Available online at www.sciencedirect.com
SCIENCE DIRECT
Thin-Walled Structures 43 (2005) 1882–1912
THIN-WALLED STRUCTURES
www.elsevier.com/locate/tws

Application of direct strength method to axially loaded perforated cold-formed steel studs: Distortional and local buckling

Jennifer Tovar [a,1], Thomas Sputo [b,*]

[a] *Schwab Structural Engineering, Inc., 555 IH 35 South, Suite 210, New Braunfels, TX 78130, USA*
[b] *Department of Civil and Coastal Engineering, University of Florida, 365 Weil Hall, Gainesville, FL 32611-6580, USA*

Received 11 April 2005; received in revised form 15 August 2005; accepted 25 August 2005

Abstract

A study to develop methods of analyzing perforated, axially loaded, cold-formed steel studs using the provisions of the Direct Strength Method [American Iron and Steel Institute (AISI). North American Specification for the Design of Cold-Formed Steel Structural Members 2001 Edition with Supplement 2004 (AISI/COFS/NASPEC 2004) and Commentary (AISI/COFS/NASPEC 2004), Washington, DC; 2004] was undertaken using the Finite Strip Method as the method for determining the elastic buckling stresses. Several different models were developed to represent the effect of the web perforations. The capacities predicted using the Direct Strength Method for the limit states of distortional and local buckling were compared to capacities calculated using the equations contained in the AISI *Specification* [American Iron and Steel Institute (AISI). North American Specification for the Design of Cold-Formed Steel Structural Members 2001 Edition with Supplement 2004 (AISI/COFS/NASPEC 2004) and Commentary (AISI/COFS/NASPEC 2004), Washington, DC; 2004]. The limit state of longwave buckling is considered in a companion paper [Sputo T, Tovar J. Application of direct strength method to axially loaded perforated cold-formed steel studs: Part 1. Longwave buckling. Thin Walled Struct, submitted for publication]. The validity of the results is

* Corresponding author.
E-mail addresses: jennifer@schwabse.com (J. Tovar), sputo@ufl.edu (T. Sputo).

[1] Formerly Undergraduate Student, Department of Civil and Coastal Engineering, University of Florida, 365 Weil Hall, Gainesville, FL 32611, USA.

doi:10.1016/j.tws.2005.08.004

discussed and recommendations are made for the use of the Direct Strength Method for these members.

Keywords: Thin-walled structures; Elastic buckling; Cold-formed steel; Effective widths; Perforated elements; Direct strength method; Local buckling; Distortional buckling

1. Introduction

This is the second of two companion papers in which the design of perforated cold-formed steel studs in axial compression using the direct strength method is studied. The first paper [3], considered the limit state of longwave buckling, while this paper considers the limit states of distortional and local buckling. For further background information on the Direct Strength Method, the Finite Strip Method of analysis, and the development of the cross-section models, refer to Sputo and Tovar [3].

2. Distortional buckling

Distortional buckling involves both rotation and translation at the corners of the cross-section. This is seen as a distortion of the cross-section when a portion of the section is 'forced out' by a more rigid response of the remaining portion (see Fig. 1). While this mode may be somewhat indistinct, stiffened flanges make it particularly easy to distinguish between distortional and local buckling for C sections.

Distortional buckling will typically occur in the second 'dip' of the buckling curve (Fig. 2). This will usually appear across half-wavelengths that are two to four times the section web height. Ideally, a local minimum will occur in this range making it easy to determine the controlling critical buckling stress for distortional buckling.

For some geometries however, no local minima will occur and the distortional buckling section of the buckling curve is very flat or has a gentle but continuous slope up. Fig. 3 illustrates an example of this. Schafer [2] provides direction on dealing with indistinct

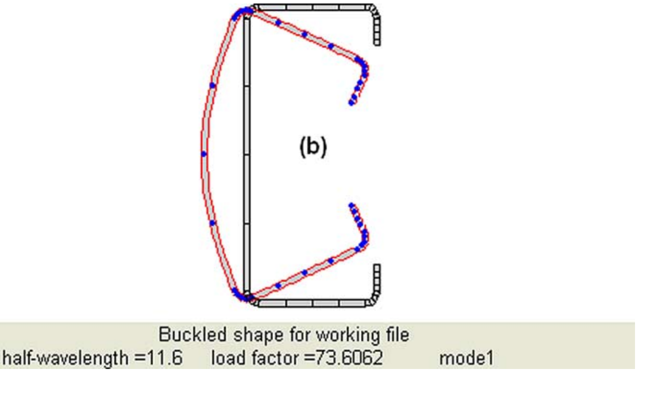

Fig. 1. Distortional buckling from CUFSM output for 362S162-68.(Figure units in English system).