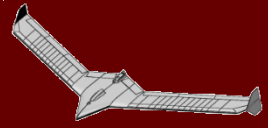

VT Updated Slides for PAAW Project

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Jan 29, 2015

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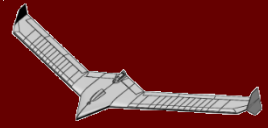
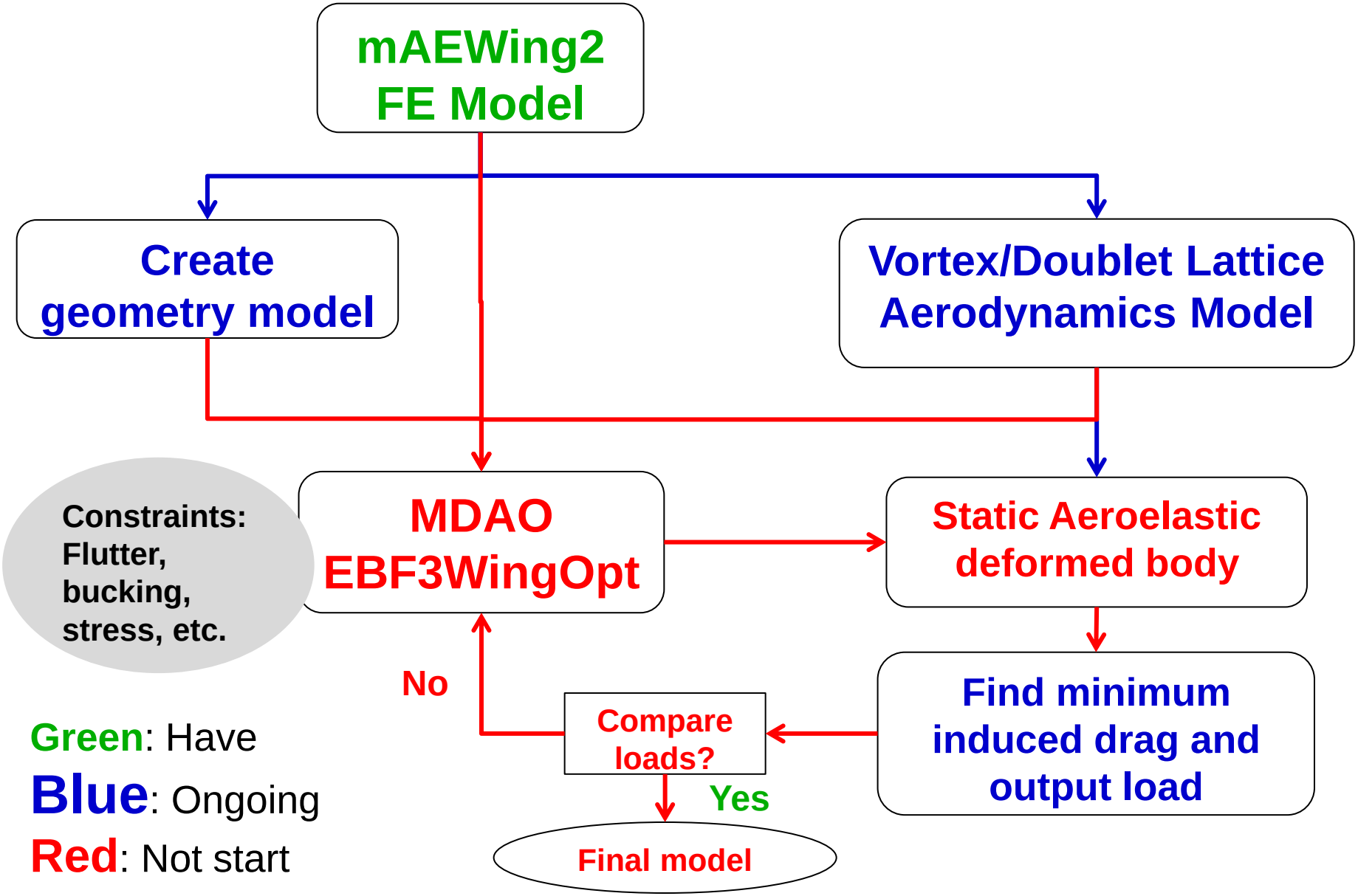
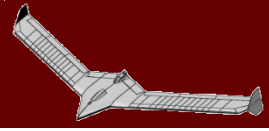
Blacksburg, VA 24061-0203

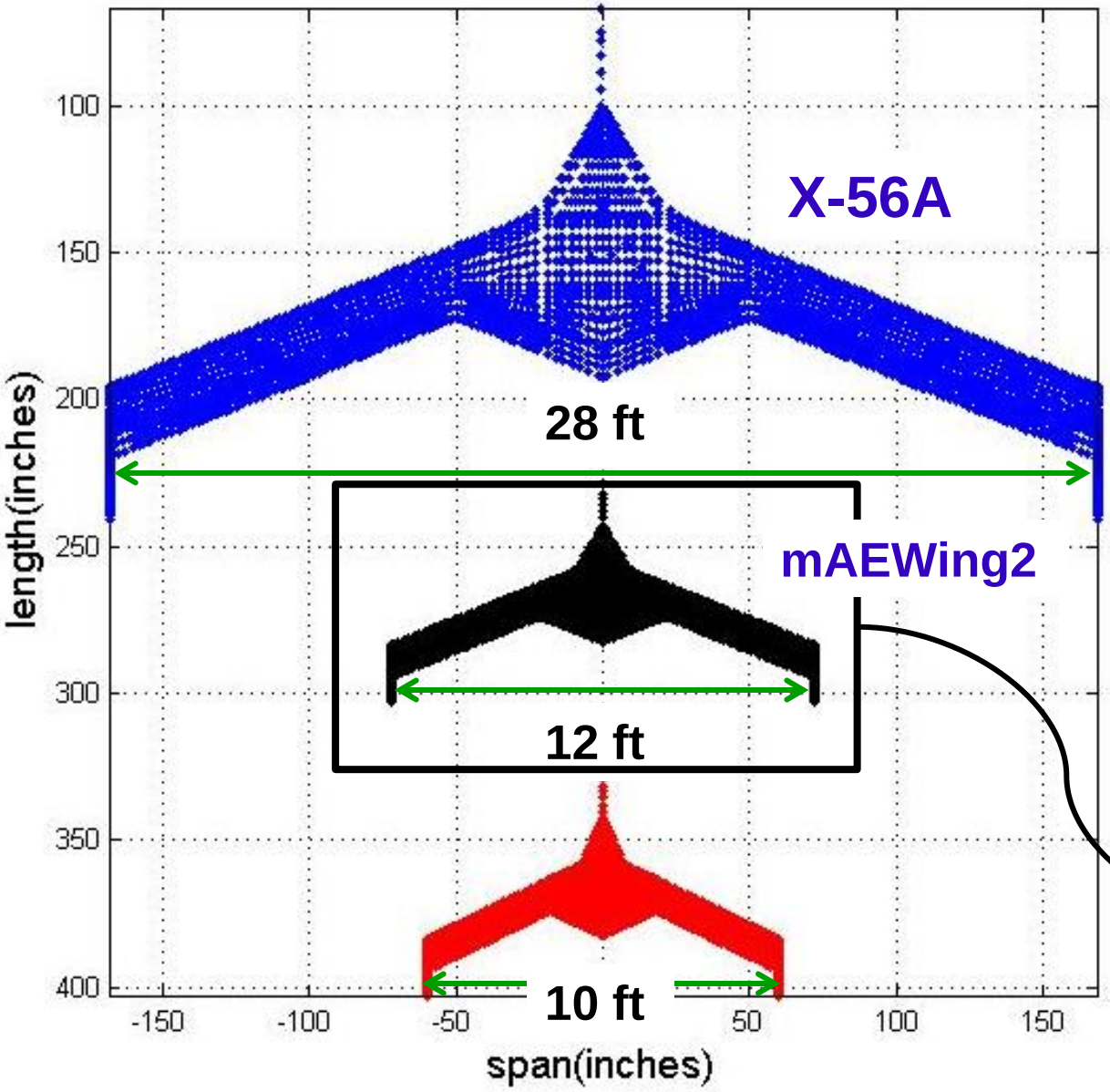
Detail MDAO work





Scaled model



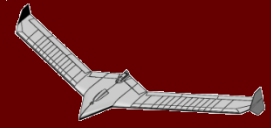


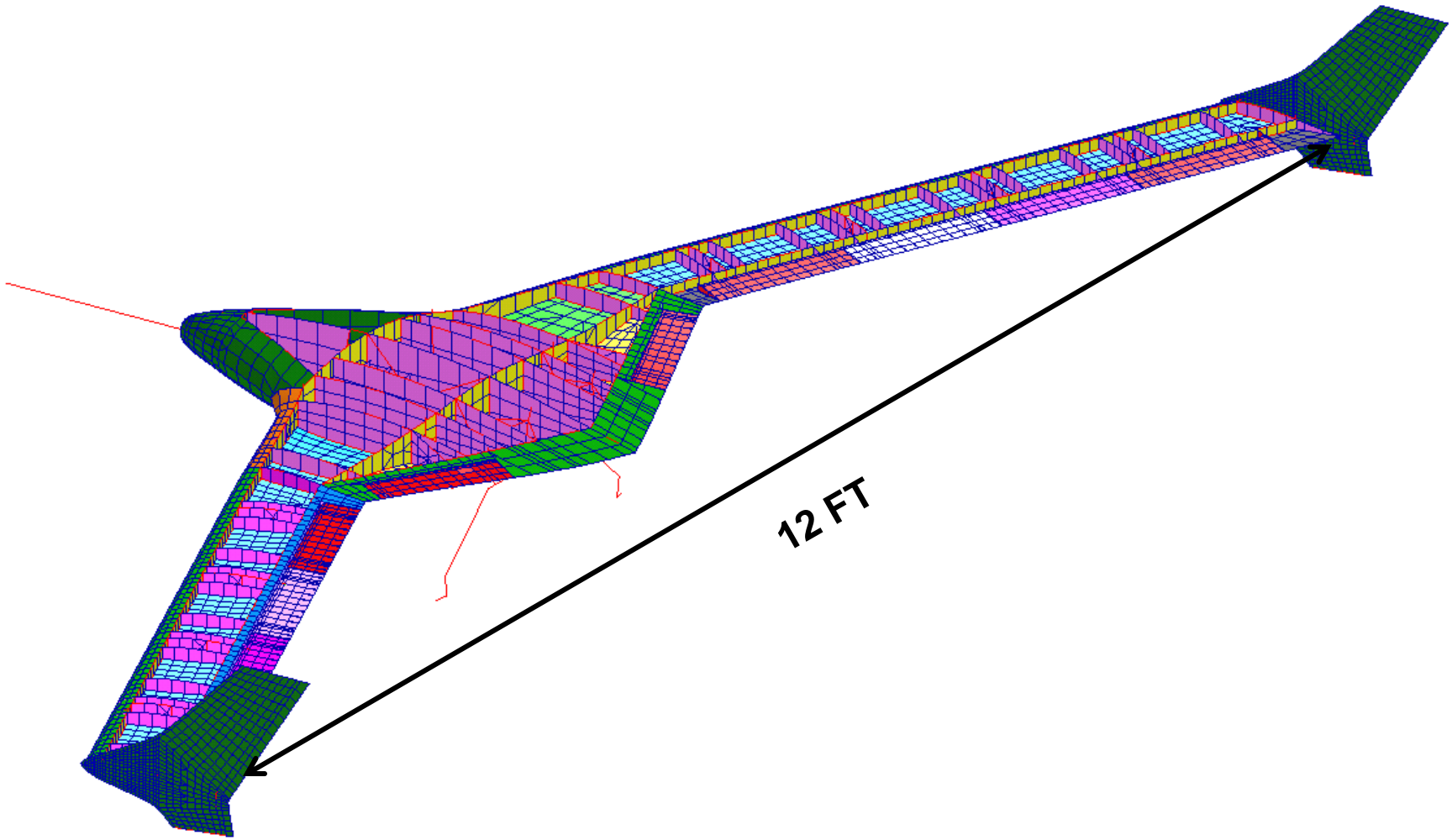
FE Model scale factor:

- Coordinates (3/7)
- Shell thickness (3/7)
- Non-structural mass $((3/7)^3)$
- Cross-sectional area of bar $((3/7)^2)$
- Area moment of inertia and torsional constant $((3/7)^4)$

Start to use in MDAO

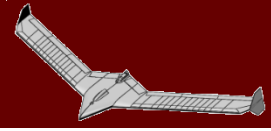
NASTRAN mAEWing2 FEM

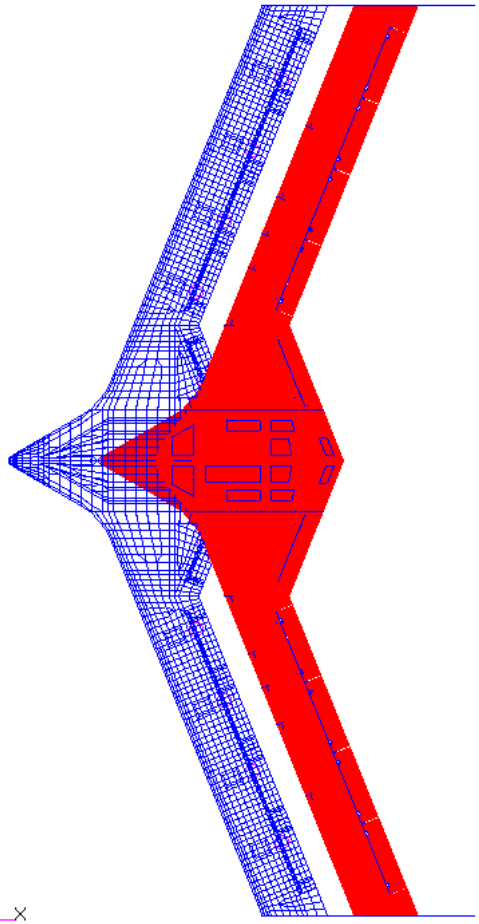


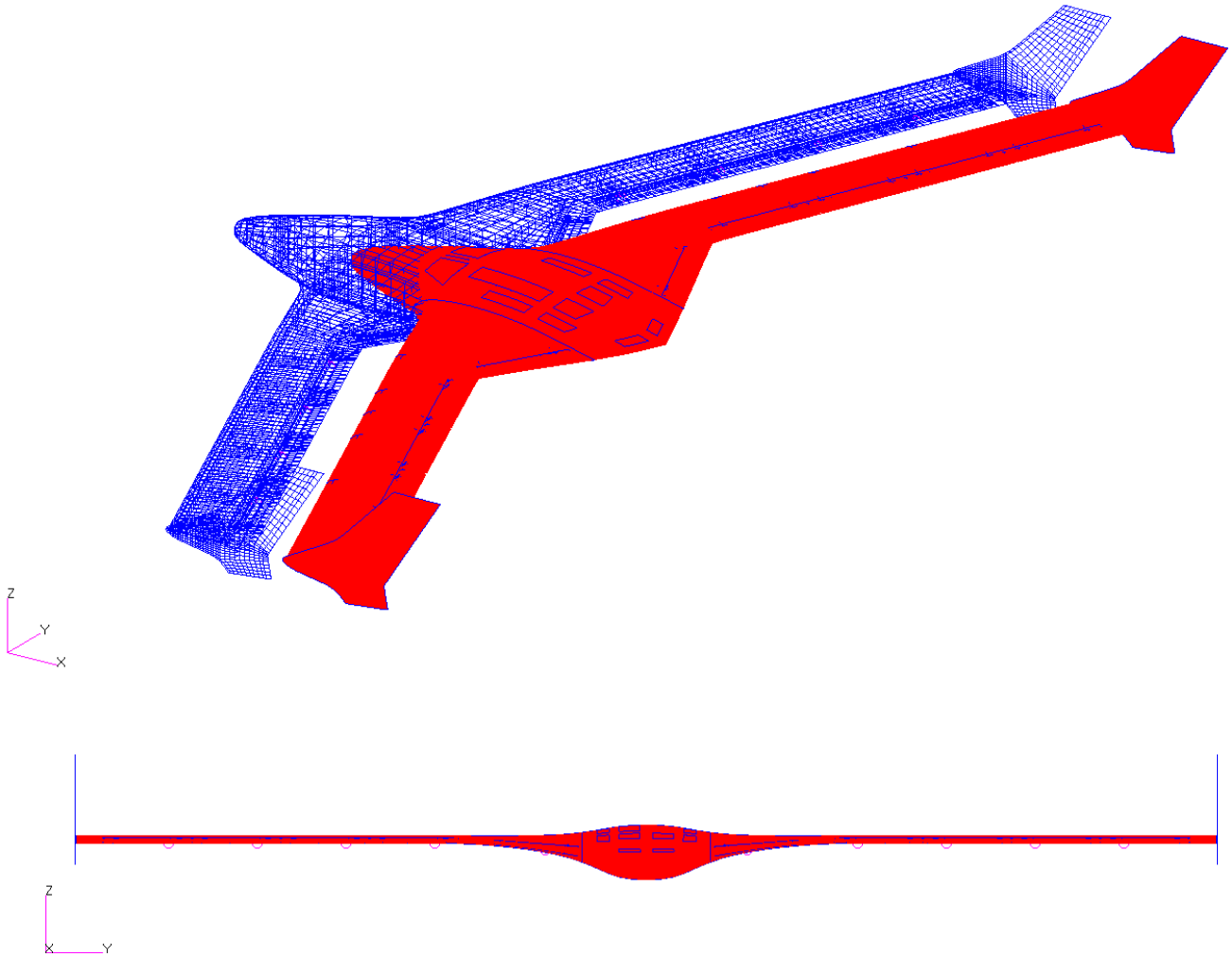


Mode shape of this mAEWing2 FE model

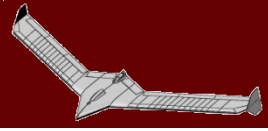
6 Rigid modes – mode 1

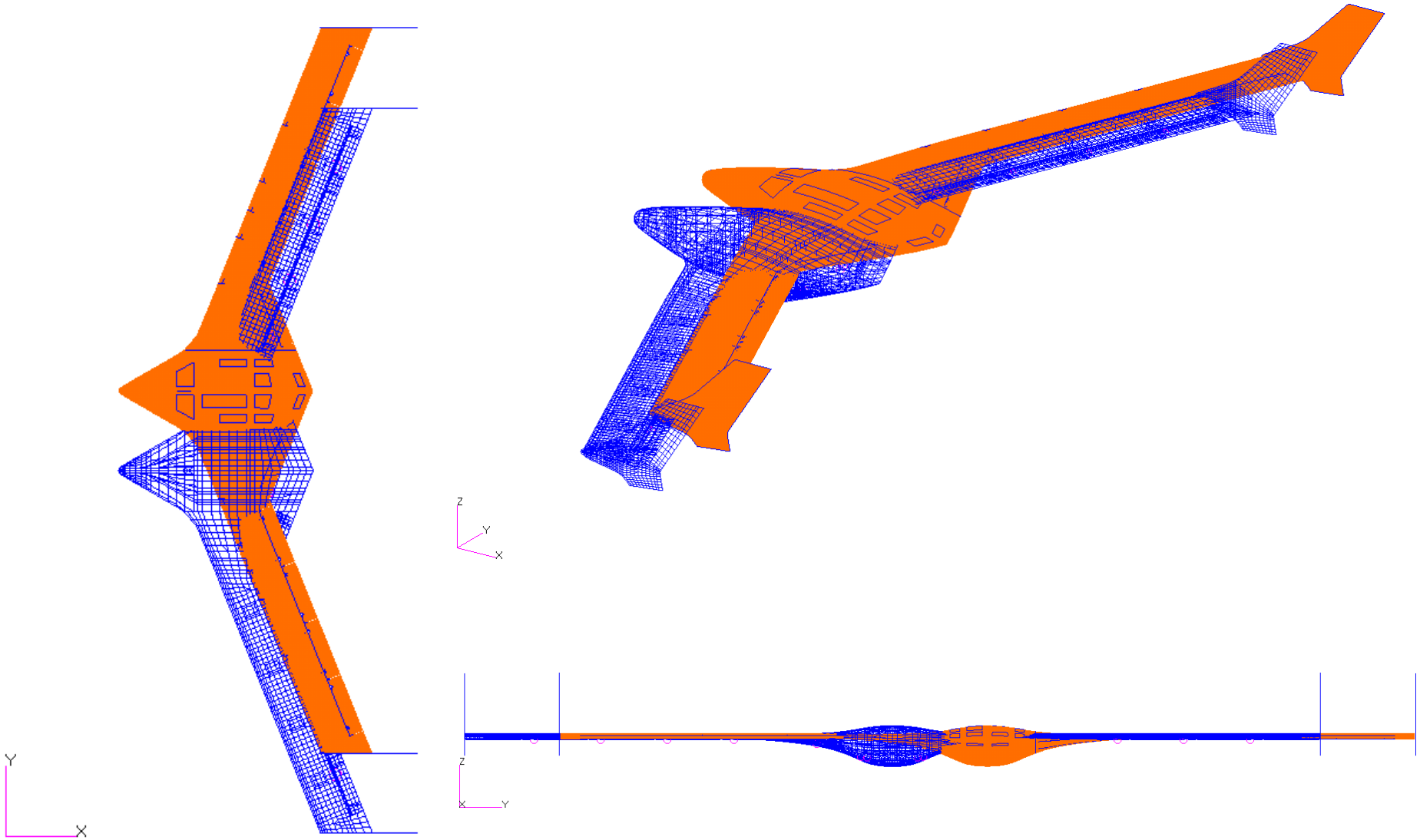




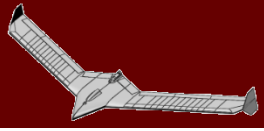


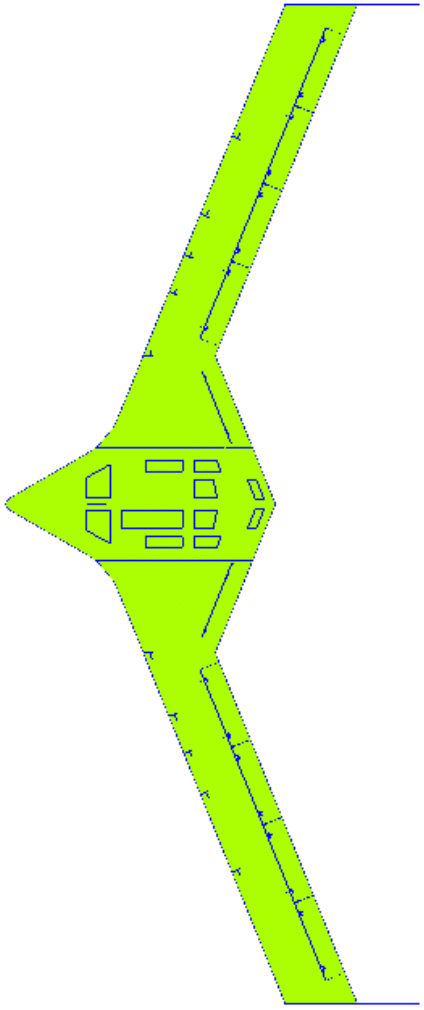
6 Rigid modes – mode 2

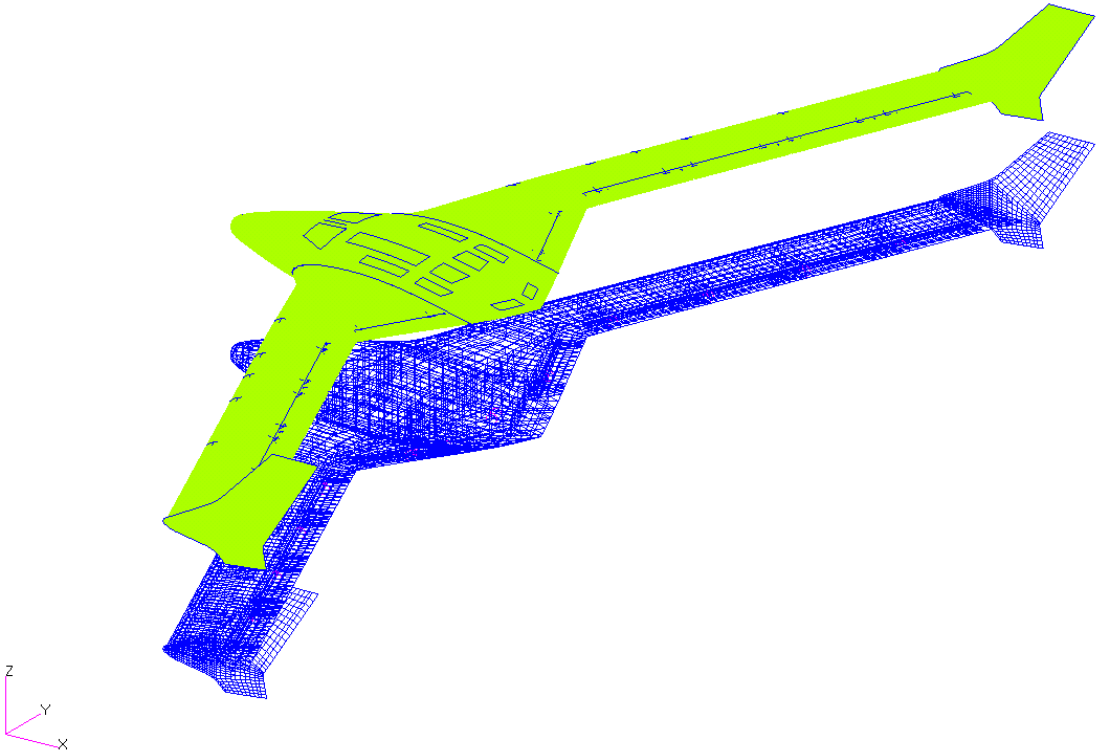


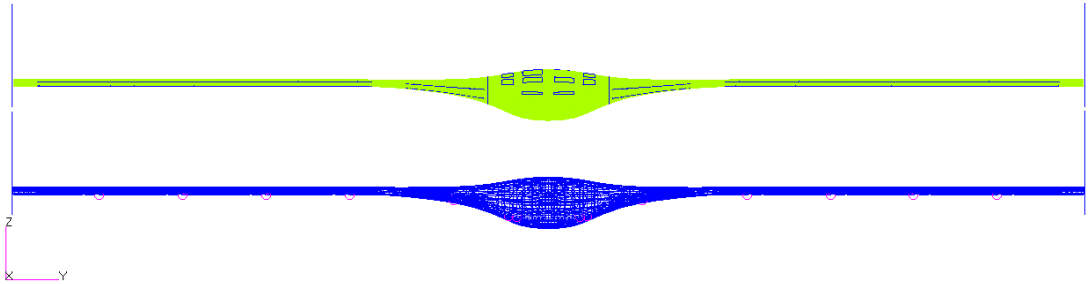


6 Rigid modes – mode 3

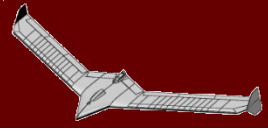


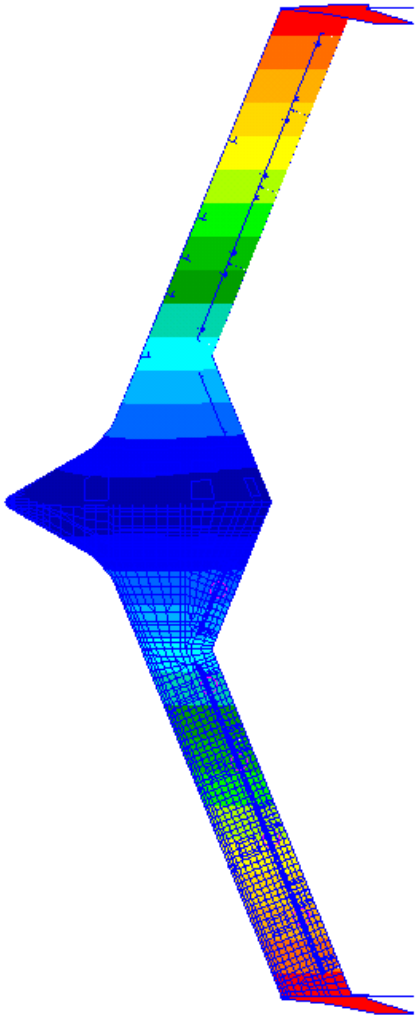


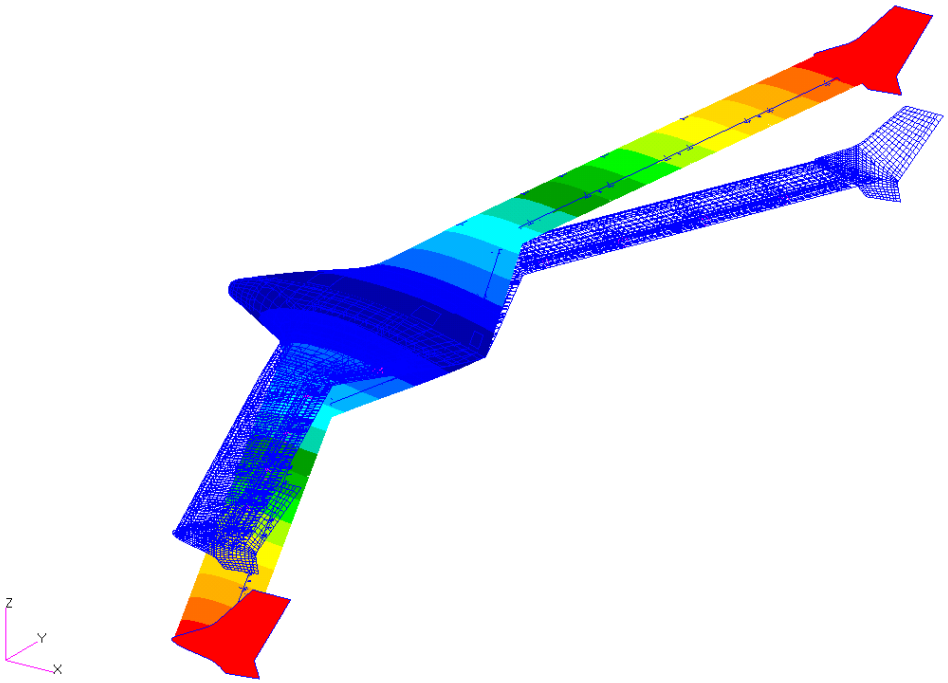


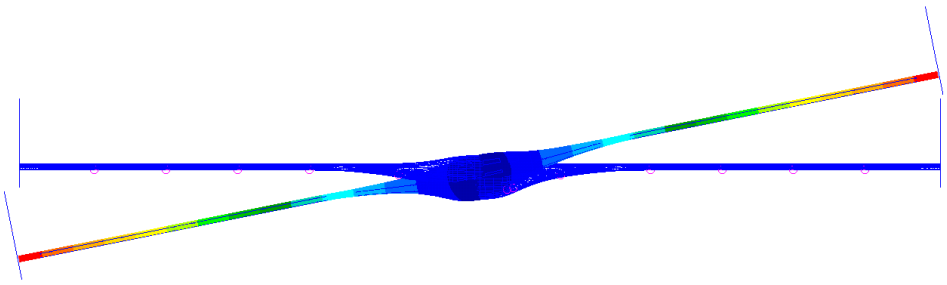


6 Rigid modes – mode 4

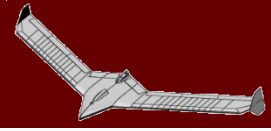


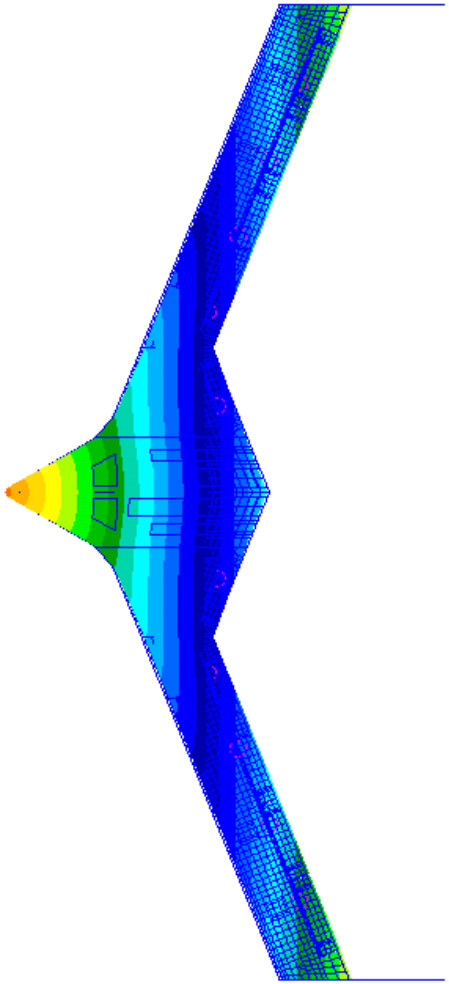


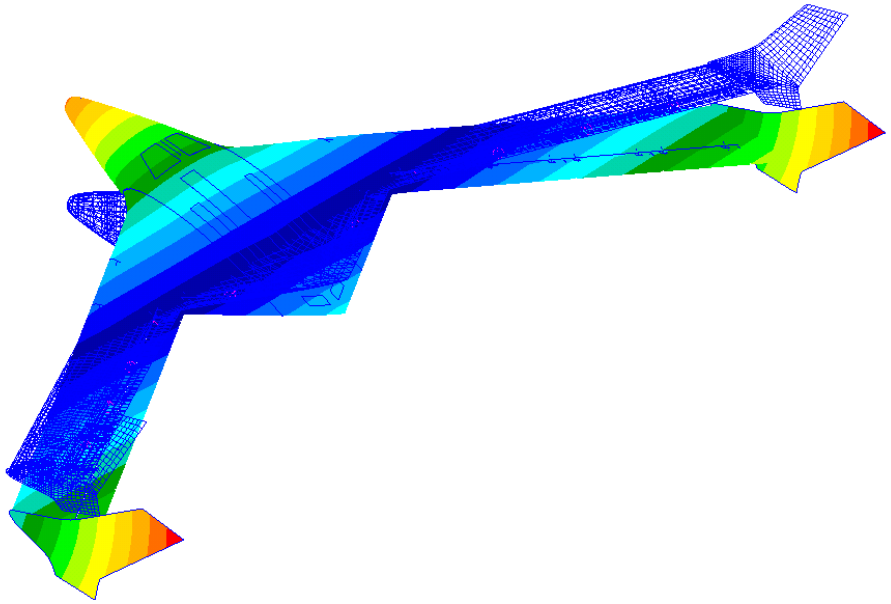


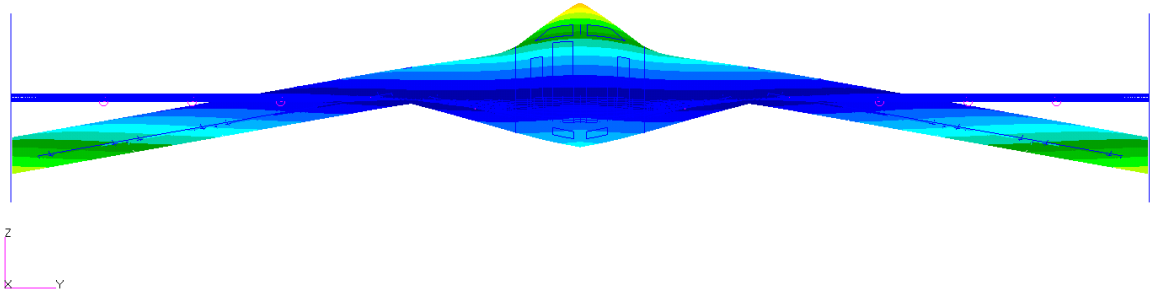


6 Rigid modes – mode 5

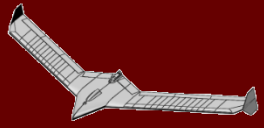


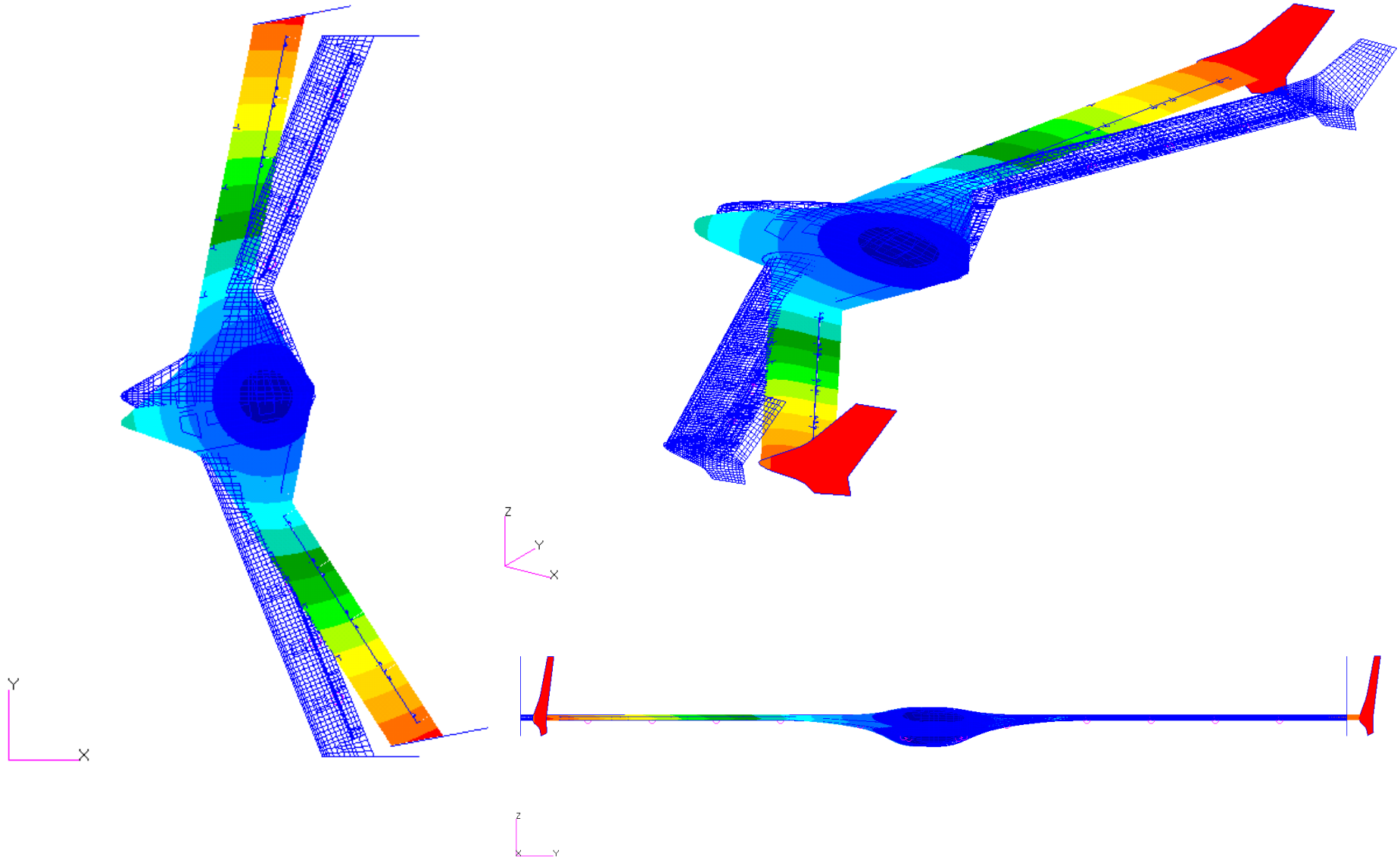




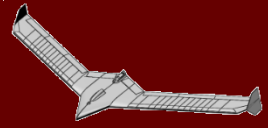


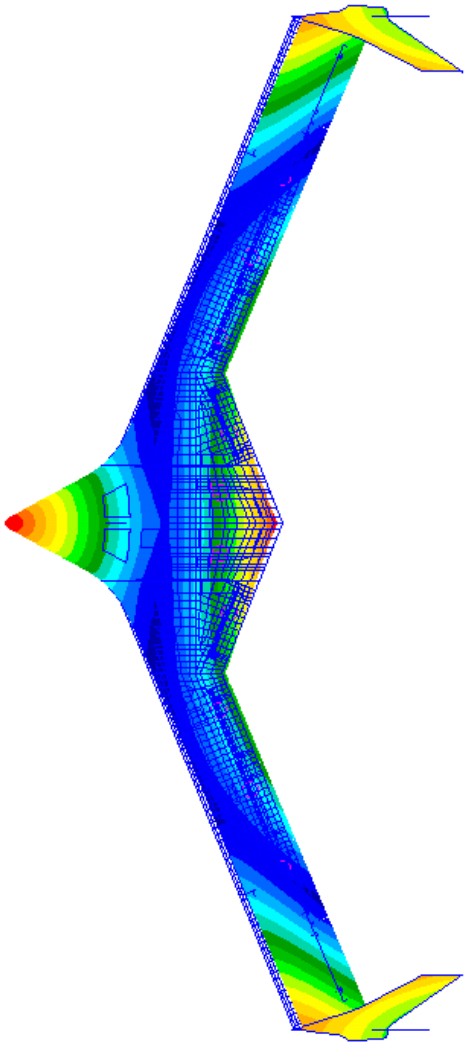
6 Rigid modes – mode 6

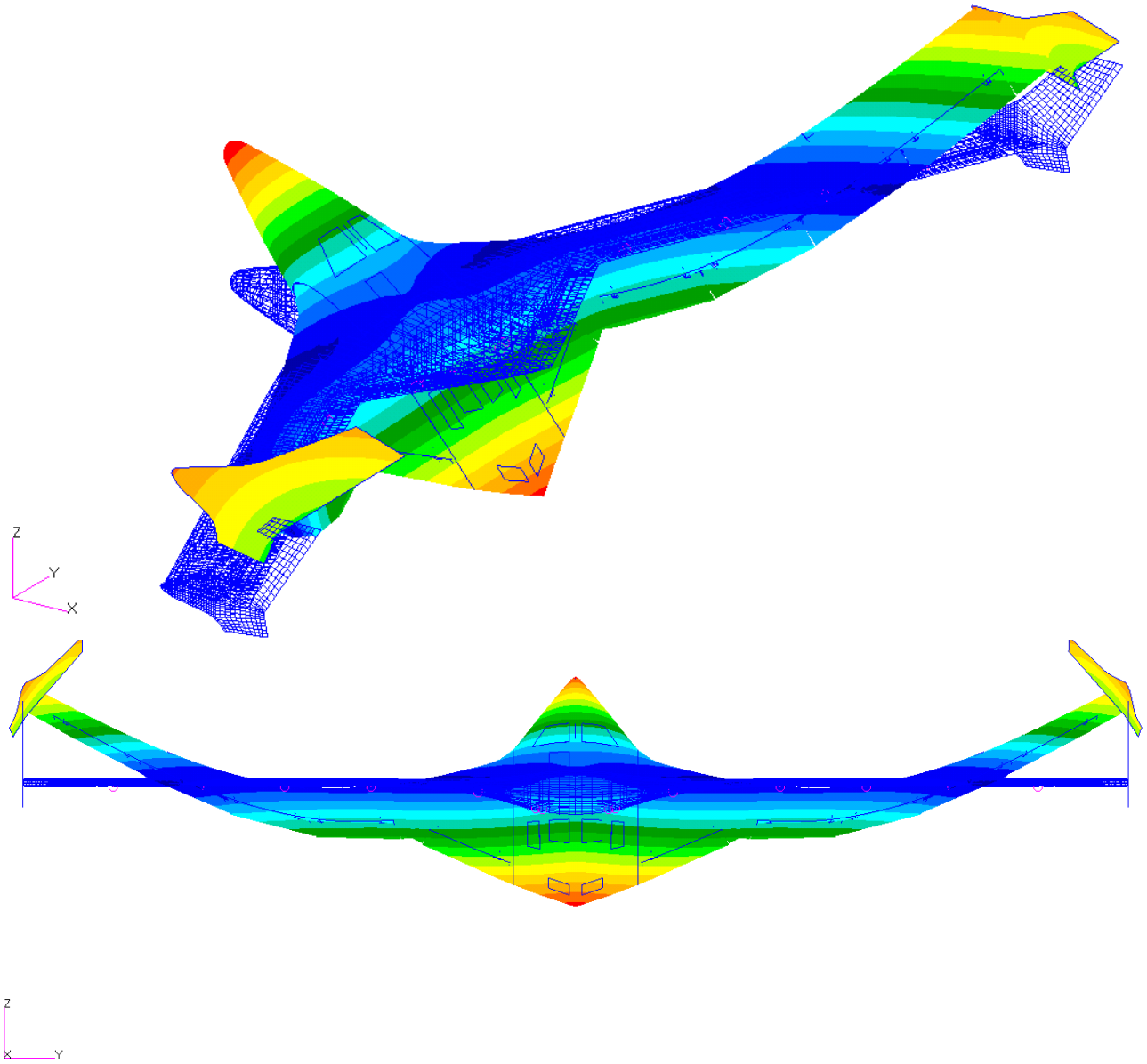




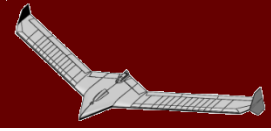
Elastic mode – mode 7

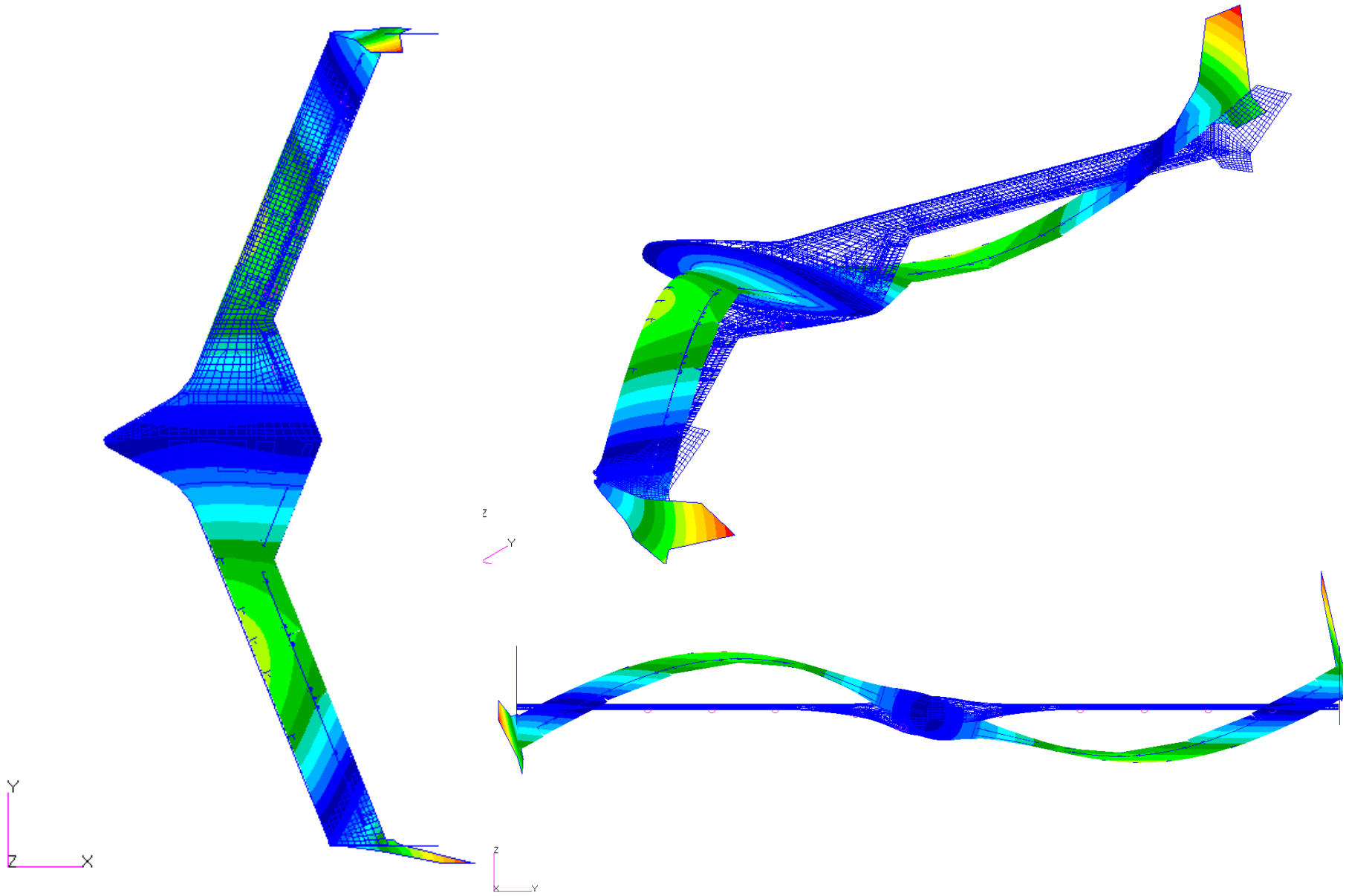




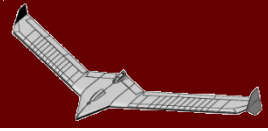


Elastic mode –mode 8





MDAO Work Status



Ongoing work

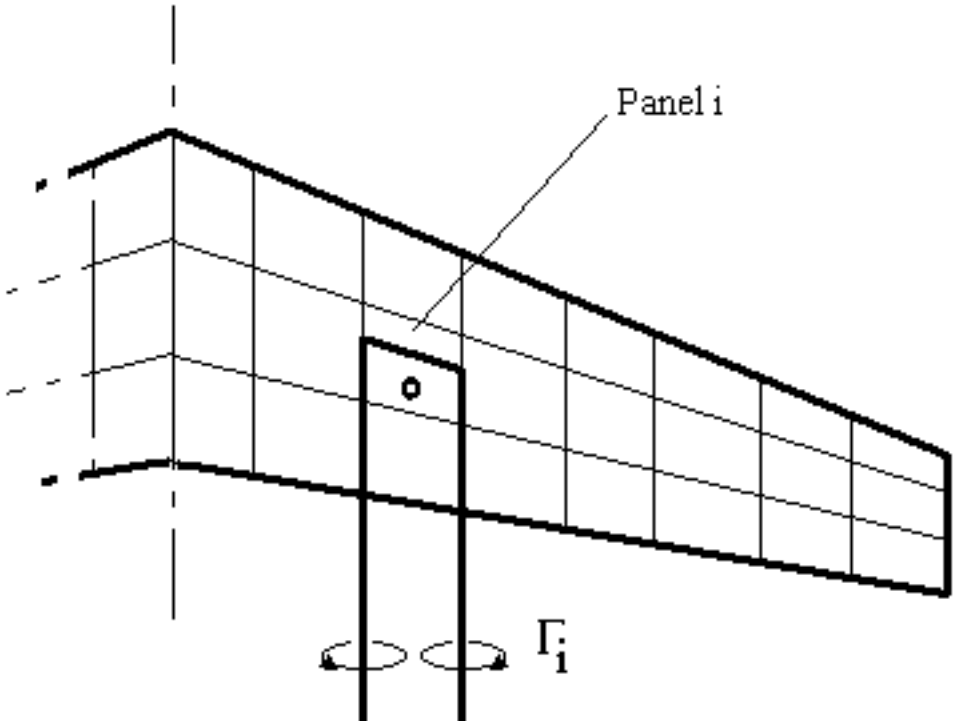
- Creating geometry model of mAEWing2 for spars and ribs parametrization in MDAO code
- Creating aerodynamics mesh in NASTRAN for aeroelastic modeling of mAEWing2
- Induced drag calculation

Questions:

- **Materials:** We will use metal in MDAO, Aluminum, later switch to composite material?
- **Flight conditions (MDAO Load Cases + minimal induced drag)**
  - Mach? 0.1? Flight altitude?
  - 3.5g during normal flying
  - 1.5~2.0g from manuevering loads
  - etc.,
- Number of control surfaces in the outer wing, 3 or 4?

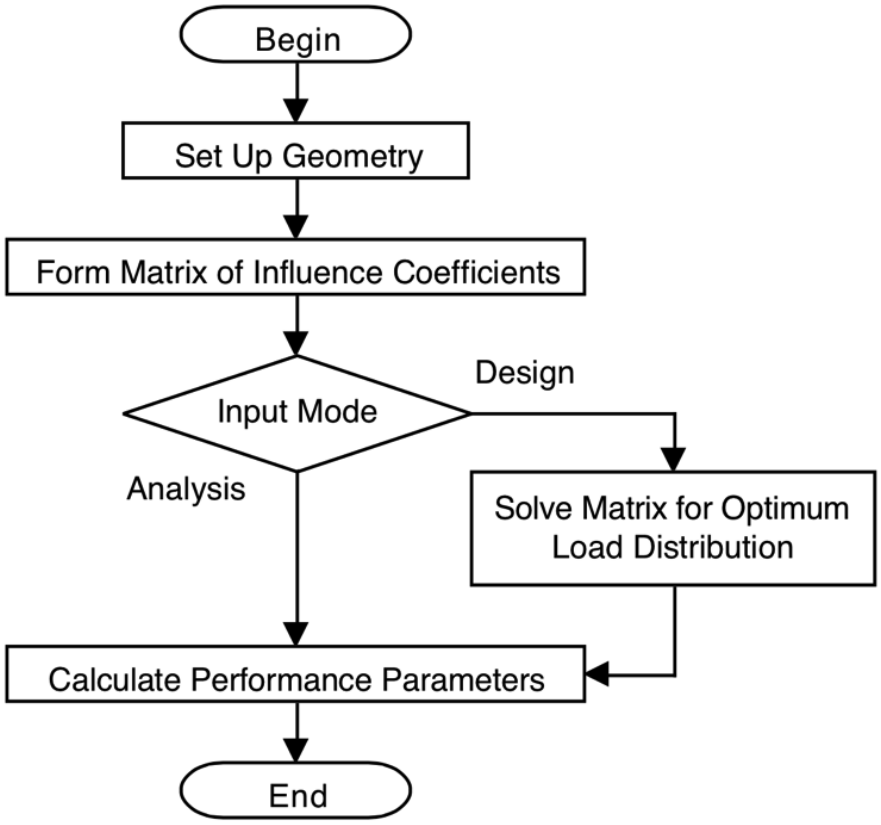
Vortex Lattice Method for Induced Drag

- For incompressible, inviscid flow, the wing is modeled as a set of lifting panels.
- Each panel will contain a single horse-shoe vortex.
- A bound vortex is located at the panel 1/4 chord position with two trailing vortex lines shed from each end.



- The required strength of the bound vortex on each panel will be calculated by applying a surface flow boundary condition.
- This induced component is a function of strengths of all vortex panels on the wing.

Methodology



Two execution options are available:

- Analysis: If the analysis mode is chosen, the code takes the geometry and load distribution as inputs, and calculates the performance parameters as outputs.
- **Design**: If the design mode is chosen, the geometry and design conditions are taken as inputs, and the code calculates the load distribution for the minimum induced drag, and returns the performance parameters as outputs.

Performance Parameters calculated are:

1. Actual Lift Coefficient
2. Span Efficiency Factor
3. Actual Moment Coefficient
4. Induced Drag Coefficient