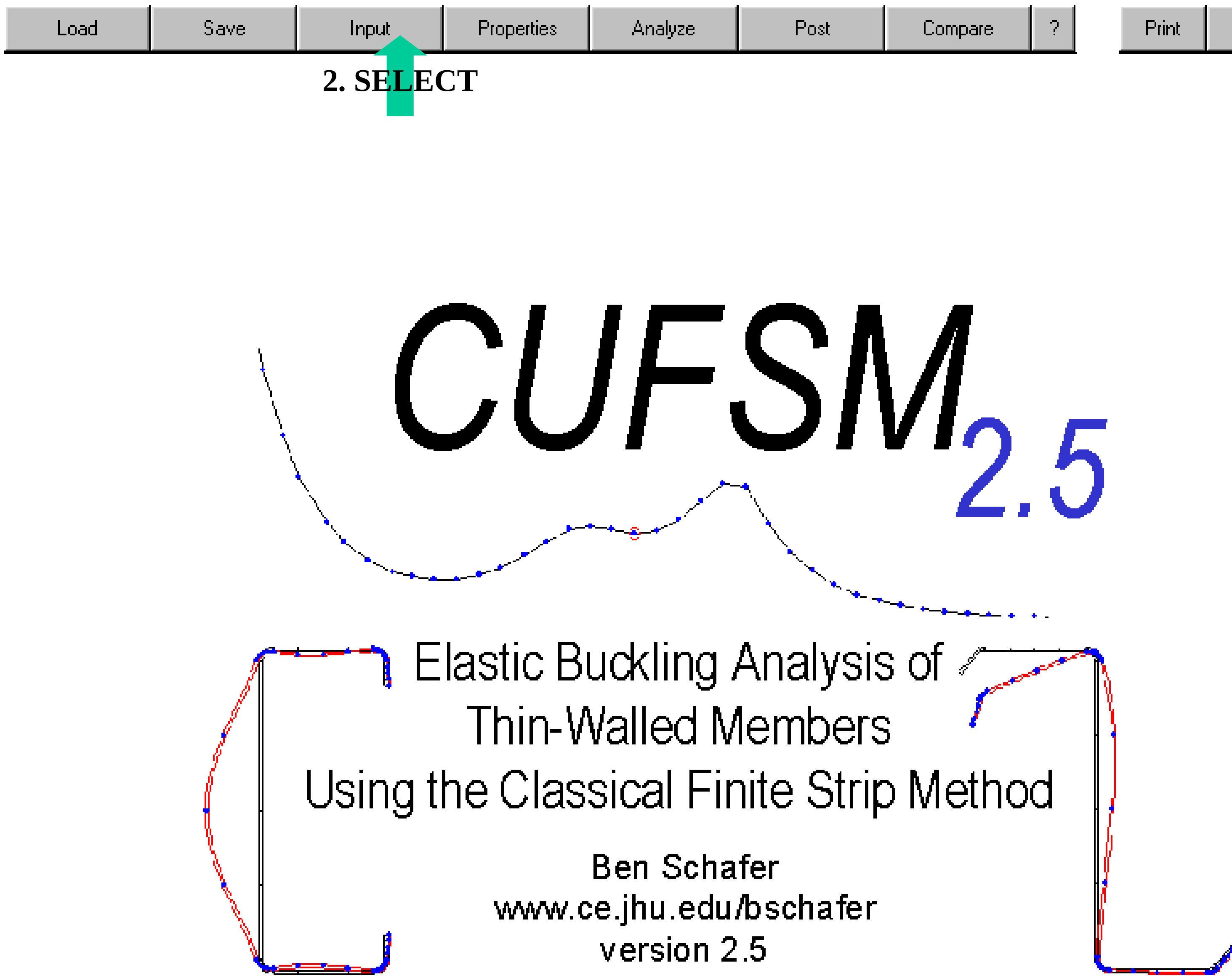
CUFSM2.5

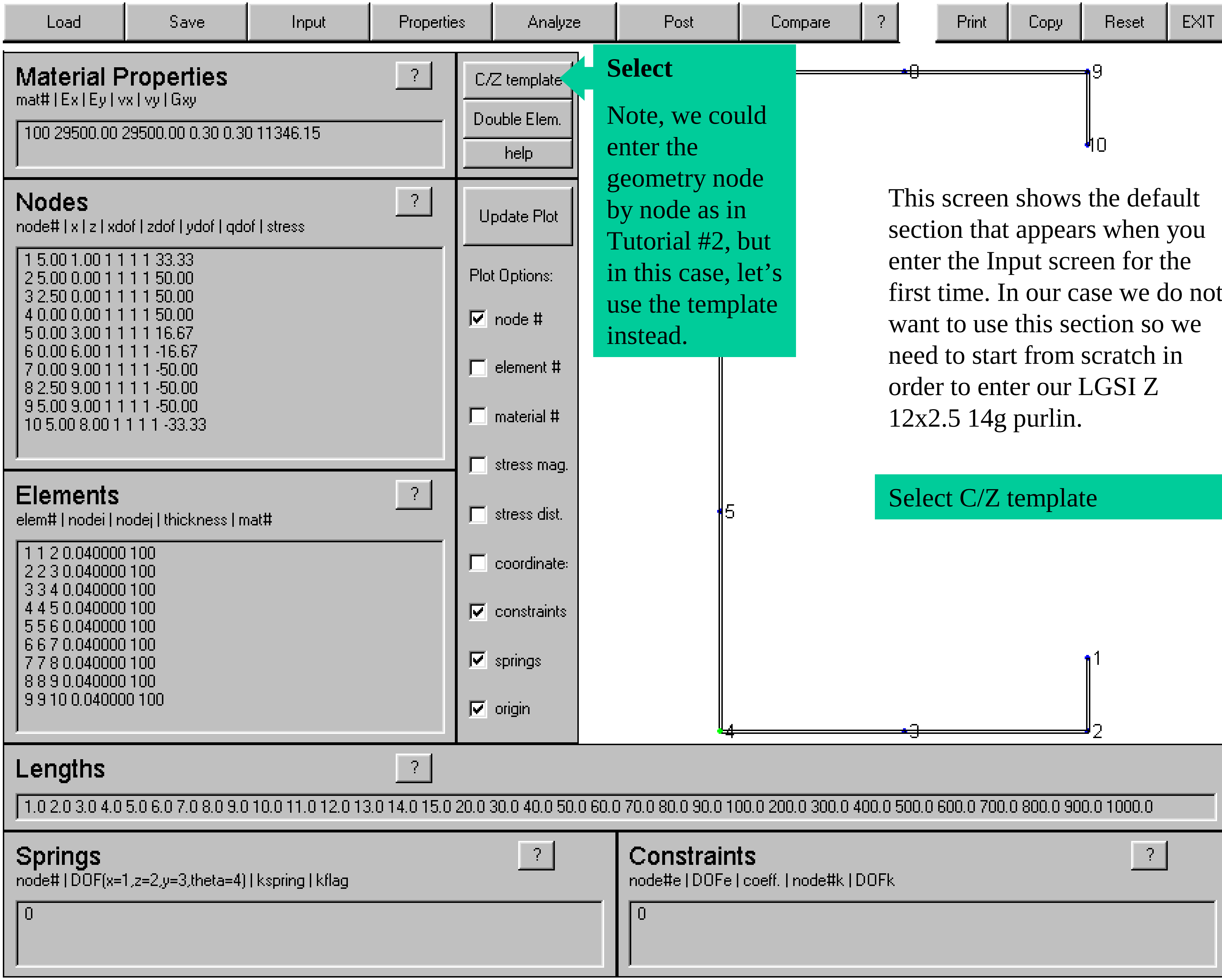
Tutorial 3

- LGSI Zee in Bending: Z 12 x 2.5 14g, F_y = 50ksi
- Objective

    To model a typical Zee purlin or girt in bending and determine the elastic critical local buckling moment ($M_{cr\ell}$)and elastic critical distortional buckling moment (M_{crd}).

- A the end of the tutorial you should be able to
    - enter material, nodes, elements, and lengths from scratch
    - OR use the C and Z template to enter a geometry
    - apply a reference load P, or M as desired
    - interpret a simple buckling curve
    - identify local and distortional buckling in a simple member
    - determine $M_{cr\ell}$ and M_{crd}


Load
Save
Input
Properties
Analyze
Post
Compare
?
Print
Copy
Reset
EXIT
2. SELECT
1. SELECT
CUFSM 2.5
Elastic Buckling Analysis of
Thin-Walled Members
Using the Classical Finite Strip Method
Ben Schafer
www.ce.jhu.edu/bschafer
version 2.5



Select

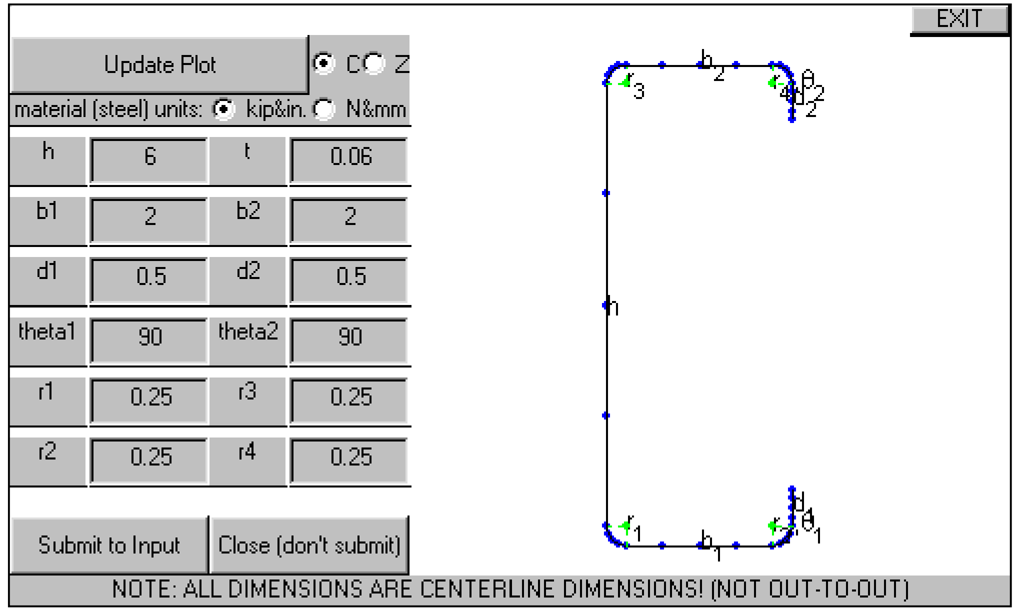
Note, we could enter the geometry node by node as in Tutorial #2, but in this case, let's use the template instead.

This screen shows the default section that appears when you enter the Input screen for the first time. In our case we do not want to use this section so we need to start from scratch in order to enter our LGSI Z 12x2.5 14g purlin.

Select C/Z template

This is the default template that comes up when you select the template button. Note that all dimensions are centerline dimensions - e.g., h is the flat distance, not the out-to-out distance as is typically listed in product catalogs, etc.

Enter in all the appropriate dimensions and select Submit to input.

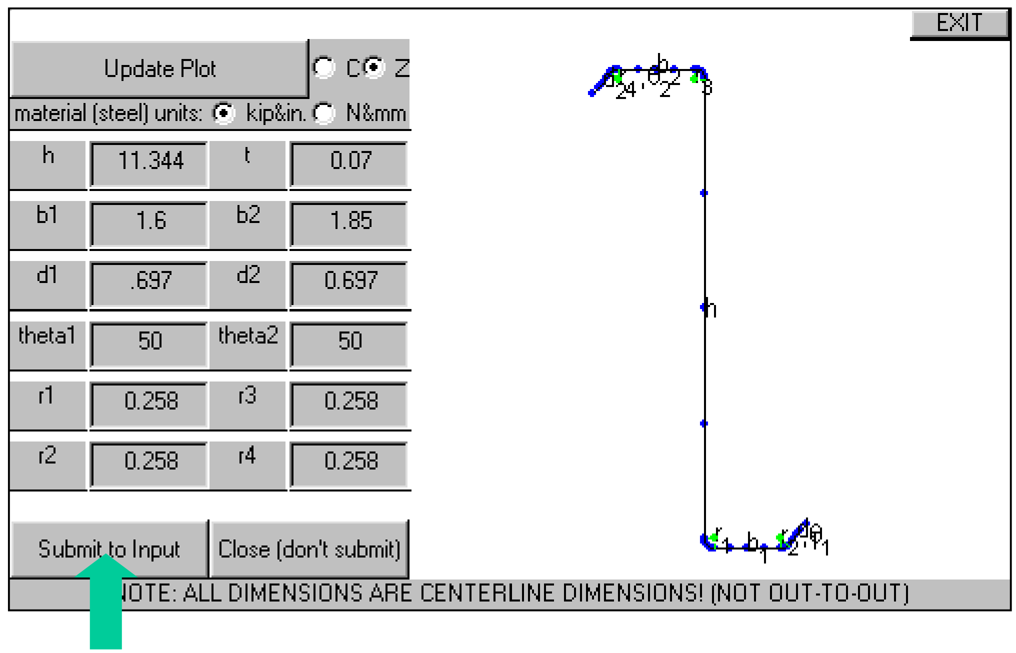


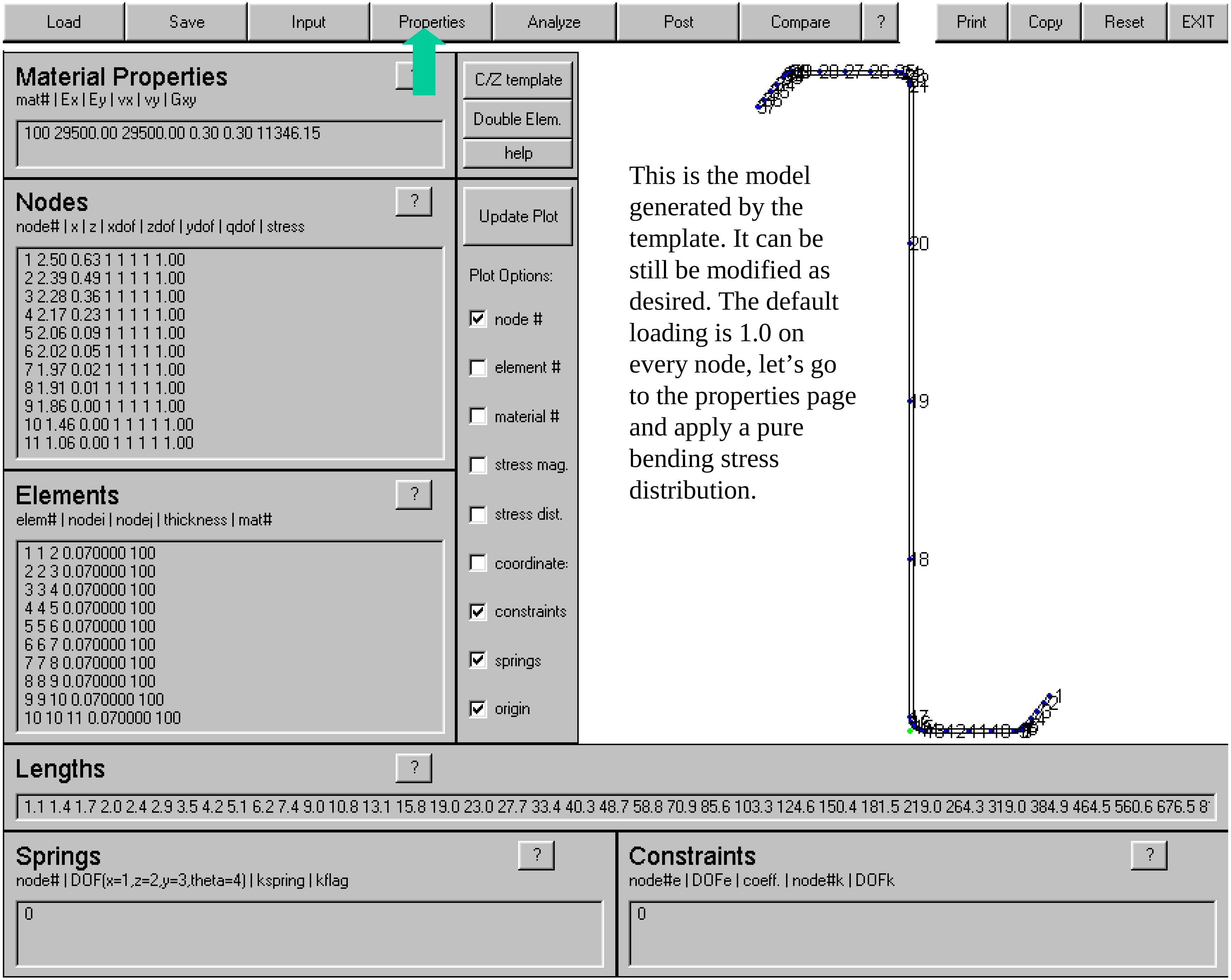
The centerline dimensions for an LGSI Z 12 x 2.5 14g member are shown to the right. Enter in these dimensions and then press Update Plot. When complete select Submit to Input.

Note, the material is assumed to be steel, but two units systems are supported. Geometry other than the typical Cee or Zee can be entered.

The template automatically selects an adequate number of elements.

The template automatically selects lengths to be analyzed as well.



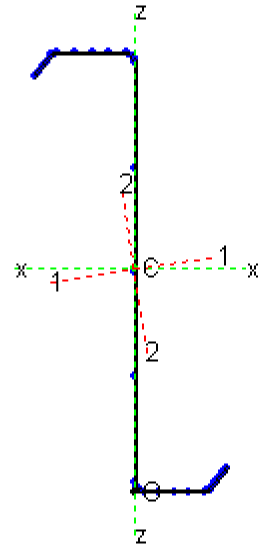


This is the model generated by the template. It can be still be modified as desired. The default loading is 1.0 on every node, let's go to the properties page and apply a pure bending stress distribution.

Load | Save | Input | Properties | Analyze | Post | Compare | ? | Print | Copy | Reset | EXIT

Calculated Section Properties

A = 1.2211	
xcg = -0.04168	zcg = 6.015
Ixx = 23.0469	Izz = 1.0744
Ixz = -3.3384	theta = 8.4511
I11 = 23.5429	I22 = 0.57838



Note that the principal coordinate system is not in line with the global x,z coordinate system, as expected.

Calculation of Loads and Moments for Generation of Stress on Member

Moment calculations should consider

(•) Unsymmetric or ( ) Restrained Bending

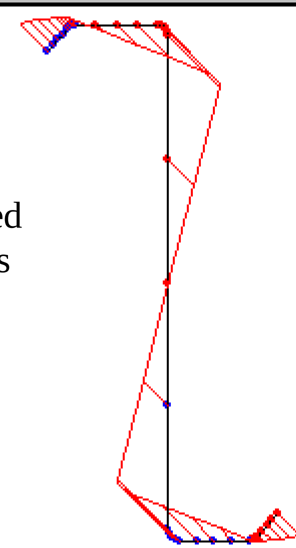
fy = 50 | Calculate P and M | ?

Loads and Moments

P =	61.0563	☐
Mxx =	110.1627	☑
Mzz =	15.1267	☐
M11 =	199.3363	☐
M22 =	8.3936	☐

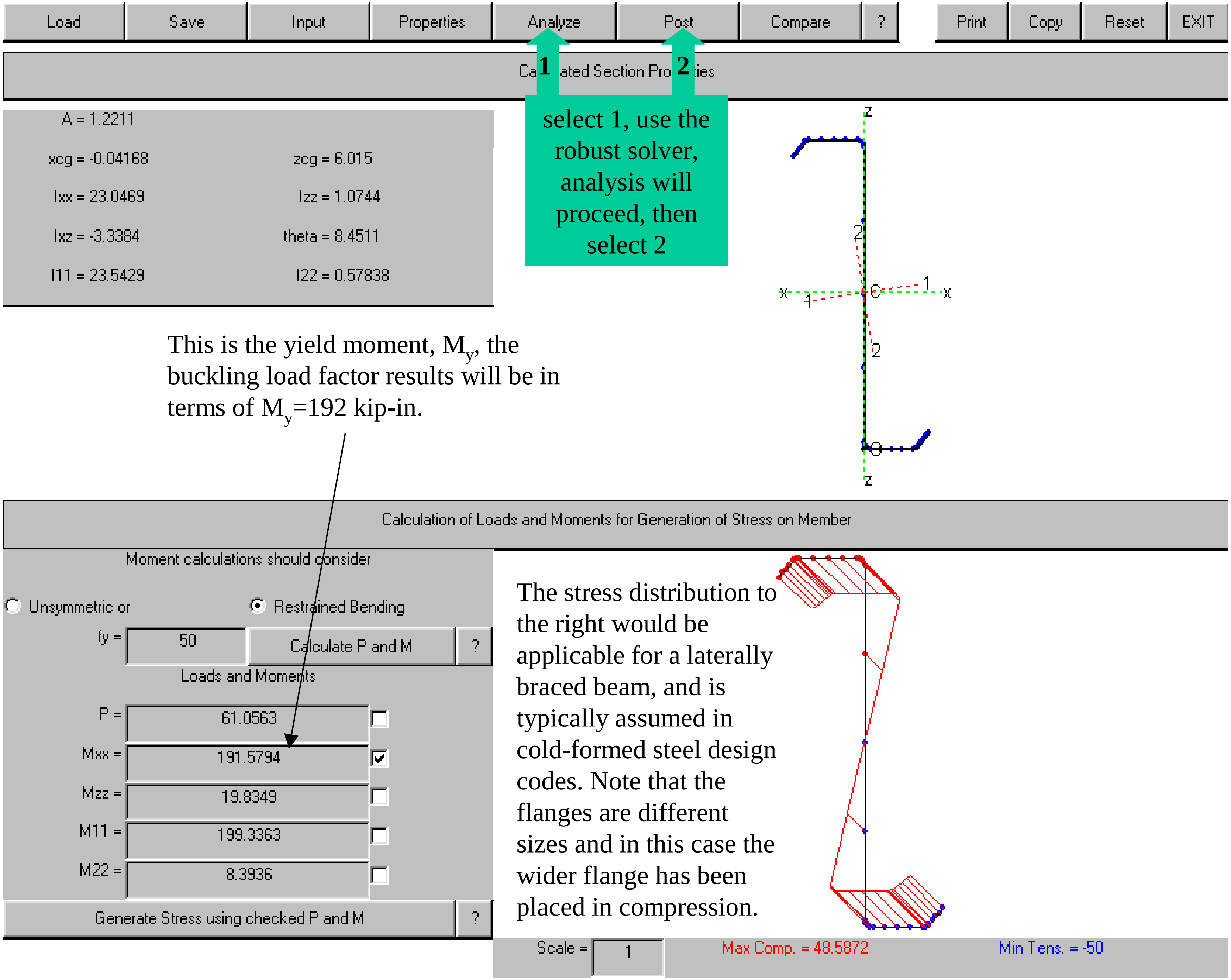
Generate Stress using checked P and M | ?

Enter a yield stress, calculate P and M, uncheck P and examine the generated stress distribution. As shown to the right, it reflects unsymmetric bending.



Scale = 1 | Max Comp. = 50 | Min Tens. = -49.226

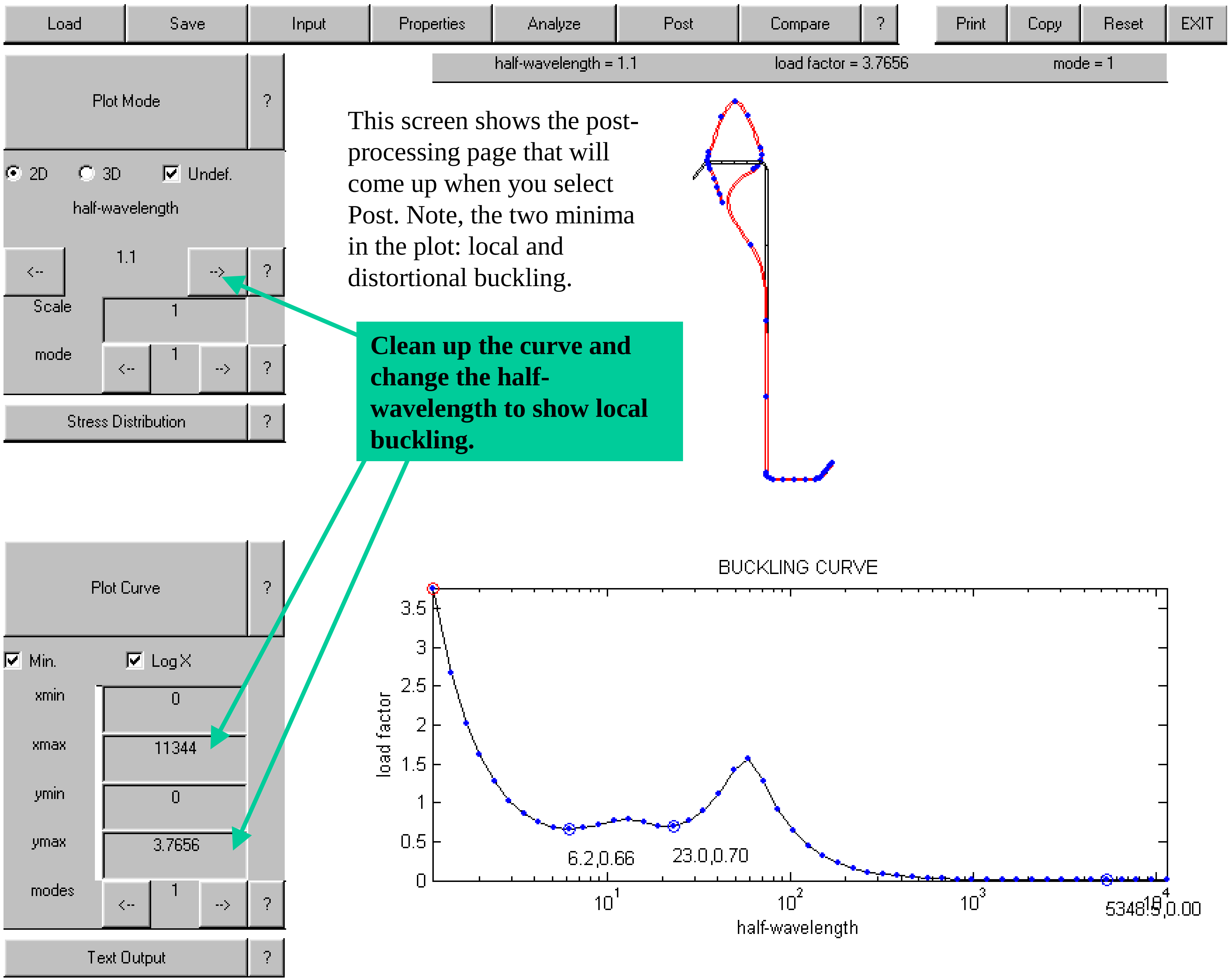
Switch to restrained bending and re-calculate the stress distribution.



select 1, use the robust solver, analysis will proceed, then select 2

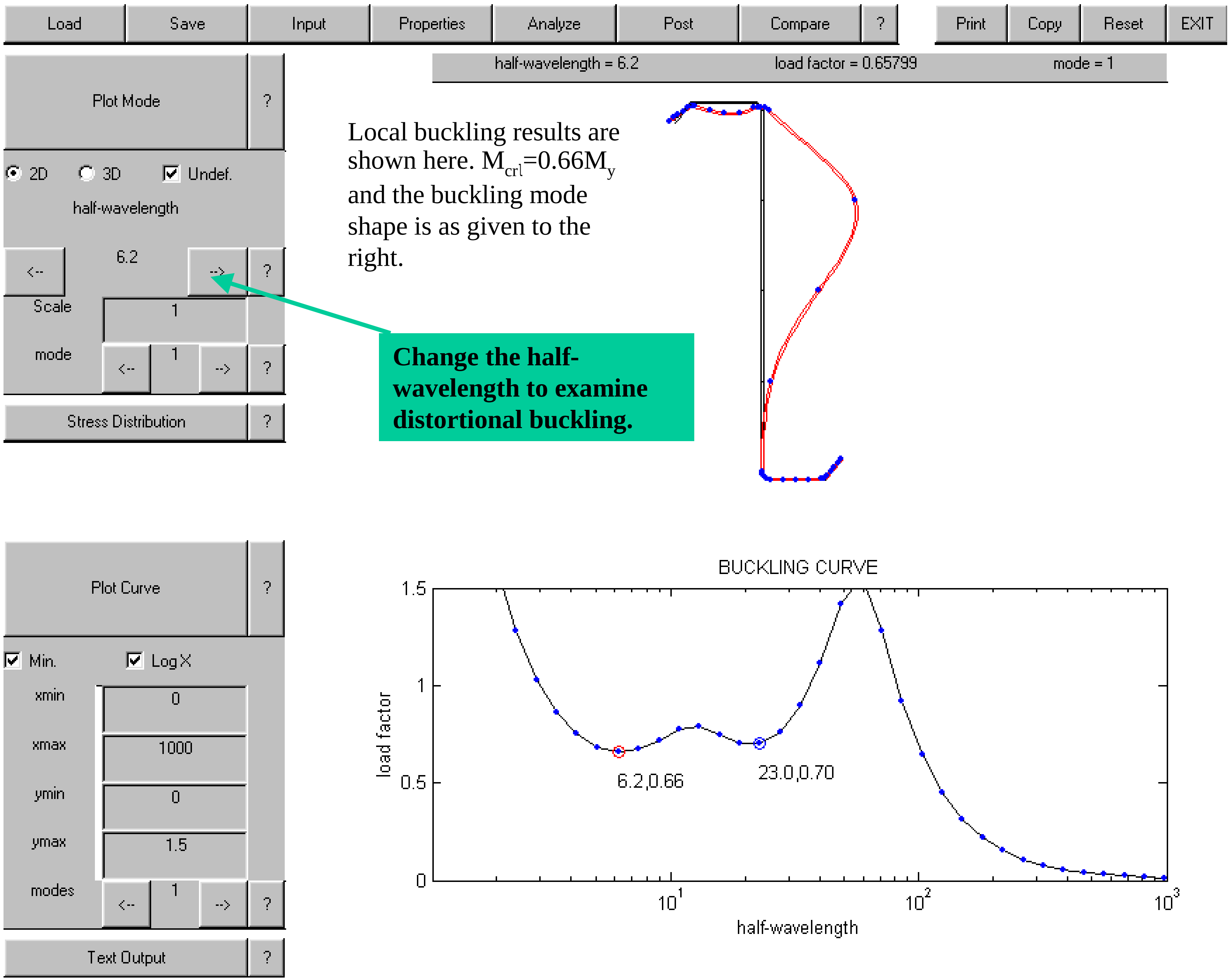
This is the yield moment, M_y, the buckling load factor results will be in terms of M_y=192 kip-in.

The stress distribution to the right would be applicable for a laterally braced beam, and is typically assumed in cold-formed steel design codes. Note that the flanges are different sizes and in this case the wider flange has been placed in compression.



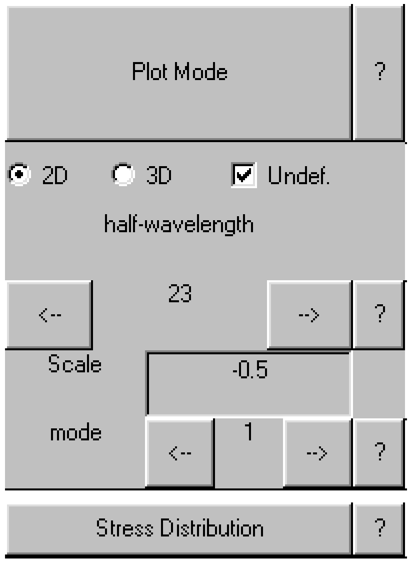
This screen shows the post-processing page that will come up when you select Post. Note, the two minima in the plot: local and distortional buckling.

Clean up the curve and change the half-wavelength to show local buckling.

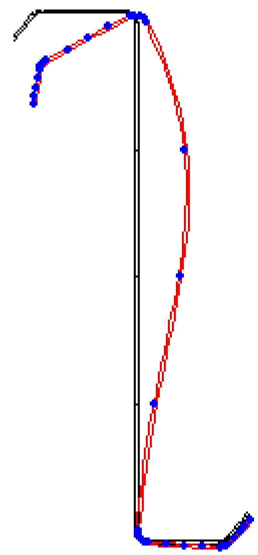


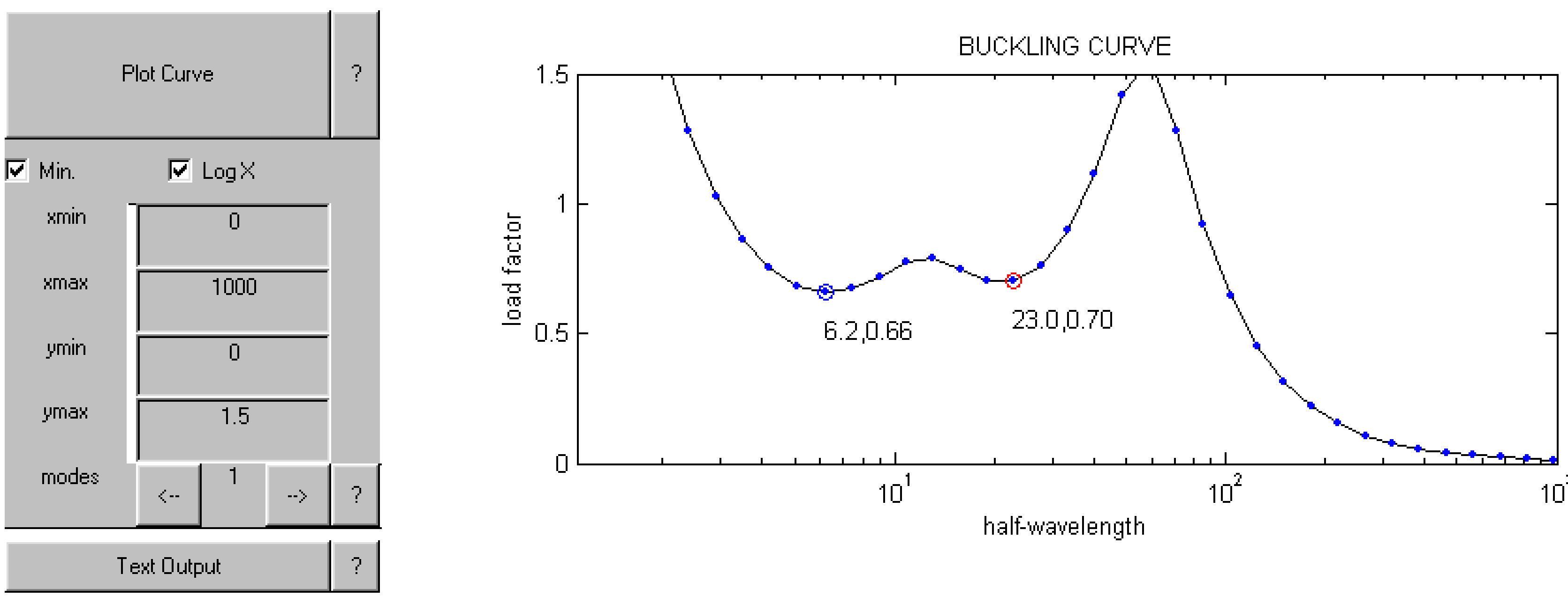
Local buckling results are shown here. $M_{crl}=0.66M_y$ and the buckling mode shape is as given to the right.

Change the half-wavelength to examine distortional buckling.



Distortional buckling results are shown here. M_{crd}=0.70M_y and the buckling mode shape is as given to the right.





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