On the Mechanics of a Thin Metal and Polymer Foil Laminate

Seminar at Tetra Pak, Modena, Orationem Meam.

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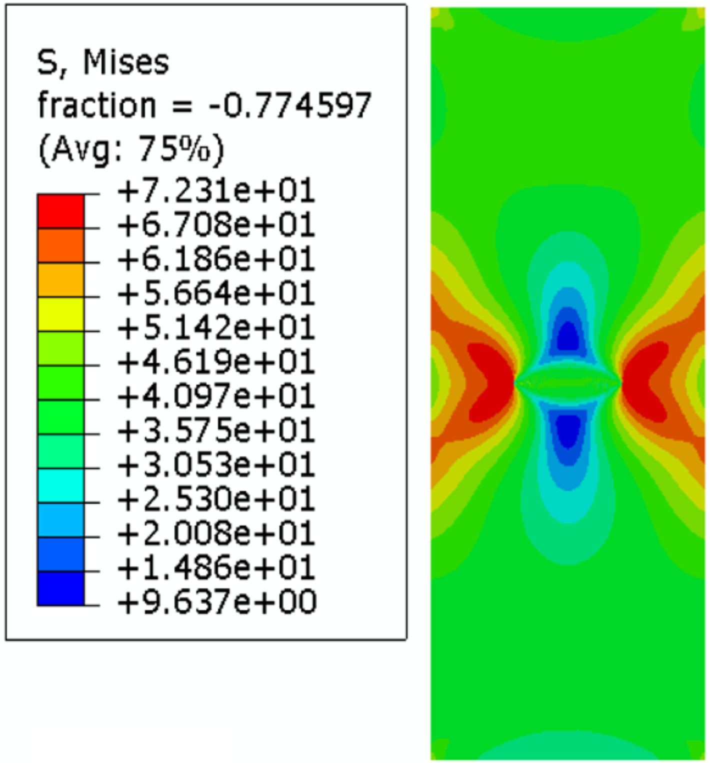
Tetra Pak, Modena

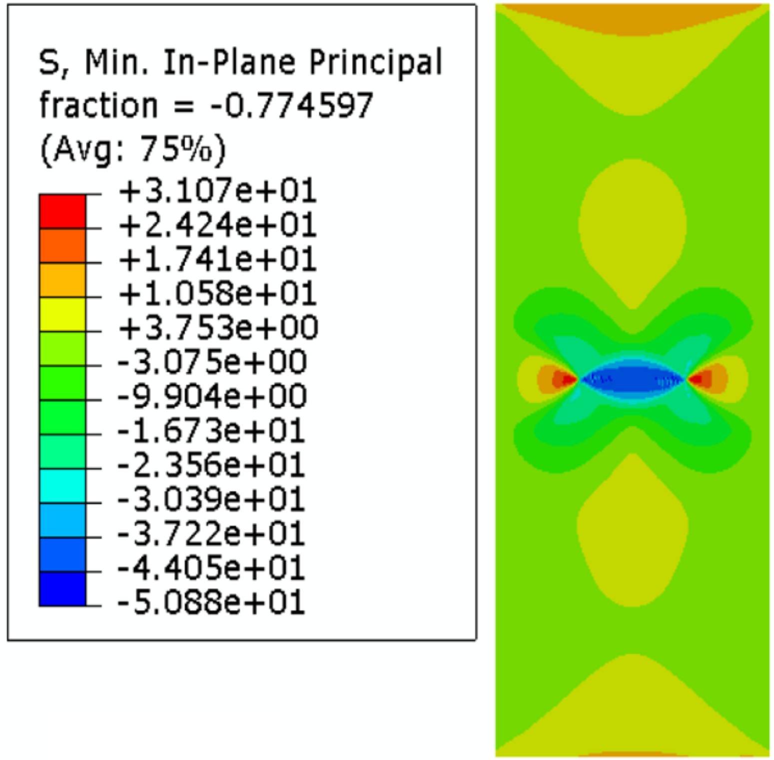
January 25th 2019

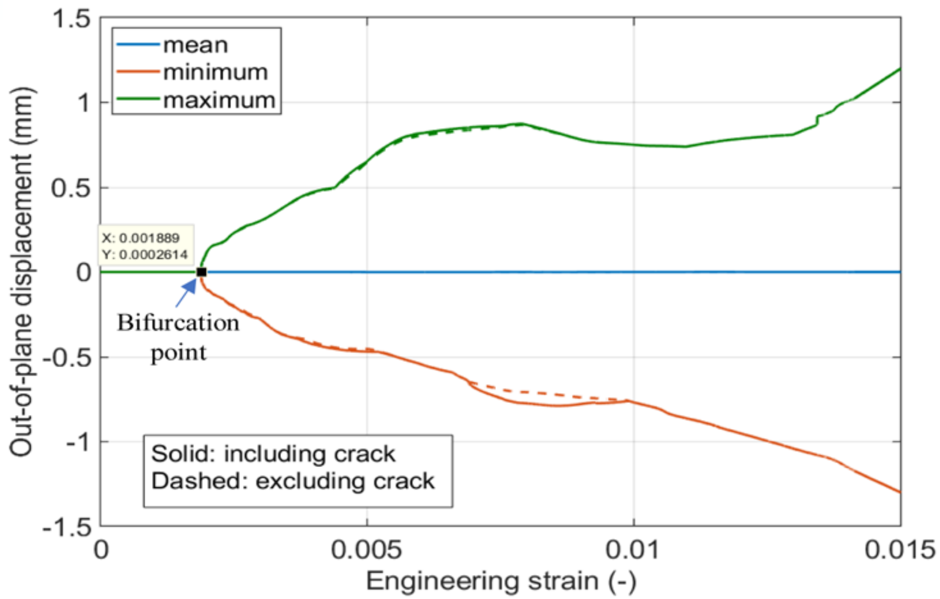
1. buckling and reduction of energy release rate
Politech Milano, BTH, LU

2. Cutting and non-linear fracture mechanics
Parma University, LU, BTH

Mises stress and Min. principle stress at bifurcation point:







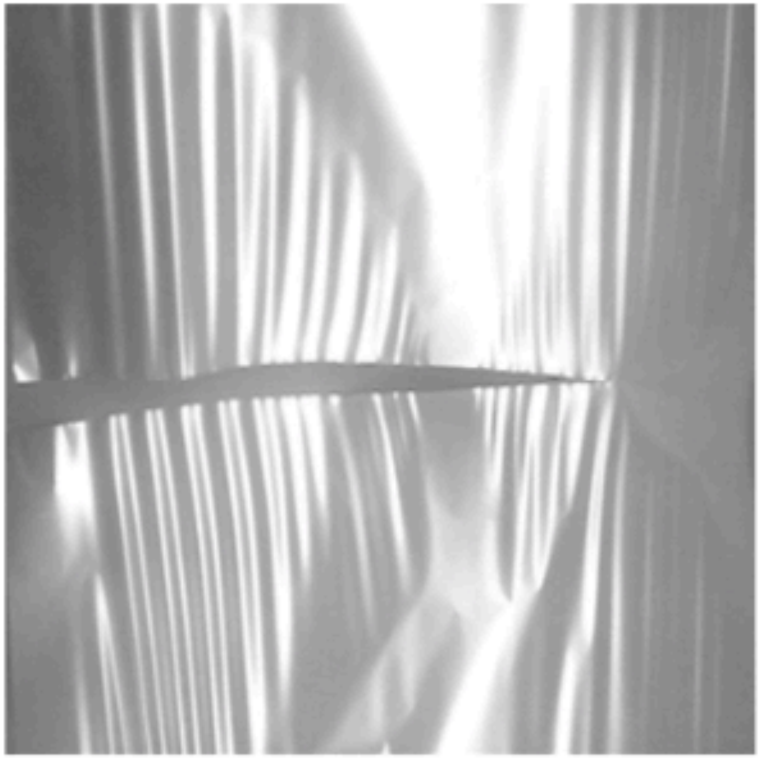


FIGURE 3. Buckling pattern

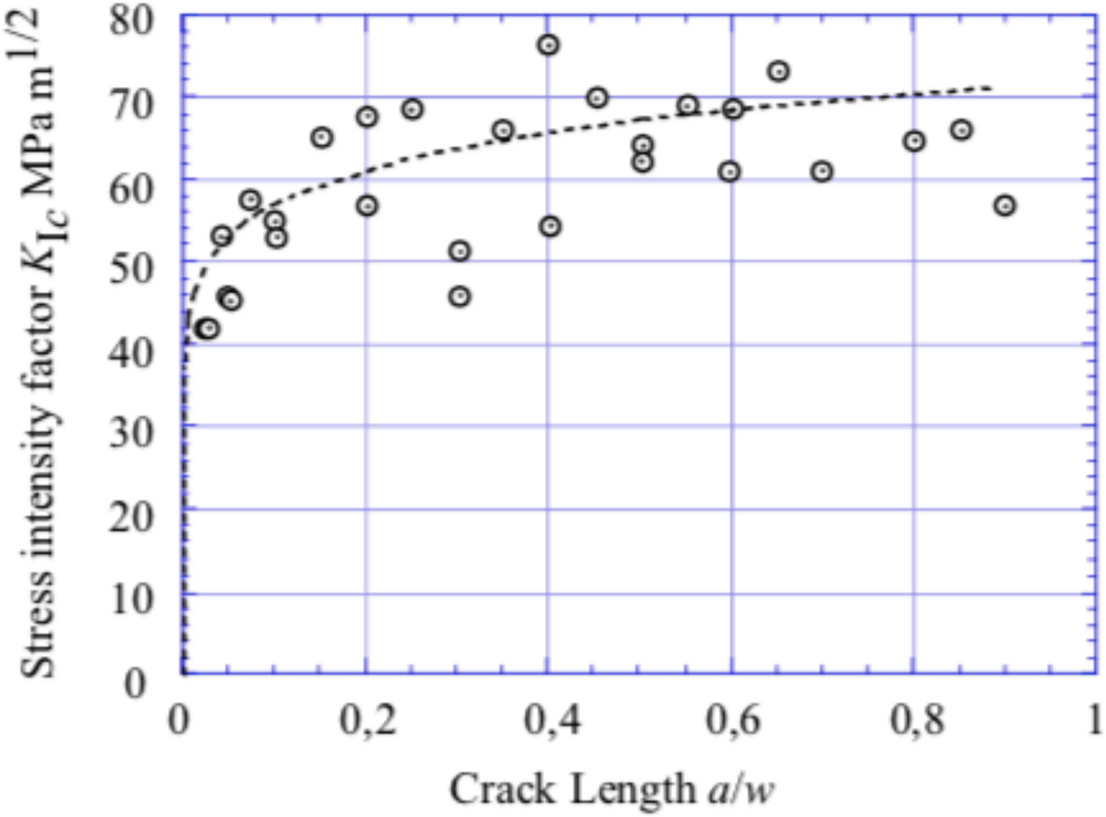
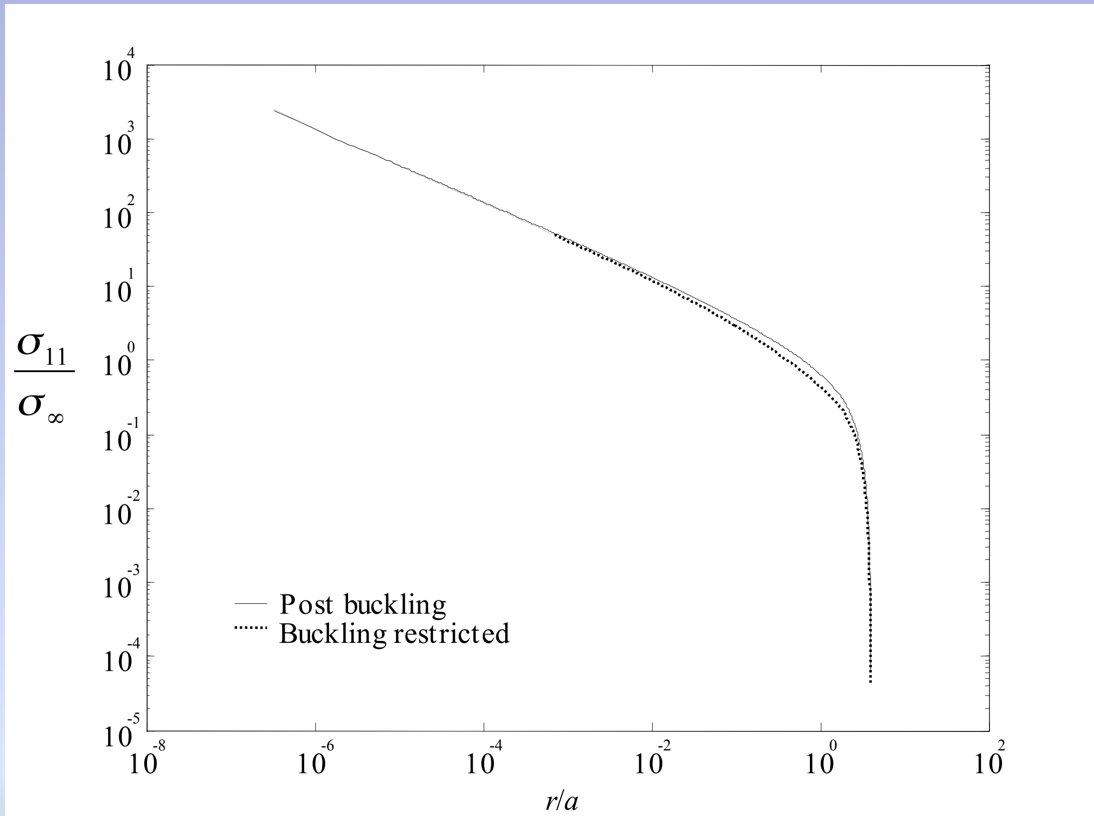
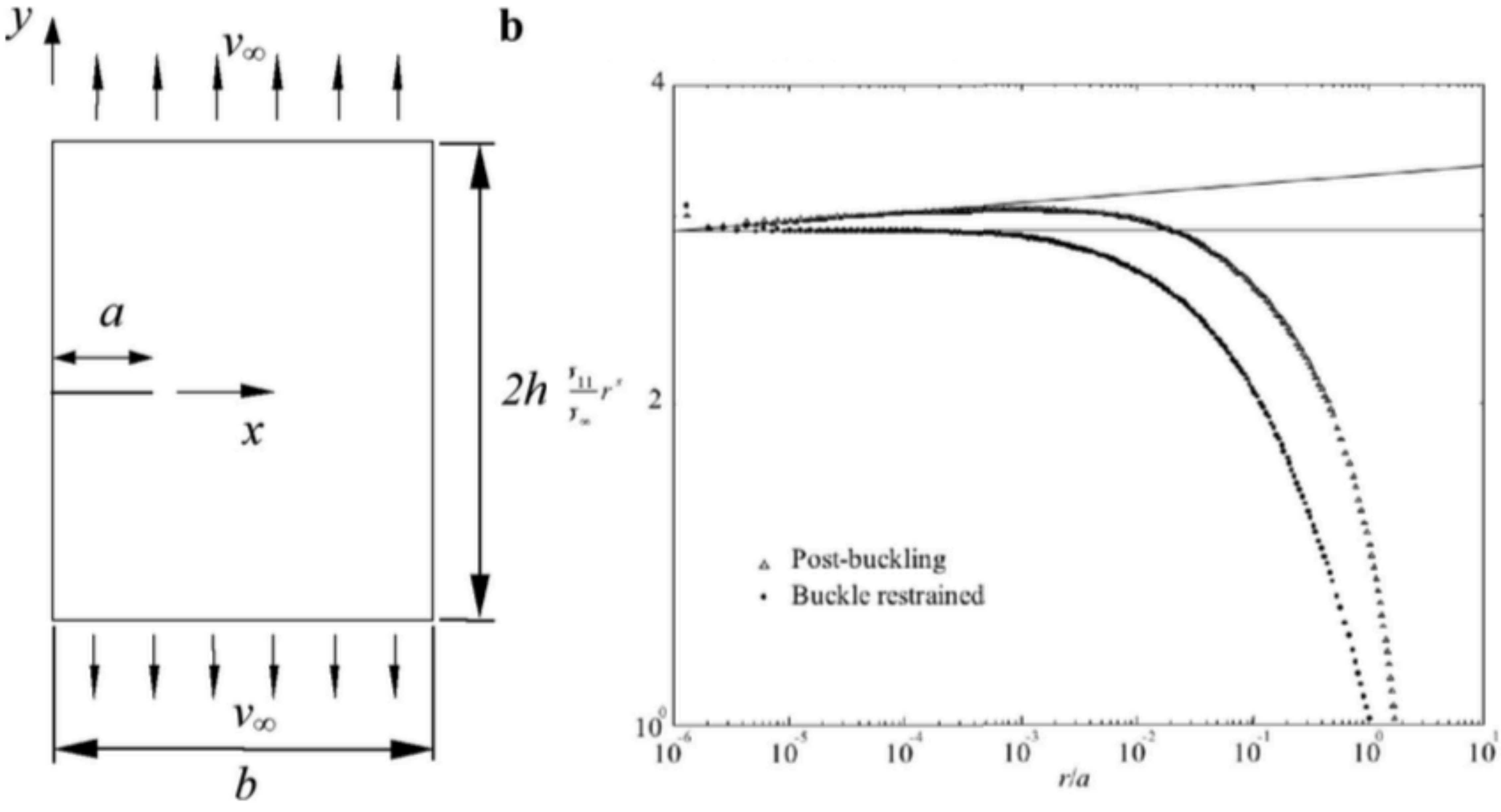


FIGURE 4. K_{Ic} results for the different tests. Dashed curve shows the theoretical result for $s = 0.4$.

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





y
v∞
a
x
2h
v∞
b
b
4
2
10^0
10^-6
10^-5
10^-4
10^-3
10^-2
10^-1
10^0
10^1
r/a
Post-buckling
Buckle restrained

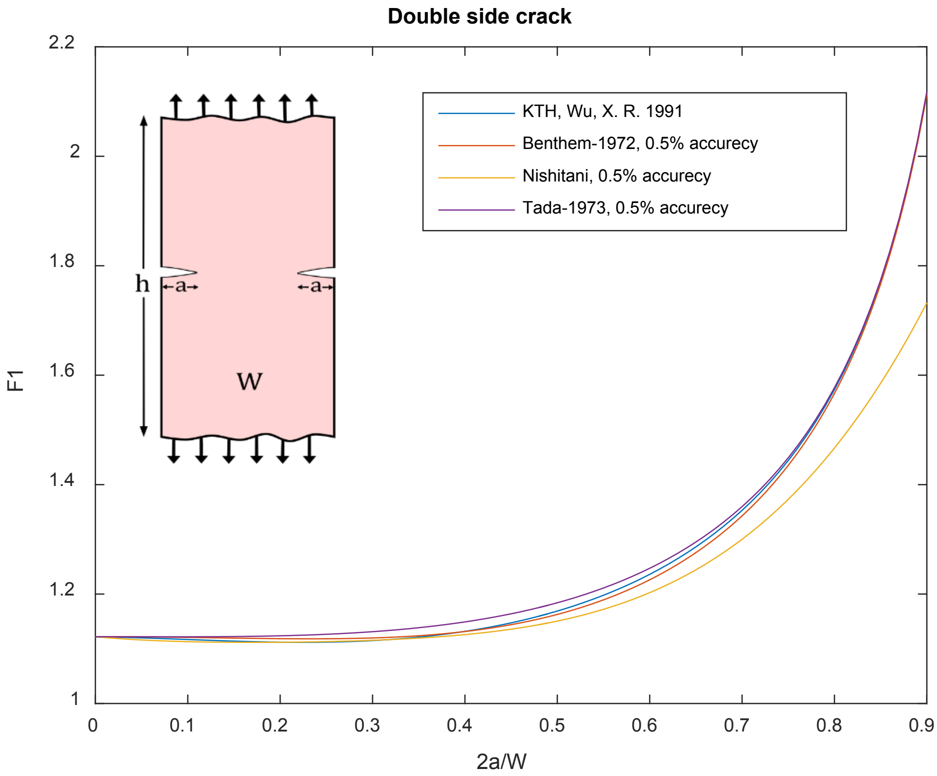
Influences on fracture criteria prediction

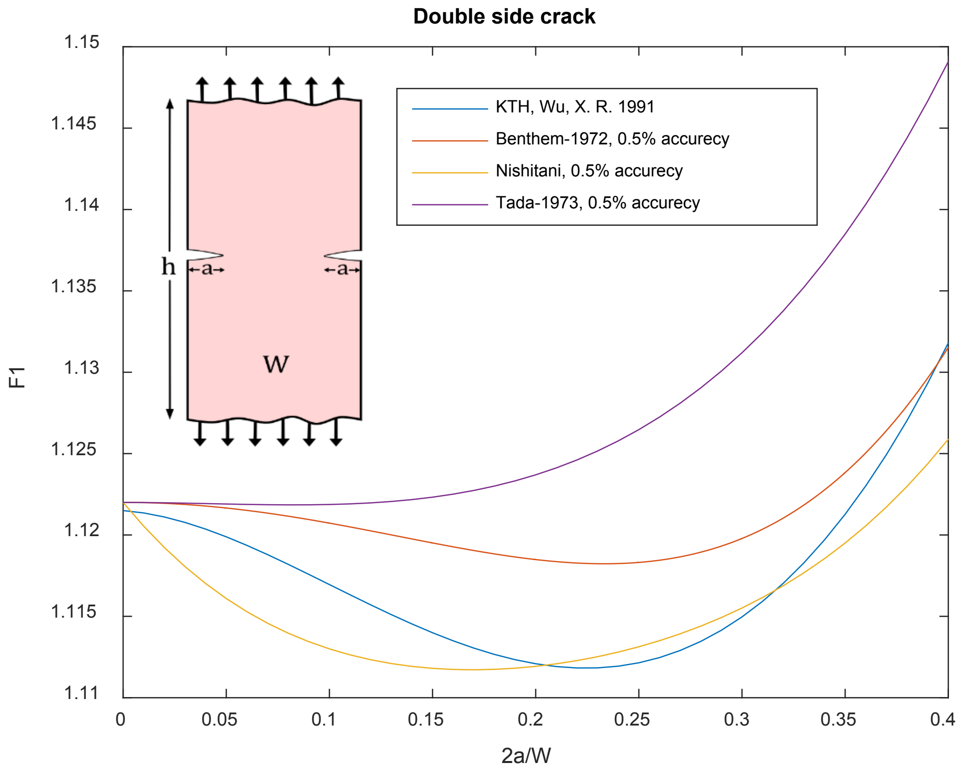
- The load capacity can be determined as:

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

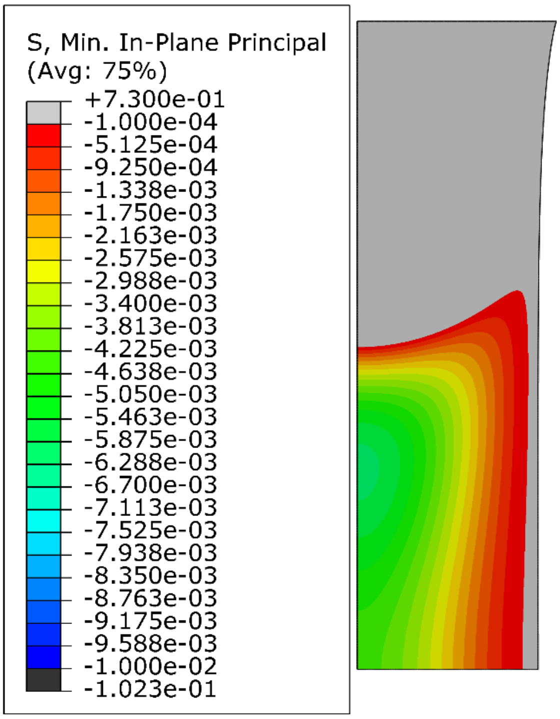
- The micro structural distance : $r_o = K_{\mathrm{Ic}}^2 / \sigma_o^2$

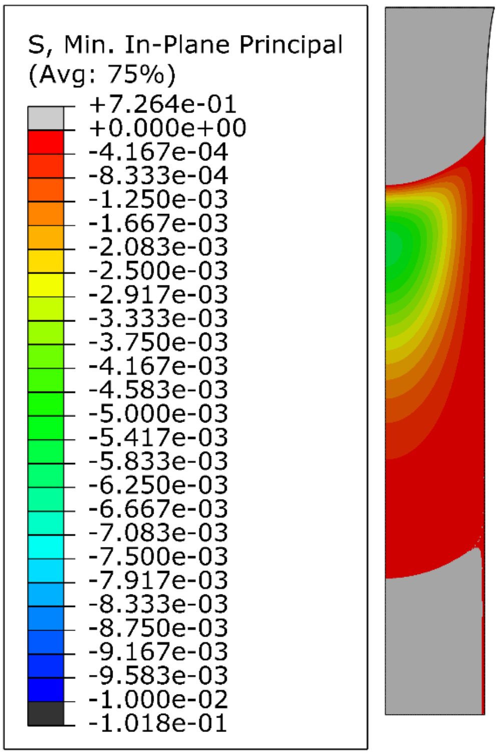
- At a critical load the load parameter $k = k_c = K_I/K_{IC}$

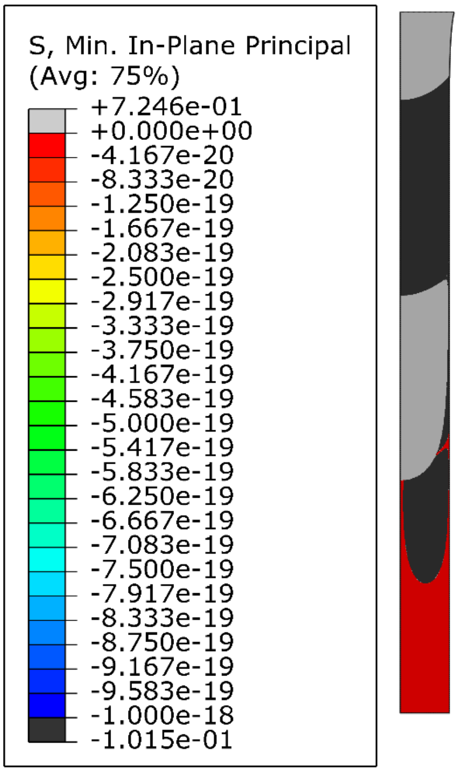




Formula and accuracy source: KTH [1,2,3], Benthem [4], Koiter [4], Tada [4], Murakami [5] and Nishitani and others [See Mahdieh's reference]







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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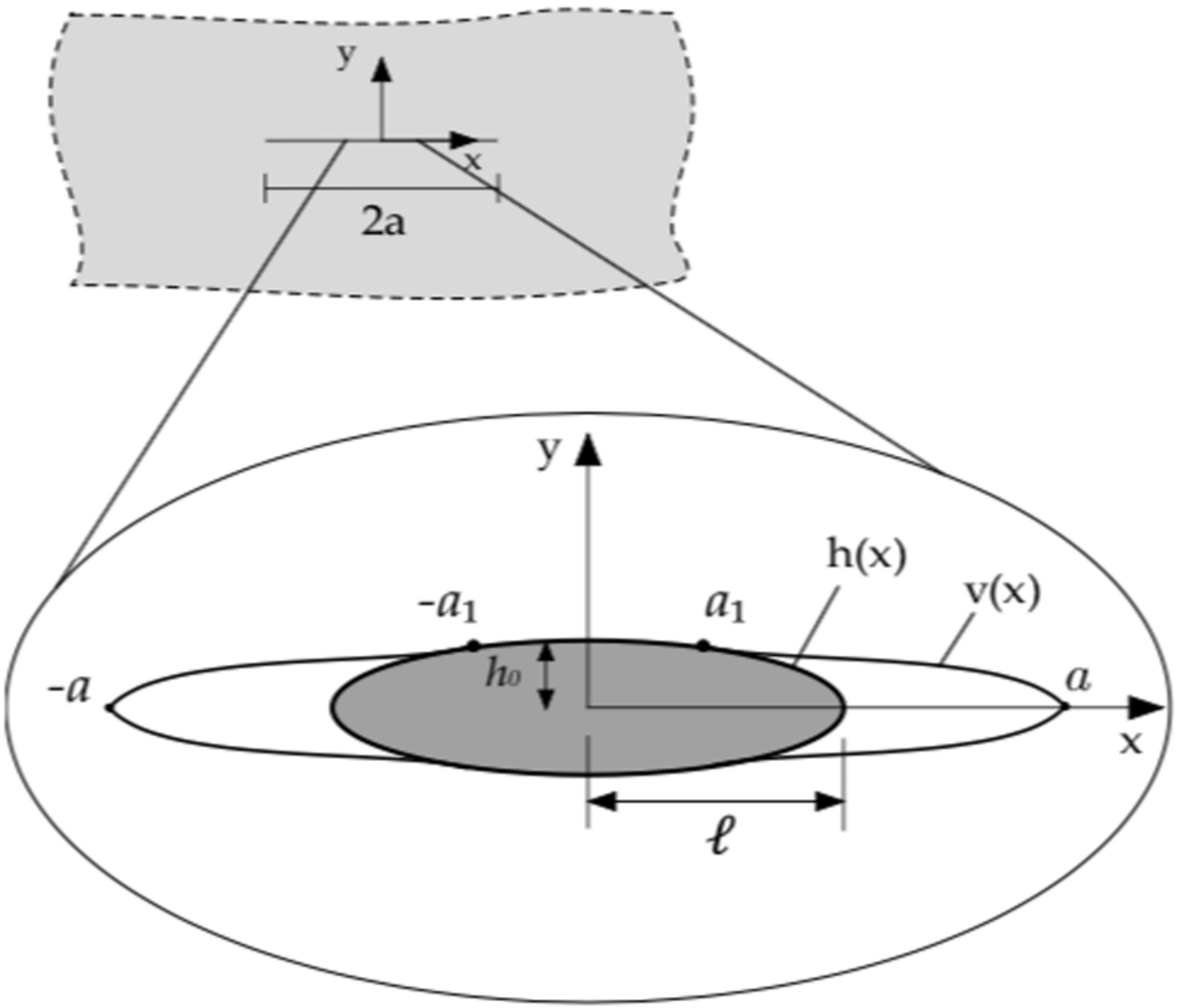
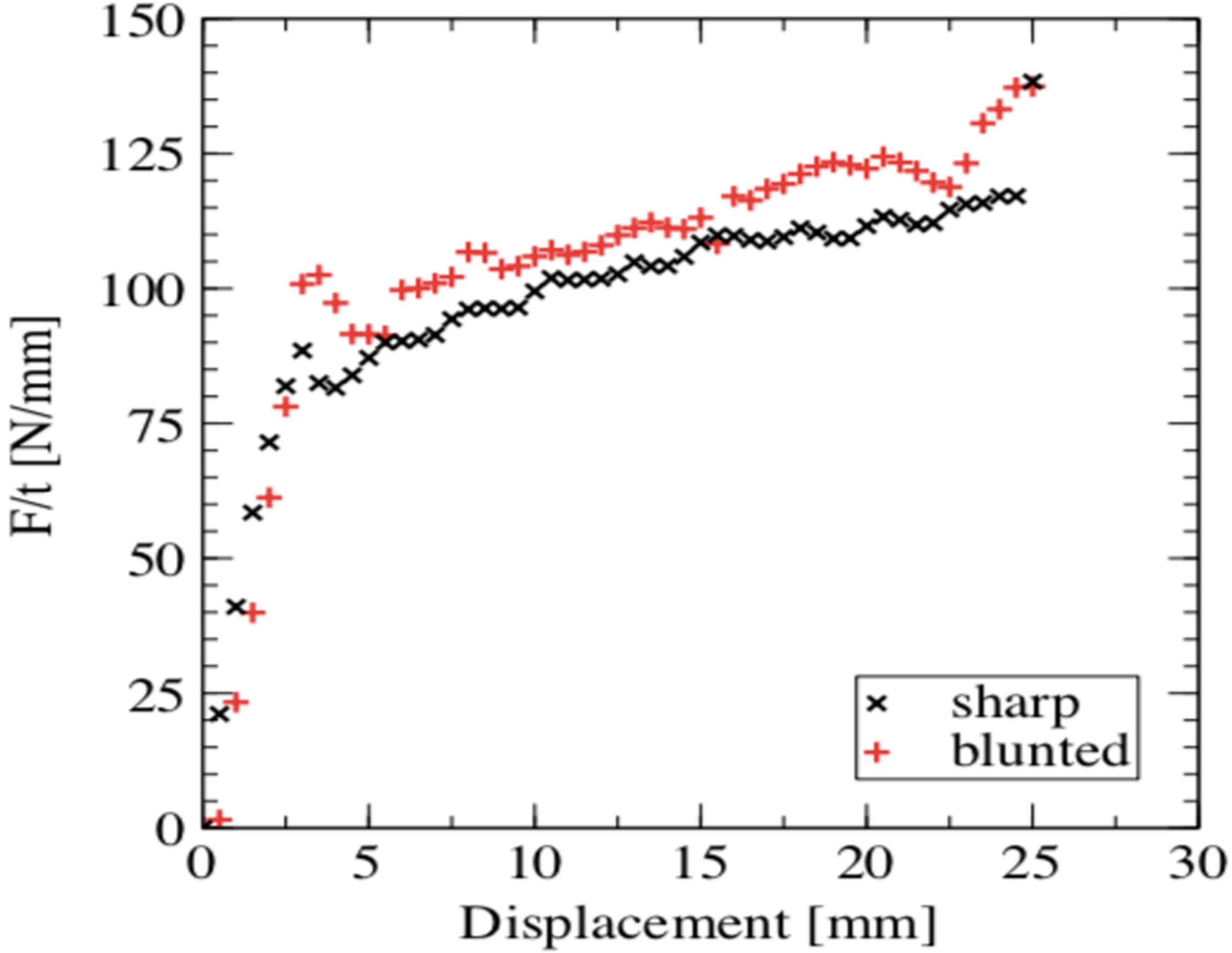
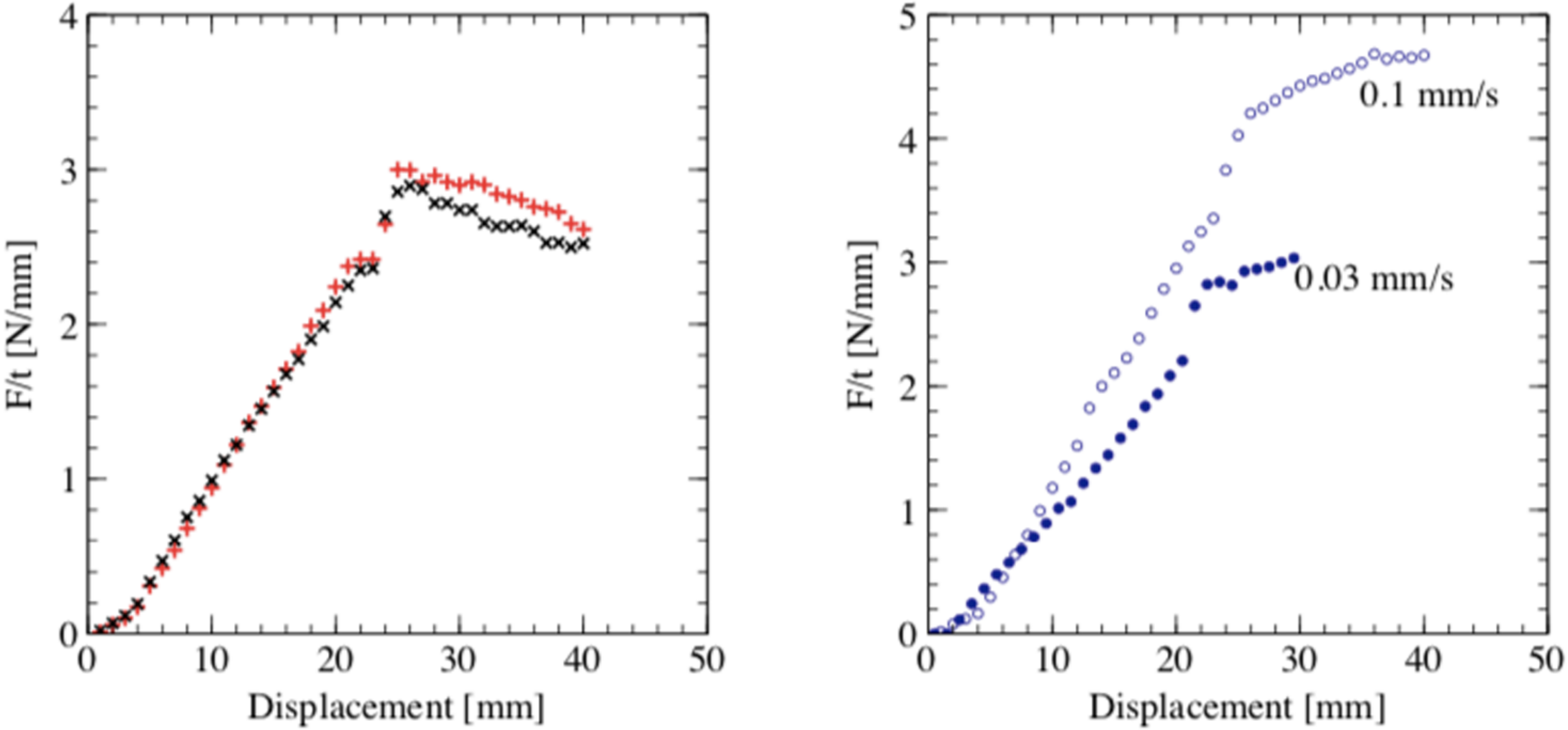

y
x
2a
y
h(x)
v(x)
$-a_1$
a_1
$-a$
h_0
a
x
ℓ



150
125
100
75
50
25
0
F/t [N/mm]
0
5
10
15
20
25
30
Displacement [mm]
sharp
blunted



(a)
(b)