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Analytical Investigation of Cable Stayed Bridge using Various Parameters

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Abstract - In this paper, analysis of 240 m long fan type cable stayed bridge having single plane of cables is carried out with the help of software facilities. Effects of various parameters such as stiffness of deck and pylon and number of cables on the behaviour of cable stayed bridge were observed. To save time in modelling of bridges manually, a programming tool has been developed in excel software with the help of visual basic macro for the purpose of parametric study of Cable stayed bridge. With the help of this tool, number of models of cable-stayed bridge can be automatically generated in software SAP-2000. From the analysis of number of models, comparison of bending moments at critical locations in the structure is done.

Keywords – Cable stayed bridge, parametric study, SAP2000, Interactive Database, VB program, Form control, Class 70R, Class A.

I. INTRODUCTION

With an ever-increasing demand for expansion of highway networks, to cater for increased traffic, new challenges have come up to researchers and designers to provide best innovative bridge structures. As one of the most competitive bridge in modern times, the cable-stayed bridge is usually a hub for transportation projects. Cable stayed bridge has a fine-looking appearance and fits in with most surrounding environments. Cable-stayed bridges are large and sophisticated structures which may greatly benefit from the use of structural optimization techniques for preliminary design improvement. Many scientists had performed parametric study of cable stayed bridge. Hany W. George studied effect of recent American & British long span bridge loads on the design of steel, composite & concrete decks of cable stayed bridge. He showed that longitudinal moments of steel, composite & concrete decks differ considerably due to dead & live loads. P.N.Godbole investigated effect of parameters such as pylon height, use of uniform & different cable diameters & different boundary conditions. He showed that with increasing height of pylon, the cable tension decreases, beam forces decreases however there is increase in pylon forces. From these studies, it has been concluded that for more accurate analysis of cable stayed bridge, some other parameters also require to be considered such as depth of stiffening girder, stiffness of pylon and length of central panel in addition to number of cables and pylon.

II. STRUCTURAL ANALYSIS

In this paper, a fan type cable stayed bridge having single plane of cables has been analysed. This bridge has three spans - the central span has length of 140.0 m and other two side spans are having length of 50.0 m each as shown in Fig.1. Total width of box girder deck is 15.0 m carrying four lanes of traffic. Live load combinations with class 70R and class A vehicles as per IRC:6-2014 are considered. Various parameters considered in the study are pylon height and width, depth of box girder, length of central panel and number of cables. The effect of parameters is studied through comparison of bending moments at following critical locations.

- Sagging moment at midspan of central panel of deck
- Hogging moment in deck at pylon location
- Moment in Pylon at deck level

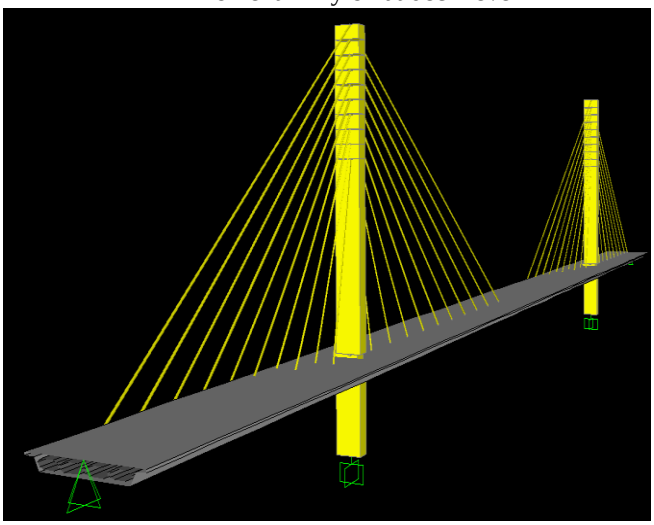

Fig.1 Cable stayed bridge Model in SAP2000

III. DESCRIPTION OF PROGRAM

'SAP2000" has a special feature called 'Interactive Database'. Using this feature the software can be interacted with other softwares such as MS-Excel, MS-Word.

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This feature can send the data table to Microsoft Excel, which launches automatically and displays the table. The model input can be written in MS-Excel and imported to the SAP2000 so that model can be generated. Also desired result output after analysing the model in SAP2000 can be transferred to Excel format. For parametric study of cable stayed bridge, a programming tool is developed in excel with the help of visual basic macro. With this programming tool, by putting few parameters, model of cable stayed bridge is automatically generated in SAP2000.

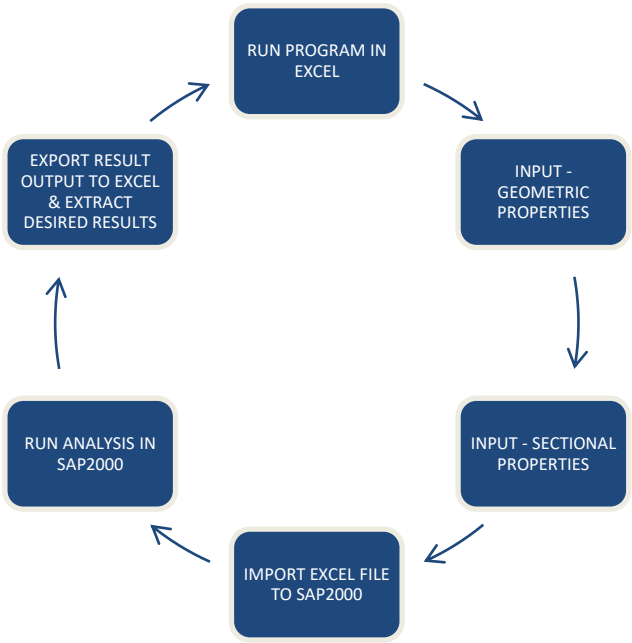

Fig. 3 Flow Chart

The program is written in excel with the help of two form controls namely 'Geometry' and 'Sectional Properties'. As the program runs, a window will appear on screen and it will ask certain parameters of the bridge which need to be specified for purpose of modelling. After putting values of various parameters, program is executed. Then this excel file is imported to software 'SAP2000'. After analysing the model, result output is exported to excel format. Typical flow chart is shown in fig.2. Bending moments at critical locations are found out and charts for these bending moments are prepared. Typical charts are shown in fig.3 & fig.4.

IV. CONCLUSION

From these graphs, various effects on maximum moments in deck at midspan of central panel and at pylon location and maximum moment in pylon at deck level were observed in governing load combinations which are as follows.

- With increasing height of pylon, sagging moment in central panel of deck and moment in pylon at deck level tend to reduce whereas hogging moment in the deck at pylon location tend to increase.
- With increasing depth of box girder deck, moments in box girder deck tend to increase as more stiff deck attract more forces whereas moment in pylon at deck level tend to reduce.
- Due to increase in pylon cross sectional properties, moment in pylon at deck level tend to increase drastically. But this has less significant effect on moments in deck.
- If length of central panel is increased, then it is obvious that there will be significant increase in the midspan of central panel. Also increase in moments in pylon at deck level can be seen. Hogging moments in deck at pylon location do not alter much.
- With increasing number of cables, sagging moment in central panel of deck and moment in pylon at deck level tend to reduce whereas hogging moment in the deck at pylon location tend to increase.

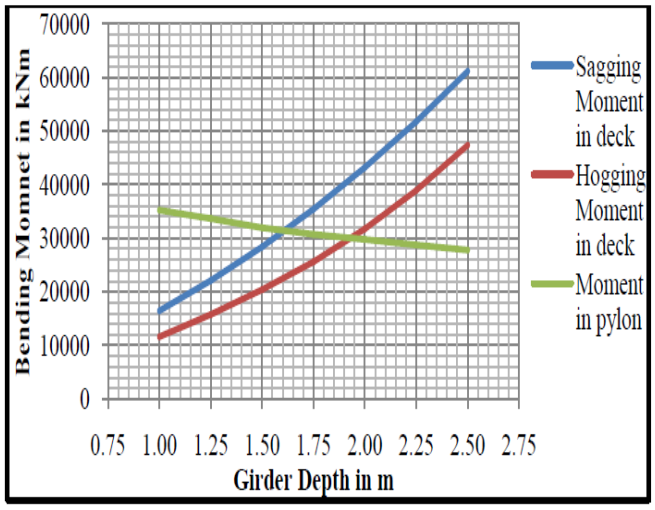

Fig.3 Graph- Girder Depth vs bending Moments

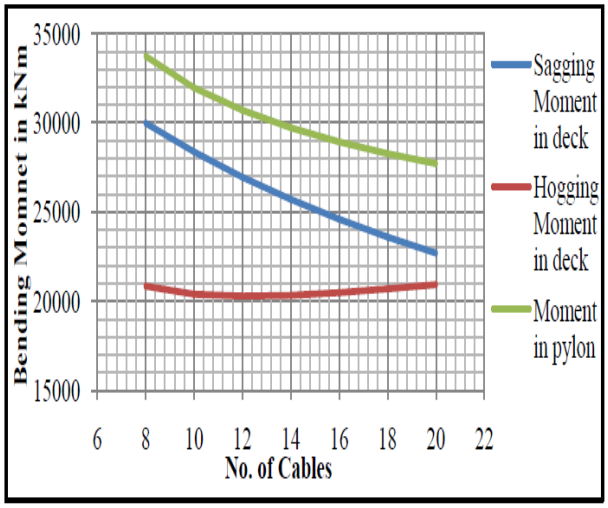

Fig.4 Graph- Number of cables vs bending Moments

From all these observations, it is seen that stiffer sections of deck and pylon will produce more bending moments in the corresponding bending moments. It is preferable that slender sections should be used for deck and pylon so as to achieve economical solution. Further, use of more number of cables reduces bending moments in overall structure.

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