DESIGN OF A VILLA

Submitted in partial fulfillment of the Degree of

Bachelor of Technology

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CERTIFICATE

This is to certify that the work titled "**DESIGN OF A VILLA"** submitted by **HIMANSHU MISHRA, YAGYIK VASHISHTH, GOVIND RAM GOYAL** in partial fulfillment for the award of degree of B.Tech in Civil Engineering at Jaypee University of Information Technology, Waknaghat has been carried out under my supervision.

This work has not been submitted partially or wholly to any other University or Institute for the award of this or any other degree or diploma.

Supervisor - Mr. Saurav

Date -

ACKNOWLEDGEMENT

We take this opportunity to express our profound gratitude and deep regards to our guide, **Mr. SAURAVKUMAR** for his exemplary guidance, monitoring and constant encouragement throughout the course ofthis project . The blessing, help and guidance given by her time to time shall carry us a long way in thejourney of life on which we are about to embark.We also take this opportunity to express a deep sense of gratitude to our Institution, college faculty andstaff members for their cordial support, valuable information and guidance, which helped us incompleting this task through various stages.

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ABSTRACT

With the advancement of technology, humans are making software to make things simpler and easier. As a result from civil engineering point of view the manual design of buildings lost its importance. It is true that design using software is easy, accurate and time saving.

On the other hand manual design is a cumbersome job and a time consuming Process, but for a beginner manual design helps to understand the basic fundamentals that are involved in designing a building. Once person gains knowledge in manual design he will know the elements involved in designing and can easily understand the usage of software.

The main objective of the project is to use the knowledge that we have gained during our graduation and learn to deal with practical cases. We wish this project will fulfill our purpose.

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LIST OF SYMBOLS

A = Total area of section

A_b= Equivalent area of helical reinforcement.

A_c= Equivalent area of section

A_h= Area of concrete core.

A_m= Area of steel or iron core.

A_{sc} = Area of longitudinal reinforcement (comp.)

A_{St}= Area of steel (tensile.)

A_l= Area of longitudinal torsional reinforcement.

A_{sv}= Total cross-sectional are of stirrup legs or bent up bars within distance S_v

A_{Φ}= Area of cross –section of one bars.

a = lever arm.

a_c= Area of concrete.

B =flange width of T-beam.

b = width.

b_r=width of rib.

C =compressive force.

c = compressive stress in concrete.

c’= stress in concrete surrounding compressive steel.

D = depth

d = effective depth

d_c= cover to compressive steel

d_t= cover to tensile steel

e = eccentricity.

F =shear force characteristic load.

F_d= design load

F_r= radial shear force.

f= stress (in general)

f_{ck}= characteristic compressive stress.

F_y= characteristic strength of steel.

H = height.

I = moment of inertia.

I_e=equivalent moment of inertia of stress.

j= lever arm factor.

K_a=coefficient of active earth pressure.

K_p=coefficient of passive earth pressure.

k = neutral axis depth factor (n/d).

L=length.

L_d=development length.

l = effective length of column; length; bond length.

M = bending moment; moment.

M_r=moment of resistance; radial bending moment.

M_t=torsion moment.

M_u= bending moment (limit state design)

M_θ=circumferential bending moment

m = modular ratio.

n = depth of neutral axis.

P_a=active earth pressure.

P_p= passive earth pressure.

P_u= axial load on the member (limit state design).

P = percentage steel.

P'= reinforcement ratio.

P_a=active earth pressure intensity.

P_e=net upward soil pressure.

Q= shear resistance.

q = shear stress due to bending.

q'=shear stress due to torsion

R= radius.

s= spacing of bars.

s_a= average bond stress.

s_b= local bond stress.

T=tensile force.

T_u= torsion moment.

t= tensile stress in steel.

t_c= compressive stress in compressive steel.

V_u= shear force due to design load.

V_{us}=strength of shear reinforcement.

W= point load.

X= coordinate.

x_u= depth of neutral axis.

Z= distance.

LIST OF FIGUERS

INTRODUCTION

The population explosion and industrial revolution led to the exodus of people from villages to urban areas. This urbanization led to a new problem – less space for housing of the people. Because of the demand for land, the land costs got skyrocketed. So, under such conditions, the vertical growth of buildings i.e. constructions of multi-storeyed buildings has become inevitable for residential purpose. For multi-storeyed buildings, the conventional load bearing structures become uneconomical as they require larger sections to resist huge moments and loads. But in a framed structure, the building frame consists of a network of beams and columns which are built monolithically and rigidly with each other at their joints. Because of this rigidity at the joints, there will be reduction in moments and also the structure tends to distribute the loads more uniformly and eliminate the excessive effects of localized loads. Therefore in non-load bearing framed structures, the moments and forces become less which in turn reduces the sections of the members. As the walls don't take any load, they are also of thinner dimensions. So, the lighter structural components and walls reduce the self weight of the whole structure which necessitates a cheaper foundation. Also, the lighter walls which can be easily shifted provide flexibility in space utilization. In addition to the above mentioned advantages the framed structure is more effective in resisting wind loads and earth quake loads.

It is proposed to construct six story residential building with underground parking at Solan (H.P). In our Project we have designed the architecture drawings with the Auto-cad and 3d sketches with chief architecture. Structure of the building is design by computer application Staad.pro for R.C.C frame including beams and columns, slabs and footing by manual calculation with the use of Latest codes. Other components of the project like elevated water tank, septic tank, Soak pit and rain water harvesting tank is designed as per the requirements of TCP (Town and country planning), Solan district.

***Site Selection*:-**

1. *Level At The Site:* - The level at the site must be higher than that of its surrounding so as to provide good drainage.

2. *Climate Condition:* - The intensity of the rainfall and sub soil water level should be low as to avoid dampness in the building.

3. *Sub-Soil Condition:* - A hard strata should be available at a reasonable depth so as to construct the foundation of the building safely and economically.

4. *Availabilities Of Modern Amenities:* - The site must be within municipal limits so that modern amenities like water supply, electricity, drainage, road etc. can be made available inner future if there is no provision at present.

5. *Availabilities Of Other Facilities :* - The site should provide as easy access from the nearest road and after sufficient light and air, these should be good and cheap transport facilities available near the site, it is always better if public services like fire brigade, police station etc.

Building:-

Any structure constructed of what so ever material and used for residential, business education or other purposes is called building.

Types Of The Building:-

A. *Based On Occupancy:-*

Residential buildings: - The building in which sleeping accommodation is provided for normal residential purposes are called residential buildings.

Educational / institutional buildings: - The building used for school, college or day care purposes are called education / institutional building.

Assembly Buildings: - The buildings which are constructed for the purposes to gathering of the people for their respective purposes i.e. social, religious, civil, political is called assembly buildings.

Business Buildings: - The buildings used for transaction of business, for the keeping of accounts and records and other similar purposes called business buildings.

Mercantile Buildings: - The buildings used for display of merchandise, either wholesale or retail are called Mercantile Buildings.

Industrial buildings: - The buildings in which products or materials of all kinds and properties are fabricated, assembled or processed are called industrial buildings**.**

Storage buildings: - The buildings used primary for the storage, handling or shattering of goods and wares or merchandise, vehicles and animals are called storage buildings.

Hazardous buildings: -The buildings used for storage, handling manufacturing or processing of highly combustible or explosive material are called Hazardous buildings.

B. *Based On Type Of Construction:-*

Building with type 1 construction: - In these building the design and material used const. are such that all structural components have about 4 hours fire resistance.

Buildings with type 2 construction: - In these building the design any type of material used in their construction are such that all structural components have 3 hours fire resistance.

Buildings with type 3 construction: - In these building the design and types of the materials used in their construction are such that all structural components have 3 hours fire resistance.

Buildings with type 4 construction: - In these buildings the design and the type of material used in their construction are such that all structural components have 4 hours fire resistance.

Parts Of A Building

A building can be divided into two parts: -

1. Sub structure
2. Super structure

1. *Sub structure:* - The part of a building constructed beneath the ground level is known as Sub structure.

2. *Super structure:* - The part of the building constructed above ground level is known as super structure. It is second part of a building. All the activities of the building construction take place after the making of sub-structure. Flooring, wall roofing are the example of super structure of a building.

Components Of A Building

1. *Foundation:* - It is the lowest part of a structure below the ground level which is direct contact with ground and transmitted all the dead, live and other loads to the soil on which the structure rests.

2. *Plinth:* - The portion of a building and the top of the floor immediately above the ground is known as plinth. The level of the surrounding ground is known as formation level of the ground floor of the building is known as plinth level.

3. *Walls:* - Walls are provided to enclose or divide the floor space n desired pattern in addition wall provided privacy security and give protection against sun, rain, cold and other undesired effect of the weather.

4. *Column:* - A column may be defined as an isolated load bearing member, the width of which is neither less than its thickness. It carries the axially compressive load.

5. *Floors:* - Floors are flat supporting elements of a building. They divided a building into different levels. There by creating more accommodation on a given plot of land. The basic purpose of a floor is to provide a firm and other items like stores, furniture, equipment etc.

6. *Doors, Windows And Ventilators:* - A door may be defined as a barrier secured in an opening left in a wall to provide usual means of access to a building, room or passage. Windows and ventilators are provided for sun light, fresh air and ventilation purposes.

7. *Roof:* - It is the uppermost component of a building and its function is to cover the space below it of a room and protect it from rain, snow, sun, wind etc.

8. *Building Finishes:* - A building is considered incomplete till such time the surface of its components is given appropriate treatment. Building finishes include items like plastering, painting, pointing, white /colour washing, varnishes and distempering etc.

Material Used In Construction

Following are the materials used for the construction of a building.

1. Bricks.
2. Sand.
3. Cement.
4. Stone.
5. Coarse Aggregate.
6. Fine Aggregate.
7. Timber.
8. Steel (Fe415).
9. Floor Tiles.
10. Reinforcement.
11. Coloring Material.
12. White Cement.
13. Paints & Varnishes.
14. Brick Ballast.
15. Sanitary Materials.
16. Water.
17. Finishing Tiles. Etc.

DESCRIPTION

Project is carried out in three different phases from the planning phase to the preparation of architectural drawings and to preparation of structural drawings and then preparation of septic tank detail and rain water harvesting tank detail.

A. Project planning phase
B. Selection of plot and site layout plan
C. Architectural drawings
D. 3-D sketches of villa
E. Design of Structural components:
   i.) Column
   ii.) Stair-case
   iii.) Slab Beam
   iv.) Slab
F. Design of rain water harvesting tank

Project Planning Phase

This project is basically designed keeping in view the space requirements for an upper-middle class family. Our project basically consists of G+2 floors.

Selection of plot and site layout plan

A suitable plot is selected near Panchkula NH-22 for the construction of villa.

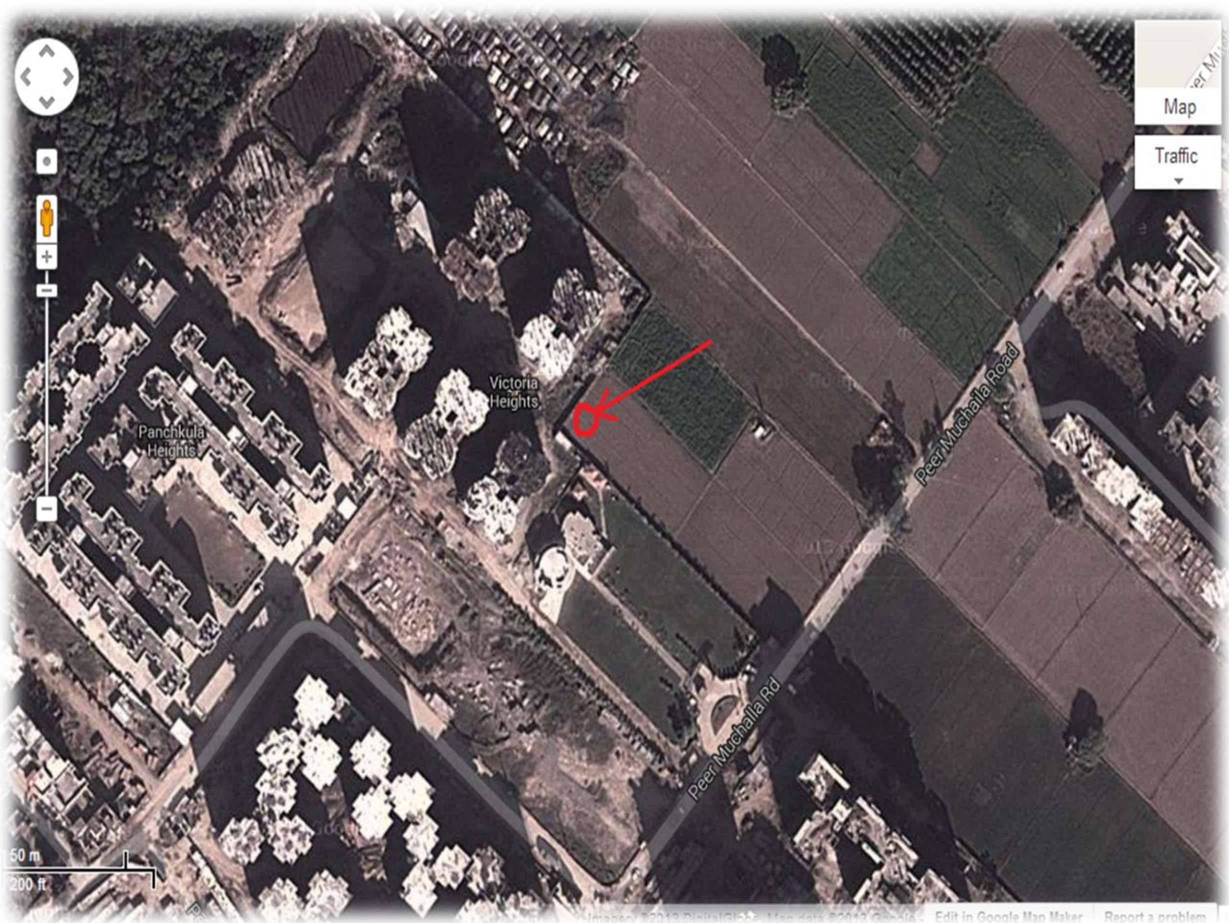


Fig 1 (Location of site)

ARCHITECTURAL DRAWINGS

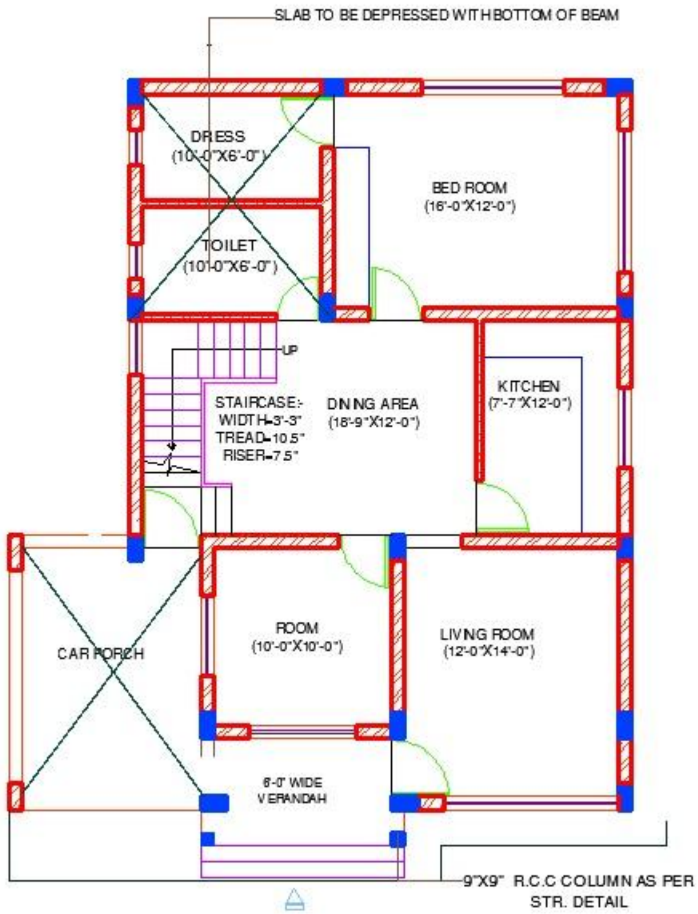


Fig 2 Ground floor plan

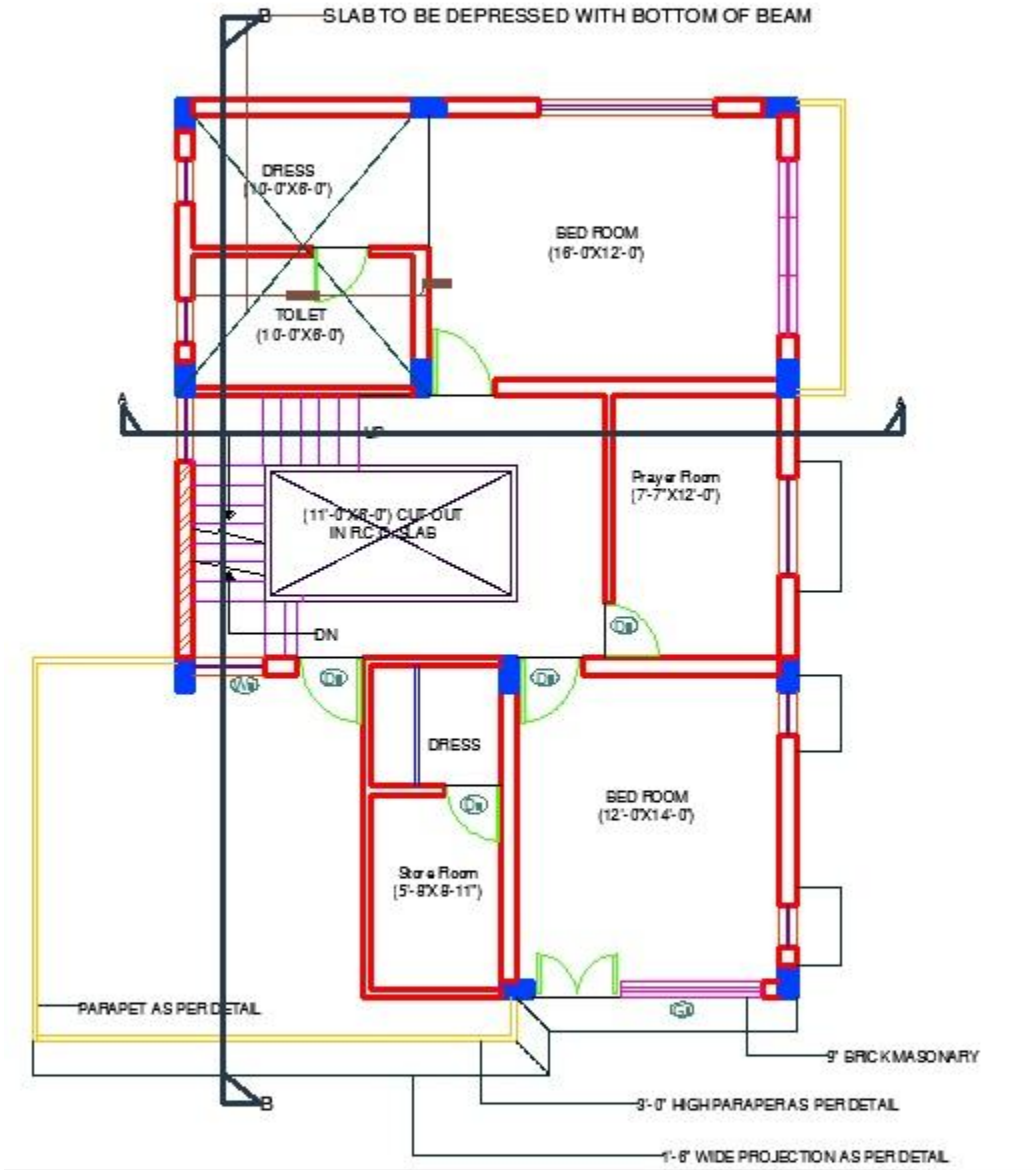


Fig 3 First floor Plan

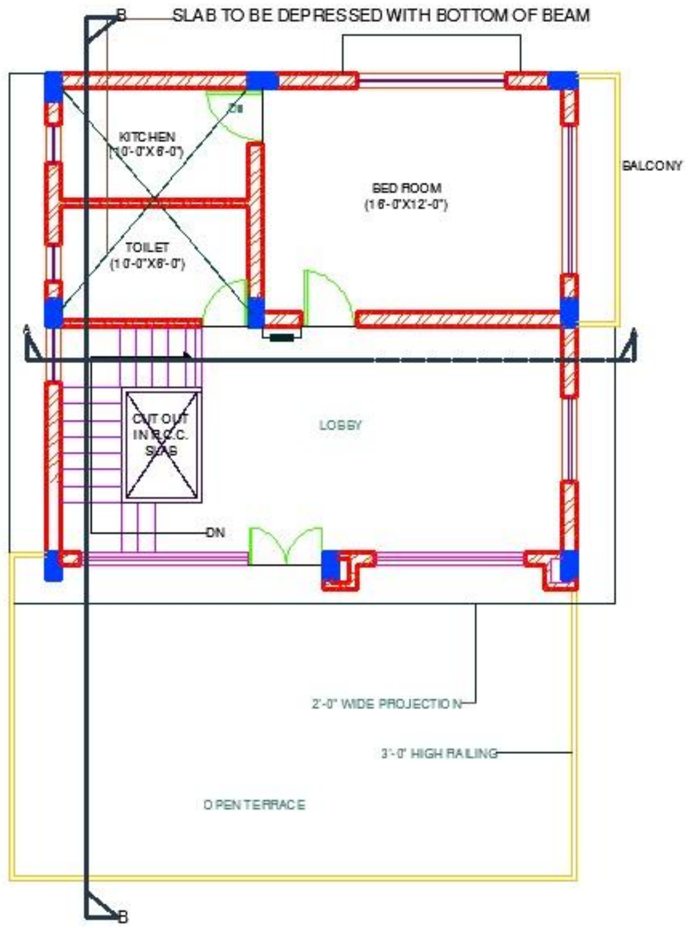


Fig 4 Second floor Plan

Fig 5 Front Elevation

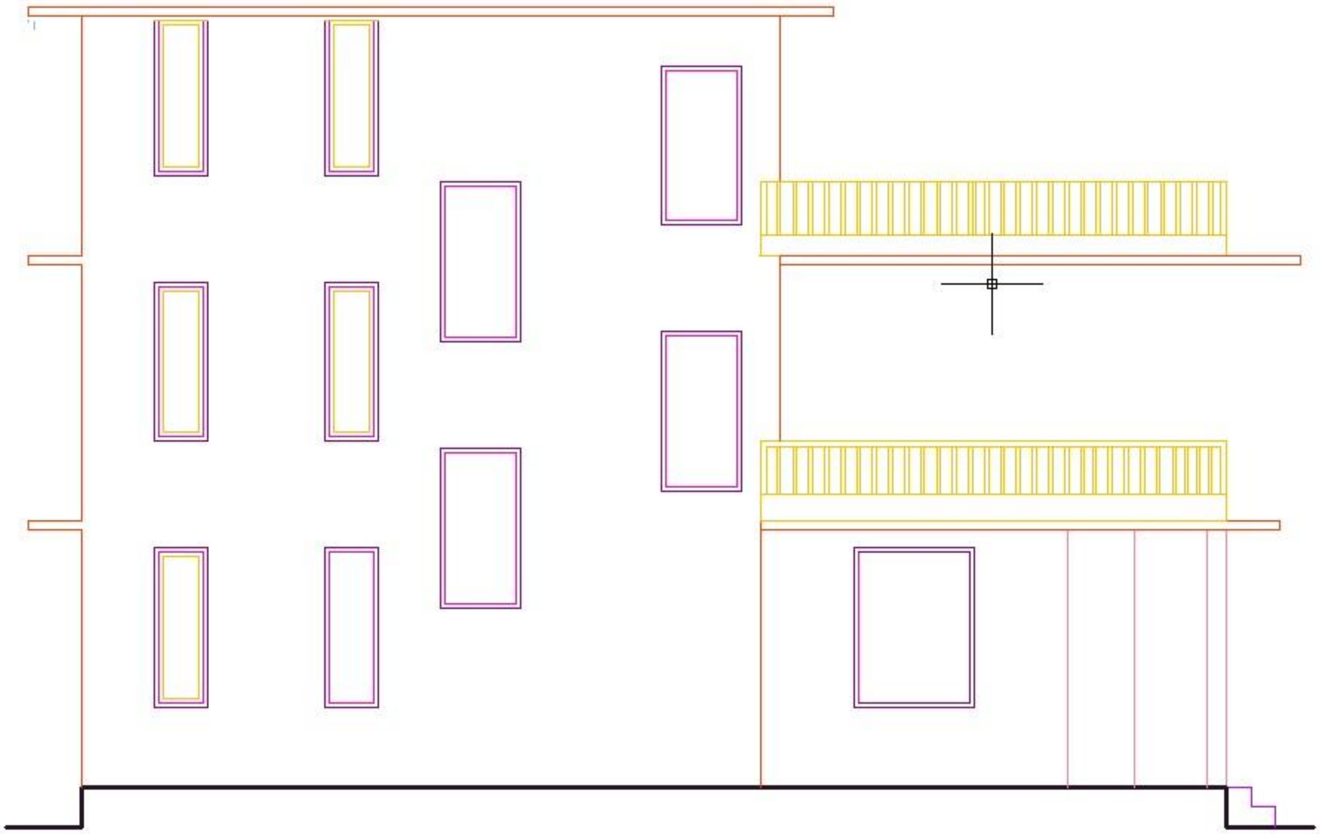


Fig 6 Left side view

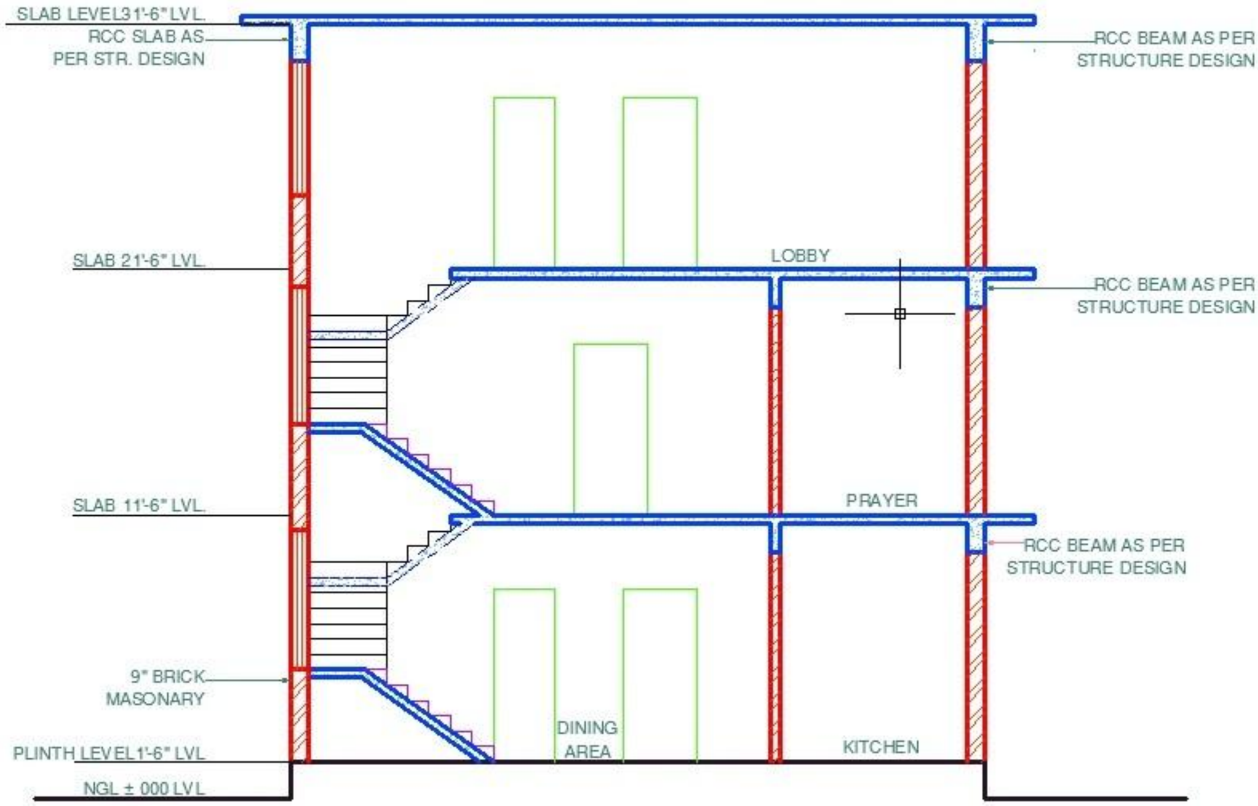


Fig 7 Section at A-A

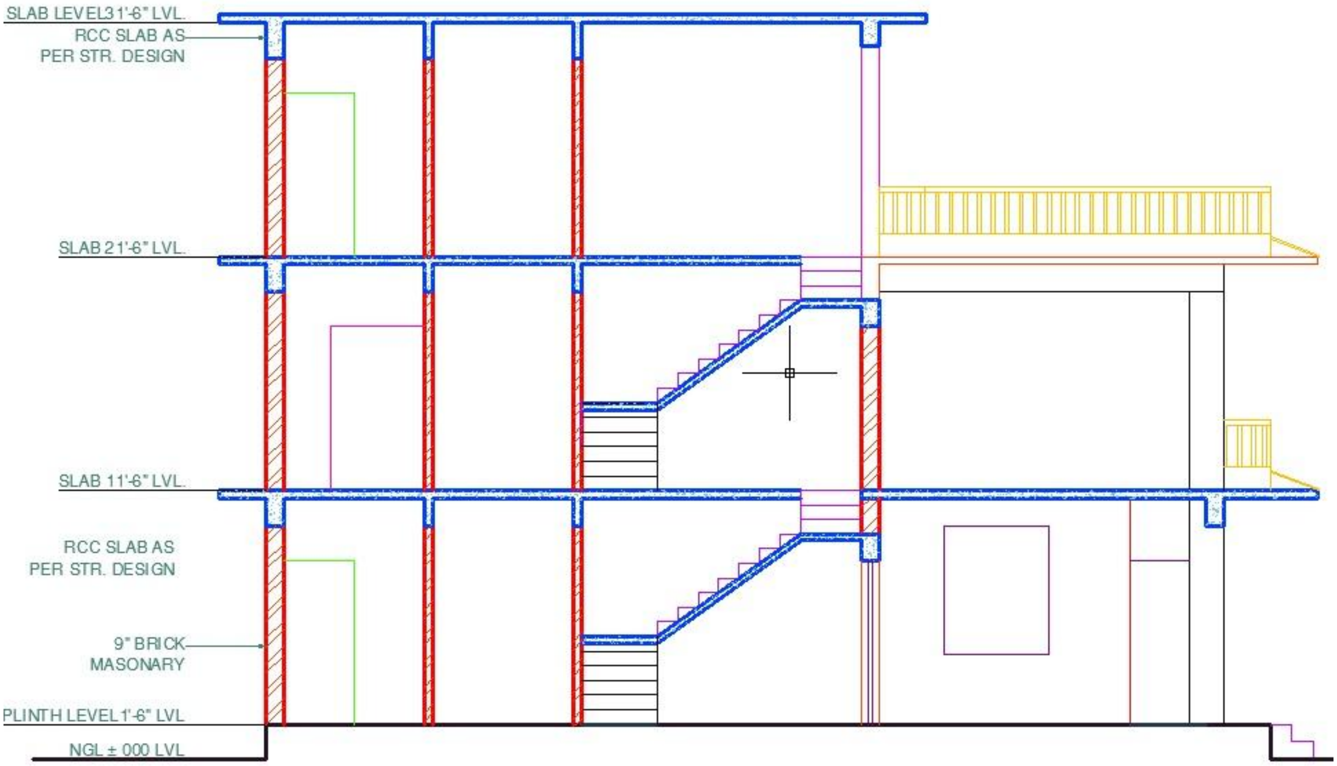
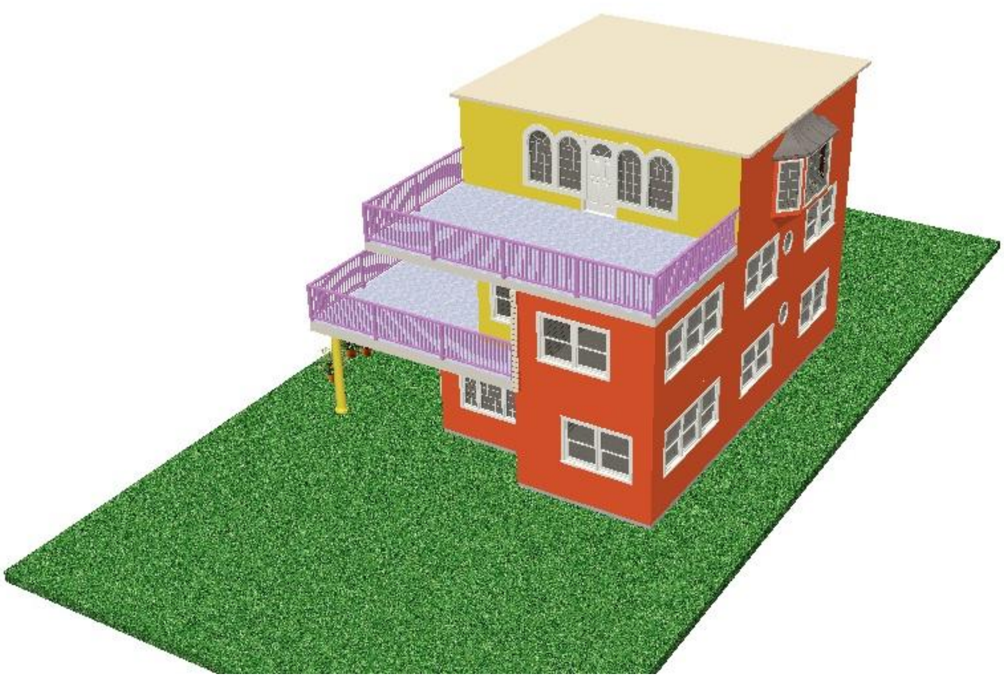


Fig 8 Section at BB

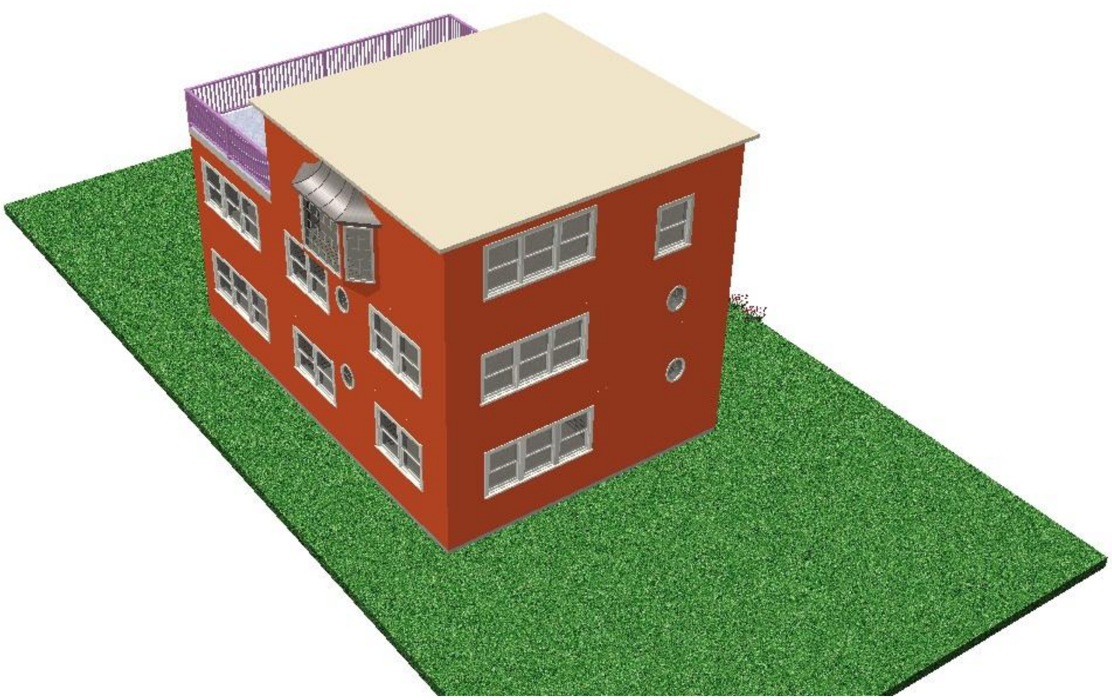
3-D SKETCHES OF VILLA

(a)



(b)

(c)



(d)

Fig 9 : 3D Views

DESIGN OF STRUCTURAL COMPONENTS

- The approach of R.C.C design upon which the STAAD is based is the LIMIT STATE DESIGN and the same design philosophy is followed in manual design.
- The Comparison is being done using STADD pro and manually.

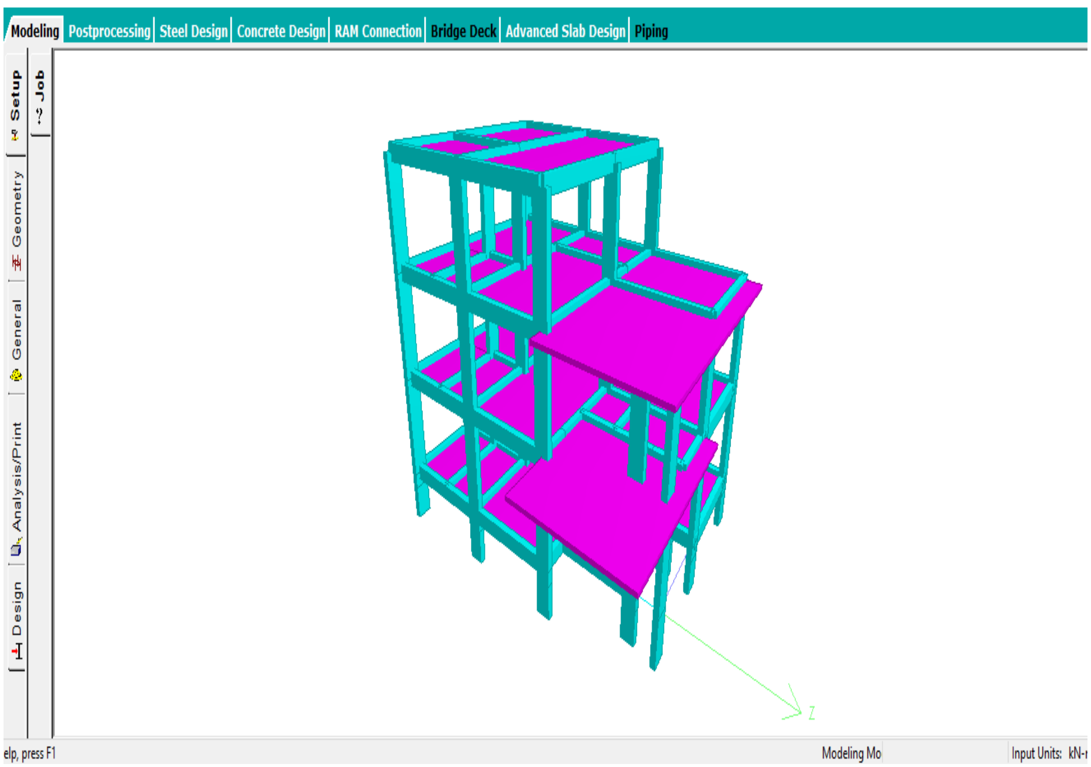


Fig 10:- STADD Pro. Model

DESIGNING PROCEDURE USING STAAD.PRO

i. Generation of geometry.
ii. Assigning the properties.
iii. Self weight of the structure (Beam, Column).
iv. Dead load on the structure (from slab).
v. Live load on the structure.
vi. Wall loads.
vii. Seismic load
viii. Reviewing the Analysis result.
ix. Performing concrete design.

COLUMN:

It is a vertical structural member supporting axial compressive loads, with or with-out moments. Support vertical loads from the floors and roof and transmit these loads to the foundation.

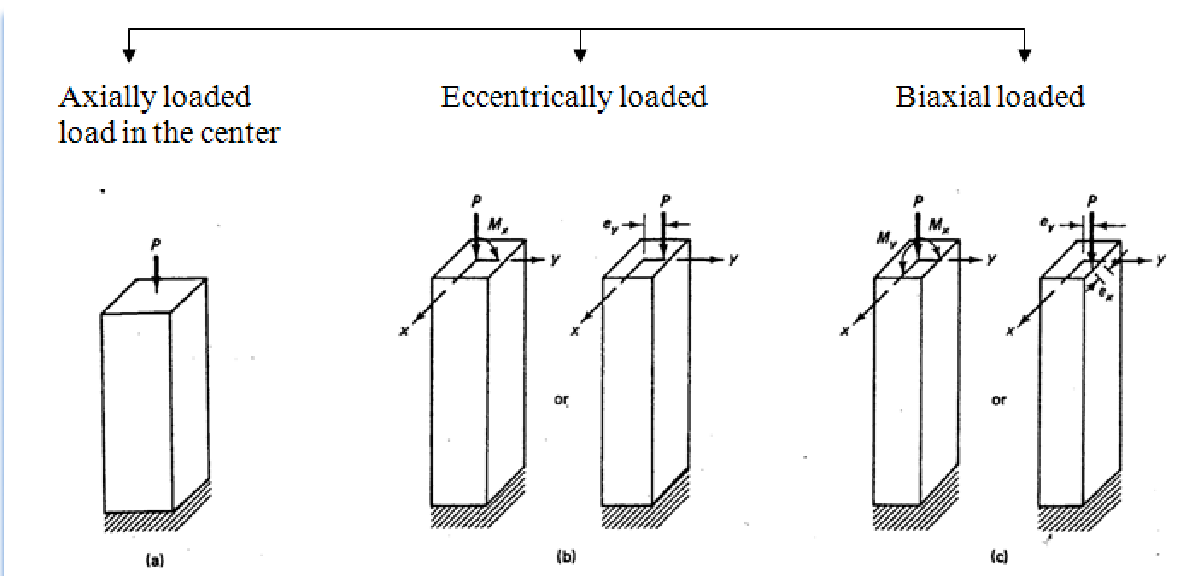


Fig 11

DESIGN OF COLUMN:

Given: l = 3000 mm, b = 230 mm and D = 460 mm

Check for ecentricities are:

e_{xmin} = greater of (3000/460 + 230/30) and 20 mm = 14.18 mm or 20 mm = 20 mm,

e_{ymin} = greater of (3000/460 + 460/30) and 20 mm = 21.85 mm or 20 mm = 21.85 mm

Again from P_u = 1200 kN, M_{ux} = 130 kNm and M_{uy} = 120 kNm,

$e_x = M_{ux}/P_u = 130(10^6)/1200(10^3)$ = 108.33 mm and $e_y = M_{uy}/P_u = 120(10^6)/1200(10^3)$ = 100mm. Both e_x and e_y are greater than e_{xmin} and e_{ymin}, respectively.

Step 2: Assuming a trial section including the reinforcement

We have b = 230 mm and D = 460 mm. For the reinforcement,

$$M_u = 1.15 \times sq.rt.\left(M_{ux}^2 + M_{uy}^2\right) = 203.456 \text{ kNm}$$

$P_u/f_{ck}bD = 1200(10^3)/(25)(230)(460) = 0.45$

$M_u/f_{ck}bD^2 = 203.456(10^6)/(25)(230)(460)(460) = 0.167$

Assuming d' = 50 mm, we have d'/D = 0.11 From Charts 44 and 45, the value of

p/f_{ck} is interpolated as 0.06. Thus, p = 0.06(25) = 1.5 per cent, giving Asc = 3000 mm^2

Provide 12-20 mm diameter bars of area 3769 mm^2

actual P provided = 1.8845 per cent. So, p/f_{ck} = 0.07538.

Step 3: Determination of M_{ux1} and M_{uy1}

We have $P_u/f_{ck}bD$ = 0.45 and p/f_{ck} = 0.167

Now, we get $M_{ux1}/f_{ck}bD^2$ from chart corresponding to d' = 50 mm

i.e., d'/D = 0.11. We interpolate the values of Charts 44 and 45, and

We get,

$M_{ux1}/f_{ck}bD^2$

= .09044. So, Mux1 = 0.0944(25)(230)(4600x460)(10-6)

= 114.85 kNm.

For M_{ux1},

$d'/b = 50/230 = .217.$

In a similar manner,

We get

$M_{uy1} = 0.0858(25)(230)(230)(460)(10\text{-}6)$

$= 52.20$ kNm.

As M_{ux1} and M_{uy1} are significantly greater than Mux and Muy, respectively, redesign of the section is not needed. Step 4: Determination of Puz and αn

From Eq.10.59, we have

$P_{uz} = 0.45(25)(400)(500) + \{0.75(415) - 0.45(25)\}(3769)$

$= 3380.7$ kN.

Checking the adequacy of the section

Using the values of M_{ux}, M_{ux1}, M_{uy}, $M_{uy}1$ and αn in Eq.10.58, we have

$(130/226.1)^{1.658} + (120/171.6)^{1.658} = 0.9521 < 1.0$. Hence, the design is safe

Alternatively, Chart 64 may be used to determine the point (Mux/Mux1),

(Muy/Muy1) is within the curve of Pu/Puz = 0.5916 or not.

Here, Mux/Mux1 = 0.5749 and Muy/Muy1 = 0.6993. It may be seen that the point is within the curve of Pu/Puz = 0.5916 of Chart 64 of SP-16.

Step 6: Design of transverse reinforcement

As per cl.26.5.3.2c of IS 456, the diameter of lateral tie should be > (20/4) mm diameter.

Provide 8 mm diameter bars following the arrangement shown in Fig.10.26.4. The spacing of lateral tie is the least of:

(a) 400 mm = least lateral dimension of column,

(b) 320 mm = sixteen times the diameter of longitudinal reinforcement (20 mm),

(c) 300 mm

Accordingly, provide 8 mm lateral tie alternately @ 250 c/c

Detailing of column reinforcement

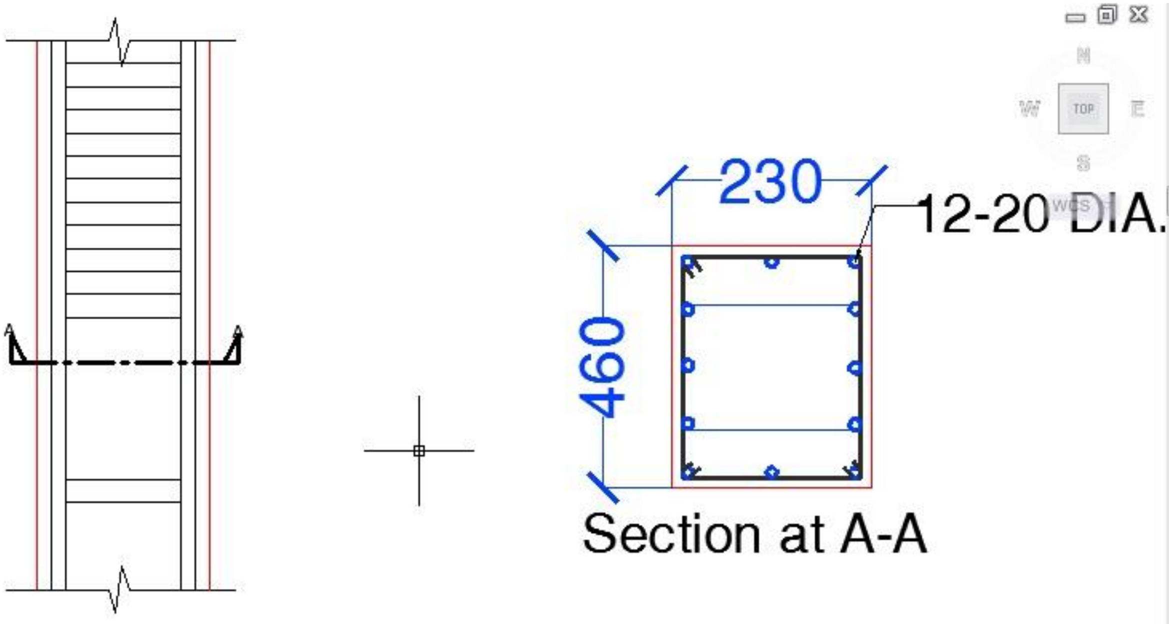


Fig 12

Fck(mpa)	30	
SPAN(L ,m)	5	
DEPTH(D,m)	0.45	
BREADTH(b,m)	0.23	
Fy(mpa)	415	
CALCULATION OF LOADS.		
DEAD LOAD(KN/m)	3.69	
LIVE LOAD(KN/m2)	2.95	
TOTAL LOAD	6.64	
FACTORED LOAD	9.96	
MAX.BENDING MOMENT,Mu(KNm)	31.11	
MAX.SHEAR FORCE,Vu(KN)	24.89	
FOR BALANCED SECTION.		
CHECK FOR DEPTH		
Mu=.138Fckbd2		
d(m)	0.34	
	D>d therefore OK.	
COVER(m)	0.03	
EFFECTIVE DEPTH,d(mm)	0.43	
	Xu=Xulim	
Xulim=.48*d	0.20	
Xu=(2.42FyAst)/bFck	0.001401573	
Ast(m2)	1292.56	
From staadpro analysis Ast = 1552.00		

DESIGN OF SHEAR REINFORCEMENT			
% STEEL	1.81		
from the table given τc	0.64		
τv	240.49	kN/m2	
	0.24	N/mm2	
since τv<τc no need for shear r/f			
provide minimum shear r/f	2 legged 8mm dia bars		
Asv(mm2) (For 2legged 8mm dia. Bar)	100.48		
Sv(mm)	300		clause 26.5.1.6
provide minimum as specified value of Sv above.			
Provide 8mm dia. Bar as shear stirrups @300mm c/c			

IS 456 : 2000

Table 19 Design Shear Strength of Concrete, τ_c, N/mm²

(*Clauses* 40.2.1, 40.2.2, 40.3, 40.4, 40.5.3, 41.3.2, 41.3.3 *and* 41.4.3)

$100\frac{A_s}{bd}$	Concrete Grade					
	M 15	M 20	M 25	M 30	M 35	M 40 and above
(1)	(2)	(3)	(4)	(5)	(6)	(7)
≤0.15	0.28	0.28	0.29	0.29	0.29	0.30
0.25	0.35	0.36	0.36	0.37	0.37	0.38
0.50	0.46	0.48	0.49	0.50	0.50	0.51
0.75	0.54	0.56	0.57	0.59	0.59	0.60
1.00	0.60	0.62	0.64	0.66	0.67	0.68
1.25	0.64	0.67	0.70	0.71	0.73	0.74
1.50	0.68	0.72	0.74	0.76	0.78	0.79
1.75	0.71	0.75	0.78	0.80	0.82	0.84
2.00	0.71	0.79	0.82	0.84	0.86	0.88
2.25	0.71	0.81	0.85	0.88	0.90	0.92
2.50	0.71	0.82	0.88	0.91	0.93	0.95
2.75	0.71	0.82	0.90	0.94	0.96	0.98
3.00 and above	0.71	0.82	0.92	0.96	0.99	1.01

NOTE — The term A_s is the area of longitudinal tension reinforcement which continues at least one effective depth beyond the section being considered except at support where the full area of tension reinforcement may be used provided the detailing conforms to 26.2.2 and 26.2.3

Fig 13

Detailing of beam reinforcement:

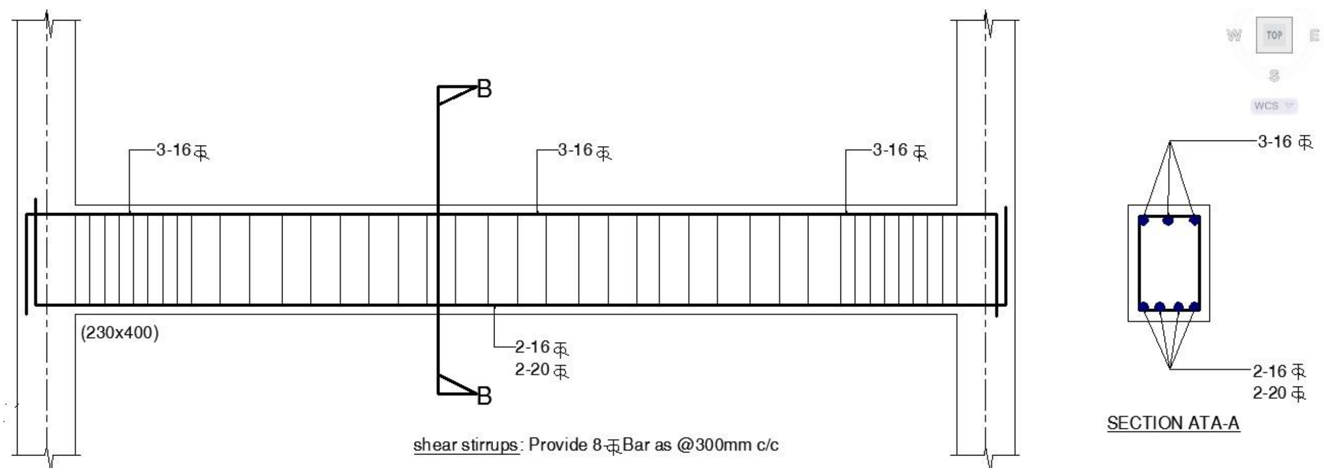


Fig 14

Design of slab:

Consideration: Dining room slab is designed.

Support conditions: All the four sides are fixed and prevented from lifting up.

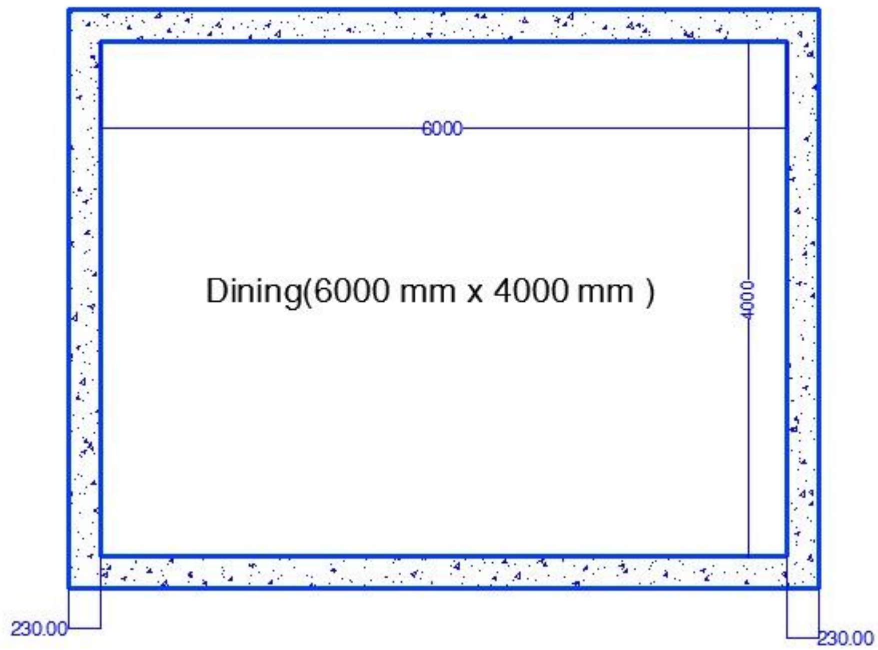


Fig 15

Step 1: Selection of preliminary depth of slab

The span to depth ratio with Fe 415 is taken from cl. 24.1(IS 456) as 0.8 (35 + 40) / 2 = 30.

This gives the minimum effective depth

d = 4000/30 = 133.33 mm, say 135 mm. The total depth D is thus 160 mm.

Step 2: Design loads, bending moments and shear forces

Dead load of slab (1 m width) = 0.16(25) = 4.0 kN/m2

Dead load of floor finish (given) = 1.0 kN/m2

Factored dead load = 1.5(5) = 7.5 kN/m^2

Factored live load (given) = 8.0 kN/m^2

Total factored load = 15.5 kN/m^2

The coefficients of bending moments and the bending moments Mx and My per unit width (positive and negative) are determined as per cl. D-1.1 and Table 26 of IS 456.

The ly / lx for this problem is 6/4 = 1.5.

Maximum bending moments

For	Short span		Long span	
	α_x	Mx (kNm/m)	α_y	My (kNm/m)
negative moment at continuous edge	0.075	18.6	0.047	11.66
Positive moment at mid-span	0.056	13.89	0.035	8.68

Maximum shear force in either direction is determined:

Vu = w(lx/2) = 15.5 (4/2) = 31 kN/m

Determination/checking of the effective depth and total depth of slab

Using the higher value of the maximum bending moments in x and y directions

$Mu,lim = R_{,lim}\ bd^2$

Or

$d = [(18.6)(106)/\{2.76(103)\}]^{1/2} = 82.09$ mm

Since, this effective depth is less than 135 mm assumed in Step 1,

we retain d = 135 mm and D = 160mm.

Depth of slab for shear force

Table 19 of IS 456 gives the value of τ_c = 0.28 N/mm2

When the lowest percentage of steel is provided in the slab. However, this value needs to be modified by multiplying with k of cl. 40.2.1.1 of IS 456. The value of k for the total depth of slab as 160 mm is 1.28.

The value of c τ is 1.28(0.28) = 0.3584 N/mm2

Table 20 of IS 456 gives cmax τ = 2.8 N/mm2

The computed shear stress

v τ = Vu/bd = 31/135 = 0.229 N/mm2

Since, $\tau_v < \tau_c < \tau_{cmax}$, the effective depth of the slab as 135 mm and the total depth as 160 mm are safe.

Determination of areas of steel

Particulars	Short span (l_x)		Long span (l_y)	
	Mx	Dia. And spacing	My	Dia. And spacing
Top steel for negative moment	18.68	10mm @200mm c/c	12.314	8mm @200mm c/c
Bottom steel for positive moment	14.388	8mm @170mm c/c	9.2	8mm @250mm c/c

Step 6: Selection of diameters and spacing of reinforcing bars

The advantages of using the tables of SP-16 are that the obtained values satisfy the requirements of diameters of bars and spacing. However, they are checked as ready reference here. Needless to mention that this step may be omitted in such a situation.

Maximum diameter allowed, as given in cl. 26.5.2.2 of IS 456, is 160/8 = 20mm which is more that the diameters used here.

The maximum spacing of main bars, as given in cl. 26.3.3(1) of IS 456, is the lesser of 3(135) and 300 mm. This is also satisfied for all the bars.

The maximum spacing of minimum steel (distribution bars) is the lesser of 5(135) and 450 mm. This is also satisfied.

STAIRCASE

The staircase is an important component of a building, and often the only means of access between the various floors in the building. It consists of a flight of steps, usually with one or more intermediate landings (horizontal slab platforms) provided between the floor levels.

This should be located in a easily accessible to all members of the family, when this is intended for visitors it should be in the front, may be on one side of veranda. It meant for family use only, the staircase should be placed the rear. The stairs case should be well ventilated & lighted the middle to make it easy & comfortable to climb. Rises & threads should be uniform through to keep rhythm while climbing or descending.

Data:

Floor height = 3000mm

Width of staircase = 900m

Tread (T) = 300mm

Riser (R) = 150mm

Number of steps required = 20

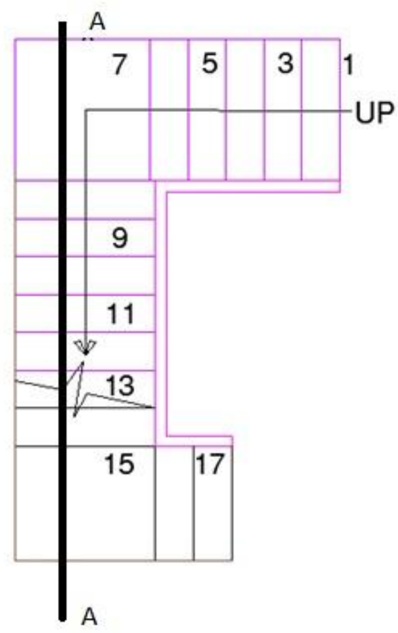


Fig 16 (Typical staircase detail)

I.S. Code recommendations are adopted here for determination of design moments.

$\sqrt{(R^2 + T^2)}$ = 335.41mm

Effective span is given by the c/c distance between the landings.

l = 2.1+0.60 = 2.70m

Assume a waist slab thickness ≈ 2700/20 = 135 →150 mm.

Assuming 20 mm cover and 12 φ bars, d = 150 – 20 – 12/2 = 124 mm

Loads Acting On-Going*:*

Self-weight of waist slab @ 25 × 0.150 × 335.41/300 = 4.19kN/m^2

Self-Weight Of Steps @ 25 × .50x.15 = 1.87 kN/m^2

Finish Load = 0.60 kN/m^2

Live Load = 3.00 kN/m^2

Total Load = 9.66 kN/m^2

Factored Load = 9.66 × 1.5

= 14.50 kN/m^2

Loads on landing:

Self-Weightb 25x0.15 = 3.75 kN/m^2

Finishes @ 0.60 kN/m^2

Live Loads @ 3.00 kN/m^2

Total Load = 7.35 kN/m^2

Factored Load = 11.025 kN/m^2

50% Of This Load May Be Assumed To Be Acting Longitudinally I.E. 5.51 kN/m^2

Design of waist slab

Reaction on landing R = (5.51x0.30) + (14.50x2.10/2) = 16.87 kN/m

Design of Mid Span

Mu $= (16.87 \times 2.70/2) - (5.51 \times 0.60/2)X\,(1.35 - .30) - (14.50 \times 1.05^2/2)$ = 13.04 KN/m

Main reinforcement

R= $\frac{Mu}{bd^2}$ = $\frac{13.04\times10^6}{10^3\times124^2} = 0.848Mpa$

Take M-25 and Fe415

$$\frac{Pt}{100} = \frac{Ast}{bd} = \frac{fck}{2fy}\left(1 - \sqrt{1} - 4.598X0.848/fck\right) = 0.489 \times 10^{-2}$$

Ast required = $(0.489 \times 10^{-2}) \times 10^3 \times 150 = 734mm^2/m$

Required spacing of 12-∅ bars = $\frac{113\times10^3}{734} = 154mm$

Provide 12 φ @ 150c/c

Distribution steel:

A_{st} required = 0.012xbt (for Fe415 bars)

=0.0012x$10^3 \times 0.150 = 180\ mm^2/m$

Assuming 8-∅ bars, spacing required = $\frac{50.30\times1000}{180} = 279.44mm$

Provide 8-∅ bars @250mm c/c as distributors.

Reinforcement detailing of staircase:

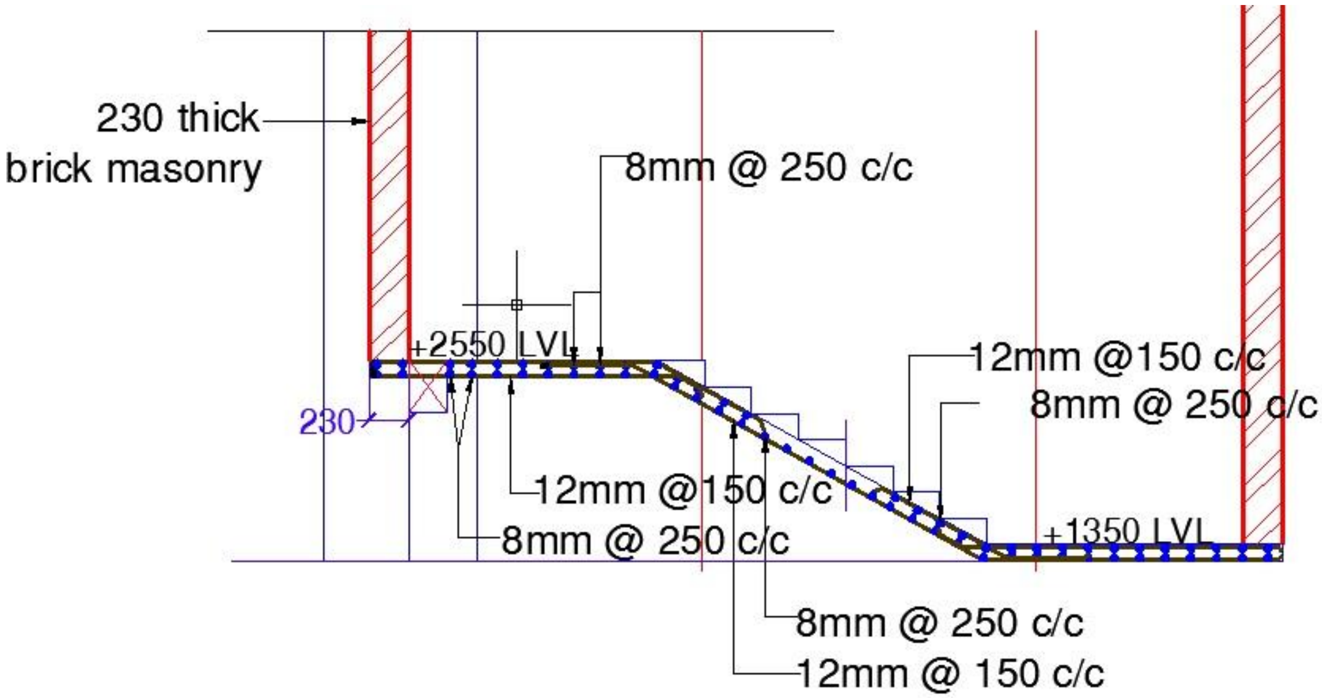


Fig 17

RAIN WATER HARVESTING TANK

Rainwater harvesting is the accumulation and deposition of rainwater for reuse before it reaches the aquifer. As per the norms of the Town and country planning (Chandigarh.) all the buildings constructed should have provision for roof rain water harvesting. Rain water harvesting tank is used to store rain water. According to national meteorological department Average annual rainfall in Chandigarh is 1424.80 mm.

Components of A Rainwater Harvesting System:

Catchments: The catchment of a water harvesting system is the surface which directly receives the rainfall and provides water to the system. It can be a paved area like a terrace or courtyard of a building, or an unpaved area like a lawn or open ground. A roof made of reinforced cement concrete (RCC) used for water harvesting.

Coarse mesh: Mesh made of readily available wire used at the end of inlet pipe prevent the deposition of debris in the rain water harvesting tank.

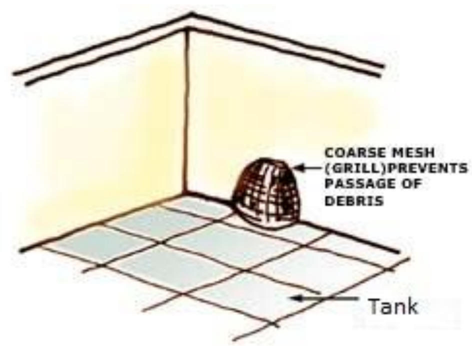


Fig 18

Gutters: Gutters are provided near the sloppy end of the roof which helps in accumulation of rain water.

Conduits: Drains that carry rainwater from the catchment or rooftop area to the harvesting system.

Filter: Sand filters are provided to filter the harvested rain water.

Fig 20: Location of Rain water harvesting tank

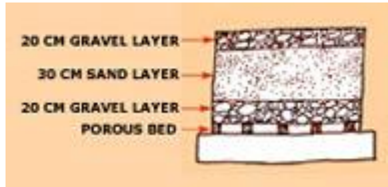


Fig 19

Calculations for capacity of RWH tank:

Total water collected from the roof in one year = 1.10x 111.48 = 122.63cum
Considering the loss
1. Roof coefficient = 0.85
2. Coefficient for evaporation, wastage = 0.78
Hence Total water collected from the roof after considering the losses
= 122.63x 0.85x 0.80
= 85.47 cum

Capacity of recharge tank is designed to retain runoff for at least 15 min of rainfall of the peak intensity.

For our project location:

28.5 mm/per 15 minutes say 30 mm per 15 minute

In our case the total area is 111.48.00 sqm. So recharge shaft/dug well type of str. Is recommended for hard rock strata for the recharge of ground water level.

Surface is of roof top catchment 111.48 sqm.

Peak rainfall for15 min 30.00 mm

Runoff co-efficient = 0.85

The capacity of tank = 111.48x0.035x0.85

= 3.32 cum

= 3320 liters

Assume depth of water in tank = 3.00m

Then diameter of the tank = 1.20m

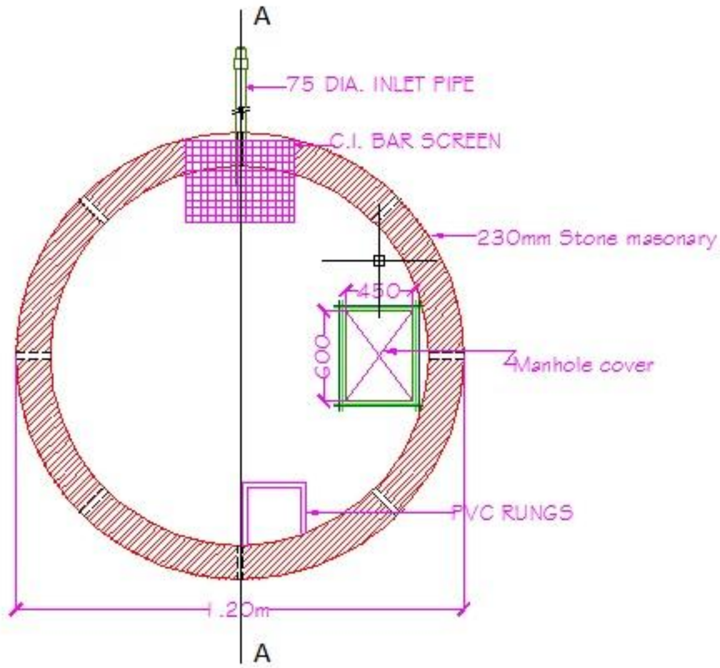

A
75 DIA. INLET PIPE
C.I. BAR SCREEN
230mm Stone masonary
450
600
Manhole cover
PVC RUNGS
1.20m
A

Fig 21

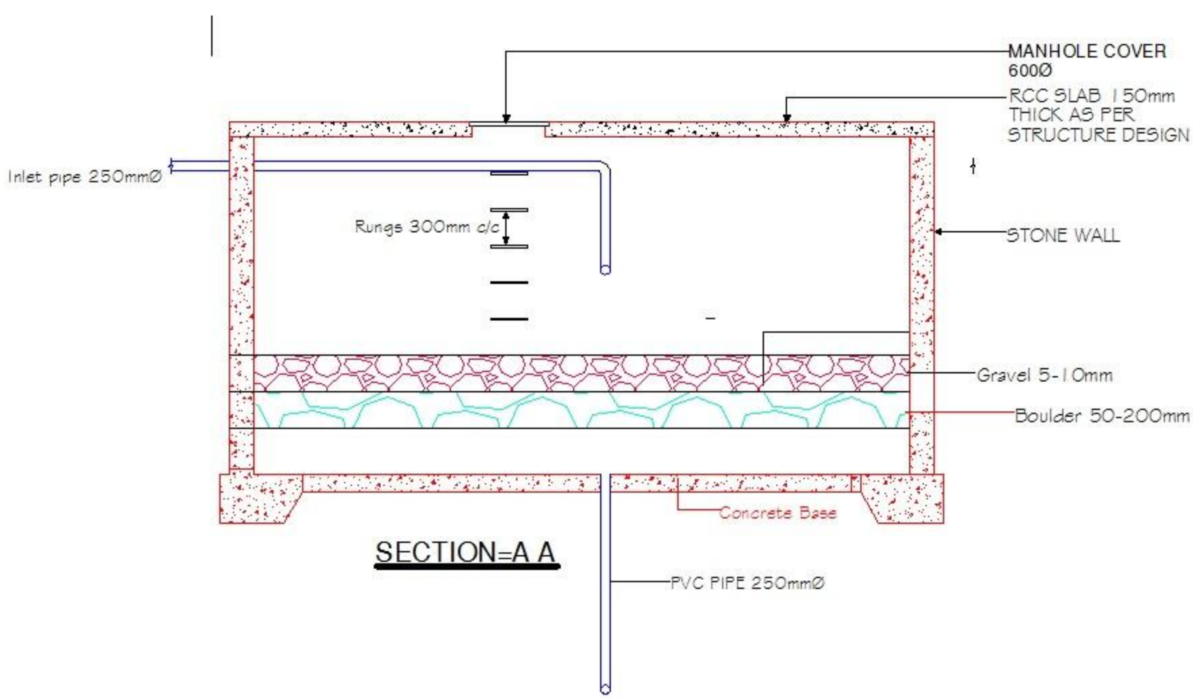

MANHOLE COVER
600Ø
RCC SLAB 150mm
THICK AS PER
STRUCTURE DESIGN
Inlet pipe 250mmØ
Rungs 300mm c/c
STONE WALL
Gravel 5-10mm
Boulder 50-200mm
Concrete Base
SECTION=A A
PVC PIPE 250mmØ

Fig 22

ADVANTAGES

a. Rainwater harvesting provides an independent water supply during regional water restrictions
b. It also helps in the availability of potable water as rainwater is substantially free of salinity and other salts.

CONCLUSION

For building STADD pro become more and more critical in the analysis of engineering & scientific problems .This facilities for the implementations of more effective & professional engineering software It should be affordable to promote their wide spread usage amongst civil engage a global scale

For water tanks Storage of water in the form of tanks for drinking and washing purposes, swimming pools for exercise and enjoyment, and sewage sedimentation tanks are gaining increasing importance in the present day life.

For small capacities we go for rectangular water tanks while for bigger capacities we provide circular water tanks. Design of water tank is a very tedious method. Without power also we can consume water by gravitational force.

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