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Effects of inclined pylon on Cable-stayed Bridge

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Abstract—Cable-stayed Bridge is the most unique structure in bridges developed in recent years. For long span bridges mostly cable stayed bridges and suspension bridges are constructed. These types of bridges give good aesthetic appearance to bridges. In recent years the pylon is also tilted in some of the bridges. In the present project, a comparative study tilting of pylon and its effects on other structural elements of bridges such as cables deck. A vertically erected pylon is modelled and analysed. For comparing with inclined pylon, pylon with 10,20 and 30 is being compare for structural parameters shear and bending. A 350m span is been modelled in MIDAS CIVIL. Most dominating factor i.e the Bending moment and Shear force is been compared for all the models.

Keywords— Inclined pylon, cable-stayed bridge, MIDAS CIVIL, structural parameters

I. INTRODUCTION

In recent years, a new type of bridge appears in the city. It is inclined pylon cable-stayed bridge. This bridge is not only in harmony with bridge aesthetics, but also form a spatial force transfer system through the balance between inclined pylon's self-weight and girder's load. However, studies on this new bridge have just started as it appears recently

II. AIM AND OBJECTIVE

The main aim of the paper is to analyse a slender bridge pier using various methods for second order effects, choosing the correct values from the various analysis reports and designing (rehabilitating) its foundation.

Objectives –

- To model cable stayed bridges by defining proper material and sectional property along with appropriate geometry .The Bridge will be modeled along with necessary boundary conditions and loading condition .Entire modeling and analysis will be done using FEA software MIDAS Civil 2016.
- To carry out static analysis for finding the initial pretension forces using unknown load factor method. Parametric study for truss forces, bending moments, axial forces and deflections will be carried out.
- To study the effect of tilting of pylon at inclination of 0^0, 10^0, $20^0$and 30^0 on structural members of cable stayed bridges such as deck and cable.
- To study the effect of load balancing concept and how moments gets generated in lower part of pylon.

III. METHODOLOGY

In this study comparison of different inclinations of pylon are compared with conventional system in terms of number of total cables, displacement, bending moment and shear force. Cable stayed bridge being highly indeterminate structure finding cable pretension force is a difficult task.

The following steps are followed for this analysis:

Step1: Cable stayed bridge modelling.

Step2: Generate load condition for dead load, main girder and unit pretension loads for cables

Step3: Calculate unknown load factor by unknown load factor condition.

STEP 4: CABLE FORCE TUNING AND DECK DEFLECTION CHECK.

STEP5: REVIEW ANALYSIS AND RESULTS

In order to determine the pretension in the truss element to satisfy constraints, Iteration will be required. The following procedure can be adopted:

1. Define the constraints and obtain the Unknown Load Factors for the Pretension Forces.
2. Determine the Pretension Force by multiplying those factors with the assigned Pretension Loads
3. Change the Pretension Forces with the new ones (obtainedinstep2)
4. Perform the Analysis.
5. Check whether the constraints are satisfied with modified pretensions
6. If not then determine the Unknown load factors again and keep repeating steps 2to5 till we get the constraints satisfied after static analysis (step5).

IV. MODELLING DATA

Total span of bridge	350m
Total height of pylon	78.5
Total width of deck	19m
Number of traffic lane	4
Width of footpath	1.2m
Analysis method	• Zero displacement method, • Analytical influence matrix method • Unknown load factor.
Codes used	• IRC 112-2011, • IRC 6-2014.

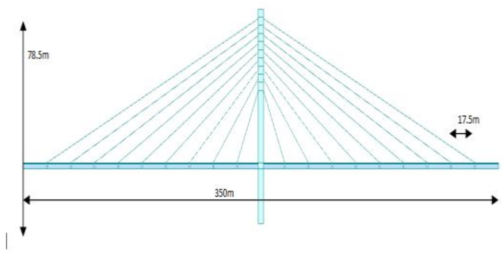

Fig1: Elevation of Cable stayed bridge 0^0

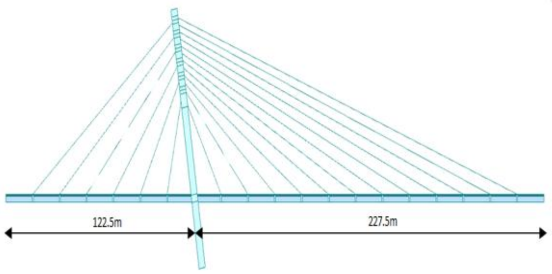

Fig2: Elevation of Cable stayed bridge 10^0

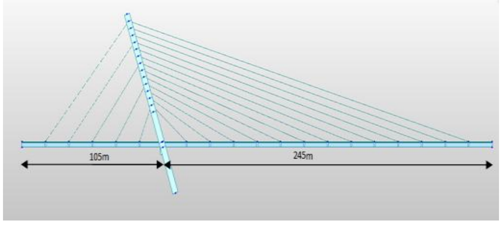

Fig3: Elevation of Cable stayed bridge 20^0

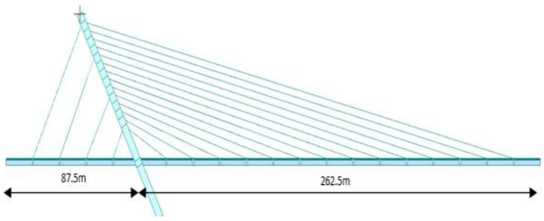

Fig4: Elevation of Cable stayed bridge 30^0

V. RESULTS

Inclination	0^0	10^0	20^0	30^0
Total no. of strands	1914	3238	4397	4949

Table.1: Total number of strands

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Inclination	0^0	10^0	20^0	30^0
Bending moment kNm	9594.68	72850.02	69057.83	70560.87

Table.2: Bending moment in cantilever portion of the pylon

Inclination	0^0	10^0	20^0	30^0
Bending moment kNm	9594.68	72850.02	69057.83	70560.87

Table.2: Bending moment in bottom portion of the pylon

Degree's tilt	0^0	10^0	20^0	30^0
Shear force kN	3825.32	28138.35	32879.6	33432.56

Table.2: Shear force in cantilever portion of the pylon

Degree's tilt	0^0	10^0	20^0	30^0
Shear force kN	20.93	15366.98	30437.62	34508.05

Table.2: Shear force in bottom portion of the pylon

VI. CONCLUSION

- Total number of strands for 0^0 is very less as compare to 10^0, 20^0 and 30^0.
- As angle of inclination of pylon increases total number of strand also increases resulting in uneconomical structure.
- Bending moment for 0^0 is quite less than other angle of inclination.
- For cantilever portion of the structure bending moment almost remains same but for the bottom part i.e. below the deck it increases considerably.
- Increase in bending moment at bottom of pylon, makes foundation of structure more heavy to be design.
- For 0^0 obviously the shear force is less as compare to other inclined angles

- Shear force for inclined pylons doesn't change considerably in cantilever portion.
- But same as bending moment, shear force also increases as we move towards bottom of pylon resulting in heavy foundation.
- Construction of inclined pylon is also tedious and cumbersome job.
- Hence, vertical pylon should be preferred over inclined pylon for economic and structural purposes

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