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ANALYSIS AND DESIGN OF COMPOSITE STEEL BRIDGE GIRDER

M.Geethanjali[1], A.Priya Dharshini[2]

[1]PG Scholar, Structural Engineering, Oxford Engineering College, Trichy, Tamil Nadu, India.
[2] Assistant Professor, Department of Civil Engineering, Oxford Engineering, College, Trichy, Tamilnadu, India

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Abstract – *Steel- Concrete composite structures have been used in bridge engineering from decades. This is due to rational utilization of the strength properties of two materials. The most commonly found in practice are composite girder bridges, particularly in highway bridges of small and medium spans in larger spans steel truss girders are applied. Bridge Composite structures are also employed in cable-stayed bridge decks the main girder spans. The aim of the article is to present the construction process and strength analysis problems concerning of this type of structures. Attention is paid to the design and calculation of the shear connectors characteristic for the discussed objects.*

Key Words: *Cable Stayed bridge, decks, Strength, Analysis.*

1. INTRODUCTION

A composite material is basically a combination of two or more materials, each of which retains it own distinctive properties. Multiphase metals are composite materials on a micro scale, but generally the term composite is applied to materials that are created by mechanically bonding two or more different materials together. Composite is applied to materials that are created by mechanically bonding two or more different materials together. The resulting material has charecteristics that are not characteristic component of isolation. Composites offer many benefits the key among them are corrosion resistance, design flexibility, durability, light weight and strength.

1.1 COMPOSITE STRUCTURES : Composite means that the steel structures of a bridge is fixed to the concrete structure of the deck so that the steel and concrete act together, so reducing deflections and increasing strength. This is done using 'shear connectors' is fixed to the steel beams and then embedded in the concrete. Shear connectors can be welded on, perhaps using a 'stud welder', or better still on export work, by finding nuts and bolts.

1.2 OBJECTIVES OF THE PROJECT:

To achieve the objectives of the current design, steel concrete composite bridges (SCCB) can be a good alternative due the recyclability of steel parts of the structure, have been used extensively since the 20th century when composite structure theories were developed more generally.

2. ANALYSIS OF THE STRUCTURE

The composite bridges are of either multi-girder or ladder form. Determining the principal effects of the various loading combinations can often be archived with a 2-dimensional analytical model but not for a more comprehensive analysis a 3-dimensional model analysis model is needed. This article reviews the appropriate analysis and modeling techniques. There are three modeling options for a typical multi-girder steel composite bridge. There are Line beam, Grillage, Full Finite element model.

ANALYSIS OF LOADS :

There are two types of loads for which are considered in the analysis. Dead load, Live Load. Dead Load : It is constant load in a structure that is due to the weight of the members, the supported structure and permanent attachments. Live Load : Live loads are calculated by using the codes for design of various type of loads.

3. DESIGN OF COMPOSITE STRUCTURE :

3.1 Data :

Effective Span = 30m

Spacing of girders = 3m

Web Section = 2100 x 12mm

Top Flange = 450 X 25mm

Bottom Flange = 600 x 40mm

Slab = 4000x 200mm deep

Fillet on top of top flange = 750mm

Self weight of girder= 9.6 KN

Total DL + SDL per girder = 1109 KN

Wind load on girder = 4.63KN(as per IS 10262)

Wind on Vehicle = 5.15 KN

Table 3.1: Section 1 Non-composite

Component Area Y_i A.Yi m^3 Yi-Y_{sb} I_g AY1^2 I_{xx}= I_g +A

(Yi-Y_{sb})^2

Top Flange 11250 2152.5 24215625 1289.6 585938 187.10 1.87x

X10^8 10^{10}

Web 25200 1090 27468000 227.1 9.26 105.10 1.06x

x 10^8 10^{10}

Bottom 24000 20 480000 -842.9 320000 171.10 1.71x

flange x 10^8 10^{10}

Total 60450 862.9 52163625 9.26x 463.10 4.63 x

10^9 x 10^8 10^{10}

Z_1 on top of steel girder = 4.63 x 10^{10}/(1289.6 + 125) = 35578131 m^3

Z_b at bottom flange of girder = 4.63 x 10^{10}/863 = 53684477 m^3

Table 3.2 :

Section 2 : Composite Short term

With m=8

Component Area Y_i A.Yi m^3 Yi-Y_{sb} I_g AY1^2 I_{xx}= I_g +A

(Yi-Y_{sb})^2

Top Flange 11250 2152.5 24215625 620.9 585938 4.34 4.34x

X10^9 10^9

Web 25200 1090 27468000 -441.6 9.26 105.10 1.06x

x10^9 x 10^9 10^{10}

Bottom 24000 20 480000 -1511.6 320000 5.48 5.48x

flange x 10^{10} 10^{10}

Top slab 50000 2340 1.17E+8 808.4 1.67x 3.27x 3.28

= 2000x 10^8 10^{10} x 10^{10}

200/8

Total 60450 862.9 52163625 9.43x 9.68 1.06 x

10^9 x 10^{10} 10^{11}

Z_b = 1.06 x 10^{11}/(620.9 + 12.5) = 1.68 X 10^8

Z_t = 1.06 x 10^{11}/1531.6 = 0.70 X 10^8

Z_{tc} in slab = 1.06 x 10^{11}/(808.4 + 100) = 1.17 X 10^8

Table 3.3 ;

Condition 3 for long term

With increased modular ratio of 16

Component Area Y_i A.Yi m^3 Yi-Y_{sb} I_g AY1^2 I_{xx}= I_g +A

(Yi-Y_{sb})^2

Top Flange 11250 2152.5 24215625 1289.6 585938 8.27 82.70x

x10^9 10^8

Web 25200 1090 27468000 227.1 9.26 1.03 103x

x10^9 x 10^{10} 10^8

Bottom 24000 20 480000 -1511.6 320000 3.9 390x

flange x 10^{10} 10^8

Top slab 50000 2340 1.17E+8 808.4 0.88x 2.74x 274

= 2000x 10^8 10^{10} x 10^{10}

200/8

Total 60450 862.9 52163625 - 9.35x 7.56 850x

10^9 x 10^{10} 10^8

Z_b = 0.85 x 10^{11}/(857.4 + 12.5) = 97.70 X 10^6

Z_t = 0.85 x 10^{11}/1295.1 = 65.63 X 10^6

Z_{tc} in slab = 0.85 x 10^{11}/(1044.9 + 100) = 77.24 X 10^6

Hence the design is safe when compared with non –Composite section than Composite Section.

4. CONCLUSIONS

Composite Steel- Concrete decks are particularly well designed to work in mid-span regions. The top concrete slab withstands the compressive forces While the bottom steel structure copes with the tensile forces generated by the positive bending moments. However these composite decks are less efficient for the negative bending moments over the intermediate support cross sections. On one hand, the slab of concrete tends to crack under the tensile forces, and significant quantities of reinforcing are needed to control this effect. On the other hand the steel structure below needs stiffeners to ensure its high resistance to compression, without local or global instability. Decks with double composite action are a recent development in this structural solution in which the second slab of concrete is added to bottom flange of steel structure.

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