Studying the Influence of Prestressing and Pounding Loads on Quasi-Isolated PC Cable Stayed Bridges with Rigid Pylon Deck Connection Using Experimentally Verified Model

By

Mohamed Abdel-Shakour Hasan Hassanoun

A thesis submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY

In

STUCTURAL ENGINEERING

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2015

Studying the Influence of Prestressing and Pounding Loads on Quasi-Isolated PC Cable Stayed Bridges with Rigid Pylon Deck Connection Using Experimentally Verified Model

By

Mohamed Abdel-Shakour Hasan Hassanoun

A thesis submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY

In

STUCTURAL ENGINEERING

Under the Supervision of

Prof. Dr. Akram Mohamed A.Torkey
Professor of Reinforced Concrete Structures
Structural Engineering Department
Faculty of Engineering, Cairo University

Prof. Dr. Walid Abdel-Latif Attia
Professor of Structural Analysis and Mechanics
Structural Engineering Department
Faculty of Engineering, Cairo University

Prof. Dr. Eehab Ahmed Badrel-Din Khalil
Professor of Structural Engineering
Construction Research Institute
National Water Research Center

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2015

ACKNOWLEDGMENTS

First, and foremost, all thanks to ***ALMIGHTILY ALLAH*,** most gracious and most merciful.

I would like to express my sincere thanks and indebtedness to Prof. Dr. ***Eehab Khalil***, Prof. Dr. ***Walid Attia*** and Prof. Dr. ***Akram Torkey*** for their supervision during this work and contribution in the published paper "***Influence of Deck Longitudinal Prestressing on Cable-Stayed Bridges***".

Grateful acknowledgment to Dr. ***Eehab Khalil*** for valuable help and the objective assistance he provided for me during all steps of the current research.

I also which to express my appreciation to the staff of ***Arab Academy of Science, Technology, and Maritime Transport-South valley branch*** for their encouragement during this work with special thanks for Prof. Dr. ***Mohamed Basher***.

Many thanks to members of the ***Japan International Cooperation Agency (JICA)*** *team and* ***General Authority of Roadways and Bridges*** in Egypt for providing as built drawings and for help during the inspection and investigation.

Finally, beat thanks to all those who, in one way or another, have helped in making this work possible.

Mohamed AbdEl-Shakour Hasan

DEDICATION

This work is dedicated to my dear parents for their love, support, and scarifies that guided me in all my pursuits in life, with a special dedication to my sincere wife and beloved son for their patience since the beginning of this study.

Mohamed AbdEl-Shakour Hasan

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS

E_{eff}	Elastic modulus taking into consideration sagging effect
E_o	Elastic modulus of cable material
γ	Specific weight of cable material
σ	Axial stress in cable
L_h	Projected length of cable in plan
t_e	Elastomer single layer thickness
t	Total elastomer thickness
μ	Coefficient of friction
K_r	Unloading stiffness
G	Shear modulus
S	Shape factor
K_H	Horizontal stiffness of bearings
K_V	Vertical stiffness of bearings
K_θ	Rotational stiffness of bearings
B	Bulk modulus
K_p	Nonlinear impact spring stiffness
g_p	Expansion joint gap length
u_1	Displacement of bridge end 1
u_2	Displacement of bridge end 2
C_p	Impact damping coefficient (energy dissipated during impact)
ζ	Impact damping ratio
e	Coefficient of restitution (represents the degree of rebound)
m_i	Mass of span
F	Cable tension
V	Vertical component of cable tension (equivalent to total vertical loads of deck)
V_w	The portion of deck loads carried by the web
V_b	The portion of deck loads carried by the central beam
Ø	Load distribution ratio
P	Tendon jacking force
C	The generated compression force in the strut
T	The effective prestressing tension in inverted V-tendons
Θ	Cable vertical angle of inclination
γ	Strut/Tendon vertical angle of inclination
ξ	Web vertical angle of inclination
ΔP	Total losses in jacking force (short term + long term)
α	Percentage of total loss in jacking force
η	Percentage of minimum jacking force to cable tension
γ	Specific weight of cable material
σ	Axial stress in cable
L_h	Projected length of cable in plan
t_e	Elastomer single layer thickness
$S_d(t)$	Design response spectrum