FRAME ANALYSIS OF REINFORCED CONCRETE SHEAR WALLS WITH OPENINGS

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To my beloved husband,
mother and family.

Thanks for all the supports..

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ABSTRAK

Terdapat beberapa jenis kaedah analisis yang tersedia untuk menganalisis struktur dinding ricih. Analisis kerangka adalah salah satu daripadanya dan telah digunakan dalam kajian ini untuk mengenalpasti kekuatan muktamad bagi struktur dinding ricih berpasangan dan kelakuan strukturnya ketika dikenakan daya mengufuk. Perisian Multiframe versi 5.16 yang berteraskan kepada kaedah analisis elastik peringkat pertama telah digunakan untuk menganalisis model dinding ricih. Keputusan analisis menunjukkan bahawa kaedah analisis kerangka elastik peringkat pertama telah terlebih anggar kekuatan muktamad bagi model dinding ricih dan kurang tepat untuk menganalisis keadaan ini berbanding dengan Kaedah Analisis Sambungan Berterusan (CCM) dan Kaedah Analisis Unsur Terhingga Tidak Linear (NLFEA). Perbezaan keputusan yang diperolehi adalah lebih kurang empat kali ganda lebih besar daripada keputusan ujian makmal yang dijalankan oleh pengkaji sebelum ini. Namun begitu kelakuan struktur bagi rasuk penyambung dan dinding ricih pada keadaan muktamad masih lagi sama seperti yang berlaku pada ujikaji makmal dan yang diperolehi daripada Kaedah Analisis Unsur Terhingga Tidak Linear (NLFEA).

ABSTRACT

There are several types of analysis methods available for analysing shear walls of the building structures. Frame analyses is one of the methods, and were used in this study to determine the ultimate strength of reinforced concrete coupled shear wall structures and its structural behaviour under lateral loading. Multiframe Version 5.16 software which based on linear (first-order elastic) analysis method were used to analyse the shear wall models adopted from previous research. Results show that linear elastic of frame analysis method was overestimating the ultimate strength of shear wall models and not reliable enough for this analysis compared to analytical Continuous Connection Method (CCM) and Non-Linear Finite Element Analysis (NLFEA) method. The difference was about four times higher than the experimental results being conducted by the previous researcher. However the structural behaviour of walls and its coupling beam at ultimate condition was still pose similar behaviour to the observation made on the experimental test and Non-Linear Finite Element Analysis (NLFEA).

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LIST OF SYMBOLS

A	-	Area
D, d	-	Depth
δ_u	-	Ultimate deflection
E	-	Modulus of elasticity
F	-	Vector of applied loads
f_c	-	Compression stress
f_t	-	Tension stress
f_y	-	Yield strength
f_{cu}	-	Characteristic strength
f_{st}	-	Splitting strength
f_{tc}	-	Limiting tensile strength
G	-	Shear modulus
H	-	Height
I	-	Moment of inertia
J	-	Torsion constant
K	-	Stiffness matrix
L, *l*	-	Length or span
P	-	Load applied
P_u	-	Ultimate load
$S_{x'}$	-	Axial stress about local x' axis of member
$S_{bz'}$	-	Bending stress about local z' axis of member
x	-	Vector of calculated displacements

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CHAPTER 1

INTRODUCTION

High rise building is a structure vertically cantilevered from the ground level subjected to axial loading and lateral forces. It consists of frames, beams, shear walls, core walls, and slab structures which interact through their connected edges to distribute lateral and axial load imposed to the building. Lateral forces generated either due to wind blowing against the building or due to the inertia forces induced by ground shaking which tend to snap the building in shear and push it over in bending. These types of forces can be resisted by the use of shear wall system which is one of the most efficient methods of ensuring the lateral stability of tall buildings.

For building taller than 10-stories, frame action obtained by the interaction of slabs and columns is not adequate to give the required lateral stiffness (Taranath 1998). It also has become an uneconomical solution for tall buildings. However it can be improved by strategically placing shear walls as it very effective in maintaining the lateral stability of tall buildings under severe wind or earthquake loading.

Coupled shear wall is a continuous wall with vertical rows of opening created for windows and doors, coupled by beams that interconnecting the wall piers across the openings. These connecting beams are referred to as coupling beams. It may be

shallow or deep beam type constrained by the walls on either side. Coupling beam has to be ensured adequately strong and stiff under elastic loading, ductile and able to dissipate energy under inelastic loading to achieve desirable performance of these structures (Lam et al., 2005) as its behaviour and modes of failure are highly effect the mode of failure of shear wall.

1.1 Analysis of Shear Walls

There are several types of analysis methods available for analysing shear walls structure. The analysis can be made in elastic, elasto-plastic and ultimate condition. However, due to uncertain and in-ability to analyse and interpret the post elastic behaviour or possibly time constraint, the elastic method is preferred for its simplicity. This elastic method of analysis consists of Continuous Connection Method (CCM), Transfer Matrix Method, Wide Column Analogy (WCA) or frame analysis, Finite Element Method and Discrete Force Method.

The Non-Linear Finite Element Analysis (NLFEA) can achieve excellent agreement with the test results (Driver et al., 1998). But this method is time consuming where relatively simple force distribution output is required. Frame analysis method offers the advantage of being simple and relatively accurate yet the results output are still acceptable by engineers. Thus, this study was carried out on shear wall structures adopted from research models by Marsono (2000) using frame analysis based software, to evaluate the accuracy of the methods.

1.2 Previous Work

Previous researcher, Marsono (2000) has conducted an experimental work on small scaled model of various types of shear walls structure. Results from the experiment in the form of stresses and strains, crack distributions and ultimate strength then used to establish the analytical method (Continuous Connection Method, CCM) of analysis. The non-linear finite element analysis (NLFEA) was performed as a tool to affirm the experimental results and the analytical mode of failure and ultimate strength predictions. The experimental and NLFEA results were in very close agreement in predicting the ultimate strength and mode of failure of coupled shear wall structure.

1.3 Objectives

The main objectives of the research are as follows:

a) To carry out a frame analysis on shear wall models using Multiframe Version 5.16 software.

b) To check the reliability of frame analysis method compared to analytical Continuous Connection Method (CCM) and Non-Linear Finite Element Analysis (NLFEA) method.

c) To approximately determine the crack formation and crushing of concrete at shear wall referring to the results obtained from the frame analysis.

1.4 Scope of Project

Analysis was carried out on a scaled model of shear walls adopted from Model Number 5 & 6 of PhD research by Marsono (2000) and no design work on the structure involved. The software used to analyse the models was Mutiframe version 5.16 which based on linear elastic method of frame analysis. All the material properties assigned and load applied were also taken from the previous research. Results obtained from the analysis then being compared to experimental study, analytical CCM and NLFEA results obtained from previous research.