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Improvement of Non-Engineered Houses by Seismic Retrofitting in Rural Areas of Tripura

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Abstract:- One of the major causes of non engineered structure failure is the lack of proper construction technique of mud wall in the rural areas of Tripura. A further barrier in this field is the socio-economic challenges in low income communities where non engineered housing is prevalent. This paper solely introduces the basic retrofitting technique and its advantages on preventing sudden collapse of traditional mud wall houses at Tripura.

Keywords:- *Seismicity; Non-Engineered Structures; Bamboo Retrofitting; Shake Table Test.*

I. INTRODUCTION

Tripura, the third smallest state of India which is situated on seismic zone five is developing rapidly these days. Although majority of the population of Tripura belongs to the rural areas where non-engineered houses are preferred due to economy. Recent Tripura earthquake (3rd January, 2017, 5.7 Mw), shows the conventional mud wall failure both in plane as well as out of plane failure. The cracks even developed at the middle of the wall which also concerns about the structural integrity of such type of conventional mud wall. This problem requires a scientific attention as because conventional mud house structures are more common not only to the North East India but also to the entire South East Asia where the average population goes for such conventional mud houses. This paper is a humble effort to analyze the lateral strength of conventional mud walls through numerical modeling and also to propose methods to improve the strength by using traditional bamboo reinforcement technique. Finite Element based model is developed using COMSOL multi physics software and Pushover analysis is done to develop the pushover capacity curve of such mud walls. Further, some retrofitting measures are incorporated by using bamboo. The retrofitted pushover analysis is done by COMSOL multi physics. Finally, this limited study will give better insight into the problem and also help an idea about the increasing lateral strength of such mud walls.

II. MOTIVATION AND OBJECTIVE

The purpose of the work was to aware people by providing simple and reliable ideas to improve house construction technique in rural areas. The main objective is to improve the withstand capacity of the conventional mud houses during earthquake so that there is a minimal loss of human lives.

III. METHODOLOGY

Strength properties of soil and reinforcing elements are determined from suitable laboratory experiments. The improvement of strength from conventional mud wall and proposed composite wall has been determined worldwide well accepted methods proposed by Bhattacharya et.al. 2010 and Asgarian et.al. 2014. Numerical modeling of mud wall (7.5 x 4.5 x 0.5 m) by COMSOL Multi physics reveals that considerable amount of stress accumulated at the top corner surface and maximum displacement occurs at the top upper surface of the bare mud walls upon giving a test load of 2 kN which ultimately fails due to its non elasticity . Response analysis has been done by using shake table test.

Table-1 Physical properties of soil

Parameters	Test Results
Specific Gravity (G)	2.54
Grain Size Analysis	
Sand (%)	55.7
Silt (%)	22.4
Clay (%)	21.9
Liquid Limit, LL (%)	28
Plastic Limit, PL (%)	21.8
Plasticity Index (%)	6.2
Maximum Dry Density (gm/cc)	1.74
Optimum Moisture Content (%)	15.5

IV. IMPORTANT OUTCOMES

Numerical analysis through Finite Element Modeling shows that the maximum displacement occurring at the top upper face of the wall as shown in Fig. 1 upon the application of the uniformly distributed 2kN test load. The direction of the displacement as shown in Fig. 2 provides the sufficient evidence that the topmost surface of the wall undergoes the maximum displacement and the most vulnerable part for cracks to occur. However, Von mises stress distribution as shown in Fig. 3 gives some clue about the stress accumulation at the top corners. Though this corner is practically remains stiff due the bonding of adjacent walls but can undergoes substantial cracking if the load applied exceeds the materials ultimate stress limit. Moreover bamboo reinforced wall in Fig. 6 also accumulates the stress on itself and not on the mud wall Fig. 5

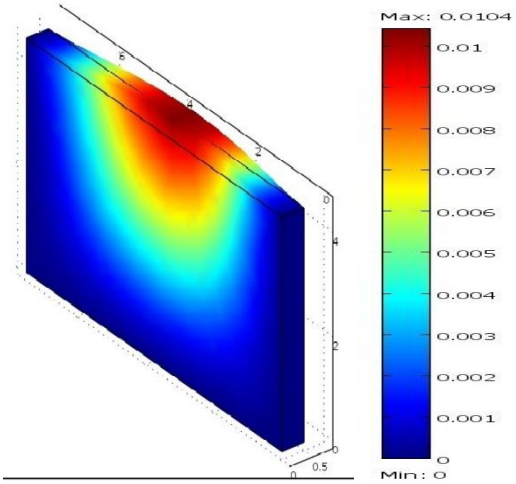

Fig. 1 Red patches showing the maximum displacement at the upper portion of the wall (modeled by COMSOL Multi physics) (m)

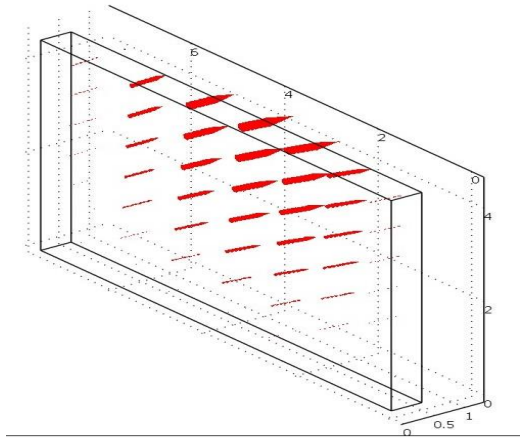

Fig. 2 Red arrows showing the displacement direction of wall (modeled by COMSOL Multi physics)

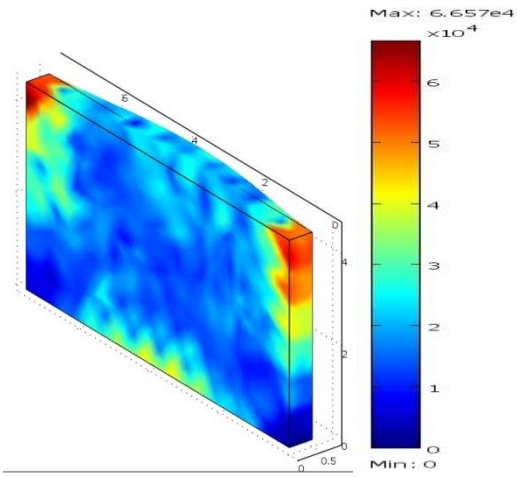

Fig. 3 Red patches showing the Von mises Stress accumulated at the upper two corners of the wall (modeled by COMSOL Multi physics) (Pa)

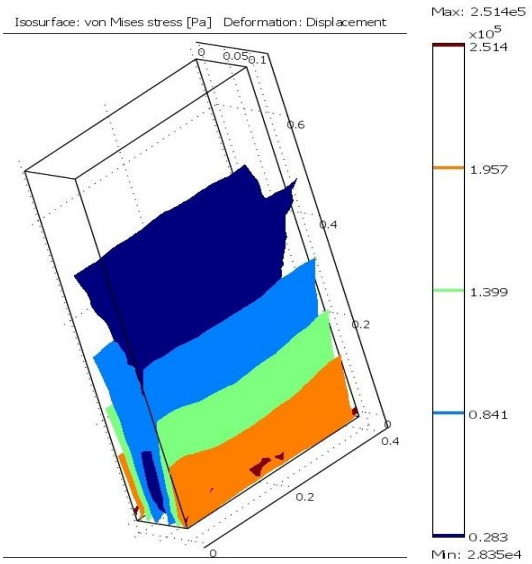

Fig. 5 Red patches showing the Von mises Stress accumulated at the lower portion of the wall (modeled by COMSOL Multi physics) (Pa)

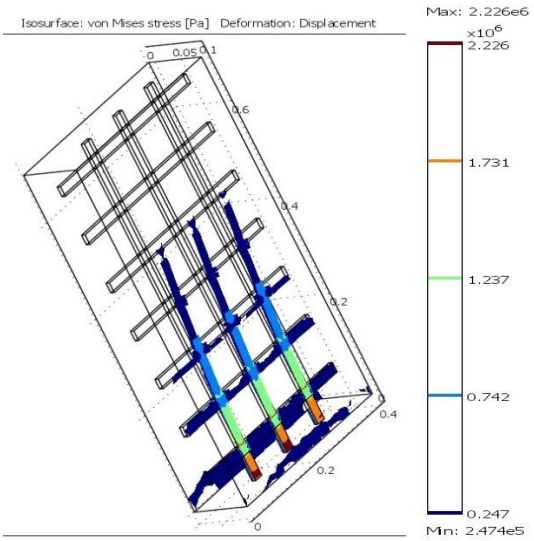

Fig. 6 Red patches showing the Von mises Stress accumulated at the lower bamboo strip portion of the wall (modeled by COMSOL Multi physics) (Pa)

V. CONCLUSIONS

The initiation and propagation of the cracks at the mud walls is still a questionable issue and also a basic finding platform of this paper. So, experimental approach is incorporated and thus more valid results are expected. But it can be safely concluded that use of bamboo reinforcement minimize the risk of sudden failure of non engineered structures during earthquakes.

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