Canadian Sheet Steel Building Institute

Sheet Steel Facts 30

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Effects of Acoustic Perforations on the Web Crippling Strength of Steel Roof Deck

Introduction

Cold formed steel roof deck is a standardized product manufactured by a number of CSSBI member companies. Some of these roof deck products have a pattern of small holes punched into the web elements (perforated webs), as illustrated in the photograph in Figure 1, and are commonly referred to as "acoustic deck". In a typical acoustic deck the holes are 3 mm (0.125 in.) in diameter spaced on 9.5 mm (0.375 in.) staggered centres. The perforations would remove approximately 10% of the web area.

Acoustic deck is used because it can improve the sound transmission properties in a building as discussed in CSSBI Fact Sheet #16. The web crippling strength of the standard roof deck is well known and can be calculated using the *North American Specification for the Design of Cold-Formed Steel Members*, CSA-S136. The subject of this fact sheet is to document the effect the web perforations can have on the web crippling strength of the deck.

Research Project Summary

A research project was carried out within the Canadian Cold Formed Steel Research Group at the University of Waterloo. The objective of the project was to develop web crippling coefficients for end-one-flange (EOF) and interior-one-flange (IOF) loading on typical acoustic deck. The EOF and IOF conditions were selected as being the limiting design conditions for continuous roof deck applications. The results are summarized in this bulletin, but the complete results are available in *Web Crippling of Cold-Formed Steel Multi-Web Deck Sections Subjected to Interior-One and End-One Flange Loading*, Canadian Cold Formed Steel Research Group Report, July 2007 (available from the CSSBI). The test specimen sizes are shown in Table 1 and were selected to be representative of common products used in Canada.

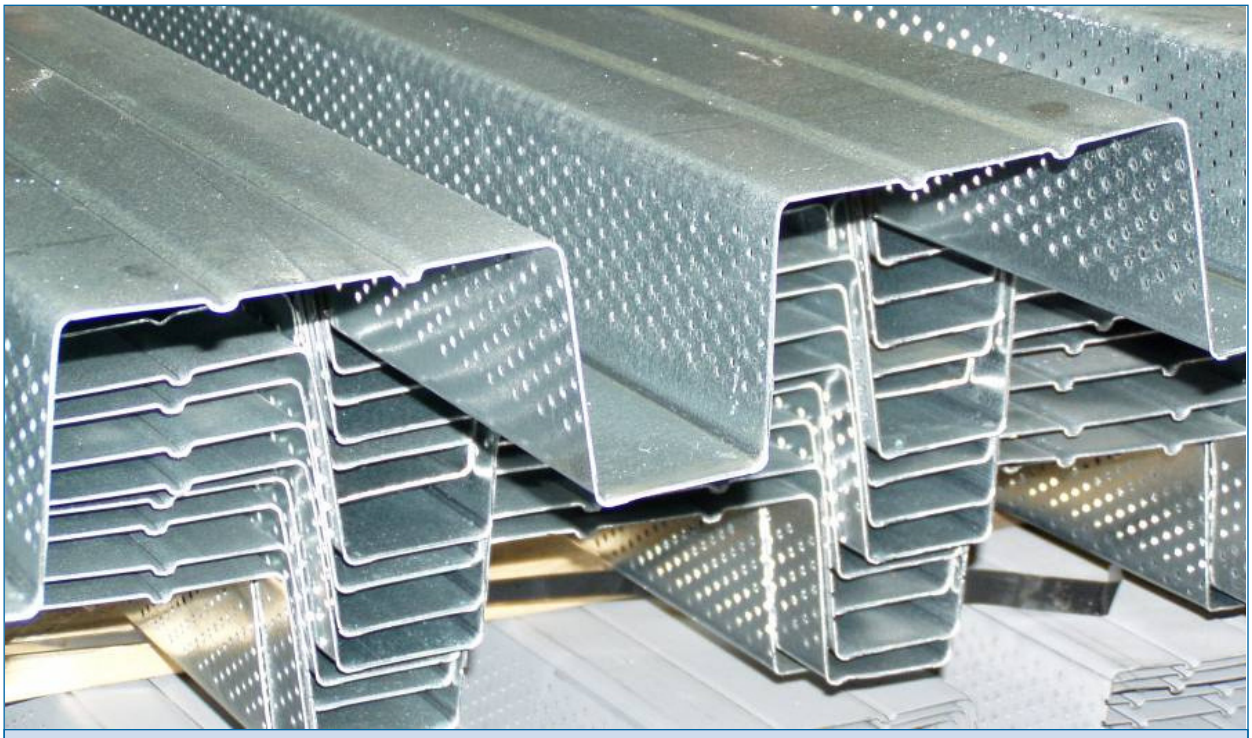

Figure 1: Photograph of Acoustic Deck

Web Crippling Loading

The scope of testing consisted of a series of end-one-flange and interior-one-flange web crippling tests on deck profiles as illustrated in the sketches in Figures 3 and 4. In all cases the deck was attached to the bearing support so the sections could not spread under load.

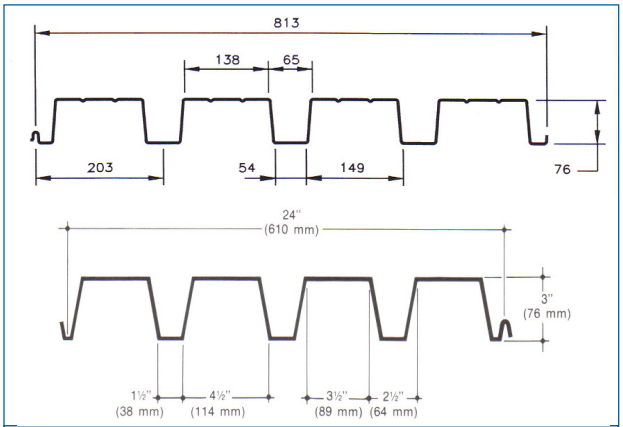

Figure 2: Deck Profiles

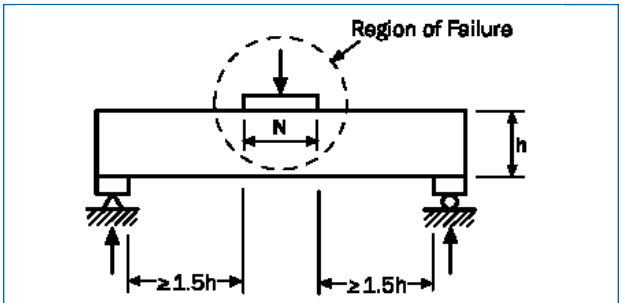

Figure 3: Interior-One-Flange (IOF) Loading

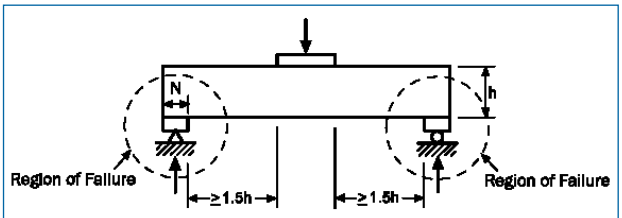

Figure 4: End-One-Flange (EOF) Loading

Web Crippling Coefficients and Resistance Factors

The nominal web crippling resistance of the deck can be calculated according to CSA-S136 using the following expression:

$$P_n = Ct^2F_y \sin\theta\left(1 - C_R\sqrt{\frac{R}{t}}\right)\left(1 + C_N\sqrt{\frac{N}{t}}\right)\left(1 - C_h\sqrt{\frac{h}{t}}\right)$$

Where,

C	=	Web crippling coefficient
C_h	=	Web slenderness coefficient
C_N	=	Bearing width coefficient
C_R	=	Inside bend radius coefficient
F_y	=	Yield strength of steel deck material (MPa)
h	=	Flat dimension of the web measured in plane of web (mm)
N	=	Bearing length (mm)
R	=	Inside bend radius of deck (mm)
t	=	Thickness of deck (mm)
Θ	=	Angle between plane of web and plane of bearing surface (deg.)

Deck Type	Base Steel Thickness		Yield Strength F_y	Deck Width	Flute Spacing	Web Angle Θ	Inside Bend Radius R	Depth h	Bearing Width N
	Gauge	(mm)	MPa	(mm)	(mm)	(deg)	(mm)	(mm)	(mm)
800-200	22	0.72	346	813	203	86	4.76	67.3	50.8
									76.2
									152
	20	0.87	378	813	203	86	3.18	70.3	50.8
									76.2
									152
	18	1.17	352	813	203	86	1.98	72.5	50.8
									76.2
									152
600-150	20	0.83	318	610	152	83	3.97	69.5	50.8
									76.2
									152
	18	1.10	339	610	152	83	2.38	72.4	50.8
									76.2
									152

Table 1: Test Specimen Dimensions

The test data was used to develop the new web crippling coefficients listed in Table 2. The calculation of the web crippling resistance using these proposed coefficients is only valid for the 76 mm (3") deck within the range of parameters tested.

New Web Crippling Coefficients		
Coefficient	EOF	IOF
C	2.7	5.3
C_R	0.01	0.01
C_N	0.64	0.33
C_h	0.061	0.046

Table 2: New Web Crippling Coefficients (fastened to support)

The statistical data from the test results shown in Table 3 were used with the calibration method given in Section F1.1 of the CSA-S136-07 to determine the resistance factors, ϕ, also listed in Table 3.

	Loading Condition (fastened to the support)	
	EOF	IOF
No. of tests	29	30
COV	0.070	0.045
P_t/P_n	0.999	1.008
ϕ	0.74	0.75

Table 3: Statistical Data and Resistance

For More Information

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