

BUCKLING IN COMPRESSION OF SHEET BETWEEN RIVETS

1. NOTATION

E	modulus of elasticity of sheet material in compression	N/m ²	lbf/in ²
E_t	tangent modulus of sheet material in compression at stress f_e	N/m ²	lbf/in ²
f_e	edge stress at which sheet buckles between rivets	N/m ²	lbf/in ²
f_n	stress at which $E_t = \frac{1}{2}E$ (see Data Item No. 76016*)	N/m ²	lbf/in ²
K	fixity coefficient at rivets		
l	rivet pitch	m	in
m	material characteristic (see Data Item No. 76016*)		
t	sheet thickness	m	in

* Data Item No. 76016 "Generalisation of smooth continuous stress-strain curves for metallic materials".

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

2. NOTES

In Figure 1 the ratio f_e/f_n is plotted against $(l/t)(f_n/KE)^{1/2}$ for a range of values of m . The auxiliary right-hand scale marked $(f_n/KE)^{1/2}$ and the straight lines marked l/t are added for convenience in computation and enable f_e/f_n to be read directly against l/t . Data Item No. 90002[†] provides a computer program that may be used to calculate f_e from the sheet material properties and l , K and t directly.

The curves may be used to find the inter-rivet buckling stress of a sheet directly and may also be used to draw curves of buckling stress against l/t for specific materials. Such curves are given in Data Item No. Struct 02.01.09.

The stress f_e refers to the edge stress in the sheet at the rivet line and may be regarded as the limiting compressive stress to which the sheet between the rivets can be subjected.

Values of f_n and m for certain materials are given in Data Item No. 76016* or they may be calculated using the methods given in that Item. Edge stresses for thin flat plates may be found from Data Items Nos Struct 02.01.02 and 02.01.03.

The fixity coefficient at the rivets, K , depends on methods of fabrication and type of rivets or other attachments. However, limited test data indicate that for conventional methods of attachment values of the order of those given in the following table are appropriate.

[†] Data Item No. 90002 "Struts: strength under flexural, local and inter-rivet buckling".

<i>Type of attachment</i>	<i>Fixity coefficient at rivets, K</i>
Flathead rivets	4
Spotwelds	3½
Mushroom or snaphead rivets	3
Countersunk or dimpled rivets	1½

It is assumed that the stringers or stiffeners to which the sheet is attached do not buckle in a wavelength comparable to the rivet pitch.

3. DERIVATION

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

The equation
$$f_e = \frac{KE_t \pi^2 t^2}{12l^2} . \quad (3.1)$$

1. BARRETT, A.J. Generalised stress-strain data for aluminium alloys and certain other
MICHAEL, M.E. materials. *Jl R. aeronaut. Soc.*, Vol. 59, No. 530, pp. 152-158, February
1955.
2. GERARD, G. Handbook of structural stability. Part V – Compressive strength of flat
stiffened panels. NACA tech. Note 3785, 1957.

4. EXAMPLES

4.1 Example 1

It is required to find the edge stress at which 18 gauge (0.48 in) sheet titanium alloy buckles with snaphead riveting at 0.70 in pitch.

The properties of the titanium alloy are

$$E = 16 \times 10^6 \text{ lbf/in}^2,$$

$$0.05 \text{ per cent compressive proof stress} = 118\,000 \text{ lbf/in}^2$$

$$\text{and } 0.1 \text{ per cent compressive proof stress} = 123\,000 \text{ lbf/in}^2.$$

A check is first made using Equation (3.1) to see if the buckling is within the elastic range. From the table,