BEHAVIOUR OF COLD FORMED STEEL UNDER AXIAL COMPRESSION
FORCE

TAN HEAN SEONG

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University Technology of Malaysia

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ABSTRACT

This master project describes a series of compression test performed on lipped channel columns fabricated from cold formed high tensile steel plates with nominal yield stress of 550 MPa. This test includes Lysaght C-section ranging from C10010 to C20024 with restraint length of 800 mm, 1300 mm & 1500 mm. Each length represents different slenderness ratios, λ_1 values (L/r_y) ranging from 13.28 to 24.91 and each different section represents different slenderness ratios λ_2 values (D/t,B,t & B/D) ranging from 83.3 to 101.3 for D/t, 31.6 to 42.6 for B/t and 0.315 to 0.335 for B/D. The objective of this project was to study the buckling mode of cold formed singly C-section with different restraint lengths and to determine the ultimate compression capacity of the C-section with different section properties. Axial compression tests were performed on the C-section with two pinned ends connection. The pinned end connections base plate consisted of 6 mm thick plate grade G 43A (yield strength 275 N/mm²). The C-section was bolted to the base plate using 4 nos M20 diameter bolt grade 8.8. Gridlines were drawn on the specimen surface measured at 3 cm x 3 cm The cold formed C-sections have high width/thickness ratio that lead to local and distortional buckling affecting mainly member with or without edge stiffeners. The effect of width to thickness ratio increases as the local buckling and distortional buckling capacity decrease. For distortional buckling mode of failure, few parameters play an important role for a cold formed steel to fail under this mode. Among the parameters are flange length, length of lipped and web depth. Other buckling modes such as flexural and flexural-torsional buckling were also observed.

ABSTRAK

Projek sarjana tahun akhir melibatkan kajian daya mampatan terhadap struktur keluli keratan C yang diperbuat daripada plat keluli terikan tinggi. Sampel terdiri daripada keluli terikan tinggi dari saiz C10010 ke C20024. Sampel terdiri daripada panjang 800 mm, 1300 mm dan 1500 mm. Setiap spesimen mempunyai panjang yang berlainan dengan nilai kelangsingan λ_1 (L/r_y) yang berbeza dari 13.28 ke 24.91. Selain itu, spesimen mempunyai nilai λ_2 yang berlainan (D/t,B,t & B/D) dari 83.3 ke 101.3 untuk D/t, 31.6 ke 42.6 untuk B/t dan 0.315 ke 0.335 untuk B/D. Tujuan ujikaji ini adalah untuk mengkaji mod lengkokan keratan C dan juga untuk menentukan kekuatan mampatan keratan C. Ujikaji dijalankan ke atas spesimen yang mempunyai hujung pin yang terdiri daripada plat besi dan 4 nombor bolt M20 Gred 8.8. Garisan berukuran 3 cm X 3 cm ditanda pada spesimen. Spesimen ini mempunyai nisbah D/t yang tinggi yang boleh memyebabkan lengkukan tempatan. Ini berlaku pada C-channel yang tidak mempunyai pengkukuh. Kesan meninggikan nisbah D/t akan mengurangkan kesan lengkukan tempatan. Hasil kajain menunjukan lengkukan tempatan adalah disebab oleh beberapa parameter pada spesimen. Antaranya adalah kedalaman spesimen dan panjang sisi specimen. Sifat lengkukan yang lain juga diperhatikan, antaranya adalah lengkukan kilasan sisi.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Cold formed steels are made by bending a flat sheet of steel at room temperature into shape that will support more load than the flat sheet itself. The section itself are formed by press brake or bending brake operation from material such as carbon, low alloy steel, or stainless steel sheet, strip, plate, or flat bar. The thickness of such members usually ranges from 0.378 mm to about 6.35 mm. Compared with other materials such as timber and concrete, cold formed steel members can offer advantages such as lightness, high strength and stiffness, ease of fabrication and mass production, fast and easy fabrication and installation, and economy in transportation and handling.

Cold formed steel can be manufactured in two processes, such as brake pressing and rolled formed. Roll forming consist of feeding a continuous steel strip through a series of opposing rolls to progressively deform the steel plastically to form the desire shape. Roll forming is usually used to produce sections where very large quantities of a given shape are required. The initial tooling costs are high but the subsequent labour content is low. Brake pressing normally involves producing

one complete fold at a time along the full length of the section using brake press dies. For section with several folds, it is normally necessary to move the steel plate in press and to repeat the pressing operation several times. Brake pressing is normally used for low volume production where a variety of shapes are required and the roll forming tooling costs can't be justified.

The first standard was developed by American Iron and Steel Institute (AISI) in 1946 and was based largely on researched work done under the direction of Prof George Winter at Cornell University.Since the development of building codes and specification in various countries, the application of cold formed steel is increasing rapidly for constructing of;

1. Roof and wall system – typical sections are Z-(zee) of C-(channel) section, uses as purlins and girt. Corrugated roofing sheet will be fastened with self drilling screw to Z or C sections.

2. Steel rack for supporting storage pallets – the uprights are usually channels with or without additional rear flanges or tubular sections. Tubular sections such as lipped channels intermittently welded toe to toe are normally bolted to the upright.

3. Structural member for plane and space trusses – typical sections used are angle, hollow and channel as diagonal or chords members. Sections joint usually by welded joints or bolted joint. The most common section used for trusses are cold formed channel and Z.

4. Frameless stressed-skin structure – corrugated sheets or sheeting profiles with stiffened edges are used to form small structure up to 30 ft clear span with no interior support.

5. Steel floor and roof deck – formed steel deck is laid across steel beams to provide a safe working platform and a form for concrete. It is normally designated as a wide rib, intermediate rib, or narrow rib deck.

(a)

(b)

(c)

(d)

Figure1.0: Application of Cold Formed Steel. a) Office b) Roof Truss c) Rack System d) Residential

Figure 1.1: Cold Formed Structure under Failure

1.2 Problem Statement

Cold formed steel structural member can be efficient in many applications where conventional hot rolled members prove uneconomic. Cold formed sections are usually thinner and have mode of failure and deformation which are not commonly encountered in normal structural steel design. In addition, cold forming process often produces structural imperfections and residual stresses which are quite different from those traditionally hot rolled and welded members.

A thin walled member under compression, there s a possibility of local buckling to occur. Besides local buckling, other mode of failure such as;

1. distortional buckling
2. flexural buckling
3. Torsional buckling
4. Flexural-torsional buckling

1.2 Objective of Research

The objectives of this research are:

1. To study the mode of failure for cold formed C section under axial compression load.
2. To study how each mode of failure behave and to understand which buckling mode is prevalent
3. To determine buckling mode for different section properties of C section. The relation of ratio h/t, b/t and b/d to section mode of failure.
4. To determine the ultimate failure load of different type of C-section, i.e. open section.

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