# Developing an Individual Excel Sheet for Design and Analysis of Beam and Slab 

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#### Abstract

Analysis and design of RC structures using FEM based software package needs basic knowledge of that software. This project focuses on developing a excel sheet with simple user interface to analyze and design RC structures without any prior knowledge of software. This excel sheet considers only the gravity loads. Grids in $X$ and $Y$ directions are defined in the sheet. User can enter distance between grids. This sheet provides design of footing and column.


## I. INTRODUCTION

Analysis and design of multi-story structure is a tedious task. FEM based software are used to carry out the same. However, use of these software needs lot of experience and expertise. Lack of exposure and expertise in these software leads to inaccurate designs. To ease the design of structures, a excel sheet with simple user interface is developed which can be used by almost anyone for building design. The excel is designed to take minimum input and provide maximum output. Building structures are usually divided by grid systems depending on their column location, which denotes centre to centre distance. This excel sheet takes centre to centre distance as input. Load on the column is calculated using the tributary area defined by the centre-to-centre distance. This load includes live load, floor finish, dead load of slab, beam, column and wall load. Depending on number of floors the total load is calculated and the same is used to design footings. Similarly, columns are designed for axial load and moments using SP16. Design of beam is carried out using bending moment and shear force factors for continuous beams as specified in the IS456:2000. Slab panels are designed using the centre-to-centre distance provided as per the support condition. All the footings,columns, beams and slabs can be independently designed. To validate the results, the same structure was analysed and designed in ETABS, which gave results with accuracy up to $95 \%$. The accuracy decreases as the size of the structure increases.
This excel sheet is very useful in designing regular structures till G+3 and up to span 7 m under gravity loading. Lateral loads are not considered for design.

## II. LITERATURE REVIEW

A. "Development of Design Spreadsheet Tool for R.C.C. Beam Design using V.B.A."

Author - Vijay Srivastav
The outline manages a complicated and repeated task because the design technique in light of the Limit State Method includes different mathematical statements and parameters. In addition, outlining is a time-consuming and extremely repeated trailing technique. Therefore, using spreadsheets can significantly cut down on a planner's or builder's time and effort. Despite the availability of numerous standard configuration programming packages, spreadsheets have emerged as one of the best options for designers due to their minimization and compliance. The main goal of this project is to create an MS Excel Spreadsheet with VBA Programming that will enable users to

1) Analyse a beam for Shear Force, Bending Moment, Slope, and Deflection for a variety of end Conditions and for a variety of load patterns.
2) To determine the safe load carrying capacity of a beam
3) To Create RCC Beams An outline equipment that can be usefully used by a professional to analyse and design an RCC beam will be the project's output.

## B. "Automated Excel Sheets for Various RC Elements."

Author - Nitin Tiwari, Rashmi Sakalle
In this work, the rebars of various RC elements, such as beams, columns, and slabs, have been calculated and analysed using the EXCEL spreadsheet programme. This project work has calculated five different types of EXCEL spreadsheets, including one-way and two-way slabs, short columns and long columns, cantilever beams, simply supported beams, and short columns and long columns.

Effective span, nominal cover, and effective length of compression members were only a few of the distinctive factors that were considered in our analysis. The RC elements have been assigned several checks in addition to having a variety of distinguishing attributes. RCC code IS 456:2000 has been used as a source of inspiration.

## C. "Structural Analysis and Design of Multistorey Reinforced Concrete Building using STAAD. Pro"

Author - Sushant Gupta
Structural design is the primary aspect of the civil engineering. The foremost basic in structural engineering is the design of simple basic components and members of a building viz., Slabs, Beams, Columns and Footings. The principle objective of this project is to analyse and design a multi-storied reinforced concrete building [G+3 (3-dimensional frame)] using STAAD Pro. The design involves manual load calculations, analysis and design of the whole structure using STAAD Pro. The design methods used in STAAD-Pro analysis are Limit State Design conforming to Indian Standard Code of Practice. Structure considered for analysis and design is 14.90 m high hospital building located in the seismic zone IV. In this project, we study the effect of various load combinations on the structure by analysing the bending moment diagrams in post processing mode.

## D. "Analysis and design of $G+5$ residential building by using E-Tabs"

Author - Lingeshwaran Navaratnam
We are living in the 21st century number of complex and irregular structure and designed to resists the Earthquake, Wind and needs to analyse , design the structure by the various software like ETABS, STAAD.Pro, TEKLA and to design the structure in this project we used the ETABS software due to company suggestion and to find stress analysis in slab, shear force for the beam and area reinforcement for the column and design the foundation depends upon the reaction and height of the foundation level depends upon site and safe bearing capacity of the soil due to stability purpose designed the retaining wall in this project.

## III. OBJECTIVE

1) Design and Analysis of RC structure by developing an independent Excel sheet and validating the result using ETABS software
2) To include structural engineering principles into design documents.
3) To improve the idea behind structural analysis and design as well as its effectiveness when a design sheet is employed.

## IV. METHODOLOGY

## A. Problem Definition

Developing an Excel sheet to Design and Analyse the RC structure and comparing using E-tab Software

## B. Flow Chart


C. Sample

1) Inputs

Self-Weight of RCC
25
Masonry
Floor Finish (FF)
Live Load (LL)
Grade of Concrete (fck)
ReinforcementGrade (fy)
Column Breadth (b)
Column Depth (D)
Height (H)
Slab Thickness (T)
Wall Thickness
No of Slab
Beam Depth
Beam Width
$\mathrm{KN} / \mathrm{m}^{3}$
$\mathrm{KN} / \mathrm{m}^{3}$
$\mathrm{KN} / \mathrm{m}^{2}$
$\mathrm{KN} / \mathrm{m}^{2}$
$\mathrm{N} / \mathrm{mm}^{2}$
$\mathrm{N} / \mathrm{mm}^{2}$
m
m
m
m
m
Units
m
m
2) Structure


Fig 1
3) Calculation of Axial Loads
a) Self-Weight on Column $=b^{*} \mathrm{~d} * \mathrm{H} *$ Self-Weight of RCC

$$
\begin{aligned}
& =0.23 * 0.38 * 3.2 * 25 \\
& =\mathbf{6 . 9 9} \mathbf{K N}
\end{aligned}
$$

b) Self-Weight of Beam $=L^{*} \mathrm{~b}^{*} \mathrm{~d} *$ Self-Weight of RCC

$$
=4 * 0.23 * 0.38 * 25
$$

$=8.74 \mathrm{KN}$
c) Self-Weight on Slab $=(\mathrm{L} * \mathrm{~B} * \mathrm{~T} *$ Self-Weight of RCC$)+(\mathrm{L} * \mathrm{~B} * \mathrm{FF})+(\mathrm{L} * \mathrm{~B} * \mathrm{LL})$

$$
=(2 * 2 * 0.125 * 25)+(2 * 2 * 1)+(2 * 2 * 2)
$$

$=\mathbf{2 4 . 5 0} \mathrm{KN}$
d) Self-Weight from Wall $=\mathrm{L}^{*}($ Height-Beam Depth $) *$ T*Masonry

$$
=4 *(3.2-0.38) * 0.23 * 18
$$

$=46.70 \mathrm{KN}$
e) Individual Floor Load $=($ Self-Weight on Column $)+($ Self-Weight of Beam $)+$ (Self-Weight on Slab) $+($ Self-Weight from Wall)

$$
\begin{aligned}
& =(6.99)+(8.74)+(24.50)+(46.70) \\
& =\mathbf{8 6 . 9 3} \mathbf{~ K N}
\end{aligned}
$$

f) Total Load $=($ Individual Floor Load*No of Slab) $+($ Self-Weight on Column $)+$ (Self-Weight of Beam)

$$
=(86.93 * 2)+6.99+8.74
$$

$$
P=189.59 \mathrm{KN}
$$

g) Factored Load $=1.5 * \mathrm{P}$

$$
=1.5 * 189.59
$$

$$
\mathrm{Pu}=284.39 \mathrm{KN}
$$

D. Design of Beam

1) Inputs

| Beam Depth | 0.38 | m |
| :--- | :---: | :---: |
| Beam Width | 0.23 | m |
| ES | 200000 | $\mathrm{~N} / \mathrm{mm}^{2}$ |
| Depth | 0.38 | m |
| Cover to centre | 0.04 | m |
| Effective Depth | 0.34 | m |
| Stirrup Día | 8 | mm |
| Cover | 25 | mm |

2) Design
a) $\mathrm{Lx}=\mathbf{4 m}$
$\mathrm{Ly}=\mathbf{4 m}$
Span Ratio $=\mathrm{Ly} / \mathrm{Lx}=\mathbf{1 m}$
b) Check for Slab

If (Span Ratio >=2,"One Way Slab", "Two Way Slab") Hence, Two Way Slab
c) $\mathrm{Wo}=($ Floor finish $*$ Slab thickness $* 25) * 1.5$
$=(1 * 0.125 * 25) * 1.5$
$=6.88 \mathrm{KN} / \mathrm{m}$
d) Dead Load calculation

- Slab Load $=$ if $(\operatorname{Lx}<\mathrm{Ly}), 1 / 3^{*} \mathrm{Wo} * \mathrm{Lx}^{*} \mathrm{Wo} * \mathrm{Lx} / 2^{*}\left(1-1\left(3^{*}\right.\right.$ Span Ratio $\left.\left.{ }^{2}\right)\right)$ ).
$=$ if $\left.(4<4), 1 / 3 * 6.88 * 4 * 6.88 * 4 / 2 *\left(1-1\left(3 * 1^{2}\right)\right)\right)$
$=\mathbf{8 . 2 5 0} \mathbf{K N} / \mathrm{m}$
- Wall load=0.23*Height*Masonry
$=0.23 * 3.2 * 18$
$=\mathbf{1 3 . 2 4 8} \mathbf{K N} / \mathrm{m}$
- Beam Load=Beam depth *Beam Width *Self Weight of RCC
$=0.38 * 0.23 * 25$
$=2.185 \mathrm{KN} / \mathrm{m}$
- Total Dead Load= Slab Load + Wall load + Beam Load
$=8.250+13.248+2.185$
$=23.683 \mathrm{KN} / \mathrm{m}$

```
e) LiveLoad calculation \(=\mathrm{if}(\mathrm{Lx}<\mathrm{Ly}), 1 / 3 * \mathrm{LL} * \mathrm{Lx} * \mathrm{LL} * \mathrm{Lx} / 2 *\left(1-1\left(3 *\right.\right.\) Span Ratio \(\left.\left.\left.{ }^{2}\right)\right)\right)\) \(=\) if \(\left.(4<4), 1 / 3 * 2 * 4 * 2 * 4 / 2 *\left(1-1\left(3 * 1^{2}\right)\right)\right)\)
\(=2.667 \mathrm{KN} / \mathrm{m}\)
```

f) Bending Moment Coefficients

- Dead load Moment's calculations
> Span moments
Middle of end= (Total Dead load *Lx*Lx)/12
$=(23.683 * 4 * 4) / 12$
$=31.577 \mathrm{KN} / \mathrm{m}$
Middle of interior= (Total Dead load *Lx*Lx)/16
$=(23.683 * 4 * 4) / 16$
$=23.683 \mathrm{KN} / \mathrm{m}$
Support moments
End Support= (Total Dead load *Lx*Lx)/10
$=(23.683 * 4 * 4) / 10$
$=37.893 \mathrm{KN} / \mathrm{m}$
Next to End Support= (Total Dead load *Lx*Lx)/12
$=(23.683 * 4 * 4) / 12$
$=31.577 \mathrm{KN} / \mathrm{m}$
- Live load moments calculations
> Span moments
Middle of end= $($ Total Live load $*$ Lx $*$ Lx) $/ 10$
$=(2.667 * 4 * 4) / 10$
$=4.267 \mathrm{KN} / \mathrm{m}$
Middle of interior $=($ Total Live load *Lx*Lx)/12
$=(2.667 * 4 * 4) / 12$
$=3.556 \mathrm{KN} / \mathrm{m}$
Support moments
End Support= (Total Live load *Lx*Lx)/9
$=(2.667 * 4 * 4) / 9$
$=4.741 \mathrm{KN} / \mathrm{m}$
Next to End Support= (Total Live load *Lx*Lx)/9
$=(2.667 * 4 * 4) / 9$
$=4.741 \mathrm{KN} / \mathrm{m}$
- Total Bending Moment Coefficients
> Middle of end $=($ DL+LL $)$
$=(31.577+4.267)$
$=35.844 \mathrm{KN} / \mathrm{m}$
> Middle of interior= $($ DL+LL $)$
$=(23.683+3.556)$
$=27.239 \mathrm{KN} / \mathrm{m}$
> End Support= (DL+LL)
$=(37.893+4.741)$
$=42.634 \mathrm{KN} / \mathrm{m}$
- Interior support= (DL+LL)
$=25.283 \mathrm{KN} / \mathrm{m}$
- Next to End Support= (DL+LL)
$=(31.577+4.741)$
$=36.318 \mathrm{KN} / \mathrm{m}$
g) Shear Coefficients calculations
- At End= (DL+LL) *0.45
$=(23.683+2.667) * 0.45$
$=\mathbf{2 4 . 8 8 3} \mathbf{K N} / \mathrm{m}$
- $\quad$ Next to End= $(\mathrm{DL}+L L) * 0.6$
$=(23.683+2.667) * 0.6$
$=\mathbf{2 5 . 2 8 3} \mathbf{K N} / \mathrm{m}$

3) Design for Bending at Left Support

- $\mathrm{Xumax} / \mathrm{d}=0.00035 /(0.0055+0.87 * \mathrm{Fy}) / \mathrm{ES}$

$$
=0.00035 /(0.0055+0.87 * 500) / 200000
$$

$=0.046$
If (Fck=15,2.5, If(Fck=20,2.8,If(Fck=25,3.1,If(Fck=30,3.5,If(Fck=35,3.7,If(Fck=40,4))))))

- Tcmax $=2.8 \mathrm{~N} / \mathrm{mm}^{2}$
- Pt $\min (\%)=0.85 / \mathrm{Fy} * 100$

$$
=0.85 / 500 * 100
$$

$=\mathbf{0 . 1 7 0}$

- Design for Bending at left Support
> $\mathrm{Mu}=\mathbf{4 2 . 6 3 4} \mathrm{KN}-\mathrm{m}$
> Mulim $=0.36 *$ Xumax/d*(1-0.416*Xumax/d)*b*d*Fck*10000/1000000
$=0.36 * 0.046 *(1-0.416 * 0.046) * 230 * 340^{2} * 25 * 10000 / 1000000$
$=85.64 \mathrm{KN}-\mathrm{m}$
If (Mu<Mulim,((1-SQRT(1-4*0.416*Mu*10^6/0.36/fck/Width/d $\left.\left.\left.\left.{ }^{2}\right)\right) / 2 / 0.416^{*} \mathrm{~d}^{2}\right), \mathrm{Xumax} / \mathrm{d}^{*} / \mathrm{d}\right)$
- $\mathrm{Xu}=85.64 \mathrm{KN}-\mathrm{m}$
- e At ASC= $\mathbf{0 . 0 0 2 5}$
- $\mathrm{fsc}=\mathbf{4 0 1 . 0 3 3} \mathbf{N} / \mathrm{mm}^{2}$

If (e At ASC $<0.002$, ( $0.446-111500 *\left(0.002-\right.$ e At ASC ${ }^{2}$ ) *Fck, $0.446 *$ Fck $)$

- $\mathrm{fcc}=\mathbf{8 . 9 2 0} \mathbf{N} / \mathrm{mm}^{2}$
- Area of Reinforcement
> Ast $-1=(0.36 *$ Fck*Width*Xu $/ 0.87 /$ Fy $)$
$=(0.36 * 20 * 230 * 85.64 / 0.87 / 500)$
$=321.44 \mathrm{~mm}^{2}$
$>$ Asc $=$ If $\left(\right.$ Mu $<=$ Mulim, $0,\left((\right.$ Mu-Mulim $) * 10^{6} /($ fcc-fsc $) /($ Eff Depth-Cover $\left.\left.)\right) / 100\right)$
$=$ If $\left(42.634<=85.64,0,\left((42.634-85.64) * 10^{6} /(8.920-401.33) /(340-25)\right) / 100\right)$
$=0.00$
$>$ Ast-2 $=$ If $\left(\mathrm{Mu}<=\right.$ Mulim, $\left.0,\left((\mathrm{fsc}-\mathrm{fcc}) / 0.87 / \mathrm{Fy}^{*} \mathrm{Asc}\right)\right)$ $=$ If $(42.634<=85.64,0,((401.33-8.920) / 0.87 / 500 * 0.00))$
$=0.00$
$>$ AST $=$ Ast- $1+$ Ast- 2
$=321.474 \mathrm{~mm}^{2}$
- $\operatorname{Pt}(\%)=$ Ast / Width /Eff Depth * 100
$=321.474 / 230 / 340 * 100$
$=0.411$
- Astmin $=$ Pt min (\%) * Width * Eff Depth
$=0.170 * 230 * 340 / 100$
$=132.940 \mathrm{~mm}^{2}$
- $\quad$ Ast Critical $=$ If (Ast<Astmin, Astmin, Ast $)$
$=$ If $(321.474<132.94,132.94,321.474)$
$=321.474$

4) Design for Shear at left Support

- $\mathrm{Vu}=\mathbf{2 4 . 8 8 3} \mathbf{K N}$

If ( $0.8 *$ Fck $/ 6.89 / \mathrm{Pt} \%>1,0.8 *$ Fck $/ 6.89 / \mathrm{Pt} \%, 1$ )

- $\beta=5.649$
- $\quad \tau \mathrm{c}=0.85 * \operatorname{SQRT}(0.8 * \mathrm{Fck}) *(\operatorname{SQRT}(1+5 * \beta)-1) / 6 / \beta$

$$
=0.85 * \operatorname{SQRT}(0.8 * 20) *(\operatorname{SQRT}(1+5 * 5.649)-1) / 6 / 5.649
$$

$=0.44 \mathrm{~N} / \mathrm{mm}^{2}$

- $\quad \tau \mathrm{v}=\mathrm{Vu} *$ Width $*$ Eff Depth
$=24.883 * 230 * 340$
$=0.318 \mathrm{~N} / \mathrm{mm}^{2}$
- $\quad \tau \mathrm{cbd}=\tau \mathrm{c} * \mathrm{~b}^{*} \mathrm{~d}$
$=0.44 * 230 * 340$
$=34.578 \mathrm{KN}$
- $\quad$ Vus $=$ If $($ Vu- $\tau c b d>0$, Vu- $\tau c b d, 0.0001)$

$$
=\text { If }(24.833-34.758>0,24.833-34.758,0.0001)
$$

$=\mathbf{0 . 0 0 0 1 ~ K N}$
If((Pt Percentage $>4, \tau v>\tau c m a x)$,"Increase Section","SectionAdequte")
Hence, Section Adequte

If((Mu)<Mulim,"Singly","Doubly")
Hence, Singly
5) Design for Bending at Midspan

- Xumax/d $=0.00035 /(0.0055+0.87 * \mathrm{Fy}) / \mathrm{ES}$

$$
\begin{aligned}
& =0.00035 /(0.0055+0.87 * 500) / 200000 \\
& =\mathbf{0 . 0 4 6}
\end{aligned}
$$

If $($ Fck $=15,2.5, \operatorname{If}($ Fck $=20,2.8, \operatorname{If}($ Fck=25,3.1,If(Fck=30,3.5,If(Fck=35,3.7,If(Fck=40,4) )) ))) $)$

- $\tau \mathrm{cmax}=2.8 \mathrm{~N} / \mathrm{mm}^{2}$
- $\operatorname{Pt} \min (\%)=0.85 / \mathrm{Fy} * 100$

$$
\begin{aligned}
& =0.85 / 500 * 100 \\
& =\mathbf{0 . 1 7}
\end{aligned}
$$

- Design for Bending at Mid Span
$>\mathrm{Mu}=\mathbf{3 5 . 8 4 4} \mathrm{KN}-\mathrm{m}$
$>$ Mulim $=0.36^{*}$ Xumax $/ \mathrm{d}^{*}\left(1-0.416 *\right.$ Xumax/d) ${ }^{*} \mathrm{~b}^{*} \mathrm{~d}^{*}$ Fck*10000/1000000
$=0.36 * 0.046 *(1-0.416 * 0.046) * 230 * 340^{2} * 25 * 10000 / 1000000$
$=85.64 \mathrm{KN}-\mathrm{m}$
If (Mu<Mulim, ((1-SQRT(1-4*0.416*Mu*10^6/0.36/fck/Width/d $\left.\left.\left.\left.{ }^{2}\right)\right) / 2 / 0.416^{*} \mathrm{~d}^{2}\right), \mathrm{Xumax} / \mathrm{d}^{*} / \mathrm{d}\right)$
- $\mathrm{Xu}=69.586 \mathrm{KN}-\mathrm{m}$
- e At ASC= 0.002
- $\mathrm{fsc}=\mathbf{3 9 0 . 5 6 5} \mathrm{N} / \mathrm{mm}^{2}$

If (e At ASC $<0.002,\left(0.446-111500 *\left(0.002-\right.\right.$ e At ASC ${ }^{2}$ ) *Fck, $0.446 *$ Fck $)$

- $\mathrm{fcc}=8.92 \mathrm{~N} / \mathrm{mm}^{2}$
- Area of Reinforcement
> Ast $-1=(0.36 *$ Fck*Width*Xu $/ 0.87 /$ Fy $)$
$=(0.36 * 20 * 230 * 85.64 / 0.87 / 500)$
$=321.44 \mathrm{~mm}^{2}$
$>$ Asc $=$ If $\left(\mathrm{Mu}<=\right.$ Mulim $, 0,\left((\mathrm{Mu}-\mathrm{Mulim}) * 10^{6} /(\right.$ fcc-fsc $) /($ Eff Depth-Cover $\left.\left.)\right) / 100\right)$
$=$ If $\left(42.634<=85.64,0,\left((42.634-85.64) * 10^{6} /(8.920-401.33) /(340-25)\right) / 100\right)$

$$
=0.00
$$

> Ast-2 $=$ If $(\mathrm{Mu}<=$ Mulim, $0,(($ fsc-fcc)/0.87/ Fy*Asc) $)$

$$
=\text { If }(42.634<=85.64,0,((401.33-8.920) / 0.87 / 500 * 0.00))
$$

$$
=0.00
$$

$>\mathrm{AST}=\mathrm{Ast}-1+$ Ast -2
$=321.474 \mathrm{~mm}^{2}$

- $\operatorname{Pt}(\%)=$ Ast / Width /Eff Depth * 100
$=321.474 / 230 / 340 * 100$
$=0.411$


## - $\quad$ Astmin $=\operatorname{Pt} \min (\%) *$ Width $*$ Eff Depth <br> $=0.170 * 230 * 340 / 100$ <br> $=132.940 \mathrm{~mm}^{2}$

- $\quad$ Ast Critical $=$ If (Ast<Astmin,Astmin, Ast)
$=$ If ( $321.474<132.94,132.94,321.474$ )

$$
=321.474
$$

6) Design for Shear at Mid Span

- $\mathrm{Vu}=0.0$

If ( $0.8 *$ Fck $/ 6.89 / \mathrm{Pt} \%>1,0.8 *$ Fck $/ 6.89 / \mathrm{Pt} \%, 1$ )

- $\beta=5.649$
- $\tau \mathrm{c}=0.85 * \operatorname{SQRT}\left(0.8^{*} \mathrm{Fck}\right) *(\operatorname{SQRT}(1+5 * \beta)-1) / 6 / \beta$

$$
=0.85 * \operatorname{SQRT}(0.8 * 20) *(\text { SQRT }(1+5 * 5.649)-1) / 6 / 5.649
$$

$=0.44 \mathrm{~N} / \mathrm{mm}^{2}$

$$
\begin{aligned}
& \text { - } \tau \mathrm{v}=\mathrm{Vu} * \text { Width } * \text { Eff Depth } \\
& =0.00 * 230 * 340 \\
& =\mathbf{0 . 0 0}
\end{aligned}
$$

- $\tau c b d=\tau c * b^{*} d$
$=0.44 * 230 * 340$
$=36.103 \mathrm{KN}$
- Vus $=$ If (Vu- $\tau c b d>0$, Vu- $\tau c b d, 0.0001)$

$$
=\text { If }(0-34.758>0,0,34.758,0.0001)
$$

$=0.0001 \mathrm{KN}$
7) Design for Bending at Right Support

- Xumax/d $=0.00035 /(0.0055+0.87 * \mathrm{Fy}) / \mathrm{ES}$

$$
\begin{aligned}
& =0.00035 /(0.0055+0.87 * 500) / 200000 \\
& =\mathbf{0 . 0 4 6}
\end{aligned}
$$

If $(\operatorname{Fck}=15,2.5, \operatorname{If}($ Fck=20,2.8,If(Fck=25,3.1,If(Fck=30,3.5,If(Fck=35,3.7,If(Fck=40,4))))))

- $\tau \mathrm{cmax}=2.8 \mathrm{~N} / \mathrm{mm}^{2}$
- $\quad \operatorname{Pt} \min (\%)=0.85 / \mathrm{Fy} * 100$

$$
\begin{aligned}
& =0.85 / 500 * 100 \\
& =\mathbf{0 . 1 7 0}
\end{aligned}
$$

- Design for Bending at left Support
$>\mathrm{Mu}=36.318 \mathrm{KN}-\mathrm{m}$
> Mulim $=0.36 *$ Xumax/d*(1-0.416*Xumax/d)*b*d*Fck*10000/1000000
$=0.36 * 0.046 *(1-0.416 * 0.046) * 230 * 340^{2} * 25 * 10000 / 1000000$
$=85.64 \mathrm{KN}-\mathrm{m}$
If $\left(\operatorname{Mu}<\operatorname{Mulim},\left(\left(1-S Q R T\left(1-4 * 0.416 * M u * 10^{\wedge} 6 / 0.36 /\right.\right.\right.\right.$ fck $\left.\left.\left.\left./ W i d t h / d^{2}\right)\right) / 2 / 0.416 * d^{2}\right), X u m a x / d * / d\right)$
- $\mathrm{Xu}=70.602 \mathrm{KN}-\mathrm{m}$
- e At ASC= 0.0025
- $\quad \mathrm{fsc}=\mathbf{3 9 1 . 4 8 7} \mathbf{N} / \mathrm{mm}^{2}$

If (e At ASC <0.002, (0.446-111500*(0.002- e At ASC ${ }^{2}$ ) *Fck, $0.446 *$ Fck)

- $\mathrm{fcc}=\mathbf{8 . 9 2 0} \mathbf{N} / \mathrm{mm}^{2}$
- Area of Reinforcement
> Ast $-1=(0.36 *$ Fck $*$ Width $*$ Xu /0.87/ Fy $)$
$=(0.36 * 20 * 230 * 70.602 / 0.87 / 500)$
$=268.77 \mathrm{~mm}^{2}$
$>\quad \mathrm{Asc}=\mathrm{If}\left(\mathrm{Mu}<=\operatorname{Mulim}, 0,\left((\mathrm{Mu}-\mathrm{Mulim}) * 10^{6} /(\mathrm{fcc}-\mathrm{fsc}) /(\right.\right.$ Eff Depth-Cover $\left.\left.)\right) / 100\right)$
$=$ If $\left(42.634<=85.64,0,\left((42.634-85.64) * 10^{6} /(8.920-401.33) /(340-25)\right) / 100\right)$
$=0.00$
$>\mathrm{Ast}-2=$ If $(\mathrm{Mu}<=\mathrm{Mulim}, 0,((\mathrm{fsc}-\mathrm{fcc}) / 0.87 / \mathrm{Fy} * \mathrm{Asc}))$
$=$ If $(42.634<=85.64,0,((401.33-8.920) / 0.87 / 500 * 0.00))$

$$
=0.00
$$

$>\mathrm{AST}=$ Ast $-1+$ Ast -2

$$
=268.77 \mathrm{~mm}^{2}
$$

- $\operatorname{Pt}(\%)=$ Ast / Width /Eff Depth *100

$$
\begin{aligned}
& =268.77 / 230 / 340 * 100 \\
& =0.344
\end{aligned}
$$

- $\quad$ Astmin $=P t \min (\%) *$ Width $*$ Eff Depth
$=0.170 * 230 * 340 / 100$
$=132.940 \mathrm{~mm}^{2}$

$=$ If $(268.77<132.94,132.94,321.474)$
$=268.77$

8) Design for Shear at Right Support

- $\mathrm{Vu}=\mathbf{2 5 . 2 8 3} \mathbf{K N}$

If ( $0.8 *$ Fck $/ 6.89 / \mathrm{Pt} \%>1,0.8 *$ Fck $/ 6.89 / \mathrm{Pt} \%, 1$ )

- $\beta=6.756$
- $\tau c=0.85 * \operatorname{SQRT}\left(0.8^{* F c k}\right) *(\operatorname{SQRT}(1+5 * \beta)-1) / 6 / \beta$

$$
=0.85 * \operatorname{SQRT}(0.8 * 20) *(\operatorname{SQRT}(1+5 * 6.756)-1) / 6 / 6.756
$$

$=0.41 \mathrm{~N} / \mathrm{mm}^{2}$

- $\tau \mathrm{v}=\mathrm{Vu}$ *Width *Eff Depth
$=25.283 * 230 * 340$

$$
=0.323 \mathrm{~N} / \mathrm{mm}^{2}
$$

- $\tau c b d=\tau c * b^{*} d$
$=0.41 * 230 * 340$
$=32.122 \mathrm{KN}$
- $\quad$ Vus $=$ If $(\mathrm{Vu}-\tau c b d>0, \mathrm{Vu}-\tau c b d, 0.0001)$
$=$ If (25.283-32.122>0,25.283-32.122,0.0001)
$=\mathbf{0 . 0 0 0 1} \mathbf{K N}$

Hence, Section Adequte
If((Mu)<Mulim,"Singly","Doubly")
Hence, Singly

9) Reinforcement Details

- Ast Provided $=\mathbf{3 2 1 . 4 7} \mathrm{mm}^{2}$
- $\mathrm{Dia}=\mathbf{1 2} \mathrm{mm}$
- No of Bars = 3
E. Design of Slab

1) Inputs
b $\quad 1000 \mathrm{~mm}$
2) Design

- Self Weight of Slab = Slab Thickness * Self Weight of RCC

$$
\begin{aligned}
& =0.125 * 25 \\
& =\mathbf{3 . 1 2 5} \mathbf{K N} / \mathbf{m}^{2}
\end{aligned}
$$

- Total Load $=$ LL + FF + Self Weight of Slab

$$
\begin{aligned}
& =2+1+3.125 \\
& =\mathbf{6 . 1 2 5} \mathbf{~ K N} / \mathbf{m}^{2}
\end{aligned}
$$

- Ultimate Load $=1.5$ * Total Load

$$
\begin{aligned}
& =1.5 * 6.125 \\
& =\mathbf{9 . 1 8 8} \mathbf{K N} / \mathbf{m}^{2}
\end{aligned}
$$

- $\mathrm{Lx}=4 \mathrm{~m}$
$\mathrm{Ly}=\mathbf{4 m}$
Span Ratio $=\mathrm{Ly} / \mathrm{Lx}$

$$
\begin{aligned}
& =4 / 4 \\
& =1 \mathbf{m}
\end{aligned}
$$

- Check For Slab

If (Ly/Lx>=2,"One Way Slab", "Two Way Slab")
Hence, Two Way Slab

- $\quad \mathrm{Le}=\operatorname{Min}((\mathrm{Lx}+$ Wall Thickness $),(\mathrm{Lx}+\mathrm{Lx} / 2))$

$$
\begin{aligned}
& =\operatorname{Min}((4+0.23),(4+4 / 2) \\
& =4.23 \mathbf{~ m}
\end{aligned}
$$

- $\quad$ Effective Depth $(\mathrm{De})=$ Slab Thickness -0.015

$$
\begin{aligned}
& =0.125-0.015 \\
& =\mathbf{0 . 1 1} \mathbf{~ m}
\end{aligned}
$$

- $\mathrm{WLx}^{2}=$ Ultimate Load $* \mathrm{Lx}^{2}$

$$
\begin{aligned}
& =9.188 * 4^{2} \\
& =\mathbf{1 4 7} \mathbf{K N}
\end{aligned}
$$

- Edge Condition = Two Adjacent Side Discontinuous

$$
=7
$$

- Multiplication Factor
-ve at Support of Short $\operatorname{Span}\left(\alpha_{x}\right)=\mathbf{0 . 0 4 7}$
+ ve at Midspan of $\operatorname{Short} \operatorname{Span}\left(\alpha_{x}\right)=\mathbf{0 . 0 3 5}$
-ve at Midspan of Long $\operatorname{Span}\left(\alpha_{y}\right)=\mathbf{0 . 0 4 7}$
+ ve at Support of Long Span $\left(\alpha_{y}\right)=\mathbf{0 . 0 3 5}$
- Bending Moments Mu

$$
\begin{aligned}
\text {-ve at Support of Short Span }\left(\alpha_{x}\right) & =\mathrm{WLx}^{2} *\left(\alpha_{\mathrm{x}}\right) \\
& =147 * 0.047 \\
& =\mathbf{6 . 9 0 9} \mathbf{K N}-\mathbf{m}
\end{aligned}
$$

$$
\begin{aligned}
+ \text { ve at Midspan of Short Span }\left(\alpha_{\mathrm{x}}\right) & =\mathrm{WLx}^{2} *\left(\alpha_{x}\right) \\
& =147 * 0.035 \\
& =\mathbf{5 . 1 4 5} \mathbf{K N}-\mathbf{m}
\end{aligned}
$$

-ve at Midspan of Long $\operatorname{Span}\left(\alpha_{y}\right)=\operatorname{WLx}^{2} *\left(\alpha_{y}\right)$

$$
=147 * 0.047
$$

$$
=6.909 \mathrm{KN}-\mathrm{m}
$$

$$
\begin{aligned}
+\mathrm{ve} \text { at Support of Long Span }\left(\alpha_{\mathrm{y}}\right) & =\mathrm{WLx}^{2} *\left(\alpha_{\mathrm{y}}\right) \\
& =147 * 0.035 \\
& -\mathbf{5 1 4 5} \mathbf{K N} \mathbf{m}
\end{aligned}
$$

- Are of Steel Required
$>$-ve at Support of Short Span $\left(\alpha_{x}\right)$
$=0.5 * \mathrm{Fck} / \mathrm{Fy}^{*} \mathrm{~b}^{*} \mathrm{De}^{*} 1000 *\left(1-\operatorname{SQRT}\left(1-4.6 * \mathrm{Mu}\left(\alpha_{\mathrm{x}}\right) * 10^{\wedge} 6 /\left(\mathrm{Fck}^{*} \mathrm{~b}^{*}(\mathrm{Y} 10 * 1000)^{\wedge} 2\right)\right)\right)$

```
= 0.5*20/500*1000*0.11*1000*(1-SQRT (1-4.6*6.909)*10^6/(20*1000*(0.11*1000)^2)))
= 149.54 mm
```

```
> +ve at Midspan of Short Span ( }\mp@subsup{\alpha}{\textrm{x}}{}
=0.5*Fck/Fy*b*De*1000*(1-SQRT (1-4.6*Mu ( }\mp@subsup{\alpha}{\textrm{x}}{*}\mp@subsup{)}{}{*}10^6/(Fck*\mp@subsup{b}{}{*}*(Y10*1000)^2))
= 0.5*20/500*1000*0.11*1000*(1-SQRT (1-4.6*5.145*10^6/ (20*1000*(0.11*1000)^2)))
= 110.34 mm
```

$>$-ve at Midspan of Long Span $\left(\alpha_{y}\right)$
$=0.5 * \mathrm{Fck} / \mathrm{Fy}^{*} \mathrm{~b}^{*} \mathrm{De}^{*} 1000 *\left(1-\mathrm{SQRT}\left(1-4.6 * \mathrm{Mu}\left(\alpha_{\mathrm{y}}\right) * 10^{\wedge} 6 /\left(\mathrm{Fck} * \mathrm{~b} *(\mathrm{Y} 10 * 1000)^{\wedge} 2\right)\right)\right)$
$=0.5 * 20 / 500 * 1000 * 0.11 * 1000 *\left(1-\operatorname{SQRT}\left(1-4.6 * 6.909 * 10^{\wedge} 6 /\left(20 * 1000 *(0.11 * 1000)^{\wedge} 2\right)\right)\right)$
$=149.54 \mathrm{~mm}^{2}$

```
> +ve at Support of Long Span (\alphay)
= 0.5*Fck/Fy*b*De*1000*(1-SQRT (1-4.6*Mu ( }\mp@subsup{\alpha}{x}{})*10^6/(Fck*b*(Y10*1000) ^2)))
= 0.5*20/500*1000*0.11*1000*(1-SQRT (1-4.6*5.145*10^6/ (20*1000*(0.11*1000)^2)))
= 110.34 mm
```

- Proposed Dia

$$
\begin{aligned}
& \text {-ve }=\mathbf{8 m m} \\
& +\mathrm{ve}=\mathbf{8 m m}
\end{aligned}
$$

- $\quad$ Area of Steel bar $=\pi / 4 * \mathrm{Dia}^{2}$
-ve at Support of Short $\operatorname{Span}\left(\alpha_{x}\right)=\pi / 4 * 8^{2}$

$$
=50.24 \mathrm{~mm}^{2}
$$

+ ve at Midspan of Short $\operatorname{Span}\left(\alpha_{\mathrm{x}}\right)=\pi / 4 * 8^{2}$

$$
=50.24 \mathrm{~mm}^{2}
$$

-ve at Midspan of Long Span $\left(\alpha_{y}\right)=\pi / 4 * 8^{2}$
$=\mathbf{5 0 . 2 4} \mathrm{mm}^{2}$

+ ve at Support of Long Span $\left(\alpha_{y}\right)=\pi / 4 * 8^{2}$

$$
=50.24 \mathrm{~mm}^{2}
$$

- Spacing
$>$-ve at Support of $\operatorname{Short} \operatorname{Span}\left(\alpha_{\mathrm{x}}\right)=\operatorname{Min}\left(1000 * \pi / 4 *(-\mathrm{veDia})^{2} /\right.$ Ast req,300 $)$

$$
\begin{aligned}
& =\operatorname{Min}\left(1000^{*} \pi / 4^{*}(8)^{2} / 149.54,300\right) \\
& =\mathbf{3 0 0} \mathbf{~ m m}
\end{aligned}
$$

$>\quad+\mathrm{ve}$ at Midspan of $\operatorname{Short} \operatorname{Span}\left(\alpha_{\mathrm{x}}\right)=\operatorname{Min}\left(1000 * \pi / 4 *(+\mathrm{veDia})^{2} /\right.$ Ast req, 300 $)$

$$
=\operatorname{Min}\left(1000 * \pi / 4 *(8)^{2} / 110.34,300\right)
$$

$=\mathbf{3 0 0} \mathrm{mm}$
$>-$ ve at Midspan of Long $\operatorname{Span}\left(\alpha_{\mathrm{y}}\right)=\operatorname{Min}\left(1000 * \pi / 4 *(-\mathrm{veDia})^{2} /\right.$ Ast req,300 $)$

$$
=\operatorname{Min}\left(1000^{*} \pi / 4 *(8)^{2} / 149.54,300\right)
$$

$=\mathbf{3 0 0} \mathbf{~ m m}$

$$
\begin{aligned}
>+ \text { ve at Support of Long } \operatorname{Span}\left(\alpha_{\mathrm{y}}\right) & =\operatorname{Min}\left(1000^{*} \pi / 4^{*}(+\mathrm{veDia})^{2} / \text { Ast req, } 300\right) \\
& =\operatorname{Min}\left(1000^{*} \pi / 4^{*}(8)^{2} / 110.34,300\right) \\
& =\mathbf{3 0 0} \mathbf{~ m m}
\end{aligned}
$$

- No of Bars
-ve at Support of Short $\operatorname{Span}\left(\alpha_{x}\right)=4$
+ ve at Midspan of Short $\operatorname{Span}\left(\alpha_{x}\right)=4$
-ve at Midspan of Long Span $\left(\alpha_{y}\right)=4$
+ ve at Support of Long Span $\left(\alpha_{y}\right)=4$
- Area of Steel Provided
$>$-ve at Support of Short Span $\left(\alpha_{x}\right)=$ Area of Steel Bar * No of Bars

$$
\begin{aligned}
& =50.24 * 4 \\
& =\mathbf{2 0 1} \mathbf{~ m m}^{2}
\end{aligned}
$$

$>+$ ve at Midspan of Short Span $\left(\alpha_{\mathrm{x}}\right)=$ Area of Steel Bar * No of Bars

$$
\begin{aligned}
& =50.24 * 4 \\
& =\mathbf{2 0 1} \mathbf{~ m m}^{2}
\end{aligned}
$$

$>$-ve at Midspan of Long Span $\left(\alpha_{y}\right)=$ Area of Steel Bar * No of Bars

$$
\begin{aligned}
& =50.24 * 4 \\
& =201 \mathbf{~ m m}^{2}
\end{aligned}
$$

$>\quad+\mathrm{ve}$ at Support of Long Span $\left(\alpha_{\mathrm{y}}\right)=$ Area of Steel Bar * No of Bars

$$
\begin{aligned}
& =50.24 * 4 \\
& =201 \mathbf{~ m m}^{2}
\end{aligned}
$$

- Check for Deflection
$>$ Percentage Main Steel Provided $=\operatorname{Max}\left(+\mathrm{ve}\right.$ at $\left(\alpha_{\mathrm{x}}\right),+\mathrm{ve}$ at $\left.\left(\alpha_{\mathrm{y}}\right)\right) * 100 /\left(1000 * \mathrm{De}^{*} 1000\right)$

$$
\begin{aligned}
& =\operatorname{Max}(201,201) * 100 /(1000 * 0.11 * 1000) \\
& =\mathbf{0 . 1 8 2}
\end{aligned}
$$

> Limiting Value of Steel $=\mathbf{1}$
If (Percentage Main Steel Provided <Limiting Value of Steel, "Steel Within the Limit", "Steel Percentage More") Hence, Steel Within the Limit

```
Overall Depth =26
\ Service Stress in Steel =216
> kt=2
P Permissible Span = Overall Depth * kt
\[
\begin{aligned}
& =26 * 2 \\
& =46 \mathrm{~mm}
\end{aligned}
\]
\[
>\text { Actual Span }=\mathrm{De}^{*} 1000 / \mathrm{Lx}
\]
\[
=0.11 * 1000 / 4
\]
\[
=28 \mathrm{~mm}
\]
If (Permissible Span >Actual Span, "Satisfies deflection Criterion", "Deflection Criterion not satisfied!!") Hence, Satisfies deflection Criterion
```


## V. RESULTS AND DISCUSSIONS

## A. General

This project focuses on developing a excel sheet with simple user interface to analyze and design RC structures without any prior knowledge of software. The forces on every member were calculated. After that we began with the design of Beam using relevant code books, and then Slab was designed manually. Various checks were performed on the members. As a result, we gained a foundational understanding of analysis and design as well as ideas like load transfer mechanisms and moment distribution.

This Excel sheet considers only the gravity loads. Grids in X and Y directions are defined in the sheet. User can enter distance between grids. Loads on various elements of the buildings such as Beam and Slab are calculated manually.The same building was modelled and analysed using E-tab also.
B. Load Calculation

1) Inputs

| Self Weight of RCC | 25 | $\mathrm{KN} / \mathrm{m}^{3}$ |
| :--- | :---: | :---: |
| Masonry | 18 |  |
| Floor Finish | 1 | $\mathrm{KN} / \mathrm{m}^{2}$ |
| Live Load | 2 | $\mathrm{KN} / \mathrm{m}^{2}$ |
| Grade of Concrete (fck) | 20 | $\mathrm{~N} / \mathrm{mm}^{2}$ |
| Reinforcenment Grade (fy) | 500 | $\mathrm{~N} / \mathrm{mm}^{2}$ |

## 2) Structure



Fig 2

## International Journal for Research in Applied Science \& Engineering Technology (IJRASET)

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue IX Sep 2022- Available at www.ijraset.com

| Self weight on column |  |  |  | Self Weight of Beam(KN) |  |  |  | Self Weight on Slab(KN/m2) |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| b | D | H | P | L | b | D | P | L | B | T | FF | LL | P |
| 0.23 | 0.38 | 3.20 | 6.99 | 4.0 | 0.23 | 0.38 | 8.74 | 2.0 | 2.0 | 0.13 | 1 | 2 | 24.50 |
| 0.23 | 0.38 | 3.20 | 6.99 | 6.5 | 0.23 | 0.38 | 14.20 | 4.5 | 2.0 | 0.13 | 1 | 2 | 55.13 |
| 0.23 | 0.38 | 3.20 | 6.99 | 7.5 | 0.23 | 0.38 | 16.39 | 5.5 | 2.0 | 0.13 | 1 | 2 | 67.38 |
| 0.23 | 0.38 | 3.20 | 6.99 | 8.5 | 0.23 | 0.38 | 18.57 | 6.5 | 2.0 | 0.13 | 1 | 2 | 79.63 |
| 0.23 | 0.38 | 3.20 | 6.99 | 5.5 | 0.23 | 0.38 | 12.02 | 3.5 | 2.0 | 0.13 | 1 | 2 | 42.88 |
| 0.23 | 0.38 | 3.20 | 6.99 | 6.5 | 0.23 | 0.38 | 14.20 | 2.0 | 4.5 | 0.13 | 1 | 2 | 55.13 |
| 0.23 | 0.38 | 3.20 | 6.99 | 9.0 | 0.23 | 0.38 | 19.67 | 4.5 | 4.5 | 0.13 | 1 | 2 | 124.03 |
| 0.23 | 0.38 | 3.20 | 6.99 | 10.0 | 0.23 | 0.38 | 21.85 | 5.5 | 4.5 | 0.13 | 1 | 2 | 151.59 |
| 0.23 | 0.38 | 3.20 | 6.99 | 11.0 | 0.23 | 0.38 | 24.04 | 6.5 | 4.5 | 0.13 | 1 | 2 | 179.16 |
| 0.23 | 0.38 | 3.20 | 6.99 | 8.0 | 0.23 | 0.38 | 17.48 | 3.5 | 4.5 | 0.13 | 1 | 2 | 96.47 |
| 0.23 | 0.38 | 3.20 | 6.99 | 7.5 | 0.23 | 0.38 | 16.39 | 2.0 | 5.5 | 0.13 | 1 | 2 | 67.38 |
| 0.23 | 0.38 | 3.20 | 6.99 | 10.0 | 0.23 | 0.38 | 21.85 | 4.5 | 5.5 | 0.13 | 1 | 2 | 151.59 |
| 0.23 | 0.38 | 3.20 | 6.99 | 11.0 | 0.23 | 0.38 | 24.04 | 5.5 | 5.5 | 0.13 | 1 | 2 | 185.28 |
| 0.23 | 0.38 | 3.20 | 6.99 | 12.0 | 0.23 | 0.38 | 26.22 | 6.5 | 5.5 | 0.13 | 1 | 2 | 218.97 |
| 0.23 | 0.38 | 3.20 | 6.99 | 9.0 | 0.23 | 0.38 | 19.67 | 3.5 | 5.5 | 0.13 | 1 | 2 | 117.91 |
| 0.23 | 0.38 | 3.20 | 6.99 | 8.5 | 0.23 | 0.38 | 18.57 | 2.0 | 6.5 | 0.13 | 1 | 2 | 79.63 |
| 0.23 | 0.38 | 3.20 | 6.99 | 11.0 | 0.23 | 0.38 | 24.04 | 4.5 | 6.5 | 0.13 | 1 | 2 | 179.16 |
| 0.23 | 0.38 | 3.20 | 6.99 | 12.0 | 0.23 | 0.38 | 26.22 | 5.5 | 6.5 | 0.13 | 1 | 2 | 218.97 |
| 0.23 | 0.38 | 3.20 | 6.99 | 13.0 | 0.23 | 0.38 | 28.41 | 6.5 | 6.5 | 0.13 | 1 | 2 | 258.78 |
| 0.23 | 0.38 | 3.20 | 6.99 | 10.0 | 0.23 | 0.38 | 21.85 | 3.5 | 6.5 | 0.13 | 1 | 2 | 139.34 |
| 0.23 | 0.38 | 3.20 | 6.99 | 5.5 | 0.23 | 0.38 | 12.02 | 2.0 | 3.5 | 0.13 | 1 | 2 | 42.88 |
| 0.23 | 0.38 | 3.20 | 6.99 | 8.0 | 0.23 | 0.38 | 17.48 | 4.5 | 3.5 | 0.13 | 1 | 2 | 96.47 |
| 0.23 | 0.38 | 3.20 | 6.99 | 9.0 | 0.23 | 0.38 | 19.67 | 5.5 | 3.5 | 0.13 | 1 | 2 | 117.91 |
| 0.23 | 0.38 | 3.20 | 6.99 | 10.0 | 0.23 | 0.38 | 21.85 | 6.5 | 3.5 | 0.13 | 1 | 2 | 139.34 |
| 0.23 | 0.38 | 3.20 | 6.99 | 7.0 | 0.23 | 0.38 | 15.30 | 3.5 | 3.5 | 0.13 | 1 | 2 | 75.03 |

Table 1

| Self Weight from Wall(KN/m) |  |  |  | Total Loads |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| L | H | T | P | Indiuval Floor load | Load | Factored load | Column |
| 4.0 | 2.82 | 0.23 | 46.70 | 86.93 | 189.59 | 284.39 | C1 |
| 6.5 | 2.82 | 0.23 | 75.89 | 152.21 | 325.61 | 488.41 | C2 |
| 7.5 | 2.82 | 0.23 | 87.56 | 178.32 | 380.01 | 570.02 | C3 |
| 8.5 | 2.82 | 0.23 | 99.24 | 204.43 | 434.42 | 651.62 | C4 |
| 5.5 | 2.82 | 0.23 | 64.21 | 126.10 | 271.20 | 406.80 | C5 |
| 6.5 | 2.82 | 0.23 | 75.89 | 152.21 | 325.61 | 488.41 | C6 |
| 9.0 | 2.82 | 0.23 | 105.07 | 255.76 | 538.18 | 807.27 | C7 |
| 10.0 | 2.82 | 0.23 | 116.75 | 297.18 | 623.21 | 934.81 | C8 |
| 11.0 | 2.82 | 0.23 | 128.42 | 338.61 | 708.24 | 1062.36 | C9 |
| 8.0 | 2.82 | 0.23 | 93.40 | 214.34 | 453.15 | 679.73 | C10 |
| 7.5 | 2.82 | 0.23 | 87.56 | 178.32 | 380.01 | 570.02 | C11 |
| 10.0 | 2.82 | 0.23 | 116.75 | 297.18 | 623.21 | 934.81 | C12 |
| 11.0 | 2.82 | 0.23 | 128.42 | 344.73 | 720.49 | 1080.73 | C13 |
| 12.0 | 2.82 | 0.23 | 140.10 | 392.28 | 817.77 | 1226.65 | C14 |
| 9.0 | 2.82 | 0.23 | 105.07 | 249.64 | 525.93 | 788.89 | C15 |
| 8.5 | 2.82 | 0.23 | 99.24 | 204.43 | 434.42 | 651.62 | C16 |
| 11.0 | 2.82 | 0.23 | 128.42 | 338.61 | 708.24 | 1062.36 | C17 |
| 12.0 | 2.82 | 0.23 | 140.10 | 392.28 | 817.77 | 1226.65 | C18 |
| 13.0 | 2.82 | 0.23 | 151.77 | 445.95 | 927.30 | 1390.95 | C19 |
| 10.0 | 2.82 | 0.23 | 116.75 | 284.93 | 598.71 | 898.06 | C20 |
| 5.5 | 2.82 | 0.23 | 64.21 | 126.10 | 271.20 | 406.80 | C21 |
| 8.0 | 2.82 | 0.23 | 93.40 | 214.34 | 453.15 | 679.73 | C22 |
| 9.0 | 2.82 | 0.23 | 105.07 | 249.64 | 525.93 | 788.89 | C23 |
| 10.0 | 2.82 | 0.23 | 116.75 | 284.93 | 598.71 | 898.06 | C24 |
| 7.0 | 2.82 | 0.23 | 81.72 | 179.04 | 380.37 | 570.56 | C25 |

Table 2
C. Design of Beam


Fig 3

1) Inputs

Beam

| Beam Depth | 0.38 | m |
| :--- | :---: | :---: |
| Beam Width | 0.23 | $\mathbf{m}$ |
| ES | 200000 | $\mathrm{~N} / \mathrm{mm}^{2}$ |
| Depth | 0.38 | $\mathbf{m}$ |
| Cover to center | 0.04 | $\mathbf{m}$ |
| Effective Depth | 0.34 | $\mathbf{m}$ |
| Stirrup Dia | 8 | $\mathbf{m m}$ |
| Cover | 25 | $\mathbf{m m}$ |

2) Design

Design of Beam

| Beam.No | $\operatorname{ES}\left(\mathrm{N} / \mathrm{mm}^{2}\right)$ | Xumax/d | Tcmax(N/mm2) | Pt $\min (\%)$ | BM | SF |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| B-1 | 200000 | 0.046 | 2.8 | 0.170 | 42.63 | 24.88 |
|  |  |  |  |  | Section Adequte |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Type Of |  | Ast | No. of Bars | Spacing (mm C/C) |  |  |
| SINC |  | 321.47 | 3.00 | 0.75 |  |  |
|  |  |  |  |  |  |  |


| Beam.No |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Panel .N0 | Span Ratio | Check For Slab | Bending Moment Coefficents |  |  |  | Shear Coefficents |  |  |
|  |  |  |  | Total |  |  |  |  |  |  |
|  |  |  |  | Middle of end | Middle of interior | End | Next to End | At Support Next to the End Support |  |  |
|  |  |  |  | DL+LL | DL+LL | DL+LL | DL+LL | At End | Next to end | Interior support |
| B1 | 1 | 1.000 | Two Way Slab | 35.844 | 27.239 | 42.634 | 36.318 | 24.883 | 25.283 | 25.283 |
| B2 | 2 | 1.250 | Two Way Slab | 46.574 | 67.738 | 98.059 | 90.318 | 19.996 | 20.468 | 20.468 |
| B3 | 3 | 1.500 | Two Way Slab | 90.191 | 68.665 | 107.138 | 91.554 | 27.508 | 28.019 | 28.019 |
| B4 | 4 | 1.750 | Two Way Slab | 125.516 | 95.593 | 149.067 | 127.457 | 28.065 | 28.600 | 28.600 |
| B5 | 5 | 1.250 | Two Way Slab | 46.844 | 35.489 | 55.834 | 47.318 | 33.133 | 33.533 | 33.533 |
|  | 1 | 1.000 | Two Way Slab |  |  |  |  |  |  |  |
| B6 | 6 | 1.000 | Two Way Slab | 68.525 | 52.088 | 81.490 | 69.451 | 30.392 | 30.892 | 30.892 |
|  | 2 | 1.250 | Two Way Slab |  |  |  |  |  |  |  |
| B7 | 7 | 1.200 | Two Way Slab | 127.421 | 96.719 | 151.676 | 128.958 | 39.592 | 40.168 | 40.168 |
|  | 3 | 1.500 | Two Way Slab |  |  |  |  |  |  |  |
| B8 | 8 | 1.400 | Two Way Slab | 180.805 | 137.298 | 215.158 | 183.064 | 41.166 | 41.789 | 41.789 |
|  | 4 | 1.750 | Two Way Slab |  |  |  |  |  |  |  |
| B9 | 9 | 1.500 | Two Way Slab | 46.844 | 35.489 | 55.834 | 47.318 | 33.133 | 33.533 | 33.533 |
|  | 5 | 1.250 | Two Way Slab |  |  |  |  |  |  |  |
| B10 | 10 | 1.200 | Two Way Slab | 83.454 | 63.285 | 99.404 | 84.380 | 37.558 | 38.058 | 38.058 |
|  | 6 | 1.000 | Two Way Slab |  |  |  |  |  |  |  |
| B11 | 11 | 1.000 | Two Way Slab | 133.488 | 101.316 | 158.906 | 135.088 | 41.496 | 42.096 | 42.096 |
|  | 7 | 1.200 | Two Way Slab |  |  |  |  |  |  |  |
| B12 | 12 | 1.167 | Two Way Slab | 194.874 | 148.006 | 231.876 | 197.341 | 44.326 | 45.006 | 45.006 |
|  | 8 | 1.400 | Two Way Slab |  |  |  |  |  |  |  |
| B13 | 13 | 1.750 | Two Way Slab | 46.844 | 35.489 | 55.834 | 47.318 | 33.133 | 33.533 | 33.533 |
|  | 9 | 1.500 | Two Way Slab |  |  |  |  |  |  |  |
| B14 | 14 | 1.400 | Two Way Slab | 83.454 | 63.285 | 99.404 | 84.380 | 37.558 | 38.058 | 38.058 |
|  | 10 | 1.200 | Two Way Slab |  |  |  |  |  |  |  |
| B15 | 15 | 1.167 | Two Way Slab | 139.874 | 106.105 | 166.568 | 141.474 | 43.625 | 44.225 | 44.225 |
|  | 11 | 1.000 | Two Way Slab |  |  |  |  |  |  |  |
| B16 | 16 | 1.000 | Two Way Slab | 202.072 | 153.460 | 240.454 | 204.613 | 45.987 | 46.687 | 46.687 |
|  | 12 | 1.167 | Two Way Slab |  |  |  |  |  |  |  |
| B17 | 13 | 1.750 | Two Way Slab | 35.844 | 27.239 | 42.634 | 36.318 | 24.883 | 25.283 | 25.283 |
| B18 | 14 | 1.400 | Two Way Slab | 61.970 | 47.172 | 73.623 | 62.896 | 27.246 | 27.746 | 27.746 |
| B19 | 15 | 1.167 | Two Way Slab | 102.749 | 78.262 | 122.018 | 104.349 | 31.250 | 31.850 | 31.850 |
| B20 | 16 | 1.000 | Two Way Slab | 127.994 | 97.901 | 151.560 | 130.535 | 27.846 | 28.546 | 28.546 |

Table 3


Table 4

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| LEFT SUPPORT |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Design Values At Left Support |  |  |  |  |  |
| Beam.No | ES (N/mm $\left.{ }^{2}\right)$ | Xumax/d | Tcmax(N/mm2) | Pt min(\%) |  |
| B-1 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-2 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-3 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-4 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-5 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-6 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-7 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-8 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-9 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-10 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-11 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-12 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-13 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-14 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-15 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-16 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-17 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-18 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-19 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-20 | 200000 | 0.046 | 2.8 | 0.170 |  |
| B-21 | 200000 | 0.046 | 2.8 | 0.170 |  |

Table 5

| Left Support(1) |  | Mid Span (2) |  | Right Support(3) |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| BM | SF | BM | SF | BM | SF | 1 | Beam | 3 | Beam |
| 42.63 | 24.88 | 35.84 | 0.00 | 36.32 | 25.28 | Section Adequte | SINGLY | Section Adequte | Singly |
| 90.32 | 20.47 | 46.57 | 0.00 | 67.74 | 20.47 | Section Adequte | DOUBLY | Section Adequte | Singly |
| 68.67 | 28.02 | 90.19 | 0.00 | 91.55 | 28.02 | Section Adequte | SINGLY | Section Adequte | Doubly |
| 127.46 | 28.60 | 125.52 | 0.00 | 149.07 | 28.07 | Section Adequte | DOUBLY | Section Adequte | Doubly |
| 55.83 | 33.13 | 46.84 | 0.00 | 47.32 | 33.53 | Section Adequte | SINGLY | Section Adequte | Singly |
| 69.45 | 30.89 | 68.53 | 0.00 | 52.09 | 30.89 | Section Adequte | SINGLY | Section Adequte | Singly |
| 96.72 | 40.17 | 127.42 | 0.00 | 128.96 | 40.17 | Section Adequte | DOUBLY | Section Adequte | Doubly |
| 183.06 | 41.79 | 180.80 | 0.00 | 215.16 | 41.17 | Section Adequte | DOUBLY | Section Adequte | Doubly |
| 55.83 | 33.13 | 46.84 | 0.00 | 47.32 | 33.53 | Section Adequte | SINGLY | Section Adequte | Singly |
| 84.38 | 38.06 | 83.45 | 0.00 | 63.29 | 38.06 | Section Adequte | SINGLY | Section Adequte | Singly |
| 101.32 | 42.10 | 133.49 | 0.00 | 135.09 | 42.10 | Section Adequte | DOUBLY | Section Adequte | Doubly |
| 197.34 | 45.01 | 194.87 | 0.00 | 231.88 | 44.33 | Section Adequte | DOUBLY | Section Adequte | Doubly |
| 55.83 | 33.13 | 46.84 | 0.00 | 47.32 | 33.53 | Section Adequte | SINGLY | Section Adequte | Singly |
| 84.38 | 38.06 | 83.45 | 0.00 | 63.29 | 38.06 | Section Adequte | SINGLY | Section Adequte | Singly |
| 106.11 | 44.22 | 139.87 | 0.00 | 141.47 | 44.22 | Section Adequte | DOUBLY | Section Adequte | Doubly |
| 204.61 | 46.69 | 202.07 | 0.00 | 240.45 | 45.99 | Section Adequte | DOUBLY | Section Adequte | Doubly |
| 42.63 | 24.88 | 35.84 | 0.00 | 36.32 | 25.28 | Section Adequte | SINGLY | Section Adequte | Singly |
| 62.90 | 27.75 | 61.97 | 0.00 | 47.17 | 27.75 | Section Adequte | SINGLY | Section Adequte | Singly |
| 78.26 | 31.85 | 102.75 | 0.00 | 104.35 | 31.85 | Section Adequte | SINGLY | Section Adequte | Doubly |
| 130.53 | 28.55 | 127.99 | 0.00 | 151.56 | 27.85 | Section Adequte | DOUBLY | Section Adequte | Doubly |
| 111.22 | 25.28 | 109.77 | 0.00 | 130.57 | 24.88 | Section Adequte | DOUBLY | Section Adequte | Doubly |

Table 6

International Journal for Research in Applied Science \& Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538 Volume 10 Issue IX Sep 2022- Available at www.ijraset.com


Table 7

| Top Reinforcement |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 (At Left Support) |  | 2 (At Mid span) |  |  | 3 (Right Support) |  |  |  |
| Ast | No. of Bars | Ast | No.of Bars | Spacing (mm C/C) | Ast | No.of Bars | Spacing (mm C/C) |  |
| 321.47 | 3.00 | 321.47 | 0.16 | 0.00 | 268.78 | 0.19 | 0.00 |  |
| 58.68 | 1.00 | 59.03 | 0.85 | 0.75 | 558.11 | 0.09 | 0.00 |  |
| 567.93 | 6.00 | 568.27 | 0.09 | 0.00 | 59.69 | 0.84 | 0.75 |  |
| 55.97 | 1.00 | 61.94 | 0.81 | 0.75 | 66.14 | 0.76 | 0.75 |  |
| 439.63 | 4.00 | 439.63 | 0.11 | 0.00 | 362.07 | 0.14 | 0.00 |  |
| 576.34 | 6.00 | 576.34 | 0.09 | 0.00 | 404.87 | 0.12 | 0.00 |  |
| 58.22 | 1.00 | 62.07 | 0.81 | 0.75 | 63.88 | 0.79 | 0.75 |  |
| 51.92 | 1.00 | 65.97 | 0.76 | 0.75 | 73.55 | 0.68 | 0.50 |  |
| 439.63 | 4.00 | 439.63 | 0.11 | 0.00 | 362.07 | 0.14 | 0.00 |  |
| 752.53 | 7.00 | 752.53 | 0.07 | 0.00 | 512.21 | 0.10 | 0.00 |  |
| 57.88 | 1.00 | 62.52 | 0.80 | 0.75 | 64.57 | 0.78 | 0.75 |  |
| 50.87 | 1.00 | 67.00 | 0.75 | 0.75 | 75.42 | 0.67 | 0.50 |  |
| 439.63 | 4.00 | 439.63 | 0.11 | 0.00 | 362.07 | 0.14 | 0.00 |  |
| 752.53 | 7.00 | 752.53 | 0.07 | 0.00 | 512.21 | 0.10 | 0.00 |  |
| 57.53 | 1.00 | 62.98 | 0.80 | 0.75 | 65.29 | 0.77 | 0.75 |  |
| 50.34 | 1.00 | 67.52 | 0.74 | 0.50 | 76.39 | 0.66 | 0.50 |  |
| 321.47 | 3.00 | 321.47 | 0.16 | 0.00 | 268.78 | 0.19 | 0.00 |  |
| 508.30 | 5.00 | 508.30 | 0.10 | 0.00 | 360.78 | 0.14 | 0.00 |  |
| 676.04 | 6.00 | 677.29 | 0.07 | 0.00 | 61.12 | 0.82 | 0.75 |  |
| 55.75 | 1.00 | 62.12 | 0.81 | 0.75 | 66.42 | 0.76 | 0.75 |  |
|  |  |  |  |  |  |  |  |  |

Table 8

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| $-\ldots$ | $\ldots$ | $\ldots$ | $\ldots$. |  |
| :---: | :---: | :---: | :---: | :---: |
| B-21 | 200000 | 0.046 | 2.8 | 0.170 |
| B-22 | 200000 | 0.046 | 2.8 | 0.170 |
| B-23 | 200000 | 0.046 | 2.8 | 0.170 |
| B-24 | 200000 | 0.046 | 2.8 | 0.170 |
| B-25 | 200000 | 0.046 | 2.8 | 0.170 |
| B-26 | 200000 | 0.046 | 2.8 | 0.170 |
| B-27 | 200000 | 0.046 | 2.8 | 0.170 |
| B-28 | 200000 | 0.046 | 2.8 | 0.170 |
| B-29 | 200000 | 0.046 | 2.8 | 0.170 |
| B-30 | 200000 | 0.046 | 2.8 | 0.170 |
| B-31 | 200000 | 0.046 | 2.8 | 0.170 |
| B-32 | 200000 | 0.046 | 2.8 | 0.170 |
| B-33 | 200000 | 0.046 | 2.8 | 0.170 |
| B-34 | 200000 | 0.046 | 2.8 | 0.170 |
| B-35 | 200000 | 0.046 | 2.8 | 0.170 |
| B-36 | 200000 | 0.046 | 2.8 | 0.170 |
| B-37 | 200000 | 0.046 | 2.8 | 0.170 |
| B-38 | 200000 | 0.046 | 2.8 | 0.170 |
| B-39 | 200000 | 0.046 | 2.8 | 0.170 |
| B-40 | 200000 | 0.046 | 2.8 | 0.170 |

Table 9

| 111.22 | 25.28 | 109.77 | 0.00 | 130.57 | 24.88 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 47.32 | 33.53 | 46.84 | 0.00 | 55.83 | 33.13 |
| 47.32 | 33.53 | 46.84 | 0.00 | 55.83 | 33.13 |
| 47.32 | 33.53 | 46.84 | 0.00 | 55.83 | 33.13 |
| 36.32 | 25.28 | 35.84 | 0.00 | 42.63 | 24.88 |
| 45.88 | 27.06 | 60.30 | 0.00 | 61.17 | 27.06 |
| 62.38 | 37.48 | 82.25 | 0.00 | 83.18 | 37.48 |
| 63.29 | 38.06 | 83.45 | 0.00 | 84.38 | 38.06 |
| 63.29 | 38.06 | 83.45 | 0.00 | 84.38 | 38.06 |
| 60.58 | 27.75 | 61.97 | 0.00 | 62.90 | 27.75 |
| 91.55 | 28.02 | 90.19 | 0.00 | 68.67 | 28.02 |
| 128.96 | 60.58 | 127.42 | 0.00 | 125.12 | 60.58 |
| 133.49 | 63.51 | 133.49 | 0.00 | 133.49 | 63.51 |
| 136.55 | 64.29 | 134.95 | 0.00 | 132.55 | 64.29 |
| 99.42 | 30.21 | 97.82 | 0.00 | 74.57 | 30.21 |
| 149.07 | 28.07 | 125.52 | 0.00 | 127.46 | 28.60 |
| 215.16 | 41.17 | 180.80 | 0.00 | 183.06 | 41.79 |
| 231.88 | 44.33 | 194.87 | 0.00 | 197.34 | 45.01 |
| 240.45 | 45.99 | 202.07 | 0.00 | 204.61 | 46.69 |
| 171.77 | 31.97 | 144.84 | 0.00 | 147.38 | 32.67 |

Table 10

International Journal for Research in Applied Science \& Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538 Volume 10 Issue IX Sep 2022-Available at www.ijraset.com

| Section Adequte | DOUBLY | Section Adequte | Doubly |
| :--- | :--- | :--- | :--- |
| Section Adequte | DOUBLY | Section Adequte | Doubly |
| Section Adequte | SINGLY | Section Adequte | Singly |
| Section Adequte | SINGLY | Section Adequte | Singly |
| Section Adequte | SINGLY | Section Adequte | Singly |
| Section Adequte | SINGLY | Section Adequte | Singly |
| Section Adequte | SINGLY | Section Adequte | Singly |
| Section Adequte | SINGLY | Section Adequte | Singly |
| Section Adequte | SINGLY | Section Adequte | Singly |
| Section Adequte | SINGLY | Section Adequte | Singly |
| Section Adequte | SINGLY | Section Adequte | Singly |
| Section Adequte | DOUBLY | Section Adequte | Singly |
| Section Adequte | DOUBLY | Section Adequte | Doubly |
| Section Adequte | DOUBLY | Section Adequte | Doubly |
| Section Adequte | DOUBLY | Section Adequte | Doubly |
| Section Adequte | DOUBLY | Section Adequte | Singly |
| Section Adequte | DOUBLY | Section Adequte | Doubly |
| Section Adequte | DOUBLY | Section Adequte | Doubly |
| Section Adequte | DOUBLY | Section Adequte | Doubly |
| Section Adequte | DOUBLY | Section Adequte | Doubly |
| Section Adequte | DOUBLY | Section Adequte | Doubly |

Table 11

| 57.16 | 1.00 | 60.79 | 0.83 | 0.75 | 64.06 | 0.78 | 0.75 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 362.07 | 4.00 | 362.07 | 0.14 | 0.00 | 439.63 | 0.11 | 0.00 |
| 362.07 | 4.00 | 362.07 | 0.14 | 0.00 | 439.63 | 0.11 | 0.00 |
| 362.07 | 4.00 | 362.07 | 0.14 | 0.00 | 439.63 | 0.11 | 0.00 |
| 268.78 | 3.00 | 268.78 | 0.19 | 0.00 | 321.47 | 0.16 | 0.00 |
| 349.46 | 4.00 | 349.46 | 0.14 | 0.00 | 491.15 | 0.10 | 0.00 |
| 503.16 | 5.00 | 503.16 | 0.10 | 0.00 | 736.92 | 0.07 | 0.00 |
| 512.21 | 5.00 | 512.21 | 0.10 | 0.00 | 752.53 | 0.07 | 0.00 |
| 512.21 | 5.00 | 512.21 | 0.10 | 0.00 | 752.53 | 0.07 | 0.00 |
| 485.30 | 5.00 | 485.30 | 0.10 | 0.00 | 508.30 | 0.10 | 0.00 |
| 58.59 | 1.00 | 59.36 | 0.85 | 0.75 | 567.93 | 0.09 | 0.00 |
| 55.86 | 1.00 | 62.07 | 0.81 | 0.75 | 63.45 | 0.79 | 0.75 |
| 55.53 | 1.00 | 62.52 | 0.80 | 0.75 | 64.39 | 0.78 | 0.75 |
| 55.31 | 1.00 | 62.62 | 0.80 | 0.75 | 64.29 | 0.78 | 0.75 |
| 58.02 | 1.00 | 59.91 | 0.84 | 0.75 | 632.93 | 0.08 | 0.00 |
| 54.40 | 1.00 | 61.94 | 0.81 | 0.75 | 63.71 | 0.79 | 0.75 |
| 49.57 | 1.00 | 65.97 | 0.76 | 0.75 | 69.95 | 0.72 | 0.50 |
| 48.35 | 1.00 | 67.00 | 0.75 | 0.75 | 71.55 | 0.70 | 0.50 |
| 47.73 | 1.00 | 67.52 | 0.74 | 0.50 | 72.37 | 0.69 | 0.50 |
| 52.74 | 1.00 | 63.35 | 0.79 | 0.75 | 65.95 | 0.76 | 0.75 |

Table 12

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3) E-tab Results


Fig 4
4) Validation of Results

| Left Support(1) |  | Mid Span (2) |  | Right Support(3) |  |  | Left Support(1) |  | Mid Span (2) |  | Right Support(3) |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| BM | SF | BM | SF | BM | SF |  | BM | SF | BM | SF | BM | SF |
| 16.20 | 48.58 | 27.91 | 4.88 | 33.75 | 58.28 | B-1 | 42.63 | 24.88 | 35.84 | 0.00 | 36.32 | 25.28 |
| 45.95 | 68.71 | 37.51 | 3.60 | 62.75 | 75.98 | B-2 | 90.32 | 20.47 | 46.57 | 0.00 | 67.74 | 20.47 |
| 73.66 | 85.41 | 50.17 | 5.85 | 106.58 | 97.12 | B-3 | 68.67 | 28.02 | 90.19 | 0.00 | 91.55 | 28.02 |
| 128.12 | 120.81 | 105.23 | 10.62 | 57.78 | 99.50 | B-4 | 127.46 | 28.60 | 125.52 | 0.00 | 149.07 | 28.07 |
| 23.98 | 65.64 | 39.08 | 5.90 | 45.67 | 77.63 | B-5 | 55.83 | 33.13 | 46.84 | 0.00 | 47.32 | 33.53 |
| 63.37 | 94.41 | 55.94 | 6.40 | 93.27 | 107.30 | B-6 | 69.45 | 30.89 | 68.53 | 0.00 | 52.09 | 30.89 |
| 108.38 | 121.95 | 77.40 | 9.30 | 160.85 | 140.62 | B-7 | 96.72 | 40.17 | 127.42 | 0.00 | 128.96 | 40.17 |
| 191.84 | 176.77 | 163.19 | 15.08 | 92.00 | 146.60 | B-8 | 183.06 | 41.79 | 180.80 | 0.00 | 215.16 | 41.17 |
| 25.58 | 66.49 | 39.01 | 5.14 | 44.21 | 76.78 | B-9 | 55.83 | 33.13 | 46.84 | 0.00 | 47.32 | 33.53 |
| 63.43 | 97.06 | 57.16 | 6.90 | 95.68 | 109.02 | B-10 | 84.38 | 38.06 | 83.45 | 0.00 | 63.29 | 38.06 |
| 112.18 | 125.60 | 82.38 | 10.28 | 169.96 | 146.16 | B-11 | 101.32 | 42.10 | 133.49 | 0.00 | 135.09 | 42.10 |
| 203.60 | 186.47 | 178.56 | 15.59 | 100.36 | 155.28 | B-12 | 197.34 | 45.01 | 194.87 | 0.00 | 231.88 | 44.33 |
| 28.52 | 68.25 | 39.26 | 3.38 | 40.77 | 75.02 | B-13 | 55.83 | 33.13 | 46.84 | 0.00 | 47.32 | 33.53 |
| 62.31 | 94.82 | 57.74 | 7.21 | 97.66 | 109.25 | B-14 | 84.38 | 38.06 | 83.45 | 0.00 | 63.29 | 38.06 |
| 113.01 | 126.42 | 83.66 | 10.61 | 172.65 | 147.64 | B-15 | 106.11 | 44.22 | 139.87 | 0.00 | 141.47 | 44.22 |
| 207.32 | 190.74 | 187.45 | 15.27 | 106.21 | 160.19 | B-16 | 204.61 | 46.69 | 202.07 | 0.00 | 240.45 | 45.99 |
| 18.39 | 49.79 | 27.92 | 3.63 | 31.55 | 57.07 | B-17 | 42.63 | 24.88 | 35.84 | 0.00 | 36.32 | 25.28 |
| 45.67 | 69.29 | 38.93 | 4.20 | 65.10 | 77.70 | B-18 | 62.90 | 27.75 | 61.97 | 0.00 | 47.17 | 27.75 |
| 77.33 | 88.93 | 54.87 | 6.92 | 116.25 | 102.79 | B-19 | 78.26 | 31.85 | 102.75 | 0.00 | 104.35 | 31.85 |
| 140.72 | 131.55 | 123.07 | 11.03 | 67.66 | 109.48 | B-20 | 130.53 | 28.55 | 127.99 | 0.00 | 151.56 | 27.85 |

Table 13

| 42.46 | 63.90 | 31.28 | 8.90 | 8.89 | 46.09 | B-21 | 111.22 | 25.28 | 109.77 | 0.00 | 130.57 | 24.88 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 58.51 | 85.48 | 43.78 | 12.17 | 12.60 | 61.13 | B-22 | 47.32 | 33.53 | 46.84 | 0.00 | 55.83 | 33.13 |
| 57.26 | 84.89 | 43.91 | 11.50 | 13.59 | 61.72 | B-23 | 47.32 | 33.53 | 46.84 | 0.00 | 55.83 | 33.13 |
| 55.00 | 83.94 | 44.39 | 10.63 | 14.90 | 62.67 | B-24 | 47.32 | 33.53 | 46.84 | 0.00 | 55.83 | 33.13 |
| 40.76 | 63.10 | 31.48 | 8.11 | 10.19 | 46.88 | B-25 | 36.32 | 25.28 | 35.84 | 0.00 | 42.63 | 24.88 |
| 69.38 | 78.15 | 38.07 | 4.23 | 49.17 | 69.67 | B-26 | 45.88 | 27.06 | 60.30 | 0.00 | 61.17 | 27.06 |
| 102.55 | 109.89 | 56.83 | 7.33 | 67.57 | 95.22 | B-27 | 62.38 | 37.18 | 82.25 | 0.00 | 83.18 | 37.48 |
| 105.36 | 111.70 | 58.20 | 8.01 | 67.11 | 95.69 | B-28 | 63.29 | 38.06 | 83.45 | 0.00 | 84.38 | 38.06 |
| 105.49 | 112.03 | 58.81 | 8.32 | 65.77 | 95.38 | B-29 | 63.29 | 38.06 | 83.45 | 0.00 | 84.38 | 38.06 |
| 71.94 | 79.98 | 39.68 | 4.90 | 48.49 | 70.14 | B-30 | 60.58 | 27.75 | 61.97 | 0.00 | 62.90 | 27.75 |
| 128.05 | 102.02 | 45.66 | 9.16 | 75.02 | 83.64 | B-31 | 91.55 | 28.02 | 90.19 | 0.00 | 68.67 | 28.02 |
| 193.27 | 147.43 | 70.48 | 14.47 | 109.76 | 118.48 | B-32 | 128.96 | 60.58 | 127.42 | 0.00 | 125.12 | 60.58 |
| 204.58 | 153.39 | 74.83 | 15.84 | 113.18 | 121.71 | B-33 | 133.49 | 63.51 | 133.49 | 0.00 | 133.49 | 63.51 |
| 208.68 | 155.17 | 75.67 | 16.47 | 113.64 | 122.23 | B-34 | 136.55 | 64.29 | 134.95 | 0.00 | 132.55 | 64.29 |
| 140.32 | 108.19 | 49.65 | 10.76 | 78.20 | 86.66 | B-35 | 99.42 | 30.21 | 97.82 | 0.00 | 74.57 | 30.21 |
| 31.05 | 95.48 | 120.38 | 16.26 | 141.19 | 128.02 | B-36 | 149.07 | 28.07 | 125.52 | 0.00 | 127.46 | 28.60 |
| 49.77 | 139.42 | 186.46 | 23.94 | 211.85 | 187.30 | B-37 | 215.16 | 41.17 | 180.80 | 0.00 | 183.06 | 41.79 |
| 54.48 | 147.42 | 203.88 | 25.12 | 224.60 | 197.67 | B-38 | 231.88 | 44.33 | 194.87 | 0.00 | 197.34 | 45.01 |
| 57.55 | 151.75 | 213.95 | 25.38 | 229.41 | 202.52 | B-39 | 240.45 | 45.99 | 202.07 | 0.00 | 204.61 | 46.69 |
| 36.46 | 104.54 | 140.50 | 17.53 | 155.17 | 139.62 | B-40 | 171.77 | 31.97 | 144.84 | 0.00 | 147.38 | 32.67 |

Table 14
D. Design of Slab


Fig 5

## 1) Input

| Slab |  |  |
| :---: | :---: | :---: |
| $\mathbf{b}$ | 1000 | mm |

2) Design

|  |  | Design OF Slab |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| SIab | Live Load | Floor Finish | Self Weight of Slab | Total Load | Ulimate Load | Lx | Ly |
| Si | (KN/m2) | (KN/m2) | (KN/m2) | (KN/m2) | Wu (KN/m2) | m | m |
| S-1 | 2 | 1 | 3.125 | 6.125 | 9.1875 | 4 | 4 |
|  |  |  |  |  |  | Two Way Slab |  |
|  | Proposed Dia |  |  | Ast min | Spacing for Main Bars |  |  |
|  |  |  |  | mm2 | mm |  |  |
|  | (-ve) | (+ve) |  | 132 | 380.80 |  |  |
|  | mm | mm |  |  |  |  |  |
|  | 8 | 8 |  |  |  |  |  |
|  | Steel Within the Limit |  |  |  |  |  |  |
|  | Satisfies deflection Criterion |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |


| Slab | Live Load | Floor Finish | Self Weight of Slab | Total Load | Ultimate Load | Lx | Ly | Span Ratio | Check for slab |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | (KN/m2) | (KN/m2) | (KN/m2) | (KN/m2) | Wu (KN/m2) |  |  | Ly/Lx |  |  |
| S-1 | 2 | 1 | 3.125 | 6.125 | 9.188 | 4.000 | 4.000 | 1.000 | Two Way Slab |  |
| S-2 | 2 | 1 | 3.125 | 6.125 | 9.188 | 4.000 | 5.000 | 1.250 | Two Way Slab |  |
| S-3 | 2 | 1 | 3.125 | 6.125 | 9.188 | 4.000 | 6.000 | 1.500 | Two Way Slab |  |
| S-4 | 2 | 1 | 3.125 | 6.125 | 9.188 | 4.000 | 7.000 | 1.750 | Two Way Slab |  |
| S-5 | 2 | 1 | 3.125 | 6.125 | 9.188 | 4.000 | 5.000 | 1.250 | Two Way Slab |  |
| S-6 | 2 | 1 | 3.125 | 6.125 | 9.188 | 5.000 | 5.000 | 1.000 | Two Way Slab |  |
| S-7 | 2 | 1 | 3.125 | 6.125 | 9.188 | 5.000 | 6.000 | 1.200 | Two Way Slab |  |
| S-8 | 2 | 1 | 3.125 | 6.125 | 9.188 | 5.000 | 7.000 | 1.400 | Two Way Slab |  |

Table 15

|  |  |  | Multiplaction Factor |  |  |  | Area of Steel Required Bar mm² (Ast req) |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Le | Effective depth | W1x ${ }^{2}$ | eax at Supporl of shorts | ve ax al Midspan of short spd | -re ay al suport of long span | +ye ay al Mid span of long span | - ve ax al Support of short span | + yeax at Midspan of short span | -ve ay al suport of long span | +ve ay at Mid span of long span |
|  | De(m) | KN | ax | $a \times$ | ay | ay | ax | $a x$ | ay | a) |
| 4.230 | 0.110 | 47.000 | 0.047 | 0.035 | 0.047 | 0.035 | 149.543 | 10.345 | 149543 | 10.335 |
| 4.330 | 0.110 | 47.000 | 0.045 | 0.034 | 0032 | 0.024 | 142958 | 107.11 | 100.659 | 75.47 |
| 4.230 | 0.110 | 477.000 | 0.053 | 0.041 | 0032 | 0.024 | 169.427 | 129.851 | 10.659 | 75.047 |
| 4.330 | 0.110 | 47.000 | 0.055 | 0.041 | 0.032 | 0.024 | 176098 | 129.851 | 100.659 | 75.047 |
| 4.330 | 0.110 | 47.000 | 0.045 | 0.034 | 0032 | 0.024 | 142558 | 107.11 | 100.559 | 75.047 |
| 5.330 | 0.110 | 229.688 | 0.032 | 0.024 | 0032 | 0.024 | 159461 | 188.450 | 159.451 | 18.450 |
| 5.330 | 0.110 | 2299688 | 0.043 | 0.032 | 0032 | 0.024 | 277.235 | 159.461 | 159.461 | 118.450 |
| 5.230 | 0.110 | 229.688 | 0.051 | 0.039 | 0.032 | 0.024 | 200333 | 196.034 | 159.451 | 118.450 |

Table 16

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| Ast min | Proposed Dia |  | Area of Steel Bar mm ${ }^{2}$ |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | (-ve) | (+ve) | - ve $\alpha \times$ at Support of short span | + ve $\alpha x$ at Midspan of short span | -ve $\alpha y$ at suport of long span | +ve $\alpha \mathrm{y}$ at Mid span of long span |
| mm2 | mm | mm | ax | ax | ay | ay |
| 132 | s | s | 50.270 | 50.270 | 50.270 | 50.270 |
| 132 | 8 | s | 50.270 | 50.270 | 50.270 | 50.270 |
| 132 | 8 | 8 | 50.270 | 50.270 | 50.270 | 50.270 |
| 132 | 8 | § | 50.270 | 50.270 | 50.270 | 50.270 |
| 132 | 8 | 8 | 50.270 | 50.270 | 50.270 | 50.270 |
| 132 | s | s | 50.270 | 50.270 | 50.270 | 50.270 |
| 132 | § | § | 50.270 | 50.270 | 50.270 | 50.270 |
| 132 | 8 | 8 | 50.270 | 50.270 | 50.270 | 50.270 |

Table 17

| Area of Steel Provided $\mathrm{mm}^{2}$ (Ast Provided) |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| -ve $\alpha x$ at Support of short span | + ve ax at Midspan of short span | -ve ay at suport of long span | +ve $\alpha y$ at Mid span of long span |  |  |
| ax | ax | ay | ay |  |  |
| 201 | 201 | 201 | 201 | Steel Within the Limit | Satisfies deflection Criterion |
| 201 | 201 | 201 | 201 | Steel Within the Limit | Satisfies deflection Criterion |
| 201 | 201 | 201 | 201 | Steel Within the Limit | Satisfies deflection Criterion |
| 201 | 201 | 201 | 201 | Steel Within the Limit | Satisfies deflection Criterion |
| 201 | 201 | 201 | 201 | Steel Within the Limit | Satisfies deflection Criterion |
| 201 | 201 | 201 | 201 | Steel Within the Limit | Satisfies deflection Criterion |
| 251 | 201 | 201 | 201 | Steel Within the Limit | Satisfies deflection Criterion |
| 302 | 201 | 201 | 201 | Steel Within the Limit | Satisfies deflection Criterion |

Table 18

| One Way Slab |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Mu for One Way Slab | Area of Steel Required | Ast min | Spacing for Main Bars | Provide | Spacing for Distribution Bars | Provide |
| KN-m | mm2 | mm2 | mm | $\mathrm{mm} \mathrm{c} / \mathrm{c}$ | mm | $\mathrm{mm} \mathrm{c} / \mathrm{c}$ |
| 0.000 | 0.000 | 132 | 380.799 | 375 | \#Div/0! | \#DIV/0! |
| 0.000 | 0.000 | 132 | 380.799 | 375 | \#DIV/0! | \#DIV/0! |
| 0.000 | 0.000 | 132 | 380.799 | 375 | \#Drv/0! | \#Div/0! |
| 0.000 | 0.000 | 132 | 380.799 | 375 | \#Drv/0! | \#DIV/0! |
| 0.000 | 0.000 | 132 | 380.799 | 375 | \#Drv/0! | \#DIV/0! |
| 0.000 | 0.000 | 132 | 380.799 | 375 | \#DIV/0! | \#DIV/0! |
| 0.000 | 0.000 | 132 | 380.799 | 375 | \#DIV/0! | \#DIV/0! |
| 0.000 | 0.000 | 132 | 380.799 | 375 | \#DIV/0! | \#DIV/0! |

Table 19

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| S-9 | 2 | 1 | 3.125 | 6.125 | 9.188 | 4.000 | 6.000 | 1.500 | Two Way Slab |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| S-10 | 2 | 1 | 3.125 | 6.125 | 9.188 | 5.000 | 6.000 | 1.200 | Two Way Slab |
| S-11 | 2 | 1 | 3.125 | 6.125 | 9.188 | 6.000 | 6.000 | 1.000 | Two Way Slab |
| S-12 | 2 | 1 | 3.125 | 6.125 | 9.188 | 6.000 | 7.000 | 1.167 | Two Way Slab |
| S-13 | 2 | 1 | 3.125 | 6.125 | 9.188 | 4.000 | 7.000 | 1.750 | Two Way Slab |
| S-14 | 2 | 1 | 3.125 | 6.125 | 9.188 | 5.000 | 7.000 | 1.400 | Two Way Slab |
| S-15 | 2 | 1 | 3.125 | 6.125 | 9.188 | 6.000 | 7.000 | 1.167 | Two Way Slab |
| S-16 | 2 | 1 | 3.125 | 6.125 | 9.188 | 7.000 | 7.000 | 1.000 | Two Way Slab |

Table 20

| 4200 | 0.10 | 14.000 | 0.053 | 0.041 | 0003 | 0.024 | 189427 | 29.851 | 10.659 | 15097 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 5230 | 0.10 | 229688 | 0.043 | acce | 0032 | 0024 | 271.25 | 189.461 | 189.451 | 118.50 |
| 6230 | 0.10 | 330750 | 0.002 | 0.024 | 0002 | 0024 | 233.76 | 122.70 | 233.76 | 122760 |
| 8200 | 0.10 | 300750 | 0.041 | 0.031 | 0030 | 0024 | 304634 | 225.94 | 233.76 | 12760 |
| 4230 | 0.10 | 14.000 | 0000 | 0.045 | 0032 | 0.024 | 128873 | 12.588 | 10.689 | 15097 |
| 5220 | 0.10 | 229688 | 0.051 | 0.ccs | 0032 | 0.024 | 200.33 | 988.34 | 189859 | 118.50 |
| 8230 | 0.10 | 330750 | 0.041 | 0.031 | 0032 | 0024 | 30.634 | 255.89 | 233.76 | 122780 |
| 1230 | 0.10 | 450188 | 0.082 | 0.024 | 0032 | 0024 | ${ }^{36} 5.616$ | 238881 | 355.61 | 228891 |

Table 21

| 132 | 8 | 8 | 50.270 | 50.270 | 50.270 | 50.270 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 132 | 8 | 8 | 50.270 | 50.270 | 50.270 | 50.270 |
| 132 | 8 | 8 | 50.270 | 50.270 | 50.270 | 50.270 |
| 132 | 8 | 8 | 50.270 | 50.270 | 50.270 | 50.270 |
| 132 | 8 | 8 | 50.270 | 50.270 | 50.270 | 50.270 |
| 132 | 8 | 8 | 50.270 | 50.270 | 50.270 | 50.270 |
| 132 | 8 | 8 | 50.270 | 50.270 | 50.270 | 50.270 |
| 132 | 8 | 8 | 50.270 | 50.270 | 50.270 | 50.270 |

Table 22

| 201 | 201 | 201 | 201 | Steel Within the Limit | Deflection Criterion not satisfied! |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 251 | 201 | 201 | 201 | Steel Within the Limit | Satisfies deflection Criterion |
| 251 | 251 | 251 | 201 | Steel Within the Limit | Satisfies deflection Criterion |
| 352 | 201 | 201 | 201 | Steel Within the Limit | Satisfies deflection Criterion |
| 302 | 251 | 251 | 201 | Steel Within the Limit | Satisfies deflection Criterion |
| 352 | 251 | 352 | 201 | Steel Within the Limit | Satisfies deflection Criterion |
| 352 |  |  |  | Steel Within the Limit | Satisfies deflection Criterion |

Table 23

## IV. CONCLUSION

1) It can be concluded that, the results obtained by Excel after comparison with E-tabs gives 90-95\% accuracy.
2) MS Excel sheet is a very useful tool for calculating the rebars of various RC elements such as footing, columns, beams, and slabs.
3) These aid in the speedy design of buildings and other structures for a variety of applications and are effective.
4) For the design of reinforced concrete elements, these excel sheets can be used in conjunction with analytical software such as STAAD and ETABS.

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