CONSTRUCTION STAGE MODELING AND ANALYSIS OF PRESTRESSED CONCRETE CABLE-STAYED BRIDGE

By

Shady Kamel Esmail El-Shafai

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
STRUCTURAL ENGINEERING

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Under the Supervision of

Prof. Dr. Walid Abdel-Latif Attia

Professor of Structural Analysis and Mechanics
Structural Engineering Department
Faculty of Engineering, Cairo University

Prof. Dr. Eehab A.B. Khalil

Professor of Structural Engineering
Construction Research Institute
National Water Research Center

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Approved by the
Examining Committee

____

Prof. Dr. Walid Abdel-Latif Attia (Thesis Main Advisor)
Professor of Structural Analysis and Mechanics, Faculty of Engineering, Cairo University

____

Prof. Dr. Eehab A.B. Khalil (Advisor)
Professor of Structural Engineering, Construction Research Institute, National Water Research Center

____

Prof. Dr. Sameh Samir Fahmy Mehanny (Internal Examiner)
Professor of Structural Analysis and Mechanics, Faculty of Engineering, Cairo University

____

Prof. Dr. Alaa Gamal Beshat Sherif (External Examiner)
Professor of Concrete Structures and deputy of postgraduate studies, Faculty of Engineering, Helwan University

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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2018

Engineer's Name: Shady Kamel Esmail El-Shafai
Date of Birth: 10/07/1989
Nationality: Egyptian
E-mail: Eng.shadyelrma7@gmail.com
Phone: +201288202114
Address: El Salam, Bibeis, Sharqia, Egypt
Registration Date: 01/10/2012
Awarding Date: …./…./2018
Degree: Master of Science
Department: Structural Engineering

Supervisors:

Prof. Dr. Walid Abdel-Latif Attia
Prof. Dr. Eehab A.B. Khalil (Professor of Structural Engineering, Construction Research Institute, National Water Research Center)

Examiners:

Prof. Dr. Walid Abdel-Latif Attia. Thesis main advisor
Prof. Dr. Eehab A.B. Khalil Advisor
(Professor of Structural Engineering, Construction Research Institute, National Water Research Center
Prof. Dr. Sameh Samir Fahmy Mehanny. Internal examiner
Prof. Dr. Alaa Gamal Beshat Sherif. External examiner
(Professor of Concrete Structures and deputy of postgraduate studies, Faculty of Engineering, Helwan University)

Title of Thesis:

Construction Stage Modeling and Analysis of Prestressed Concrete Cable-stayed Bridge

Key Words:
Construction Stage; Modeling; Cable-Stayed Bridge; Construction Analysis.

Summary:

This study deals with analysis of prestressed concrete cable-stayed bridges during and after construction implementing balanced cantilever construction method which includes the load history and geometry changes due to the construction sequence and the time-dependent effects due to creep, shrinkage and aging of the concrete under static permanent loads and investigate the effect of deck longitudinal prestressing on bridge behavior based on Aswan cable-stayed bridge as a case study in Aswan, Egypt over Nile river. A simplified procedure presented to conduct staged construction analysis based on proposed equation for iteration process after verifying the stage construction deformation calculated analysis software and how to overcome the shortcoming found. The bridge is analysis without staged construction analysis and without longitudinal prestressing to compare the result. The study shows how remarkable effect of staged construction on structural behavior and how longitudinal prestressing affect cable force distributing in staged and non-staged construction analysis.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the reference section.

Name: Shady Kamel Esmail El-Shafai   Date: / /

Signature:

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Table of Contents

List of Tables

List of Figures

List of symbols and abbreviations

2-d	Two dimensional
A	Girder cross section area
A_C	Cross-section area
B	Girder distributed load length
CAB	Cable
CEB-FIP	Comité européen du béton- Fédération Internationale de la Précontrainte
CS	Construction stage
D	Girder depth
DC	Components Dead Load
DW	Super imposed dead load
E	Young's modulus
$E_c(t)$	Modulus of elasticity at the age t
$E_c(28)$	Modulus of elasticity at the age of 28 days
E_{ci}	Modulus of elasticity at the age of 28 days
E	Distance from support of distributed load resultant force
F_{all}	Allowable stay cable force
F_u	Ultimate stay cable force
F_c	Allowable compression stress for prestressed concrete
F_t	Allowable tension stress for prestressed concrete
f_{ck}	Characteristic strength of concrete
f_{cm}	Mean compressive strength of concrete at age of 28 days
f_{cm}	Mean compressive strength of concrete at age of 28 days
f_{ck}	Characteristic strength of concrete
$f_{cm}(t)$	The mean concrete strength at age t
h	National size of the member
HDPE	High density polyethylene
I	Girder moment of inertia
I33	Moment of inertia about element local axis 33
Kn	Kilo newton
L	Girder total length
M	Meter
mm	Millimeter
Max.	Maximum
Min.	Minimum
MPa	Mega Pascal
N	Newton
Ns	Segment number
N/A	Not applicable
P	Pier
PC	Prestressed concrete
R	Joint rotation
RH	Relative humidity of the ambient environment
s	type of cement coefficient for creep
T	Ton
t	Age of concrete in days
t_s	Age of concrete when loaded and termination of curing.

t_0	Age of concrete when loaded
U	Joint displacement
u	Perimeter of the member in contact with the atmosphere
W	Girder distributed load
X	Distance along girder length
θ	Girder slope at specific point
$\epsilon_{cr}(t, t_0)$	Creep strain at time t
$\sigma_c(t_0)$	Applied stress
$\varphi_{28}(t, t_0)$	Creep coefficient
φ_0	Notational creep coefficient
β_c	Coefficient to describe the development of creep with time after loading
$\varepsilon_{cs}(t, t_s)$	Time-dependent total shrinkage strain
ε_{cs0}	Notational shrinkage coefficient
$\beta_s(t - t_s)$	Coefficient to describe the development of shrinkage with time.
ε_{cs0}	The notational shrinkage coefficient
β_{sc}	type of cement coefficient for shrinkage