BEHAVIOUR OF REINFORCED CONCRETE FRAME AT ULTIMATE LIMIT STATE

MOHD AZMIR ABU BAKAR

A technical project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Engineering (Civil-Structure)

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To my dearly loved parents…

A caring mother

and a dedicated father…

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In the name of Allah, Merciful and Sympathetic to his followers, without Him there will be never anything to be started with.

Given this scarce opportunity to recoqnise my gratitude to those people who are always there to support and encouraged me to completion of this project.

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ABSTRACT

The objective of this study is to understand reinforced concrete beam-column connection behaviour toward ultimate limit state using ATENA 2D, a non linear finite element analysis. Based on previous studies, the behaviour of beam-column with semi rigid connection in steel structure has shown a very different behaviour during elastic range and beyond yield point, because of phenomenon called moment shedding. Using the same approach, analytical studies on the response of concrete framed structures at ultimate limit have been conducted. This study shows that when the reinforced concrete structures reach the ultimate limits state, the column will behave similar to an axial loaded column. This outcome is a result of redistribution of end moment near collapse condition, where moment has been transfered to nearby structure component, in this study to a beam component. With the phenomenon occurs near ultimate limit state, a simplified design approach can be formed for reinforced concrete designed.

ABSTRAK

Objektif penyelidikan ini dijalankan adalah untuk memahami sifat konkrit ketika menghampiri keadaan had muktamad menggunakan software ATENA 2D, sebuah perisian analisa elemen terhingga tidak linear. Berdasarkan penyelidikan terdahulu, sifat untuk rasuk-tiang dengan sambungan separuh tegar, menunjukkan sifat yang berbeza ketika had kenyal dan selepas melepasi had kritikal, disebabkan fenomena yang bernama momen berkurang (*moment shedding*). Penyelidikan ini menunjukkan apabila struktur konkrit bertetulang menghampiri keadaan had muktamad. Keputusan menunjukan apabila konkrit bertetulang menghampiri keadaan had muktamad, tiang akan berubah seperti tiang yang hanya mengalami beban paksi. Ini terjadi akibat pembahagian moment hujung ketika keadaan mendekati tahap roboh, dimana momen akan dipindahkan ke komponen struktur berdekatan, dalam kes ini komponen rasuk. Dengan terjadinya fenomena ini ketika menghampiri keadaan had muktamad, satu kajian untuk kaedah mudah boleh dibentuk bagi rekabentuk konkrit bertetulang.

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LIST OF SYMBOLS

f_{cu}	-	Characteristic Strength of Concrete
f_y	-	Characteristic Strength of Steel
γ_m	-	Partial safety factors for Strength of Material
F_k	-	Characteristic Loads
γf	-	Partial safety factor for Loads
G_k	-	Dead load
Q_k	-	Imposed Load
W_k	-	Wind Load
σ	-	Stress
F,P	-	Force
A	-	Area
u	-	Deflection
f_y	-	Steel Tensile Strength
f_t	-	Concrete Tensile Strength
w	-	Width of Stress Crack
w_{to}	-	Initial Width of Stress Crack
G_f	-	Fracture Energy
ε	-	Strain
P	-	Force
Pu	-	Ultimate Force
σ_1	-	Stress at x-axis
σ_2	-	Stress at y-axis
σ_3	-	Stress at z-axis
σ_o	-	Total Acting Stress
τ_o	-	Total Acting Torque

E	-	Modulus of Elasticity
σ_y	-	Stress at y-axis
R_{cu}	-	Concrete Compression Strength
MU	-	Poisson's Ratio
f_t	-	Concrete Tensile Strength
f_{cu}	-	Concrete Compressive Strength
w_d	-	Critical Compressive Displacement
Rho	-	Specific Material Weight
α	-	Coefficient of Thermal Expansion

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CHAPTER 1

INTRODUCTION

1.1 General Introduction

Concrete has been a major construction material for centuries. Flexibility, economical and easy to find source material is an attraction for engineer which ever ready to ease their mind. Although commonly used in construction section, behaviour of concrete near ultimate limit state is known very little, but still interest many researchers to fully understand it.

1.2 Statement of the Problem

Based on previous parametric studies,the behaviour of beam-column with semi rigid connections has shown that a very different behaviour during elastic range and beyond yield point. This phenomenon called moment shedding is the reason behind the unique behaviour. Previous study showed that moment shedding not only happen after yielding point, but also during elastic period. It may not significantly influence during elastic state, but after yielding point, moment shedding impact is significant, where the moments are relaxed to near zero moment.

By this phenomenon finding, researcher has found a simplified design method, but in condition that, when the structure in collapse load condition, it still in equilibrium condition. This study is to try to find out if this phenomenon is also happen in reinforced concrete frame. By validating this, simplified design method can be implementing into reinforced concrete design, thus producing more efficient and practical approach to design problem.

1.3 Objective and Aim of Present Study

The primary aim of the thesis is to investigate the non linear aspect of reinforced concrete frame structures.

(i) To investigate the behaviour of reinforced concrete frame in non linear state in term of load-deflection, load-moment and moment-rotation.

(ii) To study the respond of moment of reinforced concrete column near Ultimate Limit State.

1.4 Scope of study

The study will be concentrating on non linear finite element analysis of reinforced concrete frame to obtain the collapse state, which the ultimate load of the frame.

The study is limited to the following scopes.

(i) Only reinforced concrete framed is considered.

(ii) The frame is considered as 3 type

- Type A – Single bay frame
- Type B – Double bay frame
- Type C – Double storey frame

(iii) The frame is subjected to 2 types of loading.

- Type 1 - Incremental load at all column head with static uniformly distributed load (UDL)
- Type 2 - Incremental load at all middle span of beam

1.5 Significant of Research

(a) To understand behaviour of reinforced concrete near Ultimate Limit State.

(b) To validate previous study on moment shedding too happen in reinforced concrete frame.

(c) To promote more research on the subject, and finally to encourage research on simplified design method for reinforced concrete design.

4) Re-analyse the frame structure using different lengths of column, to monitor the relationship between length and initial moment shedding occurrence.

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