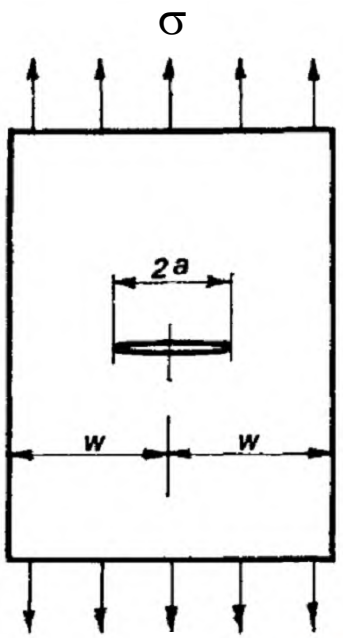
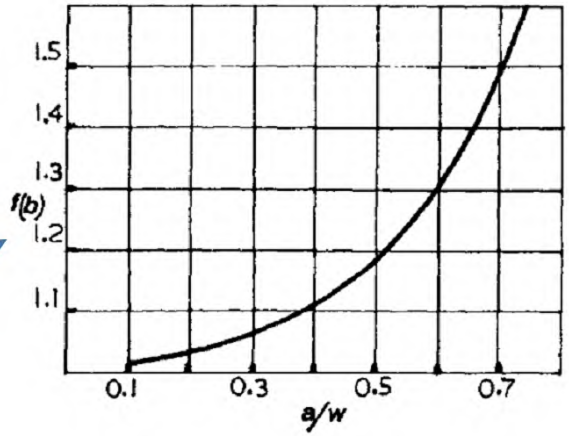
STRESS INTENSITY FACTORS (SIF)
FATTORI DI INTENSIFICAZIONE DELLO SFORZO

Esempi per diverse configurazioni e geometrie di cricca

PIASTRA CON CRICCA CENTRALE PASSANTE

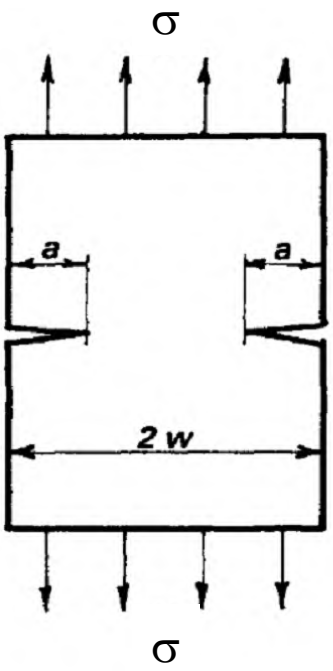


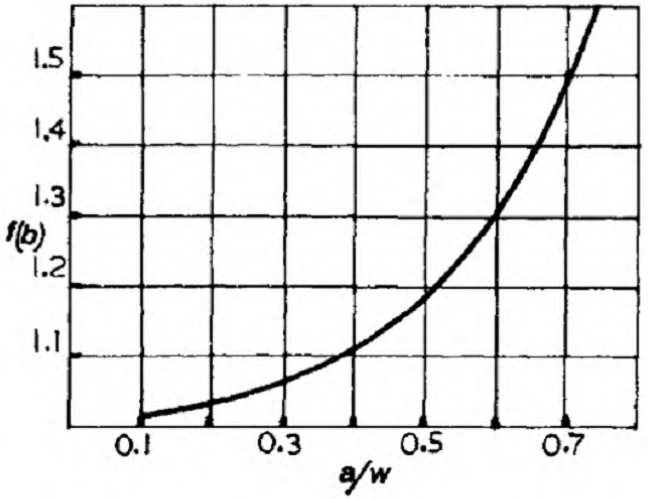


$$\beta = \sqrt{\sec\left(\frac{\pi a}{2w}\right)}$$

$$K_I = \beta \sigma \sqrt{\pi a}$$

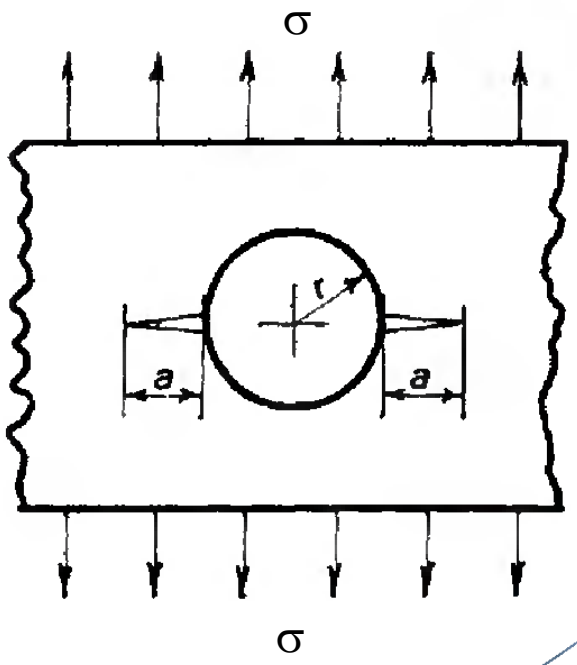
PIASTRA CON CRICCHE DI BORDO SIMMETRICHE

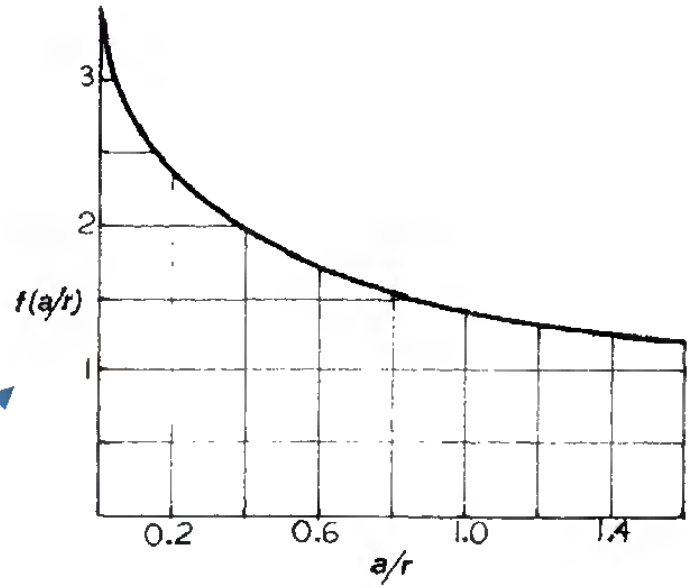




$$K_I = 1.12\,\beta\,\sigma\sqrt{\pi a}$$

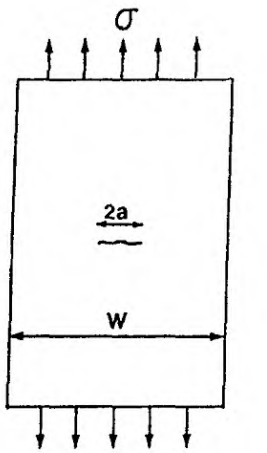
PIASTRA DI LARGHEZZA INFINITA CON CRICCHE A BORDO DEL FORO





$$K_I = \beta \sigma \sqrt{\pi a}$$

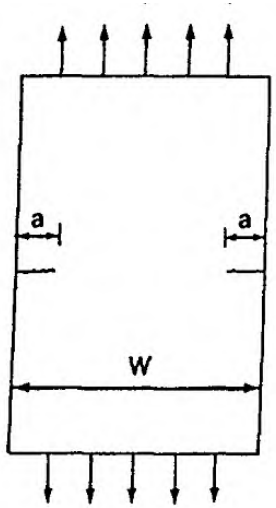
$$K_I = \beta\sigma\sqrt{\pi a}$$



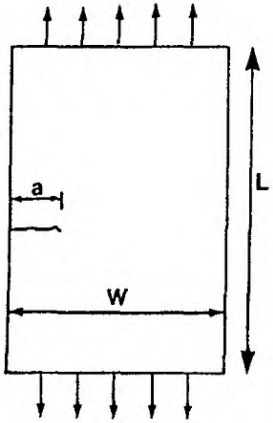
$$\beta = \sqrt{\sec\frac{\pi a}{W}}$$

or

$$\beta = 1 + 0.256\frac{a}{W} - 1.152\left(\frac{a}{W}\right)^2 + 12.200\left(\frac{a}{W}\right)^3$$



$$\beta = 1.12 + 0.43\frac{a}{W} - 4.79\left(\frac{a}{W}\right)^2 + 15.46\left(\frac{a}{W}\right)^3$$

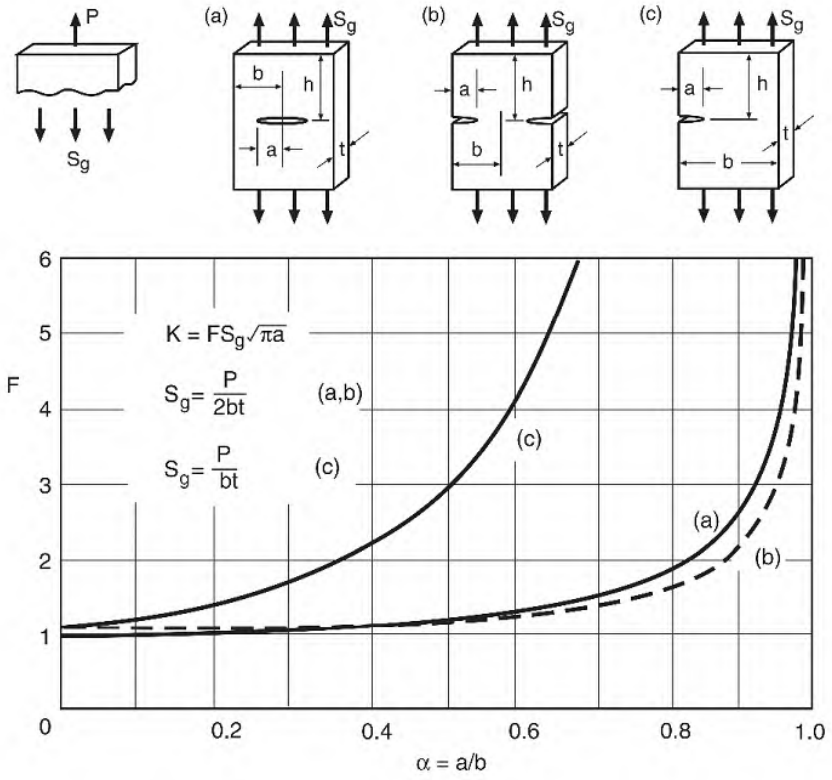


L/W = 2 ONLY:

$$\beta = 1.12 - 0.23\frac{a}{W} + 10.56\left(\frac{a}{W}\right)^2 - 21.74\left(\frac{a}{W}\right)^3 + 30.42\left(\frac{a}{W}\right)^4$$

(SEE FIGURE 8.12)

Broek, The Practical use of Fracture Mechanics, Kluwer, 1988



Values for small a/b and limits for 10% accuracy:

(a) $K = S_g\sqrt{\pi a}$ $(a/b \le 0.4)$ (b) $K = 1.12S_g\sqrt{\pi a}$ $(a/b \le 0.6)$ (c) $K = 1.12S_g\sqrt{\pi a}$ $(a/b \le 0.13)$

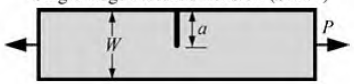
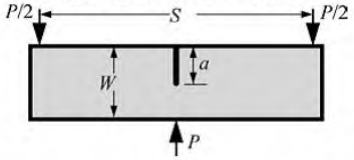
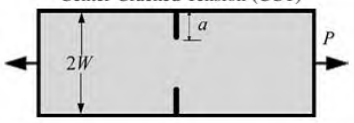
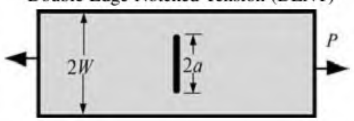
Expressions for any $\alpha = a/b$:

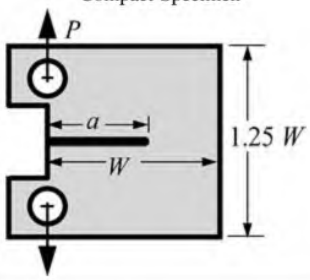
(a) $$F = \frac{1 - 0.5\alpha + 0.326\alpha^2}{\sqrt{1-\alpha}} \qquad (h/b \ge 1.5)$$

(b) $$F = \left(1 + 0.122\cos^4\frac{\pi\alpha}{2}\right)\sqrt{\frac{2}{\pi\alpha}\tan\frac{\pi\alpha}{2}} \qquad (h/b \ge 2)$$

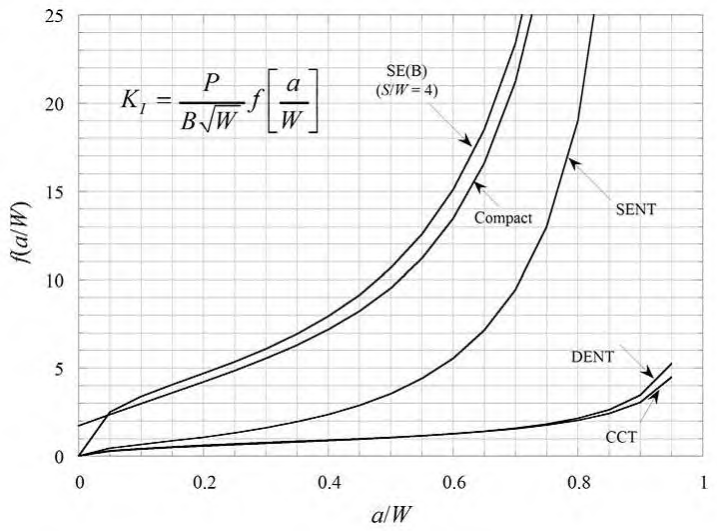
(c) $$F = 0.265\,(1-\alpha)^4 + \frac{0.857 + 0.265\alpha}{(1-\alpha)^{3/2}} \qquad (h/b \ge 1)$$

NE Dowling, Mechanical Behavior of Materials, Pearson, 2013

GEOMETRY	$f\left(\frac{a}{W}\right)^*$
Single Edge Notched Tension (SENT) 	$\frac{\sqrt{2\tan\frac{\pi a}{2W}}}{\cos\frac{\pi a}{2W}}\left[0.752+2.02\left(\frac{a}{W}\right)\right.$ $\left.+0.37\left(1-\sin\frac{\pi a}{2W}\right)^3\right]$
Single Edge Notched Bend (SE(B)) 	$\frac{3\frac{S}{W}\sqrt{\frac{a}{W}}}{2\left(1+2\frac{a}{W}\right)\left(1-\frac{a}{W}\right)^{3/2}}\left[1.99-\frac{a}{W}\right.$ $\left.\left(1-\frac{a}{W}\right)\left\{2.15-3.93\left(\frac{a}{W}\right)+2.7\left(\frac{a}{W}\right)^2\right\}\right]$
Center Cracked Tension (CCT) 	$\sqrt{\frac{\pi a}{4W}\sec\left(\frac{\pi a}{2W}\right)}\left[1-0.025\left(\frac{a}{W}\right)^2\right.$ $\left.+0.06\left(\frac{a}{W}\right)^4\right]$
Double Edge Notched Tension (DENT) 	$\frac{\sqrt{\frac{\pi a}{2W}}}{\sqrt{1-\frac{a}{W}}}\left[1.122-0.561\left(\frac{a}{W}\right)-0.205\left(\frac{a}{W}\right)^2\right.$ $\left.+0.471\left(\frac{a}{W}\right)^3+0.190\left(\frac{a}{W}\right)^4\right]$

Compact Specimen	$\frac{2+\frac{a}{W}}{\left(1-\frac{a}{W}\right)^{3/2}}\left[0.886+4.64\left(\frac{a}{W}\right)-13.32\left(\frac{a}{W}\right)^2\right.$ $\left.+14.72\left(\frac{a}{W}\right)^3-5.60\left(\frac{a}{W}\right)^4\right]$
	

$^*K_I = \frac{P}{B\sqrt{W}} f\left(\frac{a}{W}\right)$ where B is the specimen thickness.

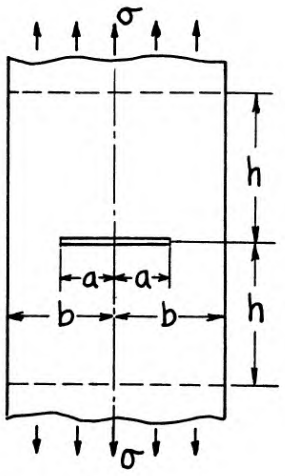


TL Anderson, Fracture Mechanics: Fundamentals and Applications, CRC Press, 2005

THE CENTER CRACKED TEST SPECIMEN

A. Stress Intensity Factor

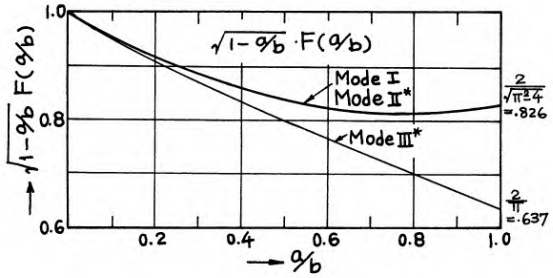
$$K_I = \sigma\sqrt{\pi a}\, F(a/b)$$



Numerical Values of $F(a/b)$

(Isida 1962, 1965a, b, 1973)

Isida's 36-term power series of $(a/b)^2$ (Laurent series expansion of complex stress potential, 1973) gives practically exact values of $F(a/b)$ up to $a/b = 0.9$. Numerical values of $F(a/b)$ are shown in the following graph and table.



a/b	$F(a/b)$
0.0	1.0000
0.1	1.0060
0.2	1.0246
0.3	1.0577
0.4	1.1094
0.5	1.1867
0.6	1.3033
0.7	1.4882
0.8	1.8160
0.9	2.5776
1.0	$\frac{2}{\sqrt{\pi^2-4}}\Big/\sqrt{1-a/b}$ **

**Exact Limit (Koiter 1965b)

Empirical Formulas

a. Accuracy
b. Method of derivation, reference

$$F(a/b) = \sqrt{\frac{2b}{\pi a}\tan\frac{\pi a}{2b}}$$

a. Better than 5% for $a/b \le 0.5$
b. Approximation by periodic crack solution (**Irwin 1957**)

$$F(a/b) = 1 + 0.128(a/b) - 0.288(a/b)^2 + 1.525(a/b)^3$$

a. 0.5% for $a/b \le 0.7$
b. Least squares fitting to Isida's results (**Brown 1966**)

$$F(a/b) = \sqrt{\sec\frac{\pi a}{2b}}$$

a. 0.3% for $a/b \le 0.7$, 1% at $a/b = 0.8$
b. Guess based on Isida's results (**Feddersen 1966**)

$$F(a/b) = \frac{1 - 0.5(a/b) + 0.326(a/b)^2}{\sqrt{1 - a/b}}$$

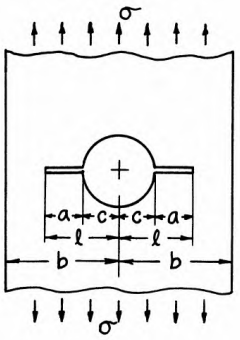
a. 1% for any a/b
b. Asymptotic approximation (**Koiter 1965b**)

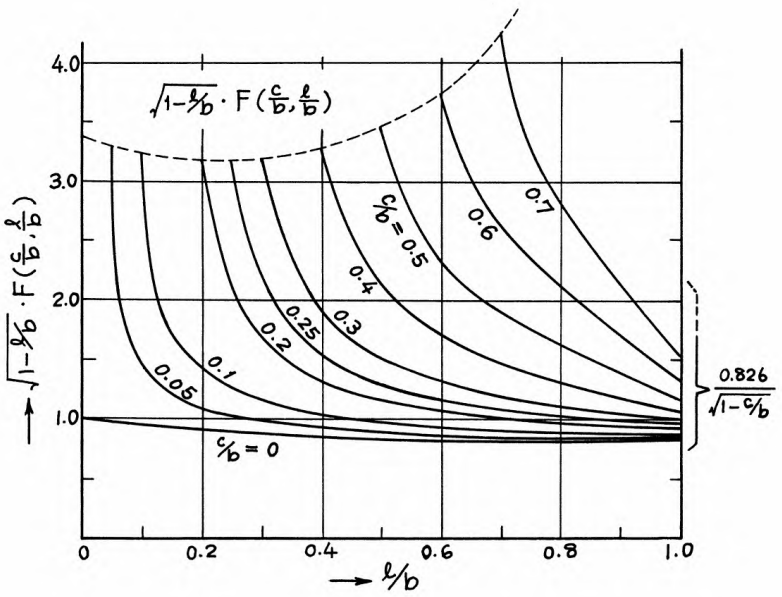
$$F(a/b) = \frac{1 - 0.5(a/b) + 0.370(a/b)^2 - 0.044(a/b)^3}{\sqrt{1 - a/b}}$$

H Tada, PC Paris, GR Irwin, The Stress Analysis of Cracks Handbook, ASME, 2000

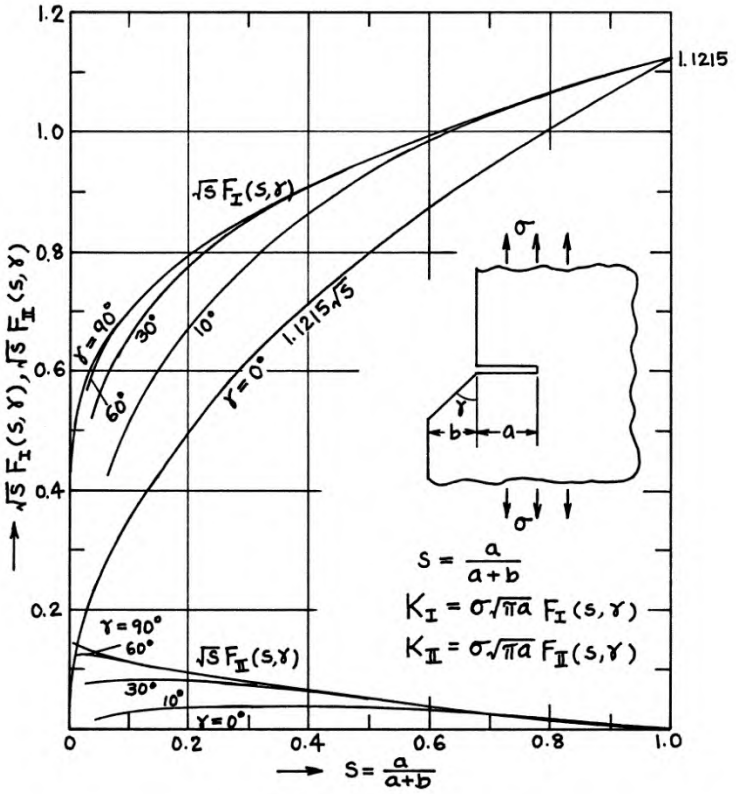
$\ell = c + a$

$K_I = \sigma\sqrt{\pi a}\, F\left(\frac{c}{b}, \frac{\ell}{b}\right)$





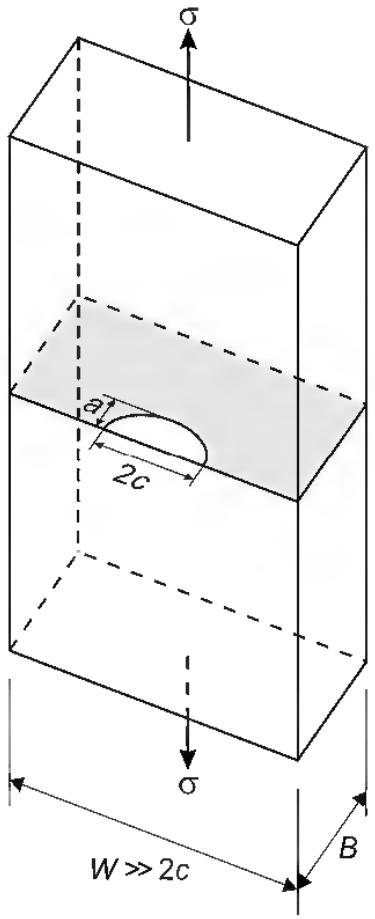
Methods: Boundary Cllocation ($c/b = 0.25,\ 0.5$; Newman), Estimated by Interpolation (c/b other than 0.25, 0.5; Tada)
Accuracy: Accurate for $c/b = 0.25,\ 0.5$; better than 5% for other values of c/b
References: **Newman 1971; Tada 1973**



Method: Conformal Mapping
Accuracy: Curves are based on accurate (0.1%) numerical values (**Hasebe 1980**).
References: **Hasebe 1980; Tada 2000**

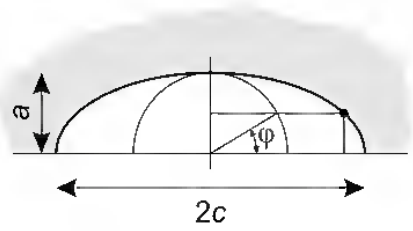
H Tada, PC Paris, GR Irwin, The Stress Analysis of Cracks Handbook, ASME, 2000

CRICCA SUPERFICIALE (Thumbnail crack)



$K_I = C\sigma\sqrt{\pi a}/\phi$

a/c	φ	C, a/B = 0.2	C, a/B = 0.4	C, a/B = 0.6	C, a/B = 0.8
0.2	0°	0.617	0.724	0.899	1.190
	45°	0.990	1.122	1.384	1.657
	90°	1.173	1.359	1.642	1.851
0.4	0°	0.767	0.896	1.080	1.318
	45°	0.998	1.075	1.247	1.374
	90°	1.138	1.225	1.370	1.447
0.6	0°	0.916	1.015	1.172	1.353
	45°	1.024	1.062	1.182	1.243
	90°	1.110	1.145	1.230	1.264
1.0	0°	1.174	1.229	1.355	1.464
	45°	1.067	1.104	1.181	1.193
	90°	1.049	1.062	1.107	1.112



NE Dowling, Mechanical Behavior of Materials, Pearson, 2013