FAA Center of Excellence AMTAS Advanced Materials in Transport Aircraft Structures

Strain Invariant Failure Theory (SIFT)

- Originally proposed by Gosse, et al

- Fundamental hypothesis: Failure is initiated at the micro level if any one of three strain invariants reach critical levels:

- Dilatational (volumetric) strain invariant of the matrix, J_1

- Deviatoric (distortional) strain invariant (J_2 ~ "von Mises strain"):
    - of the matrix, ε_{vm}^{m}
    - of the fiber, ε_{vm}^{f}

Strain Invariant Failure Theory (SIFT)

- The strain invariants of interest are defined at the micro-level (i.e., at the fiber scale)

- In practical engineering applications, strains at the micro-level are not accessible, either numerically or experimentally

- To overcome this difficulty, FE analyses of unit cell models are used to determine “strain amplification factors” (strain concentration factors) for prescribed thermal and macro strain fields

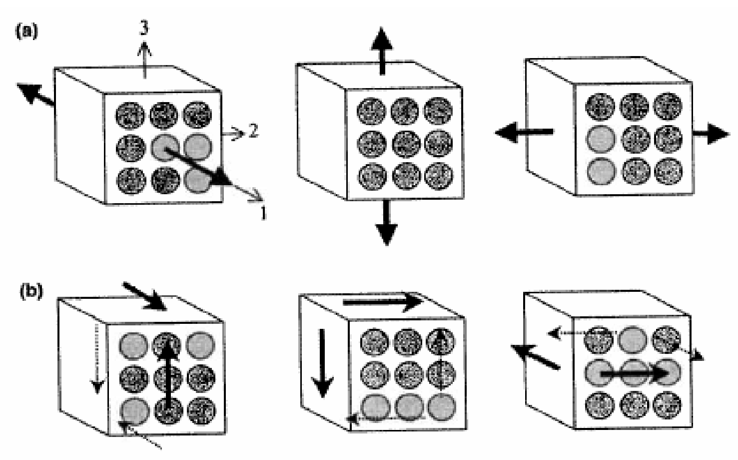


Fig. 4. (a) Prescribed normal displacements, (b) prescribed shear deformations.

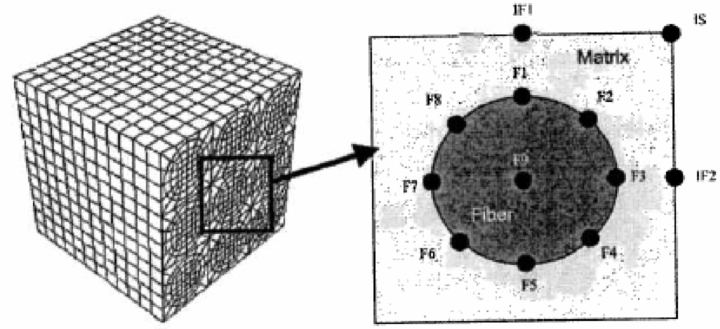


Fig. 5. Locations for extraction of amplification factors.

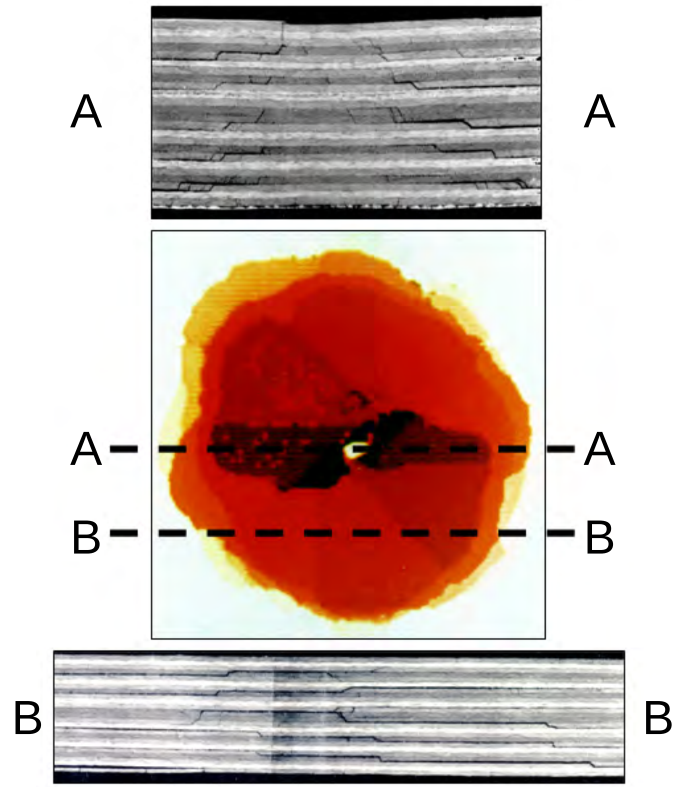
Strain Invariant Failure Theory (SIFT)

- Strain amplification factors are constant for a given fiber-resin combination

- During subsequent experimental/numerical analyses of composite structures, strains measured/predicted at the macro scale are increased by the strain amplification factors, allowing calculation of the three strain invariants and prediction of initiation of ply failures

- Additional damage predicted by combining SIFT with a FE damage progression analysis. For example:
T. E. Tay, et al: “Damage progression by the element-failure method (EFM) and the strain invariant theory (SIFT)”, *Composite Science and Technology*, Vol 65 (2005)

Measured Impact Damage (Gosse, et al)



(45/0/-45/90)3s

FAA Center of Excellence
AMTAS
Advanced Materials in Transport Aircraft Structures

Impact Damage Predicted via SIFT (Gosse, et al)