

Software Application for Design of Structural Element Using Visual Basic Coding

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Abstract— The increasing reliance of engineers on computer software in the performance of their tasks requires engineers, the future professional engineers, must be knowledgeable of sound engineering concepts, updated on the latest computer technology used in the industry and aware of the limitations and capabilities of the computer in solving engineering problems. “Computer Methods in Civil Engineering” to developed structural design program for design of structural element using Visual Basic. By creating my own software applications will demonstrate my creativity and integrate concepts, methods and skills in mathematics, basic engineering and specialized civil engineering subjects. This paper presents the learning objectives, requirements, methodology and outputs of my knowledge on “Computer Methods in Civil Engineering”.

Keywords— Structural Design, Visual Basic.

I. INTRODUCTION

The rapid development of fast, powerful and affordable microcomputers has resulted in the professional engineers’ extensive use of sophisticated computer software in the solution of large, complex and sometimes even common problems. The present day civil engineer, in particular, use some sort of computer software – for processing, spreadsheet, database management or specialized applications – in combination with traditional tools such as calculators, tables, formulas and design aids, in accomplishing his tasks. Specialized software for various civil engineering applications have now become a useful and necessary tool in the industry – Primavera, Harvard Project and CA Project for construction planning and scheduling, STAAD-III, ETABS, GRASP and BATS for 2D and 3D structural analysis of buildings and frames, XSTEEL for detailing of steel structures, SAP, STRAND, STARDYNE and ROBOT for general finite element analysis, ACECOMS GEAR and PCCOL for reinforced concrete design and analysis, PROKON for various civil engineering applications such as structural analysis, geotechnical engineering, steel and concrete design, EMME2 for transportation planning, HEC-HMS and FLDWAV for hydrology and hydraulics and AutoCAD for drafting.

II. COMPUTER METHOD IN CIVIL ENGINEERING

The introduction of the Windows operating system and the growing interest in Graphics User Interface (GUI) has introduced new paradigms in computer programming and software development. Object Oriented Programming (OOP) is one of the most recent preferred techniques being used in

the software development process (Anwar 1996, 2001). The traditional programming languages used in most of engineering applications, which are BASIC, FORTRAN and PASCAL, are not well suited for OOP implementation. Visual BASIC is a suitable language in introducing the OOP and Windows based applications. Visual BASIC is ideal for small to medium scale programs. This language is suitable for developing graphical and interactive software applications. In this “Computer Methods in Civil Engineering,” myself to develop my own programs using Visual BASIC.

1. Learning Objectives of strategy

The objectives of the project: (a) To develop simple, easy-to-use computer software applications for solving “Design of Structural Element using visual Basic” and (b) To familiarize on advanced computing technologies for civil engineers. The value aims, on the other hand, are:

- (a) To develop honesty, patience and responsibility for develop my computer programs and
 - (b) To develop a passion for excellence in the profession through exposure to the state of the art in computing technology for civil engineers.
- **Computer Projects** – Develop simple Visual Basic software applications to solve basic civil engineering problems in design of structural elements.(*Beam, Column, Slab, Staircase, Footing*)
 - **Computer Exercises** –Apply the design procedure in Visual Basic programming tools to solve simple problems.

2. Computer projects

Through the computer my creativity and integrate concepts, methods and skills in civil engineering subjects. I will expected to do the following: (a) understand the theory behind the problem, (b) derive and apply equations and numerical methods to solve the problem, (c) formulate an algorithm, (d)

design a VB user's interface which will accept input data and display the output, (e) write VB programs using correct syntax, (f) execute and debug the program, and (g) check the correctness of the results of the program.

3. Computer exercise

Computer exercises are practice sessions for me to learn the fundamentals of OOP using Visual BASIC. The exercises were derived from the book: Teach yourself Visual Basic 4 in 21 days by Gurewich, N. & Gurewich O., 1995 5. This is an ideal book for it assumes no prior experience in Visual BASIC. An overview about VB program which consists of objects and events was presented during the first week of my project. The exercises derived from Gurewich and Gurewich (1995) start with the basics of writing a simple program, introducing me to the basic elements of a VB program, and then gradually moves on to advanced techniques using VB objects and control statements. The exercises, which are expected to be completed on scheduled day, are saved on a computer.

I. *Description of the problem* : State the problem and the corresponding objectives of the computer program.

II. *Description of user's interface* – similar to simplified user's manual

III. *Sample run* : A sample problem with hand calculations with input data & resulting output

The first problem involves application for design of cantilever & simply supported beam. An example of computer project no. 1 is described below:

Problem no: 1 – A simply supported rectangular beam of effective span 6.3 m is subjected to a u.d.l of 13.5 kN/m (including its self weight) throughout its length. Design the mid span section for the limit state of collapse in flexure, using M₂₀ grade of concrete and Fe 415 grade of steel. Keep the breadth of beam as 300 mm. Assume a partial safety factor of 1.5 for load.



Fig. 1 Selection of Structural Element

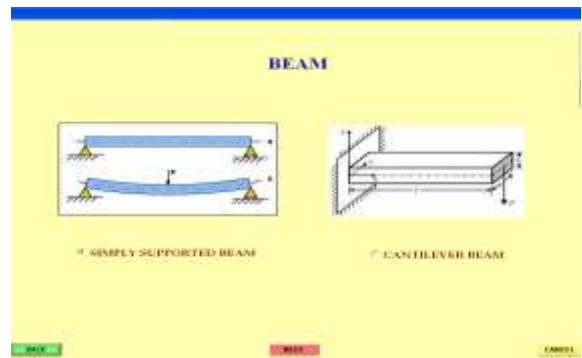


Fig. 2 Selection of beam



Fig. 3 Selection of singly reinforced beam from various types



Fig. 4 Selection of grade of concrete & steel

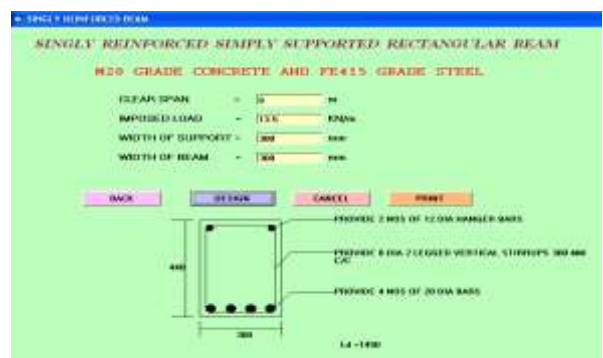


Fig. 5 Input and output result of Problem no : 1

Problem no: 2 –Axial loaded of 300 Kn circular column .design a section with reinforcement detail take M20 grade concrete and Fe415 grade steel



Fig. 6 Selection of Structural Element



Fig. 7 Selection of circular column from various types



Fig. 8 Selection of grade of concrete & steel

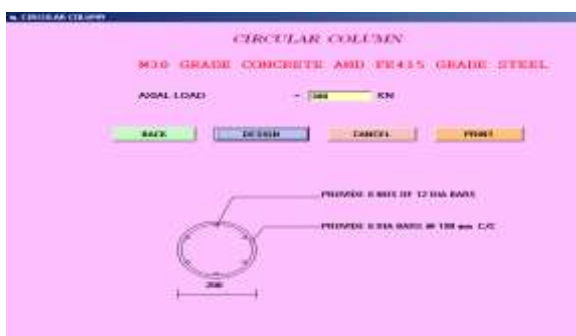


Fig. 9 Input and output result of Problem no : 2

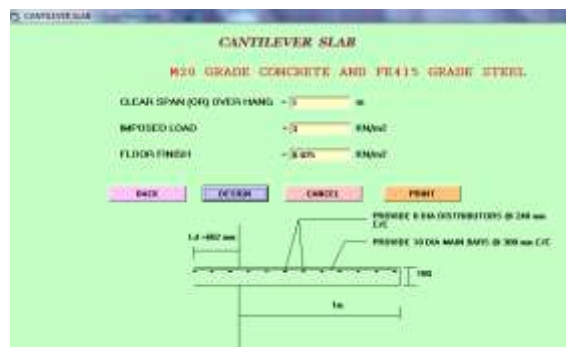
Problem no: 3 –A cantilever slab of span 1 m carries a imposed load of 3 Kn/m² and floor finish load of 0.875 Kn/m² design a slab take M20 grade concrete & Fe 415 grade steel.



Fig. 10 Selection of cantilever slab from various types



Fig. 11 Selection of grade of concrete & steel



III. VISUAL BASIC SOURCE CODING FOR SIMPLY SUPPORTED BEAM (M₂₀ & FE 415)

```
Private Sub Command2_Click()
Dim FCK As Variant
FCK = 20
Dim FY As Variant
FY = 415
Dim QU As Variant
QU = 2.759
If Text1.Text = "" Or Text2.Text = "" Or Text3.Text = "" Or Text4.Text = "" Then
MsgBox "PLEASE ENTER INPUT FOR ALL ", vbOKOnly, "ERROR"
```

```

Elseif Text1.Text > 0.01 And Text1.Text < 10 And
Text2.Text > 0.01 And Text2.Text < 20 And Text3.Text >
200 And Text3.Text < 350 And Text4.Text < 350 And
Text4.Text > 200 Then
Dim L As Variant
L = Format((Text1.Text * 1000) + Text3.Text)
Dim DEAD As Variant
Dim MU As Variant
MU = Format((((Text2.Text) * L * L * 1.5) / 8))
Dim D As Integer
D = Format(((MU) / (QU * Text4.Text)) ^ 0.5)
Dim AST As Variant
AST = Format(((0.5 * FCK * Text4.Text * (D + 25)) / FY) *
(1 - ((1 - ((4.6 * MU) / (FCK * Text4.Text * D ^ 2)))) ^ 0.5))
Dim A As Variant
Dim b As Variant
If AST < 451 Then
A = "PROVIDE 4 NOS OF 12 DIA BARS"
b = 452
Elseif AST > 452 And AST < 803 Then
A = "PROVIDE 4 NOS OF 16 DIA BARS"
b = 804
Elseif AST > 804 And AST < 1255 Then
A = "PROVIDE 4 NOS OF 20 DIA BARS"
b = 1256
Elseif AST > 1256 And AST < 1963 Then
A = "PROVIDE 4 NOS OF 25 DIA BARS"
b = 1963
Elseif AST > 1962 And AST < 2944 Then
A = "PROVIDE 4 NOS OF 25 DIA BARS & 2 NOS OF 25
DIA BARS AT UPPER TIRE"
b = 2944
Elseif AST > 2943 And AST < 3925 Then
A = "PROVIDE 4 NOS OF 25 DIA BARS & 4 NOS OF 25
DIA BARS AT UPPER TIRE"
b = 3925
End If
Dim FS As Variant
FS = Format((0.58 * FY * (AST / b)))
Dim AST1 As Variant
AST1 = Format((b / AST))
Dim MF As Variant
If FS < 120 And AST1 < 0.2 Then
MF = 2
Elseif FS < 120 And AST1 > 0.19 And AST1 < 0.4 Then
MF = 2
Elseif FS < 120 And AST1 > 0.39 And AST1 < 0.6 Then
MF = 2
Elseif FS < 120 And AST1 > 0.59 And AST1 < 0.8 Then
MF = 2
Elseif FS < 120 And AST1 > 0.79 And AST1 < 1 Then
MF = 1.8
Elseif FS < 120 And AST1 > 0.9 And AST1 < 1.2 Then
MF = 1.55
Elseif FS < 120 And AST1 > 1.19 And AST1 < 1.4 Then
MF = 1.5
Elseif FS < 120 And AST1 > 1.39 And AST1 < 1.6 Then
MF = 1.25
Elseif FS < 120 And AST1 > 1.59 And AST1 < 1.8 Then
MF = 1.2
Elseif FS < 120 And AST1 > 1.79 And AST1 < 2.2 Then
MF = 1.2
Elseif FS < 120 And AST1 > 2.19 And AST1 < 2.4 Then
MF = 1.15
Elseif FS < 120 And AST1 > 2.39 And AST1 < 3.1 Then
MF = 1.1
Elseif FS > 119 And FS < 145 And AST1 < 0.4 Then
MF = 2
Elseif FS > 119 And FS < 145 And AST1 > 0.39 And AST1 <
0.6 Then
MF = 1.8
Elseif FS > 119 And FS < 145 And AST1 > 0.59 And AST1 <
0.8 Then
MF = 1.58
Elseif FS > 119 And FS < 145 And AST1 > 0.79 And AST1 <
1 Then
MF = 1.4
Elseif FS > 119 And FS < 145 And AST1 > 0.9 And AST1 <
1.6 Then
MF = 1.2
Elseif FS > 119 And FS < 145 And AST1 > 1.59 And AST1 <
3.1 Then
MF = 1.1
Elseif FS > 144 And FS < 190 And AST1 < 0.2 Then
MF = 2
Elseif FS > 144 And FS < 190 And AST1 > 0.19 And AST1 <
0.4 Then
MF = 1.6
Elseif FS > 144 And FS < 190 And AST1 > 0.39 And AST1 <
0.6 Then
MF = 1.4
Elseif FS > 144 And FS < 190 And AST1 > 0.59 And AST1 <
0.8 Then
MF = 1.2
Elseif FS > 144 And FS < 190 And AST1 > 0.79 And AST1 <
1.1 Then
MF = 1.2
Elseif FS > 144 And FS < 190 And AST1 > 1.09 And AST1 <
1.8 Then
MF = 1
Elseif FS > 144 And FS < 190 And AST1 > 1.79 And AST1 <
3.1 Then
MF = 0.8
Elseif FS > 189 And FS < 240 And AST1 < 0.2 Then
MF = 1.6
Elseif FS > 189 And FS < 240 And AST1 > 0.19 And AST1 <
0.4 Then
MF = 1.25
Elseif FS > 189 And FS < 240 And AST1 > 0.39 And AST1 <
0.6 Then
MF = 1.15
Elseif FS > 189 And FS < 240 And AST1 > 0.59 And AST1 <
1 Then
MF = 1.1
Elseif FS > 189 And FS < 240 And AST1 > 0.9 And AST1 <
3.1 Then
MF = 0.8
Elseif FS > 239 And FS < 291 And AST1 < 0.2 Then
MF = 1.4
Elseif FS > 239 And FS < 291 And AST1 > 0.19 And AST1 <
0.4 Then
MF = 1.15
Elseif FS > 239 And FS < 291 And AST1 > 0.39 And AST1 <
0.6 Then

```

```

MF = 1.1
ElseIf FS > 239 And FS < 291 And AST1 > 0.59 And AST1 <
1.2 Then
MF = 0.8
ElseIf FS > 239 And FS < 291 And AST1 > 1.19 And AST1 <
3.1 Then
MF = 0.7
ElseIf FS > 290 And AST1 < 3.1 Then
MF = 0.1
End If
Dim D1 As Integer
D1 = Format((Text1.Text * 1000) / (FCK * MF))
Dim sh As Variant
sh = Format((Text2.Text * (L / 1000) * (L / 1000)) / 2)
Dim V As Variant
V = ((sh) / (Text4.Text * D))
Dim D2 As Integer
If D1 < D And V < 2.8 Then
D2 = D
Else
D2 = Format((D1 + 20))
End If
Dim AST2 As Integer
AST2 = Format((((0.5 * FCK * Text4.Text * (D2 + 25)) / FY)
* (1 - ((1 - ((4.6 * MU) / (FCK * Text4.Text * D2 ^ 2)))) ^
0.5))
Dim A1 As Variant
Dim B1 As Variant
Dim DIA As Variant
If AST2 < 451 Then
A1 = "PROVIDE 4 NOS OF 12 DIA BARS"
B1 = 452
DIA = 12
ElseIf AST2 > 452 And AST < 803 Then
A1 = "PROVIDE 4 NOS OF 16 DIA BARS"
B1 = 804
DIA = 16
ElseIf AST2 > 804 And AST < 1255 Then
A1 = "PROVIDE 4 NOS OF 20 DIA BARS"
B1 = 1256
DIA = 20
ElseIf AST2 > 1256 And AST < 1963 Then
A1 = "PROVIDE 4 NOS OF 25 DIA BARS"
B1 = 1963
DIA = 25
ElseIf AST2 > 1962 And AST < 2944 Then
A1 = "PROVIDE 4 NOS OF 25 DIA BARS & 2 NOS OF 25
DIA BARS AT UPPER TIRE"
B1 = 2944
ElseIf AST2 > 2943 And AST < 3925 Then
A1 = "PROVIDE 4 NOS OF 25 DIA BARS & 4 NOS OF 25
DIA BARS AT UPPER TIRE"
B1 = 3925
End If
Dim AST3 As Variant
AST3 = (((b) / (Text4.Text * D2)) * 100)
Dim V2 As Variant
If AST3 < 0.15 Then
V2 = 0.28
ElseIf AST3 > 0.15 And AST3 < 0.25 Then
V2 = 0.28
ElseIf AST3 > 0.25 And AST3 < 0.5 Then
V2 = 0.36
ElseIf AST3 > 0.5 And AST3 < 0.75 Then
V2 = 0.48
ElseIf AST3 > 0.75 And AST3 < 1 Then
V2 = 0.56
ElseIf AST3 > 1 And AST3 < 1.25 Then
V2 = 0.62
ElseIf AST3 > 1.25 And AST3 < 1.5 Then
V2 = 0.67
ElseIf AST3 > 1.5 And AST3 < 1.75 Then
V2 = 0.72
ElseIf AST3 > 1.75 And AST3 < 2 Then
V2 = 0.75
ElseIf AST3 > 2 And AST3 < 2.25 Then
V2 = 0.79
ElseIf AST3 > 2.25 And AST3 < 2.5 Then
V2 = 0.81
ElseIf AST3 > 2.5 And AST3 < 2.75 Then
V2 = 0.82
ElseIf AST3 > 2.75 And AST3 < 3 Then
V2 = 0.82
Else
V2 = 0.82
End If
Dim VUS As Variant
VUS = ((sh * 1000) - (V2 * Text4.Text * D2))
Dim SV As Integer
SV = ((0.87 * FY * 2 * 50.24) / (0.4 * Text4.Text))
Dim DE As Integer
DE = ((0.75 * D2))
Dim c As Variant
Dim SP As Integer
If SV < 300 And SV < DE Then
SP = SV
ElseIf 300 < SV And 300 < DE Then
SP = 300
ElseIf DE < SV And DE < 300 Then
SP = DE
End If
Dim SPI As Integer
SPI = Format(SP / 10)
Dim SPJ As Integer
SPJ = Format(SPI * 10)
Label13.Caption = A
Label6.Caption = "PROVIDE 2 NOS OF 12 DIA HANGER
BARS"
Label15.Caption = Text4.Text
Dim N As Integer
N = Format(D2 + 20 + DIA)
Dim na As Integer
na = Format(N / 10)
Dim nas As Integer
nas = Format(na * 10)
Label16.Caption = nas
Label10.Caption = "PROVIDE 8 DIA 2 LEGGED
VERTICAL STIRRUPS " & SPJ & " MM C/C"
If DIA > 16 Then
Cls
Circle (3975, 5000), 75
Circle (5220, 5000), 75
Circle (4000, 7000), 100
Circle (4400, 7000), 100

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Circle (4800, 7000), 100
Circle (5200, 7000), 100
Else
Cls
Circle (4000, 5025), 100
Circle (5200, 5025), 100
Circle (4000, 7000), 100
Circle (4400, 7000), 100
Circle (4800, 7000), 100
Circle (5200, 7000), 100
End If
Line (3900, 7000)-(3900, 5000)
Line (5300, 7000)-(5300, 5000)
Line (4000, 7100)-(5200, 7100)
Line (3950, 4920)-(5237.5, 4920)
Line (3780, 7200)-(3780, 4800)
Line (5420, 7200)-(5420, 4800)
Line (3780, 7200)-(5420, 7200)
Line (3780, 4800)-(5420, 4800)
Line (5250, 7000)-(5600, 6600)
Line (5600, 6600)-(6500, 6600)
Line (5300, 6000)-(5600, 5600)
Line (5600, 5600)-(6500, 5600)
Line (3650, 7200)-(3200, 7200)
Line (3650, 4800)-(3200, 4800)
Line (3500, 7200)-(3500, 4800)
Line (3780, 7300)-(3780, 7700)
Line (5420, 7300)-(5420, 7700)
Line (3780, 7500)-(5420, 7500)
Line (5250, 5000)-(5600, 4800)
Line (5600, 4800)-(6500, 4800)
Dim LD As Integer
LD = Format((DIA * 0.87 * 500) / (4 * 1.25 * 1.2))
Label14.Caption = "Ld =" & LD & " mm"
ElseIf Text1.Text < 0.01 Or Text1.Text > 10 Then
MsgBox "PLEASE ENTER A VALID LENGTH BETWEEN
0.5 AND 10 FOR SPAN", vbOKOnly, "ERROR"
ElseIf Text2.Text < 0.01 Or Text2.Text > 19.99 Then
MsgBox "PLEASE ENTER A VALID LOAD BETWEEN
0.1 AND 20 FOR IMPOSED LOAD", vbOKOnly, "ERROR"
ElseIf Text3.Text < 200 Or Text3.Text > 349.99 Then
MsgBox "PLEASE ENTER VALUE BETWEEN 200 AND
350 FOR WIDTH OF SUPPORT", vbOKOnly, "ERROR"
ElseIf Text4.Text < 200 Or Text4.Text > 349.99 Then
MsgBox "PLEASE ENTER VALUE BETWEEN 200 AND
350 FOR WIDTH OF BEAM", vbOKOnly, "ERROR"
End If
End Sub

```

IV. VISUAL BASIC SOURCE CODING FOR SIMPLY SUPPORTED BEAM (M₂₀ & FE 415)

```

Private Sub Command2_Click()
Dim FCK As Variant
FCK = 30
Dim FY As Variant
FY = 415
If Text1.Text = "" Then
MsgBox "PLEASE ENTER VALUE FOR AXIAL LOAD",
vbOKOnly, "ERROR"
ElseIf Text1.Text < 2500.01 Then

```

```

Dim P As Integer
If Text1.Text < 200 Then
P = 200
Else
P = Format((Text1.Text * 1.5))
End If
Dim ASC As Variant
ASC = Format((1 / 100))
Dim AG As Integer
Dim S1 As Variant
S1 = Format((1 - ASC * 1))
AG = Format(P / ((0.396 * FCK * S1) + (0.67 * FY * ASC)))
Dim b As Integer
b = Format(((AG * (10 ^ 3) * 4) / 3.14) ^ 0.5)
Dim AGR As Variant
AGR = Format((3.14 * b ^ 2) / 4)
Dim ASCR As Variant
ASCR = Format((P * 10 ^ 3 - 0.396 * FCK * AGR) / (0.67 *
FY))
Dim MA As Variant
Dim A As Integer
Dim L As Integer
Dim S As Integer
Dim f As Integer
Dim Q As Integer
Dim w As Integer
If ASCR < 678 Then
MA = "PROVIDE 6 NOS OF 12 DIA BARS"
A = 678
L = 12
S = 12
f = w
ElseIf ASCR > 678.01 And ASCR < 1206 Then
MA = "PROVIDE 6 NOS OF 16 DIA BARS "
A = 1206
L = 16
S = 16
f = w
ElseIf ASCR > 1206.01 And ASCR < 1885 Then
MA = "PROVIDE 6 NOS OF 20 DIA BARS"
A = 1885
L = 20
S = 20
f = w
ElseIf ASCR > 1885.01 Then
MA = "PROVIDE 6 NOS OF 25 DIA BARS "
A = 2945
L = 25
S = 25
f = w
End If
Dim ASC1 As Variant
ASC1 = Format((A * 10 ^ 2) / AGR)
Dim A1 As Integer
If ASC1 < 0.8 And ASC1 > 6 Then
A1 = A + 900
Dim MA2 As Variant
Dim A2 As Integer
Dim L2 As Integer
Dim S2 As Integer
If ASCR < 678 Then
MA2 = "PROVIDE 6 NOS OF 12 DIA BARS"

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```

A2 = 678
L2 = 12
S2 = 12
f = w
ElseIf ASCR > 678.01 And ASCR < 1206 Then
MA2 = "PROVIDE 6 NOS OF 16 DIA BARS "
A2 = 1206
L2 = 16
S2 = 16
f = w
ElseIf ASCR > 1206.01 And ASCR < 1885 Then
MA2 = "PROVIDE 6 NOS OF 20 DIA BARS"
A2 = 1885
L2 = 20
S2 = 20
f = w
ElseIf ASCR > 1885.01 Then
MA2 = "PROVIDE 6 NOS OF 25 DIA BARS "
A2 = 2945
L2 = 25
S2 = 25
f = w
End If
Label5.Caption = MA2
Else
A1 = A
Label5.Caption = MA
End If
Dim DIA As Integer
If L / 4 < 6 Then
DIA = 6
Else
DIA = 8
End If
Dim DF As Integer
DF = Format((16 * S))
Dim DP As Integer
If 300 < b And 300 < DF Then
DP = 300
ElseIf b < 300 And b < DF Then
DP = b
ElseIf DF < 300 And DF < b Then
DP = DF
End If
Dim e As Integer
e = Format(b / 10)
Dim e1 As Integer
e1 = Format(e * 10)
Dim e2 As Integer
e2 = Format(DP / 10)
Dim e3 As Integer
e3 = Format(e2 * 10)
Label7.Caption = e1
Label6.Caption = "PROVIDE " & DIA & " DIA BARS @ "
& e3 & " mm C/C"
Circle (4000, 6000), 750
Circle (4005, 6000), 680
Circle (3450, 6320), 40
Circle (4530, 6320), 40
Circle (3450, 5680), 40
Circle (4530, 5680), 40
Circle (4000, 6630), 40

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```

Circle (4000, 5360), 40
Line (4000, 5360)-(4300, 4600)
Line (4300, 4600)-(6000, 4600)
Line (3250, 7050)-(3250, 7300)
Line (4750, 7050)-(4750, 7300)
Line (3250, 7175)-(4750, 7175)
Line (4650, 5800)-(4900, 5400)
Line (4900, 5400)-(6000, 5400)
Else
MsgBox "PLEASE ENTER A VALID LOAD LESS THAN
2500 FOR AXIAL LOAD", vbOKOnly, "ERROR"
End If
End Sub

```

V. CONCLUSIONS

At the end of this project the Software application was developed by me using visual basic for design structural element such as beam, column, simply supported slab, staircase and footing. It is used to remember my knowledge in civil engineering and to innovate new application to solve the design in easy way and it helpful to me for future work in to developing the application in widely.

VI. ACKNOWLEDGMENT

The software applications were developed by me in the CIVIL COMP LAB.I would like to saw sincere thanks to my project guide Mr.K.Shyam Kumar M.E Assistant Professor in civil engineering department for the encouragement and valuable support to make this project work a great success.

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J.Manoj Babu completed my diploma in **Arasan Ganesan Polytechnic**, sivakasi and completed my undergraduate in **Karpagam University** Coimbatore. Now pursuing my postgraduate in **Nandha Engineering College**, Perundurai. I am a member in ICI student chapter and participated paper presentation in various colleges. Got first price in project presentation in **Karpagam University** and **Rathnam Engineering College**, Coimbatore. Attended nation conference in **Bannari Amman Institute**, Sakthy and **Karur College of Engineering**, Karur