EXPERIMENTAL STUDY ON SEISMIC BEHAVIOR OF IRREGULARITIES IN VERNACULAR STRUCTURES

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ABSTRACT

As vernacular structures also referred as non-engineered structures are made from locally available materials, they can be more vulnerable to damage during earthquake, hence author has tried to study this kind of structures. 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. The main purpose of this study was to increase our knowledge about the behaviour of masonry structure under earthquake or dynamic force. The main objective of the study was to understand the effect of earthquake resistant features on the behaviour and damage or failure pattern of adobe masonry structure under earthquake or dynamic force The main purpose of this study is to increase our knowledge about the behaviour of openings in masonry structures under earthquake forces. The main objective of the study will be to understand the effect of different opening arrangements on the behaviour and damage or failure pattern of stabilized earth masonry under earthquake forces .To attain this objective two series of tests were performed: A material testing programme for reduced scaling of material and Shake table testing programme for dynamic testing on 4 reduced scale masonry house models

Keyword : - *vulnerable structures , earthquake resistant, adobe masnory , and opening arrangements….*

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1. INTRODUCTION

Of the 135 crore Indians, almost 34% population live in urban areas and 66% in rural areas, according to the world bank collection of development indicators. Most of the time construction in the rural region is based on traditional knowledge transferred in legacy. The rural population generally adopt traditional practice of construction for their houses. Generally these houses are vulnerable during earthquakes. Therefore huge loss of lives along with economic loss is observed in rural region. Less initiatives are taken for enforcing implementation of codal provisions or bye laws in such type of structures. Therefore it becomes important to pay more attention to rural construction practices to reduce losses during disasters. Vernacular housing is the traditional style in which a culture builds their homes. It can be defined as, “Materials, generally taken from the indigenous natural environment, and building techniques, either the result of slowly evolved processes or borrowed from the surrounding culture, are combined in response to the physical and social needs of the accommodation of a community; this combination generates architectural models, that is, building techniques, special designs, and aesthetic results that are natural responses to the historical–cultural experience and the ecological – and therefore sustainable – practices of the region, while at the same time responding to its economic realities**.”**

Vernacular Construction practice is largely depending on availability of local building materials. According to locally available materials vernacular housing structures can be classified as: Adobe (Mud blocks or Whole walls) Masonry (Stone, clay, CSEB and Concrete blocks) Timber Bamboo Grass straw combination of above

1.1 Deciding Dimesion Of Models

Criteria for Openings as per Gujarat State Disaster Management Authority (GSDMA) Guidelines

1. For compressed Cement Stabilised Earthen Block (CSEB or CSIB) masonry built in cement mortar and the Stabilised rammed earthen walls, the doors and window openings should be controlled by following criteria:
2. Restricting the ratio of total length of openings in a wall to the length of the wall in a room to less than 0.5 in the single storeyed houses and 0.42 in double storeyed buildings 0.33 in three storeyed building.
3. The distance of openings from inside corner should be more than 450 mm
4. The pier width between consecutive openings should be more than 560 mm

1.2 Detail Plan And Geometry Of Structure

1. Total 4 reduced scaled models of masonry structure were prepared at reduced scale of 1:5. All the 4 models were prepared from scaled stabilised adobe bricks. Detail plan and elevation
2. All 4 adobe bricks models can distinguish as below;
3. A1: First model will be a simple reduced scale stabilised adobe brick masonry structure with no breaching of GSDMA Guidelines
4. A2: Second model will be a similar reduced scale stabilised adobe brick masonry structure which will breach GSDMA Criteria No. 1, 2, and 3 for Openings
5. A3: Third model will be a similar reduced scale stabilised adobe brick masonry structure which will breach GSDMA Criteria No. 1 and 3 for Openings
6. A4: Fourth model will be a similar reduced scale stabilised adobe brick masonry structure which will breach GSDMA Criteria No. 1 and 2 for Openings

Table 1 Dimension of allreduced scaled models

Model no.	1 (in mm)	2 (in mm)	3 (in mm)	4 (in mm)	5(in mm)	Remarks
A1	90	160	120	110	90	All Criteria Satisfy
A2	110	210	125	170	45	1 & 2 - Breach
A3	100	210	80	170	100	1 & 3 - Breach
A4	85	210	110	170	85	1, 2 & 3 - Breach

1.3. Dimensions of reduced scaled bricks

For Stabilised Adobe prototype bricks soil with properties shown in table was used. Compressive strength of material was 14.14 kg/cm2 which was derived experimentally.

Table 1.2 soil properties

Colour of Soil.	Bulk Density of soil. (gm/cm3)	Sand Content in %	Silt Content in %	Clay Content in %	Salinity of Soil in ppm	Ph. Value of soil
Adobe Soil	1.27	35.42 %	14.7 %	49.88 %	189	8.8

Table 1.3 size of reduced scaled bricks

Brick Dimension	Full scaled (in cm)			Reduced Scale (1:5) (in cm)		
	L	B	H	L	B	H
Stabilised Adobe Bricks	25	30	8	5	6	1.6

2. BRICK PRISM TESTING:

For adobe bricks, same material which was used for brick making was used as 1 cm thick mortar for prototype

Figure 2: 1 prism making

Figure 2: 2 testing of prism

5 Nos. of 15cm × 15cm × 15cm cubes to be casted and tested for compressive strength for adobe material according to NZS: 4298:1998.

Figure 2: 3 testing of adobe cubes

Figure 2: 4 failure of adobe prism

Figure 2: 5 prism failure

Avg. Compressive Strength Prototype Adobe Brick Prism and Model Adobe Brick Prism is around 11.30 kg/m3

3 TEST ON MODEL STRUCTURE

Test result from impact hammer test and shake table test given in graph below

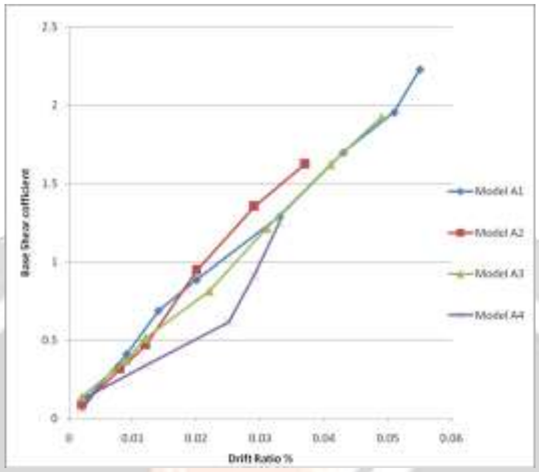

Figure 3 : 1 BSC vs. Drift ratio (%) curves for Model masonry structures

From the above below following observations are made,

- Seismic resistance of model A1 is larger than Model A3, and much larger than model A2 and Model A4.
- Both model A1 and A3 reach their ultimate capacity at drift ratio (%) 0.033 and 0.049 however BSC corresponding to model A1 is higher than BSC corresponding to model A3.
- Capacity curve of model A1 and A3 nerly equal to drift ratio of 0.025
- Capacity curve of model A4 shows competitively lesser values of BSC for corresponding drift ratio compared to other two models A2 and A3 which shows very low absorption for model A4

4. CONCLUSIONS

For Adobe masonry models reduced scale of 1:5 tends to be very small to stimulate actual cracking pattern. Due to lesser thickness of adobe bricks developed crack can pass through bricks by breaking it, instead of following the joints in the masonry which led to the separation of walls from corner. Hence, for adobe masonry lesser reduced scale like 1:2, 1:3 or real scale structure is recommended for dynamic testing.

Horizontal earthquake bands must be aided Vertical containment reinforcement and core reinforcement for better performance.

Criteria of corner opening is more important compare to pier width.

Damping of the adobe masonry models varies drastically

Model A3 perform better than A2 during testing so we can conclude that criteria of minimum corner opening should not breach in any condition

5. REFERENCES

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