Comparative Study of RCC Girder and Prestressed Girder for Roadway Bridge

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Abstract - **This project presents the comparative study of RCC girder and prestressed girder of roadway bridge for the span of 30 m. The analysis and design of girder for 30 m span subjected to IRC Class AA Tracked Vehicle loading as per IRC 6. The distribution of live load among the longitudinal girders determined using the Courbon's Method as it is mostly adopted because of its simplicity. For designing both RCC and prestressed girder a manual design procedure is adopted. This study includes the design and estimation of quantities required for RCC girder and prestressed girder. The emphasis was on the longitudinal girder. The quantities of concrete and steel required according to the design carried out for longitudinal girder of both the structure and comparing the same. The goal of the study is to determine most advantageous option from above two.**

keywords - **RCC girder, Prestressed girder, T beam, Comparative Study**

I. INTRODUCTION

General

Bridges are a vital link of communication. It is a structure constructed over an obstacle for the purpose of providing passage above the obstacle. The obstacles may be canals, rivers, valleys, roadways and railways. In the past the bridges were mostly built in stone masonry or Timber but now a day's bridges are made in reinforced concrete, prestressed concrete, structural steel, etc. The short span bridges are generally constructed in RCC whereas the long span bridges are built in prestressed concrete. The bridge construction and design should be given high importance. Bridges are supposed to live at least 50 years with usual maintenance. If not designed or executed properly, the maintenance cost will be more than the construction cost. In order to make the bridge durable and safe the engineer must follow the respected code and standards within the area while designing the bridge. The present study considers the design of girders both RCC and prestressed. First it will start with design of reinforced concrete girder and then the emphasis will be on prestressed concrete girder.

RCC Girder

Reinforced concrete is well suited for the construction of Highway bridges in this small and medium span range. RCC girder bridge is the most commonly adopted type in the span range of 10 to 25 m. For the larger spans the dead weight becomes too heavy. Because of simple geometry, easy erection and casting T beams are very popular and commonly adopted. The T beam deck made up of continuous slab cast monolithically with longitudinal girder and cross girder which are spaced at regular intervals. RCC slab form a road deck to carry the traffic. The arrangement of the girders depends upon the carriage width of roadway. The Teesta Coronation Bridge built in 1941 across Teesta river in West Bengal is an excellent example of reinforced concrete open spandrel bridge with a main span of 18.71 m and a central rise of 39.6 m. The R.C.C. Bridge across Godavari river at Sironcha Dist, Gadchiroli is the notable example this type of bridge.

Prestressed Girder

Prestressed concrete provides great technical advantages in comparison with other types of construction such as steel and reinforced concrete. The PSC T beam structure are widely adopted over RCC T beam structure due to their structural efficiency, better stability, serviceability and economy. The design of PSC structure is more complicated due to the complex structure instead RCC T beam geometry is simple and are not advanced in construction. In prestressed concrete members high strength concrete and steel are used which makes the structure lighter than is possible with reinforced concrete member. Prestressed concrete is found to be economical for the bridges of span up to 30 m and for cast in- situ work it is economical up to the span of 100 m. For long span bridges the prestressed concrete is more economical than the reinforced concrete. Lubha bridge in Assam and Ganga bridge at Patna considered as the longest bridge extending over 5575 m.

II. AIM AND OBJECTIVE

- Manual analysis and design of RCC T beam bridge girder and prestressed Concrete T beam bridge girder for a span length of 30 m.
- Calculate dead load bending moments and shear forces for both RCC girder and prestressed concrete girder
- Calculate live load bending moments and shear forces for or both RCC girder and prestressed concrete girder
- To design the sections as per the formulas in respective structures
- To calculate quantity of steel and concrete required for main girder of both the structure.
- To check the most economical structure among both.

III. METHODOLOGY

To begin with, a RCC girder and prestressed girder was manually designed by using the limit state method. The manual analysis and design is carried out by referring the book Design of Bridges by N. Krishna Raju. Based on the designed the reinforcement details was made which are shown in following figure.

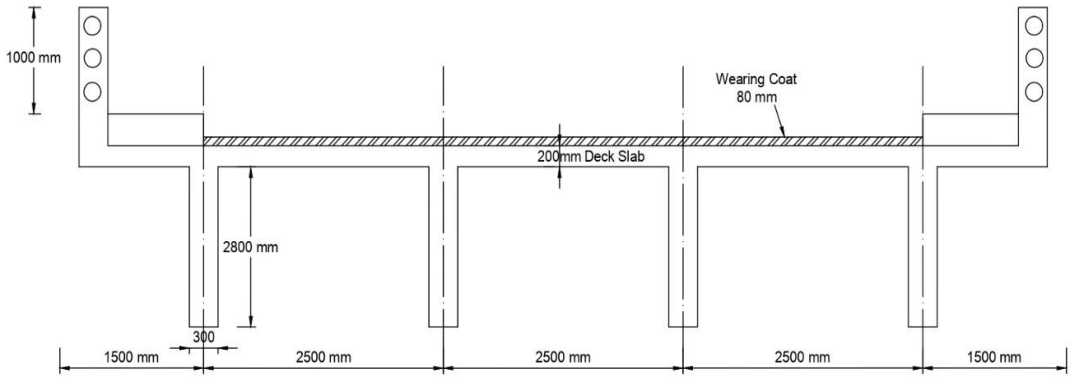

Fig.1 Cross Section of RCC Bridge Deck

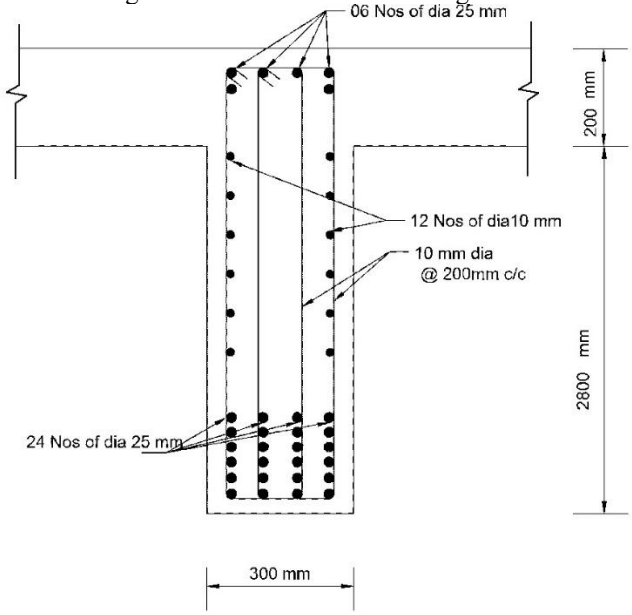

Fig.2 Reinforcement Details of RCC Girder

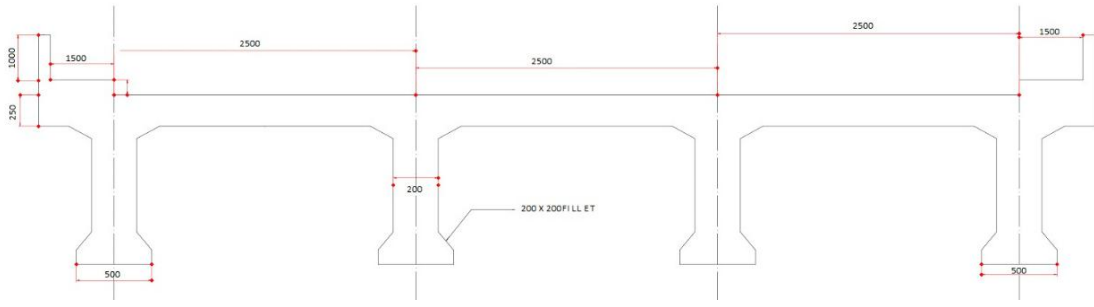

Fig.3 Cross Section of Prestressed Bridge Deck

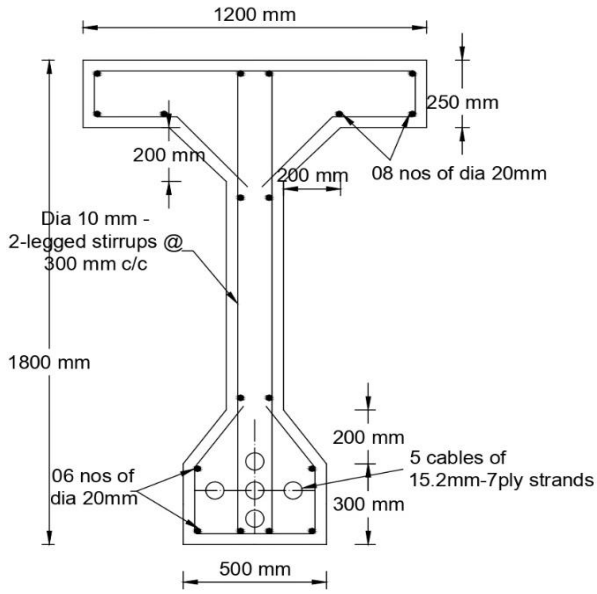

Fig.4 Reinforcement Details of Prestressed Girder at Center of Span Section

IV. RESULT

The longitudinal girder of span 30 m analyzed for RCC structure under class AA loading by limit state method and same is analyzed for prestressed structure. Quantity of steel and concrete required per girder is also determined and presented.
Following table gives the results obtained from manual calculations for RCC girder and prestressed girder with respect to 30 m span.
Table 1 gives the difference in quantity of steel required for one RCC girder and one Prestressed girder for 30 m span.
Table 2 gives the difference in the quantity of concrete required for one RCC girder and one prestressed girder for 30 m span.

Table 1 Comparison of quantity of steel in girder for RCC and Prestressed bridge for 30 m span

Span (m)	RCC girder Quantity (kg)	Prestressed girder Quantity (kg)	% Saving of Material
30	5215.21	1948.38	167.67

Table 2 Comparison of quantity of concrete in girder for RCC and Prestressed bridge for 30 m span

Span (m)	RCC girder Quantity (m^3)	Prestressed girder Quantity (m^3)	% Saving of Material
30	31.81	21.71	46.52

From all the design analysis it is seen that Prestressed girder requires lesser dimensions with respect to RCC girder of same loading conditions.

V. CONCLUSION

The main focus was manual analysis and design of RCC girder and prestressed girder subjected to IRC class AA (tracked vehicle) loads as per IRC 6 and compare the results. Here I considered span 30 m for both the structures. As per the analysis it is observed that bending moment and shear forces are more in RCC girder than in prestressed girder. The prestressed sections are thinner and lighter than the RCC sections as a result of high strength concrete and high strength steel are utilized in prestressed sections. Based on the study conducted, it could be concluded that more quantity of steel and concrete is needed for RCC girder as compared to prestressed girder. Clearly, Prestressed girders are economical than RCC girders for higher spans. In case of the design of prestressed girders, for 30 m span the quantity of concrete can be saved up to 46.52% which of steel up to 167.67%.

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