Engineering Structures 33 (2011) 3197–3207

Contents lists available at SciVerse ScienceDirect

Engineering Structures

journal homepage: www.elsevier.com/locate/engstruct

# Design formulations for non-welded and welded aluminium columns using Continuous Strength Method

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ARTICLE INFO

*Article history:*
Received 23 February 2011
Received in revised form
26 July 2011
Accepted 26 July 2011
Available online 23 September 2011

*Keywords:*
Aluminium
Buckling
Columns
Continuous Strength Method
Heat affected zones

ABSTRACT

Aluminium members are used in structural applications due to their high strength-to-weight ratio, corrosion resistance, attractive appearance, recyclability, ease of production and availability. Thin aluminium sections are susceptible to buckling at a relatively low stress and welding makes it even worse; the design stress i.e. 0.2% proof stress is almost halved in the vicinity of the heat affected zones (HAZs). Currently available design codes have their guidelines both for welded and non-welded aluminium columns, but the predictions for welded aluminium columns are often quite inconsistent. The current research exploits a newly developed strain based design approach the 'Continuous Strength Method' (CSM) to predict the behaviour of aluminium members with SHS and RHS cross-sections subjected to compression. A new design curve is proposed herein to predict the cross-sectional resistance in compression; this concept is further extended to propose a new Perry type buckling curve to predict the flexural buckling resistance of aluminium columns. A simplified technique is proposed to include the effect of heat affected zone (HAZ) in CSM formulations. The CSM predictions for aluminium columns are compared against those obtained using available guidelines proposed by the European, American and Australian/ New Zealand standards of aluminium structures. The CSM predictions for non-welded columns are in line with the code predictions, whilst the proposed simple technique for transversely welded columns seems to produce significantly improved predictions.



## 1. Introduction

Aluminium tubular members are used in structures due to their high strength-to-weight ratio, corrosion resistance and ease of production. Aluminium members are generally manufactured by heat treated aluminium alloys to increase the design strength i.e. yield stress. The welding process involved during construction, on the other hand, reduces the material strength significantly in the vicinity of welded regions; this phenomenon is known as the softening of heat-affected zone (HAZ). In the case of 6000 series aluminium alloys, the heat generated from the welding process can reduce the parent metal strength by up to 68% in the HAZ [1]. Hence accurate prediction for the resistance of welded aluminium members is an important aspect in designing aluminium structures.

Currently available design codes for aluminium are based on the effectiveness of cross-sections, which is primarily determined by the width-to-thickness ratio of the constituent elements. Softening effect is accounted for by using an equivalent reduced thickness for cross-sections subjected to welding. The available guidelines for non-welded aluminium columns produce reasonably accurate predictions although the code predictions for welded columns are considerably inconsistent when compared against those obtained from experiments. The current research exploits available test results on aluminium columns with flat plated hollow sections i.e. SHS and RHS reported by Zhu and Young [1,2], Faella et al. [3] and Langseth and Hopperstad [4] to devise design principles following a recently developed strain based design concept the Continuous Strength Method (CSM). The basic concept of CSM was originally proposed for stainless steel [5–7], whilst the suitability of this concept for other nonlinear metallic materials was demonstrated elsewhere [8]. The basic design curve in CSM is based on the behaviour of cross-sections, which can be further extended to predict the flexural buckling resistance of columns. The current paper investigates the load–deformation behaviour of aluminium SHS and RHS stub columns to devise a basic design curve to predict the deformation capacity $\varepsilon_{LB}$ of cross-sections. Perry type buckling curves are proposed herein to predict the buckling resistance of long columns using the cross-sectional resistances obtained by CSM formulations. A new addition to the CSM concept is the incorporation of the weakening effect of transverse weld for aluminium columns.

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0141-0296/$ – see front matter 
doi:10.1016/j.engstruct.2011.07.027