

UNIVERSITI TEKNOLOGI MARA

**TORSIONAL BEHAVIOUR OF AXIALLY
DISCONTINUOUS THIN-WALLED STEEL
FRAMES USING CHANNEL SECTIONS
WITH COMPOUND STIFFENERS**

MASTURA BINTI RAFEK

Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science

Faculty of Civil Engineering

July 2013

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student : Mastura Binti Rafek

Student ID No : 2010600312

Programme : Master of Science (Civil Engineering)

Faculty : Civil Engineering

Thesis Title : Torsional Behaviour of Axially Discontinuous
Thin-Walled Steel Frames Using Channel
Section with Compound Stiffeners

Signature of Student :

Date : July 2013

ABSTRACT

This study is focused on the structural behaviour of thin-walled open section when subjected to torsion. When a thin-walled open section is subjected to torsion it has tendency to twist and warp. If the thin-walled member is axially discontinuous, the warping deformation could affect the non-loaded member by significant twisting. A study of this behaviour pattern has been conducted and the results obtained are presented in this thesis. A general purpose commercial software that uses finite element method was used to model the axially discontinuous thin-walled open section frames. The numerical results were used to understand the twisting and warping transmission at the member intersection. For this present study, plain channel and lipped channel sections were used. Lips can be used to improve the strength of the section and also lips can reduce large angle of twist which leads to warping deformation. The results presented show that a frame with lipped channel section has value of angle of twist lesser than the equivalent frame with plain channel section with 41.07% for loaded member and 52.73% for non-loaded member respectively. In order to understand how the twist is transmitted through the axially discontinuous system, models with different types of joints were also carried out to investigate the magnitudes and directions of the twist for both loaded and non-loaded members. Apart from considering varieties of joint types, types of lips attached at the edges of the flanges were studied. A lip was folded one, two and three times to see the influence of each folded lip and this lip is called a compound lip. Folding of the lip can be in the direction of either inwardly or outwardly. The results show that the least twisting deformation structure is with diagonally inward lips with two folds.

TABLE OF CONTENTS

AUTHOR'S DECLARATION	ii
ABSTRACT	iii
ACKNOWLEDGEMENT	iv
TABLE OF CONTENTS	v
LIST OF TABLES	viii
LIST OF FIGURES	ix
LIST OF ABBREVIATIONS	xiii
CHAPTER ONE: INTRODUCTION	
1.1 Background of Study	1
1.2 Problem Statement	5
1.3 Objectives of Study	6
1.4 Significance of the Study	6
1.5 Scope of the Study	8
CHAPTER TWO: LITERATURE REVIEW	
2.1 Introduction	9
2.2 Types of Cold-formed Steel Sections	9
2.3 Material	10
2.4 Advantages of Cold-formed Steel	11
2.5 Finite Element Method	12
2.6 Influence of Stiffeners	13
2.7 Types of Joint in Thin-walled Structure	16
2.8 Warping	19
2.9 Findings from Previous Related Researches	22
2.10 Conclusion	23

CHAPTER THREE: THEORETICAL VALIDATION

3.1 Introduction	24
3.2 Finite Element Modeling	24
3.2.1 Selection of Suitable Finite Element Type or Types	25
3.2.2 Discretization of Frames Related to Convergence Study	26
3.3 Finite Element Frame Models	27
3.4 Convergence Study	33
3.5 Comparison with Experimental Results	34
3.6 Conclusion	36

CHAPTER FOUR: ANALYSIS OF FRAMES WITH LIPPED CHANNEL SECTION AND WITH DIFFERENT JOINT CONFIGURATIONS

4.1 Introduction	37
4.2 Comparison between Frames with Plain Channel and Lipped Channel Sections	38
4.3 Types of Joint	45
4.3.1 Angles of Twist of Frames with Different Joint Configurations	48
4.3.2 Longitudinal Stresses of Frames with Different Joint Configurations	54
4.4 Conclusion	66

CHAPTER FIVE: MECHANISM OF TORSION TRANSMISSION FOR FRAMES WITH LIPPED CHANNEL SECTIONS AND DIFFERENT JOINT CONFIGURATIONS

5.1 Introduction	67
5.2 Sectorial Coordinate	67
5.3 Mechanism of Torsion Transmission	70
5.3.1 Mechanism around Box Joint	72
5.3.2 Mechanism around Stiffened Mitre Joint	74