Analysis & Review of Suspension Bridge under Different Types of Loading as per is Code by Staad Pro Software

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Abstract— Suspension bridge is an efficient structural system particularly for large spans. Many difficulties related to design and construction feasibility arises due to its long central span. There are many suspension bridges around the world and dynamic behaviour has been found to be the primary concern for those bridges. Natural period of a suspension bridge mainly dependent on the span and other structural dimensions related to the stiffness. .In the present study, we made design and analysis of the deck slab for suspension bridge under different types of loading in the software based on IS provisions to carried out the deflected shapes and impact on the deck slab.

Key words: Introduction, Loads, Moving Load, Analysis, Design, Conclusion

I. INTRODUCTION

This is the first of a series of three reports concerning suspension bridges and wire corrosion. The second report addresses the sources and mechanistic features of suspension bridge wire corrosion. The third report discusses some technical aspects that should be addressed to preclude corrosion damage on suspension bridges. In most jurisdictions, there is a dearth of suspension bridges compared to other bridge types. The purpose of this report is to quaint those who are involved in bridge management with salient features of suspension bridges that often differ from those of other generic bridge types. A short history of suspension bridges which deals with the evolution of suspension bridge design also is included.

Suspension bridge is a type of bridge that has a larger span than any other form of bridges. As it get larger span it become more flexible structure. Major bridges were still built using a truss design until 1808, when an American inventor named James Finley filed a patent on an early version of a suspension bridge. In most jurisdictions, there is a dearth of suspension bridges compared to other bridge types.

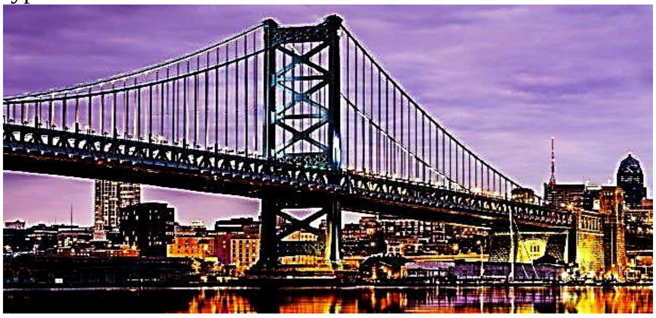

Fig. 1: Suspension Bridge

II. LOADS ON BRIDGES

The following are the various loads to be considered for the purpose of computing stresses, wherever they are applicable.

- Dead load
- Live load
- Impact load
- Longitudinal force
- Thermal force
- Wind load
- Seismic load
- Racking force

A. Dead Load

The dead load is the weight of the structure and any permanent load fixed thereon. The dead load is initially assumed and checked after design is completed. The dead load includes loads that are relatively constant over time, including the weight of the structure itself, and immovable fixtures such as walls, plasterboard or carpet. The roof is also a dead load. Dead loads are also known as permanent or static loads. Building materials are not dead loads until constructed in permanent position. IS 875(part 1)-1987 give unit weight of building materials, parts, components.

B. Live Load

Bridge design standards specify the design loads, which aremeant to reflect the worst loading that can be caused on the bridge by traffic, permitted and expected to pass over it. In India, the Railway Board specifies the standard design loadings for railway bridges in bridge rules. For the highway bridges, the Indian Road Congress has specified standard design loadings in IRC section II. Live load is a civil engineering term that refers to a load that can change over time. The weight of the load is variable or shifts locations, such as when people are walking around in a building. Anything in a building that is not fixed to the structure can result in a live load, since it can be moved around. Live loads are factored into the calculation of the gravity load of a structure. Construction approval is dependent upon design and structural plans that account for live-load requirements. The minimum live-load requirements are based on the expected maximum load.

C. Impact Load

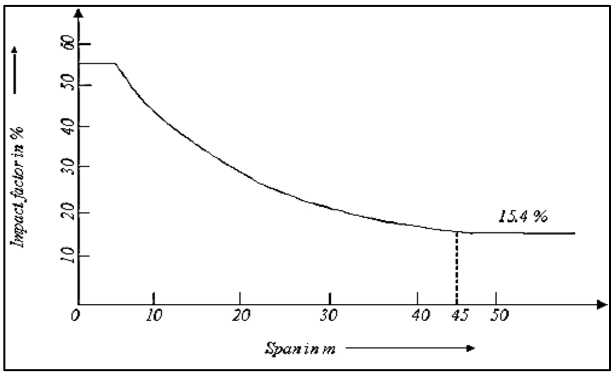

Fig. 2: Impact percentage curve for highway bridges for IRC class A and IRC Class B Loadings

The dynamic effect caused due to vertical oscillation and periodical shifting of the live load from one wheel to another when the locomotive is moving is known as impact load. The impact load is determined as a product of impact factor, I, and the live load. The impact factors are specified by different authorities for different types of bridges. The impact factors for different bridges for different types of moving loads are given in the impact percentage curve for highway bridges for class AA loading. Note that, in the above table l is loaded length in m and B is spacing of main girders in m.

D. Longitudinal Forces

Longitudinal forces are set up between vehicles and bridge deck when the former accelerate or brake.

The magnitude of the force F, is given by

$$F = \frac{W * \partial V}{g * \partial t}$$

Where,
W – Weight of the vehicle
g – Acceleration due to gravity
δV – change in velocity in time dt.

This loading is taken to act at a level 1.20 m above the road surface. No increase in vertical force for dynamic effect should be made along with longitudinal forces. The possibility of more than one vehicle braking at the same time on a multi-lane bridge should also be considered.

Bridge	Loading		Impact factor(I)
Railway bridge according due to bridge rules	Broad gauge and meter gauge	(a)single track	(20/24+l)≤ 3.0
		(b) main girder of double track with two girders	0.72×(20/14+l)≤0.72
		(c) intermediate main girder of multiple track spans	0.60×(20/14+l)≤0.60
		(d)outside main girders of multiple track spans	Specified in (a) or (b)whichever applies
		(e) cross girders carrying two or more trucks	0.72×(20/14+l)≤0.72
	Broad gauge	Rails with ordinary fish plate joints & supported directly on sleepers or transverse steel troughing	(7.32/B+5.49)
	Meter gauge		(5.49/B+4.27)
	Narrow gauge		(9.5/31.5+l)
	IRC class AA loading	(I)span less than 9m. (a)tracked vehicle (b) wheeled vehicle	0.25 for span up to 5 mand linearly reducing to 0.10 to spans of 9m 0.25
Highway bridges according to IRC regulation		(ii)spans 9m or more (a)tracked vehicle (b)wheeled vehicle	0.10 0.25 for spans up to 23 mand in accordance with the curve indicated for spans in excess of 23m
	IRC class A loading & IRC class B loading	Spans between 3m & 45 m	(9/13.5+l) In accordance with the curve indicated in all spans
Foot bridge			No separate impact allowance is made

Table 1: Bridge, Loading & Impact factor (I)

E. Thermal Forces

The free expansion or contraction of a structure due to changes in temperature may be restrained by its form of construction. Where any portion of the structure is not free to expand or contract under the variation of temperature, allowance should be made for the stresses resulting from this condition. The coefficient of thermal expansion or contraction for steel is 11.7 x 10-6 / C.

F. Wind Load

Wind load on a bridge may act

- Horizontally, transverse to the direction of span
- Horizontally, along the direction of span
- Vertically upwards, causing uplift
- Wind load on vehicles

Wind load effect is not generally significant in short-span bridges; for medium spans, the design of sub-structure is affected by wind loading; the super structure design is affected by wind only in long spans. For the purpose of the design, wind loadings are adopted from the maps and tables given in IS: 875 (Part III). A wind load of 2.40 kN/m^2 is adopted for the unloaded span of the railway, highway and footbridges. In case of structures with opening the effect of drag around edges of members has to be considered.

G. Racking Force

This is a lateral force produced due to the lateral movement of rolling stocks in railway bridges. Lateral bracing of the loaded deck of railway spans shall be designed to resist, in addition to the wind and centrifugal loads, lateral load due to racking force of 6.0kN/m treated as moving load. This lateral load need not be taken into account when calculating stresses in chords or flanges of main girders.

H. Forces on Parapets

Railings or parapets shall have a minimum height above the adjacent roadway or footway surface of 1.0 m less one half the horizontal width of the top rail or top of the parapet. They shall be designed to resist a lateral horizontal force and a vertical force each of 1.50kN/m applied simultaneously at the top of the railing or parapet.

I. Seismic Load

If a bridge is situated in an earthquake prone region, the earthquake or seismic forces are given due consideration in structural design. Earthquakes cause vertical and horizontal forces in the structure that will be proportional to the weight of the structure. Both horizontal and vertical components have to be taken into account for design of bridge structures. IS: 1893 –1984 may be referred to for the actual design loads.

J. Forces due to Curvature

When a track or traffic lane on a bridge is curved allowance for centrifugal action of the moving load should be made in designing the members of the bridge. All the tracks and lanes on the structure being considered are assumed as occupied by the moving load.

This force is given by the following formula:

$$C = \frac{W * V * V}{12.7R}$$

Where,

C - Centrifugal force in kN/m

W - Equivalent distributed live load in kN/m

V - Maximum speed in km/hour

R - Radius of curvature in m

III. Load Combination

Stresses for design should be calculated for the most sever combinations of loads and forces. Four load combinations are generally considered important for checking for adequacy of the bridge. These are given in Table and are also specified in IS 1915 – 1961.

SNo	Load combination	Loads
1	Stresses due to normal loads	Dead load, live load, impact load and centrifugal force
2	Stresses due to normal loads + occasional loads	Normal load as in (1) + wind load, other lateral loads, longitudinal forces and temperature stresses
3	Stresses due to loads during erection	-
4	Stresses due to normal loads + occasional loads + Extra-ordinary loads like seismic excluding wind load	Loads as in (2) + with seismic load instead of wind

Fig. 3: Load Combination

A. Moving Load

Which load is to carry axle vehicle or multi axle vehicle load on deck slab. Which load is axle vehicle load which load 40KN than weight. Which deck slab on software in STADD PRO.

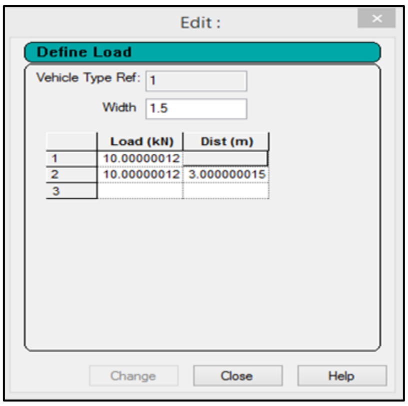

Fig. 4: Moving Load

In this Picture moving load apply on 10 KN load @ 1.5 distance.

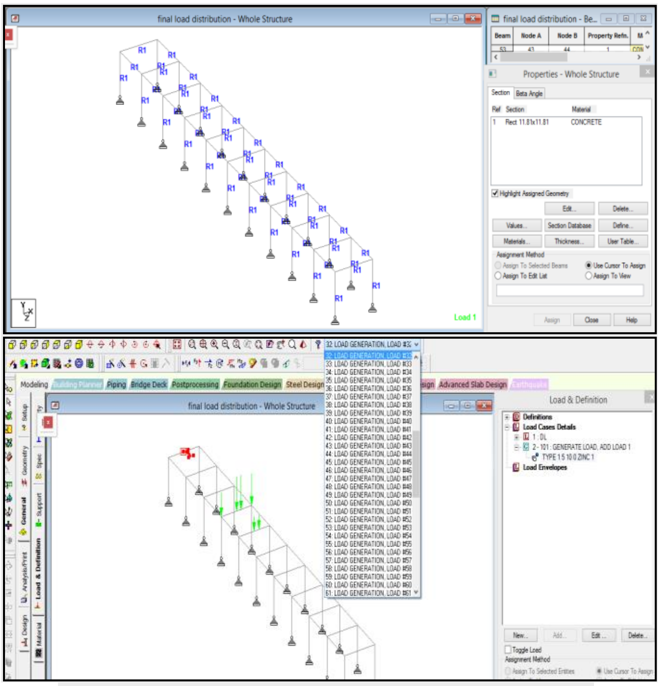

Fig. 5: Load on generation on load 100 generation

Load on generation on load 100 generation to give.

IV. Conclusions

In the deck slab there are maximum bending moment & shear force acting @ mid-point.

- At point beam 24 which that point maximum load on deck slab.
- Live load and impact load on bridge is maximum affect than the dead load affect.

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