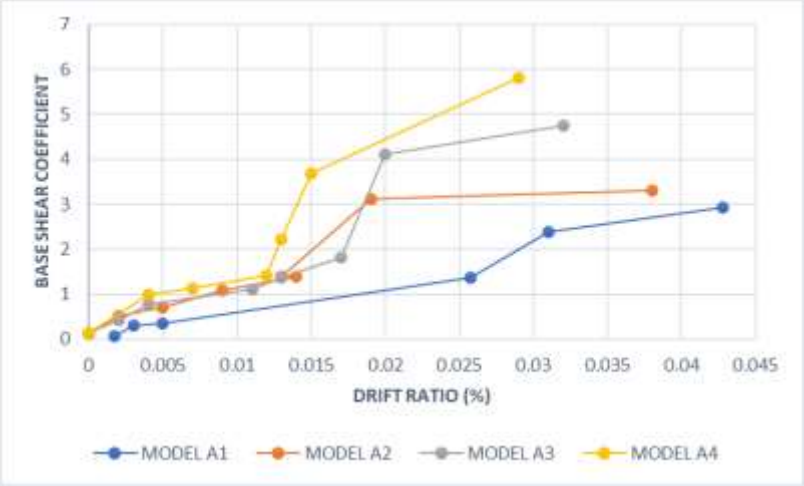

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