

UNIVERSITI TEKNOLOGI MARA

**BEHAVIOUR OF FOAMED CONCRETE
FILLED STEEL TUBES (CFST) UNDER
AXIAL LOAD**

NAZRUL AZMI BIN AHMAD ZAMRI

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

Faculty of Civil Engineering

May 2011

ABSTRACT

Composite structures such as concrete-filled steel tube (CFST) structures are steel hollow sections that are filled up with concrete. The application of this structural element has become increasingly popular in structural applications in many countries. There are many advantages to using composite structures compared to conventional reinforced concrete (RC) structures and steel structures due to its structural behaviour, advantages in terms of cost and duration of construction. However, the usage of CFST structures is not very common in Malaysia as compared to conventional RC structures. At present, the behaviour of CFST columns filled with normal strength concrete has been studied by many researchers. However, use of foamed concrete as infilled material is rare and has not comprehensively study. Thus, this research was conducted to investigate the shear bond strength capacity, the confinement effect between the steel tubes and concrete core and the axial load capacity of concrete-filled steel tubes, with foamed concrete as the concrete core, through experimental work. A series of short columns of 200mm x 200mm section and 2mm thick with additional 25mm height of longitudinal stiffeners and 40mm height of tab stiffeners were filled with different densities of foamed concrete namely, 1400 kg/m³, 1600 kg/m³ and 1800 kg/m³. The height of the column was 600mm. Nine samples for each series of specimens were made where three samples were loaded at the entire surface of the specimen to find its axial capacity, three following samples were loaded only at the concrete core surface to find the confinement effect, and the other three samples were also loaded at concrete core to allow the concrete core to slip down to determine the shear bond strength. The results of this experiment showed that all series of the column specimens failed at loads less than 90% of the analytical values although the specimens show a high confinement effect. For the shear bond strength, although density of the concrete was increased at only 28% from the lower density (1400kg/m³) to the higher density (1800kg/m³), the shear bond strength of the higher density increased until 117% from the lower density.

Keyword: Concrete filled steel tubes, foamed concrete, axial load, confinement effect, bonding strength.

ACKNOWLEDGEMENTS

A thousand thankful to the Al Mighty God ALLAH, who has made it possible for me to complete this research work and I would like to express my sincere gratitude to my supervisor, Assoc. Prof. Datin Dr. Hanizah Abdul Hamid and my co-supervisor, Assoc. Prof. Dr. Azmi Ibrahim for their guide and advices.

Thanks to VPN Engineering Sdn Bhd and MS Instruments (SEA) Sdn Bhd, the supplier of the materials and equipments that I used during the project duration. Without their commitment to fulfill my request for the material, I could not complete my work.

I would also like to take this opportunity to extend my deepest appreciation and gratitude to all the laboratory technicians from the Faculty of Civil Engineering who had contributed so much in this research work.

Lastly, tremendous appreciation is granted to my family members, for their generous support and encouragement.

Nazrul Azmi Bin Ahmad Zamri

May 2011

TABLE OF CONTENTS

TITLE	PAGE
CANDIDATE' S DECLARATION	ii
ABSTRACT	iii
ACKNOWLEDGEMENTS	iv
TABLE OF CONTENTS	v
LIST OF TABLES	ix
LIST OF FIGURES	x
LIST OF ABBREVIATION	xiii
CHAPTER 1: INTRODUCTION	
1.1 Background of study	1
1.2 Problem statement	4
1.3 Objectives of the study	5
1.4 Scope of study	5
1.5 Significance of study	7
CHAPTER 2: LITERATURE REVIEW	
2.1 Introduction	8
2.1.1 Concrete filled steel tube (CFST)	9
2.1.2 Lightweight concrete	11
2.2 Main materials of foamed CFST	13
2.2.1 Square steel hollow section as column shell	13
2.2.2 Foamed concrete as infill	14
2.2.3 Characteristic of foamed concrete	15
2.3 Shear-bond test	16
2.4 Effect of stiffener in CFST	18

2.5	Stiffener rigidity requirement	20
2.6	Confined and unconfined concrete	22
2.7	Failure mechanism of CFST	24
2.8	Analytical design for CFST	26
2.8.1	Effective area of steel section	26
2.8.2	Squash load	27
2.8.3	Bond strength	31
2.9	The advantages of lightweight concrete filled steel tube (LCFST)	34
2.10	The disadvantages of LCFST	34
2.11	Summary of literature review	35
CHAPTER 3: RESEARCH METHODOLOGY		
3.1	Introduction	36
3.2	Preparation of material	38
3.2.1	Steel section	38
3.2.2	Foamed concrete	46
3.2.2.1	Cement	46
3.2.2.2	Sand	47
3.2.2.3	Water	47
3.2.2.4	Foaming agent	47
3.3	Mix proportion	48
3.4	Preparation of the foamed concrete specimens	49
3.4.1	Preparation of mortar	50
3.4.2	Preparation of foam	50
3.4.3	Preparation of foamed concrete mixture	52
3.4.4	Filling of foamed concrete to hollow steel tubes and cube	55