

BUCKLING STRESS RATIOS FOR FLAT PLATES UNDER SHEAR AND NON-UNIFORM COMPRESSION

1. NOTATION

f_c	direct stress at centre-line of plate subject to non-uniform compression; stress at which plate first buckles under shear and non-uniform compression	N/m ²	lbf/in ²
f_{cb}	direct stress at centre-line at which plate first buckles in non-uniform compression alone	N/m ²	lbf/in ²
f_e	direct stress at edge of plate subject to non-uniform compression	N/m ²	lbf/in ²
q	shear stress at which plate first buckles under shear and non-uniform compression	N/m ²	lbf/in ²
q_b	stress at which plate first buckles in shear alone	N/m ²	lbf/in ²

Direct stresses are positive in compression.

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

2. NOTES

The curve of f_c/f_{cb} against q/q_b given in Figure 1 applies to flat plates having the following edge restraints:

- (i) ends and sides simply-supported;
- (ii) ends clamped, sides simply-supported;
- (iii) ends simply-supported, sides clamped;
- (iv) ends and sides clamped.

The curve applies to symmetric distributions of axial stress, such as those arising from initial or thermal strain, that do not vary along the length of the plate. Stresses f_{cb} and q_b can be determined using Item No. 69003 and Item No. 71005, respectively.

3. DERIVATION

1. HOPKINS, H.G.
RAO, B.V.S.C. The initial buckling of flat rectangular panels under combined shear and compression. ARC R & M 1965, March 1943.
2. BENOY, M.B. The buckling of rectangular plates under thermal compression and shear. Ministry of Technology S and T Memo. 2/70, 1970.

Issued January 1970
With Amendment A

4. EXAMPLE

During deceleration from supersonic flight, transient thermal compressive stresses are set up in an aircraft panel. The stress distribution is approximated by a parabola having $f_e/f_c = 0.6$, $f_c = 4600 \text{ lbf/in}^2$ and the mean temperature in the middle of the plate is 100°C . It is required to determine the shear stress at which the panel will first buckle.

The panel is made from DTD 5070 material 0.080 in thick, it is 12 in long and 6.5 in wide and has its ends clamped and sides simply-supported.

Referring to the example in Item No. 69003,

$$E = 10.3 \times 10^6 \text{ lbf/in}^2$$

and $f_{cb} = 7520 \text{ lbf/in}^2$.

From Data Item Struct 02.03.01, at $b/a = 0.542$,

$$K = 6.50$$

$$\text{and } q_b = 6.50 \times 10.3 \times 10^6 \left(\frac{0.080}{6.5} \right)^2 = 10\,140 \text{ lbf/in}^2.$$

From Figure 1, for

$$\frac{f_c}{f_{cb}} = \frac{4600}{7520} = 0.612,$$

$$\frac{q}{q_b} = 0.622.$$

Therefore

$$q = 0.622 \times 10\,140 = 6310 \text{ lbf/in}^2.$$