DESIGN OF RCC ELEMENTS USING MACROS

Project submitted in partial fulfilment of the requirement for the degree of

Bachelor of Technology

in

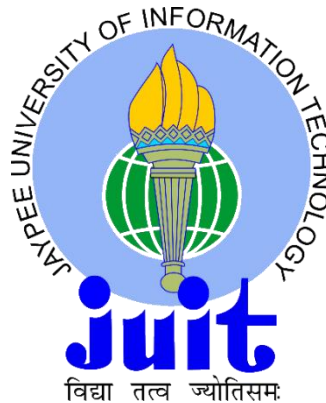CIVIL ENGINEERING

Under the supervision of

Mr. MANI MOHAN

By

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TECHNOLOGY, SOLAN (H.P.)
MAY, 2015

CERTIFICATE

This is to certify that the work entitled, "**DESIGN OF VARIOUS RCC STRUCTURES USING MACROS**" submitted by **Aayush Somani** and **Prem Kumar** in partial fulfillment for the award of degree of Bachelor of Technology in Civil Engineering of Jaypee University of Information Technology has been carried out under my supervision. This work has not been submitted partially or wholly to any other University or Institute for the award of this or any other degree or diploma.

Supervisor

Mr. MANI MOHAN

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Solan, Waknaghat

Certified the above mentioned project work has been carried out by the said group of students.

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ACKNOWLEDGEMENT

The success of any project depends largely on the encouragement and guidelines of many others. Therefore we take this opportunity to express our sincere gratitude to the people who have been instrumental in the successful completion of the project.

We would like to express our sincere appreciation and gratitude to our guide **Mr Mani Mohan** without whose able guidance, tremendous support and continuous motivation the project would not have been carried to perfection. We sincerely thank him for spending all his valuable time and energies during the execution of project.

We take this opportunity to express our sincere gratitude to the Head of Department (Civil Engineering) **Pro. Dr. Ashok Kumar Gupta** for all his support and valuable inputs. We thank him for reviving Civil Engineering as the overall mentor by leading with a vision and teaching us with a knowledge imparting attitude.

The successful compilation of final year project depends on the knowledge and attitude inculcated in the total length of course. So we want to express our sincere gratitude to all the faculties who taught us during the four years of B.Tech.

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                                                                        PREM KUMAR (111697)

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ABSTRACT

The project is to design of RCC structures like beam, slab using macros in ms-excel. Design done in excel using macros is user friendly that's the reason designing firms uses it frequently. Design of beam is being completed with cost comparison of different grades of concrete and steel and finding out the optimum cost for different d/B(effective depth/breadth) ratios. To make it efficient and simpler the inputs are provide within a specified range.

All the provisions from Indian standard codes like IS456:2000 were taken into consideration while designing.

SECTION 1:
INRODUCTION

1.1 GENERAL

Reinforced concrete (RC) is a composite material in which concrete's relatively low tensile strength and ductility are counteracted by the inclusion of reinforcement having higher tensile strength and/or ductility. The reinforcement is usually, though not necessarily, steel reinforcing bars (rebar) and is usually embedded passively in the concrete before the concrete sets. Reinforcing schemes are generally designed to resist tensile stresses in particular regions of the concrete that might cause unacceptable cracking and/or structural failure. Modern reinforced concrete can contain varied reinforcing materials made of steel, polymers or alternate composite material in conjunction with rebar or not. Reinforced concrete may also be permanently stressed (in compression), so as to improve the behaviour of the final structure under working loads.

For a strong, ductile and durable construction the reinforcement needs to have the following properties at least:

- High relative strength,
- High toleration of tensile strain,
- Good bond to the concrete, irrespective of pH, moisture, and similar factors,
- Thermal compatibility, not causing unacceptable stresses in response to changing temperatures.

Many different types of structures and components of structures can be built using reinforced concrete including slabs, walls, beams, columns, foundations, frames and more. Reinforced concrete can be classified as precast or cast-in-place concrete.

Microsoft Excel macro is a useful tool in the hands of Excel users. Macros are of a great help to reduce the time and efforts of the users to a great extent. If you need to perform repetitive tasks very often as a part of your job, then, make use of macro, as it will facilitate you to do so conveniently. Microsoft word, excel and PowerPoint are used in the workplace. As such, developing the excel skills and skills of using macros helps you greatly in carrying out your tasks effectively, faster and efficiently.

1.2 OBJECTIVE

- To design RCC structures with use of macros.
- Comparison of cost of structure taking various combinations of grades of steel and concrete.
- To look out for the most economical section

1.3 INTRODUCTION TO MACROS

A macro is a term for a series of commands and functions that are stored in a Microsoft Visual Basic module and can be run whenever you need to perform the task associated with those commands. Macros run in Microsoft Word, PowerPoint and Excel. Macros can be simple and complex and are created when you record a series of keystrokes using the macro dialogue.

A macro is a stored series of commands and functions that enables you to carry out your routine chores faster. There are several benefits that can be extracted from using excel macros.

It must be noted that mostly Microsoft word, excel and powerpoint are used in the workplace. As such, developing the excel skills and skills of using macros helps you greatly in carrying out your tasks effectively, faster and efficiently. While using the macro dialogue box, you can run macros in Word, excel and power point, as the macros support these products to the extent at which you feel comfortable. If done manually, the same tasks that are done without macros will take longer time. Also, it

would be a tedious task. Contrarily, if macros are used to perform the same tasks, the job will be much faster and convenient.

In fact, there are several benefits offered by excel macros, just to name a few are mentioned. Macros can be used for printing reports. In case of routine tasks, using macros will be of great help and assistance. They are employed for sorting and clearing the cell contents while they help you greatly in retrieving or transferring the data in different locations within spreadsheets. Macros can also facilitate the users in creating graphs or charts. If the tasks of copying and pasting the data or making calculations based on the assigned formulas are done repetitively, macros is of obvious importance and great use to carry out such activities effectively.

Excel macros are easy to create. You can assign command button with a specific name to get particular task done each time you need to do it. Thus, Microsoft excel macro is a valuable tool to carry out your routine tasks conveniently while reducing your time and efforts greatly.

1.4 ADVANTAGES OF MACROS

- It locks the value of the results and does not give instantaneous results on changing the input. We need to run the macro for changing the results.

- User interface control- A macro can provide a friendlier interface by using dialog boxes and message box.

- All of the elements in the program are changed automatically when one or more of the user inputs are changed.

- Use of Excel is more in firms and companies as compared to other design software's.

SECTION 2
DESIGN OF REINFORCED CONCRETE STRUCTUES

2.1 DIFFERENT METHOD FOR DESIGN OF RCC

- Working Stress Method
- Limit State Method
- Ultimate Load Method
- Probabilistic method of design.

2.1.1 Working Stress Method of Design

Concrete is strong in compression and crushing strength is determined by test on standard cubes. Large deformation is noticed at the failure load. Deformation is permanent in nature. This suggests for the adoption of a factor of safety.

Permissible bending & direct compression are as fraction of crushing strength. For example:

M15 concrete, the value of $\sigma_{cbc} = 5 = (15/3)$ and $\sigma_{cc} = 4 = (15/3.75)$

Assumptions in working stress method

- Plane section before bending will remain plane after bending.
- Stress-strain relations obey Hooks law (linear)
- Tensile stresses are taken by steel only.
- The modular ratio, $m = \frac{280}{3} \times \sigma_{cbc}$

2.1.2. LIMIT STATE METHOD OF DESIGN

- The object of the design based on the limit state concept is to achieve an acceptable probability, that a structure will not become unsuitable in it's lifetime for the use for which it is intended, i.e. It will not reach a limit state
- A structure with appropriate degree of reliability should be able to withstand safely.

- All loads, that are reliable to act on it throughout its life and it should also satisfy the subs ability requirements, such as limitations on deflection and cracking.
- It should also be able to maintain the required structural integrity, during and after accident, such as fires, explosion & local failure i.e. limit state must be consider in design to ensure an adequate degree of safety and serviceability
- The most important of these limit states, which must be examine in design are as follows

  Limit state of collapse

  - Flexure

  - Compression

  - Shear

This state corresponds to the maximum load carrying capacity.

Assumptions in limit state method:

- Plane section before bending will remain plane after bending.
- Tensile strength carried by of concrete is zero.
- Does not obey Hook`s law.
- Ultimate strain of concrete is 0.0035

  $\sigma_c = 0.67$ fck
- Partial safety factor for concrete = 1.5

  Hence, design strength of concrete = 0.67 fck/1.5 = 0.446 fck
- Maximum strain in tensile reinforcement at failure shall not be less than $(0.87 \times \frac{fy}{Es}) + 0.002$
- Partial safety factor for steel $\gamma_m = 1.15$. Thus the design strength will be: $0.87 \times$fy.

2.2 TYPES OF REINFORCED CONCRETE BEAMS

a) Singly reinforced beam

b)Doubly reinforced beam

c)Singly or Doubly reinforced flanged beams

2.2.1 Singly reinforced beam

In singly reinforced simply supported beams or slabs reinforcing steel bars are placed near the bottom of the beam or slabs where they are most effective in resisting the tensile stresses.
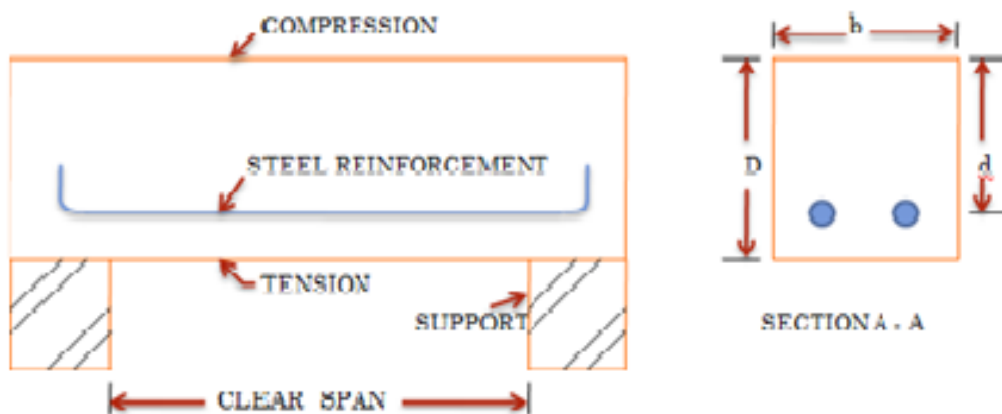

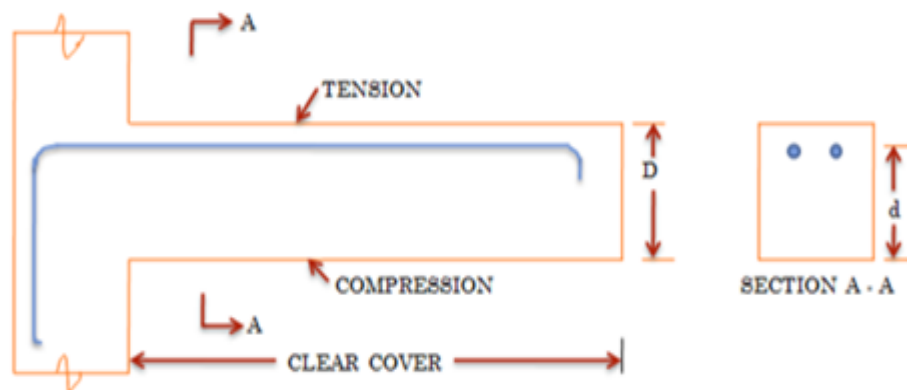**Figure 1: Reinforcement in simply supported beam**

Figure 2: Reinforcement in Cantilever
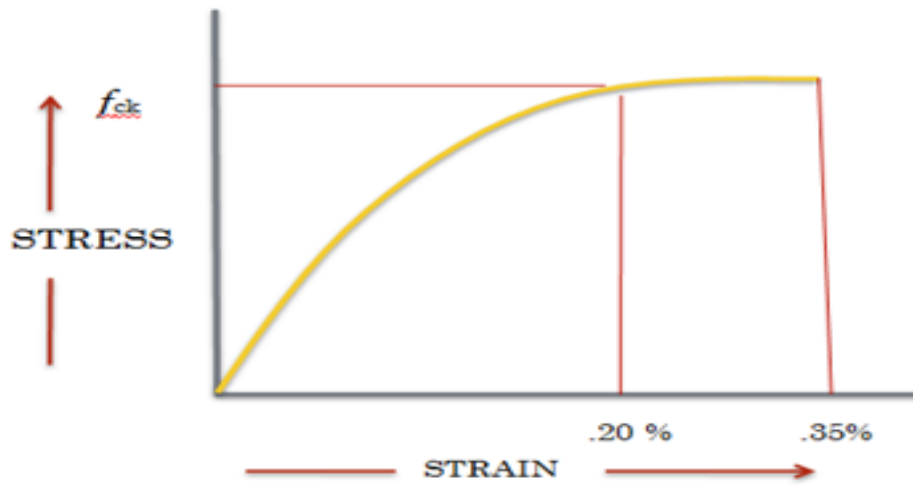
Figure 3: Stress-Strain Curve for concrete
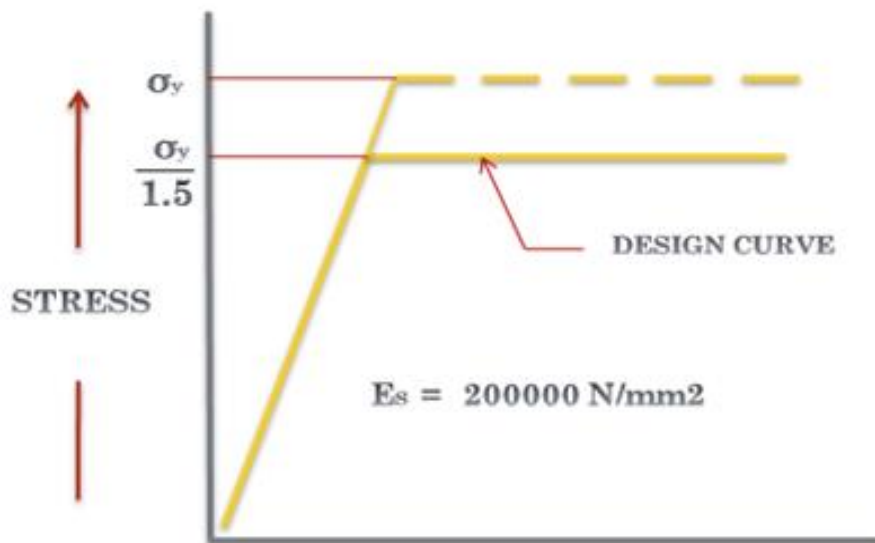
Figure 4: Stress-Strain curve for steel
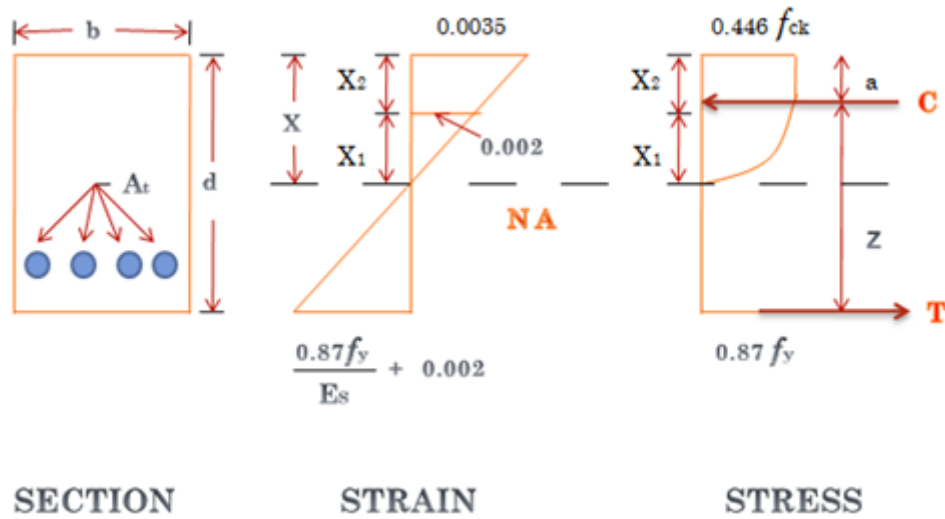
Figure 5: Stress- Strain diagram for reinforced beam

x = Depth of Neutral axis

b = breadth of section

d = effective depth of section

The depth of neutral axis can be obtained by considering the equilibrium of the normal forces, that is,

Resultant force of compression = average stress X area

$$= 0.36 \times f_{ck} \times b \times x$$

Resultant force of tension = $0.87 \times fy \times A_t$

Force of compression should be equal to force of tension,

$$0.36 \times f_{ck} \times b \times x = 0.87 \times fy \times A_t$$

The distance between the lines of action of two forces C & T is called the lever arm and is denoted by z.

Lever arm z = d – 0.42 x

$$z = d - \left(\frac{fy \times A_t}{f_{ck} \times b}\right)$$

Moment of resistance with respect to concrete = compressive force x lever arm

$$= 0.36 \times f_{ck} \times b \times x \times z$$

Moment of resistance with respect to steel = tensile force x lever arm

$= 0.87 \times fy \times A_t \times z$

Maximum depth of neutral axis

- A compression failure is brittle failure.
- The maximum depth of neutral axis is limited to ensure that tensile steel will reach its yield stress before concrete fails in compression, thus a brittle failure is avoided.
- The limiting values of the depth of neutral axis xm for different grades of steel from strain diagram.

$$\frac{xm}{d - xm} = \frac{0.0035}{\left(\frac{0.87fy}{Es}\right) + 0.002}$$

$$\frac{xm}{d} = \frac{0.0035}{\left(\frac{0.87fy}{Es}\right) + 0.0035}$$

TABLE NO.1

fy(N/mm^2)	xu$_{max}$ (mm)
250	0.53d
415	0.48d
500	0.46d

Limiting value of tension steel and moment of resistance

- Since the maximum depth of neutral axis is limited, the maximum value of moment of resistance is also limited.
- Mlim with respect to concrete

    $= 0.36$ fck b x z

    $= 0.36$ fck b xm (d $-$ 0.42 xm)

- Mlim with respect to steel = 0.87 fck At (d – 0.42 xm)

Limiting moment of resistance values, N mm

TABLE NO. 2

Grade of concrete	Grade of steel		
	Fe 250 steel	Fe 450 steel	Fe 500 steel
General	$0.148 f_{ck} bd^2$	$0.138 f_{ck} bd^2$	$0.133 f_{ck} bd^2$
M20	$2.96 bd^2$	$2.76 bd^2$	$2.66 bd^2$
M25	$3.70 bd^2$	$3.45 bd^2$	$3.33 bd^2$
M30	$4.44 bd^2$	$4.14 bd^2$	$3.99 bd^2$

2.2.2 Doubly reinforced beam

Doubly reinforced beams, have moment of resistance more than the singly reinforced beams of the same depth for particular grades of steel and concrete. In many practical situations, architectural or functional requirements may restrict the overall depth of the beams. However, other than in doubly reinforced beams compression steel reinforcement is provided when:

- Some sections of a continuous beam with moving loads undergo
- Change of sign of the bending moment which makes compression zone as tension zone or vice versa.
- The ductility requirement has to be followed.
- The reduction of long term deflection is needed.

It may be noted that even in so called singly reinforced beams there would be Longitudinal hanger bars in compression zone for locating and fixing stirrups.

Assumptions

- The assumptions of sec. 3.4.2 of Lesson 4 are also applicable here.
- Provision of compression steel ensures ductile failure and hence, the limitations of x/d ratios need not be strictly followed here.
- The stress-strain relationship of steel in compression is the same as that in tension. So, the yield stress of steel in compression is 0.87 fy.

2.3 DESIGN OF A SECTION

2.3.1 Design of rectangular beam to resist a bending moment equal to 45 KNm using

(i) M15 mix and mild steel.

The beam will be designed so that under the applied moment both materials reach their maximum stresses.

Assume ratio of overall depth to breadth of the beam equal to 2.

Breadth of the beam = b

Overall depth of beam = D

therefore, D/b = 2

For a balanced design,

Factored BM = moment of resistance with respect to concrete

= moment of resistance with respect to steel

= load factor X B.M

= 1.5 X 45

= 67.5 KNm

For balanced section,

Moment of resistance Mu = 0.36 fck b xm(d - 0.42 xm)

Grade for mild steel is Fe250

For Fe250 steel,

xm = 0.53d

Mu = 0.36 fck b (0.53 d) (1 – 0.42 X 0.53) d

= 2.22bd

Since D/b =2 or, d/b = 2 or, b=d/2

Mu = 1.11 d

Mu = 67.5 X 10 Nmm

d=394 mm and b= 200mm

Adopt D = 450 mm , b = 250 mm ,d = 415mm

Area of tensile steel At = $\dfrac{Factored\ BM}{0.87 \times fy(d-0.42xm)}$

$$= \dfrac{67.5 \times 10^6}{0.87 \times 250(1-0.42 \times 0.53) \times 415}$$

$$= 962 \text{ mm}^2 = 9.62 \text{ cm}^2$$

Minimum area of steel Ao = $0.85\dfrac{b \times d}{fy}$

$$=(0.85 \text{x} 250 \text{x} 415)/250$$

$$= 353 \text{ mm}$$

$$\therefore 353 \text{ mm} < 962 \text{ mm}$$

In beams the diameter of main reinforced bars is usually selected between 12 mm and25mm.

Provide 2-20mm and 1-22mm bars giving total area

$$= 6.28 + 3.80$$

$$= 10.08 \text{ cm} > 9.62 \text{ cm}$$
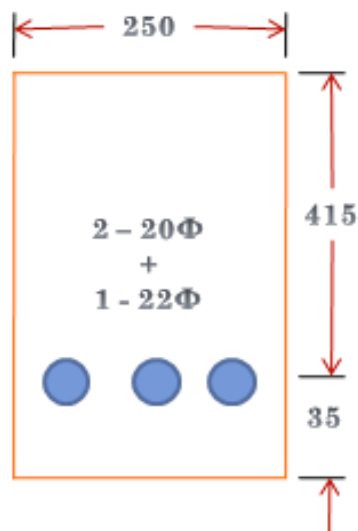
Figure 6: Detailing of Reinforcement

2.4 One-Way Slab

One way slab is supported on two opposite side only thus structural action is only at one direction. Total load is carried in the direction perpendicular to the supporting beam. If a slab is supported on all the four sides but the ratio of longer span to shorten span is greater than 2, then the slab will be considered as one way slab. Because due to the huge difference in lengths, load is not transferred to the shorter beams . Main reinforcement is provided in only one direction for one way slabs.

Figure 7: One way slab

2.4.1 Basic Rules For Design(IS:456-2000)

1. Effective span- Basic rules are same as given by beams.

2. Control of Deflection- Basic values of span to effective depth ratios, for span upto 10 m are as follows:

    Cantilever – 7

    Simply Supported – 20

    Continuous – 26

3. Minimum Reinforcement- Shall not be less than 0.15% of the cross-sectional area for mild steel. It can be reduced to 0.12% when high strength deformed bars are used.

4. Maximum diameter- Shall not exceed one eighth of the total thickness of the slab.

5. Spacing of bars- The horizontal distance between parallel main reinforcement bars shall not be more than 3 times the effective depth of slab or 300 mm, whichever is smaller.

6. Nominal Reinforcement- Shall not be less than diameter of the bar.

7. Curtailment of tension reinforcement- Shall extend for a distance equal to effective depth or 12 times the bar diameter whichever is greater.

2.5 Two-Way Slab

Two way slabs are the slabs that are supported on four sides and the ratio of longer span (l) to shorter span (b) is less than 2. In two way slabs, load will be carried in both the directions. So, main reinforcement is provided in both direction for two way slabs.
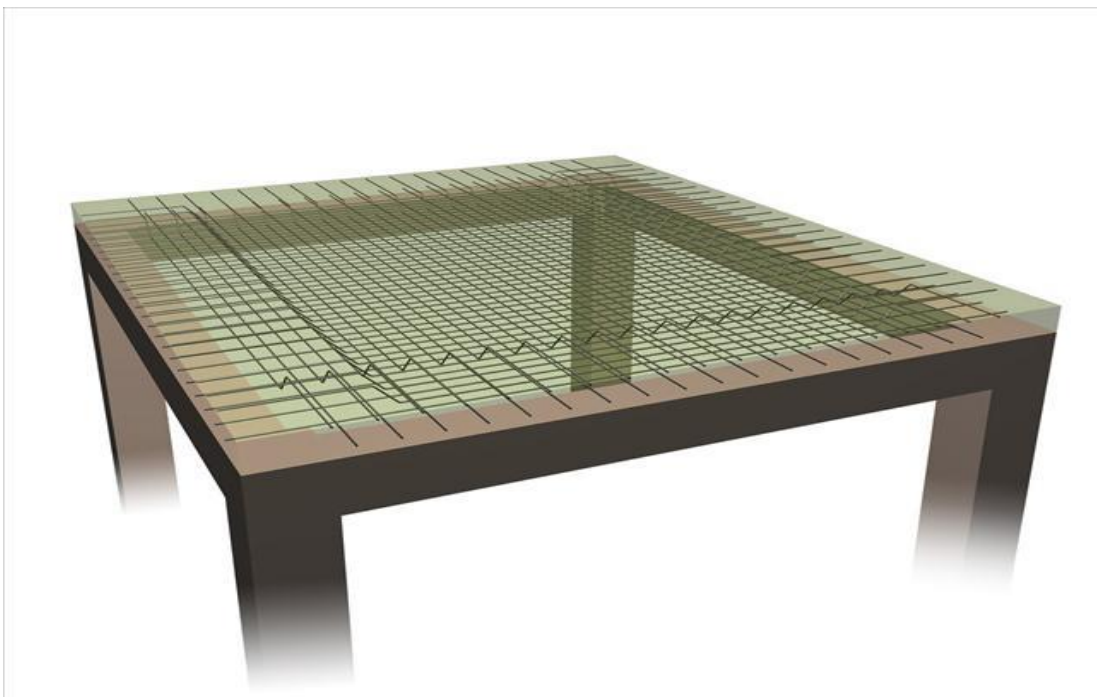
Figure 8: Two way slab

FLOW CHART FOR DESIGN OF A BEAM

Define variables

Ask for User inputs → Check for depth

Calculate xu_{max} and mu_{lim}

If mu <= mu_{lim}

YES → Design for singly reinforced beam

Calculate A_{st}

Calculate No. of bar and Spacing

Check for max. and min. area of steel and spacing of bar

Check for Shear and provide shear reinforcement

NO → Design for Doubly reinforced beam

Calculate A_{st} and A_{sc}

Calculate No. of bar and Spacing

Check for max. and min. area of steel and spacing of bar

Check for Shear and provide shear reinforcement

SECTION 4

EVALUATION OF OPTIMUM COST OF BEAM

4.1 CALCULATION OF COST IN EXCEL

For different grades of steel and concrete, we calculated the total cost on changing d/B ratios (ranging 1.5 to 2) required in casting a beam. From calculated values, we draw a graph and evaluate the d/B ratio corresponding to the optimum cost.

Table 3. for M25 grade concrete and Fe415 steel.

	Grades	Grades		d(in	B(in	d/B	
1	Concrete	Steel	Total cost	mm)	mm)	ratio	Mulim
	M25	Fe415					(KNm)
	Cost(in Rs)	Cost(in Rs)					
	2096.5	2707.2	4803.7	300	200	1.5	62.136
	2160	2627.1	4787.1	310	200	1.55	66.347
	2223.5	2553.4	4776.9	320	200	1.6	70.676
	2287.1	2485.9	4773	330	200	1.65	75.184
	2350.6	2422.6	4773.2	340	200	1.7	79.81
	2414.1	2366.9	4781	350	200	1.75	84.53
	2477.7	2312.6	4790.3	360	200	1.8	89.475
	2541.2	2264	4805.2	370	200	1.85	94.515
	2604.7	2218.8	4823.5	380	200	1.9	99.693
	2668.3	2176.7	4845	390	200	1.95	105.01
	2731.8	2135.4	4867.2	400	200	2	110.46
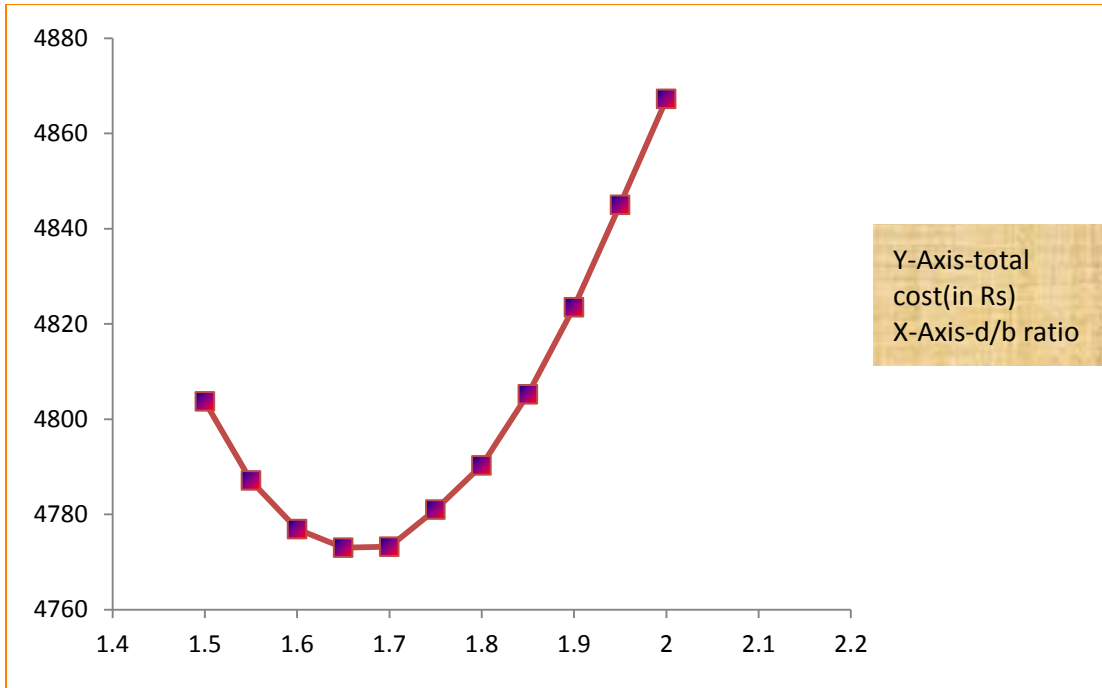
Figure 9: Cost vs d/B for M25 and Fe 415

Table4. For M30 grade concrete and Fe415 steel

	Grade		Total		B(in		
2	Concrete	Steel	cost	d(in mm)	mm)	d/B ratio	Mulim
	M30	Fe415					
	Cost(in Rs)	Cost(in Rs)					(KNm)
	2142.7	2654.1	4796.8	300	200	1.5	74.563
	2207.6	2579.5	4787.1	310	200	1.55	79.616
	2272.5	2511.3	4783.8	320	200	1.6	82.836
	2337.5	2449.2	4786.7	330	200	1.65	90.221
	2402.4	2390.8	4793.2	340	200	1.7	95.772
	2467.3	2335.8	4803.1	350	200	1.75	101.49
	2532.3	2286.7	4819	360	200	1.8	107.37
	2597.2	2240.9	4838.1	370	200	1.85	113.42
	2662.1	2196	4858.1	380	200	1.9	119.63
	2727.1	2156.5	4883.6	390	200	1.95	126.01
	2792	2117.8	4909.8	400	200	2	132.56
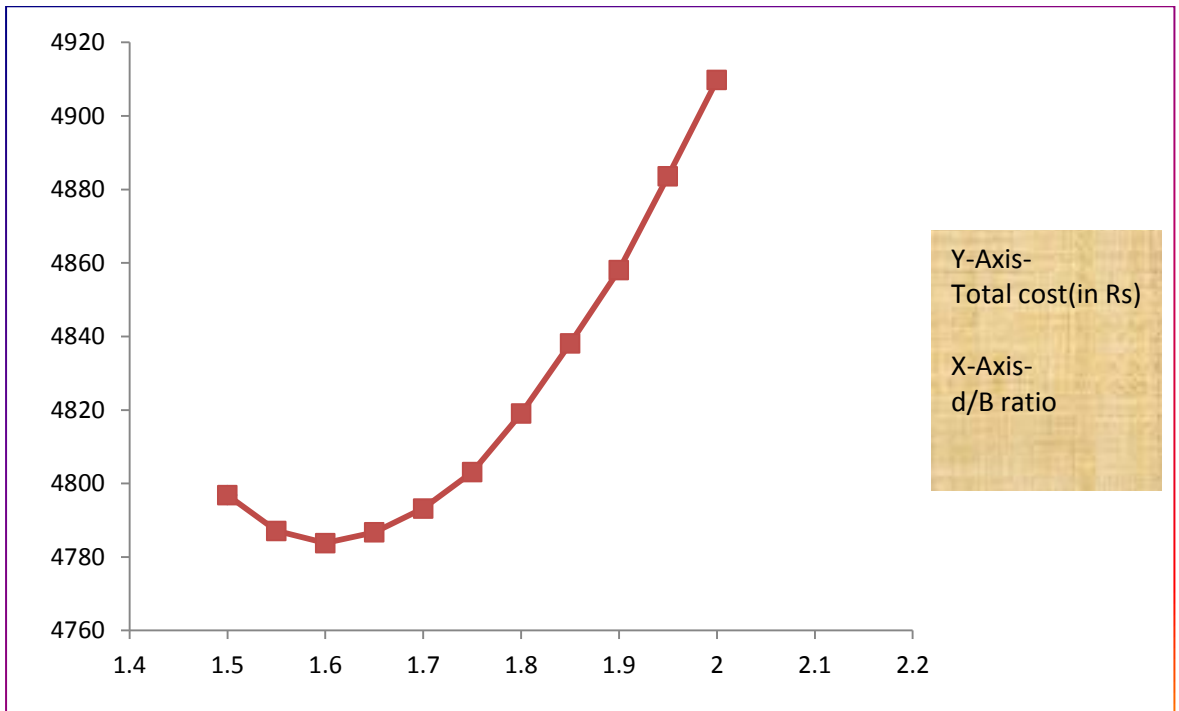
Figure 10:Cost vs d/B for M30 and Fe 415

Table5. For M25 grade concrete and Fe250 steel.

	Grades						
				d(in	B(in	d/B	
3	Concrete	Steel	Total cost	mm)	mm)	ratio	Mulim
	M25	Fe250					
	cost(in Rs)	cost(in Rs)					(KNm)
	2096.5	4202.6	6299.1	300	200	1.5	67.02
	2160	4070.8	6230.8	310	200	1.55	71.563
	2223.5	3953.3	6176.8	320	200	1.6	76.254
	2287.1	3845.2	6132.3	330	200	1.65	81.094
	2350.6	3743.9	6094.5	340	200	1.7	86.084
	2414.1	3653.7	6067.8	350	200	1.75	91.222
	2477.7	3567.6	6045.3	360	200	1.8	96.509
	2541.2	3490	6031.2	370	200	1.85	101.94
	2604.7	3416.1	6020.8	380	200	1.9	107.53
	2668.3	3345.9	6014.2	390	200	1.95	113.26
	2731.8	3281.5	6013.3	400	200	2	119.15
	2795.3	3220.4	6015.7	410	200	2.05	125.18
	2858.8	3162.7	6021.5	420	200	2.1	131.36
	2922.4	3110.4	6032.8	430	200	2.15	137.69
	3049.4	3008.6	6058	450	200	2.25	150.8
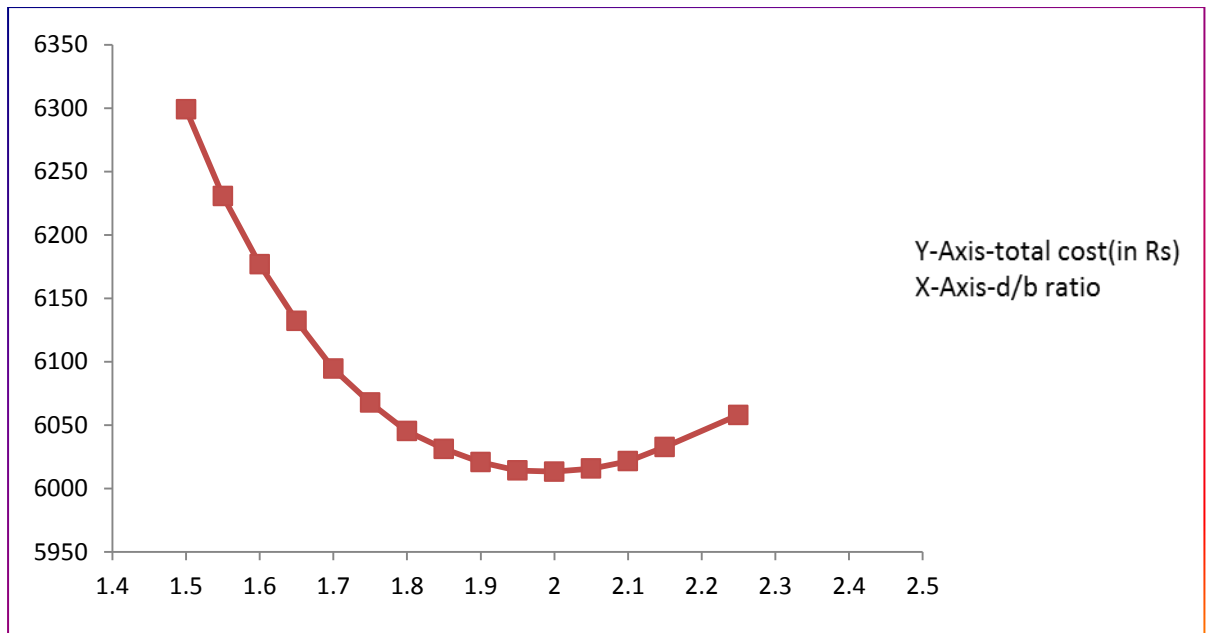
Figure 11: Cost vs d/B for M25 and Fe 250

Table6. For M30 grade concrete and Fe250 steel.

	Grades						
				d(in mm)	B(in mm)		
4	Concrete	Steel	Total cost			d/B ratio	Mulim
	M30	Fe250					
	cost(in Rs)	cost(in Rs)					(KNm)
	2142.7	4111.2	6253.9	300	200	1.5	80.424
	2207.6	3990.1	6197.7	310	200	1.55	85.875
	2337.5	3780.8	6118.3	330	200	1.65	97.313
	2467.3	3600.3	6067.6	350	200	1.75	109.47
	2597.2	3444.9	6042.1	370	200	1.85	122.33
	2727.1	3308.8	6035.9	390	200	1.95	135.92
	2662.1	3374	6036.1	380	200	1.9	129.04
	2792	3247.2	6039.2	400	200	2	142.98
	2921.8	3133.8	6055.6	420	200	2.1	157.63
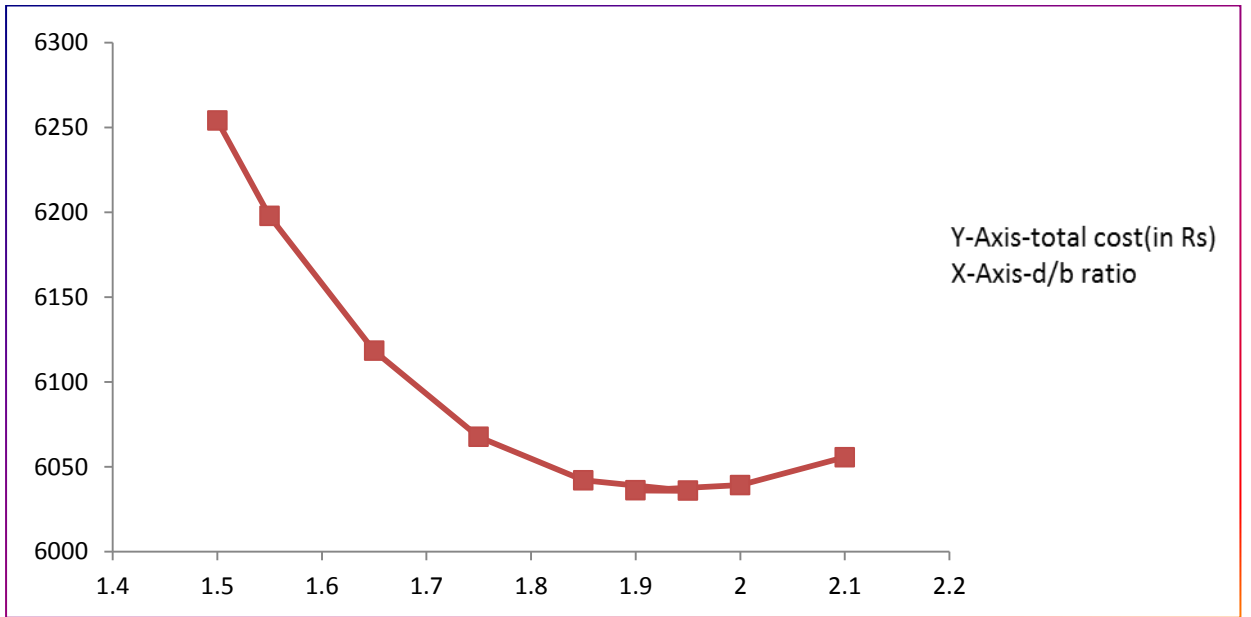
Figure 12: Cost vs d/B for M30 and Fe 250

SECTION 5
A VIEW OF DESIGNED EXCEL SHEET FOR BEAMS

SHEAR REINFORCEMENT

SHEAR FORCE , Vu	150	KN
Tc	0.5673	N/mm^2
DIAMETER OF SHEAR REINFORCEMENT	8.0	mm
TCMAX	3.5	N/mm^2
LEGGED	2	
SPACING	89	mm

COSTING AND COMPARISON

LENGTH OF THE BEAM	5	mts.	
NUMBER OF THE BEAM	1		
VOLUME OF THE CONCRETE	0.45	m^3	
RATES ACCORDING TO DELHI PWD SCHEDULE OF RATES	6493	Rs/m^3	(according to various grades)
TOTAL COST OF CONCRETE	2921.8	Rs	
WEIGHT OF STEEL USED	48.928	Kgs	
RATES OF STEEL	66.5	Rs/kg	
TOTAL COST OF STEEL	3253.7	Rs	
TOTAL COST	6175.5	Rs	

Beams / Comparison / Sheet3

Figure 13: Snapshots Of MS Excel (Beam)

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FLOW CHART FOR DESIGN OF SLABS

```
                    ┌─────────────────────┐
                    │   Define variables  │
                    └─────────────────────┘
                               │
                               ▼
                    ┌─────────────────────┐
                    │     User inputs     │
                    └─────────────────────┘
                               │
                               ▼
        NO                  ◇ If l/b              YES
                              <2
┌──────────────────┐                      ┌──────────────────┐
│   One Way slab    │                      │   Two way slab   │
└──────────────────┘                      └──────────────────┘
```

One Way slab branch (NO)	Two way slab branch (YES)
Take input for S.S, Cantilever, continuous	Take input for S.S, Cantilever, continuous
Calculate Leff and depth	Calculate Leff and depth
Calculate Total load and moment	Calculate Total load and moment in x and moment in y direction
Calculate new depth	Calculate new depth
Get effective depth	Get effective depth
Cal. Area of Main steel and dist. steel	Cal. Area of steel in x dir. and area of steel in y dir.
Cal. Spacing and check	Cal. Spacing and check
Check for shear, development length and anchorage	Check for shear, development length and anchorage

SECTION 7

A VIEW OF DESIGNED EXCEL SHEET FOR ONE WAY SLABS

Figure 14: Snapshots of MS Excel(One way slab)

SECTION 8

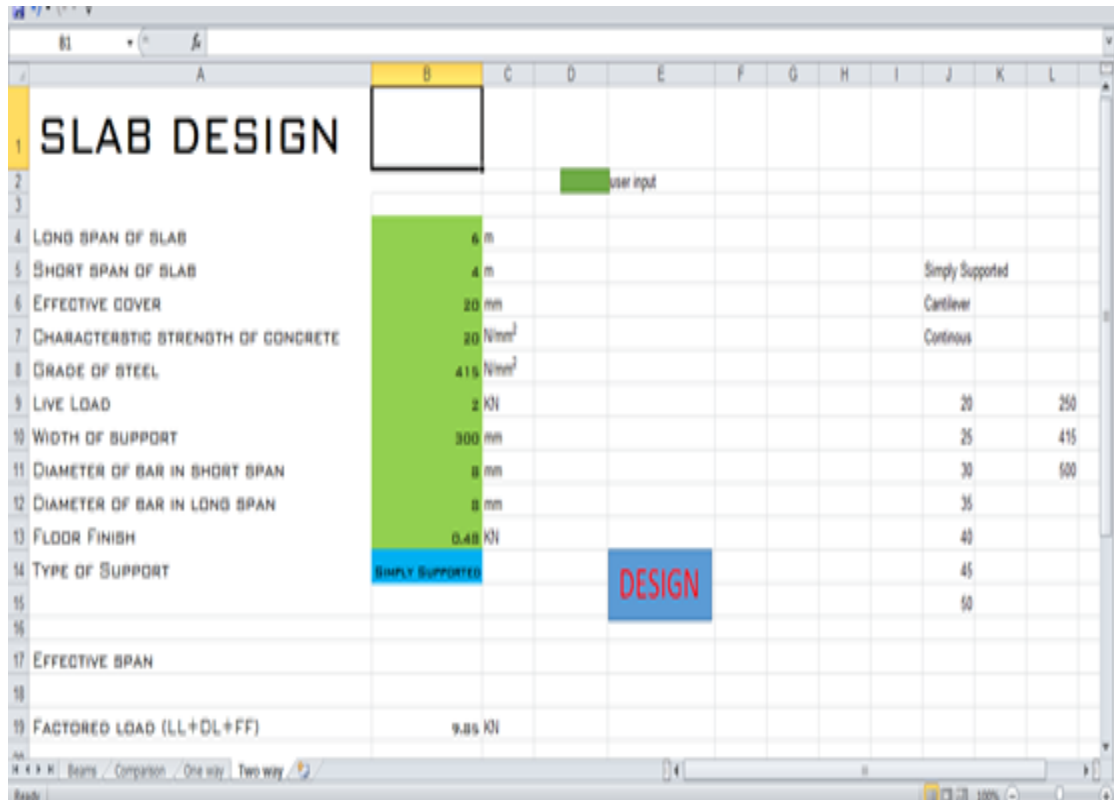# A VIEW OF DESIGNED EXCEL SHEET FOR TWO WAY SLABS

Figure 15: Snapshot of designed excel sheet for two way slab

CONCLUSION

Successfully accomplished the macro code for the design of any RCC beam section, One way slabs and Two way slabs. User inputs are taken and desired calculation for the design of singly reinforced or doubly reinforced beam are performed by the macros. All the check as per the specifications of IS456:2000 and SP34:1987 are performed. Also all the details of shear reinforcement is provided. The work is very user friendly as it provides the range of standard values of inputs to the user, and hence one can easily get results.

The work also includes calculation of the cost of the beams as per the rates mentioned in DSR(Delhi schedule of rates). Cost analysis of the beam is done on changing d/B ratios (effective depth/breadth) keeping the grades of steel and concrete same and finding out the optimum d/B ratio which is at the minimum cost for the design of the beam section. The results are:

	d/B ratio	Total Cost(Rs)
For M25 and Fe415	1.65	4773.00
For M30 and Fe415	1.6	4783.80
For M25 and Fe250	2.0	6013.30
For M30 and Fe250	1.95	6035.90

APPENDIX 1

CODE FOR DESIGN OF BEAM

```
Sub beams()
'design of a beam

Dim xumax As Single
Dim ast As Double
Dim asc As Single
Dim mulim As Single
Dim dia As Single
Dim spacing As Single
Dim number As Single
Dim astlim As Single
Dim ast2 As Single
Dim d1 As Single
Dim fsc As Single
Dim Tc As Single
Dim Tv As Single
Dim Tcmax As Single
Dim Vu As Single
Dim asv As Single
Dim sv As Single
Dim sheardia As Single
Dim diaincomp As Single
Dim legged As Single
Dim vol As Single
Dim Length As Single
Dim Numberbeam As Single
Dim designmix As Single
```

```vba
Dim beta As Single
Dim kg As Single

dia = Range("b10").Value
d = Range("B9").Value
fy = Range("B5").Value

If fy = 250 Then
xumax = 0.531 * d
End If
If fy = 415 Then
xumax = 0.479 * d
End If
If fy = 500 Then
xumax = 0.45 * d
End If
fck = Range("B4").Value
b = Range("B8").Value

If d > 2 * b Or d < 1.5 * b Then
MsgBox "It is advisable to have Depth of beam between 1.5 times to 2 times of
Width"
d = InputBox("enter new depth(mm)", "Do you want to change depth?")
Range("B9").Value = d
End If

mulim = 0.36 * fck * b * xumax * (d - 0.416 * xumax) * 10 ^ (-6)
mu = Range("B7").Value
Range("b12").Value = mulim
Vu = Range("b34").Value
legged = Range("b38").Value

Tv = Vu * 10 ^ 3 / (b * d)
sheardia = Range("b36").Value
```

asv = legged * 3.14 * sheardia ^ 2 / 4

If mu < mulim Then

MsgBox "SINGLY REINFORCED SECTION"

ast = Int((0.5 * fck / fy) * (1 - (1 - (4.6 * mu * 10 ^ 6 / (fck * b * d ^ 2))) ^ 0.5) * b * d)

Range("b15").Value = ast

number = (Range("b15").Value / (3.14 * dia ^ 2 / 4))

spacing = b / number

asc = 0

Range("b28").Value = 0

Range("b26").Value = asc

Range("e16").Value = spacing

Range("e17").Value = number

If ast < (0.85 * b * d / fy) Then

ast = (0.85 * b * d / fy)

MsgBox "Minimum area of steel provided as per IS456:2000, clause no-26.5.1.1(a)"

End If

If ast > 0.04 * b * d Then

MsgBox "Area of steel exceding IS code limits as per IS456:2000, clause no-26.5.1.1(b)"

End If

If (0.85 * b * d / fy) < ast < (0.04 * b * d) Then

MsgBox "Area of steel is withtin the permissible limits as per IS456:2000, clause no-26.5.1.1(a)& 26.5.1.1(b)"

End If

If spacing < dia Then

MsgBox "Spacing provided is less than the given limits as per IS456:2000,clause no-26.3.2"

End If

If spacing > dia Then

MsgBox "Spacing is within the limits as as per IS456:2000,clause no-26.3.2"

End If

End If

If mu = mulim Then

MsgBox "BALANCED SECTION"

ast = ((1.5 * mu * 10 ^ 6) / 0.87 * fy * (d - 0.42 * xumax))

End If

If mu > mulim Then

MsgBox "DOUBLY REINFORCED SECTION"

MsgBox "Increase Depth if you want a Singly Reinforced Section"

d1 = Range("B22").Value

fsc = Range("B24").Value

diaincomp = Range("b11").Value

astlim = Int(mulim * 10 ^ 6 / (0.87 * fy * (d - 0.42 * xumax)))

asc = Int((mu - mulim) * 10 ^ 6 / ((fsc - 0.446 * fck) * (d - d1)))

ast2 = Int(mu - mulim) * 10 ^ 6 / (0.87 * fy * (d - d1))

ast = astlim + ast2

Range("b28").Value = ast

Range("B26").Value = asc

number = ast / ((3.14 * dia ^ 2 / 4))

spacing = b / number

Range("e29").Value = spacing

Range("e30").Value = number

Range("e31").Value = (asc / (3.14 * diaincomp ^ 2 / 4))

Range("b15").Value = 0

Range("b16").Value = 0

Range("b17").Value = 0

If asc > 0.04 * b * d Then

MsgBox "Area of steel exceding IS code limits as per IS456:2000, clause no-26.5.1.2"

End If

If asc < 0.04 * b * d Then

MsgBox "Area of steel is within the permissible IS code limits as per IS456:2000, clause no-26.5.1.1(b)"

End If

End If

If fck = 20 Then

Tcmax = 2.8

End If

If fck = 25 Then

Tcmax = 3.1

End If

If fck = 30 Then

Tcmax = 3.5

End If

If fck = 35 Then

Tcmax = 3.7

End If

If fck = 40 Then

Tcmax = 4

End If

If Tcmax < Tv Then

MsgBox "redesign the section due to failure in shear"

sv = 0

End If

beta = (0.8 * fck * b * d) / (689 * ast)

Tc = ((0.85 * ((0.8 * fck) ^ 0.5)) * (((1 + 5 * beta) ^ 0.5) - 1)) / (6 * beta)

Range("b37").Value = Tcmax

Range("b35").Value = Tc

If Tcmax > Tv Then

If Tv < Tc Then

MsgBox "Nominal shear reinforcement provided per IS Code(456:2000),clause no.26.5.1.6"

sv = (asv * 0.87 * fy) / (0.4 * b)

End If

If Tc < Tv Then

MsgBox "Shear reinforcement to be provided as per IS Code(456:2000),clause no 40.4(a)"

sv = (0.87 * fy * asv * d) / ((Vu * 1000) - (Tc * b * d))

End If

If sv > (300 Or 0.75 * d) Then

MsgBox "Stirups Spacing more than as per IS Code(456:2000),clause no. 26.5.1.5 "

sv = 300

End If

Range("e40").Value = sv

End If

Length = Range("b45").Value

Numberbeam = Range("b46").Value

vol = Length * b * (d + (Range("b21").Value)) * Numberbeam * 10 ^ (-6)

```
Range("b48").Value = vol


kg = (((dia ^ 2) / 162) * (Length - (2 * 0.025) + 2 * (9 * dia / 1000)) * number) +
((((diaincomp ^ 2) / 162) * (Length - (2 * 0.025) + 2 * (9 * dia / 1000)) *
(Range("e31").Value)) + (((Length * 1000) / sv) * (2 * (b - (2 * 30) + d - d1) / 1000) *
((sheardia ^ 2) / 162))
Range("b52").Value = kg


End Sub
```

APPENDIX 2

CODE FOR DESIGN OF ONE WAY SLAB

```
Sub slabs()

Dim lx As Single
Dim ly As Single
Dim LL As Single
Dim DL As Single
Dim FF As Single
Dim fck As Single
Dim fy As Single
Dim w As Single
Dim diaM As Single
Dim diaD As Single
Dim d1 As Single
Dim d2 As Single
Dim leff As Single
Dim mu As Single
Dim vu As Single
Dim astM As Double
Dim astD As Single
Dim ec As Single
Dim ru As Single
Dim s As Single
Dim sd As Single
Dim vud As Single
Dim beta As Single
Dim tc As Single
Dim d As Single
Dim k As Single
Dim tao As Single
Dim ld As Single
```

```vba
Dim tbd As Single

ly = Range("B4").Value
lx = Range("B5").Value


If (ly / lx) >= 2 Then
MsgBox "design for one way slab"


If Range("B14").Value = "Simply Supported" Then
w = Range("B10").Value * (10 ^ (-3))
leff = lx + w
d1 = leff / (20 * 1.5)
ec = Range("B6").Value * 10 ^ (-3)


Range("B17").Value = leff
LL = Range("B9").Value
FF = Range("B13").Value


FL = 1.5 * (LL + (d1 + ec) * 25 + FF)
Range("B19").Value = FL
If lx + d1 < lx + w Then
leff = lx + d1
End If
mu = (FL * (leff) ^ 2) / 8
Range("B20").Value = mu
vu = (FL * leff) / 2
Range("B21").Value = vu
fck = Range("B7").Value
fy = Range("B8").Value


ru = 0.36 * fck * 0.48 * (1 - (0.416 * 0.48))
d2 = ((mu * 10 ^ (6) / (ru * 1000)) ^ 0.5) * 10 ^ (-3)
If d1 > d2 Then
Range("B22").Value = d1 * 1000
```

```
Else
Range("B22").Value = d2 * 1000
End If


astM = Int((0.5 * fck / fy) * (1 - (1 - (4.6 * mu * 10 ^ 6 / (fck * 1000 * (d1 * 1000) ^
2))) ^ 0.5) * 1000 * d1 * 1000)
Range("B23").Value = astM


astD = 0.12 * 1000 * ((Range("B22").Value) + (ec * 10 ^ (3))) / 100
Range("B24").Value = astD


diaM = Range("B11").Value
s = 1000 * 3.14 * (diaM ^ 2) / (4 * astM)
Range("E25").Value = s
diaD = Range("b12").Value
sd = (1000 * 3.14 * (diaD ^ 2)) / (4 * astD)
Range("E26").Value = sd


vud = vu - FL * (Range("B22").Value + (Range("B22").Value / 2))
tao = vud / (1000 * Range("B22").Value)
beta = (0.8 * fck * 1000 * Range("B22").Value) / (689 * astM)
tc = ((0.85 * ((0.8 * fck) ^ 0.5)) * (((1 + 5 * beta) ^ 0.5) - 1)) / (6 * beta)
d = Range("B22").Value + 15
k = 1 + ((0.05 * (300 - d)) / 25)
If d <= 150 Then
k = 1.3
End If
If d > 300 Then
k = 1
End If
If tao <= (k * tc) Then
MsgBox ("Section is safe in shear according to Annexture B5")
Else
MsgBox ("Section is unsafe in shear according to annexture B5")
```

```vba
End If
tbd = Range("K17").Value


ld = ((0.87 * fy * diaM) / (4 * tbd))
Range("H4").Value = ld


If (w * (10 ^ 3)) > ((ld / 3) + 25) Then
MsgBox ("Anchorage condition is satisfied")
End If


End If


If Range("b14").Value = "Cantilever" Then


w = Range("B10").Value * (10 ^ (-3))
leff = lx + (w / 2)
d1 = leff / (7 * 1.68)



ec = Range("B6").Value * 10 ^ (-3)


Range("B17").Value = leff
LL = Range("B9").Value
FF = Range("B13").Value


FL = 1.5 * (LL + (d1 + ec) * 25 + FF)
Range("B19").Value = FL
If lx + (d1 / 2) < lx + (w / 2) Then
leff = lx + (d1 / 2)
End If
mu = (FL * (leff) ^ 2) / 2
Range("B20").Value = mu
vu = (FL * leff)
Range("B21").Value = vu
```

```
fck = Range("B7").Value
fy = Range("B8").Value


ru = 0.36 * fck * 0.48 * (1 - (0.416 * 0.48))
d2 = ((mu * 10 ^ (6) / (ru * 1000)) ^ 0.5) * 10 ^ (-3)
If d1 > d2 Then
Range("B22").Value = d1 * 1000
Else
Range("B22").Value = d2 * 1000
End If


astM = Int((0.5 * fck / fy) * (1 - (1 - (4.6 * mu * 10 ^ 6 / (fck * 1000 * (d1 * 1000) ^
2))) ^ 0.5) * 1000 * d1 * 1000)
Range("B23").Value = astM


astD = 0.12 * 1000 * ((Range("B22").Value) + (ec * 10 ^ (3))) / 100
Range("B24").Value = astD


diaM = Range("B11").Value
s = 1000 * 3.14 * (diaM ^ 2) / (4 * astM)
Range("E25").Value = s
diaD = Range("b12").Value
sd = (1000 * 3.14 * (diaD ^ 2)) / (4 * astD)
Range("E26").Value = sd


vud = vu - FL * (Range("B22").Value + (Range("B22").Value / 2))
tao = vud / (1000 * Range("B22").Value)
beta = (0.8 * fck * 1000 * Range("B22").Value) / (689 * astM)
tc = ((0.85 * ((0.8 * fck) ^ 0.5)) * (((1 + 5 * beta) ^ 0.5) - 1)) / (6 * beta)
d = Range("B22").Value + 15
k = 1 + ((0.05 * (300 - d)) / 25)
If d <= 150 Then
k = 1.3
End If
```

```
If d > 300 Then
k = 1
End If


If tao < (k * tc) Then
MsgBox ("Section is safe in shear according to Annexture B5")
Else
MsgBox ("Section is unsafe in shear according to annexture B5")
End If
tbd = Range("K17").Value


ld = ((0.87 * fy * diaM) / (4 * tbd))
If (w * (10 ^ 3)) > ((ld / 3) + 25) Then
MsgBox ("Anchorage condition is satisfied")
End If
End If


If Range("B14").Value = "Continous" Then
w = Range("B10").Value * (10 ^ (-3))
leff = lx + w
d1 = leff / (26 * 1.5)
ec = Range("B6").Value * 10 ^ (-3)


Range("B17").Value = leff
LL = Range("B9").Value
FF = Range("B13").Value



If lx + d1 < lx + w Then
Range("B17").Value = lx + d1
End If


mu = 1.5 * (((((d1 + ec) * 25) + FF) * leff ^ 2) / 10) + (LL * (leff ^ 2) / 9)
Range("B20").Value = mu
```

```vba
fck = Range("B7").Value
fy = Range("B8").Value


ru = 0.36 * fck * 0.48 * (1 - (0.416 * 0.48))
d2 = ((mu * 10 ^ (6) / (ru * 1000)) ^ 0.5) * 10 ^ (-3)
If d1 > d2 Then
Range("B22").Value = d1 * 1000
Else
Range("B22").Value = d2 * 1000
End If


astM = Int((0.5 * fck / fy) * (1 - (1 - (4.6 * mu * 10 ^ 6 / (fck * 1000 * (d1 * 1000) ^
2))) ^ 0.5) * 1000 * d1 * 1000)
Range("B23").Value = astM


astD = 0.12 * 1000 * ((Range("B22").Value) + (ec * 10 ^ (3))) / 100
Range("B24").Value = astD


diaM = Range("B11").Value
s = 1000 * 3.14 * (diaM ^ 2) / (4 * astM)
Range("E25").Value = s
diaD = Range("b12").Value
sd = (1000 * 3.14 * (diaD ^ 2)) / (4 * astD)
Range("E26").Value = sd
vud = 1.5 * ((0.6 * DL * lx) + (0.6 * LL * lx))
tao = vud / (1000 * Range("B22").Value)
beta = (0.8 * fck * 1000 * Range("B22").Value) / (689 * astM)
tc = ((0.85 * ((0.8 * fck) ^ 0.5)) * (((1 + 5 * beta) ^ 0.5) - 1)) / (6 * beta)
d = Range("B22").Value + 15
k = 1 + ((0.05 * (300 - d)) / 25)
If d <= 150 Then
k = 1.3
End If
```

```vba
If d > 300 Then
k = 1
End If
If tao < k * tc Then
MsgBox ("Section is safe in shear according to Annexture B5")
Else
MsgBox ("Section is unsafe in shear according to annexture B5")
End If
tbd = Range("K17").Value


ld = ((0.87 * fy * diaM) / (4 * tbd))
If (w * (10 ^ 3)) > ((ld / 3) + 25) Then
MsgBox ("Anchorage condition is satisfied")
End If
End If
End If


If (ly / lx) < 2 Then
MsgBox "design for two way slab"



End If


End Sub
```

APPENDIX 3

CODE FOR DESIGN OF TWO WAY SLAB

```
Sub twowayslab()

Dim ly As Single
Dim lx As Single
Dim fck As Single
Dim fy As Single
Dim xumax As Single
Dim d1 As Single
Dim ru As Single
Dim d2 As Single
Dim w As Single
Dim lxeff As Single
Dim ec As Single
Dim lyeff As Single
Dim r As Single
Dim mux As Single
Dim muy As Single
Dim alphax As Single
Dim alphay As Single
Dim astX As Single
Dim astY As Single
Dim diaX As Single
Dim diaY As Single
Dim sx As Single
Dim sy As Single
Dim vuy As Single
Dim taoy As Single
Dim beta As Single
Dim tc As Single
Dim d As Single
```

```vba
Dim taox As Single
Dim vux As Single
Dim xux As Single
Dim xuy As Single
Dim mu1x As Single
Dim mu1y As Single
Dim tbd As Single
Dim ld As Single

ly = Range("B4").Value
lx = Range("B5").Value
fck = Range("B7").Value
fy = Range("B8").Value

If ly / lx < 2 Then
MsgBox ("Design of two way slab")
End If
If Range("B14").Value = "Simply Supported" Then
w = Range("B10").Value * (10 ^ (-3))
lxeff = lx + w
d1 = lxeff / (20 * 1.5)
ec = Range("B6").Value * 10 ^ (-3)

LL = Range("B9").Value
FF = Range("B13").Value

FL = 1.5 * (LL + (d1 + ec) * 25 + FF)
Range("B19").Value = FL
If lx + d1 < lx + w Then
lxeff = lx + d1
End If
lyeff = ly + d1
r = lyeff / lxeff
```

mux = alphax * FL * (lxeff ^ 2)

muy = alphay * FL * (lxeff ^ 2)

ru = 0.36 * fck * 0.48 * (1 - (0.416 * 0.48))

If mux > muy Then

d2 = ((mux * 10 ^ (6) / (ru * 1000)) ^ 0.5) * 10 ^ (-3)

Else

d2 = ((muy * 10 ^ (6) / (ru * 1000)) ^ 0.5) * 10 ^ (-3)

End If

If d1 > d2 Then

Range("B22").Value = d1 * 1000

Else

Range("B22").Value = d2 * 1000

End If

astX = Int((0.5 * fck / fy) * (1 - (1 - (4.6 * mux * 10 ^ 6 / (fck * 1000 * (d1 * 1000) ^ 2))) ^ 0.5) * 1000 * d1 * 1000)

Range("B23").Value = astX

astY = Int((0.5 * fck / fy) * (1 - (1 - (4.6 * muy * 10 ^ 6 / (fck * 1000 * (d1 * 1000) ^ 2))) ^ 0.5) * 1000 * d1 * 1000)

Range("B24").Value = astY

diaX = Range("B11").Value

sx = 1000 * 3.14 * (diaX ^ 2) / (4 * astX)

Range("E25").Value = sx

diaY = Range("b12").Value

sy = (1000 * 3.14 * (diaY ^ 2)) / (4 * astY)

Range("E26").Value = sy

vuy = FL * lxeff * (r / (2 + r))

taoy = vuy / (1000 * Range("B22").Value)

beta = (0.8 * fck * 1000 * Range("B22").Value) / (689 * astM)

tc = ((0.85 * ((0.8 * fck) ^ 0.5)) * (((1 + 5 * beta) ^ 0.5) - 1)) / (6 * beta)

```
d = Range("B22").Value + ec
k = 1 + ((0.05 * (300 - d)) / 25)
If d <= 150 Then
k = 1.3
End If
If d > 300 Then
k = 1
End If
If taoy <= (k * tc) Then
MsgBox ("Short span is safe in shear according to Annexture B5")
Else
MsgBox ("Short span is unsafe in shear according to annexture B5")
End If


vux = (FL * lxeff) / 3
taox = vux / (1000 * Range("B22").Value)
If taox <= (k * tc) Then
MsgBox ("Long span is safe in shear according to Annexture B5")
Else
MsgBox ("Long span is unsafe in shear according to annexture B5")
End If


xux = (0.87 * fy * astX) / (0.36 * fck * b)
xuy = (0.87 * fy * astY) / (0.36 * fck * b)
mu1x = 0.87 * fy * astX * (Range("B22").Value - (0.416 * xux))
mu1y = 0.87 * fy * astY * (Range("B22").Value - (0.416 * xuy))


tbd = Range("K17").Value
ld = ((0.87 * fy * diaM) / (4 * tbd))


If (1.3 * ((mu1x / vuy) + ((w / 2) - ec))) > ld Then
MsgBox ("Code requirement for development length is satisfied for short span")
End If
```

```
If (1.3 * ((mu1y / vux) + ((w / 2) - ec))) > ld Then

MsgBox ("Code requirement for development length is satisfied for long span")

End If

Range("B27").Value = lxeff / 5

Range("B28").Value = (3 * astX) / 4

Range("b29").Value = (1000 * 3.14 * (diaY ^ 2)) / (3 * astX)


End If

End Sub
```

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