PARASITIC MOMENT EFFECT FOR THE THREE SPANS CONTINUOUS PRESTRESSED CONCRETE BRIDGE

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To my beloved parents and family

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ABSTRACT

In the analysis of a continuous prestressed concrete bridge, Dead Load (self-weight of bridge), Superimposed Dead Load (Surfacing and Parapet) and Live Load (HA, HB or combined) are considered as major loadings for bridge structure. However, there are other factors that should be considered in the analysis such as Parasitic Moment. The effect from parasitic moment can contribute a significant value in designing a continuous prestressed concrete bridge. This study focuses on the effect of parasitic moment for a three spans continuous prestressed concrete bridge. An analysis of a continuous bridge using Staad Pro software is carried out to determine the parasitic moments of the bridge. The parasitic moments obtained from Staad Pro are slightly higher compared to the parasitic moments from Adapt software with a difference less than 10 percent. The parasitic moment is sagging throughout the whole bridge and the maximum moment is at the second span. A positive value of the parasitic moment will increase the value of the sagging moment at the mid span but will reduce the hogging moment at the support. For the case when parasitic moment effect is considered, the stress at bottom of beam is lower than the stress at top of beam. Whereas, the situation is reverse for the case when parasitic moment effect is not considered. If the same dead load, superimposed dead load and live load proportions are to be considered, the resultant stress at bottom of the beam will exceed the tensile stress limit when the parasitic moment proportion is more than 55% of the total moment. Hence, the parasitic moment effect should be considered in the design of a continuous prestressed concrete bridge especially when it comes to the value of moment at the mid span of the bridge.

ABSTRAK

Dalam analisis jambatan konkrit prategasan selanjar, beban mati (berat sendiri jambatan), beban mati kenaan (permukaan dan dinding jambatan) dan beban hidup (HA, HB atau gabungan) dianggap beban utama bagi struktur jambatan. Walau bagaimanapun, terdapat factor-faktor lain yang perlu dipertimbangkan dalam analisis seperti momen parasitik. Kesan daripada momen parasitik boleh menyumbang nilai yang signifikan dalam mereka bentuk sesebuah jambatan konkrit prategasan selanjar. Kajian ini menumpukan kepada kesan momen parasitik terhadap jambatan konkrit prategasan selanjar yang mempunyai tiga rentang. Analisis jambatan selanjar menggunakan perisian Staad Pro digunakan untuk menentukan momen parasitik jambatan tersebut. Momen parasitik yang diperolehi daripada Staad Pro adalah lebih tinggi berbanding momen parasitik daripada analisis perisian Adapt, dengan perbezaan kurang daripada 10 peratus. Momen parasitik adalah melendut pada keseluruhan jambatan dan momen maksimum adalah pada rentang kedua. Momen parasitik positif akan meningkatkan momen melendut di tengah rentang dan mengurangkan momen meleding di penyokong. Apabila kesan momen parasitik diambil kira, tekanan di bahagian bawah rasuk adalah lebih rendah daripada tekanan di bahagian atas rasuk. Manakala, keadaan adalah sebaliknya bagi kes apabila momen parasitik tidak dipertimbangkan. Jika bahagian beban mati, beban mati kenaan dan beban hidup yang sama dipertimbangkan, tekanan di bahagian bawah rasuk akan melebihi had tegasan tegangan apabila momen parasitik melebihi 55 peratus daripada jumlah momen. Oleh itu, kesan momen parasitik perlu dipertimbangkan dalam rekabentuk jambatan konkrit pretegasan selanjar terutama jika melibatkan nilai momen di pertengahan rentang jambatan.

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2-D	-	Two-dimensional space
A, A_s	-	Area of section
d	-	Diameter
e, e_c	-	Eccentricity
E, E_s	-	Modulus of elasticity
f_{cu}	-	Concrete strength
I	-	Moment of inertia
l	-	Span length
M	-	Bending moment
NA	-	Neutral axis
P, P_{ult}	-	Force
w	-	Load per meter
y_b	-	Distance of cable from bottom section
Z_b, Z_t	-	Section modulus
θ	-	End rotation

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CHAPTER 1

INTRODUCTION

1.1 General

Normal practice in bridge design is to combine the longitudinal and transverse designs, different load conditions and long term effects in order to suit the design requirements. However, these criteria are practically analyzed separately. The analysis that commonly used to derive the forces and moments for bridge design is two- or three dimensional finite-element modeling or grillage models. This type of analysis can be applicable for any types of bridge materials as steel, prestressed concrete and many more.

Prestressed concrete is frequently chosen as the material for bridge constructions. This is because the development of prestressed concrete bridges has given the bridge engineers increased flexibility in his selection of bridge form and in the construction techniques available. Prestressing in bridgeworks is normally applied as an external force to the concrete by the use of wires, strands or bars, and can greatly increase the strength of concrete alone. This can result in longer or slender spans, which improves aesthetics while providing economy in the construction (Hewson, 2003).

For prestressed concrete bridge, the prestress effect must be applied within the model as other loads. The principle of prestress design is to make sure that the resulting stress came from primary and secondary effects are within the allowable limit. The stress is generated due to self-weight and loadings from the prestress effect. The secondary moment such as parasitic moment is one of the prestress effects. If the resulting stresses are exceeding the allowable limit, adjustments have to be made to the prestress arrangement. So, it is important to analysis the prestress effects before determining the final bridge design.

The stresses inside the prestress structure also undergo short and long term losses such as creep and shrinkage. Since the continuous prestressed concrete bridge generally constructed stage-by-stage, each stage must be analyzed separately to obtain the moments, shears and prestress effects for that stage. The total moment and force distribution at each stage is the combination of the results from the stage and from all the earlier stages. However, the results from previous stages must be modified to consider the long term losses. At the final stage, the analysis results for the completed structure are calculated after all long term losses occurred and these values are used to verify the final design.

1.2 Problem Statement

In analysis of a continuous prestressed concrete bridge, Dead Load (self-weight of bridge), Superimposed Dead Load (Surfacing and Parapet) and Live Load (HA, HB or combined) are considered as major loadings for bridge structure. However, there are other factors that should also be considered in the analysis such as Parasitic Moment. The effect from parasitic moment may contribute a significant value in designing a prestressed concrete bridge. If this effect is neglected, improper design of bridges may be obtained. Furthermore, if the total stresses resulted from the applied loads and this additional effect exceeded the capacity of the bridge, the bridge may fail.

1.3 Aim and Objectives

The aim of this study is to study the parasitic moment effect for three-span continuous prestressed concrete bridges. The objectives for this study are:

i. To analyze the three-span continuous prestressed concrete bridge due the parasitic moment effect with Staad Pro.
ii. To compare the analysis results from Staad Pro. with existing results from Adapt.
iii. To determine the effect of parasitic moment for the three-span continuous prestressed bridge.
iv. To propose a suitable position for considering the parasitic moment effect that will have some significant in the design of three-span continuous prestressed concrete bridge.
v. To determine the limit of parasitic moment's value which will be significant in the design of three-span continuous prestressed concrete bridge.

1.4 Scope of Work

This study only focuses on the Putai Bridge which is a three-span continuous prestressed concrete bridge. The dimensions, section properties and tendons location of the bridge will be shown on Appendix section. The bridge will be modelled in Staad Pro. for different stages. The stages consider will follow the sequences of construction. This model will be analyzed for self weight, superimposed dead load and highway loadings at different stages. Parasitic moment effect will be analyzed using line-beam analysis. The eccentricities and forces of tendons inside the complete prestressed concrete bridge are applied directly to the model. The analysis results from Staad Pro. are compared to the existing results from Adapt to determine the accuracy of the model. The resultant stresses of the prestressed concrete beam is checked against the stress limit using spreadsheet.

1.5 Significant of Study

i. The study will shows the method to analyze the parasitic moment effects by using general structural analysis such as Staad Pro.

ii. The study will show the effect of parasitic moment for the continuous prestressed concrete bridge.

iii. The study will be the basis on whether parasitic moment values will be of some significant in designing continuous prestressed concrete bridge.

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