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On Buckling of Thin Foils

Talk given at Politechnico di Milano, Orationem Meam.

Ståhle, P.

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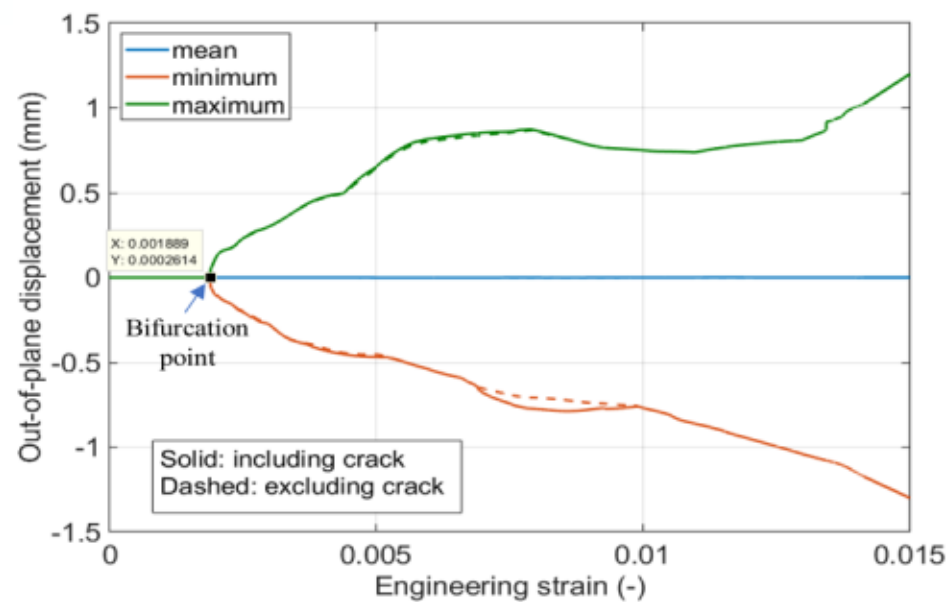
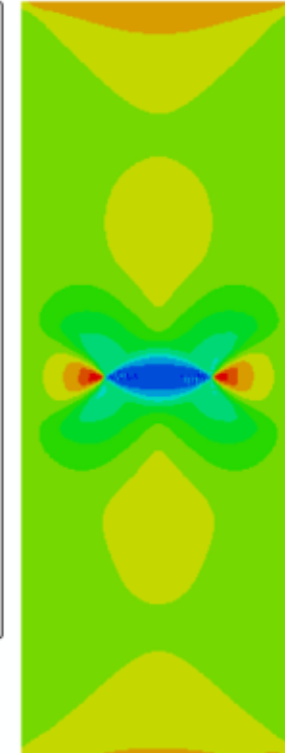
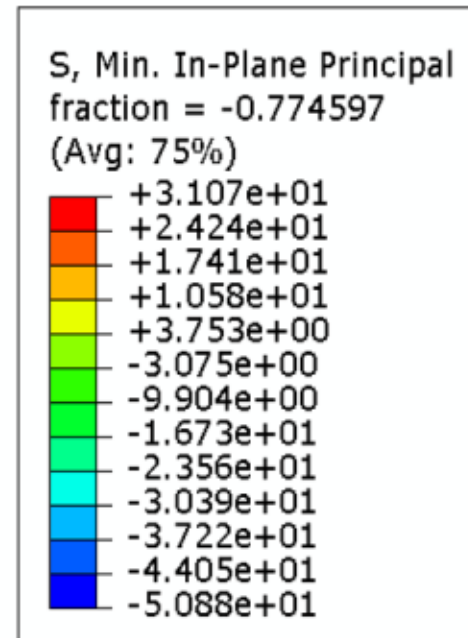
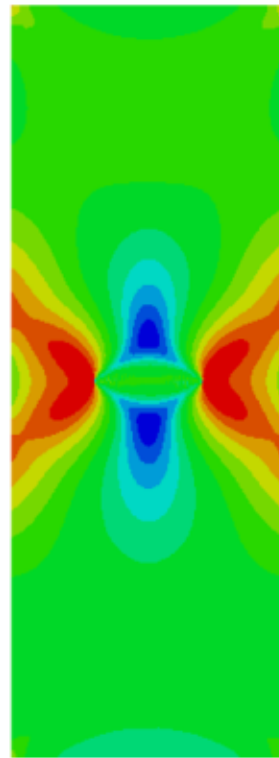
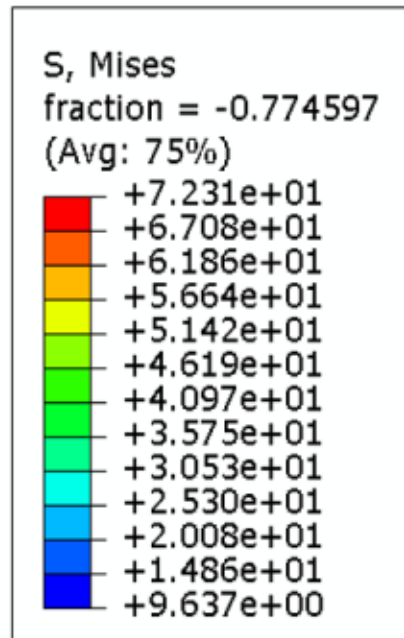
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Gruppo Gabriella, Milano

January 28th, 2019

1. Buckling and reduction of energy release rate
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Mises stress and Min. principle stress at bifurcation point:



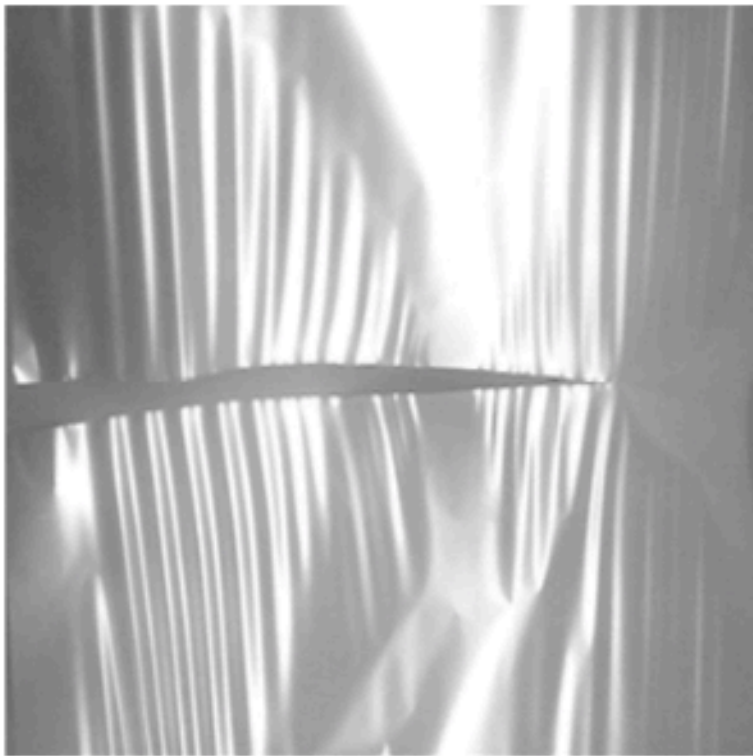


FIGURE 3. Buckling pattern

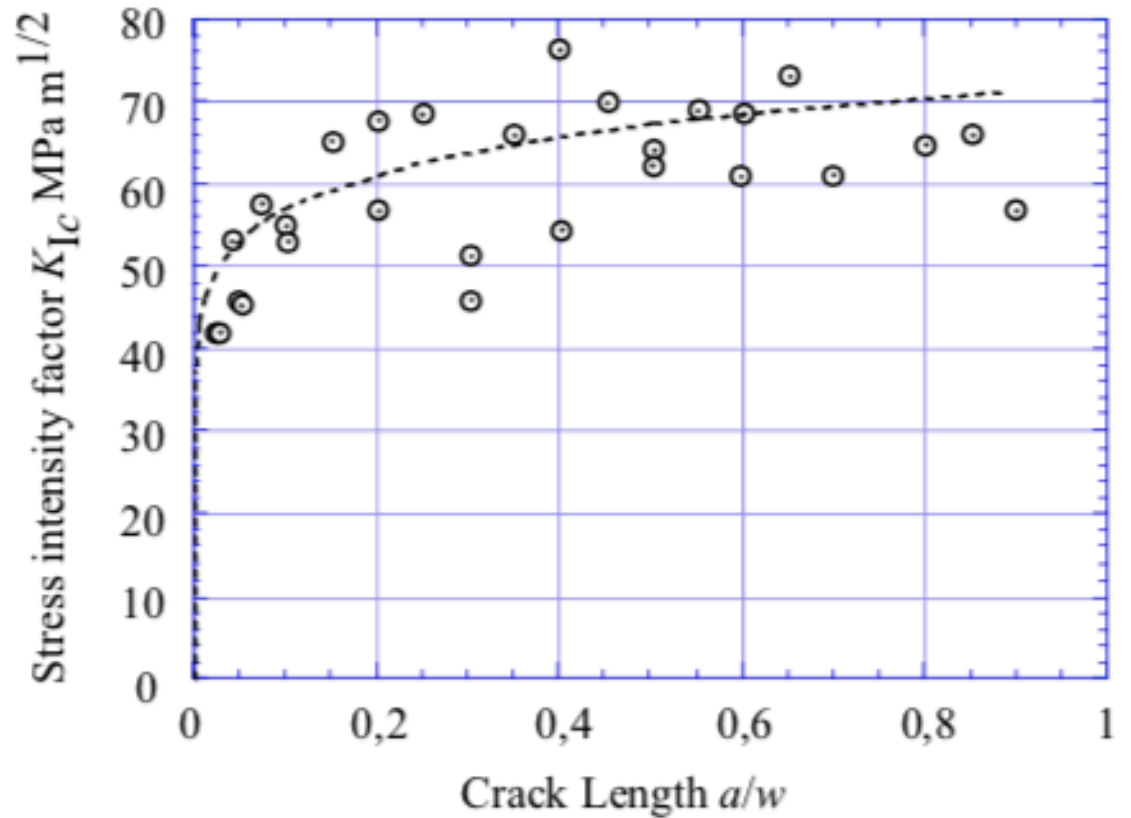
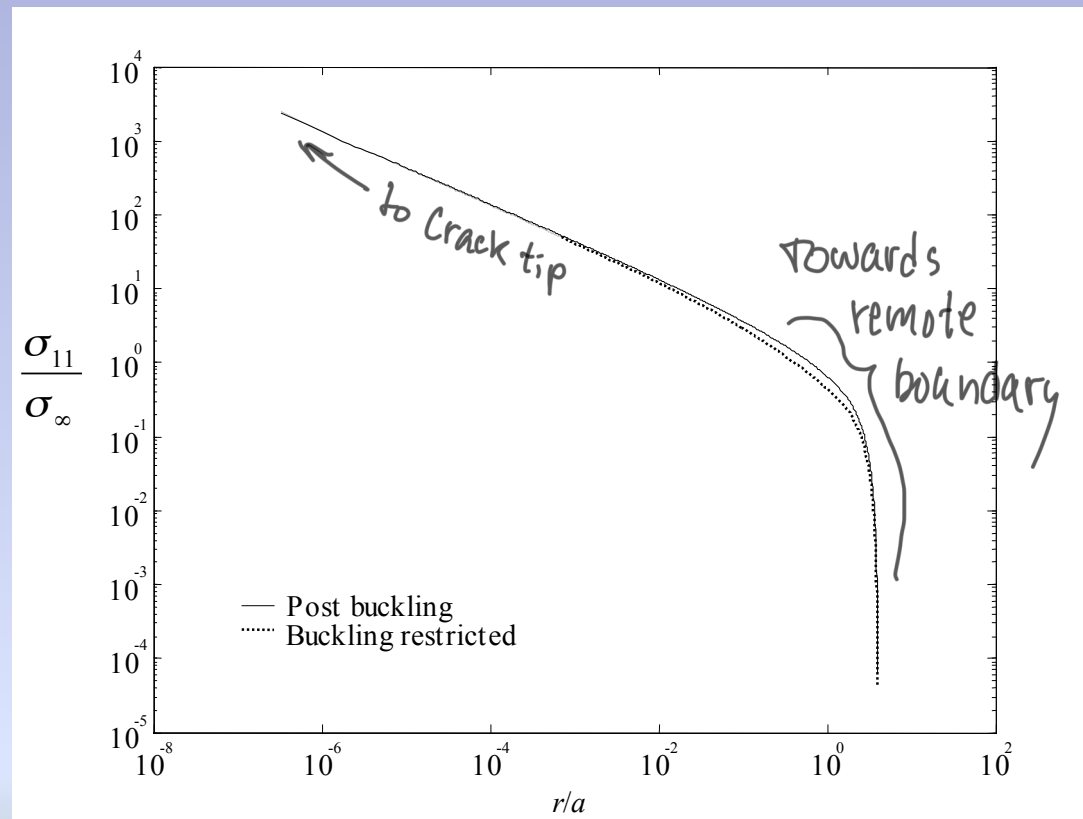
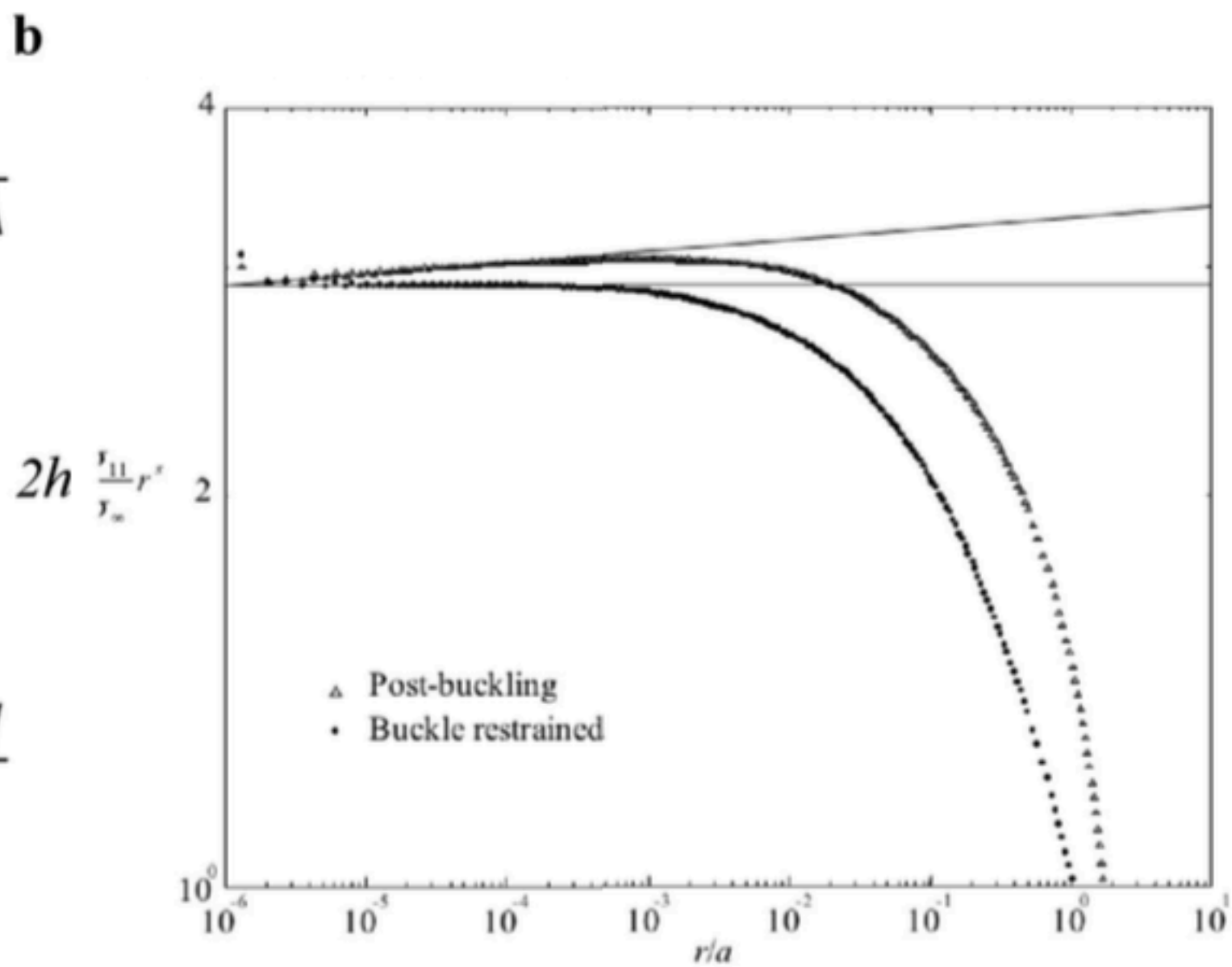
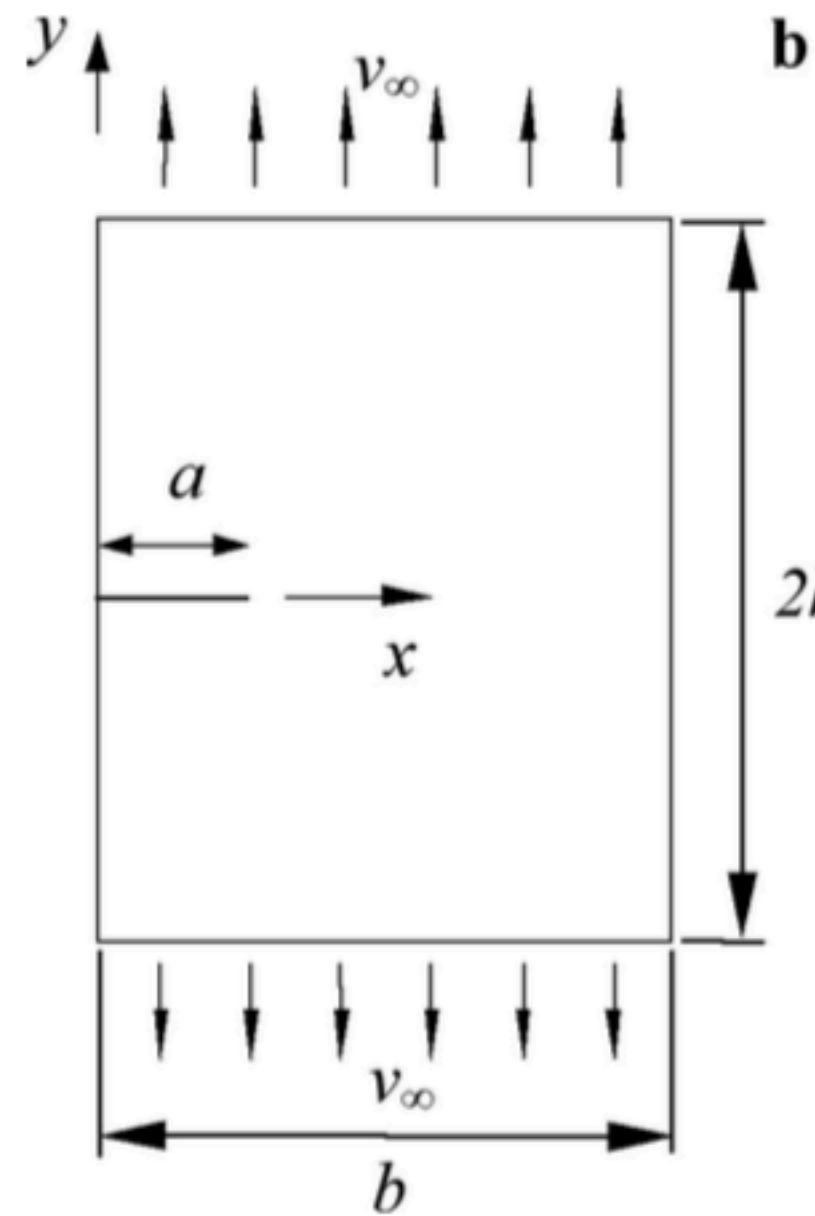


FIGURE 4. K_{Ic} results for the different tests. Dashed curve shows the theoretical result for $s = 0.4$.

- Central crack Denser case, $a/b = 0.1$





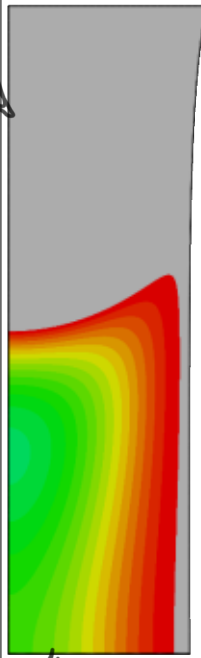
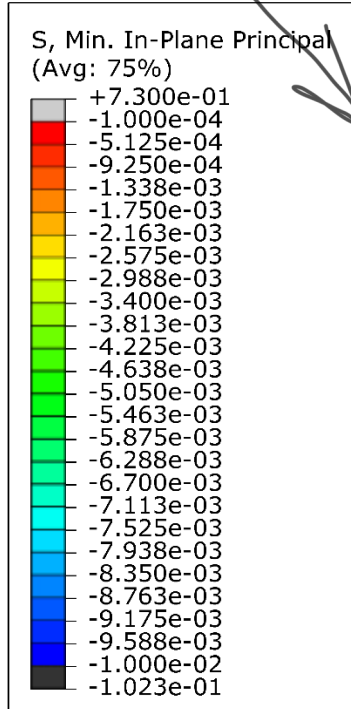
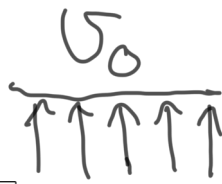
Influences on fracture criteria prediction

- The load capacity can be determined as:

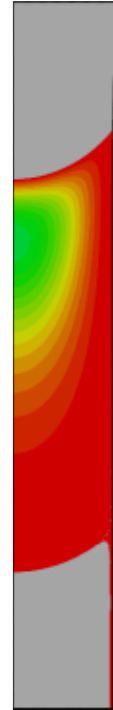
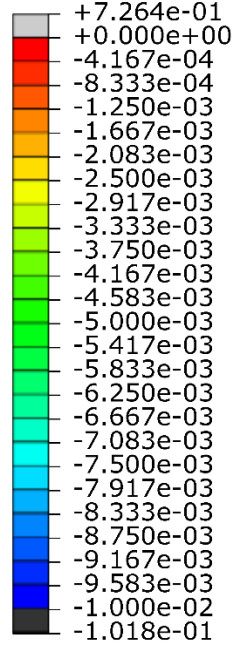
$$\sigma_c = \frac{k_c \sigma_o (2\pi a / r_o)^s}{f(a/b, h/b)}$$

- The micro structural distance : $r_o = K_{Ic}^2 / \sigma_o^2$
- At a critical load the load parameter $k = k_c = K_I / K_{Ic}$

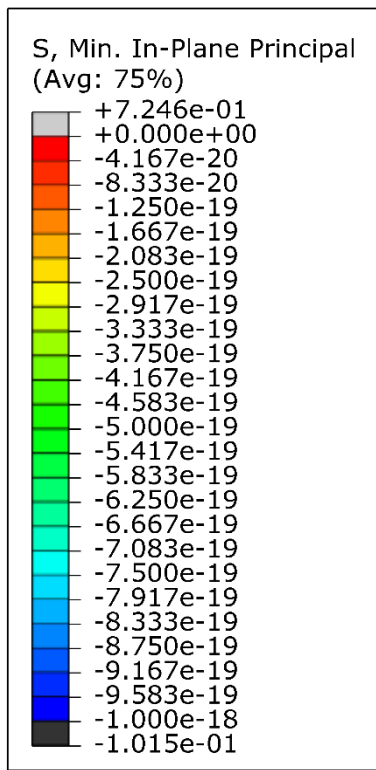
X Symm



S, Min. In-Plane Principal (Avg: 75%)



Y Symm



Same condition as earlier studies (Except deformation is not exactly scaled).

L =length, W =width, $r = \frac{L}{W}$.

For $r=2.5$ compressive stress order $1e-3$. For $r=5$ no compressive stress. For $r=10$ compressive stress is back and is in the order $1e-19$.

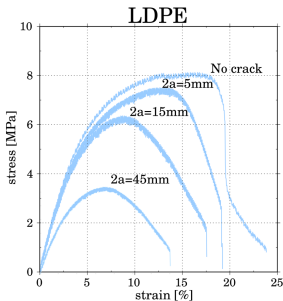
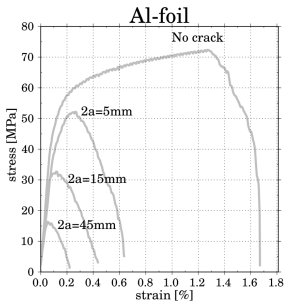
Conclusion: Probable 'r' value to neglect clamp effect at the centre region, $2.5 < r < 5$

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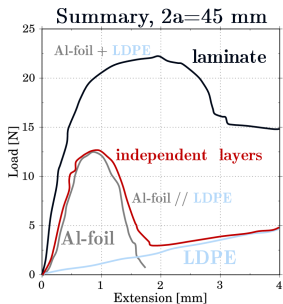
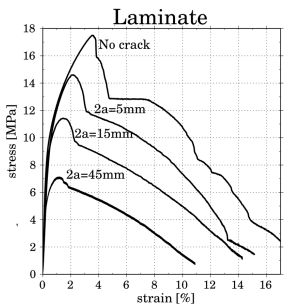
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Test results



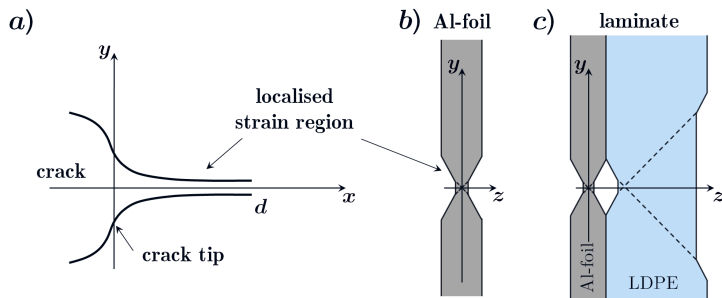
Stress vs. strain for tensile tests

a) Al-foil, b) Polymer



a) Stress vs. strain for the laminate. b) Load vs. extension. Summary of the aluminium, polymer and laminate results. Crack length 45mm (Kao-Walter et al., 2002), (Hutchinson, 2013)

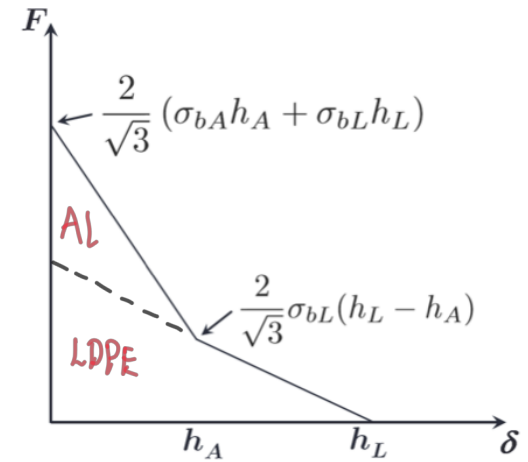
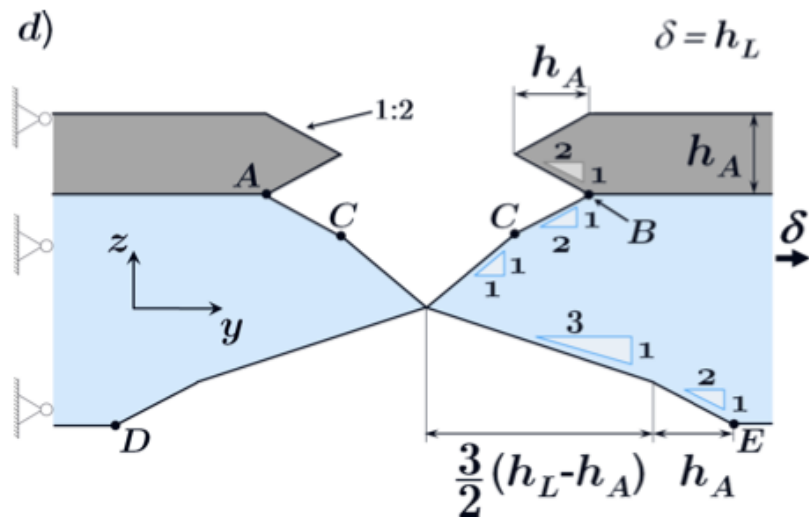
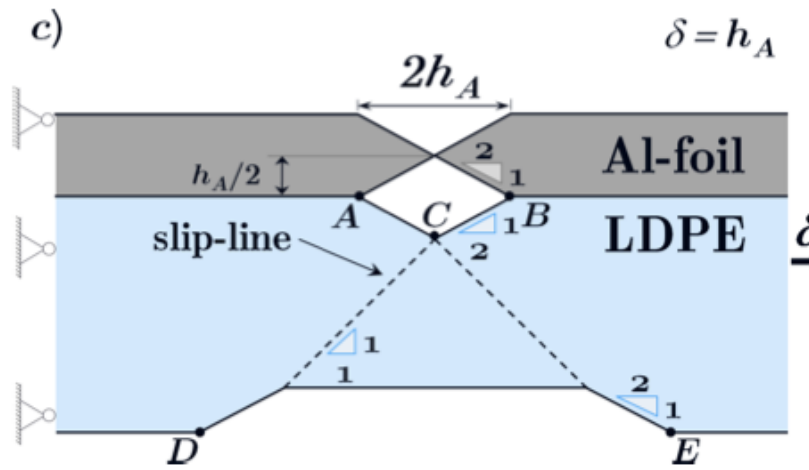
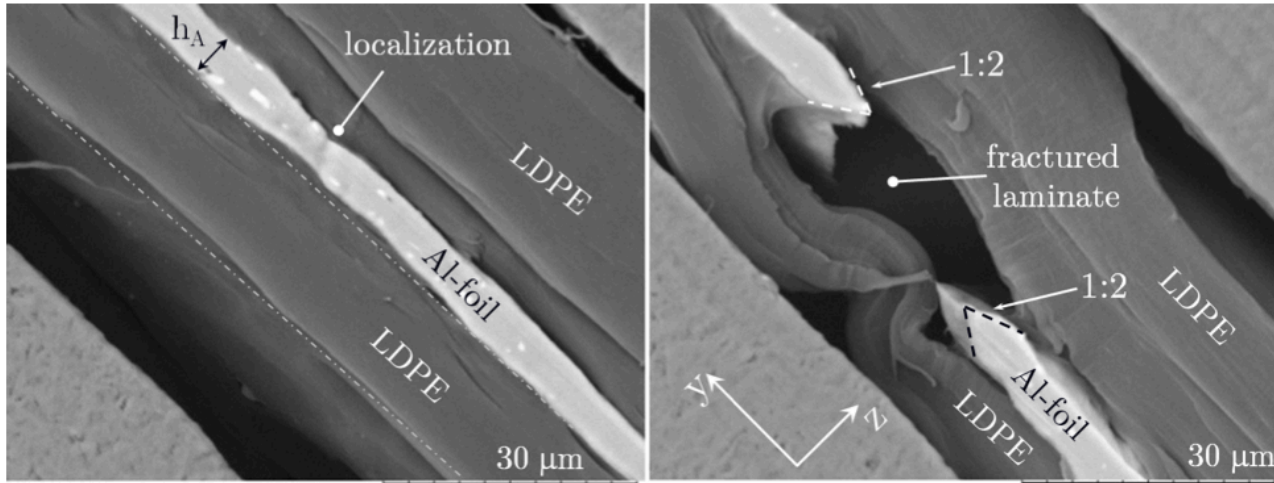
Work of failure



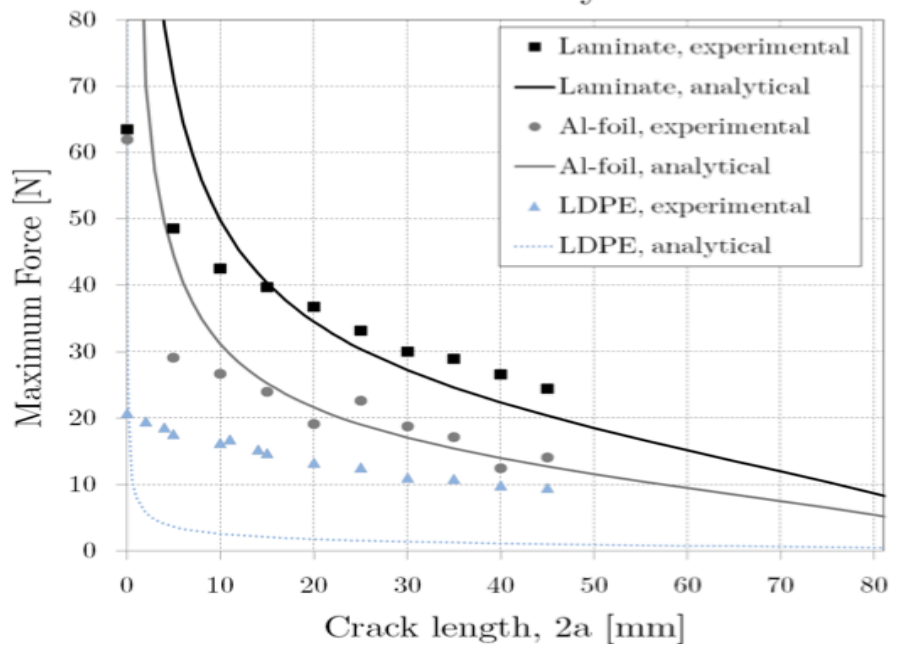
Strip yield zone ahead a crack tip. a) the crack geometry in the plane $z = 0$. b and c) the slip region as seen in a plane $x = \text{const}$.

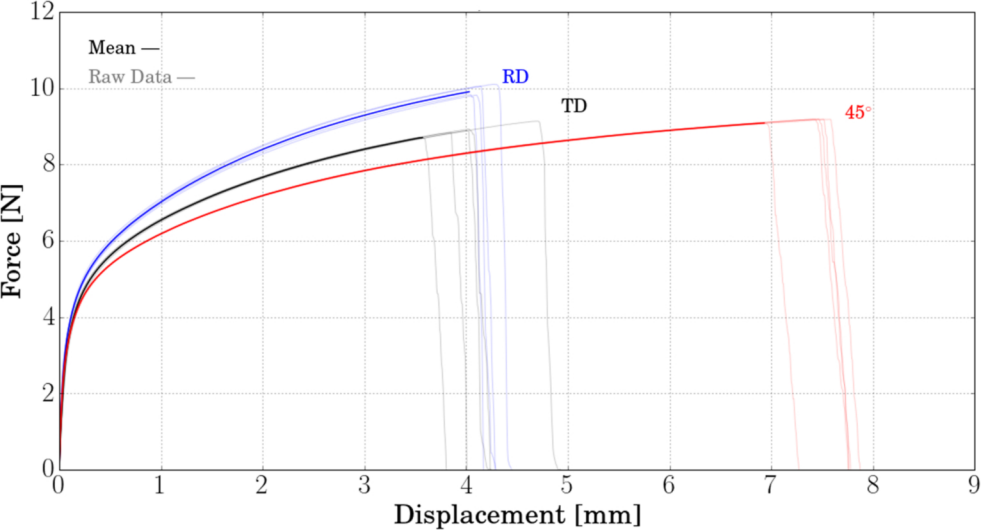
Super-tough Thin Film Laminates

Sharon Kao-Walter, Rickard Hägglund, Eskil Andreasson



Summary





Compliance

0.0015

0.0010

0.0005

0.000

0.005

0.010

0.015

used
measurements

Strain

