FATIGUE ANALYSIS OF OFFSHORE STEEL STRUCTURES

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Abstract - The suspension bridge is a highly non-linear three dimensional structure. The complete study is done by dynamic analysis with respect to time. A method for time buffeting analysis is presented and implemented in ANSYS. The entire numerical analysis of suspension bridge under wind load and seismic load procedure is implemented in ANSYS and buffeting responses can be conveniently computed with very concise input data. Seismic analysis is mainly carried out using response spectrum. This is not an accurate method. Hence choose another method with concern of time dependent acceleration over a time period. Data's used for plotting acceleration time graph of Solomon island earth quake .The modeling is carried out by using ANSYS software. The natural frequencies are obtained by modal analysis. And further harmonic analysis and seismic analysis are carried out. Compare the output analysis. Optimization is carrying out using various parameters and obtained results are evaluated.

Key Words: Suspension bridge; Wind; Earthquake; ANSYS.

1. INTRODUCTION

Bridge is a structure built to span across a valley, road, body of water, or other physical resistance, for the purpose of providing passage over an obstacle. Bridges are those marvels in civil engineering tool kit which help in connecting the places located on other side of bank. Varieties of bridges have evolved from history. One of them is suspension bridge.

Suspension bridge is most commonly built to span across water body. It is built by suspending the roadway from cables attached to a master cable which runs above the length of the bridge. In addition to being strong and lightweight, suspension bridges are also beautiful. The design of a suspension bridge is simple and straightforward, and takes advantage of several techniques to distribute the weight of the bridge safely and evenly.

2. OBJECTIVE OF THE STUDY

1. To study the effects of the variations in wind load and seismic load due to geometrical parameters are changed in the case of suspension bridge.
2. The optimization of parameters such as materials used for string, column size number of strings and changing the dimensions of main cables and suspenders.
3. To conduct a numerical analysis using ANSYS
4. The study on response spectrum of suspension bridge under the different loading conditions and geometrical conditions.

3. METHODOLGY

Finite element analysis is methodology implemented on the study. It is the process of discretization of materials into finite elements where loads are applied on each element and analysed to obtain the overall performance of the analysis of suspension bridge under wind load and seismic load. This method is gaining in the modern research field as it yields accurate results for the given inputs, details and boundary conditions similar to realistic structure. ANSYS Mechanical Work Bench 17 is the software used to analyse the problem supported by explicit dynamics as platform. Thus with the aid of the computer software, computation efforts can be minimized and errors can be restricted to an extent for exact results conforming to realistic structure.

4. MODELING OF SUSPENSION BRIDGE

For the modeling of suspension bridge in SOLID WORKS 2016 the engineering data is assigned as shown in Table 1. The static structural model is shown in Figure.1. The detailed dimension of the geometric model is shown in Table 2. Analyzing the model in ANSYS WORKBENCH 17.0.

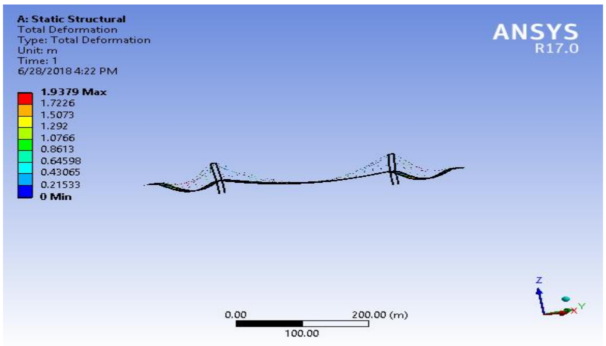

Figure 2 Static structural model before meshing

Table -1 Engineering data

Engineering data	Specifications	
Material used	Structural steel	Concrete
Density	7850 kgm^{-3}	2300 kgm^{-3}
Young's modulus	2x10^5 MPa	3x10^5 MPa
Poisson's Ratio	0.3	0.18
Bulk Modulus	1.6667x10^5 MPa	1.5625x10^5 MPa
Shear Modulus	0.76923x10^5 MPa	1.2712x10^5 MPa

Table 2- Geometric Dimensions

Geometric parameters	Main cables	Suspension cables
Diameter	264mm	120mm
	Main column	Main cross member
Breadth	762 mm	952.5 mm
Length	1422mm	1220mm

5.1 Boundary Conditions

Two ends of the chords are held fixed.

5.2 Load assigning

The loads, designed to be exerted on the surface of the joint, are then translated to the cables. For response spectrum analysis the acceleration, frequency data was taken from a live earthquake data of Savannah River.

6. ANALYSIS

6.1 MODAL ANALYSIS

A modal analysis determines the vibration characteristics (natural frequencies and mode shapes) of a linear elastic structure or a machine component.

6.2 HARMONIC ANALYSIS

Harmonic response analysis are used to determine the steady-state response of a linear structure as sinusoidal response to sinusoidal varying loads all acting at a specified frequency (harmonically) with time.

6.3 SEISMIC ANALYSIS

Mainly response spectrum analysis is based on the maximum response value, but this is not an accurate method. So in this part of the study, we have closely spaced modes, change the combination method to something other than SRSS.

7. PA. **Parameters taken for the study**

In this study parameters taken for the study are

1. Main Cable Diameters :- 0.304 m, 0.344 m, 0.384 m, 0.424 m, 0.464 m
2. Suspension Cable Diameters:- 0.16 m, 0.2 m, 0.24 m, 0.28 m, 0.32 m.
3. No. of Suspension Cables:- From Deck end – 4, 8, 12

Middle of Deck- 16, 20.

RAMETRIC STUDY

8. CONCLUSIONS

- The response spectrum of total and directional are decreased as the diameter increases.
- Frequency of modal is increases as the diameter increases.
- Proposed structure was also compared with the reducing suspenders.
- The reducing suspenders of structure have less influence in the response spectrum of structures.
- All modes have f = fsp, so all the modes are in low region. Therefore no rigid or missing mass is needed.
- When comparing the diameter of main cable, diameter of suspension cables and reducing suspender, diameter of suspension is better than others.

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