

INITIAL BUCKLING OF FLAT PLATES UNDER BENDING AND COMPRESSION OR TENSION

1. NOTATION

a	length of plate	m	in
b	width of plate	m	in
E	modulus of elasticity of plate material	N/m ²	lbf/in ²
f_1	longitudinal compressive stress at edge AB	N/m ²	lbf/in ²
f_2	longitudinal stress at edge CD, positive if compressive	N/m ²	lbf/in ²
f_{1b}, f_{2b}	critical values of f_1 and f_2 respectively at which plate first buckles	N/m ²	lbf/in ²
K	buckling stress coefficient, defined by $f_{1b} = KE(t/b)^2$		
K_{min}	minimum value of K		
t	thickness of plate	m	in

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

2. NOTES

The buckling stress coefficients K and K_{min} are plotted in Figure 1 against the ratio f_2/f_1 ; K depends also on the ratio a/b . The plate is assumed to be isotropic, with Poisson's ratio 0.3, and simply-supported along all four edges which are free from lateral restraint. The stress varies linearly along the edges BC and AD. The range of loadings covered by Figure 1 extends from pure compression ($f_2/f_1 = 1$) to combined tension and bending with $f_2/f_1 = -1.3$.

For a given ratio of f_2/f_1 , K_{min} occurs when a is a multiple of the natural wavelength into which an infinite plate of width b buckles. The natural wavelength varies from $2b/3$ in pure bending to b in pure compression.

For $a/b > 2/3$ the difference between K and K_{min} is small and the latter value may be used always.

3. DERIVATION

This section lists selected sources that have assisted in the preparation of this Item.

1. ARGYRIS, J.H.
DUNNE, P.C. Work done for Structures Data Sheet Committee, 1948.
2. LEGGETT, D.M.A. On the elastic stability of a rectangular plate when subjected to a variable edge thrust. *Proc. Camb. Phil. Soc.*, Vol. XXXI, Part 3, 1935.
3. UNOLD, I.G. *Stahlbau – Kalender*, published by Deutschen Stahlbau – Verband, Berlin, Chapter 5, p. 360, 1939.
4. TIMOSHENKO, S.P.
GERE, J.M. *Theory of elastic stability*. Second edition, p. 373, published by McGraw-Hill, New York, 1961.

4. EXAMPLE

It is required to find the buckling stress f_{1b} at which a flat plate buckles when $a = 150$ mm, $b = 450$ mm, $t = 1$ mm, $E = 72\,400$ MN/m² and $f_2/f_1 = -1.2$.

From Figure 1, for $a/b = 0.33$, by interpolation $K = 36.0$.

$$\text{Therefore, } f_{1b} = 36 \times 72\,400 \times \left(\frac{1 \times 10^{-3}}{450 \times 10^{-3}} \right)^2 = 12.87 \text{ MN/m}^2.$$