

WEB APPLICATION FOR CALCULATION OF PROPERTIES OF BEAM CROSS-SECTION OF ARBITRARY SHAPE

The program takes in the geometry of a cross section and outputs the following properties:

1. Area
2. Location of CG
3. Second moment of area about X axis
4. Second moment of area about Y axis
5. Second moment of area I_{XY}
6. Major Axis angle with X
7. Minor Axis angle with X
8. Second moment of area about major axis
9. Second moment of area about minor axis
10. Torsion Constant (J)
11. Shear Correction Factor along major axis
12. Shear Correction Factor along minor axis
13. Shear Center along major axis
14. Shear Center along minor axis
15. Warping Constant

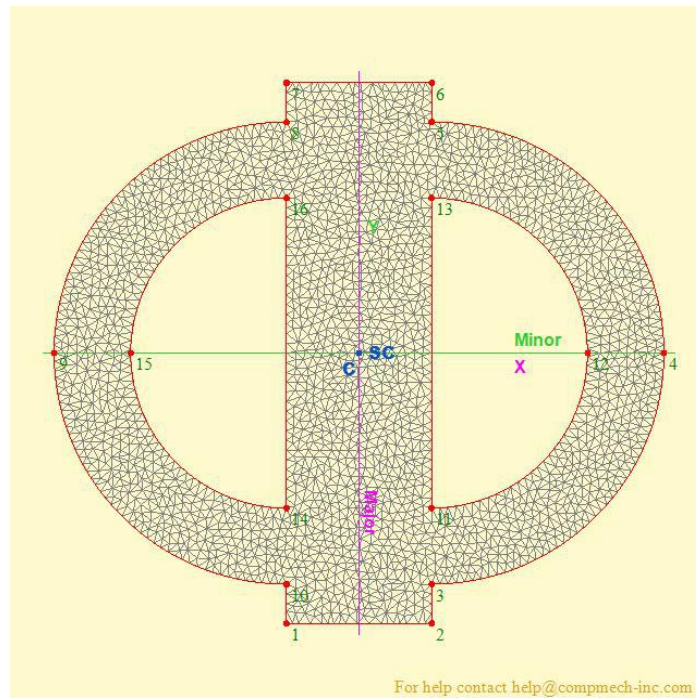
Properties 1-10 are exactly calculated whereas the program uses Finite Element Method with three-noded triangles to compute properties 11-16. Any cross section whose boundary is defined using straight segments and circular arcs can be analyzed. The input has two parts (a) Nodal coordinates and (b) Boundary connectivity.

Nodal coordinates: The user needs to enter a series of pairs of numbers representing x and y coordinates of the nodes. The node numbers themselves are not entered. They are implied to start from 1 with an increment of 1.

Boundary connectivity: Each boundary segment is entered using three numbers. For a circular arc segment the three numbers are start node, a node anywhere on the arc, and the end node. The middle node should not coincide with the start or end node. A full circle needs a minimum of two segments to define. A straight segment needs only two node numbers to define. The number zero (0) is entered as the last node. While defining the outer boundary, the order of segment definition is counter-clockwise, whereas for inner boundary segments it is clockwise.

Example

Nodal coordinates:	Boundary Connectivity:
0 0	1, 2, 0
1.44 0	2, 3, 0
1.44 0.39	3, 4, 5
3.75 2.7	5, 6, 0
1.44 5.01	6, 7, 0
1.44 5.4	7, 8, 0
0 5.4	8, 9, 10
0 5.01	10, 1, 0
-2.31 2.7	13, 12, 11
0 0.39	11, 13, 0
1.44 1.15	16, 14, 0
2.99 2.7	14, 15, 16
1.44 4.25	
0 1.15	
-1.55 2.7	
0 4.25	



Properties calculated by the web application:

Area = 16.992

CG = 0.720, 2.700

Ixx = 36.726

Iyy = 40.468

Ixy = 0.000

Major Axis = 90.000 deg (CW from X+)

Minor Axis = 0.000 deg (CCW from X+)

I @ major axis = 40.468

I @ minor axis = 36.726

Torsion Constant = 69.887

Shear Correction Factor along major axis = 1.479

Shear Correction Factor along minor axis = 1.970

Shear Center along major axis = 0.000

Shear Center along minor axis = 0.000

Warping Constant = 0.681

Note:- Please email suggestions and bugs to help@floatdyn.com

Bibliography

1. [G. C. Everstine, Elasticity, lecture notes, May 2006.](#)
2. [F. Gruttmann F, R. Sauer, and W. Wagner, Shear Stresses in Prismatic Beams with Arbitrary Cross-sections, Int J. Num Meth Engng, 45 \(1999\), 865-889.](#)
3. [F. Gruttmann and W. Wagner, Shear Correction Factors in Timoshenko's Beam Theory for Arbitrary Shaped Cross-sections, Computational Mechanics, 27 \(2001\), 199-207.](#)