

Composite Optimisation

What?

- In a structural engineer perspective- Two or more materials combined at macroscopic level to form a new material.

Why?

- To take advantage of desired qualities where required.
- Advantage with strength to weight ratio compared to conventional materials.
- High strength, stiffness, fatigue, resistance to corrosion, etc..

Applications:

- Widely used in aerospace structures. (Airbus XWB350, both fuselage and wings made primarily with composites)
- Few automotive skeletons, crash box, formula car monocoque, etc...
- Sports equipments like tennis rackets, golf, etc.. To take the advantage of strength over weight.
- Civil engineering applications-Bridges

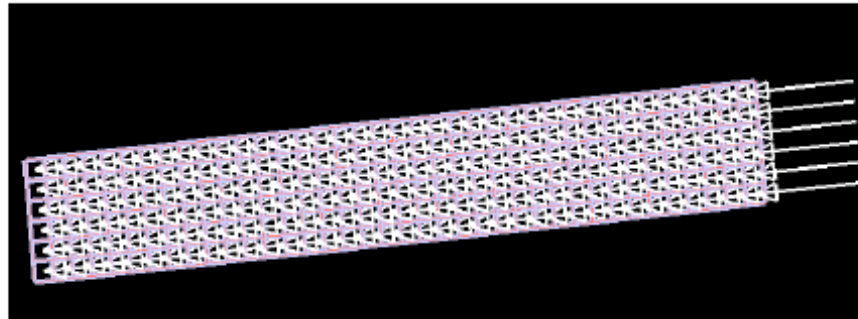
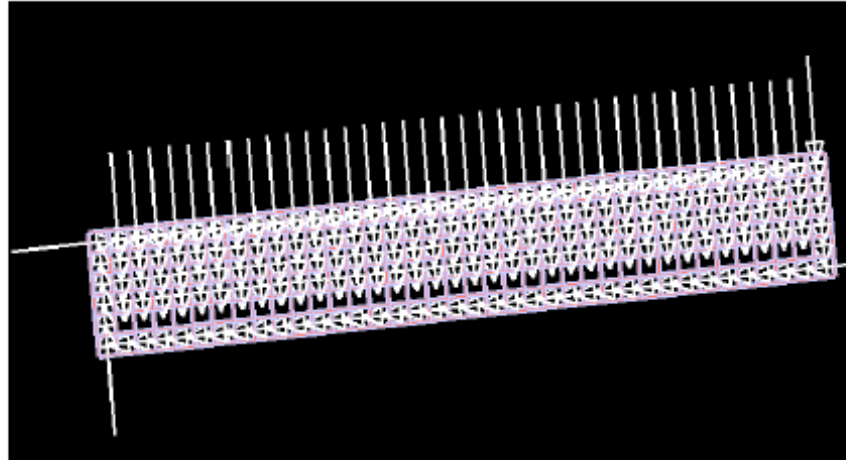
Composite Optimisation

- Fibre orientation
- Number of plys
- Stacking sequence
- Isotropic materials v Anisotropic/Orthotropic material properties
- Anisotropic = different material properties in different directions
- Orthotropic materials have 3 mutually perpendicular material properties

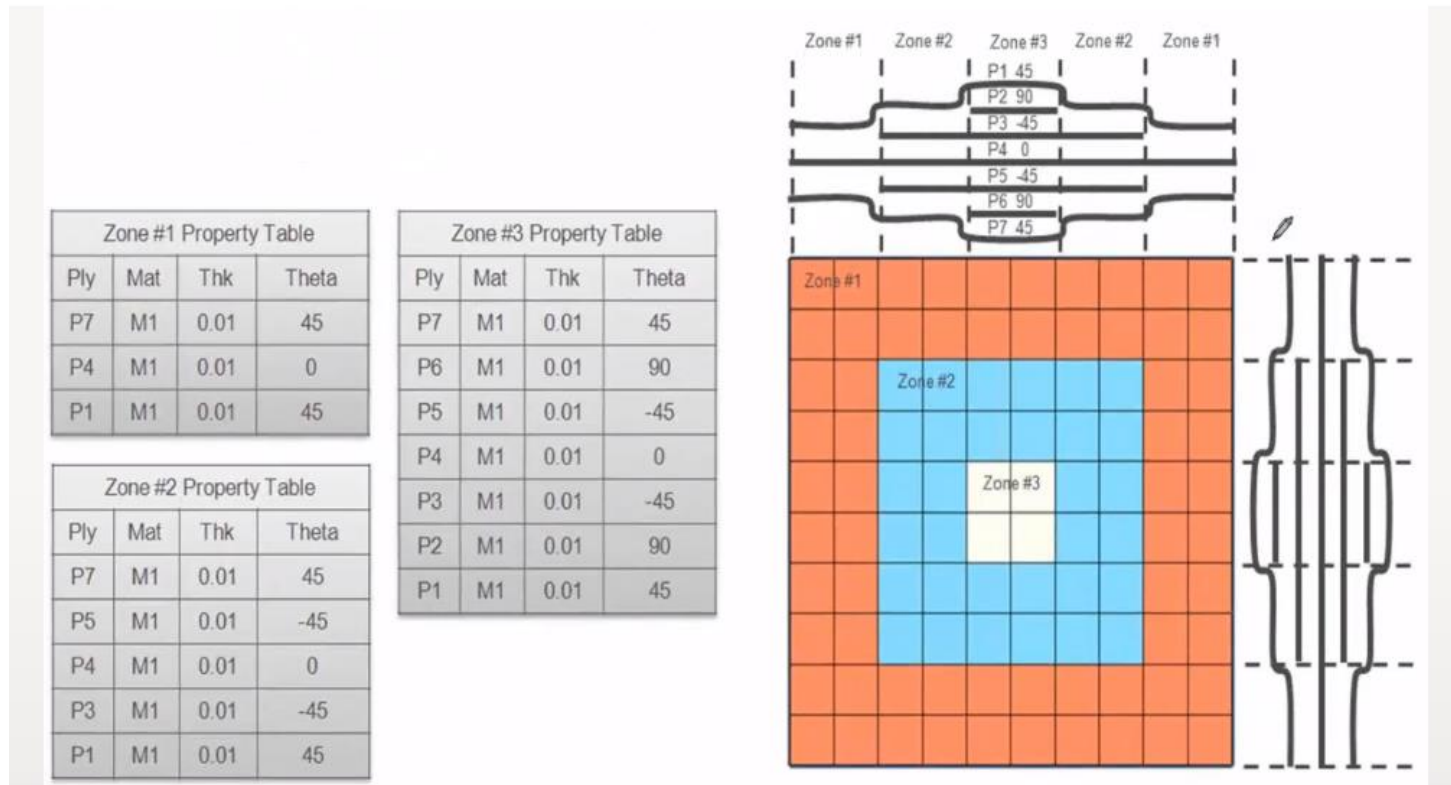
Property	Material 1
Youngs modulus in the longitudinal direction (E_1)	185000
Youngs modulus in the lateral direction (E_2)	5000
Poissons ratio (Nu_12)	0.05
Inplane shear modulus (G_12)	1000
Transverse shear modulus (1-Z plane) (G_1z)	1000
Transverse shear modulus (2-Z plane) (G_2z)	1000
Mass density (Rho)	1.6e-9
Allowable longitudinal stress in tension (Xt)	950
Allowable longitudinal stress in compression (Xc)	600
Allowable transverse stress in tension (Yt)	50
Allowable transverse stress in compression (Yc)	50
Allowable inplane shear stress (S)	50

Composite Optimisation

- Element Orientations for Anisotropic materials

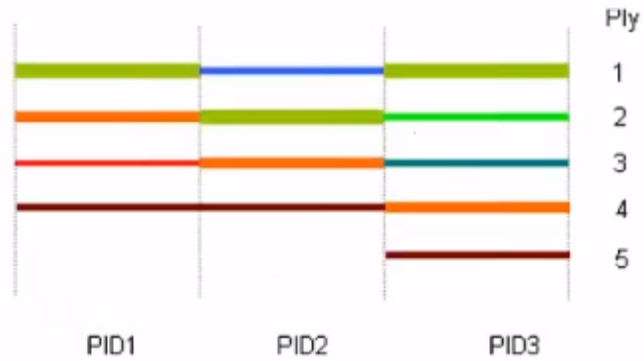


Composite Optimisation – Zone based modelling



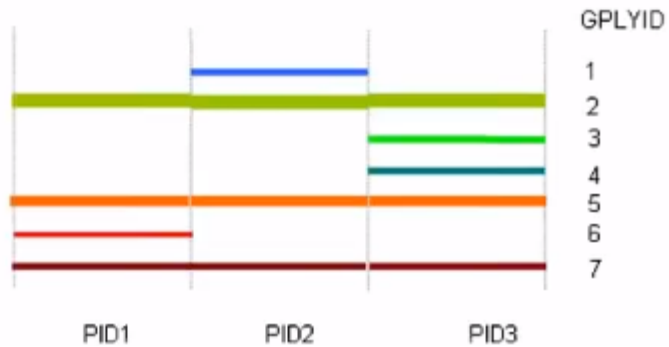
Composite Optimisation – Zone based modelling

PCOMP



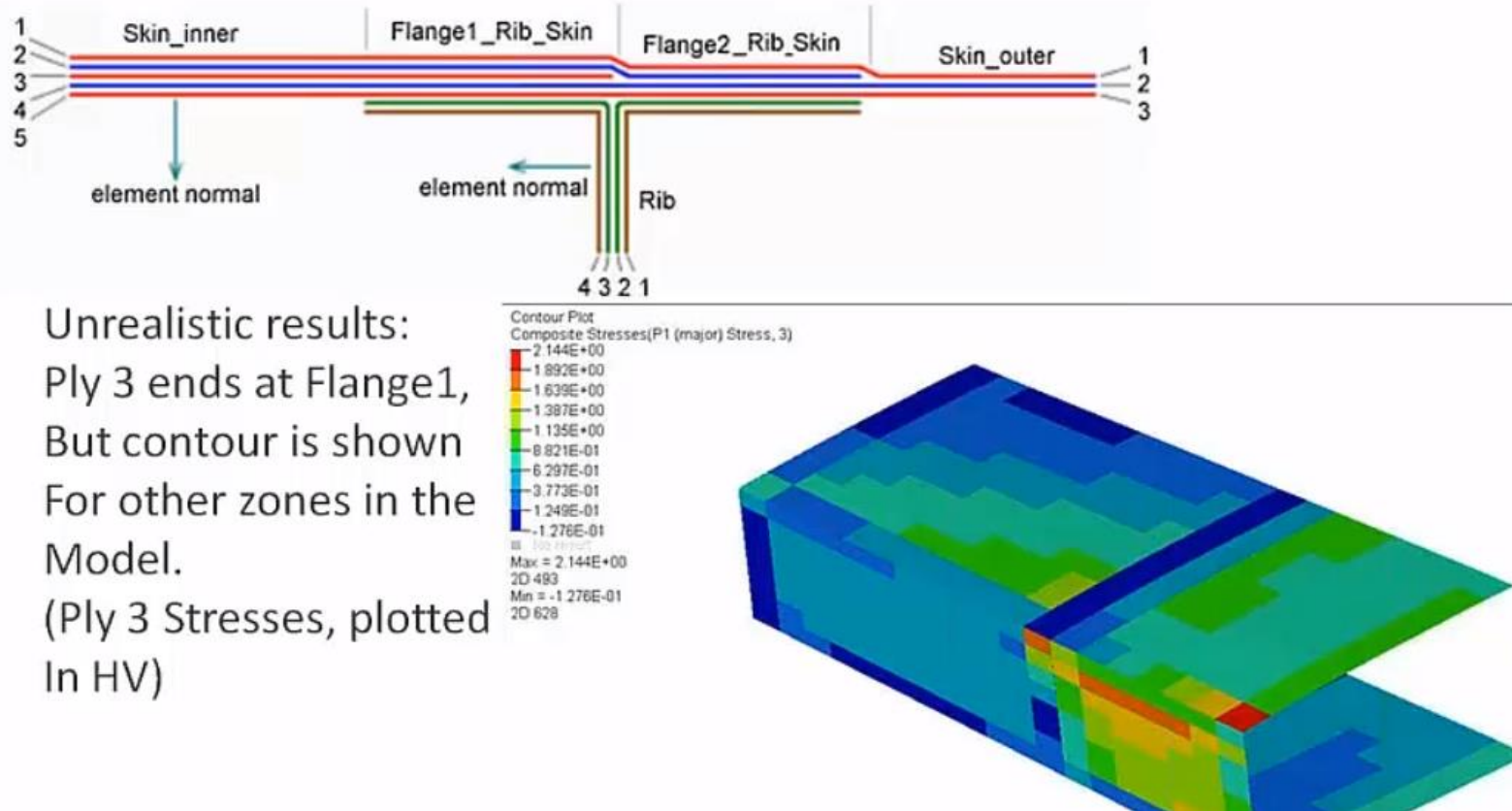
- PCOMP v PCOMPG

PCOMPG



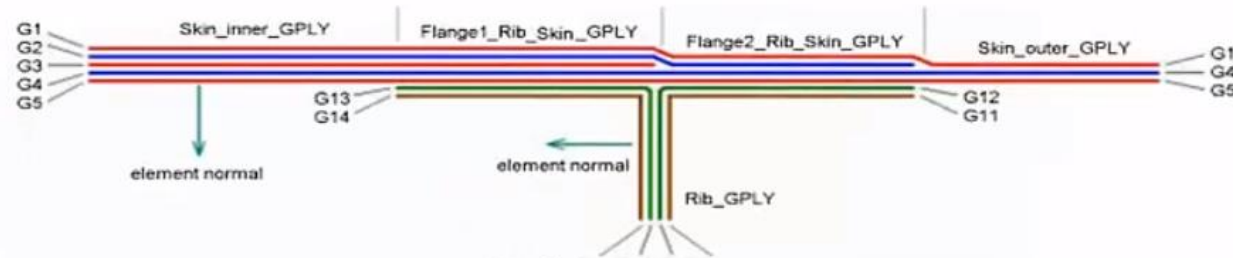
Composite Optimisation – Zone based modelling

PCOMP- no relationship of a ply that is common across several properties



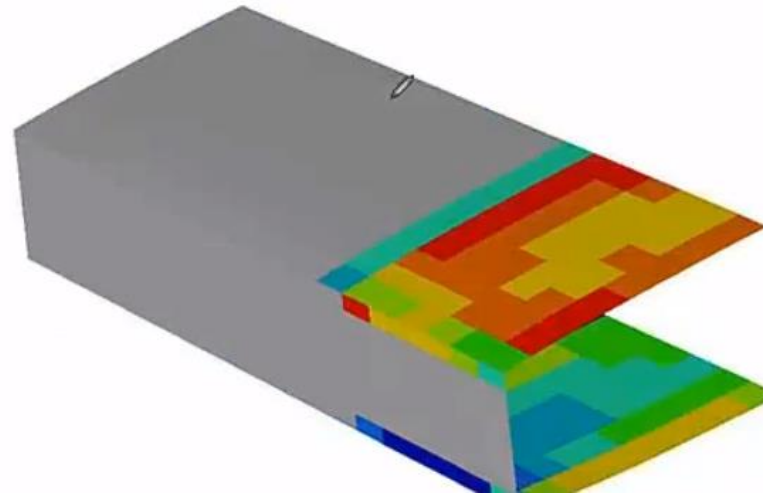
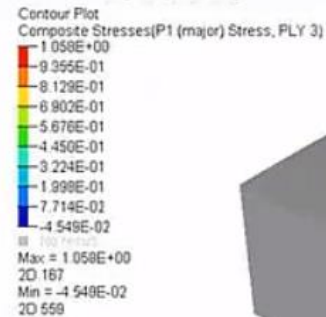
Composite Optimisation – Zone based modelling

PCOMPG- Relationship is maintained for plies which are common across different properties based on Global ply ID



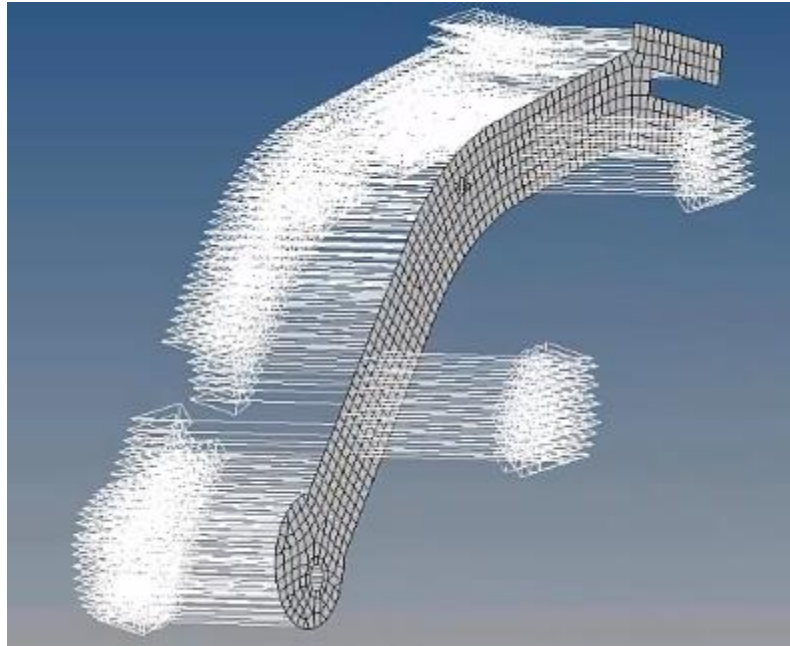
Results make sense in this Model.

For global ply 3 the results are realistic with PCOMPG

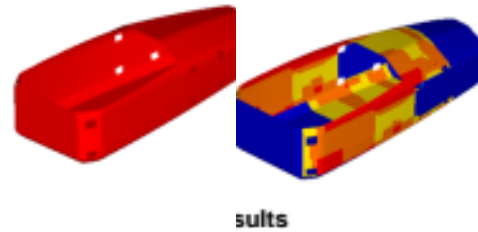
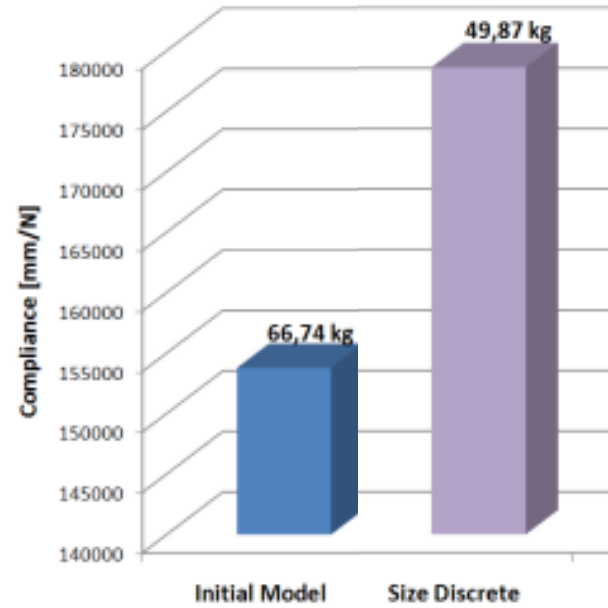
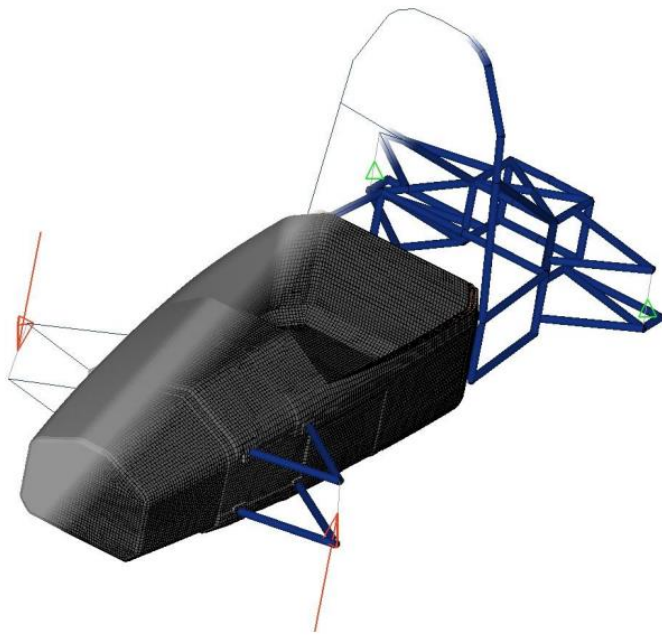


Composite Optimisation

- Element Normals for stacking sequence



Composite Optimisation – Formula SAE example



Notes adapted from/Further reading

- Practical Aspects of Structural Optimisation, Altair University, 2014