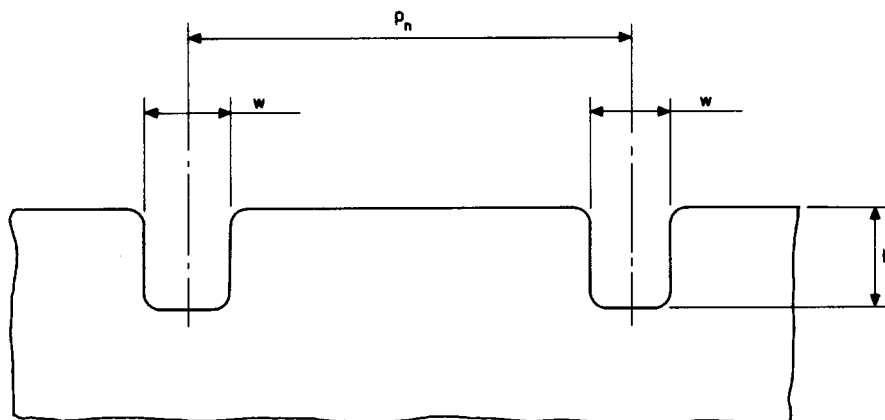


STIFFNESS DATA FOR FINITE ELEMENT CALCULATIONS EQUIVALENT STIFFNESS FACTORS FOR SHEAR WEBS

1. NOTATION

A	effective cross-sectional area of shear web associated with flange	m^2	in^2
a	length of shear web (where $a > b$)	m	in
a_d	developed length of corrugated shear web	m	in
b	shear web depth	m	in
D	diameter of lightening hole	m	in
G	modulus of rigidity of shear web material	N/m^2	lbf/in^2
h	depth of notch, see Sketch 1.1	m	in
p_n	pitch of notches, see Sketch 1.1	m	in
t	thickness of shear web	m	in
w	width of notch, see Sketch 1.1	m	in
α	$= w/p_n$		
β	$= 2h/b$		
γ	$= b/p_n$		
Suffix			
i	denotes chosen section of shear web of varying stiffness (see Sketch 4.1).		

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



Sketch 1.1

2. NOTES

This Item gives values for the effective stiffness of a number of different shear web configurations and a listing of stiffnesses and related data that are available in the Structures Sub-series.

Most aircraft structures involve many discontinuities and changes in type of load carrying member. It is therefore usually convenient to perform a finite element analysis with the object of determining the gross load distribution throughout the entire structure and then to use the loads for a detailed stress analysis. In order to obtain reasonable and economic solutions to the load distributions it is advantageous to represent the effect of smaller features, such as cut-outs and holes, by providing an equivalent stiffness for the appropriate element(s). This provides an improved estimate of the loads so that subsequent detailed analysis of stresses is also improved.

The effective stiffnesses for shear webs given in Table 5.1 enable a membrane, shear load carrying only, element to be assigned the equivalent stiffness of a complete shear web that has a more complex subscale structure when applying the element to a larger finite element system. This will allow an economic analysis of the resultant stresses within the system and thereby element loading without the necessity of modelling non-standard element (component) configurations in detail. The factors given in Table 5.1 have been derived from, and are applicable to, typical aircraft structures. The stiffnesses given are approximations only and are not applicable to the detailed stress analysis of individual components of the system.

In Table 5.1 the effective stiffnesses for different shear web configurations are given with the effective flange area associated with each configuration tabulated alongside. The effective stiffnesses can be related to the stiffness of a plain shear web, Gt , and for simple rectangular elements can be input to finite element programs as a corresponding simple factor on the modulus of rigidity, G . In the case of shear webs of varying stiffness it is assumed that the element may be represented by sections, taken along the length, and denoted by the suffix i , see example, Section 4. The effective stiffness, $(Gt)_i$, and effective flange area, A_i , are determined from the other configurations given that are then combined using the formulae shown in the bottom row of Table 5.1, to provide the total element stiffness and flange area. When more than one feature is present in the shear web (or section i of a shear web) the resulting stiffness factor (for that section) is the product of the factors calculated for each feature, see the example of Section 4. Values of A_i for sections containing more than one feature are simply the least value. When more than one feature exists in the web (or section i of the web) it is necessary to check that the area of web, A_i , to be assigned to the boundary member actually exists. Note that when A is combined with the area of boundary members account should be taken of any difference in their material moduli.

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