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ANALYSIS, MODELLING AND ESTIMATION OF SUSPENSION BRIDGE

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Abstract – *A bridge is a structure built to span a body of water, valley, road or any other physical obstacles, for the purpose of providing passage over the obstacles. Among them suspension bridge is one of a type of bridge which has span larger than any other types of bridges. This project has carried out the modelling and analysis of suspension bridge using MIDAS Civil Software. We have modelled a 650m spanning suspension bridge with 2 lane road. The 3D model of the designed bridge has done in Revit Architecture Software. A preliminary estimation of the same bridge has done manually. All loading cases in the analysis and design are as per IRC 6-2017 code specifications. In MIDAS Software, the total modelling of the suspension bridge was done as per IRC 112-2020. The intensity of vehicle moving load as per IRC 6-2017 (heavy loading class 70R and class A wheel load) is analyzed by MIDAS Civil. Moments and load at each point within the element can be easily observed from the software output results. After manual estimation we have came to known that our designed suspension bridge costs a sum of Rs.365Cr.*

Key Words: Analysis, Force, Midas Civil, Moment, IRC 6- 2017, IRC1112-2020, estimation, Revit Architecture.

1.INTRODUCTION

Suspension bridges are a type of structure where the deck is hung below a series of suspension cables that are on vertical suspender. Suspension bridges have cables that hangs between its pylons to help carry the weight of the deck with its vertical suspenders. This design allows for the deck system to arc upwards for additional clearance. Many of them built without falsework. With this project we aim to design a suspension bridge of 650m span and 11m width connected to two pylons using suspension cables. The analysis can be carried out using MIDAS Civil Software. For modelling and analyzing structural systems, the analysis program in MIDAS Civil has proved itself to be a powerful tool because the provision of the Construction Stage Analysis feature allows the generation of construction stages by the choice to vary the structural system and therefore the loading condition.

The approximate cost of any engineering project can be calculated by Estimation, which is a scientific way of working out of the cost before the execution of work. Estimate is prepared by calculating the quantities from the dimension on the drawings for various items required to complete the project and multiplied by unit cost of items concerned. The unit rates of each items used in the construction can be taken from Delhi Schedule of Rates which is a comprehensive and useful technical document for execution of civil works.

1.1 OBJECTIVES

I. To study about suspension bridges.

II. To understand the design procedure of suspension bridge in MIDAS Civil.

III. To perform completed state and construction stage analysis.

IV. To study the preliminary estimation of suspension bridge.

V. To study the 3D modelling of suspension in REVIT ARCHITECHTURE Software.

2. STUDY ON SUSPENSION BRIDGE

Suspension bridge is one of a type of bridge that has a larger span than any other form of bridges. As it gets larger span it will get more flexible structure. A suspension bridge is a type of bridge which is build by hanging the deck system from cables attached to a master cable which runs above the length of the bridge. 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 uniformly. The different components and forces acting on a typical suspension bridge is shown below.

3. CASE STUDY: INCHATHOTTY SUSPENSION BRIDGE

Inchathotty is a village located near Neriamangalam, Thattekkad and Kothamangalanm in Eranakulam dist. In kerala , India. It is famous for its hanging bridge , which is considered as the longest suspension bridge in kerala with a length of about 183m and a width of about 1.2m. Further details of the bridge is shown in the table below.

Table – 1: Details of Inchathotty Suspension Bridge

Type	Single Span(Steel)
Span	183 m
Width	1.2 m
Height of Pylon	22.5 m (above deck)
Hanger Spacing	1.2 m
No. of Hangers	149

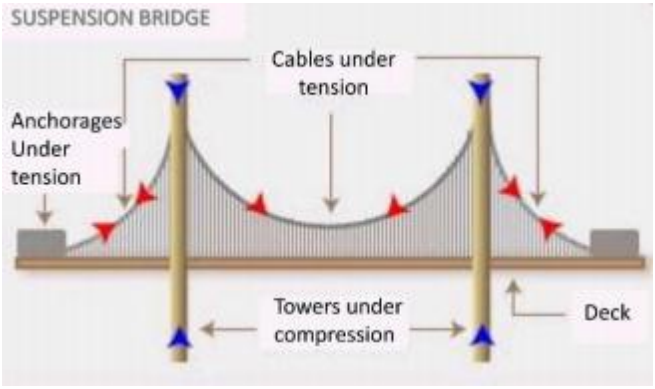

Fig -1: Forces acting on suspension bridge

Fig – 2: Inchathotty Suspension Bridge

4. SELECTED BRIDGE PARAMETES

Type : 3 Span

Span: L = 125 + 400 + 125 = 650 m

Bridge width = 11 m

Height of Pylon = 40.08 (above deck)

Hanger spacing = 12.5 m

No. of Hangers = 52

Table – 2: Element material property

Classification	Cable	Hanger	Deck	Pylon
Modulus of elasticity	2.0e+07	1.4e+07	2.1e+07	2.1e+07
Weight Density	8.267	7.85	0.00	7.85
Section	Solid Round	Solid Round	Box	Box

5. COMPLETED STATE ANALYSIS

The Completed State Analysis is performed to check the behavior ofthe completed bridge. At this stage, the structure is balanced under self weight, and the deflection due to the self weight has already occurred. This state is referred to as the initial equilibrium state of suspension bridge.

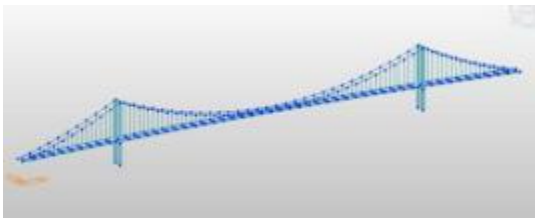

Fig – 3: Completed bridge model in MIDAS Civil

6. CONSTRUCTION STAGE ANALYSIS

Construction stage analysis is performed to check the structural stability and to calculate section forces during erection. In carrying out the construction stage analysis, large displacement theory (geometric nonlinear theory) is applied in which equilibrium equations are formulated to represent the deformed shape.

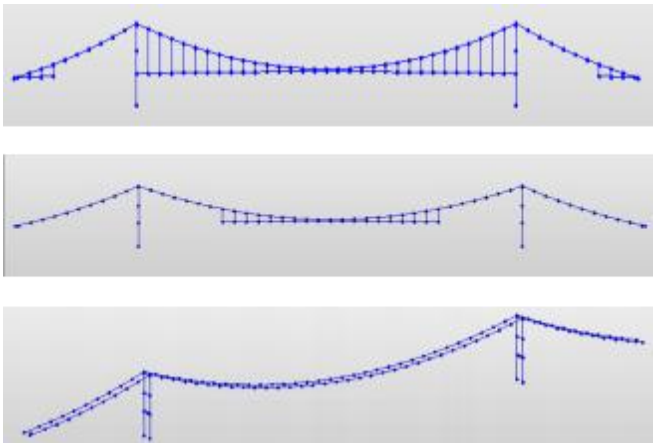

Fig – 4: Backward stages of construction

7. ESTIMATION

7.1 Earthwork and Excavation

*(Nos. *L*B*H = Q)*

Footing 1 : 2*17*24*7.6 = 6201.6

Footing 2 : 2*29*35*9.6 = 19488

Abutment : 4*35*3.2*5.6 = 2508.8

Road : 1*12*70*1.2 = 1008

*(Amount(A) = Total Q*R)*

A = 17552*259 = 4545968

7.2 Site Levelling and Clearance

L/S ; A = 2045680

7.3 Earth Filling

Deduction

P.C.C :> 569

R.C.C :> 25003

Sand Filling :> 570

A = 3065*92 = 281980

7.4 Sand Filling

Footing 1 :> 2*17*24*0.2 = 163.2

Footing 2 :> 2*29*35*0.2 = 406

A = 570*515.22 = 293675.4

7.5 P.C.C M20 Grade

Footing 1 :> 2*17*24*0.2 = 163.2

Footing 2 :> 2*29*3.2*0.2 = 406

Abutment :> 4*35*3.2*0.2 = 89.6

A = 659*7399.2 = 48876072.8

7.6 R.C.C M20 Grade

Footing pier 1 :> 2*13*20*10 = 5200

Footing pier 2 :> 2*29*30*12*20880

Approaches :> 4*30*3*8 = 2880

Concrete fender :> 2*81.4*10.8 = 1758.24

Deck slab :> 1*865*12*0.4 = 4152

Anchorageous pylon = 34750

A = 69621*7399.3 = 515146665.3

Reinforcement work bent = 82423466.45

7.7 Steel work

Main tower :> 2*5755000 = 11510000

Suspended structure :> 1*6220572 = 6220572

Anchorages :> 1*1140300 = 1140300

Approaches :> 1*2642900 = 2642900

A = 21514*71367.66 = 1535403837

7.8 Fining Work

Painting :> 21300*254.4 = 5418720

Water proofing :> 21300*97.6 = 2078880 A = 2152514945

Electricity, Labour charges, Transportation, Utilities, Frame works and Machineries, Miscellaneous, Insurance etc. are taken as LS.

Therefore total cost of designed bridge = **3650000000Rs**

Second part of our project was to do the completed state and construction stage analysis of suspension bridge using MIDAS Civil. After the analysis we have done the

8. 3D MODELLING

Fig – 5. 3D Model using Revit Architecture

9. CONCLUSIONS

Suspension Bridges provide an outstanding architectural view because of their unique cable arrangement and pylon shapes. However, in India it is not much popular and there are only a few number of Suspension Bridges namely Punalur Suspension Bridge, Pamban Bridge and few others. This may because of the lack of availability of standard textbooks and bridge codes for understanding the design procedures and techniques.

In this project we have first conducted a detailed study on suspension brides and as part of this study, we have visited Inchathotty Suspension Bridge and took the dimensions of the same. Based on these studies we have taken some optimum design consideration values and modelled a suspension bridge using MIDAS Civil Software. preliminary estimation manually and came to known that our designed bridge costs a sum of Rs. 365Cr.

As a final part, we have done the 3D modelling of the suspension bridge using Revit Architecture.

REFERENCES

JOURNALS

[1] Suleyman Adanur, Murat Gunaudin, Construction Stage Analysis of Humber Suspension Bridge, Applied Mathematical Modelling, 2012

[2] Subeesh Nath S, Parametric Study of Structural Behaviour of Self Anchored Suspension Bridge, IJERT ISSN: 2278-0181, 2015

[3] Hajime HOSOKAWA, Alternative Proposal for Suspension Bridge Cable, Innovative Infrastructure – Toward Human Urbanism,

TEXT BOOKS

[4] D. J. Victor, 'Essentials of Bridge Engineering, OXFORD & IBH, New Delhi, 1973

[5] F. J. Taylor, 'Modern Bridge Construction' The Technical Press, London, 1951

[6] Sir Alfred Pugsley, 'The Theory of Suspension Bridges' Edward Arnold, 1957