

INITIAL BUCKLING OF FLAT ISOSCELES TRIANGULAR PLATES UNDER COMBINED COMPRESSION AND SHEAR

1. NOTATION

$2a$	base length of plate (see Figure 1)	m	in
E	Young's modulus of material	N/m ²	lbf/in ²
f_b	critical compressive stress	N/m ²	lbf/in ²
h	height of plate	m	in
K_f	buckling coefficient defined by $f_b = K_f E \left(\frac{t}{h} \right)^2$		
K_q	buckling coefficient defined by $q_b = K_q E \left(\frac{t}{h} \right)^2$		
q_b	critical shear stress	N/m ²	lbf/in ²
t	plate thickness	m	in
ν	Poisson's ratio		

Both SI and British units are quoted but any coherent system of units may be used.

2. NOTES

In Figure 1 the buckling coefficient K_f is plotted against the coefficient K_q for various values of h/a for the cases of flat isosceles triangular plates with all edges clamped or with all edges simply-supported. Values of K_f or K_q taken from the curves give the values of the compressive and shear stresses appropriate to a critical combination of stresses f_b and q_b . From the definition of the buckling coefficients, the ratio of critical stresses $f_b/q_b = K_f/K_q$.

Because of changes in the buckling pattern of the plate, curves obtained by cross plotting from the curves of Figure 1, for purposes of interpolation, may not always have curvature of the same sense throughout their length.

The shear stress is taken as positive when it tends to increase the vertical angle as shown in Figure 1. Shear acting in the opposite direction gives a higher critical buckling stress.

The curves are applicable only to plates of isotropic material and have been calculated for a value of $\nu = 0.3$.

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3. DERIVATION

1. WITTRICK, W.H. Symmetrical buckling of right-angled isosceles triangular plates. *Aeronaut. Q.*, Vol. 5, pp. 131-143, July 1954.
2. COX, H.L.
KLEIN, B. The buckling of isosceles triangular plates. *J. aeronaut. Sci.*, Vol. 22, pp. 321-325, May 1955.
3. COX, H.L. The buckling of isosceles triangular plates subjected to combined compression and shear. *J. aeronaut. Sci.*, Vol. 23, pp. 287-288, March 1956.

4. EXAMPLES

4.1 Example 1

To find the value of f_b , at which a flat isosceles triangular plate with all edges simply-supported first buckles, when

$$h = 10.0 \text{ in}, \quad a = 5.0 \text{ in}, \quad t = 0.048 \text{ in}, \quad E = 10 \times 10^6 \text{ lbf/in}^2, \quad \nu = 0.3,$$

and a shear stress of 1000 lbf/in^2 is applied.

$$\text{Then} \quad K_q = \frac{1000}{10 \times 10^6} \times \left(\frac{10}{0.048} \right)^2 = 4.34 \text{ and } \frac{h}{a} = 2.0.$$

From Figure 1, $K_f = 1.0$.

$$\text{Hence} \quad f_b = 1.0 \times 10 \times 10^6 \times \left(\frac{0.048}{10} \right)^2 = 230 \text{ lbf/in}^2.$$

4.2 Example 2

To find the critical compressive and shear stresses for the plate of Example 1 when the ratio of shear stress to compressive stress is 2.5.

$$\text{Then, at buckling } \frac{K_q}{K_f} = 2.5.$$

On Figure 1 a straight line given by $K_q = 2.5K_f$ is drawn from the origin to cut the curve $\frac{h}{a} = 2.0$. At the intersection $K_f = 1.5$ and $K_q = 3.75$.

$$\text{Hence,} \quad f_b = 1.5 \times 10 \times 10^6 \times \left(\frac{0.048}{10} \right)^2 = 346 \text{ lbf/in}^2$$

$$\text{and} \quad q_b = 3.75 \times 10 \times 10^6 \times \left(\frac{0.048}{10} \right)^2 = 864 \text{ lbf/in}^2.$$