Report on:

Member Selection and Structural Design

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Non-loadbearing Steel Stud Composite Limiting Height Calculations for Canadian Applications

Introduction

There is a large application for cold-formed steel framing members as interior non-loadbearing partitions. The steel studs have a layer of gypsum board attached to each side, and the composite strength of this combined assembly is stronger than the steel stud by itself. The maximum height that these wall assemblies can safely span is determined by a number of factors such as the differential air pressure across the wall, stud size, stud thickness and type of gypsum board. The performance of this composite assembly is determined by testing, most commonly in accordance with ICC-ES AC86, *Acceptance Criteria for Cold Formed Steel Framing Members – Interior Non-loadbearing Wall Assemblies*, published by the International Code Council Evaluation Service.

The calculation of the limiting heights is controlled by both the stiffness of the assembly and the ultimate strength. The stiffness is a serviceability requirement and the specified load is used. However, the strength limit state requires the determination of a resistance factor, and an equivalent factor of safety. The objective of this bulletin is to define how the applicable factor of safety required in the AC86 analysis is determined for Canadian applications.

Loads and Safety Factors

The calculation procedures included in AC86 are based on the Allowable Strength Design (ASD) approach that utilizes a factor of safety (Ω) to determine allowable loads. The ASD philosophy is commonly used in the United States, whereas in Canada the Limit States Design (LSD) philosophy is used. LSD utilizes resistance factors (φ) determined by testing and load factors (α) specified in the *National Building Code of Canada* (NBCC) to arrive at the loads a structural member can safely carry. To use the AC86 procedure for calculating limiting heights for composite walls, it is necessary to determine an equivalent safety factor for Canadian applications.

Even though these walls are classified as non-loadbearing, they are still structural elements and need to be engineered as such. In Commentary I, Wind Load and Effects, paragraph 61, of the *User's Guide - NBC 2010 Structural Commentaries (Part 4 of Division B)* there is the recommendation that the design of interior walls and partitions an unfactored pressure difference of at least 0.25 kPa is suggested and a value of 0.5 kPa or higher may be appropriate. While an argument could be made that the loads on a partition are not just internal wind pressures but live loads, the CSSBI has elected to treat them as wind loads with a corresponding load factor of 1.4.

According to the NBCC, the internal wind pressure is calculated as follows:

$$p_i = I_w q C_e C_{pi} C_{gi}$$

If p_i is taken as the 0.25 kPa unfactored pressure difference referred to in the Structural Commentaries, then this is the specified load used in determining the limiting heights according the AC86 procedure based on deflection (serviceability).

Canadian Sheet Steel Building Institute
652 Bishop St. N., Unit 2A
Cambridge, Ontario N3H 4V6
Tel.: (519) 650-1285
Fax: (519) 650-8081
Web Site: www.cssbi.ca

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For the limiting heights based on strength and with a transverse pressure not more than 0.5 kPa, CSA-S136-12, *North American Specification for the Design of Cold-Formed Steel Structural Members*, includes the following values in Appendix B:

$C_{\varphi} = 1.42$
$M_M = 1.10$
$F_M = 1.00$
$V_M = 0.10$
$V_F = 0.05$
$\beta = 1.82$

Using these values along with a $V_p = 0.065$ and n = 3 gives a $\varphi = 0.931$ calculated in accordance with Chapter F1.1 of S136. Since the load factor for wind specified in the NBCC is 1.4, then the equivalent safety factor for determining the limiting height based on strength is (1.4/0.931) = 1.503.

For the strength calculations with a transverse pressure more than 0.5 kPa, CSA-S136-12 lists the following values in Chapter F:

$C_{\varphi} = 1.42$
$M_M = 1.10$
$F_M = 1.00$
$V_M = 0.10$
$V_F = 0.05$
$\beta = 3.0$

Using these values along with a $V_p = 0.065$ and n = 3 gives a $\varphi = 0.666$. The equivalent safety factor for determining the limiting height based on strength is (1.4/0.666) = 2.101.

When determining the equivalent safety factor based on a test program, the actual values of V_p and n are used. This can result in safety factors larger than those given above.

Requirements in the US

The equivalent requirements for determining the safety factors for US applications are specified in AISI S100-12, *North American Specification for the Design of Cold-Formed Steel Structural Members*. Using the statistical values in S100 along with a $V_p = 0.065$ and n = 3 gives a safety factor of 1.508 for transverse pressures not more than 10 psf and a safety factor of 2.327 for transverse pressures more than 10 psf.

Conclusion

Limiting height tables for Canadian applications determined in accordance with CSA-S136-12 and AC86 uses minimum safety factors of 1.503 (0.5 kPa and less) and 2.101 (more than 0.5 kPa). Tables calculated for US applications can also be used for Canadian applications; however, the minimum transverse pressure of 0.25 kPa is equivalent to 5.22 psf, not the 5 psf typically used.

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