MANUAL METHOD TO FIND CABLE FORCES IN EXTRADOSED BRIDGES

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Degree of Master of Science in Structural Engineering

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DECLARATION

I declare that this is my own work and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

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The above candidate has carried out research for the PhD/MPhil/Masters thesis/dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of Supervisor:

Signature of the Supervisor: Date:

DEDICATION

This thesis is dedicated to the people who have supported, inspired, and guided me throughout this journey.

To my parents, whose unwavering love, encouragement, and sacrifices have laid the foundation for everything I have achieved. Your belief in me has been a constant source of strength.

To my wife and daughter, for your endless patience, understanding, and the immeasurable support you have shown. Your love and encouragement have been my guiding light through every challenge.

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ABSTRACT

The first extradosed bridge was completed in 1994 and within the following three decades, this new bridge type has gained popularity due to its indistinguishable appearance to a cable stayed bridge. Balanced cantilever construction method was adopted in many of the extradosed bridges. Limited number of reference availability to study the extradosed bridges has limited the understanding of design concepts and practicing the designs among the engineers. Objective of this research is to develop a manual calculation method to determine the stay cable force for a prestressed concrete extradosed bridges constructed using balanced cantilever method. In addition, a detailed explanation about the design concepts, construction methods and comparison of extradosed bridge with other bridge types is also intended in this study.

Determination of the stay cable force has been a challenging task for extradosed bridges due to its high statical indeterminacy. At present, modern bridge design software equipped with the required iteration functions are used mainly for this but no literature is available to manually approximate the stay cable force for an extradosed bridge constructed using balanced cantilever method. This research aims at bridging this gap and assisting the readers to understand all the basic concepts with regard to an extradosed bridge built using balanced cantilever method.

Detailed literature review was conducted to understand the design concept and the initial sizing of the members. Based on the study, it was identified that the self-weight and the internal prestressing forces are the two main factors which affect the required final stay cable force. This was further verified using a computer analysis model developed using CSiBridge software. In developing a manual calculation method, it was assumed that the bridge behaves as a propped cantilever vertically supported at the stay cable anchorage locations. With the internal prestressing applied as a bending moment, self-weight applied as a uniformly distributed load (UDL) and the form traveller load applied as a point load at the cantilever end, stay cable force required was determined considering that the total displacement at cable anchorage location requires to be zero. Several assumptions were made in this simplified method and the stay cable force determined from the simplified method was found to be reasonably accurate compared with the actual force.

Keywords: extradosed bridge/cable force/form traveller/balanced cantilever/manual calculation

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LIST OF ABBREVIATIONS

Abbreviation	Description
UDL	Uniformly Distributed Load
COG	Centre of gravity
HDPE	High Density Poly Ethylene
f_{pu}	Tensile strength of the strands
$\Delta\sigma_L$	Stress variation of the strands
P	Form traveller weight
w	Self-weight of the box girder as a UDL
T	Vertical component of the stay cable force
L	Cantilever length
M	Moment about the COG due to internal prestressing
a	Distance from edge of cantilever to point considered
δ	Displacement of the cantilever at free end

LIST OF APPENDICES