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A theoretical Approach Project Management & Planning of Modern Residential Building by using ETABS

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ABSTRACT
For analyzing a multi storied building one has to consider all the possible loadingsand see that the structure is safe against all possible loading conditions. There areseveralmethodsforanalysisofdifferentframeslikecantilevermethod,portalmethod, Matrixmethod.The present project deals with the analysis of a multi storied residential building ofG+5consisting of 4 apartments in each floor. The dead load &live loads are appliedandthedesignfor beams,columns,footing isobtained.
Keywords- Planning, Structural Design, ETABS,

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I. INTRODUCTION

The process of planning, designing and construction of a structure is considered to be providing modern facilities & comfortable apartment on very low budget. Our country is experiencing unprecedented Problems of urban population. There is a growing tendency of rural influx into big cities due to the developing economy and industrialization besides the growth of population. This lead to large scale construction and planning to meet the growing demand of urban population also cost of land is forcing planners to get in for "APARTMENT" and these buildings become inevitable.

1.2 STAGES IN STRUCTURAL DESIGN

There are five stages for the design of structures:

- Planning of Structure
- Drawing Study
- Load Combinations
- Analysis of Structures
- Structural Design

II. LITERATURE REVIEW

High Rise Buildings and How They Affect Countries Progression (Dr. Akram Farouk) stated that Facades must be distinct and able to achieve a good balance between form and economic cost, Creating laws and principles governing high rise buildings construction in order to stimulate capital and investment in such projects formation of various an investment committee which will provide all the required economic studies in order to ensure the success of the projects.

They used ETABS for the analysis and design of a G+5 multi storied building. The dead loads acting on the slab were calculated manually while live load, seismic load and wind load have been entered by following respective IS Codes. The design was done using limit state of design according to IS 456:2000. They showed how efficiently and easily such a high rise building can be designed within a very short span of time.

PROBLEM IDENTIFICATION

Then it was designed manually following Limit State Method. After that ETABS is used to match the design and make structure optimize and economical by trying different dimension for same capacity. For quick cost prediction of Building, this study therefore examines the cost effectiveness in terms of amount of materials. In case of real life structure are used for working stress method because the structure are crack free.

III. METHODOLOGY

To achieve the objectives of the study that is to analyze and design residential building using ETABS and by manual method, which meets the basic requirements such as safety, durability, it has been proposed to follow the following methodology.

- ***Site survey***
- ***Soil investigation***
- ***Structural planning***
- ***Analysis and design in ETABS***
- ***Verification by manual method***
- ***Detailing***

SELECTION OF PLOT AND STUDY

- 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.

PLANNING

The planning is done as per the building by laws rules and regulations. Its G+5 story apartment. 5 tower 4 rooms in each floor. The general rules are as

Total Area	**10117.1 sq.m**
Buildup Area	929.030 sq m Each tower
Apartment Area	148.64 sq.m
No of Tower	5 tower , G+5
Apartments	4 in each floor.
Lift	500kg
Gym	232.25 sq.m
Mini super market	371.61 sq.m
Club house	232.25 sq.m

Table.1.1. Area in Apartment

- The distance from Bilaspur airport 10km
- The distance from Bilaspur railway station 15km
- The main shopping market is 2km away
- All rooms have attached bathroom

APARTMENTS ARE DIVIDED INTO 3 DIFFRENT CATEGORIES ACCORDING TO INCOME GROUP:-

HIGH INCOME GROUP

Total plot area **-** 2500.00sq.ft.

Total built up area – 2400.00sq.ft

MINIMUM FLOOR AREA & HEIGHT OF ROOMS:-

	ROOM	**FLOOR AREA**	**HEIGHT (m)**
□	HALL	23.09sqm(248.6sqft)	3.3m
□	DINING	8.78sqm(94.6sq.ft)	3.3m
□	TOILET	3.84sqm(41.4sqft)	2.7m
□	BED ROOM-a	12.26sqm(132sqft)	3.0m
□	BED ROOM-b	11.24sqm(121sqft)	3.0m
□	KITCHEN	8.78sqm(94.6sqft)	3.0m
□	TERRACE	13.93sqm(150sqft)	------
□	TERRACE	8.78sqm(94.6sqft)	------
□	MIN. HIEGHT OF PLINTH	Built-up area	0.6m (2ft)
□	MIN. DEPTH OF FOUNDATION	------	1.5m(4.92ft)

□	DAMP PROOF COURSE	------	0.02m TO 0.025m
□	WALL Thick(0.02m)	------	------

Table.1.2. HIG Area

SPECIFICATION:-

FLOOR FINISHES	**ROOM – ONYX TILES IN ALL ROOMS** **TOILET – PORCELAIN TILES**
STAIR	RAVERTINET TILES
KITCHEN	KITCHEN PLATFORM, GREEN MARBLE, SINK STAINLESSSTEEL
DOOR	FRONT DOOR - WOODEN ARCH,DOOR, INTERNAIL DOOR – WOODEN DOOR, OTHER DOOR – FLUSH DOOR.
WINDOW	WOOD ARECH & SLIDING ALUMINUM WINDOW
WALL	INTERNAL – POP AND PLASTIC PAINT EXTERIOR – CEMENT BASED PAINT
ELECTRICAL	MODULAR SWITCHES AND COPPERWIRE
WATER SUPLLIY	G.I. PIPELINE WITH 500ltr.INDIVIDUAL TANK

Table.1.3. HIG Specification

COST ESTIMATING

COST ESTIMATING		
Building cost Rs.2500 sq.m	152 sq.m built-up area	228000/-
Foundation	1%	228228/-
Architectural	1%	230510.28/-
Water supply	6%	244340.89/-
Electric installation	12%	273661.79/-
Fire and sound resistance	20%	328394.14/-
Other service	2.5%	336603.99/-
Supervision charge	5%	353434.18/-
	Total	

Table.1.4. HIG Cost Estimating

MEDIUM INCOME GROUP

Total plot area **-** 2000.00sq.ft.

Total built up area – 1800.00sq.ft.

MINIMUM FLOOR AREA & HEIGHT OF ROOMS:

Table.1.5. MIG Area

	ROOM	**FLOOR AREA**	**HEIGHT (m)**
□	HALL	23.09sqm(248.6sqft)	3.3m
□	DINING	8.78sqm(94.6sq.ft)	3.3m
□	TOILET	3.84sqm(41.4sqft)	2.7m
□	BED ROOM-a	10.21sqm(110sqft)	3.0m
□	BED ROOM-b	11.24sqm(121sqft)	3.0m
□	KITCHEN	6.74sqm(72.6sqft)	3.0m
□	TERRACE	12.07sqm(130sqft)	------
□	TERRACE	6.74sqm(72.6sqft)	------
□	MIN. HIEGHT OF PLINTH	Built-up area	0.6m (2ft)
□	MIN. DEPTH OF FOUNDATION	------	1.5m(4.92ft)
□	DAMP PROOF COURSE	------	0.02m TO 0.025m
□	WALL Thick(0.02m)	------	------

COST ESTIMATING

COST ESTIMATING		
Building cost Rs.2500 sq.m	152 sq.mbuiltup area	228000/-
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Other service	2.5%	336603.99/-
Supervision charge	5%	353434.18/-
	Total	

Table.1.6. MIG

Cost Estimation

SPECIFICATION

FLOOR FINISHES	**ROOM – ONYX TILES IN ALL ROOMS** **TOILET – PORCELAIN TILES**
STAIR	RAVERTINET TILES
KITCHEN	KITCHEN PLATFORM, GREEN MARBLE, SINK STAINLESSSTEEL
DOOR	FRONT DOOR - WOODEN ARCH,DOOR, INTERNAIL DOOR – WOODEN DOOR, OTHER DOOR – FLUSH DOOR.
WINDOW	WOOD ARECH & SLIDING ALUMINUM WINDOW
WALL	INTERNAL – POP AND PLASTIC PAINT EXTERIOR – CEMENT BASED PAINT
ELECTRICAL	MODULAR SWITCHES AND COPPERWIRE
WATER SUPLLIY	G.I. PIPELINE WITH 500ltr.INDIVIDUAL TANK

Table.1.7. MIG Specification

LOW INCOME GROUP:-
Total plot area **-** 1500.00sq.ft.
Total built up area – 1450.00sq.ft.

MINIMUM FLOOR AREA & HEIGHT OF ROOM:-

	ROOM	**FLOOR AREA**	**HEIGHT (m)**
	HALL	36.69sqm(395sqft)	3.3m
	TOILET	3.84sqm(41.4sqft)	2.7m
	BED ROOM-a	8.36sqm(90sqft)	3.0m
	BED ROOM-b	9.82sqm(105.8sqft)	3.0m
	KITCHEN	5.98sqm(64.4sqft)	3.0m
	MIN. HIEGHT OF PLINTH	Built-up area	0.6m (2ft)
	MIN. DEPTH OF FOUNDATION	------	1.5m(4.92ft)
	DAMP PROOF COURSE	------	0.02m TO 0.025m
	WALL Thick(0.02 TO 0.3m)	------	------

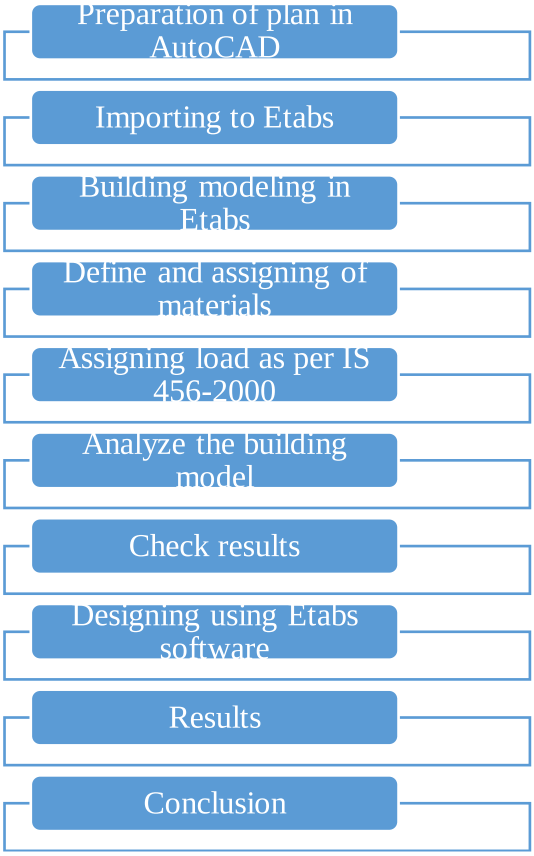
Table.1.8.LIG Area

SPECIFICATION:-

FLOOR FINISHES	**ROOM– PORCELAIN TILES IN ALL ROOMS** **TOILET – MARBLE TILES** **PORCH – GRANITE TILES**
STAIR	CERAMIC TILES
KITCHEN	GREEN MARBLE, SINK STAINLESS STEEL
DOOR	FRONT DOOR - WOODEN ARCH,DOOR, INTERNAIL DOOR – WOODEN DOOR, OTHER DOOR – FLUSH DOOR.
WINDOW	WOOD ARECH & SLIDING ALUMINUM WINDOW
WALL	INTERNAL – POP AND PLASTIC PAINT EXTERIOR – CEMENT BASED PAINT
ELECTRICAL	MODULAR SWITCHES AND COPPERWIRE
WATER SUPLLIY	G.I. PIPELINE WITH 500ltr.INDIVIDUAL TANK

Table.1.9. LIG Specification

MODELING AND DESIGN



Layout Plan

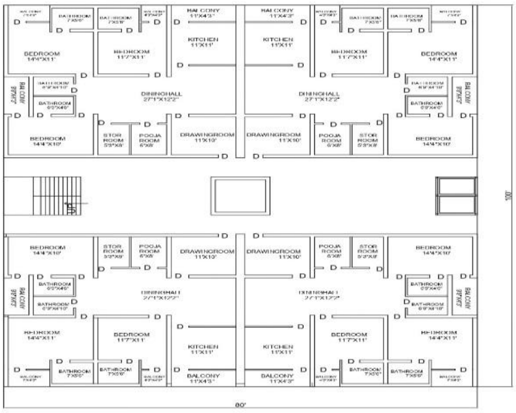


Fig 4.2.1. Layout Plan

Column Position

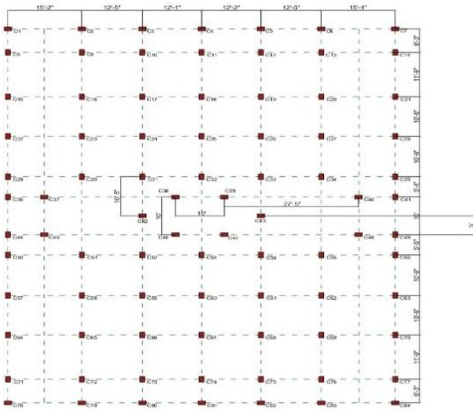


Fig 4.2.2. Column Position

PROPERTIES

This chapter provides property information for materials, frame sections, shell sections, and links.

Frame Section

Name	Material	Shape
Column300x450	M35	Concrete Rectangular
Column 450x350	M35	Concrete Rectangular
Beam300x450	M35	Concrete Rectangular

Shell Sections

Name	Design Type	Element Type	Material	Total Thickness mm

Shear wall	Wall	Shell-Thin	M35	228.6
Slab 150 mm	Slab	Shell-Thin	M35	150
Slab 200 mm	Slab	Shell-Thin	M35	150

Table.4.3.3. Shell Sections
Reinforcement Size

Name	Diameter mm	Area mm^2
12	12	113.09
16	16	201
20	20	314

Table.4.3.4. Reinforcing Bar Sizes

ANALYSIS IN ETABS AND MANUAL METHOD

The scope of the study encompasses various aspects in the structural analysis & design of building using ETABS nowadays most of the civil engineering projects are done using this software having done this project it enabled as to gain exposure in various computer applications related to civil engineering.

NAME	WEIGHT
BEAM	3.63KN/M2
COLUMN	3.63KN/M2
LIVE	2.25KN/M2
SEISMIC	1KN
WIND	39M/SEC

Table.4.4. Load type and weight

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:
fck = 20 N/mm   fy=500N/m
SPAN:
1. Shorter Span Lx = 24.63m
2. Longer Span Ly = 30.73m
3. Check Ly/Lx = 30.73/24.63 = 1.24< 2

Hence Slab is Two way slab
Providing over all depth of slab is 150mm
Using 12 mm Ø bars and providing 15 mm clear cover
Effective depth = D-15- Ø/2
= 150-15-12/2 = 129 mm
LOAD CALCULATION OF SLAB:
1. Dead Load = 25 x 0.15 x 1 = 3.75 kn/m^2
2. Live Load = 1 x 5 = 5 kn/m^2
3. Load due to finish = 1 kn/m^2

Total Load = 3.75 + 5 + 1 = 9.75 kn/m^2

Bending Moment Calculation:
As per IS:code 456:2000
a_x (+) = 0.049 a_x (-) = 0.065
a_y (+) = 0.035 a_y (-) = 0.047
The negative moment at continues edge and positive moment at mid span

M_x = $a_x Wl^2_x$
M_y = $a_x Wl^2_y$
Bending moment at mid span in shorter direction
1. M_x (+) = $a_x Wl^2_x$
= 0.049 x 9.75 x $(24.63)^2$
= 289.82kn-m.
Factored bending moment BM = 1.5 x 289.82 = 434.73 kn-m.
2. M_x(-) = 0.065 x 9.75 x $(24.63)^2$
=384.45 kn-m.
Factored bending moment BM = 1.5 x 384.45 = 576.68 kn-m.
3. M_y (+) = 0.035 x 9.75 x $(24.63)^2$
= 207.01kn-m.
Factored bending moment BM = 1.5 x 207.01 = 310.52 kn-m.
4. M_y (-) = 0.047 x 9.75 x $(24.63)^2$
= 277.99kn-m.
Factored bending moment BM = 1.5 x 277.99 = 416.98 kn-m.
Check depth:
d = $\sqrt{\underline{M}/Rb}$
R = $0.36X_{umax\,/}\, d\,(1 - 0.42 \times X_{umax\,/}\, d)$ fck
= 0.36 x 0.48(1-0.42 x 0.48)20 = 2.75
d = $\sqrt{576.68x10^6/ 2.75 \times 1000}$ = 457 mm < d
i.e. required minimum permissible depth is 100 mm

Check depth:
Mid Span
Ast_{xx} = m_{x+ve}/ 0.87 X fy X d X a_1
a_1 = 1-0.42X 0.48 = 0.80
Ast_{xx} = $289.82X10^6$/ 0.87 X 500 X 200 X 0.80
Ast_{xx} = $4164mm^2$

Ast_{min} = 0.12/ 100 X 1000X 150 =180 mm^2

So providing minimum reinforcement
Spacing =113/180X1000 = 627 ≈ 600 mm

From code max. Spacing is the lest of 3d and 450mm
3d= 3X150 = 450mm

Provide 12mm Ø bars @ 400mm C/C
Ast_{yy}= $310.52X10^6$/ 0.85 X 500 X 150 X 0.80
Ast_{xx}= 6088.62 mm^2

Provide 12mm Ø bars @ 400mm C/C

At the edges
Ast_{xx} = $384.45X10^6$/ 0.85 X 500 X 150 X 0.80
Ast_{xx} = 7538.23 mm^2

Specing
= 113/7538.23X1000 = 14.99≈ 15 mm

Provide 12mm Ø bars @20mm C/C

Ast_{yy} = $416.98X10^6$/ 0.85 X 500 X 150 X 0.80
Ast_{xx} = 8176.07 mm^2

Specing
= 113/8176.07 X1000 = 13.82≈ 14 mm

Provide 12mm Ø bars @mm C/C

Corner reinforcement:
Area of corner reinforcement
= 3/4 x max. positive reinforcement area
= 202.5 mm^2
Size of corner mash = 0.2 x 7m + 1.4 m

Check for deflection :
I_x /d X mf = 6.09/0.15x1.6 = 25.37 <26
I_y /d X mf = 6/0.15x1.6 = 25 <26

Hence, safe.

DESIGN OF BEAMS
SPAN:
B1: BEAM
1. Shorter Span Lx = 24.63 m
2. Beam size = 300X450 mm
3. Height of the wall = 10ft – 3m
LOAD CALCULATION OF BEAM:
1. Wall Load = 0.30X3X19 = 17.11 kn/m^2
2. Self Load = 0.30X0.45X25 = 3.37 kn/m^2
3. Slab Load (w) = 6 kn
WLx/3 = (6X24.63)/3 = 49.26 kn/m
Total Load = 17.1+ 3.37 + 49.26 = 69.73 kn/m

DESING OF STIRRUPS: CALCULATION OF SHEAR FORCE:
Va = Vb = Total Load X L/2
= 69.73X24.63/2 = 858.72 kn
CALCULATION OF NORMAL SHEAR :
Tv = Vu/Bd = 1.5X858.72X10^3 /300X450
= 9.54 kn
CALCULATION OF PERMISSIBLE SHEAR STRESS:
Tc = % of tension steel
Pt =Ast X 100/ Bd
Ast
= Ast/Bd = 0.85/fy
= 0.85/500 X 300 X 450
= 229.5
Pt = 229.5 X 100 / 300 X 450
= 0.22 %
Tc =Pt
Tc = 0.22
Tc<Pt
0.022 < 0.76
Hence Provide Shear Reinforcement
DESIGN OF SHEAR:
Vs = (Tv – Tc) / bd
= (0.76 – 0.22) / 300 x 450
Calculation Vus/ D(cm) = 72.90 / 37.3
= 1.95 KN/cm
Hence provide 8mm dia @ 20 cm c/c spacing.

CHECK FOR SPACING:
Spacing should be provided min of the following
(a) 0.75d = 0.75X 450 = 337.5 mm
(b) Asvfy / 0.4b = 2 x (9.75^2 x P/4)x250 / 0.4 x 300

= 99.82 mm

Hence provide 6 mm dia stirrup @ 15 cm c/c spacing.

SPAN:

B2: BEAM

1. Longar Span Ly = 30.73 m
2. Beam size = 300X450 mm
3. Height of the wall = 10ft – 3m

LOAD CALCULATION OF BEAM:

1.Wall Load = 0.30X3X19 = 17.11 kn/m^2

2. Self Load= 0.30X0.45X25 = 3.37 kn/m^2

3. Slab Load (w) = 6 kn

WLy/3 = (6X30.73)/3 = 182.22 kn/m

Total Load = 17.1+ 3.37 + 182.22 =202.69 kn/m

DESING OF STIRRUPS:CALCULATION OF SHEAR FORCE:

Va = Vb = Total Load X L/2

= 202.69 X30.37/2 = 3077.84 kn

CALCULATION OF NORMAL SHEAR:

Tv = Vu/Bd = 1.5X3077.84 X10^3 /300X450

= 6925140 kn

CALCULATION OF PERMISSIBLE SHEAR STRESS:

Tc = % of tension steel

Pt = Ast X 100/ Bd

Ast

= Ast/Bd = 0.85/fy

= 0.85/500 X 300 X 450

= 229.5

Pt = 229.5 X 100 / 300 X 450

= 0.22 %

Tc =Pt

Tc = 0.22

Tc<Pt

0.022 < 0.76

Hence Provide Shear Reinforcement

DESIGN OF SHEAR: Vs= (Tv – Tc) / bd

= (0.76 – 0.22) / 300 x 450

Calculation Vus/ D(cm) = 72.90 / 37.3

= 1.95 KN/cm

Hence provide 8mm dia @ 20 cm c/c spacing.

CHECK FOR SPACING:

Spacing should be provided min of the following

(a) 0.75d = 0.75X 450 = 337.5 mm

(b) Asvfy / 0.4b = 2 x (9.75^2 x P/4)x250 / 0.4 x 300

= 99.82 mm

Hence provide 6 mm dia stirrup @ 15 cm c/c spacing.

DESIGN OF COLUMN

Columns are compression members.

SELF LOAD

= 0.30 X 0.45 X 3 X 25

= 10.125 KN

WALL LOAD

.Roof Load = (24.63 + 30.73) /2 X 0.115 X 0.91X 19

= 55.03 KN

.Floor Load = (24.63 + 30.73) /2 X 0.30 X 3X 19

= 473.32 KN

SELF LOAD
.Roof Load = (24.63 + 30.73) /2 X 6
= 166.08 KN
.Floor Load = (24.63 + 30.73) /2 X 6
= 166.08 KN
BEAM LOAD
.Roof Load = (24.63 + 30.73) /2 X 0.30 X 0.45 X 25
= 93.43 KN
.Floor Load = (24.63 + 30.73) /2 X 0.30 X 0.45 X 25
= 93.43 KN
Total Roof Load = 55.03 + 166.08 + 93.43 = 314.54 kn/m
Total Floor Load = 473.32 + 166.08 + 93.43 = 732.83 kn/m
Total Load on column = 10.125 + 314.54 + 732.83 = 1057.49 kn/m

Column Axial load:
Pu= 1057.49kn/m
Cross section = 300 X 450 mm
Pu/fck.b.d= $1057.49x10^3$/ 20x300x450
= 0.39
Calculation of Eccentricity:
e = 1/500 + b/30
e = 4640/500 + 300/30
e = 19.28
e $\leq$ 20mm
Mue =Pu*e
= 1057.49 x 0.020
= 21.14kn-m
$\frac{\text{Mue}}{\text{fck.b.d}^2} = \frac{21.14\text{x}10^6}{20\text{x}300\text{x}450^2}$
= 0.01
= 21.14kn-m
d'/D = 0.2
P/fck = 0.02
P = 0.02x20
P = 0.4% minimum 0.8
AREA OF STEEL
$\frac{0.8\text{Bd}}{100} = \frac{0.8\text{x}300\text{x}450}{100}$
= 1080 mm
No. of bars for 12mm dia
$= \frac{1080}{\frac{\pi}{4}\text{x}12^2}$
= 10 bars

STIRRUPS SPACING

16dia of main reinforcement=16x12 =192 mm.
48dia = 48x12 = 576 mm.
Provide 6 mm dia. @ 192 mm c/c when main bars size is 12 mm

DESIGN OF FOOTING
1. Size of column = 300x450 mm
2. Load = 1500 KN
3.Self-wt. of footing = 10%
4. Bearing Capacity of soil = 250 Kn/m^2
5. Total Load = 1650 KN
6. Area of footing = 1650/250 = 6.6 m^2
The side of the footing be in the same ratio of column
= 0.30x*0.45x = 6.6

= $0.135x^2$ = 6.6

x = 6.99 m

Short side of footing

= 0.30x6.6

= 1.98m

Long side of footing

= 0.45x6.6

= 2.97m

Proved a rectangle footing is 1.98m X 2.97m

Up ward soil pressure

$= \frac{1650}{1.98x2.97}$

= 280.58 kn/m^2 = 280 kn/m^2

BENDING MOMENT CALCULATION

Maximum bending moment along y- direction longer direction

Mxx $= \frac{wl}{8}(B-b)^2$

$= \frac{280x2.97}{8}(1.98-0.30)^2$

= 36.67 KN-m

Maximum bending moment along x- direction shorter direction

Myy $= \frac{wl}{8}(B-b)^2$

$= \frac{280x1.98}{8}(2.97-0.45)^2$

= 123.78 KN-m

DEPTH OF FOOTING

Depth of footing

Myy =Md

mu_{lim} = $0.138fckbd^2$

123.78 = $0.138x20x2.97d^2$

d = 3.88 m = 388.59mm

d = 388.59mm = 600mm

dx' =dy'

540mm = 532mm

Reinforcement in longitudinal direction

Ast $= \frac{123.78x10^6}{0.87x450x532}$

= 594.30 mm

Specing

$= \frac{\text{Area of one bar}}{\text{Ast}}x1000$

$= \frac{\pi/4x12^2}{594.30}x1000$

= 190.30 mm = 150mm

Provide 12mm bars at 150 mm c/c

Reinforcement in shorter direction

Ast $= \frac{36.67x10^6}{0.87x300x532}$

= 264.09 mm = 260 mm

Specing

$= \frac{\text{Area of one bar}}{\text{Ast}}x1000$

$= \frac{\pi/4x12^2}{260}x1000$

= 434.98 mm = 200mm
Provide 12mm bars at 200 mm c/c

Two way shear
dy = 532 mm
Perimeter of critical plan
= $300+\frac{532}{2}+\frac{532}{2}+\left\{450+\frac{532}{2}+\frac{532}{2}\right\}x2$
= 2796 mm
Area of shaded portion
= 2.97+1.98-(0.30+0.53)x(0.45+0.53)
= 4.13 m^2

Ks
Ks = 0.5+β = <1
$\beta = \frac{Lx}{Ly} = \frac{300}{450}$
β= 0.66 = 1
τc
$\tau c = 0.25\sqrt{fck}$
$\tau c = 0.25\sqrt{20}$
τc = 1.11 N/mm^2
Shear force resisted by concrete
= τc x area of critical plan
= 1.11 x 300 x 532
= 177156 N
= 1771.56 KN (Vue)

Shear force causing two way shear failure
= w x area of Shaded portion
= 280 x 4.95
= 1386 KN (Vud)
= Vue>Vud

One way shear for y direction
critical plan = 2.97 m
Area of shaded plan
= 2.97 $\bar{x}$
= $2.97x\frac{1.98-0.30}{2}-0.53$
τc = 0.89 N/mm^2

Shear force resisted by concrete
= τc x area of critical plan
= 0.89 x 2.97x 0.532 x1000
= 1406.23 KN (Vue)
Shear force causing one way shear failure
= w x area of Shaded portion
= 280 x 2.97x0.0205
= 16.63 KN (Vud)
= Vue>Vud
One way shear for x direction
critical plan = 1.98 m
Area of shaded plan
= 1.98 $\bar{x}$
= $1.98x\frac{2.97-0.45}{2}-0.53$
τc = 1.44 N/mm^2

Shear force resisted by concrete x- direction

= τc x area of critical plan
= 1.44 x 1.98 x 0.532 x1000
= 1516.83 KN (Vue)
Shear force causing one way shear failure x- direction
= w x area of Shaded portion
= 280 x 1.98x0.0205
= 11.088 KN (Vud)
= Vue>Vud
Development length

$$Ld = \frac{0.87 fy\varphi}{4\sigma bd}$$

$$= \frac{0.87x415x12}{4x5.88}$$

Ld = 184.20mm
$Ld<L_{actual}$
Check for load transfer

$$= \sqrt{\frac{A1}{A2}}$$ note gather then 2

Actual bearing stress = $\frac{P}{bd}$
Actual bearing stress = $\frac{1650x10^6}{300x450}$
Actual bearing stress = 12.22 N/mm^2
Permissible bearing stress

$$= 0.45fck \sqrt{\frac{A1}{A2}}$$ note smaller then 2

A1 =LxB or $[b + 4D][d + 4D]$
A1 = 2970x1980
A1 = 5880600 mm^2 = 5880.6m^2
A2 = 300x450
A2 = 135000 mm^2 = 135m^2

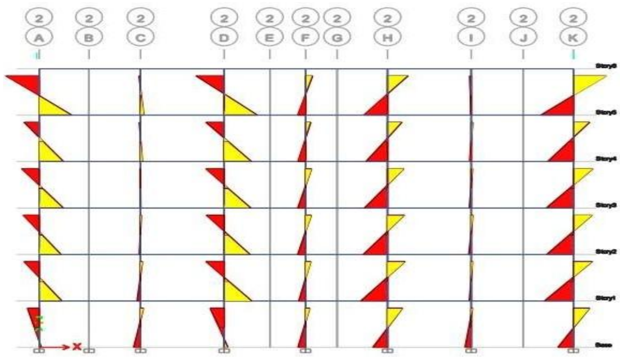
$$= 0.45x20 \sqrt{\frac{5880.6}{135}}$$

= 59.4 N/mm^2
Actual < Permissible hence safe

IV. RESULT

Maximum Bending Moment

The below fig 5 and fig 6 tells about the maximum bending moment in 3-3 direction and shear force applied in 2-2 direction after analyzing the model.



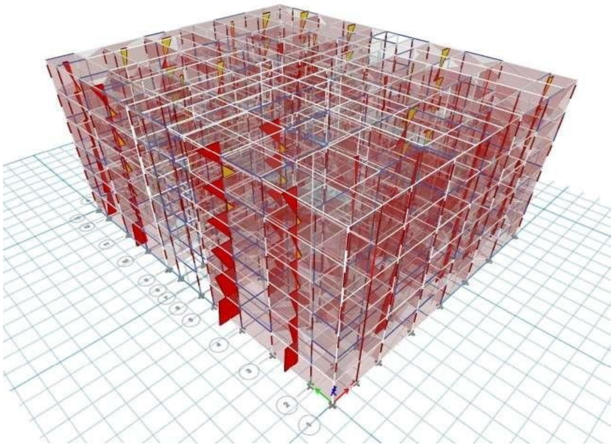


Fig 6.1.1. Maximum Bending Moment 2d & 3d

Shear Force

The below fig 5 and fig 6 tells about the shear force in 2-2 direction andmaximumbendingmomentappliedin3-3directionafteranalyzingthemodel.

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