



Un'espressione approssimata per lo stress intensity factor
di una barra circolare contenente un difetto trasversale
superficiale e caricata a flessione

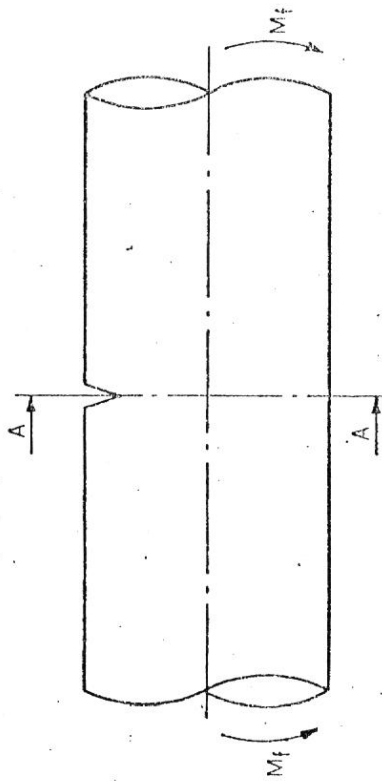
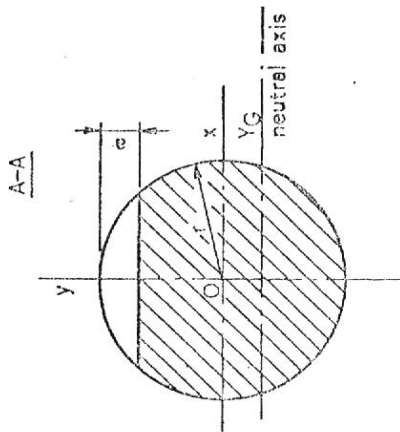
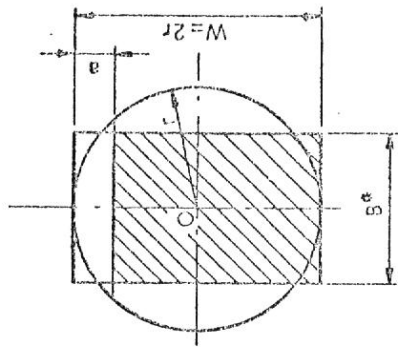
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In questo lavoro viene presentata una espressione approssimata per la valutazione dello stress intensity factor di una barra circolare contenente un difetto trasversale superficiale e caricata in flessione.

L'espressione del K_I è stata dedotta da quella relativa ad una barra rettangolare avente dimensioni scelte in maniera opportuna sulla base di semplici considerazioni di resistenza dei materiali.

L'espressione ricavata ha dato risultati soddisfacenti sia ad una verifica sperimentale diretta effettuata su 7 provini, sia al confronto con i valori numerici relativi a questa geometria, riportati in letteratura.



$$K_I = \frac{6M_f}{BW^2} a^{1/2} Y\left(\frac{a}{W}\right) = \sigma_g a^{1/2} Y\left(\frac{a}{W}\right) = \sigma_n \left(1 - \frac{a}{W}\right)^2 a^{1/2} Y\left(\frac{a}{W}\right) \quad (1)$$

$$\frac{B^*}{r} = \frac{6}{(1+z)^2} \cdot \frac{\frac{1}{2} \left[\frac{\pi}{4} + \frac{1}{2} \arcsin z + z \left(z^2 - \frac{1}{2} \right) \sqrt{1-z^2} \right] - \frac{4}{9} \cdot \frac{(1-z^2)^3}{\pi - \arccos z + z \sqrt{1-z^2}}}{z + \frac{2}{3} \cdot \frac{(1-z^2)^{3/2}}{\pi - \arccos z + z \sqrt{1-z^2}}} \quad (2)$$

$$\frac{K_I r^{5/2}}{M_f} = \frac{2.985}{(B^*/r)} \sqrt{\frac{a}{r}} h\left(\frac{a}{r}\right) \quad (3)$$

$$h_p\left(\frac{a}{r}\right) = 1 - 0.6206 \left(\frac{a}{r}\right) + 1.6294 \left(\frac{a}{r}\right)^2 - 1.4554 \left(\frac{a}{r}\right)^3 + 0.7789 \left(\frac{a}{r}\right)^4 \quad (4)$$

$$h_s\left(\frac{a}{r}\right) = 0.9698 - 0.7713 \left(\frac{a}{r}\right) + 1.8254 \left(\frac{a}{r}\right)^2 - 1.5747 \left(\frac{a}{r}\right)^3 + 0.8103 \left(\frac{a}{r}\right)^4 \quad (5)$$

$$\frac{y_G}{r} = \frac{2}{3} \cdot \frac{(1-z^2)^{3/2}}{\pi - \arccos z + z\sqrt{1-z^2}} \quad (A-1) \quad z = 1 - \frac{3}{r}$$

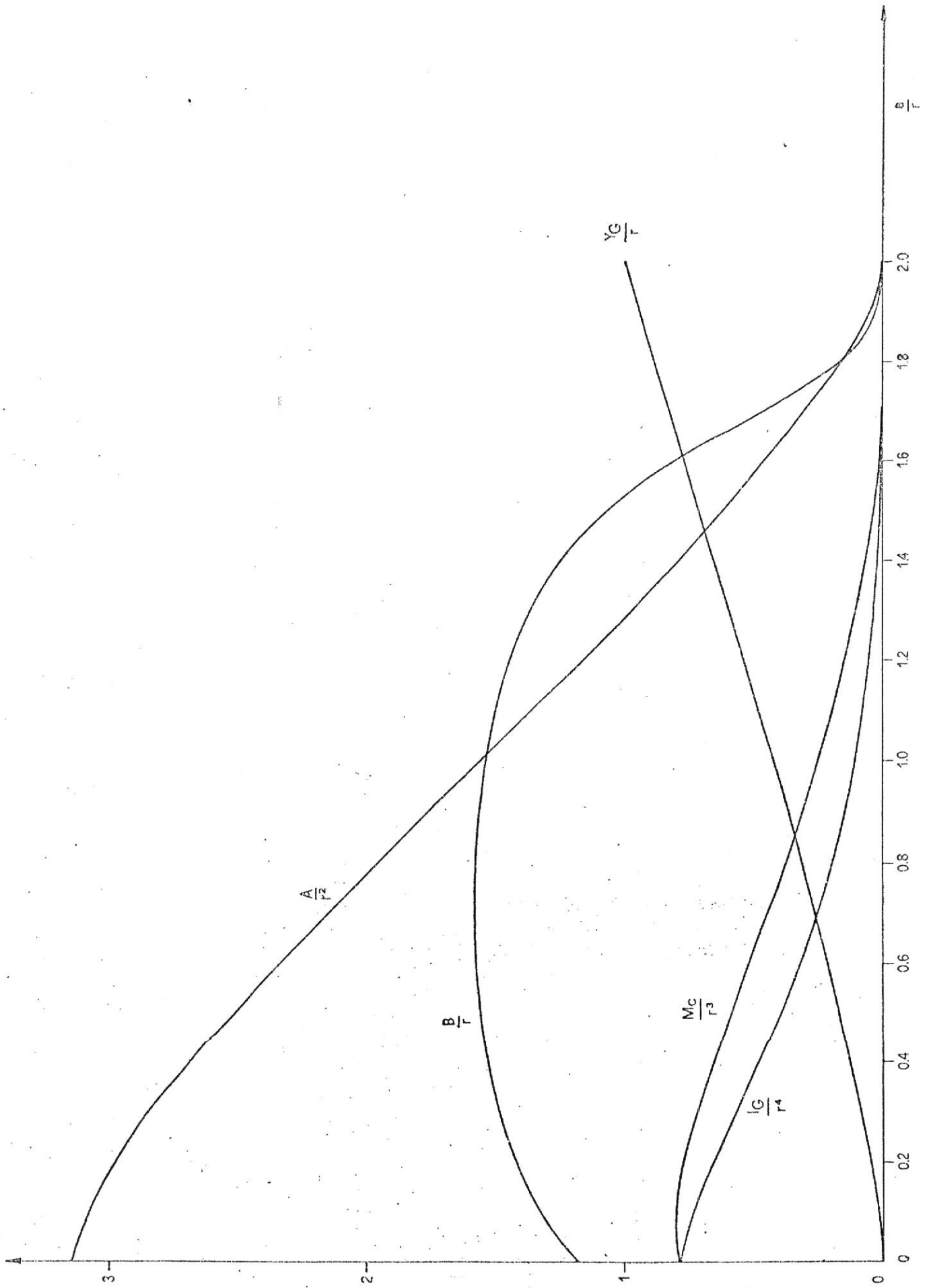
$$\begin{aligned} \frac{I_G}{r^4} &= \frac{I_X}{r^4} - \left(\frac{y_G}{r}\right)^2 \cdot \frac{A_X}{r^2} = \\ &= \frac{1}{z} \left\{ \frac{\pi}{4} + \frac{1}{2} \arcsin z + z \left(z^2 - \frac{1}{2} \right) \sqrt{1-z^2} \right\} - \frac{4}{9} \frac{(1-z^2)^3}{\pi - \arccos z + z\sqrt{1-z^2}} \end{aligned} \quad (A-2)$$

$$\frac{S_C}{r^3} = \frac{\frac{I_G}{r^4}}{z - \frac{y_G}{r}} \quad (A-3)$$

$$S_r = \frac{B r^2 (1+z)^2}{6} \quad (A-4)$$

$$\frac{B^*}{r} = \frac{\frac{1}{2} \left[\frac{\pi}{4} + \frac{1}{2} \arcsin z + z \left(z^2 - \frac{1}{2} \right) \sqrt{1-z^2} \right] - \frac{4}{9} \frac{(1-z^2)^3}{\pi - \arccos z + z\sqrt{1-z^2}}}{(1+z)^2 \cdot \left[z + \frac{2}{3} \frac{(1-z^2)^{3/2}}{\pi - \arccos z + z\sqrt{1-z^2}} \right]} \quad (A-5)$$

$$\frac{K_I r^{5/2}}{M_f} = \frac{2.985}{(B^*/r)} \sqrt{\frac{a}{r}} h\left(\frac{a}{r}\right) \quad (A-7)$$



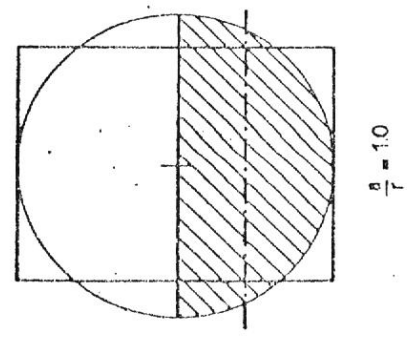
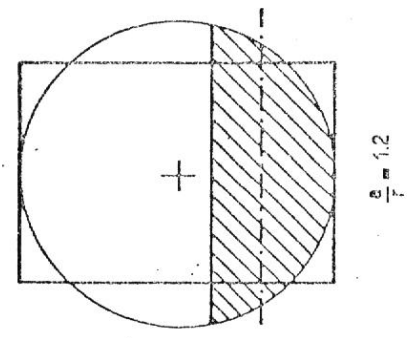
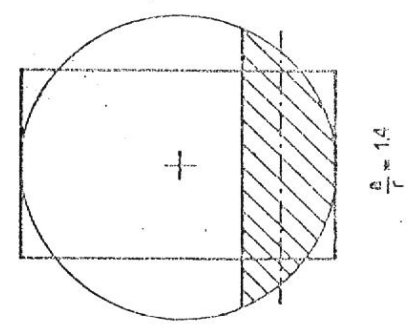
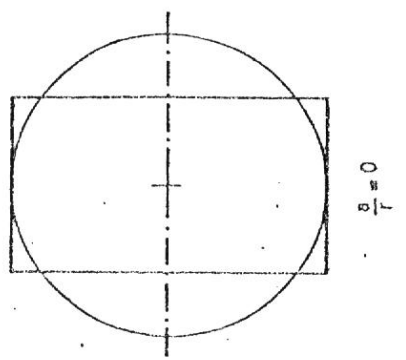
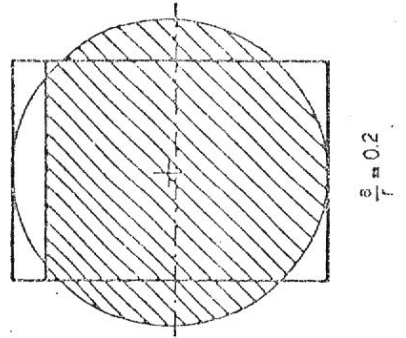
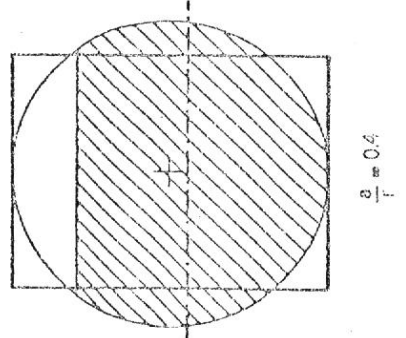
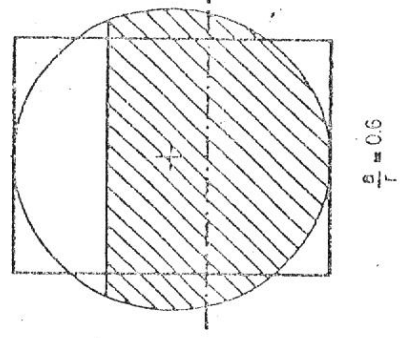
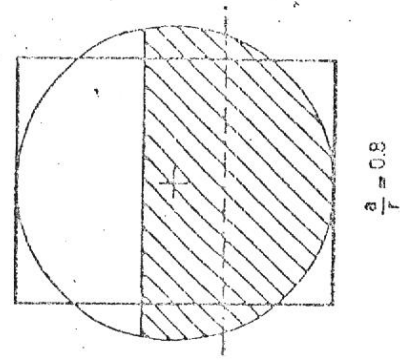


fig. 9

A-A

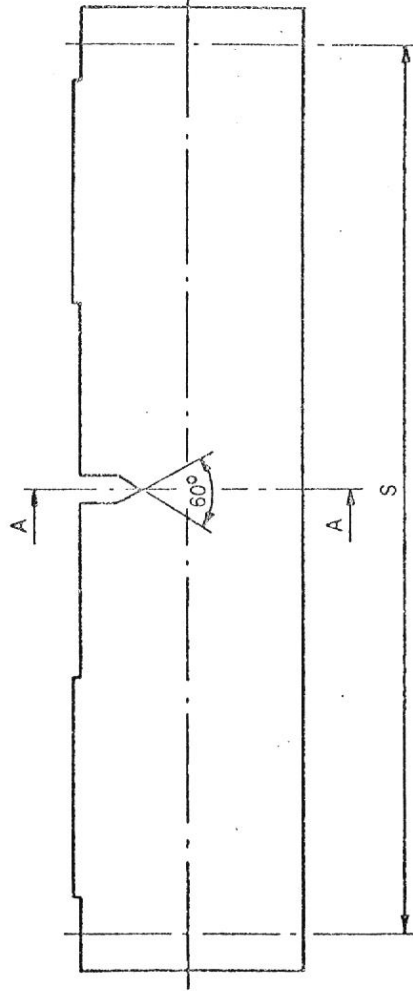
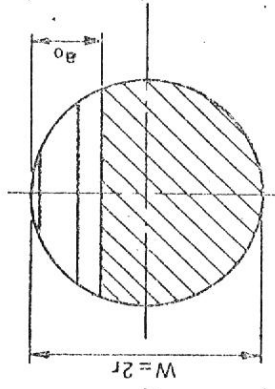


Table 2 - Experimental results

Round bar specimens

| n. | $\phi = 2 r$ mm | Span S mm | $\frac{a}{r}$ | $M_f \text{ exp}$ N · m | K_{Ic} (MPa \sqrt{m}) | | | | Cannon [4] |
|---------------|--------------------|-----------------|---------------|----------------------------|----------------------------|--------------------|---------------------|---------------------|---------------|
| | | | | | Equation (3) | | Bush [6] | | |
| | | | | | Pure bending | 3 point bending | For $\phi = 3''$ | For $\phi = 6''$ | |
| 1 | 30 | 120 | 0.645 | 1112 | 62.0 | 57.77 | 64.3 | 57.6 | 65.8 |
| 2 | 30 | 120 | 0.778 | 907 | 59.9 | 56.14 | 62.3 | - | 61.5 |
| 3 | 30 | 120 | 1.083 | 531 | 57.5 | 54.78 | 59.0 | - | 57.1 |
| 4 | 45 | 180 | 0.661 | 3360 | 69.3 | 64.62 | 71.9 | 64.1 | 73.8 |
| 5 | 45 | 180 | 0.784 | 2724 | 65.9 | 61.70 | 68.5 | - | 68.4 |
| 6 | 45 | 180 | 1.140 | 1409 | 62.0 | 59.30 | 63.1 | - | 60.5 |
| 7 | 60 | 240 | 0.968 | 4539 | 70.5 | 66.81 | 73.8 | - | 70.3 |
| Average value | | | | | 63.9 | 60.16 | 66.1 | 60.8 | 65.3 |

Rectangular specimens

| n. | BxW mm | S mm | a/w | $M_f \text{ exp}$ N.m | K_{Ic} (MPa \sqrt{m}) |
|---------------|-----------|---------|-------|--------------------------|----------------------------|
| 8 | 24 x 30 | 120 | 0.549 | 615 | 61.8 |
| 9 | 36 x 45 | 180 | 0.597 | 1779 | 77.2 |
| Average value | | | | | 69.5 |

