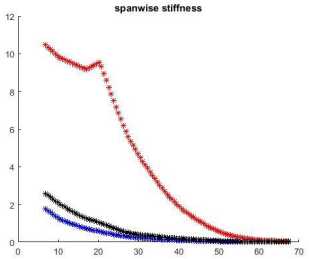
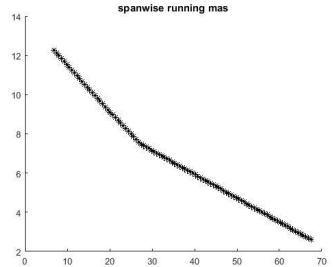
Scaling study

B757 wing finite element modeling

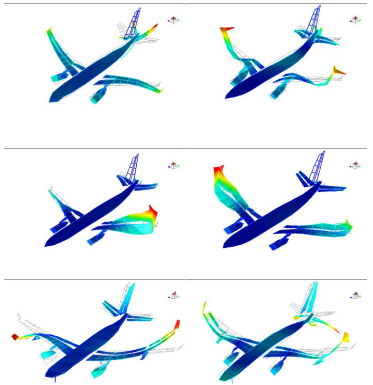
Objectives: comparisons between B757 wing with ribs and spars against same wing with voxel lattice

- EI, GJ, running mass distributions
  - We have results for B757 with ribs and spars





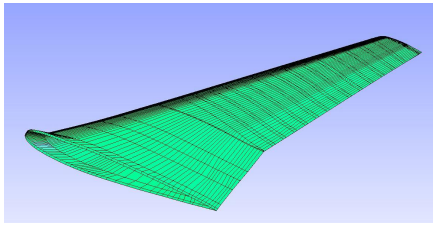
- Frequencies and mode shapes of beam models



- Coupled aero-elastic analyses
  - flutter results?

- Other comparisons

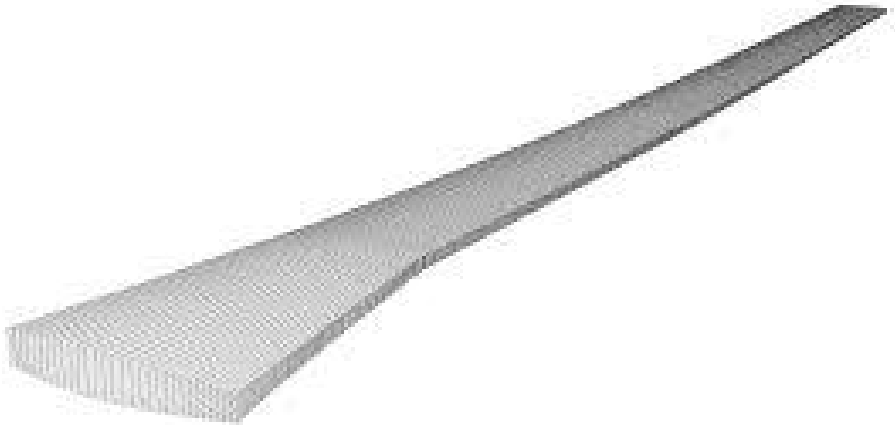
Modeling strategy and challenges



- Meshing the voxel lattice substructure
- Meshing wing skin
- Attaching substructure to skin
  - Meshing is much simpler if mesh size of lattice and skin is independent
  - Need a method that will simplify the meshing
- Static and modal analyses of 3D model
- Reduce 3D wing with cuboid lattice substructure to simple beam model with EI, GJ and mass distribution along beam
- Static and modal analyses of beam model

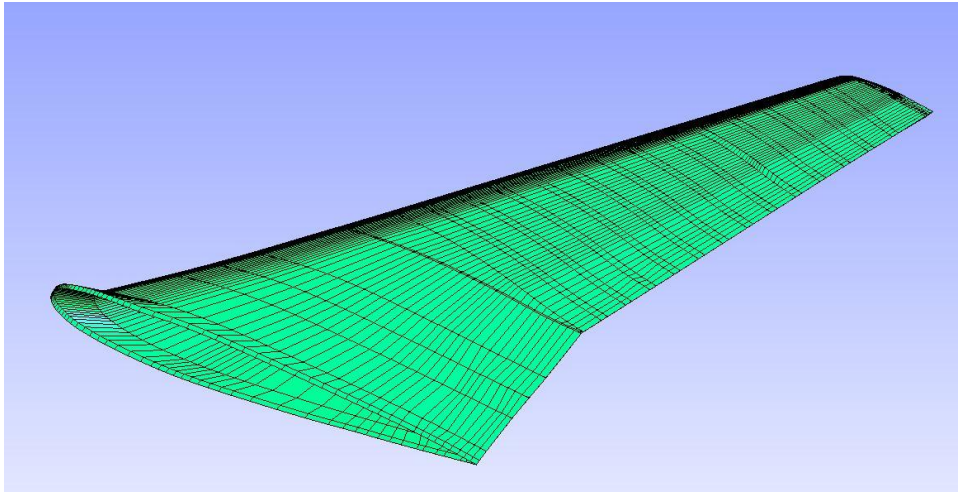
Meshing the voxel lattice substructure

- We can do this now
- Need to have a process for producing large mesh

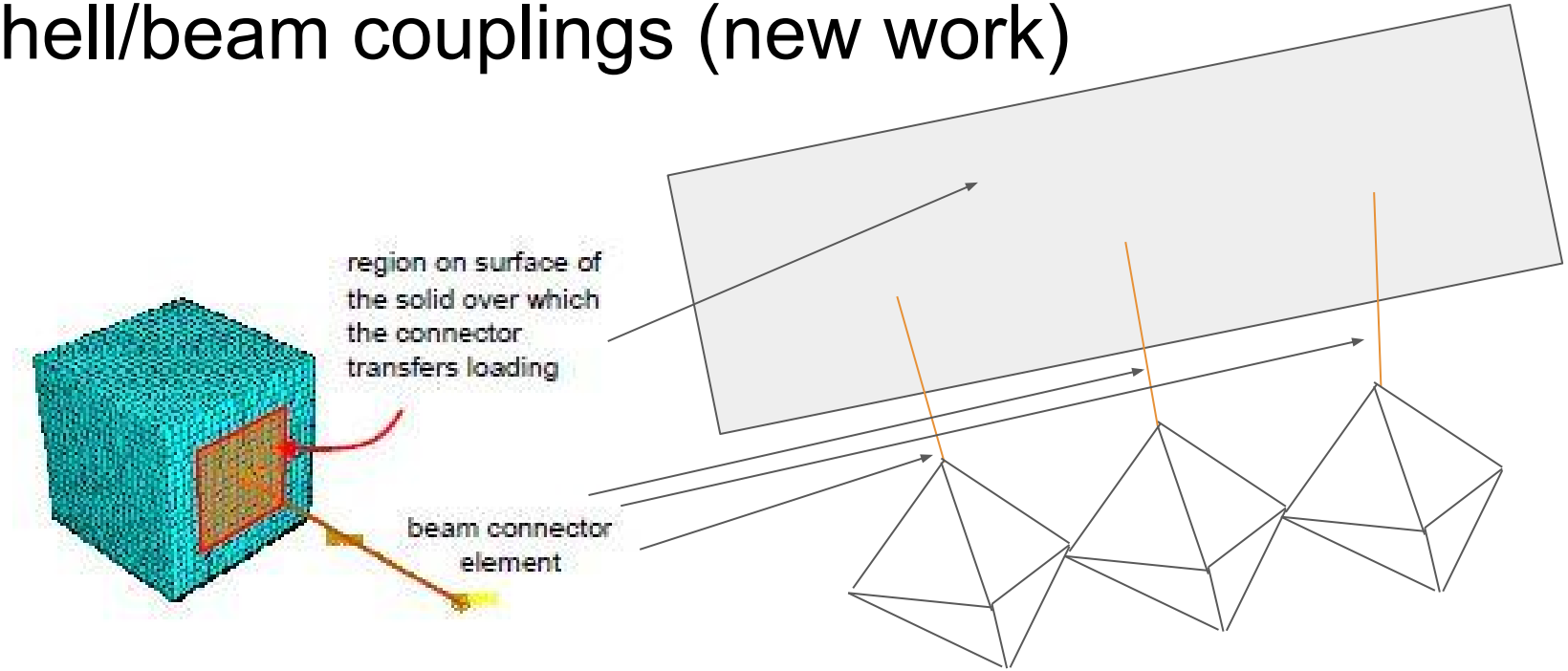


Meshing wing skin with 3D shell elements from CAD

- Extract points on wing surface at constant cross sections
- Set mesh seeds on each section using same pattern
- Create structured quad shell mesh by joining nodes on adjacent sections
- We have done this before!



Shell/beam couplings (new work)



- Verify this modeling approach with simple model (Khanh?)
- Identify boundary nodes of lattice (Joseph?)
- Pair boundary nodes with nearest surface shell element (Joseph?)
  - Calculate connector point on wing surface (line/plane intersection calculations)

Reduce 3D wing with lattice substructure to simple beam model.

- Estimate spanwise bending stiffness ($EI_{11,}$, EI_{22}, GJ) along wing (Khanh?)
  - Using multiple simple beam loading static analyses and Euler-Bernoulli equations
- Estimate weight distribution along wing (Khanh?)
- We have not done this before

Tentative schedule

- Select and verify beam/shell coupling modeling technique — now - 7/29
- Develop automated mesh building code — now - 8/5
- Develop method for reducing 3D wing model to beam model — now - 8/10
- Working ABAQUS model (code integrations, trial analyses) — 8/10
- Optimization (different voxel designs) and getting results — 8/11 - 8/16