

INTRODUCTION

LGBEAMER v7 Professional edition is a Windows®-based programs for analyzing single and multi-span beams using cold-formed stud, joist, track and z-shaped sections. In addition, and new for version 7 is the ability to analyze HSS sections.

Cold-Formed Steel Calculations are based on the American Iron and Steel Institute (AISI) "Specification for the Design of Cold-Formed Structural Members" (the Specification). The 1996 edition, 1996 edition with the 1999 Supplement, the 2001 North American Specification (NASPEC), - US provisions only – or the 2004 Supplement to the 2001 NASPEC – US provisions only - can be used. For all specifications, ASD provisions are used. In addition for the 1996 edition, web punchouts are treated in accordance with the International Conference of Building Officials (ICBO) Acceptance Criteria for Steel Studs, Joists and Track, AC46. When using the 1999 Supplement or 2001 NASPEC provisions, punchouts are treated accordingly. The user should be familiar with each of these documents to properly understand the methods and assumptions of the program.

Where Specification sections or equations are referenced in the body of this document the reference to the most current edition of the Specification is used.

HSS section calculations are based on the AISC "Manual of Steel Construction, Allowable Stress Design," 9th edition.

DISCLAIMER

The developers have extensively verified this program and its documentation. However, in using the program and documentation, the user accepts and understands that no warranty, expressed or implied, is made with regard to the accuracy of the results of the program. The program is intended for use by qualified professionals familiar with the design of cold-formed steel systems and AISC based HSS design. The user must understand the basis for calculations and independently verify results.

SETUP

LGBEAMER is designed to operate in the Windows® environment (32-bit operating systems). **Before setting up the program, it is important to close all applications, including MS Office®.** To setup the program, close all other applications and run Setup.exe from the installation CD. The setup routine will automatically create a folder called "**Program Files\LGBEAMER**", or a name of your choice, and install the executable, initialization and database files into that folder.

LGBEAMER has a built-in database feature that allows users to create their own cold-formed geometry databases. Databases that include geometry information from the Steel Stud Manufacturer's Association (SSMA), as well as several individual manufacturers' section databases and a generic Z-section database are included with the program. An HSS section database is also included. The databases will be automatically loaded into the LGBEAMER\DATABASE sub-folder during setup.

Program Description

LGBEAMER is an analysis and design tool intended to simplify the tasks involved in selecting appropriate members in cold-formed or HSS framing systems. Single and multi-span members with cantilevers can be modeled with uniform and concentrated bending loads as well as axial loads. Single, back-to-back, boxed or built-up cold-formed sections can be used (note that for Z-sections and HSS, only single members are considered).

Input is done from one simple graphics screen where the beam and loads are drawn in correct proportions. Changing input modes (e.g. from uniform loads to flexural bracing intervals) is as simple as clicking on a toolbar button.

LGBEAMER analyzes the beam to determine reactions, shear, moment and deflection at each node (i.e. reaction or point load) as well as 1000 intervals along each segment of the beam. Then, using the input section, interactions are checked based on the provisions of the Specification.

Results can be viewed in tabular or graphic format and either output can be sent to your printer by clicking the printer icon on the master toolbar.

LGBEAMER is also equipped with a comprehensive Help system to assist the user in proper modeling and interpretation of results. The following pages include a list of the various help topics available and an alphabetical summary of each topic.

Notation

LGBEAMER uses only the ASD provisions of the AISI, NASPEC and AISC 9th ed. Specifications. In later editions of the cold-formed Specification, the allowable load quantities are listed as R_n/Ω . However, for simplicity this manual and the Help documentation use the notation R_a where $R_a = R_n/\Omega$.

What's New in and v7 Professional edition

- 2004 Supplement to the North American Specification provisions (US provisions only).
- HSS Sections per AISC 9th edition
- Enhanced Framed Opening/Wall design, including load-bearing stud design and built-up members with up to (4) elements.
- Floor joist tool for analyzing members with alternating span live load in combination with dead load.
- Yield Point, F_y , toggle on the toolbar
- Enhancements to Concentrated Load input, including automatic entry of end loads and repeating loads.


Each of these features is discussed in detail below.

Analysis Methods

LGBEAMER uses successive integration to determine shear, moment, curvature, slope and deflection of the modeled beams. Each beam span and cantilever is divided into segments for purposes of integration. The number of segments can be varied from 100 to 1000. To change the number of integration steps, choose Settings from the menu and select Integration Steps. Then select the level precision you wish to use. To save this setting as the default, select Save Integration Steps as Default from the Integration Steps menu item.

Because small errors can occur through the integration process, for very long beams there may be some residual deflections at, for example, an end support. However, a comparison of magnitude of this deflection to the deflection inside adjacent spans will show that the approximations are quite accurate.

Analysis Results


The moment, shear and deflection values of each span of a model can be viewed by selecting **Analysis Results** from the View menu item of the main menu or by clicking on the  button on the toolbar.

Analysis results are given at 1/10 points of each span or cantilever. The X-distance listed for each span or cantilever is a “local” distance, measured from that elements’ leftmost end.

Maximum values of moment, shear and deflection are also listed in the analysis results.

Axial Loads

Axial loads, either compression (+) or tension (-) can be modeled on one or more spans. To

enter axial loads, click on the  button. A different axial load can be entered on each span.

If the axial load is the same on every span, check the box labeled “**Repeat Load**” and enter the axial load in the box for the Left Cantilever. As you type, your entry will be made in each of the axial load boxes.

Bracing intervals perpendicular to the plane of bending and for torsional buckling must also be entered. Separate lengths for $K_y L_y$ ($K_x L_x$ for y-y axis orientation of members though the $K_y L_y$ notation is used hereafter for convenience.) and $K_t L_t$ can be entered for each span. Note that for HSS sections, the value of $K_t L_t$ is not used in calculation as the section is torsionally stable. However, most often, the flexural and torsional unbraced lengths are the same in any given span. By checking the box labeled “**KtLt = KyLy**” your flexural buckling unbraced length entries will automatically be duplicated in the $K_t L_t$ boxes.

If the bracing is entered as “Sheathed” allowable axial loads will be calculated in accordance with section D4.1 of the Specification. The sheathing parameters for 3/8” to 5/8” thick gypsum board are used per Table D4.1 of the Specification. The Specification places several limits on the section and member length for sheathing braced design. If these limits are exceeded, LGBEAMER will display a warning message. However, calculations will proceed. It is up to the user to determine if the provisions are appropriate for their particular design.

Note that sheathing braced design is not included in the 2004 NASPEC Supplement. As such, if sheathing bracing is selected when designing with the 2004 NASPEC Supplement, a warning message will appear and sheathing bracing will not be allowed.


The 2001 NASPEC changed the provisions for calculating the compressive capacity for boxed and back-to-back members. These new provisions require the input of the interconnection spacing in order to calculate a modified radius of gyration. **In addition, the 2001 and later versions of the NASPEC require specific end interconnections and connection strength for boxed and back-to-back members. These provisions should be reviewed carefully and applied to all designs using such members.**

When viewing interaction summary information, compressive loads are followed by “(c)” and tensile loads are shown as “(t)” rather than the +/- format that is used for input. In this way, there is no confusion about what type of load is being checked in the interaction equations.

Details such as the nominal stresses and the actual value of the several interaction equations can be viewed by selecting **Interaction Details** from the **View** menu.

Beam Modeling

LGBEAMER uses a graphics screen to model all beam input. From this screen, span lengths, uniform loads, point loads, sloped and partial span loads, load multipliers for strength and deflection, axial loads, bearing lengths and flexural bracing are all input and edited.

To return to the beam-modeling screen from any of the other screens, click on the  button or select **Beam Input** from the **View** topic of the main menu

Bearing Lengths

Bearing lengths are used in the calculation of allowable web crippling loads. LGBEAMER uses a default end and interior bearing length of one inch.

To change the bearing length at any support, click on the button labeled “**Bearing Lengths**”, then enter the appropriate lengths.

To enter a bearing length for a point load, while in point load entry mode, enter the bearing length as part of the point load data. When the “**Apply**” button is clicked, all point load data, including the bearing length will be recorded.

Boxed and Back-to-Back Members

LGBEAMER can analyze members in five configurations including: **single, back-to-back, boxed, built-up and Y-Y axis**. Back-to-back and boxed configurations are commonly used in applications such as headers, jambs, posts or beams.

To enter a member configuration, use the dropdown box on the toolbar. The analysis and interactions will incorporate the configuration entered. It is assumed that for the back-to-back and boxed configurations that the members are adequately interconnected for the section to behave as one member. **2001 NASPEC (Section C4.5) and later versions include specific provisions regarding interconnection of boxed and back-to-back compression members.**

Note that multiple member input is not available for Z-sections, Y-Y axis orientations or HSS sections.

The treatment of multiple members in the interaction checks is discussed under the heading of the particular interaction.

Built-Up Members

LGBEAMER can analyze cold-formed members consisting of up to six stud or channel/track type sections in their strong (x-x axis) orientation. To analyze a built-up member, **input the span, load and bracing information then select Built-Up from the member configuration drop-down adjacent to the section input drop-downs.** A special form will appear allowing you to input up to six sections.

IT IS IMPORTANT TO INPUT THE SPAN AND LOAD DATA INFORMATION FIRST, AND THEN MOVE TO THE BUILT-UP MEMBER FORM. If 'Built-up' is selected from a screen other than the main data entry screen, the span, load and bracing information may not be properly saved and proportioned to the sections making up the built-up member.

Built-Up members are limited to sections that can be added from the section database drop-downs. No custom shapes are allowed. If you require shapes in a built-up member that are not currently in a database, you can build a special database of 'custom' shapes.

To input a section, select the section from the section input drop-downs and click the '**Add Section**' button. The section will be added to the built-up member. In addition, the flexural and axial stiffness table as well as the analysis summary table will be updated.

To delete a section, select the section by clicking the radio button to the left of the section, then click the '**Delete Section**' button.

Bending loads (uniform and concentrated) are proportioned to each section in the built-up member based on flexural stiffness (i.e. moment of inertia). Similarly, axial loads are proportioned based on the axial stiffness (i.e. area).

Each section in the built-up member is treated as an individual section with the loads proportioned as noted above. The unbraced length (axial and flexural) for each section is treated as the input bracing. Due to the number of possible configurations for a built-up member, no attempt is made to analyze the stability affect of building up the piece.

The summary output on the Built-Up form shows the maximum values of several key design parameters. The maximums shown represent the maximum for the given section at any point along its length. For flexure, the value of M/M_a is taken as the maximum moment ratio for positive moment (with allowable moment calculated with the input flexural bracing) or the absolute value of maximum moment at any point divided by the allowable moment at yield.

To view the analysis and interaction checks for an individual section, select the section by clicking the radio button to the left of the section name and clicking on the toolbar interaction button, or the 'Review Selected Section Analysis' button.

To return to the built-up member input screen, click the '**Return to Built-Up**' button on the main toolbar.

There are three options for getting a printed copy of output. By choosing '**Summary Only**' from the '**Print Mode**' box, a one-page summary of the overall input as well as the output for each section will be printed. Choosing '**Selected Section Only**' will give a standard interaction printout for the selected section. Choosing '**All**' will create a multi-page output consisting of the interaction outputs for each section as well as the summary report.

Codes and Specifications

For cold-formed members, LGBEAMER uses the AISI "Specification for the Design of Cold-Formed Steel Structural Members" - 1996 edition, the 1996 edition with 1999 Supplement, the "North American Specification", 2001 edition (NASPEC) or the 2004 Supplement to the NASPEC as the basis for section property calculations and interaction checks. Where the term "Specification" is used in the manuals and help screens, it is the AISI or NASPEC as appropriate.

When the 1996 edition of the Specification is used for members with punchouts, the ICBO "Acceptance Criteria for Steel Studs, Joists and Track" (AC46) is used. ICBO AC46 gives parameters for calculating allowable shear, web crippling and axial loads for members with punchouts. When the 1999 AISI Supplement or 2001 NASPEC is used, the provisions particular to those documents are used for punched members.

For HSS sections, LGBEAMER uses the AISC "Manual of Steel Construction, Allowable Stress Design" 9th edition.

Code Year

For cold-formed members, LGBEAMER can utilize the provisions of the 1996 edition of the Specification, the 1996 Specification including the 1999 Supplement, the 2001 North American Specification or the 2004 Supplement to the NASPEC (US provisions). The current Code Year setting is displayed just to the left of the toolbar buttons.

To change the Code Year setting, select **Settings** from the main menu then select **Code** from the menu items listed. Finally, select the Code Year you wish to use. Your new selection will be displayed in the Code Year box on the toolbar.

If you wish to have your current selection saved as a default to use at startup, again go to the Code Year menu items and select **Save Code as Default**.

For HSS Sections, only the AISC 9th edition, ASD is available. As such, the code year settings noted above do not apply when HSS sections are being analyzed.


Cold-Work of Forming

The cold-formed Specification allows the design yield strength to be increased for certain members based on the elevated yield strength caused by cold working. LGBEAMER uses these provisions where applicable. Some Building Codes, however, do not allow such an increase in strength. For this reason, LGBEAMER allows the user to over-ride the cold-work of forming increases.

To over-ride the cold-work of forming increase, select **Settings** from the main menu, then go to **Cold Work of Forming** and select the appropriate setting.

Diagrams



Shear, Moment and Deflection diagrams can be viewed by clicking on the  button or by selecting **Diagrams** from the **View** menu item of the main menu. Once in the diagram-viewing screen, choose the type of diagram you wish to view by using the dropdown box at the top of the graph.

Maximum and minimum values of the selected quantity are given at the left of the vertical axis. By clicking on the graphic screen at any location, the value of the selected quantity at that location will also be printed.

Flexural Bracing

Cold-formed flexural members in their strong axis orientation without continuous bracing (via properly attached sheathing for example) or HSS sections can be modeled with any unbraced length. LGBEAMER defaults to a fully braced condition for flexural calculations. Therefore, it is important to consider the actual bracing conditions when building the model.

Because there are no provisions in the Specification for determining bracing requirements in the zone of negative moment near supports of multi-span members, LGBEAMER considers only “positive” moment when comparing to the allowable moment based on stability. Positive moment is taken as the maximum value of moment between 0.2L and 0.8L of the span. Proper consideration must be given to bracing near supports to ensure stability in this region of rapidly changing moment.


To change the flexural bracing intervals, from the modeling screen, click on the button labeled “**Flexural Bracing**” and enter the bracing interval for each span.

Note that for Y-Y axis bending of cold-formed members, the Specification does not give provisions for flexural stability. As such, LGBEAMER forces the flexural bracing inputs to be ‘FULL’ when Y-Y axis members are analyzed. The design of such members should ensure that flexural instability is not a viable failure mechanism.

Floor Joists

LGBEAMER v7 Pro includes a floor joist design tool to aid in the analysis of multiple load cases required for members with alternate span live loads. To use the floor joist design tool, select



‘Floor Joists’ from the ‘Pro-Tools’ item of the main menu, or click on the Floor Joist button  in the Pro Tools command buttons.

Enter span and cantilever lengths exactly as you would for a typical LGBEAMER model.

Dead Load and Live Load are input as pressures (psf or Pa) as opposed to line loads (lb/ft or N/m) that typical LGBEAMER models use. The joist design tool uses member spacing is entered to convert the loads to line loads.

Total Load and Live Load deflection limits are entered via the ‘Deflection Limits’ dropdowns.

Bearing lengths are input just as they are for standard LGBEAMER models.

With all of the inputs entered, LGBEAMER will analyze the members for six (6) different load cases simultaneously:

1. DL + LL (All spans)
2. DL + LL (Even spans)
3. DL + LL (Odd spans)
4. LL only (All spans)
5. LL only (Even spans)
6. LL only (Odd spans)

Note that the 'LL only' cases are for checking the Live Load deflection only. Strength comparisons will always be controlled by DL + LL cases.

The analysis results for each load combination and the controlling load combination(s) can all be viewed from the Floor Joist modeling screen. The 'Results Summary – All Load Cases' box shows the maximum values of Total Deflection, Live Load Deflection, Moment ratio, Combined Bending and Shear Interaction and if web stiffeners are required at any supports.

The 'Results – Selected Load Case' box allows you to view the values of Total Deflection, Live Load Deflection, Moment ratio, Combined Bending and Shear Interaction and if web stiffeners are required at any supports for one specific load case. Use the dropdown in the upper right of the screen to select which load case you would like to preview.

For a hardcopy of the Floor Joist output, click on the printer button on the toolbar. A 'Summary Only' can be printed that will show the maximum values of each of the various design parameters and which load case generated the maximum value. The 'Summary and Each Load Case' can also be printed by selecting the button so labeled. If the 'Summary and Each Load Case' button is selected, there will be (7) pages printed; the summary printout and the individual printouts for each of the (6) load cases.



General Interactions

There may be instances where a frame model is done with a program other than LGBEAMER, but the complex interactions of the AISI Specification or NASPEC still need to be checked.

The **General Interactions** module allows the user to enter moments (x-x and y-y for single members or x-x only for boxed or back-to-back members) and axial loads derived from any source, along with unbraced lengths in each direction (x, y and torsion). LGBEAMER then creates a simple output showing the interaction values for the selected member and the input forces and unbraced lengths.


To access the General Interactions module, select '**Pro Tools**' from the main menu, then select

'General Interactions' or click the General Interactions button .

K_yL_y and K_tL_t can be input as "Sheathed" to use the provisions of Specification Section D4. When sheathing braced design is designated, a value of $K_yL_y = 24$ inches is used in the calculation of P_{cr} for combined bending and axial interactions.

In addition, C_b can be entered or calculated from M_A , M_B and M_C in accordance with the AISI and NASPEC Specifications. The specific values of C_{mx} and C_{my} can also be entered for combined bending and compression interactions.

Some building codes allow loads including wind or earthquake forces to be reduced for strength checks. Such load multipliers can be entered in the dropdown labeled 'Load Multiplier for Strength Checks.'

To print the General Interactions input and output, click the printer button  on the main menu.

HSS Sections

LGBEAMER v7 Pro designs with HSS sections in addition to cold-formed members. All HSS design is done in accordance with the AISC "Manual of Steel Construction, Allowable Stress Design" 9th edition.

To access the HSS sections, select 'Settings' from the main menu, then select 'Database' and 'HSS Sections'. To return to designing cold-formed sections from your default cold-formed database select 'Settings' – 'Database' – 'Default Cold Formed'. To change to a new cold-formed database, select 'Settings' – 'Database' – 'Cold Formed'.

Select the member size from the toolbar dropdown. Also, select the orientation 'Strong' or 'Weak' and the yield stress, F_y .

Note that the properties and the compactness check for the selected section are shown to the right of the modeling screen for preview.

Interaction Details

For members that are not fully braced for flexure and/or have axial loads applied, details of the interaction analysis can be viewed and printed. To view the interaction details, select **Interaction Details** from the **View** topic of the main menu.

For X-X axis bending of single and back-to-back cold-formed members that are not fully braced, LGBEAMER uses the provisions of Section C3.1.2 of the Specification, using the input bracing intervals as the K_tL_t and K_yL_y distances. C_b is determined using Eq. C3.1.2-11 using the moment values for the segment containing the point of maximum moment. For bracing intervals entered in inches (rather than "NONE", "Mid-Pt." etc.) it is assumed that the bracing interval is centered on the point of maximum moment.

For cold-formed boxed members, the provisions of Section D3.3 are used (1996 edition of the Specification) to determine the maximum allowable unbraced length. For the 1999 Supplement and later, Section C3.1.2.2 is used for flexural stability of boxed members.


The maximum "positive" moment is taken as the absolute maximum value of moment between 0.2L and 0.8L of an individual span, or as the exterior 0.8L of cantilevers. The Specification gives no guidance with regard to bracing of members near supports with moments. However, all members must have adequate bracing at supports.

The maximum positive moment and the location of this moment (in global coordinates) are given along with the input bracing intervals. The various intermediate inputs into the equation for M_n are given along with the allowable moment for the span and bracing condition modeled.

For axially loaded members, LGBEAMER uses Sections C4 and C5 of the Specification - Section D4 if the members are modeled as “sheathed”. The interaction details listing indicate applied loads, effective lengths, buckling stresses and the allowable axial load. In addition, each of the interaction equations from section C5 is listed with the associated intermediate inputs. Note that if $P/P_a > 0.15$, Eq. C5.2.1-3 does not apply. If this is the case, the value of Eq. C5.2.1-3 will be listed as “NA”.

For HSS sections the allowable stress, F_b , and the maximum unbraced length, L_c are calculated in accordance with section F3 of the AISC Manual. Additionally, section B5.1 is used to check the section elements for compactness.

Interaction Summary (Cold-Formed Members)

An interaction summary can be viewed by selecting **Interaction Summary** from the **View** item on the main menu or by clicking on the  button on the toolbar.

Flexural and Deflection Check: For each span and cantilever, the maximum moment, M_{max} , and the maximum moment ratio (M_{max}/M_a) are listed. The maximum positive moment (taken as the maximum value of moment between 0.2L and 0.8L), the flexural bracing, the allowable moment with the listed bracing and the ratio of positive moment to allowable moment with bracing are also listed. Finally the deflection and the deflection ratio are tabulated. Note that the deflection ratio is based on twice the input element length of cantilevers. Also, the maximum allowable deflection is not input as part of the model. Therefore the actual deflections must be verified to be within allowable limits.

Definitions of printout terms:

- **Span** – The span or cantilever for which moment and deflection information is given.
- **Mmax** - The maximum applied moment anywhere along the span before application of any load modifiers.
- **Mmax/Maxo** – The ratio of Mmax and the section’s yield moment, Maxo. This ratio does include the load modifier for strength.
- **Mpos** – The maximum positive moment (see above for how this value is determined).
- **Bracing** – The maximum unbraced length for flexure.
- **Ma(Brc)** – The allowable moment considering flexural instability based on the input unbraced length.
- **Mpos/Ma(Brc)** – The ratio of maximum positive moment over allowable moment considering flexural instability.
- **Deflection (in/mm)** – The maximum deflection anywhere along the span or cantilever. This value includes the load modifier for deflection.
- **Deflection Ratio** – The ratio of span length to maximum deflection. For cantilevers, the span length is taken as twice the cantilever length. This value includes the load modifier for deflection.

Combined Bending and Web Crippling: For each reaction or point load, the applied concentrated load or reaction is listed along with the bearing length and the maximum moment at the location of the concentrated load or reaction. The value of the interaction equation listed is based on Specification Eq C3.5.1-1 for single or boxed members and Eq C3.5.1-2 for back-to-back members. If the applied concentrated load or reaction exceeds the allowable load, or if the interaction equation exceeds its limit, web stiffeners are required and will be tabulated accordingly.

For members analyzed in their Y-Y axis orientation, the web crippling strength is calculated using the flat width of each flange. The total allowable web crippling load is taken as twice the minimum value for either flange.

Definitions of printout terms:

- **Reaction or Pt Load** – The label given to the reaction or point load as seen on the graphic model.
- **Load P** – The value of the reaction or point load. This value does not include the load modifier for strength.
- **Brng** – The bearing length used in the determination of the allowable web crippling load.
- **Pa** – The allowable web crippling load.
- **Mmax** – The value of bending moment at the location of the reaction or point load. This is used in the Combined Bending and Web Crippling interaction. This value does not include the load modifier for strength.
- **Intr. Value** - The value of the Combined Bending and Web Crippling interaction.
- **Stiffen Req'd?** – The indicator as to whether or not web stiffeners are required. This can be 'YES' if the reaction or point load exceeds Pa, or if the interaction exceeds the limits of the Specification.

Combined Bending and Shear: The maximum shear is listed at the location of each point load or reaction along with the moment at that location. An adjustment factor to the shear is also listed. This factor is used to reduce the allowable shear if a punchout is located within 1.5 times the web depth from the edge of bearing of the concentrated load or reaction. If punchouts are near concentrated loads or reactions, the model must indicate it. If no punchouts are specified near the load or reaction, the value of this factor is 1.00. The ratio of applied shear to allowable and the ratio of applied moment to allowable are listed. Interactions are also listed for both stiffened and unstiffened webs in accordance with Specification Section C3.3. If $M/M_a \leq 0.5$ or $V/V_a \leq 0.7$, the interaction equation for stiffened webs need not be checked and will be listed as "NA".

If the unstiffened interaction exceeds 1.0, web stiffeners must be used. If the stiffened interaction exceeds 1.3, the member is overstressed even with stiffeners and a different member must be used.

For members analyzed in their Y-Y axis orientation, the shear strength is calculated using the flat width of each flange. The total allowable shear is taken as twice the minimum value for either flange.

For members with partial span loads, the maximum combined bending and shear interaction may occur somewhere within the span. As such, for partial span loads, LGBEAMER checks combined bending and shear throughout the span. The number of integration steps used in the analysis determines the interval for checking inter-span combined bending and shear. For punched members, combined bending and shear is checked for both the punched and unpunched condition since the exact layout of punchouts is seldom known at design time. Also, the interactions are checked only for the case of unstiffened webs. For distributed loads, web stiffeners are not practical. If a partial span load is distributed over a very short distance of the beam, it should be analyzed as a concentrated load.

Definitions of printout terms:

- **Reaction or Pt Load** – The label given to the reaction or point load as seen on the graphic model.

- **Vmax** – The value of the maximum shear force at the location of the reaction or point load. This value does not include the load modifier for strength.
- **Mmax** – The value of bending moment at the location of the reaction or point load. This is used in the Combined Bending and Shear interactions. This value does not include the load modifier for strength.
- **Va Factor** - The value of the shear capacity reduction factor due to punchouts near the reaction or point load. If none of the check boxes for punchouts near supports or point loads have been checked, this value will be 1.0.
- **V/Va** – The ratio of the maximum shear force to the allowable shear.
- **M/Ma** – The ratio of the applied moment to the allowable moment at the location of the reaction or point load. Note that Ma for this ratio is the yield moment.
- **Intr. Unstiffen** – The value of the Combined Bending Shear interaction for unstiffened members. Note that if this value exceeds 1.0 the member is overstressed unless stiffeners are provided.
- **Intr. Stiffen** - The value of the Combined Bending Shear interaction for stiffened members. Note that if this value exceeds the Specification limits the member is overstressed and an alternate member should be selected.

Combined Bending and Axial Load: If any element has a non-zero axial load, the results of the combined bending and axial check are tabulated for each span and cantilever.

The applied axial load is listed, followed by a “(c)” for compressive or a “(t)” for tensile loads. In addition, the unbraced length parallel to the axis of bending ($K_y L_y$ for X-X axis bending or $K_x L_x$ for Y-Y axis bending) and torsional ($K_t L_t$) bracing intervals are listed. The allowable axial load is listed (again followed by a “(c)” if the applied load is compressive or a “(t)” if it is tensile). The maximum value of KL/r , the axial load ratio “ P/P_a ” and interaction value are also listed. The moment used in the interactions is the absolute maximum value of moment anywhere on the element.

The value of the effective length factor, K_x (K_y for Y-Y axis bending orientations), for cantilevers is dependent on the stiffness of the back span. For a perfectly stiff back span (i.e. a true fixed base), $K = 2$. Therefore, the value of the effective length factor for cantilevers has a minimum value of 2 and then increases as the length of the back span increases (and its stiffness decreases). The equation $K = 2 + 0.77(L_{span}/L_{cant})^{0.7}$ provides a good approximation of K for ratios of L_{span}/L_{cant} up to about 30 in simple span conditions. Beyond this span ratio and for multiple spans it becomes more conservative. The above equation is used for approximating K about the axis of bending for cantilevers with axial loads.

The 2001 NASPEC added specific provisions for axial capacity of boxed and back-to-back members based on the spacing between member interconnections. The revised procedure (see NASPEC C4.5) uses a reduced radius of gyration of the composite members. The amount of reduction in the radius of gyration is dependent on the interconnection spacing. The NASPEC also places limits on the spacing of interconnections.


LGBEAMER requires as an input the spacing of interconnection for all boxed and back-to-back members designed under the 2001 NASPEC. If the input spacing exceeds the maximum allowed, LGBEAMER alerts the user and automatically adjusts the spacing to the maximum allowable value.

There are specific requirements for end connections and the strength of the interconnections (welds or mechanical fasteners) in NASPEC C4.5. It is critical that the designer understands these requirements and incorporates them as well as the spacing input into LGBEAMER.

Definitions of printout terms:

- **Span** – The span or cantilever for which moment and deflection information is given.
- **Axial Ld** – The value of the input axial load. This value does not include the load modifier for strength.
- **Bracing KyLy** – The input effective weak axis unbraced length.
- **Bracing KtLt** – The input effective torsional unbraced length.
- **Max Kl/r** – The maximum value of the ratio of KL/r (slenderness ratio).
- **Allow Ld** - The allowable axial load, tension or compression.
- **P/Pa** – The ratio of applied axial load to allowable axial load. This ratio does include the load modifier for strength.
- **Intr. Value** – The value of the combined bending and axial load interaction. Note that for compression, there are up to (3) interaction equations that are checked with the maximum interaction value shown.

Interaction Summary (HSS Members)

An interaction summary can be viewed by selecting **Interaction Summary** from the **View** item on the main menu or by clicking on the  button on the toolbar.

Flexural and Deflection Check: For each span and cantilever, the maximum moment, M_{max} , and the bending stress, f_b , are listed. Additionally, for sections with elements that exceed the non-compact limits of section B5.1 the effective section modulus, S_{xxe} is listed. For compact sections, S_{xxe} is noted as “N/A” and only the full section modulus is used in the determination of f_b . The input unbraced length is listed along with the maximum unbraced length, L_c . Based on the compactness limits the allowable flexural stress, F_b , is listed.

Finally the deflection and the deflection ratio are tabulated. Note that the deflection ratio is based on twice the input element length of cantilevers. Also, the maximum allowable deflection is not input as part of the model. Therefore the actual deflections must be verified to be within allowable limits.

Web Yielding, Crippling and Sidesway Buckling: For each reaction or point load, the applied concentrated load or reaction is listed along with the bearing length.

Allowable local web yielding forces are listed as “R(yield)” based on the provisions of section K1.3 of the AISC Manual. Allowable web crippling forces are listed as “R(cripple)” based on section K1.4 of the AISC Manual. Finally, allowable sidesway web buckling forces are listed as “R(sidesway)” based on section K1.5 of the AISC Manual.

If any reaction or concentrated load exceeds any one of the items listed above, the “Stiffen Req’d?” will read “YES” and bearing stiffeners are required.

Allowable Shear Stress: At each reaction or point load, the value of the maximum shear force is listed. The shear area of the member is also listed at each location along with the resulting shear stress, f_v . The web height to thickness ratio, H/t_w , is shown along with the value of the term $380/F_y^{1/2}$ used to determine which AISC equation, (F4-1) or (F4-2) will be used. Finally, the allowable shear stress, F_v is shown.

Combined Bending and Axial Load: If any element has a non-zero axial load, the results of the combined bending and axial check are tabulated for each span and cantilever.

The applied axial load is listed, followed by a “(c)” for compressive or a “(t)” for tensile loads. In addition, the unbraced length parallel to the axis of bending, $K_y L_y$, is listed. The maximum value of the slenderness ratio, KL/r , along with the allowable axial load is listed (again followed by a “(c)” if

the applied load is compressive or a “(t)” if it is tensile). The applied axial stress, f_a , and allowable axial stress, F_a , are shown along with the ratio f_a/F_a .

The value of the effective length factor, K_x , for cantilevers is dependent on the stiffness of the back span. For a perfectly stiff back span (i.e. a true fixed base), $K = 2$. Therefore, the value of the effective length factor for cantilevers has a minimum value of 2 and then increases as the length of the back span increases (and its stiffness decreases). The equation $K = 2 + 0.77(L_{\text{span}}/L_{\text{cant}})^{0.7}$ provides a good approximation of K for ratios of $L_{\text{span}}/L_{\text{cant}}$ up to about 30 in simple span conditions. Beyond this span ratio and for multiple spans it becomes more conservative. The above equation is used for approximating K about the axis of bending for cantilevers with axial loads.

Load Modifiers

Strength: Some Building Codes allow loads to be modified for combinations including wind, seismic or multiple transient loads. Previous versions of LGBEAMER used a simple ‘Wind or Earthquake’ check box that, if checked, would cause all loads to be multiplied by 0.75 when checking strength interactions. Newer building codes use a more complex set of rules for load modification and have eliminated the simple 0.75 factor for load combinations containing wind or earthquake forces. As such, LGBEAMER allows the input of any value for the strength load modifier. For complex load combinations, the user can modify the loads before entering them in the model and use a strength modifier of 1.0. As an alternative, the total ‘nominal loads’ can be entered in the model along with the appropriate strength modifier based on the applicable Building Code’s load combinations.

Deflection: IBC 2000 and 2003 Table 1604.3, note f. allows wind load to be multiplied by 0.7 for checking “component and cladding” deflection limits. To accommodate this, LGBEAMER allows the application of a deflection modification factor. The deflection modification factor will be applied to all bending loads when determining the deflection and deflection ratio. When designing members with lateral loads from wind only using the IBC, a value of 0.7 can be entered in the deflection modifier dropdown box. If lateral loads are generated from wind in combination with other load types, a value greater than 0.7 would apply since the IBC only permits wind loads to be modified for deflection checks. The appropriate factor can be calculated as $(0.7 \times \text{Wind} + \text{Other Bending Loads}) / (\text{Wind} + \text{Other Bending Loads})$.

New Model

To clear all of the inputs and start a new model from scratch, simply select New from the File menu. All input boxes, dropdowns and check boxes will be cleared or returned to their initial value.

Open Files

To open a model that has been generated and saved, choose File from the main menu, and then select Open, or click on the ‘Open File’ button on the toolbar.

LGBEAMER is shipped with an example model file called ‘Example.mdl’. It is stored in the \models sub-folder of the main LGBEAMER folder.

Point Loads

Up to twelve point loads can be entered on any model. To enter point load information, from the



beam input screen, click on the button.

Enter the load, positive (down) or negative (up) in the box labeled “Load”.

Enter the location of the point load in the box labeled “X-Dist”. Note that the X-distance is measured from the far left of the global beam model - not from the origination of any particular span.

The X-distance can be entered numerically or for point loads at the ends of members, ‘Left’ or ‘Right’ can be selected and the load will automatically be applied at the selected member end. Repeating point loads can also be entered by selecting ‘Repeat’ from the X-Distance dropdown and then entering the ‘Start X-dist’ and the interval. LGBEAMER will add the point loads starting from the starting x-distance at the interval selected until there is no more space on the beam model or the maximum number of point loads is exceeded.

Enter the bearing length of the point load. This length will be used in web crippling calculations.

If the member will have a web perforation (i.e. punchout) within 1.5 times the web depth of the edge of bearing, click on the box labeled “**Punched Near Ptlid?**”. The allowable web-crippling load will be reduced to account for the punchout. For example, if a six-inch joist has a punchout with its nearest edge within nine inches of the edge of bearing of the point load, the “**Punched Near Ptlid?**” box should be checked.


When all of the data is entered, click on the “**Apply**” button.

To delete a point load, while in point load entry mode, click with the right mouse button on the point load icon on the beam model.

To modify existing point load data, click with the left mouse button on the appropriate point load icon. Re-enter the data, then click **Apply** to enter the new data. A list of all entered point load data appears in the grid below the point-load data entry box. If the point load icon is not visible (for example, if when redrawing, the load position is beyond the end of the beam) click on the column in the point load data grid, modify the data and click on the **Apply** button.

To clear all point load entries, click on the ‘**Clear**’ button of the Point Load frame.

Printing

Any of the various outputs, including diagrams, can be sent to the printer by clicking on the  button or by selecting **Print** from the **File** item on the main menu. Printed output will contain all of the information given on the screen. In addition, for all output except section properties, beam input information will also be graphically printed.

Punched Webs

Many cold-formed steel members are supplied with punchouts through their webs to accommodate certain types of bracing or to pass conduit or pipe through. Punchouts reduce the strength of the member for axial loads, shear and web crippling. The 1999 Supplement and later Specifications also contain provisions that reduce the flexural strength of punched members with certain configurations. Shear and web crippling are only reduced in the region of the punchout,

so if there are no punchouts near the edge of bearing for a reaction or point load, they need not be considered (for what constitutes 'near' a reaction or point load, see the appropriate Specification). Allowable axial loads are always reduced by the presence of punchouts.

For the 1996 edition of the Specification, LGBEAMER treats punched webs in accordance with the ICBO Acceptance Criteria for Steel Studs, Joists and Track (AC46). When using later versions of the Specification, the provisions of the appropriate document are used to treat members with web punchouts.

For Y-Y axis bending of punched members with the web in compression, the web is treated in the same fashion as for axial loads.

The 1999 Supplement and later Specifications place certain limits on the punchout size and bearing length of members for use of the reduction factors. If these limits are not met, LGBEAMER will display a warning message. However, calculations will proceed. It is up to the user to determine if the provisions are appropriate for the particular design.

Save Files

LGBEAMER v4.0 and later have a Save feature that allows all of your model inputs to be saved for retrieval and modification later. All span, load, bracing, bearing length and section information from your model is saved.

To save a model you have created, select **F**ile from the main menu and then choose **S**ave or click the 'Save' button on the toolbar. A standard windows file dialog box will appear that allows you to choose a name and location for your file.

You can also set the default model folder location so LGBEAMER will know where to start looking when you go to open a file. Once you have saved a file to the location you would like to use as the default, choose **S**ettings from the main menu, then choose **M**odel **F**olders and click on '**S**ave Model Folder as Default'. The initial setting for the default model folder is the \Models sub-folder of the main LGBEAMER folder.

Section Input

Cold-formed steel sections to be used in analysis and interaction checks can be entered via a database, or by manually entering the section dimensions from a graphic entry screen. HSS section entry is via database only.

To enter a cold-formed section from the current database, use the dropdown boxes on the toolbar at the top of the screen. Each of the dropdown boxes controls a portion of the section input. The leftmost dropdown controls the depth of the section. The value listed in the box corresponds to an actual depth in the current database. The middle dropdown determines the section configuration (i.e. whether the section is a track, stud or joist and the flange size). The last dropdown indicates the member thickness.


If the section you wish to analyze is not in a database, you can enter the dimensions and steel properties manually. To do so, choose **S**ection from the main menu followed by **G**eometry. To modify a database section, select **C**ustomize **S**hape from **D**atabase. If you prefer to start from scratch, select **I**nterface **S**hape.

From the Section Input screen, enter the type of member, steel properties and member dimensions. You can also enter a special section name in the toolbar box that replaces the database dropdown boxes.

For HSS sections, the section must be selected from the toolbar dropdown. The orientation, 'Weak' or 'Strong' is also selected from a toolbar dropdown as is the yield stress, F_y .

Section Properties


Properties of cold-formed sections and configuration (i.e. single, back-to-back or boxed) can be

viewed by clicking on the  button. Input dimensions and steel properties are displayed along with gross and effective properties. For single sections, torsional properties are also given. Effective properties are calculated in accordance with the Specification.

Properties of HSS sections can be seen from the Property Preview of the beam modeling screen.



Shearwalls

To design Shearwalls with LGBEAMER v7 Professional edition, select '**Pro Tools**' from the main menu, then select 'Shearwalls' or click the Shearwall button .

Enter the height and width of the shearwall in the dimension boxes in the shearwall diagram.

To enter various design parameters for the shearwall, select the appropriate radio buttons: **Load Data, Shearwall Data, Chord Data or Uplift Data.**

Both wind and seismic shear forces can be entered. LGBEAMER uses published shearwall capacities from the 1997 UBC, IBC 2000 and IBC 2003. Each of these Building Codes lists separate shearwall capacity for wind loads and seismic loads. **Each Building Code has specific requirements regarding analysis, design and construction of cold-formed steel shearwalls. It is critical that the designer understand and incorporate these requirements into the design.**

Choose the Building Code from the '**Data Source**' dropdown and then choose the sheathing type and fastener spacing. LGBEAMER uses these inputs to determine the allowable shear forces on the shearwalls as well as the maximum aspect ratios. The allowable values are shown in the Results area on the right of the screen. If any of the code allowable values is exceeded, the value will appear in red on screen.


LGBEAMER calculates the axial force on chord studs based on the maximum wind or seismic shear and the geometry of the wall. Since shearwalls are often bearing walls, additional axial load and moment can also be incorporated. In addition, some Building Codes allow loads caused by wind or seismic forces to be reduced for strength checks. This factor can be entered in the '**Load Multiplier for Strength Checks**' dropdown. Note that the Load Multiplier will be applied to axial and flexural loads in the interaction checks. The Load Multiplier applies only to the chord design – not the unit shear forces on the panel.

The unbraced length of the chord for both axial and flexural loads is entered in the dropdowns 'Axial Bracing' and 'Flexural Bracing' respectively. These values will be used for $K_y L_y$ and $K_t L_t$ for determination of axial and flexural capacity. $K_x L_x$ is the height of the shearwall.


For shearwalls with panels on only one side, the vertical chord forces are not aligned with the centroid of the chord studs. To account for the moment induced by this eccentricity, the user can check the box labeled **'Include Eccentric Moment for Sheathing One Side.'** This moment will be added to the moment input as 'Add'l Moment' above.

For some seismic designs, the strength of the chord members is required. To include the strength of the chords in the output, check the box labeled **'Show Chord Strength (1.7 * Pa) for Seismic Checks.'**

LGBEAMER also calculates the gross uplift at the anchor locations – including any anchor offsets and seismic increase factors. Enter anchor offsets (distance from the anchor to the end of panel), in the dropdown labeled 'Holddown/A.B. Offset (each end).' The effect of a non-zero offset value is to decrease the base width effective for resisting overturning – thus increasing the uplift and chord forces. The amount of the increase is equal to (Shearwall Length)/(Shearwall Length – Offset). The seismic increase factor is a simple multiplier on uplift forces which are required by some building codes.

To print the Shearwall input and output, click the printer button  on the main menu.

Sloped and Partial Span Loads

To enter sloped or partial span loads, click on the  button. Up to five (5) separate loads can be entered. Each sloped or partial span load requires four inputs: Load at X1, position X1, Load at X2 and position X2. The 'Load at X1' is the value of the distributed load at its leftmost end in lb/ft (N/m). X1 is simply the 'starting' position of the load. The 'Load at X2' is the value of the load at its right end, X2. Note that X1 and X2 are measured from the left end of the model – not on any individual span. As such, a sloped or partial span load may extend over several spans and/or cantilevers.

To apply the input loads to the beam model, after entering all of the load and position data, click **'Apply'**. A graphic representation of the input loads will be shown on the beam-modeling diagram.

To clear all sloped and partial span loads, click **'Clear'**. If you wish to clear individual load values, enter '0' in each box associated with the individual load and click **'Apply'**.

Partial span loads can create critical zones of combined bending and shear within a span away from concentrated loads or reactions relative to combined bending and shear. As such, when partial span or sloped loads exist, LGBEAMER checks combined bending and shear along the span as well as at points of concentrated loads and reactions.

Span Lengths

One, two or three continuous spans with or without cantilevers at each end can be modeled. Before entering span lengths, select the proper number of spans (one, two or three) from the buttons located directly below the beam on the beam-input screen.

To modify the length of any span or cantilever, highlight the text in the dimension box below the appropriate span and type in the correct length. After the new span length is entered, the beam will be re-scaled to show the spans upon the next click of the mouse.


Start Up Settings

LGBEAMER uses Startup Settings to help the user customize the building and analysis of models. Startup Settings include: Database, Code, Units, Integration Steps and Model Folders. Each of these items is stored in the LGBEAMER.ini file that is read upon startup of LGBEAMER. If there is a problem with the LGBEAMER.ini file, some or all of the above items may not be available. To re-establish these settings, go to **Settings** on the main menu, select each of the preferred settings and save them as default. This will re-generate the LGBEAMER.ini file.

Uniform Loads

Each span and cantilever can have its own uniform load. To enter uniform loads, from the beam-



input screen, click on the  button. Enter the value of the load (lb/ft or N/m) in the uniform load box, and then click on the span or cantilever that carries the load. Either negative or positive values of uniform loads can be input. To enter the same load on all spans, double-click just above the beam.

To delete a uniform load, click on the span from which it is to be deleted with the right mouse button.

Units

LGBEAMER can work in either English or Metric units. It can also solve metric problems with sections from an English database and vice-versa. However, all other input must be in the current unit system.

To change the Units setting, select **Settings** from the main menu then select **Units** from the menu items listed. Finally, select the unit system you wish to use. Note that the Units setting cannot be changed while viewing output results. The modeling screen should be active in order to set the unit system.

If you wish to have your current selection saved as the default to use at startup, again go to the Units menu items and select **Save Units as Default**.



Walls with Openings

LGBEAMER v7 Professional edition automates the process of designing single story walls with openings. Wall studs, headers (vertical and lateral), sills and jamb studs can all be designed from one screen. To design Walls with Openings, select '**Pro Tools**' from the main menu and then select '**Walls with Openings**.'

Note that lateral and vertical load on headers is designed using separate elements – not as composite 'boxed' headers. Composite boxed headers generate excessive compressive stresses into the 'lateral' members and are seldom economical due to the interconnection requirements to make a true composite section.

Input the wall span, parapet and opening width along with the head and sill dimensions in the appropriate text and dropdown boxes.

For load data, input the wall and parapet pressures by selecting a value from the dropdown or typing in the dropdown box. For headers that carry only the weight of the wall above, input the wall dead load in psf (Pa) and select the '**Compute**' radio button. The header uniform load will be calculated as the dead load multiplied by the height of wall above the header, including the parapet. If the header carries additional vertical load, the input can be made in lb/ft (N/m). To input a special header gravity load, select the '**Override**' radio button.

Lateral loads can be modified for both strength and deflection as allowed by certain building codes. Enter load modifiers in the appropriate dropdown boxes. All elements carrying lateral loads will be designed based on the input modifiers. For example, if a 0.75 is input as the strength modifier, wall studs, sills, header (lateral) and jambs will include the 0.75 factor in all strength calculations – including axial load on jambs.

Stud spacing is used in design of wall studs as well as jambs and should be entered accordingly. Flexural bracing inputs are used in the design of wall studs as well as jambs. Jamb axial bracing must also be input. If the jamb axial bracing is input as 'Head/Sill', the unbraced lengths K_yL_y and K_tL_t will be the maximum value of the sill height or the distance between the head and sill.

Load-bearing wall systems can be designed by adding axial loads to the studs. To design a load-bearing wall, check the box labeled 'Axial Load Bearing' in the stud data input frame. Enter the design axial load on the studs and the unbraced length to be used for axial loads. **Note that the axial load is entered in lb/stud – not lb/ft.** The load entered will be added to the 'Header Vertical' design and carried to the jambs as axial load. Any entered 'Header Vertical Load' is in addition to the stud axial loads to account for things like the weight of wall material above the header.

Click on the element you wish to design – it will be red once it is selected. For the header, toggle between '**Lateral**' and '**Vertical**' design by clicking the header.


Lateral pressures on the surface of the framed opening are distributed differently for different types of window/door or open systems. As such, LGBEAMER allows the user to have the lateral pressures distributed as: Head/Sill Only, Jambs Only, 4-Ways or Open.

If '**Head/Sill Only**' is selected, lateral pressures on the surface of the opening will be distributed equally to the header – lateral and the sill. If '**Jamb Only**' is selected, lateral pressures on the surface of the opening will be distributed horizontally to the jambs. If '**4-Ways**' is selected, lateral pressures will be distributed to the header, sill and jamb assuming a line of distribution at 45 degrees from each corner (sometimes called a 'hip roof' distribution). If '**Open**' is selected, the opening surface will be assumed to distribute no lateral loads to header, sill or jamb.

With the element selected, choose the section and configuration from the main toolbar. The output preview is automatically updated as the section dropdowns are modified.

For Built-up sections, choose 'Built-Up' from the main toolbar section configuration dropdown. A 'Built-Up Section' entry frame will appear that allows entry of up to (4) stud or track elements. To add an element, choose the element on the main toolbar and click 'Add Section' from the Built-Up Section Frame. To delete a selected element, click on the element you wish to delete and then click 'Delete Section'. Note that the design preview shown is for the selected (Bold) element. You can preview any element by selecting it (click on the section name). Sections shown in red are overstressed.


The full output for any element can also be viewed by clicking on the '<=' button of the main

menu. To return to wall design, click the 'Walls With Openings' button  on the toolbar. If the output preview has been cleared, clicking '**UPDATE**' will recalculate the outputs for the section.

Once a section/configuration has been selected meeting the required stress ratios, deflections etc., the section can be stored in the '**Summary Report**' by clicking the '**Store**' button. Note that if any of the basic input quantities is modified, the 'Summary Report' will be cleared.

Walls with Openings inputs can be saved and retrieved in the same way as other LGBEAMER models.

To print the Walls with Openings Summary report including input and output, while still in the

Walls with Openings screen, click the printer button  on the main menu.

Wind or Earthquake Loads

See **Load Modifiers** above.



X-braces

To design X-braces (tension only braces) with LGBEAMER v7 Professional edition, **select 'Pro**

Tools' from the main menu, then select 'X-Braces' or click the X-Brace button

To enter various design parameters for the brace, select the appropriate radio buttons: **Load Data, Strap Data, Chord Data or Strap Connections.**

Enter the height and width of the X-Brace in the dimension boxes in the brace diagram.

Both wind and seismic shear forces can be entered. In addition, a 'Load Modifier for Strength Checks' factor can be entered to be used for straps, chord studs and connection design. Design forces are multiplied by the input value for strength checks. The 'Load Modifier for Strength Checks' factor is generally 1.0 or 0.75.

For some seismic designs, the connection forces are required to be increased. The value of this increase – as prescribed by the building codes – can be entered in the dropdown labeled '**Seismic Increase Factors – Strap Connections.**' This factor can be selected as 'Strap Strength' – requiring the connections to be designed to carry the full ultimate strength of the strap.


Braces can be designed with straps on one or both sides. Note that when a one-sided strap brace is selected, the eccentric moment from the strap is automatically incorporated into the chord stud design. Enter the yield stress of the strap in the dropdown labeled '**Fy (ksi).**' The width of the strap can be entered, or can be designated as 'Design'. If the strap width is entered as 'Design', LGBEAMER will determine the minimum strap width required for the input forces and geometry. Similarly, strap thickness can be input as a numeric value or as 'Design.' If the strap thickness is entered as 'Design', LGBEAMER will determine the minimum thickness required for the input forces and geometry. Note that only one input parameter can be designated 'Design.' If

the '**Seismic Increase Factors – Strap Connections.**' Is entered as 'Strap Strength', the strap ultimate stress, F_u , must also be entered.

LGBEAMER calculates the axial force on chord studs based on the maximum wind or seismic shear and the geometry of the brace. Since braced walls are often bearing walls, additional axial load and moment can also be incorporated

The unbraced length of the chord for both axial and flexural loads is entered in the dropdowns '**Axial Bracing**' and '**Flexural Bracing**' respectively. These values will be used for $K_y L_y$ and $K_t L_t$ for determination of axial and flexural capacity. $K_x L_x$ is the height of the shearwall.

For some seismic designs, the strength of the chord members is required. To include the strength of the chords in the output, check the box labeled '**Show Chord Strength (1.7 * Pa) for Seismic Checks.**'

To print the X-Brace input and output, click the printer button  on the main menu.

Y-Y Axis Orientation

LGBEAMER allows the analysis of cold-formed single channels and cee's in their y-y axis orientation. To analyze a member for Y-Y axis bending, select '**Y-Y axis**' from the section configuration dropdown of the main Toolbar.

The flexural capacity of members in this orientation can be dependent on the location of the compressive stresses (i.e. near the web, or near the flange tips). LGBEAMER calculates the moment capacity of the sections in both orientations and uses the minimum value. For channel and track type sections, when calculating the effective section modulus, the distance from the neutral axis to the extreme fiber is measured to the extreme 'effective' fiber as opposed to the extreme fiber of the full section. The alternative of measuring to the extreme fiber of the full section results in more conservative flexural strength.

For members with web punchouts with the web in compression, the effective properties are calculated using the 'unstiffened strip' approach presented in section D4 of the Specification.

The flexural stability of cee's and channels is not predictable using equations given in the Specification. As such, LGBEAMER forces the flexural bracing to 'FULL' when Y-Y axis orientations are analyzed.

The Specification also does not specifically address web-crippling of web elements without 'flanges'. As such for track or channel sections in the Y-Y axis orientation, a warning message is given reminding the user to take special care when designing such members.