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Structural Behaviour of Cellular Box Girder & I Girder in Long Span Cable Stayed Bridge using Midas Civil Software

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ABSTRACT: Cable stayed bridges are becoming more popular these days. Cable stayed bridges offer a high degree of structural efficiency, attractive aesthetic, efficient use of structural materials, inexpensive design and maintenance cost. Cable stayed bridges can resist the earthquake loads in a better way. Basically, this investigation is carried out to study the structural behaviour of cellular box girder and I-girder in long span cable stayed bridges using MIDAS CIVIL software. The analysis and design are compared for cellular box girder and I-girder. The bending moment and shear force with both the girders are estimated along with the forces in each cable. The study shows that four celled box girders exhibit significant lower bending moment as compared to I-girder.

KEYWORDS: Stay Cables, Four celled Box-girder, I-girder, MIDAS CIVIL.

I. INTRODUCTION

The lifesaving cable-stayed bridges have beautiful architecture. The attractive designs and lower construction costs of cable-stayed bridges have led to an increase in their development all over the world. Due to the low damping and high flexibility associated with cable-stayed bridges, which are relatively common nowadays, they are vulnerable to strong earthquake shocks. Cable-stayed bridges offer a high degree of structural efficiency, attractive aesthetics, efficient use of the structural materials, and inexpensive design and the maintenance costs.

as a result, these kinds of bridges are becoming more and more common and are frequently chosen over suspension bridges for long-span crossings. One or more pylons with cables sustaining the bridge deck make up a cable-stayed bridge. The most popular designs of cable-stayed bridges are in terms of the cable configurations are semi-fan, fan, and fan bridges. These bridges require more complex analysis than normal bridges due to their vast size and nonlinear structural behaviour. The cables are primarily responsible for the nonlinearity in these bridges. It is difficult to create the best cable-stayed bridge design at the lowest possible cost while yet meeting strength and serviceability standard.

Cable-stayed bridges: The deck of a cable-stayed bridge is supported by cables to form one or more towers (also known as pylon). The cables or the stays, which extend directly from towers to the deck and usually take the form of fan-like design or a collection of parallel lines, are to identify its characteristic. The deck cables of a contemporary suspension bridge, by contrast, are suspended vertically in the form of main cable, which runs between the towers and anchored at both ends of the bridge. The cable stayed bridge is the best option for spans that are both shorter than the suspension bridges and longer than the cantilever bridges. Within this range, suspension bridge cable costs would increase and cantilever bridge weight would quickly increase.



Fig-1.Cable stayed bridge

II. RELATED WORK

Nayan K. Janbandhu and Sandeep Gaikwad et al. [1] Above authors have conducted research on the elements of a cable-stayed bridge. And cable stays in a variety of forms. STAAD PRO software was used for the analysis and design, and for significant structures, parallel hand computations were also performed for the study of the structure. They came to the conclusion that the cable-stayed bridges had substantially more rigidity than the suspension bridges, reducing deck deformation. Chen. D.W, F. T. K. Au et. al. [2] Above authors have described a method that has been put up as an alternative force equilibrium approach to the zero-displacement method for calculating the initial forces on cable. The authors first discussed the significance of cable-stayed bridges before analysing the techniques currently in use to calculate cable forces. In the paper, the approach has been described and an example is provided. The study work's findings include the following: A) The approach put forward renders the computation linear and eliminates the cable's stiffness. B) The vertical profile's impact on the bending moment has also been taken into consideration. Compared to the current ways, the one that has been offered is both more sensible and useful. Bhivgade [3] Due to its functionality, aesthetics, effectiveness, and stability, box girder bridge construction is becoming more and more common. In order to comprehend the link between the span to depth ratio and the prestressing force needed during construction, a full study of box girder design is presented in this work. The author designed and modelled the sections using SAP 2000 v14. Vikas A.C et.al. [4] Above authors have examined the structural behaviour of a cable-stayed bridge with a fan-shaped cable arrangement and cables that have experienced corrosion. The goal of the study is to comprehend how corrosion affects the tensile force in cables and to quantify the deflection of the deck, frequency of cable vibration, and reaction to earthquake. IRC 6- 2000 is the load that was placed on the bridge during design. Rajamallu & Jitha [5] The design of a post-tensioned, I-girder balanced cantilever bridge with a 50 m span has been studied in the article that follows. The name "balanced cantilever bridges" refers to the way they are built, which begins at permanent piers and moves toward the middle of the span. It was designed using MIDAS CIVIL. The bridge was built to withstand wind, earthquake, and dead loads.

III. METHODOLOGY

The following methodology has been adopted in this project:

- i Creating a model of a cable-stayed bridge using several girder types in MIDAS CIVIL.
- ii Specifying the components and sectional characteristics of a cable-stayed bridge.
- iii Assigning loads to the model, such as other loads, self-weight, and pretension cable force.
- iv Providing IRC class AA monitored loading when assigning a vehicle definition from the vehicle data base.
- v Assigning each load combination and the earthquake's time history data.
- vi Finally, analyse the cable-stayed bridge.

ANALYSIS OF CABLE STAYED BRIDGE IN MIDAS CIVIL SOFTWARE

The modelling was carried out using the MIDAS CIVIL software. Better working conditions are provided by the program me itself it is simple to apply. The static and dynamic analysis, was also performed with the MIDAS CIVIL.

The procedure of calculating initial prestresses for cable-stayed bridges by unknown load factor is outlined in fig.1 below.

Table- 1Data for the Analysis

Overall length of the bridge	300m
Type of the bridge	Cable stayed bridge
Shape of the pylon	'h' shape
No. of pylons	Two twin pylons
Deck width	10.5m
Depth of the deck	2m
Type of the decks	Multi-cell girder & i-girder
Arrangements of the cables	Semifan type
Min. Road clearance	7.5m
Footpath width	1.25m

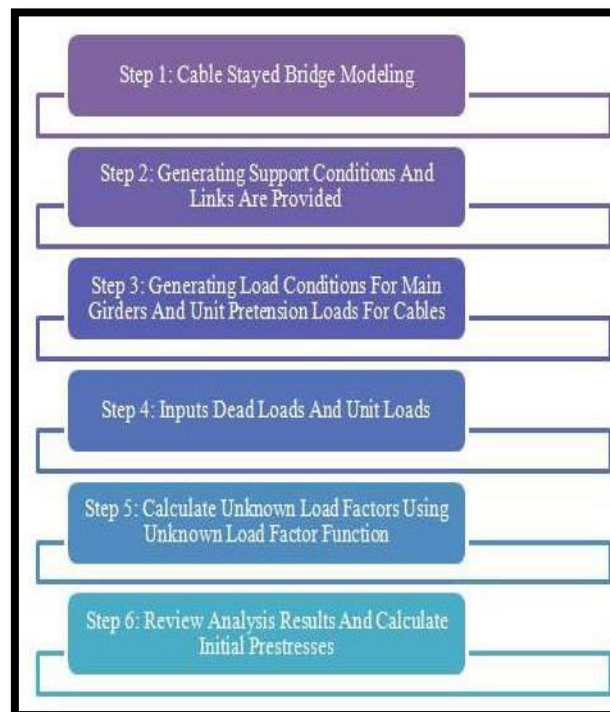


Fig. 2. Flowchart of cable force turning



IV. EXPERIMENTAL RESULTS

Results of initial forces in cables stay: The cable stays are designed for tensile forces which act as an axial load due to effect of dead load, moving load and all load case effects. Below table 2 shows the results of the stay cables design.

Table-2Initialaxial forces in cables

CablENO.	Pretension forces(kN)
C1	5615.0
C2	89.3
C3	2811.3
C4	4479.8
C5	5389.5
C6	8138.0
C7	8954.4
C8	9543.9
C9	9758.1
C10	9790.4
C11	9693.6
C12	7697.9
C13	6724.0
C14	5637.5
C15	3789.8
C16	2576.5
C17	2449.0
C18	2071.9
C19	1350.8
C20	1054.5

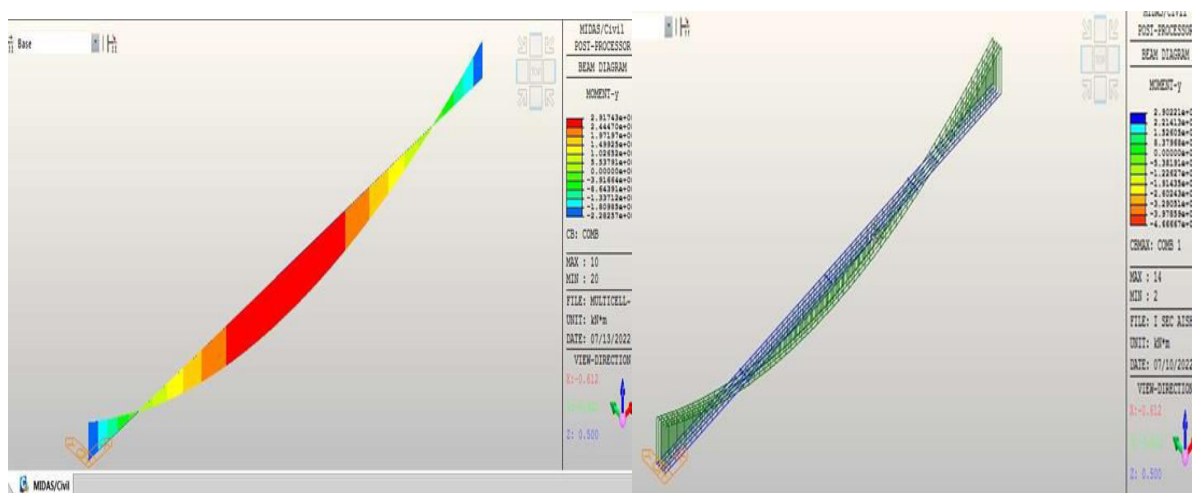


Fig-3. Bending moments obtained from MIDAS CIVIL for four celled box girder and I-girder.

TABLE-3 BENDING MOMENTS OBTAINED FROM THE ANALYSIS

Maximum BM in four celled box girder	Maximum BM in I-section girder	Units	Remark
(+ve) BM = 72758	79969	kN-m	+ve BM is more in the I-section. Hence, satisfied.
(-ve) BM = 57242	93333	kN-m	-ve BM is more in the I-section. Hence, satisfied.

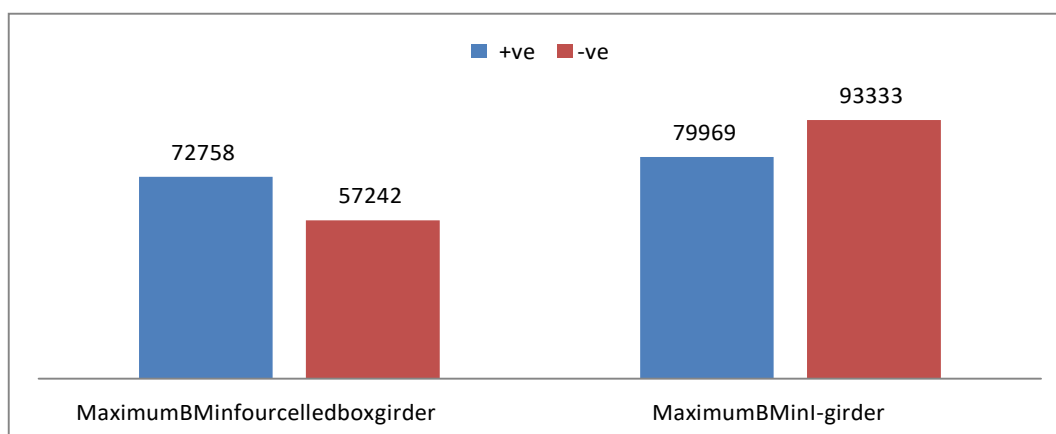


CHART-1 BENDING MOMENT COMPARISON

Discussion:

1. Table 4.1 shows the axial tension forces in the cable stays. It can be seen that the maximum forces are least at the support and increase in the mid support.
2. It has been found that the axial shear forces in the pylon are 59615 kN and BM obtained is 5125 kN-m.
3. The above graph shows the -ve and +ve BM are maximum in I-section girder when it is compared with the four-celled box girder which is efficient.



V. CONCLUSION

1. For any bridge construction involving spans of 300 metres or more, a post-tensioned concrete cable-stayed bridge is the best option.
2. Since the cables can withstand higher axial tensile force, cable-stayed bridges are substantially more rigid.
3. According to the study, the H-shaped pylons have low levels of sagging moment in the cables, and the deck's non-homogeneity is caused by the higher number of joints, which means that the concentration of stress and tension carrying capacity of the cables was not effectively distributed to the other parts of the cable and may result in maximum concentration in some cables.
4. It was found that response of the four celled box girder is efficient as compared to I-section girder.
5. So, the effective way to resist weight is by in cooperating the cells in girder than the I-section girder.

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