Development of Spreadsheet Design Tool for R.C.C. Two Way Slab Design Using V.B.A.

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Abstract

Reinforced Cement Concrete (RCC) slabs are one of the most widely used structural elements in buildings, providing a flat horizontal surface for flooring and roofing. Their safe and economical design is crucial in structural engineering. While commercial design software like STAAD Pro and ETABS are powerful, they are often complex, require significant expertise and costly. On the other hand, manual design methods, though conceptually straightforward, can be time-consuming, repetitive, and prone to calculation errors. To address these challenges, this thesis presents the development of a spreadsheet-based design tool using Microsoft Excel and Visual Basic for Applications (VBA) for the analysis and design of RCC slabs. The tool aims to simplify and automate the structural design of one-way and two-way simply supported RCC slabs based on IS 456:2000 guidelines. The user-friendly Excel interface allows users to input essential design parameters such as slab dimensions, loading conditions, material grades (concrete and steel), and support configurations. The VBA code performs structural analysis, calculates design moments, determines the required area of steel reinforcement, checks serviceability criteria such as deflection, and provides reinforcement detailing as output. The developed tool has been validated using standard design problems with manual calculations and RCDC design software. Results show high accuracy and reliability, with significant time savings for design engineers. Additionally, the use of Excel and VBA ensures accessibility, making it a practical solution for students, educators, and professionals who may not have access to advanced design software. This thesis demonstrates that spreadsheet tools, when combined with simple programming logic, can provide efficient and accurate solutions for structural design. The tool can be further extended to cover more structural elements such as beams, columns, and footings, thereby increasing its scope and usability in practical applications.

Keywords: Spreadsheet design Tool, V.B.A., R.C.C. Slab, Reinforcement, Design, IS456-2000, One Way Slab

1. Introduction

Reinforced Cement Concrete (RCC) slabs are among the most fundamental elements in structural systems, serving as the horizontal platforms for floors and roofs in buildings. The safe and economical design of slabs are crucial in structural engineering, as they transfer loads from above to beams and walls and ultimately to the foundation. Depending on the support conditions and aspect ratios, slabs are categorized into one-way or two-way slabs, each requiring different design approaches as per established codes like IS 456:2000. Traditionally, the design of RCC slabs is carried out manually using standard procedures, formulas, and design charts. While this method ensures a clear understanding of the structural behavior and design process, it is often time-consuming, tedious, and vulnerable to calculation errors. On the other hand, commercial software such as STAAD Pro, ETABS, and SAFE offer advanced analysis capabilities but may be expensive, complex, and less accessible to students or professionals in smaller firms. There is a clear need for a middle-ground solution that is simple, accessible, accurate, and capable of reducing the time required for RCC slab design. Spreadsheet tools, particularly Microsoft Excel, are widely available and familiar to most engineers. When combined with Visual Basic for Applications (VBA), Excel can be transformed into a powerful platform for custom engineering applications.

A) Introduction to Visual Basics for Applications (VBA)

Visual Basic for Applications (VBA) is an event-driven programming language developed by Microsoft. It is built into most Microsoft Office applications, including Excel, and allows users to automate tasks, customize functions, and create powerful tools within the familiar spreadsheet environment. VBA is a simplified version of Visual Basic, designed specifically for use with Office applications, and is particularly useful for engineers, analysts, and professionals who need to perform repetitive or complex tasks.

B) Advantages of using Excel with VBA

1) One can make his own tailor-made programs which include sets of functions and formulas all bind up with a VBA Programs.
2) If a VBA program is well created, a person with no info of VBA can run it without any strain.
3) One can do things in Excel that are otherwise not possible.
4) Looping or repetition process is possible in Excel Sheets only with use of VBA
5) Data Analysis becomes calmer and more orderly with use of VBA
6) While writing complex calculations, use of VBA program can lessen the chances of unplanned changes in cell while working.

C) Importance of spreadsheet as a design tool

Spreadsheets, particularly Microsoft Excel, have become indispensable tools in engineering design due to their versatility, accessibility, and efficiency. Their tabular structure allows for the organized presentation of data and formulas, making them highly intuitive for engineers and students alike. In structural design, especially for RCC elements like slabs, spreadsheets offer real-time calculation capabilities. Any change in input values automatically update the results, making iterative design fast and efficient. One of the key advantages of using spreadsheets is the transparency they offer in the design process. Each step, formula, and result are visible and traceable, which is essential for reviewing and verifying structural calculations. Spreadsheets can also be customized to suit various design standards, such as IS 456:2000, allowing users to build tailored solutions for specific structural problems. This flexibility makes them applicable to a wide range of structural elements beyond slabs, including beams, columns, and footings. In addition to numerical calculations, spreadsheets support data visualization through built-in charting tools. This enables the graphical representation of loads, stress distributions, and reinforcement layouts, aiding in better interpretation of design results. Moreover, with the integration of Visual Basic for Applications (VBA), spreadsheets evolve from simple calculation sheets into powerful design tools. VBA enhances functionality by allowing automation, conditional logic, and the creation of interactive user forms, turning Excel into a lightweight yet intelligent design platform. The use of spreadsheets also facilitates proper documentation and record-keeping. Input data, intermediate steps, and final results can be saved, shared, and printed easily, ensuring clarity and professionalism in design reports. Due to these benefits, spreadsheets are widely used in both academic environments for teaching design principles and in professional practice for preliminary and detailed design tasks.

D) Advantages of using spreadsheets over Design Software's

1) Unlike design software, spreadsheets can be made for an exact problem.
2) The Design Software need proper working out to use them; however, a spreadsheet is designed correctly it can be used without any prior training.
3) Design Software are expensive and have patent issues.
4) Spreadsheet are totally customizable as per necessity of user.
5) Design Spreadsheet can run on any system with running Microsoft Office, hence need no installation prior to use.

2.Objective

The basic purpose behind writing this paper is to develop a spreadsheet tool in MS Excel using Visual Basic Application, which will let user to design RCC Slab. The spreadsheet design is fundamentally based on the several characteristics of MS Excel along with development in Visual Basic Editor Atmosphere. The spreadsheet comprises of all the numerical functions and mathematical relations and expressions for different design methods.

3. Overview of Developed Spreadsheet

The developed Design Spreadsheet contains three modules excluding Main Menu, which let the user simply toggle between different modules, by just clicking the respected button.

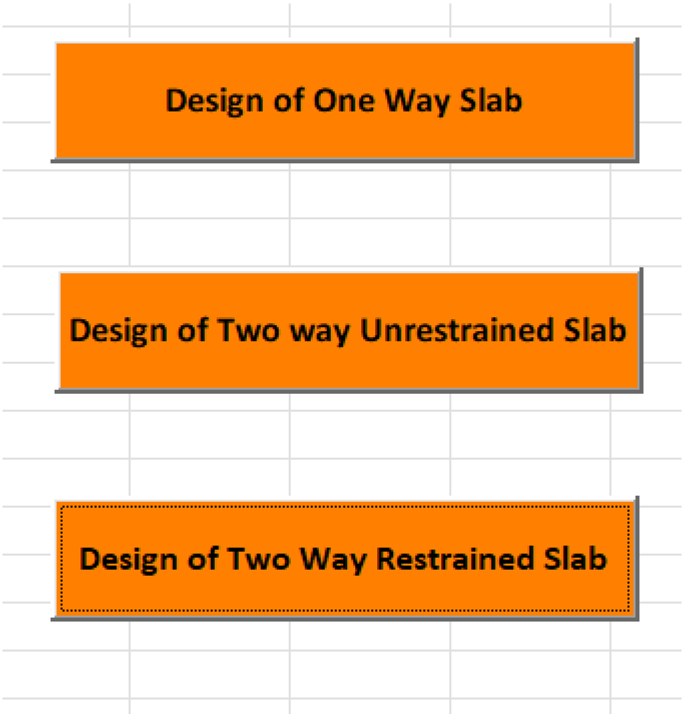

Figure.1: Snapshot of Main Menu of Design Tool

Module:1 Design of one-way slab: This module focuses on the automated design of one-way RCC slabs using VBA in Excel. A one-way slab is defined as a slab where the ratio of longer span (Ly) to shorter span (Lx) is greater than or equal to 2. In such slabs, the primary bending occurs in the shorter direction. This module focuses on the automated design of one-way RCC slabs using VBA in Excel. Based on user inputs such as span, loads, concrete and steel grade, and effective cover, the program calculates bending moment, required effective depth, and area of reinforcement as per IS 456:2000. The tool uses standard formulas to compute the moment and depth, and then selects appropriate bar diameter and spacing. A simple and user-friendly interface is provided, and the design results are displayed instantly upon clicking the "Design" button. The module reduces manual errors and saves time in routine slab design tasks.

Module:2 Design of two-way unrestrained slab: This module deals with the design of two-way unrestrained RCC slabs using VBA in Excel. When the slab's longer span to shorter span ratio is less than 2, it is considered a two-way slab. The program calculates bending moments in both directions using moment coefficients from Table 27 of IS 456:2000, assuming all edges are simply supported (unrestrained). Based on the calculated moments, the tool computes the required effective depth and reinforcement in both directions. The VBA code automates these calculations and suggests appropriate bar sizes and spacing, displaying results in a structured output sheet. This module ensures quick, accurate design of two-way slabs without boundary restraints.

Module 3: Design of two-way restrained slab This module is designed to automate the structural design of two-way restrained RCC slabs, where all edges are supported and partially or fully restrained against rotation. Unlike unrestrained slabs, restrained slabs develop negative moments at supports and require special consideration in design. The moment coefficients used in this module are derived from Table 26 of IS 456:2000, which provides values for nine different slab edge conditions, depending on the degree of continuity along the edges.

The tool allows the user to select from the following 9 standard cases as per IS 456:

1. All four edges discontinuous
2. Two adjacent edges continuous
3. Two adjacent edges discontinuous and the other two continuous
4. Three edges continuous and one edge discontinuous
5. Two opposite edges continuous and the other two discontinuous
6. All four edges continuous
7. Two adjacent edges continuous and the other two discontinuous
8. Three edges discontinuous and one edge continuous
9. Two adjacent edges discontinuous and the other two continuous (alternate arrangement)

4. Operating Spreadsheet Design Tool

This segment primarily deals with the method by use of which spread sheet should be operated. Since, the design spreadsheet is outcome of use of programming in VB Editor, the spreadsheet contains visual basic programming language and there by saved as Microsoft Excel Binary Worksheet. The user must, therefore check first the "Enable Content" Button positioned below the ribbon of the spreadsheet. Some programming process run upon opening of the workbook; thus, the user is suggested to always enable the macros content of this program.

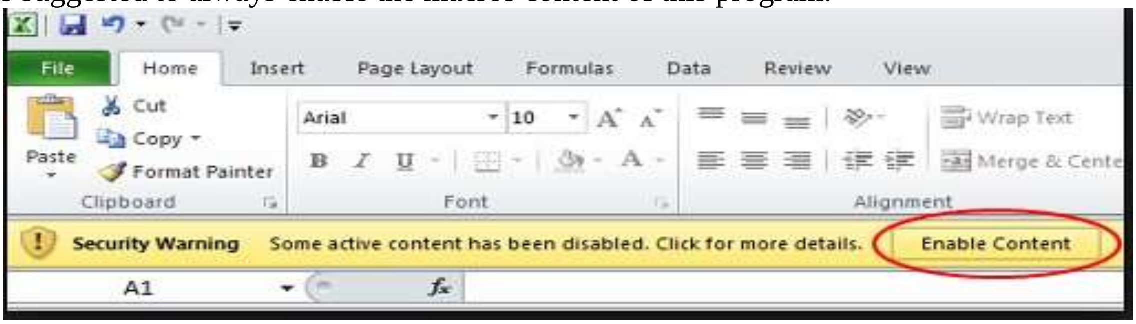

Figure.2: Snapshot of Enable content Option

Now, as discussed earlier, the design spreadsheet contains three modules. As we open the design Spreadsheet the Main Menu Page Opens Figure below, shows the presence of the main menu as it looks once opened.

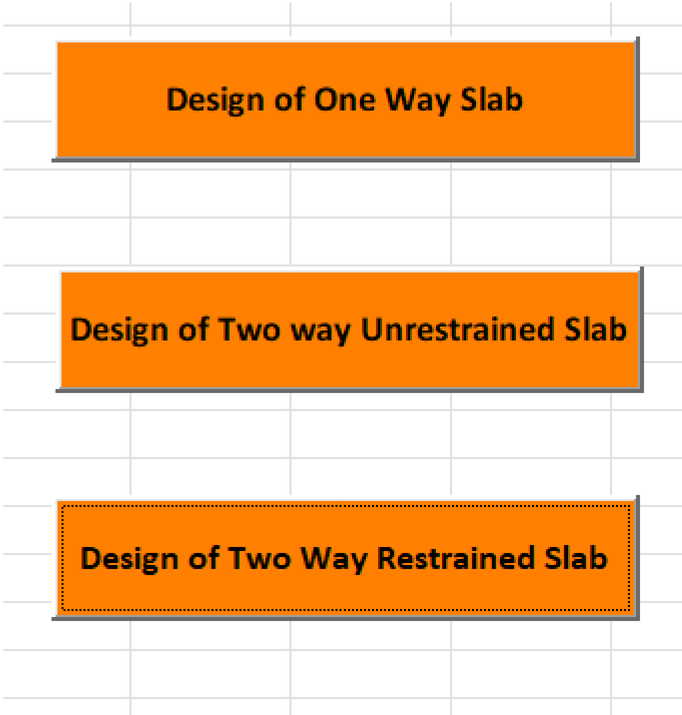

Figure.3: Snapshot of Main Menu of Design Tool

Operating Module: 3, Design of Two-way slab

As discussed earlier this module deals with design of Two-way slab.

Clear Longer Span (Ly)	5
Clear Shorter Span (Lx)	3
Live Load	3
Floor Finish	1
Supporting Wall Thickness	250
Strength of Concrete (fck)	20
Grade of Steel (Fy)	415

Figure.4: Snapshot of Input units

As can been seen from the figure the spread sheet contains following
As can been seen from the figure the spread sheet contains following

1. Input Box: To input following data
   Clear Longer span (Ly)
   Clear Shorter span (Lx)
   Live load
   Floor finish
   Supporting wall thickness
   fck

2. After input data when we click on design msg box asked for bar diameter.

Figure.4: Snapshot of Message box of bar diameter

3.After entering the bar diameter, it asks for slab panel type

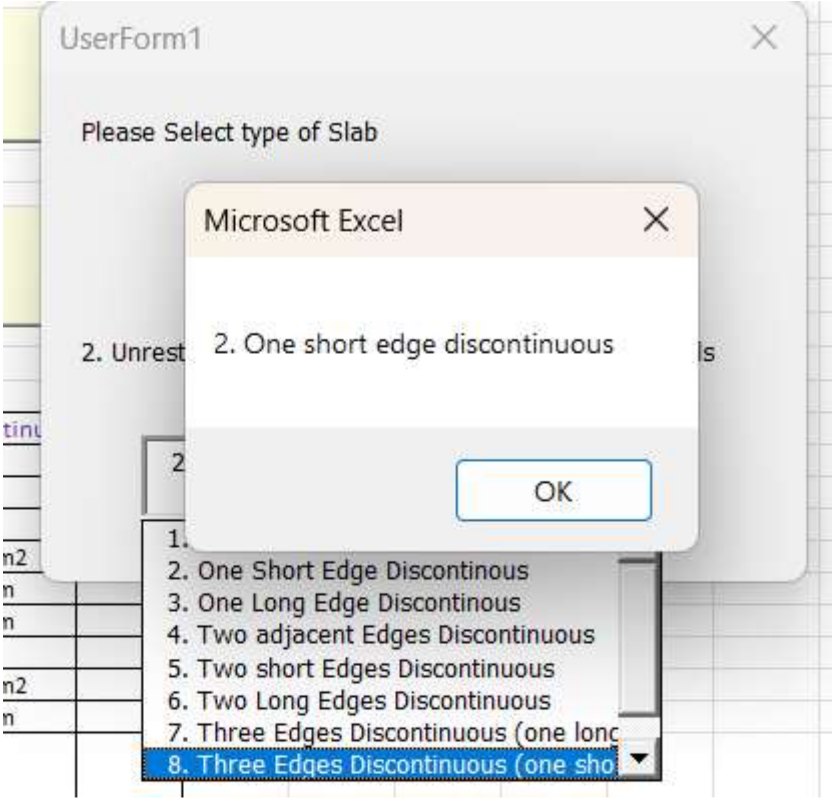

Figure.5: Snapshot of selection of panel type

4. After selecting slab panel, it gives results.

	Type of panel	One short edge discontinuous		
1	Along shorter span			
	Width of middle strip	3.75	m	
	Provided area of R/F along middle strip	167.4666667	mm2	
	Bar dia	8	mm	
	Spacing	300	mm	
	Width of edge strip	0.625	m	
	Provided area of R/F along edge strip	162	mm2	
	Bar dia	8	mm	
	Spacing	300	mm	
2	Along longer span			
	Width of middle strip	2.25	m	
	Provided area of R/F along middle strip	167.4666667	mm2	
	Bar dia	8	mm	
	Spacing	300	mm	
	Width of edge strip	0.375	m	
	Provided area of R/F along edge strip	162	mm2	
	Bar dia	8	mm	
	Spacing	300	mm	
3	Torsional R/F			
	At corners where slab is discontinuous over both the edges		0	mm2
	Distance		0.6	m
	bar dia		8	mm
	spacing		0	mm
	At corners where one edge is discontinuous & one edge is continuous		62.8	mm2
	Distance		0.6	m
	bar dia		8	mm
	spacing		300	mm
	At corners where both the edges of slab is continuous		0	
		Thickness of slab	135	mm

Figure.6: Snapshot of results

5. VBA Programming Code in VB Editor

```
Private Sub CommandButton1_Click()

'STEP-1 DETERMINATION OF TYPE OF SLAB

Range("v8") = Range("b6") / Range("b7") 'determination of type of slab
If Range("v8") < 2 Then


'STEP-2 CALCULATION OF DEPTH

If Range("b7") <= 3 And Range("b7") <= 3.5 Then 'Effective depth of slab , page-37 , IS456:2000
Dim D As Integer
D = (Range("b7") * 1000) / 28
Range("v9") = D
Else
D = (Range("b7") * 1000) / 25
Range("v9") = D
End If
If Range("v9") < 135 Then
Range("v9") = 135
End If
Range("v10") = Range("v9") - 20 - (Range("x10") / 2)

'STEP-3 CALCULATION OF EFFECTIVE SPAN

If (Range("b7") + Range("v10") / 1000) < (Range("b7") + Range("b10")) Then 'effective span for shorter span , page 34 , IS456:2000
Range("v12") = (Range("b7") + Range("v10") / 1000)
Else
Range("v12") = (Range("b7") + Range("b10"))
End If
If (Range("b6") + Range("v10") / 1000) < (Range("b6") + Range("b10")) Then 'effective span for longer span , page 34 , IS456:2000
Range("v13") = (Range("b6") + Range("v10") / 1000)
Else
Range("v13") = (Range("b6") + Range("b10"))
End If
```

Figure.7: Snapshot of VBA Code

```
'Bar Dia Selection
sinput = Application.InputBox("Please enter dia of bar to be used")
If sinput = False Then
Exit Sub
Else
Range("x10") = sinput
If Range("x10") < (Range("v9") / 8) Then
Select Case sinput  'v100 = area of bars choosen
Case 8
Range("x10") = 8
Range("v100") = 50.26
Case 10
Range("x10") = 10
Range("v100") = 78.54
Case 12
Range("x10") = 12
Range("v100") = 113.09
Case 16
Range("x10") = 16
Range("v100") = 201.06
Case 20
Range("x10") = 20
Range("v100") = 314.16
Case 25
Range("x10") = 25
Range("v100") = 490.87
Case 32
Range("x10") = 32
Range("v100") = 804.25
Case Else
dummy = MsgBox("wrong input", vbCritical)
End Select
Else
MsgBox ("As per IS 456:2000 Cl: 26.5.2.2 Max. Bar Dia should br less than equal to D/8")
're enter of bar condition to be provided
```

Figure.8: Snapshot of VBA Code

```
'STEP-4 CALCULATION OF LOADS

Range("v15") = (Range("v9") / 1000) * 1 * 25 'dead load
Range("v16") = Range("b8")  'live load
Range("v17") = Range("b9") 'finishing load
Range("v18") = 1.5 * (Range("v15") + Range("v16") + Range("v17")) 'Ultimate load


'STEP-5 CALCULATION OF BENDING MOMENT
UserForm1.Show
Range("v82") = Range("v21") * Range("v18") * Range("v12") * Range("v12") 'BM along shorter span (positive moment at mid span)
Range("v83") = Range("v22") * Range("v18") * Range("v12") * Range("v12") 'BM along shorter span (negative moment at continuous edge)
Range("v84") = Range("v23") * Range("v18") * Range("v12") * Range("v12") 'BM along longer span (positive moment at mid span)
Range("v85") = Range("v24") * Range("v18") * Range("v12") * Range("v12") 'BM along longer span (negative moment at continuous edge)

'STEP-6 CHECK FOR EFFECTIVE DEPTH

Dim k As String
k = Range("b12")
Select Case k
Case 250
Range("x87") = 0.148
Case 415
Range("x87") = 0.138
Case 500
Range("x87") = 0.133
End Select
Range("v87") = Sqr((Range("v82") * 1000000) / (Range("x87") * Range("b11") * 1000)) 'check for effective depth
Range("v89") = Range("v87") < Range("v10")
```

Figure.9: Snapshot of VBA Code

```
'STEP-7 AREA OF R/F

Range("v92") = (3 / 4) * Range("b6") 'Along shorter span width of middle strip
Range("v96") = (3 / 4) * Range("b7") 'Along longer span width of middle strip
Range("v93") = (0.5 * Range("b11") / Range("b12")) * (1 - Sqr(1 - (4.6 * Range("v82") * 1000000) / (Range("b11") * 1000 * Range("v10") * Range("v10"))))
Range("v94") = (0.5 * Range("b11") / Range("b12")) * (1 - Sqr(1 - (4.6 * Range("v83") * 1000000) / (Range("b11") * 1000 * Range("v10") * Range("v10"))))
Range("v81") = (Range("v10") - Range("x10"))
Range("v97") = (0.5 * Range("b11") / Range("b12")) * (1 - Sqr(1 - (4.6 * Range("v84") * 1000000) / (Range("b11") * 1000 * Range("v81") * Range("v81"))))
Range("v98") = (0.5 * Range("b11") / Range("b12")) * (1 - Sqr(1 - (4.6 * Range("v85") * 1000000) / (Range("b11") * 1000 * Range("v81") * Range("v81"))))
Range("v100") = (3.14 * Range("x10") * Range("x10")) / 4


'SPACING ALONG SHORTER SPAN AT MID SPAN

If (Range("v100") / Range("v93")) * 1000 > 300 Then
Range("v101") = 300
Else
If (Range("v100") / Range("v93")) * 1000 < 3 * Range("v10") And (Range("v100") / Range("v93")) * 1000 < 300 Then 'spacing for main r/f
If (Range("v100") / Range("v93") * 1000) > 30 Then
Range("v101") = (Round((Range("v100") / Range("v93") * 1000) / 10) * 10)
Else
Range("v101") = 30
End If
ElseIf (3 * Range("v10")) < (Range("v100") / Range("v93")) * 1000 And (3 * Range("v10")) < 300 Then
Range("v101") = 3 * Range("v10")
Else
Range("v101") = 300
End If
End If
```

Figure.10: Snapshot of VBA Code

```
'STEP-9 TORSION R/F

Dim s As String
s = Range("v25")
Select Case s
Case "Interior Panel"
Range("v118") = 0
Range("v120") = 0
Range("v122") = 0

Case "One short edge discontinuous"
Range("v118") = 0
Range("v120") = (1 / 2) * (3 / 4) * (Range("v108"))
Range("v122") = 0

Case "One long edge discontinuous"
Range("v118") = 0
Range("v120") = (1 / 2) * (3 / 4) * (Range("v108"))
Range("v122") = 0

Case "two adjacent edges discontinuous"
Range("v118") = (3 / 4) * (Range("v108"))
Range("v120") = (1 / 2) * (3 / 4) * (Range("v108"))
Range("v122") = 0

Case "two short edges discontinuous"
Range("v118") = 0
Range("v120") = (1 / 2) * (3 / 4) * (Range("v108"))
Range("v122") = 0

Case "two long edges discontinuous"
Range("v118") = 0
Range("v120") = (1 / 2) * (3 / 4) * (Range("v108"))
Range("v122") = 0
```

Figure.11: Snapshot of VBA Code

```
'STEP-10 CHECK FOR DEFLECTION

Range("v132") = (Range("v108")) / (1000 * Range("v10")) * 100 '% of tension r/f
Range("v131") = (0.58 * Range("b12") * Range("v93")) / (Range("v108")) 'stress in steel under service load
Range("v159") = (Range("b7") * 1000) / (20 * Range("v137")) 'check for deflection
Range("v161") = Range("v159") < Range("v10")

'STEP-11 CHECK FOR DEVELOPMENT LENGTH

Range("v166") = (0.87 * Range("b12") * Range("v108")) / (0.36 * 2 * Range("b11") * 1000) 'Xu , (0.87*fy*Ast/0.36*fck*b) , page96 , IS456:2000
Range("v167") = 0.87 * Range("b12") * (Range("v108") / 2) * (Range("v10") - 0.42 * Range("v166")) 'M1 , (0.87*fy*(Ast/2))*(d-0.42*xu)
Range("v169") = (1.3 * Range("v167")) / (Range("v170")) + (Range("v168")) 'Ld , (1.3*M1/V)+Lo , page44 , IS456:2000 , for Lo=(d or 12*bar dia) wh
Range("v170") = (Range("v18") * Range("v12") * 1000) / 2 'v
Dim T As String
T = Range("b11")
Select Case T
Case 20
Range("v171") = 1.2
Case 25
Range("v171") = 1.4
Case 30
Range("v171") = 1.5
Case 35
Range("v171") = 1.7
Case 40
Range("v171") = 1.9
End Select
Range("v172") = (0.87 * Range("b12") * Range("x10")) / (4 * 1.6 * Range("v171")) 'development length , Ld=(0.87*fy*bar dia)/(4*deign bond stress)
Range("v174") = Range("v172") < Range("v169") 'safe , Ld<(1.3*M1/V)+Lo
```

Figure.12: Snapshot of VBA Code

6. Validation of Results

In any computational or design automation tool, ensuring the accuracy and reliability of the results is of paramount importance. The credibility of the developed system depends not only on its functionality or user interface but also on the validity of the output it produces. In the case of structural engineering applications, such as the design of reinforced concrete (RCC) slabs, this becomes even more critical, as any inaccuracy may directly affect the safety and serviceability of the structure. The results obtained from the spreadsheet tool is compared with those derived from manual calculations for selected slab design problems and from RCDC software results. Key design parameters such as bending moments, effective depth, required steel area (Ast), and reinforcement detailing is evaluated. The level of agreement between the manual, RCDC software and spreadsheet outputs serve as a measure of the tool's accuracy.

To validate the developed spreadsheet tool, manual design calculations were performed for a Two-way RCC slab as per IS 456:2000. The slab had a span of 3m x 5m and was subjected to a live load of 3 kN/m². Key design parameters including bending moment, effective depth, and reinforcement area were calculated manually and compared with the tool output.

Further validation was carried out by comparing the reinforcement detailing results from the developed tool with outputs from RCDC software for a slab of span 1.75m x 2.73m under 2 KN/m2 Live load loading conditions. The focus was on bar diameter and spacing of main and distribution reinforcement.

7. Results and Discussions

The tool was evaluated in terms of design speed, user interface experience, implementation of IS 456:2000 provisions, and its support for advanced features such as torsional reinforcement. While the accuracy of the tool has already been validated in the using both manual methods and RCDC software. The developed tool effectively automates the RCC slab design process based on user-defined parameters such as slab span, support condition, imposed loads, and material properties. Key features of the tool include: Identification of slab type (one-way or two-way), Load calculation (DL + LL + FF), Moment calculation using IS 456 coefficients, Depth and reinforcement design, Corner torsion reinforcement provision (if required), Reinforcement spacing and bar selection. These features provide a comprehensive and compliant design solution for typical RCC slabs used in building construction.

Table below Compared the Results-

Manual Vs VBA tool (Table -1)

SN	Type of Slab	Span	Bar dia.	Manual (Spacing) S/L	VBA tool (Spacing) S/L	Deviation S/L (%)
1.	Two-way Slab	3m x5m	8 mm	180 /290	190/300	5.55/3.42

RCDC vs VBA tool (Table – 2)

SN	Type of Slab	Span	Bar dia.	RCDC (Spacing) S/L	VBA tool (Spacing) S/L	Deviation S/L (%)
1.	Two-way Slab	1.75m x2.73m	8 mm	275 /300	300/300	9.09/0

8. Conclusion

The objective was to develop a user-friendly, Excel-based spreadsheet tool for the design of RCC slabs using Visual Basic for Applications (VBA), in accordance with IS 456:2000. The developed tool successfully automates the design of one-way and two-way slabs by performing accurate calculations, reducing manual effort, and minimizing human errors. It allows users to input key design parameters and instantly obtain outputs such as required reinforcement and slab thickness, thereby saving time and improving productivity. The tool serves as a valuable resource for students, academicians, and practicing engineers by simplifying the slab design process. Although it currently focuses on basic slab types and does not consider lateral loads such as earthquake and wind forces, it lays a solid foundation for further development. Future enhancements can include additional structural components, graphical outputs, cost estimation, integration with analysis software, and consideration of seismic and wind loads. In conclusion, this work demonstrates the potential of combining engineering knowledge with programming tools like VBA to create efficient, practical design aids that can bridge the gap between theory and real-world applications.

References

[1] Amalfitano, Amatucci Nicola, Simone Vincenzo De, Fasoline Anna Rita, Tramontana Portfirio **“**Toward Reverse Engineering of VBA based Excel Spreadsheets Applications**”** arXiv:1503.03401v1 [cs.SE] 11 Mar 2015

[2] Choi Kang Kyu “Reinforced Concrete Structure Design Assistance Tool for Beginners” (2002)

[3] Danavandi Varsha S.“Developing Civil Engineering Design Software using MS Excel ” ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-4, ISSUE-5, 2017

[4] Din Essam Zanel “Using Spreadsheets and VBA for Teaching Civil Engineering Concepts” ICSIT 2010 - International Conference on Society and Information Technologies, Proceedings

[5] Edstrom Linda “A Finite Element Tool for Beam Analysis” Method September 2015 International Review of Civil Engineering (IRECE)6(5):124-132

[6] Labadan Rimmon S., “Design of Post Tensioned Prestressed Concrete Beams using Excel Spreadsheet with Visual Basic Applications” International Journal of Advances in Mechanical and Civil Engineering, ISSN: 2394-2827 Volume-3, Issue-4, Aug.-2016

[7] MJ Shree Lakshmi, Mnjunatha, Spandan, Ritesh “Development of IOS Application for Design of Flat Slabs” (IRJET) Volume: 04 Issue: 09 | Sep -2017

[8] Suh Yong S. “Development of educational software for beam loading analysis using pen-based user interfaces” Volume 1, Issue 1, January 2014

[9] Tiwari Suryam, Srivastava Vijay “Development of Design Spreadsheet Tool for R.C.C. Beam Design using V.B.A” IJIRST, Volume 4, Issue 11, April 2018, ISSN (online): 2349-6010

[10] Singh Rohan, Grover Rakesh Kumar “Comparative Study and Analysis of Conventional and Diagrid Building in seismic Loading” Journal of Computational Analysis and Applications, VOL. 33, NO. 8, 2024

[11] Jain shejal, Grover Rakesh “A Comparative Study on an RC Frame Building with Different Types of Bracing for Various Seismic Zones” ISSN: 2321-8169 Volume: 11 Issue: 1