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# DESIGN AND ANALYSIS OF RESIDENTIAL BUILDING WITH FLOATING COLUMNS BY CONSIDERING FOOTING DESIGN

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## ABSTRACT

*Hyderabad is the fifth largest city in our country. As it is rapidly developing the construction in the city is very costly. Economic point of view if the building is constructed at a far distance from the city it will be cheaper and residents can live peaceful without any external polluted sources. Having a peaceful surroundings is the main objective in view of most residing people in present generation. Our proposed site is located at Vijaya buildings, Bandalguda, Nagole road, Hyderabad. The main road which is near to site leads to kamineni hospital. A branch road of 10m which is near is existing WBM road connected very near to the plot. The total area of the site is about 235.11sq m. the residential building consists of two bed room.*

***Keywords:*** *Building analysis, E-Tabs and bending momentum calculations.*

## INTRODUCTION

The basics needs of human existences are food, clothing's & shelter. From times immemorial man has been making efforts in improving their standard of living. The point of his efforts has been to provide an economic and efficient shelter. The possession of shelter besides being a basic, used, gives a feeling of security, responsibility and shown the social status of man.

Every human being has an inherent liking for a peaceful environment needed for his pleasant living, this object is achieved by having a place of living situated at the safe and convenient location, such a place for comfortable and pleasant living requires considered and kept in view.

- A Peaceful environment.
- Safety from all natural source & climate conditions
- General facilities for community of his residential area.

The engineer has to keep in mind the municipal conditions, building bye laws, environment, financial capacity, water supply, sewage arrangement, provision of future, aeration, ventilation etc., in suggestion a particular type of plan to any client.

## 2.0 Literature Review

The house is the first unit of the society and it is the primary unit of human habitation. The house is built to grant the protection against wind, weathers, and to give insurance against physical insecurity of all kinds.The special features of the demand for housing consists of in its unique nature and depend on the following factors.

**A'zamiYasrebi and Salehipoor (2005) [1]**

The architecture in hot and dry regions of Iran. The research says that providing optimum cooling and heating of residential buildings of hot and dry regions in Iran so far has been according to the relations of 18 ecology, so that using architectural methods based on climate, local materials and also culture has damaged the environment as little as possible. Iran's traditional architecture has been generated from a climate and the situation which it has grown on it, so that all existing spaces of these regions such as urban spaces of passages, yards and buildings are protected against the atmospheric factors especially undesirable winds and using desirable winds and the sun's radiation are done according to some special arrangements. In order to recreate the least sun light and heat, outer parts of building walls of urban texture of these regions are condensed to each other and the houses are thickly joined to each other. The lanes are thin and disordered and sometimes they are covered with quite high walls, it is believed that while these situations create a shadow against the sun's radiation they control the speed of Kavir (Salt desert) winds. The idea of court yard in the houses of these regions has been formed according to the climatic factors, so that construction of courtyard houses of these regions with the indicators such as thick walls of porches, basements, wind catchers, arches and domes show that architects had an explicit concept of environmental conditions.

**Salem et al (2010) [2]** The concurrence of thermal comfort of courtyard housing and privacy in the traditional Arab house in Middle East. The research qualitatively identifies the physical features of the traditional Arab houses in Tripoli and Libya in terms of their privacy and their physical response to the environment. It measures elements of courtyard housing style and consequently how they adapt to the environment's culture and climate. The physical features of a traditional house and user behavioral preferences of 19 gender segregation are evaluated for matching. Thus the research concludes by contributing in establishing environmental analogy of man and his habitat. Social, physical and psychological dimensions of housing regionalism are symbiotic. In order to enhance housing sustainability several interrelated sectors like planners, designers and developers need to carefully harness these potentials considering their economical viability.

**YoungryelRyua et al (2009) [3]** The influence of wind flows on thermal comfort in the Daechung of a traditional Korean house, Daechung, a semi-open space with wooden floor located between the front and backyards of traditional Korean residences, is well known as a cool space in summer due to cross-ventilation, but it has not yet been scientifically explained thoroughly. The purpose of this study is to characterize the wind flow measured at a Daechung to interpret the effects of the wind characteristics on thermal comfort. They have measured 10-Hz turbulence data at the Daechung and partitioned the wind vector into two directions (i.e. backyard to Daechung and front yard to Daechung). Interestingly, the wind from the cool backyard flowing through the Daechung was of less frequency and shorter duration but had higher velocity compared to wind from the opposite direction, which can provide thermal comfort to the dwellers. They have suggested that the wind characteristics were determined by various aspects of the house's design, such as its location and the degree of enclosure in front and backyards. Their study concludes with results showing the traditional Korean house made use of a natural ventilation system during the summer and the principles of this system could be helpful in constructing environmentally friendly and sustainable residences.**]**

**Manioglu and YÕlmaz (2007) [4** A made research on energy efficient design strategies in the hot dry area of Turkey. Climate has a major effect on the performance of the building and its energy consumption. Their study is based on a student workshop, which has been carried out for a hot dry area of Turkey. Further the study first aims to show the similarities and the differences of the traditional housing principles from the climate responsive design point of view. Secondly, it aims to put forward the basic principles and their meaningful changes in usage that can be used in the sustainable housing designs of the future.

**Ehsan et al (2011) [5]** The learning from the past by taking a case study of traditional architecture of southern shores of Caspian sea region in Iran. The research says that climate has a vital role in 24 the design of buildings. Today we are facing some environmental problems such as global warming, Ozone layer depletion and shortage of fossil fuels which make it necessary to consider the effects of climate in the building design. Traditional architecture has always been a good example of climatic design and represents the techniques which our ancestors have found to improve their living conditions. In addition, traditional architecture can be a source of inspiration in the contemporary building design to learn from it and try to adapt modern buildings with the natural environment as far as possible. Thus this research concludes that the traditional architecture of southern shores of Caspian sea region in Iran is explored to find the role of climate in the formation of the buildings. Also Mahoney tables which provide design recommendations on the building design are used to compare with the design techniques in traditional architecture of this region.

## 3.0METHODOLOGY

The Selection of plot is very important for buildings a house. Site should be in good place where there community but service is convenient but not so closed that becomes a source of inconvenience or noisy. The conventional transportation is important not only because of present need but for retention of property value in future closely related to are transportation, shopping, facilities also necessary. One should observe the road condition whether there is indication of future development or not in case of un developed area. The factor to be considered while selecting the building site are as follows:-

- Access to park & playground.
- Agriculture polytonality of the land.
- Availability of public utility services, especially water, electricity & sewage disposal.
- Contour of land in relation the building cost. Cost of land .
- Distance from places of work.
- Ease of drainage.
- Location with respect to school, collage & public buildings.
- Nature of use of adjacent area.
- Transport facilities.
- Wind velocity and direction.

### 3.1 SURVEY OF THE SITE FOR PROPOSED BUILDING:

- Reconnaissance survey: the following has been observed during reconnaissance survey of the site.
- Site is located nearly.
- The site is very clear planned without ably dry grass and other throne plats over the entire area.
- No leveling is require since the land is must uniformly level.
- The ground is soft.
- Labor available near by the site.
- Houses are located near by the site.
- Detailed survey: the detailed survey has been done to determine the boundaries of the required areas of the site with the help of theodolite and compass.

### 3.2 RESIDENTIAL BUILDING

Requirement for residential accommodation are different for different classes of people & depends on the income &status of the individual a highly rich family with require a luxurious building, while a poor man we satisfied with a single room house for even poor class family.

A standard residential building of bungalow type with has drawing room, dining room office room, guest room, kitchen room, store, pantry, dressing room, bath room, front verandah, stair etc., for other house the number of rooms may be reduced according to the requirements of many available

### 3.4 LIMITATION OF BUILT UP AREA:

Area of plot up to 200sq.m (240sq.yd)- maximum permissible built up area, Ground and first-60% of site area on floor only. 201 to 500sq.m (241to 600sq.yd)- 50% of the site area. 501 to 1000sq.m (601 to 1200sq.yd)- 40% of the site area. More than 1000sq.m-33% of the site area

## 3.5 MINIMUM FLOOR AREA & HEIGHT OF ROOMS:

**Table shows the dimensions of build up**

| Description | Floor area | Height |
|---|---|---|
| Living | 10sqm (100sqft)<br>(breadth min 2.7 m or 9') | 3.3 (11') |
| Kitchen | 6sqm (60sqft) | 3.0 (10') |
| Bath | 2sqm (20sqft) | 2.7 (9') |
| Latrine | 1.6sqm (16sqft) | 2.7 (9') |
| Bath & Water closet | 3.6sqm (36sqft) | 2.7 (9') |
| Servant room | 10sqm (100sqft) | 3.0 (10') |
| Garage | 2.5*4.8 m (8'*16') | 3.0 (10') |
| Minimum height for main building plinth | | 0.6 (2') |
| Minimum height for servant room plinth | | 0.3 (1') |
| Minimum depth of foundation | | 0.9 (3') |
| Damp proof course | 2cms to 2.5cms(3/4" to1") | |
| Thickness of the wall | 20cms to 30cms(9" to13.5") | |

## 4.0 DESIGNS

Figure Shows 4.1 Design Of Slabs

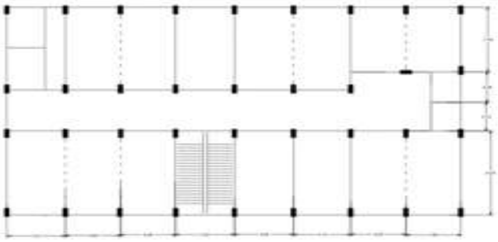

Figure 4.2 Loads On Beams

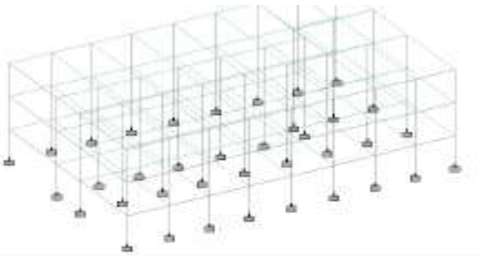

Figure 4.3 Shows Design Of Beams

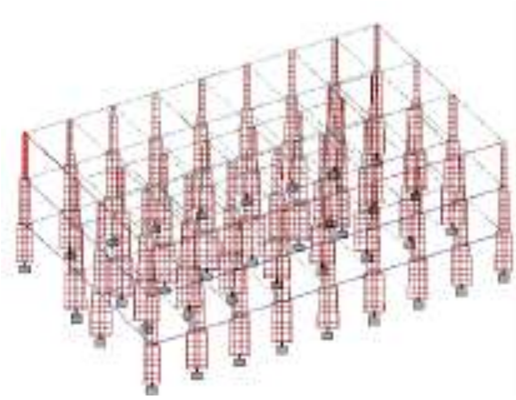

Figure 4.4 Loads Of Columns

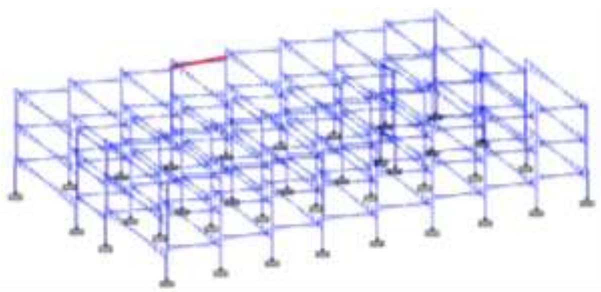

Figure 4.5 Beams Loading

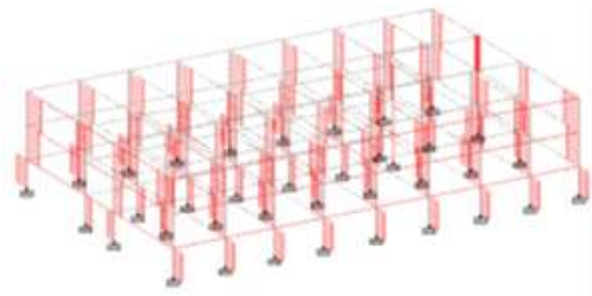

Figure 4.6 Design Of Footings

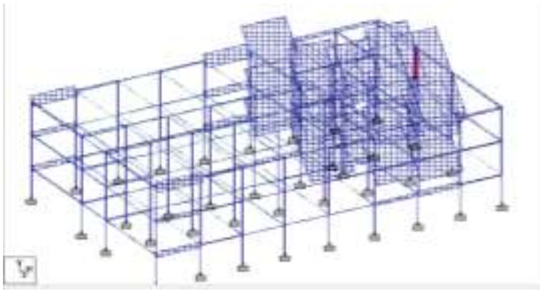

Figure 4.7 Initial Structure Of Residential Building

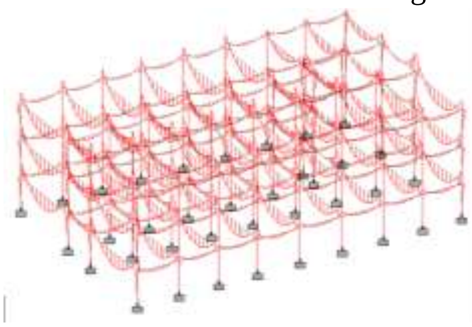

Figure 4 .8 Initial Load Moment Of Residential Building

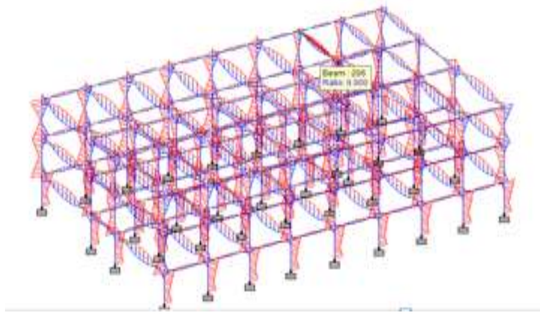

Figure 4.9 Live Loads Of Residential Building

Figure 4.10 Dead Loads Of Residential Building

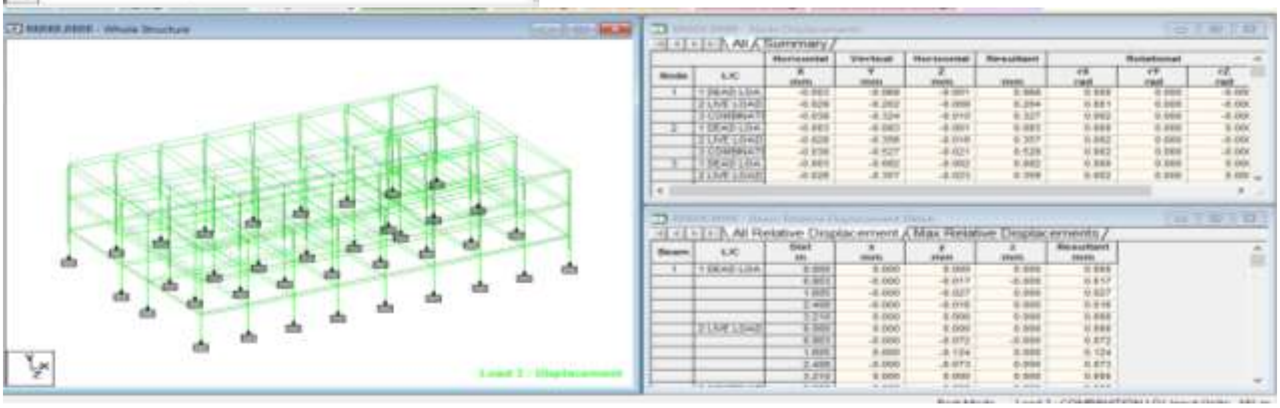

Figure 4.11 Displacement Loads Of Residential Building

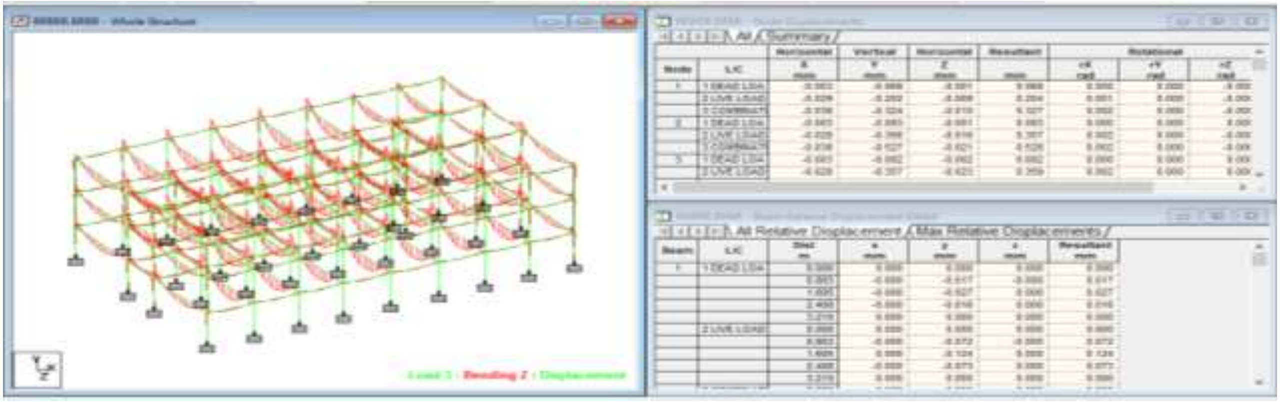

Figure 4.11 Displacement Loads Of Z- Axis Residential Building

## DESIGN OF SLAB

Slabs are to be designed under limit state method by reference of IS 456:2000.

- When the slab are supported in two way direction it acts as two way supported slab.
- A two way slab is economical compared to one way slab.

**SLAB DESIGN:**

$F_{CK}$= 15 N/mm2,F $_y$=415 N/m2

**Span**

- Shorter span:- Lx = 5.8m
  longer span:-Ly =7.62m
- Check Lx/Ly= 7.62/5.8 =1.3<2

Hence the slab has to be designed as **"two way slab".**

iii. Providing over all depth of slab as 5", 120mm eff. depth= D-15-/2 =120-15-10/2=100mm

iv. Condition:- supported on four sides.

v. Load calculation:-

Dead load = 25x0.12x1 = 3.0KN/m
Live load =2x1 = 2.0KN/m
Floor finish =1x1 = <u>1x1KN/m</u>
= <u>6.0 KN/m</u>

vi. Bending moment calculation:- (as per IS code 456-2000) Type of panel:- Two adjacent edges are discontinuous

ax(+) = 0.049 ax(-) = 0.065
ay(+) = 0.035 ay(-) = 0.047

(+ve) B.M at mid span in shorter directions.
Mx(+) = ax(+)wlx2
= 0.049x6x5.8^2= 9.9kn-m
Factored B.M = 9.9x1.5 =14.85kn-m
Spacing and diameter:
As per sp-16.
Provide 8mmØ bars at 210mm spacing.
(-ve) B.M at continuous edge in shorter direction. Mx(-) =ax (-) wlx2
= 0.065x6x (5.8)^2 =13.1196kn-m
Factored B.M = 13.1196x1.5=19.6794 kn-m
(+ve) B.M at mid span in longer directions.
My (+)= ay(+)wlx2
= 0.035x6x(5.8)^2 =7.06kn-m
Factored B.M=7.06x1.5 =10.59kn-m
(-ve) B.M at continuous edge in longer direction.
My(-ve) = ay (-ve)wlx2 =0.047x6x(5.8)^2 =9.48kn-m
Factored B.M=9.48x1.5 =14.22kn m.

**CHECK FOR DEPTH:**

Permissible depth=100mm
Mu.lim =0.36.<u>Xumax</u>(1-0.42<u>Xumax</u>)fckbd^2 d d
14.86x10^6= 0.36.<u>Xumax</u> (1-0.42x0.48)15x1000d^2
d= 84.71 < 100mm
Hence ok

## DESIGN OF BEAMS

- Beam is a member which transfers the loads from slab to columns and then foundation to soil.
- Beam is a tension member.
- Span of slabs, which decide the spacing of beams.
- Following are the loads which are acting on the beams.
- Dead load
- Live load
- Wind load

**LOADS ON BEAMS:**

B1: BEAM

SPAN=5.8m (shorter span)
Assuming beam size = 9"x16"(230x405mm)
Height of the wall-10'-3m
Load calculations

- Wall load - 0.23x3x19 =13.11Kn/m
- Self load – 0.23x0.406x25 =2.33Kn/m
- Slab load – W = 6KNLx = 5.8

WLx/3= (6x5.8)/3 = 11.6Kn/m
Total load = 13.11+2.33+11.6 = 27.04Kn/m

**DESIGN OF STIRRUPS:**

B1:BEAM

Calculation of shear force
Va= Vb = total load 2
=27.04x5.8 = 156.832 KN 2
Calculation of normal shear
Tv =Vu=1.5x78.416x10^3 =117624
Bd 230x373
Calculation of permissible shear stress
Tc = % of tension steel
Pt = Ast x 100 Bd
Ast = 2x16^2xp =402.12mm^4
Pt = 402.12x100 = 0.60%
230x373
Tc =0.50
Tc<Tv 0.05 < 0.76
Hence provide shear reinforcement.

**Design of shear:**

Vs = (Tv-Tc)bd =(0.76-0.50)x230x373 =22.30KN
Calculation: Vus =22.30 =0.59 KN/cm
D(cm) 37.3
From sp-16 table no 62 we will get dia& spacing.
Hence provide 6mm dia @ 20 cm c/c spacing.

**Check for spacing:**

Spacing should be provided min of the following.
(a) 0.75d = 0.75x373 =279.75 mm
(b) Asvfy =2x(6^2xp/4)x250 =153.2mm
0.4b 0.4x230
(c) design spacing 45cm c/c
Hence provide 6mm dia stirrups @ 15 cm c/c.

**LOADS ON BEAMS:**

B2: BEAM

SPAN=7.62m (longer span)
Assuming beam size = 9"x16"(230x405mm)
Height of the wall-10'-3m
Load calculations

- Wall load - 0.23x3x19 =13.11Kn/m
- Self load – 0.23x0.406x25 =2.33Kn/m
- Slab load –

W = 6KN
Ly = 7.62
WLy/3= (6x7.62)/3 = 15.24Kn/m
Total load = 13.11+2.33+15.24 = 30.68Kn/m

**DESIGN OF STIRRUPS:**

B2:BEAM

- Calculation of shear force

Va=Vb= total load 2
=30.68x7.62 = 233.7816 KN 2

- Calculation of normal shear

Tv=Vu =1.5x233.7816 x10^3 =2104034.4
Bd 230x373=85790

- Calculation of permissible shear stress

Tc = % of tension steel
Pt = Ast x 100
Bd
`Ast = 2x16^2xp =402.12mm^24
Pt = 402.12x100 = 0.60%
230x373
Tc =0.50
Tc<Tv 0.05 < 0.85

Hence provide shear reinforcement.

**Design of shear:**
Vs = (Tv-Tc) bd=(0.85- 0.50)x230x373
=30.02KN
Calculation: Vus =230.02 =0.89KN/cm
D(cm) 37.3
From sp-16 table no 62 we will get dia& spacing.
Hence provide 6mm dia @ 15cm c/c spacing
**Check for spacing:**
Spacing should be provided min of the following.
(a) 0.75d = 0.75x373 =279.75 mm
(b) Asvfy =2x(6^2xp/4)x250 =153.2mm
0.4b
0.4x230
(c) design spacing 45cm c/c
Hence provide 6mm dia stirrups @ 15 cm c/c

**DESIGN OF BEAMS:**
Mu at Left span = 11.577 KN-m
Mu at Mid span = 19.18 KN-m
Mu at Right span = 20.36KN-m

**Check for spacing:**
Calculation limiting moment of resistances:
Mu = 11.577 KN-m
Mulimt =0.138 fck bd2
= 0.138x20x230x305^2 =59.05 KN-m
Mu <Mulimit
Hence it is designed as simply reinforcement beam using sp-16 Mu =11.577x10^6 =1.39
bd 230x305^2
Refer table no.2 at sp-16 and read out the value o percentage of reinforcement
Corresponding to fy = 415 N/mm^2 and fck = 20N/mm^2
For Mu= 1.39 Pt= bd^2=0.422
Pt = 0.422 %

**Area of reinforcement**
Pt = Astx100
Bd =0.422x230x405
100
= 393.093 mm^2
Ast required = 393.093 mm^2
Ast provided:
Hence provide 3 bars & 12 mmdia
Ast provide =400 mm^2

**Reinforcement of mid span:-**
Calculate limiting moment of resistances Mu =19.18 KN-m
Mulimt = 0.138 fck bd^2
=0.138x20x230x305^2 = 59.05 KN-m
Mu <Mulimit
Hence it is designed as singly reinforcement.
BY USING SP-16
Mu =19.18x10^6
Bd^2 230x305^2
= 21395750
Refer table no.2 at sp-16and read out the value of percentage of reinforcement
Corresponding to fy = 415N/mm^2 and fck = 20 N/mm2

| Mu | pt Bd^2 |
|---|---|
| 0.65 | 0.187 |
| 0.70 | 0.203 |
| 0.66 | ? |

Pt =0.190% Reinforcement
Pt = Astx100
Bd =0.19x230x305*100
=133.285mm2 Ast provided Hence provided 2mm bars & 12mm diaAst provided = 155.2mm2

**Reinforcement of right span:-**
Calculate limiting moment of resistance:-Mu =20.36 KN-m
Mulimi = 0.138 fck bd^2
=0.138x20x230x305^2 = 59.05KN-m
Mu <Mulimit
Hence it is designed as singly reinforcement.
BY USING SP-16
Pt = 0.422%
Reinforcement = Pt = Ast x100bd
Ast =0.422x230x305*100
= 296.033mm2 Ast provided
Hence provide 3 bars and 12mm dia
Ast provided =300mm^2.

## 5.0 RESULTS

| S.NO | TYPE OF LOAD | ROOF LOAD | FLOOR LOAD |
|---|---|---|---|
| 1. | Wall load | (5.8+7.62)x0.115x 0.91x192=888.021389KN | (5.8+7.62)x0.23x3x192=5855.08608KN |
| 2. | Slab load | (5.8+7.62)x62=40.26KN | (5.8+7.62)x62=40.26KN |
| 3. | Self wt. of beam | 0.23x0.406x(5.5+7.62)x252= 986.21606 KN | 0.23x0.406x(5.5+7.62)x252= 308.73669KN |
| | Total load | 1914.49741KN | 6204.08277KN |

## CONCLUSION

We can conclude that there is difference between the theoretical and practical work done. As the scope of understanding will be much more when practical work is done. As we get more knowledge in such a situation where we have great experience doing the practical work. Knowing the loads we have designed the slabs depending upon the ratio of longer to shorter span of panel. In this project we have designed slabs as two way slabs depending upon the end condition, corresponding bending moment. The coefficients have been calculated as per I.S. code methods for corresponding lx/ly ratio. The calculations have been done for loads on beams and columns and designed frame analysis by moment distribution method. Here we have a very low bearing capacity, hard soil and isolated footing done.

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