AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

STRUCTURAL ENGINEERING DEPARTMENT

Study of the impact of increasing the span of self-anchored suspension bridge on the bridge components

Thesis

Submitted in Partial Fulfillment of the Requirements of the Degree of Master of Science in Civil Engineering (Structural Engineering)

By

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STATEMENT

This thesis is submitted to Ain Shams University for the degree of M.Sc. in Civil Engineering.

The author carried out the work included in this thesis , and no part of it has submitted for a degree or a qualification at any other scientific entity.

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ABSTRACT

This thesis aims to indicate the behavior of self-anchored suspension bridge (Pylon- Girder and Cables) of prestressed concrete girder type when the main span increases from 160 meters up to 500 meters while monitoring the impact of this increase on the bridge components. For analyzing the bridge behavior at increasing span , parametric study has been done to clarify the relation between bridge components and the impact of changing the geometrical properties for each of the elements on other elements that maintain the same properties with presenting the results of the studied six models for each element and also the impact of the sag value on other bridge elements has been figured out for the three studied models.

To determine the straining actions of bridge components under both dead and live loads a study on eight models with different spans has been considered ,the increment process is done using scaling method as all of the bridge geometrical properties and components dimensional properties are selected relative to the bridge main span.

The results of the different models were presented separately on each element of the bridge. A comparison was made between the results obtained from the "CSI BRIDGE 20" program which was used for the analysis of the study and compared with the results of the manual solutions with the suggestion of another method of manual solution in accordance with the nature of the bridge and show the results and the percentage of the results differences from the solution extracted from the program for all eight studied models.

The results clarify that with increasing the span the bridge components straining actions under dead and live loads have monotonous and regular increase which mean that the validated dimensions proved to be efficient, the prestressing system is important in order to control the stresses at girder and keep them at allowable range which indicates the difficulty of reaching this limit of spans using a reinforced concrete girder.

The study concluded the possibility of access to a span of more than 500 meters after studying the behavior of the bridge elements during the operational phase with a necessity to study the behavior of the bridge components during the construction phase in future studies on this type of bridges.

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Summary

This study was carried out in the light of what is observed for this type of suspension bridges, as the span range for self-anchored suspension bridge considered to be limited compared to the conventional suspension type and to analyze the causes for this phenomenon the bridge behavior has been studied through the final stage under both of dead and live loads.

A set of preliminary studies were done to achieve the purpose of this research and also to clarify the behavior of the bridge depending on different cases and conditions.

Parameter study on the verified reference model considered changes of four bridge components and geometries (Girder-Cable-Pylon-Sag) is done to determine the effect of elements on each other and also on the bridge general behavior.

A comparison between results of analysis using CSI bridge and manual calculations using elastic theory for the calculation of initial forces at main cable under permanent loads and (increase at cable force-girder bending moment-girder deflection) under live loads analysis is done for all of the models of different spans which start from main span of 160 meters till 500 meters to clarify the difference between results using different theories.

The behavior of the bridge at span increase was analyzed for different models with span up to 500 meters which considered to be more than any of the existent span for this type of bridges.

This thesis contains seven chapters

Chapter One: Introduction

This chapter is concerned with the identification of the self-anchored suspension bridge and its components, study objective, summary of thesis content and comparison between it and the conventional suspension bridges.

Chapter Two: Bridge Review

This chapter presents an overview at what has been achieved historically in this type of bridges, reviewing the theories used for analysis, clarifying the geometric characteristics of a number of bridges of this type at different time periods and highlighting the main obstacles to reaching a relatively larger spans.

Chapter Three: Reference Model

This chapter indicates the followed basis for reference model geometrical properties through which a series of comparisons and studies will be carried out, studying the detailed geometrical and mechanical characteristics of the components, load model and loading cases on the bridge, primary analysis for the bridge components cross sections.

Chapter Four: Validation of Reference Model

This chapter includes definition of the used code, clarifying the validation procedures of the bridge components and the process of components validation for different sections according to the properties of the studied element.

Chapter Five: Parameter Study

This chapter shows the relationship between bridge components and the impact of loads acting on each of the components according to other components cross sections and make the final conclusion of those effects

Chapter Six: Span Increment Possibility

This chapter presents a comparison between the bridge straining actions results for manual calculations & computer analysis and indicates the effect of increasing the main span and other bridge geometries on each element of the bridge to determine its behavior at a relatively larger spans with making a final conclusion of the studied models.

Chapter Seven: Conclusion and Recommendations

This chapter outlines a summary for a set of final conclusions reached from studying different models of the bridge as well as the recommendations to be taken into account in the future studies of this type of bridges.

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