# Developing an Individual Excel Sheet for Design and Analysis of Footing and Column 

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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 userinterface 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 needslot 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 outusing bending moment and shear force factors for continuous beams as specified in the IS456:2000. Slab panels are designed using the centre-to-centredistance 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 withaccuracy up to $95 \%$. The accuracy decreases as the size of the structure increases.
This excel sheet is very useful in designing regular structures till $\mathrm{G}+3$ 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. Themain 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 ofend 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 toanalyse 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 columnsand 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 usingSTAAD. Pro"

Author - Sushant Gupta
Structural design is the primary aspect of the civil engineering. The foremost basic in structuralengineering 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 Designconforming 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 diagramsin 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 softwarelike 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

A. Design and Analysis of RC structure by developing an independent Excel sheet andvalidating the result using ETABS software
B. To include structural engineering principles into design documents.
C. To improve the idea behind structural analysis and design as well as its effectivenesswhen a design sheet is employed.

## IV. METHODOLOGY

## A. Problem Definition

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

## B. Flow Chart


C. Sample

1) Inputs

| Self-Weight of RCC | 25 | $\mathrm{KN} / \mathrm{m}^{3}$ |
| :--- | :--- | :--- |
| Masonry | 18 | $\mathrm{KN} / \mathrm{m}^{3}$ |
| Floor Finish (FF) | 1 | $\mathrm{KN} / \mathrm{m}^{2}$ |
| Live Load (LL) | 2 | $\mathrm{KN} / \mathrm{m}^{2}$ |
| Grade of Concrete (fck) | 20 | $\mathrm{~N} / \mathrm{mm}^{2}$ |
| Reinforcement Grade (fy) | 500 | $\mathrm{~N} / \mathrm{mm}^{2}$ |
| Column Breadth (b) | 0.23 | m |
| Column Depth (D) | 0.38 | m |
| Height (H) | 3.2 | m |
| Slab Thickness (T) | 0.125 | m |
| Wall Thickness | 0.23 | m |
| No of Slab | 2 | Units |
| Beam Depth | 0.38 | m |
| Beam Width | 0.23 | m |



Fig 1
3) Calculation of Axial Loads

- Self-Weight on Column $=b^{*} d^{*} H^{*}$ Self-Weight of RCC

$$
\begin{aligned}
& =0.23 * 0.38 * 3.2 * 25 \\
& =6.99 \mathbf{K N}
\end{aligned}
$$

- Self-Weight of Beam $=L^{*} b^{*} d^{*}$ Self-Weight of RCC

$$
\begin{aligned}
& =4 * 0.23 * 0.38 * 25 \\
& =\mathbf{8 . 7 4} \mathbf{~ K N}
\end{aligned}
$$

- Self-Weight on Slab $=\left(L^{*} * * T *\right.$ Self-Weight of RCC $)+(\mathrm{L} * \mathrm{~B} * \mathrm{FF})+(\mathrm{L} * \mathrm{~B} * \mathrm{LL})$

$$
\begin{aligned}
& =(2 * 2 * 0.125 * 25)+(2 * 2 * 1)+(2 * 2 * 2) \\
& =\mathbf{2 4 . 5 0} \mathbf{~ K N}
\end{aligned}
$$

- Self-Weight from Wall = L* (Height-Beam Depth) *T*Masonry

$$
\begin{aligned}
& =4 *(3.2-0.38) * 0.23 * 18 \\
& =\mathbf{4 6 . 7 0} \mathbf{~ K N}
\end{aligned}
$$

- Individual Floor Load $=($ Self-Weight on Column $)+($ Self-Weight of Beam $)+$
(Self-Weight on Slab) + (Self-Weight from Wall)
$=(6.99)+(8.74)+(24.50)+(46.70)$
$=86.93 \mathrm{KN}$
- 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 KN

- Factored Load $=1.5 * \mathrm{P}$

$$
=1.5 * 189.59
$$

$$
\mathbf{P u}=284.39 \mathrm{KN}
$$

D. Design of Footing

1) Inputs

| SBC | 150 | $\mathrm{KN} / \mathrm{m}^{2}$ |
| :--- | ---: | :---: |
| Clear Cover | 40 | mm |
| Width | 1000 | mm |

2) Design

- Design Load $\mathrm{Pu}=284.39 \mathrm{KN}$
- Column Size

$$
b=230 \mathrm{mmD}=380 \mathrm{~mm}
$$

- Moments

$$
\mathrm{X} \text {-Direction }=0
$$

$$
\mathrm{Y} \text {-Direction }=0
$$

- Area Required $=\left(\mathrm{Pu}^{*} 1.1\right) / 1.5 *$ SBC

$$
\begin{aligned}
& =(284.39 * 1.1) / 1.5 * 150 \\
& =\mathbf{1 . 3 9} \mathbf{~ m}^{2}
\end{aligned}
$$

- Footing Size

$$
\mathrm{L}=1.25 \mathrm{mB}=1.25 \mathrm{~m}
$$

- Area Provided $=$ L*B

$$
\begin{aligned}
& =1.25 * 1.25 \\
& =1.56 \mathbf{~ m}^{2}
\end{aligned}
$$

- i) $\mathrm{Zx}=\mathrm{B}^{2} \mathrm{~L} / 6$

$$
\begin{aligned}
& =1.25^{2} * 1.25 / 6 \\
& =\mathbf{0 . 3 3}
\end{aligned}
$$

ii) $Z y=L^{2} B / 6$
$=1.25^{2} * 1.25 / 6$

$$
=0.33
$$

- Net Upward Pressure $=($ P/Area Provided*1.1 $)+($ Moment X/1.5*Zx $)+$
(Moment Y/1.5*Zy)

$$
\begin{aligned}
& =(189.59 * 1.1 / 1.56 * 1.1)+(0 / 1.5 * 0.33)+(0 / 1.5 * 0.33) \\
& =\mathbf{1 2 1 . 3 4}
\end{aligned}
$$

IF (Net Upward Pressure<SBC,"Footing Size OK","Change Footing Dimension")Hence, Footing Size OK
3) Slab Design

- $\mathrm{Lx}=(\mathrm{L}-(\mathrm{b} / 1000)) / 2$

$$
\begin{aligned}
& =(1.25-(230 / 1000)) / 2 \\
& =\mathbf{0 . 5 1} \mathbf{~ m}
\end{aligned}
$$

$$
\begin{aligned}
\mathrm{Ly} & =(\mathrm{B}-(\mathrm{D} / 1000)) / 2 \\
& =(1.25-(380 / 1000)) / 2 \\
& =\mathbf{0 . 4 4} \mathbf{~ m}
\end{aligned}
$$

- Bending Moments

$$
\begin{aligned}
\mathrm{Mx} & =\left(1.5^{*} \text { Net Upward Pressure } * \mathrm{Lx}^{2}\right) / 2 \\
& =\left(1.5^{*} 121.34^{*} 0.51^{2}\right) / 2 \\
& =\mathbf{2 3 . 6 7} \mathbf{K N}-\mathbf{m} \\
\mathrm{My} & =\left(1.5^{*} \text { Net Upward Pressure } \mathrm{Ly}^{2}\right) / 2 \\
& =\left(1.5^{*} 121.34^{*} 0.51^{2}\right) / 2 \\
& =\mathbf{1 7 . 2 2} \mathbf{~ K N}-\mathbf{m}
\end{aligned}
$$

$\begin{array}{cclc}\text { - Dia }(\mathrm{mm}) & \text { Spacing }(\mathrm{mm}) \text { Across X } & 10 & 200 \\ \text { Across Y } & 10 & 200 & \end{array}$

- Area of Steel Provided

$$
\begin{aligned}
\text { Across } X= & \left(\left(\left(\left(\mathrm{PI}() * \mathrm{Dia}^{2} / 4\right) * 1000\right) / \text { Spacing }\right)\right. \\
& =\left(\left(\left(\left(\mathrm{PI}() * 10^{2} / 4\right) * 1000 / 200\right)\right.\right. \\
& =\mathbf{3 9 2 . 7 0} \mathbf{~ m m}^{2}
\end{aligned}
$$

$$
\begin{aligned}
\text { Across } \mathrm{Y}= & \left(\left(\left(\left(\mathrm{PI}() * \mathrm{Dia}^{2} / 4\right) * 1000\right) / \text { Spacing }\right)\right. \\
& =\left(\left(\left(\left(\mathrm{PI}() * 10^{2} / 4\right) * 1000 / 200\right)\right.\right. \\
& =\mathbf{3 9 2 . 7 0} \mathbf{~ m m}^{2}
\end{aligned}
$$

- Area of Steel Required

$$
\text { Across X = If (Mx < Mulim, Ast, Min Steel })
$$

$$
=316.27 \mathrm{~mm}^{2}
$$

$$
\text { Across } \mathrm{Y}=\text { If }(\mathrm{My}<\text { Mulim, Ast, Min Steel })
$$

$$
=227.13 \mathrm{~mm}^{2}
$$

- Across X-direction, ProvideDepth D $=\mathbf{2 2 5} \mathbf{~ m m}$

$$
\text { Effective Cover d = (Cover }+ \text { Dia }) / 2
$$

$$
\begin{aligned}
& =(40+10) / 2 \\
& =\mathbf{4 5} \mathbf{~ m m}
\end{aligned}
$$

Effective Depth d' $=$ D - d

$$
=225-45
$$

$$
=180 \mathrm{~mm}
$$

If $($ Fck $=15,(\mathrm{If}(\mathrm{Fy}=250,2.24, \mathrm{If}(\mathrm{Fy}=415,2.07, \mathrm{If}(\mathrm{Fy}=500,2)))), \mathrm{If}(\mathrm{Fck}=20,(\mathrm{If}(\mathrm{Fy}=250,2.98$, If ( $\mathrm{Fy}=415,2.76, \mathrm{If}(\mathrm{Fy}=500,2.66)))$ ),If(Fck=25,(If(Fy=250,3.73,If(Fy=415,3.45,
If $(\mathrm{Fy}=500,3.33)))$ ), If(Fck=30,(If(Fy=250,4.47,If(Fy=415,4.14,If(Fy=500,3.99))))))))

1) $\mathrm{Mulim} / \mathrm{bd}^{2}=\mathbf{2 . 6 6}$
2) Mulim $=\left(\right.$ Mulim $\left./ \mathrm{bd}^{2}\right) *\left(\mathrm{~d}^{2}\right) *($ Width $) / 1000000$

$$
\begin{aligned}
& =2.66 * 180^{2 *} * 1000 / 1000000 \\
& =\mathbf{8 6 . 1 8} \mathbf{K N}-\mathbf{m}
\end{aligned}
$$

3) $\mathrm{Xumax} / \mathrm{d}=(0.0035) /(0.0055+((0.87 * \mathrm{Fy}) /(200 * 1000)))$

$$
\begin{aligned}
& =(0.0035) /(0.0055+((0.87 * 500) /(200 * 1000))) \\
& =\mathbf{0 . 4 6}
\end{aligned}
$$

4) $\operatorname{Xumax}=X u m a x / d$ * d'

$$
\begin{aligned}
& =0.46 * 180 \\
& =\mathbf{8 2 . 0 8}
\end{aligned}
$$

5) $\operatorname{Rumax}=(0.36$ * Xumax/d *(1-(0.42 * Xumax/d)))

$$
\begin{aligned}
& =(0.36 * 0.46 *(1-(0.42 * 0.46))) \\
& =\mathbf{0 . 1 3}
\end{aligned}
$$

- $\operatorname{Minimum~Depth~Required~(Dmin)~}=$ SQRT $\left(\left(\operatorname{Max}(\mathrm{Mx}, \mathrm{My}) * 10^{6}\right) /\right.$ Rumax*1000*Fck

$$
\begin{aligned}
& =\operatorname{SQRT}\left(\left(\operatorname{Max}(23.67,17.22) * 10^{6}\right) / 0.13 * 1000 * 20\right. \\
& =\mathbf{9 4 . 4 3} \mathbf{~ m m}
\end{aligned}
$$

- SRB

$$
\begin{aligned}
\mathrm{a} & =\left(0.87435 * \mathrm{Fy}{ }^{2}\right) /(\mathrm{Fck} * 10000) \\
& =\left(0.87435 * 500^{2}\right) /(20 * 10000) \\
& =\mathbf{1 . 0 9} \\
\mathrm{b} & =-(0.87 * \mathrm{Fy}) / 100 \\
& =-(0.87 * 500) / 100 \\
& =-4.35 \\
\mathrm{c} & =(\mathrm{Mx} * 1000000) / \mathrm{Width} * \mathrm{~d}^{2} \\
& =(23.67 * 1000000) / 1000 * 180^{2} \\
& =\mathbf{0 . 7 3} \\
\mathrm{p}= & \left(-\mathrm{b}-\mathrm{SQRT}\left(\left(\mathrm{~b}^{2}\right)-\left(4 * \mathrm{a}^{2} * \mathrm{c}\right)\right)\right) /(2 * \mathrm{c}) \\
= & \left(-4.35-\mathrm{SQRT}\left(\left(-4.35^{2}\right)-(4 * 1.09 * 0.73)\right)\right) /(2 * 0.73) \\
= & \mathbf{0 . 1 8}
\end{aligned}
$$

- Area of steel (Ast) $=\mathrm{p}^{*} \mathrm{~d}^{\prime} *$ Width $/ 100$

$$
\begin{aligned}
& =0.18 * 180 * 10000 / 100 \\
& =316.27 \mathbf{~ m m}^{2}
\end{aligned}
$$

- Minimum Steel Percentage $=(0.85 * 100) /$ Fy

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

- Minimum Steel $=(0.12 *$ Width*d') $/ 100$

$$
\begin{gathered}
=(0.12 * 1000 * 180) / 100 \\
=\mathbf{2 1 6}
\end{gathered}
$$

- Maximum Steel $=0.09 *$ Width ${ }^{\text {d }}$ '

$$
\begin{array}{r}
=0.09 * 1000 * 180 \\
=\mathbf{7 2 0 0}
\end{array}
$$

- Area of Steel Required (Ast)

Across X $=$ If (Mx < Mulim, Ast, Min Steel)

$$
=316.27 \mathrm{~mm}^{2}
$$

- Pt Provided $=($ Ast* 100$) /\left(1000 *{ }^{*}{ }^{\prime}\right)$

$$
\begin{aligned}
& =(316.27 * 100) /(1000 * 180) \\
& =\mathbf{0 . 2 2}
\end{aligned}
$$

- $\beta=(0.8 * \mathrm{Fck}) /(6.89 * \mathrm{Pt})$

$$
\begin{aligned}
& =(0.8 * 20) /(6.89 * 0.22) \\
& =\mathbf{1 0 . 6 4}
\end{aligned}
$$

- Ks Trail $=0.5+(\operatorname{Min}(b, D) / \operatorname{Max}(b, D))$

$$
\begin{aligned}
& =0.5+(\operatorname{Min}(230,380) / \operatorname{Max}(230,380)) \\
& =\mathbf{1 . 1}
\end{aligned}
$$

- $\mathrm{Ks}=\mathrm{If}(\mathrm{Ks}$ Trail>1,1, Ks Trail)

$$
=1.00
$$

- Across Y-direction, ProvideDepth D $=\mathbf{2 2 5} \mathbf{~ m m}$

$$
\text { Effective Cover d = (Cover }+ \text { Dia }) / 2
$$

$$
\begin{aligned}
& =(40+10) / 2 \\
& =\mathbf{4 5} \mathbf{~ m m}
\end{aligned}
$$

Effective Depth d' $=$ D - d

$$
\begin{aligned}
& =225-45 \\
& =\mathbf{1 8 0} \mathbf{~ m m}
\end{aligned}
$$

If (Fck=15,(If(Fy=250,2.24,If(Fy=415,2.07,If(Fy=500,2)))),If(Fck=20,(If(Fy=250,2.98, If ( $\mathrm{Fy}=415,2.76, \mathrm{If}(\mathrm{Fy}=500,2.66)))$ ), If(Fck=25,(If(Fy=250,3.73,If(Fy=415,3.45, If $(\mathrm{Fy}=500,3.33)))$ ), If(Fck=30,(If(Fy=250,4.47,If(Fy=415,4.14,If(Fy=500,3.99))))))))

1) $\mathrm{Mulim} / \mathrm{bd}^{2}=\mathbf{2 . 6 6}$
2) Mulim $=\left(\right.$ Mulim $\left./ \mathrm{bd}^{2}\right) *\left(\mathrm{~d}^{2}\right) *($ Width $) / 1000000$

$$
=2.66 * 180^{2} * 1000 / 1000000
$$

$=86.18 \mathrm{KN}-\mathrm{m}$
3) $\mathrm{Xumax} / \mathrm{d}=(0.0035) /(0.0055+((0.87 * \mathrm{Fy}) /(200 * 1000)))$

$$
\begin{aligned}
& =(0.0035) /(0.0055+((0.87 * 500) /(200 * 1000))) \\
& =\mathbf{0 . 4 6}
\end{aligned}
$$

4) $\operatorname{Xumax}=X u m a x / d$ * d'

$$
\begin{aligned}
& =0.46 * 180 \\
& =\mathbf{8 2 . 0 8}
\end{aligned}
$$

5) $\operatorname{Rumax}=(0.36 * \operatorname{Xumax} / \mathrm{d} *(1-(0.42 * \operatorname{Xumax} / \mathrm{d})))$

$$
\begin{aligned}
& =(0.36 * 0.46 *(1-(0.42 * 0.46))) \\
& =\mathbf{0 . 1 3}
\end{aligned}
$$

- Minimum Depth Required (Dmin) = SQRT ((Max (Mx, My) *10 $\left.{ }^{6}\right) /$ Rumax*1000*Fck

$$
\begin{aligned}
& =\operatorname{SQRT}\left(\left(\operatorname{Max}(23.67,17.22) * 10^{6}\right) / 0.13 * 1000 * 20\right. \\
& =\mathbf{9 4 . 4 3} \mathbf{~ m m}
\end{aligned}
$$

- SRB

$$
\begin{aligned}
& \mathrm{a}=\left(0.87435 * \mathrm{Fy}^{2}\right) /(\mathrm{Fck} * 10000) \\
&=\left(0.87435 * 500^{2}\right) /(20 * 10000) \\
&=\mathbf{1 . 0 9} \\
& \mathrm{b}=-(0.87 * \mathrm{Fy}) / 100 \\
&=-(0.87 * 500) / 100 \\
&=-\mathbf{4 . 3 5} \\
& \mathrm{c}=(\mathrm{My} * 1000000) / \text { Width } * \mathrm{~d}^{\prime 2} \\
&=(17.22 * 1000000) / 1000^{*} 180^{2} \\
&=\mathbf{0 . 5 3} \\
& \mathrm{p}=\left(-\mathrm{b}-\mathrm{SQRT}\left(\left(\mathrm{~b}^{2}\right)-(4 * \mathrm{a} * \mathrm{c})\right)\right) /(2 * \mathrm{c}) \\
&=\left(-4.35-\mathrm{SQRT}\left(\left(-4.35^{2}\right)-(4 * 1.09 * 0.73)\right)\right) /(2 * 0.53) \\
&=\mathbf{0 . 1 3}
\end{aligned}
$$

- Area of steel (Ast) $=\mathrm{p}^{*} \mathrm{~d}^{\prime} *$ Width $/ 100$

$$
\begin{aligned}
& =0.13 * 180 * 10000 / 100 \\
& =277.13 \mathbf{~ m m}^{2}
\end{aligned}
$$

- Minimum Steel Percentage $=(0.85 * 100) / \mathrm{Fy}$

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

- $\quad$ Minimum Steel $=\left(0.12 *\right.$ Width $\left.^{*} \mathrm{~d}^{\prime}\right) / 100$

$$
\begin{aligned}
& =(0.12 * 1000 * 180) / 100 \\
& =\mathbf{2 1 6}
\end{aligned}
$$

- Maximum Steel $=0.09 *$ Width ${ }^{*}$ d'

$$
\begin{aligned}
& =0.09 * 1000 * 180 \\
& =\mathbf{7 2 0 0}
\end{aligned}
$$

- Area of Steel Required (Ast)
Across Y = If (My < Mulim, Ast, Min Steel)

$$
=227.13 \mathrm{~mm}^{2}
$$

- Pt Provided $=($ Ast* 100$) /\left(1000^{*}{ }^{\prime}\right.$ ' $)$

$$
\begin{aligned}
& =(227.13 * 100) /(1000 * 180) \\
& =\mathbf{1 . 0 5}
\end{aligned}
$$

- $\beta=(0.8 * \mathrm{Fck}) /(6.89 * \mathrm{Pt})$

$$
\begin{aligned}
& =(0.8 * 20) /(6.89 * 1.05) \\
& =\mathbf{2 . 2 2}
\end{aligned}
$$

- Ks Trail $=0.5+(\operatorname{Min}(b, D) / \operatorname{Max}(b, D))$

$$
\begin{aligned}
& =0.5+(\operatorname{Min}(230,380) / \operatorname{Max}(230,380)) \\
& =\mathbf{1 . 1}
\end{aligned}
$$

- $\mathrm{Ks}=\mathrm{If}(\mathrm{Ks}$ Trail>1,1, Ks Trail)

$$
=1.00
$$

4) One-Way Shear along X-Direction

- Vu1 $=(1.5 *$ Net Upward Pressure $) * B^{*}\left(\right.$ Lx $\left.-\left(d^{\prime} / 1000\right)\right)$

$$
\begin{aligned}
& =(1.5 * 121.34) * 1.25 *(0.51-(180 / 1000)) \\
& =75.08
\end{aligned}
$$

- $\tau_{\mathrm{v}}=(\mathrm{Vu} 1 * 1000) /\left((\mathrm{B} * 1000) * \mathrm{~d}^{\prime}\right)$

$$
\begin{aligned}
& =(75.08 * 1000) /((1.25 * 1000) * 180) \\
& =\mathbf{0 . 3 3}
\end{aligned}
$$

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

$$
\begin{aligned}
& =((0.85 * \operatorname{SQRT}(0.8 * 20) *(\operatorname{SQRT}(1+(5 * 10.64))-1))) /(6 * 10.64)) \\
& =\mathbf{0 . 3 4}
\end{aligned}
$$

- $\mathrm{Vc} 1=\tau_{\mathrm{c}}$ * B * d

$$
\begin{aligned}
& =0.34 * 1.25 * 180 \\
& =76.22
\end{aligned}
$$

If ( $\tau_{\mathrm{v}}<\tau_{\mathrm{c}}$, "One Way Shear Check OK", "Increase Depth")Hence, One Way Shear Check OK
5) One-Way Shear along Y-Direction

- Vu1 $=\left(1.5^{*}\right.$ Net Upward Pressure) ${ }^{*}{ }^{*}\left(\mathrm{Ly}-\left(\mathrm{d}^{\prime} / 1000\right)\right)$

$$
\begin{aligned}
& =(1.5 * 121.34) * 1.25 *(0.44-(180 / 1000)) \\
& =\mathbf{5 8 . 0 2}
\end{aligned}
$$

- $\tau_{\mathrm{v}}=(\mathrm{Vu} 1 * 1000) /\left((\mathrm{L} * 1000) * \mathrm{~d}^{\prime}\right)$

$$
\begin{aligned}
& =(58.02 * 1000) /((1.25 * 1000) * 180) \\
& =0.26
\end{aligned}
$$

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

$$
\begin{aligned}
& =((0.85 * \operatorname{SQRT}(0.8 * 20) *(\operatorname{SQRT}(1+(5 * 2.22))-1)) /(6 * 2.22)) \\
& =3.16
\end{aligned}
$$

- $\mathrm{Vc} 1=\tau_{\mathrm{c}} * \mathrm{~B} * \mathrm{~d}^{\prime}$

$$
\begin{aligned}
& =0.34 * 1.25 * 180 \\
& =711.55
\end{aligned}
$$

If ( $\tau_{\mathrm{v}}<\tau_{\mathrm{c}}$, "One Way Shear Check OK", "Increase Depth")Hence, One Way Shear Check OK
6) Two-Way Shear

- $\quad$ Vu2 $=\left(1.5^{*}\right.$ Net Upward Pressure $) *\left(((\mathrm{~B}) *(\mathrm{~L}))-\left(\left(\left(\mathrm{b}+\left(\mathrm{d}^{\mathrm{\prime}} / 2\right)+\left(\mathrm{d} / 2\left(\mathrm{D}+\left(\mathrm{d}^{\prime} / 2\right)+(\mathrm{d} / 2)\right)\right) /(1000 * 1000)\right)\right)\right.\right.$

$$
\begin{aligned}
& =(1.5 * 121.34) *(((1.25) *(1.25))-(((230+(180 / 2)+(180 / 2(380+(180 / 2)+(180 / 2)))) /(1000 * 1000))) \\
& =\mathbf{2 4 2 . 6 0}
\end{aligned}
$$

- $\left.\tau_{\mathrm{v}}=(\mathrm{Vu} 2 * 1000) /\left(\left(\left(\mathrm{b}+\left(\mathrm{d}^{\prime} / 2\right)+\left(\mathrm{d}^{\prime} / 2\right)\right)+\left(\mathrm{D}+\left(\mathrm{d}^{\prime} / 2\right)+\left(\mathrm{d}^{\prime} / 2\right)\right)\right){ }^{2} 2\right) * \mathrm{~d}^{\mathrm{d}}\right)$

$$
\begin{aligned}
& =(242.60 * 1000) /((((230+(180 / 2)+(180 / 2))+(380+(180 / 2)+(180 / 2))) * 2) * 180) \\
& =\mathbf{0 . 6 7}
\end{aligned}
$$

- $\mathrm{Kstc}=\mathrm{Ks}^{*}\left(0.25^{*} \mathrm{SQRT}(\mathrm{Fck})\right)$

$$
\begin{aligned}
& =1.00 *(0.25 * \operatorname{SQRT}(20)) \\
& =\mathbf{1 . 1 2}
\end{aligned}
$$

- $\quad \mathrm{Vc} 1=\left(\mathrm{Kscc} *\left(\left(\left(\mathrm{~b}+\left(\mathrm{d}^{\prime} / 2\right)+\left(\mathrm{d}^{\prime} / 2\right)\right)+\left(\mathrm{D}+\left(\mathrm{d}^{\prime} / 2\right)+\left(\mathrm{d}^{\prime} / 2\right)\right)\right) * 2\right) * \mathrm{~d}^{\prime}\right) / 1000$

$$
\begin{aligned}
& =(1.12 *(((230+(180 / 2)+(180 / 2))+(380+(180 / 2)+(180 / 2))) * 2) * 180) / 1000 \\
& =\mathbf{4 0 5 . 4 0}
\end{aligned}
$$

If ( $\tau_{\mathrm{v}}<\mathrm{Ks} \tau_{\mathrm{c}}$, "Two Way Shear Check OK", "Increase Depth")Hence, Two Way Shear Check OK

## E. Design of Column

1) Inputs

| Column Breadth (b) | 0.23 | m |
| :--- | ---: | ---: |
| Column Depth (D) | 0.38 | m |
| Height (H) | 3.2 | m |
| Slab Thickness (T) | 0.125 | m |
| Wall Thickness | 0.23 | m |
| No of Slab | 2 |  |
| Cover d' |  | 40 |
| Steel Percentage | 1 |  |

2) Design

- Design Load $\mathrm{Pu}=\mathbf{2 8 4 . 3 9} \mathbf{K N}$
- Moments

$$
\begin{aligned}
& \text { Mux }=10 \mathrm{KN}-\mathrm{m} \\
& \text { Muy }=10 \mathrm{KN}-\mathrm{m}
\end{aligned}
$$

$\operatorname{If}\left(\left(d^{\prime} / D\right)<=0.05,0.05, \operatorname{If}\left(\left(d^{\prime} / D\right)<=0.1,0.1, \operatorname{If}\left(\left(d^{\prime} / D\right)<=0.15,0.15, \operatorname{If}\left(\left(d^{\prime} / D\right)<=0.2,0.2,0.2\right)\right)\right)\right)$
If $((40 / 380)<=0.05,0.05$, If $((40 / 380)<=0.1,0.1$, If $((40 / 380)<=0.15,0.15$,

If $((40 / 380)<=0.2,0.2,0.2)))$ )

- $\mathrm{d}^{\prime} / \mathrm{D}=\mathbf{0 . 1 5}$
$\operatorname{If}\left(\left(\mathrm{d}^{\prime} / \mathrm{b}\right)<=0.05,0.05, \operatorname{If}\left(\left(\mathrm{~d}^{\prime} / \mathrm{b}\right)<=0.1,0.1, \operatorname{lf}\left(\left(\mathrm{~d}^{\prime} / \mathrm{b}\right)<=0.15,0.15, \operatorname{If}\left(\left(\mathrm{~d}^{\prime} / \mathrm{b}\right)<=0.2,0.2,0.2\right)\right)\right)\right)$
If $((40 / 230)<=0.05,0.05$, If $((40 / 230)<=0.1,0.1$, If $((40 / 230)<=0.15,0.15$,
If $((40 / 230)<=0.2,0.2,0.2)))$ )
- $d^{\prime} / b=\mathbf{0 . 2 0}$
- Area of Steel $($ Ast $)=\left(\right.$ Steel Percentage $\left.* \mathrm{~b}^{*} \mathrm{D}\right) / 100$

$$
\begin{aligned}
& =(1 * 230 * 380) / 100 \\
& =\mathbf{8 7 4} \mathbf{~ m m}^{2}
\end{aligned}
$$

- 6 Ast Min $=\left(0.8^{*} \mathrm{~b} * \mathrm{D}\right) / 100$

$$
\begin{aligned}
& =(0.8 * 230 * 380) / 100 \\
& =\mathbf{6 9 9 . 2} \mathbf{~ m m}^{2}
\end{aligned}
$$

- Pt / Fck = Steel Percentage /Fck

$$
\begin{aligned}
& =1 / 20 \\
& =\mathbf{0 . 0 5}
\end{aligned}
$$

- $\mathrm{Pu} / \mathrm{Fck} * \mathrm{~b} * \mathrm{D}=(\mathrm{Pu} * 1000) /(\mathrm{Fck} * \mathrm{~b} * \mathrm{D})$

$$
\begin{aligned}
& =(284.39 * 1000) /(20 * 230 * 380) \\
& =\mathbf{0 . 1 6}
\end{aligned}
$$

- Mux $/$ Fck ${ }^{*} b^{*} D^{2}=\mathbf{0 . 0 9 2}$

$$
\text { Muy } / \text { Fck } * b^{*} * D^{2}=\mathbf{0 . 0 9 6}
$$

- Puz $=((0.45 *$ Fck*b*D) $+(((0.75 * \mathrm{Fy})-(0.45 * \mathrm{Fck}))$
*((Steel Percentage/100) *b*D)) /1000

$$
\begin{aligned}
& =((0.45 * 20 * 230 * 380)+(((0.75 * 500)-(0.45 * 20)) *((1 / 100) * 230 * 380))) / 1000 \\
& =\mathbf{1 1 0 6 . 4 8}
\end{aligned}
$$

- Mux $1=$ Mux $/$ FckbD $^{2} *$ Fck*b*D $\left.{ }^{2}\right) / 1000000$

$$
\begin{aligned}
& =0.0092 * 20 * 230 * 380^{2} / 1000000 \\
& =\mathbf{6 1 . 1 1} \mathbf{K N}-\mathbf{m}
\end{aligned}
$$

- Muy1 $=$ Mux $/$ FckDb ${ }^{2} *$ Fck*D* ${ }^{2}$ )/ $/ 1000000$

$$
\left.=0.0096 * 20 * 380 * 230^{2}\right) / 1000000
$$

$$
=38.61 \mathrm{KN}-\mathrm{m}
$$

- $\mathrm{Pu} / \mathrm{Puz}=284.39 / 1106.5$

$$
=0.257
$$

- $\operatorname{Mux} / \operatorname{Mux1}=10 / 61.11$

$$
=0.164
$$

- Muy / Muy $1=10 / 38.61$

$$
=0.259
$$

If (Pu/Puz <0.2,1, If (Pu/Puz >0.8,2, $(1+(((\mathrm{Pu} / \mathrm{Puz}-0.2) /(0.8-0.2)) *(2-1)))))$
If ( $0.257<0.2,1$, If $(0.257>0.8,2,(1+(((0.257-0.2) /(0.8-0.2)) *(2-1)))))$

- $\alpha \mathrm{n}=1$
- $(\text { Mux/Mux1 })^{\boldsymbol{\alpha n}}+(\text { Muy } / \text { Muy1 })^{\boldsymbol{\alpha n}}=0.164^{1}+0.259^{1}$

$$
=0.37
$$

$\operatorname{If}\left((\mathrm{Mux} / \mathrm{Mux} 1)^{\boldsymbol{\alpha n}}+(\mathrm{Muy} / \mathrm{Muy1})^{\boldsymbol{\alpha n}}<1\right.$,"Steel Percentage OK", "Revise the Section")Hence, Steel Percentage OK

- Area of Reinforcement Provided
- Number of Bars = $\mathbf{6}$ No's
- Día = $\mathbf{1 2} \mathbf{~ m m}$

$$
\begin{aligned}
& \text { If ( } \left.\text { Día }^{2}=" \mathrm{C} \text { """, (((PI ()/4) *Día }{ }^{2}\right) \text { * Number of Bars)) } \\
& \text { If ( } \left.12^{2}=\text { "",""", (((PI }\right) / 44 \text { * } 12^{2}{ }^{2} \text { * 6)) }
\end{aligned}
$$

- Ast $=\mathbf{6 7 8 . 5 8} \mathbf{~ m m}^{2}$
- Percentage $=(\mathrm{Ast} /(\mathrm{b} * \mathrm{D})) * 100$

$$
\begin{aligned}
& =(678.58 /(230 * 380 *)) * 100 \\
& =\mathbf{0 . 7 7 6} \%
\end{aligned}
$$

## 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 Footing using relevant code books, andthen Column 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 loadtransfer 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 Footing and Column are calculated manually. The same building was modelled and analysed using E-tab also.
B. Load Calculation

1) Inputs

| Self Weight of RCC | 25 | $\mathrm{KN} / \mathrm{m}^{3}$ |
| :--- | :---: | :---: |
| Masomry | 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 | $\mathrm{~N} / \mathrm{mm}^{2}$ |

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2) Structure


Fig 2

| Self weight on column |  |  |  |
| :---: | :---: | :---: | :---: |
| b | D | H | P |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
| 0.23 | 0.38 | 3.20 | 6.99 |
|  |  |  |  |


| Self Weight of Beam(KN) |  |  |  |
| :---: | :---: | :---: | :---: |
| L | b | D | P |
| 4.0 | 0.23 | 0.38 | 8.74 |
| 6.5 | 0.23 | 0.38 | 14.20 |
| 7.5 | 0.23 | 0.38 | 16.39 |
| 8.5 | 0.23 | 0.38 | 18.57 |
| 5.5 | 0.23 | 0.38 | 12.02 |
| 6.5 | 0.23 | 0.38 | 14.20 |
| 9.0 | 0.23 | 0.38 | 19.67 |
| 10.0 | 0.23 | 0.38 | 21.85 |
| 11.0 | 0.23 | 0.38 | 24.04 |
| 8.0 | 0.23 | 0.38 | 17.48 |
| 7.5 | 0.23 | 0.38 | 16.39 |
| 10.0 | 0.23 | 0.38 | 21.85 |
| 11.0 | 0.23 | 0.38 | 24.04 |
| 12.0 | 0.23 | 0.38 | 26.22 |
| 9.0 | 0.23 | 0.38 | 19.67 |
| 8.5 | 0.23 | 0.38 | 18.57 |
| 11.0 | 0.23 | 0.38 | 24.04 |
| 12.0 | 0.23 | 0.38 | 26.22 |
| 13.0 | 0.23 | 0.38 | 28.41 |
| 10.0 | 0.23 | 0.38 | 21.85 |
| 5.5 | 0.23 | 0.38 | 12.02 |
| 8.0 | 0.23 | 0.38 | 17.48 |
| 9.0 | 0.23 | 0.38 | 19.67 |
| 10.0 | 0.23 | 0.38 | 21.85 |
| 7.0 | 0.23 | 0.38 | 15.30 |
|  |  |  |  |


| Self Weight on Slab(KN/m2) |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| L | B | T | FF | LL | P |
| 2.0 | 2.0 | 0.13 | 1 | 2 | 24.50 |
| 4.5 | 2.0 | 0.13 | 1 | 2 | 55.13 |
| 5.5 | 2.0 | 0.13 | 1 | 2 | 67.38 |
| 6.5 | 2.0 | 0.13 | 1 | 2 | 79.63 |
| 3.5 | 2.0 | 0.13 | 1 | 2 | 42.88 |
| 2.0 | 4.5 | 0.13 | 1 | 2 | 55.13 |
| 4.5 | 4.5 | 0.13 | 1 | 2 | 124.03 |
| 5.5 | 4.5 | 0.13 | 1 | 2 | 151.59 |
| 6.5 | 4.5 | 0.13 | 1 | 2 | 179.16 |
| 3.5 | 4.5 | 0.13 | 1 | 2 | 96.47 |
| 2.0 | 5.5 | 0.13 | 1 | 2 | 67.38 |
| 4.5 | 5.5 | 0.13 | 1 | 2 | 151.59 |
| 5.5 | 5.5 | 0.13 | 1 | 2 | 185.28 |
| 6.5 | 5.5 | 0.13 | 1 | 2 | 218.97 |
| 3.5 | 5.5 | 0.13 | 1 | 2 | 117.91 |
| 2.0 | 6.5 | 0.13 | 1 | 2 | 79.63 |
| 4.5 | 6.5 | 0.13 | 1 | 2 | 179.16 |
| 5.5 | 6.5 | 0.13 | 1 | 2 | 218.97 |
| 6.5 | 6.5 | 0.13 | 1 | 2 | 258.78 |
| 3.5 | 6.5 | 0.13 | 1 | 2 | 139.34 |
| 2.0 | 3.5 | 0.13 | 1 | 2 | 42.88 |
| 4.5 | 3.5 | 0.13 | 1 | 2 | 96.47 |
| 5.5 | 3.5 | 0.13 | 1 | 2 | 117.91 |
| 6.5 | 3.5 | 0.13 | 1 | 2 | 139.34 |
| 3.5 | 3.5 | 0.13 | 1 | 2 | 75.03 |
|  |  |  |  |  |  |

Table 1

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| Self Weight from Wall(KN/m) |  |  |  |
| :---: | :---: | :---: | :---: |
| $\mathbf{L}$ | $\mathbf{H}$ | $\mathbf{T}$ | $\mathbf{P}$ |
| 4.0 | 2.82 | 0.23 | 46.70 |
| 6.5 | 2.82 | 0.23 | 75.89 |
| 7.5 | 2.82 | 0.23 | 87.56 |
| 8.5 | 2.82 | 0.23 | 99.24 |
| 5.5 | 2.82 | 0.23 | 64.21 |
| 6.5 | 2.82 | 0.23 | 75.89 |
| 9.0 | 2.82 | 0.23 | 105.07 |
| 10.0 | 2.82 | 0.23 | 116.75 |
| 11.0 | 2.82 | 0.23 | 128.42 |
| 8.0 | 2.82 | 0.23 | 93.40 |
| 7.5 | 2.82 | 0.23 | 87.56 |
| 10.0 | 2.82 | 0.23 | 116.75 |
| 11.0 | 2.82 | 0.23 | 128.42 |
| 12.0 | 2.82 | 0.23 | 140.10 |
| 9.0 | 2.82 | 0.23 | 105.07 |
| 8.5 | 2.82 | 0.23 | 99.24 |
| 11.0 | 2.82 | 0.23 | 128.42 |
| 12.0 | 2.82 | 0.23 | 140.10 |
| 13.0 | 2.82 | 0.23 | 151.77 |
| 10.0 | 2.82 | 0.23 | 116.75 |
| 5.5 | 2.82 | 0.23 | 64.21 |
| 8.0 | 2.82 | 0.23 | 93.40 |
| 9.0 | 2.82 | 0.23 | 105.07 |
| 10.0 | 2.82 | 0.23 | 116.75 |
| 7.0 | 2.82 | 0.23 | 81.72 |
|  |  |  |  |


| Total Loads |  |  |  |
| :---: | :---: | :---: | :---: |
| Indiuval Floor load | Load | Factored load | Column |
| 86.93 | 189.59 | 284.39 | C1 |
| 152.21 | 325.61 | 488.41 | C2 |
| 178.32 | 380.01 | 570.02 | C3 |
| 204.43 | 434.42 | 651.62 | C4 |
| 126.10 | 271.20 | 406.80 | C5 |
| 152.21 | 325.61 | 488.41 | C6 |
| 255.76 | 538.18 | 807.27 | C7 |
| 297.18 | 623.21 | 934.81 | C8 |
| 338.61 | 708.24 | 1062.36 | C9 |
| 214.34 | 453.15 | 679.73 | C10 |
| 178.32 | 380.01 | 570.02 | C11 |
| 297.18 | 623.21 | 934.81 | C12 |
| 344.73 | 720.49 | 1080.73 | C13 |
| 392.28 | 817.77 | 1226.65 | C14 |
| 249.64 | 525.93 | 788.89 | C15 |
| 204.43 | 434.42 | 651.62 | C16 |
| 338.61 | 708.24 | 1062.36 | C17 |
| 392.28 | 817.77 | 1226.65 | C18 |
| 445.95 | 927.30 | 1390.95 | C19 |
| 284.93 | 598.71 | 898.06 | C20 |
| 126.10 | 271.20 | 406.80 | C21 |
| 214.34 | 453.15 | 679.73 | C22 |
| 249.64 | 525.93 | 788.89 | C23 |
| 284.93 | 598.71 | 898.06 | C24 |
| 179.04 | 380.37 | 570.56 | C25 |

Table 2
C. Design of Footing


Fig 3

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1) Inputs

| Footing |
| :--- | :---: | :---: |
| SBC 150 <br> $\mathrm{KN} / \mathrm{m}^{2}$  <br> Clear Cover 40 <br> mm  |

2) Design



Table 3

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| Across X |  | Across Y |  | Ast Provided |  | Ast Required |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Across X | Across Y | Across X | Across Y |  |
| Dia (mm) | Spacing (c/c) |  |  | Dia (mm) | Spacing (c/c) | $\mathrm{mm}^{2}$ | $\mathrm{mm}^{2}$ | $\mathrm{mm}^{2}$ | $\mathrm{mm}^{2}$ |  |
| 10 | 200 | 10 | 200 | 392.70 | 392.70 | 306.93 | 222.00 | Reinf OK |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 424.66 | 342.13 | Reinf OK |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 412.40 | 372.00 | Reinf OK |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 492.77 | 409.92 | Reinf OK |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 276.51 | 372.00 | Reinf OK |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 424.66 | 342.13 | Reinf OK |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 455.88 | 492.00 | Reinf OK |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 512.93 | 522.00 | Reinf OK |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 564.56 | 552.00 | Increase Ast |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 473.48 | 402.00 | Reinf OK |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 451.56 | 363.91 | Reinf OK |
| 10 | 135 | 10 | 135 | 581.78 | 581.78 | 512.93 | 522.00 | Reinf OK |
| 10 | 135 | 10 | 135 | 581.78 | 581.78 | 574.65 | 552.00 | Reinf OK |
| 10 | 125 | 10 | 125 | 628.32 | 628.32 | 619.05 | 582.00 | Reinf OK |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 475.96 | 462.00 | Reinf OK |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 390.90 | 462.00 | Reinf OK |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 564.56 | 552.00 | Increase Ast |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 586.79 | 612.00 | Increase Ast |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 616.39 | 672.00 | Increase Ast |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 438.85 | 582.00 | Increase Ast |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 371.32 | 286.08 | Reinf OK |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 473.48 | 402.00 | Reinf OK |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 445.20 | 492.00 | Reinf OK |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 524.16 | 492.00 | Increase Ast |
| 10 | 150 | 10 | 150 | 523.60 | 523.60 | 307.47 | 492.00 | Reinf OK |

Table 4

| Depth | One Way Shear along X-Direction | One Way Shear along Y-Direction | Two Way Shear |
| :---: | :--- | :--- | :--- |
|  |  | One Way Shear Check OK | Two Way Shear Check OK |
| 225 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 300 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 350 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 350 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 350 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 300 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 450 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 475 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 500 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 375 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 325 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 475 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 500 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 525 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 425 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 425 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 500 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 550 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 600 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 525 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 275 | One Way Shear Check OK | One Way Shear Check OK | Two Way Shear Check OK |
| 375 | One Way Shear Check OK | One Way Shear Check OK | One Way Shear Check OK |

Table 5

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3) E-tab Results


Fig 4

| Footing | Force |  |
| :---: | :---: | :---: |
| F-1 | 240.04 |  |
| F-2 | 434.52 |  |
| F-3 | 510.3 |  |
| F-4 | 624.66 |  |
| F-5 | 344.78 |  |
| F-6 | 454.4 |  |
| F-7 | 765.4 |  |
| F-8 | 886.69 |  |
| F-9 | 1058.51 |  |
| F-10 | 614.71 |  |
| F-11 | 519.04 |  |
| F-12 | 868.91 |  |
| F-13 | 1013.25 |  |
| F-14 | 1210.01 |  |
| F-15 | 706.27 |  |
| F-16 | 657.93 |  |
| F-17 | 1073.47 |  |
| F-18 | 1247.06 |  |
| F-19 | 1463.09 |  |
| F-20 | 876.03 |  |
| F-21 | 342.72 |  |
| F-22 | 589.55 |  |
| F-23 | 692.7 |  |
| F-24 | 835.42 |  |
| F-25 | 480.8 |  |

Table 6
4) Validation of Results

| Footing | E-tab Reults | Excel Results |
| :---: | :---: | :---: |
| $\mathrm{F}-1$ | 240.04 | 284.39 |
| $\mathrm{~F}-2$ | 434.52 | 488.41 |
| $\mathrm{~F}-3$ | 510.3 | 570.02 |
| $\mathrm{~F}-4$ | 624.66 | 651.62 |
| $\mathrm{~F}-5$ | 344.78 | 406.80 |
| $\mathrm{~F}-6$ | 454.4 | 488.41 |
| $\mathrm{~F}-7$ | 765.4 | 807.27 |
| $\mathrm{~F}-8$ | 886.69 | 934.81 |
| $\mathrm{~F}-9$ | 1058.51 | 1062.36 |
| $\mathrm{~F}-10$ | 614.71 | 679.73 |
| $\mathrm{~F}-11$ | 519.04 | 570.02 |
| $\mathrm{~F}-12$ | 868.91 | 934.81 |
| $\mathrm{~F}-13$ | 1013.25 | 1080.73 |
| $\mathrm{~F}-14$ | 1210.01 | 1226.65 |
| $\mathrm{~F}-15$ | 706.27 | 788.89 |
| $\mathrm{~F}-16$ | 657.93 | 651.62 |
| $\mathrm{~F}-17$ | 1073.47 | 1062.36 |
| $\mathrm{~F}-18$ | 1247.06 | 1226.65 |
| $\mathrm{~F}-19$ | 1463.09 | 1390.95 |
| $\mathrm{~F}-20$ | 876.03 | 898.06 |
| $\mathrm{~F}-21$ | 342.72 | 406.80 |
| $\mathrm{~F}-22$ | 589.55 | 679.73 |
| $\mathrm{~F}-23$ | 692.7 | 788.89 |
| $\mathrm{~F}-24$ | 835.42 | 898.06 |
| $\mathrm{~F}-25$ | 480.8 | 570.56 |

Table 7
D. Design of Column


Fig 5

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1) Inputs

| Columm |  |  |
| :---: | :---: | :---: |
| Column Breadth (B) | 0.23 | m |
| Column Depth (D) | 0.38 | m |
| Height (H) | 3.2 | m |
| Slab Thickness (T) | 0.125 | m |
| Wall Thickness | 0.23 | m |
| No of Slab | 2 | Units |

2) Design


| Column | $\mathbf{P u}$ | Mux | Muy | b | D | $d^{\prime}$ | Steel Percentage | Ast | Ast Min |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  | pt | $\mathrm{mm}^{2}$ | $\mathrm{mm}^{2}$ |
|  |  |  |  |  |  |  |  |  |  |
| C-1 | 284.39 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-2 | 488.41 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-3 | 570.02 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-4 | 651.62 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-5 | 406.80 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-6 | 488.41 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-7 | 807.27 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-8 | 934.81 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-9 | 1062.36 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-10 | 679.73 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-11 | 570.02 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-12 | 934.81 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-13 | 1080.73 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-14 | 1226.65 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-15 | 788.89 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-16 | 651.62 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-17 | 1062.36 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-18 | 1226.65 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-19 | 1390.95 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-20 | 898.06 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-21 | 406.80 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-22 | 679.73 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-23 | 788.89 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-24 | 898.06 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |
| C-25 | 570.56 | 10 | 10 | 230 | 380 | 40 | 1 | 874 | 699.2 |

Table 8

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| $\text { Mux/FckbD }{ }^{2}$ | $\text { Muy/FckbD }{ }^{\mathbf{2}}$ | 人n | $(\text { Mux/Mux1 })^{a_{n}}+(\text { Muy } / \text { Muy1 })^{\alpha_{n}}$ |  |
| :---: | :---: | :---: | :---: | :---: |
| 0.092 | 0.096 | 1 | 0.37 | Steel Percentage OK |
| 0.11 | 0.11 | 1 | 0.19 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.15 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.12 | Steel Percentage OK |
| 0.11 | 0.11 | 1 | 0.23 | Steel Percentage OK |
| 0.11 | 0.11 | 1 | 0.19 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.08 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.07 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.07 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.12 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.15 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.07 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.07 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.07 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.09 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.12 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.07 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.07 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.07 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.07 | Steel Percentage OK |
| 0.11 | 0.11 | 1 | 0.23 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.12 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.09 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.07 | Steel Percentage OK |
| 0.11 | 0.11 | 2 | 0.15 | Steel Percentage OK |

Table 9

| No | Dia | Ast | Percentage |
| :---: | :---: | :---: | :---: |
|  | mm | $\mathrm{mm}^{2}$ |  |
|  |  |  |  |
| 6 | 12 | 678.58 | 0.776 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |
| 10 | 20 | 3141.59 | 3.594 |

Table 10
3) E-tab Results


Fig 6

| Column | Force |
| :---: | :---: |
| C-1 | 240.04 |
| C-2 | 434.52 |
| C-3 | 510.3 |
| C-4 | 624.66 |
| C-5 | 344.78 |
| C-6 | 454.4 |
| C-7 | 765.4 |
| C-8 | 886.69 |
| C-9 | 1058.51 |
| C-10 | 614.71 |
| C-11 | 519.04 |
| C-12 | 868.91 |
| C-13 | 1013.25 |
| C-14 | 1210.01 |
| C-15 | 706.27 |
| C-16 | 657.93 |
| C-17 | 1073.47 |
| C-18 | 1247.06 |
| C-19 | 1463.09 |
| C-20 | 876.03 |
| C-21 | 342.72 |
| C-22 | 589.55 |
| C-23 | 692.7 |
| C-24 | 835.42 |

Table 11

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4) Validation of Results

| Footing | E-tab Reults | Excel Results |
| :---: | :---: | :---: |
| C-1 | 240.04 | 284.39 |
| C-2 | 434.52 | 488.41 |
| C-3 | 510.3 | 570.02 |
| C-4 | 624.66 | 651.62 |
| C-5 | 344.78 | 406.80 |
| C-6 | 454.4 | 488.41 |
| C-7 | 765.4 | 807.27 |
| C-8 | 886.69 | 934.81 |
| C-9 | 1058.51 | 1062.36 |
| C-10 | 614.71 | 679.73 |
| C-11 | 519.04 | 570.02 |
| C-12 | 868.91 | 934.81 |
| C-13 | 1013.25 | 1080.73 |
| C-14 | 1210.01 | 1226.65 |
| C-15 | 706.27 | 788.89 |
| C-16 | 657.93 | 651.62 |
| C-17 | 1073.47 | 1062.36 |
| C-18 | 1247.06 | 1226.65 |
| C-19 | 1463.09 | 1390.95 |
| C-20 | 876.03 | 898.06 |
| C-21 | 342.72 | 406.80 |
| C-22 | 589.55 | 679.73 |
| C-23 | 692.7 | 788.89 |
| C-24 | 835.42 | 898.06 |
| C-25 | 480.8 | 570.56 |
|  |  |  |

Table 12

## IV. CONCLUSION

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

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