UNIVERSITI TEKNOLOGI MALAYSIA

DECLARATION OF THESIS / UNDERGRADUATE PROJECT PAPER AND COPYRIGHT

Author's full name : **SITI RAHAYU BINTI JAFFAR**

Date of birth : **02 SEPTEMBER 1985**

Title : **STRENGTH BEHAVIOUR OF COLUMN STUDS IN PREFABRICATED WALL PANELS USING COLD-FORMED STEEL**

Academic Session : **2009/2010**

I declare that this thesis is classified as :

☐	**CONFIDENTIAL**	(Contains confidential information under the Official Secret Act 1972)*
☐	**RESTRICTED**	(Contains restricted information as specified by the organization where research was done)*
☑	**OPEN ACCESS**	I agree that my thesis to be published as online open access (full text)

I acknowledged that Universiti Teknologi Malaysia reserves the right as follows:

1. The thesis is the property of Universiti Teknologi Malaysia.
2. The Library of Universiti Teknologi Malaysia has the right to make copies for the purpose of research only.
3. The Library has the right to make copies of the thesis for academic exchange.

Certified by :

SIGNATURE

850902-11-5378
(NEW IC NO. /PASSPORT NO.)

Date : 28 APRIL 2010

SIGNATURE OF SUPERVISOR

DR ARIZU SULAIMAN
NAME OF SUPERVISOR

Date : 28 APRIL 2010

NOTES : * If the thesis is CONFIDENTAL or RESTRICTED, please attach with the letter from the organization with period and reasons for confidentiality or restriction.

“I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Master of Engineering (Civil-Structure)”

Signature : ....
Name of Supervisor : DR. ARIZU SULAIMAN
Date : 28 APRIL 2010

STRENGTH BEHAVIOUR OF COLUMN STUDS IN PREFABRICATED WALL PANELS USING COLD-FORMED STEEL

SITI RAHAYU BINTI JAFFAR

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

Faculty of Civil Engineering
Universiti Teknologi Malaysia

APRIL 2010

I declare that this project report entitled *"STRENGTH BEHAVIOUR OF COLUMN STUDS IN PREFABRICATED WALL PANELS USING COLD-FORMED STEEL"* is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ....
Name : SITI RAHAYU BINTI JAFFAR
Date : 28 APRIL 2010

To my beloved family...

ACKNOWLEDGEMENT

I am extremely grateful to my supervisor, Dr. Arizu Sulaiman for his enthusiastic and expertise guidance, constructive suggestions, encouragements and the valuable assistance in many ways. Also, I am very thankful to him for sharing his precious time to view this report. This study would not have been what it is without such assistance.

Many thanks are extended to Structural and Material Laboratory staff members especially to En. Zailani Aman, En. Zaaba Maarop, En. Raja Ezar Ishamuddin, En. Zul Ismail and En. Azmi Abd. Aziz for their enthusiasm and willingness to help throughout the project with fabricating, preparing and testing the cold-formed steel specimens.

It is my pleasure to thank my fellow post-graduate students for their support and contribution to make this project success. I would also like to acknowledge the contributions of those who have helped either directly or indirectly in the completion of this project.

Finally, I would like to express my sincere appreciation to my husband and parents for their endless support, encouragement and patient throughout the duration of this project.

ABSTRACT

A full-scale experimental study on the strength behaviour of individual studs and column studs in a prefabricated wall panel is presented in this report. The individual stud and the panel are made of cold-formed steel sections with a dimension of 3 m height, and 3.15 m height and 1.5 m width respectively. At the moment, the British Code has not provided adequate detail design to account the load capacity of a cold-formed steel column stud in a prefabricated wall panel. The structural performances of column stud therefore need to be obtained through the experimental investigation. A total of five specimens were tested in pure axial compression until failure. The specimens consist of three specimens with one type of lipped C-channel designated here as S350CT1, S350CT2 and S350CT3, one specimen of I-section, D350CT1 and one specimen of wall panel, W350CT1. Comparison between experimental values for column stud in the wall panel and experimental values for the individual studs were made. Experimental values for the individual studs were also compared with the theoretical values computed based on BS 5950-Part 5:1998 Code of practice. All individual studs which were subjected to pure axial compression, except the S350CT1, failed due to flexural buckling (FB) mode, with a substantial visible permanent deformation and without significant torsional buckling. S350CT1 failed due to shearing of the bolts in the bolted connection. From the investigation, it can be concluded that the selection of section geometries affect the failure stress capacity of individual studs dramatically. All individual stud failure loads obtained experimentally are in good agreement with the predicted values. As for the prefabricated wall panel, it was found that a flexural buckling and local buckling had occurred in the wall panel as the wall panel reaching the failure, and subsequently the ultimate load.

ABSTRAK

Kajian ujikaji berskala penuh terhadap kelakuan dan kekuatan stad individu dan stad tiang di dalam panel dinding pasang siap dibentangkan di dalam laporan ini. Stad individu dan panel ini dibina menggunakan keratan keluli terbentuk sejuk dengan ukuran ketinggian 3 m untuk stad individu, dan 3.15 m tinggi dan 1.5 m lebar untuk panel. Ketika ini, *British Code* tidak menyediakan butir-butir rekabentuk yang lengkap untuk pengiraan beban keupayaan bagi stad tiang menggunakan keluli terbentuk sejuk di dalam panel dinding pasang siap ini. Oleh itu, ciri-ciri dan kelakuan struktur stad tiang perlu diperolehi melalui kajian ujikaji. Sebanyak lima spesimen telah diuji di bawah daya paksi mampatan sehingga mencapai kegagalan. Lima spesimen ini terdiri daripada tiga spesimen yang menggunakan keratan berbibir berbentuk C, ditandakan sebagai S350CT1, S350CT2 dan S350CT3, satu spesimen yang menggunakan bentuk keratan-I, D350CT1, dan satu lagi spesimen panel dinding, W350CT1. Perbandingan antara keputusan ujikaji makmal untuk stad tiang di dalam panel dinding dan keputusan ujikaji makmal untuk stad individu kemudiannya dibuat. Keputusan ujikaji makmal untuk stad individu juga dibandingkan dengan nilai secara teoritikal yang diperolehi daripada pengiraan berpandukan *BS 5950-Part 5:1998 Code of practice.* Kesemua stad individu yang dikenakan daya paksi mampatan, kecuali S350CT1, gagal di dalam mod lengkukan lenturan, dengan kerosakan kekal yang kelihatan dengan ketara dan tanpa lengkukan kilasan. S350CT1 telah gagal disebabkan oleh kegagalan bolt secara ricihan di dalam sambungan secara bolt. Daripada ujikaji, dapat disimpulkan bahawa pemilihan bentuk keratan amat mempengaruhi keupayaan kegagalan tegasan bagi stad individu. Kesemua nilai beban kegagalan secara ujikaji untuk stad individu selaras dengan nilai yang dijangkakan. Untuk panel dinding pasang siap, keputusan ujikaji menunjukkan lengkukan lenturan dan lengkukan tempatan kelihatan apabila panel dinding mencapai kegagalan.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	DECLARATION	**ii**
	DEDICATION	**iii**
	ACKNOWLEDGEMENTS	**iv**
	ABSTRACT	**v**
	ABSTRAK	**vi**
	TABLE OF CONTENTS	**vii**
	LIST OF TABLES	**xi**
	LIST OF FIGURES	**xiii**
	LIST OF SYMBOLS	**xvii**
	LIST OF APPENDICES	**xxi**
1	**INTRODUCTION**	**1**
	1.1 Background of the Study	1
	1.2 Problem Statement	3
	1.3 Aim and Objectives	4
	1.4 Scope	5
2	**LITERATURE REVIEW**	**6**
	2.1 Introduction	6
	2.2 Previous Researches on Cold-Formed Wall Panel and Built-Up Section	6
	2.3 Wall Studs	10

2.4 Applications of Cold-Formed Steel 13

2.5 Types of Cold-Formed Steel 15

2.6 Manufacturing Processes of Cold-Formed Steel 17

2.7 Connection for Cold-Formed Steelwork 18

  2.7.1 Bolted Connections 20

    2.7.1.1 Bolt Spacing 22

    2.7.1.2 Bolt Capacity 22

  2.7.2 Screw Connections 24

    2.7.2.1 Screw Spacing 25

    2.7.2.2 Screw Capacity 25

2.8 Strength and Design Criteria for Cold-Formed Steel 26

  2.8.1 Stiffeners in Compression Elements 27

  2.8.2 Limit States for Cold-Formed Steel Compression Members 28

    2.8.2.1 Local Buckling of Individual Elements 29

    2.8.2.2 Yielding 30

    2.8.2.3 Distortional Buckling 31

    2.8.2.4 Flexural Buckling 31

    2.8.2.5 Torsional Buckling 32

    2.8.2.6 Torsional-Flexural Buckling 33

  2.8.3 Local Buckling and Postbuckling of Thin Compression Elements 34

  2.8.4 Web Crippling 37

  2.8.5 Mid-line Method for Computing Properties of Cold-Formed Steel Sections 38

  2.8.6 Shear Modulus, Modulus of Elasticity and Tangent Modulus 38

  2.8.7 Yield Point of Cold-Formed Steel 39

  2.8.8 Effective Length Factor, *K* 40

2.9 I-Section Compression Member 41

3 EXPERIMENTAL INVESTIGATION 42
3.1 Introduction 42
3.2 Material Properties 43
3.3 Coupon Test 43
  3.3.1 Specimens of Coupon Test 44
  3.3.2 Coupon Test Procedure 44
  3.3.3 Coupon Test Measurement and Calculation 45
3.4 Predicted Ultimate Load 47
3.5 Individual Stud Test 48
  3.5.1 Specimens of Individual Stud Test 48
  3.5.2 Individual Stud Test Procedure 50
3.6 Wall Panel Test 61
  3.6.1 Specimens of Wall Panel Test 61
  3.6.2 Wall Panel Test Procedure 68

4 RESULTS AND ANALYSIS 74
4.1 General 74
4.2 Tensile Coupon Tests 74
  4.2.1 Observation of Tensile Coupon Tests 75
  4.2.2 Results of Tensile Coupon Tests 75
4.3 Theoretical Approach for Axial Compression Capacities 78
  4.3.1 Singly Lipped C-Channel (250×75×20×2.05 mm) 78
  4.3.2 Doubly Lipped Channel (I-Section) (250×150×20×4.1/2.05 mm) 91
4.4 Individual Stud Tests 106
  4.4.1 Observation of Individual Stud Tests 107
    4.4.1.1 S350CT1: Type I 107
    4.4.1.2 S350CT2: Type II 108
    4.4.1.3 S350CT3: Type III 109
    4.4.1.4 D350CT1: Type III 110
  4.4.2 Results of Individual Stud Tests 112

4.4.2.1 S350CT1: Type I 112
4.4.2.2 S350CT2: Type II 114
4.4.2.3 S350CT3: Type III 117
4.4.2.4 D350CT1: Type III 119
4.5 Comparison and Discussion of Individual Stud Test Results 122
4.6 Wall Panel Test 124
4.6.1 Observation of Wall Panel Test 125
4.6.2 Results of Wall Panel Test 127
4.7 Comparison and Discussion of Individual Stud Test and Column Stud Test Results 129

5 CONCLUSIONS 131
5.1 Summary of study 131
5.2 Conclusions 132
5.3 Future Studies 133

REFERENCES 134
Appendices A - C 137-158

LIST OF TABLES

TABLE NO.	TITLE	PAGE
2.1	Typical applications and types of fasteners	20
2.2	Bearing capacity in bolted connections	23
2.3	Shear capacity in screw connections	25
2.4	Effective lengths for compression members	40
3.1	Parameter value for S1	45
3.2	Parameter value for S2	46
3.3	Parameter value for S2	46
3.4	Test piece dimension	46
3.5	Type of test method for each specimen	52
4.1	The ultimate and yield strength of material	77
4.2	Exact, mid-line and actual dimensions of a C-channel section	79
4.3	Mid-line and actual dimensions for the each C-channel element	79
4.4	Measurement of each element for the calculation of Y_1, Y_2, X_1 and X_2 of C-channel	80
4.5	Measurement of each element based on x and y axis for the calculation of I_x and I_y of C-channel	80
4.6	Calculation of A and $\bar{X}$ using each element of a C-channel	85
4.7	Calculation of A_{eff} and $\bar{X}$ using each element of a C-channel	85
4.8	Calculation of A and $\bar{Y}$ using each element of a C-channel	86

4.9 Calculation of A_{eff} and $\bar{Y}$ using each element of a C-channel 86
4.10 Exact, mid-line and actual dimensions of an I-section 92
4.11 Mid-line and actual dimensions for the each I-section element 93
4.12 Measurement of each element for the calculation of Y_1, Y_2, X_1 and X_2 of I-section 93
4.13 Measurement of each element based on x and y axis for the calculation of I_x and I_y of I-section 94
4.14 Calculation of A and $\bar{X}$ using each element of an I-section 98
4.15 Calculation of A_{eff} and $\bar{X}$ using each element of an I-section 99
4.16 Calculation of A and $\bar{Y}$ using each element of an I-section 100
4.17 Calculation of A_{eff} and $\bar{Y}$ using each element of an I-section 100
4.18 Failure stress of individual studs 123
4.19 Test result for wall panel 129
4.20 Stud failure load in wall panel 130

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
1.1	Typical wall assemblies	3
2.1	Wall studs	11
2.2	Buckling of studs between screws	12
2.3	Overall column studs buckling	12
2.4	Steel sections used in building construction	14
2.5	Cold-formed steel cross-sections	15
2.6	C-channel cold-formed steel with x and y axis, and the depth, D	16
2.7	Profiled steel sheeting	16
2.8	Cold-roll forming tools	17
2.9	Manufacturing by press braking	18
2.10	Manufacturing by folding	18
2.11	Example of mechanical fasteners for thin wall elements	19
2.12	Tension failure	21
2.13	Various failure modes of bolted connection	21
2.14	Spacing of bolts, S_v and edge distances, e	22
2.15	Failure modes of screwed connection	24
2.16	Types of compression elements	28
2.17	Buckling modes for a lipped C-channel in compression	28
2.18	Buckling modes of lipped C-channel using finite strip analysis	29
2.19	Local buckling of cold-formed steel plain channel column	30

2.20 Torsional-flexural buckling of a nonsymmetric section 34
2.21 Local buckling of compression elements of columns 34
2.22 Postbuckling strength model 35
2.23 Stress distribution stages in stiffened compression elements, where f_{cr} is the critical local buckling stress and F_y is the yield point 36
2.24 Effective width of stiffened compression element 36
2.25 Maximum stress for unstiffened compression elements 37
2.26 Mid-line of the cross-section 38
2.27 Gradual yielding of stress-strain curve 40
2.28 Effective lengths of various end conditions 41
3.1 Tensile coupon test 43
3.2 Coupon dimension 45
3.3 Dimensions of sections 49
3.4 Geometry of I-section 49
3.5 Actual I-section 49
3.6 Stiffener in the top and bottom ends of individual studs 52
3.7 Type of data logger and hand pump used in experiment 52
3.8 Individual stud test using type I for S350CT1 53
3.9 Actual setup test for S350CT1 54
3.10 Individual stud test using type II for S350CT2 55
3.11 Actual setup test for S350CT2 56
3.12 Individual stud test using type III for S350CT3 57
3.13 Actual setup test for S350CT3 58
3.14 Individual stud test using type III for D350CT1 59
3.15 Actual setup test for D350CT1 60
3.16 Geometry of wall panel with one middle stud 62
3.17 A complete prefabricated wall panel 63
3.18 Side view of W350CT1 64
3.19 Dimensions of sections in wall panel 64
3.20 C-channel bracing configuration 65
3.21 Prefabricated wall panel 66

3.22 Detail connections between top track and studs in wall panel 67
3.23 Actual bolted connections in wall panel 67
3.24 Installation of wood pieces at the top end of wall panel 70
3.25 A full scale wall panel test 71
3.26 Actual setup test for W350CT1 72
3.27 Arrangement of rods on both spreaders, S1 and S2 73
4.1 Failure modes of the specimens 75
4.2 Coupon test result for coupon specimen 1 (S1) 76
4.3 Coupon test result for coupon specimen 2 (S2) 76
4.4 Coupon test result for coupon specimen 3 (S3) 77
4.5 Singly C-channel section dimensions
4.6 Gross section and reduced section of a C-channel
4.7 I-section dimensions
4.8 Gross section and reduced section of an I-section
4.9 Specimen 1 (S350CT1) failure modes 108
4.10 Specimen 2 (S350CT2) failure modes 109
4.11 Specimen 3 (S350CT3) failure modes 110
4.12 Specimen 4 (D350CT1) failure modes 111
4.13 Load versus deflection chart for S350CT1 113
4.14 Some data from load versus deflection graph for S350CT1 114
4.15 Load versus deflection chart for S350CT2 115
4.16 Some data from load versus deflection graph for S350CT2 116
4.17 S350CT2 116
4.18 Load versus deflection chart for S350CT3 108
4.19 Some data from load versus deflection graph for S350CT3 118
4.20 S350CT3 119
4.21 Load versus deflection chart for D350CT1 in the range of deflection -4.0 to 4.0 mm 120
4.22 Load versus deflection chart for D350CT1 121

4.23 Some data from load versus deflection graph for D350CT1 121
4.24 D350CT3 122
4.25 Failure mode of W350CT31 126
4.26 Local buckling in the connection area 127
4.27 Load versus deflection chart for W350CT1 128
4.28 Some data from load versus deflection graph for W350CT1 128
4.29 Local buckling at middle stud 128

LIST OF SYMBOLS

a^b - Thickness of flat test piece (for coupon specimen)
A - Area of a cross-section or gross area
A_{eff} - Effective cross-sectional area
A_i - Area of each element
A_n - Net area of a section
A_t - Tensile stress area of the bolt or area at the bottom of the threads
α - Coefficient of linear thermal expansion or
- Factors for member in compression
b - Flat width of an element or
- Width of the parallel length of a flat test piece (for coupon specimen)
b_{eff} - Effective width of a compression element
b_{eu} - Effective width of an unstiffened compression element
b_g - Gripped end width (for coupon specimen)
b_j - Width of flat elements (mid-line dimension)
b_1, b_2 - Mid-line dimensions of the respective elements assuming rounded corners are replaced with intersections of the flat elements
B - Overall flange width
BL - Overall lipped depth
C_w - Warping constant of a section
d - Nominal diameter of the bolt or
- Diameter of the screw
d_e - Distance from the centre of a bolt to the end of the connected element in the direction of the bolt force
d_s - Head of screw or washer diameter

D - Overall web depth

D_c - Depth of the compression zone of the web, taken as the distance from the neutral axis of the gross cross-section to the compression element

D_w - Section depth or twice the depth of the compression zone

e - Distance between the centre of a bolt and any edge of the connected member or

- Shear centre position as shown in Table D.1 BS 5950-Part 5

e_s - Distance between the geometric neutral axis and the effective neutral axis of a section

E - Modulus of elasticity of steel

E_t - Tangent modulus

f - Local buckling stress

f_c - Compressive stress on the effective element

f_{cr} - Critical local buckling stress

f_{pr} - Proportional limit

F_s - Longitudinal shear force

F_y - Yield point

G - Shear modulus of steel

I_x, I_y - Second moment of area of a cross-section about the x and y axis respectively

J - St Venant torsion constant of a section

K - Buckling coefficient of an element

L_c - Parallel length (for coupon specimen)

L_E - Effective length of a member about the critical axis

L_g - Length between gripped area (for coupon specimen)

L_o - Original gauge length (for coupon specimen)

L_t - Total length of test piece (for coupon specimen)

m - Number of flat elements

M_c - Moment capacity of a cross-section

M_i - Distance from centre of each element to the bottom flange

n - Number of all 90^{o} corners

N_i - Distance from centre of each element to the web

p_c - Compressive strength

p_{cr} - Local buckling stress of an element

p_o - Limiting compressive stress

p_S - Shear strength obtained from Table 11; BS 5950-Part 5

p_t - Tension strength obtained from Table 11; BS 5950-Part 5

p_y - Design strength of steel

P_{bb} - Bearing capacity of bolt

P_{bs} - Bearing capacity of connected elements

P_c - Buckling resistance under axial load

P_{cs} - Short strut capacity

P_E - Elastic flexural buckling load (Euler load) for a column

P_{Ex}, P_{Ey} - Elastic flexural buckling load (Euler load) for a column about x and y axis respectively

P_{fs} - Shear capacity of screw by testing

P_{ft} - Tensile capacity of screw by testing

P_S - Shear capacity of bolt or

- Shear capacity of screw

P_t - Tension capacity of bolt or

- Tensile capacity of screw

P_T - Torsional buckling load of a column

P_{TF} - Torsional-flexural buckling load of a column

P'_c - Buckling resistance after consider M_c and e_s

Q - Factor defining the effective cross-sectional area of a section

r_{cy} - Radius of gyration of one channel

r_i - Radius of corner (mid-line dimension)

r_o - Polar radius of gyration of a section about the shear centre

r_x, r_y - Radius of gyration of a section about the x and y axis respectively

s - Longitudinal spacing of interconnections

S_o - Original cross-sectional area of the parallel length (for coupon specimen)

S_v - Spacing between bolts or screws

S_x, S_y - Plastic modulus about the x and y axis respectively

t - Net material thickness or

- Minimum thickness of the connected material

t_1, t_2 - Thicknesses of element widths b_1 and b_2 respectively

t_3 - Thickness of the member in contact with the screw head

t_4 - Thickness of the member remote from the screw head

v - Poisson ratio

w - Width of the plate

x_o - Distance from the shear centre to the centroid of a section measured along the x axis of symmetry

X_1, X_2 - Distance from centroid to left and right edge of the section measured along the x axis of symmetry respectively

$\bar{X}, \bar{Y}$ - Horizontal and vertical position of the neutral axis from the web or lipped and bottom flange respectively

X_i, Y_i - Distance from centre of each element to the centre of cross-section in horizontal and vertical direction respectively

Y_s - Material yield strength

Y_1, Y_2 - Distance from centroid to top and bottom edge of the section measured along the y axis of symmetry respectively

Z_x, Z_y - Section modulus about the x and y axis respectively

λ_x, λ_y - Slenderness ratio about the x and y axis respectively

η - Perry coefficient

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A1	Results from Individual Stud Test S350CT1	138
A2	Results from Individual Stud Test S350CT2	142
A3	Results from Individual Stud Test S350CT3	144
A4	Results from Individual Stud Test D350CT1	147
B1	Results from Wall Panel Test W350CT1	153
C1	Calculation of the Bolted Connection between Stud and Track	156

CHAPTER 1

INTRODUCTION

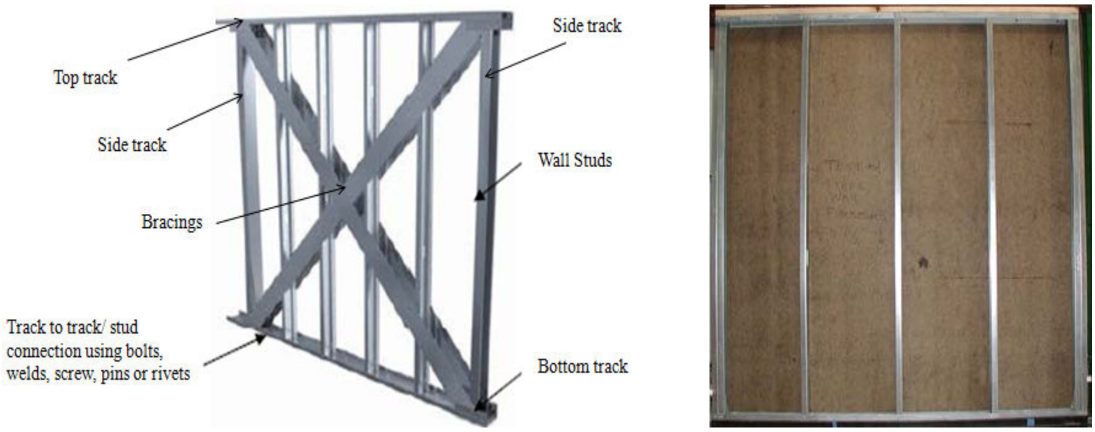
1.1 Background of the Study

A wall is a continuous vertical structure, which is thin relative to its length and height. External walls help to provide shelter against our environment such as wind, rain and the daily and seasonal variations of outside temperature to its location, for reasonable indoor comfort and internal walls divide buildings into rooms or compartments. To provide adequate shelter a wall must have sufficient strength and stability to be self-supporting and to resist the loads from roofs and upper floors. To differentiate the structural requirements of those walls that carry lateral and axial loadings (the loads from roof and upper floors in addition to their own weight) from those that are freestanding and carry only their own weight, the terms load bearing and non load bearing are used [1]. Other functions of walls are to enclose the space within it and to divide that space to provide privacy, security and equable conditions for storage and operations for occupants in the building. The commonly accepted specific requirements of a wall are stability, strength, resistance to weather and ground moisture, durability, fire safety, good thermal properties and resistance to airborne and impact sound, security and aesthetics [2].

Nowadays, the use of prefabricated wall panel in the construction industry has become a very common trend. The need to increase production efficiency, to save materials and to respond to the changing demands of building, users is leading to increase the use of prefabrication. Advantages of using prefabricated wall panel is to ensure consistency of quality as the wall frames have been properly engineered to meet specific load, wind bearing and bracing requirements, to include savings cost and time and easier site inspection as well as greatly improved in design details and during fabrication of the units. For instance, prefabricated and preassembled construction has been successfully applied to the standard public housing blocks throughout the 1990s. Prefabricated wall systems are manufactured in the factory, trucked to a construction site, lifted into position on a building using a crane, and anchored in place. The current market for prefabricated wall system is diverse and extensive, ranging from precast concrete wall panels to utilized glass and metal curtain wall systems [3].

Masonry, timber and reinforced concrete have traditionally been used for walls, but cold-formed steel continues to grow in popularity due to its structural and material advantages. In comparison with these conventional construction materials, steel is inherently recyclable and incurs much less cost to the environment (in terms of energy consumption and pollution) during its processing. The use of cold-formed steel has been more prevalent as well as in commercial or community applications because they are lighter than traditional concrete. A cold-formed steel wall panel internally or externally normally consists of top and bottom tracks, studs, braces (depending on the strength requirements) and the studs to track were connected together using bolts, welds, screws, pins or rivets (Figure 1.1). The studs were connected to horizontal tracks top and bottom, and sheathed on one or two side with board, which can be assembled together on site or manufactured in the factory. Steel frame should be fully integrated with both the external and internal wall panel systems as well as the floor systems so that they are mutual supporting. This lead naturally to consideration of stresses skin design [4].

Many companies involved in the construction industry are small or medium sized and so their ability to industrialise their methods may be limited. There is also increasing pressure to develop construction systems that are more sustainable. Buildings should be designed to use materials from renewable sources that minimise transportation costs, can be easily disassembled and reused. One area where there is an opportunity to develop system that may suit a variety of different sized organisations and improved the sustainability of construction is the use of cold-formed steel prefabricated wall panels as it is very cheap [5].



(a) (b)

Figure 1.1 Typical wall assemblies a) wall panel with bracing, b) wall panel with one side sheathing

1.2 Problem Statement

When the demand of low capital cost, easy and simple fabricated structure component, new techniques that suitable for both factory and site construction, erection that allows for deconstruction and recycling, and a very light structure component; is on the rise, prefabricated wall is one of the solution. The cheapest and suitable material is cold-formed steel that can be used as a main structure or column studs in a wall panel. Typically, the cold-formed steel cross-sections mostly used as column studs are single C-channel and I-section made of back-to-back C-channel. The strength of the wall is depending on the overall buckling of main structure, column stud. At the moment, the British Code [6] has not provided adequate detail design to account the load capacity of a cold-formed steel column stud in a prefabricated wall panel. The structural performances of column stud therefore need to be obtained through the experimental investigation.

For these reason, an experimental study was carried out to evaluate the possibility behaviour of four individual stud specimens using two different section geometries (C-channel and I-section) and column studs using C-channel in one full-scale prefabricated wall panel. Then the relation between individual stud and column stud will be observed.

1.3 Aim and Objectives

The aim of this study is to determine the strength behaviour of the individual stud and column studs in prefabricated wall panel made by cold-formed steel. The main objectives of this study are:

a) To investigate the buckling behaviour by determining the ultimate load of both; the individual stud and column studs in a prefabricated wall panel subjected to compression.

b) To obtain the overall behaviour in terms of the failure modes of prefabricated wall panel.

c) To observe the insensitivity of the individual studs to the geometry of the sections.

d) To compare the individual stud test failure loads with the predicted load values, calculated based on BS5950-Part 5:1998 Code of practice for the design of cold-formed sections [6].

e) To correlate the results of the individual stud test to the results of the column stud in prefabricated wall panel test.

1.4 Scope

The scopes of this study will cover both the experimental and theoretical investigation of cold-formed steel section subject to compression;

1. The specimens for individual stud test were included three C-channel sections and one I-section, and were tested in simply supported condition for compression failure.

2. Determination of the design yield strength of cold-formed steel sections using tensile coupon test.

3. Determination of the axial compression capacity of cold-formed steel sections experimentally and theoretically.

4. The wall panel constructed with 3.15 m height and 1.5 m width.

5. Column studs will be the focus of the study for prefabricated wall panel experimental.