Multi-Fidelity, Multi-Physics Analysis Degenerate Geometry

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VSP Workshop
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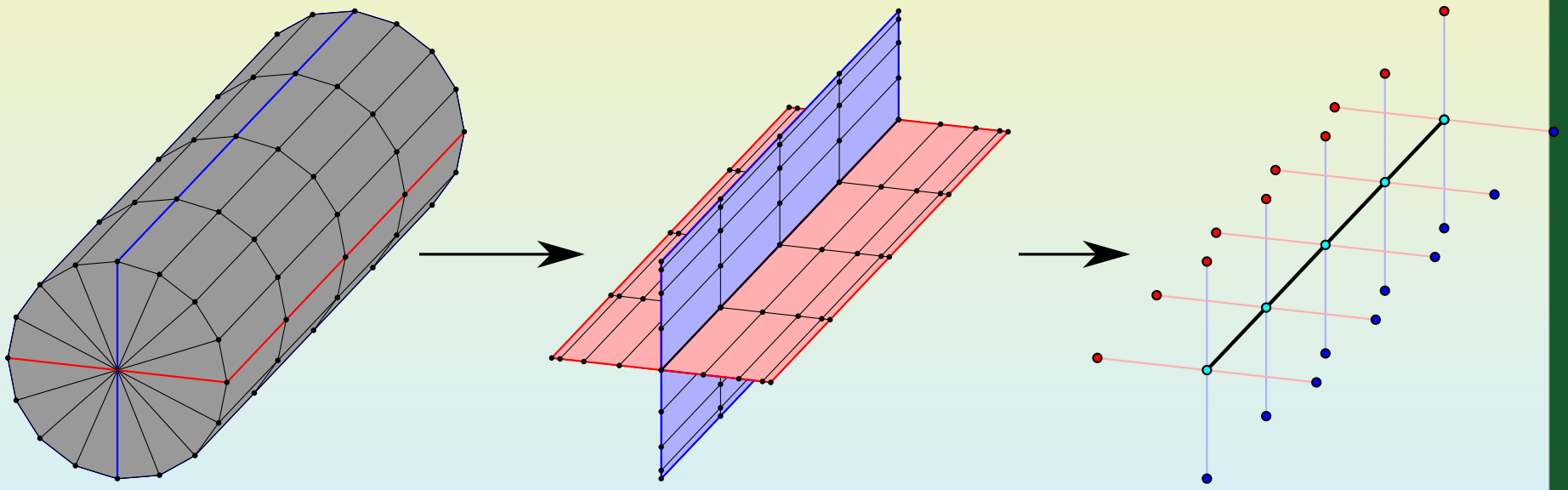
Degenerate Geometry



Surface

Plate

Stick

Degenerate Surface

Surface

- Surface Node Locations
- Parametric u & w
- Surface normal vectors

Plate

- Plate Node locations
- Parametric u & w_{top}, w_{bot}
- Plate normal vectors
- Camber surface height
- Camber normal vectors
- Thicknesses

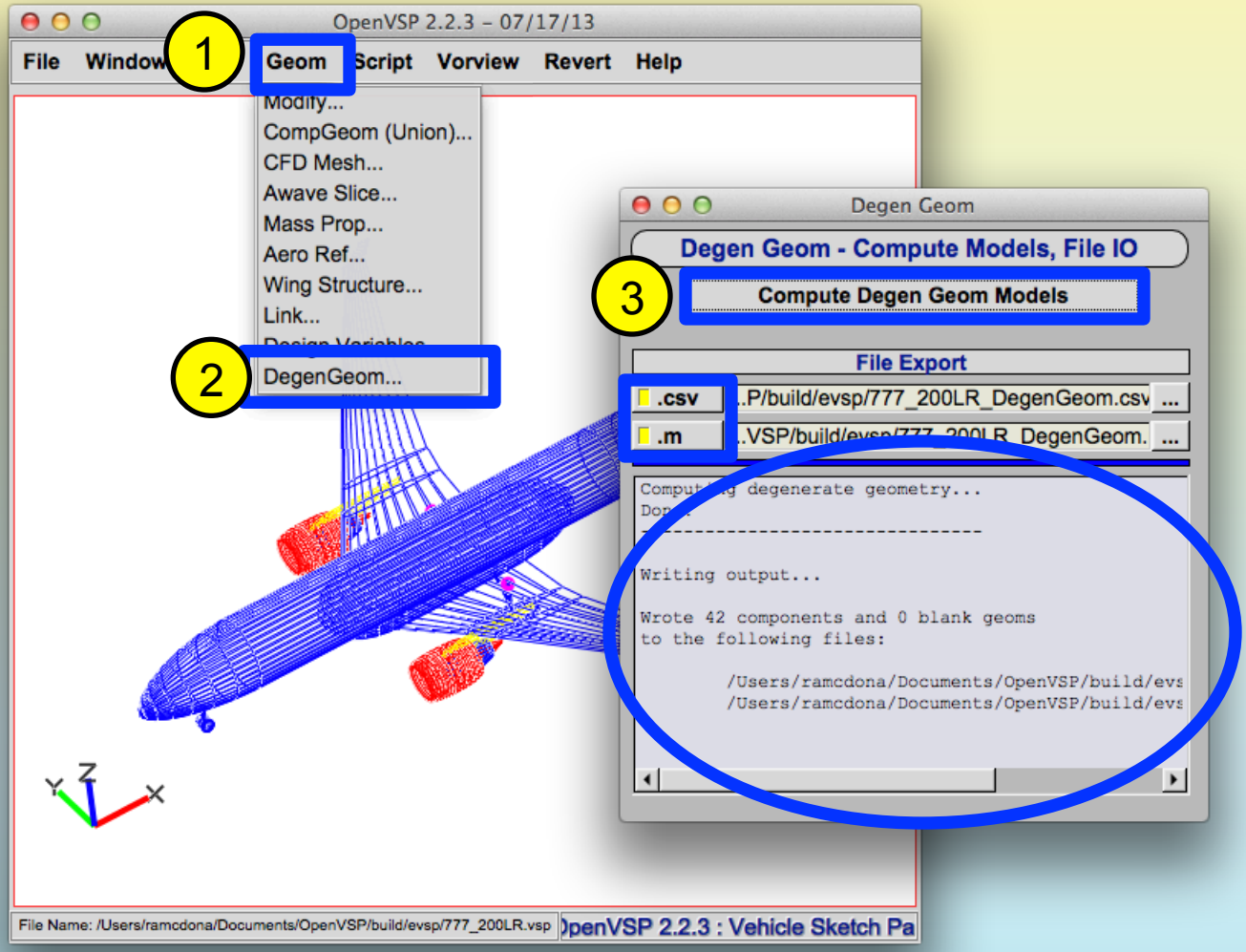
Stick

- LE & TE node locations
- Parametric u
- Max t/c & location
- Chord
- Sweep
- Section line & area inertias & cg
- Area, perimeters

Point

- Surface area & volume
- Wetted area & volume
- Shell & solid inertias & cg

Creating Degenerate Geometry in VSP



Output Formats

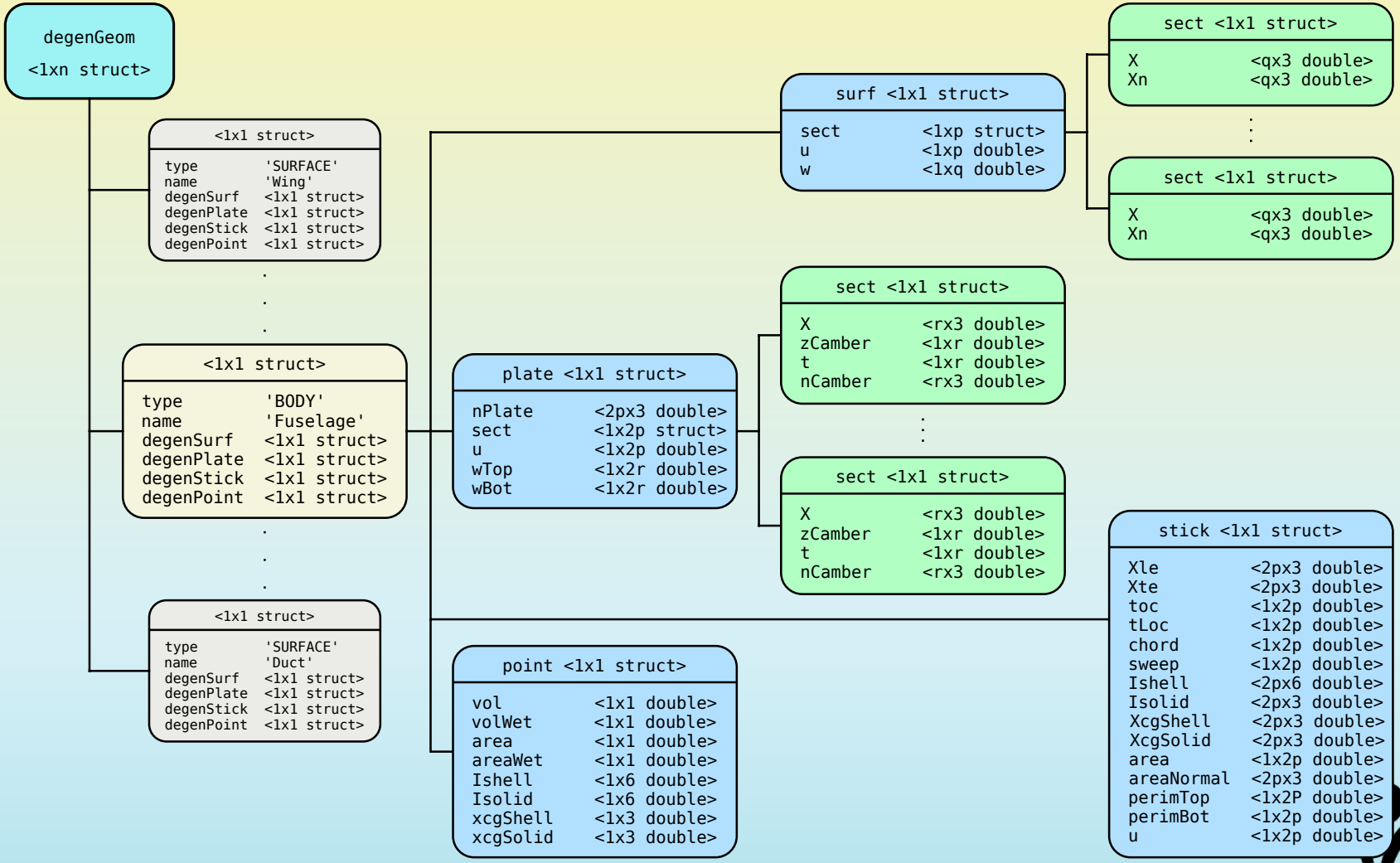
CSV

- Ready-made MS Excel file
- Easily human-readable (Comments)
- Easily parsed (C, Fortran, Java)

Matlab

- Information direct to data structure
- Remove parsing barrier
- Design students in mind

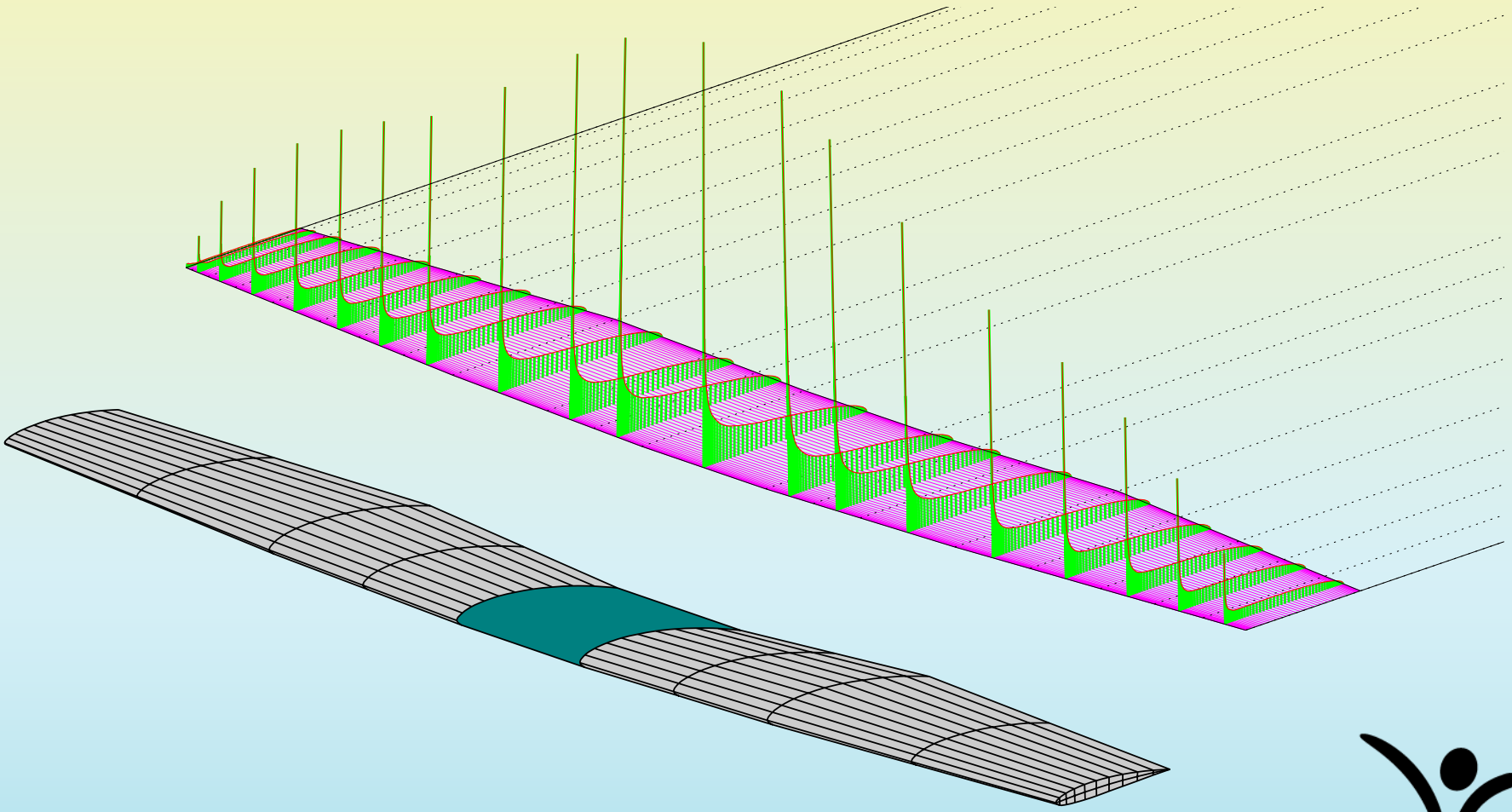
M-File Structure



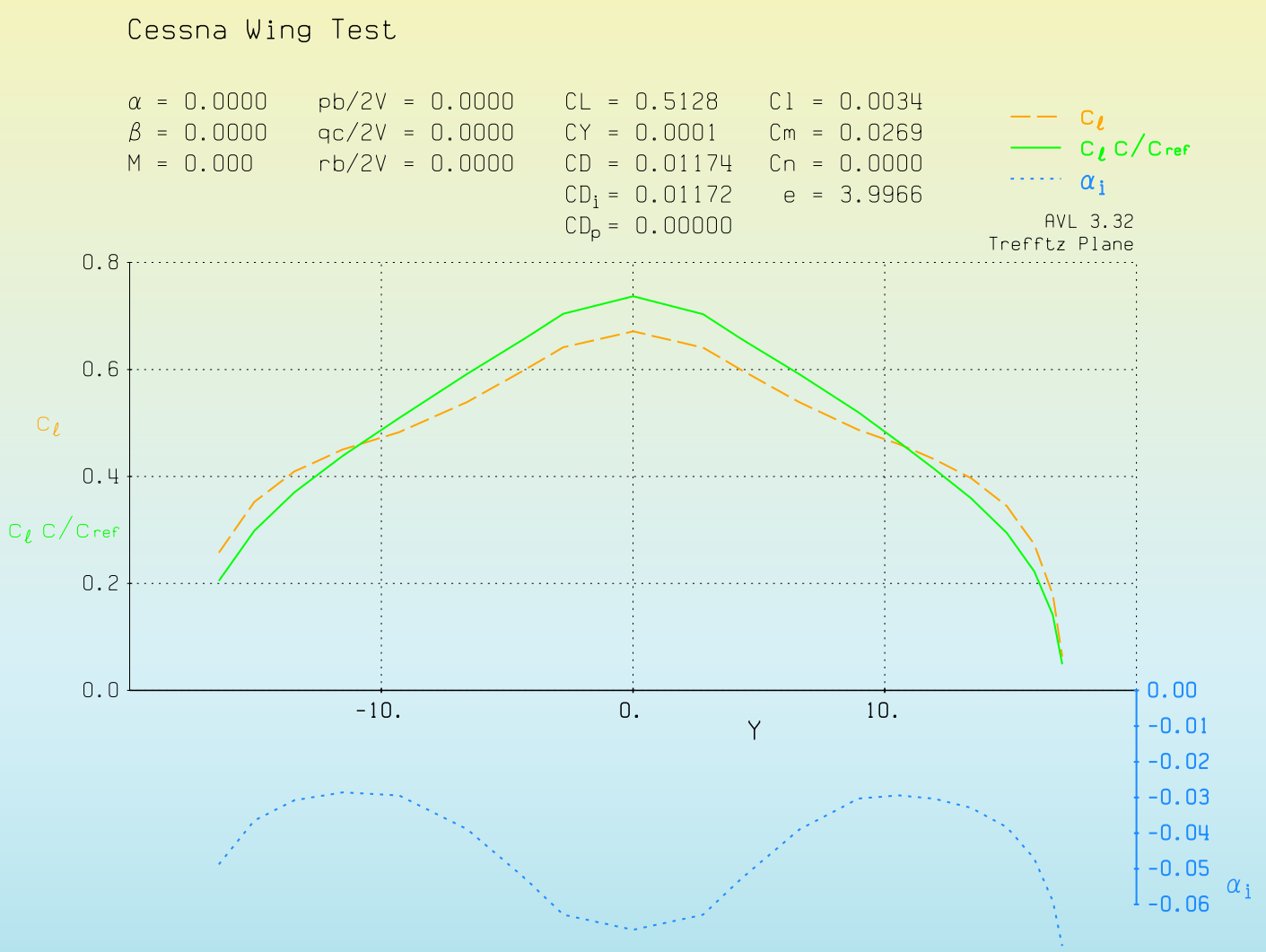
Test Cases

- Aerodynamic
  - Lifting line theory
  - AVL (vortex lattice theory)
- Structural
  - Equivalent beam theory (sort of…)
  - ELAPS (equivalent plate theory)

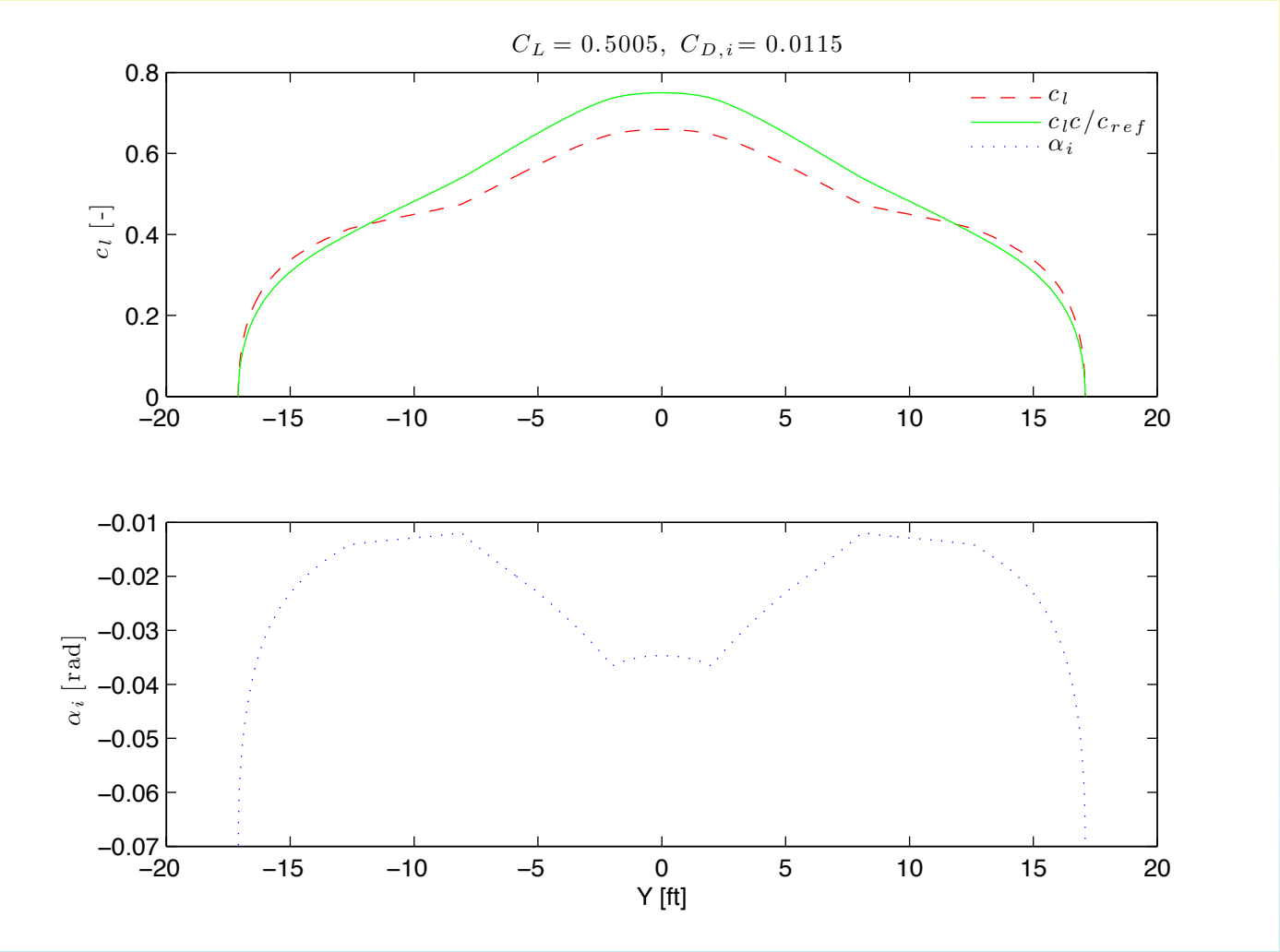
Test Cases: Vortex Lattice



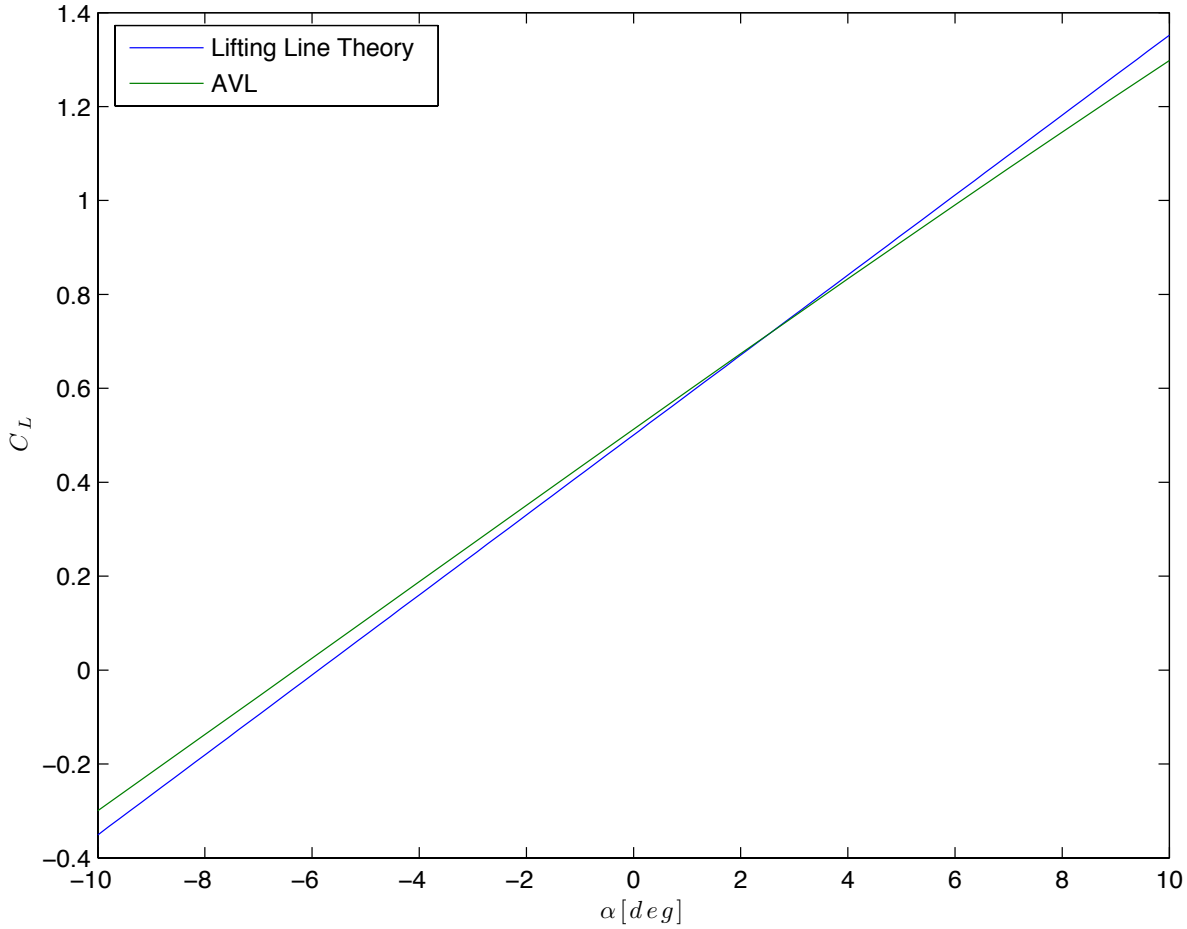
Test Cases: Vortex Lattice (AVL)



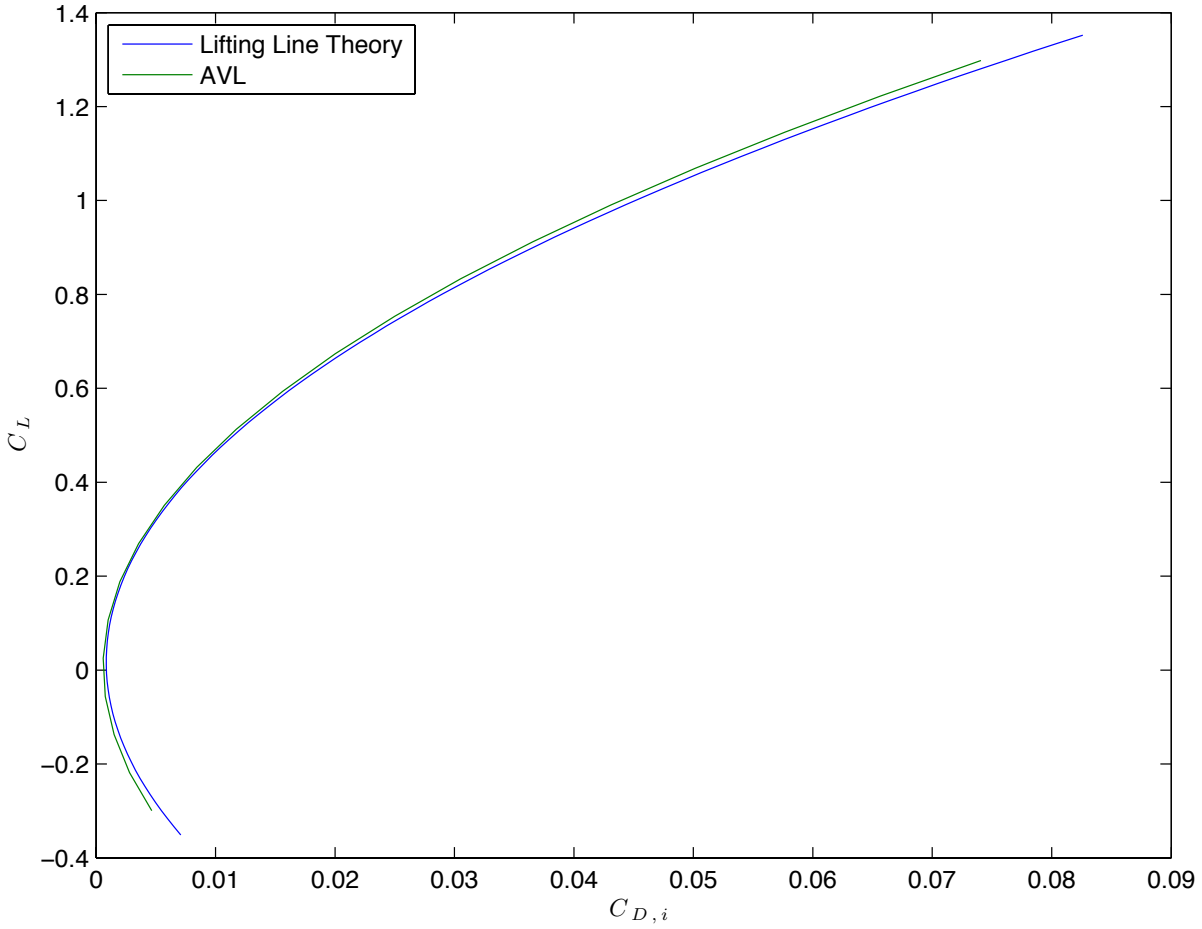
Test Cases: Lifting Line Theory



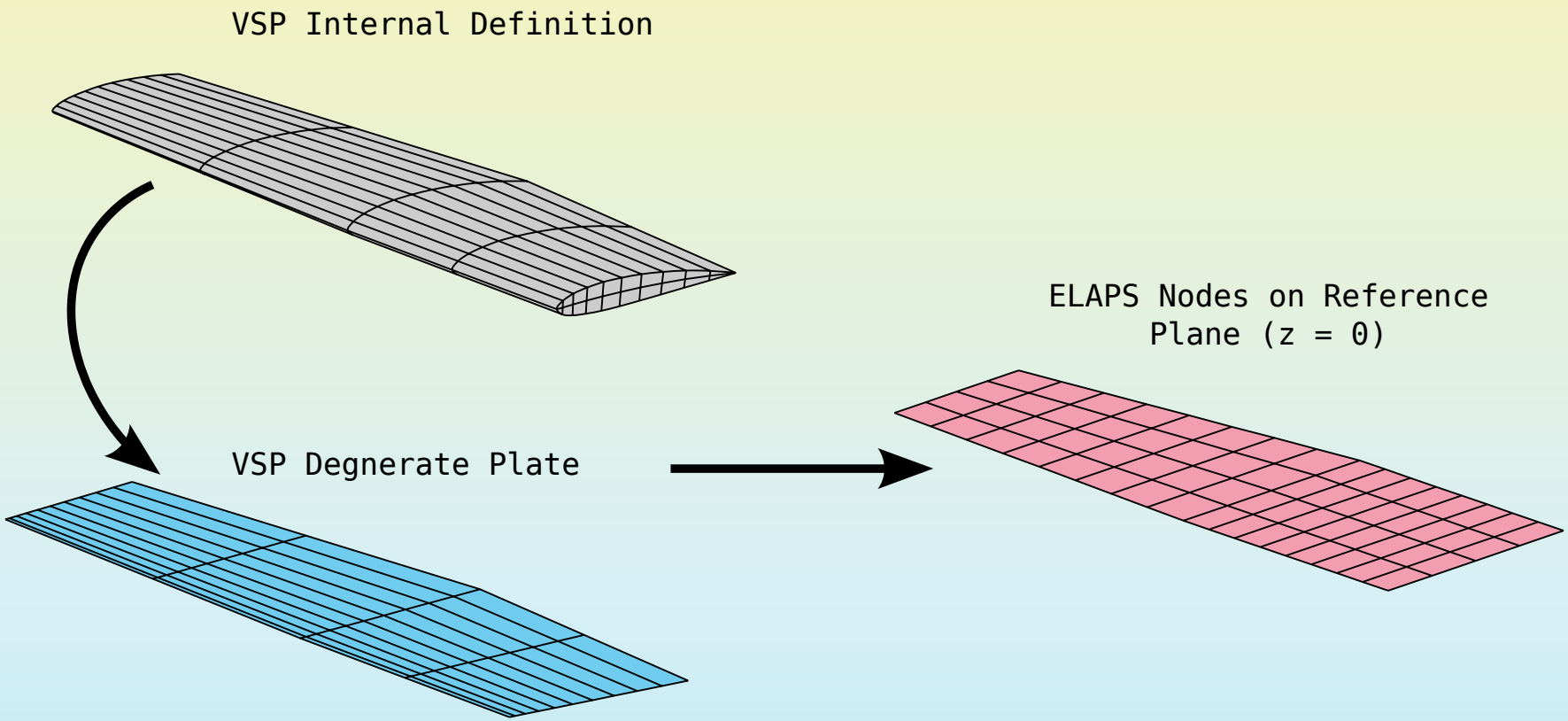
Test Cases: Aero Comparison



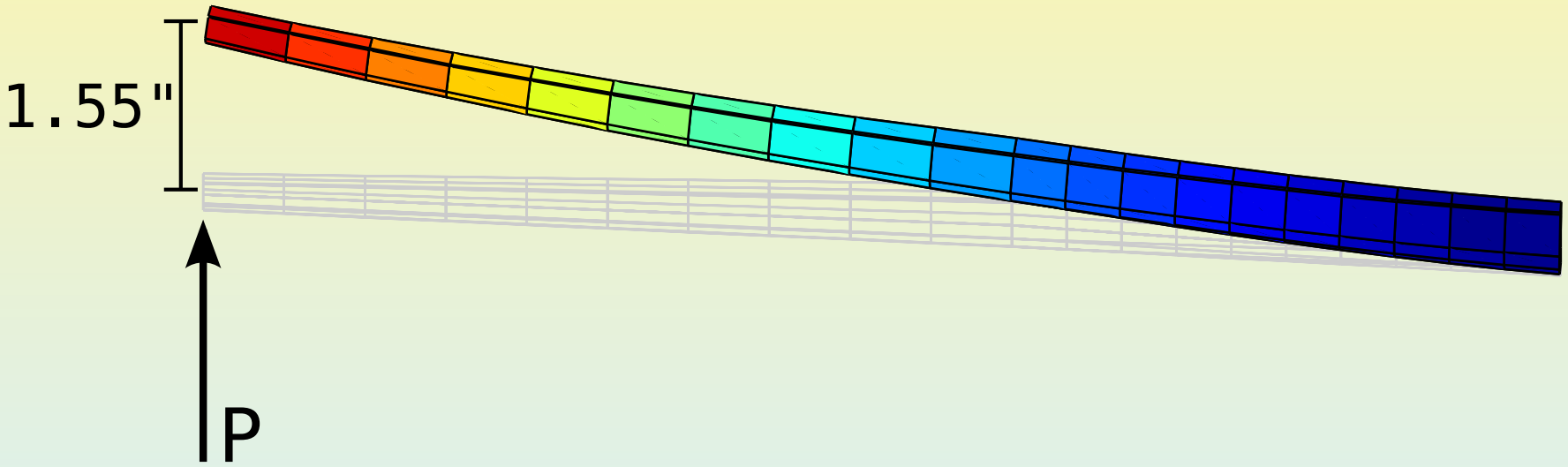
Test Cases: Aero Comparison



Test Cases: Equivalent Plate (ELAPS)



Test Cases: Equivalent Plate (ELAPS)



E_{chord}	3169 ksi
E_{span}	3169 ksi
ν	0.32
G	1200 ksi
ρ	0.288 lb_m/in^3

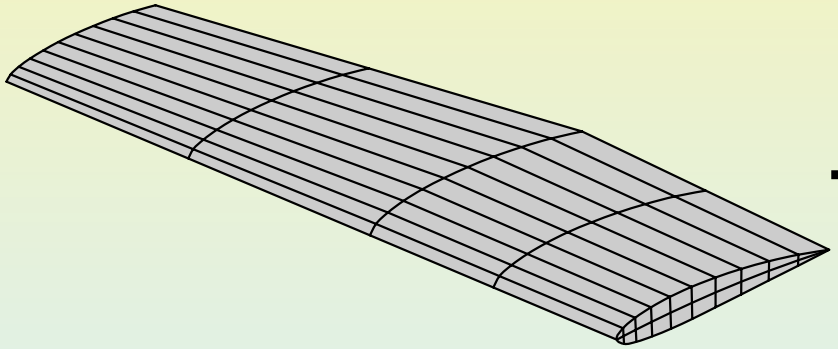
Force of P = 1550 lb applied at wing tip, mid chord

Test Cases: Equivalent Plate (ELAPS)

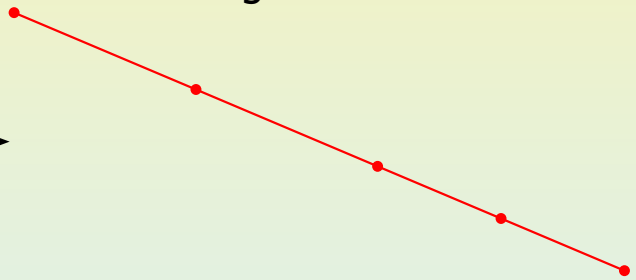
	ELAPS	DegenPoint	% Difference
Volume	27.841	27.370	1.723
x_{cg}	4.167	4.153	0.334
y_{cg}	8.529	8.532	0.032
z_{cg}	1.956	2.106	7.109

Test Cases: Equivalent Beam

VSP Internal Definition



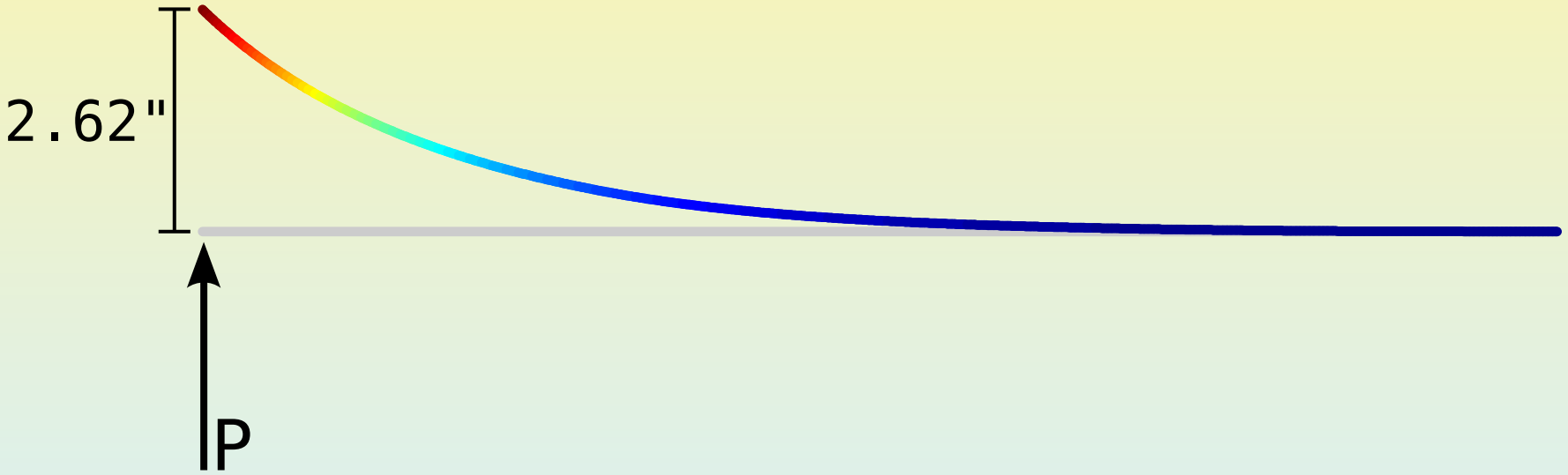
Beam Compsed of Leading Edge Nodes



Euler-Bernoulli Beam Theory

$$\frac{d^2}{dy^2}\left(EI\frac{d^2w}{dy^2}\right) = 0$$

Test Cases: Equivalent Beam



E	3169 ksi
I	From DegenStick
P	1550 lb

Questions?