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DYNAMIC ANALYSIS OF SUSPENSION BRIDGE UNDER MOVING LOAD

Kotiya Tejal[1], Farhan Vahora[2]

[1]*P.G.Student Department of structural Engineering L.J.I.E.T., Ahmedabad, Gujarat, India*

[2]*Associate Professor, Department of Structural Engineering L.J.I.E.T., Ahmedabad, Gujarat, India*

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Abstract - *Suspension bridge is most significantly used for the larger span. The main purpose of this report is to understand the basic concept of the suspension bridge & dynamic analysis of suspension bridge under moving load. The suspension is a bridge in which the weight of the deck is supported by vertical cables, this cables are suspended from further cables. Primitive suspension bridges, or simple crossing devices, were the forebears to today's modern suspension bridge structures. Suspension bridges were constructed with iron chain cables over 2000 years ago. The analysis of suspension bridge is carried out by SAP 2000 software. In this report also included the introduction of this software. SAP 2000/Bridge is an analysis and design program for bridge structures. The ease with which complex bridge structure can be modeled has made the SAP 2000/Bridge program the most useful bridge analysis and design program. This report is designed to introduce you to SAP 2000/Bridge analysis with modeling of two 2-D bridges, one is cable with supports at different levels and the other is suspension bridge with 3 hinged stiffening girders. Software validation is also included in this report by using SAP 2000 software. Decided the work plan of thesis. The analysis of the suspension bridge is carried out with the different span of the bridge with different methods. Suspension bridge is better able to withstand earthquake movements than heavier and more rigid bridges.*

***Key Words*: SUSPENSION BRIDGE, MOVING LOAD, DYNAMIC ANALYSIS, SAP 2000**

1. INTRODUCTION

The origins of the suspension bridge go back a long way history. Primitive suspension bridges, or simple crossing devices, were the forebears to today's modern suspension bridge structures. Suspension bridges were constructed with iron chain cables over 2000 years ago in China and a similar record has been left in India.

The iron suspension bridge, assumed to have originated in the Orient, appeared in Europe in the 16th century and was developed in the 18th century. Although wrought iron chain was used as the main cables in the middle of the 18th century, a rapid expansion of the center span length took place in the latter half of the 19th century triggered by the invention of steel. Today, the suspension bridge is most suitable type for very long-span bridge and actually represents 20 or more of all the longest span bridges in the world.

A suspension bridge is a type of bridge that has its deck suspended by suspension cables usually pass over towers and are securely anchored at the ends.

The deck is then hang on vertical suspenders attached to the suspension cables, which have a catenary shape of all the types of bridges, the suspension bridge is the one that allows the longest spans.

It has a span range from 70 to 2000 meters. The longest suspension bridge in the world is presently the Akashi Kakiyo Bridge in Japan, which total length is 3911m.

1.1 DYNAMIC ANALYSIS METHOD

Dynamic analysis is a simple extension of static analysis. Dynamic analysis is performed to evaluate the response of a structure to earthquake motion and wind load. It can be achieved by applying several available analytical technique. To study the effect of various dampers on vibration, acceleration, natural frequency and other dynamic properties of suspension bridges, computer models have been developed and analyzed, modal analysis is performed to determine the vibration modes or the structure.

Numbers of analysis are required to find out number of modes that gives satisfactory mass partition. They can also be used as the basis for modal superposition in response-spectrum and modal time history analysis. Then response spectrum and time history analysis is performed for earthquake loading. Response spectrum analysis is a statistical type of analysis for determination of the likely response of a structure to seismic loading.

Time history analysis is a step by step analysis of the dynamical response of a structure to a specified loading that may vary with time. The analysis may be linear or nonlinear. For dynamic analysis first analysis is performed without any external damping enclosed to the structure and then the analysis is performed providing external damping. Again an analysis is performed without external damping but with modal damping to find out percent of damping provided by the external damper. In the present study, analyses were performed using the modal analysis, linear elastic time history analysis.

2. DYNAMIC BEHAVIOR OF SUSPENSION BRIDGE UNDER MOVING LOAD

In this study suspension bridge have been analyzed with different load cases and using variable like wind and moving load.

Different load cases:

1. Bridge under wind only
2. Bridge under wind and 1 train
3. Bridge under wind and 2 train
4. Bridge under wind, 1 train and 70 R loading
5. Bridge under wind, 1 train and class AA loading
6. Bridge under wind, 2 train and 70 R loading
7. Bridge under wind, 2 train and class AA loading

Different types of girder which is used in this analysis are as follows:

1. I girder
2. Precast I girder
3. Box girder

SMALL SPAN BRIDGE DATA:

Left span length: 97.536m Number of divisions: 6
Middle span length: 243.84m Number of divisions: 24
Right span length: 97.536m Number of divisions: 6
Deck width: 30.58m Minimum middle sag: 6.096m
Column height H1: 15.24m Column height H2: 30.48m

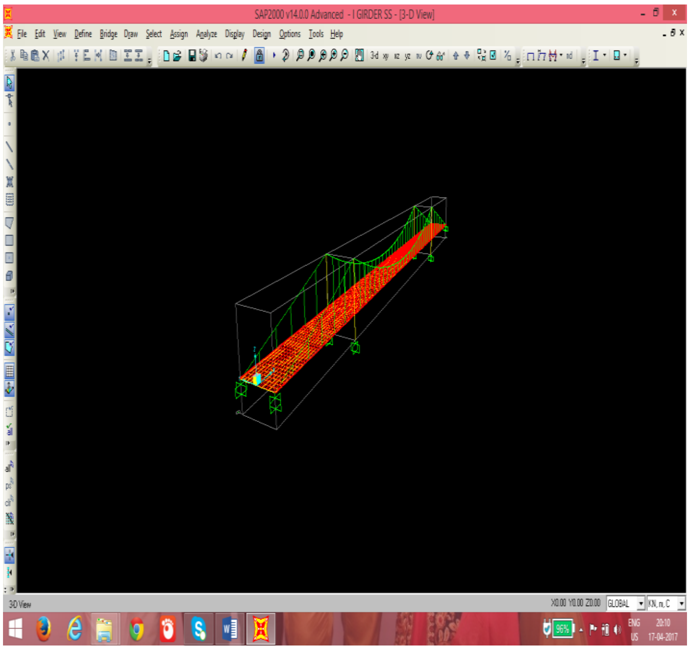

Fig – 1: Geometry of small span 3-D view

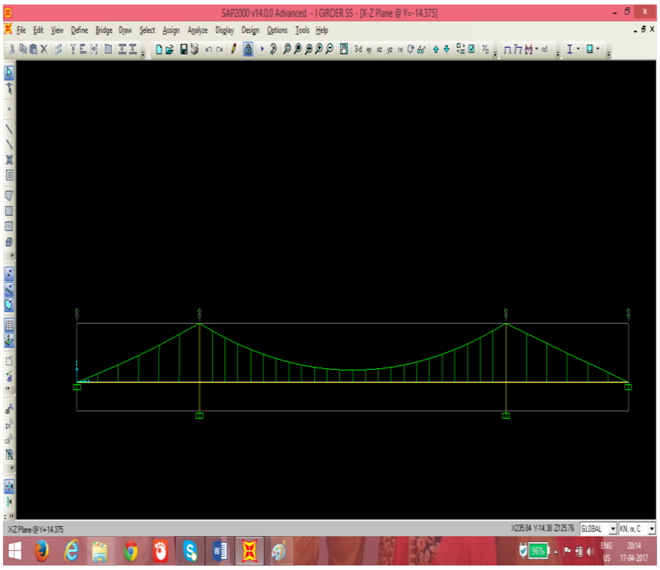

Fig – 2; Geometry of small span 2-D view

3. ANALYSIS RESULTS:

Comparison of this three types of girders in this similar data of small span suspension bridge but there is a different types of girders are used for analysis. Using SAP 2000 making a 3 different model of this small span bridge data with different girders section properties.

For analysis I choose only critical loading in different load cases which is given above.

Critical loading are load case no. 4, 5, 6 & 7.

I just unroll axial force in result in this analysis.

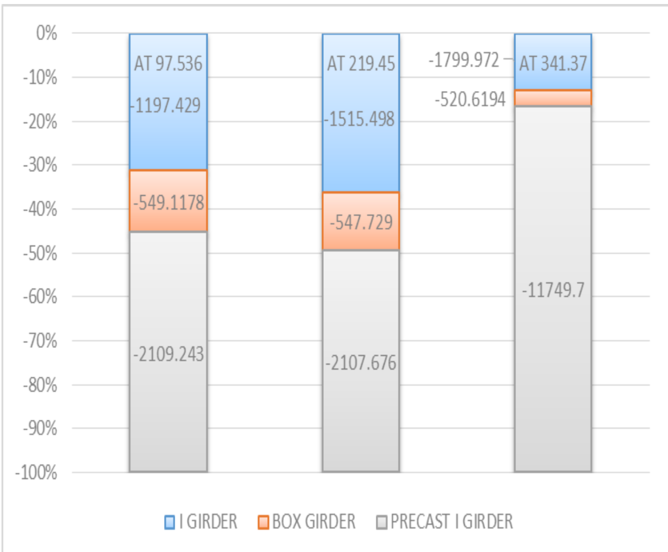

Chart – 1: Axial force for critical load - Bridge under Wind, 2 train and Class AA loading

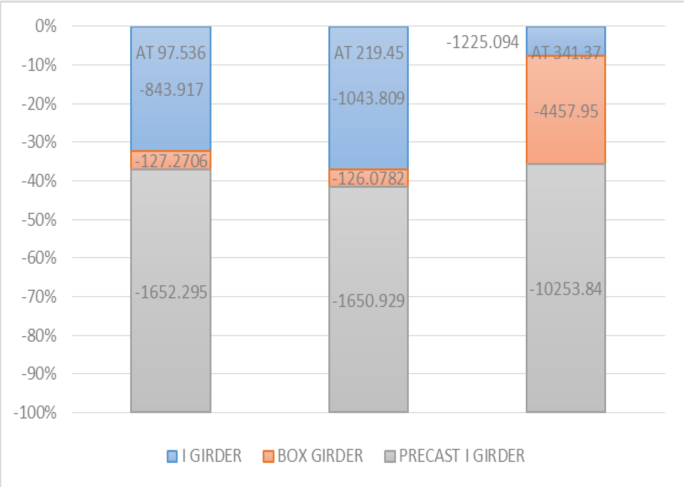

Chart – 2: Axial force for critical load – Bridge under Wind, 1 train and Class AA Loading

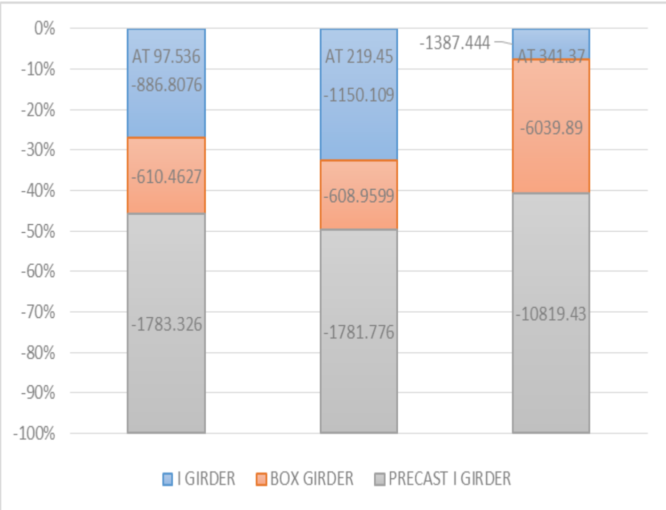

Chart – 3: Axial force for critical load – Bridge under Wind, 2 train and Class 70 R Loading

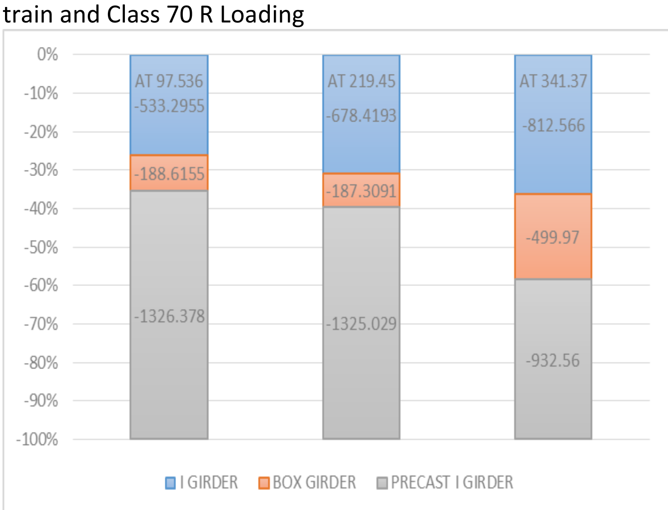

Chart – 4: Axial force for Critical load – Bridge under Wind, 1 train and Class 70 R loading

4. CONCLUSION:

With using different girders there is a different behavior of bridge in different critical load case. Far the many researchers are research on suspension bridge under moving load but they are only consider 1 train or 2 train in opposite direction instead of that I have consider the 1 train, 2 train with highway loading that's why it is converted in critical loading as per this critical load we know the behavior of bridge under highest moving load. For this analysis I choose SAP 2000 software. This software is best for bridge analysis.

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