RISASection

Rapid Interactive Structural Analysis –Sectional Property Calculator

Verification Problems

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Verification Overview

Verification Methods

We at RISA maintain a library of dozens of test problems used to validate the computational aspects of RISA programs. In this verification package we present a representative sample of these test problems for your review.

These test problems should not necessarily be used as design examples; in some cases the input and assumptions we use in the test problems may not match what a design engineer would do in a "real world" application. The input for these test problems was formulated to test RISASection's performance, not necessarily to show how certain structures should be modeled.

The RISASection solutions for each of these problems are compared to hand calculations or values from trusted published references.

The data for each of these verification problems is provided. The files are RISASection Verification Problem 1.nmsx for problem 1, RISASection Verification Problem 2.nmsx for problem 2, etc. When you install RISASection these data files are copied into the **C:\RISA\Examples** directory. If you want to run any of these problems yourself, just read in the appropriate data file and have at it.

Verification Version

This document contains problems that have been verified in RISASection version 2.1.

Verification Problem 1

Problem Statement

This problem is a tapered wide flange section (prismatic wide flange section with unequal flanges).

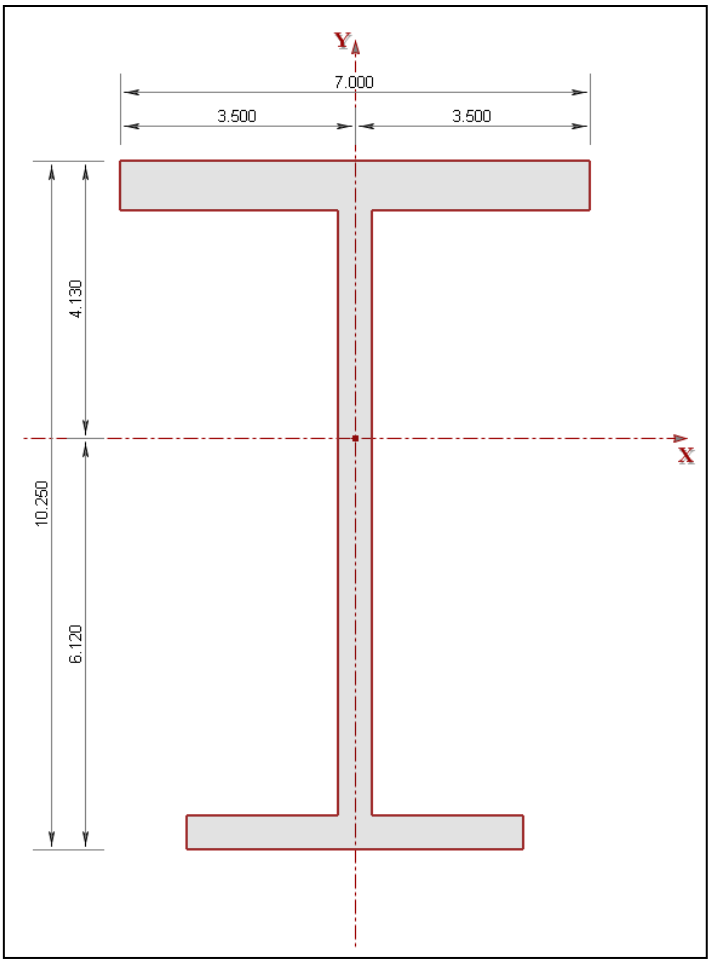

Figure 1.1- Tapered WF Section

Validation Method

The model was created in RISASection using flat plate shapes from the Basic Steel Shapes library. The section was then merged to create the single section. After solution, the property results will be compared to hand-calculated values.

Hand Calculations

Area of Section

Section	b(in)	h(in)	A(in^2)
Top Flange	7	0.75	5.25
Web	0.5	9	4.5
Bot Flange	5	0.5	2.5
		Σ=	12.25 in^2

Centroid Location

Section	A(in^2)	x(in)	y(in)	Ax(in^3)	Ay(in^3)
Top Flange	5.25	0	9.875	0	51.84
Web	4.5	0	5	0	22.5
Bot Flange	2.5	0	0.25	0	0.625
			Σ=	0	74.97

$$x_{centroid} = \frac{\Sigma Ax}{\Sigma A} = 0\ in$$

$$y_{centroid} = \frac{\Sigma Ay}{\Sigma A} = 6.12\ in$$

Therefore,

$$Y\_Bar_{top} = d - y_{centroid} = 10.25\ in - 6.12\ in = 4.13\ in$$

$$Y\_Bar_{bottom} = x_{centroid} = 6.12\ in$$

$$X\_Bar_{right} = b/2 = 7in/2 = 3.5\ in$$

$$X\_Bar_{left} = b/2 = 7in/2 = 3.5\ in$$

Moments of Inertia

About the XX Axis:

Section	I(in^4)	A(in^2)	d^2(in^2)	A*d^2(in^4)
Top Flange	0.25	5.25	14.10	74.03
Web	30.38	4.5	1.25	5.64
Bot Flange	0.05	2.5	34.46	86.14
Σ=	30.67			165.81

$$I_{xx} = \sum I + A * d^2 = \sum 30.67 + 165.81 = 196.49\ in^4$$

About the YY Axis:

Section	I(in^4)	A(in^2)	d^2(in^2)	A*d^2(in^4)
Top Flange	21.44	5.25	0	0
Web	0.09	4.5	0	0
Bot Flange	5.21	2.5	0	0
Σ=	26.74			0

$$I_{yy} = \sum I + A * d^2 = \sum 26.74 + 0 = 26.74\ in^4$$

Comparison

	Hand Calcs	RISASection	% Difference
Area (in^2)	12.25	12.25	0.00
Y-Bar (Top) (in)	4.13	4.13	0.00
Y-Bar (Bot) (in)	6.12	6.12	0.00
X-Bar (Right) (in)	3.50	3.50	0.00
X-Bar (Left) (in)	3.50	3.50	0.00
Ixx (in^4)	196.49	196.49	0.00
Iyy (in^4)	26.74	26.74	0.00

Table 1.1 – Results Comparison

As seen above, the results match exactly.

Verification Problem 2

Problem Statement

This problem is a wide flange section capped with a channel section.

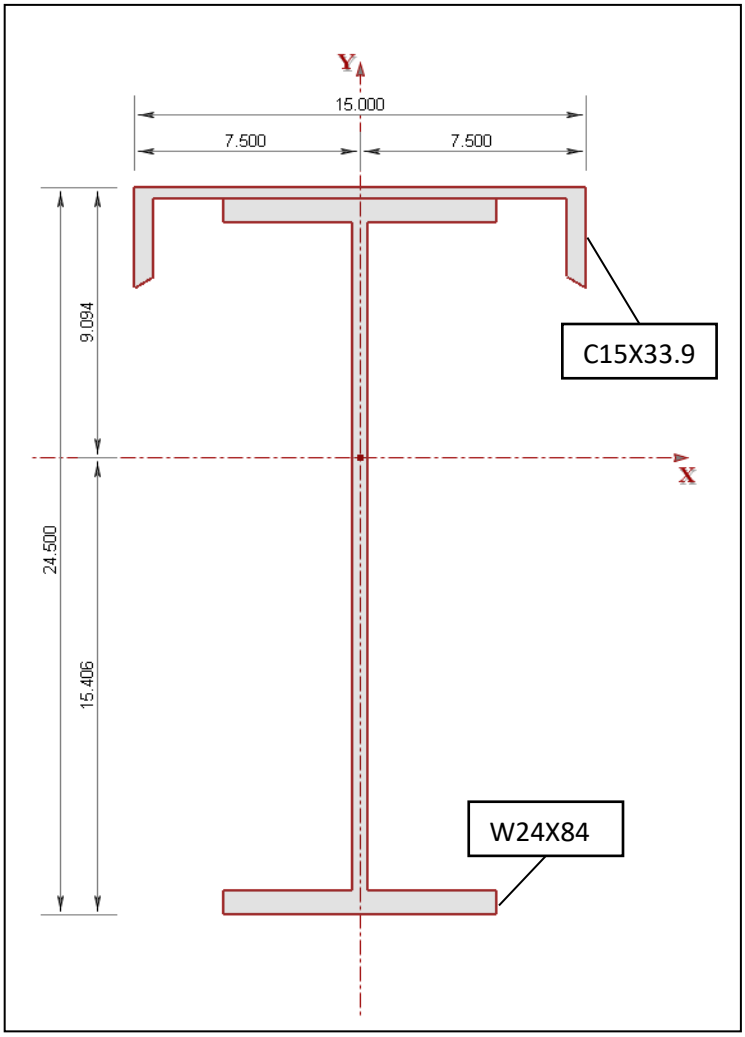

Figure 2.1- Cap Channel Section

Validation Method

The model was created in RISASection using AISC database shapes from the RISA HR Database library. After solution, the property results will be compared to values published in Table 1-19 from the *AISC 14th Edition Steel Manual*.

Comparison

	AISC 14th Edition	RISASection	% Difference
Area (in^2)	34.7	34.7	0.00
Y-Bar_Top (in)	9.1	9.1	0.00
Y-Bar_Bot (in)	15.4	15.406	0.04
Sx_Top (in^3)	367	367.64	0.17
Sx_Bot (in^3)	217	217.02	0.01
Sy (in^3)	54.5	54.587	0.16
Ix (in^4)	3340	3343.33	0.10
Iy (in^4)	409	409.4	0.10
Zx (in^3)	286	279.71	2.20
Zy (in^3)	83.4	81.212	2.62

Table 2.1 – Results Comparison

As seen above, the results match within a reasonable percent difference which is likely due to rounding in the code.

Verification Problem 3

Problem Statement

This problem compares published torsional properties to those calculated by RISASection.

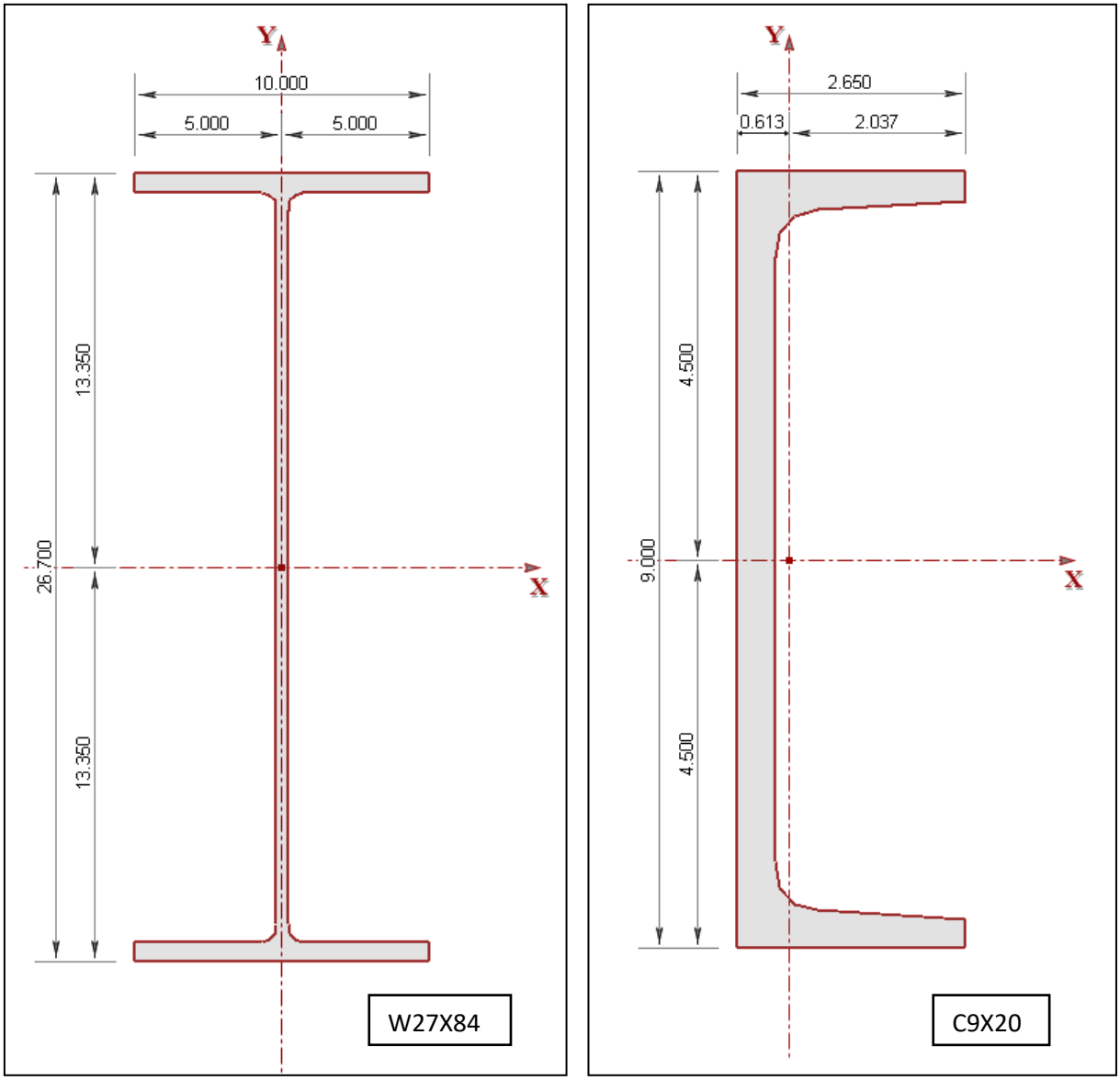

Figure 3.1- Wide Flange and Channel Cross Sections

Validation Method

The model was created in RISASection using DXF imported shapes. Since RISASection calculates the Torsional J property per a finite element method, using flat plates will result in higher discrepancies. Therefore, we have modeled a more accurate shape (with tapered edges and fillets) using CAD which is then imported into RISASection for analysis. After solution, the property results will be compared to values published in the *AISC 14th Edition Steel Construction Manual*.

Comparison

	AISC 14th Edition	RISASection	% Difference
Torsional J (in^4)	2.81	2.773	1.32
Cw (in^6)	17900	18150	1.38
Wno (in^2)	65.2	65.15	0.08
Sw (in^4)	104	104.24	0.23
Qf (in^3)	39.8	39.778	0.06
Qw (in^3)	121	120.55	0.37

Table 3.1 – Wide Flange Section Results Comparison

	AISC 14th Edition	RISASection	% Difference
Torsional J (in^4)	0.427	0.422	1.17
Cw (in^6)	39.4	39.432	0.08
eo (in)	0.515	0.516	0.19

Table 3.2 – Channel Section Results Comparison

As seen above, the results match within a reasonable percent difference. Any error can be attributed to round off and discrepancy in the CAD drawing.

Verification Problem 4

Problem Statement

This problem verifies the cross sectional properties of a 8HU4x075 Cold Formed Steel Hat section with dimensions taken directly from the *2008 AISI Design Manual*.

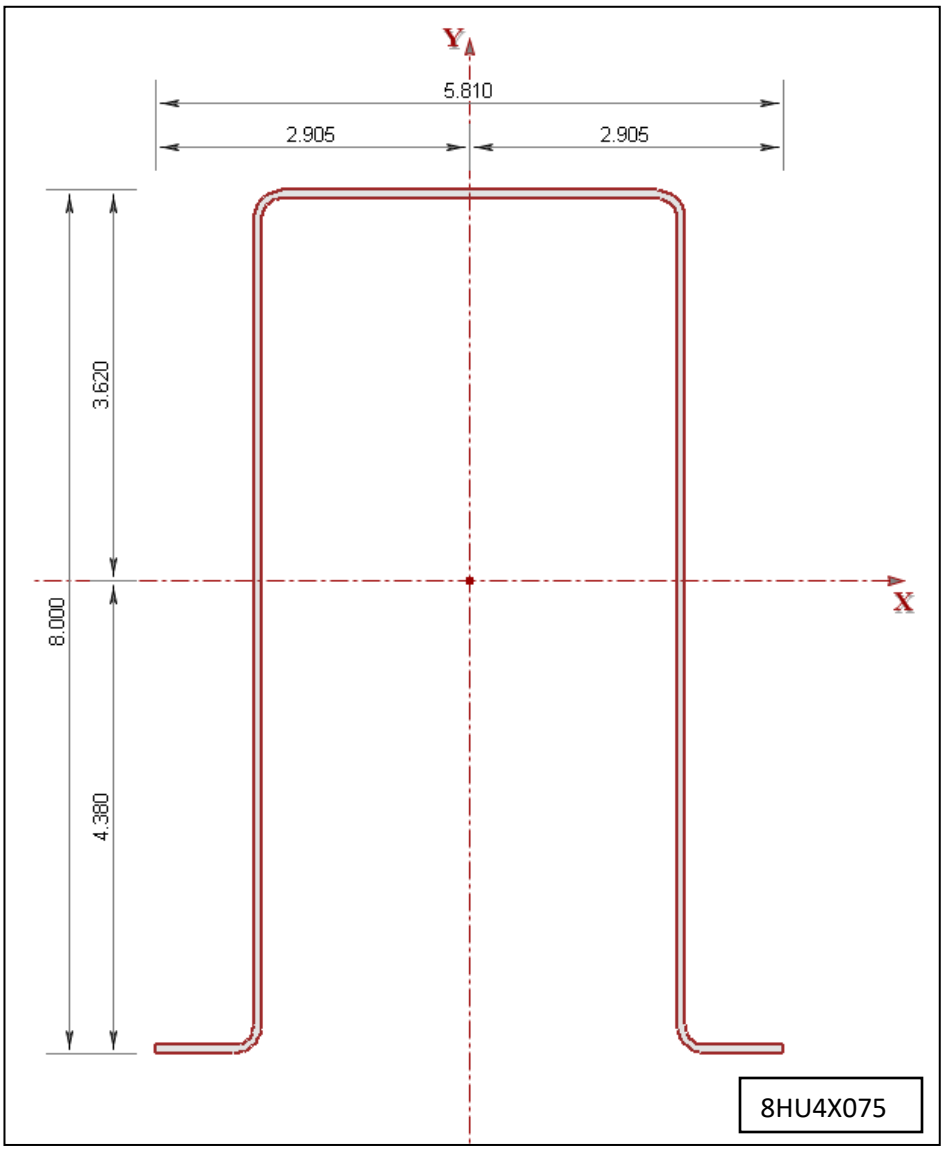

Figure 4.1- Hat Section

Validation Method

The model was created in RISASection using Cold Formed Steel shapes from the Basic Steel Shapes library. After solution, the property results will be compared to the values listed in Table I-8 from the *2008 AISI Design Manual*.

Comparison

	AISI 2008	RISASection	% Difference
Area (in^2)	1.6	1.595	0.31
Ix (in^4)	5.69	5.691*	0.02
Iy (in^4)	12.4	12.362*	0.31
Sx (in^3)	1.96	1.959*	0.05
Sy (in^3)	2.82	2.822*	0.07
J (in^4)	0.00299	0.003	0.33
X_Bar (in)	3.62	3.62*	0.00

*Note: The local axes directions are different between the two sources. Those shown above are in reference to those used in the AISI code.

Table 4.1 – Results Comparison

As seen above, the results match within a reasonable percent difference.