

# BEAMCHEK™ 2010

**STRUCTURAL DESIGN SOFTWARE**

for Microsoft Windows™

**The fast, accurate and easy to use design tool  
for the professional home designer, builder,  
residential architect and structural engineer.**

NDS® 1997, 2001, and 2005 values

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- |   |   |
|---|---|
| <input checked="" type="checkbox"/> Complex, multiple loading         | <input checked="" type="checkbox"/> 52 Wood Species built-in        |
| <input checked="" type="checkbox"/> Simple span and overhanging       | <input checked="" type="checkbox"/> A36 and 50 ksi Steel values     |
| <input checked="" type="checkbox"/> On-line help & boundary checking  | <input checked="" type="checkbox"/> Glu-Lams and SCL beams          |
| <input checked="" type="checkbox"/> Preview a selection of candidates | <input checked="" type="checkbox"/> Column design for wood & steel  |
| <input checked="" type="checkbox"/> Custom wood species and grades    | <input checked="" type="checkbox"/> Wind Loading on Studs           |
| <input checked="" type="checkbox"/> Beam notch and trim analysis      | <input checked="" type="checkbox"/> Concise printout & load diagram |
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**AC SOFTWARE, INC.**

Setting a new standard for Architecture and Construction software.

# **BEAMCHEK™ 2010**

for Microsoft® WINDOWS™

**AC SOFTWARE INC.**

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**To receive technical support, occasional updates and information about upgrades you must register your BeamChek license.**

Please fill out the enclosed, self-addressed and stamped registration post card and mail it today. All information is kept confidential and not shared with any other parties. Add any comments or suggestions you may have, so we can continue improving our product. Thanks!

**Visit our website at [www.BeamChek.com](http://www.BeamChek.com) for news and information about updates. We recommend that you regularly check our website once every 3 to 6 months for updates.**

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# **BEAMCHEK™**

**W**elcome to the structural design tool specifically created for beam, joist and rafter analysis. We are committed to providing you the quickest and easiest method of sizing structural members for residential construction.

BeamChek features continue to grow and evolve and we appreciate your comments, criticisms and suggestions. Please let us know what program additions or modifications would increase your work efficiency. Send a fax, email a note or just call. To date we have added more than fifty enhancements and features requested by designers like you.

Please remember to return the **BeamChek Registration Card** so we will know who you are when you request tech support or updates to BeamChek. If you need to call for technical support, have your registration number on available. Your number is printed on the CD-ROM envelope and after installation, it will show on your BeamChek opening screen.

**We strongly urge you to read this manual** before using BeamChek. You will also find this manual available in the BeamChek 'Help file' and on the installation CD-ROM in Acrobat Reader PDF format.

The installation CD-ROM contains valuable **Examples** of BeamChek problems along with explanations of how to properly insert the data into BeamChek forms. Other documentation includes a novice guide to residential load paths and values for structural composite lumber. Please browse the CD for the 'documents' folder. Adobe's Acrobat Reader is required to open the PDF Files. To Install the Reader, download a copy from [www.adobe.com](http://www.adobe.com).

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## **INSTALLATION INSTRUCTIONS**

### **MINIMUM SYSTEM REQUIREMENTS**

IBM compatible PC and Microsoft WINDOWS™ 7, Vista, or XP  
6 MB available Hard Disk Space, mouse, and printer

### **Instructions for installing and registering BeamChek**

1. BeamChek has a **30 day evaluation period**, with a 100% money back satisfaction guarantee (minus shipping costs) if all materials and software are returned in good condition. You will be responsible for return shipping costs and insurance. If you purchased from a BeamChek dealer, you must contact them for your refund.
2. To install the software, close all applications and start Windows normally. Insert your BeamChek Installation CD. If the CD auto-run procedure does not start automatically, select **Start**, select **Run**, Type **x:setup** (where “x” = letter of the drive holding the installation CD). Follow the instructions on the setup screens to install BeamChek.
  - a) If setup displays a message that you do not have enough disk space, quit setup, free up some space by deleting unwanted files, then run setup again.
  - b) If setup generates an error message or will not install, follow the on screen instructions, read the manual instructions and attempt setup again. If necessary call AC Software, Inc. for assistance.
3. Remove the BeamChek Installation CD when setup is complete. Start BeamChek (double-click the BeamChek Icon) and at the opening screen, carefully type your name and registration number. The registration number is on a sticker on the CD envelope. Click “Authorize” to unlock the software. You will find several supporting documents in Adobe PDF format on the installation CD that you may read and print.
4. Fill out your BeamChek Registration Card and mail it promptly. We can provide technical assistance only to registered users. Please visit our website every 3 to 6 months for news on available updates. **www.BeamChek.com**
5. Mail or Email us your suggestions for future improvements. Many of the features in BeamChek are the direct requests of BeamChek users with specific needs. **acsoftware@beamchek.com**

**PRIVACY STATEMENT: Your personal information will not be shared or sold to other parties. Registration information is only used to verify a registered users identity for upgrades and tech support purposes.**

## **RECOMMENDED REFERENCE BOOKS**

We have a novice guide to residential load paths available on our website at [www.BeamChek.com](http://www.BeamChek.com) on the User Resources Page.

### National Design Specification® (NDS®)

American Forest & Paper Association  
1111 - 19th Street NW Suite 800  
Washington, DC 20036

### International Residential/Building Code®

(or Code in force in user's jurisdiction)  
International Code Council  
5203 Leesburg Pike, Suite 600 Falls Church , VA 22041

### Manual of Steel Construction® (ASD) 9th Edition

American Institute of Steel Construction, Inc.  
1 East Wacker Drive, Suite 3100  
Chicago, IL 60601

## **OVERVIEW OF BEAMCHEK**

*The main three forms are numbered 1 through 3, in sequence of use.*

### **CRITERIA FORM 1**

BeamChek calculates both simple span beams and beams overhanging a support at one end. Live loads may be calculated simultaneously along with total loads to check deflection. A dozen complex total loads and live loads can be evaluated for simple and overhanging beams as described below:

#### SIMPLE SPAN BEAM

1 uniform, 6 point, and 5 partial uniform loads

#### OVERHANGING BEAM

at backspan: 1 uniform, 4 point, and 3 partial uniform loads

at overhang: 2 point and 2 partial uniform loads

(one may be used as a uniform load on the overhang)

#### *Additional design tools:*

#### HIPS AND VALLEYS

1 uniformly increasing load on a simple span  
plus an optional normal uniform load

#### MULTIPLE SPAN (continuous beam)

2 or 3 equal spans with a uniform load

## **NDS EDITION**

Optional NDS® 1997, 2001, or 2005 values are available. To select values, go to the menu bar and click on OPTIONS, then select SET DEFAULTS. The NDS 1997 values have switched over to the NDS 2005 in states like California. Most jurisdictions currently use the NDS 2005, which is referenced in the new 2006 IRC & IBC codes. Check with your building department for the correct NDS edition.

All species are automatically calculated in No.1 and No.2 grades. Other grades and species may be entered on the Custom Values Form. Manually entered sizes for 3x members and widths up to 14x in solid sawn lumber (except for Southern Pine and Mixed So. Pine which use unique factors.) A dozen species groupings are automatically available which provides a total of fifty-two species from which to choose. See your NDS manual for species group lists. Glu-laminated beams are available in two species groupings, with four grades each (2 grades are for overhanging beams). Glu-Lam Headers and other grade designations may be calculated with user entered values in the Custom Values Form.

All loads, plus adjustments for duration of load, maximum deflection limits for total loads and live loads, unbraced length, wet use, repetitive use, and joist spacing can be entered in the Criteria Form 1.

## **SELECTION FORM 2**

A Preview display of beam candidates is provided *before* the user is required to identify a breadth or depth. The user may test any breadth or depth by clicking its button or by typing in any valid beam size in the proper format (see BeamChek Sizes, Grades, and Species).

## **REPORT FORM 3**

The report of a specific beam includes total load and live load reactions, moment, reduced shear, minimum bearing areas for each reaction, deflection due to dead load if live loads were entered, actual projected deflections for total and live loads on both the backspan and overhang. Base values, adjusted base values and all modifier values are also displayed.

If you wish to view the complete beam data, click on 'OK Select' to view the DATA RECORD. You may print the Data record or save the data record to disk as text for later printing (minus the loading diagram). If you anticipate revising the loads, return to the Criteria Form 1 and save it as well.

## NAVIGATION and ON LINE HELP

### NAVIGATION WITHIN A FORM

You can navigate by use of a mouse, the TAB key, or by selecting an underlined letter of a label caption while holding down the ALT key.

Example: Exit **ALT + X** will exit the program.

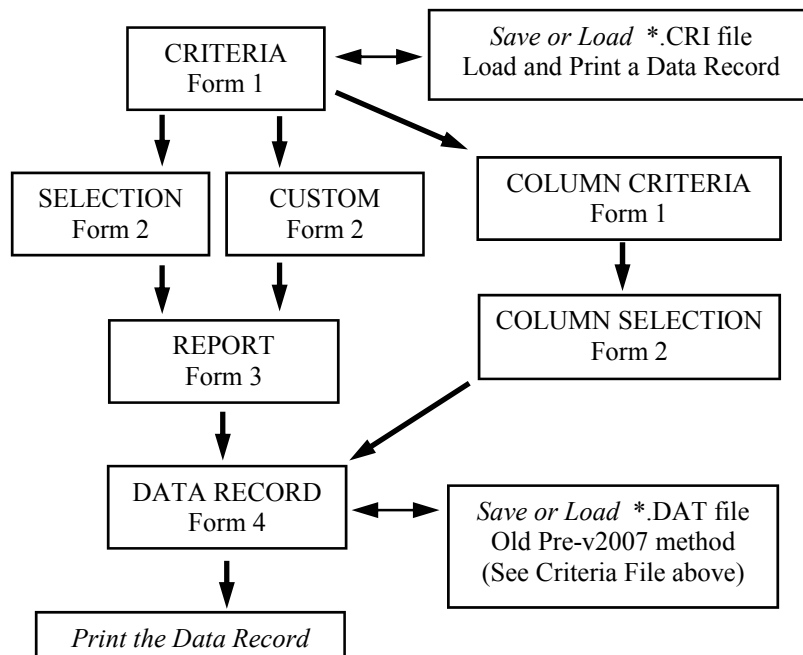
Try this! TAB through the entry boxes with your left hand and enter numbers with right hand.

### NAVIGATION BETWEEN FORMS

The OK buttons on each form will take you sequentially through a beam calculation. Traveling backward through the different BeamChek forms can be accomplished by selecting an available location (a form) from the menu bar item 'GOTO', selecting BACK to return to the previous form, or pressing function keys. The title of the current form is in the title bar at the top of the form and each is numbered sequentially: CRITERIA FORM 1 (F1), SELECTION FORM 2 (F2), REPORT FORM 3. (F3), and the DATA RECORD (F4) [print preview].

**NOTE: To properly calculate a beam you must proceed through forms 1, 2 and 3, in that order!**

A DIAGRAM OF THE RELATIONSHIP OF FORMS IN BEAMCHEK



## NAVIGATION BETWEEN APPLICATIONS

BeamChek was designed to run with other Windows applications, i.e., a word processor, spreadsheet or CAD program. Depending upon your monitor and screen resolution you may or may not be able to see the running application or its icon beneath BeamChek forms. You may cycle through the open Windows applications by pressing TAB while holding down the ALT key (**ALT + TAB**). Double clicking the desktop, if visible, will bring up the Windows Task Manager, or click the desired application from the task bar.

## TILE TIPS

Several of the BeamChek forms have “Instant help” buttons available, containing a shortened version of a help topic, a diagram, or a definition. Simply click the small, gray, raised squares next to an item to display the information. If more detailed information on a topic is desired, see Help or this manual.

## LUMBER AND BEAM SIZES

### SOLID SAWN LUMBER

<u>Nominal Widths</u>	<u>Nominal Depths</u>	<u>Increments</u>
2x, 3x	4 to 14	2”
2x built-up	4 to 14	2”
4x	4 to 16	2”
6x to 14x	6 to 16	2” (Custom 1/2”)
ROUND	5-1/2 to 30 diameter	Any

### GLU-LAM BEAMS

<u>Combination</u>	<u>Actual Widths</u>	<u>Actual Depths</u>	<u>Lam Depth</u>
DF/DF	3-1/8 to 10-3/4”	9 to 31-1/2”	1-1/2”
SP/SP	3-1/8 to 10-1/2”	9-5/8 to 30-1/4”	1-3/8”

### GLU-LAM HEADERS

<u>Combination</u>	<u>Actual Widths</u>	<u>Actual Depths</u>	<u>Lam Depth</u>
Custom	3-1/2 to 5-1/2”	9 to 18”	1-1/2”

## **SPECIES AND GRADES**

<u>Abbreviation</u>	<u>Species Groups</u>	<u>Auto-sized Grades</u>
Hem Fir / DF-L	Hem-Fir Douglas Fir & Larch	All in No.1 & No.2
SPF / SPF South	Spruce Pine Fir Spruce Pine Fir South	
Eastern Species	Eastern Spruce Eastern Hemlock & Tamarack	
Cedar / West Woods	Western Woods Western Cedars	
DF So. / DF No.	Douglas Fir South Douglas Fir North	
Southern Pine	Southern Pine Mixed Southern Pine	
Red Oak / White Oak	Red Oak White Oak	

### **STRUCTURAL COMPOSITE LUMBER (SCL)**

Eight SCL manufacturers are represented, Boise Cascade, Trus Joist, Georgia and Louisiana Pacific, West Fraser, Nordic, Roseburg and Rosboro. Each are represented by one or two 'E' groups, such as 1.8, 1.9 or 2.0, and descriptions may be edited for the printout. Common available sizes (which vary with each manufacturer) may be tested by selecting 'SCL Beams' from the Species Menu on Form 1. It is the user's responsibility to enter current values for Fb, Fc, E, and Fv and specify built-up connections. By clicking the "Load" button, default values will be inserted for that product, but these should be confirmed with the manufacturer's product literature. Also only notch, drill or trim SCL's only as permitted by the manufacturer. We are no longer supporting the Anthony Forest Products and have recently added the Rosboro "BigBeam" product line which is a hybrid LSL and LVL. Remember, SCL products are usually zero camber.

### **GLU-LAM BEAMS**

DF/DF (Douglas Fir) Glu-Lams are available in all wood groups listed above except the Southern Pine Group which has Southern Pine Glu-Lam sizes. The grades are 24F and 16F with common lamination grade combinations. Simple span and overhanging conditions require different glu-lam grades or species combinations used for the compression/tension laminations. This specification is made automatically by BeamChek. If you require a combination not listed you may use the Custom Values Form 2 and specify any glu-lam grade or combination. Overhanging glu-lam grades are usually zero camber.

## WOOD TERMS AND ABBREVIATIONS

<b>Symbol</b>	<b>Abbreviation</b>	<b>Description</b>
Act.		Actual
BS	Backspan	Main Span of an overhanging beam
	Base	Base Value (a tested beam species value)
	Camber	Built-in curvature to glu-lams (1-1/2 x DL)
Cd	Dur	Duration of Load Factor
Cf	Form Factor	Round Shape Adj. (Only 97 & 01 NDS)
CF	Size Factor	Size Effect Factor
Ch	Shear Factor	Horizontal Shear Factor (Only in 97 NDS)
Ci	Incise Factor	Incision adjustment to Pres. Treated wood
Cm	Wet Use	Wet Use Factor
Cr	Rep	Repetitive Use Factor
Cv	Volume	Volume Effect Factor
D	Defl	Deflection in inches
Dis	Distance	Location of a point load
DL	Dead Load	Permanent load of structure & components
E	MOE	Modulus of Elasticity
ETL		Equivalent Tabular Load
E(mil)		$E \div 1,000,000$
Fb		Base unit stress extreme fiber bending, PSI
Fb adj		Fb adjusted for size and other modifiers
Fc $\perp$		Compression perpendicular to grain, in PSI
Fv	Shear	Unit of Horizontal Shear Stress, in PSI
KD		Kiln Dried
Ksi		Kips per square inch (1 kip = 1000 lbs)
L		Length in inches (deflection ratio to span)
LL	Live Load	Non permanent loads
LVL		Laminated Veneer Lumber
LSL		Laminated Strand Lumber (like glu-lam)
M	Moment	Bending Moment in Ft/lbs
MC		Moisture Content
OH	Overhang	Beam projecting beyond a support
Pt	Point	Point load (concentrated load at a point)
PLF		Pounds per Lineal foot
PSF		Pounds per Square foot
PSI		Pounds per square inch
	Par Unif	Partial Uniform Load
S	Section	Section Modulus
SCL		Structural Composite Lumber
SR		Stress Rated
TL	Total Load	Total Load (live load plus dead load)
V		Shear Force

## CUSTOM BEAMS

### **CRITERIA FORM**

Custom beam species and grades for visually graded solid sawn members and Glu-Lams can be tested by selecting the 'Custom Values' label located in the Species Group box in Form 1.

Enter loads and set modifiers as you would for a typical beam from the data base. Click OK or press Enter.

### **CUSTOM VALUES FORM**

When the CUSTOM VALUES FORM appears, select the Breadth Group (2x, 4x, 5x+, MEL/MSR machine rated dimension lumber, Glu-Lam, or Glu-Lam Header) you wish to test first. Next, enter the values for Fb, Fv, E and Fc perpendicular to the grain which are appropriate for the breadth group chosen. Enter values in the same format as the examples below each box. Note: you may save these values to disk if you plan to use them repeatedly. Select FILE, select SAVE VALUES, and save using the default file name extension \*.VAL.

Lower on the form, below the heading of your chosen Breadth Group, buttons display the acceptable beam depths. You may accept any beam size displayed on a button by clicking on it, or you may change the Breadth Grouping and re-enter new Fb, Fv, E and Fc values and test again. If no beam depths meet the requirements (either too large or too small), a message to this effect will be displayed. BeamChek filters out illogical (extreme) choices. However, the beam text boxes for breadth and depth may be edited by the user to test a beam even if BeamChek states that no beams in the data base meet the requirements. Any beam size within the scope of BeamChek may be tested. Be sure to enter it in the proper format using nominal sizes and place an 'x' immediately after the breadth with no spaces.

Example: (2) 2x

**Custom Timbers** (5x+) may be sized in 1/2" nominal increments. Type in the desired breadth or depth to be tested, in the correct format.

The Species and Grade box is not evaluated in the calculations. This box simply allows you to document your custom species and grade for the printout.

Click on OK, or press Enter, to test your custom beam. Proceed on as you would with any other beam calculation. Return to adjust beam values and/or beam sizes as necessary.

## DATA ENTRY OF LOADS AND LOAD LOCATIONS

### GENERAL

A diagram of how to enter loads and load locations is available by clicking the On Line Help button (small gray square) next to the Simple Span or Overhang button in the Criteria Form 1.

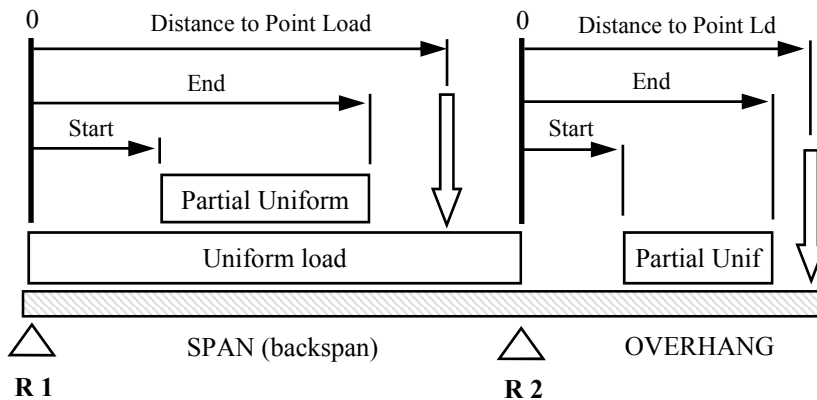
You may quickly move between entry boxes by use of the TAB key.

Three types of total loads (DL+LL) and their corresponding optional live loads (LL) may be entered on the Criteria Form. These are POINT loads, PARTIAL UNIFORM loads, and UNIFORM load. All loads are to be entered in pounds (not kips).

Overhanging (OH) loads may be entered in the BLUE BOXES ONLY. Select the Overhanging Load  button and the blue boxes will appear.

### LOAD ENTRY DIAGRAM

#### UNIFORM LOAD



To enter a continuous, unchanging load along the entire span of the beam, use the Uniform (LL+DL) box. An optional Uniform Live Load (LL) may also be entered. Enter Loads in pounds per LINEAL FOOT. To use the tributary calculator, click the 'Calc using PSF' button. Enter the tributary length in feet and pounds per SQUARE FOOT. The uniform load boxes will show the result when you click the 'Multiply' button. It is just a calculator.

**NOTE:** When sizing an Overhanging beam, the uniform load is **ONLY** on the backspan (between R1 and R2). An Overhanging uniform load must be entered in a blue box as a Partial Uniform Load which starts at zero (**the right reaction, R2**) and ends at the end of the overhang.

## **POINT LOADS and PARTIAL UNIFORM LOADS**

A **Point load** is a concentrated load at a specific point on a beam. Up to six point loads and their optional live point loads can be entered for a beam. Enter in pounds (not kips). DISTANCE is the location on the beam from the left support (R1). Enter the distance in feet (decimal for a fraction of a foot).

A **Partial Uniform load** is a uniform load that is NOT continuous over the full beam span. Up to five loads of this type may be entered in pounds per lineal foot. A starting and ending distance from the left reaction (R1) must be entered to properly locate the load on the beam. If the loading begins at the left reaction (R1), enter a zero under start.

When sizing an **Overhanging beam**, enter point loads in the BLUE BOXES ONLY. The distance is from the **right support** (R2) to the location of load.

## **UNIFORMLY INCREASING LOADS (HIPS and VALLEYS)**

When the Hips and Valleys condition is selected a special data entry box opens. Enter the tributary lengths and check areas on the diagram that will contribute load to the beam. Enter the PSF for live (optional) and total load.

If the Auto-Span Calc  button is checked, BeamChek will calculate the **horizontal** span of the beam. Select OK and proceed on normally. On line help buttons (the small, gray squares) provide explanation diagrams.

## **LIVE LOAD (LL) and DEAD LOAD (DL)**

Live Load is the load superimposed by the use and occupancy of the building, not including any wind load, earthquake load, or dead load. Consult your local building code for occupancy live load values.

Live Load data entry is **not** required by BeamChek. However, live loads are recommended when beam deflection is critical, such as with floor joists. If live loads are not entered, a more stringent default deflection limit for the total load is necessary. For recommended deflection values see User Adjustments in the manual or click on the on line help button (small gray square) next to the MAXIMUM ALLOWABLE DEFLECTION caption on the CRITERIA FORM. Dead Load is the vertical load due to the weight of all permanent structure and non-structural components of a building, such as walls, floors, roofs, and fixed service equipment.

## **BEAM SELF-WEIGHT**

Beam self-weight is automatically added and calculated along with the other loads. You may turn off this feature by checking the 'Neglect beam weight' checkbox next to the OK button on form 1. This is automatic when selecting Repetitive Use. The average weight for solid sawn joists, beams and glu-lams is 35 lbs per cubic foot at normal moisture content. Some

## USER ADJUSTMENTS

### SPAN

Enter the beam span in feet using a decimal equivalent for fractions of a foot. Example: 12'-3" should be entered as 12.25. Span length should include the bearing lengths as follows:

For simple span beams, the span shall be taken as the distance from face to face of supports, *plus one half the required length of bearing at each end*; for continuous beams, the span is the distance between centers of bearings on supports over which the beam is continuous. The minimum bearing area for wood is 1-1/2 inches.

When using the Multi-Span loading selection enter the length of one span. Note all spans are equal when using this option.

The span of sloping members, such as rafters, should be entered as the horizontal distance between supports.

### DURATION OF LOAD

The default value is 1.0 (not zero)

Enter the appropriate percentage adjustment as a modifier to the factor of One (1.0). Example: An increase of 15% is entered as 1.15

Values for wood are subject to the following adjustments for the various durations of loading:

(i) Fully stressed to maximum for more than 10 years. Modify to 90%  
*Note: Check dead load by itself at 0.90 if DL is > 70%± of total load.*

(ii) When duration of the full maximum load during the life of the member does not exceed the period indicated below, the values may be increased as follows:

for 2 months' duration, as for snow	15%	1.15
for 7 days' duration, as for roof loads	25%	1.25
for wind or earthquake	33-1/3%	1.33
for impact	100%	2.00

**Note:** increases are **not** cumulative for **combined** duration of loading.

The resultant structural member shall not be smaller than required for the larger duration of loading. Factors do not apply to  $F_c$  perpendicular to the grain based on a deformation limit or to the modulus of elasticity (E).

(iii) Impact

Values for normal loading conditions may be used without regard to impact if the stress induced does not exceed the values for normal loading.

## MAXIMUM DEFLECTION LIMITS

Deflection limits are expressed as a ratio of beam length (in inches) to deflection (in inches). This limit is set by code, however appearance in the final project may dictate a more stringent deflection ratio. BeamChek provides the projected dead load in the DATA RECORD if the user has entered live loads. BeamChek will also recommend camber for glu-lams at 1.5 times the dead load. Deflection limits on overhangs are based on twice the overhang length. BeamChek will alert you if deflection might exceed 1/3". Your discretion is required to determine if this will be acceptable. The Total load deflection will include an increase of 1.5 to 2.0 of the dead load for anticipated long term "creep".

## MAX ALLOWABLE DEFLECTION

Roof members supporting plaster	Live load only	L / 360
	Total load	L / 240
Floor members	Live load only	L / 360
	Total load	L / 240

Allowances must be anticipated for water accumulation or ponding on roofs due to deflection which may affect drainage and structural integrity. BeamChek recommends using a default deflection limit of L / 360 for total load when live loads are not being evaluated. L / 480 is prudent for long span floor joists. A bouncy floor can satisfy the code, but may not satisfy the occupant!

Other live load recommended factors are:

Ceilings (of materials other than plaster)	L / 240
Roofs, slope 3:12 or less	L / 240
Roofs, slope 3:12 or more	L / 180
Industrial buildings, no appearance factor	L / 180

## SLOPE ADJUSTMENT

Roof dead load and rafter weight may be automatically increased by checking the 'slope adjustment' checkbox and entering the proposed roof pitch on form 1. Roof pitch is entered as the rise (in inches) per 12 inches of run. Use this **only for rafters**, not for members supporting rafters, because the increase is based on the length of the span.

## UNBRACED LENGTH

If the compression edge of the member is not supported by the default methods based on member width vs. depth, as stated in the NDS, you may enter the largest length of the member that has no lateral bracing of the compression edge in the Unbraced Length box in decimal feet.

**WET USE**  check box

Wet Use is for beams used under conditions that increase the wood moisture content above 19% for visually graded sawn lumber or 16% for glu-lams. Generally, if wood is *not* inside a covered structure, it may be prone to a high moisture content, but this depends upon the climate in your locale and the opinion of your building official.

**INCISING FACTOR**  check box

This adjustment factor is for pressure treated members that have staple-like incisions to aid the penetration of treatment chemicals.

**SHEAR REDUCTION**  check box

When checked, BeamChek will remove loads at the beam ends, that are within the depth of the beam to the end, then calculate the maximum horizontal shear. 'Uncheck' when *sideload*ing beams at these end locations.

**REPETITIVE USE**  checkbox

BeamChek automatically increases the beam Fb value by 15% if you check the repetitive use checkbox. Members must meet the following requirements:

***Joists and rafters not over 4 inches in thickness, spaced not more than 24 inches apart and not less than 3 in number, joined by transverse load distributing elements such as floor or roof sheathing.***

**NOTE:** This increase does *not* apply to Glu-lams or 6x members and they will not be available as candidates in the preview array in Selection Form 2. Some repetitive SCL's may be reduced by 4%.

**REP SPACING**  buttons (**Automatic increase of ALL loads entered**)

This is a multiplication tool for quickly adjusting your loads on repetitive spaced members such as joists and rafters.

When the repetitive use checkbox is selected, the Repetitive Spacing Selections become active. Enter your joist or rafter loads normally on a per square foot basis, i.e. equivalent to 12 inches on center. The spacing of your proposed members may be adjusted to 16, 19.2, or 24 inches on center by selecting the appropriate  button.

When you click the 'OK Calculate' button, **all loads** will be **automatically multiplied** as follows: 16" o.c. by a factor of 1.33, 19.2" o.c. by a factor of 1.6, and 24" o.c. by a factor of 2. If you later return to Criteria Form 1 the loads return to their original entry value so you may edit them without confusion.

**NOTE:** You may wish to select "No Spacing" for 3 members (built-up) that are not spaced but qualify for repetitive use.

## THE CALCULATION FLOW

### CRITERIA FORM 1

User selects: Span, loading type, loads, deflection limits, modifiers, member spacing and species group.

BeamChek calculates: Reactions and maximum moment are calculated, then an array of beam candidates are selected from the database in two grades for two species along with two types of glu-lams based on required Section Modulus. BeamChek then tests each for required qualities in horizontal shear and deflection.

### SELECTION FORM 2

User selects: Beam breadth, depth, and species by clicking a button or editing the entry boxes.

BeamChek Calculates: Maximum moment modified by the beam weight.  $F_b$ ,  $E$ ,  $F_v$ , and  $F_c$  are modified with their respective adjustments for duration, repetitive use, size factor, and wet use. Required shear ( $\text{Max } V$ ) is reduced as allowed by code and deflection is calculated for total loads and live loads.

Next, BeamChek calculates the same as above for the next smaller beam depth.

*BeamChek no longer displays shear and moment diagrams.* As entertaining as they may be, they do not provide any useful information unless you're doing calculations by hand.

**IMPORTANT:** BeamChek does **NOT** include automatic calculation of adjustments for temperature, snow vs. pitch, and reductions of live loads for floor beams supporting large areas. These must be entered manually (adjust the loads before entering into program).

**UNBRACED LENGTHS:** Lateral support is **usually not** a limiting factor in residential construction beam design as most applications of joists and beams easily meet the default NDS requirements for support. It is, however, necessary for the user to be familiar with the default provisions of the NDS and to compensate for any conditions that require an  $F_b$  adjustment due to a lack of lateral support by entering an appropriate Unbraced Length for the Slenderness and Stability calculations.

NOTE: BeamChek does not evaluate multiple-span members, structural composite lumber, steel plates for flitch beams, or rectangular steel tubes with unbraced lengths. If the member is solid sawn wood, it must meet the NDS defaults, for braced compression edge, or the user

### **REPORT FORM 3**

#### **BEAM TEST STATUS**

The results of the beam test are displayed, showing the status of the selected beams' required and proposed section, shear, and deflection values along with a percentage ratio of critical to actual properties. If the ratio exceeds 100% the beam fails to meet the requirements.

#### **SHEAR FACTOR Ch** (No splits option) ***DELETED IN NDS 2001!***

If a solid sawn beam fails only in shear, BeamChek will suggest specifying 'No Splits' and increasing the shear factor (Ch) from 1.0 to 2.0. The Data Record will document the 'No Splits' option as a beam condition. No splits means wood without checks or splits in it, i.e., a quality piece of wood. Code allows for adjustments different qualities (acceptable defects) with Ch shear factor adjustments between 1.0 and 2.0, but the responsibility of the designer to specify and control the installation of an appropriate member becomes problematic. BeamChek does not adjust for Ch values between 1.0 and 2.0.

#### **PLUS AND MINUS BUTTONS**

If the next smaller beam depth will also pass, you will be alerted with a message at the top of the form. The plus and minus depth and breadth buttons allow you to increase or decrease either the beam depth or breadth without leaving the form.

#### **HIGH DEFLECTION ALERT**

If the anticipated deflection will be greater than 1/3 of an inch an alert caption will appear. 1/3 of an inch is an arbitrary limit in BeamChek to alert you to a potential unsatisfactory condition before having to carefully scrutinize the deflection numbers in the table. Acceptable deflection for the proposed use of the structural member is at the discretion of the designer. Code limits on deflection do not necessarily produce an acceptable result in the finished structure. Good judgment in this regard is the responsibility of the designer. Another important value to review is the anticipated deflection from the dead loads, listed below the table.

#### **UNBALANCED LOADS ON OVERHANGING MEMBERS**

Unbalanced loads should be checked if an overhanging member is supporting a floor load or if it is supporting roof live loading less than 20 psf. First, test the member by removing live loads from the overhang to verify that the maximum moment is in the backspan and deflection is within acceptable limits. Next, test the member with all live loads removed from the backspan to check for a possible uplift condition at the left reaction (R1). These tests require a little more effort, but provide you with three printouts fully documenting all possible conditions. 'Unbalance' buttons (below the point load boxes in form 1) will do the live load subtraction for you.

## **STEEL BEAMS**

To size a steel beam, select 'steel beams' from the species drop down list box in the upper left area of the criteria (form 1) form. It is the last entry and you will have to scroll down. When you click on 'steel beams', duration of load and wet use modifiers become inactive because they do not apply to steel.

Three special boxes selection boxes will appear:

TYPE OF STEEL  Option box

Select from 'W' wide flange, 'S' American Standard I shapes, 'C' channels, 'T' rectangular tubes, and 'PL' plates for use as flitch beams..

UNBRACED LENGTH text box

Appearing under the span entry box, this box is for entering a proposed maximum unbraced length for lateral support of the beam. If the beam will be continuously supported along its compression edge, you may enter a '0' or leave the box blank. If lateral support will be at specified intervals, enter the largest unbraced length in feet (and decimal fractions, if any). Tube shapes do not have lateral bracing requirements and this box will become inactive and set to zero.

MAX DESIRED DEPTH text box

You may enter a maximum depth in inches to have BeamChek filter out beam choices that are too deep for your requirements. This will be helpful in form 2 when you will select from a list of beams designated and sorted by weight rather than by size.

### **SELECTION FORM 2**

Beam candidates displayed on form 2 are presented in list form with up to 16 possible choices. Take note of the actual beam sizes. Wide flange beams are sorted by weight for economy. W, S, C and PL shapes are available in A36 or 50 ksi steel and rectangular tubes in A46. Simply click on your selection or you may edit the selection box manually with a size in the database (see database button) and in the exact format required by BeamChek. When you have made your selection, click 'OK' and continue as you would with a wood beam. To use 50 ksi go to form 1, Options, Set Defaults, select 50 ksi steel, click Save Defaults.

### **STEEL CALCULATIONS**

Bending strength, shear resistance, deflection, lateral support, web crippling, and web yielding are analyzed per the AISC allowable stress design method (ASD). Analysis is for strong axis bending only. Shear stress is assumed to be developed in the web only with a maximum stress of  $0.40F_y$  and calculated by the formula in AISC Chapter F-F4. Lateral unsupported length is evaluated up to the maximum  $L_u$ .

The special analysis of unbraced lengths greater than  $L_u$  is beyond the scope of BeamChek. W and S shapes are tested for the bonus of unbraced lengths less than  $L_c$  where  $F_b$  can be taken at  $0.66F_y$ . At unbraced lengths between  $L_c$  and  $L_u$ ,  $F_b$  is taken at  $0.60F_y$ . C (channel) shapes are evaluated to  $L_u$  only. All rectangular tube shapes in the BeamChek database have depths less than 6 times their width and lateral bracing is not required except at bearing points. All W, S, and C shapes in the database qualify as compact shapes. All T shapes are non-compact.

### **SPECIAL DESIGN CONSIDERATIONS**

Web crippling and yielding are checked at end reactions and at concentrated (point) load locations. If necessary, either the bearing length must be sufficiently long enough to spread out the force or web stiffeners must be added to prevent the web from failing. The data record will list the required bearing lengths and if these lengths will not be achieved, the designer must specify an appropriate stiffener. (See AISC Chapter K, K1-8)

**NOTE:** BeamChek does **NOT** evaluate beams loaded on their weak axis, combined or non-symmetrical forces, torsional stresses, or local flange bending. If extremely large point loads are present it would be prudent for the designer to manually check local flange bending per AISC Chapter K K-2, or simply add stiffeners at heavy concentrated loads.

**STEEL SIZES** (Click the 'database' button on form 2 to see a full list)

W, S, and C shapes are Compact sections, T shapes are Non-compact.

W SHAPES (wide flange) range up to the following weights:

6 x 25, 8 x 48, 10 x 60, 12 x 87, 14 x 120, 16 x 100, 18 x 130 and 36 x 280

S SHAPES (American Standard I) 3 x 5.7 to 24 x 121

C SHAPES (channels) 3 x 4.1 to 15 x 50

T SHAPES (rectangular tubes) 4 x 2 x 1/4 to 20 x 8 x 5/16.

Thickness choices are 1/4, 3/8, 1/2 and 5/16 inch when available for the size.

PL SHAPES (plates) Single and double plates 3 to 15-1/2 inches in depth.

Thickness choices are 1/4 to 1 inch. *Intended to be sandwiched with wood.*

### **ABBREVIATIONS**

$F_y$	specified minimum yield stress for type of steel
$L_c$	maximum unbraced length of compression flange, $F_b = 0.66F_y$
$L_u$	maximum unbraced length of compression flange, $F_b = 0.60F_y$
N	length of bearing of applied load (in.)
tw	web thickness
tf	flange thickness
k	distance from the outer face of flange to web toe

## WOOD COLUMN DESIGN

BeamChek sizes solid wood columns from 2x4s to 10x10s and built-up, nailed or bolted 2x combinations of up to 5 members. Column calculations are based on the 97, 01 or 05 NDS®. The column design form may be accessed by selecting COLUMNS from the Criteria form 1 menu bar. Enter the total reaction in pounds, the actual column length in feet (and decimal fraction if any), and the unbraced length in feet for each plane of the column, L1 and L2. L1 and L2 will be multiplied by the  $K_e$ , buckling mode, to arrive at the controlling effective column length,  $l_e$ . Please refer to your building code or to appendix G of the NDS for specifics on the 'buckling mode factor'. In residential design the appropriate  $K_e$  value is almost always 1.0.

**IMPORTANT:** On the Column form 2, **VERIFY that the controlling “d” width is as you had intended.** If not, return to Form 1 and swap the unbraced lengths for L1 and L2, then recalculate.

BeamChek will test for the maximum slenderness ratio,  $l_e/d$ , and may not exceed 50. The column stability factor,  $C_p$ , is calculated by BeamChek using the Equation 3.7-1 of the NDS. Built-up columns use the same stability equation, but are modified by the  $K_f$  factor as specified in chapter 15.3 of the NDS 97 & 01.  $K_f = 0.6$  for nailed and  $K_f = 0.75$  for bolted columns. NDS 05 achieves the same results with a different formula.

The following are elements of the  $C_p$ , stability formula:  $F_c E = K_c E (E_{adj}) / (l_e/d)^2$ ,  $K_c E = 0.3$  for visually graded lumber,  $c = 0.8$  for sawn lumber

Reference values are adjusted  $E$  and  $F_c$  perpendicular to grain, along with the CF size factor,  $C_d$  duration of load factor, and  $C_m$  wet use factor are all used in a similar fashion as in beam design. You may select from the wood species in the drop down list box, which offers Select, #1, and #2 grades or edit the  $F_c$  and  $E$  value boxes and enter your own species. BeamChek automatically changes the preset values when the Post & Timber or Beam & Stringer categories are changed. **NOTE:** Post & Timber grade is for square columns or rectangular with only 2 inches difference such as 6 x 6 and 6 x 8. A 6 x 10 is greater than 2” different and the Beam & Stringer values should be used. Also, if you enter values for stud grade, make sure the actual column length doesn't exceed 10 feet which is the maximum length that stud grade will apply.

## WIND LOADED STUD DESIGN

Combined axial (vertical gravity load) and horizontal wind loads (up to 3 partial uniform loads) may be tested by selecting Wind/Stud from the menu bar. Assumed conditions are bracing in the narrow breadth of the studs, dry use, repetitive use, wind duration factor of 1.6 and  $K_e$  and  $L_e$  of 1.0.

Analysis is for axial load only, wind load only and combined interaction per the 01 or 05 NDS 3.9.2 . Stud grade should only be used for members up to 10 ft in length. Enter loads and select OK Calculate, adjust grade, breadth, depth or loads as necessary. Select Report for details and to save or print

## STEEL COLUMNS

BeamChek steel column design is for concentric axial loading on a primary, vertical member without the presence of a bending moment. Wet Use and Duration of Load do not apply to steel and their buttons will become inactive.

### UNBRACED HEIGHT

All steel columns in the database are symmetrical (round or square) and therefore only one unbraced height needs to be entered (as plane D1). This entry, of course, would be the longest unbraced height from either plane D1 or plane D2.

### COLUMN VALUES

Fy and E values need not be edited because these values are preset from the database. BeamChek does not support custom steel grades or sizes.

### SLENDERNESS RATIO

The steel column slenderness ratio is  $Kl/r$  and has a maximum of 200.  $Kl$  is the effective length (height) of the column, similar to  $K_e \times l$  in wood column design. 'r' is the radius of gyration which is a property of the column size and type.

### ALLOWABLE STRESS

Allowable stress is determined by the formula:  $P$  (reaction load) =  $A$  (area)  $\times$   $F_a$  (allowable axial stress).  $F_a$  is determined by the formulas in AISC Chapter E-E2 along with the value for  $C_c$ , a factor in the formulas.

### STEEL COLUMN SIZES

#### **Round, unfilled pipe, A36 steel**

ASTM A501 or ASTM A53, in type E or S, in grade B:

Weights: Standard, Extra strong, and Double extra strong

Nominal diameters in inches: 3, 3-1/2 (standard & extra only), 4, 5, and 6.

#### **Structural Tubing, A46 steel**

ASTM A500, grade B

Thickness: 1/4 inch, 3/8 inch, and 1/2 inch when available for the size.

Outside square net dimensions: 3 x 3, 4 x 4, 5 x 5, 6 x 6, and 8x8

## NOTCHED WOOD MEMBERS

End (at support) notched rectangular and round wood members may be checked for Shear strength by selecting “Notches” from the Menu bar on the Criteria Form 1. Note: The raised buttons under the titles may be clicked for instant help and explanations. For interior notches see the NDS for limits.

1. Member attributes are selected first. You may choose from solid sawn, rectangular and round members or glu-lams. SCL’s are not included... see the manufacturer’s literature. Enter the total **V** (shear load in pounds) without any reductions. Next, select the breadth and depth in decimal inches or click the “Standard Sizes” button and choose from the nominal sizes and import the actual decimal sizes. Round members only need the breadth selected as the depth and breadth are the same. Continuing down, select the wood species or Glu-lam combination, code edition and tabulated base **F<sub>v</sub>**. Select “wet use” for members exposed to the weather, select the incising factor (for small staple-like incisions sometimes created by pressure treating) if applicable, and the enter the duration of load.

2. Notch attributes may now be selected. Three types of notches are available. A “tension” notch is at the underside, “compression” at the top of the member and “tapered” is for members with the top edge trimmed at an angle as per the diagram at the right. Non-applicable entries will be grayed out. Above the OK Calculate button will be the minimum “**dn**” as allowed by the NDS. The NDS tension side limits at  $1/4 \mathbf{d}$  for solid sawn and  $1/10 \mathbf{d}$  with a maximum of 3 inches for Glu-lams. Glu-lam Compression notches are limited to  $2/5 \mathbf{d}$  and trimming limited to  $2/3 \mathbf{d}$ . See the NDS for additional information.

**NOTE:** “**dn**” is NOT the depth of the notch! It is the depth **REMAINING** after the notch is subtracted. This terminology is used to match the formulas of the NDS.

When checking a taper notch, enter the **rd** (rafter depth), **t** (wall or post thickness), and **rp** (roof pitch). By clicking the button “to 12 Pitch”, it will change the user entry box to accept degrees for the angle. Click it again to return to roof pitch. The **e** and **dn** will be auto-calculated based on your entries.

3. When all the entries are complete, click the “OK Calculate” button to complete the report with the ratio of **F<sub>v</sub>** and **f<sub>v</sub>** and status of the proposed notch. Round members will include the net area at the point of critical shear and taper notches will show the tapered angle in degrees. Certain notches may not enter the middle third of the span, therefore the “minimum span” listed is an alert to the user to prevent this from happening.

4. Your choice now is to print or save the report to your hard drive. Previously saved notch calculations can be retrieved by selecting “Open” from the menu bar. Save the reports under the default extension \*.SCD for easy retrieval.

## **SAVING YOUR DATA TO YOUR HARD DISK**

Beam Criteria and beam selection may be saved to a disk file using the menu in the Criteria Form 1. Custom values may be saved in the Custom Values Form 2, and the Data Record (without the load diagram) can be saved by using the menu in the Data Record Form. Select FILE, select SAVE (or LOAD to retrieve files) and choose the file location in the dialog box. The default extensions are \*.CRI for Criteria, \*.VAL for Custom Values, \*.DAT for Data Records, \*.COL for wood columns, \*.WSC for wind loaded studs, and \*.SCO for steel columns. We recommend that you use these default extensions to help prevent the frustration of opening of an incorrect file type. NOTE: To retrieve a data record, you must have the DATA RECORD form open. **We recommend that you save only the Criteria Form as it now contains all the necessary information. You may easily print saved beams by selecting “LOAD and PRINT...” from the File Menu on the Criteria Form 1.**

## **REVISING A BEAM**

When a Data Record is retrieved, the numeric values are **text** and are not active numerically in BeamChek. You may print the Data Record, but loads and criteria cannot be revised and the loading diagram will not be displayed. If you might revise beam criteria, possibly select alternative beam sizes or species, or need the loading diagram, be sure to save the **CRITERIA** in Form 1. You will automatically be given this choice when saving your data record.

**Important:** To reload a saved CRITERIA file, you must have the CRITERIA form (the input form) open. To load saved criteria, select FILE, select LOAD CRITERIA, and select the saved criteria file from the selection box. You may either step through the calculation forms with the same beam or make changes to loads, species, or beam selection and print or save the results normally. **When retrieving v2007 or later saved files, you may easily print saved beams by selecting “LOAD and PRINT...” from the File Menu on Form 1.**

## **PRINTING**

The current beam **Data Record** may be viewed by selecting ‘OK Select member’ on REPORT FORM 3. To print this Data Record, select the PRINT button or select FILE, and select PRINT. A form will appear with optional spaces for adding or editing the project name, beam description and ID, and notes. If you wish, you may enter a centered, two line heading to the page. You may also add initials, and date. Heading information is retained until you exit BeamChek. Selecting the 600 DPI option will enhance the layout of borders when printing on a 600+ DPI printer. Note: Be sure your printer is set to print pages in ‘portrait’, (not landscape). You may change this by selecting ‘PRINT SETUP’ under FILE on the Menu bar.

## **PRINT MANAGER and FONTS**

Windows Print Manager will use the highest resolution available on your printer. Printer location and configuration is handled by Windows itself, not BeamChek. If you need to re-configure your printer, do so at your Windows Control panel, or select FILE and then select PRINT SETUP.

The default print-out font is 9 pt. ARIAL, a Windows True Type font. If for some reason Arial is not available, Windows will attempt to substitute another font or may generate an error. You may use any font available on your system by selecting FONTS on the menu bar. Please remember the print-out is optimized for Arial, so you should select a Type Face with letters that aren't wider than Arial, otherwise some words and numbers may overwrite each other becoming unreadable.

NOTE: At least one Printer Driver must be installed on your computer to generate the basic shapes of any fonts.

## **SETTING DEFAULTS**

To save your name and address used in the report heading, go to form 1 and from the menu bar, select OPTIONS, select SET DEFAULTS. You may enter a permanent Heading of name and address for your print-outs, set a preferred Species group or material, set '97, '01 or '05 NDS values, add your initials, select a print-out font and set the 600+ DPI option.

You may also enter up to four pairs of "commonly used" Live and Total Loads for auto-insertion in the Criteria Form's Uniform Loads. Later, when using the Criteria form 1, click on the PSF and PLF buttons (next to uniform load entry boxes) and you will cycle through your "commonly used" Loads. If there are loads currently displayed in the entry boxes the auto-fill action will not be activated. To use this feature you will need to "clear" the entries first. Simply click directly on the adjacent letter "A" to clear the boxes, or you may single click somewhere within the surrounding rectangle to clear all loads within the rectangle.

Checkboxes allow you to have the software retain your default printer if you regularly print BeamChek to an auxillary printer, and another that allows you to center or move around all the BeamChek forms on your monitor.

After your selections are complete, select the SAVE DEFAULTS button and the information will be recorded to your hard drive. If you do not want to make any changes to the current settings select CLOSE. Any changes made will be used in the current BeamChek session and will revert to their previous setting after exiting the software.