STUDY ON STRUCTURAL DESIGN OF HIGHWAY BOX STRUCTURES

S.S.L.D.Chinthaka

(138729 J)

Degree of Master of Engineering in Structural Engineering Designs

Department of Civil Engineering

`

University of Moratuwa

Sri Lanka

August 2017

STUDY ON STRUCTURAL DESIGN OF HIGHWAY BOX STRUCTURES

Seethagala Subasinghage Lahiru Dulan Chinthaka

(138729 J)

Dissertation submitted in partial fulfilment of the requirements for the degree of Master of Engineering in Structural Engineering Design

Department of Civil Engineering

University of Moratuwa

Sri Lanka

August 2017

DECLARATION

I declare that this is my own work and this 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 believe it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

S.S.L.D.Chinthaka Date:

The above candidate has carried out research for the Masters Dissertation under my supervision.

Dr. K. Baskaran Date:

ABSTRACT

Box culverts are the highest in numbers from the list of structures in highway construction because of their advantages such as low ground bearing capacity requirement, low maintenance requirement and easy construction compared to bridge structures.

Box culverts in Sri Lanka are not standardized. People are still keep designing box culverts consuming lots of engineers valuable time, which can be used productively for the development process of the country. This research investigates typical box culverts that are used in Sri Lanka and then develops standard charts for various size box culverts with different overburden.

This study is carried out using numerical methods for different box culvert opening sizes with 1.5 x 1.5 m, 2.0 x 2.0 m and 3.0 x3.0 m

This dissertation presents analysis and design results of box culverts of varying numerical models of size 1.5x1.5m , 2.0x2.0m and 3.0x3.0m internal size with slab/wall thickness from 200mm to 400mm with 50mm gap as appropriate, for overburden of 0.5m, 1.0m, 2.0m, 4.0m, 6.0m, 8.0m and 10.0m

Total number of structures analyzed was 120

Final results are presented in both tabulated and graphical format

Observation shows that internal forces in the element of box culvert is less sensitive to bearing capacity of ground for thicker bases but sensitive for thin bases.

Every box culvert of given size and over burden has its own optimum thickness.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my research supervisor Dr.K.Baskaran, Senior Lecturer, Department of Civil Engineering, University of Moratuwa, Sri Lanka for his guidance, suggestions and continuous support throughout my M.Eng. research work.

I am also much grateful to the Head of the Department of Civil Engineering, the Course Coordinator of Master of Structural Engineering, and the staff of the Department of Civil Engineering for their valuable guidance and cooperation given in many ways.

I also extend my sincere gratitude towards my employer, Road Development Authority (RDA) for granting leave to follow this course and other assistances provided for my research works. I would like to take this opportunity to convey my sincere gratitude to Mr.L.V.S.Weerakoon (Project Director, Central Expressway Project, RDA), Dr.Ruwan (Head , Structural design office, Central Expressway Project, RDA),for the assistance extended to me in numerous ways throughout, and Dr.Naveed Anwar (AIT,Thailand/International Consultant for Central Expressway Structural design works) for the guidance given in finite element modelling. Finally, I thank for all my colleagues and family members for the valued cooperation and encouragement received to complete my M. Eng. Program successfully.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS AND ABBREVIATIONS

ESE	Extension of Southern Expressway
OCH	Outer Circular Highway
CEP	Central Expressway
OAPI	Open Application Programming Interface
CSi	Computers and Structures.Inc.
Ka	Coefficient of Active earth pressure
Kp	Coefficient of Passive earth pressure
Ko	Coefficient of at rest earth pressure
φ	Friction angle of soil
D	Depth from ground to point under consideration
β	Super imposed dead load factor
Ks	Subgrade reaction
SF	Factor of safety
B.C	Allowable bearing capacity
Kt	Traction factor
F	Traction force
H'	Height of soil cover
W	Internal width of culvert
H	Internal height of culvert
t	Wall/Base/Top slab thickness

L_L Overall length of structure perpendicular to wall

L Length of culvert

M Bending moment

M_{200} Bending moment at 200kN/m^2 bearing capacity