Sirindhorn International Institute of Technology
Thammasat University

Thesis CE-PhD-2009-03

STRESS CONCENTRATION DUE TO SHEAR LAG IN SIMPLY SUPPORTED BOX GIRDERS WITH LONGITUDINAL STIFFENERS AND CONTINUOUS BOX GIRDERS AND FINITE ELEMENT MODELING OF STEEL-CONCRETE COMPOSITE BRIDGE

Jaturong Sa-nguanmanasak

STRESS CONCENTRATION DUE TO SHEAR LAG IN SIMPLY SUPPORTED BOX GIRDERS WITH LONGITUDINAL STIFFENERS AND CONTINUOUS BOX GIRDERS AND FINITE ELEMENT MODELING OF STEEL-CONCRETE COMPOSITE BRIDGE

A Thesis Presented

by

Jaturong Sa-nguanmanasak

Doctor of Philosophy

School of Civil Engineering and Technology

Sirindhorn International Institute of Technology

Thammasat University

May 2010

STRESS CONCENTRATION DUE TO SHEAR LAG IN SIMPLY SUPPORTED BOX GIRDERS WITH LONGITUDINAL STIFFENERS AND CONTINUOUS BOX GIRDERS

FINITE ELEMENT MODELING OF STEEL-CONCRETE COMPOSITE BRIDG

A Thesis Presented

By

Jaturong Sa-nguanmanasak

Submitted to

Sirindhorn International Institute of Technology

Thammasat University

In partial fulfillment of the requirement for the degree of

DOCTOR OF PHILOSOPHY IN ENGINEERING

Approved as to style and content by

Advisor and Chairperson of Thesis Committee ______________________
Assoc. Prof. Taweep Chaisomphob, D.Eng

Co-Advisor ______________________
Assoc. Prof. Pruettha Nanakorn, D.Eng

Chairperson of Examination Committee ______________________
Assoc. Prof. Winyu Rattanapitikon, D.Eng

Committee Member ______________________
Asst. Prof. Nakhorn Pooyarodom, D.Eng

External Examiner: Prof. Teruhiko Yoda, D.Eng

May 2010

Acknowledgement

The author wishes to express my profound gratitude and sincerest appreciation to my advisor, Assoc. Prof. Dr. Taweep Chaisomphob, for his valuable guidance, enthusiastic encouragement, and advice throughout this study. I also acknowledge my co-advisor, Prof. Dr. Eiki Yamaguchi, Department of Civil Engineering, Kyushu Institute of Technology, Japan, for all there invaluable suggestions, comments and guidance.

Great appreciations are conveyed to the committee members, Assoc. Prof. Dr. Pruettha Nanakorn, Assoc. Prof. Dr Winyu Rattanapitikon, Faculty Members of School of Civil Engineering and Technology, Sirindhorn International Institute of Technology, and Assoc. Prof. Nakhorn Pooyarodom, Department of Civil Engineering, Thammasat University for their valuable advices, interesting in this work and devoting their valuable time to serve as members of the thesis committee.

The author also wishes to extend his appreciation and gratitude to the external examiner, Prof. Dr. Yoda Teruhiko, Faculty of Science and Engineering, Department of Civil Engineering, Waseda University, Japan, for his valuable time spent on this thesis.

Special thanks are also given to the Department of Civil Engineering, Kyushu Institute of Technology for all their help during my research in Japan. The author would like to thank Prof. Dr. Eiki Yamaguchi, Prof. Dr. Yoshihisa Yasushi, Assoc. Prof. Dr. Kitirou Kimura, Faculty Members of Department of Civil Engineering, and all students there for their friendly help and warm welcome during that inspiring period.

Sincere appreciations are given to all members of School of Civil Engineering and Technology who taught the author and staffs who facilitated the author during studying at SIIT. Thoughtful thanks are extended to Mrs. Pitchayapa Yuenyaw, the secretary of School of Civil Engineering and Technology, for all help and friendly discussions.

Special thanks are given to Unique Engineering and Construction Public Company Limited for providing information on the Rama III - Sathu Pradit Bridge.

Finally, the author would like to express his sincere gratitude to his beloved parents for their tremendous encouragement, support and sacrifice in his study and all of his life.

Abstract

This dissertation covers two separate topics using the finite element method (FEM). In the first part of Section I, the shear lag causing the non-uniform distribution of normal stress over the flange of simply supported box girders with longitudinal stiffeners was studied. In the second part of Section I, the stress concentration due to shear lag in continuous box girders was also investigated. In Section II, a study on the three-dimensional finite element modeling of steel-concrete composite bridge was conducted to simulate the actual bridge behavior. The research synopses of these two topics are summarized below.

In Section I of this research, the present study investigates the shear lag effect in a simply supported box girders with longitudinal stiffeners, and continuous box girders by using the three-dimensional finite element method. The whole girder is modeled by shell elements, and extensive parametric study with respect to the geometry of a box girder is carried out. The influence of finite element mesh on the shear lag is carefully treated by the multimesh extrapolation method. Based on the numerical results thus obtained, empirical formulas are proposed to compute stress concentration factors that include the shear lag effect.

In Section II, three-dimensional finite element analysis of composite steel-concrete bridges is performed to simulate the actual bridge behavior. The solid elements are employed for the concrete deck and the shell elements for steel girders and the cross frames. The accuracy of model is verified against the result acquired from a field test. Thai trucks are loaded at possible locations of the Rama III–Sathu Pradit Bridge in order to obtain the maximum stresses of the bridge. The influences of concrete barriers, Young’s modulus of concrete, and the interaction between superstructure and bridge piers are discussed, so as to reveal the actual behavior of the steel-concrete composite bridge. The reactions at the bearings on the bridge piers are also evaluated and discussed in this conjunction. Good agreement is obtained between the models and loading tests to show that the finite element model can aid engineer in design practice.

Table of Contents

Table of Contents

List of Figures

List of Figures

List of Illustrations

Photo **Page**

List of Tables

Table **Page**