EARLY AGE CRACKS IN CONCRETE WALLS

D. S. Hettiarachchi

(138735A)

Degree of Master of Science

Department of Civil Engineering

University of Moratuwa
Sri Lanka

November 2017

Declaration

I declare that this is my own work and this thesis 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.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis, 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.

Signature Date

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

Signature of the Supervisor Date

Abstract

Construction of a concrete structure requires a large volume of concrete. Due to the small surface area-to-volume ratio, concrete structures are often subjected to high potential of thermal cracking, caused by the heat generation from cement hydration. To reduce the thermal cracking and ensure structural integrity, a good understanding about the crack patterns in concrete elements is required. These kinds of cracks mostly occur during the early age state of concrete. Since Sri Lanka is very near to the equator, the probability of early age crack occurring is even higher.

The purpose of this research is to explore the potential early age crack patterns in vertical concrete walls. Main reason for the early age cracking in vertical walls are shrinkage and thermal contraction. This research focuses on the understanding of early age thermal cracking in concrete and developing a simple method to model this phenomenal computationally. Series of boundary conditions were modelled to obtain stress distributions using walls 3m high and 4m & 8m long. Boundary conditions were imposed according to guidelines in BS8007 and wall thickness maintained as 300mm during the analysis. All the analysis was carried out using FEM commercial software Sap 2000 (V19.1). Two approaches were followed initially to identify the best method to represent the restraint conditions as per BS8007. End restraints reduced by using roller supports up to a 2.4m distance from the free edge of the wall with gradually increasing applied horizontal forces proved to be the better technique than that of using reduced E-values.

The case studies yielded the following general findings that agree with the literature and field observations;

(i) 4m walls can have possible vertical and horizontal cracks.
(ii) 8m walls can have possible cracks approximately 2.4m away from the free edges with an inclination of approximately 45º-60º.
(iii) 8m walls get the highest stress close to 2.4m from the free edges whereas the 4m walls get the highest stress at the centre.
(iv) In 8m walls higher stresses are distributed over a central length whereas in 4m walls the higher stress is concentrated at the centre.
(v) 4m wall with top movement can cause possible inclined cracks.
(vi) 8m wall with top movement can lead to two possible dominant cracks and two minor cracks.

This validation was done qualitatively using the literature and on-site observations.

Key Words: Early age cracking, concrete, walls, thermal cracking

Acknowledgement

I would first like to express my greatest gratitude to my supervisor, Prof. Priyan Dias of the Department of Civil Engineering at University of Moratuwa. The door to Prof. Dias's office was always open whenever I ran into a trouble spot or had a question about my research or writing. He consistently allowed this paper to be my own work, but steered me in the right the direction whenever he thought I needed it.

I would also like to thank the Eng. Shiromal Fernando, who has been my superior and my mentor from the first day of my career. Without his guidance and encouragement, completing this work would have been impossible.

Finally, I must express my very profound gratitude to my parents and to my wife for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Thank you.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

ASTM	American Society for Testing and Materials
RH	Relative Humidity