Research in Composites at ITA

CISB | CENTRO DE PESQUISA E INOVAÇÃO SUECO-BRASILEIRO

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Research objective

Expand the design space of aeronautical composite structures without compromising safety

Key factors:

- Review current design guidelines
- Use angles other than 0, 90, 45 and -45 degrees
- Consider allowing buckling at limit load
- Develop a consistent fracture criteria
- Avoid delamination (including skin/stiffener)
- Integrated optimization: include design guidelines, manufacturing constraints and environmental effects

Design & Optimization

Composite materials are considered very stiff and strong materials

However, a quasi-isotropic carbon/epoxy laminate has only slightly better properties than aluminum or steel even normalizing by density

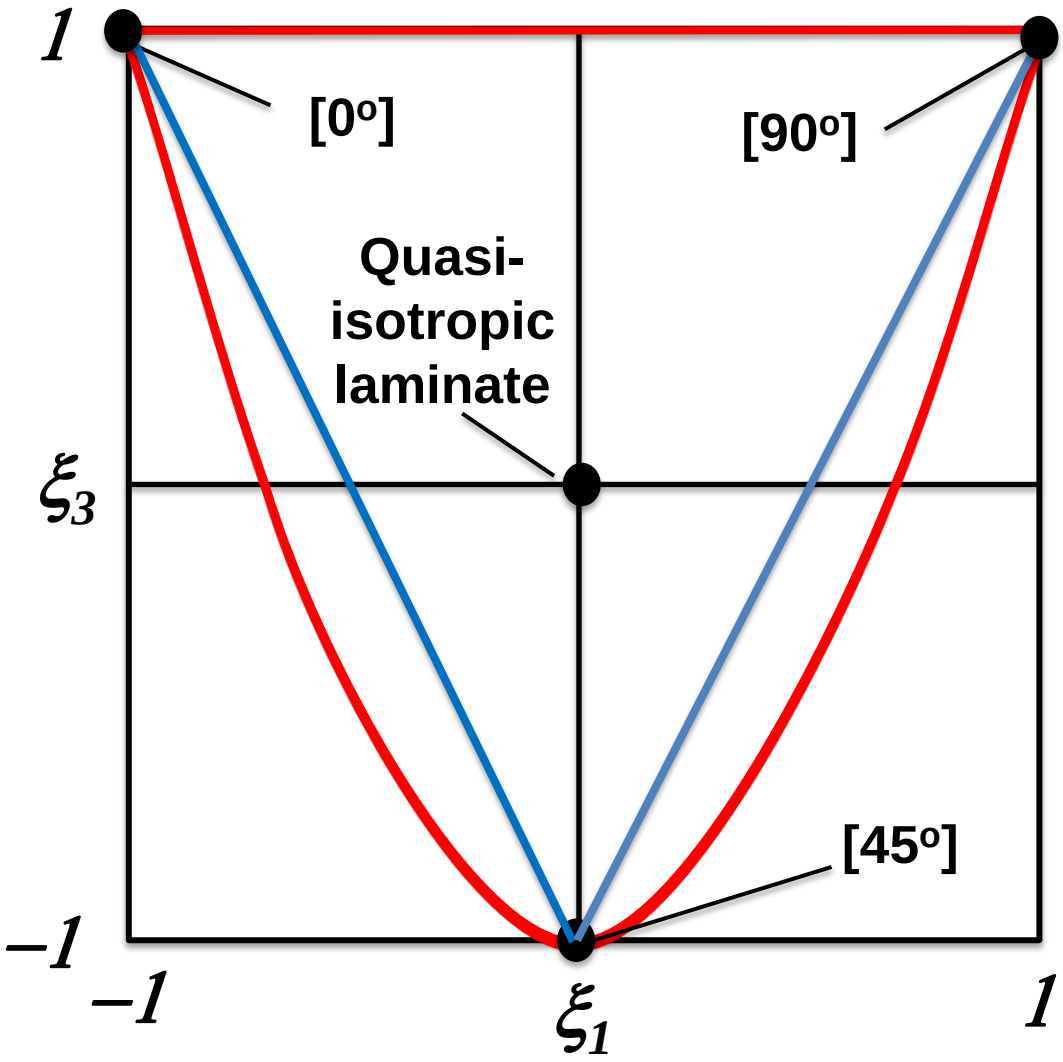
Basic idea:

the optimum for a elasticity driven design is as far as possible to the quasi-isotropic laminate

Design guidelines

feasible region

0, 90, 45 and -45 angles



Other design guidelines

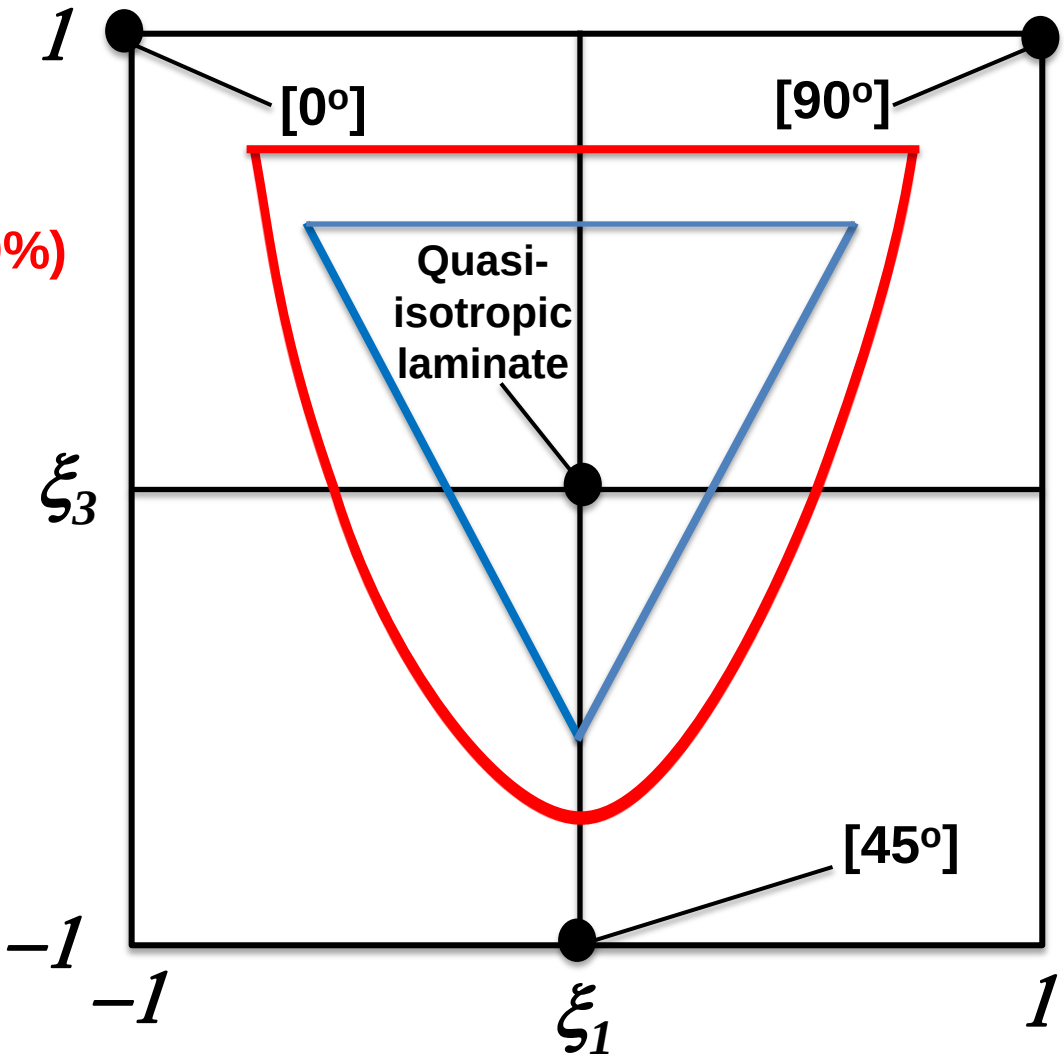
- Limit number of consecutive unidirectional layers with same orientation (fatigue)
- 10% rule: minimum of 10% layers at 0, 90, 45 and -45 angles (fracture)
- Use symmetric laminates (warping)
- Use balanced laminates and minimize bending coupling terms (coupling terms)
- AML guideline (fracture)

Design guidelines

homothetic rule (20%)

10% rule

AML rule further constrains the design space



Design guidelines

- All design guidelines constrain the design space
- When a component design is dominated by stiffness requirements, the guidelines intended to fatigue & fracture are not applicable

Design challenge:

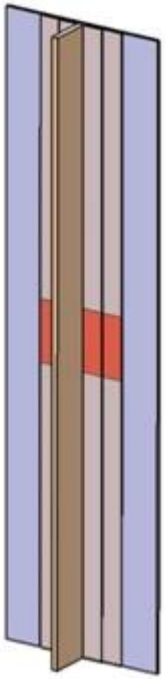
- Design a component dominated by stiffness requirements with a stress concentration (joints, opening holes, repair)
- In this case, the strength requirements is locally dominant

Proposed topics

- Design optimization taking into account general design guidelines, manufacturing constraints and environmental effects
- Consistent fracture criterion
- Innovative design of joints and repairs
- Investigate delamination growth between skin and stiffener in post-buckling regime (for bonded structures)
- Review the number of repeated unidirectional layers: fatigue tests

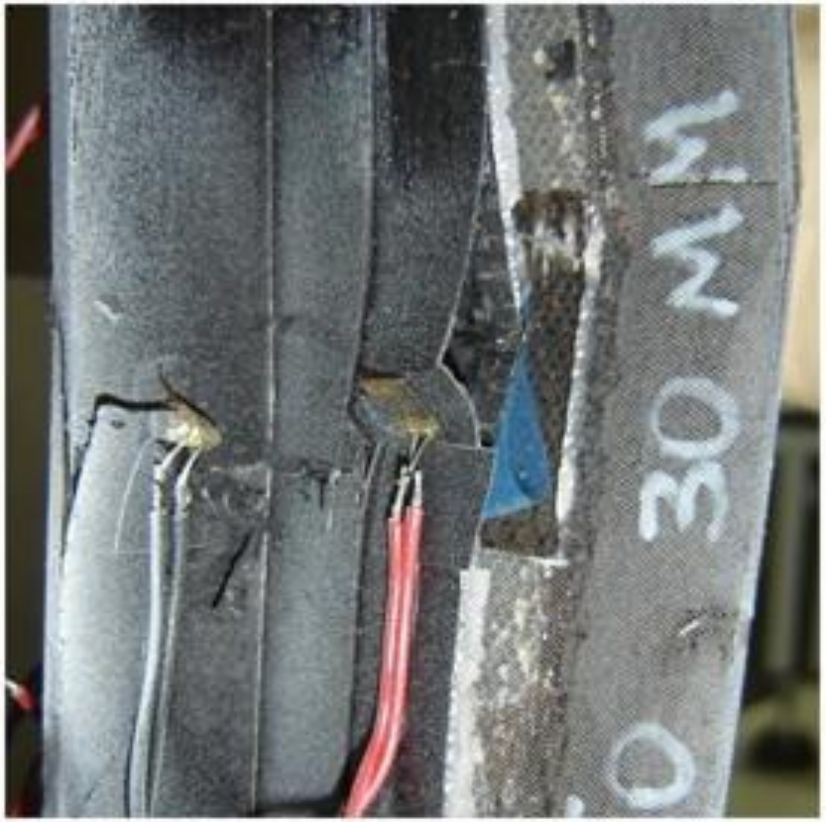
Buckling / post-buckling

Stringer delamination: compression



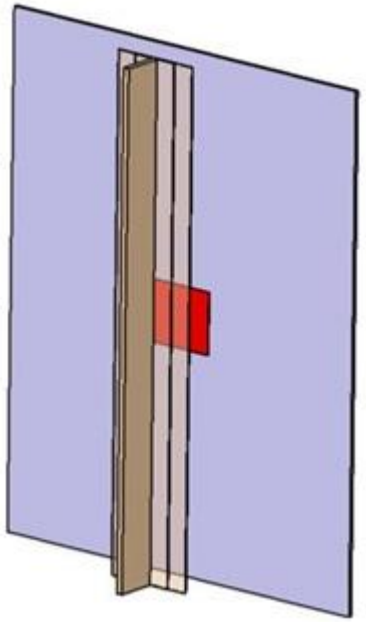
Buckling / post-buckling

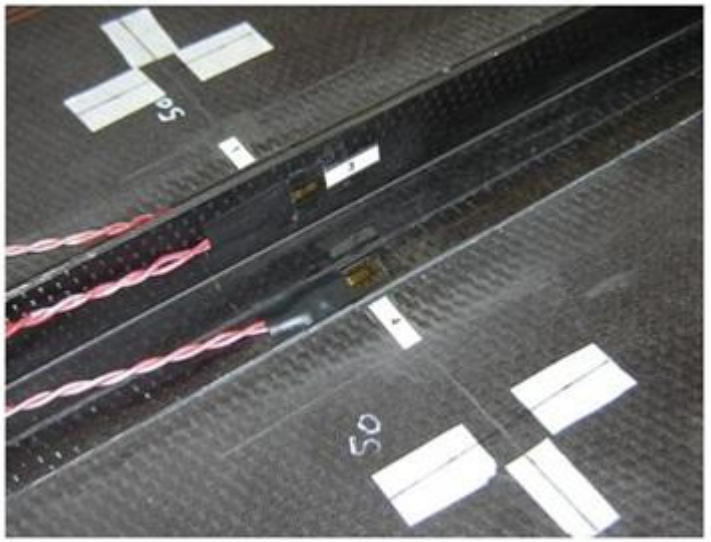
Stringer delamination: compression



Buckling / post-buckling

Stringer delamination: seven point bending





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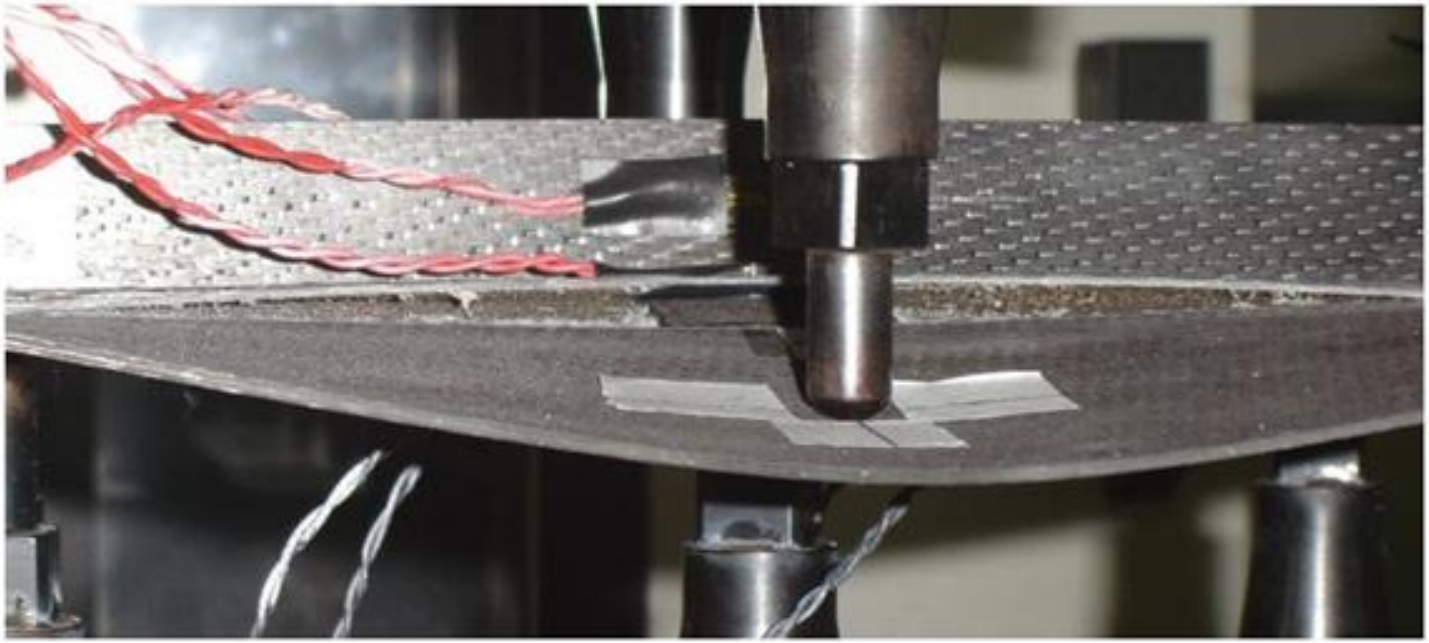

Thank you!

Questions?