



# **SEISMIC BEHAVIOR OF STRENGTHENED ADOBE MASONRY STRUCTURES**

**(CASE STUDY: DISTRICT AWARAN)**

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## **ABSTRACT**

Earth quake engineering in Pakistan became popular in last few decades for both assessment and design of structures. Innovation in design codes for all structural topologies with the incorporation of seismic assessment, procedures based on identification of damage status in terms of displacement thresholds have brought revolution in the said field. Most of the rural areas in Pakistan employ Adobe and mud masonry for construction dwelling.

In Pakistan, most of the rural areas use Adobe and mud masonry construction for dwelling primarily because, one, they are poor and, second, it is cheap and extreme environmental conditions favor this construction. In Baluchistan, 80% of the population is living in houses constructed of Adobe masonry. Baluchistan is an earthquake prone area and has seen many earthquakes in the past. Thus, it is essential that houses constructed in Baluchistan should be properly designed to perform well during earthquakes. Adobe and mud masonry construction did not perform well during the past earthquakes and most of the houses were severely damaged. During recent Awaran Earthquake, more than 80% of houses in earthquake hit area were completely destroyed resulting into loss of life and property. Thus, there is a need to make this type of construction better earthquake resistant.

In this research, gravity load and seismic analysis of Adobe Wall Panel (12 feet x 10 feet) having 18 inches thickness and Adobe room (12 feet x 12 feet x 10 feet) was performed using commercial software SAP2000. Nonlinear Static Pushover and Nonlinear Dynamic Time History Analysis procedures were used for Seismic Analysis. First, simple Adobe Wall Panels and then Adobe room were analyzed and the weaknesses were identified. Then, Adobe Wall Panels and Adobe room strengthened with locally available Bamboos and Palm Leaves were analyzed. Lateral displacement and shear stresses were studied under all kinds of loadings.

Before seismic and gravity load analysis, material like Adobe unit, Bamboos and Palm Leaves were obtained from Awaran area. Compressive strength, tensile strength, stress-strain curves and elastic modulus of Adobe unit and bamboos and tensile strength of Palm Leaves was determined using Universal Testing Machine of MCE. Compressive strength of Adobe prism and Adobe block is 105 psi and 42 psi, respectively. Tensile strength of Bamboos and Palm Leaves is 12886 psi and 12132 psi, respectively.

Lateral displacement of Simple Adobe Wall, Adobe Wall strengthened with Bamboos and Adobe Wall strengthened with Bamboos and Palm Leaves found from Pushover analysis is 6 in, 4.97 in and 1.2 inches, respectively. Thus, lateral displacement of Adobe Wall strengthened with Bamboos and Palm Leaves is significantly reduced as Palm Leaves provide confinement to the Adobe Wall which prevents wall from disintegration and significant energy is dissipated.

Maximum shear stress value in Simple Adobe Wall, Adobe Wall strengthened with Bamboos and Adobe Wall strengthened with Bamboos and Palm Leaves found from Time History Analysis is 71.5 psi, 31.2 in and 13 inches, respectively. Thus, shear stresses in Adobe Wall strengthened with Bamboos and Palm Leaves is significantly reduced as Palm Leaves provide confinement to the Adobe Wall which prevents wall from disintegration and significant energy is dissipated.

Keeping in view the results of adobe wall an adobe room was modeled and analyzed for shear stresses against time history analysis. There was a uniformity in distribution of shear stresses observed in reinforced adobe room. No significant concentration of shear stresses on corners of wall openings and adobe wall.

From this study, it is found that seismic performance of Adobe masonry can be significantly improved by using Bamboos and Palm Leaves which are locally available and are also cheap.

# TABLE OF CONTENTS

<i>Acknowledgement</i>	II
<i>Abstract</i>	III
<i>Table Of Contents</i>	V
<i>List Of Tables</i>	VIII
<i>List Of Figures</i>	IX

## CHAPTERS

<b>CHAPTER-1: INTRODUCTION</b>	1
1.1 STUDY BACKGROUND	1
1.2 PROBLEM STATEMENT	4
1.3 AIM AND OBJECTS	6
1.4 SCOPE	6
1.5 SCENARIOS TO BE STUDIED	8
1.6 LIMITATIONS	8
1.7 RESEARCH METHODOLOGY	9
<b>CHAPTER-2: LITERATURE REVIEW</b>	10
2.1 INTRODUCTION	10
2.2 ADOBE	11
2.2.1 <i>Definition</i>	11
2.2.2 <i>Allied Techniques</i>	11
2.2.3 <i>Division</i>	13
2.2.4 <i>Advantages</i>	15
2.2.5 <i>Disadvantages</i>	16
2.2.6 <i>Performance Against Earthquake</i>	16
2.3 Failure Patterns And Causes	17
2.3.1 <i>Dowling Theory</i>	18
2.3.2 <i>Memari And Kauffman Theory</i>	26
2.3.3 <i>Blondet Theory</i>	27
2.4 Numerical modeling	30
2.4.1 <i>Introduction</i>	30

2.4.2	<i>Non Linear Analysis Methods</i>	31
2.4.3	<i>Solution Schemes For Non Linear Behavior</i>	33
2.5	Strengthening And Retrofitting Solutions	34
2.5.1	<i>Introduction</i>	34
2.5.2	<i>Solution By H.Varum</i>	34
2.5.3	<i>Adobe Tutorial</i>	36
2.5.4	<i>Comparison Of Reinforcing Techniques</i>	48
<b>CHAPTER-3: EXPERIMENTAL WORK</b>		49
3.1	INTRODUCTION	49
3.2	TESTS PERFORMED ON ADOBE MATERIAL	49
3.2.1	<i>Compression Test On Adobe Brick Unit</i>	49
3.2.2	<i>Compression Test On Mud Masonry Block(In Situ)</i>	52
3.2.3	<i>Compression Test On Mud Masonry Block(Astm)</i>	55
3.2.4	<i>Mortar Test</i>	57
3.3	TESTS PERFORMED ON NATURALLY AVAILABLE REINFORCING MATERIAL	58
3.3.1	<i>Compression Test On Bamboo</i>	58
3.3.2	<i>Tensile Test On Bamboo</i>	59
3.3.3	<i>Tensile Test On Date Palm Leaves</i>	62
3.3.4	<i>Tensile Test On Joints/Connections</i>	63
3.4	SUMMARY OF TESTS PERFORMED	66
<b>CHAPTER-4: NUMERICAL MODELING OF ADOBE BUILDING</b>		67
4.1	FINITE ELEMENT SIMULATION OF ADOBE MASONRY	67
4.2	DATA INPUT IN SAAP 2000	68
4.2.1	<i>Selecting A Grid Frame</i>	68
4.2.2	<i>Defining Materials</i>	68
4.2.3	<i>Defining Area Section</i>	68
4.2.4	<i>Defining Functions</i>	69
4.2.5	<i>Defining Load</i>	70
4.3	ANALYSING EXISTING ADOBE MASONRY MODEL IN SAAP 2000	71

4.3.1	<i>Analysis Of Simple Adobe Wall Under Gravity Loading</i>	72
4.3.2	<i>Pushover Analysis Of Simple Adobe Wall</i>	72
4.3.3	<i>Time History Analysis Of Simple Adobe Wall</i>	73
4.4	ANALYSING ADOBE MASONRY WALL REINFORCED WITH BAMBOO FRAME	74
4.4.1	<i>Pushover Analysis Of Adobe Wall Reinforced With Bamboo Frame</i>	74
4.4.2	<i>Time History Analysis Of Adobe Wall Reinforced With Bamboo Frame</i>	75
4.5	ANALYSING ADOBE MASONRY WALL REINFORCED WITH BAMBOO FRAME AND DATE PALM LEAVES	76
4.5.1	<i>Pushover Analysis Of Adobe Wall Reinforced With Bamboo Frame And Date Palm Leaves</i>	78
4.5.2	<i>Time History Analysis Of Adobe Wall Reinforced With Bamboo Frame And Date Palm Leaves</i>	78
4.6	ANALYSIS AND RESULTS	80
	<b>CHAPTER-5: CONCLUSIONS AND RECOMMENDATIONS</b>	81
	<b>REFERENCES</b>	83

## LIST OF TABLES

TABLE	TITLE	PAGE NO
2.1	Earthquakes in areas where mud masonry is used extensively	17
2.2	Comparison of Reinforcing Techniques	48
3.1	Dimensions of Mud Brick	50
3.2	Compressive Strength of Adobe Mud Bricks	51
3.3	Results of Compressive Strength of Mud Block	54
3.4	Results of Compressive Strength of Mud Block (ASTM)	56
3.5	Compressive strength of Mortar	57
3.6	Results of Compressive Strength of Bamboo	59
3.7	Results of Tensile Strength of Bamboo Strips	60
3.8	Results of Tensile Strength of Composite Bamboo	61
3.9	Results of Tensile Strength of Date Palm Leaves	63
3.10	Summary of tests performed	66
4.1	Mechanical properties of Materials	67
4.2	Lateral displacements for all kinds of wall for pushover load case	80



## LIST OF FIGURES

FIGURE	TITLE	PAGE NO
1.1	Global distribution of Earth Architecture	2
1.2	Earthquake damages to adobe houses	3
1.3	Awaran Earthquake, 2013	4
1.4	Location of different Tectonic Plates converging in Pakistan	5
2.1	Tapial construction technique	12
2.2	Construction process of Quincha panel	13
2.3	Global maps of mud masonry and earthquake prone areas	14
2.4	Modern adobe home (Earth ways, Wollemi, Australia)	15
2.5	Vertical corner cracking due to shear failure	18
2.6	Vertical corner cracking due to tearing failure	19
2.7	Vertical crack of a corner, Awaran, 2013	19
2.8	Overturning of upper part of wall, Awaran, 2013	20
2.9	Overturning of upper part of wall	20
2.10	Vertical cracking and overturning of wall panel	20
2.11	Inclined cracking in wall, Awaran, 2013	21
2.12	Inclined cracking in wall due to in-plane shear	21
2.13	Inclined cracking	22
2.14	Sequence of corner dislocation	23
2.15	Corner dislocation, Awaran, 2013	23
2.16	Horizontal cracking in upper section of wall panel	24
2.17	Horizontal cracking, Awaran, 2013	24
2.18	Displacement of roof, Awaran, 2013	25
2.19	Seismic effects on adobe masonry [CENAPRED 2003]	26
2.20	Vertical cracks at wall's intersection Peru, 2007	27
2.21	Roof collapse Awaran,2013	27
2.22	When roof joist rested on the façade	28
2.23	Roof joist rested on transverse walls Awaran,2013	28
2.24	Corner house Awaran,2013	29

2.25	'V' shaped cracks in corner buildings Peru,2007	29
2.26	Typical X-shape cracks Peru,2007	30
2.27	Internal cane/timber reinforcement	35
2.28	External can reinforcement	36
2.29	Dry Strength test	37
2.30	Roll test	38
2.31	Adding and mixing of straw to soil	38
2.32	Micro cracking control test	39
2.33	Concrete foundation with asphalt layer	40
2.34	Uniform and filled mortar joints	40
2.35	Covering walls with mud plaster	41
2.36	Empirical recommendations regarding wall construction	42
2.37	Box type layout	43
2.38	Wooden ring beam	44
2.39	Welded wire mesh	44
2.40	Construction scheme using polymer mesh	45
2.41	Used car tires as reinforcement	46
2.42	Polypropylene bands reinforcing technique	46
2.43	Integral masonry scheme	47
3.1	Compression test on adobe brick unit	51
3.2	Compression test Stress-Strain curve	52
3.3	Compression test on mud masonry block	53
3.4	Stress-Strain curve of mud block (in situ)	54
3.5	Compression Test on Mud Masonry Block	55
3.6	Stress-Strain curve Mud Block (ASTM)	57
3.7	Compression test on bamboo	58
3.8	Tensile test on Date palm leaves	63
3.9	Tensile tests on T- joints	64
3.10	Load-Deformation curve for T-joints	65
3.11	Tensile tests on L-joints	65
3.12	Load-Deformation curve for L-joints	66

4.1	Defining materials	68
4.2	Defining area section	69
4.3	Defining functions	69
4.4	Defining load cases	70
4.5	Over view of model room before analysis	71
4.6	Adobe wall with vertical point loads	71
4.7	Deformed shape of Adobe wall under gravity loading	72
4.8	Deformed shape of adobe wall for pushover analysis	73
4.9	Shear stresses in adobe wall for Time History function	73
4.10	Adobe wall with bamboo frame	74
4.11	Deformed shape of adobe wall with bamboo frame for pushover analysis	75
4.12	Overview of shear stresses in adobe wall with bamboo frame	76
4.13	Adobe wall reinforced with bamboo frame and palm leaves	77
4.14	Adobe wall reinforced with bamboo frame and palm leaves	77
4.15	Deformed shape of reinforced adobe wall for push over load case	78
4.16	Overview of shear stresses in Adobe wall for time history load case	79