

ESTIMATION OF THE INITIAL BUCKLING STRESS UNDER UNIAXIAL COMPRESSION OF A CORRUGATED SANDWICH PANEL

1. INTRODUCTION

This Item illustrates the use of Items Nos 73007 and Struct. 02.01.28 for the estimation of the initial buckling stress under uniaxial compression of a corrugated sandwich panel manufactured from an isotropic material. A diagram of a cross section of this type and the computation of the buckling stress are given in Section 3. Explanatory notes on this computation are given below.

Since flat *C* is attached to flat *H* by a continuous adhesive joint it is assumed that these flats act as one flat, *CH*, of thickness equal to the sum of the thicknesses joined. The same assumption is made with regard to flats *D* and *F*. Attention is also drawn to Section 2 of Item No. Struct. 02.01.28 (see note (8) below). The symmetry of the cross section of this example may be used to reduce the computation that would be involved in the use of Equation (4.4) of Item No. Struct. 02.01.28. From the equations leading up to Equation (4.4) on that Item,

$$\begin{aligned} T_{\theta}/\theta &= B_2 + \frac{1}{2}(A_2 + A_3) + (DF)_2 + \frac{1}{2}(\psi/\theta)(A_2 - A_3) \\ T_{\psi}/\psi &= G_2 + \frac{1}{2}(A_2 + A_3) + (CH)_2 + \frac{1}{2}(\theta/\psi)(A_2 - A_3) . \end{aligned}$$

At the same value of the longitudinal compressive stress and the same wavelength of buckling for all flats, from the symmetry of the cross section,

$$B_2 = G_2 \quad \text{and} \quad (DF)_2 = (CH)_2 .$$

At buckling, T_{θ}/θ and T_{ψ}/ψ are simultaneously zero; hence $\theta = \pm\psi$. If $\theta = +\psi$, T_{θ}/θ reduces to an equation involving A_2 and not A_3 , and if $\theta = -\psi$, T_{θ}/θ reduces to the same equation but with A_3 replacing A_2 . Within the range of values of b/λ for which stiffnesses are plotted in Item No. 73007, A_3 will always be greater than A_2 , and the mode in which $\theta = -\psi$ leads to a higher value of the critical stress than that in which $\theta = +\psi$.

The expression to be investigated reduces to

$$T_{\theta}/\theta = A_2 + B_2 + (DF)_2 .$$

The computation of the initial buckling stress, appropriate to a mode of deformation involving distortion of the cross section without translation of any of the junctions of the component flats, consists of a search for the minimum value of the longitudinal compressive stress f_x associated with a zero value of the total stiffness T_{θ}/θ .

2. EXPLANATORY NOTES

- (1) All stresses are quoted in thousands of pounds force per square inch and, in accordance with Item No. 73007, compressive stresses are positive. Since there is no transverse stress the term β_I of Item No. 73007 reduces to one so that $\beta_I^{1/2}b/\lambda$ reduces to b/λ . The stress parameter α_I similarly reduces to f_x/f_I and is a convenient means of expressing the longitudinal compressive stress in non-dimensional form. The value of the modulus of elasticity used in the calculation of f_I should be that appropriate to the stress f_x .

Issued June 1954

With Amendment B, March 1974

- (2) Stiffnesses are obtained from Figures 7 and 8 of Item No. 73007.
- (3) The best initial choice of a value for the half wavelength λ is largely a matter of experience but a value somewhat less than the value of b for the widest component flat is suggested.
- (4) A series of values of f_x is selected until both positive and negative values of T_0/θ have been obtained. Inspection of the cross section suggests that an appropriate initial choice of f_x is a value somewhat below the buckling stress for component flat B for clamped edge conditions.
- (5) Values of $\mu/(E't^3/(3b))$ are obtained as noted in (2).

In the case noted,

$$\frac{f_x}{f_I} = \frac{19.05}{41.7} = 0.457 \quad \text{and} \quad \frac{b}{\lambda} = 0.663.$$

From Figure 7,

$$\frac{\mu_2}{E't^3/(3b)} = 0.61$$

$$\text{giving} \quad \mu_2 = 0.61 \times E't^3/(3b) = 0.61 \times 161.4 = 98 \text{ lbf.}$$

- (6) Critical f_x is the value of f_x appropriate to $T_0/\theta = 0$ and is obtained graphically.
- (7) Minimum critical f_x and the associated value of λ are obtained by plotting critical f_x against λ .
- (8) If the flats C and H and D and F were each attached by a double row of rivets at 0.6 in spacing the buckling stress might be reduced to 15 900 lbf/in² which is appropriate to the lengthened flat G if the edges were completely clamped along the rivet lines.