# Analysis and Design of RC Structure with Light Weight Bricks Using Etabs

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**Abstract.** A Building has to be defined is an enclosed structure intended for human occupancy. Constructions work has been seen in most of the countries developing with the increase of material cost in the construction work, there is a need to find more cost which can be affordable to people. In the manufacturing of brunt clay bricks, smoke evolved at a great extent and also toxic gases which can harm an environment. So, as to overcome with all these problems. From previous research observed that light weight bricks of Recycle paper mill residue (RPMR) and rice husk ash (RHA) which composes of Recycle paper mill residue (RPMR) and rice husk ash (RHA) and cement which are more economical and eco-friendly. The use of recycle factory residue and rice husk ash bricks are reduce load of wall on beams and columns makes it a relatively lighter members and reducing the hundreds (or) moments. This project includes analysis and design of multi-stored RC structure (G+3) with light weight bricks by using ETABS, comparison will be done with conventional bricks.

#### **1** Introduction

Building construction is that the engineering deals with the development of building like residential houses. In a simple building are often define as an enclose space by walls with roof, food, cloth and therefore the basic needs of citizen. In the early past humans lived in caves, over trees or under trees, to guard themselves from wild animals, rain, sun, etc. as the times passed as humans being started living in huts made from timber branches. The shelters of these old are developed nowadays into beautiful houses. Rich people live in sophisticated condition houses.

A homogeneous mixture of RPMR (Recycle paper mill residue) – RHA (rice husk ash) – cement was prepared with varying proportions, each set comprising of varying percentage of RPMR, RHA and cement were prepared. Sample set A has 80% RPMR, 10% RHA and 10% of cement by weight, sample set B has 75% RPMR, 15% RHA and 10% cement by weight whereas sample set C has 70% RPMR, 20% RHA and 10% of cement by weight. Results suggests that the optimum mix, both in terms of the strength parameters and overall physico-chemical characteristics will be 80% RPMR, 10% RHA and 10% cement.

In this project, attempt has to been done to replace the red bricks with light weight blocks. The use of light weight block significantly reduces the cost of construction. Compressive strength of RPMR–RHA–cement brick was increased and found to be more than 11MPa in all the three samples. All brick samples had excellent compressive strength (11–15 MPa) is nearly five times higher than the compressive strength of the conventional burnt clay brick. RHA and RPMR block is a load-bearing construction material that is of lower density(588kg/m3) than other construction materials due to its high porosity. Due to its lower density of these blocks, tall buildings constructed using these blocks have less need for steel and concrete for structural members.

This project mainly deals with the comparative analysis of conventional bricks and light weight bricks, results which are obtained from the analysis of a multi storied building where analyzed by using ETABS software.

## 2. METHODOLOGY

#### Steps to Analyse and Design of Building:

Creating of grid points and generation of structure- After getting opened the program, select a new model and a window appears where we had entered the details of grid dimensions and story dimensions of our building. Here the program had generated 2D and 3D structure by specifying the building details in the two windows.

Grid Dimensions (Plan)	Story Dimensions
O Uniform Grid Spacing	Simple Story Data
Number of Grid Lines in X Direction	Number of Stories 4
Number of Grid Lines in Y Direction	Typical Story Height 3
Spacing of Grids in X Direction	Bottom Story Height 3
Spacing of Grids in Y Direction	
Specify Grid Labeling Options	id Labels
Custom Grid Spacing	Custom Story Data
Specify Data for Grid Lines	t Grid Data Specify Custom Story Data Edit Story Data
Add Structural Objects	

Fig. 1. Creation of grid points & structure generation

centra dyskemi ne	me		Story R	ange Option		Click to Modify	/Show:			
21			۵ ۵	efault - All Stories		B	eference Points			
Susteen Oxioio			0 0	ser Specified		Re	ference Planes			AUBUC
Clobal X	0	-		Top Story		0.0			(4)-	+++
Clobal V	0			360194		D Able Car	1250	-	3-	+++
Rotation	0	deg		Base		Grid Color	1280		A:	
Rectangular G	ide Grid Date as Ordenat		0.0	incine Onto Data an	Snacing			Outrie St	at New Rectance In	Goda
X Grid Data			0.	apay are can ar	upacing .	Y Grid Data				
Grid II	> × Ordinate (	m)	Visible	Bubble Loo		Geed ID	Y Ordinate (m)	Vsble	Bubble Loc	
A	0		Yes	End	Add	1	0	Yes	Start	Add
В	2.74		Yes	End	Delete	2	2.13	Yes	Start	Delete
С	5.48		Yes	End		3	5.69	Yes	Start	
					-	4	9.19	Yes	Start	
										304
Seneral Grids										
Grid ID	X1 (m			Y1 (n)	X2 (m)	Y	2 (m)	Visible	Bubble Loc	
										Add
										Delete
										Sort by I

Fig. 2. Grid system data

1. Defining of fabric property and sectional property. After making the grids, begin to outline the fabric property bychoosing outline menu-material properties (define concrete and steel reinforcement). afterward outline section properties (beams, columns, slabs and wall) bygivingthe required details in shaping. Afterward we tend to outline section size bychoosingframe sections as shown below and supplementarythe desired section for beams, column etc.`



Fig. 3. Defining the material properties

General Data		General Data		
Material Name		Material Name	HYSD415	
Rateria Type Ca	screte	Material Type	Rebar	$\vee$
Directional Symmetry Type	topic V	Directional Symmetry Type	Uniaxial	
Material Display Color	Change	Material Display Color	Change	
Material Notes	Modify/Show Notes	Material Notes	Modify/Show Notes	
Material Weight and Mass				
Specify Weight Density	<ul> <li>Specify Mass Density</li> </ul>	Material Weight and Mass		
Weight per Unit Volume	24.9926 kN/m <sup>3</sup>	<ul> <li>Specify Weight Density</li> </ul>	<ul> <li>Specify Mass Density</li> </ul>	
Mass per Unit Volume	2548.538 kg/m <sup>3</sup>	Weight per Unit Volume	76.9729	kN/m <sup>3</sup>
Mechanical Property Data		Mass per Unit Volume	7849.047	kg/m³
Modulus of Elasticity, E	25000 MPa	Mechanical Property Data		
Poisson's Ratio, U	0.2	Modulus of Elasticity, E	200000	MPa
Coefficient of Thermal Expansion, A	0.0000055 1/C	Coefficient of Thermal Expansi	ion. A 0.0000117	1/C
Shear Modulus, G	10416.67 MPa			
		Design Property Data		
Modify/Show Material	Property Design Data	Modify/Shi	ow Material Property Design Data	
		Advanced Material Property Data		
Advanced Material Property Data		Nonlinear Material Data	Material Damping R	Properties
Nonlinear Material Data	Material Damping Properties		me Denundarit Pronettes	
Time Depend	ent Properties		the surplet set of the set of the set of the	

Fig. 4. Assigning of material property data



Fig.5. Assigning of sectional property data

2. Assigning of defined properties to the grid points. After defining the property for material and section properties, now draw the structural components using command menu > Draw line for beam and create column in degion for columns by which property assigning is completed for beams and columns sections.



Fig.6. Assigning of different properties to the grid points

 Assigning of supports. After drawing the details of building (beams, columns slabs, wall), now assign the supports by going to assign menu > joint menu > restraints > fixed.

Joint Assignment - Restraints	x
Restraints in Global Directions	
Translation X Rotation about X	
Translation Y Rotation about Y	
Translation Z Rotation about Z	
Fast Restraints	
OK Close Apply	-

Fig.7. Assigning of supports

- 4. Defining of loads. The loads in ETABS program are defined as using static load cases command in define menu.
- 5. Assigning of dead load (IS 875:1987 part 1). After defining all the loads, dead loads are assigned for external walls and internal walls, slabs. As per IS:875(part-1) -1987, Indian Standard code of practice dead load include weight of walls (exterior and interior walls) floor finishes, false ceilings and the permanent constructions within the buildings.

Load Pattern Name	Dead $\checkmark$
Jniform Load Load <b>15</b> Direction Gravity ~	options         kN/m²       Add to Existing Loads         Image: Constraint of the existing Loads
OK Fig.8. Assi	Close Apply
A B C 3100 127100 4 4 4 4 4 4 527100 10 10 10 10 10 10 10 10 10	

Fig.9. Loading diagram of dead loads

6. Assigning of Live load (IS 875:1987 part 2).Live loads are assigned for the entire structure including floor finishing. This load is created by the moving loads, distributed and targeted masses and also with the supposed use or occupancy of a building.

Load Pattern Name	Live	~
Jniform Load		Options
Load 3	kN/m²	Add to Existing Loads
		Replace Existing Loads
Direction Gravity ~		<ul> <li>Delete Existing Loads</li> </ul>

Fig.10. Assigning of live load



Fig.11. Loading diagram of live load and dead load

 Assigning of load combinations (IS 875:1987 part 5).Load combinations are given based on IS 875:1987 Part 5 using load combinations command in define menu.

the second	1.50	1+11	
	1.0(6		
Combination Type	Linea	er Add	
Notes		Modify/Show No	tes
Auto Combination	No		
Dead	$\sim$	1.5	Add
Dead	~	1.5	Add
live			Delete
Live		1.5	
Live		1.5	
Live		1.5	
Live		1.9	

Fig.12. Assigning of load combinations

8. Analysing and checking all the errors. After completion of all steps above, now perform the analysis and check the errors. Errors occurred are resolved at the located frame and section.

Length Tolerance for Checks Length Tolerance for Checks Joint Checks Joints/Joints within Tolerance Joints/Frames within Tolerance Joints/Shells within Tolerance Frame Checks Frame Overlaps Frame Intersections with Area Edges Shell Checks Shell Overlaps Other Checks Check Meshing for All Stories Check Loading for All Stories OK Cancel	neck Model	
Length Tolerance for Checks       1       mm         Joint Checks        Joints/Joints within Tolerance         Ø Joints/Frames within Tolerance       Joints/Shells within Tolerance         Ø Joints/Shells within Tolerance       Frame Checks         Frame Checks       Frame Intersections within Tolerance         Frame Intersections with Area Edges       Shell Checks         Ø Shell Overlaps       Shell Overlaps         Other Checks       Check Meshing for All Stories         Ø Check Loading for All Stories       Ok	Length Tolerance for Checks	
Image: Stress of the stress	Length Tolerance for Checks	1 n
<ul> <li>Joints/Joints within Tolerance</li> <li>Joints/Frames within Tolerance</li> <li>Joints/Shells within Tolerance</li> <li>Frame Checks</li> <li>Frame Overlaps</li> <li>Frame Intersections within Tolerance</li> <li>Frame Intersections with Area Edges</li> <li>Shell Checks</li> <li>Shell Overlaps</li> <li>Other Checks</li> <li>Check Meshing for All Stories</li> <li>Check Loading for All Stories</li> <li>OK</li> </ul>	Joint Checks	
<ul> <li>Joints/Frames within Tolerance</li> <li>Joints/Shells within Tolerance</li> <li>Frame Checks</li> <li>Frame Overlaps</li> <li>Frame Intersections within Tolerance</li> <li>Frame Intersections with Area Edges</li> <li>Shell Checks</li> <li>Shell Overlaps</li> <li>Other Checks</li> <li>Check Meshing for All Stories</li> <li>Check Loading for All Stories</li> <li>OK</li> </ul>	Joints/Joints within Tolerance	
<ul> <li>✓ Joints/Shells within Tolerance</li> <li>Frame Checks</li> <li>✓ Frame Intersections within Tolerance</li> <li>✓ Frame Intersections with Area Edges</li> <li>Shell Checks</li> <li>✓ Shell Overlaps</li> <li>Other Checks</li> <li>✓ Check Meshing for All Stories</li> <li>✓ Check Loading for All Stories</li> <li>✓ OK Cancel</li> </ul>	Joints/Frames within Tolerance	
Frame Checks   Frame Overlaps  Frame Intersections within Tolerance  Frame Intersections with Area Edges  Shell Checks  Shell Overlaps  Other Checks  Check Meshing for All Stories  OK  Cancel	Joints/Shells within Tolerance	
<ul> <li>Frame Overlaps</li> <li>Frame Intersections within Tolerance</li> <li>Frame Intersections with Area Edges</li> <li>Shell Checks</li> <li>Shell Overlaps</li> <li>Other Checks</li> <li>Check Meshing for All Stories</li> <li>Check Loading for All Stories</li> <li>OK</li> </ul>	Frame Checks	
<ul> <li>Frame Intersections within Tolerance</li> <li>Frame Intersections with Area Edges</li> <li>Shell Checks</li> <li>Shell Overlaps</li> <li>Other Checks</li> <li>Check Meshing for All Stories</li> <li>Check Loading for All Stories</li> <li>OK</li> </ul>	Frame Overlaps	
Frame Intersections with Area Edges  Shell Checks  Shell Overlaps  Other Checks  Check Meshing for All Stories  Check Loading for All Stories  OK  Cancel	Frame Intersections within Tolera	ance
Shell Checks  ✓ Shell Overlaps  Other Checks  ✓ Check Meshing for All Stories  ✓ Check Loading for All Stories  OK Cancel	Frame Intersections with Area Ed	lges
Checks Check Loading for All Stories OK Cancel	Shell Checks	
Other Checks  Check Meshing for All Stories  Check Loading for All Stories  OK Cancel	Shell Overlaps	
Check Meshing for All Stories Check Loading for All Stories OK Cancel	Other Checks	
Check Loading for All Stories	Check Meshing for All Stories	
OK Cancel	Check Loading for All Stories	
	ОК	Cancel

Fig.13. Performing the analysis and checking the errors

9. Performing of concrete design on the structure as per IS 456: 2000 code book. This step considers the last step of procedure. After completing the analysis, now perform concrete design on the structure as per IS code of practice. For this go to Design menu > concrete design > select design combinations. After this again go to design menu> concrete frame design > Start design\ check of structure. Then the ETABS software performs the design for every structural element.



Fig.14. Showing used codes books

#### **3. CALCULATIONS**

#### LOAD CALCULATIONS:

The load calculation of the structure is calculated as follows;

- Live Load :3kN/m2  $\geq$ 
  - Dead Load (floor finishes) :1.5kN/m2
- Wall Loads (light weight bricks)
  - For 9" wall  $- 0.23 \times 3 \times 5.76 = 3.973 \text{kN/m}$
  - For 4.5" wall - 0.11 x 3 x 5.76 = 1.903kN/m
- For parapet wall  $-0.11 \times 1.2 \times 5.76 = 0.760 \text{kN/m}$ Wall Loads (conventional bricks)
  - For 9" wall  $- 0.23 \times 17.65 \times 3 = 12.183 \text{kN/m}$
  - For 4.5" wall  $- 0.11 \times 17.65 \times 3 = 5.833 \text{kN/m}$
  - For parapet wall  $-0.11 \times 17.65 \times 1.2 = 2.33 \text{ kN/m}$

#### 4. DESIGN AND ANALYSIS

After the detailed analysis of structure, the following results are obtained which shows the area of steel required in respective structural members (beams, columns, shear walls). Along with the steel area, the bending moment details, shear force details and deflections in each beam is also obtained in a systematic manner. All these details are obtained in an auto generated file which is generated automatically by ETABS software while we work on the structure. Necessary snapshots are given in this chapter.

As beams, columns and slabs are designed in detailed manner in ETABS, the design of footing is done in Microsoft Excel Spreadsheets. Also manual calculations have been performed for Beams, slabs and columns and checked with software results.

After obtaining the detailed design reports and necessary AutoCAD plans, the 3D modelling of the structure is carried out in E-TABS for analysis and design. We have also done the Rebar Modelling which shows the reinforcement details structural members as per the design.

#### STRUCTURE DATA **Story Data**

	Table 1. Story Data							
Name	Heigh t mm	Elevati on mm	Master Story	Simila r To	Splice Story			
Story4	3000	12000	No	None	No			
Story3	3000	9000	No	Story4	No			
Story2	3000	6000	No	Story4	No			
Story1	3000	3000	No	Story4	No			
Base	0	0	No	None	No			

#### Grid Data

Table 2. Grid Systems

Nam e	Туре	Story Range	X Origi n m	Y Origi n m	Rotatio n deg	Bubbl e Size mm	Color
G+3	Cartesia n	Defaul t	0	0	0	1250	GRA Y

	Table 3. Grid Lines						
Grid	Grid	Grid	Visible	Bubble	Ordinate		
System	Direction	ID	v ISIOIC	Location	m		
G+3	Х	Α	Yes	End	0		
G+3	Х	В	Yes	End	2.74		
G+3	Х	С	Yes	End	5.48		
G+3	Y	1	Yes	Start	0		
G+3	Y	2	Yes	Start	2.13		
G+3	Y	3	Yes	Start	5.69		
G+3	Y	4	Yes	Start	9.19		

#### PROPERTIES

#### Materials

 Table 4. Material Properties - Summary

Name	Туре	E MPa	ν	Unit Weight kN/m <sup>3</sup>	Design Strengths
HYSD415	Rebar	200000	0	76.9729	Fy=415 MPa Fu=485 MPa
M25	Concrete	25000	0.2	24.9926	Fc=25 MPa

#### **Frame Sections**

The Frame sections that is columns and beams that are used in the structure are given with the material, shape and size used

Table 5	. Frame	Sections	for	conventional	bricks
---------	---------	----------	-----	--------------	--------

Name	Material	Shape	Size
B1 - 230	M25	Concrete	230mm X
300		Rectangular	300mm
B2 - 230	M25	Concrete	230mm X
250		Rectangular	250mm
B3 - 230	M25	Concrete	230mm X
230		Rectangular	230mm
C 230	M25	Concrete	230mm X
450		Rectangular	450mm

#### **Shell Sections**

Table 6. Shell Sections - Summary

Name	Design Type	Element Type	Material	Total Thickness mm
Slab120	Slab	Shell-Thin	M25	120

#### **Reinforcement Sizes**

The following reinforcement sizes are used for the structures.

#### Table 7. Reinforcing Bar Sizes for conventional building

Name	Diameter mm	Area mm²
12	12	113
16	16	201
25	25	491
26	26	531

Table 8. Reinforcing Bar Sizes for light weight building

Name	Diameter mm	Area mm²
10	10	79
12	12	113
16	16	201
20	20	314

#### LOADS

The loading information is applied to the models as shown below.

#### **Load Patterns**

Loau I atterns						
Table 9. Load Patterns						
Name	Туре	Self Weight Multiplier				
Dead	Dead	1				
Live	Live	0				

#### Load Cases

Table 10. Load Cases - Summary

Name	Туре
Dead	Linear Static
Live	Linear Static

## Load Combinations

Name	Load Case/Combo	Scale Factor	Type	Auto
1.5(DL+ LL)	Dead	1.5	Linear Add	No
1.5(DL+ LL)	Live	1.5		No

### **5. ANALYSIS RESULTS**

#### SFD and BMD of Conventional Building



Fig.15. SFD of conventional building



Fig.16. BMD of conventional building





Fig.17. SFD of Light weight building



Fig.18. BMD of Light weight building

**Deformed Shapes** 



Fig.19. Displacements of Conventional and Light Weight Buildings

#### **DESIGN RESULTS**

Longitudinal reinforcement for different stories of conventional building





2.74 (m)



2.74 (m)

153 153 153

216 216 216

130 130 130

130 130 130

183 183 183

216 216 216

183 183 183

191

153

166

186

153

186

153



136

183

30 06

179

162 183

30 83

167

30 32

83

83 30

153 153 153 153 153 153 153

Story3

183

216 216 216

183



2.13 (m)

Fig.20. Plan views of longitudinal reinforcement details of

different stories

38

38

153 38 153

216 216

Story4

## Longitudinal Reinforcement for Different Stories of **Light Weight Building**













153
216

153
216

38

153

153

38

38

183 183

153 38 153

216 216 216

32

32

## Rebar percentage for Different Stories of Conventional Building

## Rebar percentage for Different Stories of Light Weight Building







Fig.23. Plan views of Rebar Percentage of different stories

Shear Reinforcement for Different Stories of Conventional Building



Fig.24. Plan views of Shear Reinforcement details of different stories

## Shear Reinforcement for Different Stories of Light Weight Building



Fig.25. Plan views of Shear Reinforcement details of different stories

## 6. RESULTS AND DISCUSSIONS

**Structural Modelling of Building in E-TABS 2017** 



Fig.26. Plan of the model



Fig.27. 3D view of the model



Fig.28. 3D-Render view of the model

#### Structural Details of a Building with Conventional and Light Weight Bricks at story 1











Fig.31. Maximum SF and BM of Beam B14 of conventional building



Fig.33. maximum SF and BM of column C1 of conventional building



Fig.34. maximum SF and BM of Beam B14 of Light Weight building

.oad Case/Load Comb	nation			End Offse	t Location	
🔿 Load Case	Load Combination	n 🔿 Modal	Case	I-End	0.0000	m
1.5(DL+LL)	~			J-End	2.7000	m
				Length	3.0000	m
Component	D	isplay Location				
Major (V2 and M3)	× (	Show Max	O Scroll for	Values		
					6.0296 kN at 2.7000 m	
				-	6.0296 kN at 2.7000 m	
Ioment M3					6.0296 kN at 2.7000 m -10.5907 kN-	m
Ioment M3					6.0296 kN at 2.7000 m -10.5907 kN- at 2.7000 m	m

## Fig.35. maximum SF and BM of column C1 of Light Weight building



## Fig.36. maximum SF and BM of Column C7 of conventional building



Fig.37. maximum SF and BM of Column C7 of Light Weight building

#### ANALYSIS RESULTS

Percentage of reduction in BM and SF in Corner Beam9 from figures 6.4 & 6.5:

> From the analysis 6.15% of shear force is reduced in light weight bricks when compared to conventional bricks.

Where as 11.690% of bending moment is reduced in beam.

Percentage of reduction in BM and SF in Corner Column1 from figures 6.8 & 6.9:

➤ From the analysis 5.260% 0f shear force is reduced in light weight bricks when compared to conventional bricks.

> Where as 7.897% of bending moment is reduced in column.

Percentage of reduction in BM and SF in Intermediate Beam14 from figures 6.6 & 6.7:

➤ From the analysis 3.312% of shear force is reduced in light weight bricks when compared to conventional bricks

> Where as 7.244% of bending moment is reduced in beam

Percentage of reduction in BM and SF in Intermediate Column7 from figures 6.10 & 6.11:

➤ From the analysis 17.43% 0f shear force is reduced in light weight bricks when compared to conventional bricks.

> Where as 17.21% of bending moment is reduced in column.

#### DESIGN DATA

#### **Concrete Frame Design**

• Column details

Table 12. Conventional Brick Column Summary	1
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Story	Label	Station mm	Load combinations	At v major mm²/m	At v minor mm²/m
Story 1	C1	0	1.5(DL+LL)	332.53	554.22
Story 1	C1	1325	1.5(DL+LL)	332.53	554.22
Story 1	C1	2650	1.5(DL+LL)	332.53	554.22
Story 1	C7	0	1.5(DL+LL)	332.53	554.22
Story 1	C7	1350	1.5(DL+LL)	332.53	554.22
Story 1	C7	2700	1.5(DL+LL)	332.53	554.22

Story	Label	Station mm	Load combinations	At v major mm2/m	At v minor mm2/m
Story 1	C1	0	1.5(DL+LL)	254.94	498.8
Story 1	C1	1350	1.5(DL+LL)	254.94	498.8
Story 1	C1	2700	1.5(DL+LL)	254.94	498.8
Story 1	C7	0	1.5(DL+LL)	254.94	498.8
Story 1	C7	1375	1.5(DL+LL)	254.94	498.8
Story 1	C7	2750	1.5(DL+LL)	254.94	498.8

#### Table 13. Light Weight Brick Column Summary

#### • Corner Beam – B9

<b>Table 14.</b> Conventional blick Corner Deam Summa	Table 14.	Conventional Brick Corner Beam Summary
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Stor y	Labe l	Statio n mm	Desig n sectio n	Load combination s	As top mm 2	As botto m mm2
Stor y 1	В9	250	230 x 350	1.5(DL+LL)	179	216
Stor y 1	В9	718.3	230 x 350	1.5(DL+LL)	153	216
Stor y 1	В9	1186.7	230 x 350	1.5(DL+LL)	153	216
Stor y 1	В9	1186.7	230 x 350	1.5(DL+LL)	153	216
Stor y 1	В9	1582.2	230 x 350	1.5(DL+LL)	153	216
Stor y 1	В9	1977.8	230 x 350	1.5(DL+LL)	153	216
Stor y 1	В9	2373.3	230 x 350	1.5(DL+LL)	153	216
Stor y 1	В9	2373.3	230 x 350	1.5(DL+LL)	153	216
Stor y 1	В9	2841.7	230 x 350	1.5(DL+LL)	153	216
Stor y 1	В9	3310.0	230 x 350	1.5(DL+LL)	184	216
					1587	2160

Table 15. Light Weight Brick Corner Beam Summary

Stor y	Labe l	Statio n mm	Desig n sectio n	Load combination s	As top mm 2	As botto m mm2
Stor y 1	В9	225	230 x 300	1.5(DL+LL)	197	183
Stor y 1	В9	705.8	230 x 300	1.5(DL+LL)	130	183
Stor y 1	В9	1186.7	230 x 300	1.5(DL+LL)	130	183
Stor y 1	В9	1186.7	230 x 300	1.5(DL+LL)	130	183
Stor y 1	В9	1582.2	230 x 300	1.5(DL+LL)	130	183
Stor y 1	В9	1977.8	230 x 300	1.5(DL+LL)	130	183
Stor y 1	В9	2373.3	230 x 300	1.5(DL+LL)	130	183
Stor y 1	В9	2373.3	230 x 300	1.5(DL+LL)	130	183
Stor y 1	В9	2854.2	230 x 300	1.5(DL+LL)	130	183
Stor y 1	В9	3335	230 x 300	1.5(DL+LL)	201	183
					1438	1830

#### • Intermediate Beam – B14

Table 16. Conventional Brick Intermediate Beam Summary

Stor y	Labe l	Statio n mm	Desig n sectio n	Load combination s	As top mm 2	As botto m mm2
Stor y 1	B14	250	230 x 300	1.5(DL+LL)	164	183
Stor y 1	B14	718.3	230 x 300	1.5(DL+LL)	130	183
Stor y 1	B14	1186.7	230 x 300	1.5(DL+LL)	130	183
Stor y 1	B14	1186.7	230 x 300	1.5(DL+LL)	130	183
Stor y 1	B14	1582.2	230 x 300	1.5(DL+LL)	130	183
Stor y 1	B14	1977.8	230 x 300	1.5(DL+LL)	130	183
Stor y 1	B14	2373.3	230 x 300	1.5(DL+LL)	130	183
Stor y 1	B14	2373.3	230 x 300	1.5(DL+LL)	130	183
Stor y 1	B14	2841.7	230 x 300	1.5(DL+LL)	130	183
Stor y 1	B14	3310.0	230 x 300	1.5(DL+LL)	170	183
					1374	1830

 Table 17. Light Weight Brick Intermediate Beam Summary

Stor y	Labe l	Statio n mm	Desig n sectio n	Load combination s	As top mm 2	As botto m mm2
Stor y 1	B14	225	230 x 250	1.5(DL+LL)	196	150
Story 1	B14	705.8	230 x 250	1.5(DL+LL)	106	150
Stor y 1	B14	1186.7	230 x 250	1.5(DL+LL)	106	150
Stor y 1	B14	1186.7	230 x 250	1.5(DL+LL)	106	150
Stor y 1	B14	1582.2	230 x 250	1.5(DL+LL)	106	152
Stor y 1	B14	1977.8	230 x 250	1.5(DL+LL)	106	150
Stor y 1	B14	2373.3	230 x 250	1.5(DL+LL)	106	150
Stor y 1	B14	2373.3	230 x 250	1.5(DL+LL)	106	150
Stor y 1	B14	2854.2	230 x 250	1.5(DL+LL)	106	150
Stor y 1	B14	3335	230 x 250	1.5(DL+LL)	203	150
					1247	1502

#### DATA RESULTS

Corner Beam Details of Conventional Brick and Light Weight Bricks:

➤ From the above tables, we observed that the area of top reinforcement in light weight brick decreases upto 9.4% and also 15.28% area of bottom reinforcement decreased in light weight brick compared to conventional brick.

Intermediate Beam Details of Conventional Brick and Light Weight Bricks:

> From the above tables, we observed that the area of top reinforcement in light weight brick decreases upto 9.2% and also 17.92% area of bottom reinforcement decreased in light weight brick compared to conventional brick.

## 7. CONCLUSIONS

The following conclusions can be enumerated point wise as follows:

- 1. In Beams, considering light weight bricks effect, the values of bending moment, shear force, area of reinforcement is less compared to conventional bricks.
- 2. The bending moment in light weight bricks decreased upto 11% and also shear force in light weight bricks decreased upto 8.03%.so there is a reduction in the size of the sections.

- 3. The area of reinforcement in light weight bricks of columns decreased upto 16.66%
- 4. The area of reinforcement in light weight bricks of corner beams decreased upto 12.34% and area of reinforcement in light weight bricks of intermediate beams decreased upto 13.56%.

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