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Study of Toll Plaza on Thane Creek Bridge – Design of Columns and Purlins

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Abstract

Toll Plaza containing various toll booths is generally constructed for collection of toll fees on highways. At the toll plaza, each vehicle has to slow down and often wait before paying the toll at tool booth.The toll plaza is being constructed on Thane Creek Bridge-IIIon Sion Panvel Road that provides six more lanes to the existing Thane Creek Bridge-II. Thane Creek Bridge-III once ready, will ensure smooth traffic movement and hassle-free connectivity between the twin cities – Mumbai and Navi Mumbai. It comprises of 2 separate three-laned bridges.The design and construction of this toll plaza is being carried out by L&T Infrastructure. We are designing columns and purlins for this toll plaza under their guidance.The design will be carried out in conjunction with various indian standard codes like IS 800:2007 and IS 875:1983 (Part-1/ Part-2/ Part-3). The Modelling is done inStaad Pro for all structural steel members.The design of all steel structural elements are done in Staad Pro. The main goal of this project is to understand the structure of toll plaza and ensure safety to public at toll plaza.

Keywords: hassle-free connectivity

1. Introduction

The toll plaza is being constructed for Thane Creek Bridge-III on Sion-Panvel Highway. The toll plaza mainly consists of two structures i.e. Admin Building and Walkway. The toll plaza has a separate provision for light and heavy vehicles.The toll plaza consists of ten toll lanes. The five toll lanes are provided for light vehicles. The remaining five toll lanes are provided for heavy vehicles. The different lanes are separated by the toll booths. The footpaths are provided on both sides of the toll lanes. The entire toll plaza is composite structure. This toll plaza is designed as per guidelines provided in Indian Standard codes.The walkway consists of the foot-over bridge for movement of working staff. The walkway consists of total nine steel columns. The height of the columns is 6500mm from floor level. In walkway, three spiral staircases are provided for vertical communication. The walkway consists of

curved roof canopy. The canopy provides protection to the walkway from the rain, sun and wind. The curved roof canopy of the walkway is made up of the longitudinal and transverse steel sections. The steel sections are used for purlins and principal rafters. We are designing columns and purlins of walkway structure with the help of Indian Standard codes.The Admin Building is provided at north side structure of the toll plaza. The admin building is a structure used primarily for day-to-day activities that are related to administrative tasks such as record keeping, billing. The admin building generally consists of several units for staff working at toll plaza. The admin building is composite structure made up of steel and concrete. It consists of twelve circular columns having 600mm diameter made up of steel hollow sections. The height of the columns provided for Admin Building is 6150mm. We are designing columns and purlins for admin building with the help of Indian Standard codes. The provision of straight staircase is made to provide an access to the admin building.

2. Literature Review

1) **Dr Ranadheer Donthi St.Martin's Engineering College**

He studied that now a day's toll gates are very common on each and every national highway and users of these toll gates are paying the toll tax to the government or infrastructure companies. In the recent years the automobile technology has been developed lot, due to this reason the usage personal vehicles has been increased even though the public transportation system is available and traffic also has been increased on the roads in the recent years. Because of the increased traffic many roads are expanded according to the requirements and toll gates also are increased due to lack of sufficient time and funds with the government. These toll gates are occupying lot of agriculture land throughout the country. Many research articles focused on to reduced the traffic and electronic payment methods at toll gates, but this research article focused on the importance of the agriculture land and to minimize the construction area of tollgates and new model has been introduced to reduce the construction area of the toll plazas.

2) **Vaibhav B. Chavan, Vikas N. Nimbalkar, Abhishek P. Jaiswal**

Their work aims to evaluate the economic significance of the Hollow Structural Sections (HSS) in contrast with open sections. This study was carried out to determine the percentage economy achieved using Hollow Structural Sections (HSS) so as to understand the importance of cost effectiveness. The technique used in order to achieve the objective included the comparison of different profiles for various combinations of height and material cross-section for given span and loading conditions. The analysis and design phase of the project was performed using STAAD PRO V8i. The sample results of STAAD analysis were validated with the results of Manual analysis.

3) **Wardenier**

He has contributed to a great extent in the analysis of hollow sections. This can be reflected in his work on HOLLOW SECTIONS IN STRUCTURAL APPLICATIONS, which is a book made available for free. This study is related to the load carrying capacity of all
structural members, economy and their safety measures respectively. Prime purpose of this study is comparison of closed hollow steel section with conventional steel section of

given above requirements. This study proves that tubular sections are economical by saving of 40% to 50% in total cost is achieved..

3. Objectives

- To understand the general arrangement of Toll Plaza for Thane Creek Bridge (TCB III).
- To design a column for Admin Building and Walkway of Toll Plaza.
- To design a purlin for Admin Building and Walkway of Toll Plaza.
- Tomake the most cost-effective design of column and purlin for Toll Plaza.

4. Toll Plaza Structure

- **Admin Building**
- **Walkway**

Components of Admin Building and Walkway

Accounts section	Meeting room
Audit cum record room	Open office
Cash vault	Pantry
Changing / rest room	Toll manager room
Electrical room	Toll surveillance / server room
FAST TAG insurance room	UPS room
Gents toilet and ladies toilet	Staircase
Lobby	Handrail

Steps for Design of Column

- Design forces
- Member properties
- Check for slenderness ratio
- Section classification
- Compressive stress check
- Shear strength
- Design strength in bending
- Check for combined axial and bending
- Check for lateral deflection

Steps for Design of Column

- Properties of section
- Load calculation
- Section classification
- Check for bending strength
- Check for deflection
- Check for shear
- Check for web bearing at support

- Check for web buckling at support

5. Results and discussions

COMPARISON BETWEEN RESULTS OF COLUMN

Table 2: Comparison between results of column

Criteria	Manual	Software
Compression	5.482E+03KN	5.639E+03KN
Shear	2.199E+03KN	2.199E+03KN
Bending	832KNM	867.872KNM

Table 3: Comparison between results of purlin

Criteria	Manual	Software
Compression	180.73KN	186.678KN
Shear	89.44KN	142.540KN
Bending	40.09KNM	29.594KNM

6. Conclusion

1. About 20% of steel is saved in the structure analyzed and designed using hollow steel sections.
2. The hollow sections are more effective in buckling resistance as compared to other open sections.
3. By using hollow steel sections, 40% to 50% of total cost is saved. Thus, economy is achieved.
4. STAAD Pro gives conservative design results which is proved in this study by comparing the results of STAAD Pro and Manual calculations.
5. STAAD Pro is the perfect software which can be adopted for analysis of steel structure.

7. Acknowledgement

The author wish to thank to our sponsor.

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