“SELF SUSTAINABLE BUILDING ANALYSIS AIDED STRUCTURAL DESIGN, ESTIMATION AND COSTING”

A PROJECT

Submitted in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision of

Mr. Chandra Pal Gautam

Assistant Professor

By

Tarak Kuthiala (121628)

Ashish Sharma (121627)

To

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

WAKNAGHAT SOLAN – 173 234

HIMACHAL PRADESH INDIA

JUNE, 2016

CERTIFICATE

This is to certify that the work which entitled " **SELF SUSTAINABLE BUILDING ANALYSIS AIDED STRUCTURAL DESIGN, ESTIMATION AND COSTING** " in partial fulfillment of the requirements for the award of the degree of Bachelor of technology in Civil Engineering by Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by **Tarak Kuthiala (121628) and Ashish Sharma (121627)** during a period from July 2015 to June 2016 under the supervision of **Mr. Chandra Pal Gautam Assistant Professor.** This work has not been submitted partially or wholly to any other University or Institute for the award of this or any other degree/diploma.

The above statement made is correct to the best of our knowledge.

Date ………………..

……………………	………………….	…………………
Dr. Ashok Kumar Gupta	Mr. Chandra Pal Gautam	External Examiner
Head of Department	Assistant Professor	
Department of Civil Engineering	Department of Civil Engineering	
JUIT Waknaghat	JUIT Waknaghat	

ACKNOWLEDGEMENT

This project report gives a detailed insight to the work done on the project titled "**SELF SUSTAINABLE BUILDING ANALYSIS AIDED STRUCTURAL DESIGN, ESTIMATION AND COSTING**" in the final year for the partial fulfillment of the requirements for the degree of Bachelor of Technology in Civil Engineering, under the supervision of Mr. Chandra Pal Gautam (Project Guide, Assistant Professor).

We are extremely grateful to Mr. Chandra Pal Gautam (Project Guide, Assistant Professor), Mr. Lav Singh (Assistant Professor, Department of Civil Engineering, JUIT) for their help and guidance without whom this project could not have succeeded. Gratitude continues to Er. Ajay Kuthiala, Er. Raj Kumar Yadav, Er. Rajesh Sood and Er. Karan Veer Singh Bhadwal who all advised and steered us in the right direction making it possible for us to understand the reality of the concept and its practical applications.

Date: June 1, 2016

Tarak Kuthiala (121628)

Ashish Sharma (121627)

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ABSTRACT

Going Green in building constructions avails us many environmental, economical as well as social benefits. Example if all buildings in urban areas were made to adopt Green Building concepts, India could save more than 8400 MW of power annually which is enough to light half of Delhi or 5.5 lakh homes a year according to estimates by TERI.

Hence, in context of that, we worked on the Self Sustainable Building Analsis Aided Structural Design, Estimation and Costing of Univesity hostel design, using economical green materials to effectively improve lighting, electricity, cost, insulation, water needs and demand on resources. This study replaces certain conventional applications with easy economical substitutes, structural elemental designs and a comparative study between our design incorporations and conventional applications; We have also managed to presents bill of quantities calculating project finances, project network with PERT and CPM analysis. Also we have determined energy and water demand in a 5 floors 60 resident 225 m^2 built up area of hostel block.

While analyzing the structure using STAAD Pro we have realized the discrepancies between software designs and manual designs to the effect that how overly safe the software designs are hence making them expensive, which can be checked by designed Excel files.

CHAPTER 1: INTRODUCTION

1.1 What is a Green Building?

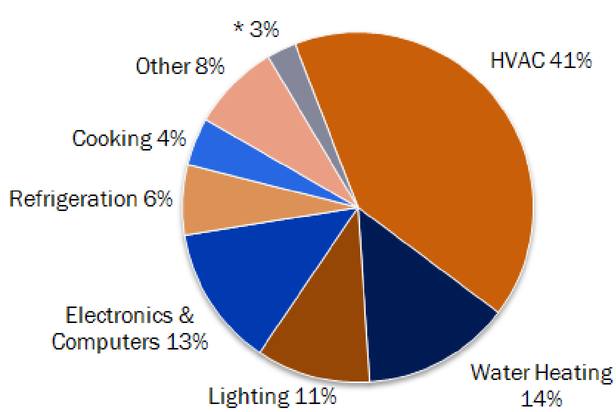
Green Building refers to the incorporation of environment friendly and resource efficient processes at each stage of construction, right from site selection and designing to construction, operation followed by maintenance, renovation or even demolition. The endeavor is to seek minimum possible impact on environment.

The concept of Green Building concentrates mainly on two points:

- Increasing the efficiency with which buildings use energy, water and materials
- Reducing building impacts of human health and the environment, through better site selection, design, construction, operation, maintenance, and removal throughout the complete life cycle.

1.2 Need for going Green?

Buildings account for 40% of worldwide energy use — which is much more than transportation. Furthermore, over the next 25 years, CO_2 emissions from buildings are projected to grow faster than any other sector (in the USA), with emissions from commercial buildings projected to grow the fastest—1.8% a year through 2030 (USGBC).



[5] Figure 1.2 (a): Residential Buildings Total Energy End-Use (2008)

* [5] This chart includes an adjustment factor used by the EIA to reconcile two datasets.
Source: U.S. Department of Energy, *2010 Buildings Energy Data Book*, Section

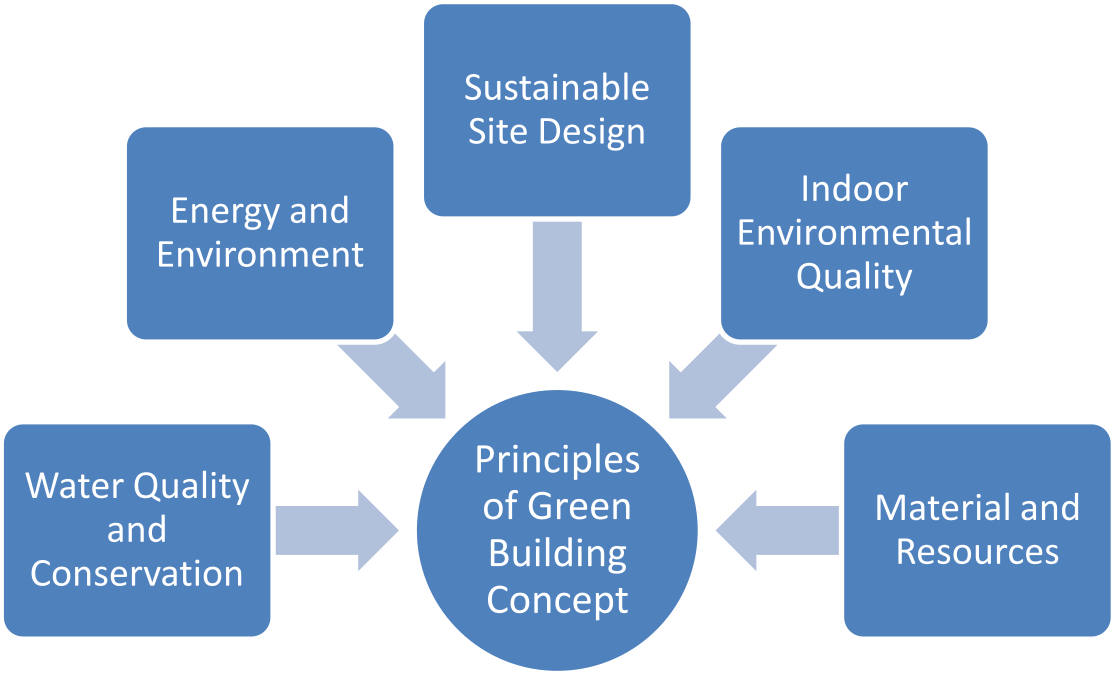


Figure 1.2 (b): Green Building Concept Research

1.3 Translucent Concrete

- Transparent concrete was originally developed in 2001 by a Hungarian architect Aronlosonzi by using glass fibers. Transparent concrete is produced by mixing 4% to 5% (by volume) optical fibers in the concrete mixture. This concrete has less weight compared to original concrete.

- Transparent concrete is manufactured by using combination of fiber optics and fine concrete. These fibers blend into the concrete like any other aggregates. These optical fibers can transmit light from natural and artificial sources into spaces enclosed by the translucent concrete panels. The main reason for using optical fiber in concrete is that it can transmit light even an incident angle greater than 60^0.

- Optical fiber consists of three layers called as core, cladding and buffer coating or jacket. The light is transmitted through the core of the optical fiber.

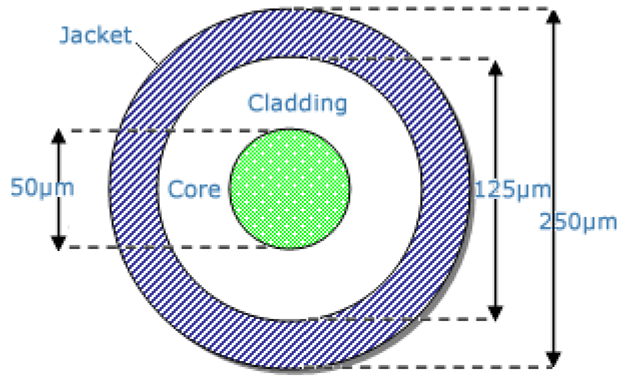


Figure 1.3 (a): Optical Fiber Cross-section

- Transparent concrete is manufactured using fine materials only. It does not contain coarse aggregates. This concrete can have the compressive strength of that of high strength concrete around 70 MPa (10,000 psi).

- Thickness of the optical fibers can be varied between 2 μm and 2 mm to suit the particular requirements of light transmission. Fabric and concrete are alternately inserted into molds at intervals of approximately 2 to 5 millimeters. Smaller or thinner layers allow an increased amount of light to pass through the concrete. Following casting, the material is cut into panels or blocks of the specified thickness and the surface is then typically polished, resulting in finishes ranging from semi-gloss to high-gloss.

- Translucent concrete is also a great insulating material that protects against outdoor extreme temperatures while also letting in daylight. This makes it an excellent compromise for buildings in harsh climates, where it can shut out heat or cold without shutting the building off from daylight.

- The blocks come in a range of sizes, the maximum for glass fiber being 1200 x 400 mm (47.2 x 15.7 inches), and the thickness can range from 25-500mm (1-20 inches)

1.3.1 Materials used:

- **Cement:** As the optical fiber is only responsible for transmission of light, there is no special cement required. So, ordinary Portland cement is used for transparent concrete.

- **Sand:** Since the transparent concrete is manufactured only using fine materials, the size of sand should pass through 1.18mm sieve. The sand should be free from any impurities such as vegetation, large stones etc.

- **Water:** Water to be used for transparent concrete should be of drinking water quality, free from any impurities.

- **Optical fibers:** Optical fibers in the range of 4 to 5% by volume are used for transparent concrete. Thickness of the optical fibers can be varied between 2 μm and 2 mm to suit the particular requirements of light transmission.

1.4 Rat-Trap Bond

A “Rat-Trap Bond” is a type of wall brick masonry bond in which bricks are laid on edge such that the shiner and rowlock are visible on the face of masonry as shown below.

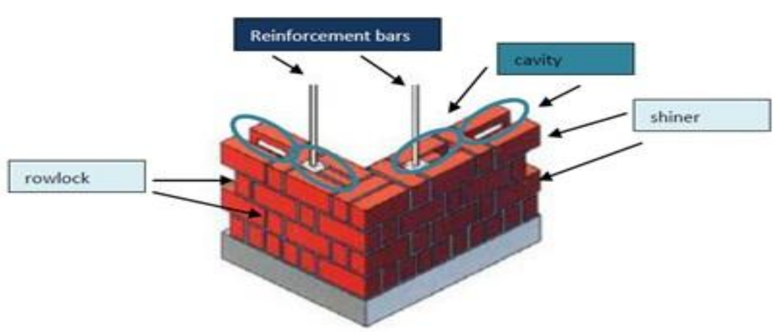


Figure 1.4(a) Rat Trap Bond Illustration

This gives the wall with an internal cavity bridged by the rowlock. This is the major reason where virgin materials like brick clay and cement can be considerably saved. This adds this technology to the list of Green building technologies and sustainability for an appropriate option as against conventional solid brick wall masonry.

This cavity adds an added advantage as it adds a Green building feature of help maintain improved thermal comfort and keep the interiors colder than outside and vice versa.

The Rat trap bond construction is a modular type of masonry construction. Due care must be taken while designing the wall lengths and heights for a structure.

1.4.1 Advantages of using Rat Trap Bond Technique

- By adopting this method of masonry, you can save on approx. 20-35% less bricks and 30-50% less mortar; also this reduces the cost of a 9 inch wall by 20-30 % and productivity of work enhances.
- For 1 m^3 of Rat trap bond, 470 bricks are required compared to conventional brick wall where a total of 550 bricks are required.
- Rat trap bond wall is a cavity wall construction with added advantage of thermal comfort. The interiors remain cooler in summer and warmer in winters.
- Rat-trap bond when kept exposed, create aesthetically pleasing wall surface and cost of plastering and painting also may be avoided.
- Rat trap bond can be used for load bearing as well as thick partition walls.
- All works such as pillars, sill bands, window and tie beams can be concealed.
- The walls have approx. 20% less dead weight and hence the foundations and other supporting structural members can suitably be designed, this gives an added advantage of cost saving for foundation.
- Service’s installations should be planned during the masonry construction if not exposed.
- Virgin materials such as bricks, cement and steel can be considerably saved upon by adopting this technology. It will also help reduce the Embodied Energy of virgin materials and save the production of Green House Gases into the atmosphere.

1.4.2 Cost Savings:

Material saving ***per m³***: *Rat trap bond vs. Conventional Brickwork.*

- 1.11 bags (57% saving) = Rs 288/ m^3 saving in cement cost.
- 80 nos. of bricks (20% saving) = Rs 576 saving in brick cost.
- 0.18 m^3 less sand (61% saving) = Rs 13/ m^3 saving.

Summarizing the material cost, an approximate saving of Rs. 478 (20% saving) is achieved per m^3 of Rat trap bond brickwork compared to conventional solid BW.

EXAMPLE:

- Assume building a house with 100 sq m on each floor, and the periphery walls are made of Rat trap bond instead of conventional bond, the savings in materials cost and total brickwork cost that can be achieved are listed below:

TABLE.NO. 1.4.2(I): Example summarizing the material cost

Sr. no	Description	In Units	In Rs.	In Percentage
1	**Material saving**			
	Cement	*78 (bags)*	*Rs. 20193*	**57%**
	Bricks	*5599 (nos)*	*Rs. 10086*	**19%**
	Sand	*13 (cu.m)*	*Rs. 3153*	**61%**

	Description	Conventional Solid Brickwork	Rat Trap Bond Brickwork	Difference
2	**Total Saving**			
	For 1 cu.m of BW	3843	*3380*	*462*
	For 70 cu.m of BW	***269012***	***236642***	*32370*

CHAPTER 2: LITERATURE REVIEW

AUTHOR	**TOPIC**	**CONCLUSION**
Piet Eichholtz Nils Kok John M. Quigley	The Economics of Building	Research on climate change suggests that small improvements in the sustainability of the existing building stock can have large effects on energy efficiency in the economy.
Ramesh S P, Emran Khan	Energy Efficiency in Green Building – Indian Concept	With the convergence of urbanization, globalization and a rapidly changing and expanding economy, India is experiencing a rapid spurt in building construction, increasing consumption of building materials resulting in environmental degradation.
Soumyajit Paul, Avik Dutta	Translucent Concrete	This new kind of building material can integrate the concept of green energy saving with the usage self-sensing properties of functional materials
Divya Kamath, K.Vandana Reddy	Analysis and Design of Reinforced Concrete Structures-A G+5 Building Mode	Overall, the concepts and procedures of designing the basic components of a multistory building were described. Apart from that, the planning of the building with regard to appropriate directions for the respective rooms, choosing position of beams and columns were also explained.

B. N Punamia	Limit State Design	Designing Concepts
Bureau of Indian Standards	IS Code: 875 part 1 and 3	IS Code referred
Bureau of Indian Standards	IS Code 456	IS Code referred
K.Ramanathan	Progress toward 20% efficiency in Cu(In,Ga)Se_2polycrystalline thin-film solar cells	Increasing efficiency of solar panels.
D.K Edwards	Natural Convection in Enclosed Spaces—A Review of Application to Solar Energy Collection	A useful solar-thermal converter requires effective control of heat losses from surroundings.
Munir Hanad	Using STAAD Pro 2007 (Courseware with American Design Codes)	STAAD PRO Employment
Pillai and menon	Reinforced Concrete Design	Designing concepts

Conclusion: These Literature writings have helped us to showcase what we desired to achieve in our project, from designing to cost estimation above reviews have contributed quality information, insight and factual support in our Endeavour.

<u>CHAPTER 3: BUILDING DESIGN</u>

3.1 3-D Designs

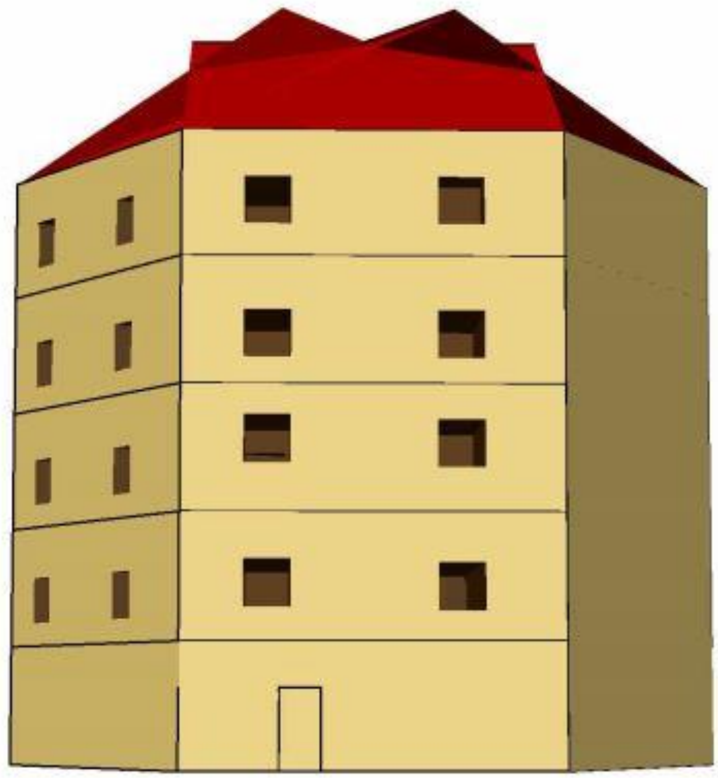


Figure 3.1(a) 3-D view Snapshot

<u>DESCRIPTION:</u>

JAYPEE HOSTEL BUILDING BLOCK T-A

5 floors

225 sqm built-up area

3.2 2-D Designs

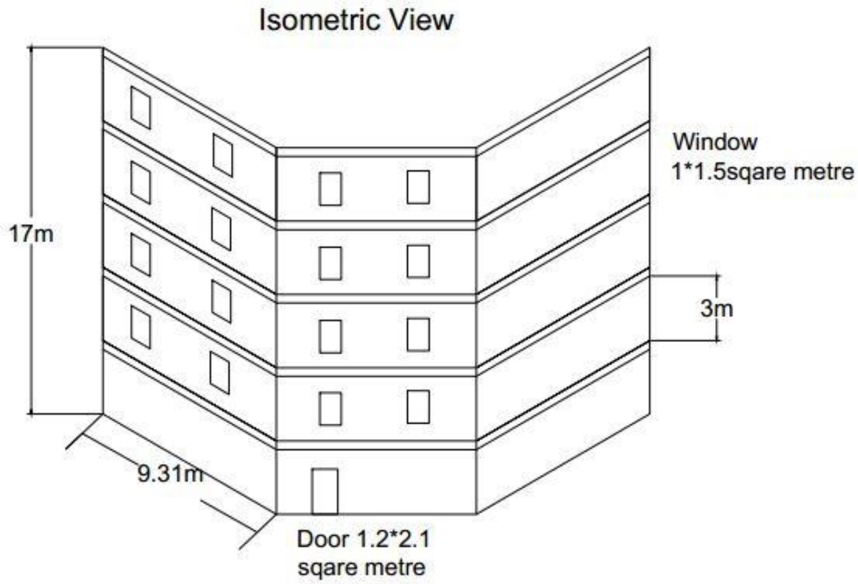


Figure 3.2 (a) Isometric View

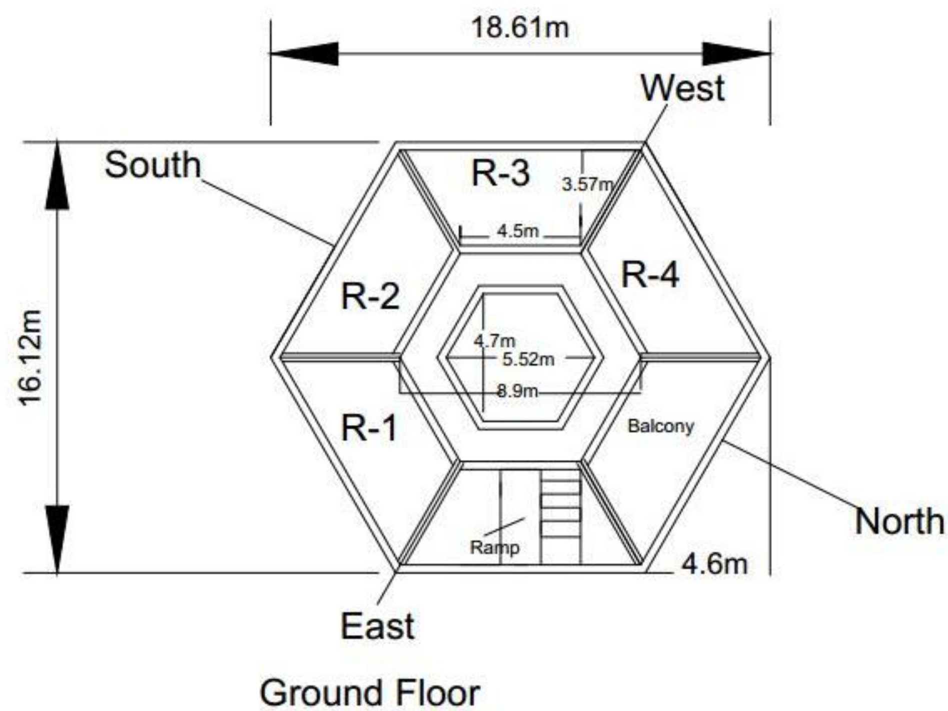


Figure 3.2 (b) Ground Floor Plan

3.3 SOLAR PANNEL ADJUSTMENT

Our Location: 31° 6’ 17.35” latitude and 77° 10’ 24.2” longitude (H.P)

3.3.1 Fixed or Adjustable?

It is simplest to mount solar panels at a fixed tilt and just leave them there. But because the sun is higher in the summer and lower in the winter, we can capture more energy during the whole year by adjusting the tilt of the panels according to the season. The following table shows the effect of adjusting the angle, using a system at 40° latitude as an example. (The comparison would be a little different for different latitudes.)

In short, adjusting the tilt twice a year gives a meaningful boost in energy.

TABLE.NO. 3.3.1 (i) Efficiency: Fixed v/s Adjustable

	Fixed	Adj. 2 seasons	Adj. 4 seasons
% of optimum	71.1%	75.2%	75.7%

3.3.1.1 Fixed Tilt

Fixed angle is convenient, but note that there are some disadvantages. As mentioned Above, one gets less power than if we adjust the angle. Following formulas could be used in order to find the best angle from the horizontal at which the panel should be tilted:

- If your latitude is below 25°, use the latitude times 0.87.
- If your latitude is b/w 25° & 50°, use the latitude, times 0.76, plus 3.1°
- If your latitude is above 50°, efficiency decreases.

Conclusion: Based on our location the fixed tilt should be 26.74 degrees

3.3.1.2 Adjusting the tilt twice a year

If we are going to adjust the tilt of our solar panels twice a year, and we want to get the most energy over the whole year. The following table gives the best dates on which to adjust: Since our latitude is between 25° and 50°, then the best tilt angle for summer is the latitude, times 0.93, minus 21 degrees. The best tilt angle for winter is the latitude, times 0.875, plus 19.2 degrees. Generally, any panels that aren't south-facing should face west, because the available sun at sunset is "more valuable" to the grid.

TABLE.NO. 3.3.1.2(ii)

	Northern hemisphere	Southern hemisphere
Adjust to summer angle on	March 30	September 29
Adjust to winter angle on	September 12	March 14

Conclusion: Based on our location the adjusted tilt should be 7.93 degrees in summers and 46.42 degrees in winters

3.4 Reasons for such a design

In the current area occupied by Hostel Block H2- Shastri, JUIT of 225m2 a hexagonal building design with 9.31 m outer walls and same area is considered mainly due to:

- Circular cross-sectional buildings have minimum surface area, enabling us to minimize insulation losses saving electricity costs.
- Our six outer walls use Translucent Concrete increasing the light efficiency and decreasing electricity usage drastically.
- Furthermore it enables maximum possibilities for solar panel installation and adjustment.
- Aesthetic reasons

3.5 SOLAR PANEL SELECTION CRITERIONS:

3.5.1 PTC Rating:

The PTC rating is an independent rating of the solar panels. In general panel, the PTC rating is about 90% of the nameplate rating, the rating that is advertised on the solar panel

TABLE.NO. 3.5.1(i)

	Sanyo 210	**Sharp 230**	**BP 200**	**Canadian Solar 230e**	**GE Solar 200W**	**Solon Blue 220W**
PTC Rating	195	198	177.6	209.4	173	194.3
PTC/Nameplate	**93%**	86%	89%	91%	87%	88%

3.5.2 Size Matters:

Assuming that we have size limitations on our roof. We have used as a baseline a 500 square foot roof, which we assume is a square 22.3 feet by 22.3 feet. How many panels from the select group can you fit onto your roof? These are the results.

TABLE.NO. 3.5.2(i)

	Sanyo 210	**Sharp 230**	**BP 200**	**Canadian Solar 230e**	**GE Solar 200W**	**Solon Blue 220W**
# of panels 500 sq ft	32	24	32	28	28	24
Array Watts (Name Plate)	6720	5520	6400	6440	5600	5280
Array PTC Watts (Actual)	6240	4752	5683	5863	4844	4663
Expected Annual Output Daily year avg 4.47)	10,183	7752	9271	8084	7902	7606

3.5.3 Price of the Solar Module:

As we can see from the chart below, the panel cost for your array will differ considerably. Example the Solon Blue array on our 500 sq ft roof will only cost about Rs960000 while the Sanyo array will cost over Rs1620000, or 69% more.

TABLE.NO. 3.5.3(i)

All in Rs	Sanyo 210	Sharp 230	BP 200	Canadian Solar 230e	GE Solar 200W	Solon Blue 220W
Cost Per Panel	51000	42900	52800	37980	52800	39840
Cost for Array	1630080	1029600	1687680	1063440	1478400	956160
Cost Per Watt (PTC output)	261	216.6	297	181.2	305.4	205.2

3.5.4 5kW System or Bust

Now if we say that we do not have any size constraints on our roof. We'll be mostly interested in getting a 5 kW system on our roof.

TABLE.NO. 3.5.4(i)

	Sanyo 210	Sharp 230	BP 200	Canadian Solar 230e	GE Solar 200W	Solon Blue 220W
# of Panels	26	26	29	24	29	26
Maximum Output (Watts)	5070	5148	5150	5026	5017	5051

Expected Annual Output (Daily year average 4.47)	8271	8399	8403	8200	8185	8242
Cost for Array (Rs)	1324440	1115400	1529460	911520	1531200	1035840

.

Each homeowner faces various constraints when choosing solar panels. It is not a decision that one should take lightly as we'll be living with these solar panels on our roof for a long time to come. The key factors that will influence our decision may and will differ from homeowner to homeowner.

See Discussion and Results for selection of the most efficient solar panel.

3.6 Best Building Orientation for maximum solar efficiency

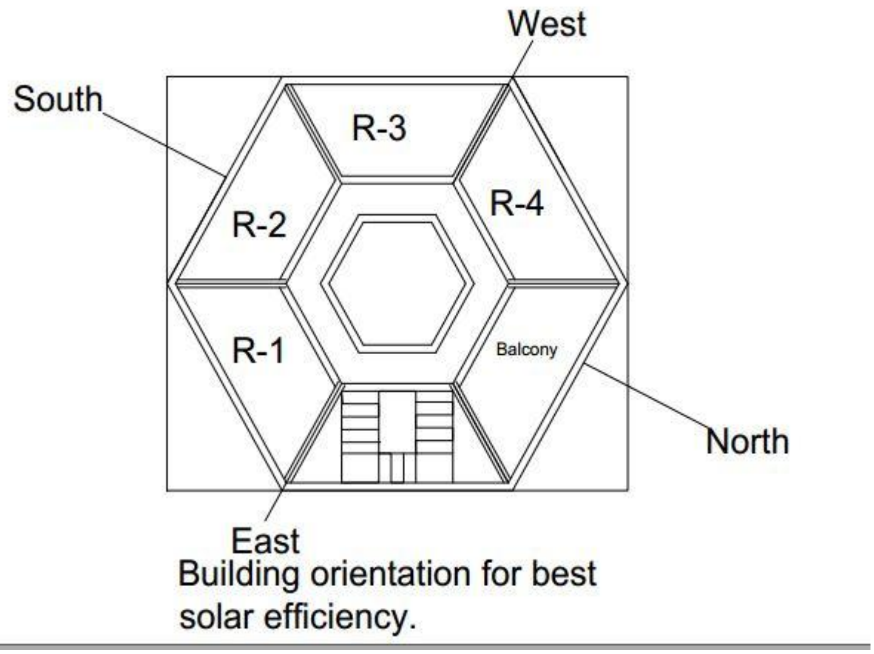


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Figure 3.6 (a)

CHAPTER 4: STAAD Pro Analysis

4.1 Loading and Costing Analysis of wall

TABLE NO. 4.1.(i)

I)

MATRIALS	DENSITY(kg/m^3)	COST(kg/m^3)
BRICKS+MORTAR	1900	7500
STONE	2500	300
PAINT	_	50
Putty	_	50
Plaster	1900	200
Ordinary Concrete	2400	5000
Translucent Concrete	2100	11250
Doors and Windows	950	4000/m^2

II)

TABLE NO. 4.1 (ii)

Reference	*B.N Dutta - Estimation and Costing
	*Kuthiala Engineers- Er. Ajay Kuthiala(25 year Experience)
	*Ex Eng- Er. Raj kumar Yadav(25 years)
	*Kuthiala Constructions- SH. Shiv Kumar Kuthiala (54 years experience)
	*consultant Eng. - karan vir singh badwal (20 years)

III)

TABLE NO. 4.2(iii)

TYPES:	Thickness (m)	Area(m^2)	Cost Analysis (Rs)	Load Analysis (kN)
BRICK +STONE	.13 + .2	2.65*9.31= 24.67	18040+11100= 53810	145.8

ORDINARY CONCRETE	0.3	2.65*9.31= 24.68	27755+24670= 52425	146.1
TRANSLUCENT CONCRETE	0.2	2.65*9.31= 24.69	41633+24670= 66303.2	88.677
RAT TRAP BOND BRICK WORK DIAGONAL WALL	0.2	2.65*6.2	18513.5	49.06
RAT TRAP BOND BRICK WORK INNER HEXAGONAL WALL	0.2	2.65*3.1	9242	19

4.2 Types of Loadings Applied: Dead Load + Live Load

TABLE NO. 4.2(i)

LOADING	TYPE	CALCULATIONS	VALUES	REMARKS
Self weight	Uniformly Distr. Load	Y -1	Self calc.	Using STAAD Pro
Due to Translucent concrete on outer hexagonal Beams	Uniformly Distributed Load	[.75*24.67*.2*2100] + [.015*.25*24.67*1900] + [.25*24.67*.13*950]	9.55 kN/m	Wall area=24.67, Wall %= 75%, Windows %= 25%, Beam Length= 9.31m, Transl. Concrete Dens.= 2100kN/m^{3,} Plaster Dens. = 1900 kN/m^{3,} Plaster Thickness= .015, Wall Thick= .13m

Transmitted due to slabs two ways on near beams	Area Load	(.15*25) + (2.5)	6.25kN/m^2	Slab's thickness = .15m RCC density=25kN/m^3 Load on slab by to wall anywhere=2.5 kN/m^2
Due to Brick Wall on Inner Diagonal Beams	Uniformly Distributed Load	[6.21*2.65*.13*1900]/[6.21*100]	6.42kN/m	Beam Length= 6.21m Floor height = 2.65m Wall Thickness= .13m Wall Dens=1900kN/m^3
Due to Brick Wall on Inner Hexagonal Beams	Uniformly Distributed Load	{[3.1*2.65*.13*.75*1900] + [.25*3.1*2.65*.13*950]}/[3.1*100]	5.616kN/m	Wall Ht = 2.65 Wall %= 75% Windows %= 25% Translucent Concrete Dens= 2100kN/m^3 Beam Length= 3.1m Plaster Dens = 1900 kN/m^3 Plaster Thickness= .015 Wall Thick= .13m Wall Dens =1900kN/m^3

On Chajjas on Outer Hexagonal Beams	Uniformly Distributed Load	[.15*.866*10.51*25]/10.51 + [0.75]	4kN/m	Chajjas Dimensions
Live Load	Area Load		4kN/m^2	Using IS Code

4.3 STAAD Pro

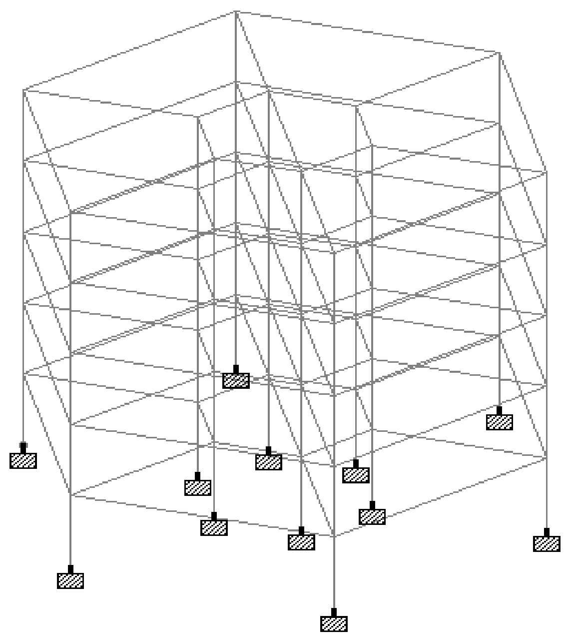

Figure 4.3(a) Project Model

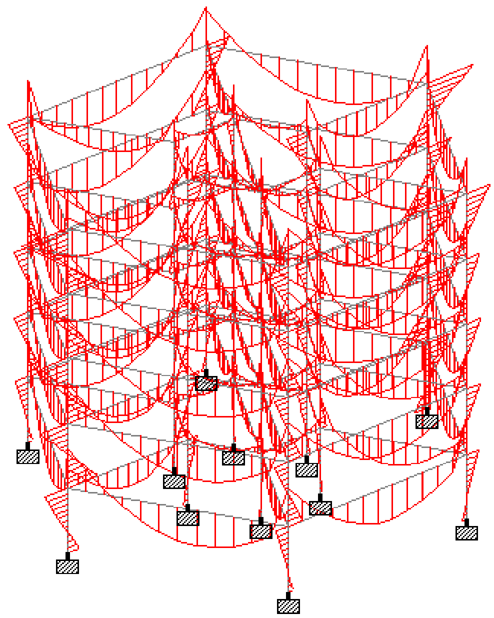

Figure 4.3(b) bending effect due to load on members

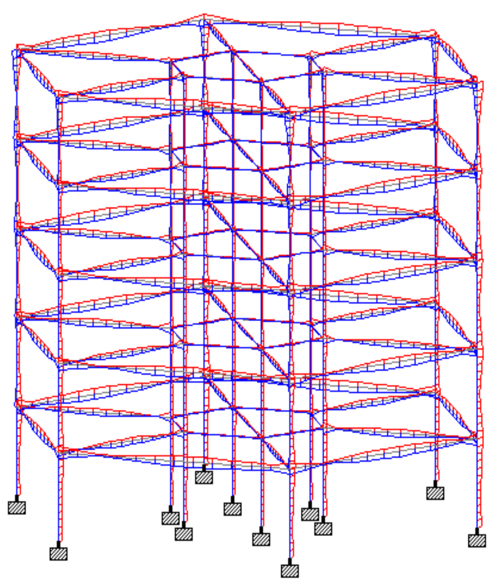

Figure 4.3(c) Stress effect due to loading

STAAD Pro Report: Appendix 'A'

CHAPTER 5: STRUCTURAL DESIGNS

5.1 BEAM DESIGN

5.1.1 Beam Design for Outer Hexagonal Beams

TABLE NO. 5.1.1 (i)

DESCRIPTION		VALUES	REMARKS
BEAM NUMBER (Nos.)		13, 14, 15, 16, 17, 18	
DIMENSION (m X m)		0.3 X 0.6	
CLEAR COVER (mm)		35	
Negative Factored Moment (kNm)		516.71	
Positive Factored Moment (kNm)		430.5	
Maximum Factored Shear Force (kN)		310.5	
Yield Strength of steel, Fy (N/mm^2)		415	
Design Strength, Fck (N/mm^2)		20	
Effective Depth, d (mm)		555	
d'		45	
d'/d		0.1	
Due to Negative Moment	Mu/bd^2 (N/mm^2)	5.4	refer table 50 of IS 456 for doubly reinforced beams
	% steel in Tension (UPPER) phase	1.768	
	% steel in Compression (LOWER) phase	0.854	
	Area of steel at Tension Phase (mm^2)	2943.27	
	Area of steel at Compression Phase (mm^2)	1421.9	
Due to Positive Moment	Mu/bd^2 (N/mm^2)	4.7	refer table 50 of IS 456 for doubly reinforced beams
	% steel in Tension (LOWER) phase	1.553	
	% steel in Compression (UPPER) phase	0.628	
	Area of steel at Tension Phase (mm^2)	2585.745	
	Area of steel at Compression Phase (mm^2)	1045.62	

Shear Stress, Z_v (N/mm^2)	1.917	refer table J
Maximum Shear Stress, Z_{cmax} (N/mm^2)	2.8	o.k if $Z_v<Z_{cmax}$
Design Shear Strength of Concrete, Z_c (N/mm^2)	0.74	o.k if $Z_v>Z_c$
Shear Capacity of Concrete Section, $Z_c$bd (kN)	119.88	
Shear to be carried by Stirrups, $V_{us}=V_s-Z_c$bd (kN)	110.62	
V_{us}/d (kN/cm)	1.993	Check table 62
Type of Reinforcement	Doubly	
Result	Refer diagram	

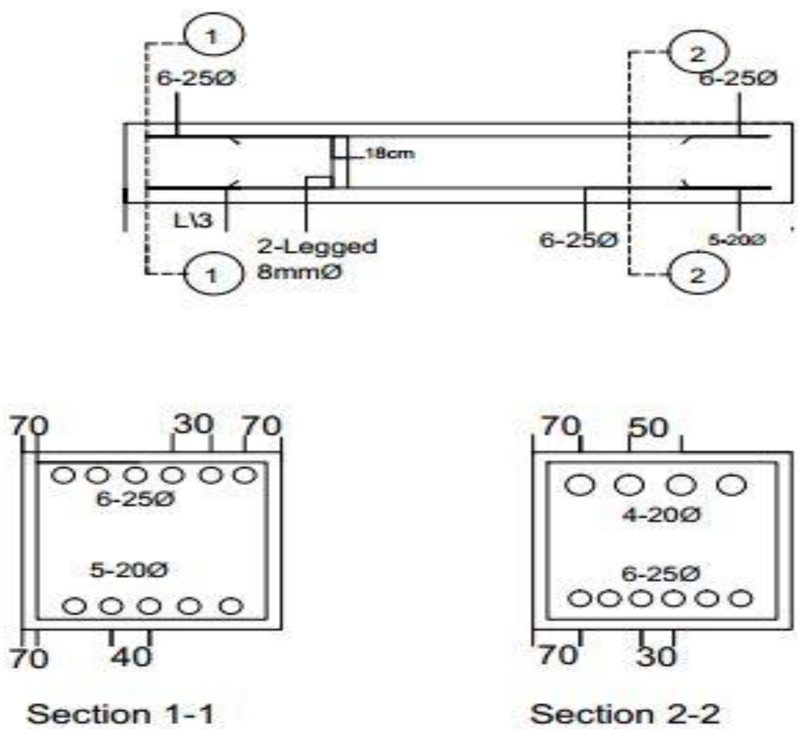

Figure 5.1.1(a) Design of beam no. 13, 14, 15, 16, 17 and 18

5.1.2 Beam Design for Diagonal Beams

TABLE NO. 5.1.2(i)

DESCRIPTION		VALUES	REMARKS
BEAM NUMBER (Nos.)		37, 38, 39, 40, 41, 42	
DIMENSION (m X m)		0.3 X 0.6	
CLEAR COVER (mm)		35	
Negative Factored Moment (kNm)		451.5	
Positive Factored Moment (kNm)		309	
Maximum Factored Shear Force (kN)		403.5	
Yield Strength of steel, Fy (N/mm^2)		415	
Design Strength, Fck (N/mm^2)		20	
Effective Depth, d (mm)		555	
d'		45	
d'/d		0.1	
Due to Negative Moment	Mu/bd^2 (N/mm^2)	4.9	refer table 50 of IS 456 for doubly reinforced beams
	% steel in Tension (UPPER) phase	1.614	
	% steel in Compression (LOWER) phase	0.692	
	Area of steel at Tension Phase (mm^2)	2687.3	
	Area of steel at Compression Phase (mm^2)	1152	
Due to Positive Moment	Mu/bd^2 (N/mm^2)	3.4	refer table 50 of IS 456 for doubly reinforced beams
	% steel in Tension (LOWER) phase	1.152	
	% steel in Compression (UPPER) phase	0.207	
	Area of steel at Tension Phase (mm^2)	1918.08	
	Area of steel at Compression Phase (mm^2)	344.65	
Shear Stress, Z_v (N/mm^2)		2.49	refer table J
Maximum Shear Stress, Z_{cmax} (N/mm^2)		2.8	o.k if $Z_v<Z_{cmax}$
Design Shear Strength of Concrete, Z_c (N/mm^2)		0.73	o.k if $Z_v>Z_c$

Shear Capacity of Concrete Section, $Z_c bd$ (kN)	118.26	
Shear to be carried by Stirrups, $V_{us=}V_s$-$Z_c bd$ (kN)	285.24	
V_{us}/d (kN/cm)	5.14	Check table 62
Type of Reinforcement	Doubly	
Result	Refer diagram	

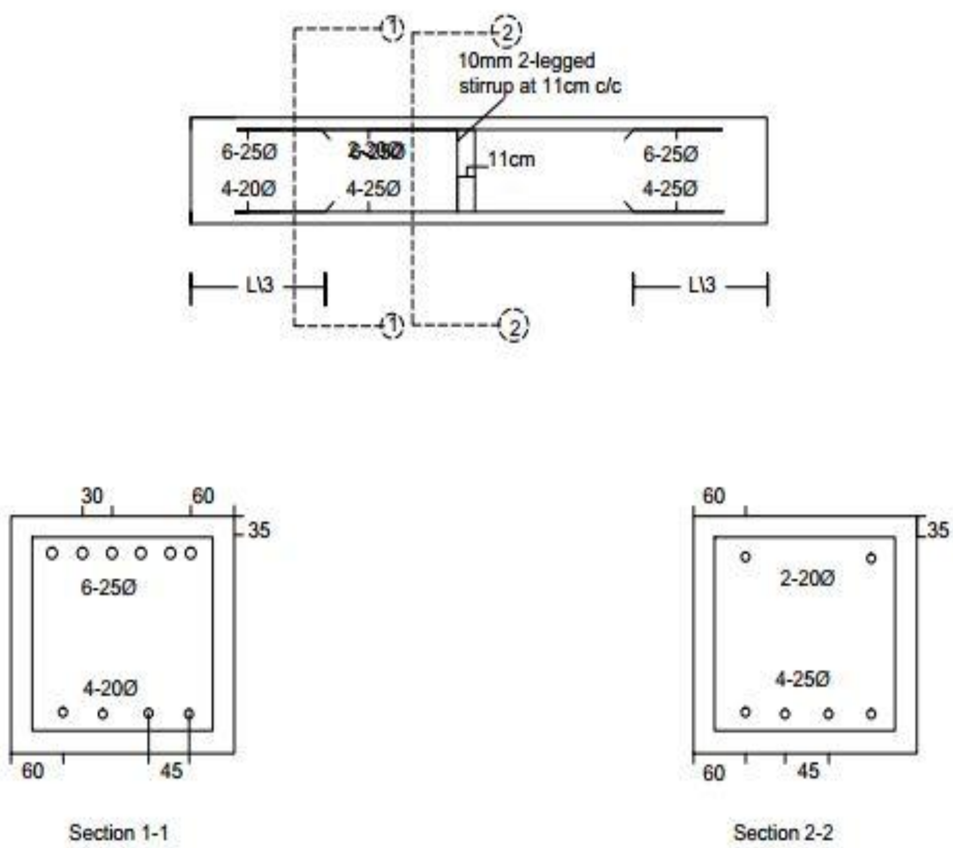

Figure 5.1.2(a) Design for beam no. 37, 38, 39, 40, 41 and 42

5.1.3 Beam Design for Inner Hexagonal Beams

TABLE NO. 5.1.3(i)

DESCRIPTION		VALUES	REMARKS
BEAM NUMBER (Nos.)		25, 26, 27, 28, 29, 30	
DIMENSION (m X m)		0.3 X 0.6	
CLEAR COVER (mm)		35	
Negative Factored Moment (kNm)		144	
Positive Factored Moment (kNm)		45.75	
Maximum Factored Shear Force (kN)		189	
Yield Strength of steel, Fy (N/mm^2)		415	
Design Strength, Fck (N/mm^2)		20	
Effective Depth, d (mm)		555	
d'		45	
d'/d		0.1	
Due to Negative Moment	Mu/bd^2 (N/mm^2)	1.6	refer table 50 of IS 456 for doubly reinforced beams
	% steel in Tension (UPPER) phase	0.494	
	% steel in Compression (LOWER) phase	_	
	Area of steel at Tension Phase (mm^2)	822.51	
	Area of steel at Compression Phase (mm^2)	_	
Due to Positive Moment	Mu/bd^2 (N/mm^2)	0.495	refer table 50 of IS 456 for doubly reinforced beams
	% steel in Tension (LOWER) phase	0.143	
	% steel in Compression (UPPER) phase	_	
	Area of steel at Tension Phase (mm^2)	238.1	
	Area of steel at Compression Phase (mm^2)	_	
Shear Stress, Z_v (N/mm^2)		1.17	refer table J
Maximum Shear Stress, Z_{cmax} (N/mm^2)		2.8	o.k if Z_v<Z_{cmax}
Design Shear Strength of Concrete, Z_c (N/mm^2)		0.48	o.k if Z_v>Z_c

Shear Capacity of Concrete Section, $Z_c bd$ (kN)	77.76	
Shear to be carried by Stirrups, $V_{us=}V_s\text{-}Z_c bd$ (kN)	111.24	
V_{us}/d (kN/cm)	2.004	Check table 62
Type of Reinforcement	Singly	
Result	Refer diagram	

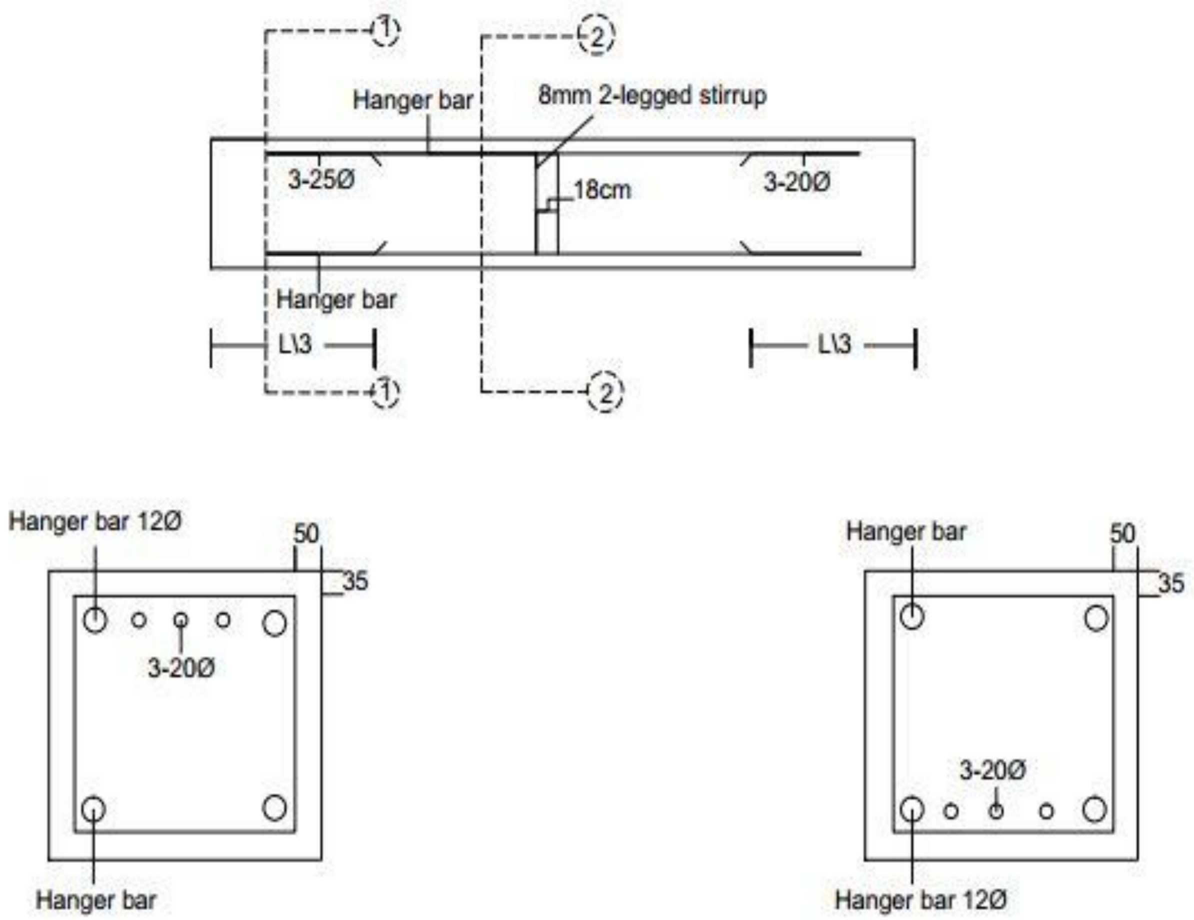

Figure 5.1.3(a) Design for beam no. 25, 26, 27, 28, 29 and 30

5.1.4 Beam Design for Central Beam

TABLE NO. 5.1.4 (i)

DESCRIPTION		VALUES	REMARKS
BEAM NUMBER (Nos.)		207	
DIMENSION (m X m)		0.3 X 0.6	
CLEAR COVER (mm)		35	
Negative Factored Moment (kNm)		229.5	
Positive Factored Moment (kNm)		148.5	
Maximum Factored Shear Force (kN)		181.5	
Yield Strength of steel, Fy (N/mm^2)		415	
Design Strength, Fck (N/mm^2)		20	
Effective Depth, d (mm)		555	
d'		45	
d'/d		0.1	
Due to Negative Moment	Mu/bd^2 (N/mm^2)	2.48	refer table 50 of IS 456 for doubly reinforced beams
	% steel in Tension (UPPER) phase	0.831	
	% steel in Compression (LOWER) phase	_	
	Area of steel at Tension Phase (mm^2)	1383.6	
	Area of steel at Compression Phase (mm^2)	_	
Due to Positive Moment	Mu/bd^2 (N/mm^2)	1.61	refer table 50 of IS 456 for doubly reinforced beams
	% steel in Tension (LOWER) phase	0.494	
	% steel in Compression (UPPER) phase	_	
	Area of steel at Tension Phase (mm^2)	822.51	
	Area of steel at Compression Phase (mm^2)	_	
Shear Stress, Z_v (N/mm^2)		1.12	refer table J
Maximum Shear Stress, Z_{cmax} (N/mm^2)		2.8	o.k if $Z_v<Z_{cmax}$
Design Shear Strength of Concrete, Z_c (N/mm^2)		0.57	o.k if $Z_v>Z_c$
Shear Capacity of Concrete Section, $Z_c bd$ (kN)		92.34	
Shear to be carried by Stirrups, $V_{us}=V_s-Z_c bd$ (kN)		89.16	

V_{us}/d (kN/cm)	1.606	Check table 62
Type of Reinforcement	Singly	
Result	Refer diagram	

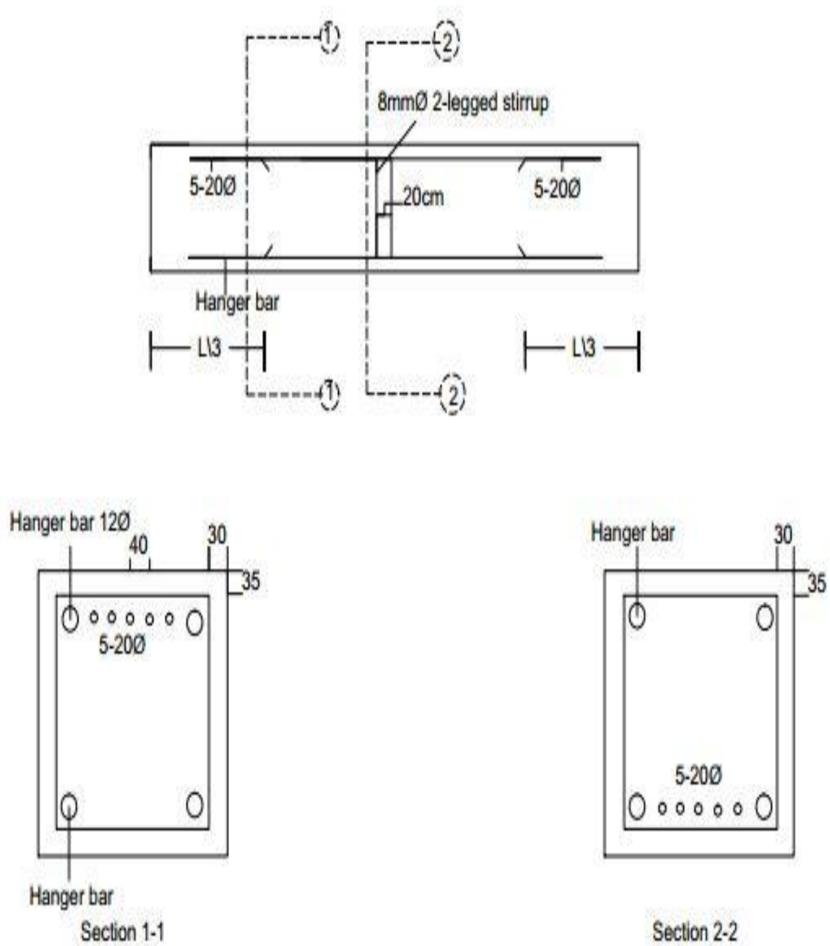

Figure 5.1.4(a) Design for beam no. 207

5.2 COLUMN DESIGN

5.2.1 Ground Floor Column Design

TABLE NO. 5.2.1 (ii)

DESCRIPTION	**VALUES**	**REMARKS**
Floor Level	Ground Floor	
BEAM NUMBER (Nos.)	7, 8, 9, 10, 11, 12, 31, 32, 33, 34, 35, 36	
DIMENSION (m X m)	0.45 X 0.6	
P_u Factored Load (kN)	5010	
M_u Factored Moment (kNm)	349.28	
Yield Strength of steel, Fy (N/mm^2)	415	
Design Strength, Fck (N/mm^2)	20	
d' (mm)	56	
d'/D	0.1	chart for .1 will be used
$P_u/f_{ck}bd$	0.93	
$M_u/f_{ck}bd^2$	0.11	
p/f_{ck}	0.23	refer chart 44
p (%)	4.6	not >6% by IS Code
A_s (mm^2)	12420	
Type of Reinforcement	On all four sides equally spaced	
Result	Longitudinal Reinforcement= 16Nos-32mmϕ and ties= 8mmϕ @450mmc/c	IS Code- Clause: 25.5.3.2

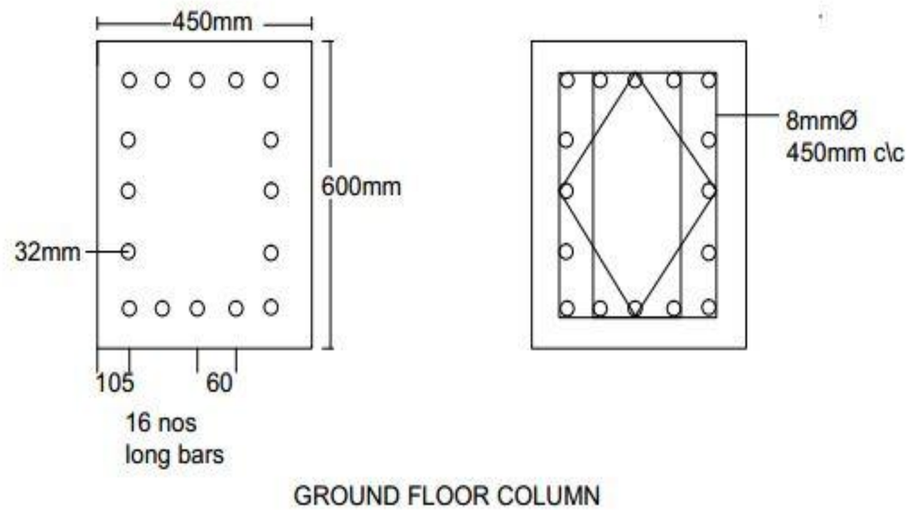

Figure 5.2.1(a) Design for Ground floor Column

5.2.2 Top Floor Column Design

Table 5.2.2(i) 1

DESCRIPTION	VALUES	REMARKS
Floor Level	Top(4th) Floor	
BEAM NUMBER (Nos.)	165, 166, 167, 168, 169, 170, 183, 184, 185, 186, 187, 188	
DIMENSION (m X m)	0.45 X 0.6	
P_u Factored Load (kN)	900.33	

M_u Factored Moment (kNm)	681	
Yield Strength of steel, Fy (N/mm^2)	415	
Design Strength, Fck (N/mm^2)	20	
d' (mm)	52.5	
d'/D	0.1	chart for .1 will be used
$P_u/f_{ck}bd$	0.166	
$M_u/f_{ck}bd^2$	0.21	
p/f_{ck}	0.16	refer chart 44
p (%)	3.2	not >6% by IS Code
A_s (mm^2)	8640	
Type of Reinforcement	On all four sides equally spaced	
Result	Longitudinal Reinforcement= 18Nos-25mmϕ and ties= 8mmϕ @450mmc/c	IS Code- Clause: 25.5.3.2

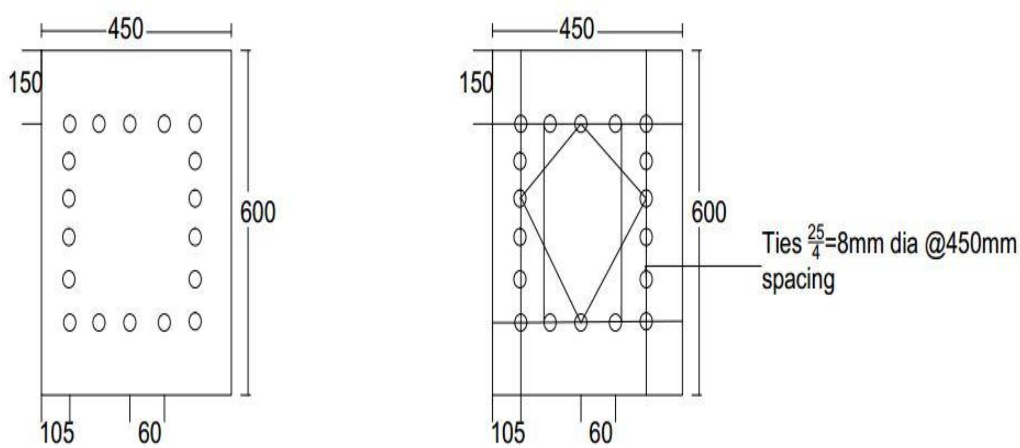

Figure 5.2.3(a) Top Floor Column design

5.4 SLAB DESIGN

5.3.1 Outer Slab Design

TABLE NO. 5.3.1 (i)

DESCRIPTION		DIRECTION		REMARK
		Along L_x	Along L_y	
Load acting (kN/m^2)		10.25	10.25	L_y/L_x=
Length (m)		5.4	6.205	
Span Coefficient for	Negative Moment at Continuous Edge	0.06	0.032	refer table 22 IS Code
	Positive Moment at Mid Span	0.045	0.024	
Bending Moment for	Negative Moment at Continuous Edge (kNm)	17.78	9.486	
	Positive Moment at Mid Span (kNm)	13.34	7.115	
Factored Moment for	Negative Moment at Continuous Edge (kNm)	26.68	14.23	
	Positive Moment at Mid Span (kNm)	20	10.673	
Percentage Steel for	Negative Moment at Continuous Edge (%)	0.46	0.25	refer Chart 13 IS Code
	Positive Moment at Mid Span (%)	0.35	0.18	
Area of Steel	Negative Moment at Continuous Edge (mm^2)	5.98	3.28	
	Positive Moment at Mid Span (mm^2)	4.55	2.34	
Result	Negative Moment at Continuous Edge	8mmϕ @8cm c/c	8mmϕ @15cm c/c	refer table 96 IS Code
	Positive Moment at Mid Span	8mmϕ @10cm c/c	8mmϕ 20 c/c	

Distribution steel 8mm @ 38 cm c/c

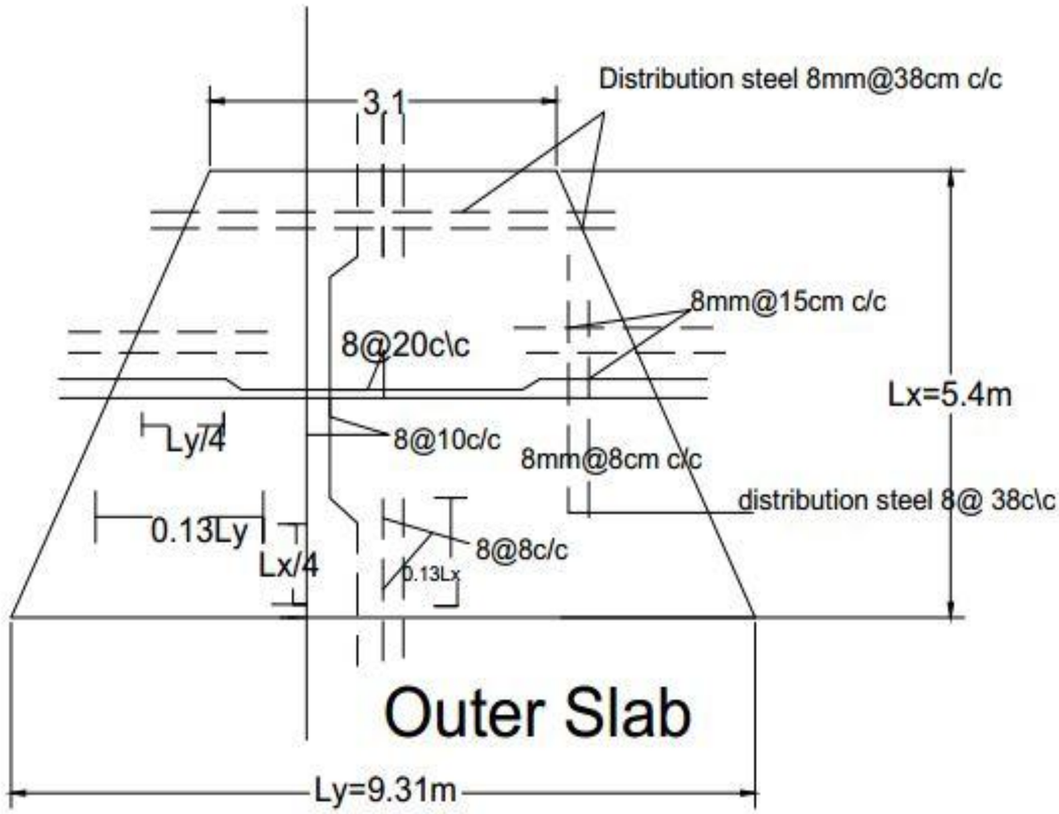

Figure 5.3.1 (a) Outer Slab Design

5.3.2 Inner Slab Design

TABLE NO. 5.3.2 (i)

DESCRIPTION		DIRECTION		REMARK
		Along L_x	Along L_y	
Load acting (kN/m^2)		10.25	10.25	L_y/L_x=
Length (m)		2.7	4.55	
Span Coefficient for	Negative Moment at Continuous Edge	0.065	0.032	refer table 22 IS Code
	Positive Moment at Mid Span	0.049	0.024	
Bending Moment for	Negative Moment at Continuous Edge (kNm)	5.223	2.6	
	Positive Moment at Mid Span (kNm)	3.94	1.92	
Factored Moment for	Negative Moment at Continuous Edge (kNm)	7.9	3.85	
	Positive Moment at Mid Span (kNm)	6	2.9	
Percentage Steel for	Negative Moment at Continuous Edge (%)	0.14	0.12	refer Chart 13 IS Code
	Positive Moment at Mid Span (%)	0.13	0.11	
Area of Steel	Negative Moment at Continuous Edge (mm^2)	1.82	1.56	
	Positive Moment at Mid Span (mm^2)	1.69	1.43	
Result	Negative Moment at Continuous Edge	8mmᶲ @27cm c/c	8mmᶲ @32cm c/c	refer table 96 IS Code
	Positive Moment at Mid Span	8mmᶲ @30cm c/c	8mmᶲ @34cm c/c	

Distribution steel 8mmᶲ @ 38 cm c/c

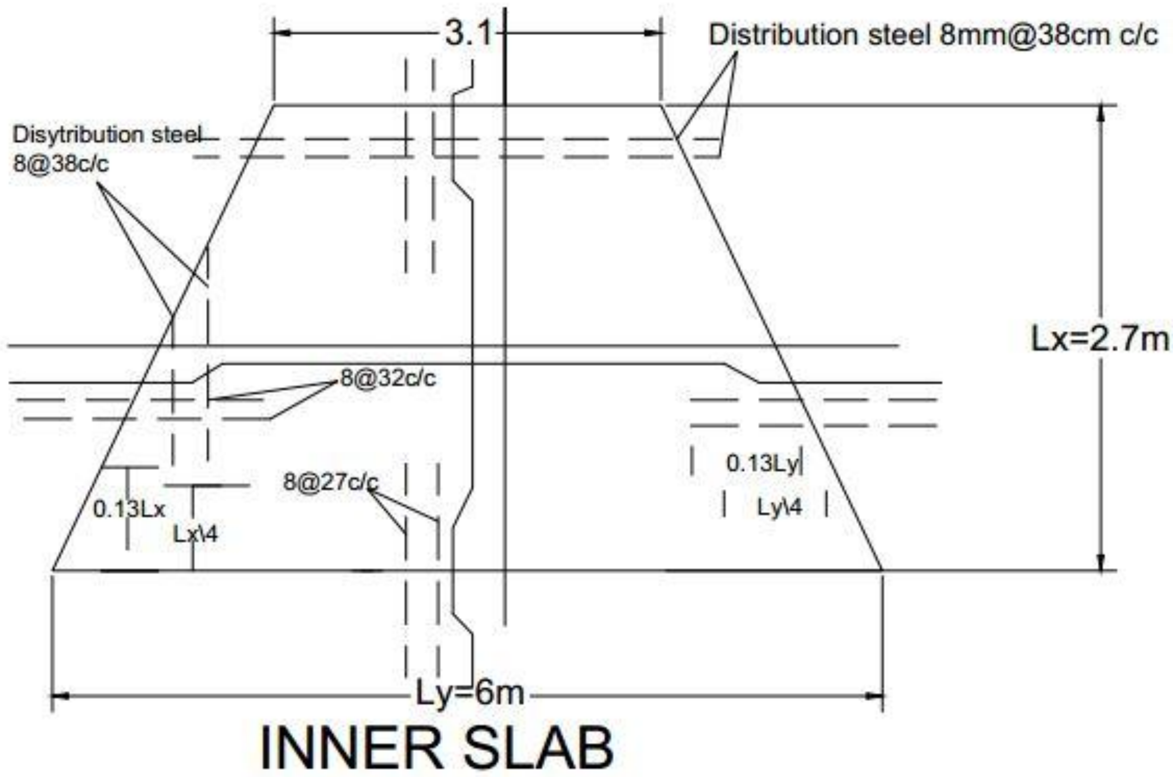

Figure 5.3.2 (a) Inner Slab Design

5.4 CHAJJA Design

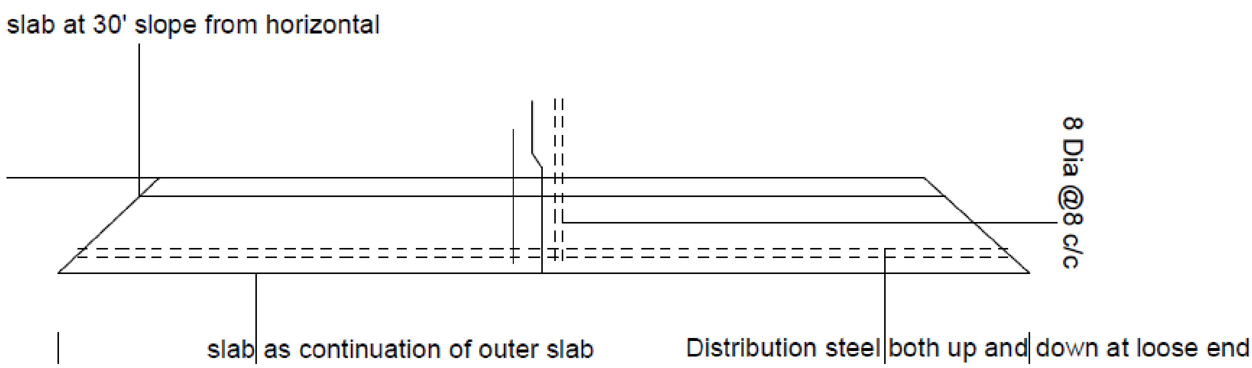

Figure 5.4(a) CHAJJA DESIGN

DIMENSIONS: 9.31m X 1m at 30 degrees from horizontal

4.4 STAIRCASE DESIGN

I)

TABLE NO. 5.4 (i)

	DESCRIPTION	VALUE	REMARK
DESIGN CONSTANT	Fy	415 N/mm2	
	Fck	20 N/mm2	
	Effective span, L	5 m	700/(1100=(0.87*415))
	Waist Slab Thickness	250 mm	L/20
	Clear cover	20 mm	assumed
	d eff	224	250-(20)-(12/2)
	Risers	200 mm	assumed
	Treads	300 mm	assumed
	width of stairs	1.5 m	assumed
	Finish Load	0.8kN/m2	assumed
	depth of waist slab	200 mm	
	Live Load	5 kN/m2	IS Code: 875
EFFECTIVE SPAN	L for Landing X and Y	1 m	Assumed
	L for going	3 m	calculated
LOADINGS for flight portion	Self weight of waist slab	7.51 kN/m2 N/m2	25*0.25*360.5/300
	Self weight of steps	2.5 kN/m2	25*.5*.2
	Weight of finishing	0.8 kN/m2	Contractor
	Total Factored Load	23.715 kN/m2	
LOADINGS for landing portion	Dead load	6.25 kN/m2	25*.25
	Weight of finishing	0.8 kN/m2	Contractor
	Live Load	5 kN/m2	
	Total factored Load	18.075 kN/m2	

II)

TABLE NO. 5.4 (ii)

DESCRIPTION	VALUE	REMARK
Reaction at A	58.76kN	Ra + Rb = 101.87 kN/m
Reaction at B	43.11kN	(15.36*0.425)+(71.145*1.925)+(15.36*3.85)=Rb*4.7
distance of max Mu	2.35 m	Midspan of 4.7((2*0.85) +3)
Mu	74.64 Nm/m	(58.76*2.35)-(18.075*(0.85^2/2))-(23.715*1.5*1.6)
Mu/bd^2 , R	1.63 Mpa	code formulae
Main Reinforcement Ast	1079 mm2	Ast/bd=(fck/2fy)(1-(1-4.598*R/fck)^(1/2))
Dia of long. Bars	12mm	assumed
Spacing of main reinforcement bars	100mm	113*1000/1079
Ast of distributors	300 mm2	0.0012bt
Dia of distributor bars	8mm	assumed
Spacing of distributor bars	160 mm	50.3*1000/300
Vu	54.89 kN/m	58.76-(18.075*0.214)
Zv	0.256 MPa	(54.89*1000)/(1000*214)
Zc	0.499MPa	0.42*1.19 acc to Cl. 40.2.1.1 of code , hence safe

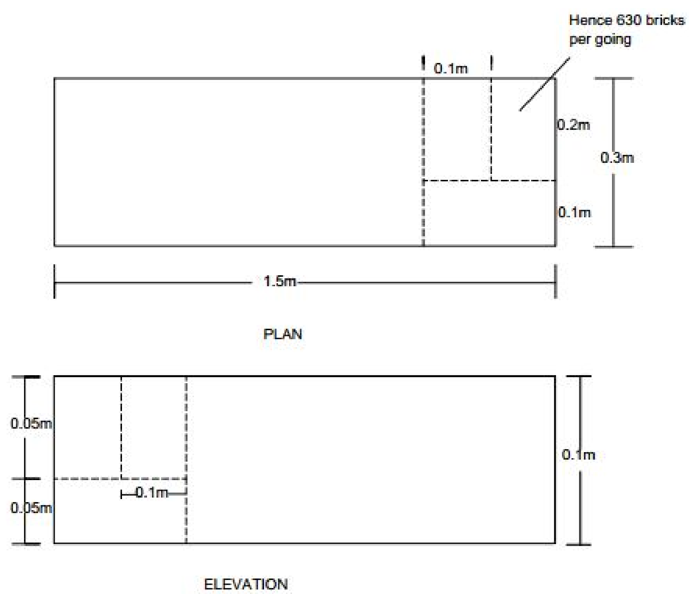

Figure 5.5 (a) Staircase Brickwork Pattern

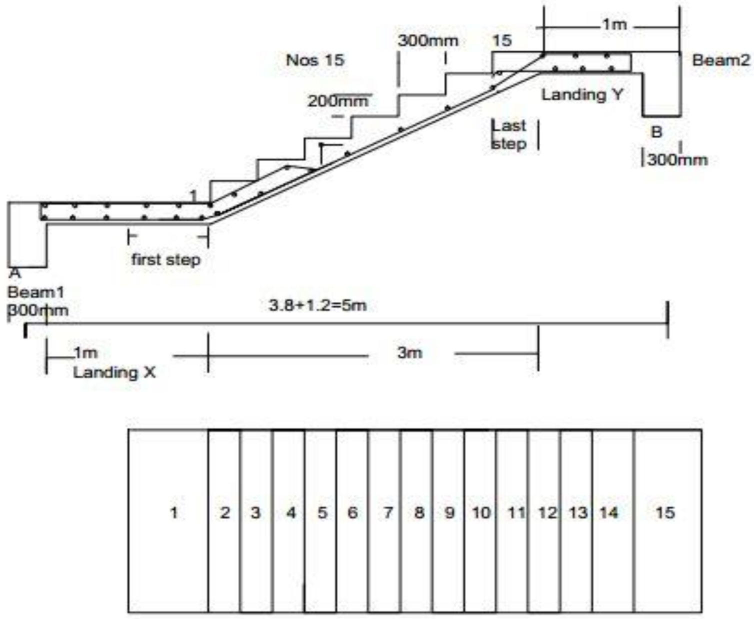

Figure 5.5 (b) simply supported single span staircase with 1 going and 2 landing platforms

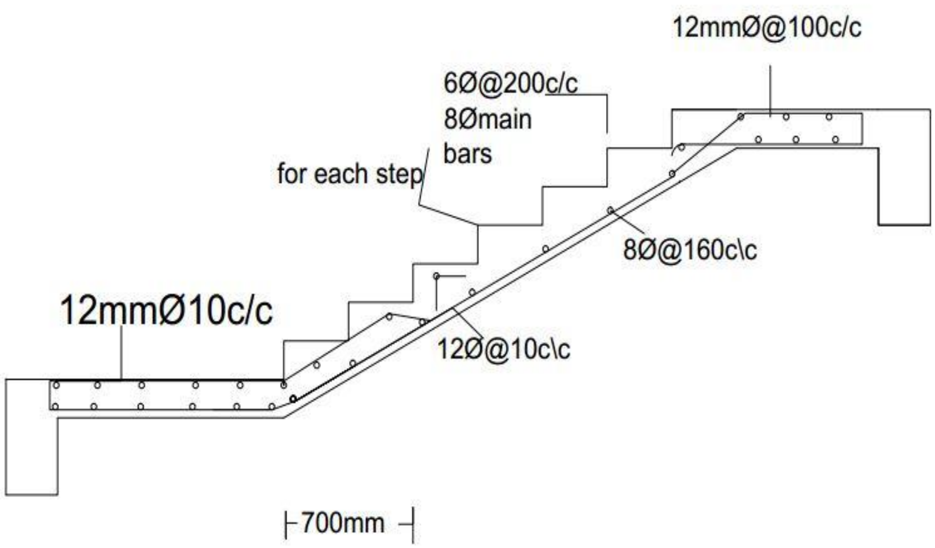

Figure 5.5 (c) Staircase Structural Design

5.6 STAIRCASE RAMP DESIGN

TABLE NO. 5.6 (i)

	DESCRIPTION	VALUE	REMARK
DESIGN CONSTANT	Fy	415 N/mm2	
	Fck	20 N/mm2	
	Effective span, L	5 m	700/(1100=(0.87*415))
	Waist Slab Thickness	250 mm	L/20
	Clear cover	20 mm	Assumed
	d eff	224	250-(20)-(12/2)
	width of stairs	1.5 m	Assumed
	Finish Load	0.8kN/m2	Assumed
	depth of waist slab	200 mm	
	Live Load	5 kN/m2	IS Code: 875
EFFECTIVE SPAN	L for going	4.7 m	calculated
LOADINGS for flight portion	Self weight of waist slab	7.51 kN/m2 N/m2	25*0.25*360.5/300
	Weight of finishing	0.8 kN/m2	Contractor
	Total Factored Load	23.715 kN/m2	
DESIGN MOMENT	Reaction at A	46.92kN	Ra + Rb = 19.965*4.7 kN/m
	Reaction at B	46.92kN	Ra + Rb = 19.965*4.7 kN/m
	distance of max Mu	2.35 m	Midspan of 4.7
	Mu	55.14 kNm/m	(46.92*2.35)-(19.965*(2.35^2/2))
MAIN REINFORCEMENT	Mu/bd^2 , R	1.204 Mpa	code formulae
	Main Reinforcement Ast	771.256 mm2	Ast/bd=(fck/2fy)(1-(1-4.598*R/fck)^(1/2))
	Dia of long. bars	12mm	assumed
	Spacing of main reinf bars	145mm	113*1000/771.256

DISTRIBUTORS	Ast of distributors	300 mm2	0.0012bt
	Dia of distributor bars	8mm	assumed
	Spacing of distributor bars	160 mm	50.3*1000/300
CHECK FOR SHEAR	Vu	42.647 kN/m	46.92-(19.965*0.214)
	Zv	0.199 MPa	(42.65*1000)/(1000*214)
	Zc	0.499MPa	0.42*1.19 acc Cl. 40.2.1.1 of code. safe

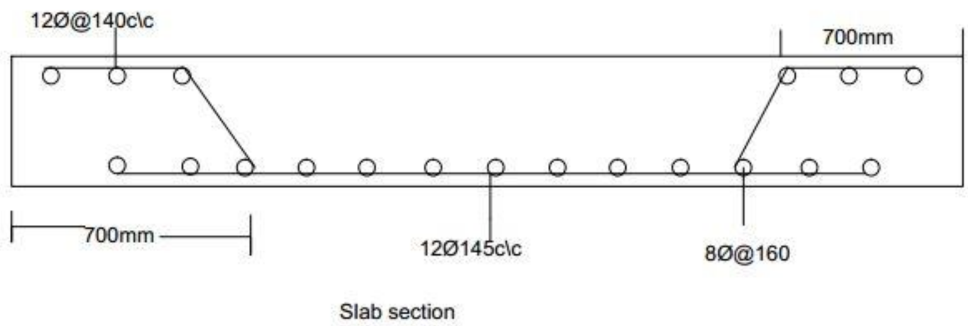

Figure 5.6 (a) Ramp Structural Cross-Section

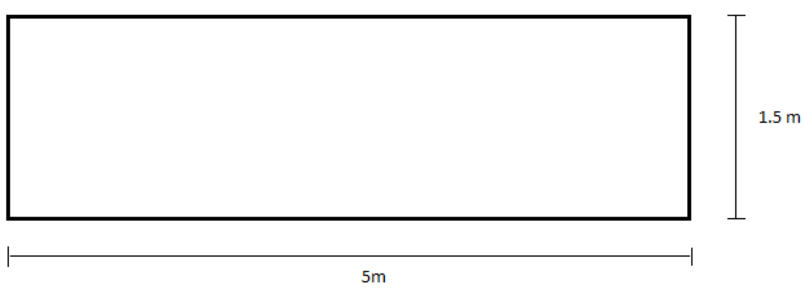

Figure 5.6 (b) Ramp Plan

5.7 FOUNDATION DESIGN

TABLE NO. 5.7 (i)

	DESCRIPTION	VALUES	UNIT	REMARKS
GENERAL	Dimensions of Column	450 X 600	mm X mm	
	Dimensions of Fooing	3 X 3 and 3.6 X 2.5	m X m	Square & Rectangular Footing
	Load on the Footing	3340	kN	
	Safe Bearing Capacity of soil, qa	400	kN/m2	table 9.1
	Base Area of Footing	9.185	m2	3340*1.1/400
	Net Soil Pressure at Ultimate Loads, qu	556.67	kN/m2	3340*1.5 / 3*3
ONE WAY SHEAR	Design Shear Strength of Concrete, Z_c	0.36	Mpa	M20, Pt=0.25 , table 6.1
	One way Shear Resistance, Vc1	1080d	N	0.36*3000*d
	Effective Depth, d	774	Mm	2126700-1668d = 1080d
TWO WAY SHEAR	Factored Shear Force, Vu2	4171.04 * 10^3	N	0.556*[3000^(2) - ((450+d)^(2))]
	Effective depth, d	766	Mm	4171.014 * 10^(3) = 2012.4*d + 4.472*d^(2)

	Clear Cover	75	Mm	
	Dia of Reinforcement	16	Mm	
	Final Effective depth, d	774	Mm	
	Total Depth, D	865	Mm	774+(75*16)
	Unit weight of concrete	24	kN/m3	
	Unit weight of soil	18	kN/m3	
RESULT	Soil Pressure due to superstructure	390	kN/m2	390<400 Hence O.K
	Mu	1355.74 * 10^(6)	Nmm	
	R= Mu/Bd^(2)	0.754	MPa	
	% Reinforcement	0.1365	%	
	Ast min	2700	mm2	
	Spacing of Reinforcement, S	118	Mm	
	Development Length, Ld	752	Mm	Dia*(0.87*fy)/(4*Zbd)

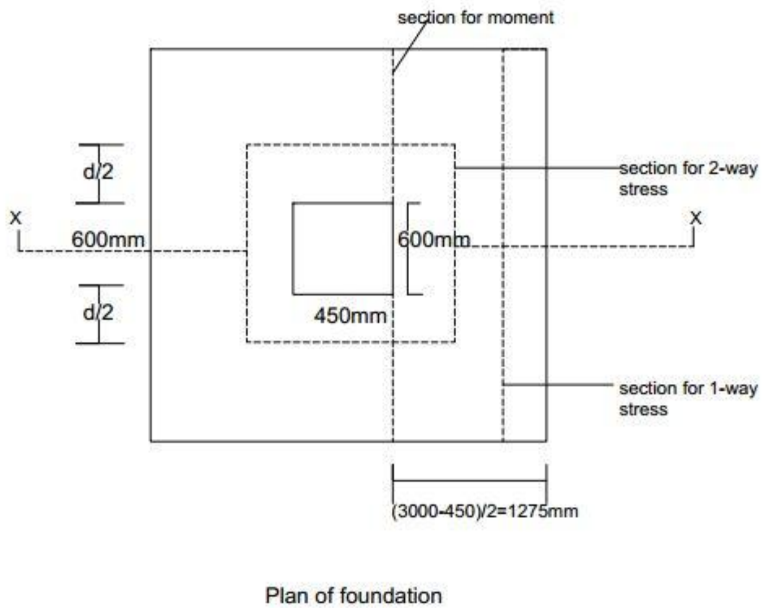

Figure 5.7(a) Foundation Plan

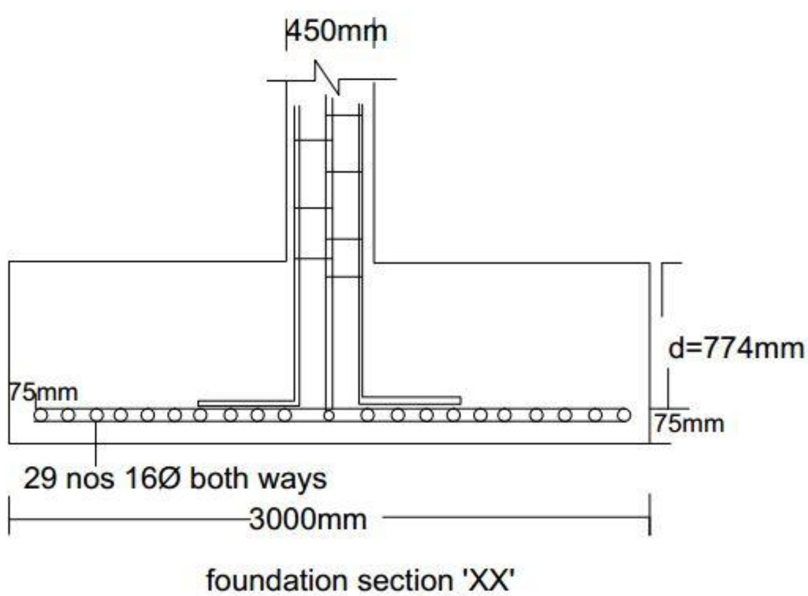

Figure 5.7(b) Foundation Design Section

CHAPTER 6: PROJECT MANAGEMENT

6.1 Project Network

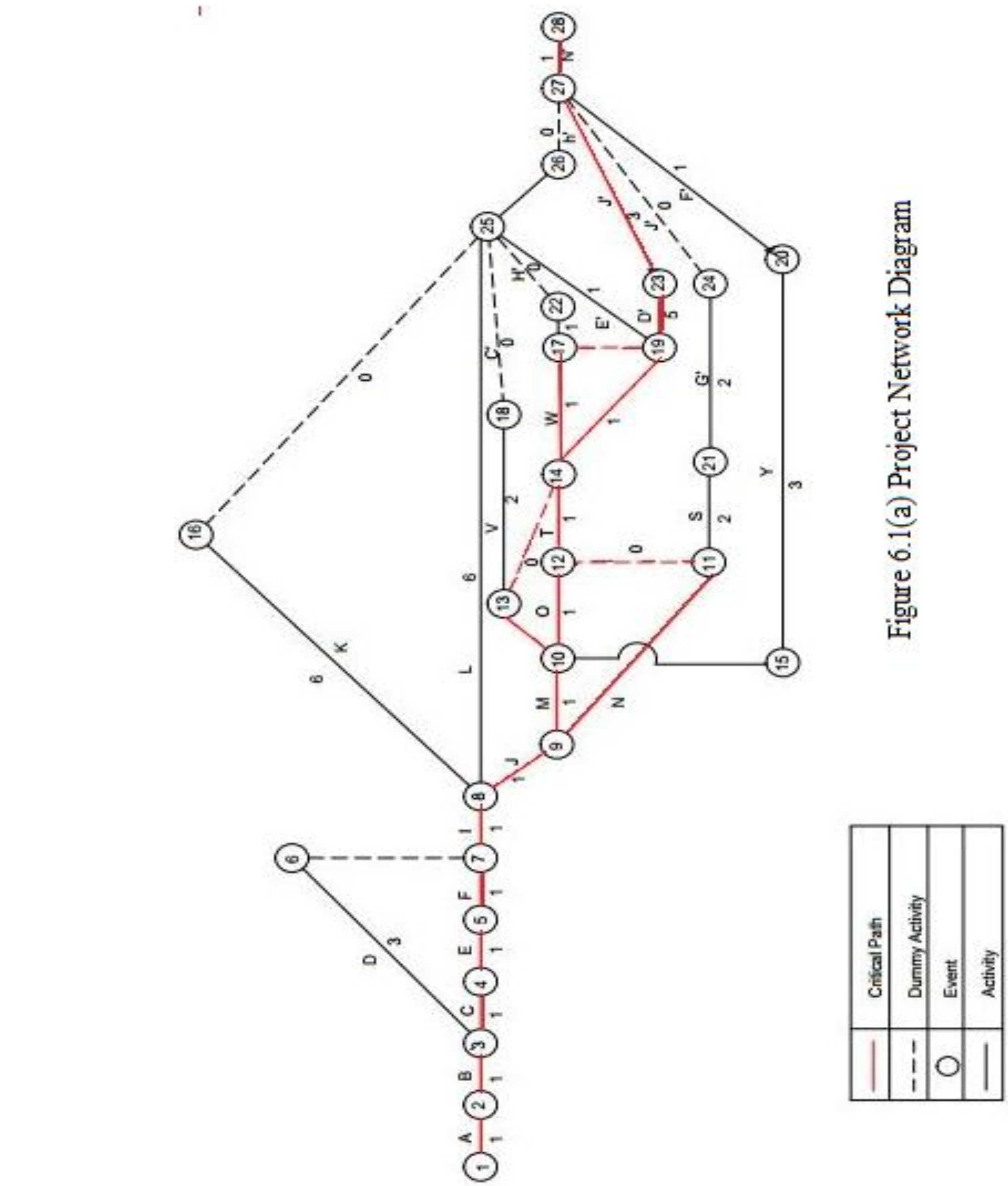

Figure 6.1(a) Project Network Diagram

6.2 Gantt Chart

TABLE NO. 6.2(a)

NAME	S.No.	*ACTIVITY*	TIME (Months)																		
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A	1	Layout and site Establishment	■																		
B	2	Excavation in Foundations		■																	
C	3	R.C.C. Work Foundations			■																
E	4	R.C.C. Work Pedestal,Plinth				■															
F	5	Columns G/F to F/F R.C.C.					■														
H	6	F/F Slab R.C.C.						■													
I	7	Columns F/F to 2nd /F R.C.C.							■												
L	8	2nd /F Slab R.C.C.								■											
N	9	Columns 2/F to 3/F R.C.C.									■										
S	10	3/F Slab R.C.C.Slab										■									
V	11	Columns 3/F to 4th /F R.C.C.											■								
A'	12	4th /F Slab R.C.C.												■							
D	13	Manufacturing D/W Frames			■	■	■														
M	14	Masonry and D/W frames G/F								■	■										
O	15	Masonry and D/W framesF/F									■	■									
R	16	Masonry and D/W frames 2/F										■	■								
U	17	Masonry and D/W frames3rd/F											■	■							
F'	18	Masonry and D/W frames4th/F												■	■						
P	19	Internal Plastering work									■	■	■	■	■	■					
K'	20	External Plastering													■	■	■				
K	21	W.S & S.I. Work concealed							■	■	■	■	■	■							
J	22	Electrical wiring and conduiting							■	■	■	■	■	■							
W	23	Structural Roofing work											■								
D'	24	Eaves , Fascia, gutter work												■							
J'	25	Roof Sheeting work													■						
C'	26	Flooring												■	■	■	■	■			
X	27	Door Window shutters and															■	■	■		
H'	28	Painting works																■	■	■	
E'	29	Sanitary fixtures and fittings																		■	
M'	30	External site dev. & misc. Items																			■
Dummy Activities are: G, Q, Y, Z, B', G', I' and L'						TABLE NO. 5.2 (i)															

6.3 PERT ANALYSIS

TABLE NO. 6.3(i)

EVENT	EARLIEST EXPECTED TIME(Te)				LATEST EXPECTED TIME (Tl)				SLACK TIME (Ts= Tl-Te)
	Predecessor Event	**Duration (teij)**	**Tej**	**Te**	**Successor Event**	**Duration (teij)**	**Tej**	**Tl**	
1	-	-	0	0	2	1	0	0	0
2	1	1	1	1	3	1	1	1	0
3	2	1	2	2	4	1	2	2	0
	-	-	-		6	3	2		
4	3	1	3	3	5	1	3	3	0
5	4	1	4	4	7	1	4	4	0
6	3	3	5	5	7	0	5	5	0
7	5	1	5	5	8	1	5	5	0
	6	0	5		-	-			
8	7	1	6	6	9	1	6	6	0
	-	-	-		16	6	10		
	-	-	-		25	6	10		
9	8	1	7	7	10	1	7	7	0
	-	-	-		11	2	7		
10	9	1	8	8	12	1	8	8	0
	-	-	-		13	2	8		
	-	-	-		15	6	9		
11	9	2	9	9	12	0	9	9	0
	-	-	-		21	2	15		
12	10	1	9	9	14	1	9	9	0
	11	0	9		-	-			
13	10	2	10	10	14	0	10	10	0
	-	-	-		18	2	14		
14	12	1	10	10	17	1	10	10	0
	13	0	10		19	1	10		

<table>
<tr><td>15</td><td>10</td><td>6</td><td>14</td><td>14</td><td>20</td><td>3</td><td>15</td><td>15</td><td>1</td></tr>
<tr><td>16</td><td>8</td><td>6</td><td>12</td><td>12</td><td>25</td><td>0</td><td>16</td><td>16</td><td>4</td></tr>
<tr><td rowspan="2">17</td><td>14</td><td>1</td><td>11</td><td rowspan="2">11</td><td>19</td><td>0</td><td>11</td><td rowspan="2">11</td><td rowspan="2">0</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>22</td><td>1</td><td>15</td></tr>
<tr><td>18</td><td>13</td><td>2</td><td>12</td><td>12</td><td>25</td><td>0</td><td>16</td><td>16</td><td>4</td></tr>
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<tr><td>17</td><td>0</td><td>11</td><td>25</td><td>1</td><td>15</td></tr>
<tr><td>20</td><td>15</td><td>3</td><td>17</td><td>17</td><td>27</td><td>1</td><td>18</td><td>18</td><td>1</td></tr>
<tr><td>21</td><td>11</td><td>2</td><td>11</td><td>11</td><td>24</td><td>2</td><td>17</td><td>17</td><td>6</td></tr>
<tr><td>22</td><td>17</td><td>1</td><td>12</td><td>12</td><td>25</td><td>0</td><td>16</td><td>16</td><td>4</td></tr>
<tr><td>23</td><td>19</td><td>5</td><td>16</td><td>16</td><td>27</td><td>3</td><td>16</td><td>16</td><td>0</td></tr>
<tr><td>24</td><td>21</td><td>2</td><td>13</td><td>13</td><td>27</td><td>0</td><td>19</td><td>19</td><td>6</td></tr>
<tr><td rowspan="5">25</td><td>8</td><td>6</td><td>12</td><td rowspan="5">12</td><td>26</td><td>1</td><td>18</td><td rowspan="5">16</td><td rowspan="5">4</td></tr>
<tr><td>16</td><td>0</td><td>12</td><td>27</td><td>3</td><td>16</td></tr>
<tr><td>18</td><td>0</td><td>12</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>19</td><td>1</td><td>12</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>22</td><td>0</td><td>12</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>26</td><td>25</td><td>1</td><td>12</td><td>12</td><td>27</td><td>0</td><td>19</td><td>19</td><td>7</td></tr>
<tr><td rowspan="5">27</td><td>20</td><td>1</td><td>18</td><td rowspan="5">19</td><td>28</td><td>1</td><td>19</td><td rowspan="5">19</td><td rowspan="5">0</td></tr>
<tr><td>23</td><td>3</td><td>19</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>24</td><td>0</td><td>13</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>25</td><td>3</td><td>15</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>26</td><td>0</td><td>12</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>28</td><td>27</td><td>1</td><td>20</td><td>20</td><td>-</td><td>24</td><td>20</td><td></td><td>0</td></tr>
</table>

6.4 CPM ANALYSIS

TABLE NO. 6.4(i)

Activity	**Duration**	**Earliest Occurrence Time**		**Latest Occurrence Time**		**Float**			
		Earliest Start Time	Earliest Finish Time	Latest Start Time	Latest Finish Time	Total Float	Free Float	Interfering Float	Independent Float
A(1-2)	1	0	1	0	1	0	0	0	0
B(2-3)	1	1	2	1	2	0	0	0	0
C(3-4)	1	2	3	2	3	0	0	0	0
D(3-6)	3	2	5	2	5	0	0	0	0
E(4-5)	1	3	4	3	4	0	0	0	0
F(5-7)	1	4	5	4	5	0	0	0	0
G(6-7)	0	5	5	5	5	0	0	0	0
H(7-8)	1	5	6	5	6	0	0	0	0
I(8-9)	1	6	7	6	7	0	0	0	0
J(8-16)	6	6	12	10	16	4	0	4	4
K(8-25)	6	6	12	10	16	4	0	4	4
L(9-10)	1	7	8	7	8	0	0	0	0
M(9-11)	2	7	9	7	9	0	0	0	0
N(10-12)	1	8	9	8	9	0	0	0	0
O(10-13)	2	8	10	8	8	0	0	0	0
P(10-15)	6	8	14	9	15	1	1	1	0
Q(11-12)	0	9	9	9	9	0	0	0	0
R(11-21)	2	9	11	15	17	6	0	0	6
S(12-14)	1	9	10	9	10	0	0	0	0
T(13-14)	0	10	10	10	10	0	0	0	0
U(13-18)	2	10	12	14	16	4	0	0	4
V(14-17)	1	10	11	14	15	4	4	4	0
W(14-19)	1	10	11	10	11	0	0	0	0
X(15-20)	3	14	17	15	18	1	0	-1	1

Y(16-25)	0	12	12	16	16	4	0	-4	4
Z(17-19)	0	11	11	15	15	4	4	4	0
A'(17-22)	1	11	12	15	16	4	0	0	4
B'(18-25)	0	12	12	16	16	4	0	-4	4
C'(19-23)	5	11	16	11	16	0	0	0	0
D'(19-25)	1	11	12	15	16	4	0	0	4
E'(20-27)	1	17	18	18	19	1	1	0	0
F'(21-24)	2	11	13	17	19	6	0	-6	6
G'(22-25)	0	12	12	16	16	4	0	-4	4
H'(23-27)	3	16	19	16	19	0	0	0	0
I'(24-27)	0	13	13	19	19	6	6	0	0
J'(25-26)	1	12	13	18	19	6	-1	-5	7
K'(25-27)	3	12	15	16	19	4	4	0	0
L'(26-27)	0	13	13	19	19	6	6	-1	0
M'(27-28)	1	19	20	19	20	0	0	0	0

CHAPTER 7: ESTIMATION AND COSTING

7.1 Bill of Quantities

I) TABLE NO. 7.1(i)

Item no	Particulars of item	No.	L (m)	B (m)	H/D (m)	Quantity	Unit	Remark
1	Earthwork excavation of foundation	12	3	3	0.9	97.23	m^3	12*3*3*0.9
2	Earthwork filling in plinth							
	a) Outer Rooms	6	9.31	5.58	0.3	93.50964	m^3	6*9.31*(5.38+0.2)*0.3
	b) Washroom Area	2	6.4	2.8	0.3	10.752	m^3	2*(6.2+0.2)*(2.7+0.1)*0.3
	TOTAL:					**104.2616**	m^3	
3	RCC work in foundation	12	3	3	0.865	93.42	m^3	12*3*3*0.8656
4	2.5cm DPC covering							
	Outer hexagonal wall	6	9.3	0.2	-	11.16	m^2	(9.1+0.2)*0.2*6
	Inner diagonal wall	6	6.21	0.2	-	7.452	m^2	6.21*0.2*6
	Inner hexagonal wall	6	2.9	0.2		3.72	m^2	2.9*0.2*0.2*6
	TOTAL:					**22.32**	$\mathbf{m^2}$	

II)

TABLE NO. 7.1(ii)

Item no	Particulars of item	No.	L (m)	B (m)	H/D (m)	Quantity	Units	Remark
5	Outer hexagonal Translucent concrete brick work (N = 5-1 = 4)	1	37.24	0.2m	2.65	16.8752	m^3	(37.24*0.2*2.65)-(4*0.45*0.6*2.65)
	Deduct:							
	Window openings	8	1	0.2	1.5	2.4	m^3	(8*0.2*1*1.5)
	TOTAL:					**14.4752**	m^3	
6	Diagonal Rat Trap bond brick work (N=2-1=1)	6	6.21	0.2	2.65	19.75	m^3	(6.21*0.2*2.65*6)
7	Partition wall brick work (N= 5-1 =4)	1	17.24	0.2	2.65	6.28	m^3	(17.24*0.2*2.65)-(4*0.45*0.6*2.65)
	Deduct:							
	Door openings	4	1.2	0.2	2.1	2.016	m^3	(4*0.2*1.2*2.1)
	TOTAL:					**4.26**	m^3	
						-		

8	Inner Hexagonal wall Rat Trap bond brick work (N=6-1=5)	1	18.6	0.2	2.65	6.28	m^3	(18.6*0.2*2.65)-(5*0.45*0.6*2.65)
	Deduct:							
	Door Opening	1	1.2	0.2	2.1	0.504	m^3	(1.2*0.2*2.1*1)
	TOTAL:					5.776	m^3	

III)

TABLE NO. 7.1(iii)

Item no	**Particulars of item**	**No.**	**L (m)**	**B (m)**	**H/D (m)**	**Quantity**	**Units**	**Remark**
9	Outer hexagonal Translucent Concrete wall Windows	8	1	0.04	1.5	12	m^3	8*1*1.5
10	Partition Wall Doors	4	1.2	0.04	2.1	10.08	m^3	(4*1.2*2.1)
11	Washroom Door	1	1.2	0.04	2.1	2.52	m^3	(1*1.2*2.1)
12	***PRIMER COATING:***							
	a) Outer hexagonal Translucent Concrete wall Windows	8	1	-	1.5	12	m^2	8*1*1.5

	b) Partition Wall Doors	4	1.2	-	2.1	10.08	m^2	(4*1.2*2.1)
	c) Washroom Door	1	1.2	-	2.1	2.52	m^2	(1*1.2*2.1)
	TOTAL:					**24.6**	**m2**	
13	Railing works Ground Floor							
	a) Balcony	2	9.31			18.62	m	
	b) Going	1	5			5	m	
	c) Ramp	1	5			5	m	
	TOTAL:					**28.62**	**m**	

IV)

TABLE NO. 7.1(iv)

Item no	Particulars of item	No	L (m)	B (m)	H/D (m)	Quantity	Units	Remark
14	RCC Slab Work on Floor							
	a)Outer Slabs	5	9.31	5.38	0.13	32.55	m3	(5*9.31*5.38*0.13)
	b) Inner Slabs	2	6.2	2.7	0.13	4.33	m3	(2*6.2*2.7*0.13)
	TOTAL:					**36.88**	**m3**	
15	Floor Work on Floor							
	a) Outer Slabs	5	9.31	5.38	-	250.439	m2	(5*9.31*5.38)
	b) Inner Slabs	2	6.2	2.7	-	33.48	m2	(2*6.2*2.7)
	TOTAL:					**283.919**	**m2**	

16	Staircase Work on Floor							
	a)RCC work							
	i) Landings	2*2	1	1.5	0.25	1.5	m3	(4*1*1.5*0.25)
	ii) Going	1	3	1.5	0.25	1.125	m3	(1*3*1.5*0.25)
	iii) Ramp	-	-	-	-	-	-	-
	TOTAL:					**2.625**	**-**	
	b) Floor work							
	i) Landings	2	1	1.5	-	3	m2	(2*1*1.5)
	ii) Steps	15	1.5	0.3	-	6.75	m2	(15*1.5*0.3)
	iii) Ramp	-	-	-	-	-	-	-
	TOTAL:					**9.75**	**m2**	

V)

TABLE NO. 7.1(v)

Item no.	Particulars of Item	Nos.	L (m)	B(m)	D/H (m)	Quantity	Unit	Remark
17	12mm cement sand plastering 1:6 in Diagonal Walls	6*2	6.21	-	2.65	197.478	m2	6*2*6.21*2.65
18	12mm cement sand plastering 1:6 partition walls (N=5-1=4)	4*2	17.24	-	2.65	81.62	m2	[(17.2*2.65)-(4*0.45*2.65)]*2
	Deduct:							
	Door Openings	4	1.2	-	2.1	10.08	m2	4*1.2*2.1
	TOTAL:					**71.54**	**m^2**	

19	12mm cement sand plastering 1:6 Inner Hexagonal wall (N=6-1=5)	1	18.6	-	2.65	86.655	m^2	[(18.6*2.65)-(5*0.45*2.65)]*2
	__Deduct:__							
	__Door Opening__	1	1.2	0.012	2.1	2.52	m^2	(1.2*2.1)
	TOTAL:					**84.135**	$\mathbf{m^2}$	
20	White washing on the Diagonal Walls	6*2	6.21	-	2.65	197.478	m^2	6*2*6.21*2.65
21	White washing on partition walls (N=5-1=4)	4*2	17.24	-	2.65	20.405	m^2	[(17.2*2.65)-(4*0.45*2.65)]*2
	__Deduct:__							
	Door Openings	4	1.2	-	2.1	10.08	m^2	4*1.2*2.1
	TOTAL:					**30.485**	$\mathbf{m^2}$	
22	White washing on Inner Hexagonal wall (N=6-1=5)	1	18.6	-	2.65	21.663	m^2	[(18.6*2.65)-(5*0.45*2.65)]*2
	__Deduct:__							
	__Door Opening__	1	1.2	-	2.1	2.52	m^2	(1.2*2.1)
	TOTAL:					**1.01**	$\mathbf{m^2}$	
23	Paint on the Diagonal Walls	6*2	6.21	-	2.65	197.478	m^2	6*2*6.21*2.65

24	Paint on partition walls (N=5-1=4)	4*2	17.24	-	2.65	20.405	m^2	[(17.2*2.65)-(4*0.45*2.65)]*2
	<u>Deduct:</u>							
	Door Openings	4	1.2	-	2.1	10.08	m^2	4*1.2*2.1
	TOTAL:					**30.485**	$\mathbf{m^2}$	
25	Paint on Inner Hexagonal wall (N=6-1=5)	1	18.6	-	2.65	21.663	m^2	[(18.6*2.65)-(5*0.45*2.65)]*2
	<u>Deduct:</u>							
	<u>Door Opening</u>	1	1.2	-	2.1	2.52	m^2	(1.2*2.1)
	TOTAL:					**1.01**	$\mathbf{m^2}$	

7.2 PROJECT FINANCES

I)

TABLE NO. 7.2(i)

Item No.	Particulars of Item	Floors	Quantity	Total	Unit	Rate (Rs)	Per	Amount (Rs)
1	Earthwork excavation of foundation	1	97.23	97.23	m^3	500	m^3	48615
2	Earthwork filling in plinth	1	104.2616	104.2616	m^3	300	m^3	31278.48
3	RCC work in foundation	1	93.42	93.42	m^3	8000	m^3	747360
4	2.5cm DPC covering	1	22.32	22.32	m^2	175	m^3	3906
5	Ground floor - fourth floor outer hexagonal Translucent concrete brickwork	5	14.4752	72.376	m^3	11250	m^3	814230

6	Ground Floor till fourth floor Diagonal Rat Trap bond brick work	5	19.75	98.75	m^3	5625	m^3	555468.75
7	Ground Floor till fourth floor Partition wall brick work	5	4.26	21.3	m^3	5625	m^3	119812.5
8	Ground Floor till fourth floor Inner Hexagonal wall Rat Trap bond brick work	5	6.28	31.4	m^3	5625	m^3	176625
9	Ground floor till fourth floor outer hexagonal Translucent Concrete wall Windows	5	12	60	m^2	4000	m^2	240000
10	Ground Floor till fourth floor Partition Wall Doors	5	10.08	50.4	m^2	4000	m^2	201600
11	Ground Floor till fourth floor Washroom Door	5	2.52	12.6	m^2	4000	m^2	50400
12	Primer Coating on ground floor till fourth floor	5	24.6	123	m^2	50	m^2	6150
13	Railing works Ground Floor till fourth floor	5	28.62	143.1	m	1500	m	214650
14	RCC Slab Work from First Floor - Roof	5	36.88	184.4	m^3	10000	m^3	1844000
15	Floor Work from First Floor - Roof	5	283.919	1419.595	m^2	1250	m^2	1774493.8
16	a) Staircase RCC Work from Ground till fourth floor	5	2.625	13.125	m^3	10000	m^3	131250
	b) Staircase Floor Work from Ground till fourth floor	5	9.75	48.75	m^2	1250	m^2	60937.5

17	12mm cement sand plastering 1:6 in Diagonal Walls at Ground Floor till fourth floor	5	197.5	987.5	m^2	250	m^2	246875
18	12mm cement sand plastering 1:6 partition walls at Ground floor till fourth floor	5	71.54	357.7	m^2	250	m^2	89425
19	12mm cement sand plastering 1:6 Inner Hexagonal wall at Ground floor till fourth floor	5	84.135	420.675	m^2	250	m^2	105168.75
20	White washing on the Diagonal Walls at Ground Floor till fourth floor	5	197.478	987.39	m^2	25	m^2	24684.75
21	White washing on partition walls at Ground floor till fourth floor	5	71.54	357.7	m^2	25	m^2	8942.5
22	White washing on Inner Hexagonal wall at Ground floor till fourth floor	5	84.135	420.675	m^2	25	m^2	10516.875
23	Paint on the Diagonal Walls at Ground Floor till fourth floor	5	197.478	987.39	m^2	50	m^2	49369.5
24	Paint on partition walls from ground floor till fourth floor	5	71.54	357.7	m^2	50	m^2	17885
25	Paint on Inner Hexagonal wall at Ground floor till fourth floor	5	84.135	420.675	m^2	50	m^2	21033.75
26	Total Brickwork employed in steps of staircase	5	0.63	3.15	m^3	7000	m^3	22050

27	Toiletries :							
	a) Flush Systems	5	2	10	Nos	12500	Nos	125000
	b) Taps	5	8	40	Nos	630	Nos	25200
	c) Seat Covers	5	2	10	Nos	400	Nos	4000
	d) Sink Systems	5	2	10	Nos	4200	Nos	42000
	e) Mirrors	5	2	10	Nos	5000	Nos	50000
	f) Urinals	5	2	10	Nos	8200	Nos	82000
	g) Exhaust Fan	5	2	10	Nos	200	Nos	2000
28	Roofing	1	225	225	m^2	1000	m^2	225000
	Structural Steel Work below roofing		5625	5625	m^2	70	kg	393750
29	Rain water harvesting system 2.6m X 2.6m X 2.6m	1	17450	17450	Liter	10	Liter	174500
30	Electrical Requirements:							
	a) Fans	5	4	20	Nos	800	Nos	16000
	b) LEDs	5	14	70	Nos	1200	Nos	84000
	c) Switches	5	36	180	Nos	150	Nos	27000
31	Godrej Almerah	5	12	60	Nos	4780	Nos	286800
32	Solar Panels	-	12040	12040	kW	911520	2 kW	1823040
33	Reinforcement in RCC Work	-	177744.6	177744.6	kg	65	kg	11553399
34	GRAND TOTAL:							22530417
Reference	*B.N Dutta - Estimation and Costing							
	*Kuthiala Engineers- Er. Ajay Kuthiala(25 year Experience)							
	*Executive Engineer- Er. Raj Kumar Yadav(25 years)							
	*Kuthiala Constructions- SH. Shiv Kumar Kuthiala (54 years experience)							
	*Consultant Engineer - Karan Vir Singh Badwal (20 years)							

7.3 ENERGY AND WATER REQUIREMENTS

I)

TABLE NO. 7.3(i)

Item No.	Equipment	No.	Equivalent to	Watt (Power)	Quantity	Time	Cost
1	ROOM	4					
A	LEDs		75W	9W	2	8 Hours	1200
B	Fan		-	20W	1	8 Hours	800
C	Laptop Ports		-	20W	3	3 Hours	
2	CORRIDOR	1					
A	LEDs		75W	9W	2	8 Hours	1200
3	WASHROOM	1					
A	LEDs		75W	9W	4	8 Hours	1200
B	Exhaust Fan		-	5W	2	4 Hours	200
			TOTAL	12040W			

II)

TABLE NO. 7.3(ii)

Item No.	Particulars	Minute/Load/Flush	Unit	Quantity	Total
1	Teeth brushing	5	Liter per minute	3.78	18.9
2	Hands/face washing	5	Liter per minute	3.78	18.9
3	Dish washing by hand:	3	Liter per minute	5.67	17.01
4	Clothes washer	4	Liter per Load	95	380
5	Toilet flush	2	Liter per Flush	6.05	12.1
6	Glasses of water you drank	8	Liter per glass	0.23	1.84
7	Bathing	7	Liter per minute	19	133
8	TOTAL (Liter)				581.75
Per Person for a month Water Requirement is= 581.75*30 = 17452.5 L = **17.45 m^3**					
Hence Rain water Harvesting Tank Dimensions are: 2.6mX 2.6mX 2.6m					

7.4 COMPARATIVE STUDY

- Why are we comparing cost and loads due to walls?

  This is because our design doesn't substitutes major components for the sake of simplicity and ease of access to materials by the contractor. Furthermore walls form a major reason for cost and load on the superstructure, determining dimension and the amount of steel used in columns and beams.

- How our walls are different?
  The 4 sided walls on the outer hexagonal beams are made up of translucent concrete which is 50% more expensive but 12.5% lesser in loads. Rest all the walls uses "Rat-Trap Bond" which saves 20% in costs and are 30% lighter.

TABLE NO. 7.4(i)

Item No.	**Particular**	**Cost of walls (Rs)**		**Load due to walls (kN)**		**Difference observed in:**	
		Conventional	**Our design**	**Conventional**	**Our design**	**Cost (Rs)**	**Load (kN)**
1	Outer Hex. Wall	1076228.6	1326064	2756.8	1673.54	-249835	1083.2
2	Diagonal Wall	740542.5	555406.9	367.98	294.36	185135.6	73.62
3	Partition Wall	485413.75	421167.8	0	0	64245.95	0
4	Inner Hex. Wall	369675	277256.25	142.4	114	92418.75	28.4
	TOTAL:	2529091.1	2415710.9	3267.18	2081.9	91964.93	1185.2

Our Self Sustainable design saves 91964.93Rs over Conventional design (on walls only). Saving=4.2%. Our Self Sustainable Design incorporates 1185.28 kN lesser load. Hence, saving = 36.28%, which enables us to use approx. **36.27% less materials in beams and columns.**

CHAPTER 8: DISCUSSION AND RESULTS

- The project focuses on a self sustainable green hostel building of 5 floors, built up area being 225m^2. It involves structural designing of key elements, estimation, costing, PERT & CPM analysis and Gantt chart enabling us to put a time frame on the project. Overall, the construction but not hand over of this type of building takes **19 months** to be completed.

- Amongst 5 popular solar panels we selected a 10 kW Canadian Solar array with a total 48 solar panels in number costing Rs 1823040 excluding batteries. Since to get a 5 kW Canadian Solar array, it will cost just over Rs 900000, but the BP solar array will cost over Rs1500000 that is around **67% more.** Though it may still seem expensive, but in a longer run they replenish more than **80% of the electricity needs**, with additional benefits of selling electricity in surplus i.e. holidays seasons.

- Based on the location of project of **31° 6' 17.35" latitude** and **77° 10' 24.2" longitude** (H.P). The tilt of the solar panels installed on the chajja's outside every room should be **26.74 degrees** in case of a fixed tilt and should be **7.93 degrees in summers** and **46.42 degrees in winters** in case of an adjustable tilt and building's orientation being such that solar panels face south and west side over north and east.

- Our Self Sustainable design saves **Rs91964.93** over Conventional design (on Superstructure only). That is conventional cost being **Rs 2529091.1** and cost incurred by our incorporations being **Rs2415710.875**. Hence, savings = **3.8%.**

- Our Self Sustainable Design also incorporates **1185.28 kN** less as load. That is 36.28% less load leading to approx. **36.27%** less materials in beams and columns due to lighter loads.

- Total project's material cost being **22530417 Rs,** including approx. Labor and Shuttering Costs

Hence, the proposed project to the best of our abilities is both viable and beneficial.

CHAPTER 9: CONCLUSION

- The growth and development of our communities has a large impact on our natural environment. The manufacturing, design, construction, and operation of the buildings in which we live and work are responsible for the consumption of many of our natural resources. But our initiative to use green materials in our building for the efficient use of lighting, electricity, insulation, water needs and ventilation is an important step towards self efficiency.
- Having incorporated methods such as translucent concrete see-through walls, rat trap bonds we have been able to improve the lighting, insulation, electrical and design situation drastically, Project costs hence estimated includes shuttering and labor costs too. Hence, seen from the results the cost of wall constructions in our design are less due to lighter techniques of wall design incorporations. Though translucent concrete is expensive but lesser number of walls on the periphery and cheaper cost of the inner walls due to rat trap bond help in save money.
- The amount of material saved is directly proportional to the overlying load due to the fact that translucent concrete is 12.5% lighter and rat trap bond walls are 30% lighte than conventional walls; hence our design helps save that much material.
- The south and west side preference to solar panels is due to the fact that our position the project is north of the equator so best efficiency is achieved by facing south. And the west side is to avoid short circuit due to over demand at morning office hours, instead generate and store electricity past 2 PM due to panels facing west side and use the next morning.
- This shows that even by incorporating little usually overlooked things one can smartly design a structure which not only incorporates green building techniques economically, but at the same time make the idea in fact beneficial.

CHAPTER 10: FUTURE SCOPE

Self Sustainable building design is a huge topic and takes years and years to master. Various techniques are being developed everyday, which after little tuning and refinement can be put to use effectively. These methods should be incorporated on every level, be Ventilation, Water Demand, Electricity or Lighting.

- These methods are not only being developed in high end laboratories but also where necessity is on continuous test for man's skill to adapt. For example people of slum areas in Mumbai lives in terrible and inhuman conditions, a major problem being availability of electricity. Since the slums are connected with each other at a cut throat level they don't receive sunlight even past 1 PM, which makes it impossible to see let alone for children to study even in afternoons. As a result necessity breads innovation and this lead to a local woman using a remarkable technique to solve this problem. So she took a 1 Liter Pepsi bottle filled 75% of the bottle volume with water chlorine and bleach in the ratio of 3: 0.5: 1 then she stuck 25% of the bottle vertically through the roof (G.I. Iron Sheets) using M seal. As a result the bottle containing the solution glows like a 30W bulb through Sunlight during the day. This may not solve their entire problems, but definitely helps a lot.
- Use of different material's efficiency v/s cost can be analyzed and researched upon. Example use of straw bales instead of hollow bricks or rat trap bond and/or use of water trinkling for cooling purposes and ventilation.
- Use of different designs such as spiral down floors , wherein hollow walls carry water dripping, and to avoid water accumulation, floors are designed to spiral down and allow water to flow in downward direction and be collected for reuse
- Design of biogas plant at the base/underground of building, using all the waste from dustbins and used to produce biogas.

Hence, there is a lot of scope if the investments keep pouring into the development of these techniques; all we need to do is try them out one at a time.

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APPENDIX ‘A’

STAAD Pro REPORT:

Job Information

	Engineer
Name:	TARAK KUTHIALA
Date:	23-Nov-15

Structure Type	SPACE FRAME

Number of Nodes	72	Highest Node	72
Number of Elements	155	Highest Beam	207

Number of Basic Load Cases	2
Number of Combination Load Cases	1

Included in this printout are data for:

All	The Whole Structure

Included in this printout are results for load cases:

Type	L/C	Name
Primary	1	DL
Primary	2	LD
Combination	3	DL + LL

Section Properties

Prop	Section	Area (cm^2)	I_{yy} (cm^4)	I_{zz} (cm^4)	J (cm^4)	Material
1	Rect 0.60x0.45	2.7E 3	456E 3	810E 3	984E 3	CONCRETE
2	Rect 0.60x0.30	1.8E 3	135E 3	540E 3	371E 3	CONCRETE

Support Reaction

Node	L/C	Force-X (kN)	Force-Y (kN)	Force-Z (kN)	Moment-X (kNm)	Moment-Y (kNm)	Moment-Z (kNm)
3	3	-111.149	3.41E 3	0.127	0.257	-0.008	111.715
4	3	-54.405	3.36E 3	-84.509	-85.984	-0.007	54.854
2	3	-53.566	3.34E 3	83.667	85.294	-0.008	53.704
13	3	-43.700	2.84E 3	2.531	2.465	-0.042	42.574
14	3	-20.813	2.93E 3	-34.457	-34.502	-0.055	20.155
18	3	-12.660	3.21E 3	17.966	17.821	-0.034	12.377
15	3	12.660	3.21E 3	-17.966	-17.820	-0.034	-12.377
17	3	20.813	2.93E 3	34.457	34.502	-0.055	-20.155
16	3	43.700	2.84E 3	-2.531	-2.465	-0.042	-42.575
5	3	53.566	3.34E 3	-83.666	-85.294	-0.008	-53.704
1	3	54.405	3.36E 3	84.510	85.984	-0.007	-54.854
6	3	111.149	3.41E 3	-0.128	-0.258	-0.008	-111.715

Beam End Force

Beam	L/C	Node	Axial Force (kN)	Shear-Y (kN)	Shear-Z (kN)	Torsion (kNm)	Moment-Y (kNm)	Moment-Z (kNm)
190	3	69	-120.701	289.420	-0.136	2.290	-0.521	-332.499
193	3	72	-120.701	289.418	-0.136	2.290	-0.521	-332.498
189	3	68	-123.973	284.493	0.211	-3.058	0.820	-308.797
192	3	71	-123.973	284.491	0.211	-3.058	0.820	-308.796
191	3	70	-149.745	282.348	0.176	0.688	0.701	-317.316
194	3	67	-149.744	282.348	0.176	0.688	0.701	-317.315
38	3	21	40.331	276.403	0.007	1.633	0.025	-319.331
41	3	24	40.331	276.402	0.007	1.632	0.025	-319.330
114	3	45	-4.963	273.703	-0.004	1.491	-0.015	-315.100
117	3	48	-4.963	273.702	-0.004	1.491	-0.015	-315.100
76	3	33	-5.282	273.157	0.013	1.393	0.052	-315.577
79	3	36	-5.282	273.156	0.013	1.393	0.052	-315.576
37	3	20	40.763	272.560	0.005	-2.034	0.022	-301.704
40	3	23	40.763	272.558	0.005	-2.033	0.022	-301.703
113	3	44	-5.343	271.483	0.050	-1.923	0.203	-303.813
116	3	47	-5.343	271.481	0.050	-1.923	0.203	-303.812
152	3	57	37.537	271.369	-0.040	1.335	-0.168	-314.391
155	3	60	37.537	271.368	-0.040	1.335	-0.168	-314.390
75	3	32	-6.104	270.775	0.026	-1.767	0.102	-303.991
78	3	35	-6.103	270.773	0.026	-1.767	0.102	-303.990
151	3	56	40.139	269.794	0.083	-1.677	0.355	-306.368
154	3	59	40.139	269.792	0.083	-1.677	0.355	-306.367
115	3	46	-7.730	269.417	0.052	0.320	0.211	-307.496
118	3	43	-7.730	269.417	0.052	0.320	0.211	-307.496
153	3	58	53.925	269.250	0.092	0.289	0.377	-313.678

156	3	55	53.925	269.250	0.092	0.289	0.377	-313.678
39	3	22	43.537	268.804	0.004	0.243	0.017	-301.202
42	3	19	43.537	268.804	0.004	0.243	0.017	-301.201
77	3	34	-7.373	268.255	0.027	0.257	0.109	-305.677
80	3	31	-7.373	268.255	0.027	0.257	0.109	-305.677
165	3	63	600.219	244.245	0.293	0.015	-0.434	454.542
168	3	54	-674.208	244.245	0.291	-0.015	0.471	-302.617
172	3	66	-94.087	208.443	-0.137	0.985	-0.637	-334.964
175	3	63	-94.086	208.441	-0.137	0.985	-0.637	-334.962
176	3	63	-94.579	208.321	0.054	-0.937	0.264	-334.641
173	3	66	94.578	208.319	-0.054	0.937	0.264	334.639
14	3	12	30.488	207.661	-0.000	0.849	-0.000	-345.086
17	3	9	30.487	207.659	-0.000	0.849	-0.000	-345.084
18	3	9	30.546	207.497	-0.002	-0.812	-0.010	-344.480
15	3	12	-30.546	207.496	0.002	0.812	-0.010	344.477
96	3	42	-3.398	207.133	-0.021	0.722	-0.100	-345.405
99	3	39	-3.398	207.131	-0.021	0.722	-0.100	-345.402
100	3	39	-3.338	207.049	-0.003	-0.745	-0.013	-345.063
97	3	42	3.338	207.047	0.003	0.745	-0.013	345.061
58	3	30	-4.299	207.036	-0.007	0.712	-0.033	-345.842
61	3	27	-4.299	207.034	-0.007	0.712	-0.033	-345.839
62	3	27	-4.303	206.934	-0.005	-0.730	-0.021	-345.392
59	3	30	4.303	206.932	0.005	0.730	-0.021	345.389
138	3	51	28.062	206.636	0.004	-0.664	0.027	-346.330
135	3	54	-28.061	206.635	-0.004	0.664	0.027	346.328
134	3	54	27.844	206.576	-0.052	0.580	-0.244	-346.113
137	3	51	27.844	206.574	-0.052	0.580	-0.244	-346.110
133	3	49	34.609	204.361	0.011	0.073	0.056	-339.970
136	3	52	34.610	204.361	0.011	0.073	0.056	-339.970
171	3	62	106.511	204.314	-0.033	0.066	0.141	323.693
174	3	65	106.511	204.314	-0.033	0.066	0.141	323.693
13	3	8	-31.455	204.295	0.002	0.071	-0.010	335.205
16	3	11	-31.455	204.295	0.002	0.071	-0.010	335.205
95	3	37	-3.847	204.289	-0.001	-0.006	-0.006	-337.185
98	3	40	-3.847	204.289	-0.001	-0.006	-0.006	-337.185
57	3	25	-4.442	204.278	-0.004	-0.014	-0.018	-337.647
60	3	28	-4.442	204.278	-0.004	-0.014	-0.018	-337.647
60	3	29	4.442	204.242	0.004	0.014	-0.018	337.482
57	3	26	4.442	204.242	0.004	0.014	-0.018	337.482
98	3	41	3.847	204.232	0.001	0.006	-0.008	336.919
95	3	38	3.847	204.232	0.001	0.006	-0.008	336.919
16	3	10	31.455	204.225	-0.002	-0.071	-0.011	-334.883
13	3	7	31.455	204.225	-0.002	-0.071	-0.011	-334.883
171	3	61	-106.511	204.206	0.033	-0.066	0.164	-323.195
174	3	64	-106.511	204.206	0.033	-0.066	0.164	-323.194
136	3	53	-34.610	204.159	-0.011	-0.073	0.042	339.033
133	3	50	-34.609	204.159	-0.011	-0.073	0.042	339.033
134	3	49	-27.844	201.952	0.052	-0.580	-0.244	324.597
137	3	52	-27.844	201.951	0.052	-0.580	-0.244	324.594
138	3	50	-28.062	201.892	-0.004	0.664	0.014	324.255
135	3	53	28.061	201.892	0.004	-0.664	0.014	-324.253
62	3	26	4.303	201.595	0.005	0.730	-0.021	320.547
59	3	29	-4.303	201.594	-0.005	-0.730	-0.021	-320.545
58	3	25	4.299	201.493	0.007	-0.712	-0.033	320.049
61	3	28	4.299	201.492	0.007	-0.712	-0.033	320.046
100	3	38	3.338	201.480	0.003	0.745	-0.016	319.148
97	3	41	-3.338	201.479	-0.003	-0.745	-0.016	-319.146
96	3	37	3.398	201.396	0.021	-0.722	-0.100	318.710
99	3	40	3.398	201.395	0.021	-0.722	-0.100	318.708
18	3	8	-30.546	201.031	0.002	0.812	-0.010	314.392
15	3	11	30.546	201.031	-0.002	-0.812	-0.010	-314.390
14	3	7	-30.488	200.868	0.000	-0.849	-0.000	313.478
17	3	10	-30.487	200.867	0.000	-0.849	-0.000	313.476

176	3	62	94.579	200.208	-0.054	0.937	0.241	296.890
173	3	65	-94.578	200.207	0.054	-0.937	0.241	-296.888
172	3	61	94.087	200.086	0.137	-0.985	-0.637	296.078
175	3	64	94.086	200.085	0.137	-0.985	-0.637	296.076
77	3	27	7.373	197.550	-0.027	-0.257	0.059	193.891
80	3	30	7.373	197.550	-0.027	-0.257	0.059	193.891
39	3	9	-43.537	197.001	-0.004	-0.243	0.006	186.008
42	3	12	-43.537	197.001	-0.004	-0.243	0.006	186.007
153	3	51	-53.925	196.555	-0.092	-0.289	0.194	195.717
156	3	54	-53.925	196.555	-0.092	-0.289	0.194	195.716
115	3	39	7.730	196.388	-0.052	-0.320	0.110	188.499
118	3	42	7.730	196.388	-0.052	-0.320	0.110	188.499
151	3	49	-40.139	195.983	-0.083	1.677	0.158	184.965
154	3	52	-40.139	195.983	-0.083	1.677	0.158	184.964
75	3	25	6.104	195.002	-0.026	1.767	0.059	176.500
78	3	28	6.103	195.002	-0.026	1.767	0.059	176.499
152	3	50	-37.537	194.408	0.040	-1.335	-0.077	183.214
155	3	53	-37.537	194.408	0.040	-1.335	-0.077	183.214
113	3	37	5.343	194.295	-0.050	1.923	0.110	171.930
116	3	40	5.343	194.294	-0.050	1.923	0.110	171.929
37	3	7	-40.763	193.217	-0.005	2.034	0.007	163.136
40	3	10	-40.763	193.217	-0.005	2.033	0.007	163.135
76	3	26	5.282	192.621	-0.013	-1.393	0.031	173.306
79	3	29	5.282	192.620	-0.013	-1.393	0.031	173.305
114	3	38	4.963	192.074	0.004	-1.491	-0.012	169.438
117	3	41	4.963	192.074	0.004	-1.491	-0.012	169.438
38	3	8	-40.331	189.374	-0.007	-1.633	0.017	156.915
41	3	11	-40.331	189.374	-0.007	-1.632	0.017	156.915
51	3	27	2.65E 3	185.205	-0.073	-0.004	0.101	274.748
54	3	12	-2.73E 3	185.205	-0.075	0.004	-0.128	-299.389
191	3	63	149.745	183.457	-0.176	-0.688	0.388	118.068
194	3	66	149.744	183.457	-0.176	-0.688	0.388	118.068
189	3	61	123.973	181.285	-0.211	3.058	0.488	96.180
192	3	64	123.973	181.284	-0.211	3.058	0.488	96.180
190	3	62	120.701	176.358	0.136	-2.290	-0.323	89.310
193	3	65	120.701	176.358	0.136	-2.290	-0.323	89.310
89	3	39	1.97E 3	173.529	-0.055	-0.010	0.133	271.926
92	3	30	-2.04E 3	173.529	-0.057	0.010	-0.041	-266.014
127	3	51	1.28E 3	162.416	0.036	-0.008	0.036	240.405
130	3	42	-1.36E 3	162.416	0.035	0.008	0.145	-263.084
178	3	68	30.904	138.292	-1.127	-4.852	2.312	126.893
181	3	71	30.904	138.292	-1.127	-4.852	2.312	126.893
140	3	56	0.371	133.782	-0.466	-2.157	1.031	100.758
143	3	59	0.371	133.782	-0.466	-2.157	1.031	100.758
102	3	44	-2.455	132.411	-0.122	-2.652	0.289	103.241
105	3	47	-2.455	132.411	-0.122	-2.651	0.289	103.241
144	3	55	6.458	130.504	0.517	-0.641	1.095	-97.993
141	3	58	6.458	130.504	0.517	-0.641	1.095	-97.992
182	3	67	-38.116	130.491	1.251	-2.362	2.485	-117.617
179	3	70	-38.116	130.491	1.251	-2.362	2.485	-117.617
64	3	32	-0.537	129.268	-0.001	-2.467	0.022	96.860
67	3	35	-0.537	129.268	-0.001	-2.467	0.022	96.860
106	3	43	1.246	129.145	0.053	-1.156	0.190	-100.307
103	3	46	1.246	129.145	0.053	-1.156	0.190	-100.306
26	3	20	-9.398	126.460	0.021	-3.088	-0.026	96.108
29	3	23	-9.398	126.460	0.021	-3.088	-0.026	96.108
68	3	31	-0.466	125.769	-0.041	-1.144	-0.036	-93.495
65	3	34	-0.466	125.768	-0.041	-1.144	-0.036	-93.495
170	3	64	585.576	121.522	188.634	0.016	-337.612	225.042
167	3	49	-659.566	121.522	188.635	-0.016	247.156	-151.675
30	3	19	10.853	121.186	0.022	-1.545	0.037	-89.794
27	3	22	10.853	121.186	0.022	-1.545	0.037	-89.793
203	3	69	23.324	121.012	0.534	0.928	-1.657	166.856

207	3	21	11.456	121.012	-0.002	-0.516	-0.006	-152.571
205	3	45	-2.796	121.012	-0.089	-0.578	-0.275	-151.951
206	3	33	-3.526	121.012	-0.022	-0.524	-0.070	-150.074
204	3	57	6.364	121.012	-0.271	-0.638	-0.839	-148.060
204	3	60	-6.364	121.012	0.271	0.638	-0.839	148.060
206	3	36	3.526	121.012	0.022	0.524	-0.070	150.074
205	3	48	2.796	121.012	0.089	0.578	-0.275	151.950
207	3	24	-11.456	121.012	0.002	0.516	-0.006	152.571
203	3	72	-23.324	121.012	-0.534	-0.928	-1.657	-166.855
169	3	53	-654.867	119.647	-186.371	-0.060	-244.846	-149.829
166	3	62	580.879	119.646	-186.372	0.060	332.907	221.075
187	3	58	-578.193	113.885	-9.920	0.391	-13.104	-141.360
183	3	67	504.204	113.885	-9.920	-0.391	17.649	211.683
7	3	9	3.34E 3	111.149	-0.127	-0.008	0.136	232.846
10	3	6	-3.41E 3	111.149	-0.128	0.008	-0.258	-111.715
180	3	71	-27.467	109.159	-2.295	-2.384	-3.539	-121.291
177	3	68	-27.467	109.158	-2.295	-2.384	-3.539	-121.291
28	3	23	7.899	107.759	0.021	-1.329	0.037	-95.858
25	3	20	7.899	107.758	0.021	-1.329	0.037	-95.858
66	3	35	-1.675	105.206	-0.026	-1.184	-0.048	-87.392
63	3	32	-1.675	105.205	-0.026	-1.185	-0.048	-87.392
104	3	47	0.636	104.926	-0.202	-1.361	-0.321	-89.748
101	3	44	0.636	104.925	-0.202	-1.361	-0.321	-89.748
142	3	59	2.199	104.302	-0.859	-1.443	-1.316	-82.535
139	3	56	2.199	104.301	-0.859	-1.443	-1.316	-82.535
139	3	55	-2.199	96.222	0.859	1.443	-1.346	70.008
142	3	58	-2.199	96.222	0.859	1.443	-1.346	70.008
104	3	46	-0.636	95.597	0.202	1.361	-0.304	75.285
101	3	43	-0.636	95.597	0.202	1.361	-0.304	75.285
66	3	34	1.675	95.317	0.026	1.184	-0.032	72.062
63	3	31	1.675	95.317	0.026	1.185	-0.032	72.061
30	3	24	-10.853	93.557	-0.022	1.545	0.032	64.112
27	3	21	-10.853	93.556	-0.022	1.545	0.032	64.112
28	3	22	-7.899	92.765	-0.021	1.329	0.029	72.613
25	3	19	-7.899	92.765	-0.021	1.329	0.029	72.613
180	3	70	27.467	91.364	2.295	2.384	-3.578	93.706
177	3	67	27.467	91.364	2.295	2.384	-3.578	93.705
56	3	28	2.61E 3	90.996	146.213	-0.003	-218.017	135.146
53	3	7	-2.68E 3	90.995	146.214	0.003	235.246	-146.939
55	3	11	-2.67E 3	89.919	-145.044	0.004	-232.935	-144.830
52	3	26	2.6E 3	89.919	-145.044	-0.004	216.701	133.919
68	3	36	0.466	88.974	0.041	1.144	-0.092	53.606
65	3	33	0.466	88.973	0.041	1.144	-0.092	53.606
26	3	21	9.398	88.263	-0.021	3.088	-0.040	-54.045
29	3	24	9.398	88.263	-0.021	3.088	-0.040	-54.045
94	3	40	1.94E 3	85.635	137.217	-0.010	-214.630	133.823
91	3	25	-2.01E 3	85.635	137.218	0.010	210.746	-131.645
106	3	48	-1.246	85.597	-0.053	1.156	-0.027	49.950
103	3	45	-1.246	85.597	-0.053	1.156	-0.027	49.950
64	3	33	0.537	85.454	0.001	2.467	-0.019	-46.091
67	3	36	0.537	85.454	0.001	2.467	-0.019	-46.091
93	3	29	-2E 3	84.995	-136.738	-0.004	-209.933	-130.521
90	3	38	1.93E 3	84.995	-136.739	0.004	213.956	132.964
182	3	72	38.116	84.251	-1.251	2.362	1.393	63.086
179	3	69	38.116	84.250	-1.251	2.362	1.393	63.086
144	3	60	-6.458	84.239	-0.517	0.641	0.508	43.423
141	3	57	-6.458	84.238	-0.517	0.641	0.508	43.424
102	3	45	2.455	82.312	0.122	2.652	0.089	-42.729
105	3	48	2.455	82.312	0.122	2.651	0.089	-42.729
140	3	57	-0.371	80.940	0.466	2.157	0.414	-35.994
143	3	60	-0.371	80.940	0.466	2.157	0.414	-35.994
132	3	52	1.26E 3	80.790	129.682	-0.014	-193.075	119.432
129	3	37	-1.34E 3	80.789	129.683	0.014	208.941	-131.015

131	3	41	-1.33E 3	80.329	-129.551	-0.039	-208.053	-129.749
128	3	50	1.26E 3	80.328	-129.552	0.039	193.556	119.269
73	3	22	-2.28E 3	77.863	-5.106	0.126	-7.819	-126.923
69	3	31	2.21E 3	77.863	-5.107	-0.126	8.011	114.451
181	3	72	-30.904	76.430	1.127	4.852	1.181	-48.149
178	3	69	-30.904	76.430	1.127	4.852	1.181	-48.149
111	3	34	-1.72E 3	71.547	-6.093	0.167	-9.130	-108.490
107	3	43	1.64E 3	71.547	-6.093	-0.167	9.758	113.306
149	3	46	-1.15E 3	63.097	-6.495	0.265	-10.334	-106.579
145	3	55	1.07E 3	63.097	-6.495	-0.265	9.800	89.020
12	3	10	3.28E 3	54.405	84.509	-0.007	-175.995	113.801
9	3	1	-3.36E 3	54.405	84.510	0.007	85.984	-54.854
11	3	5	-3.34E 3	53.566	-83.666	0.008	-85.294	-53.704
8	3	8	3.27E 3	53.566	-83.667	-0.008	174.072	112.350
184	3	68	531.943	46.990	85.742	-0.406	-154.802	88.742
188	3	59	-605.931	46.990	85.742	0.406	110.999	-56.927
35	3	16	-2.84E 3	43.700	-2.531	0.042	-2.465	-42.575
31	3	19	2.76E 3	43.700	-2.531	-0.042	5.380	92.895
186	3	57	-645.101	37.585	-51.015	-0.396	-64.920	-45.446
185	3	72	571.111	37.585	-51.015	0.396	93.227	71.066
70	3	32	2.28E 3	35.762	62.952	-0.089	-93.976	51.938
74	3	23	-2.35E 3	35.762	62.951	0.089	101.173	-58.925
108	3	44	1.7E 3	31.291	59.116	-0.165	-93.608	49.595
112	3	35	-1.77E 3	31.291	59.116	0.165	89.651	-47.405
146	3	56	1.11E 3	26.263	53.740	-0.337	-79.119	36.978
150	3	47	-1.19E 3	26.263	53.740	0.337	87.475	-44.439
72	3	21	-2.56E 3	23.116	-33.536	0.046	-53.794	-37.737
71	3	36	2.48E 3	23.116	-33.536	-0.046	50.167	33.922
110	3	33	-1.91E 3	21.534	-32.423	-0.083	-48.807	-32.208
109	3	48	1.84E 3	21.534	-32.423	0.083	51.704	34.547
32	3	20	2.86E 3	20.813	34.457	-0.055	-72.316	44.365
36	3	17	-2.93E 3	20.813	34.457	0.055	34.502	-20.155
148	3	45	-1.28E 3	18.645	-29.520	-0.311	-48.513	-32.083
147	3	60	1.2E 3	18.645	-29.520	0.311	43.000	25.716
34	3	15	-3.21E 3	12.660	-17.966	0.034	-17.820	-12.377
33	3	24	3.14E 3	12.660	-17.966	-0.034	37.875	26.869
33	3	18	-3.21E 3	-12.660	17.966	0.034	17.821	12.377
34	3	21	3.14E 3	-12.660	17.966	-0.034	-37.875	-26.869
147	3	48	-1.28E 3	-18.645	29.520	-0.311	48.513	32.083
148	3	57	1.2E 3	-18.645	29.520	0.311	-43.000	-25.716
36	3	23	2.86E 3	-20.813	-34.457	-0.055	72.315	-44.365
32	3	14	-2.93E 3	-20.813	-34.457	0.055	-34.502	20.155
109	3	36	-1.91E 3	-21.534	32.423	-0.083	48.807	32.208
110	3	45	1.84E 3	-21.534	32.423	0.083	-51.704	-34.547
71	3	24	-2.56E 3	-23.116	33.536	0.046	53.794	37.737
72	3	33	2.48E 3	-23.116	33.536	-0.046	-50.167	-33.922
150	3	59	1.11E 3	-26.263	-53.740	-0.337	79.119	-36.978
146	3	44	-1.19E 3	-26.263	-53.740	0.337	-87.475	44.439
112	3	47	1.7E 3	-31.291	-59.116	-0.165	93.607	-49.595
108	3	32	-1.77E 3	-31.291	-59.116	0.165	-89.651	47.406
74	3	35	2.28E 3	-35.762	-62.951	-0.089	93.976	-51.938
70	3	20	-2.35E 3	-35.762	-62.952	0.089	-101.174	58.925
185	3	60	-645.100	-37.585	51.015	-0.396	64.920	45.446
186	3	69	571.112	-37.585	51.015	0.396	-93.227	-71.066
31	3	13	-2.84E 3	-43.700	2.531	0.042	2.465	42.574
35	3	22	2.76E 3	-43.700	2.531	-0.042	-5.380	-92.895
188	3	71	531.942	-46.990	-85.742	-0.406	154.801	-88.741
184	3	56	-605.932	-46.990	-85.742	0.406	-110.999	56.927
8	3	2	-3.34E 3	-53.566	83.667	0.008	85.294	53.704
11	3	11	3.27E 3	-53.566	83.666	-0.008	-174.071	-112.351
9	3	7	3.28E 3	-54.405	-84.510	-0.007	175.996	-113.801
12	3	4	-3.36E 3	-54.405	-84.509	0.007	-85.984	54.854
145	3	43	-1.15E 3	-63.097	6.495	0.265	10.335	106.579

149	3	58	1.07E 3	-63.097	6.495	-0.265	-9.800	-89.021
107	3	31	-1.72E 3	-71.547	6.093	0.167	9.130	108.490
111	3	46	1.64E 3	-71.547	6.093	-0.167	-9.757	-113.306
69	3	19	-2.28E 3	-77.863	5.107	0.126	7.820	126.923
73	3	34	2.21E 3	-77.863	5.106	-0.126	-8.011	-114.451
128	3	38	-1.33E 3	-80.328	129.552	-0.039	208.054	129.749
131	3	53	1.26E 3	-80.329	129.551	0.039	-193.555	-119.269
129	3	49	1.26E 3	-80.789	-129.683	-0.014	193.076	-119.432
132	3	40	-1.34E 3	-80.790	-129.682	0.014	-208.940	131.016
90	3	26	-2E 3	-84.995	136.739	-0.004	209.934	130.521
93	3	41	1.93E 3	-84.995	136.738	0.004	-213.955	-132.964
91	3	37	1.94E 3	-85.635	-137.218	-0.010	214.631	-133.823
94	3	28	-2.01E 3	-85.635	-137.217	0.010	-210.745	131.645
52	3	8	-2.67E 3	-89.919	145.044	0.004	232.936	144.830
55	3	29	2.6E 3	-89.919	145.044	-0.004	-216.700	-133.919
53	3	25	2.61E 3	-90.995	-146.214	-0.003	218.018	-135.146
56	3	10	-2.68E 3	-90.996	-146.213	0.003	-235.244	146.940
10	3	12	3.34E 3	-111.149	0.128	-0.008	-0.138	-232.846
7	3	3	-3.41E 3	-111.149	0.127	0.008	0.257	111.715
183	3	55	-578.193	-113.885	9.920	0.391	13.105	141.359
187	3	70	504.204	-113.885	9.920	-0.391	-17.648	-211.683
166	3	50	-654.869	-119.646	186.372	-0.060	244.847	149.828
169	3	65	580.878	-119.647	186.371	0.060	-332.905	-221.076
167	3	61	585.577	-121.522	-188.635	0.016	337.614	-225.041
170	3	52	-659.565	-121.522	-188.634	-0.016	-247.154	151.676
130	3	54	1.28E 3	-162.416	-0.035	-0.008	-0.038	-240.405
127	3	39	-1.36E 3	-162.416	-0.036	0.008	-0.147	263.084
92	3	42	1.97E 3	-173.529	0.057	-0.010	-0.135	-271.926
89	3	27	-2.04E 3	-173.529	0.055	0.010	0.038	266.014
54	3	30	2.65E 3	-185.205	0.075	-0.004	-0.103	-274.748
51	3	9	-2.73E 3	-185.205	0.073	0.004	0.126	299.389
168	3	66	600.219	-244.245	-0.291	0.015	0.430	-454.541
165	3	51	-674.208	-244.245	-0.293	-0.015	-0.474	302.617