International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 Issue: IX Month of publication: September 2022

DOI: https://doi.org/10.22214/ijraset.2022.46196

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

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 7m 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

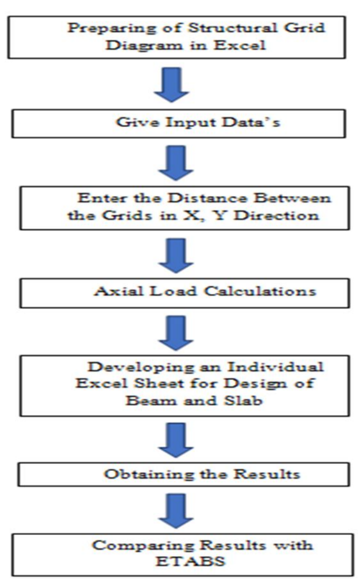
1) Design and Analysis of RC structure by developing an independent Excel sheet and validating the result using ETABS software
2) To include structural engineering principles into design documents.
3) To improve the idea behind structural analysis and design as well as its effectiveness when a design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



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C. Sample

1) Inputs

Self-Weight of RCC	25	KN/m^3
Masonry	18	KN/m^3
Floor Finish (FF)	1	KN/m^2
Live Load (LL)	2	KN/m^2
Grade of Concrete (fck)	20	N/mm^2
ReinforcementGrade (fy)	500	N/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

2) Structure

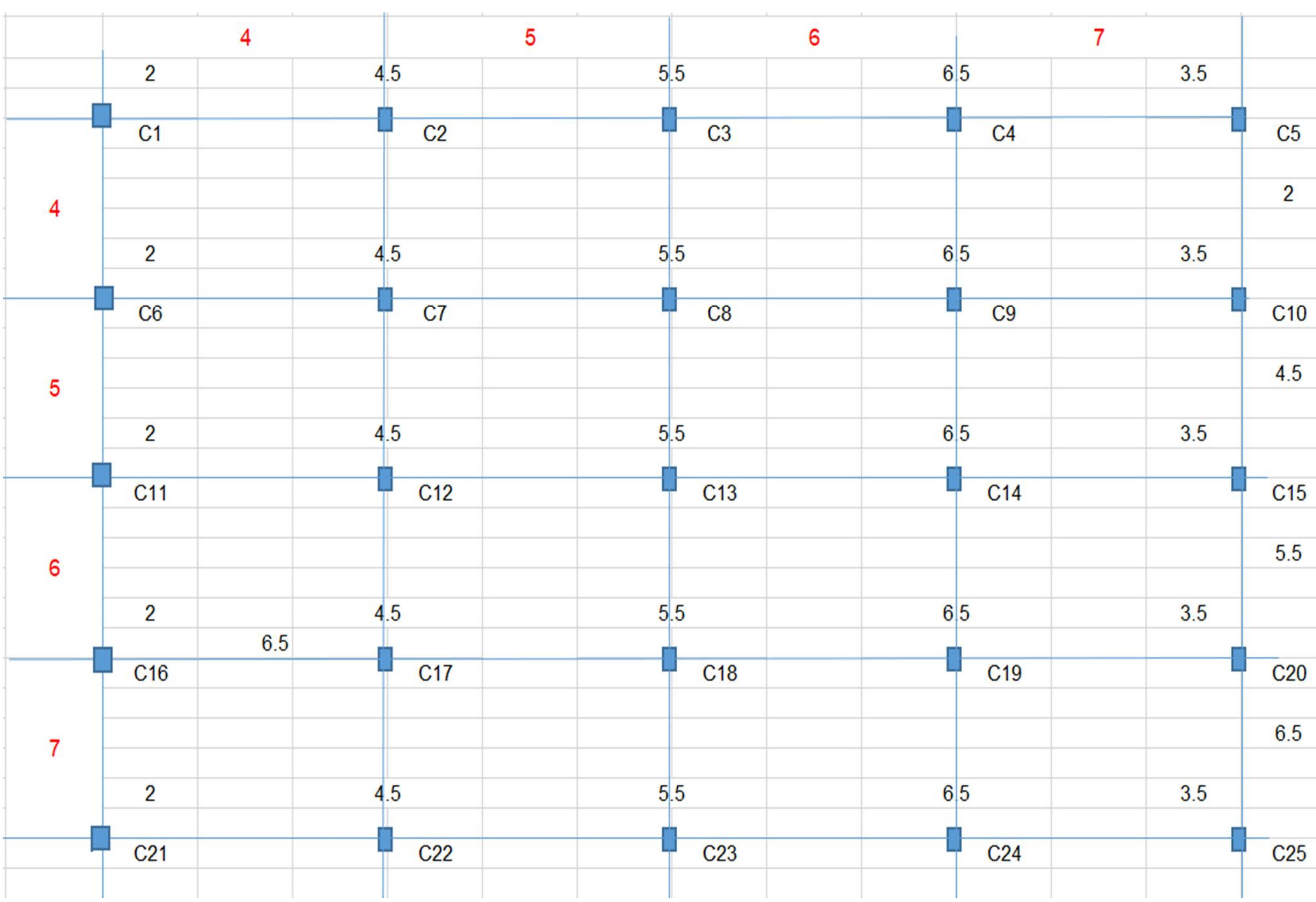

Fig 1

3) *Calculation of Axial Loads*

a) Self-Weight on Column = b*d*H*Self-Weight of RCC
= 0.23*0.38*3.2*25
= **6.99 KN**

b) Self-Weight of Beam = L*b*d*Self-Weight of RCC
= 4*0.23*0.38*25
= **8.74 KN**

c) Self-Weight on Slab =(L*B*T*Self-Weight of RCC)+(L*B*FF)+(L*B*LL)
= (2*2*0.125*25)+(2*2*1)+(2*2*2)
= 24.50 KN

d) Self-Weight from Wall = L* (Height-Beam Depth) *T*Masonry
= 4* (3.2-0.38) *0.23*18
= 46.70 KN

e) 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 KN

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 KN

g) Factored Load = 1.5*P
= 1.5*189.59
Pu = 284.39 KN

D. *Design of Beam*

1) *Inputs*

Beam Depth	0.38	m
Beam Width	0.23	m
ES	200000	N/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) Lx = **4m**
Ly =**4m**
Span Ratio = Ly/Lx = **1m**

b) Check for Slab
If (Span Ratio >=2,"One Way Slab", "Two Way Slab")
Hence, **Two Way Slab**

c) Wo = (Floor finish *Slab thickness*25) *1.5
= (1*0.125*25) *1.5
= 6.88 KN/m

d) Dead Load calculation
- Slab Load =if (Lx <Ly), 1/3* Wo*Lx* Wo*Lx/2*(1-1(3* Span Ratio^2))).

=if (4<4), 1/3*6.88*4*6.88*4/2* (1-1(3*1^2)))
= 8.250 KN/m

- Wall load=0.23*Height*Masonry

=0.23*3.2*18
= 13.248 KN/m

- Beam Load=Beam depth *Beam Width *Self Weight of RCC

=0.38*0.23*25
= 2.185 KN/m
- Total Dead Load= Slab Load + Wall load + Beam Load

= 8.250+13.248+2.185
=23.683 KN/m

e) LiveLoad calculation =if (Lx<Ly),1/3*LL *Lx*LL*Lx/2*(1-1(3* Span Ratio^2)))
=if (4<4), 1/3*2*4*2*4/2*(1-1(3*1^2)))
=2.667 KN/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 KN/m

Middle of interior= (Total Dead load *Lx*Lx)/16
= (23.683*4*4)/16
=23.683 KN/m

➢ Support moments
End Support= (Total Dead load *Lx*Lx)/10
= (23.683*4*4)/10
=37.893 KN/m

Next to End Support= (Total Dead load *Lx*Lx)/12
= (23.683*4*4)/12
=31.577 KN/m

- Live load moments calculations
- ➢ Span moments

Middle of end= (Total Live load *Lx*Lx)/10
= (2.667*4*4)/10
= 4.267 KN/m

Middle of interior= (Total Live load *Lx*Lx)/12
= (2.667*4*4)/12
= 3.556 KN/m

- ➢ Support moments

End Support= (Total Live load *Lx*Lx)/9
= (2.667*4*4)/9
= 4.741 KN/m

Next to End Support= (Total Live load *Lx*Lx)/9
= (2.667*4*4)/9
= 4.741 KN/m

- Total Bending Moment Coefficients
- ➢ Middle of end = (DL+LL)

= (31.577 +4.267)
= 35.844 KN/m

- ➢ Middle of interior= (DL+LL)

= (23.683+3.556)
= 27.239 KN/m

- ➢ End Support= (DL+LL)

= (37.893+4.741)
= 42.634 KN/m

- Interior support= (DL+LL)

= 25.283 KN/m

- Next to End Support= (DL+LL)

= (31.577+4.741)
= 36.318 KN/m

g) Shear Coefficients calculations

- At End= (DL+LL) *0.45

= (23.683+2.667) *0.45
= 24.883 KN/m

- Next to End= (DL+LL) *0.6

= (23.683+2.667) *0.6
= 25.283 KN/m

3) Design for Bending at Left Support

- Xumax/d = 0.00035/ (0.0055+0.87*Fy) / 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 N/mm^2**

- Pt min (%) = 0.85 / Fy * 100
  = 0.85 /500*100

= 0.170

- Design for Bending at left Support
- ➢ Mu= **42.634 KN-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 KN-m

If (Mu<Mulim,((1-SQRT(1-4*0.416*Mu*10^6/0.36/fck/Width/d^2))/2/0.416*d^2),Xumax/d*/d)

- Xu =**85.64 KN –m**
- e At ASC= **0.0025**
- fsc = **401.033 N/mm^2**

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

- fcc= **8.920 N/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 mm^2

➢ Asc =If (Mu<=Mulim,0, ((Mu-Mulim) *10^6/(fcc-fsc)/ (Eff Depth-Cover))/100)

= If (42.634<=85.64,0, ((42.634-85.64) *10^6/ (8.920-401.33)/(340-25))/100)

= 0.00

➢ Ast-2 = If (Mu<=Mulim,0, ((fsc-fcc)/0.87/ Fy*Asc))
= If (42.634<=85.64,0, ((401.33-8.920)/0.87/ 500*0.00))

=0.00

➢ AST =Ast-1+Ast-2

= 321.474 mm^2

- 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 mm^2

- 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

- Vu = **24.883 KN**

If (0.8*Fck /6.89/ Pt% >1,0.8*Fck /6.89/ Pt%,1)

- β = **5.649**

- τc =0.85*SQRT (0.8*Fck)*(SQRT(1+5*β)-1)/6/β

  = 0.85*SQRT (0.8*20) *(SQRT (1+5*5.649)-1)/6/5.649

= 0.44 N/mm^2

- τv =Vu *Width *Eff Depth

=24.883 *230 *340

=0.318 N/mm^2

- τcbd = τc*b*d

= 0.44 *230 *340

=34.578 KN

- Vus = If (Vu-τcbd>0, Vu-τcbd,0.0001)

  = If (24.833-34.758>0,24.833-34.758,0.0001)

= 0.0001 KN

If((Pt Percentage>4,τv>τcmax),"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*Fy) / 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))))))

- τcmax**= 2.8 N/mm^2**
- Pt min (%) = 0.85 / Fy * 100

  = 0.85 /500*100

  = 0.17

- Design for Bending at Mid Span
- ➢ Mu= **35.844 KN-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 KN-m

If (Mu<Mulim,((1-SQRT(1-4*0.416*Mu*10^6/0.36/fck/Width/d^2))/2/0.416*d^2),Xumax/d*/d)

- Xu = **69.586 KN –m**
- e At ASC= **0.002**
- fsc = **390.565 N/mm²**

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

- fcc= **8.92 N/mm²**
- Area of Reinforcement

➢ Ast – 1 =(0.36*Fck*Width*Xu /0.87/ Fy)
= (0.36*20*230*85.64 /0.87 /500)
= 321.44 mm²

➢ Asc =If (Mu<=Mulim,0, ((Mu-Mulim) *10^6/(fcc-fsc)/ (Eff Depth-Cover))/100)
= If (42.634<=85.64,0, ((42.634-85.64) *10^6/ (8.920-401.33)/(340-25))/100)
= 0.00

➢ Ast-2 = If (Mu<=Mulim,0, ((fsc-fcc)/0.87/ Fy*Asc))
= If (42.634<=85.64,0, ((401.33-8.920)/0.87/ 500*0.00))
= 0.00

➢ AST =Ast-1+Ast-2
= 321.474 mm²

- 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 mm²

- 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

- Vu = **0.0**

If (0.8*Fck /6.89/ Pt% >1,0.8*Fck /6.89/ Pt%,1)

- β = **5.649**
- τc =0.85*SQRT (0.8*Fck)*(SQRT(1+5*β)-1)/6/β
= 0.85*SQRT (0.8*20) *(SQRT (1+5*5.649)-1)/6/5.649

= 0.44 N/mm²

- τv =Vu *Width *Eff Depth

=0.00 *230 *340
= 0.00

- τcbd = τc*b*d

= 0.44 *230 *340
= 36.103 KN

- Vus = If (Vu-τcbd>0, Vu-τcbd,0.0001)
= If (0-34.758>0,0,34.758,0.0001)

= 0.0001 KN

7) *Design for Bending at Right Support*

- Xumax/d = 0.00035/ (0.0055+0.87*Fy) / 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))))))

- τcmax**= 2.8 N/mm^2**

- Pt min (%) = 0.85 / Fy * 100
  = 0.85 /500*100
  = 0.170

- Design for Bending at left Support

➢ Mu= **36.318 KN-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 KN-m

If (Mu<Mulim,((1-SQRT(1-4*0.416*Mu*10^6/0.36/fck/Width/d^2))/2/0.416*d^2),Xumax/d*/d)

- Xu = **70.602 KN –m**
- e At ASC= **0.0025**
- fsc = **391.487 N/mm^2**

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

- fcc= **8.920 N/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 mm^2

➢ Asc =If (Mu<=Mulim,0, ((Mu-Mulim) *10^6/(fcc-fsc)/ (Eff Depth-Cover))/100)

= If (42.634<=85.64,0, ((42.634-85.64) *10^6/ (8.920-401.33)/(340-25))/100)

= 0.00

➢ Ast-2 = If (Mu<=Mulim,0, ((fsc-fcc)/0.87/ Fy*Asc))
  = If (42.634<=85.64,0, ((401.33-8.920)/0.87/ 500*0.00))
  = 0.00

➢ AST =Ast-1+Ast-2
  = 268.77 mm^2

- Pt(%) = Ast / Width /Eff Depth *100

= 268.77/230/340*100

= 0.344

- Astmin = Pt min (%) * Width * Eff Depth

=0.170 *230 *340/100

=132.940 mm^2

- Ast Critical = If (Ast<Astmin,Astmin, Ast)

=If (268.77<132.94, 132.94,321.474)

= 268.77

8) Design for Shear at Right Support

- Vu = **25.283 KN**

If (0.8*Fck /6.89/ Pt% >1,0.8*Fck /6.89/ Pt%,1)

- β = **6.756**
- τc =0.85*SQRT (0.8*Fck)*(SQRT(1+5*β)-1)/6/β
  = 0.85*SQRT (0.8*20) *(SQRT (1+5*6.756)-1)/6/6.756

= 0.41 N/mm²

- τv =Vu *Width *Eff Depth

=25.283 *230 *340
= 0.323 N/mm²

- τcbd = τc*b*d

= 0.41 *230 *340
= 32.122 KN

- Vus = If (Vu-τcbd>0, Vu-τcbd,0.0001)

= If (25.283-32.122>0,25.283-32.122,0.0001)
= 0.0001 KN

If((Pt Percentage>4,τv>τcmax),"Increase Section","SectionAdequte")
Hence**, Section Adequte**

If((Mu)<Mulim,"Singly","Doubly")
Hence, **Singly**

9) Reinforcement Details

- Ast Provided = **321.47 mm²**
- Dia = **12mm**
- No of Bars = **3**

E. Design of Slab

1) Inputs

b 1000 mm

2) Design

- Self Weight of Slab = Slab Thickness * Self Weight of RCC
  = 0.125 * 25
  = 3.125 KN/m²

- Total Load = LL + FF + Self Weight of Slab
  = 2 + 1 + 3.125
  = 6.125 KN/m²

- Ultimate Load = 1.5 * Total Load
  = 1.5 * 6.125
  = 9.188 KN/m²

- Lx = **4m**
  Ly = **4m**
  Span Ratio = Ly / Lx
  = 4 / 4
  = 1m

- Check For Slab

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

- Le = Min((Lx+ Wall Thickness),(Lx + Lx/2))
  = Min ((4 + 0.23), (4 + 4 / 2)
  = 4.23 m

- Effective Depth (De) = Slab Thickness – 0.015
  = 0.125 – 0.015
  = 0.11 m
- WLx^2 = Ultimate Load * Lx^2
  = 9.188 * 4^2
  = 147 KN

- Edge Condition = **Two Adjacent Side Discontinuous**
  = 7

- Multiplication Factor
  -ve at Support of Short Span (α_x) = **0.047**
  +ve at Midspan of Short Span (α_x) = **0.035**
  -ve at Midspan of Long Span (α_y) = **0.047**
  +ve at Support of Long Span (α_y) = **0.035**

- Bending Moments Mu
  -ve at Support of Short Span (α_x) = WLx^2 * (α_x)
  = 147 * 0.047
  = 6.909 KN-m

  +ve at Midspan of Short Span (α_x) = WLx^2 * (α_x)
  = 147 * 0.035
  = 5.145 KN-m

  -ve at Midspan of Long Span (α_y) = WLx^2* (α_y)
  = 147 * 0.047
  = 6.909 KN-m

  +ve at Support of Long Span (α_y) = WLx^2 * (α_y)
  = 147 * 0.035
  = 5.145 KN-m

- Are of Steel Required

➢ -ve at Support of Short Span (α_x)
=0.5*Fck/Fy*b*De*1000*(1-SQRT (1-4.6*Mu (α_x) *10^6/(Fck*b*(Y10*1000) ^2)))

= 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^2

- +ve at Midspan of Short Span (α_x)

= 0.5*Fck/Fy*b*De*1000*(1-SQRT (1-4.6*Mu (α_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^2

- -ve at Midspan of Long Span (α_y)

= 0.5*Fck/Fy*b*De*1000*(1-SQRT (1-4.6*Mu (α_y) *10^6/(Fck*b*(Y10*1000) ^2)))
= 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^2

- +ve at Support of Long Span (α_y)

= 0.5*Fck/Fy*b*De*1000*(1-SQRT (1-4.6*Mu (α_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^2

- Proposed Dia

  -ve = **8mm**
  +ve = **8mm**

- Area of Steel bar = π/4 * Dia^2

-ve at Support of Short Span (α_x) = π/4 * 8^2
= 50.24 mm^2
+ve at Midspan of Short Span (α_x) = π/4 * 8^2
= 50.24 mm^2
-ve at Midspan of Long Span (α_y) = π/4 * 8^2
= 50.24 mm^2
+ve at Support of Long Span (α_y) = π/4 * 8^2
= 50.24 mm^2

- Spacing

- -ve at Support of Short Span (α_x) = Min (1000*π/4*(-veDia)^2/Ast req,300)
= Min (1000*π/4*(8)^2/149.54,300)
= 300 mm

- +ve at Midspan of Short Span (α_x) = Min (1000*π/4*(+veDia)^2/Ast req,300)
= Min (1000*π/4*(8)^2/110.34,300)
= 300 mm

- -ve at Midspan of Long Span (α_y) = Min (1000*π/4*(-veDia)^2/Ast req,300)
= Min (1000*π/4*(8)^2/149.54,300)
= 300 mm

- +ve at Support of Long Span (α_y) = Min (1000*π/4*(+veDia)^2/Ast req,300)
= Min (1000*π/4*(8)^2/110.34,300)
= 300 mm

- No of Bars

  -ve at Support of Short Span (α_x) = **4**

+ve at Midspan of Short Span (α_x) = **4**
-ve at Midspan of Long Span (α_y) = **4**
+ve at Support of Long Span (α_y) = **4**

- Area of Steel Provided
- -ve at Support of Short Span (α_x) = Area of Steel Bar * No of Bars
  = 50.24 * 4
  = 201 mm^2

- +ve at Midspan of Short Span (α_x) = Area of Steel Bar * No of Bars
  = 50.24 * 4
  = 201 mm^2

- -ve at Midspan of Long Span (α_y) = Area of Steel Bar * No of Bars
  = 50.24 * 4
  = 201 mm^2

- +ve at Support of Long Span (α_y) = Area of Steel Bar * No of Bars
  = 50.24 * 4
  = 201 mm^2

- Check for Deflection
- Percentage Main Steel Provided = Max (+ve at (α_x), +ve at (α_y)) *100/(1000*De*1000)
  = Max (201, 201) *100/ (1000*0.11*1000)
  = 0.182
- Limiting Value of Steel = **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**
- Permissible Span = Overall Depth * kt
  = 26 * 2
  = 46mm
- Actual Span = De*1000/ Lx
  = 0.11*1000 / 4
  = 28mm

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	KN/m^3
Masonry	18	
Floor Finish	1	KN/m^2
Live Load	2	KN/m^2
Grade of Concrete (fck)	20	N/mm^2
Reinforcenment Grade (fy)	500	N/mm^2

2) Structure

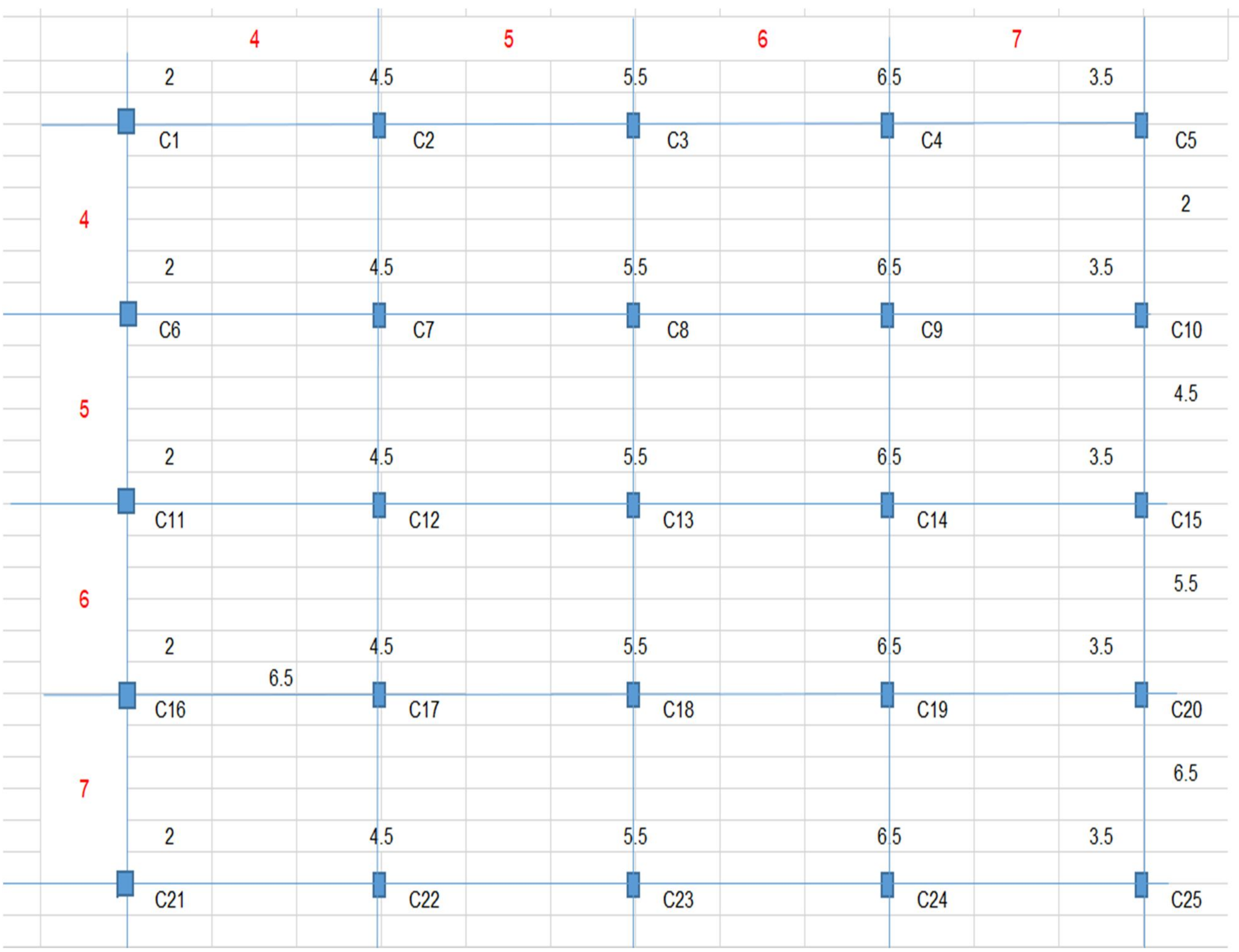

Fig 2

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			
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

Self Weight from Wall(KN/m)			
L	H	T	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 Beam

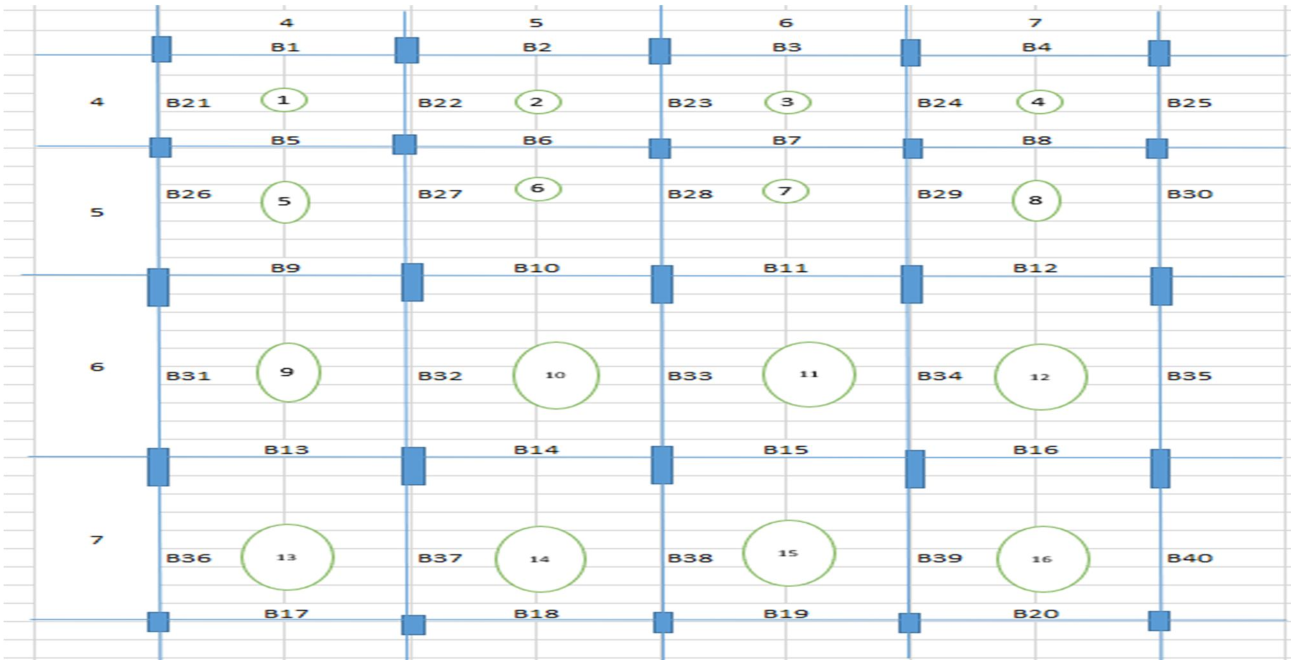

Fig 3

1) Inputs

Beam		
Beam Depth	0.38	m
Beam Width	0.23	m
ES	200000	N/mm^2
Depth	0.38	m
Cover to center	0.04	m
Effective Depth	0.34	m
Stirrup Dia	8	mm
Cover	25	mm

2) Design

<u>Design of Beam</u>

Beam.No	ES (N/mm$^{2)}$	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 Beam	Ast	No. of Bars	Spacing (mm C/C)
SINGLY	321.47	3.00	0.75

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

Beam.No	Panel .No	Span Ratio	Check For Slab	Bending Moment Coefficents				Shear Coefficents		
				Total				At Support Next to the End Support		
				Middle of end DL+LL	Middle of interior DL+LL	End DL+LL	Next to End 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

B21	1	1.000	Two Way Slab	109.772	83.418	130.565	111.224	24.883	25.283	25.283
B22	2	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							
B23	3	1.500	Two Way Slab	46.844	35.489	55.834	47.318	33.133	33.533	33.533
	2	1.250	Two Way Slab							
B24	4	1.750	Two Way Slab	46.844	35.489	55.834	47.318	33.133	33.533	33.533
	3	1.500	Two Way Slab							
B25	4	1.750	Two Way Slab	35.844	27.239	42.634	36.318	24.883	25.283	25.283
B26	5	1.250	Two Way Slab	60.300	45.881	71.661	61.174	26.584	27.056	27.056
B27	6	1.000	Two Way Slab	82.251	62.383	97.961	83.177	36.981	37.481	37.481
	5	1.250	Two Way Slab							
B28	7	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							
B29	8	1.400	Two Way Slab	83.454	63.285	99.404	84.380	37.558	38.058	38.058
	7	1.200	Two Way Slab							
B30	8	1.400	Two Way Slab	61.970	60.581	62.896	62.896	27.246	27.746	27.746
B31	9	1.500	Two Way Slab	90.191	68.665	107.138	91.554	27.508	28.019	28.019
B32	10	1.200	Two Way Slab	127.421	125.116	128.958	128.958	39.592	60.580	60.580
	9	1.500	Two Way Slab							
B33	11	1.000	Two Way Slab	133.488	133.488	133.488	133.488	41.496	63.514	63.514
	10	1.200	Two Way Slab							
B34	12	1.167	Two Way Slab	134.949	132.549	136.549	136.549	41.983	64.293	64.293
	11	1.000	Two Way Slab							
B35	12	1.167	Two Way Slab	97.824	74.568	116.109	99.424	29.608	30.208	30.208
B36	13	1.750	Two Way Slab	125.516	95.593	149.067	127.457	28.065	28.600	28.600
B37	14	1.400	Two Way Slab	180.805	137.298	215.158	183.064	41.166	41.789	41.789
	13	1.750	Two Way Slab							
B38	15	1.167	Two Way Slab	194.874	148.006	231.876	197.341	44.326	45.006	45.006
	14	1.400	Two Way Slab							
B39	16	1.000	Two Way Slab	202.072	153.460	240.454	204.613	45.987	46.687	46.687
	15	1.167	Two Way Slab							
B40	16	1.000	Two Way Slab	144.838	110.534	171.773	147.379	31.971	32.671	32.671

Table 4

LEFT SUPPORT

Design values At Left Support				
Beam.No	ES (N/mm^{2})	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

1	Beam	3	Beam
Section Adequte	SINGLY	Section Adequte	Singly
Section Adequte	DOUBLY	Section Adequte	Singly
Section Adequte	SINGLY	Section Adequte	Doubly
Section Adequte	DOUBLY	Section Adequte	Doubly
Section Adequte	SINGLY	Section Adequte	Singly
Section Adequte	SINGLY	Section Adequte	Singly
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	DOUBLY	Section Adequte	Doubly
Section Adequte	DOUBLY	Section Adequte	Doubly
Section Adequte	SINGLY	Section Adequte	Singly
Section Adequte	SINGLY	Section Adequte	Singly
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	Doubly
Section Adequte	DOUBLY	Section Adequte	Doubly
Section Adequte	DOUBLY	Section Adequte	Doubly

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

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

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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ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
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3) E-tab Results

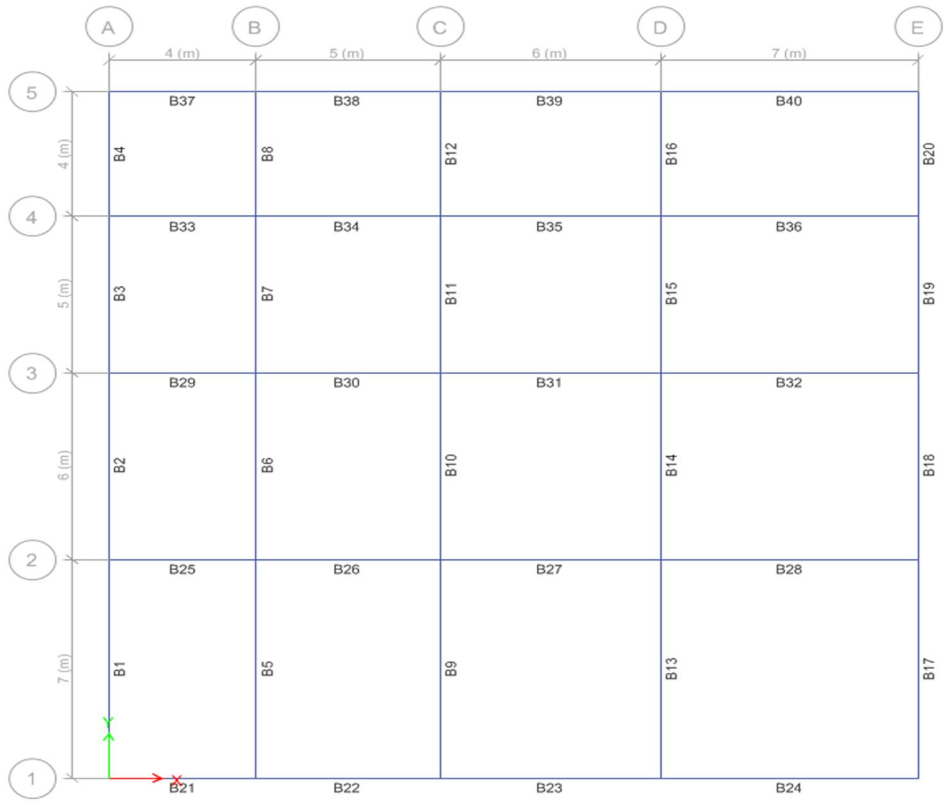

Fig 4

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	37.48	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

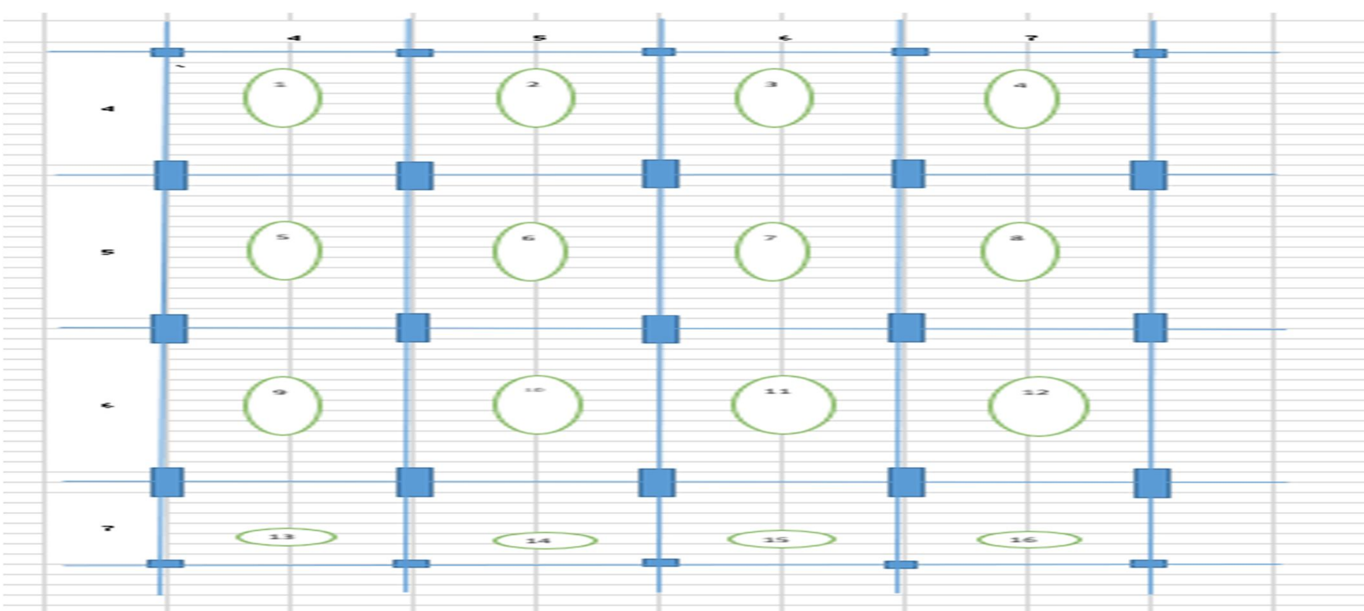

Fig 5

1) Input

Slab		
b	1000	mm

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2) Design

Design OF Slab

Slab	Live Load (KN/m2)	Floor Finish (KN/m2)	Self Weight of Slab (KN/m2)	Total Load (KN/m2)	Ultimate Load Wu (KN/m2)	Lx m	Ly m
S-1	2	1	3.125	6.125	9.1875	4	4

Two Way Slab

Proposed Dia	
(-ve)	(+ve)
mm	mm
8	8
Steel Within the Limit	
Satisfies deflection Criterion	

Ast min mm2	Spacing for Main Bars mm
132	380.80

Slab	Live Load (KN/m2)	Floor Finish (KN/m2)	Self Weight of Slab (KN/m2)	Total Load (KN/m2)	Ultimate Load Wu (KN/m2)	Lx	Ly	Span Ratio Ly/Lx	Check for slab
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 De (m)	W lx ² KN	e αx at Support of short s αx	ve αx at Midspan of short spa αx	-ve αy at suport of long span αy	+ve αy at Mid span of long span αy	- ve αx at Support of short span αx	+ ve αx at Midspan of short span αx	-ve αy at suport of long span αy	+ve αy at Mid span of long span αy
4.230	0.110	147.000	0.047	0.035	0.047	0.035	149.543	110.345	149.543	110.345
4.230	0.110	147.000	0.045	0.034	0.032	0.024	142.958	107.111	100.659	75.047
4.230	0.110	147.000	0.053	0.041	0.032	0.024	169.427	129.851	100.659	75.047
4.230	0.110	147.000	0.055	0.041	0.032	0.024	176.098	129.851	100.659	75.047
4.230	0.110	147.000	0.045	0.034	0.032	0.024	142.958	107.111	100.659	75.047
5.230	0.110	229.688	0.032	0.024	0.032	0.024	159.461	118.450	159.461	118.450
5.230	0.110	229.688	0.043	0.032	0.032	0.024	217.235	159.461	159.461	118.450
5.230	0.110	229.688	0.051	0.039	0.032	0.024	260.333	196.034	159.461	118.450

Table 16

Ast min	Proposed Dia		Area of Steel Bar mm^2			
	(-ve)	(+ve)	- ve αx at Support of short span	+ ve αx at Midspan of short span	-ve αy at suport of long span	+ve αy at Mid span of long span
mm2	mm	mm	α x	α x	α y	α y
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 17

Area of Steel Provided mm^2 (Ast Provided)					
- ve αx at Support of short span	+ ve αx at Midspan of short span	-ve αy at suport of long span	+ve αy at Mid span of long span		
α x	α x	α y	α y		
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	mm c/c	mm	mm c/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	#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!
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

4.230	0.110	147.000	0.053	0.041	0.032	0.024	169.427	129.851	100.659	75.047
5.230	0.110	229.688	0.043	0.032	0.032	0.024	217.235	159.461	159.461	118.450
6.230	0.110	330.750	0.032	0.024	0.032	0.024	233.716	172.760	233.716	172.760
6.230	0.110	330.750	0.041	0.031	0.032	0.024	304.634	225.994	233.716	172.760
4.230	0.110	147.000	0.060	0.045	0.032	0.024	192.873	142.958	100.659	75.047
5.230	0.110	229.688	0.051	0.039	0.032	0.024	260.333	196.034	159.461	118.450
6.230	0.110	330.750	0.041	0.031	0.032	0.024	304.634	225.994	233.716	172.760
7.230	0.110	450.188	0.032	0.024	0.032	0.024	325.261	238.881	325.261	238.881

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	201	251	201	Steel Within the Limit	Satisfies deflection Criterion
352	251	251	201	Steel Within the Limit	Satisfies deflection Criterion
201	201	201	201	Steel Within the Limit	Satisfies deflection Criterion
302	201	201	201	Steel Within the Limit	Satisfies deflection Criterion
352	251	251	201	Steel Within the Limit	Satisfies deflection Criterion
352	251	352	251	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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