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BEHAVIOR OF CONCRETE WITH IN-PLANE HOLLOW CIRCULAR INCLUSION

MOHD ZULKARNAAIN BIN SULAIMAN

A project report submitted in partial fulfillment of the requirement for the award of the degree of Master of Engineering (Civil – Structure)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

NOVEMBER, 2007

I declare that this project report entitled "Behavior of concrete with in-plane hollow circular inclusion" is the result of my own research except as cited in the references. The report has not been accepted for my degree and is not concurrently submitted in candidature of any other degree.

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DEDICATION

Alhamdulillah thank to Allah with blessing me for finishing my Master Degree report. Secondly, thank to my lecture Dr. Redzuan Abdullah that giving me guidance to produced this report. Lastly, to my Allahyarham my father, my mother, my brother and sister also my fiance that give me strength and courage.

Mohd Zulkarnaain Bin Sulaiman
Universiti Teknologi Malaysia
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ABSTRAK

Blok konkrit berukuran 200 mm x 200 mm x 200 mm yang mengandungi lubang bulat pelbagai saiz menembusi keseluruhan ketebalannya telah diuji secara ujian mampatan. Datanya telah digunakan untuk tujuan pengesahan analisis dengan menggunakan kaedah unsur terhingga tak terlurus. Mekanisma kegagalan blok konkrit, anjakan tegak, keupayaan menanggung beban dan taburan tegasan telah dikaji. Didapati dengan pertambahan saiz lubang akan menyebabkan pengurangan kekuatan blok konkrit, pertambahan anjakan tegak, pengurangan taburan tegasan dan pengurangan keupayaan blok konkrit menanggung beban. Hubungan antara saiz lubang dengan parameter tersebut adalah lelurus.

ABSTRACT

Concrete blocks measuring 200 mm x 200 mm x 200 mm with variable sizes of circular inclusions through their thicknesses were tested by applying compressive force. The test data was used to verify the analysis results using non linear finite element method. Once the FE model has been verified, failure mechanism, for vertical displacement, load bearing capacity and stress distribution were studied. With increasing void sizes, the strength of the concrete block decreases, the vertical displacement increases, the stress distribution decreases and the load bearing capacity of the block decreases. The relationship between void sizes and these parameters are linear.

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A		Area of concrete surface (mm)
E	-	Young's modulus (kN/mm^2)
fcu	-	Concrete grade
f_{yk}		Reinforcement steel strength
λm	-	Partial safety factor for strength of material
f'_m	-	Compressive strength of concrete masonry prism.
f_{mr}	-	Compressive strength of mortar.
f_{bl}	-	Compressive strength of concrete block.
f_{gr}	-	Compressive strength of grout.
P		Loads (kN)
σ	-	Stress (kN/mm^2)
σ_{SE}		Stress equivalent
ε	-	Strain

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Occasionally, brick or concrete block walls for buildings had to be drilled holes through their thickness. This reason are for passing services such as wiring ducts, water piping, air conditions duct, etc. When the holes are provide, the strength of the walls, especially those that carry the load will be affected. Stress concentration generally occurs around the holes and crack usually initiate around this area. The study of the behavior concrete block with in-plane circular hollow-inclusion is needed. Stress concentration and maximum load carrying capacity are two important parameters that should be looked into. In the past, studies on hollow concrete block focused more on vertical holes, but not on the horizontal hole through the thickness.

The primary aim of this project is to study the behavior of a structure can be load carrying capacity, deflection (deformation shape), stress concentration, crack pattern failure mode,(all related to structure). With continuing development of computer software and hardware, and with the new finding in material, the finite element method can be used for simulation for experiments and to predict the structural performance and behavior of the hollow in-plane concrete block. The nonlinear finite

element analysis of the hollow concrete block reported in this paper was carried out by the LUSAS 13.6 software package. The finite element analyses were compared with the test result conducted in the University Technology Malaysia, civil laboratory.

1.2 OBJECTIVES

The objectives of this research were:

1. To study the behavior of concrete block with in-plane circular hollow inclusion under compression load by non linear FE method. The parameters to be studied included the ultimate load capacity, stress contour, crack pattern and failure mode.

2. To conduct compression test on concrete blocks with and without circular holes for validation of the FE model.

3. To study the percentage of strength reduction due to increasing the void sizes in concrete block with in-plane circular hollow inclusion.

1.3 SCOPE OF THE STUDY

The scopes of work for this research are:

1. Two dimension of FE modeling using plane stress element.

2. Only one hole at the middle of the concrete block were investigated but the size of holes will be varies.

3. The same characteristic for material properties and analysis of parameter control used for all FE modeling.

4. The dimensions of concrete block size 200 mm x 200 mm x 200mm were used.