

## Development of a Program for the Design of Steel Structure in Visual Basic

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### Abstract

*Design of the steel structure is the basic requirement in the construction field. If design is safe then only the structure will be erected. While designing the tall structures, time consumptions is large because of large numbers of elements. There are many software programs available for exact analysis of structures. Some software programs have been developed for the design of individual element for Indian Standard Code IS 800:2007 [1], The Visual Basic Software Programs are used to analyse the beam, column and joint with inputs like maximum shear force, bending moment and preliminary dimensions. This can easily check all the parameters for safe design. The use of this Visual Basic Program saves time and minimizes human error.*

**Keywords:** visual basic, steel structures, beam, design

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### INTRODUCTION

Steel is the most commonly used material for building structures with strength and ductility more than concrete. Steel is the ideal material for modern construction. Due to its large strength to weight ratio, steel structures tend to be more economical than concrete structures for tall buildings, large span buildings and bridges. Steel structures can be constructed very fast and this enables the structure to be used early thereby leading to overall economy. Steel structures are ductile and robust and can withstand severe loadings such as earthquakes. Steel structures can be easily repaired and retrofitted to carry higher loads.

Steel is also a very ecofriendly material and steel structures can be easily dismantled and sold as scrap. Thus the life cycle cost of steel structures, which includes the cost of construction, maintenance, repair, and dismantling, can be less than that for concrete structures. Since steel is produced in the factory under better quality control, steel structures have higher reliability and safety [2–5].

It is his responsibility to advise both the architect and the contractor about the

possibilities of achieving good structures with economy. Ever since steel began to be used in the construction of structures, it has made possible some of the grandest structures both in the past and also in the present day.

### METHODOLOGY FOR DESIGN THE STRUCTURE

In this work the visual basic software were used for analysis and design the structure. For this program, software like Microsoft Visual Studio, Programming Language; and\_for writing a program, Visual Basic were used.

#### Microsoft Visual Studio

It is an integrated development environment (IDE) from Microsoft. It is used to develop computer program for Microsoft windows super family of operating systems, as well as websites, web applications and web services. Visual Studio uses Microsoft software development platforms such as Windows API, Windows forms, Windows Presentation Foundation, Windows Store and Microsoft Silver light. It can produce both native code and managed code [3].

Microsoft Windows uses a graphical user interface (GUI), pronounced “goeey”. The

Windows GUI defines how the various elements look and function. As a Visual Basic programmer, you have available a toolbox of these elements. You will create new windows, called *forms*. Then you will use the toolbox to add the various elements, called *controls*.

The projects that you will write follow a programming technique called *object-oriented programming (OOP)*.

The following steps involve setting up the user interface, defining the properties, and then creating the code.

### Planning

1. **Design the User Interface:** When you plan the user interface, you draw a sketch of the screens the user will see when running your project. On your sketch, show the forms and all the controls that you plan to use. Indicate the names that you plan to give the form and each of the objects on the form. Refer to Figure 1 for examples of user interfaces. Before you proceed with any more steps, consult with your user and make sure that you both agree on the look and feel of the project.
2. **Plan the Properties:** For each object, write down the properties that you plan to set or change during the design of the form.
3. **Plan the Basic Code:** In this step, you plan the classes and procedures that will execute when your project runs. You will determine which events require action to be taken and then make a step-by-step plan for those actions. Later, when you actually write the Visual Basic **code**, you must follow the language syntax rules. But during the planning stage, you will write out the actions using **pseudo code**, which is an English expression or comment that describes the action. For example, you must plan for the event that occurs when the user clicks on the Exit button. The pseudo code for the event could be *Terminate the project* or *Quit*.

### Programming

After you have completed the planning steps and have got approval from your user, you are ready to begin the actual construction of the

project. Use the same three-step process that you used for planning.

1. **Define the User Interface:** When you define the user interface, you create the forms and controls that you designed in the planning stage. Think of this step as defining the objects you will use in your application.
2. **Set the Properties:** When you set the properties of the objects, you give each object a name and define such attributes as the contents of a label, the size of the text, and the words that appear on top of a button and in the form's title bar. You might think of this step as describing each object.
3. **Write the Basic Code:** You will use basic programming statements (called *Basic code*) to carry out the actions needed by your program. You will be surprised and pleased by how few statements you need to create a powerful Windows program. You can think of this third step as defining the actions of your program.

## DESIGN AND DEVELOPMENT OF SOFTWARE

### Design of Beam

Following points must be considered for the design of beam:

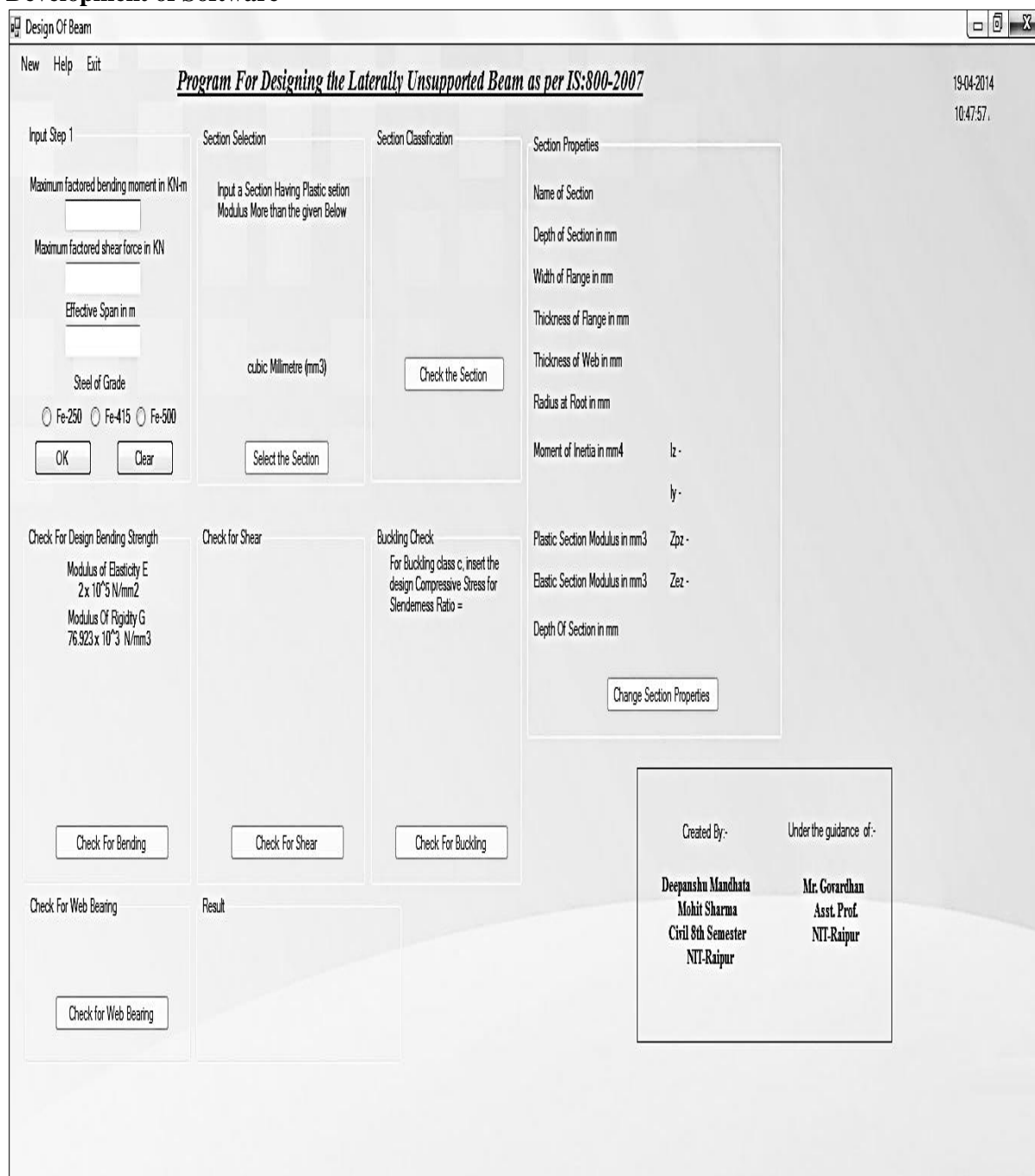
- a) Maximum factored bending moment, maximum shear force, effective span length and steel grade is given.
- b) For the design of column, I-section is considered.
- c) All the section properties of section is known from IS Hand book (steel table).
- d) It is user responsibility to input an economical section by the information of sectional area. It will not give any information regarding economic design.

### Design Strength in Bending (Flexure)

**Laterally Supported Beam:** The design bending strength of beams, adequately supported against lateral torsional buckling (laterally supported beam) is governed by the yield stress.

**Laterally Unsupported Beams:** When a beam is not adequately supported against lateral buckling (laterally unsupported beams), the design bending strength may be governed by lateral torsional buckling strength.

## Development of Software



**Fig.1:** Design of Laterally Unsupported Beam as per IS: 800-2007.

### Objective and Procedure (Figure 1)

- This form is for designing the laterally unsupported beam as per IS: 800-2007.
- All the input values i.e., maximum factored load, maximum factored shear and effective span length can be inserted in labels presented in group box 1.
- Radio button in group box are to select the grade of steel and give command of 'OK' and 'clear'.
- After pressing OK button in group box 1, radio button in group box 2 is to select the required section.
- In group box 3, radio button is used to check the type of section it is.
- In group box 4, 5, 6, and 7 radio buttons are used to check for bending, check for shear, check for web buckling and check for web bearing.

Fig.2: Form Showing Section Properties.

#### Objective and Procedure (Figure 2)

- This form is for inserting the section properties of required section from the Steel Table.
- In the labels name of section, depth of section, width of flange, thickness of flange, thickness of web, radius at root, moment of inertia, plastic section modulus, elastic section modulus are to be inserted in mm.
- After giving input in all the labels, radio buttons are used for giving command of 'OK' and 'clear'.

#### Example of a Beam Problem

a) Manual Method of Designing a Beam

Maximum Shear Force = 200 KN

Maximum Bending Moment = 550 KN-m

Given  $f_y = 250 \text{ MPa}$ ,  $\gamma_{m0} = 1.1$

$$KL = 4 \text{ m} = 4000 \text{ mm}$$

Imperfection factor:  $\alpha_{LT} = 0.21$  (For rolled section)

$$= 0.49 \text{ (For welded section)}$$

Plastic section modulus required

$$Z_{pz, req} = 1.3 \times 550 \times 10^6 \times 1.1 / 250 \\ = 3146 \times 10^3 \text{ mm}^3$$

Let us try ISJB 600 @ 1202.71 N/m

$$d = h - 2(t_f - R_1) = 600 - 2 \times (20.8 + 20) \\ = 518.4 \text{ mm}$$

#### Sectional Classification

$$\epsilon = 1, b = b_f / 2 = 210 / 2 = 105 \text{ mm}$$

$$b / t_f = 105 / 20.8 = 5.04 < 9.4$$

$$d / t_w = 518.4 / 12 = 43.2 < 84$$

Hence section is *Plastic*.

#### Check for Design Bending Strength

$$M_d = \beta_p Z_{pz} f_{bd}$$

$$\beta_p = 1$$

$$Z_{pz} = 3510.63 \times 10^3 \text{ mm}^3$$

$$\alpha_{LT} = 0.21 \text{ (for rolled section)}$$

$$F_{bd} = 170.06 \times 10^{-6} \text{ N/mm}^2 \text{ (from table 13(a), IS 800:2007)}$$

$$M_d = 597 \times 10^6 \text{ N-mm or } 597 \text{ KN-m} < 550 \text{ KN-m}$$

Hence section is OK.

#### Check for shear Capacity

$$V_d = (250 \times 12 \times 200 \times 10^{-3}) / (\sqrt{3} \times 1.1) \\ = 944.75 \text{ KN} > 200 \text{ KN}$$

Hence *safe*.

#### Check for Web Buckling

$$d / t_w = 52.94 < 67 \epsilon$$

Hence check for web buckling is not required.

#### Check for Web Bearing

$$F_w = (b + n_1) t_w f_y / \gamma_{m0}$$

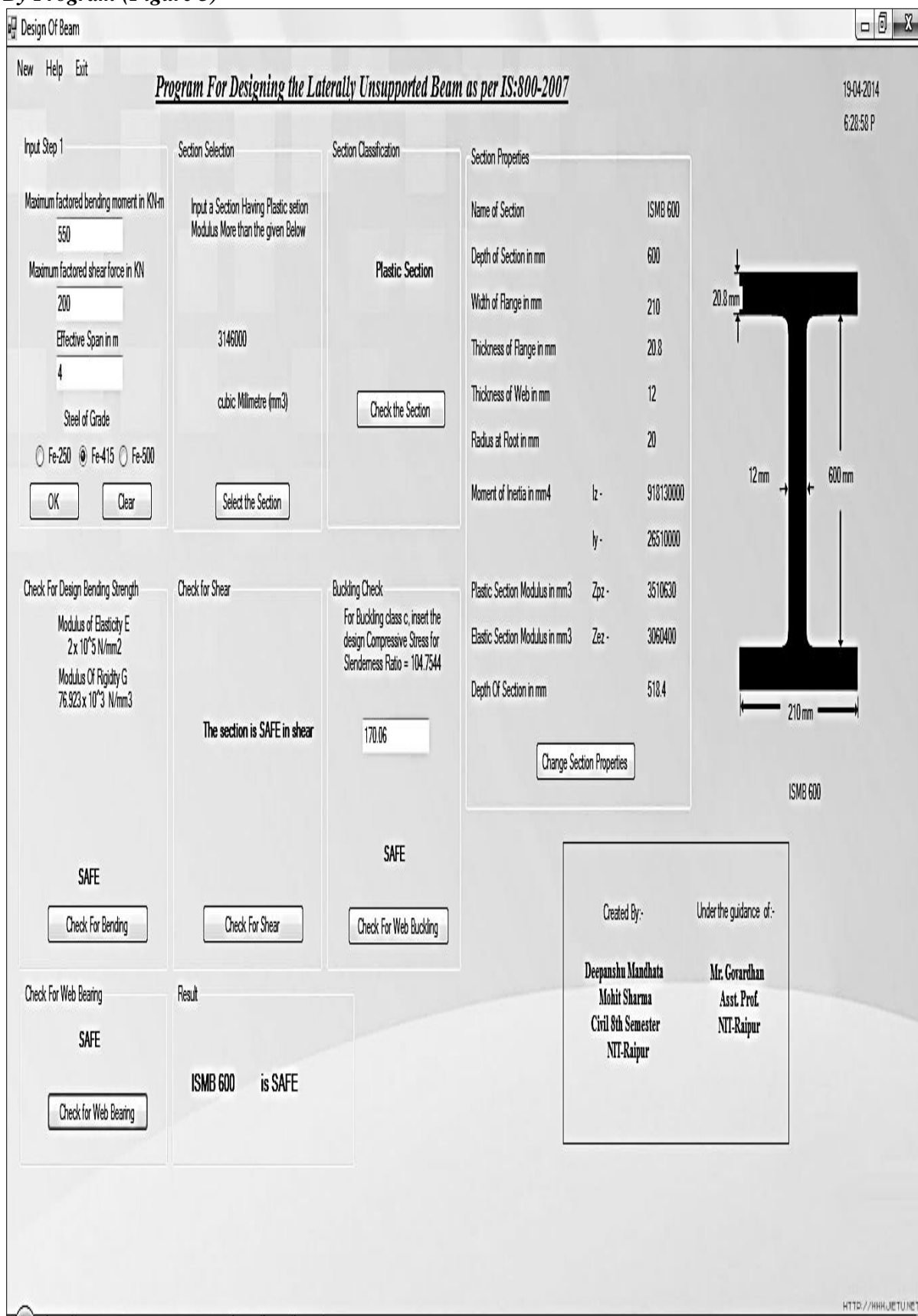
$$b = 100 \text{ mm}$$

$$h_1 = 2.5(t_f + R_1) = 2.5(20.8 + 20) = 102 \text{ mm}$$

$$F_w = (100 + 102) \times 12 \times 250 \times 10^{-3} / 1.1 \\ = 550.90 \text{ KN} > 200 \text{ KN}$$

Hence section is OK.

**By Program (Figure 3)**



**Design Of Beam**

New Help Exit

**Program For Designing the Laterally Unsupported Beam as per IS:800-2007**

19-04-2014  
6:28:58 P

**Input Step 1**

Maximum factored bending moment in KN-m  
550

Maximum factored shear force in KN  
200

Effective Span in m  
4

Steel of Grade  
 Fe-250  Fe-415  Fe-500

OK Clear

**Section Selection**

Input a Section Having Plastic section Modulus More than the given Below

3146000  
cubic Millimetre (mm<sup>3</sup>)

Select the Section

**Section Classification**

Plastic Section

Check the Section

**Section Properties**

Name of Section	ISMB 600
Depth of Section in mm	600
Width of Flange in mm	210
Thickness of Flange in mm	20.8
Thickness of Web in mm	12
Radius at Root in mm	20
Moment of Inertia in mm <sup>4</sup>	lz - 918130000
	ly - 26510000
Plastic Section Modulus in mm <sup>3</sup>	Zpz - 3510630
Elastic Section Modulus in mm <sup>3</sup>	Zez - 3060400
Depth Of Section in mm	518.4

Change Section Properties

**Check For Design Bending Strength**

Modulus of Elasticity E  
2 x 10<sup>5</sup> N/mm<sup>2</sup>

Modulus Of Rigidity G  
76.923 x 10<sup>3</sup> N/mm<sup>2</sup>

SAFE

Check For Bending

**Check For Shear**

The section is SAFE in shear

170.06

SAFE

Check For Shear

**Buckling Check**

For Buckling class c, insert the design Compressive Stress for Slenderness Ratio = 104.7544

SAFE

Check For Web Buckling

**Check For Web Bearing**

SAFE

Check For Web Bearing

**Result**

ISMB 600 is SAFE

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ISMB 600

HTTP://WWW.NETU.NET/

**Fig.3: Example of Laterally Unsupported Beam as per IS: 800-2007 [1].**

## CONCLUSION

The Visual Basic Program software has been designed and developed for the steel beam design in steel structures as per IS 800:2007 [1]. The program was tested for different problems and final result found was same as calculated manually. Time taken to solve these problems is very less compared to manual calculation and without any errors as in manual solving. Repetitive type of problem can be easily solvable by our designed program. Being user friendly program it is very easy to solve a problem by giving input required.

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