Techsource Programme: Simply Supported Reinforced Concrete Beam Design By Microsoft Excel

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Abstract: This study was conducted to help students in the form of providing and calculating the problems regarding reinforced concrete beam in the simplest and easiest way. The main reason students face multitude kinds of problems while calculating reinforced beam manually is due to the complex calculation in order to obtain the output analysis. Hence, a program is created in order to solve this complex calculation. This project presents a design of reinforced concrete beam by Microsoft Excel Visual for Application (VBA), mainly focusing on the problems that arise se from a long calculation that is both time and energy-consuming. In other words, this project promotes automatic calculation as opposed to a more difficult one where it is done manually. By using VBA as the medium attraction, this project offers attractive displays and produce automated applications such as data entry worksheet that can be used to generate reports, in addition to the ability to print the said reports in a PDF form, which is arguably the most convenient form and is accepted worldwide as of current status. Users only need to place an input of the required data onto this program and a desired output will be displayed. Users can also revise the previously printed PDF reports as their revision in the future. This report will act as a learning material for users as well as guidance in the design calculation process.

Keywords: Reinforced Concrete Design, Simply Supported Beam, Microsoft Excel, Visual Basic Application, Programme.

1. Introduction

Computer is effective tools for teaching electronics particularly in the context of today. In several universities the Ministry of Education has implemented the use of computer-assisted learning. The use of software definitely improves the learning process among students. The computer facilitates the integration and motion, the transfer of image and sound into lessons. These multimedia resources present materials that encourage the learner to interact with the subject. To make the learning process

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easier for the student, programming animation could help get more attention from the student [1] [2] [3].

This project is specific for students of University Tun Husein Onn Malaysia (UTHM) at a diploma level in civil engineering and this concrete design project applies to Eurocode, British Standard and Malaysian Standard. Moreover, this project is limited to being used only on personal computers (PCs) and not on capable devices based on android.

1.1   Reinforced Concrete Design (RCD)

Reinforced concrete design (RCD) is a concrete that is strengthen using steel reinforcement. Steel reinforcement is a material that strong in tension and compression, but it is become weak in lateral stability during compression and lost most of its strength during fire. Concrete surrounding steel to protect it from corrosion that is caused by moist air or salt water. The tensile strength of steel will reduce rapidly if the temperature over 1200 degree of Fahrenheit. Steel were protected with concrete cover by several inches will retain its strength during several hours of exposure to intense heat. When the reinforcement is strongly bonded to the concrete, strong, stiff and ductile construction material is produced and this called RCD, use as extensively to construct foundations, structural frames, storage tanks, shell roof, highways, walls, dams, canals, and innumerable other structures and building products. Two other characteristic of concrete that present even when concrete is reinforced are shrinkage and creep, but the negative effects of these properties can be mitigated by careful design [4] [5] [6].

1.2   Comprasion of Methods Reinforced Concrete Design RCD calculation

There are three methods are considered as a calculation reinforced concrete, made up of a manual calculation, using application and using TechSource Program. Each method has different calculations of measuring as shown in **Table 1**.

<p style="text-align:center">Table 1: Different of methods RCD calculation</p>

No.	Manual Calculation	Using Application (RC Beam Free)	Using TechSource Program
1	All the data must be calculated manual and by using calculator	Enter data to get the solution	Enter the data for every step.
2	Must remember the formulae to finish the calculation	The formulae do not show for calculation	This program will show the formulae that had been used for every calculation
3	Cannot check the answer whether it is right or wrong	The answer will be show without the calculation	Every output data will be show with the right calculation and details

2.   Methods

Microsoft Excel is a spreadsheet software used for measurements, visualization and documentation of business process data of all kinds. This means it is used to create text grids, numbers and all calculation-specific formula. It can be programmed to use formula such as engineering models to pull in data to update such information in real time. In the exchange of data Microsoft Excel has become a de facto standard and perform various calculations.

VBA stands for Visual Basic Applications, an event-driven programming language from Microsoft that is now primarily used in the Microsoft Office application. It helps techies build custom

application and solutions to improve the capabilities of those apps. The most popular among VBA's, is Excel VBA. VBA isn't as vast as many popular languages [7] [8].

2.1 Common Worksheet Funtions

User can choose to use the Excel Text to Columns command to convert an entire column of Excel numbers to text. Although, this option can be less effective if the data is covering many tables, because the order Text to Tables only operates for one column at a time. The Excel text function converts the given number to text in a user-specific format.

2.1.1 Convert Numbers Into Text as Output

The Excel text function converts the given number to text in a user-specific format. The form of this function is TEXT(Value, Format_Text) which is the Value is the number to be converted to text and format_text is a text string that defines the formatting to be applied to the supplied value.

The spreadsheet below provides samples of the Excel Formulas function used to translate a basic number, currency, date and time to document as **Figure 1** for the formula and **Figure 2** the result.

	A	B
1	1234.5	=TEXT(A1, "General")
2	1234	=TEXT(A2, "$#,##0.00")
3	01/01/2016	=TEXT(A3, "mm/dd/yyyy")
4	01/01/2016	=TEXT(A4, "mmm dd yyyy")
5	12:00:00	=TEXT(A5, "hh:mm:ss")

Figure 1: The TEXT formulas

	A	B
1	1234.5	1234.5
2	1234	$1,234.00
3	01/01/2016	01/01/2016
4	01/01/2016	Jan 01 2016
5	12:00:00	12:00:00

Figure 2: Results of used the TEXT formulas

2.2 VBA Functions

VBA's input and output is easy to address. All it is need to do is gain worksheet information and keep the macro recording going. And after all the work has been done, quit recording.

2.2.1 Form with Input Box to Receive Data

User may use the InputBox function in Excel VBA to prompt the user to enter a value. Place a command button on your worksheet and add the following step code lines.

(i)   Declare the variable myValue of type Variant as shown in **Figure 3**.

```
Dim myValue As Variant
```

Figure 3: Example to declare the coding
Note: We use a variable of type Variant here because a Variant variable can hold any type of value. This way the user can enter text and numbers.

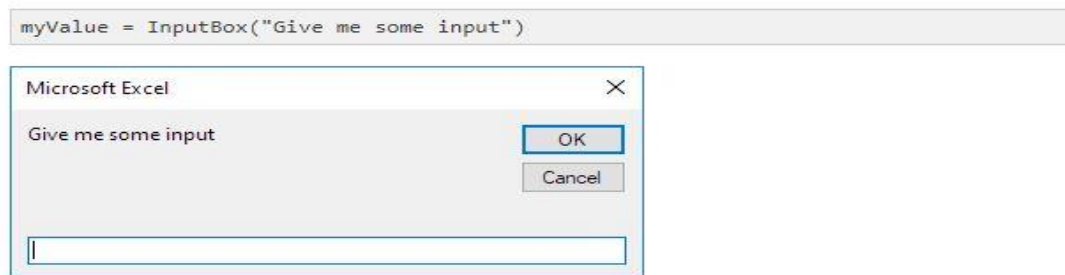(ii)   Add the following code line to show the input box as **Figure 4** below.

```
myValue = InputBox("Give me some input")
```

Microsoft Excel ✕

Give me some input   OK
                      Cancel

|

Figure 4: Code line

(iii)   Write the value of myValue to cell A1 as shown in Figure below. Then, the result will be show when user enters the value 5 and clicks the OK button as **Figure 5**.
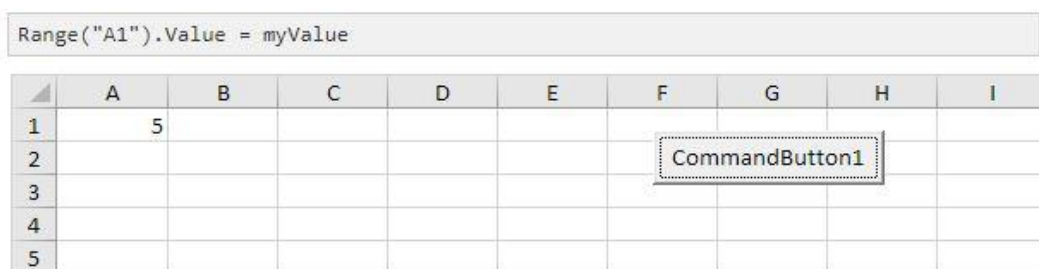
```
Range("A1").Value = myValue
```

	A	B	C	D	E	F	G	H	I
1	5								
2							CommandButton1		
3									
4									
5									

Figure 5: InputBox to receive data myValue

(iv)   The InputBox function has more optional arguments. The following code line shows an input box with a title displayed in the title bar and has a default value as Figure below. The default value will be used if no other input is provided. Result when the user only clicks the OK button as shown in **Figure 6**.
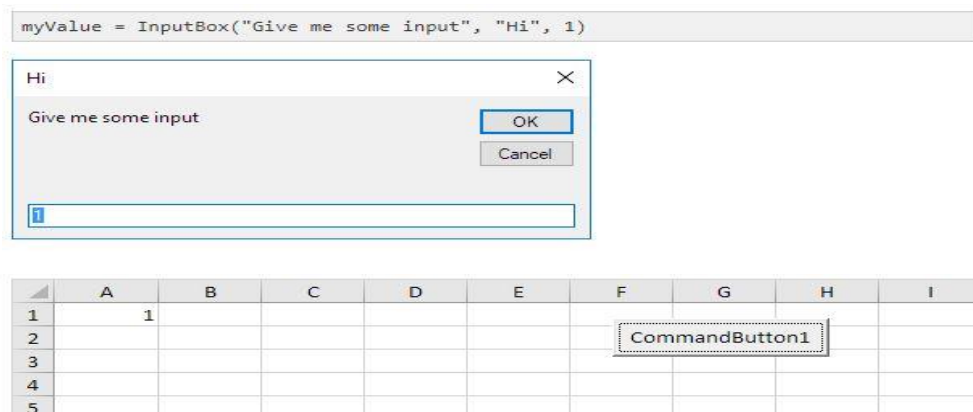
```
myValue = InputBox("Give me some input", "Hi", 1)
```

Hi ✕

Give me some input   OK
                      Cancel

1

	A	B	C	D	E	F	G	H	I
1	1								
2							CommandButton1		
3									
4									
5									

Figure 6: Result when user click OK

Note: Place the cursor on InputBox in the Visual Basic Editor and click F1 for help on the other optional arguments

2.2.2   Create IF THEN statement, ELSE statement which following steps below.

(i)   IF THEN Statement

Use the If then statement in Excel VBA to execute code lines if a specific condition is met. Place a **command button** on your worksheet and add the following code lines as Figure below. If score is greater than or equal to 60, Excel VBA returns pass. **Figure 7** shows the result when you click the command button on the sheet.

```
Dim score As Integer, result As String
score = Range("A1").Value

If score >= 60 Then result = "pass"

Range("B1").Value = result
```

◢	A	B	C	D	E	F	G	H	I
1	80	pass							
2						CommandButton1			
3									
4									
5									

Figure 7: Result when click command button

Note: if score is less than 60, Excel VBA places the value of the empty variable result into cell B1.

(ii)   Else Statement

Place a command button on your worksheet and add the following code lines with **Figure 8**. If score is greater than or equal to 60, Excel VBA returns pass, else Excel VBA returns fail. Result will be show when user click the command button on the sheet as shown in **Figure 9**.

```
Dim score As Integer, result As String
score = Range("A1").Value

If score >= 60 Then
    result = "pass"
Else
    result = "fail"
End If

Range("B1").Value = result
```

Figure 8: Code lines for command button

◢	A	B	C	D	E	F	G	H	I
1	40	fail							
2							CommandButton1		
3									
4									
5									

Figure 9: Result when user click at command button

Note: only if you have one code line after Then and no Else statement, it is allowed to place a code line directly after Then and to omit (leave out) End If (first example). Otherwise start a new line after the words Then and Else and end with End If (second example).

3. Result And Discussion

The common design of a row and column array in Excel spreadsheets with automated updating and display of results has been expanded with Formulas libraries, flexible graphics and charting facilities, appealing and fully efficient graphical user interfaces and the ability to write custom code in Visual Basic for Excel languages. The advanced spreadsheet program can be used for the design and analysis of rectangular reinforced concrete beams for educational purposes.

3.1 Result of Project

Users will be guided step by step in this current chapter, using graphics and how to run this program.

3.1.1 Home Page

The program will automatically be loaded as soon as the user clicks on the TechSource Program. There's going to be a little introduction to this feature. Users are led to choose three key choices, Learning Module, Form Input Page and Worksheet Input Page, as seen in **Figure 10**. Each of these three options has its own functions.
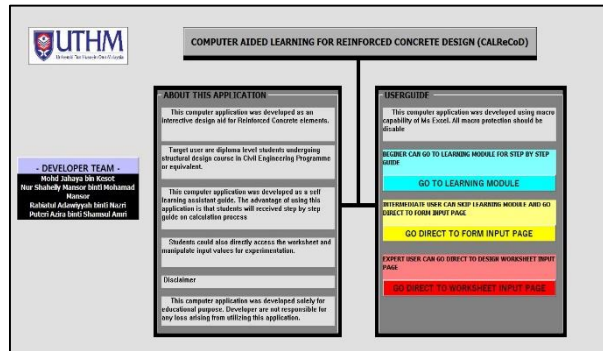
Figure 10: Home page

3.1.2 Learning Module

This Learning Module has nine chapters describing Reinforced Concrete Beam, divided by two main topics, Reinforced Concrete and Design Calculation, as shown in **Figure 11**. This Learning Module will help users learn more about this Reinforced Concrete with a simple and helpful note.
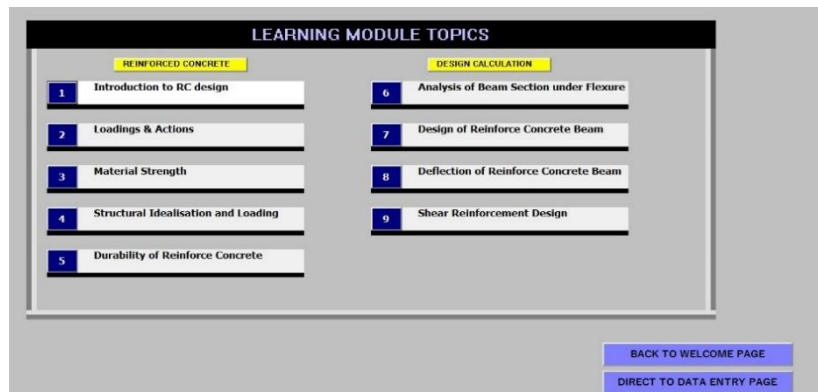

Figure 11: Learning Module

3.1.3 Input Data

This program can provide and gives the required of lever arm, tension and compression steel required, minimum and maximum reinforcement provided, maximum and minimum spacing based on user's preference and input data. The input data is composed of pages that are related to the information calculated in the spreadsheet. User needed to fill in all data displayed in the input page choice program as shown in **Figure 12** and **13** and it will be registerd at worksheet as **Figure 14**.
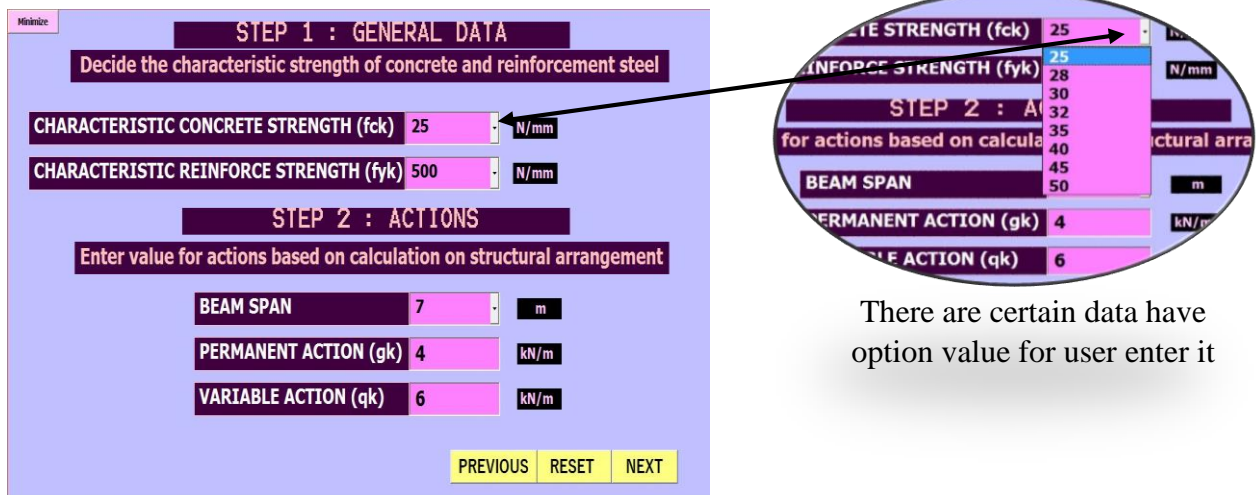
Figure 12: Input Data for General Data and Actions

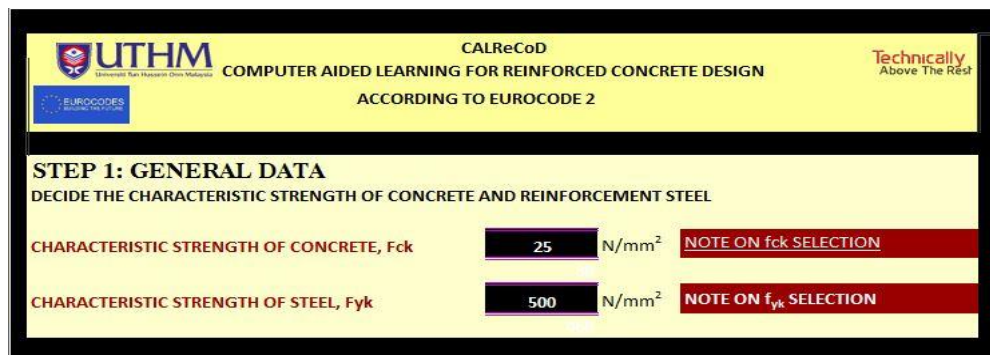**Figure 13: Input Data for Preliminary Sizing**

Figure 14: Data input at worksheet

3.1.4 Output Data

The output will be seen in both the program and the worksheet. **Figure 15** shows the value of data will enter by the user is already connected from VBA to the worksheet in excel, so that the user can directly print the measured beam sheet. Meanwhile **Figure 16** shows data output at worksheet that already connected from VBA form.
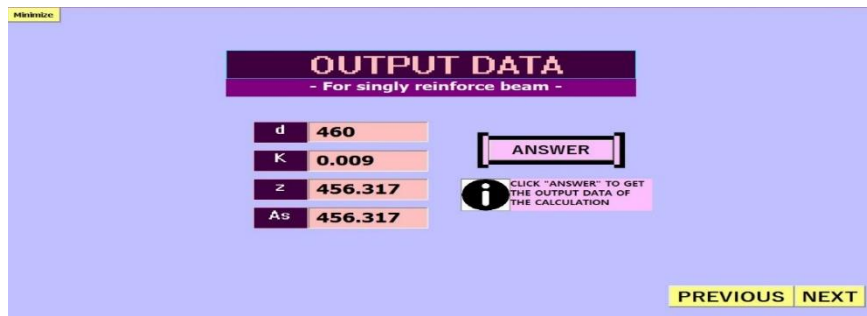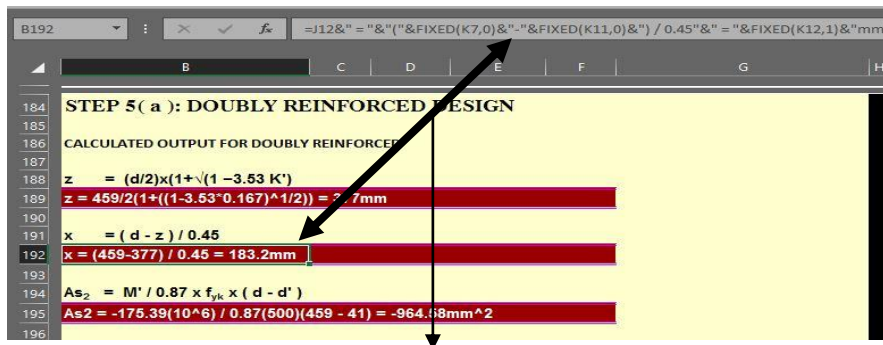
Figure 15: Formed for Output Data

Each output has their own formula function to

Figure 16: Data output at worksheet

3.2 Discussion of The Project

There are many type of the ouput in this program such as graphical result of bending moment diagram and also graphic image of cross-section of the beam.

3.2.1 Graphical Result

Basically, the graphic image is based on the data that the user has entered. How it is designed will link the coordinate to another worksheet that has already been set up as **Figure 17.**
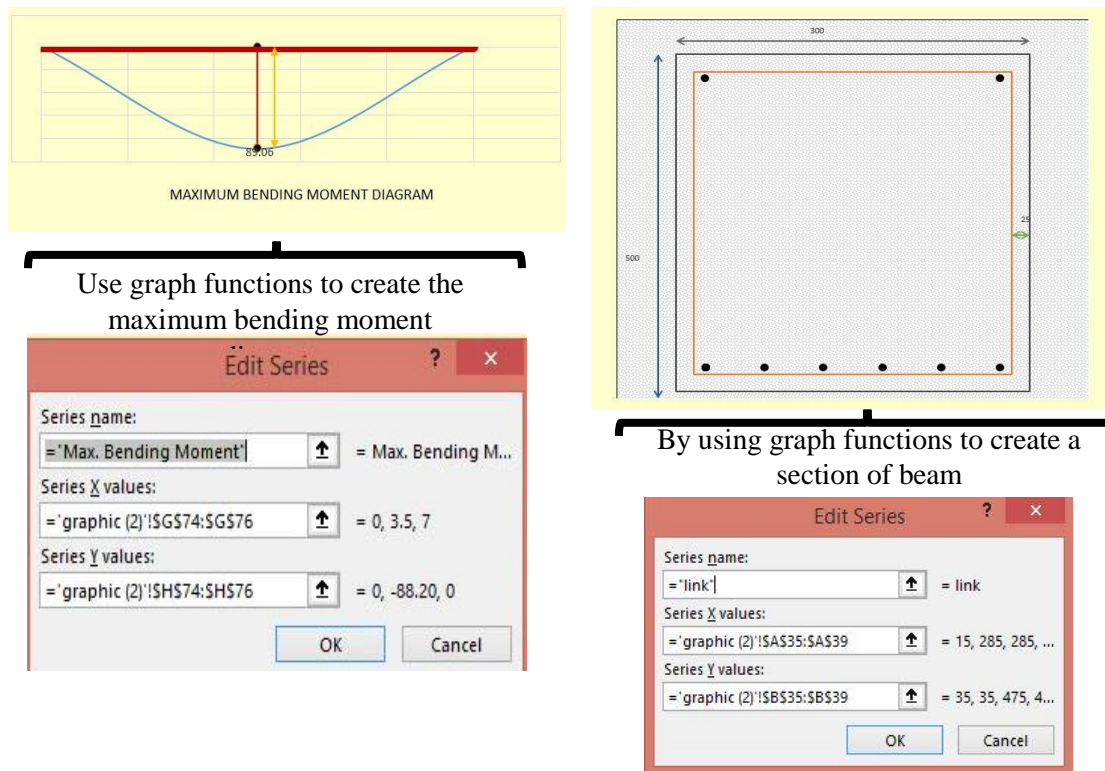
Use graph functions to create the maximum bending moment

By using graph functions to create a section of beam

Figure 17: Maximum bending moment diagram and cross-section of beam

3.2.2 Summary

Detailing drawing for the calculation will be create and user also may click directly print or save as shown in Figure 18.
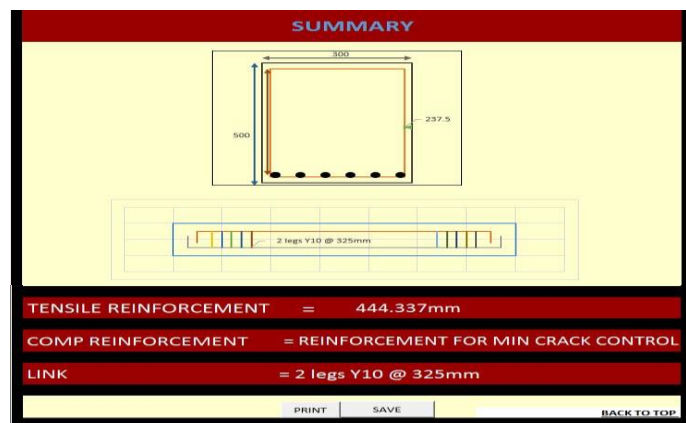
Figure 18: Summary for calculation

4. Conclusion

In conclusion, this programme was created to help students understand more about the rectangular beam design procedure to evaluate the singly or doubly reinforced beam with reinforcement and all other required checks. Generally speaking, students are aware of this complex calculation procedure and it will surely lower the student's interaction with this subject. Thus, with the existence of Visual Basic Application (VBA) which indirectly helps students to become more attracted to this topic and make it fun to study this complex calculation. It therefore requires the user to input the data and it will calculate automatically from the data input according to the formula already specified and the output of the date will appear in VBA's user form.

Acknowledgement

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