CANAM
BUILDINGS

LATERAL STABILITY OF PURLINS AND GIRTS:
ELEMENTS AFFECTING STABILITY AND HYPOTHESES USED TO CREATE BENDING RESISTANCE TABLES

By Serge Moreau, P.Eng.

December 2011

TABLE OF CONTENTS

SUMMARY

The present article supplements information contained in the Canam-Buildings Purlins and Girts catalog. The lateral stability of purlins is further detailed in order to make optimal use of the tables in the catalog. Other subjects, including discrete bracing, the role of sag rods and sloped roofs are also covered and an explanation of the variables used in the catalog tables is equally provided.

LATERAL STABILITY OF PURLINS AND GIRTS

In the most recent edition of North American Specification for the Design of Cold-Formed Steel Structural Members, CAN/CSA-S136-M07, various concepts regarding the stability of purlins and girts are discussed and calculations relating to the flexion/torsion of buckling control members added. The Canam Purlins and Girts catalog includes these additions and a new chapter, entitled Lateral stability of purlins, which discusses the stability of cold-formed C and Z sections (figures 1 and 2).

Figure 1
Cold-formed C section

Figure 2
Cold-formed Z section

The following paragraphs discuss the various factors impacting stability as well as the hypotheses used to create bending resistance tables for purlins and girts.

Calculation of purlins and girts
There are now three basic equations to calculate bending of cold-formed sections:

1. Nominal resistance based on the elastic section modulus of the effective section
   $M_n = S_e F_y$ (article C3.1.1)

2. Flexion/torsion resistance based on the elastic section modulus of the effective section to the extreme compression fiber F_c
$M_n = S_c F_c$ (article C3.1.2.1)
3. Distortional buckling and bending resistance based on the elastic section modulus of the gross section to the extreme compression fiber
$M_n = M_y$ for $\lambda_d \leq 0.673$ and $M_n = M_n$ for $\lambda_d > 0.673$ (article C3.1.4)

Concept of discrete bracing
When undertaking calculations, the laterally unsupported length used to determine bending resistance depends on the definition of lateral support indicated in the specification.

The concept of discrete bracing is mentioned in the S136-01 specifications, however, article D3.2a in the seventh edition, S136-07, contains a precise definition of a lateral support. To be considered a lateral support, the section must be braced simultaneously on both flanges of the cold-formed C or Z section.

Two lateral support parameters are used to calculate specific flexural/torsional factors:
L_y = Unsupported length between fasteners on the compressed flange
L_t = Unsupported length between discrete bracing supporting both flanges against torsion

Various types of discrete bracing allow for the reduction of the laterally unsupported length (Lt). They are presented in the Lateral stability of purlins section (figure 3).

Figure 3
Canam purlins and girts catalog

Purlin and girt selection tables for bending resistance
The resulting calculations using the three flexion/torsion equations contain many variables that require us to consider various hypotheses. The hypotheses that we have chosen in our selection tables are lightly overdesigned for certain types of construction but are fully effective for others.

Hypotheses are:

- rigidity according to the type of purlin fasteners;
- sheathing or steel deck used;
- the rotation of extremities according to the different fasteners used;
- the type of lateral stabilizer used;
- the laterally unsupported length used according to L_y and L_t.

The tables preclude that the roofing material used is a standing seam roof with standard fasteners spaced at a maximum distance of 610 mm (24 in.)[1]. The tables were designed assuming a torsional rigidity of connectors $K_f = 0$, according to article C3.1.4, which means that the type of fastener used will not impact the bending resistance indicated in the tables.

[1] The 610 mm (24 in.) spacing is the maximum distance for the flexural calculation of girts. However, a smaller spacing may be necessary due to wind up lift or lateral diaphragm capacity.

Explanation of bending resistance variables used in tables

M_{re} = Factored bending moment resistance including the three flexion/torsion equations. The two flanges are laterally braced along the length of the section at a maximum spacing Lu between each discrete bracing. In addition, the fasteners on the compressed flange must be spaced as described in the previous paragraphs. For example, a girt with sheathing on each flange can be designed with M_{re} for a lateral wind up lift.

M_u = Factored bending moment resistance including the three flexion/torsion equations. The unsupported length corresponds to the distance between the discrete bracings, i.e. between the transversal element allowing for the resistance of both flanges against torsion and bending. For example, a roof purlin with no transversal element other than sheathing between the extremities on the compressed flange will have an unsupported length equal to its overall length.

Sloped roofs
Cold-formed C or Z sections used in sloped roofs are particularly sensitive to torsion. Lateral loads from dead, live or snow loads increase the magnitude of the effect (see equation number 3). It is necessary to consider discrete bracing and validate the resulting transferred loads in order to properly direct them towards the building's extremities.

The Lateral stability of purlins section contains different tools to assist designers in defining the minimum number of discrete bracings required with a 2:12 or 4:12 slope. In addition, four tables allow for the determination of loads on discrete bracing in order to

design these elements and the ridge and peripheral fasteners according to the factored gravity loads.

An example of a complete calculation for a sloped roof is also presented in the above-mentioned section.

Role of sag rods

In the case of both roof purlins and girts, the use of sag rods other than for the alignment of components during erection, must be determined in compliance with the definition of discrete bracing.

If a sag rod is positioned in the center of a cold-formed C or Z section, it will lightly provide any torsion resistance because the two flanges are still free to move. In the case of low profile sections, the center of gravity is close to the stressed or compressed flange, which means that the strut produces a specific resistance against torsion that can be determined only with a complex calculation. In the case of deeper sections, sag rods have no impact on the member's ability to resist against torsion or bending.

In the case of walls and flat roofs, if sag rods are used in the proximity of a flange and the opposite flange is withheld by sheathing, the unsupported length (Lt) used for the calculation with the tables will be the maximum distance between the sag rods.

The Lateral stability of purlins section presents three ideal types of discrete bracing for sloped roofs. However, the use of sag rods remains possible if they are installed in the proximity of the member's bottom flange with sheathing on the upper flange, provided that the loads are adequately analyzed.

Should you require additional information, wish to meet with one of our representatives, please call:
1-866-466-8769

Thank you for your interest in Canam-Buildings products!

www.canam-construction.com
Canam-Buildings
270, chemin Du Tremblay
Boucherville (Québec)
J4B 5X9

Canam Group is a North American expert in the design, fabrication and installation of construction products and solutions for the erection of commercial, institutional and multi-residential buildings. Its Canam-Buildings business unit designs and fabricates steel joists and girders, steel deck, the Hambro composite floor system, Econox prefabricated buildings and Murox insulated wall panels. Thanks to its BuildMaster fast-track construction process, Canam-Buildings works in concert with all project partners to ensure that customer jobsites are safe and free of any surprises.