COMPARATIVE ANALYSIS AND DESIGN OF PUBLIC BUILDING USING MANUAL METHOD AND STAAD. PRO SOFTWARE

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ABSTRACT: Analysis and design of a any building needs basic knowledge of structural analysis, so in this project considering basic idealization how the structure is to analyze and design is to be carry out is covered by considering some ongoing projects. In the project tried to cover all the necessary analysis data consideration for different loads and load combination is considered manually and results are compared with software readings by considering same and design data loads and load combination. In detailed detailing is also tried to cover as per the IS code provisions.

1. INTRODUCTION

1.1 ABOUT THE PROJECTS

We started our project through inspection of drawings of function hall building which is proposed to locate at K.R.Nagar. The project work deals with the structural analysis and design of a proposed multipurpose hall located at K.R.Nagar, Having C+G+1 floors. Architectural plans were provided. With the given plan, beam column layout was plotted, with the help of which slabs were identified as one way, two way.Loads were worked out using IS:875-1987. Here the analysis of the structure is carried out using the software STAAD.Pro V8i. 3D Model were considered and are analyzed for Dead loads and Live loads. The design is carried out as according to IS: 456:2000. Design aids of SP 16 are considered for the design of section. After the completion of function hall building we did many more buildings which include Residential building consists of C+G+2 floors and a Hospital building having G+3 floors.

1.3 ABOUT THE SOFTWARES

STAAD.Pro:

STAAD.Pro is one of the leading analysis and design software used in the industry. It stands for Structural Analysis and Design Program.

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STAAD.Pro is designed for engineers by engineers who understand the process of modeling, analysis and designing a structure. It is a general purpose program for performing the analysis and design of a wide variety of structures.

The basic three activities which are to be carried out to achieve the goals are:

- Model Generation
- Calculation to obtain the analytical results.
- Result verification (Post processing).

SALIENT FEATURES:

- Following are the salient features of STAAD.Pro
- STAAD.Pro is the only structural analysis and design software which meets the rigid requirements of NUPIC/NCR (Nuclear Regulatory Commission).
- STAAD.Pro has the building codes of the countries including India, US of A, Britain, among others. More are constantly being added.
- STAAD.Pro easily generates comprehensive custom reports and it can be exported to Microsoft word or Microsoft excel.
- STAAD.Pro Structure wizard contains a library of trusses and frames using which models can be generated quickly.

2. PROJECTS UNDERTAKEN

2.1 FUNCTION HALL LOCATED AT K .R. NAGAR.

2.1.1 TECHNICAL DATA:

- Structure type : Framed structure
- No of storey : Cellar plus Ground plus one
- Height of cellar floor : 3m
- Height of ground floor : 3.4m
- Height of first floor : 3m
- SBC of soil : 200KN/m^2
- Grade of concrete f_{ck} : 20N/mm^2
- Grade of steel f_y : 415N/mm^2

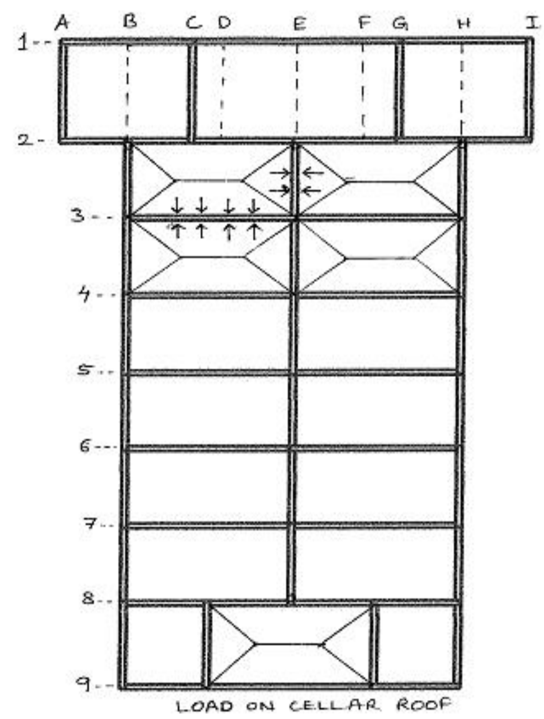

Fig 1: Cellar plan

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2.1.2 CALCULATION OF LOADS

Load calculations for Rooms in Cellar:

Assume 150 mm thick slab

Dead load of slab=0.15x25 =3.75 kN/m^2

Live load =2 kN/m^2

Floor finish and partition =2 kN/m^2

Total =7.75≈8 kN/m^2

Load on beam AC and GI:

Assume beam size 230mmx450mm

Self weight of beam = 0.23x0.45x25=2.587 kN/m

Load from slab=$\frac{w\,l_x}{6}\left[3-\left(\frac{l_x}{l_y}\right)^2\right]$=$\frac{8X4.80}{6}\left[3-\left(\frac{4.8}{4.93}\right)^2\right]$=13.13 kN/m

Weight of wall = 0.225x2.8x20 =12.6 kN/m

Total=28.3≈30 kN/m

Load on beam 1-2 along A and I:

Assume beam size 230mmx380mm

Self weight of beam=0.23x0.38x25=2.185 kN/m

Load from slab=$\frac{w\,l_x}{3}$=$\frac{8X4.80}{3}$ =12.8 kN/m

weight of wall = 12.6 kN/m Total=27.58≈30 kN/m

Load calculation for Hall and kitchen:

Assume 150 mm thick slab

Dead load of slab=0.15x25 =3.75 kN/m^2

Liveload = 4 kN/m^2

Floor finish and partition =2 kN/m^2

Total=9.75≈10 kN/m^2

Load on beam CG along 1:

Assume beam size 230mmx550mm

Self weight of beam=0.23x0.55x25=3.16

Load from slab=$\frac{10X4.80}{6}\left[3-\left(\frac{4.8}{7.24}\right)^2\right]$=20.48

Weight of wall=0.225x2.8x20 =12.6

Load calculation for Hall and kitchen:

Total=36.24≈37

Load on beam 1-2 along C and G:

Self weight of beam=0.23x0.38x25=2.185 kN/m

Load from slab=$\frac{8X4.80}{3}+\frac{10X4.80}{3}$=28.8 kN/m

Weight of wall=0.225x2.8x20 =12.6 kN/m

Total=43.5≈44 kN/m

Load on beam CG along 2:

Self weight of beam=0.23x0.55x25=3.16 kN/m

Load from slab =

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$\frac{10X4.80}{6}\left[3-\left(\frac{4.8}{7.24}\right)^2\right]+\frac{10X3.76}{6}\left[3-\left(\frac{3.76}{6.22}\right)^2\right]$ =37 kN/m

Total=41 kN/m

Load on beam AC & GI along 2:

Self weight of beam = 0.23x0.45x25=2.587 kN/m

Load from slab=13.13+16.5=29.63 kN/m

Weight of wall=0.225x2.8x20 =12.6 kN/m Total=45 kN/m

Load on beam BE & EH along 3 to7:

Assume beam size=300mmx750mm

Load from slab=$\frac{10X3.66}{6}\left[3-\left(\frac{3.66}{6.22}\right)^2\right]X2$=32.37 kN/m

Self weight of beam=0.3x0.75x25 =5.625 kN/m Total=38 kN/m

Load on beam 3-4 along B & H:

Self weight of beam=0.23x0.38x25=2.185 kN/m

Load from slab=$\frac{10X3.66}{3}$=12.2 kN/m

Weight of wall=0.225x3.4x20 =15.3 kN/m

Total=29.6≈30 kN/m

Load on beam 3-4 along E:

Self weight of beam=0.23x0.38x25=2.185 kN/m

Load from slab=$\frac{10X3.66}{3}$x2=24.4 kN/m

Total=26.5≈27 kN/m

Load on beam CG along 8:

Self weight of beam=0.23x0.55x25=3.16 kN/m

Load from slab= $\frac{10X3.66}{6}\left[3-\left(\frac{3.66}{6.22}\right)^2\right]+\frac{10X4.02}{6}\left[3-\left(\frac{4.025}{6.375}\right)^2\right]$ = 33.63 kN/m Total =36.7≈37 kN/m

Load on beam 8-9 along C&G:

Self weight of beam=0.23x0.38x25 =2.185 kN/m

Load from slab =$\frac{10X4.025}{3}$ =13.416 kN/m

Weight of wall=0.225x3.4x20 =15.3 kN/m

Total=30 kN/m

Load on beam 8-9 along B&H:

Self weight of beam=0.23x0.38x25 =2.185 kN/m

Weight of wall=0.225x3.4x20 =15.3 kN/m

Total=17.48≈18 kN/m

Load calculation for stair case:

Assume Tread=260mm, Rise=150mm

Self weight of flight slab along the slope for 1m^2=0.15x25=3.75 kN/m^2

Slab for 1m horizontal span=1x1x0.15x25$\sqrt{\frac{0.15^2+0.26^2}{0.26^2}}$=4.33 kN/m^2

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Weight of one step for 1m width=0.5x1x0.26x0.15x25=0.4875

No. of steps in a horizontal span=$\frac{1}{T}$ =(1/0.26)=3.846

Self weight of step for one horizontal span=wt. of one step x no. of steps in 1m horizontal span =0.4875x3.846 =1.875 kN/m^2

Therefore total weight = weight of slab=4.329 =weight of step=1.875

=live load =5 Floor finish and partiti =2 kN/m^2 Total=13.2≈15 kN/m^2

Load on beam=15x(4.125/2)=31 kN/m

Load on beam BC&GH along 8:

Self weight of beam = 0.23x0.45x25=2.587 kN/m

Load from slab and stair case=16.18+31=47.18 kN/m Total=50 kN/m

Load on beam CG along 9:

Self weight of beam=0.23x0.55x25=3.16 kN/m Load from slab = 17.45 kN/m

Weight of wall=0.225x3.4x20 =15.3 kN/m

=35.9≈36 kN/m

Load on beam BC & GH along 9:

Self weight of beam = 0.23x0.45x25=2.587 kN/m Load from stair case=31 kN/m

Weight of wall=0.225x3.4x20 =15.3 kN/m

=48.8≈50 kN/m

Load calculations for Rooms in ground floor:

Assume 150 mm thick slab

Dead load of slab=0.15x25 =3.75 kN/m^2 Live load =2 kN/m^2

Floor finish and partition =2 kN/m^2

Total =7.75≈8 kN/m^2

Load on beam AC & GI along 1:

Assume beam size 230x450 mm

Self weight of beam = 0.23x0.45x25=2.587 kN/m

Load from slab=$\frac{8X4.8}{6}\left[3-\left(\frac{4.8}{4.93}\right)^2\right]$=13.13 kN/m

Weight of wall=0.225x2.9x20 =13.05 kN/m

Total=28.7≈30 kN/m

Load on beam 1-2 along A & I:

Assume beam size 230x380 mm

Self weight of beam=0.23x0.38x25 =2.185 kN/m Load from slab =$\frac{8X4.8}{3}$ =12.8 kN/m

Weight of wall=0.225x2.9x20 =13.05 kN/m

Total=28.03≈30 kN/m

Load on beam CG along 1:

Self weight of beam=0.23x0.55x25=3.16 kN/m Weight of wall=0.225x2.9x20 =13.05 kN/m Total=16.2≈17 kN/m

Load on beam 1-2 along C and G:

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Self weight of beam=0.23x0.38x25 =2.185 kN/m Load from slab $=\frac{8X4.8}{3}$ =12.8 kN/m

Weight of wall=0.225x2.9x20 =13.05 kN/m

Total=28.3≈30 kN/m

Load calculations for Balcony:

Assume 150 mm thick slab

Dead load of slab=0.15x25 =3.75 kN/m^2

Live load=3 kN/m^2 Floor finish and partition =2 kN/m^2 Total =8.75≈9 kN/m^2

Load on beam BC & GH along 3 to7:

Self weight of beam = 0.23x0.45x25=2.587 kN/m Load from slab =9x3.6=32.4 kN/m

Total=34.9≈35 kN/m

Load on beam AC & GI along 2:

Self weight of beam = 0.23x0.45x25=2.587 kN/m Load from slab =13.13+(9x1.8)=29.33 kN/m Weight of wall=0.225x2.9x20 =13.05 kN/m Total=45 kN/m

Load on beam 3-4 along B & H:

Self weight of beam=0.23x0.38x25 =2.185 kN/m Weight of wall=0.225x2.9x20 =13.05 kN/m Total=15.24≈16 kN/m

Load on beam BC & GH along 8:

Self weight of beam = 0.23x0.45x25=2.587 kN/m Load from slab =9x1.8=16.2 kN/m

Load from stair case = 31 kN/m =49.7≈50 kN/m

Load on beam CG along 8:

Self weight of beam=0.23x0.55x25=3.16 kN/m

Load from slab =9x1.5+9x0.9=21.6 kN/m

Total=24.7≈25 kN/m

Load on beam 8-9 along B & H:

Self weight of beam=0.23x0.38x25 =2.185 kN/m

Weight of wall=0.225x2.9x20 =13.05 kN/m

Total=15.24≈16 kN/m

Load on beam 8-9 along C & G:

Self weight of beam=0.23x0.38x25 =2.185 kN/m

Weight of slab =9x0.9x1=8.1 kN/m

Weight of wall=0.225x2.9x20 =13.05 kN/m

Total=23.3≈25 kN/m

Load on beam BC & GH along 9:

Self weight of beam = 0.23x0.45x25=2.587 kN/m Load from stair case =31 kN/m

Weight of wall=0.225x2.9x20 =13.05 kN/m

Total=46.6≈47 kN/m

Load calculation for porch:

Assume 150 mm thick slab

Dead load of slab=0.15x25 =3.75 kN/m^2

Live load =2 kN/m^2 Floor finish and partition =2 kN/m^2 Total =7.75≈8 kN/m^2

Load on beam CG along 9:

Self weight of beam=0.23x0.55x25=3.16 kN/m Load from slab=(9x0.9x1)+$\left\{\frac{8X4.5}{6}\left[3-\left(\frac{4.5}{6.15}\right)^2\right]\right\}$=22.88 kN/m Weight of wall=0.225x2.9x20 =13.05 kN/m Total=39≈40 kN/m

Load on beam 9-10 along C & G:

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Self weight of beam=0.23x0.38x25 =2.185 kN/m Load from slab= $\frac{8X4.5}{3}$ = 12 kN/m

Total= 14.18≈15 kN/m

Load on beam CG along 10:

Self weight of beam=0.23x0.55x25=3.16 kN/m

Load from slab= $\frac{8X4.5}{6}\left[3-\left(\frac{4.5}{6.15}\right)^2\right]$ = 14.78 kN/m Total=17.9≈18 kN/m

Load calculation for top roof :

Assume 140 mm thick slab

Dead load of slab = 0.14x 25x1x1=3.5 KN/m^2 Live load =2 kN/m^2

Floor finish and partition =2 kN/m^2

Total=7.5≈8 kN/m^2

Load on beam AC & GI Along 1 :

Assume beam size 230x450 mm

Self weight of beam = 1x0.23x0.45x25= 2.587 kN/m Load from slab = $\frac{8X4.80}{6}\left[3-\left(\frac{4.8}{4.93}\right)^2\right]$=13.13 kN/m

wt of parapet wall = 8 kN/m Total =23.7≈25 kN/m

Load on beam 1-2 along A&I:

Assume beam size 230x380 mm

Self wt of beam = 0.23x0. 38X25=2.185 kN/m Load from slab = $\frac{8X4.80}{3}$ = 12.8 kN/m

wt of parapet wall = 8 kN/m Total =22.9≈25 kN/m

Load on beam CG along 1:

Self wt of beam = 0.23x0.55x25 = 3.1625 kN/m

Load from slab = $\frac{8X4.80}{6}\left[3-\left(\frac{4.8}{7.24}\right)^2\right]$=16.38 kN/m wt of parapet wall = 8 kN/m

Total=27.54≈30 kN/m

Load on beam 1-2 along C & G:

Self wt of beam = 0.23x0.38x25=2.185 kN/m

Load from slab =2[(8X4.8)/3]=25.6 kN/m

Total = 27.78 ≈ 30 kN/m

Load on beam CG Along 2:

Self wt of beam = 0.23x0.55x25=3.1625 kN/m Load from slab = $\frac{8X4.80}{6}\left[3-\left(\frac{4.8}{7.24}\right)^2\right]$+(8x1.8x1) =30.78 kN/m Total=33.9≈ 34 kN/m

Load on beam AC & GI Along 2:

Self wt of beam = 0.23x0.45x25=2.587 kN/m

Load from slab =(13.13+14.4)=27.53 kN/m

Total=30 kN/m **Load on beam BH Along 3 to 7:** Self wt of beam = 0.3x0.75x25 = 5.625 kN/m Load from slab = 1x1.8=14.4 kN/m

Total = 20 kN/m

Load on beam 3-4 Along B and H:

Self wt of beam = 0.23x0.38x25=2.185 kN/m Load from parapet wall = 8 kN/m

Total = 15 kN/m

Load on beam BC & GH Along 8:

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Self wt of beam = 0.23x0.45x25 = 2.587 kN/m Load from slab = 14.4 kN/m

Stair case= 31 kN/m Total=47.9 ≈ 50 kN/m

Load on beam CG along 8:

Self wt of beam = 0.23x0.55x25=3.1625 kN/m Load from lab=14.4+$\frac{8X4.025}{6}\left[3-\left(\frac{4.025}{6.15}\right)^{2}\right]$= 28.20 kN/m Total=31.36≈32 kN/m

Load on beam 8-9 Along C and G:

Self weight of beam=0.23x0.38x25 =2.185 kN/m Load from slab =$\frac{8X4.025}{3}$ =10.73 kN/m

Total=12.9≈15 kN/m

Load on beam BC & GH Along 9:

Self wt of beam = 0.23x0.45x25 = 2.587 kN/mLoad from stair case =31 kN/m

Load from parapet wall = 8 kN/m

Total=41.5≈42 kN/m

Load on beam CG along 9:

Self wt of beam = 0.23x0.55x25=3.1625 kN/m Load from slab =13.8 kN/m

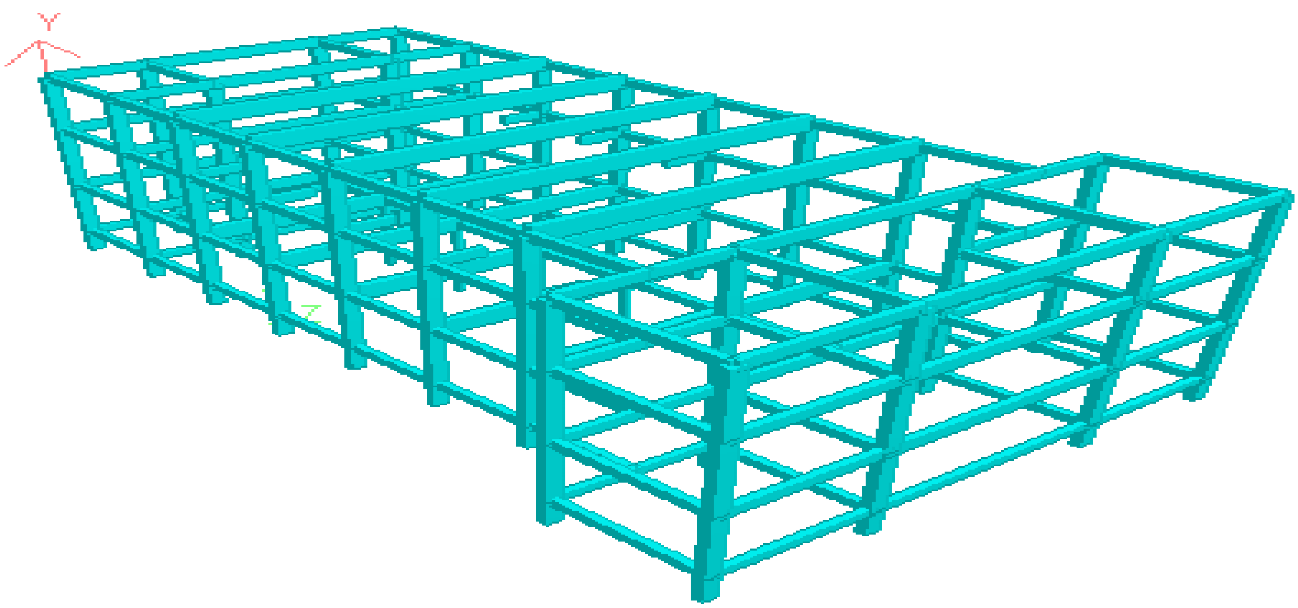

Fig-2: 3-D modelling

Load from parapet wall = 8 kN/m

Total=24.9≈ 30 kN/m

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2.1.3 Design of slab:

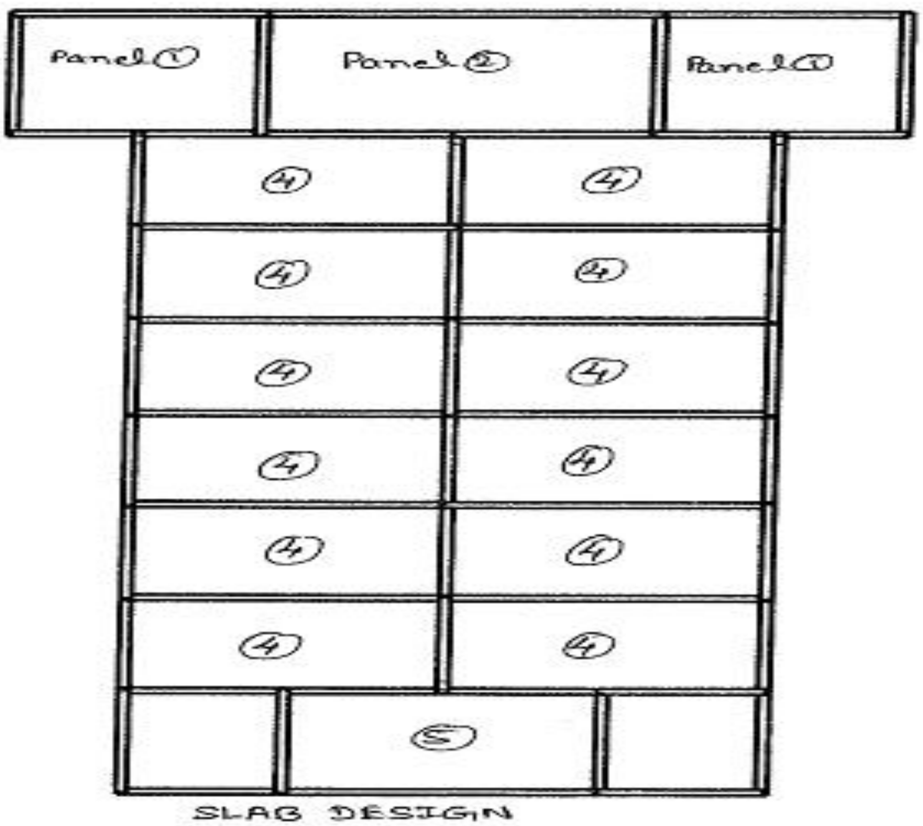

Fig-3: Slab design

2.1.4 Design of corner slab (panel number 1&3):

L_x=4.725m

L_y=4.825m

L_y/L_x=1.02<2

Therefore Design as Two way slab

Design ultimate load w_u=12kN/m^2

Ultimate design moments: From Table 26 of IS456 2000 case-8

L_y/L_X=1.02

Long Direction: Negative moment on continuous edge=0.057×12×4.725^2 =15.27KN-m

Positive moment on mid span=0.043×12×4.725^2 =11.52KN-m

Negative moment on discontinuous edge=11.52/2=5.76 KN-m

Short Direction: Positive moment on mid span=0.046×12×4.725^2=12.32KN-m

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Negative moment on discontinuous edge=6.16KN-m

Check for depth: $d=\sqrt{\frac{Mu}{0.138\, f_{ck}\, b}} = \sqrt{\frac{15.27\times10^6}{0.138\times20X1000}}$=75mm<150mm Hence OK

Reinforcement:

For short span: a) Positive moment on mid span=12.32KN-m

$\frac{M_u}{bd^2}=\frac{12.32\times10^6}{1000\times120^2}$=0.86

From SP 16,page number 48

p_t=0.249

$A_{st}=\frac{0.249\times1000\times120}{100}$=299mm^2

Provide 8mm dia at 170mm c/c

b) Negative moment on discontinuous edge=6.16 KN-m

$\frac{M_u}{bd^2}=\frac{6.16\times10^6}{1000\times120^2}$=0.43

From SP 16,page number 48

P_t=.120

$A_{st}=\frac{0.120\times1000\times120}{100}$=153mm^2

Provide 8mm dia at 300mm c/c

For long span: a) Negative moment on discontinuous edge=15.27 KN-m

$\frac{M_u}{bd^2}=\frac{15.27\times10^6}{1000\times120^2}$=1.06

From SP 16,page number 48

P_t=0.314

$A_{st}=\frac{0.134\times1000\times120}{100}$=376mm^2

Provide 8mm dia at 130mm c/c

b) Positive moment on mid span=11.52KN-m

$\frac{M_u}{bd^2}=\frac{11.52\times10^6}{1000\times120^2}$=0.8

From SP 16,page number 48

p_t=0.233

$A_{st}=\frac{0.233\times1000\times120}{100}$=261mm^2

Provide 8mm dia at 190mm c/c

c) Negative moment on discontinuous edge=5.76 KN-m

$\frac{M_u}{bd^2}=\frac{5.76\times10^6}{1000\times120^2}$=0.4

From SP 16,page number 48

P_t=0.114

$A_{st}=\frac{0.114\times1000\times120}{100}$=137mm^2

Provide 8mm dia at 300mm c/c

2.1.5 Design of Intermediate panel(panel number2):

L_x=4.725m

L_y=7.175m

L_y/L_x=1.52<2

Therefore Design as Two way slab

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Design ultimate load w_u=15kN/m^2

Ultimate design moments: From Table 26 of IS456 2000 case3L_y/L_X=1.02

Short Direction: Negative moment on continuous edge=0.069×15×4.725^2 =23.11KN-m

Positive moment on mid span=0.053×15×4.725^2=17.72KN-m

Negative moment on discontinuous edge=17.72/2=8.87 KN-m

Long Direction: Positive moment on mid span=0.028×15×4.725^2 =9.372KN-m

Negative moment on continuous edge=0.037×15×4.725^2
=12.39 KN-m

Negative moment on discontinuous edge=4.76KN-m

Reinforcement:

For short span:

a) Positive moment on mid span=17.72KN-m

$\frac{M_u}{bd^2}=\frac{17.72\times10^6}{1000\times120^2}$=1.23

From SP 16,page number 48

p_t=0.34

$A_{st}=\frac{0.34\times1000\times120}{100}$=408mm^2

Provide 8mm dia at 120mm c/c

b) Negative moment on discontinuous edge=8.87 KN-m

$\frac{M_u}{bd^2}=\frac{6.16\times10^6}{1000\times120^2}$=0.395

From SP 16,page number 48

P_t=.115

$A_{st}=\frac{0.120\times1000\times120}{100}$=212mm^2

Provide 8mm dia at 240mm c/c

c) Negative moment on continuous edge=23.11KN-m

$\frac{M_u}{bd^2}=\frac{23.11\times10^6}{1000\times120^2}$=1.6

From SP 16,page number 48

p_t=0.4

$A_{st}=\frac{0.4\times1000\times120}{100}$=480mm^2

Provide 8mm dia at 100mm c/c

For long span:

a) Negative moment on continuous edge=12.39 KN-m

$\frac{M_u}{bd^2}=\frac{12.39\times10^6}{1000\times120^2}$=0.86

From SP 16,page number 48

P_t=0.249

$A_{st}=\frac{0.249\times1000\times120}{100}$=285mm^2

Provide 8mm dia at 170mm c/c

b) Positive moment on mid span=9.372KN-m

$\frac{M_u}{bd^2}=\frac{9.372\times10^6}{1000\times120^2}$=0.65

From SP 16,page number 48

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p_t=0.187

$A_{st}=\frac{0.233\times1000\times120}{100}$=218mm^2

Provide 8mm dia at 220mm c/c

c) Negative moment on discontinuous edge=4.7 KN-m

$\frac{M_u}{bd^2}=\frac{4.7\times10^6}{1000\times120^2}$=0.21

From SP 16,page number 48

P_t=0.085

$A_{st}=\frac{0.085\times1000\times120}{100}$=153mm^2

Provide 8mm dia at 300mm c/c

2.1.6 Design of panel number 4:

L_x=3.6m

L_y=6m

L_y/L_x=1.67 <2

Therefore Design as Two way slab

Design ultimate load w_u=15kN/m^2

Ultimate design moments:

From Table 26 of IS456 2000 case3

L_y/L_X=1.02

Short Direction:

Negative moment on continuous edge=0.061×15×3.6^2

=11.86KN-m

Positive moment on mid span=0.047×15×3.6^2=9.142KN-m

Negative moment on discontinuous edge=9.142/2=4.57 KN-m

Long Direction:

Positive moment on mid span=0.028×15×3.6^2=5.52KN-m

Negative moment on continuous edge=0.037×15×3.6^2=7.19 KN-m

Negative moment on discontinuous edge=2.73KN-m

Reinforcement:

For short span:

a) Positive moment on mid span=9.142KN-m

$\frac{M_u}{bd^2}=\frac{9.142\times10^6}{1000\times120^2}$=0.41

From SP 16,page number 48

p_t=0.116

$A_{st}=\frac{0.116\times1000\times120}{100}$=209mm^2

Provide 8mm dia at 230mm c/c

b) Negative moment on discontinuous edge=4.57 KN-m

$\frac{M_u}{bd^2}=\frac{4.57\times10^6}{1000\times120^2}$=0.203

From SP 16,page number 48

P_t=.085

$A_{st}=\frac{0.085\times1000\times120}{100}$=153mm^2

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Provide 8mm dia at300mm c/c

c) Negative moment on continuous edge=11.86KN-m

$\frac{M_u}{bd^2}=\frac{11.86\times10^6}{1000\times120^2}$=0.53

From SP 16,page number 48

p_t=0.147

$A_{st}=\frac{0.147\times1000\times120}{100}$=265mm^2

Provide 8mm dia at 180mm c/c

For long span:

a) Negative moment on continuous edge=7.19 KN-m

$\frac{M_u}{bd^2}=\frac{7.19\times10^6}{1000\times120^2}$=0.139

From SP 16,page number 48

P_t=0.090

$A_{st}=\frac{0.090\times1000\times120}{100}$=162mm^2

Provide 8mm dia at 300mm c/c

b) Positive moment on mid span=5.5KN-m

$\frac{M_u}{bd^2}=\frac{5.5\times10^6}{1000\times120^2}$=0.24

From SP 16,page number 48

p_t=0.085

$A_{st}=\frac{0.085\times1000\times120}{100}$=153mm^2

Provide 8mm dia at 300mm c/c

c) Negative moment on discontinuous edge=2.73 KN-m

$\frac{M_u}{bd^2}=\frac{2.73\times10^6}{1000\times120^2}$=0.121

From SP 16,page number 48

P_t=0.085

$A_{st}=\frac{0.085\times1000\times120}{100}$=153mm^2

Provide 8mm dia at 300mm c/c

2.1.7 Design of panel number 5:

L_x=3.9m

L_y=6.478m

L_y/L_x=1.66 <2

Therefore Design as Two way slab

Design ultimate load w_u=15kN/m^2

Ultimate design moments:

From Table 26 of IS456 2000 case7

L_y/L_X=1.02

Short Direction:

Negative moment on continuous edge=0.090×15×3.9^2=20.54KN-m

Positive moment on mid span=0.069×15×3.9^2=15.74KN-m

Negative moment on discontinuous edge=15.74/2 =7.87 KN-m

Long Direction:

Positive moment on mid span=0.043×15×3.6^2 =9.81KN-m

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Negative moment on discontinuous edge=4.91KN-m

Reinforcement:

For short span: a) Positive moment on mid span=15.74KN-m

$\frac{M_u}{bd^2}=\frac{15.74\times10^6}{1000\times120^2}$=1.093

From SP 16,page number 48

p_t=0..327

$A_{st}=\frac{0.327\times1000\times120}{100}$=393mm^2

Provide 8mm dia at 120mm c/c

b) Negative moment on discontinuous edge=7.9 KN-m

$\frac{M_u}{bd^2}=\frac{7.9\times10^6}{1000\times120^2}$=0.5465

From SP 16,page number 48

P_t=0.163

$A_{st}=\frac{0.163\times1000\times120}{100}$=240mm^2

Provide 8mm dia at200mm c/c

c) Negative moment on continuous edge=20.54KN-m

$\frac{M_u}{bd^2}=\frac{20.54\times10^6}{1000\times120^2}$=1.46

From SP 16,page number 48

p_t=0.448

$A_{st}=\frac{0.448\times1000\times120}{100}$=538mm^2

Provide 8mm dia at 100mm c/c

For long span:

a) Positive moment on mid span=9.81KN-m

$\frac{M_u}{bd^2}=\frac{9.81\times10^6}{1000\times120^2}$=0.68

From SP 16,page number 48

p_t=0.2

$A_{st}=\frac{0.085\times1000\times120}{100}$=240mm^2

Provide 8mm dia at 200mm c/c

b) Negative moment on discontinuous edge=4.91 KN-m

$\frac{M_u}{bd^2}=\frac{4.91\times10^6}{1000\times120^2}$=0.34

From SP 16,page number 48

P_t=0.2

$A_{st}=\frac{0.2\times1000\times120}{100}$=240mm^2

Provide 8mm dia at 200mm c/c

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2.2.DESIGN OF BEAMS

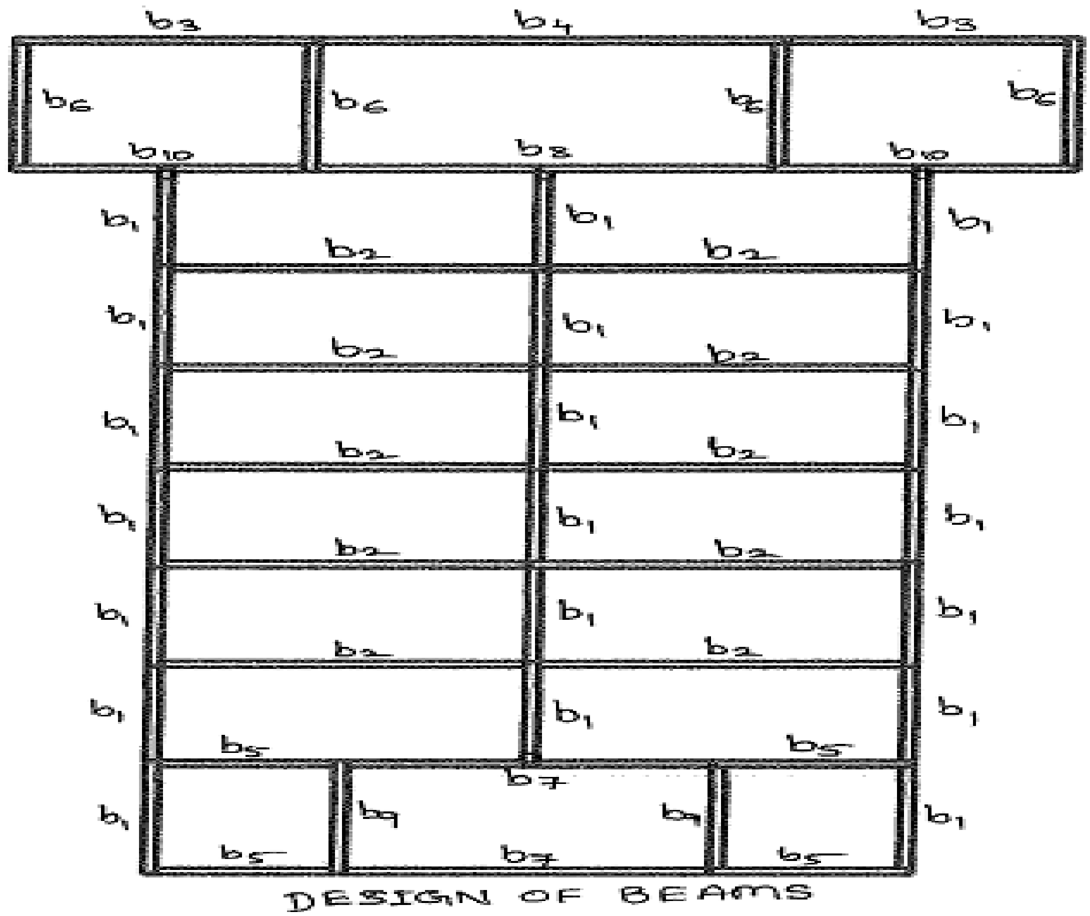

Fig-4: Design of beams

Design of beam b1:

a) Maximum positive B.M=1.5x25=38 kN-m
b) Maximum negative B.M=1.5x57=86 kN-m
c) Maximum S.F =70x1.5=105 kN

a) $\frac{M_u}{bd^2}=\frac{38\times10^6}{230\times330^2}$=1.52 From SP 16

P_t=0.475

$A_{st}=\frac{0.475x230x330}{100}$=360 mm^2

Therefore Provide ϕ 12 mm 4 no.s(452 mm^2)

b) $\frac{M_u}{bd^2}=\frac{86\times10^6}{230\times330^2}$=3.43 From SP 16

P_t=1.175 & P_c=0.24

$A_{st}=\frac{1.175x230x330}{100}$=892 mm^2

Provide ϕ 16 mm of 5 no.s

$A_{sc}=\frac{0.24x230x330}{100}$=183 mm^2

Provide ϕ12 mm of 2 no.s

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c) Max S.F

$\tau_V = \frac{V_u}{bd} = \frac{105X10^3}{230X330}$=1.38

τ_c=0.65 (From IS 456 Table 19)

$\frac{V_{us}}{d} = \frac{(1.38-0.65)230X330}{33X10^3}$=1.68

Provide ϕ8 mm 2 legged stirrups @ 200 mm c/c

Design of beam b2:

a) Maximum positive B.M=1.5x84=126 kN-m
b) Maximum negative B.M=1.5x138=207 kN-m
c) Maximum S.F =130x1.5=195 kN

a) $\frac{M_u}{bd^2}$=$\frac{126\times10^6}{300\times720^2}$=0.81 From SP 16

P_t=0.235

A_{st}=$\frac{0.235x300x720}{100}$=508 mm^2

Therefore Provide ϕ 16 mm 3 no.s(603 mm^2)

b) $\frac{M_u}{bd^2}$=$\frac{207\times10^6}{300\times720^2}$=1.33 From SP 16

Page 48, P_t=0.405

A_{st}=$\frac{0.405x300x720}{100}$=875 mm^2

Provide ϕ 20 mm of 3 no.s(942 mm^2)

c) Max S.F

$\tau_V = \frac{V_u}{bd} = \frac{195X10^3}{300X720}$=0.902

τ_c=0.45 (From IS 456 Table 19)

$\frac{V_{us}}{d} = \frac{(0.902-0.45)300X720}{72X10^3}$=1.36

Provide ϕ8 mm 2 legged stirrups @ 200 mm c/c

Design of beam b3:

a) Maximum positive B.M=1.5x27=40.5 kN-m
b) Maximum negative B.M=1.5x86=129 kN-m
c) Maximum S.F =82x1.5=123 kN

a) $\frac{M_u}{bd^2}$=$\frac{40.5\times10^6}{230\times420^2}$=0.998 From SP 16 P_t=0.295

A_{st}=$\frac{0.295x230x420}{100}$=285 mm^2

Therefore Provide ϕ 12 mm 3 no.s

b) $\frac{M_u}{bd^2}$=$\frac{129\times10^6}{230\times420^2}$=3.18 From SP 16

Page 48, P_t=1.091 & P_c=0.141

A_{st}=$\frac{1.091x230x420}{100}$=1054 mm^2

Provide ϕ 12 mm of 2 no.s

A_{sc} = $\frac{0.2x230x420}{100}$=194 mm^2

Provide ϕ 20 mm of 3 no.s(942 mm^2)

c) Max S.F

$\tau_V = \frac{V_u}{bd} = \frac{123X10^3}{230X420}$=1.27

τ_c=0.63 (From IS 456 Table 19)

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$\frac{V_{us}}{d} = \frac{(1.27-0.63)\,230X420}{42X\,10^3}$=1.48

Provide ϕ8 mm 2 legged stirrups @ 230 mm c/c

Design of beam b4:

a) Maximum positive B.M=1.5x106=159 kN-m
b) Maximum negative B.M=1.5x175=263 kN-m
c) Maximum S.F =146x1.5=219 kN

a) $\frac{M_u}{bd^2}=\frac{159\times10^6}{230\times500^2}$=2.76 From SP 16

P_t=0.958

$A_{st}=\frac{0.958x230x500}{100}$=1101 mm^2

Therefore Provide ϕ 20 mm 4 no.s

b) $\frac{M_u}{bd^2}=\frac{263\times10^6}{230\times500^2}$=4.57 From SP 16

Page 48, P_t=1.512 & P_c=0.585

$A_{st}=\frac{1.512x230x500}{100}$=1738.8$mm^2$

Provide ϕ 25 mm of 4 no.s

$A_{sc} = \frac{0.585x230x500}{100}$=673 mm^2

Provide ϕ 16 mm of 4 no.s

c) Max S.F

$\tau_V = \frac{V_u}{bd} = \frac{219X\,10^3}{230X500}$=1.9

τ_c=0.78 (From IS 456 Table 19)

$\frac{V_{us}}{d} = \frac{(1.9-0.78)\,230X500}{50X\,10^3}$=2.58

Provide ϕ8 mm 2 legged stirrups @ 140 mm c/c

Design of beam b5:

a) Maximum positive B.M=1.5x19=29 kN-m
b) Maximum negative B.M=1.5x64=96 kN-m
c) Maximum S.F =90x1.5=135 kN

a) $\frac{M_u}{bd^2}=\frac{29\times10^6}{230\times420^2}$=0.71 From SP 16

P_t=0.205

$A_{st}=\frac{0.205x230x420}{100}$=200 mm^2

Therefore Provide ϕ 12 mm 2 no.s

b) $\frac{M_u}{bd^2}=\frac{96\times10^6}{230\times420^2}$=2.37 From SP 16

Page 48, P_t=0.786

$A_{st}=\frac{0.786x230x420}{100}$=760$mm^2$

Provide ϕ 16 mm of 4 no.s

c) Max S.F

$\tau_V = \frac{V_u}{bd} = \frac{135X\,10^3}{230X420}$=1.40

τ_c=0.59 (From IS 456 Table 19)

$\frac{V_{us}}{d} = \frac{(1.4-0.59)\,230X420}{42X\,10^3}$=1.88

Provide ϕ8 mm 2 legged stirrups @ 190 mm c/c

Design of beam b6:

a) Maximum positive B.M=1.5x66=99 kN-m
b) Maximum negative B.M=1.5x66=99 kN-m
c) Maximum S.F =107x1.5=161 kN

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a) $\frac{M_u}{bd^2}=\frac{99\times10^6}{230\times350^2}=3.51$ From SP 16

Page 48, $P_t=1.185$ & $P_c=0.239$

$A_{st}=\frac{1.85x230x350}{100}=953\ mm^2$ Provide

ϕ 16 mm of 5 no.s

$A_{sc} = \frac{0.239x230x350}{100}=193\ mm^2$

Provide ϕ 12 mm of 2 no.s

b) Max S.F

$\tau_V = \frac{V_u}{bd} = \frac{161X10^3}{230X350}=2$

$\tau_c=0.66$ (From IS 456 Table 19)

$\frac{V_{us}}{d} = \frac{(2-0.66)230X350}{35X10^3}=3.1$ Provide

ϕ8 mm 2 legged stirrups @ 110 mm c/c

2.3 Detailing:

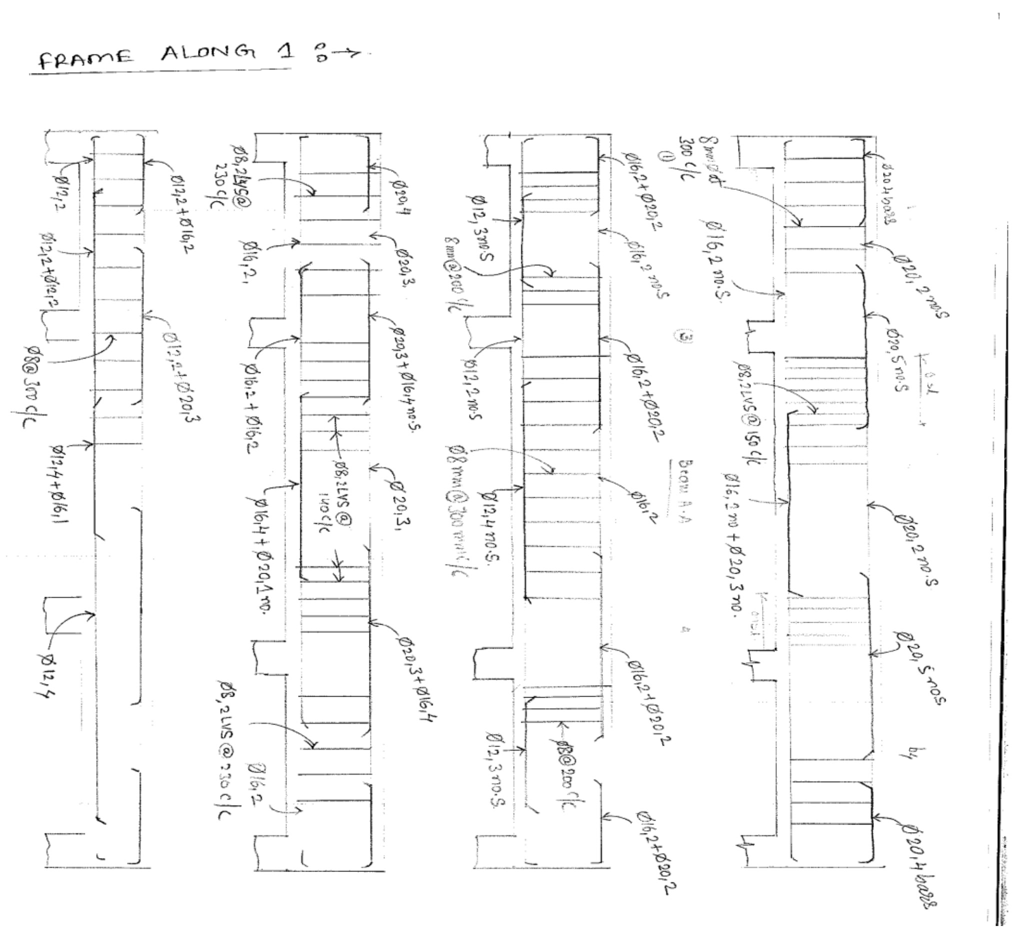

Fig-5: Detailing of frame along 1

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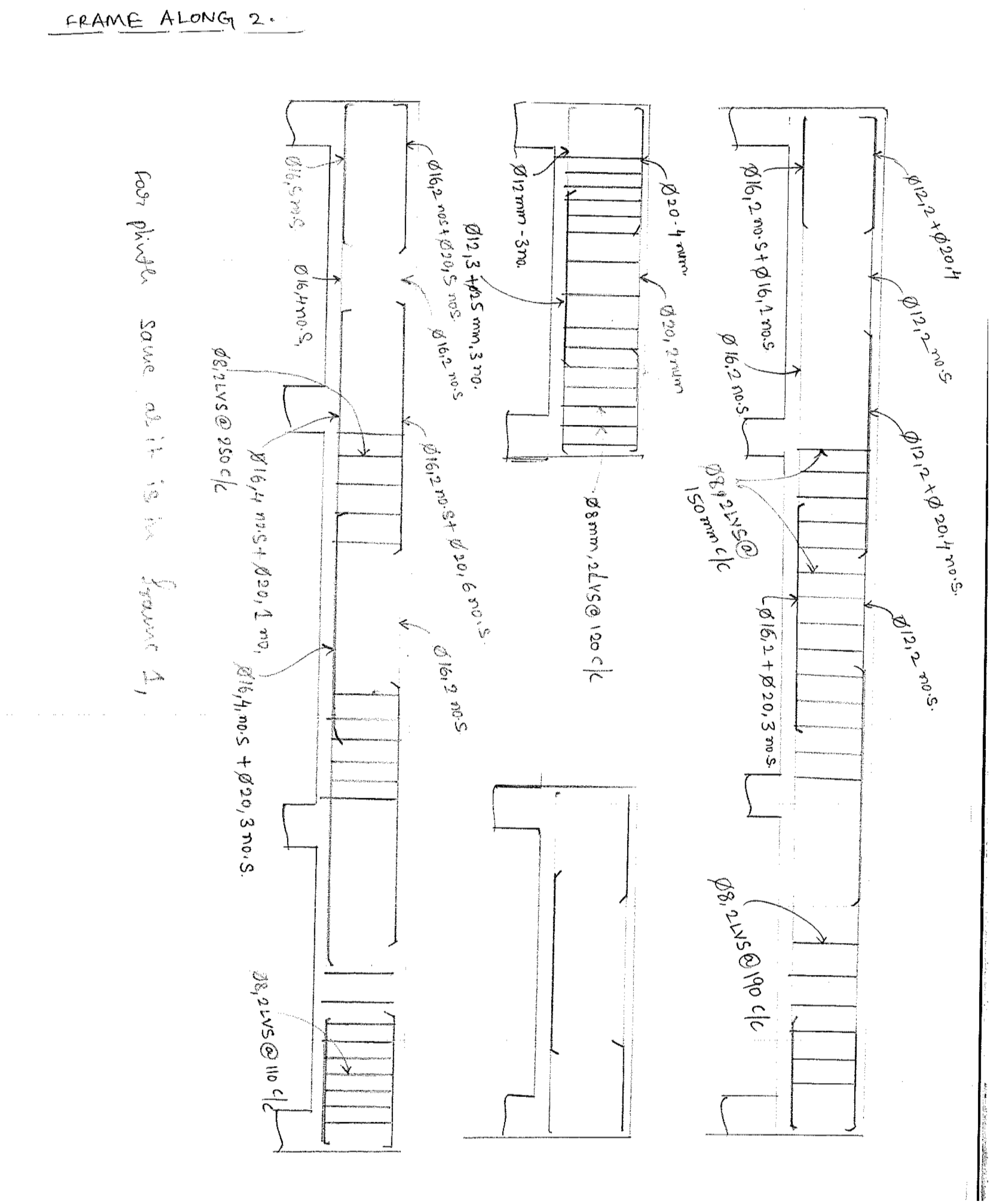

Fig-6: Detailing of frame along 2

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Frame Along 3

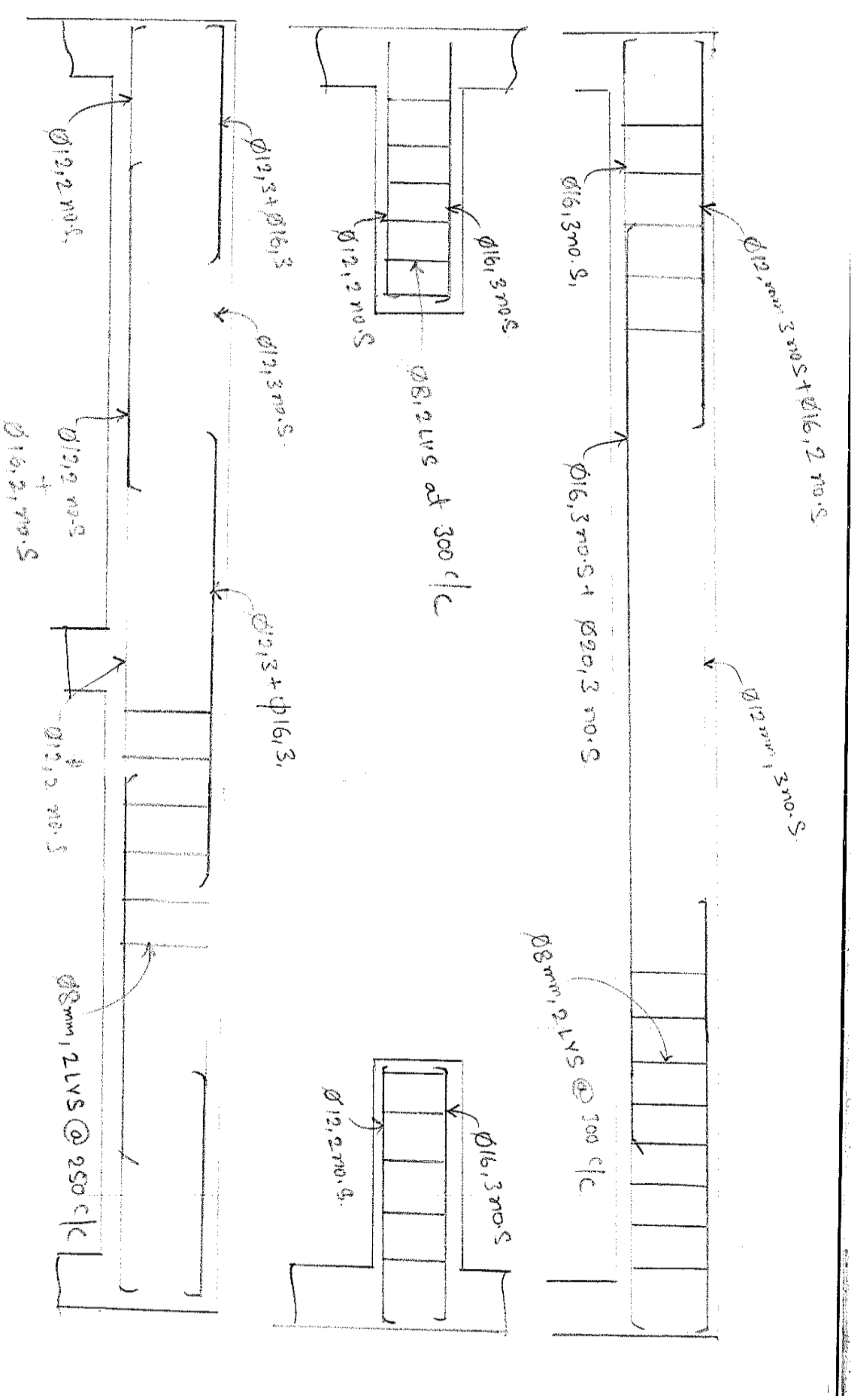

Fig-6: Detailing of frame along 2

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Frame Along 3

Fig-7: Detailing of frame along 2

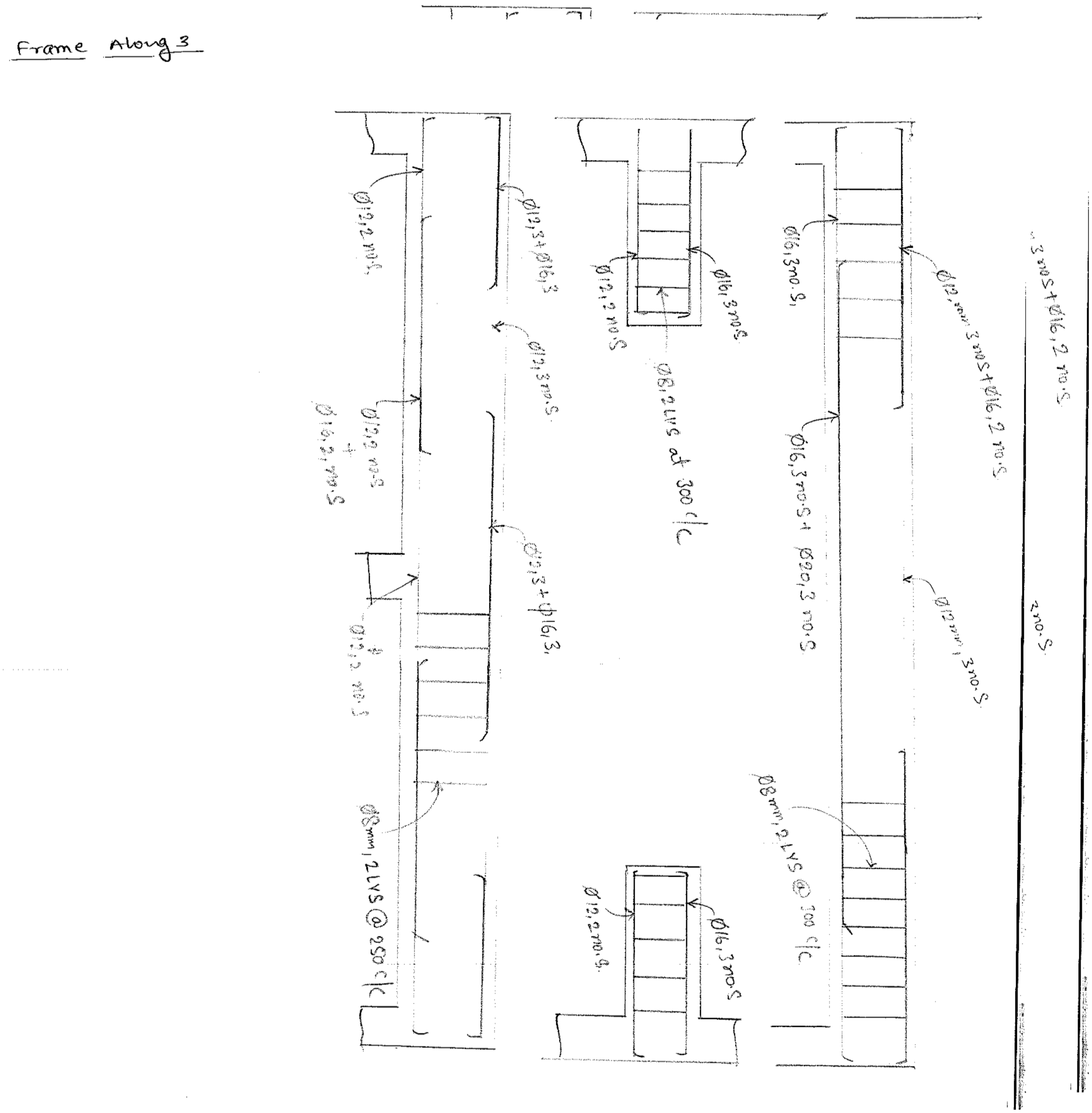

Fig-8: Detailing of frame along 3

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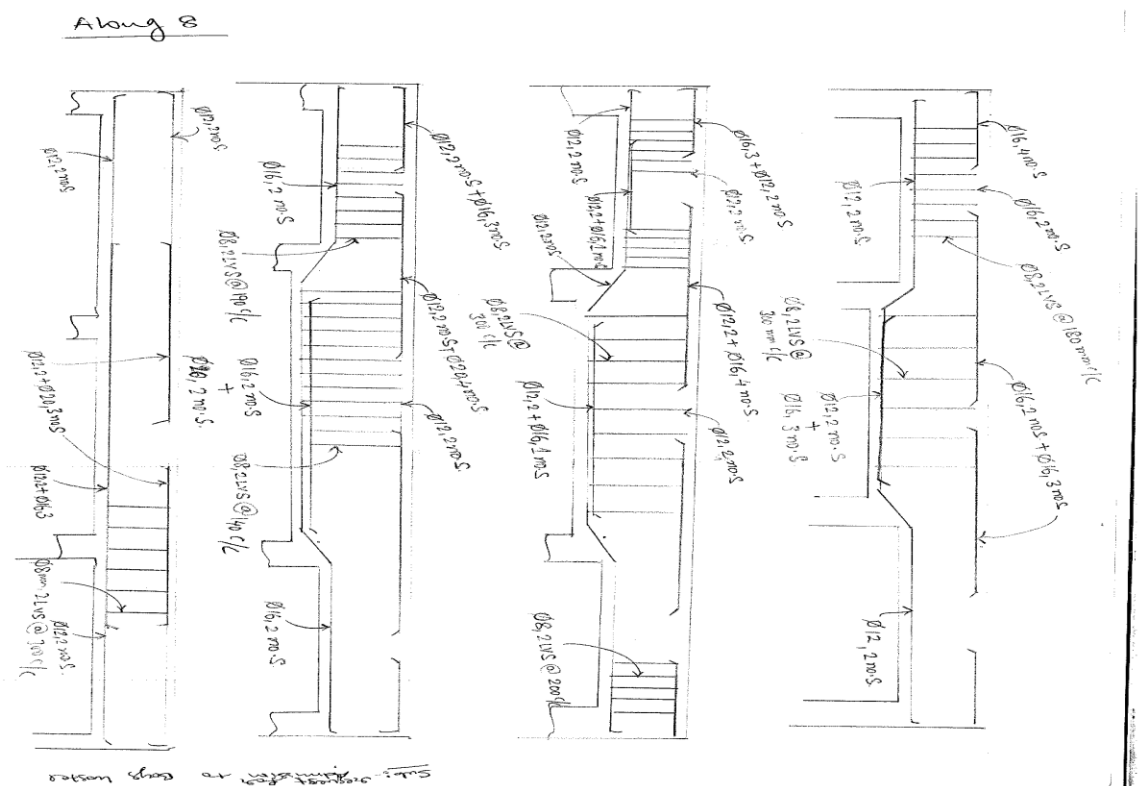

Fig-9: Detailing of frame along 8

2.4 Design of columns:

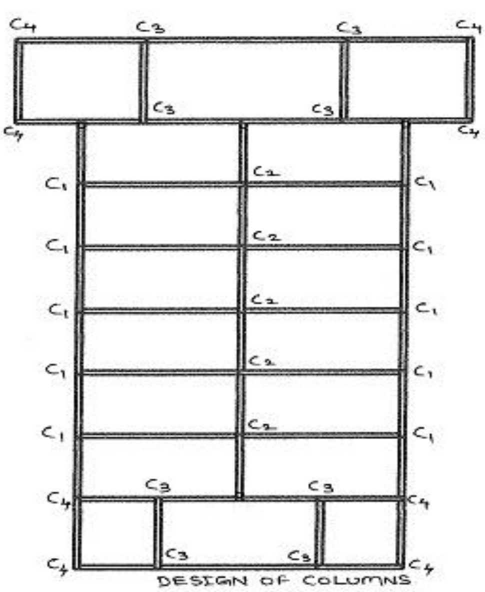

Fig-10:Design of columns

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DESIGN OF RECTANGULAR COLUMN WITH BIAXIAL BENDING (AS PER SP 16)

Length of the column (d), mm	=	450
Breadth of the column (b), mm	=	230
fck in N/mm^2	=	20
fy in N/mm^2	=	415
Factored Load (Pu), kN	=	1050
Mux in kN-m	=	9
Muy in kN-m	=	32
Trial steel percent, p%	=	1.8
p/fck	=	0.09
d'	=	40
d'/D	=	0.088888889
Pu/(fck*b*d)	=	0.507246377
Mux1/(fck*b*d^2)	=	0.09
Mux1, kN-m	=	83.835
d'/b	=	0.173913043
Muy1/(fck*d*b^2)	=	0.08
Muy1, kN-m	=	38.088

Calculation of Puz:

Puz/Ag	=	19
Puz, kN	=	1966.5

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Pu/Puz	=	0.533943555
Mux/Mux1	=	0.107353731
Muy/Muy1	=	0.84015963

Refering to chart, permissible value of Mux/Mux1, corresponding to Pu/Puz and Muy/Muy1

Mux/Mux1	=	0.6

No increase in steel percentage
Increase in steel percentage

Increase in steel percentage

Revised % of steel	=	3
p/fck	=	0.15
Pu/(fck*b*d)	=	0.507246377
Mux1/(fck*b*d^2)	=	0.05
Mux1, kN-m	=	46.575
Muy1/fck*d*b^2)	=	0.04
Muy1, kN-m	=	19.044
Puz/Ag	=	13
Puz, kN	=	1345.5
Pu/Puz	=	0.780379041
Mux/Mux1	=	0.193236715
Muy/Muy1	=	1.680319261

Refering to chart, permissible value of Mux/Mux1, corresponding to Pu/Puz and Muy/Muy1

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Mux/Mux1 = 0.6

Table-1: Column details for function hall

_Grid no	b (mm)	D (mm)	Pu,cr (KN)	Mu,cr (KN-m)	Pu/ fckbd	Mu/ $fckbd^2$	Pt %	Ast (mm^2)	Dia & number of main reinforcement	Dia & spacing of lateral ties
C1	300	450	1050	188	0.39	0.18	2.8	3780	**8 - #25**	**#8 @300c/c**
C2 circular		300	570	15			0.8	565	**6 - #16**	**#8 @200c/c**
C3	300	450	1782	82.5	0.64	0.12	3.2	4320	**6 - #25 6 - #20**	**#8 @300c/c**
C4	300	450	891	84	0.33	0.15	2.4	3573	**6 - #25 2 - #20**	**#8 @300c/c**

2.5 Design of Foundation:

Table-2 Details for foundation

Footing type	Pu,cr kN	Mu,cr (KN-m)	SBC of soil (KN/m^2)	L (m)	B (m)	D (m)	Reinforcement	
							Along length	Along breadth
F1	1053	15	200	2.5	2.5	500	**#12@130C/C**	**#12@130C/C**
F2	697	0	200	1.5	1.5	400	**#10@120C/C**	**#10@120C/C**
F3	1782	55	200	3.25	3.25	600	**#12@100C/C**	**#12@100C/C**

3. CONCLUSIONS

- Knowledge about visualization of structure is obtained.
- Design of slabs, beams, columns, footing is done manually.
- All the design requirements were checked for codal provisions.

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- An exposure to Staad Pro software are been obtained.
- Knowledge about preparation of structural design report is obtained.
- Practical knowledge regarding execution of various construction stages in the site.

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