

# sCheck

**A Steel Section Check and Design Program**



**Computations & Graphics, Inc.**

Highlands Ranch, CO 80130, USA

Email: [info@cg-inc.com](mailto:info@cg-inc.com)

Web: [www.cg-inc.com](http://www.cg-inc.com)



# ***End User License Agreement for CGI Software (Non-SDK)***

The Software is protected by United States copyright laws and various international treaties. By installing or using the Software, you agree to be bound by the terms of this Agreement. If you do not agree with the terms of this Agreement, do not install or use the Software. This Agreement is governed by the laws of the United States and the State of Colorado. You may not export the Software in violation of applicable export laws.

## **1. DEFINITIONS**

“Software” means all of the contents of the files, disk(s), CD-ROM(s), or other media with which this Agreement is provided.

“Documentation” means all of the contents of the files, printed materials with which this Agreement is provided. “End User” means you. “CGI” means Computations & Graphics, Inc.

## **2. GRANT OF LICENSE**

a). The following applies if you have purchased a perpetual Software license:

CGI grants you (the End User) a non-exclusive, non-transferable license to use the Software on a single computer. You may not rent, lease, or resell the Software. You may not disassemble, decompile, reverse engineer, or modify the Software in any way. This License starts from the date you receive the Software and will last as long as the End User complies with the terms of this Agreement.

b). The following applies if you have purchased a subscription Software license:

CGI grants you (the End User) a non-exclusive, non-transferable license to use the Software simultaneously via the internet on a certain number of computers for a certain subscription period. You may not rent, lease, or resell the Software. You may not disassemble, decompile, reverse engineer, or modify the Software in any way. This License starts from the date you purchased the subscription license and will last for the subscription period.

## **3. SUPPORT**

CGI offers limited 30 days of free email technical support related to the installation and use of the most recent version of the Software, starting from the start date of this Agreement. CGI has no obligation to provide support in any form if your version of the Software is not the most recent version. CGI, in its sole discretion, will determine what constitutes a support incident. CGI reserves the right to refuse support service to anyone.

## **4. COPYRIGHT**

The Software and Documentation are the intellectual property of and are owned by CGI. You may make at most one copy of the Software and/or the Documentation for backup purposes.

## **5. COMMERCIAL USES**

The Standard and Professional versions of the Software may be used for commercial purposes.

The Evaluation, Educational, and Beta versions of the Software may not be used for commercial purposes.

## **6. LIMITATION OF LIABILITY**

IN NO EVENT WILL CGI OR ITS SUPPLIERS BE LIABLE TO YOU FOR ANY DAMAGES, CLAIMS, OR COSTS WHATSOEVER OR ANY CONSEQUENTIAL, INDIRECT, INCIDENTAL DAMAGES, OR ANY LOST PROFITS OR LOST SAVINGS, EVEN IF CGI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH LOSS, DAMAGES, CLAIMS, OR COSTS.

## **7. DISCLAIMER**

CGI HAS TAKEN EVERY EFFORT TO MAKE THE SOFTWARE RELIABLE AND ACCURATE. HOWEVER, IT IS THE END USER’S RESPONSIBILITY TO INDEPENDENTLY VERIFY THE ACCURACY AND RELIABILITY OF THE SOFTWARE. NO EXPRESS OR IMPLIED WARRANTY IS PROVIDED BY CGI OR ITS DEVELOPERS ON THE ACCURACY OR RELIABILITY OF THE SOFTWARE.

## **8. REFUND POLICY**

All sales are final and no refunds will be given. If you do not agree to and accept this policy, do not purchase the license of this software.

## **9. TERMINATION OF THIS LICENSE:**

This Agreement becomes effective on the date you accept this Agreement and will continue until terminated as provided for in this Agreement. CGI may terminate this license at any time if you are in breach of any of its terms and conditions. Upon termination, you must immediately return to CGI or destroy the Software and all copies thereof.

## ***Copyright***

THE SOFTWARE SCHECK AND ALL ITS DOCUMENTATION ARE THE INTELLECTUAL PROPERTY OF AND ARE OWNED BY COMPUTATIONS & GRAPHICS INC. (CGI). ILLEGAL USE OF THE SOFTWARE OR REPRODUCTION OF ITS DOCUMENTATION IS STRICTLY PROHIBITED.

## ***Disclaimer***

CGI HAS TAKEN EVERY EFFORT TO MAKE THE SOFTWARE RELIABLE AND ACCURATE. HOWEVER, IT IS THE END USER'S RESPONSIBILITY TO INDEPENDENTLY VERIFY THE ACCURACY AND RELIABILITY OF THE SOFTWARE. NO EXPRESS OR IMPLIED WARRANTY IS PROVIDED BY CGI OR ITS DEVELOPERS ON THE ACCURACY OR RELIABILITY OF THE SOFTWARE.

Windows® is a registered trademark of Microsoft Corporation.  
sCheck is a trademark of Computations & Graphics, Inc.

Copyright 2014-2025 by Computations & Graphics, Inc. All rights reserved.

Last Revised Feb. 2025

# Table of Contents

END USER LICENSE AGREEMENT FOR CGI SOFTWARE (NON-SDK) .....	I
COPYRIGHT .....	II
DISCLAIMER .....	II
INTRODUCTION.....	5
<i>Graphical User Interface (GUI)</i> .....	5
<i>Operating System Requirements</i> .....	7
CHAPTER 1: SECTION ORIENTATIONS .....	8
CHAPTER 2: MEMBER INTERNAL FORCES AND MOMENTS .....	9
CHAPTER 3: SECTION CHECK .....	10
CHAPTER 4: SECTION DESIGN .....	12
CHAPTER 5: VERIFICATION EXAMPLES – AISC 360-22 (16 <sup>TH</sup> EDITION) LRFD .....	13
<i>Example 1 – W Shape Beam (Flexure in Major Axis, <math>L_p &lt; L_b &lt; L_r</math>)</i> .....	13
<i>Example 2 – W Shape Beam (Flexure in Major Axis, <math>L_b &gt; L_r</math>)</i> .....	14
<i>Example 3 – W Shape Beam (Flexure in Minor Axis)</i> .....	15
<i>Example 4 – W Shape Beam (Shear in Minor Axis)</i> .....	16
<i>Example 5 – W Shape Column (Combined Axial Compression and Flexure)</i> .....	17
<i>Example 6 – W Shape Column (Combined Axial Tension and Flexure)</i> .....	18
<i>Example 7 – C Shape Beam (Flexure and Shear)</i> .....	19
<i>Example 8 – WT Shape Column (Axial Compression)</i> .....	20
<i>Example 9 – HSS Shape Column (Axial Compression)</i> .....	21
<i>Example 10 – Rectangular HSS Shape Beam (Flexure)</i> .....	22
<i>Example 11 – Pipe Shape Column (Compression)</i> .....	23
<i>Example 12 – Round HSS Shape Beam (Shear)</i> .....	24
<i>Example 13 – Double Angle Shape Beam (Axial Compression)</i> .....	25
<i>Example 14 – Single Angle Shape Column (Axial Compression and Flexure)</i> .....	26
<i>Example 15 – W Shape Beam-Column Design – A Tutorial</i> .....	27
CHAPTER 6: VERIFICATION EXAMPLES – AISC 360-16 (15 <sup>TH</sup> EDITION) LRFD .....	30
<i>Example 1 – W Shape Beam (Flexure in Major Axis, <math>L_p &lt; L_b &lt; L_r</math>)</i> .....	30
<i>Example 2 – W Shape Beam (Flexure in Major Axis, <math>L_b &gt; L_r</math>)</i> .....	31
<i>Example 3 – W Shape Beam (Flexure in Minor Axis)</i> .....	32
<i>Example 4 – W Shape Beam (Shear in Minor Axis)</i> .....	33
<i>Example 5 – W Shape Column (Combined Axial Compression and Flexure)</i> .....	34
<i>Example 6 – W Shape Column (Combined Axial Tension and Flexure)</i> .....	35
<i>Example 7 – C Shape Beam (Flexure and Shear)</i> .....	36
<i>Example 8 – WT Shape Column (Axial Compression)</i> .....	37
<i>Example 9 – HSS Shape Column (Axial Compression)</i> .....	38
<i>Example 10 – Rectangular HSS Shape Beam (Flexure)</i> .....	39
<i>Example 11 – Pipe Shape Column (Compression)</i> .....	40
<i>Example 12 – Round HSS Shape Beam (Shear)</i> .....	41
<i>Example 13 – Double Angle Shape Beam (Axial Compression)</i> .....	42
<i>Example 14 – Single Angle Shape Column (Axial Compression and Flexure)</i> .....	43
<i>Example 15 – W Shape Beam-Column Design – A Tutorial</i> .....	44
CHAPTER 7: VERIFICATION EXAMPLES – AISC 360-10 (14 <sup>TH</sup> EDITION) LRFD .....	47
<i>Example 1 – W Shape Beam (Flexure in Major Axis, <math>L_p &lt; L_b &lt; L_r</math>)</i> .....	47
<i>Example 2 – W Shape Beam (Flexure in Major Axis, <math>L_b &gt; L_r</math>)</i> .....	48
<i>Example 3 – W Shape Beam (Flexure in Minor Axis)</i> .....	49
<i>Example 4 – W Shape Beam (Shear in Minor Axis)</i> .....	50
<i>Example 5 – W Shape Column (Combined Axial Compression and Flexure)</i> .....	51
<i>Example 6 – W Shape Column (Combined Axial Tension and Flexure)</i> .....	52
<i>Example 7 – C Shape Beam (Flexure and Shear)</i> .....	53
<i>Example 8 – WT Shape Column (Axial Compression)</i> .....	54
<i>Example 9 – HSS Shape Column (Axial Compression)</i> .....	55
<i>Example 10 – Rectangular HSS Shape Beam (Flexure)</i> .....	56
<i>Example 11 – Pipe Shape Column (Compression)</i> .....	57

<i>Example 12 – Round HSS Shape Beam (Shear)</i> .....	58
<i>Example 13 – Double Angle Shape Beam (Axial Compression)</i> .....	59
<i>Example 14 – Single Angle Shape Column (Axial Compression and Flexure)</i> .....	60
<i>Example 15 – W Shape Beam-Column Design – A Tutorial</i> .....	61
CHAPTER 8: SAMPLE SCHECK DETAILED REPORT .....	64
<i>General Info</i> .....	65
<i>Section Property - W10X33</i> .....	65
<i>Design Input</i> .....	65
<i>Axial Capacity Calculation</i> .....	65
<i>Moment Magnification Calculation</i> .....	66
<i>Major Flexure Capacity Calculation</i> .....	67
<i>Minor Flexure Capacity Calculation</i> .....	68
<i>Flexural and Axial Interaction Shape Calculation</i> .....	69
<i>Major Shear Capacity Calculation</i> .....	69
<i>Minor Shear Capacity Calculation</i> .....	70
REFERENCES .....	71

\*\*\*\*\*

## Introduction

sCheck is a versatile steel section check and design Windows program based on ANSI/AISC 360-22 (16<sup>th</sup> edition) LRFD, 360-16 (15<sup>th</sup> edition) LRFD, and ANSI/AISC 360-10 (14<sup>th</sup> edition) LRFD.

The program includes the following features:

- Check the capacity of any of the standard AISC shapes (W, M, S, HP, C, MC, L, WT, MT, ST, 2L, HSS, PIPE) against a set of load effects.
- Design and select optimal standard AISC shapes against a set of load effects.
- Consider moment magnification for non-sway condition.
- Auto generate (and batch generate) detailed calculation procedures in Word and PDF formats.

## Graphical User Interface (GUI)

sCheck has a simple and user-friendly user interface (Figure 0.1). There are two modes in sCheck: Section Check (Figure 0.2) and Section Design (Figure 0.3).

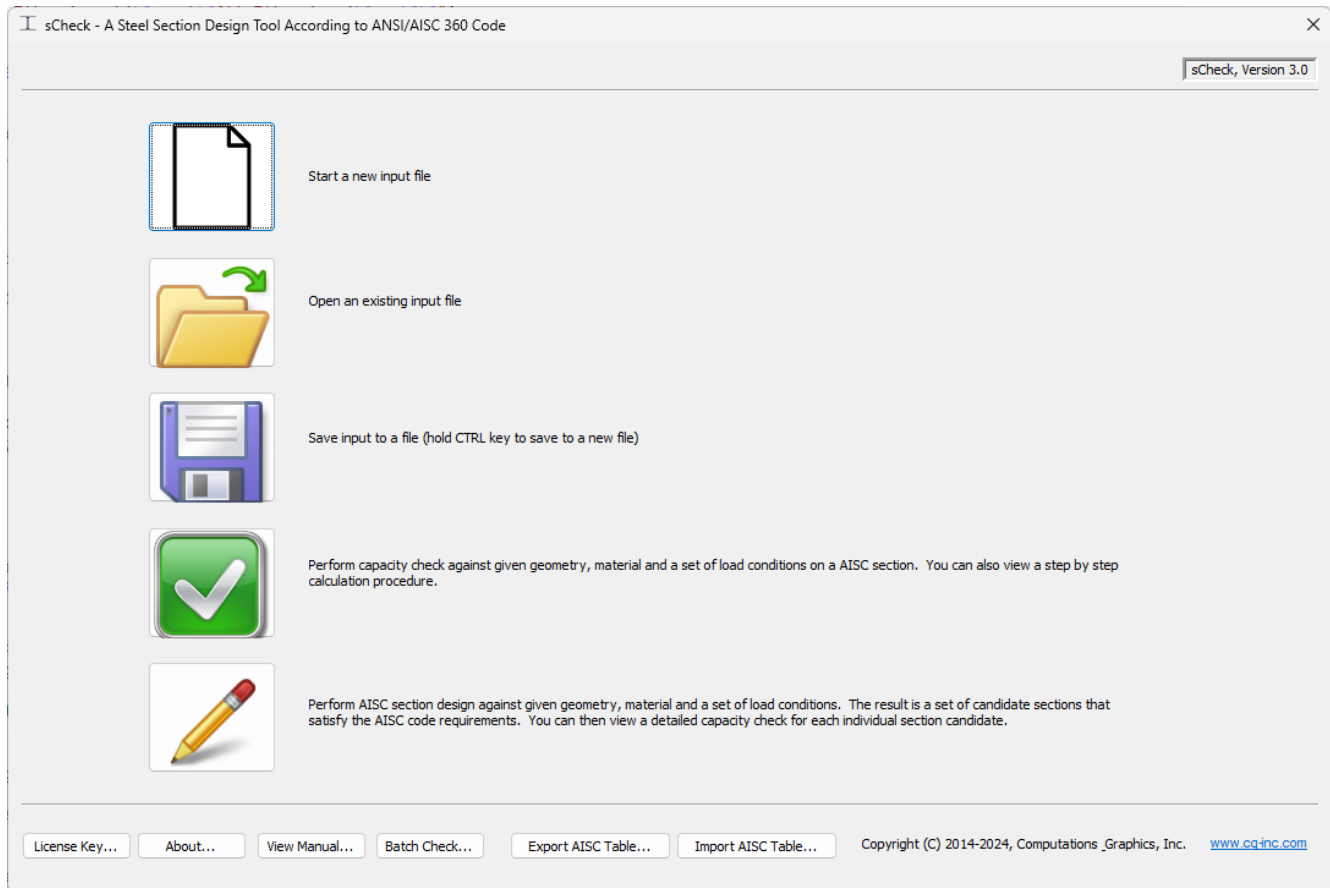


Figure 0.1

**Steel Beam-Column Check**

Code: AISC 360-22 (16th Edition) LRFD ☒ Use Direct Analysis Method

Section: W12x58 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress: 50 ksi

**Geometry**

Length: 15 ft Lb: 15 ft Cb: 1 Connector Distance (for double angles only): 0 ft

Lux: 15 ft Luy: 15 ft Luz: 15 ft

Kx: 1 Ky: 1 Kz: 1

**Load Effects &**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	0	113	0	30	1	1								
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

Figure 0.2

**Steel Beam-Column Design**

Code: AISC 360-22 (16th Edition) LRFD

Shape: W

Section Filter Criteria (Optional)

Section Prefixes (Comma delimited list, e.g. W12, W14): w8,w10,w12

Section Min Depth: 0 in Section Max Depth: 0 in

Section Min Width: 0 in Section Max Width: 0 in

☒ Use Direct Analysis Method

☒ Consider Moment Magnification

Maximum Number of Section Candidates: 10

Steel Yield Stress (Fy): 50 ksi

**Loads:**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy
1	30	90	12	0	0	1	1
2							
3							
4							
5							
6							
7							
8							

**Geometry**

Length: 14 ft

Lux: 14 ft Kx: 1

Luy: 14 ft Ky: 1

Luz: 14 ft Kz: 1

Lb: 14 ft Cb: 1.14

Connector Distance (for double angles only): 0 ft

**Section Candidates**

	Section	Critical Ratio	Critical Load
1			
2			
3			
4			
5			
6			
7			

Perform Design Check Section... OK Close

Figure 0.3



## **Operating System Requirements**

x64-based Windows 7, 8, 10, 11

ARM64-based Windows 11

**Chapter 1: Section Orientations**

The orientations of section local X and Y axes of various AISC shapes are shown below.

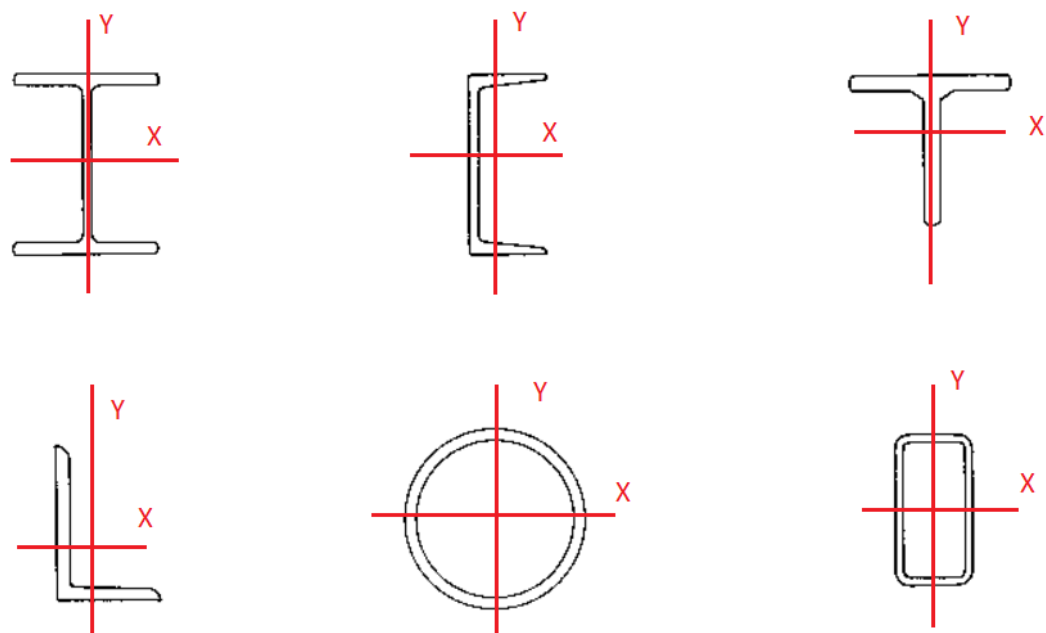


Figure 1.1

## Chapter 2: Member Internal Forces and Moments

1. Axial force  $P$  acts perpendicular to the section. Moments  $M_x$  and  $M_y$  act about section local  $X$  and  $Y$  axes respectively. They have the following sign conventions.

Axial Force  $P$ : positive for compression; negative for tension

Moment  $M_x$ : Positive when section top most fiber is under compression.

Moment  $M_y$ : Positive when section rightmost fiber is under compression.

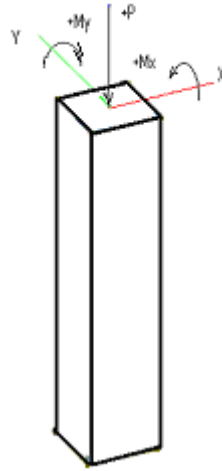


Figure 2.1

2. All moments are referenced about the geometric centroid of the gross section.

3. Unlimited number of factored load sets can be input via spreadsheet. Loads are the required strength computed by the code-specified factored load combinations using either hands or analysis program such as Real3D-Analysis. It is assumed that an overall 2<sup>nd</sup> order P-Delta ( $P-\Delta$ ) analysis has been performed on a sway structure. If desired, the program uses moment magnification procedure to calculate the P-delta ( $P-\delta$ ) effect, which accounts for slenderness of columns in non-sway structure or for slenderness along the lengths of columns in sway structure.

4. Critical ratio is computed for each section based on the magnified factored loads and the capacity of the section. Critical ratio equal or less than 1.0 means the design strength is greater than the required strength and the section is adequate. Critical ratio greater than 1.0 means the design strength is less than the required strength and the section is inadequate.

## Chapter 3: Section Check

The Section Check input and output are shown below, followed by a detailed calculation procedure that sCheck produces.

Steel Beam-Column Check

Code: AISC 360-22 (16th Edition) LRFD

Section: W12x58

Steel Yield Stress: 50 ksi

Use Direct Analysis Method

Consider Moment Magnification

Geometry

Length: 15 ft

Lb: 15 ft

Cb: 1

Connector Distance (for double angles only): 0 ft

Lux: 15 ft

Luy: 15 ft

Luz: 15 ft

Kx: 1

Ky: 1

Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	0	113	0	30	1	1								
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

Figure 3.1

Lux, Luy and Luz are unbraced lengths in local x, y and z directions.  
Kx, Ky and Kz are unbraced length factors in local x, y and z directions.

Lb is the unbraced lateral length.

Cb is the lateral-torsional buckling modification factor for non-uniform moment diagrams. It should be greater or equal to 1.0. You can use 1.0 for Cb conservatively.

Connector Distance is used for double angles only.

Pu, Mux, Muy, Vux, Vuy are required axial, major moment, minor moment, major shear and minor shear. For Pu, the compressive force is positive while tensile force is negative. Moment Mux is positive when section top most fiber is under compression. Moment Muy is positive when section rightmost fiber is under compression. Moment magnification may be optionally considered to account for the P-delta (P- $\delta$ ) effect.

If direct analysis method is chosen, the program will account for stiffness reduction when calculating the moment magnification factor  $B_{1x}$  and  $B_{1y}$  for P- $\delta$  effects. It is assumed that a P- $\Delta$  (only) second-order analysis is performed for the load effects (Pu, Mux, Muy, Vux, and Vuy).

$C_{mx}$ ,  $C_{my}$  are coefficients accounting for non-uniform moments when computing moment magnification. You can use 1.0 for  $C_{mx}$  and  $C_{my}$  conservatively. If 0 is entered for  $C_{mx}$  or  $C_{my}$ , 1.0 is used in the computation instead.

Results include axial capacity ( $\phi P_n$ ), moment capacity ( $\phi M_{nx}$ ,  $\phi M_{ny}$ ), shear capacity ( $\phi V_{nx}$ ,  $\phi V_{ny}$ ), moment magnification factors ( $B_{1x}$ ,  $B_{1y}$ ), and critical ratio. The section is deemed safe to resist a load if the critical ratio is less than 1.0, otherwise, the section is deemed unsafe. Please note that for a single angle, the moment capacities are given about the principal w-w and z-z axes and the input moments  $M_{ux}$  and  $M_{uy}$  are transformed in the principal axes before flexural-axial interaction ratio is checked.

## Chapter 4: Section Design

The Section Design input and output are shown below:

**Steel Beam-Column Design**

Code: AISC 360-22 (16th Edition) LRFD

Shape: W

Section Filter Criteria (Optional)

Section Prefixes (Comma delimited list, e.g. W12, W14): w8,w10,w12

Section Min Depth: 0 in      Section Max Depth: 0 in

Section Min Width: 0 in      Section Max Width: 0 in

Use Direct Analysis Method ☒

Consider Moment Magnification ☒

Maximum Number of Section Candidates: 10

Steel Yield Stress (Fy): 50 ksi

**Loads:**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy
1	30	90	12	0	0	1	1
2							
3							
4							
5							
6							
7							
8							

**Geometry**

Length: 14 ft

Lux: 14 ft      Kx: 1

Luy: 14 ft      Ky: 1

Luz: 14 ft      Kz: 1

Lb: 14 ft      Cb: 1.14

Connector Distance (for double angles only): 0 ft

**Section Candidates**

	Section	Critical Ratio	Critical Load
1			
2			
3			
4			
5			
6			
7			

Perform Design

Check Section...

OK

Close

Figure 4.1

For Section Filter Criteria, you can use either Section Prefixes or section dimension limits (but not both). The section prefixes is a comma delimited list such as W12, W14. If section prefixes is used, the section dimension limits will be ignored. If a section dimension limit is zero, then that limit criteria is ignored.

By default, a maximum of ten section candidates will be provided after a successful design. You can then view the detailed check for each of the section candidate.

## Chapter 5: Verification Examples – AISC 360-22 (16<sup>th</sup> edition) LRFD

### Example 1 – W Shape Beam (Flexure in Major Axis, $L_p < L_b < L_r$ )

[Ref 2, pp435]

Check the flexural capacity of W18x97 beam.

$F_y = 50$  ksi,  $L = 50$  ft,  $L_b = 25$  ft.  $C_b = 1.3$ .

Steel Beam-Column Check

Code: AISC 360-22 (16th Edition) LRFD ☒ Use Direct Analysis Method

Section: W18x97 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress: 50 ksi

Geometry

Length: 50 ft Lb: 25 ft Cb: 1.3 Connector Distance (for double angles only): 0 ft

Lux: 50 ft Luy: 50 ft Luz: 50 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	684	0	54.75	0	1	1	125.595	740.336	207.375	298.53	521.478	1.0000	1.0000	0.9239
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

### Result Comparison

The reference gives  $\phi M_{nx} = 740$  ft-kips while sCheck gives  $\phi M_{nx} = 740.336$  ft-kips. They are practically identical.

## Example 2 – W Shape Beam (Flexure in Major Axis, $L_b > L_r$ )

[Ref 2, pp440]

Check the flexural capacity of W33x118 beam.

$F_y = 50$  ksi,  $L = 28$  ft,  $L_b = 28$  ft,  $C_b = 2.0$ .

Steel Beam-Column Check

Code: AISC 360-22 (16th Edition) LRFD ☒ Use Direct Analysis Method

Section: W33x118 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 50 ksi

Geometry

Length: 28 ft Lb: 28 ft Cb: 2 Connector Distance (for double angles only): 0 ft

Lux: 28 ft Luy: 28 ft Luz: 28 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	1380	0	0	0	1	1	373.738	1388.77	192.375	488.565	459.54	1.0000	1.0000	0.9937
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

## Result Comparison

The reference gives  $\phi M_{nx} = 1390$  ft-kips while sCheck gives  $\phi M_{nx} = 1388.77$  ft-kips. They are practically identical.



### Example 3 – W Shape Beam (Flexure in Minor Axis)

[Ref 6, Example F.5]

Check the flexural capacity of W12x58 beam in minor axis.  $F_y = 50$  ksi,  $L = 15$  ft.

Steel Beam-Column Check

Code:  ☒ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress  ksi

Geometry

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	0	113	0	30	1	1	525.237	289.138	121.875	131.76	345.6	1.0000	1.0000	0.9272
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

### Result Comparison

The reference gives  $\phi M_{ny} = 122$  ft-kips while sCheck gives  $\phi M_{ny} = 121.875$  ft-kips. They are practically identical.

## Example 4 – W Shape Beam (Shear in Minor Axis)

[Ref 6, Example G.6]

Check the shear capacity of W21x48 beam in minor axis.

$F_y = 50$  ksi

Steel Beam-Column Check

Code: AISC 360-22 (16th Edition) LRFD ☒ Use Direct Analysis Method

Section: W21x48 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 50 ksi

Geometry

Length: 10 ft Lb: 10 ft Cb: 1 Connector Distance (for double angles): 0 ft

Lux: 10 ft Luy: 10 ft Luz: 10 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	0	0	0	120	1	1	404.525	340.419	55.2265	216.3	189.011	1.0000	1.0000	0.6349
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

## Result Comparison

The reference gives  $\phi V_{ny} = 189$  ft-kips while sCheck gives  $\phi V_{ny} = 189.011$  ft-kips. They are practically identical.

## Example 5 – W Shape Column (Combined Axial Compression and Flexure)

[Ref 6, Example H.4]

Check the capacity of W10x33 column in combined axial compression and flexure.

$F_y = 50$  ksi,  $L = 14$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_{ux} = L_{uy} = L_b = 14$  ft,  $C_b = 1.14$ .

**Steel Beam-Column Check**

Code: AISC 360-22 (16th Edition) LRFD ☐ Use Direct Analysis Method

Section: W10x33 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 50 ksi

**Geometry**

Length: 14 ft Lb: 14 ft Cb: 1.14 Connector Distance (for double angles only): 0 ft

Lux: 14 ft Luy: 14 ft Luz: 14 ft

Kx: 1 Ky: 1 Kz: 1

**Load Effects &**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	30	90	12	0	0	1	1	252.522	136.59	52.5	84.651	186.98	1.0176	1.0879	0.9786
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

### Result Comparison

The reference gives  $\phi P_n = 253$  kips,  $\phi M_{nx} = 137$  ft-kips,  $\phi M_{ny} = 52.5$  ft-kips while sCheck gives  $\phi P_n = 252.522$  kips,  $\phi M_{nx} = 136.59$  ft-kips,  $\phi M_{ny} = 52.5$  ft-kips. They are practically identical.

## Example 6 – W Shape Column (Combined Axial Tension and Flexure)

[Ref 6, Example H.3]

Check the capacity of W14x82 column in combined axial tension and flexure.

$F_y = 50$  ksi,  $L = 30$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_{ux} = L_{uy} = L_b = 30$  ft,  $C_b = 1.41$ .

Note: tension load must be entered as negative value.

Steel Beam-Column Check

Code: AISC 360-22 (16th Edition) LRFD ☒ Use Direct Analysis Method

Section: W14x82 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 50 ksi

Geometry

Length: 30 ft Lb: 30 ft Cb: 1.41 Connector Distance (for double angles only): 0 ft

Lux: 30 ft Luy: 30 ft Luz: 30 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	-174	192	67.6	0	0	1	1	1080	491.54	168	218.79	466.317	1.0000	1.0000	0.8735
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

## Result Comparison

The reference gives  $\phi P_n = 1080$  kips,  $\phi M_{nx} = 492$  ft-kips,  $\phi M_{ny} = 168$  ft-kips while sCheck gives  $\phi P_n = 1080$  kips,  $\phi M_{nx} = 491.54$  ft-kips,  $\phi M_{ny} = 168$  ft-kips. They are practically identical. Please note that absolute value of axial load should be used for axial-flexural interaction formula.

## Example 7 – C Shape Beam (Flexure and Shear)

[Ref 6, Example F.2-2A and G.2B]

Check the capacity of C15x33.9 column in flexure and shear.

$F_y = 50$  ksi,  $L = 25$  ft,  $L_b = 5$  ft,  $C_b = 1.0$ .

**Steel Beam-Column Check**

Code:  ☒ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress:  ksi

**Geometry**

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

**Load Effects &**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	108	0	150	0	1	1	20.3773	172.323	18.54	162	119.34	1.0000	1.0000	0.9259
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

## Result Comparison

The reference gives  $\phi M_{nx} = 173$  ft-kips,  $\phi V_{nx} = 162$  kips while sCheck gives  $\phi M_{nx} = 172.323$  ft-kips,  $\phi V_{nx} = 162$  kips. They are practically identical.

## Example 8 – WT Shape Column (Axial Compression)

[Ref 6, Example E.8]

Check the capacity of WT7x15 column in axial compression.

$F_y = 50$  ksi,  $L = 20$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_u = 20$  ft,  $C_b = 1.41$ .

Steel Beam-Column Check

Code: AISC 360-22 (16th Edition) LRFD ☒ Use Direct Analysis Method

Section: WT7x15 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 50 ksi

Geometry

Length: 20 ft Lb: 20 ft Cb: 1 Connector Distance (for double angles only): 0 ft

Lux: 20 ft Luy: 20 ft Luz: 20 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	36	0	0	0	0	1	1	36.6049	18.3176	16.8375	50.4468	69.9583	1.9107	13.3382	0.9835
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

## Result Comparison

The reference gives  $\phi P_n = 36.6$  kips while sCheck gives  $\phi P_n = 36.6049$  kips. They are practically identical.

## Example 9 – HSS Shape Column (Axial Compression)

[Ref 6, Example E.10]

Check the capacity of HSS12x8x3/16 column in axial compression.

$F_y = 50$  ksi,  $L = 30$  ft,  $K_x = K_y = 0.8$ ,  $K_z = 1.0$ ,  $L_u = 30$  ft,  $C_b = 1.0$ .

**Steel Beam-Column Check**

Code:  ☒ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress  ksi

**Geometry**

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

**Load Effects &**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	154	0	0	0	0	1	1	151.33	78.7949	48.2464	96.8465	70.3009	1.6674	3.8498	1.0176
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

## Result Comparison

The reference gives  $\phi P_n = 151$  kips while sCheck gives  $\phi P_n = 151.33$  kips. They are practically identical. The reference gives  $\phi P_n = 177$  kips while sCheck gives  $\phi P_n = 177.832$  kips for  $L_c = 18$  ft. The reference gives  $\phi P_n = 74.2$  kips while sCheck gives  $\phi P_n = 74.3864$  kips for  $L_c = 40$  ft.

## Example 10 – Rectangular HSS Shape Beam (Flexure)

[Ref 6, Example F.8B]

Check the capacity of HSS8x8x3/16 column in flexure.

$F_y = 50$  ksi,  $L = 21$  ft,  $L_b = 21$  ft,  $C_b = 1.0$ .

**Steel Beam-Column Check**

Code:  ☒ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress:  ksi

**Geometry**

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

**Load Effects &**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	41.3	0	0	0	1	1	151.31	45.2811	45.2811	70.3009	70.3009	1.0000	1.0000	0.9121
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

### Result Comparison

The reference gives  $\phi M_{nx} = 45.4$  ft-kips while sCheck gives  $\phi M_{nx} = 45.2811$  ft-kips. They are practically identical.



## Example 11 – Pipe Shape Column (Compression)

[Ref 6, Example E.11]

Check the capacity of Pipe10STD column in flexure.

$F_y = 35$  ksi,  $L = 30$  ft

Steel Beam-Column Check

Code: AISC 360-22 (16th Edition) LRFD ☒ Use Direct Analysis Method

Section: Pipe10STD AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 35 ksi

Geometry

Length: 30 ft Lb: 30 ft Cb: 1 Connector Distance (for double angles only): 0 ft

Lux: 30 ft Luy: 15 ft Luz: 30 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	210	0	0	0	0	1	1	221.966	96.8625	96.8625	108.675	108.675	4.7314	1.2456	0.9461
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

### Result Comparison

The reference gives  $\phi P_n = 222$  kips while sCheck gives  $\phi P_n = 221.966$  kips. They are practically identical.

## Example 12 – Round HSS Shape Beam (Shear)

[Ref 6, Example G.5]

Check the capacity of HSS16.000X0.375 column in shear.

$F_y = 50$  ksi,  $L = 32$  ft

**Steel Beam-Column Check**

Code:  ☒ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress:  ksi

**Geometry**

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

**Load Effects &**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	0	0	180	0	1	1	544.034	311.896	311.896	232.2	232.2	1.0000	1.0000	0.7752
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

## Result Comparison

The reference gives  $\phi V_{nx} = 232$  kips while sCheck gives  $\phi V_{nx} = 232.2$  kips. They are practically identical.

## Example 13 – Double Angle Shape Beam (Axial Compression)

[Ref 6, Example E.6]

Check the capacity of 2L5x3x1/4x3/4LLBB column in axial compression.

$F_y = 50$  ksi,  $L = 8$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_{ux} = L_{uy} = L_{uz} = 8$  ft.

Connector distance = 32 in = 2.66667 ft.

Steel Beam-Column Check

Code: AISC 360-22 (16th Edition) LRFD ☒ Use Direct Analysis Method

Section: 2L5x3x1/4x3/4LLBB AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 50 ksi

Geometry

Length: 8 ft Lb: 8 ft Cb: 1 Connector Distance (for double angles only): 2.66667 ft

Lux: 8 ft Luy: 8 ft Luz: 8 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	60	0	0	0	0	1	1	73.7865	17.2846	10.873	67.5	40.5	1.3102	1.5433	0.8132
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

## Result Comparison

The reference gives  $\phi P_n = 73.8$  kips while sCheck gives  $\phi P_n = 73.7865$  kips. Please note that  $L_{cy}/r_y$  is modified based on AISC Specification Section E6.

## Example 14 – Single Angle Shape Column (Axial Compression and Flexure)

[Ref 6, Example E.14B]

Check the capacity of L8X4X1/2 column in axial compression and flexure.

$F_y = 50$  ksi,  $L = 5$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_{ux} = L_{uy} = L_{uz} = 5$  ft.

Steel Beam-Column Check

Code: AISC 360-22 (16th Edition) LRFD ☐ Use Direct Analysis Method

Section: L8X4X1/2 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 50 ksi

Geometry

Length: 5 ft Lb: 5 ft Cb: 1 Connector Distance (for double angles only): 0 ft

Lux: 5 ft Luy: 5 ft Luz: 5 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	85.9	8.303	-8.798	0	0	1	1	168.786	31.2506	10.2375	108	54	1.0271	1.3335	1.6764
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

### Result Comparison

The reference gives  $\phi P_n = 168$  kips,  $\phi M_{nx}$  ( $\phi M_{nw}$ ) = 375 in-kips = 31.25 ft-kips,  $\phi M_{ny}$  ( $\phi M_{nz}$ ) = 123 in-kips = 10.25 ft-kips while sCheck gives  $\phi P_n = 168.786$  kips,  $\phi M_{nx}$  ( $\phi M_{nw}$ ) = 31.2506 ft-kips,  $\phi M_{ny}$  ( $\phi M_{nz}$ ) = 10.2375 ft-kips. They are practically identical. Please note that for a single angle, the moment capacities are given about the principal w-w and z-z axes and the input moments  $M_{ux}$  and  $M_{uy}$  are transformed in the principal axes before flexural-axial interaction ratio is checked. In a conservative approach, the program always uses the absolute value for each term in Eq. H2-1, thus we have different critical ratio between sCheck and the reference.

## Example 15 – W Shape Beam-Column Design – A Tutorial

[Ref 6, Example H.4]

Design a W8, W10 or W12 shape pinned beam-column that will resist the following conditions.

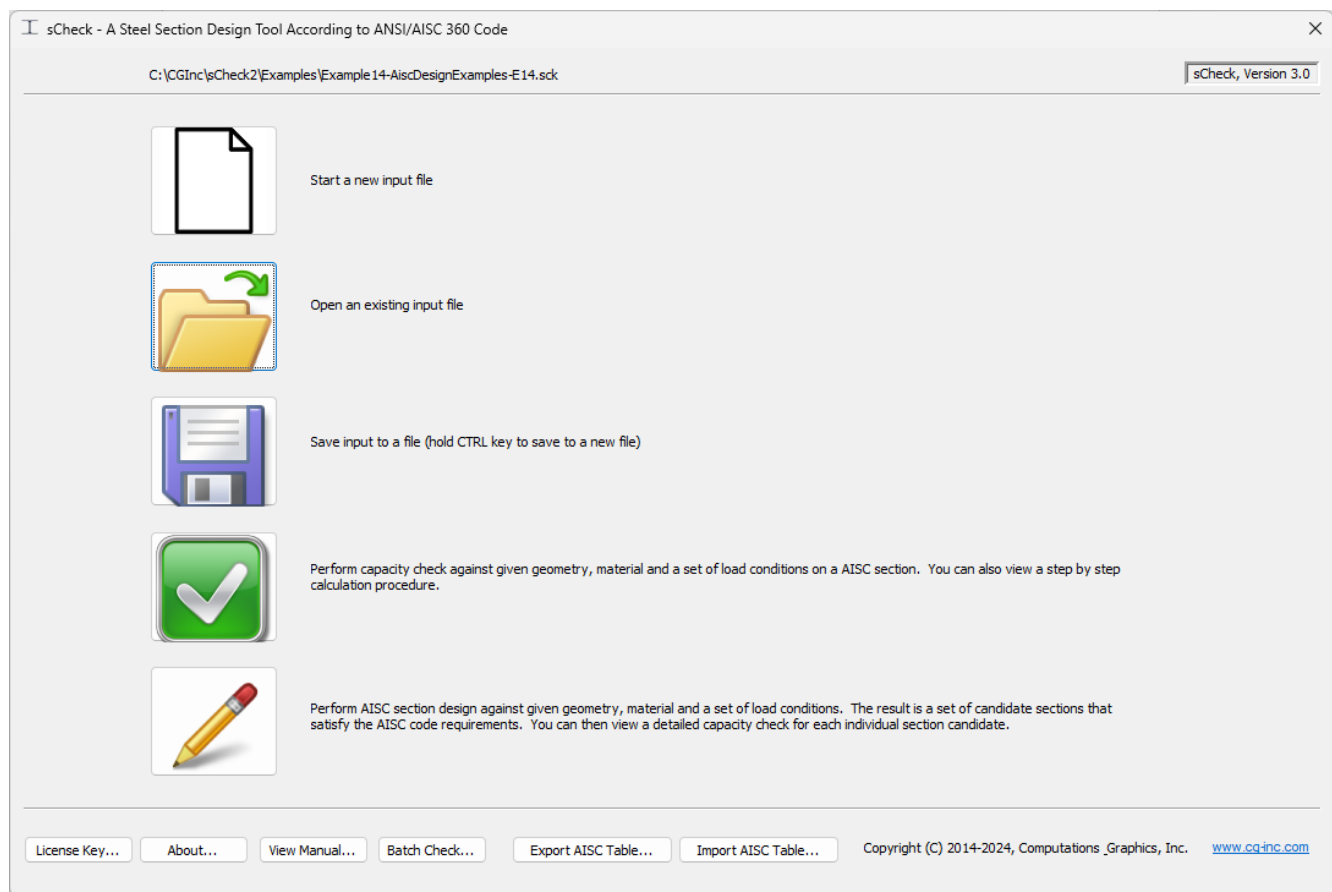
$F_y = 50$  ksi,  $L = 14$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_{ux} = L_{uy} = L_b = 14$  ft,  $C_b = 1.14$ .

$P_n = 30$  kips,  $M_{ux} = 90$  ft-kips,  $M_{uy} = 12$  ft-kips,  $C_{mx} = 1.0$ ,  $C_{my} = 1.0$ .

The required moments do not include second-order effects.

Step 1:

Click on the design button  from the sCheck main screen.



## Step 2:

Enter the geometry, load condition and design criteria on the “Steel Beam-Column Design” dialog as following and click on “Perform Design”. By default, 10 section candidates will be chosen by the program. The sections are ordered in terms of section weight by linear foot.

Steel Beam-Column Design

Code: AISC 360-22 (16th Edition) LRFD

Shape: W

Section Filter Criteria (Optional)

Section Prefixes (Comma delimited list, e.g. W12, W14): w8,w10,w12

Section Min Depth: 0 in

Section Max Depth: 0 in

Section Min Width: 0 in

Section Max Width: 0 in

☒ Use Direct Analysis Method

☒ Consider Moment Magnification

Maximum Number of Section Candidates: 10

Steel Yield Stress (Fy): 50 ksi

Loads:

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy
1	30	90	12	0	0	1	1
2							
3							
4							
5							
6							
7							
8							

Geometry

Length: 14 ft

Lux: 14 ft

Luy: 14 ft

Luz: 14 ft

Lb: 14 ft

Kx: 1

Ky: 1

Kz: 1

Cb: 1.14

Connector Distance (for double angles only): 0 ft

Section Candidates

	Section	Critical Ratio	Critical Load
1	W10x33	0.9871	1
2	W8x35	0.9874	1
3	W12x35	0.9897	1
4	W10x39	0.7908	1
5	W8x40	0.8525	1
6	W12x40	0.7154	1
7	W12x45	0.6250	1

Perform Design

Check Section...

OK

Close

### Step 3:

The first section candidate is W10x33, which is the one given by the reference. We can view the detailed check on a section candidate by first selecting the section candidate, then clicking on “Check Section” button on the “Steel Beam-Column Design” dialog above. The following is the “Steel Beam-Column Check” dialog. From here we are able to view very detailed calculation procedure by clicking on “Procedure in Word” or “Procedure in PDF”.

**Steel Beam-Column Check**

Code:  ☒ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress  ksi

**Geometry**

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

**Load Effects &**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	30	90	12	0	0	1	1	252.522	136.59	52.5	84.651	186.98	1.0221	1.1124	0.9871
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

## Chapter 6: Verification Examples – AISC 360-16 (15<sup>th</sup> edition) LRFD

### Example 1 – W Shape Beam (Flexure in Major Axis, $L_p < L_b < L_r$ )

[Ref 2, pp435]

Check the flexural capacity of W18x97 beam.

$F_y = 50$  ksi,  $L = 50$  ft,  $L_b = 25$  ft.  $C_b = 1.3$ .

Steel Beam-Column Check

Code: AISC 360-16 (15th Edition) LRFD ☒ Use Direct Analysis Method

Section: W18x97 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 50 ksi

Geometry

Length: 50 ft Lb: 25 ft Cb: 1.3 Connector Distance (for double angles only): 0 ft

Lux: 50 ft Luy: 50 ft Luz: 50 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	684	0	54.75	0	1	1	125.595	740.336	207.375	298.53	521.478	1.0000	1.0000	0.9239
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

### Result Comparison

The reference gives  $\phi M_{nx} = 740$  ft-kips while sCheck gives  $\phi M_{nx} = 740.336$  ft-kips. They are practically identical.



## Example 2 – W Shape Beam (Flexure in Major Axis, $L_b > L_r$ )

[Ref 2, pp440]

Check the flexural capacity of W33x118 beam.

$F_y = 50$  ksi,  $L = 28$  ft,  $L_b = 28$  ft,  $C_b = 2.0$ .

Steel Beam-Column Check

Code: AISC 360-16 (15th Edition) LRFD ☒ Use Direct Analysis Method

Section: W33x118 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 50 ksi

Geometry

Length: 28 ft Lb: 28 ft Cb: 2 Connector Distance (for double angles only): 0 ft

Lux: 28 ft Luy: 28 ft Luz: 28 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	1380	0	0	0	1	1	373.738	1388.77	192.375	488.565	459.54	1.0000	1.0000	0.9937
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

## Result Comparison

The reference gives  $\phi M_{nx} = 1390$  ft-kips while sCheck gives  $\phi M_{nx} = 1388.77$  ft-kips. They are practically identical.

### Example 3 – W Shape Beam (Flexure in Minor Axis)

[Ref 4, Example F.5]

Check the flexural capacity of W12x58 beam in minor axis.  $F_y = 50$  ksi,  $L = 15$  ft.

Steel Beam-Column Check

Code:  ☒ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress  ksi

Geometry

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	0	113	0	30	1	1	525.237	289.138	121.875	131.76	345.6	1.0000	1.0000	0.9272
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

### Result Comparison

The reference gives  $\phi M_{ny} = 122$  ft-kips while sCheck gives  $\phi M_{ny} = 121.875$  ft-kips. They are practically identical.

## Example 4 – W Shape Beam (Shear in Minor Axis)

[Ref 4, Example G.6]

Check the shear capacity of W21x48 beam in minor axis.

$F_y = 50$  ksi

Steel Beam-Column Check

Code: AISC 360-16 (15th Edition) LRFD ☒ Use Direct Analysis Method

Section: W21x48 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 50 ksi

Geometry

Length: 10 ft Lb: 10 ft Cb: 1 Connector Distance (for double angles only): 0 ft

Lux: 10 ft Luy: 10 ft Luz: 10 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	0	0	0	120	1	1	404.525	340.419	55.2265	216.3	189.011	1.0000	1.0000	0.6349
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

## Result Comparison

The reference gives  $\phi V_{ny} = 189$  ft-kips while sCheck gives  $\phi V_{ny} = 189.011$  ft-kips. They are practically identical.

## Example 5 – W Shape Column (Combined Axial Compression and Flexure)

[Ref 4, Example H.4]

Check the capacity of W10x33 column in combined axial compression and flexure.

$F_y = 50$  ksi,  $L = 14$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_{ux} = L_{uy} = L_b = 14$  ft,  $C_b = 1.14$ .

Steel Beam-Column Check

Code:  ☐ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress  ksi

Geometry

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	30	90	12	0	0	1	1	252.522	136.59	52.5	84.651	186.98	1.0176	1.0879	0.9786
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

### Result Comparison

The reference gives  $\phi P_n = 253$  kips,  $\phi M_{nx} = 137$  ft-kips,  $\phi M_{ny} = 52.5$  ft-kips while sCheck gives  $\phi P_n = 252.522$  kips,  $\phi M_{nx} = 136.59$  ft-kips,  $\phi M_{ny} = 52.5$  ft-kips. They are practically identical.

## Example 6 – W Shape Column (Combined Axial Tension and Flexure)

[Ref 4, Example H.3]

Check the capacity of W14x82 column in combined axial tension and flexure.

$F_y = 50$  ksi,  $L = 30$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_{ux} = L_{uy} = L_b = 30$  ft,  $C_b = 1.41$ .

Note: tension load must be entered as negative value.

Steel Beam-Column Check

Code: AISC 360-16 (15th Edition) LRFD ☒ Use Direct Analysis Method

Section: W14x82 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 50 ksi

Geometry

Length: 30 ft Lb: 30 ft Cb: 1.41 Connector Distance (for double angles only): 0 ft

Lux: 30 ft Luy: 30 ft Luz: 30 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	-174	192	67.6	0	0	1	1	1080	491.54	168	218.79	466.317	1.0000	1.0000	0.8735
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

### Result Comparison

The reference gives  $\phi P_n = 1080$  kips,  $\phi M_{nx} = 492$  ft-kips,  $\phi M_{ny} = 168$  ft-kips while sCheck gives  $\phi P_n = 1080$  kips,  $\phi M_{nx} = 491.54$  ft-kips,  $\phi M_{ny} = 168$  ft-kips. They are practically identical. Please note that absolute value of axial load should be used for axial-flexural interaction formula.

## Example 7 – C Shape Beam (Flexure and Shear)

[Ref 4, Example F.2-2A and G.2B]

Check the capacity of C15x33.9 column in flexure and shear.

$F_y = 36$  ksi,  $L = 25$  ft,  $L_b = 5$  ft,  $C_b = 1.0$ .

**Steel Beam-Column Check**

Code:  ☒ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress:  ksi

**Geometry**

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

**Load Effects &**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	108	0	105	0	1	1	20.3773	130.434	13.3488	116.64	85.9248	1.0000	1.0000	0.9002
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

### Result Comparison

The reference gives  $\phi M_{nx} = 130$  ft-kips,  $\phi V_{nx} = 117$  kips while sCheck gives  $\phi M_{nx} = 130.434$  ft-kips,  $\phi V_{nx} = 116.64$  kips. They are practically identical.

## Example 8 – WT Shape Column (Axial Compression)

[Ref 4, Example E.8]

Check the capacity of WT7x15 column in axial compression.

$F_y = 50$  ksi,  $L = 20$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_u = 20$  ft,  $C_b = 1.41$ .

**Steel Beam-Column Check**

Code: AISC 360-16 (15th Edition) LRFD ☒ Use Direct Analysis Method

Section: WT7x15 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 50 ksi

**Geometry**

Length: 20 ft Lb: 20 ft Cb: 1 Connector Distance (for double angles only): 0 ft

Lux: 20 ft Luy: 20 ft Luz: 20 ft

Kx: 1 Ky: 1 Kz: 1

**Load Effects &**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	36	0	0	0	0	1	1	36.6049	18.3176	16.8375	50.4468	69.9583	1.9107	13.3382	0.9835
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

## Result Comparison

The reference gives  $\phi P_n = 36.6$  kips while sCheck gives  $\phi P_n = 36.6049$  kips. They are practically identical.

## Example 9 – HSS Shape Column (Axial Compression)

[Ref 4, Example E.10]

Check the capacity of HSS12x8x3/16 column in axial compression.

$F_y = 50$  ksi,  $L = 30$  ft,  $K_x = K_y = 0.8$ ,  $K_z = 1.0$ ,  $L_u = 30$  ft,  $C_b = 1.0$ .

**Steel Beam-Column Check**

Code:  ☒ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress  ksi

**Geometry**

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

**Load Effects &**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	154	0	0	0	0	1	1	151.33	78.7949	48.2464	96.8465	70.3009	1.6674	3.8498	1.0176
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

## Result Comparison

The reference gives  $\phi P_n = 151$  kips while sCheck gives  $\phi P_n = 151.33$  kips. They are practically identical. The reference gives  $\phi P_n = 177$  kips while sCheck gives  $\phi P_n = 177.832$  kips for  $L_c = 18$  ft. The reference gives  $\phi P_n = 74.2$  kips while sCheck gives  $\phi P_n = 74.3864$  kips for  $L_c = 40$  ft.



## Example 10 – Rectangular HSS Shape Beam (Flexure)

[Ref 4, Example F.8B]

Check the capacity of HSS8x8x3/16 column in flexure.

$F_y = 50$  ksi,  $L = 21$  ft,  $L_b = 21$  ft,  $C_b = 1.0$ .

Steel Beam-Column Check

Code: AISC 360-16 (15th Edition) LRFD ☒ Use Direct Analysis Method

Section: HSS8x8x3/16 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 50 ksi

Geometry

Length: 21 ft Lb: 21 ft Cb: 1 Connector Distance (for double angles only): 0 ft

Lux: 21 ft Luy: 21 ft Luz: 21 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	41.3	0	0	0	1	1	151.31	45.2811	45.2811	70.3009	70.3009	1.0000	1.0000	0.9121
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

### Result Comparison

The reference gives  $\phi M_{nx} = 45.4$  ft-kips while sCheck gives  $\phi M_{nx} = 45.2811$  ft-kips. They are practically identical.

## Example 11 – Pipe Shape Column (Compression)

[Ref 4, Example E.11]

Check the capacity of Pipe10STD column in flexure.

$F_y = 35 \text{ ksi}$ ,  $L = 30 \text{ ft}$

Steel Beam-Column Check

Code:  ☒ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress  ksi

Geometry

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	0	0	0	0	1	1	221.966	96.8625	96.8625	108.675	108.675	1.0000	1.0000	0.0000
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

### Result Comparison

The reference gives  $\phi P_n = 222 \text{ kips}$  while sCheck gives  $\phi P_n = 221.966 \text{ kips}$ . They are practically identical.

## Example 12 – Round HSS Shape Beam (Shear)

[Ref 4, Example G.5]

Check the capacity of HSS16.000X0.375 column in shear.

$F_y = 46$  ksi,  $L = 32$  ft

**Steel Beam-Column Check**

Code:  ☒ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress:  ksi

**Geometry**

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

**Load Effects &**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	0	0	180	0	1	1	514.829	292.186	292.186	213.624	213.624	1.0000	1.0000	0.8426
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

### Result Comparison

The reference gives  $\phi V_{nx} = 213$  kips while sCheck gives  $\phi V_{nx} = 213.624$  kips. They are practically identical.

## Example 13 – Double Angle Shape Beam (Axial Compression)

[Ref 4, Example E.6]

Check the capacity of 2L5x3x1/4x3/4LLBB column in axial compression.

$F_y = 36$  ksi,  $L = 8$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_{ux} = L_{uy} = L_{uz} = 8$  ft.

Connector distance = 32 in = 2.66667 ft.

Steel Beam-Column Check

Code: AISC 360-16 (15th Edition) LRFD ☒ Use Direct Analysis Method

Section: 2L5x3x1/4x3/4LLBB AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 36 ksi

Geometry

Length: 8 ft Lb: 8 ft Cb: 1 Connector Distance (for double angles only): 2.66667 ft

Lux: 8 ft Luy: 8 ft Luz: 8 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	60	0	0	0	0	1	1	67.5394	12.7086	8.42908	48.6	29.16	1.3102	1.5433	0.8884
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

## Result Comparison

The reference gives  $\phi P_n = 67.5$  kips while sCheck gives  $\phi P_n = 67.5394$  kips. Please note that  $L_{cy}/r_y$  is modified based on AISC Specification Section E6.

## Example 14 – Single Angle Shape Column (Axial Compression and Flexure)

[Ref 4, Example E.14]

Check the capacity of L8X4X1/2 column in axial compression and flexure.

$F_y = 36$  ksi,  $L = 5$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_{ux} = L_{uy} = L_{uz} = 5$  ft.

Steel Beam-Column Check

Code:  ☐ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress  ksi

Geometry

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	67.7	6.544	-6.934	0	0	1	1	140.612	25.3584	7.371	77.76	38.88	1.0212	1.2455	1.6560
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

### Result Comparison

The reference gives  $\phi P_n = 141$  kips,  $\phi M_{nx}$  ( $\phi M_{nw}$ ) = 304 in-kips = 25.33 ft-kips,  $\phi M_{ny}$  ( $\phi M_{nz}$ ) = 88.5 in-kips = 7.375 ft-kips while sCheck gives  $\phi P_n = 140.612$  kips,  $\phi M_{nx}$  ( $\phi M_{nw}$ ) = 25.3584 ft-kips,  $\phi M_{ny}$  ( $\phi M_{nz}$ ) = 7.371 ft-kips. They are practically identical. Please note that for a single angle, the moment capacities are given about the principal w-w and z-z axes and the input moments  $M_{ux}$  and  $M_{uy}$  are transformed in the principal axes before flexural-axial interaction ratio is checked. In a conservative approach, the program always uses the absolute value for each term in Eq. H2-1, thus we have different critical ratio between sCheck and the reference.

## Example 15 – W Shape Beam-Column Design – A Tutorial

[Ref 4, Example H.4]

Design a W8, W10 or W12 shape pinned beam-column that will resist the following conditions.

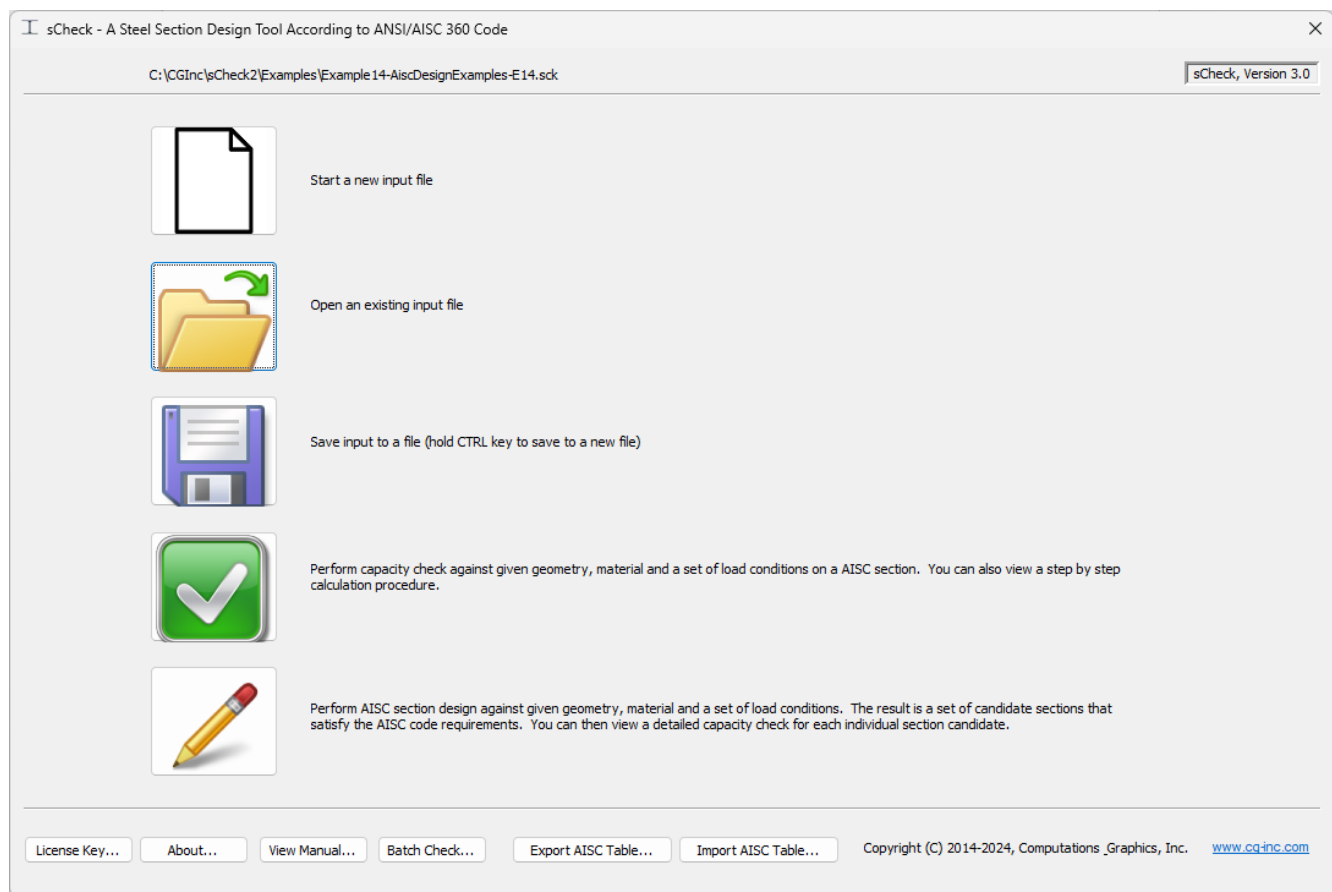
$F_y = 50$  ksi,  $L = 14$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_{ux} = L_{uy} = L_b = 14$  ft,  $C_b = 1.14$ .

$P_n = 30$  kips,  $M_{ux} = 90$  ft-kips,  $M_{uy} = 12$  ft-kips,  $C_{mx} = 1.0$ ,  $C_{my} = 1.0$ .

The required moments do not include second-order effects.

Step 1:

Click on the design button  from the sCheck main screen.



## Step 2:

Enter the geometry, load condition and design criteria on the “Steel Beam-Column Design” dialog as following and click on “Perform Design”. By default, 10 section candidates will be chosen by the program. The sections are ordered in terms of section weight by linear foot.

Steel Beam-Column Design

Code: AISC 360-16 (15th Edition) LRFD

Shape: W

Section Filter Criteria (Optional)

Section Prefixes (Comma delimited list, e.g. W12, W14): w8,w10,w12

Section Min Depth: 0 in

Section Max Depth: 0 in

Section Min Width: 0 in

Section Max Width: 0 in

☒ Use Direct Analysis Method

☒ Consider Moment Magnification

Maximum Number of Section Candidates: 10

Steel Yield Stress (Fy): 50 ksi

Loads:

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy
1	30	90	12	0	0	1	1
2							
3							
4							
5							
6							
7							
8							

Geometry

Length: 14 ft

Lux: 14 ft

Luy: 14 ft

Luz: 14 ft

Lb: 14 ft

Kx: 1

Ky: 1

Kz: 1

Cb: 1.14

Connector Distance (for double angles only): 0 ft

Section Candidates

	Section	Critical Ratio	Critical Load
1	W10x33	0.9871	1
2	W8x35	0.9874	1
3	W12x35	0.9897	1
4	W10x39	0.7908	1
5	W8x40	0.8525	1
6	W12x40	0.7154	1
7	W12x45	0.6250	1

Perform Design

Check Section...

OK

Close

### Step 3:

The first section candidate is W10x33, which is the one given by the reference. We can view the detailed check on a section candidate by first selecting the section candidate, then clicking on “Check Section” button on the “Steel Beam-Column Design” dialog above. The following is the “Steel Beam-Column Check” dialog. From here we are able to view very detailed calculation procedure by clicking on “Procedure in Word” or “Procedure in PDF”.

**Steel Beam-Column Check**

Code:  ☒ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress  ksi

**Geometry**

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

**Load Effects &**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	30	90	12	0	0	1	1	252.522	136.59	52.5	84.651	186.98	1.0221	1.1124	0.9871
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															



## Chapter 7: Verification Examples – AISC 360-10 (14<sup>th</sup> edition) LRFD

### Example 1 – W Shape Beam (Flexure in Major Axis, $L_p < L_b < L_r$ )

[Ref 2, pp435]

Check the flexural capacity of W18x97 beam.

$F_y = 50$  ksi,  $L = 50$  ft,  $L_b = 25$  ft.  $C_b = 1.3$ .

Steel Beam-Column Check

Code: AISC 360-10 (14th Edition) LRFD ☒ Use Direct Analysis Method

Section: W18x97 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress: 50 ksi

Geometry

Length: 50 ft Lb: 25 ft Cb: 1.3 Connector Distance (for double angles only): 0 ft

Lux: 50 ft Luy: 50 ft Luz: 50 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects & Saved to this PC

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	684	0	54.75	0	1	1	125.595	740.336	207.375	298.53	521.478	1.0000	1.0000	0.9239
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

### Result Comparison

The reference gives  $\phi M_{nx} = 740$  ft-kips while sCheck gives  $\phi M_{nx} = 740.336$  ft-kips. They are practically identical.

## Example 2 – W Shape Beam (Flexure in Major Axis, $L_b > L_r$ )

[Ref 2, pp440]

Check the flexural capacity of W33x118 beam.

$F_y = 50$  ksi,  $L = 28$  ft,  $L_b = 28$  ft,  $C_b = 2.0$ .

Steel Beam-Column Check

Code: AISC 360-10 (14th Edition) LRFD ☒ Use Direct Analysis Method

Section: W33x118 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 50 ksi

Geometry

Length: 28 ft Lb: 28 ft Cb: 2 Connector Distance (for double angles only): 0 ft

Lux: 28 ft Luy: 28 ft Luz: 28 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	1380	0	0	0	1	1	373.738	1388.77	192.375	488.565	459.54	1.0000	1.0000	0.9937
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

## Result Comparison

The reference gives  $\phi M_{nx} = 1390$  ft-kips while sCheck gives  $\phi M_{nx} = 1388.77$  ft-kips. They are practically identical.

### Example 3 – W Shape Beam (Flexure in Minor Axis)

[Ref 3, Example F.5]

Check the flexural capacity of W12x58 beam in minor axis.  $F_y = 50$  ksi,  $L = 15$  ft.

Steel Beam-Column Check

Code:  ☒ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress  ksi

Geometry

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	0	113	0	30	1	1	525.237	289.138	121.875	131.76	345.6	1.0000	1.0000	0.9272
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

### Result Comparison

The reference gives  $\phi M_{ny} = 122$  ft-kips while sCheck gives  $\phi M_{ny} = 121.875$  ft-kips. They are practically identical.

## Example 4 – W Shape Beam (Shear in Minor Axis)

[Ref 3, Example G.6]

Check the shear capacity of W21x48 beam in minor axis.

$F_y = 50$  ksi

Steel Beam-Column Check

Code: AISC 360-10 (14th Edition) LRFD ☒ Use Direct Analysis Method

Section: W21x48 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 50 ksi

Geometry

Length: 10 ft Lb: 10 ft Cb: 1 Connector Distance (for double angles only): 0 ft

Lux: 10 ft Luy: 10 ft Luz: 10 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	0	0	0	120	1	1	402.764	340.419	55.2265	216.3	189.011	1.0000	1.0000	0.6349
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

## Result Comparison

The reference gives  $\phi V_{ny} = 189$  ft-kips while sCheck gives  $\phi V_{ny} = 189.011$  ft-kips. They are practically identical.

## Example 5 – W Shape Column (Combined Axial Compression and Flexure)

[Ref 3, Example H.4]

Check the capacity of W10x33 column in combined axial compression and flexure.

$F_y = 50$  ksi,  $L = 14$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_{ux} = L_{uy} = L_b = 14$  ft,  $C_b = 1.14$ .

**Steel Beam-Column Check**

Code:  ☐ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress  ksi

**Geometry**

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

**Load Effects &**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	30	90	12	0	0	1	1	252.522	136.59	52.5	84.651	186.98	1.0176	1.0879	0.9786
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

### Result Comparison

The reference gives  $\phi P_n = 253$  kips,  $\phi M_{nx} = 137$  ft-kips,  $\phi M_{ny} = 52.5$  ft-kips while sCheck gives  $\phi P_n = 252.522$  kips,  $\phi M_{nx} = 136.59$  ft-kips,  $\phi M_{ny} = 52.5$  ft-kips. They are practically identical.

## Example 6 – W Shape Column (Combined Axial Tension and Flexure)

[Ref 3, Example H.3]

Check the capacity of W14x82 column in combined axial tension and flexure.

$F_y = 50$  ksi,  $L = 30$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_{ux} = L_{uy} = L_b = 30$  ft,  $C_b = 1.41$ .

Note: tension load must be entered as negative value.

Steel Beam-Column Check

Code: AISC 360-10 (14th Edition) LRFD ☒ Use Direct Analysis Method

Section: W14x82 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 50 ksi

Geometry

Length: 30 ft Lb: 30 ft Cb: 1.41 Connector Distance (for double angles only): 0 ft

Lux: 30 ft Luy: 30 ft Luz: 30 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	-174	192	67.6	0	0	1	1	1080	491.54	168	218.79	466.317	1.0000	1.0000	0.8735
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

### Result Comparison

The reference gives  $\phi P_n = 1080$  kips,  $\phi M_{nx} = 492$  ft-kips,  $\phi M_{ny} = 168$  ft-kips while sCheck gives  $\phi P_n = 1080$  kips,  $\phi M_{nx} = 491.54$  ft-kips,  $\phi M_{ny} = 168$  ft-kips. They are practically identical. Please note that absolute value of axial load should be used for axial-flexural interaction formula.

## Example 7 – C Shape Beam (Flexure and Shear)

[Ref 3, Example F.2-2A and G.2B]

Check the capacity of C15x33.9 column in flexure and shear.

$F_y = 36$  ksi,  $L = 25$  ft,  $L_b = 5$  ft,  $C_b = 1.0$ .

**Steel Beam-Column Check**

Code:  ☒ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress:  ksi

**Geometry**

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

**Load Effects &**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	108	0	105	0	1	1	20.3773	130.434	13.3488	116.64	85.9248	1.0000	1.0000	0.9002
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

### Result Comparison

The reference gives  $\phi M_{nx} = 130$  ft-kips,  $\phi V_{nx} = 117$  kips while sCheck gives  $\phi M_{nx} = 130.434$  ft-kips,  $\phi V_{nx} = 116.64$  kips. They are practically identical.

## Example 8 – WT Shape Column (Axial Compression)

[Ref 3, Example E.8]

Check the capacity of WT7x15 column in axial compression.

$F_y = 50$  ksi,  $L = 20$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_u = 20$  ft,  $C_b = 1.41$ .

**Steel Beam-Column Check**

Code:  ☒ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress:  ksi

**Geometry**

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

**Load Effects &**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	36	0	0	0	0	1	1	36.6049	21.3	16.8375	50.4468	69.9583	1.9107	13.3382	0.9835
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

### Result Comparison

The reference gives  $\phi P_n = 36.6$  kips while sCheck gives  $\phi P_n = 36.6049$  kips. They are practically identical.



## Example 9 – HSS Shape Column (Axial Compression)

[Ref 3, Example E.10]

Check the capacity of HSS12x8x3/16 column in axial compression.

$F_y = 46$  ksi,  $L = 30$  ft,  $K_x = K_y = 0.8$ ,  $K_z = 1.0$ ,  $L_u = 30$  ft,  $C_b = 1.0$ .

**Steel Beam-Column Check**

Code:  ☒ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress:  ksi

**Geometry**

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

**Load Effects &**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	154	0	0	0	0	1	1	142.063	73.846	45.5152	92.8919	64.6422	1.6624	3.8012	1.0840
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

### Result Comparison

The reference gives  $\phi P_n = 142$  kips while sCheck gives  $\phi P_n = 142.063$  kips. They are practically identical. Please be advised that sCheck takes a conservative initial assumption ( $f = F_y$ ) in applying AISC specification Eq. E7-18.

### Example 10 – Rectangular HSS Shape Beam (Flexure)

[Ref 3, Example F.8B]  
Check the capacity of HSS8x8x3/16 column in flexure.  
 $F_y = 46 \text{ ksi}$ ,  $L = 21 \text{ ft}$ ,  $L_b = 21 \text{ ft}$ ,  $C_b = 1.0$ .

Steel Beam-Column Check

Code: AISC 360-10 (14th Edition) LRFD

☒ Use Direct Analysis Method

Section: HSS8x8x3/16

AISC Table...

☒ Consider Moment Magnification

Steel Yield Stress 46 ksi

Geometry

Length: 21 ft

Lb: 21 ft

Cb: 1

Connector Distance (for double angles only): 0 ft

Lux: 21 ft

Luy: 21 ft

Luz: 21 ft

Kx: 1

Ky: 1

Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	41.3	0	0	0	1	1	134.586	42.5486	42.5486	64.6422	64.6422	1.0000	1.0000	0.9707
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute

Procedure in Word

Procedure in PDF

OK

Close

### Result Comparison

The reference gives  $\phi M_{nx} = 42.5 \text{ ft-kips}$  while sCheck gives  $\phi M_{nx} = 42.5486 \text{ ft-kips}$ . They are practically identical.

## Example 11 – Pipe Shape Column (Compression)

[Ref 3, Example E.11]

Check the capacity of Pipe10STD column in flexure.

$F_y = 35 \text{ ksi}$ ,  $L = 30 \text{ ft}$

Steel Beam-Column Check

Code:  ☒ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress  ksi

Geometry

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	0	0	0	0	1	1	221.966	96.8625	96.8625	108.675	108.675	1.0000	1.0000	0.0000
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

## Result Comparison

The reference gives  $\phi P_n = 222 \text{ kips}$  while sCheck gives  $\phi P_n = 221.966 \text{ kips}$ . They are practically identical.

## Example 12 – Round HSS Shape Beam (Shear)

[Ref 3, Example G.5]

Check the capacity of HSS16X0.375 column in shear.

$F_y = 42$  ksi,  $L = 32$  ft

Steel Beam-Column Check

Code: AISC 360-10 (14th Edition) LRFD ☒ Use Direct Analysis Method

Section: HSS16.00X0.375 AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 42 ksi

Geometry

Length: 32 ft Lb: 32 ft Cb: 1 Connector Distance (for double angles only): 0 ft

Lux: 32 ft Luy: 32 ft Luz: 32 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	0	0	0	180	0	1	1	483.508	269.325	269.325	195.048	195.048	1.0000	1.0000	0.9228
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

## Result Comparison

The reference gives  $\phi V_{nx} = 195$  kips while sCheck gives  $\phi V_{nx} = 195.048$  kips. They are practically identical.

## Example 13 – Double Angle Shape Beam (Axial Compression)

[Ref 3, Example E.6]

Check the capacity of 2L5x3x1/4x3/4LLBB column in axial compression.

$F_y = 36$  ksi,  $L = 8$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_{ux} = L_{uy} = L_{uz} = 8$  ft.

Connector distance = 32 in = 2.66667 ft.

Steel Beam-Column Check

Code: AISC 360-10 (14th Edition) LRFD ☒ Use Direct Analysis Method

Section: 2L5x3x1/4x3/4LLBB AISC Table... ☒ Consider Moment Magnification Steel Yield Stress 36 ksi

Geometry

Length: 8 ft Lb: 8 ft Cb: 1 Connector Distance (for double angles only): 2.66667 ft

Lux: 8 ft Luy: 8 ft Luz: 8 ft

Kx: 1 Ky: 1 Kz: 1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	60	0	0	0	0	1	1	64.2975	13.0464	8.42908	48.6	29.16	1.3102	1.5433	0.9332
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Compute Procedure in Word Procedure in PDF OK Close

## Result Comparison

The reference gives  $\phi P_n = 64.3$  kips while sCheck gives  $\phi P_n = 64.2975$  kips. They are practically identical.

## Example 14 – Single Angle Shape Column (Axial Compression and Flexure)

[Ref 3, Example E.14]

Check the capacity of L8X4X7/16 column in axial compression and flexure.

$F_y = 36$  ksi,  $L = 5$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_{ux} = L_{uy} = L_{uz} = 5$  ft.

Steel Beam-Column Check

Code:  ☐ Use Direct Analysis Method

Section:   ☒ Consider Moment Magnification Steel Yield Stress  ksi

Geometry

Length:  ft Lb:  ft Cb:  Connector Distance (for double angles only):  ft

Lux:  ft Luy:  ft Luz:  ft

Kx:  Ky:  Kz:

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	62.9	0	0	0	0	1	1	113.679	20.762	6.5205	68.1178	34.0589	1.0222	1.2595	0.5533
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

### Result Comparison

The reference gives  $\phi P_n = 113$  kips,  $\phi M_{nx}$  ( $\phi M_{nw}$ ) = 248 in-kips = 20.67 ft-kips,  $\phi M_{ny}$  ( $\phi M_{nz}$ ) = 78.3 in-kips = 6.525 ft-kips while sCheck gives  $\phi P_n = 113.679$  kips,  $\phi M_{nx}$  ( $\phi M_{nw}$ ) = 20.762 ft-kips,  $\phi M_{ny}$  ( $\phi M_{nz}$ ) = 6.5205 ft-kips. They are practically identical. Please note that for a single angle, the moment capacities are given about the principal w-w and z-z axes and the input moments  $M_{ux}$  and  $M_{uy}$  are transformed in the principal axes before flexural-axial interaction ratio is checked. In a conservative approach, the program always uses the absolute value for each term in Eq. H2-1, thus we have different critical ratio between sCheck and the reference.

## Example 15 – W Shape Beam-Column Design – A Tutorial

[Ref 3, Example H.4]

Design a W8, W10 or W12 shape pinned beam-column that will resist the following conditions.

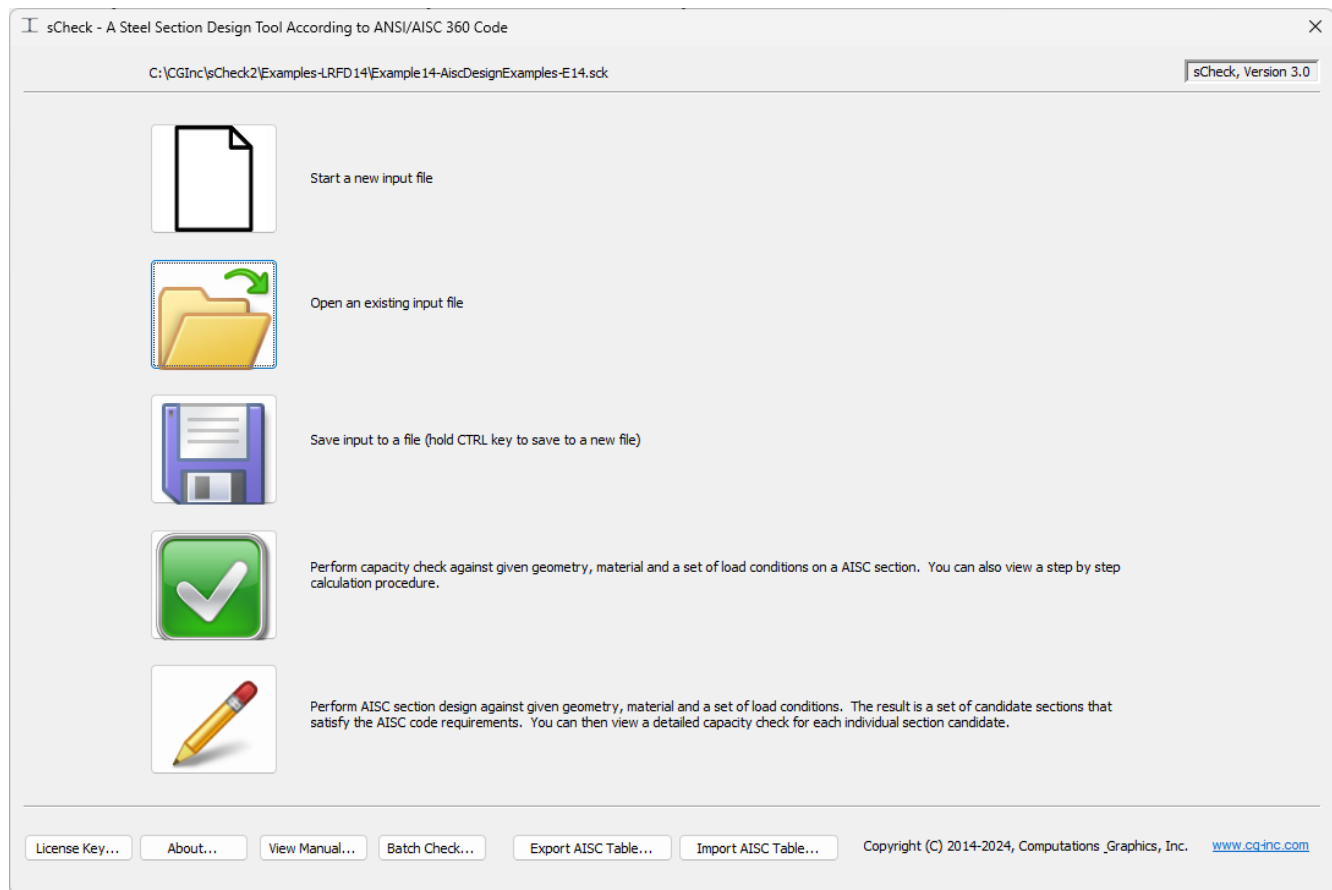
$F_y = 50$  ksi,  $L = 14$  ft,  $K_x = K_y = K_z = 1.0$ ,  $L_{ux} = L_{uy} = L_b = 14$  ft,  $C_b = 1.14$ .

$P_n = 30$  kips,  $M_{ux} = 90$  ft-kips,  $M_{uy} = 12$  ft-kips,  $C_{mx} = 1.0$ ,  $C_{my} = 1.0$ .

The required moments do not include second-order effects.

Step 1:

Click on the design button  from the sCheck main screen.



## Step 2:

Enter the geometry, load condition and design criteria on the “Steel Beam-Column Design” dialog as following and click on “Perform Design”. By default, 10 section candidates will be chosen by the program. The sections are ordered in terms of section weight by linear foot.

**Steel Beam-Column Design**

Code: AISC 360-10 (14th Edition) LRFD

Shape: W

Section Filter Criteria (Optional)

Section Prefixes (Comma delimited list, e.g. W12, W14): w8,w10,w12

Section Min Depth: 0 in Section Max Depth: 0 in

Section Min Width: 0 in Section Max Width: 0 in

☒ Use Direct Analysis Method

☒ Consider Moment Magnification

Maximum Number of Section Candidates: 10

Steel Yield Stress (Fy): 50 ksi

**Loads:**

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy
1	30	90	12	0	0	1	1
2							
3							
4							
5							
6							
7							
8							

**Geometry**

Length: 14 ft

Lxx: 14 ft Kx: 1

Lyy: 14 ft Ky: 1

Lzz: 14 ft Kz: 1

Lb: 14 ft Cb: 1.14

Connector Distance (for double angles only) 0 ft

**Section Candidates**

	Section	Critical Ratio	Critical Load
1	W10x33	0.9871	1
2	W8x35	0.9874	1
3	W12x35	0.9900	1
4	W10x39	0.7908	1
5	W8x40	0.8525	1
6	W12x40	0.7154	1
7	W12x45	0.6250	1

**Perform Design**

Check Section...

OK

Close

## Step 3:

The first section candidate is W10x33, which is the one given by the reference. We can view the detailed check on a section candidate by first selecting the section candidate, then clicking on “Check Section” button on the “Steel Beam-Column Design” dialog above. The following is the “Steel Beam-Column Check” dialog. From here we are able to view very detailed calculation procedure by clicking on “Procedure in Word” or “Procedure in PDF”.



Steel Beam-Column Check

Code:
AISC 360-10 (14th Edition) LRFD
☒ Use Direct Analysis Method

Section:
W10X33
AISC Table...
☒ Consider Moment Magnification
Steel Yield Stress
50
ksi

Geometry

Length:
14
ft
Lb:
14
ft
Cb:
1.14
Connector Distance (for double angles only):
0
ft

Lux:
14
ft
Luy:
14
ft
Luz:
14
ft

Kx:
1
Ky:
1
Kz:
1

Load Effects &

	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical Ratio
1	30	90	12	0	0	1	1	252.522	136.59	52.5	84.651	186.98	1.0221	1.1124	0.9871
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

## **Chapter 8: Sample sCheck Detailed Report**

*The following lists an example of detailed calculation procedures in Word format that is automatically generated by sCheck.*

## General Info

File Name	C:\CGInc\sCheck3\Examples-LRFD16\Example15-AiscDesignExamples-H4.sck
Design Code	AISC 360-22 (16th edition) LRFD
Using Direct Analysis Method	Yes
Consider Multiplier B1 for P-delta Effect	Yes
Date & Time	11/26/2023 18:39

## Section Property - W10X33

Property	Value	Unit	Property	Value	Unit	Property	Value	Unit
A = Ag	9.71	in <sup>2</sup>	bf	7.96	in	tf	0.435	in
tw	0.29	in	d	9.73	in	h / tw	27.1	
Cw	791	in <sup>6</sup>	h0	9.3	in	rts	2.2	in
Zx	38.8	in <sup>3</sup>	Sx	35	in <sup>3</sup>	Ix	171	in <sup>4</sup>
rx	4.19	in	Zy	14	in <sup>3</sup>	Sy	9.2	in <sup>3</sup>
Iy	36.6	in <sup>4</sup>	ry	1.94	in	J	0.583	in <sup>4</sup>

## Design Input

Input	Value	Unit	Input	Value	Unit	Input	Value	Unit
Pu = Pr	30	kips	Mux = Mxr	90	kip-ft	Muy = Myr	12	kip-ft
Cmx	1		Cmy	1		Vux	0	kips
Vuy	0	kips	Fy	50	ksi	Cb	1.14	
Lb	14	ft	Kx	1		Ky	1	
Kz	1		Lx	14	ft	Ly	14	ft
Lz	14	ft						

\* Lcx = Kx \* Lx; Lcy = Ky \* Ly; Lcz = Kz \* Lz

## Axial Capacity Calculation

Step	Equation	Value	Note
Checking flange slenderness			
	$b = bf / 2$	3.98 in	
	$b / tf$	9.1494	
	$\lambda_r = 0.56 \sqrt{\frac{E}{F_y}}$	13.487	
The section has non-slender flange element			
Checking web slenderness			
	$b / t = h / tw$	27.1	
	$\lambda_r = 1.49 \sqrt{\frac{E}{F_y}}$	35.884	

The section has non-slender web				
Compressive strength to account for flexural buckling				
		$\frac{K_x L_x}{r_x}$	40.095	
		$\frac{K_y L_y}{r_y}$	86.598	
		$\frac{KL}{r} = \max \left( \frac{K_x L_x}{r_x}, \frac{K_y L_y}{r_y} \right)$	86.598	
		$F_e = \frac{\pi^2 E}{\left( \frac{KL}{r} \right)^2}$	38.167 ksi	Eq.E3-4
		$4.71 \sqrt{\frac{E}{F_y}}$	113.43	
		$\frac{KL}{r} \leq 4.71 \sqrt{\frac{E}{F_y}}$		
		$F_n = \left( 0.658^{\frac{F_y}{F_e}} \right) F_y$	28.896 ksi	Eq.E3-2
		$P_n = F_n A_g$	280.58 kips	Eq.E3-1
Compressive strength to account for torsional and flexural-torsional buckling				
		$F_e = \left( \frac{\pi^2 E C_w}{L_{cz}^2} + GJ \right) \frac{1}{I_x + I_y}$	70.092 ksi	Eq.E4-2
		$\frac{F_y}{F_e}$	0.71335	
		$\frac{F_y}{F_e} \leq 2.25$		
		$F_n = \left( 0.658^{\frac{F_y}{F_e}} \right) F_y$	37.094 ksi	Eq.E3-2
		$P_n = F_n A_g$	360.18 kips	Eq.E4-1
		Flexural buckling controls: $P_n$	280.58 kips	
		$\phi_c P_n$	252.52 kips	

## Moment Magnification Calculation

Step	Equation	Value	Note
Stiffness reduction parameter			

	$\alpha = 1.00(\text{LRFD})$	1	
	$P_r / P_{ns} = P_r / (F_y * A_e)$	0.061792	
	$\alpha P_r / P_{ns} \leq 0.5$		
	$\tau_b = 1.0$	1	Eq.C2-2a
Moment magnifier B1 for P-delta effects in local x direction			
	$EI^* = 0.8\tau_b EI$	3.9672e+06 ksi	
	$P_{e1} = \frac{\pi^2 EI^*}{(K_1 L)^2}$	1387.3 kips	Eq.A-8-5
	$B_1 = \frac{C_m}{1 - \alpha P_r / P_{e1}} \geq 1$	1.0221	Eq.A-8-3
	Magnified Mux = Mux * B1	91.989 kip-ft	
Moment magnifier B1 for P-delta effects in local y direction			
	$EI^* = 0.8\tau_b EI$	8.4912e+05 ksi	
	$P_{e1} = \frac{\pi^2 EI^*}{(K_1 L)^2}$	296.93 kips	Eq.A-8-5
	$B_1 = \frac{C_m}{1 - \alpha P_r / P_{e1}} \geq 1$	1.1124	Eq.A-8-3
	Magnified Muy = Muy * B1	13.349 kip-ft	
Mrx = Mux; Mry = Muy			

## Major Flexure Capacity Calculation

Step	Equation	Value	Note
Web compactness:			
	$\lambda = \frac{h_c}{t_w}$	27.1	
	$\lambda_{pw} = 3.76 \sqrt{\frac{E}{F_y}}$	90.553	
	$\lambda_{rw} = 5.70 \sqrt{\frac{E}{F_y}}$	137.27	
Web is compact			
Flange compactness:			

	$\lambda = \frac{b_f}{2t_f}$	9.1494	
	$\lambda_{pf} = 0.38\sqrt{\frac{E}{F_y}}$	9.1516	
	$\lambda_{rf} = 1.0\sqrt{\frac{E}{F_y}}$	24.083	
Flange is compact			
Mnx to account for yielding			
	$M_n = M_p = F_y Z_x$	161.67 kip-ft	Eq.F2-1
Mnx to account for flange local buckling			
	$\lambda < \lambda_{pf}$		
	$M_n = M_p$	161.67 kip-ft	
Mnx to account for lateral-torsional buckling			
	$L_p = 1.76r_y\sqrt{\frac{E}{F_y}}$	6.8525 ft	Eq.F2-5
	For I section, c	1	
	$L_r = 1.95r_{ts}\frac{E}{0.7F_y}\sqrt{\frac{Jc}{S_x h_o} + \sqrt{\left(\frac{Jc}{S_x h_o}\right)^2 + 6.76\left(\frac{0.7F_y}{E}\right)^2}}$	21.776 ft	Eq.F2-6
	$M_n = M_p = F_y Z_x$	161.67 kip-ft	Eq.F2-1
Since $L_p < L_b < L_r$			
	$M_n = C_b \left[ M_p - (M_p - 0.7F_y S_x) \left( \frac{L_b - L_p}{L_r - L_p} \right) \right] \leq M_p$	151.77 kip-ft	Eq.F2-2
	Controlling nominal flexural strength Mnx	151.77 kip-ft	
	$M_{cx} = \phi_b M_{nx}$	136.59 kip-ft	

## Minor Flexure Capacity Calculation

Step	Equation	Value	Note
Mny to account for yielding			
	$F_y * Z_y$	58.333 kip-ft	

	$F_y * S_y$	38.333 kip-ft	
	$M_n = M_p = F_y Z_y \leq 1.6 F_y S_y$	58.333 kip-ft	Eq.F6-1
Mny to account for lateral-torsional buckling			
	$\lambda < \lambda_{pf}$		
	$M_n = M_p$	58.333 kip-ft	
	Controlling nominal flexural strength Mny	58.333 kip-ft	
	$M_{cy} = \phi_b M_{ny}$	52.5 kip-ft	

## Flexural and Axial Interaction Calculation

Step	Equation	Value	Note
	$\frac{P_r}{P_c} = \frac{P_u}{\phi_c P_n}$	0.1188	
	$\frac{P_r}{P_c} < 0.2$		
	$\frac{P_r}{2P_c} + \left( \frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}} \right) \leq 1.0$	0.98713	Eq.H1-1b
Axial-flexural strength: OK			

## Major Shear Capacity Calculation

Step	Equation	Value	Note
	$A_w = dt_w$	2.8217 in <sup>2</sup>	
Computing Cv for major axis using G2.1			
	$k_v = 5.34$		
	$h/t_w$	27.1	
	$2.24 \sqrt{E/F_y}$	53.946	
	$h/t_w \leq 2.24 \sqrt{E/F_y}$		
	$C_{v1} = 1.0$		Eq.G2-2
Major shear strength			
	$V_n = 0.6 F_y A_w C_{v1}$	84.651 kips	Eq.G2-1

	$h/t_w \leq 2.24\sqrt{E/F_y}$		
	$\phi_v = 1.00$		
	$\phi_v V_n$	84.651 kips	
	$\frac{V_u}{\phi_v V_n}$	0	
Shear strength (major axis): OK			

## Minor Shear Capacity Calculation

Step	Equation	Value	Note
	$A_w = 2b_f t_f$	6.9252 in <sup>2</sup>	
Computing Cv2 for weak axis using G2.2			
	$k_v = 1.2$		
	$h/t_w = b/t_f$	9.1494	
	$1.10\sqrt{k_v E/F_y}$	29.02	
	$1.37\sqrt{k_v E/F_y}$	36.143	
	$h/t_w \leq 1.10\sqrt{k_v E/F_y}$		
	$C_{v2} = 1.0$	1	Eq.G2-9
Minor shear strength			
	$V_n = 0.6F_y b_f t_f C_{v2}$	207.76 kips	Eq.G6-1
	$\phi_v = 0.90$		
	$\phi_v V_n$	186.98 kips	
	$\frac{V_u}{\phi_v V_n}$	0	
Shear strength (minor axis): OK			



## **References**

1. American Institute of Steel Construction, “Steel Construction Manual” 14<sup>th</sup> Edition
2. Charles G. Salmon, John E. Johnson, Faris A. Malhas, “Steel Structures – Design and Behavior”, 5<sup>th</sup> edition., Pearson Education, Inc., 2009
3. American Institute of Steel Construction, “Design Examples” Version 14.1
4. American Institute of Steel Construction, “Design Examples” Version 15.1
5. American Institute of Steel Construction, AISC 360-16, “Specification for Structural Steel Building” , July, 2016
6. American Institute of Steel Construction, “Design Examples” Version 16.0
7. American Institute of Steel Construction, AISC 360-22, “Specification for Structural Steel Building” , August, 2022