

INFORMATION ON THE USE OF DATA ITEMS ON SANDWICH PANELS

1. INTRODUCTION

This Item gives a brief account of the theoretical basis of the Data Items of the Structures Sub-series relating to the buckling of sandwich panels. The necessary plate constants are defined and, for the more common types of sandwich construction, approximate formulae for the plate constants are given. An index is also included that lists all Data Items pertaining to sandwich construction.

2. NOTATION

a	length of panel in x -direction	m	in
b	width of panel in y -direction	m	in
D_{qx}, D_{qy}	shear stiffness per unit width in xz - and yz -planes respectively	N m	lbf in
D_x, D_y	flexural stiffness per unit width for bending about y - and x -axes respectively	N m ² /m	lbf in ² /in
D_{xy}	twisting stiffness of the panel about x - and y -axes	N/m	lbf/in
E	Young's modulus of face-plate material	N/m ²	lbf/in ²
E_{cx}	Young's modulus of core material in x -direction	N/m ²	lbf/in ²
G	modulus of rigidity of face-plate material	N/m ²	lbf/in ²
G_{cx}, G_{cy}	modulus of rigidity of the core in xz - and yz -planes respectively	N/m ²	lbf/in ²
h	depth of core	m	in
I_{cx}	second moment of area per unit width of core about y -axis	m ³	in ³
I_{fx}, I_{fy}	second moment of area per unit width of face plates about y - and x -axes respectively	m ³	in ³
l	half length of one corrugation (see Figure 2)	m	in
M_x, M_y	bending moment per unit width acting about y - and x -axes respectively	N m/m	lbf in/in
M_{xy}	twisting moment per unit width acting about x - and y -axis	N m/m	lbf in/in
p	pitch of corrugations (see Figure 2)	m	in
P_E	$\frac{4\pi^2 D_y}{b^2(1 - \nu_x \nu_y)}$ reference load per unit width (see Data Items on buckling listed in Section 8.3)	N/m	lbf/in

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Q_x, Q_y	shear force per unit width acting in xz - and yz -planes respectively	N/m	lbf/in
t	thickness of face plates	m	in
t_c	thickness of corrugated core (see Figure 2)	m	in
t_1, t_2	thickness of face plates ($t_1 \neq t_2$)	m	in
w	panel deflection measured in z -direction	m	in
ν	Poisson's ratio of face-plate material		
ν_x, ν_y	apparent values of Poisson's ratio for the panel in x - and y -directions respectively		

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

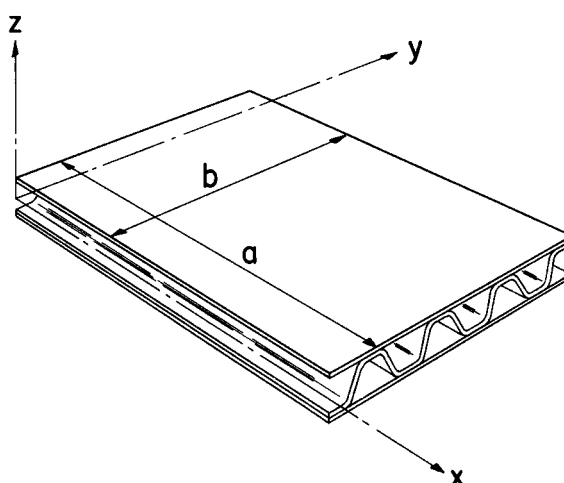


FIGURE 1

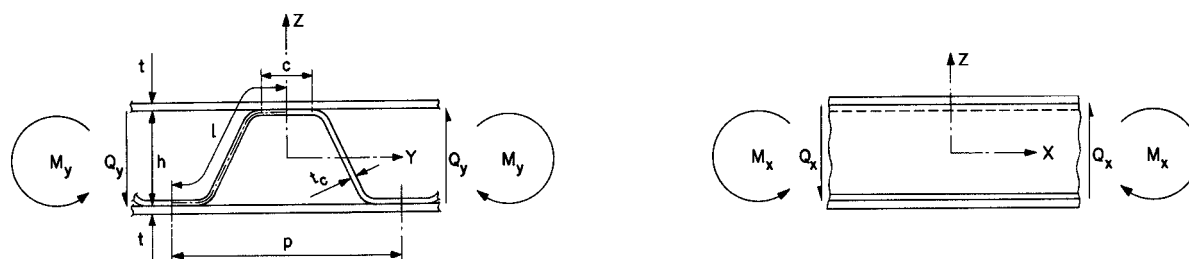


FIGURE 2

Figures 1 and 2 use a corrugated-core sandwich to illustrate the co-ordinate system used throughout the series of Data Items on sandwich construction.

3. BASIC THEORY OF BENDING

The following equations are applicable to any panel that has two orthogonal planes of bending and a common neutral plane. The x - and y -axes are taken to lie in this neutral plane parallel to the principal axes of bending.

$$\begin{aligned}\frac{\partial^2 w}{\partial x^2} &= -\frac{M_x}{D_x} + \nu_y \frac{M_y}{D_y} + \frac{1}{D_{qx}} \frac{\partial Q_x}{\partial x} \\ \frac{\partial^2 w}{\partial y^2} &= -\frac{M_y}{D_y} + \nu_x \frac{M_x}{D_x} + \frac{1}{D_{qy}} \frac{\partial Q_y}{\partial y} \\ \frac{\partial^2 w}{\partial x \partial y} &= \frac{M_{xy}}{D_{xy}} + \frac{1}{2D_{qx}} \frac{\partial Q_x}{\partial y} + \frac{1}{2D_{qy}} \frac{\partial Q_y}{\partial x}.\end{aligned}$$

Seven plate constants D_x , D_y , D_{xy} , D_{qx} , D_{qy} , ν_x and ν_y are therefore required. Four of these constants are related by means of the reciprocal theorem which gives

$$\frac{\nu_x}{D_x} = \frac{\nu_y}{D_y}.$$

The following sections deal with the determination of the plate constants and the application of the theory to the two groups of sandwich construction for which Data Items are presented (see Section 8.3).

If the data required are not listed in Section 8 it is recommended that the Engineering Sciences Data Index should be consulted as further data may become available from time to time.

4. DETERMINATION OF PANEL CONSTANTS

The theoretical solutions for the panel constants are given for the more common forms of construction in Sections 5.1 and 5.2 of this Item. It should be noted that a theoretical solution is often only a guide to the actual value. This is usually due to the effect of minor variations of the geometry caused by the production process. Accordingly it is advisable to determine the panel constants experimentally and Item No. 66025 deals with the experimental determination of the stiffnesses D_x , D_y , D_{qx} and D_{qy} for any type of construction. Reference 1 indicates possible methods for experimental determination of the remaining three constants D_{xy} , ν_x and ν_y .

5. APPLICATION TO SANDWICH CONSTRUCTION

5.1 Sandwich Panels with Isotropic Face Plates and Orthotropic Cores of Zero Flexural Stiffness

A typical example of a sandwich panel that comes under this heading is the honeycomb-core type.

For this group of panels the following assumptions can be made.

- (i) The face plates are isotropic and have identical material properties.
- (ii) The face-plate thicknesses are sufficiently small in relation to the depth of core for the twisting and bending moments developed within them to be negligible.