

TECHNICAL NOTE

A NOTE ON THE PLATE WIDTH AND NOTCH ANGLE
CORRECTION FACTORS FOR SINGLE EDGE V-NOTCHED
PLATES IN TENSION

The stress intensity factor, K_1 , for a plate of finite width, with a single edge V-notch and supporting a tensile end load, can be written in the general form:

$$K_1 = S\sqrt{(a)}f_1(a/W)f_2(\psi) \tag{1}$$

where S is the nominal stress, a is the length of the notch, 2ψ is the notch apex angle, $f_1(a/W)$ is a finite-width correction factor, and $f_2(\psi)$ describes the modifying effect of the notch angle.

Gross and Mendelson[1] have examined the effects of notch angle and plate geometry on the stress intensity factor and have presented, in tabular form, analytic solutions from which the stress intensity factor can be obtained for notched plate geometries in the range $0 \leq a/W \leq 0.7$ and $2\psi \leq 120^\circ$.

In this note, closed form expressions for both the plate width and notch angle correction factors are suggested, and which when combined, provide K_1 estimates which agree very closely with those derived in Ref.[1].

Gerberich and Katz[2] have shown that the fourth order polynomial form of the finite width correction factor given by Brown and Srawley[3] can be described using a trigonometric expression such that:

$$f_1(a/W) = 2 \left(\sin^2 \frac{\pi a}{2W} + \sec^2 \frac{\pi a}{2W} \right). \tag{2}$$

This expression follows the polynomial solution with a maximum error of $\pm 1.3\%$ over the range $0 \leq a/W \leq 0.5$. With a somewhat higher degree of accuracy for $a/W \leq 0.3$, and with a maximum error of 1.7% in the range $0.3 \leq a/W \leq 0.5$, the finite width correction factor can also be described by

$$f_1(a/W) = 2 \cosh \frac{\pi a}{W}. \tag{3}$$

As yet, closed form expressions for the notch angle correction factor are not available. However, based on the solutions tabulated by Gross and Mendelson, it has been found that this effect can be described using a secant expression such that

$$f_2(\psi) = \sec^{2/3} \psi. \tag{4}$$

Thus, by combining the correction factors given by eqns (3) and (4), the stress intensity factor can be written as:

$$K_1 = 2S\sqrt{(a)} \cosh \frac{\pi a}{W} \sec^{2/3} \psi \tag{5}$$

and the values obtained using this expression are compared with those obtained by Gross and Mendelson in Table 1.

Table 1. Non-dimensional stress intensity factor, $K_1/S\sqrt{a}$

Notch apex angle 2ψ	Notch length to plate width ratio a/W							
	0	0.1	0.2	0.3	0.4	0.5	0.6	
0°	GM		2.426	2.947	3.746	5.005	7.148	
	(5)	2.000	2.100	2.408	2.956	3.799	5.019	6.739
60°	GM		2.614	3.148	3.984	5.312	7.564	
	(5)	2.202	2.311	2.651	3.253	4.180	5.523	7.417
120°	GM		4.034	4.734	5.955	7.692	11.533	
	(5)	3.175	3.333	3.823	4.692	6.029	7.967	10.696

In the range $a/W \leq 0.5$, $2\psi \leq 120^\circ$, the maximum error incurred by using eqn (5) is of the order $\pm 5\%$ which, for most practical purposes, is an acceptable degree of accuracy.

REFERENCES

- [1] B. Gross and A. Mendelson, Plane elastostatic analysis of V-notched plates. *Int. J. Fracture Mech.* **8** , 267–276 (1972).
- [2] W. W. Gerberich and Y. Katz, On a trigonometric expression for the single-edge-notch specimen. *Engng Fracture Mech.* **1**, 727–728 (1970).
- [3] W. F. Brown and J. E. Srawley, Plane strain crack toughness testing of high strength metallic materials. *ASTM STP* 410 (1966).