FINITE ELEMENT ANALYSIS OF PRESTRESSED CONCRETE BOX GIRDER BRIDGE

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To my precious family

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ABSTRACT

Curved concrete bridge girders have very complex internal forces, stress and strain distribution. As a consequence of their shape, not only the usual bending moments and shear forces are generated, but also important torsion moments are created. These moments rotate the axes of principal tensional stresses and increasing the risk of cracking. A study of torsional moment is found limited in the literature. Post-tensioning can prevent the cracks, but the additional of compression forces in different directions increase the complexity of stress and strain fields sometimes tendons lead to break away the web. Therefore, the curved post-tensioned concrete girders must be particularly designed and carefully constructed. The complete Senai Bridge has been modeled and used for a case study. Trapezoidal section has been chosen in the present investigation. The linear analysis of the box girder has been carry out by using LUSAS software. Three dimensional line modeling have been employed for discretization of domain and to analyze the complex behavior of straight and curved box-girders. Dead Load and Live Load according to British Standard code of practice, for zero torsion as well as maximum torsion are considered. Box section produces higher torsion in curved span compared to straight span with considering the same load. From the analysis result shows that higher thickness of the base and walls leads to increasing the torsional moment.

ABSTRAK

Jambatan konkrit galang melengkung mempunyai daya-daya dalaman yang sangat kompleks, tekanan dan pengedaran ketegangan. Akibat bentuk tersebut, bukan sahaja momen lentur yang biasa dan daya ricih yang dihasilkan, tetapi momen kilasan juga akan terhasil. Momen ini memutar paksi tegasan tegangan utama dan meningkatkan risiko keretakan. Kajian mengenai momen kilasan didapati terhad dalan literatur. Pasca-tegangan boleh mengelakkan keretakan, tetapi tambahan daya mampatan dalam arah yang berbeza boleh meningkatkan tekanan yang komplek dan medan terikan tendon juga boleh membawa kepada pemisahan web. Oleh itu, konkrit pasca-tegangan galang melengkung perlu direka bentuk dan dibina dengan teliti. Jambatan Senai telah dimodelkan dan digunakan sebagai kajian kes. Seksyen trapezoid telah dipilih dalam kajian ini. Analisis linear galang kotak telah dijalankan dengan menggunakan perisian LUSAS. Tiga dimensi model garis telah digunakan dalam pengdiskretan domain untuk menganalisis tingkah laku yang kompleks ke atas kotak lurus dan melengkung. Beban Mati dan Beban Hidup menurut Specifikasi British, untuk kilasan sifar serta kilasan maksimum dipertimbangkan. Seksyen Kotak menghasilkan kilasan lebih tinggi dalam rentang melengkung berbanding rentang lurus untuk pembebanan yang sama. Dari hasil analisis menunjukkan bahawa peningkatan ketebalan asas dan dinding boleh membawa kepada peningkatan momen kilasan.

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INTRODUCTION

1.1 Background

Box girders, have gained wide acceptance in freeway and bridge systems due to their structural efficiency, better stability, serviceability, economy of construction and pleasing aesthetics. Analysis and design of box-girder bridges are very complex because of its three dimensional behaviors consisting of torsion, distortion and bending in longitudinal and transverse directions. The longitudinal bending stress distribution in wide flange girders is distributed non-uniformly throughout the width it remain maximum at the edge and reduces towards the centre, and usually cannot be obtained accurately from elementary beam theory.

1.2 Problem statement

Analysis of prestressed concrete curved box girder bridges is complicated by some factors, including shear, torsional moment, interaction between shear and torsion and degree of horizontal curvature.

Torsional moment is created in the curved concrete box girder in an eccentric loading case which increases the risk of cracking. When Post-tensioning is used somehow can prevent the cracks, but the additional of compression forces in different directions increase the complexity of stress and strain fields sometimes tendons lead to break away the web. A study of torsional moment is found limited in the literature review.

1.3 Objectives

The overall objective of this project is to obtain analysis data that will be useful for the design guidelines for composite curved box girders. Specific objectives include the following:

- Investigate and quantify the effect of loading on torsional behavior in both existing spans, straight and curved box girder.
- Investigate the effect of base & wall thickness of cross section on torsional behavior in straight & curved span.

1.4 Scope of the study

The scopes of the study are defined to achieve the objectives of the research are shown as below:

- The research focuses on the concept study; analysis of pre stresses concrete box girder deck.
- Box girder analysis is based on finite element method.
- Torsion is the main concerns of study.
- The procedures of pre stresses concrete box girder analysis are developed into software by using LUSAS. The input data can be easily manipulated by user and the analysis results can be obtained directly from the software.

1.5 Importance of the study

LUSAS software for the analysis of 3-dimensional curved box Girder Bridge has been developed to obtain study result based on BS code of practice since the program can consider all structural behavior such as torsion, distortion, longitudinal & transverse bending, & shear lag.

Analysis of box girder by using FEM is time saving and more accurate compared to manual calculation, the software can perform the analysis well to ensure safe and reliable bridge with optimum size of pre stressed and reinforced curved box girder design.

Analysis of curved deck by FEM gives a good approximation for analyzing the structure then from analysis the exact location of tendons, location of reinforced bars, thickness of the webs and flanges can be indicated.

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