Analysis and Design of Skew Steel Bridge.

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Abstract: The skew bridge is one whose longitudinal axis makes an angle less than or equal to 90^0.The skewness may be the way to avoid certain obstacles and thus create the most economically viable options. This is due to space constraints in congested urban areas. Skew bridges are common at highway inter change, railway crossing and other extreme grade changes where skew geometry due to space limitations. One of the biggest advantages of steel is weight savings which means lower erection cost, since bridge pieces can be handled with lighter equipment. Some other advantages of steel are faster erection, lighter foundation, structural efficiency, longer spans, lighter weight, and faster construction. The analysis and design of steel bridge with skew angle 30^0 involves the planning, load calculations, analyzing, design of steel truss, deck slab, pier and design of foundation. Analysis design has done for various load combinations etc. as per the Indian Standard Code of Practice.

Keywords- Skew steel bridge, IRC loading, Deck slab, Pier.

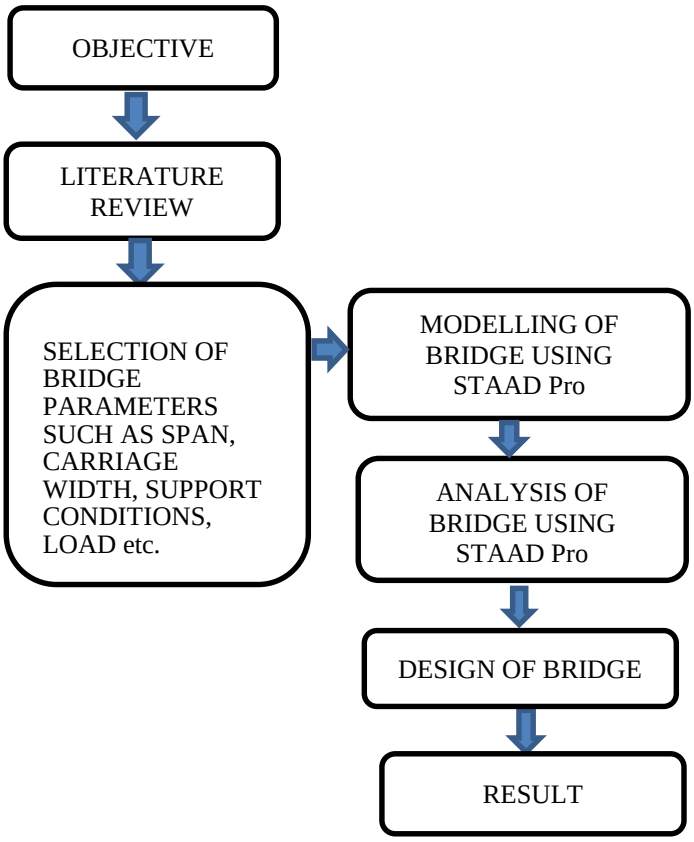
I. INTRODUCTION

A **bridge** is a structure built to span physical obstacles without closing the way underneath such as a body of water, valley, or road, for the purpose of providing passage over the obstacle, usually something that can be detrimental to cross otherwise. There are many different designs that each serve a particular purpose and apply to different situations. Designs of bridges vary depending on the function of the bridge, the nature of the terrain where the bridge is constructed and anchored, the material used to make it, and the funds available to built it.

A. SKEW STEEL BRIDGE:

In this study, an attempt is made to implement the advantages of steel bridge in skew angle less than or equal to 90^0 for topographical needs such as crossing of rivers, streams, railway tracks, etc., by using IRC CLASS AA loading.

II. METHEDOLOGY



III. ANALYSIS OF STEEL SKEW BRIDGE

A. SELECTION OF BRIDGE PARAMETERS:

1. Span = 60m
2. Two Lane width of 3.75m
3. Foot path = 1m on either side
4. Height of panel = 5m
5. No of bays along length = 12
6. No of bays along width = 2
7. Grade of concrete = M25
8. Grade of steel = Fe 415
9. Loading: IRC class AA tracked vehicle.

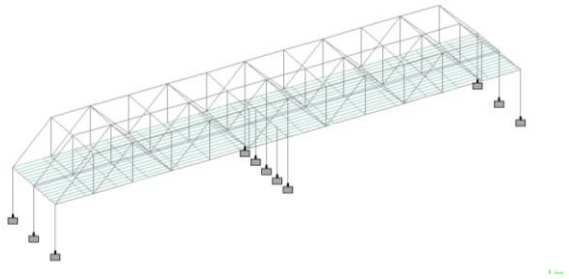


Fig 1: Model of bridge.

IV. ANALYSIS OF BRIDGE:

The analysis of the structure with all the conditions that are given were performed by using the run analysis command. The analysis run made by selecting all the necessary parameters that the software must consider while running the analysis of the structure.

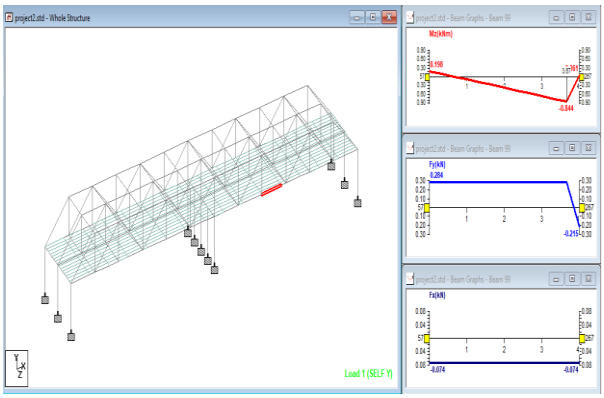


Fig 2: Shear force and bending moment diagram for beam.

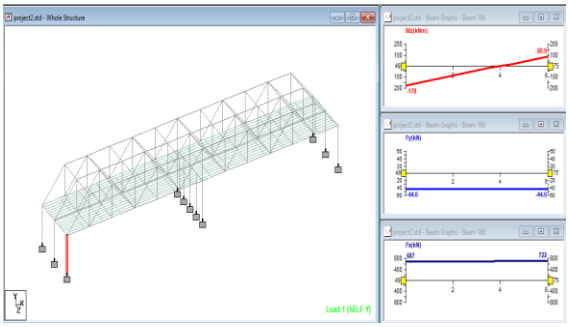


Fig 3: Shear force & bending moment diagram for column.

V. DESIGN OF STEEL SKEW BRIDGE

A. Design of cantilever slab portion:

Dead load Bending Moment = 7.582 kNm.
C.G of wheel from edge of cantilever = 200mm.
Load effective length = 730mm.
Actual load effective portion = 39.25 kN.
Effective breadth (b_{ef}) = 0.848m.
Impact factor = 0.625.
Live load bending moment = 25.34 kNm.
Design Bending moment = 33.2 kNm.
Effective depth = $\sqrt{}$ (M/QB) = 180mm.
'd' Provided = 210mm . Hence ok.
A_{st}= 1051.09 mm^2
Spacing = 105mm c/c.
Provide 12mm φ at 100mm c/c spacing as main reinforcement.

Distribution reinforcement:

0.3 M_L+ 0.2 M_D = 11.482 kNm.
A_{st}= 355.05 mm^2
Spacing =315mm c/c.
Provide 8mm φ at 315 mm c/c as distribution reinforcement.

Design of interior panel:

Internal panel dimensions are 4.75X5m.
Dead load Shear force = 9.126kN.
Dead load Bending Moment for
i) longer span= 0.035 kNm
ii) Shorter span= 0.042 kNm
Live load Shear force = 44.0 kNm
Live load Bending moment for
i) longer span= 78 kNm
ii) Shorter span= 94 kNm

Design of slab:

Effective depth of slab (d) = 293.9mm. Provide 290mm. Hence ok.
Shorter span, A_{st} = 1832.97 mm^2, Spacing = 61.7 mm.
Provide 12mm φ at 60mm c/c.
Longer span, A_{st} = 7198.2 mm^2, Spacing = 20mm'

Provide 8mm φ at 20mm c/c.

Check for Shear:

τ_v= 0.223 N/mm^2, τ_c = 0.39 N/mm^2.

$\tau_v < \tau_c$. Hence safe.

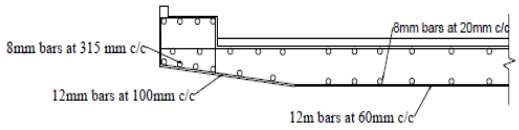


Fig 4: Cross section of deck

B. Steel Truss section:

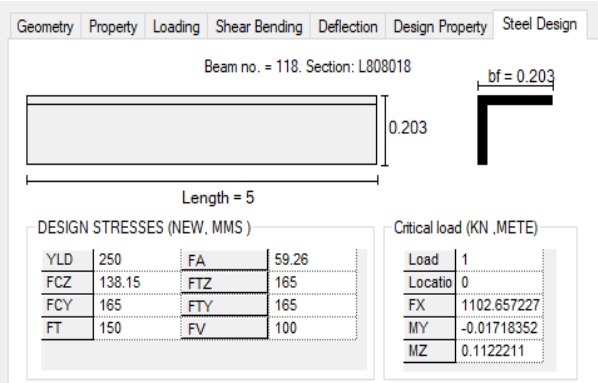


Fig 5: Steel truss detailing.

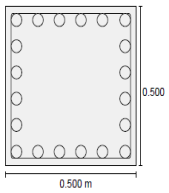


Fig 6: Detailing of pier

Main reinforcement: Provide 20 - 12 φ (0.90%, 2261.95 Sq.mm.)

Tie reinforcement: Provide 8 mm φ rectangular ties @ 190 mm c/c

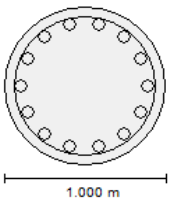


Fig 7: Detailing of pier

Main reinforcement: Provide 12mm φ bar at 60mm spacing.

Shear reinforcement: Provide 8mm φ bar at 190mm spacing.

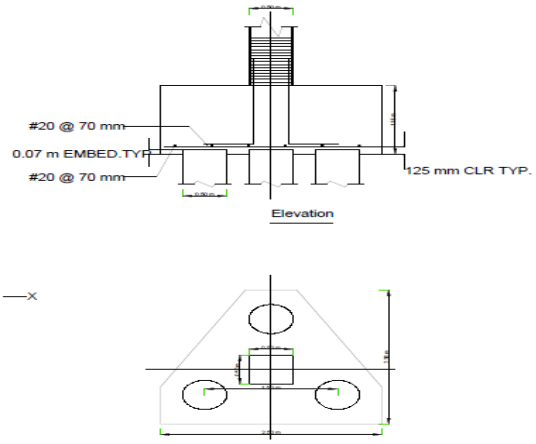


Fig 8: Detailing of rectangular pile.

Provide 20mm dia reinforcement bars at 70mm spacing.

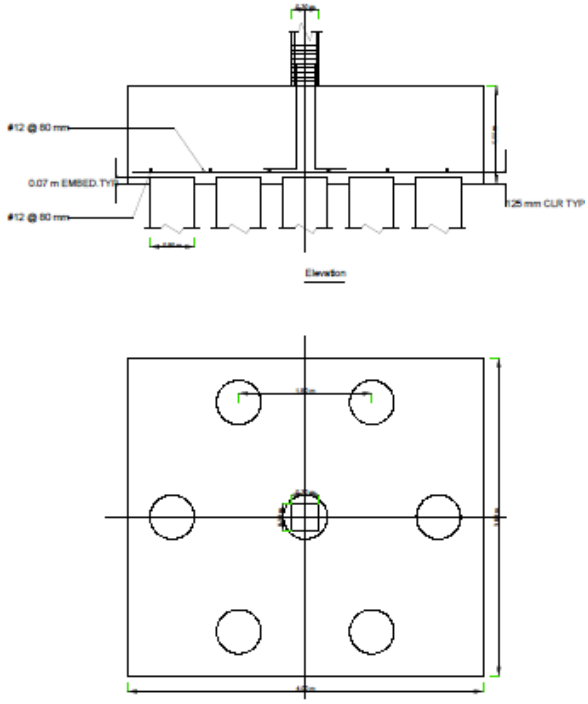


Fig 9: Detailing of circular pile.

Provide 20mm dia reinforcement bars at 80mm spacing.

VI. CONCLUSION:

The analysis and design of steel skew bridge using STAAD Pro is carried out and the following results are obtained.

- ✓ **Longitudinal girder detailing:** length: 60m, depth: 0.148m, thickness of flange (t_f):0.005m, Thickness of web (t_w):0.004m, width of flange: 0.100 m.
- ✓ **Pier detailing:** 1. Provide 20 - 12 φ, (Equally distributed) and 8mm φ at 190mm centre to centre spacing as shear reinforcement.2. Provide 14 - 12 φ, (Equally distributed) and 8mm φ at 190mm centre to centre spacing as shear reinforcement
- ✓ **Deck slab detailing:** Span 60m, Width of road 7.5m, Footpath 1m from each side, Number of main girders = 3, Live load: IRC Class AA tracked vehicle loading, 8mm bars at 20mm c/c for slab, 12 bars of 32mm φ in four rows of HYSD bars.
- ✓ **Steel Truss detailing:** Length (l) = 5m, breadth of leg (b_f) = 0.203 m, thickness of leg = 0.004m.
- ✓ **Pile detailing:**
  i) Detailing of rectangular pile: Provide 20mm φ bars at 70mm spacing.
  ii) Detailing of circular pile: Provide 20mm φ bars at 80mm spacing.

VII. SUMMARY:

This paper involves the analysis and design of steel bridge with skew angle 30^0 involves the planning, load calculations, analyzing, design of steel truss, deck slab, pier and design of foundation. Analysis design has done for various load combinations etc. as per the Indian Standard Code of Practice.

VIII. SCOPE FOR FUTURE WORKS:

The further work can be carried out by using various skew angle for analyse and design of steel bridges

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REFERENCES:

1. Anagha Manoharan and Glynez joseph "**Analysis of skew bridge with varying skew angles**", International journal of scientific and engineering research, Vol:7, Issue 10,Page no: 240-244, October 2016.
2. Cagri ozgur, Donald W White, "**Behavior and analysis of a curved and skewed i-girder bridge**", Journal of research gate, page no; 1-16, September 2016.
3. Geethumol Unnikrishnan, Najma Anantha kumar, "**Analysis and design of skew bridge**", International journal of advanced scientific and technical research Vol:5, Issue 6, Page no: 186-190, October 2016.
4. Katarina serdelova and Josef vican , "**Analysis and design of steel bridge with ballast less track**", Journal of science direct, Page no; 702-708, March 2015.
5. Kevin Rens, Chair Cheng Yu Li, Yail Jimmy Kim, "**Behavior and Analysis of Highly skewed steel I-girder bridges**", International Journal of Research Gate, Volume 8, Page no: 1125-1132, November 2013
6. Midhun b Sankar, Priya A Jacob , "**Comparison of Design Standards for Steel Railway Bridges**", International Journal of Engineering Research and Applications(IJERA), Vol.3,Issue 2, pp.1131-1138, March-April 2013.
7. Oyati.E.N, **"Design of a Pedestrian-Steel Bridge Crossing Auchi-Benin Expressway",** Global Journals Inc. (USA), Volume 18 Issue 1, ISSN: 2249-4596, June 2018.
8. Punit patel, Asst.Prof.Hardik Solanki, Bhanuprasad N kadia "**Behavior of skew bridge using grillage analogy method**", Journal of research gate, Page no; 1-6, March 2016.
9. Raj. K K and Phani. R G **"Design and study on behavior of skew slab bridges with various skew angles",** Journal of applied science and innovations. Vol: 01, Issue: 02, Page no: 37-49, July – 2017.
10. Tze-wei choo, Daneil G.linzell, Je ll Lee, James A.Swanson "**Response of a continuous, skewed, steel bridge during deck placement**", Journal of constructional steel research, No: 61, page no: 567-586, May 2015.