

ELASTIC STRESSES IN SINGLE LAP JOINTS UNDER TENSION OR COMPRESSION

1. NOTATION

t	thickness of each plate	m	in
d	length of joint overlap	m	in
L	distance from centre of joint to nearest lateral support	m	in
R	transverse radius of curvature of plates (see Figure 1)	m	in
E	Young's modulus of plate material	N/m ²	lbf/in ²
ν	Poisson's ratio		
λ_F	rotational stiffness per unit width of plate due to restraint applied at centre of joint by a frame member	N m/m rad	lbf in/in rad
λ_c	rotational stiffness per unit width of plate due to curvature	N m/m rad	lbf in/in rad
λ	$\lambda_F + \lambda_c$	N m/m rad	lbf in/in rad
f	direct stress applied to each plate	N/m ²	lbf/in ²
f_T	maximum total stress in plates	N/m ²	lbf/in ²

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

2. INTRODUCTION

This Item gives the maximum total elastic stress resulting from the combination of the bending stress and the applied direct stress in a single lap joint between two flat or curved plates of the same thickness and material. Some form of rotational restraint may exist at the joint centre.

The data apply to joints between plates in which the width of the plates is at least $3t$. A value of Poisson's ratio equal to $1/3$ has been used throughout.

The stress f_T has been derived by means of conventional bending theory and always occurs at the edges of the joint interface. There is, in addition, a local stress concentration at the edges of the joint which is affected by the local conditions of attachment.

This Item does not deal with the calculation of λ_F since this is dependent upon the associated frame member.

3. JOINTS IN COMPRESSION

For joints between plates that are in compression the following approximate value for f_T/f may be used provided that the structure does not buckle and that $R/t > 250$,

$$\frac{f_T}{f} = 1 + \frac{3}{1 + 2(1 - \nu^2) \left(\frac{\lambda L}{Et^3} \right)}.$$

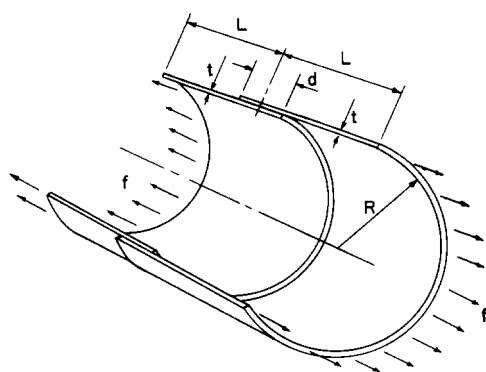
4. JOINTS IN TENSION

For joints in tension Figures 1, 2, 3 and 4 show values of f_T/f plotted against $(f/E)(L/t)^2$ for various values of $\lambda L/Et^3$, each figure pertaining to a different value of L/d .

The curves may be used irrespective of the degree of rotational stiffness of the end fixings of the plates. At values of $(f/E)(L/t)^2 < 1.0$ the end fixings of the plates significantly affect f_T/f . However, the ratio f_T/f never exceeds four.

The curves apply strictly to cases where L is the same for each plate. However, provided that the L values of the plates do not differ greatly, no significant error in f_T/f will result if an average value of L/d is used. If a large difference in the values of L exists a conservative estimate of f_T will be obtained if the smaller value of L/d is used.

Rotational restraint of the centre of the joint will arise if the plates are jointed on a frame member or are curved as shown in Sketch 4.1. If the plates form more than a quadrant of a cylinder, and provided that $R/t \geq 25$ and that $d \leq 15t$ an approximate value of λ_c is given by



Sketch 4.1

$$\lambda_c = \frac{Et d^3}{6R^2},$$

$$\text{whence } \frac{\lambda_c L}{Et^3} = \frac{d^3 L}{6R^2 t^2}.$$