Software Development for Analysis and Design of Railway Bridges

Abhijeet Soni, Mrs jyoti Yadav[2]

[1]PG Scholar, CED, SRK University Bhopal, M.P., India
[2]Professor, CED, SRK University Bhopal, M.P., India

Abstract- Bridges on the Indian railway are basic infrastructure for the operation of trains. There are more than 1, 20,000 bridges on the Indian railway, and day by day the new bridges are being constructed for extension of railway network/gauge conversion. The strengthening of existing bridges is also required due to old age or change of loading standard. Quick and accurate design of railway bridges is a primary requirement for scheduled completion of railway projects. Analysis and design of PSC Girder, Deck slab, Pier, Abutment, return wall, and Foundation for a railway bridge is an iterative process depending on loading standard and site conditions. Generally, the calculations involved in the analysis and design are very tedious and time-consuming. In the present project work, an attempt is made to develop software, which can help the designer to arrive at a rational, economical, and sound solution. The software is developed using visual basic for linear static analysis of bridge components. The scope of present work includes the development of software for analysis and design of PSC girder, ballasted deck slab, Pier, Abutment, Return wall and pile foundation of railway bridges.

***Keywords*: PSC Girder, Deck slab, Pier, Abutment, return wall**

I. INTRODUCTION

The railway is an economical and effective means of transportation of passenger and goods in India. The Indian railway is basically laid with three different gauges i.e., Broad Gauge (1676 mm), Meter Gauge (1000 mm) and Narrow Gauge (762 mm). At present about 80% of total length of railway line is laid with B.G. and existing M.G. and N.G. lines are being converted into B.G. to achieve uniform gauge all over India. Therefore, this project is based on analysis and design of bridges on B.G. railway line. Railway Bridge is constructed for passage of a railway line over an obstacle such as a river, road, valley, depression. The span of railway bridges varies from 0.30 m to 120 m.

In response to fix an appropriate inspection schedule of various bridges on Indian railway, the railway bridges are classified in following three classes.

- **Important bridge**: - The bridge, having linear waterway of 300 m or a total waterway of 1000 m2 or more, is classified as important bridge.
- **Major bridge: -** The bridge, having either a linear waterway of 18 m or more or which have a clear opening of 12 m or more in any one span, is classified as major bridge.
- **Minor bridge: -** The bridge, not covered under the definition of important or major bridge, is classified as minor bridge.

Based on superstructure, the railway bridges are further classified into following class.

1. Steel truss bridge

2. Steel plate girder bridge

3. PSC girder bridge

4. RCC / PSC slab bridge

5. RCC box bridge

6. Arch bridge

Superstructure

Superstructure is the part of bridge to support the railway line and it transfers the load from railway track to substructure through bearings. The superstructure consists following components.

1. 1.Deck Slab
2. 2.Girder
3. 3.Diaphragm

Substructure

Substructure is the part of bridge to support the superstructure and it transfers the load from bearings to foundation. The substructure consists following components.

1. Bearings
2. Pier cap and Pier
3. Abutment
4. Return wall

Foundation

Foundation is the part of bridge. It transfers the load from substructure to soil.

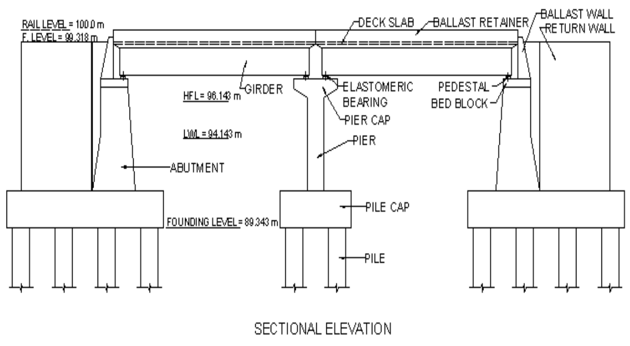


Figure 1 Component of bridge

II. OBJECTIVES OF THE WORK

The software for analysis and design of various components a railway bridge is developed to achieve following objectives.

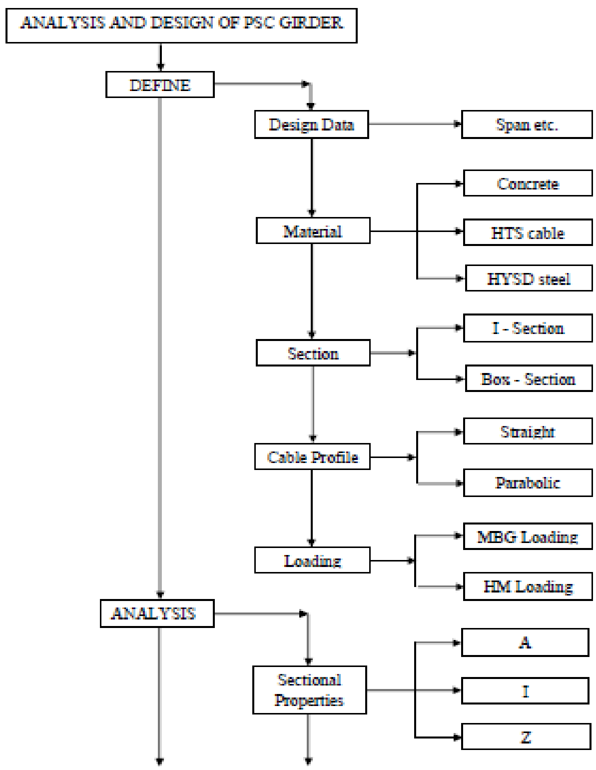
- To obtain the design of railway bridge components as per provisions of IRC codes.
- To eliminate the requirement for reference of various codes, during analysis and design process, as all codal provisions are available with data base.
- To achieve most economical and safe design by trial of various sections of different components of bridge like girder, pier, abutment etc. and interpretation of results.
- To obtain final design report as per requirement of designer.
- To assess the strength of existing railway bridge.
- To assess the requirement of strengthening works, arise due to change of loading standard or any other reason, in existing railway bridges

III. Software Development

In recent years Visual Basic has become one of the world's most popular event driven programming language. An event driven language is one that responds to events – clicking a button, selecting an item from a list, tabbing out of a control and so on. Various software, based on Visual Basic language, are being used in banking and financial sector successfully. Visual Basic language has lot of potential that can be explored for development of software in the field of analysis and design of Civil engineering structures.

IV. Methodology

The software for analysis and design of bridge components is developed in two parts to make it more versatile. In Part – I the software is developed for analysis and design of PSC girder and RCC deck slab. In Part – II the software is developed for analysis and design of RCC pier, PCC abutment, PCC return wall and pile foundation. The software development process is explained with the help of flow chart. The software is based on concept that, we must define the section, material of component of bridge and apply the load which will have most adverse effect on the component in its service life. Calculations for stresses, deflection and reinforcement will be performed by the software. These stresses and deflection should be within permissible limit as per provisions of relevant IRS code and IS code. In case the calculated values of stresses and deflection are not within permissible limits then section to be revised and analysis process to be repeated. This exercise is to be done till safe section of bridge component is achieved. Step by step instructions will be displayed by the system during operation of software. Basically, we must enter data in the text boxes having white background and output will be displayed in the text boxes having yellow background.



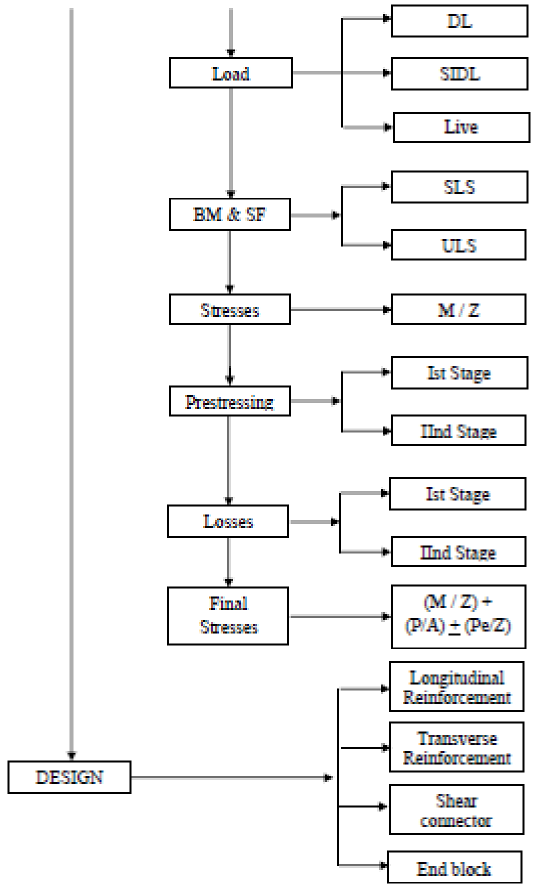


Fig: 2 Flow charts for analysis and design of PSC girder

V. RESULTS

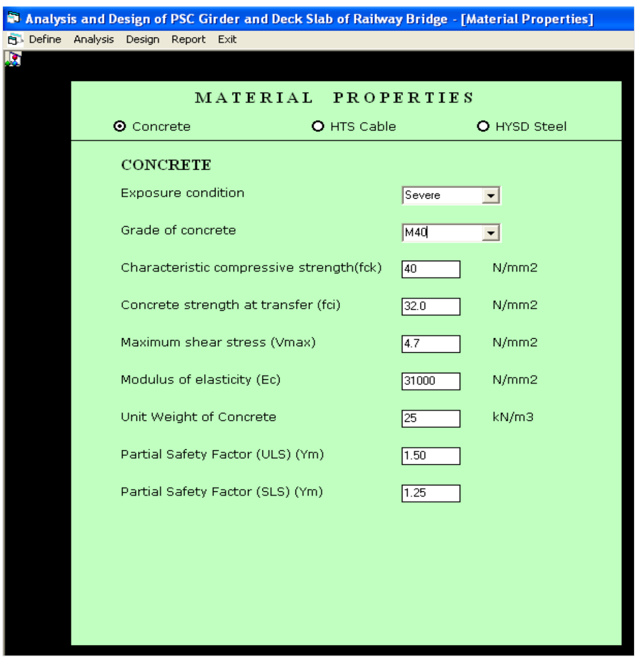


Fig.3 Define design data for PSC girder

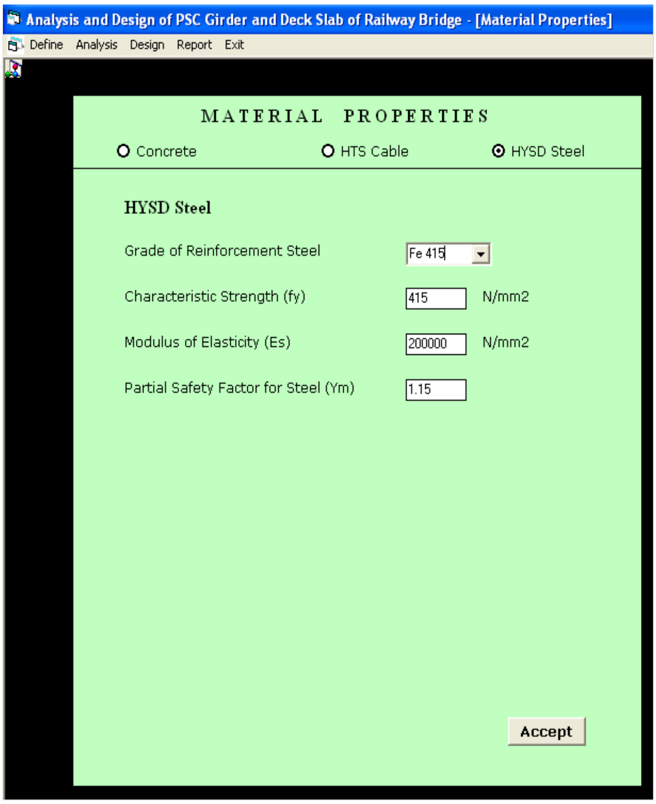


Fig 4: Define material properties for girder

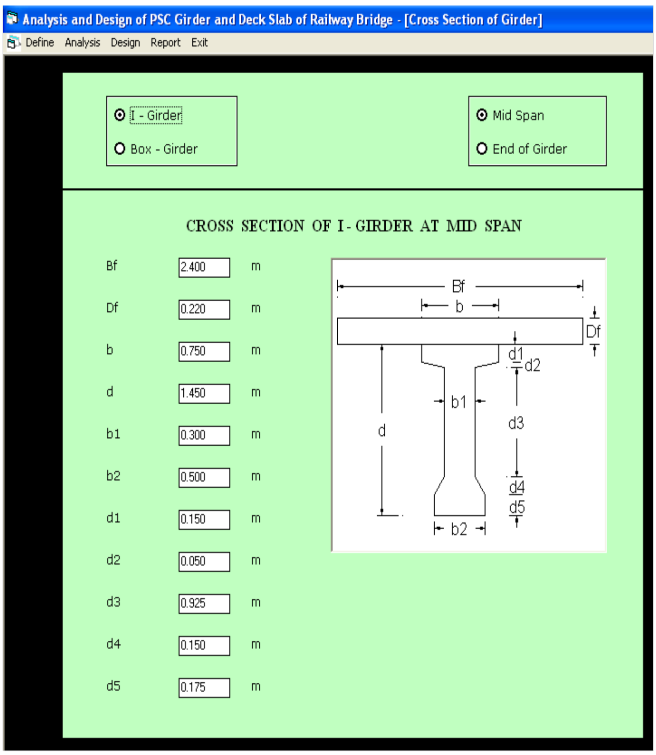


Fig 5: Define section of I – Girder at mid span

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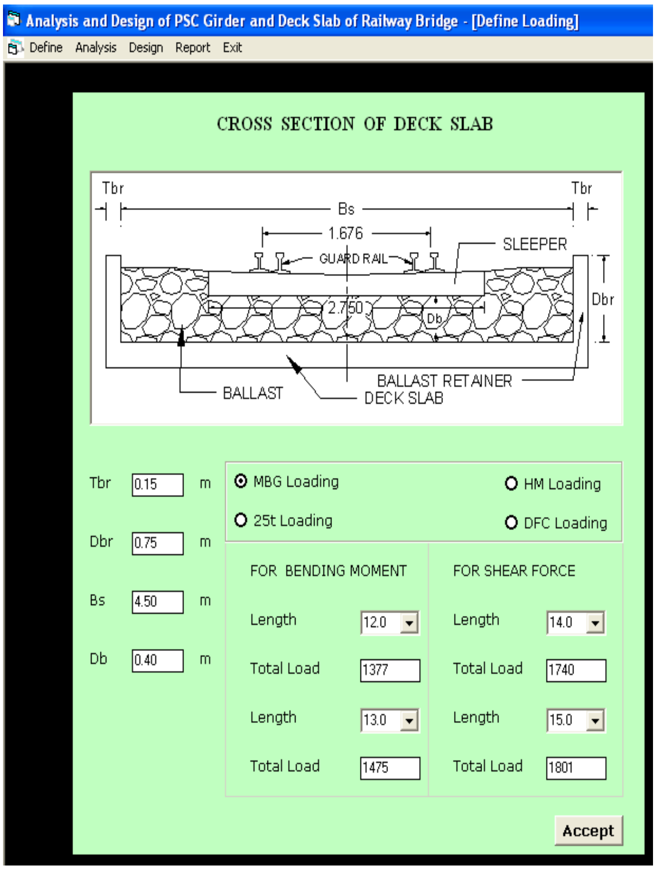

Fig.6 Deck slab Calculation

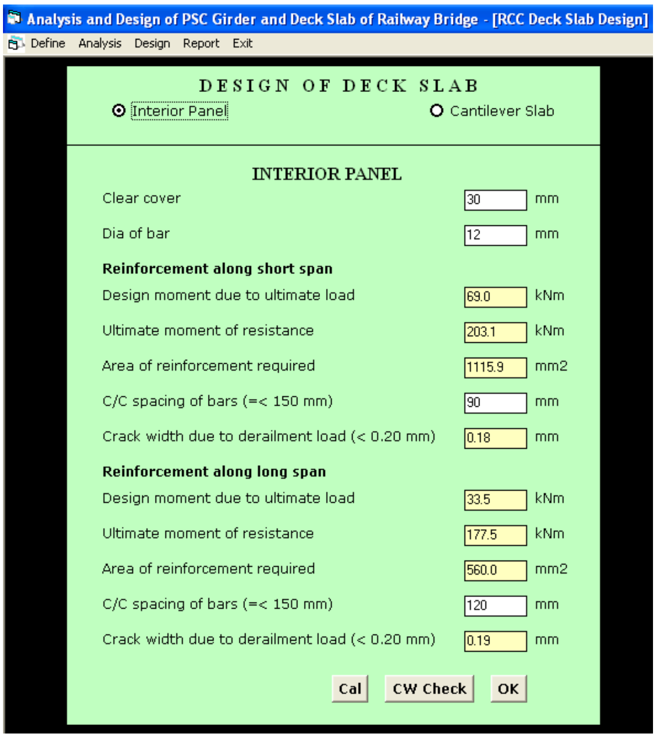

Fig.7 Deck Slab Design

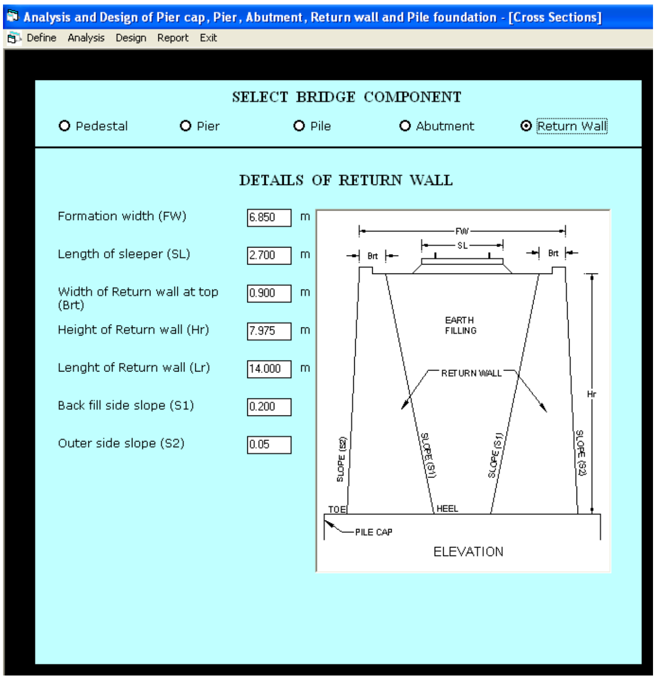

Fig.8 Deck Slab Design

VI. CONCLUSIONS

The accuracy of software is primary requirement of any software development work. To validate the results of software, the analysis and design of 2 X 12.2 m span PSC girder railway bridge is done by hand calculations and results are presented in annexure - A. The analysis and design results for various components of this bridge are also obtained by the software. The results of software are in conformity with results obtained by hand calculations. So, it can be concluded that the accuracy of software is beyond doubt. It is possible to design another bridge with different span, loading standard and design data, without rigorous hand calculations, with the help of software. The detailed design report can be obtained from software and can be used without further formatting. It means the software is useful in saving time and effort during accurate analysis and design of railway bridges.

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