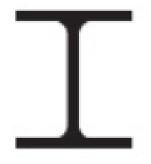
# sCheck

# A Steel Section Check and Design Program



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# 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).

I sCheck - A Steel Section Design Tool A	According to ANSI/AISC 360 Code	×
		sCheck, Version 3.0
	Start a new input file	
	Open an existing input file	
	Save input to a file (hold CTRL key to save to a new file)	
	Perform capacity check against given geometry, material and a set of load conditions on a AISC section. You can also view a step by step calculation procedure.	
	Perform AISC section design against given geometry, material and a set of load conditions. The result is a set of candidate sections that satisfy the AISC code requirements. You can then view a detailed capacity check for each individual section candidate.	
License Key About View	v Manual Batch Check Export AISC Table Import AISC Table Copyright (C) 2014-2024, Computations Graphics, In	nc. <u>www.cq-inc.com</u>

Figure 0.1

Code:	AISC 3	360-22 (16th	Edition) LRFI	D	~		🔽 Use Dire	ct Analysi	is Method						
ection:	W12x5	58		10	AISC Table		— 🔽 Consider			on	Ste	eel Yield Str	ess	50	ksi
Geometry	_													_	
Length:	15	ft		Lb:	15	ft	с	h- 1				nnector Dis		0	ft
Lengui.	_	I.		LD.		п		_			(fo	r double an	gles only):		
Lux	15	ft		Luy:	15	ft	L	JZ: 1	5	ft					
Kx:	1			Ky:	1		k	(z: 1							
							'								
oad 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															
<b>∢</b> 12															•
٩															

Figure 0.2

Code:	AISC 360	1-22 (16th Editi	on) LRFD							~						
Shape:	W									~						
	Section f	Filter Criteria (C	)ptional)								🔽 Use Di	rect Analysis I	lethod			
	Section (Comm	n Prefixes a delimited list,	. e.g. W12, W	/14).	,w12						🕑 Consid	er Moment Ma	agnificatio	n		
	Section	n Min Depth:	0	in	Se	ection Max D	epth:	0		in	Maximum Section C		10			
	Section	n Min Width:	0	in	Se	ection Max V	Vidth:	0		in	Steel Yield	l Stress (Fy):	50	k	si	
Loads:		Pu	Mux	Muy	Vux	Vuy	Crr	14	Cmy		Geometry					
		(kip)	(kip-ft)	(kip-ft)	(kip)	(kip)			Only		Length:	14	ft			
	1	30	90	12	0	0		1		1	Lux	14	ft	Kx	1	
	3											14	-		1	5
	4										Luy:	14	ft	Ky:	-	_
	5										Luz:	14	ft	Kz:	1	
	6									_	LЬ	14	ft	Cb:	1.14	
	7									-	Connoctor	Distance (for	double av	adaa anku)	0	Ξ.
	8										Connecto	Distance (for	double ar	igies only)	<u> </u>	
Section Candidates			Section			Critical Ratio		0.00	al Load		Perform I	Design				
canaldates			Section			chucai nauu		Chuc								
	1									_	Check Se	ection				
	2															
	4															
	5															
	6						_				UK	· .				

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.

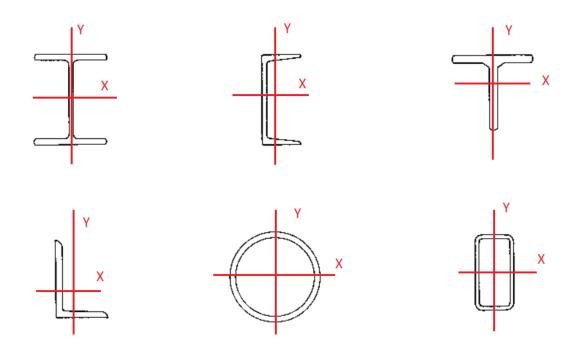


Figure 1.1

# 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<sub>x</sub>: Positive when section top most fiber is under compression.

Moment M<sub>y</sub>: Positive when section rightmost fiber is under compression.

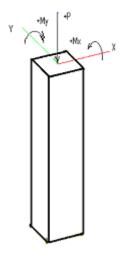


Figure 2.1

#### 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  $2^{nd}$  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.

	AISC 3	160-22 (16th E	Edition) LRFE	)	~		🔽 Use Dire	et Analysi	s Method						
ection:	W12x5	18		AI	SC Table		Consider			on	Ste	eel Yield St	2291	50	k
c					JC Table			in one in one	magninoadi	011					
Geometry															
Length:	15	ft		Lb:	15	ft	CI	ы 1				nnector Di: r double an		0	ft
Lux	15	ft		Luy:	15	ft	L	uz: 1	5	ft					
		_						_							
Kx:	1			Ky:	1		k	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
oad Effects	8														
								110							
	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															
5 6															
5 6 7															
5 6 7 8															
5 6 7 8 9															
5 6 7 8															

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).

Cmx, Cmy are coefficients accounting for non-uniform moments when computing moment magnification. You can use 1.0 for Cmx and Cmy conservatively. If 0 is entered for Cmx or Cmy, 1.0 is used in the computation instead.

Results include axial capacity (phi-Pn), moment capacity (phi-Mnx, phi-Mny), shear capacity (phi-Vnx, phi-Vny), moment magnification factors (B1x, B1y), 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 Mux and Muy are transformed in the principal axes before flexural-axial interaction ratio is checked.

# Chapter 4: Section Design

Steel Beam-	Column D	esign													×
Code:	AISC 36	:0-22 (16th Editi	ion) LRFD						~						
Shape:	W								~						
	Sectio	Filter Criteria (C on Prefixes na delimited list,		/14). <u></u>	,w12				]		rect Analysis   er Moment M		n		
	Sectio	on Min Depth:	0	in	S	ection Max D	epth:	0	in	Maximum Section Ca		10			
	Sectio	on Min Width:	0	in	S	ection Max W	/idth:	0	in		i Stress (Fy):	50	k	si	
Loads:		Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cmx	Cmy		Geometry	14				
	1	30	90	12	0	0		1	1	Length:	14	ft			
	2									Lux	14	ft	Kx	1	
	3									Luy:	14	ft	Ky:	1	
	4								_			_			_
	5								_	Luz:	14	ft	Kz:	1	_
	6								_	Lb	14	ft	Cb:	1.14	
	7								-	Connector	Distance (for	- double ar	ales onluì	0	
	•									Connector	Distance (iui	uouble ar	igles only)	<u> </u>	ft
Section Candidates			Section			Critical Ratio	(	Critical Load		Perform [	Design				
	1									Check Se	ection				
	2														
	3														
	4								_						
	5									OK					
	6								-	Clos					
	4									Lios	e				

The Section Design input and output are shown below:

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, Lp < Lb < Lr)

#### [Ref 2, pp435] Check the flexural capacity of W18x97 beam. Fy = 50 ksi, L = 50 ft, Lb = 25 ft. Cb = 1.3.

Steel Beam-	Column (	Check													×
Code:	AISC 3	60-22 (16th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi	s Method						
Section:	W18X9	97			AISC Table		< Consider	r Moment I	Magnificati	on	Ste	el Yield Str	ess	50	ksi
Geometry															
Length:	50	ft		Lb:	25	ft	С	b: 1	.3			nnector Dis double an		0	ft
Lux:	50	ft		Luy:	50	ft	L	uz: 5	0	ft					
Kx:	1			Ky:	1		k	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
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 A
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															
7															
8															
9															
10															
11															
4															► ►
Com	pute	Pro	ocedure in W	/ord	Procedure	e in PDF	)						0	ĸ	Close

#### **Result Comparison**

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

# Example 2 – W Shape Beam (Flexure in Major Axis, Lb > Lr)

[Ref 2, pp440] Check the flexural capacity of W33x118 beam. Fy = 50 ksi, L = 28 ft, Lb = 28ft, Cb = 2.0.

Steel Beam-	Column (	Check													×
Code:	AISC 3	60-22 (16th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi	s Method						
Section:	W33X1	18			AISC Table		🔽 Consider	Moment	Magnificati	on	Ste	el Yield Str	ess	50	ksi
Geometry															
Length:	28	ft		Lb:	28	ft	С	ь: 2				nnector Dis r double an		0	ft
Lux:	28	ft		Luy	. 28	ft	L	uz: 2	8	ft					
Kx:	1			Ky:	1		k	(z: 1							
						-		_							
Load Effects	&														
	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (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															
5															
6															
7															
8															
9															
10															
11															
•															
Com	pute	Pro	ocedure in W	/ord	Procedur	e in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  $_{\phi}Mnx = 1390$  ft-kips while sCheck gives  $_{\phi}Mnx = 1388.77$  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. Fy = 50 ksi, L = 15 ft.
```

	AISC 3	360-22 (16th	Edition) LRF	D	$\sim$		🔽 Use Dire	ect Analysi	s Method						
ection:	W12x5	58		A	SC Table		🔽 Conside	r Moment I	dagnificati	on	Ste	el Yield Str	ess	50	ks
Geometry-															
Length:	15	ft		Lb:	15	ft	c	b: 1				nnector Dis		0	ft
-		_									lot)	double an	gles only):		_
Lux:	15	ft		Luy:	15	ft	L	uz: <u>1</u>	5	ft					
Kx:	1			Ky:	1		ł	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
								_							
	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		1	1				131.76	345.6	1.0000	1.0000	0.9272
2															
3															
4															
5															
6															
7															
8															
8 9															_
8															

#### **Result Comparison**

The reference gives  $_{\phi}Mny = 122$  ft-kips while sCheck gives  $_{\phi}Mny = 121.875$  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.

Fy = 50 ksi

ode:	AISC 3	360-22 (16th	Edition) LRF	D	~		🔽 Use Dire	ect Analysia	s Method						
ection:	W21x4	48		A	ISC Table		- Consider			on	Ste	eel Yield Sti	ess	50	ksi
Geometry-															
Length:	10	ft		Lb:	10	ft	C	ы: <b>1</b>				nnector Dis r double an		0	ft
_	10	_			10			_			(roi	r double an	gies onlyj:		
Lux:	10	ft		Luy:	10	ft	L	uz: 1	U	ft					
Kx:	1			Ky:	1		k	(z: 1							
oad 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	(	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															

### **Result Comparison**

The reference gives  $_{\varphi}$ Vny = 189 ft-kips while sCheck gives  $_{\varphi}$ Vny = 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. Fy = 50 ksi, L = 14 ft, Kx = Ky = Kz = 1.0, Lux = Luy = Lb = 14 ft, Cb = 1.14.

Steel Beam	-Column (	Check													>
Code:	AISC 3	60-22 (16th	Edition) LRF	D	~		🗌 Use Dire	ect Analysi	s Method						
Section:	W10x3	3			AISC Table		🔽 Conside	r Moment I	Magnificati	on	Ste	el Yield Str	ess	50	ksi
Geometry															
Length:	14	ft		Lb:	14	ft	С	ь: 1	.14			nnector Dis double an		0	ft
Lux:	14	ft		Luy	. 14	ft	L	uz: 1	4	ft					
Kx:	1			Ky:	1	]									
							ľ	×2.							
Load Effects	. *														
Load Ellects															Critical
	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (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															_
6															
7															
8															
9															
10															
11															
<b>▲</b>															• •
Con	npute	Pro	ocedure in W	/ord	Procedur	e in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  $_{\phi}Pn = 253$  kips,  $_{\phi}Mnx = 137$  ft-kips,  $_{\phi}Mny = 52.5$  ft-kips while sCheck gives  $_{\phi}Pn = 252.522$  kips,  $_{\phi}Mnx = 136.59$  ft-kips,  $_{\phi}Mny = 52.5$  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. Fy = 50 ksi, L = 30 ft, Kx = Ky = Kz = 1.0, Lux = Luy = Lb = 30 ft, Cb = 1.41. Note: tension load must be entered as negative value.

Code:       AISC 360-22 (16h Edition) LRFD       I use Direct Analysis Method         Section:       W/14/832       AISC Table       Consider Moment Magnification       Steel Yield Stress       50       ksi         Geometry       Length:       30       R       Lb:       30       R       Cb:       141       Connector Distance (for double angles only):       0       R         Lux       30       R       Luy:       30       R       Luz:       30       R         Lux       1       Ky:       1       Kz:       1       Connector Distance (for double angles only):       0       R         Lux       30       R       Luy:       30       R       Luz:       30       R         Lux       1       Ky:       1       Kz:       1       Kz:       1       Connector Distance (for double angles only):       0       R         Lux       30       R       Luy:       30       R       Luz:       30       R       Luz:       30       R         Lux       1       Ky:       1       Ky:       1       Kz:       1       B1y       Critical for R         Lux       (kip)       (kip)       (kip)       Cmx	Steel Beam-	-Column (	Check													×
Geometry       Disc rate:       Disc rate: <thdisc rate:<="" th="">       Disc rate:</thdisc>	Code:	AISC 3	860-22 (16th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi	s Method						
Length:       30       R       Lb:       30       R       Cb:       1.41       Connector Distance (for double angles only):       0       R         Lux:       30       R       Luy:       30       R       Luz:       10       10	Section:	W14X8	32			AISC Table		🔽 Conside	r Moment I	Magnificati	on	Ste	eel Yield Str	ress	50	ksi
Length:       30       ft       Lb:       30       ft       Lb:       30       ft       Lb:       1       (for double angles only):       0       ft         Lux:       30       ft       Luy:       30       ft       Luz:       30       ft       Luz:       30       ft         Ka:       1       Ky:       1       Kz:       1	Geometry															
Lux       30       R       Luz       30       R       Luz       30       R         Kx       1       Ky       1       Kz       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1 <td>Length:</td> <td>30</td> <td>ft</td> <td></td> <td>Lb:</td> <td>30</td> <td>ft</td> <td>C</td> <td>b: 1</td> <td>.41</td> <td></td> <td></td> <td></td> <td></td> <td>0</td> <td>ft</td>	Length:	30	ft		Lb:	30	ft	C	b: 1	.41					0	ft
Lad Effects &	Lux:	30	ft		Luy	c 30	ft	L	uz: 3	10	ft	(		JJ,		
Lad Effects &	Kur	1	_		K	1	1		· 1							
Pu (kip)         Mux (kip-ft)         Muy (kip-ft)         Vux (kip)         Vuy (kip)         Cmx         Cmy         Phi-Mnx (kip)         Phi-Vny (kip)         Phi-Vny (kip)         B1x         B1y         Critical Ratio           1         -174         192         67.6         0         0         1         1         1080         491.54         168         218.79         46.317         1.0000         0.8735           2         -<	NX.	-	_		κy.			1	(Z:							
Pu (kip)         Mux (kip+t)         Muy (kip)         Vux (kip)         Vuy (kip)         Cmx         Cmy         Phi-Mnx (kip)         Phi-Vny (kip)         Phi-Vny (kip)         Phi-Vny (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         0.8735           2         -																
Pu       Mux       Muy       Vux       Vuy       Cmx       Cmy       pni-Mnx       pni-Mny       pni-Vny       B1x       B1y       Cmcal         1       -174       192       67.6       0       0       1       1       1080       491.54       168       218.79       466.317       1.0000       0.8735         2       -	Load Effects	s &						1								
2 <t< td=""><td></td><td></td><td></td><td>Muy (kip-ft)</td><td></td><td>: Vuy ) (kip)</td><td>Cmx</td><td>Cmy</td><td></td><td>phi-Mnx (kip-ft)</td><td></td><td>phi-Vnx (kip)</td><td>phi-Vny (kip)</td><td>B1x</td><td>B1y</td><td>Unitical —</td></t<>				Muy (kip-ft)		: Vuy ) (kip)	Cmx	Cmy		phi-Mnx (kip-ft)		phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Unitical —
3	1	-174	192	67.6		0 0	1	1	1080	491.54	168	218.79	466.317	1.0000	1.0000	0.8735
4 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>																
5																
6 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>																
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9 10 11 11 11 11 11 11 11 11 10 10																
	10															
	11															
Compute Procedure in Word Procedure in PDF OK Close	C	-		nondura in V	lord	Procedur										Close

#### **Result Comparison**

The reference gives  $_{\phi}Pn = 1080$  kips,  $_{\phi}Mnx = 492$  ft-kips,  $_{\phi}Mny = 168$  ft-kips while sCheck gives  $_{\phi}Pn = 1080$  kips,  $_{\phi}Mnx = 491.54$  ft-kips,  $_{\phi}Mny = 168$  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. Fy = 50 ksi, L = 25 ft, Lb = 5 ft, Cb = 1.0.

Steel Beam-	Column (	Check													>
Code:	AISC 3	60-22 (16th	Edition) LRF	D	~		🔽 Use Dire	ct Analysi	s Method						
Section:	C15X3	3.9			AISC Table		🔽 Consider	r Moment I	Magnificati	on	Ste	eel Yield Str	ess	50	ksi
Geometry															
Length:	25	ft		Lb:	5	ft	C	ь: 1				nnector Dis r double an		0	ft
Lux:	25	ft		Luy:	25	ft	L	uz: 2	5	ft	(10)		gios orny).		
Kx:	1	_		Ky:	1		k	(z: 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	108	0	1	150 0	1	1	20.3773	172.323	18.54	162	119.34	1.0000	1.0000	0.9259
2															
3															
5															
6															
7															
8															
9															
10															
11															
<b>1</b>															► •
<u> </u>															0
Com	pute	Pro	ocedure in W	vora	Procedur	e in PDF							0		Close

# **Result Comparison**

The reference gives  $_{\phi}Mnx = 173$  ft-kips,  $_{\phi}Vnx = 162$  kips while sCheck gives  $_{\phi}Mnx = 172.323$  ft-kips,  $_{\phi}Vnx = 162$  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. Fy = 50 ksi, L = 20 ft, Kx = Ky = Kz = 1.0, Lu = 20 ft, Cb = 1.41.

Steel Beam	-Column (	Check													×
Code:	AISC 3	60-22 (16th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi	s Method						
Section:	WT7x1	5			AISC Table		🗹 Conside	r Moment	Magnificati	on	Ste	el Yield Sti	ress	50	ksi
Geometry															
Length:	20	ft		Lb:	20	ft	С	b: 1				nnector Dis double an		0	ft
Lux:	20	ft		Luy	. 20	ft	L	uz: 2	0	ft	,				
Kx	1	_		Ky:	1	1		- <z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
150.		_		Ny.	·		r	×2.							
Load Effect:	- 0														
Load Effects															
	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (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															_
7															
8															
9															
10															
11															
4															
Con	npute	Pro	ocedure in W	/ord	Procedur	e in PDF							( 0	к ] [	Close

#### **Result Comparison**

The reference gives  $_{\phi}Pn = 36.6$  kips while sCheck gives  $_{\phi}Pn = 36.6049$  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. Fy = 50 ksi, L = 30 ft, Kx = Ky = 0.8, Kz = 1.0, Lu = 30 ft, Cb = 1.0.

Steel Beam	n-Column (	Check		-												×
Code:	AISC 3	60-22 (16th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi	s Method							
Section:	HSS12	×8×3/16			AISC Table		🔽 Consider	r Moment I	Magnificati	on	Ste	eel Yield Str	ess	50	ksi	
Geometry	,															
Length	n: <u>30</u>	ft		Lb:	30	ft	С	b: 1				nnector Dis r double any		0	ft	
Lux:	24	ft		Luy	24	ft	L	uz: 2	4	ft						
Kx:	1			Ky:	1		k	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>								
Load Effec	ts &															
	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															_	
6															_	
7																
8																
9																
10																
11																-
4															•	
Co	mpute	Pro	ocedure in W	/ord	Procedur	e in PDF							0	ĸ	Close	

#### **Result Comparison**

The reference gives  $_{\varphi}Pn = 151$  kips while sCheck gives  $_{\varphi}Pn = 151.33$  kips. They are practically identical. The reference gives  $_{\varphi}Pn = 177$  kips while sCheck gives  $_{\varphi}Pn = 177.832$  kips for Lc = 18 ft. The reference gives  $_{\varphi}Pn = 74.2$  kips while sCheck gives  $_{\varphi}Pn = 74.3864$  kips for Lc = 40 ft.

# Example 10 – Rectangular HSS Shape Beam (Flexure)

[Ref 6, Example F.8B] Check the capacity of HSS8x8x3/16 column in flexure. Fy = 50 ksi, L = 21 ft, Lb = 21 ft, Cb = 1.0.

Steel Beam-	Column (	Check													×
Code:	AISC 3	60-22 (16th	Edition) LRF	D	~		🖂 Use Dire	ct Analysi	s Method						
Section:	HSS8×	8×3/16			AISC Table		- Consider	-		on	Ste	el Yield Str	ess	50	ksi
Geometry															
Length:	21	ft		Lb:	21	ft	С	ь: 1				nnector Dis r double an		0	ft
Lux:	21	ft		Luj	r. 21	ft	L	uz: 2	1	ft					
Kx:	1			Ky:	1		k	(z: 1							
Load Effects	: &														
	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vu» (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	(MP	, (NP) 0 0	1	1	151.31		45.2811	70.3009	70.3009	1.0000	1.0000	0.9121
2	-		-												
3															
4															
5															
6															
7															
8															
10															
11															
4															►
Com	pute	Pro	ocedure in W	/ord	Procedu	e in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  $_{\varphi}Mnx = 45.4$  ft-kips while sCheck gives  $_{\varphi}Mnx = 45.2811$  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. Fy = 35 ksi, L = 30 ft

Steel Beam	-Column	Check													×
Code:	AISC 3	360-22 (16th	Edition) LRF	Đ	~		🕑 Use Dire	ect Analysi	s Method						
Section:	Pipe10	STD		A	AISC Table		🚾 Consider			on	Ste	el Yield St	ress	35	ksi
Geometry															
Length	: 30	ft		Lb:	30	ft	С	b: 1				nnector Di double ar		0	ft
Lux:	30	ft		Luy:	15	ft	L	uz: 3	0	ft					
Kx:	1			Ky:	1		k	(z: 1							
						-									
Load Effect	ts &														
	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				108.675	4.7314	1.2456	0.9461
2															
3															
4															
5															
6															
7															
8															
9															
10															
40															<b></b>
•															•
Co	mpute	Pro	ocedure in V	√ord	Procedur	e in PDF							0	к	Close

### **Result Comparison**

The reference gives  $_{\phi}Pn = 222$  kips while sCheck gives  $_{\phi}Pn = 221.966$  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. Fy = 50 ksi, L = 32 ft

Code:       AISC 360-22 (16th Edition) LRFD       Image: Construction       Image: Construction       Steel Yield Stress       50         Section:       HSS16.000X0.375       AISC Table       Image: Construction       Steel Yield Stress       50         Geometry       Image: Construction       Image: Construction       Image: Construction       Steel Yield Stress       50         Length:       32       ft       Lb:       32       ft       Cb:       1       Connector Distance (for double angles only):       0         Lux:       32       ft       Luy:       32       ft       Luz:       32       ft       Luz:       32       ft       Luz:       32       ft       Luz:       4 </th <th>ksi</th>	ksi
Geometry     Length:     32     ft     Lb:     32     ft     Cb:     1     Connector Distance (for double angles only):     0       Lux:     32     ft     Luy:     32     ft     Luz:     32     ft     Luz:     32     ft     1	
Length:     32     ft     Lb:     32     ft     Cb:     1     Connector Distance (for double angles only):     0       Lux:     32     ft     Luy:     32     ft     Luz:     32     ft	ft
Length:     32     rt     Lb:     32     rt     Lb:     1     (for double angles only):     0       Lux:     32     ft     Luy:     32     ft     Luz:     32     ft	ft
K.x. 1 K.y. 1 K.z. 1	
Load Effects &	
Du Muu Muu Yuu Yuu yuu ahiDa shiMau shiMau shiYuu	Critical
Image: Second	Ratio
<b>1</b> 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	
7	
8	
9	
10	
11	-
Compute Procedure in Word Procedure in PDF OK	Close

#### **Result Comparison**

The reference gives  $_{\phi}$ Vnx = 232 kips while sCheck gives  $_{\phi}$ Vnx = 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. Fy = 50 ksi, L = 8 ft, Kx = Ky = Kz = 1.0, Lux = Luy = Luz = 8 ft. Connector distance = 32 in = 2.66667 ft.

Steel Beam-	-Column (	Check													×
Code:	AISC 3	60-22 (16th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi:	s Method						
Section:	2L5x3x	1/4x3/4LLB	B		AISC Table		🔽 Conside	r Moment I	lagnificati	on	Ste	el Yield Str	ess	50	ksi
Geometry															
Length:	8	ft		Lb:	8	ft	C	b: 1				nnector Dis double an		2.660	667 ft
Lux:	8	ft		Luy	: 8	ft	L	uz: 8		ft					
Kx:	1			Ky:	1		,	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
						-		_							
Load Effects	s &														
	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)		Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical A
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															
5															
6															
7															
8															
9															
10															
11															
•					1										•
Com	npute	Pro	ocedure in W	/ord	Procedur	e in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  $_{\varphi}Pn = 73.8$  kips while sCheck gives  $_{\varphi}Pn = 73.7865$  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.

Fy = 50 ksi, L = 5 ft, Kx = Ky = Kz = 1.0, Lux = Luy = Luz = 5 ft.

Code:	AISC 3	60-22 (16th	Edition) LRF	D	~		🗌 Use Dire	ct Analysi	s Method						
Section:	L8×4×	1/2			AISC Table		🔽 Consider	r Moment I	Magnificati	on	Ste	el Yield Str	ress	50	ksi
Geometry															
Length:	5	ft		Lb:	5	ft	с	ь: 1				nnector Dis double an		0	ft
-	5			1	: 5	_		uz: 5			(roi	double an	gies only):		
Lux:	5	ft		Luy		ft	U	uz:		ft					
Kx:	1			Ky:	1		k	(z: 1							
.oad Effects	&														
	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (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	-								4.0005	1.6764
2					0 0		1 1	168.786	31.2506	10.2375	108	54	1.0271	1.3335	1.0104
					0 0		1 1	168.786	31.2506	10.2375	108	54	1.0271	1.3335	1.0104
3							1 1	168.786	31.2506	10.2375	108	54	1.0271	1.3335	
4								168.786	31.2506	10.2375	108	54	1.0271	1.3335	
4 5								168.786	31.2506	10.2375	108	54	1.0271	1.3335	
4								168.786	31.2506	10.2375	108	54	1.0271	1.3335	
4 5 6								168.786	31.2506	10.2375		54	1.0271	1.3335	
4 5 6 7								168.786	31.2506	10.2375		54	1.0271	1.3335	
4 5 6 7 8 9 10								168.786	31.2506	10.2375				1.3335	
4 5 6 7 8 9									31.2506	10.2375					

#### **Result Comparison**

The reference gives  ${}_{\phi}Pn = 168 \text{ kips}$ ,  ${}_{\phi}Mnx ({}_{\phi}M_{nw}) = 375 \text{ in-kips} = 31.25 \text{ ft-kips}$ ,  ${}_{\phi}Mny ({}_{\phi}M_{nz}) = 123 \text{ in-kips} = 10.25 \text{ ft-kips}$  while sCheck gives  ${}_{\phi}Pn = 168.786 \text{ kips}$ ,  ${}_{\phi}Mnx ({}_{\phi}M_{nw}) = 31.2506 \text{ ft-kips}$ ,  ${}_{\phi}Mny ({}_{\phi}M_{nz}) = 10.2375 \text{ ft-kips}$ . 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 Mux and Muy 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. Fy = 50 ksi, L = 14 ft, Kx = Ky = Kz = 1.0, Lux = Luy = Lb = 14 ft, Cb = 1.14. Pn = 30 kips, Mux = 90 ft-kips, Muy = 12 ft-kips, Cmx = 1.0, Cmy = 1.0. The required moments do not include second-order effects.

Step 1:

Click on the design button *from the sCheck main screen.* 

I sCheck - A Steel Section Design Tool	According to ANSI/AISC 360 Code	×
C:\CGInc\sCheck2\Exan	nples\Example 14-AiscDesignExamples-E14.sck	sCheck, Version 3.0
	Start a new input file	
	Open an existing input file	
	Save input to a file (hold CTRL key to save to a new file)	
	Perform capacity check against given geometry, material and a set of load conditions on a AISC section. You can also view a step by step calculation procedure.	
	Perform AISC section design against given geometry, material and a set of load conditions. The result is a set of candidate sections that satisfy the AISC code requirements. You can then view a detailed capacity check for each individual section candidate.	
License Key About View	w Manual Batch Check Export AISC Table Import AISC Table Copyright (C) 2014-2024, Computations Graphics, I	nc. <u>www.cq-inc.com</u>

### 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 D	esign														×
Code:	AISC 36	0-22 (16th Editi	on) LRFD							~						
Shape:	W									~						
	Section	Filter Criteria (O	(ptional)								🔽 Use Di	rect Analysis I	Method			
	Sectio (Comn	n Prefixes na delimited list,	e.g. W12, W	w8,w10, 14).	.w12						🔽 Consid	er Moment Ma	agnificatior	n		
	Sectio	on Min Depth:	0	in	Se	ection Max D	epth:	0		in	Maximum Section C	Number of andidates:	10			
	Sectio	on Min Width:	0	in	Se	ection Max W	/idth:	0		in	Steel Yield	l Stress (Fy):	50	ks	si	
Loads:		Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cm	IX	Cmy		Geometry	14	9			
	1	30	90	12	0	0		1		1	Length:	14	ft			
	2										Lux:	14	ft	Kx:	1	
	3										Luy:	14	ft	Ky:	1	
	4												_	-		
	5									_	Luz:	14	ft	Kz:	1	
	6									_	LЬ	14	ft	Cb:	1.14	
	7									_	- ·	D	-			
	8									•	Lonnecto	Distance (for	double an	igles onlyj	0	ft
Section Candidates			Section			Critical Ratio		Critica	al Load		Perform I	Design				
	1		W10X33			0.9871			1		Check Se	ection				
	2		W8X35			0.9874			1							
	3		W12X35			0.9897			1							
	4		W10X39			0.7908			1							
	5		W8X40			0.8525			1		OK					
	6		W12X40			0.7154			1	-						
	1		\/12×45			0.6250			1		Clos	e				

#### 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 3	60-22 (16th	Edition) LRF	Đ	~		🕑 Use Dire	ct Analvsi	s Method						
Section:	W10X3	33		Al	SC Table		🚾 Consider			on	Ste	eel Yield St	ress	50	ksi
Geometry															
Length:	14	ft		Lb:	14	ft	C	ь: 1	.14			nnector Di: r double an		0	ft
Lux:	14	ft		Luy:	14	ft	L	uz: 1	4	ft					
Kx:	1			Ky:	1		k	(z: 1							
								_							
Load Effects	s &														
	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															
7															
8															
9															
10															
11															
4															•
Con	npute	Pro	ocedure in V	Vord	Procedur	e in PDF							0	ĸ	Close

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

# Example 1 – W Shape Beam (Flexure in Major Axis, Lp < Lb < Lr)

#### [Ref 2, pp435] Check the flexural capacity of W18x97 beam. Fy = 50 ksi, L = 50 ft, Lb = 25 ft. Cb = 1.3.

Steel Beam	-Column (	Check													×
Code:	AISC 3	60-16 (15th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi	is Method						
Section:	W18X9	AISC 360-16 (15th Edition) LRFD V18X97 AISC Ta i0 ft Lb: 25 i0 ft Luy: 50 Ky: 1 u Mux Muy Vux V p) (kip-ft) (kip) V(k		AISC Table	🔽 Consider Moment Magnification						Steel Yield Stress			ksi	
Geometry															
Length:	50	50 ft Luy: 50		25	ft	C	ib: 1	.3			nnector Dis r double an	istance ngles only):		ft	
Lux:	50	ft		Luy:	50	ft	L	uz: 5	50	ft					
Kx:	1			Ky:	1		ł	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
								_							
Load Effect	s &														
	Pu (kip)		Muy (kip-ft)		Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical A
1	0	684	0	54.	.75 0	1	1	125.595	5 740.336	207.375	298.53	521.478	1.0000	1.0000	0.9239
2															
3															_
4 5															
6															
7															
8															
9															
10															
11															
•															
Cor	npute	Pro	ocedure in W	/ord	Procedure	e in PDF							0	ĸ	Close

#### **Result Comparison**

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

# Example 2 – W Shape Beam (Flexure in Major Axis, Lb > Lr)

[Ref 2, pp440] Check the flexural capacity of W33x118 beam. Fy = 50 ksi, L = 28 ft, Lb = 28ft, Cb = 2.0.

Steel Beam-	Column (	Check														×
Code:	AISC 3	60-16 (15th	Edition) LRF	D		~	🔽 Use Dire	ect Analysi	is Method							
Section:	W33X1	18			AISC Table.		🔽 Conside	r Moment	Magnificati	on	Ste	eel Yield Str	ress	50	ks	si
Geometry																
Length:	28	ft		Lb:	28	ft	C	ib: 2	2			nnector Dis r double an		0	ft	
Lux:	28	ft		Luy	y: 28	ft	L	uz: 2	28	ft						
Kx:	1			Ky:	1		,	Kz: 1								
						_		_								
Load Effects	: &															
	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (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	3 1388.77	192.375	488.565	459.54	1.0000	1.0000	0.9937	
2																
3																
4																
6																
7																
8																
9																
10																
11																
4															•	-
6																
Com	ipute	Pro	ocedure in V	√ord	Proce	dure in PDF							0	K j	Close	

#### **Result Comparison**

The reference gives  $_{\phi}Mnx = 1390$  ft-kips while sCheck gives  $_{\phi}Mnx = 1388.77$  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. Fy = 50 ksi, L = 15 ft.
```

ode:	AISC 3	360-16 (15th	Edition) LRF	D	$\sim$		🔽 Use Dire	ect Analysi:	s Method						
ection:	W12x5	58		A	SC Table		< Conside	Steel Yield Stress			50	ksi			
Geometry-															
Length:	15	15 ft Lb: 15		ft	ft Cb: 1					nnector Dis	0	ft			
-		_									lot)	double an	gles only):		
Lux:	15	ft		Luy:	15	ft	L	uz: <u>1</u>	5	ft					
Kx:	1			Ky:	1		,	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
	(kip)	(kip-ft)	Muy (kip-ft)	(kip)	Vuy (kip)	Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	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															
-															
10															
10 11							1								[

#### **Result Comparison**

The reference gives  $_{\phi}Mny = 122$  ft-kips while sCheck gives  $_{\phi}Mny = 121.875$  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. Fy = 50 ksi

iteel Beam-G	Column (	Check													
Code:	AISC 3	60-16 (15th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi	s Method						
Section:	W21x4	8		7	AISC Table	Consider Moment Magnification						Steel Yield Stress			ksi
Geometry	ometry														
Length:	10	ft		Lb:	10	ft	С	b: 1				nnector Dis double an		0	ft
-	10	_		1	10			uz: 1	0	a	(roi	r double an	igies onlyj:		_
Lux:	10	ft		Luy:	10	ft	U	uz:	0	ft					
Kx:	1			Ky:	1		k	<z: <u="">1</z:>							
.oad 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															
<b>↓</b>															
														<b>K</b>	~
Comp	oute	Pro	ocedure in V	vord	Procedur	e in PDF							0	K I	Close

#### **Result Comparison**

The reference gives  $_{\phi}$ Vny = 189 ft-kips while sCheck gives  $_{\phi}$ Vny = 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.

Fy = 50 ksi, L = 14 ft, Kx = Ky = Kz = 1.0, Lux = Luy = Lb = 14 ft, Cb = 1.14.

Steel Beam	-Column (	Check													>
Code:	AISC 3	160-16 (15th	Edition) LRF	D	~		🗌 Use Dire	ect Analysi	is Method						
Section:	W10x3	3			AISC Table		Consider Moment Magnification						Steel Yield Stress		
Geometry															
Length:	: 14	14 ft Lb: 14		ft			nnector Dis r double an	0	ft						
Lux:	14	ft		Luj	c 14	ft	L	uz: 1	4	ft					
Kx:	1			Ky:	1	]	,								
	_							·							
Load Effect	- l.														
		14	1.1 m					-Li Da	- hi hdaaa	-1.14	-1:37	-1:37			Calend 🔺
	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	2 136.59	52.5	84.651	186.98	1.0176	1.0879	0.9786
2															
3															_
5															
6															
7															
8															
9															
10															
11															
•															•
Cor	npute	Pro	ocedure in W	/ord	Procedur	e in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  $_{\varphi}Pn = 253$  kips,  $_{\varphi}Mnx = 137$  ft-kips,  $_{\varphi}Mny = 52.5$  ft-kips while sCheck gives  $_{\varphi}Pn = 252.522$  kips,  $_{\varphi}Mnx = 136.59$  ft-kips,  $_{\varphi}Mny = 52.5$  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. Fy = 50 ksi, L = 30 ft, Kx = Ky = Kz = 1.0, Lux = Luy = Lb = 30 ft, Cb = 1.41. Note: tension load must be entered as negative value.

Steel Beam	-Column (	Check													>
Code:	AISC 3	60-16 (15th	Edition) LRF	D	~		🔽 Use Dire	ect Analys	is Method						
Section:	W14X8	32			AISC Table		🔽 Conside	r Moment	Magnificati	on	Ste	el Yield Sti	ress	50	ksi
Geometry															
Length:	: 30	ft		Lb:	30	ft	С	ь: 1	.41			nnector Dis r double an		0	ft
Lux:	30	ft		Luy	: 30	ft	L	uz:	30	ft					
Kx:	1			Ky:	1		,	<z: 1<="" td=""><td>I</td><td></td><td></td><td></td><td></td><td></td><td></td></z:>	I						
Load Effect	s &														
	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															
6															
7															
8															
9															
10															_
11															
4					1										•
Cor	npute	Pro	ocedure in W	/ord	Procedur	e in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  $_{\phi}Pn = 1080$  kips,  $_{\phi}Mnx = 492$  ft-kips,  $_{\phi}Mny = 168$  ft-kips while sCheck gives  $_{\phi}Pn = 1080$  kips,  $_{\phi}Mnx = 491.54$  ft-kips,  $_{\phi}Mny = 168$  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.
```

Fy = 36 ksi, L = 25 ft, Lb = 5 ft, Cb = 1.0.

Steel Beam-	Column (	Check													×
Code:	AISC 3	60-16 (15th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi	s Method						
Section:	C15X3	3.9			AISC Table		🗹 Consider	r Moment I	Magnificati	on	Ste	el Yield Str	ess	36	ksi
Geometry															
Length:	25	ft		Lb:	5	ft	С	b: 1				nnector Dis double an		0	ft
Lux:	25	ft		Luy	: 25	ft	L	uz: 2	5	ft					
Kx:	1			Ky:	1		k	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
								_							
Load Effects	: &														
	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)		Cmx	Cmy	phi-Pn (kip)	phi-Mnx (kip-ft)	phi-Mny (kip-ft)	phi-Vnx (kip)	phi-Vny (kip)	B1x	B1y	Critical A
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															_
7															
8															
9															
10															
11															
4															
ſ		_													
Com	pute	Pro	ocedure in W	/ord	Procedur	e in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  $_{\varphi}Mnx = 130$  ft-kips,  $_{\varphi}Vnx = 117$  kips while sCheck gives  $_{\varphi}Mnx = 130.434$  ft-kips,  $_{\phi}$ Vnx = 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. Fy = 50 ksi, L = 20 ft, Kx = Ky = Kz = 1.0, Lu = 20 ft, Cb = 1.41.

Steel Beam-	Column (	Check													×
Code:	AISC 3	60-16 (15th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi	s Method						
Section:	WT7x1	5			AISC Table		🔽 Consider	r Moment I	Magnificati	on	Ste	eel Yield Str	ess	50	ksi
Geometry															
Length:	20	ft		Lb:	20	ft	С	b: 1				nnector Dis r double an		0	ft
Lux:	20	ft		Luy	: 20	ft	L	uz: 2	0	ft	Ì				
Kx:	1			Ky:	1		L	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
156.	· · · · ·			ι.y.	·		r	×2.							
1 15%															
Load Effects															
	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (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															
10															<b>▼</b>
<i></i>					_		<u></u>						_		
Com	pute	Pro	ocedure in W	/ord	Procedur	e in PDF							0	к	Close

#### **Result Comparison**

The reference gives  $_{\phi}Pn = 36.6$  kips while sCheck gives  $_{\phi}Pn = 36.6049$  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. Fy = 50 ksi, L = 30 ft, Kx = Ky = 0.8, Kz = 1.0, Lu = 30 ft, Cb = 1.0.

Steel Beam	-Column (	Check														X
Code:	AISC 3	60-16 (15th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi	s Method							
Section:	HSS12	×8×3/16			AISC Table		🕑 Conside	r Moment I	Magnificati	on	Ste	el Yield Str	ess	50	ksi	
Geometry																
Length:	30	ft		Lb:	30	ft	С	ib: 1				nnector Dis double an		0	ft	
Lux:	24	ft		Luy	: 24	ft	L	uz: 2	4	ft	(10)		gioo oriiy).			
Kan	1	_			1	1										
Kx:	1			Ky:	-		ł	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>								
Load Effect:	s &															
	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (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																
6																
7																
8																
9																
10																
11																
4															• •	
Con	npute	Pro	ocedure in W	/ord	Procedur	e in PDF							0	ĸ	Close	

#### **Result Comparison**

The reference gives  $_{\varphi}Pn = 151$  kips while sCheck gives  $_{\varphi}Pn = 151.33$  kips. They are practically identical. The reference gives  $_{\varphi}Pn = 177$  kips while sCheck gives  $_{\varphi}Pn = 177.832$  kips for Lc = 18 ft. The reference gives  $_{\varphi}Pn = 74.2$  kips while sCheck gives  $_{\varphi}Pn = 74.3864$  kips for Lc = 40 ft.

# Example 10 – Rectangular HSS Shape Beam (Flexure)

[Ref 4, Example F.8B] Check the capacity of HSS8x8x3/16 column in flexure. Fy = 50 ksi, L = 21 ft, Lb = 21 ft, Cb = 1.0.

Steel Beam	-Column (	Check													×
Code:	AISC 3	60-16 (15th	Edition) LRF	Đ	~		🖂 Use Dire	ect Analysi	is Method						
Section:	HSS8×	8×3/16			AISC Table		Conside	-		on	Ste	el Yield Str	ess	50	ksi
Geometry															
Length:	21	ft		Lb:	21	ft	С	ь: 1				nnector Dis r double an		0	ft
Lux:	21	ft		Luj	g: 21	ft	L	uz: 2	21	ft					
Kx:	1			Ky:	1		,	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
						_		_							
Load Effect:	s &														
	Pu	Mux	Muy	Vux	( Vuy	Cmx	Cmy	phi-Pn	phi-Mnx	phi-Mny	phi-Vnx	phi-Vny	B1x	B1y	Critical
	(kip)	(kip-ft)	(kip-ft)	(kip				(kip)	(kip-ft)	(kip-ft)	(kip)	(kip)			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															
4															
5															
6															
7															
8															
9															
10															
11															
4															
													_		
Con	npute	Pro	ocedure in W	/ord	Procedu	re in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  $_{\varphi}Mnx = 45.4$  ft-kips while sCheck gives  $_{\varphi}Mnx = 45.2811$  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. Fy = 35 ksi, L = 30 ft

Steel Beam	-Column (	Check													×
Code:	AISC 3	60-16 (15th	Edition) LRF	D	~		🕑 Use Dire	ct Analvsi	s Method						
Section:	Pipe10	STD			AISC Table		🚾 Consider			on	Ste	el Yield Sti	ress	35	ksi
Geometry															
Length	30	ft		Lb:	30	ft	С	ь: 1				nnector Dis r double an		0	ft
Lux:	30	ft		Luy:	15	ft	L	uz: 3	0	ft					
Kx:	1			Ky:	1		k	(z: 1							
Load Effect	ts &														
	Pu	Mux	Muy	Vux	Vuy	Cmx	Cmy	phi-Pn	phi-Mnx	phi-Mny	phi-Vnx	phi-Vny	B1x	B1y	Critical
	(kip)	(kip-ft)	(kip-ft)	(kip)	(kip)			(kip)	(kip-ft)	(kip-ft)	(kip)	(kip)		-	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															
6															
7															
8															
9															
10															
11															
4															•
6					_								_		
Cor	mpute	Pro	ocedure in V	Vord	Procedure	e in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  $_{\phi}Pn = 222$  kips while sCheck gives  $_{\phi}Pn = 221.966$  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. Fy = 46 ksi, L = 32 ft

Steel Beam-	-Column (	Check													×
Code:	AISC 3	60-16 (15th	Edition) LRF	Đ	~		🔽 Use Dire	ect Analvsi	s Method						
Section:	HSS16	.000×0.375			AISC Table		🚾 Consider	-		on	Ste	el Yield Str	ress	46	ksi
Geometry															
Length:	32	ft		Lb:	32	ft	С	ь: 1				nnector Dis r double an		0	ft
Lux:	32	ft		Luy:	32	ft	L	uz: 3	2	ft					
Kx:	1			Ky:	1		k	(z: 1							
Load Effects	: &														
	Pu	Mux	Muy	Vux	Vuy			phi-Pn	phi-Mnx	phi-Mny	phi-Vnx	phi-Vny			Critical 🔼
	(kip)	(kip-ft)	(kip-ft)	(kip)	(kip)	Cmx	Cmy	(kip)	(kip-ft)	(kip-ft)	(kip)	(kip)	B1x	B1y	Ratio
1	0	0	0	18	30 0	1	1	514.829	292.186	292.186	213.624	213.624	1.0000	1.0000	0.8426
2															
3															_
4															
6															
7															
8															
9															
10															
11															
4															▼
6													_		
Com	npute	Pro	ocedure in V	Vord	Procedur	e in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  $_{\phi}$ Vnx = 213 kips while sCheck gives  $_{\phi}$ Vnx = 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. Fy = 36 ksi, L = 8 ft, Kx = Ky = Kz = 1.0, Lux = Luy = Luz = 8 ft. Connector distance = 32 in = 2.66667 ft.

Steel Beam	-Column (	Check													×
Code:	AISC 3	360-16 (15th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi	s Method						
Section:	2L5x3x	(1/4x3/4LLB	B		AISC Table		🗹 Conside	r Moment I	Magnificati	on	Ste	el Yield Str	ess	36	ksi
Geometry															
Length	: 8	ft		Lb:	8	ft	С	ib: 1				nnector Dis double an		2.66	667 ft
Lux:	8	ft		Luy	8	ft	L	uz: 8		ft		·			
Kx:	1	_		Ky:	1	1		<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
					_			\ <u>.</u>							
Load Effect	10 L														
	Pu	Mux	b de un	Vux	Maria			ahi Da	phi-Mnx	- lei beleen	phi-Vnx	phi-Vny			Critical 🔺
	Pu (kip)	мих (kip-ft)	Muy (kip-ft)	(kip)		Cmx	Cmy	phi-Pn (kip)	pni-Mnx (kip-ft)	phi-Mny (kip-ft)	pni-vnx (kip)	pni-vny (kip)	B1x	B1y	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															_
5															
6															
7															
8															
9															
10															
11															
<b>1</b>															
-															
Cor	mpute	Pro	ocedure in V	/ord	Procedur	e in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  $_{\varphi}Pn = 67.5$  kips while sCheck gives  $_{\varphi}Pn = 67.5394$  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.

Fy = 36 ksi, L = 5 ft, Kx = Ky = Kz = 1.0, Lux = Luy = Luz = 5 ft.

Steel Beam	n-Column (	Check													×
Code:	AISC 3	360-16 (15th	Edition) LRF	D	~		🗌 Use Dire	ect Analysi	s Method						
Section:	L8×4×	1/2			AISC Table		🔽 Conside	r Moment I	Magnificati	on	Ste	el Yield Str	ess	36	ksi
Geometry	,														
Length	τ 5	ft		Lb:	5	ft	С	b: 1				nnector Dis double an		0	ft
Lux:	5	ft		Luy	r 5	ft	L	uz: 5		ft	(		3,,,		
K	1	_		v	1	-									
Kx:	-			Ky:	-		ł	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
Load Effec															
	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (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															
7															
8															
9															
10															
11															
42															▼
															~
Lo	mpute	Pro	ocedure in V	Vord	Procedu	re in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  ${}_{\phi}Pn = 141$  kips,  ${}_{\phi}Mnx ({}_{\phi}M_{nw}) = 304$  in-kips = 25.33 ft-kips,  ${}_{\phi}Mny ({}_{\phi}M_{nz}) = 88.5$  in-kips = 7.375 ft-kips while sCheck gives  ${}_{\phi}Pn = 140.612$  kips,  ${}_{\phi}Mnx ({}_{\phi}M_{nw}) = 25.3584$  ft-kips,  ${}_{\phi}Mny ({}_{\phi}M_{nz}) = 7.371$  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 Mux and Muy 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. Fy = 50 ksi, L = 14 ft, Kx = Ky = Kz = 1.0, Lux = Luy = Lb = 14 ft, Cb = 1.14. Pn = 30 kips, Mux = 90 ft-kips, Muy = 12 ft-kips, Cmx = 1.0, Cmy = 1.0. The required moments do not include second-order effects.

Step 1:

Click on the design button *from the sCheck main screen.* 

I sCheck - A Steel Section Design Tool A	According to ANSI/AISC 360 Code	×
C:\CGInc\sCheck2\Exam	nples\Example 14-AiscDesignExamples-E14.sck	sCheck, Version 3.0
	Start a new input file	
	Open an existing input file	
	Save input to a file (hold CTRL key to save to a new file)	
	Perform capacity check against given geometry, material and a set of load conditions on a AISC section. You can also view a step by step calculation procedure.	
	Perform AISC section design against given geometry, material and a set of load conditions. The result is a set of candidate sections that satisfy the AISC code requirements. You can then view a detailed capacity check for each individual section candidate.	
License Key About View	w Manual Batch Check Export AISC Table Import AISC Table Copyright (C) 2014-2024, Computations Graphics, In	c. <u>www.cq-inc.com</u>

#### 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 D	esign														×
Code:	AISC 36	0-16 (15th Editi	on) LRFD							~						
Shape:	W									~						
	Section	Filter Criteria (O	(ptional)								🔽 Use Di	rect Analysis I	Method			
		n Prefixes na delimited list,	e.g. W12, W	w8,w10,	.w12						🔽 Consid	er Moment M	agnificatior	n		
	Sectio	on Min Depth:	0	in	Se	ection Max D	epth:	0		in	Maximum Section Ca		10			
	Sectio	on Min Width:	0	in	Se	ection Max W	'idth:	0		in	Steel Yield	Stress (Fy):	50	ks	si	
Loads:		Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy (kip)	Cm	IX	Cmy		Geometry					
	1	30	(Kiphi) 90	(NIPH) 12	(مانع) D			1		1	Length:	14	ft			
	2	30	30	12	U	0		-		-	Lux:	14	ft	Kx:	1	
	3											14	_		1	=
	4										Luy:	14	ft	Ky:	1	_
	5										Luz:	14	ft	Kz:	1	
	6										Lb	14	ft	Cb:	1.14	
	7												_			_
	8									•	Connector	Distance (for	double ar	igles only)	0	ft
Section Candidates			Section			Critical Ratio		Critic	al Load		Perform [	Design				
	1		W10X33			0.9871			1		Check Se	ection				
	2		W8X35			0.9874			1							
	3		W12X35			0.9897			1							
	4		W10X39			0.7908			1							
	5		W8X40			0.8525			1		OK					
	6		W12X40			0.7154			1	-						
	₹		\w/1 <i>2</i> \x <b>4</b> 5			0.6250			1		Clos	e				

#### 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 Bear	m-Column	Check													×
Code:	AISC	360-16 (15th	Edition) LRF	Đ	~		🔽 Use Dire	ct Analysi:	s Method						
Section:	W10	(33		Al	SC Table		- Consider			on	Ste	eel Yield St	ress	50	ksi
Geometr	y														
Lengt	h: 14	ft		Lb:	14	ft	C	ы 1	.14			nnector Di: r double an		0	ft
Lux:	14	ft		Luy:	14	ft	L	uz: 1	4	ft					
Kx:	1			Ky:	1		k	(z: 1							
								·							
Load Effe	cts &														
	Pu	Mux	Muy	Vux	Vuy			phi-Pn	phi-Mnx	phi-Mny	phi-Vnx	phi-Vny			Critical
	(kip)	(kip-ft)	(kip-ft)	(kip)	(kip)	Cmx	Cmy	(kip)	(kip-ft)	(kip-ft)	(kip)	(kip)	B1x	B1y	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															
6															
7															
8															
9															
10															
11															
42															
(******															
C	ompute	Pr	ocedure in V	Vord	Procedur	e in PDF							0	ĸ	Close

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

# Example 1 – W Shape Beam (Flexure in Major Axis, Lp < Lb < Lr)

#### [Ref 2, pp435] Check the flexural capacity of W18x97 beam. Fy = 50 ksi, L = 50 ft, Lb = 25 ft. Cb = 1.3.

Steel Beam-	-Column (	Check													×
Code:	AISC 3	60-10 (14th	Edition) LRF	D	~		🖂 Use Dire	ect Analysi:	s Method						
Section:	W18X9	17			AISC Table		🗹 Conside	r Moment N	dagnificati	on	Ste	el Yield Str	ess	50	ksi
Geometry															
Length:	50	ft		Lb:	25	ft	С	њ: 1.	3			nnector Dis double an		0	ft
Lux:	50	ft		Luy:	50	ft	L	uz: 5	D	ft					
Kx	1			Ky:	1		,	< <sub>z:</sub> 1							
	_							\ <b>L</b> .							
Load Effects	s &													Save	d 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 A
1	0	684	0	54.3	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															_
9															
10															
11															
4															•
Com	npute	Pro	ocedure in W	/ord	Procedur	e in PDF							0	K (	Close

#### **Result Comparison**

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

# Example 2 – W Shape Beam (Flexure in Major Axis, Lb > Lr)

[Ref 2, pp440] Check the flexural capacity of W33x118 beam. Fy = 50 ksi, L = 28 ft, Lb = 28ft, Cb = 2.0.

Steel Beam-G	Column (	Check													>
Code:	AISC 3	60-10 (14th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi	s Method						
Section:	W33X1	18			AISC Table		< Consider	r Moment	Magnificati	on	Ste	el Yield Str	ess	50	ksi
Geometry															
Length:	28	ft		Lb:	28	ft	С	b: 2				nnector Dis r double an		0	ft
Lux:	28	ft		Luy	: 28	ft	L	uz: 2	8	ft					
Kx:	1			Ky:	1		k	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
Load Effects	&														
	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)		Стх	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															
5															
6															
7															
8															
9															
10															
11															
<b>▲</b>															
Comp	oute	Pro	ocedure in W	/ord	Procedur	re in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  $_{\phi}Mnx = 1390$  ft-kips while sCheck gives  $_{\phi}Mnx = 1388.77$  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. Fy = 50 ksi, L = 15 ft.
```

ode:	AISC 3	360-10 (14th i	Edition) LRFI	)	~		🔽 Use Dire	ect Analysi	s Method						
ection:	W12x5	58		A	SC Table		< Conside	r Moment I	Magnificati	on	Ste	eel Yield Str	ess	50	ks
Geometry-															
Length:	15	ft		Lb:	15	ft	C	b: 1				nnector Dis		0	ft
_	15	_			15				-		lo1)	r double an	gles onlyj:		_
Lux:	15	ft		Luy:	15	ft	L	uz: 1		ft					
Kx:	1			Ky:	1		ł	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
	D.,	Mus	Muu	Mus	Muu			phi Pn	obiMov	obiMou	phi)/py	obi∛nu			Critical
oad 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															
о 6															
7															
8															
9															
10															
11															

#### **Result Comparison**

The reference gives  $_{\phi}$ Mny = 122 ft-kips while sCheck gives  $_{\phi}$ Mny = 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.

Fy = 50 ksi

Steel Beam-	Column (	Check													>
Code:	AISC 3	60-10 (14th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi	s Method						
Section:	W21x4	8			AISC Table		🔽 Consider	r Moment	Magnificati	on	Ste	el Yield Sti	ress	50	ksi
Geometry															
Length:	10	ft		Lb:	10	ft	С	b: 1				nnector Dis double an		0	ft
Lux:	10	ft		Luy	z 10	ft	Ŀ	uz: 1	0	ft	,				
Kx:	1			K	1	1									
NX.	-	_		Ky:			K	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
Load Effects	&								1						
	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (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															
7															
8															_
9															
10															
11															
4															▼
Com	pute	Pro	ocedure in V	Vord	Procedur	e in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  $_{\varphi}$ Vny = 189 ft-kips while sCheck gives  $_{\varphi}$ Vny = 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. Fy = 50 ksi, L = 14 ft, Kx = Ky = Kz = 1.0, Lux = Luy = Lb = 14 ft, Cb = 1.14.

	Loiumn C	Check													
ode:	AISC 3	60-10 (14th	Edition) LRF	D	~		🗌 Use Dire	ect Analysi	s Method						
ection:	W10x3	3			AISC Table		🕑 Conside	r Moment I	Magnificati	on	Ste	el Yield Str	ess	50	ks
Geometry-															
-	14				14		_	. 4	.14		Co	nnector Dis	tance	0	a
Length:	14	ft		Lb:	14	ft	C	b: 1	.14			double an		<u> </u>	ft
Lux:	14	ft		Luy	: 14	ft	L	uz: 1	4	ft					
Kx:	1			K	1	1		(m. 1							
NX.	-			Ky:	·		1	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
ad Effects	Pu	Mux	Muy	Vux		Cmx	Cmy	phi-Pn	phi-Mnx	phi-Mny	phi-Vnx	phi-Vny	B1x	B1y	Critical
-	(kip)	(kip-ft)	(kip-ft)	(kip)			Citiy	(kip)	(kip-ft)	(kip-ft)	(kip)	(kip)		-	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															
-															
6															
6 7 8 9															
6 7 8 9 10															
6 7 8 9															

#### **Result Comparison**

The reference gives  $_{\varphi}Pn = 253$  kips,  $_{\varphi}Mnx = 137$  ft-kips,  $_{\varphi}Mny = 52.5$  ft-kips while sCheck gives  $_{\varphi}Pn = 252.522$  kips,  $_{\varphi}Mnx = 136.59$  ft-kips,  $_{\varphi}Mny = 52.5$  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. Fy = 50 ksi, L = 30 ft, Kx = Ky = Kz = 1.0, Lux = Luy = Lb = 30 ft, Cb = 1.41. Note: tension load must be entered as negative value.

Steel Beam-	-Column (	Check													>
Code:	AISC 3	60-10 (14th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi	is Method						
Section:	W14X8	32			AISC Table		🔽 Conside	r Moment	Magnificati	on	Ste	eel Yield Sti	ress	50	ksi
Geometry															
Length:	30	ft		Lb:	30	ft	C	ib: 1	.41			nnector Dis r double an		0	ft
Lux:	30	ft		Luy	30	ft	L	uz: 3	30	ft					
Kx:	1			Ky:	1	1		<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
150.	-	_		т.у.				×2.							
Load Effects	. 0														
															Calend 🔺
	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (kip)	Vuy I (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															
6															
7															
8															
9															
10															
11															-
4															
<i>(</i>													_		
Corr	npute	Pro	ocedure in W	/ord	Procedu	re in PDF							0	К	Close

#### **Result Comparison**

The reference gives  $_{\phi}Pn = 1080$  kips,  $_{\phi}Mnx = 492$  ft-kips,  $_{\phi}Mny = 168$  ft-kips while sCheck gives  $_{\phi}Pn = 1080$  kips,  $_{\phi}Mnx = 491.54$  ft-kips,  $_{\phi}Mny = 168$  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. Example 26 being 25 ft L h = 5 ft C h = 1.0
```

Fy = 36 ksi, L = 25 ft, Lb = 5 ft, Cb = 1.0.

Steel Beam	-Column (	Check													×
Code:	AISC 3	860-10 (14th	Edition) LRF	Đ	~		🖂 Use Dire	ct Analysi	s Method						
Section:	C15X3	3.9			AISC Table		< Consider	r Moment I	Magnificati	on	Ste	el Yield Str	ess	36	ksi
Geometry															
Length:	: 25	ft		Lb:	5	ft	С	ь: 1				nnector Dis r double an		0	ft
Lux:	25	ft		Luy:	25	ft	Ŀ	uz: 2	5	ft	,				
Kx:	1	_		Ky:	1	1	ŀ	(z: 1							
150.				1.34	·		r								
	. 0														
Load Effect															Column A
	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	1	05 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															
4															▼
Cor	mpute	Pro	ocedure in V	Vord	Procedure	e in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  $_{\phi}$ Mnx = 130 ft-kips,  $_{\phi}$ Vnx = 117 kips while sCheck gives  $_{\phi}$ Mnx = 130.434 ft-kips,  $_{\phi}$ Vnx = 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. Fy = 50 ksi, L = 20 ft, Kx = Ky = Kz = 1.0, Lu = 20 ft, Cb = 1.41.

Geometry       Length:       20       ft       Lb:       20       ft       Cb:       1       Connector Distance (for double angles only):       0         Lux:       20       ft       Luy:       20       ft       Luz:       20       ft         Kx:       1       Ky:       1       Kz:       1       For double angles only):       0         Load Effects &       Provide angles       View       View       prime       prim       prime       prime	$\rightarrow$
Section:     WT7x15     AISC Table     Consider Moment Magnification     Steel Yield Stress     50       Geometry     Length:     20     ft     Lb:     20     ft     Cb:     1     Connector Distance (for double angles only):     0       Lux:     20     ft     Luy:     20     ft     Luz:     20     ft       Kx:     1     Ky:     1     Kz:     1     Connector Distance (for double angles only):     0       Lux:     20     ft     Luz:     20     ft     Luz:     20     ft       Load Effects &	
Geometry     Length:     20     ft     Lb:     20     ft     Cb:     1     Connector Distance (for double angles only):     0       Lux:     20     ft     Luy:     20     ft     Luz:     20     ft       Kx:     1     Ky:     1     Kz:     1     For double angles only):     0	
Length:       20       ft       Lb:       20       ft       Cb:       1       Connector Distance (for double angles only):       0         Lux:       20       ft       Luy:       20       ft       Luz:       Luz:       20       ft       Luz:       Luz:       20       ft       Luz:	si
Length:       20       ft       Lb:       20       ft       Cb:       1       Connector Distance (for double angles only):       0         Lux:       20       ft       Luy:       20       ft       Luz:       Luz:       20       ft       Luz:       Luz:       20       ft       Luz:	
Lux:     20     ft     Luz:     20     ft     Luz:     20     ft       Lux:     1     Ky:     1     Kz:     1	ł
Kx:     1     Ky:     1     Kz:     1       Load Effects &	
Load Effects &	
Load Effects &	
Du Muu Muu Yuu Yuu Yuu biiYuu shiMuu shiMuu shiMuu shiYuu Cuiisa	
Du Mun Mun Yuu Yuu Yuu ahiDa ahiMau ahiMau ahiYuu ahiYuu Culiaa	
Pu Mux Muy Vux Vuy o o phi-Pn phi-Mnx phi-Mnx phi-Vnx or or Critical	
<b>1</b> 36 0 0 0 0 1 1 36.6049 21.3 16.8375 50.4468 69.9583 1.9107 13.3382 0.983	5
2         3         4	
4	
5	
6	
7	
8	
9	
	-
Compute Procedure in Word Procedure in PDF OK Clos	

#### **Result Comparison**

The reference gives  $_{\varphi}Pn = 36.6$  kips while sCheck gives  $_{\varphi}Pn = 36.6049$  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. Fy = 46 ksi, L = 30 ft, Kx = Ky = 0.8, Kz = 1.0, Lu = 30 ft, Cb = 1.0.

Steel Beam	ı-Column (	Check													×
Code:	AISC 3	:60-10 (14th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi	s Method						
Section:	HSS12	×8×3/16			AISC Table		< Conside			on	Ste	el Yield Str	ess	46	ksi
Geometry															
Length	. 30	ft		Lb:	30	ft	С	ib: 1				nnector Dis double an		0	ft
Lux:	30	ft		Luy	30	ft	L	uz: 3	10	ft					
Kx:	0.8			Ky:	0.8	]	,	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
								·•· _							
Load Effect	te L														
	Pu	Mux	kd	Vux	Vuy			phi-Pn	phi-Mnx	phi-Mny	phi-Vnx	phi-Vny			Critical 🔺
	(kip)	(kip-ft)	Muy (kip-ft)	(kip)		Cmx	Cmy	(kip)	(kip-ft)	(kip-ft)	(kip)	(kip)	B1x	B1y	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															
4															
5															
6															
7															
8															
9															_
10															
11															
•															•
Cor	mpute	Pro	ocedure in V	/ord	Procedur	e in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  $_{\phi}Pn = 142$  kips while sCheck gives  $_{\phi}Pn = 142.063$  kips. They are practically identical. Please be advised that sCheck takes a conservative initial assumption (f = Fy) 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. Fy = 46 ksi, L = 21 ft, Lb = 21 ft, Cb = 1.0.

Steel Bean	n-Column	Check													×
Steel bean	n-column	CHECK													^
Code:	AISC	360-10 (14th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi	s Method						
Section:	HSS8	×8×3/16		A	ISC Table		🔽 Conside	r Moment	Magnificati	on	Ste	eel Yield Str	ess	46	ksi
Geometry	y														
Lengt	h: 21	ft		Lb:	21	ft	С	b: 1				nnector Dis r double an		0	ft
Lux:	21	ft		Luy:	21	ft	L	uz: 2	:1	ft	(10)		gics only).		
							-	_		i.					
Kx:	1			Ky:	1		ł	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
Load Effec	cts &														
	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															
4 <b>1</b>															<b>▼</b>
<i>(</i>													_		
Co	ompute	Pro	ocedure in W	/ord	Procedur	e in PDF							0	K l	Close

#### **Result Comparison**

The reference gives  $_{\phi}Mnx = 42.5$  ft-kips while sCheck gives  $_{\phi}Mnx = 42.5486$  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. Fy = 35 ksi, L = 30 ft

Steel Beam-G	Column C	Check													×
Code:	AISC 3	60-10 (14th	Edition) LRF	D	~		🔽 Use Dire	ct Analysi	s Method						
Section:	Pipe108	STD			AISC Table		🚽 Consider	-		on	Ste	el Yield St	ress	35	ksi
Geometry															
Length:	30	ft		Lb:	30	ft	C	b: 1				nnector Di: I double an		0	ft
Lux:	30	ft		Luy:	30	ft	L	uz: 3	0	ft					
Kx:	1			Ky:	1		k	(z: 1							
	-														
Load Effects	&														
	Pu	Mux	Muy (1.5- W	Vux	Vuy	Cmx	Cmy	phi-Pn	phi-Mnx	phi-Mny	phi-Vnx	phi-Vny	B1x	B1y	Critical Ratio
1	(kip) 0	(kip-ft) 0	(kip-ft) O	(kip)	(kip) 0 0	1	1	(kip) 221.966	(kip-ft) 96.8625	(kip-ft) 96.8625	(kip) 108.675	(kip) 108.675	1.0000	1.0000	0.0000
2		U	U		0 0	1	1	221.300	36.0623	36.0623	106.670	106.670	1.0000	1.0000	0.0000
3															
4															
5															
6															
7															
8															
9															
10															
11															
•															
Comp	oute	Pro	ocedure in W	/ord	Procedure	e in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  $_{\phi}Pn = 222$  kips while sCheck gives  $_{\phi}Pn = 221.966$  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. Fy = 42 ksi, L = 32 ft

ode:	AISC 3	360-10 (14th	Edition) LRF	D	~		🛃 Use Dire	ct Analysi	s Method						
ection:	HSS16	6.000×0.375			AISC Table		🔽 Consider	Moment I	Magnificati	on	Ste	eel Yield Str	ess	42	k
Geometry –															_
-	32	ft		Lb:	32	ft	_	b: 1			Co	nnector Dis	ance	0	ft
Length:	32	rt		LD:	52	n	С	b: _			(fo	r double an	gles only):		I
Lux:	32	ft		Luy:	32	ft	L	uz: 3	2	ft					
Kx:	1			Ky:	1		L.	(m. 1							
INA.				Ny.	·		r	(z: 1							
ad Effects	&														
	Pu	Mux	Muy	Vux	Vuy	Cmx	Cmy	phi-Pn	phi-Mnx	phi-Mny	phi-Vnx	phi-Vny	B1x	B1y	Critical
-	(kip)	(kip-ft)	(kip-ft)	(kip)	(kip)			(kip)	(kip-ft)	(kip-ft)	(kip)	(kip)		-	Ratio
1	0	0	0	18	30 0	-	1 1	483.508	269.325	269.325	195.048	195.048	1.0000	1.0000	0.9228
2															
3															
4 5															
о 6															
7															
8															
9															
10															
11															

#### **Result Comparison**

The reference gives  $_{\phi}$ Vnx = 195 kips while sCheck gives  $_{\phi}$ Vnx = 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. Fy = 36 ksi, L = 8 ft, Kx = Ky = Kz = 1.0, Lux = Luy = Luz = 8 ft. Connector distance = 32 in = 2.66667 ft.

Steel Beam	-Column (	Check													×
Code:	AISC 3	60-10 (14th	Edition) LRF	D	~		🔽 Use Dire	ect Analysi	s Method						
Section:	2L5x3x	:1/4x3/4LLB	В		AISC Table		Consider Moment Magnification					el Yield Str	ess	36	ksi
Geometry															
Length	8	ft		Lb:	8	ft	ft Cb: 1				Connector Distance (for double angles only):		2.66667 ft		
Lux:	Lux: 8 ft Luy: 8			ft	L	uz: 8		ft	(10)		gioo oniy).				
K	1	_				1									
Kx:		_		Ky:		_	k	(z: 1							
Load Effect	:s &														
	Pu (kip)	Mux (kip-ft)	Muy (kip-ft)	Vux (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															
8															
9															
10															
11															
1															▼
Cor	mpute	Pro	ocedure in W	/ord	Procedu	re in PDF							0	ĸ	Close

#### **Result Comparison**

The reference gives  $_{\phi}Pn = 64.3$  kips while sCheck gives  $_{\phi}Pn = 64.2975$  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.

Fy = 36 ksi, L = 5 ft, Kx = Ky = Kz = 1.0, Lux = Luy = Luz = 5 ft.

Steel Beam	-Column (	Check													×
Code:	AISC 3	60-10 (14th	Edition) LRF	Đ	~		🗌 Use Dire	ect Analysi	s Method						
Section:	L8×4×	7/16			AISC Table		Consider Moment Magnification						ress	36 ksi	
Geometry															
Length	Length: 5 ft Lb: 5				ft	ft Cb: 1				Connector Distance (for double angles only):			0	ft	
Lux:	Lux: 5 ft Luy: 5				ft	L	uz: 5		ft						
Kx:	1			Ky:	1		k	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
			_		_										
Load Effect	s &														
	Pu	Mux	Muy	Vu	: Vuy	Cmx	Cmy	phi-Pn	phi-Mnx	phi-Mny	phi-Vnx	phi-Vny	B1x	B1y	Critical
	(kip)	(kip-ft)	(kip-ft)	(kip	) (kip)	Cillx	Citiy	(kip)	(kip-ft)	(kip-ft)	(kip)	(kip)		-	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															
6															
7															
8															
9															
10															
11															
4															•
Cor	npute	Pro	ocedure in V	Vord	Procedu	re in PDF							0	ĸ	Close

#### **Result Comparison**

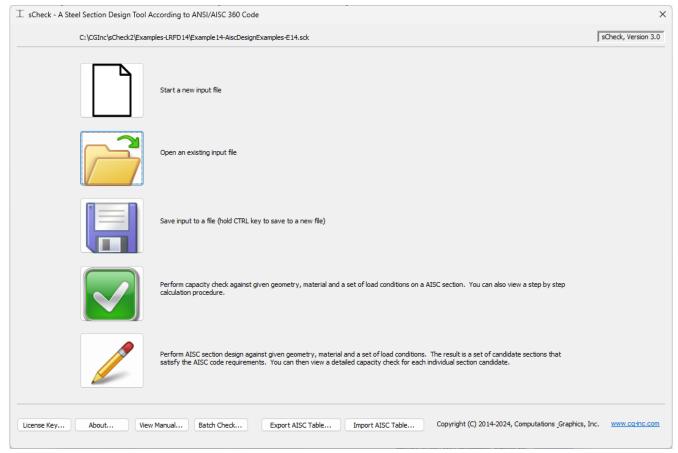
The reference gives  ${}_{\phi}Pn = 113$  kips,  ${}_{\phi}Mnx ({}_{\phi}M_{nw}) = 248$  in-kips = 20.67 ft-kips,  ${}_{\phi}Mny ({}_{\phi}M_{nz}) = 78.3$  in-kips = 6.525 ft-kips while sCheck gives  ${}_{\phi}Pn = 113.679$  kips,  ${}_{\phi}Mnx ({}_{\phi}M_{nw}) = 20.762$  ft-kips,  ${}_{\phi}Mny ({}_{\phi}M_{nz}) = 6.5205$  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 Mux and Muy 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. Fy = 50 ksi, L = 14 ft, Kx = Ky = Kz = 1.0, Lux = Luy = Lb = 14 ft, Cb = 1.14. Pn = 30 kips, Mux = 90 ft-kips, Muy = 12 ft-kips, Cmx = 1.0, Cmy = 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.

Code:	AISC 360	)-10 (14th Editi	on) LRFD							~				
Shape:	W									~				
	Section	Filter Criteria (O	ptional)							🔽 Use Direct Ar	nalysis Metho	bd		
	Section (Comm	n Prefixes a delimited list,	e.g. W12, W	w8,w10,	,w12					🔽 Consider Mor	nent Magnific	ation		
	Sectio	n Min Depth:	0	in	S	ection Max D	epth:	0	in	Maximum Numbe Section Candida		10		
	Sectio	n Min Width:	0	in	S	ection Max V	Vidth:	0	in	Steel Yield Stress	s (Fy):	50	ksi	
.oads:		Pu	Mux	Muy	Vux	Vuy	Cm	x f	my .	Geometry				
	-	(kip)	(kip-ft)	(kip-ft)	(kip)	(kip)				Length: 14	ft			
	1	30	90	12	0	0		1	1	Lux: 14	ft	Кж	1	
	3													-
	4									Luy: <u>14</u>	ft	Ky:	1	_
	5									Luz: 14	ft	Kz	1	
	6									Lb 14	ft	СЬ	1.14	
	7													_
	8								•	<ul> <li>Connector Distar</li> </ul>	nce (for doub	le angles on	ly) 0	_
ection										٦				
andidates			Section			Critical Ratio		Critical L	ad	Perform Design				
	1		W10X33			0.9871		1		Check Section				
	2		W8X35			0.9874		1						
	3		W12X35			0.9900		1						
	4		W10X39			0.7908		1						
	5		W8X40			0.8525		1	_	ОК				
	6		W12X40			0.7154		1						

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	n-Column (	Check													×
Code:	AISC 3	160-10 (14th	Edition) LRF	D	~		🔽 Use Dire	ect Analusi	s Method						
Section:	W10X	33		AB	SC Table		Conside			on	Ste	el Yield Sti	ress	50	ksi
Geometry	,														
Length	n: 14	ft		Lb:	14	ft	ft Cb: 1.14 Connector Distance (for double angles on						u): O ft		
Lux:	14	ft		Luy:	14	ft	L	uz: 1	4	ft	Ì				
Kx:	1			Ky:	1	]	,	<z: 1<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td></z:>							
Load Effect	oad Effects &														
	Pu	Mux	Muy	Vux	Vuy	_		phi-Pn	phi-Mnx	phi-Mny	phi-Vnx	phi-Vny			Critical 🔺
	(kip)	(kip-ft)	(kip-ft)	(kip)	(kip)	Cmx	Cmy	(kip)	(kip-ft)	(kip-ft)	(kip)	(kip)	B1x	B1y	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															
9															
10															
11															
4.2															<b>•</b>
•								_	_		_	_	_		•
Co	Compute         Procedure in Word         Procedure in PDF         OK         Close														

# 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^2	bf	7.96	in	tf	0.435	in
tw	0.29	in	d	9.73	in	h / tw	27.1	
Cw	791	in^6	h0	9.3	in	rts	2.2	in
Zx	38.8	in^3	Sx	35	in^3	Ix	171	in^4
rx	4.19	in	Zy	14	in^3	Sy	9.2	in^3
ly	36.6	in^4	ry	1.94	in	J	0.583	in^4

# 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		Ку	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 elem	nent		
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
$4.71\sqrt{rac{E}{F_y}}$	113.43	
$\frac{KL}{r} \le 4.71 \sqrt{\frac{E}{F_y}}$		
$F_n = \left(0.658^{\frac{F_y}{F_e}}\right) F_y$	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	
$\frac{F_y}{F_e} \le 2.25$		
$F_n = \left(0.658^{\frac{F_y}{F_e}}\right) F_y$	37.094 ksi	Eq.E3-2
$P_n = F_n A_g$	360.18 kips	Eq.E4-1
Flexural buckling controls: Pn	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	
Pr / Pns = Pr / (Fy * Ae)	0.061792	
$\alpha P_r/P_{ns} \le 0.5$		
$\tau_b = 1.0$	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	
$P_{e1} = \frac{\pi^2 E I^*}{\left(K_1 L\right)^2}$	1387.3 kips	Eq.A-8-5
$B_1 = \frac{C_m}{1 - \alpha P_r / P_{e1}} \ge 1$	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	
$P_{e1} = \frac{\pi^2 E I^*}{\left(K_1 L\right)^2}$	296.93 kips	Eq.A-8-5
$B_1 = \frac{C_m}{1 - \alpha P_r / P_{e1}} \ge 1$	1.1124	Eq.A-8-3
Magnified Muy = Muy * B1	13.349 kip-ft	
Mrx = Mux; Mry = Muy	I	

# Major Flexure Capacity Calculation

Step	Equation	Value	Note
Web compactness:	/	1	
	$\lambda = \frac{h_c}{t_w}$	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		
$L_p = 1.76 r_y \sqrt{\frac{E}{F_y}}$	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 Lp < Lb < Lr		
$M_n = C_b \left[ M_p - (M_p - 0.7F_y S_x) \left( \frac{L_b - L_p}{L_r - L_p} \right) \right] \le M_p$	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			
	Fy * Zy	58.333 kip-ft	

Fy * Sy	38.333 kip-ft	
$M_n = M_p = F_y Z_y \le 1.6 F_y S_y$	58.333 kip-ft	Eq.F6-1
Mny to account for lateral-torsional buckling	I	
$\lambda < \lambda_{pf}$		
$M_n = M_p$	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	
	$\frac{P_r}{P_c} < 0.2$		
	$\frac{P_r}{2P_c} + \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right) \le 1.0$	0.98713	Eq.H1-1b
Axial-flexural strength: OK			

# **Major Shear Capacity Calculation**

Step	Equation	Value	Note
	$A_w = dt_w$	2.8217 in^2	
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	
	$h/t_w \le 2.24 \sqrt{E/F_y}$		
	$C_{v1} = 1.0$		Eq.G2-2
Major shear strength			
	$V_n = 0.6F_y A_w C_{v1}$	84.651 kips	Eq.G2-1

	$h/t_w \le 2.24 \sqrt{E/F_y}$		
	$\phi_v = 1.00$		
	$\phi_v V_n$	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^2	
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	
	$h/t_w \le 1.10 \sqrt{k_v E/F_y}$		
	$C_{v2} = 1.0$	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	
	$rac{V_u}{\phi_v V_n}$	0	
Shear strength (minor axis): OK			

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