



Initial buckling of flat isosceles triangular plates under compression reacted by compression and/or shear

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Mr J.H. van der Sloot	— Independent

The construction and subsequent development of the Data Item was undertaken by

Mr N. Dev-Anand	— Senior Engineer.
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The person with overall responsibility for the work in this subject area is Mr Adam Quilter, Head of Aerospace Structures Group.

INITIAL BUCKLING OF FLAT ISOSCELES TRIANGULAR PLATES UNDER COMPRESSION REACTED BY COMPRESSION AND/OR SHEAR

CONTENTS

	Page
1. NOTATION	1
2. INTRODUCTION	2
3. DERIVATION AND REFERENCES	5
3.1 Derivation	5
3.2 Reference	5
4. EXAMPLE	6

INITIAL BUCKLING OF FLAT ISOSCELES TRIANGULAR PLATES UNDER COMPRESSION REACTED BY COMPRESSION AND/OR SHEAR

1. NOTATION

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

$2a$	length of base of triangular plate (see Sketch 2.1)	m	in
E	Young's modulus of plate material	N/m ²	lbf/in ²
f	total applied compressive stress along base of triangular plate (see Sketch 2.1)	N/m ²	lbf/in ²
f_c	applied uniform compressive stress along base of triangular plate reacted by uniform compressive stress, f_c , along equal edges of plate (see Sketch 2.1)	N/m ²	lbf/in ²
$f_{c,cr}$	critical compressive stress for load condition in Sketch 2.1a and Figure 1 ($f_s = 0$)	N/m ²	lbf/in ²
f_{cr}	critical total compressive stress along base of triangular plate due to applied uniform stress $f = f_c + f_s$ along base of plate (see Sketch 2.1c)	N/m ²	lbf/in ²
f_s	applied uniform compressive stress along base of triangular plate reacted by uniform shear stress, q , along equal edges of plate, $f_s = q(h/a)$ (see Sketch 2.1)	N/m ²	lbf/in ²
$f_{s,cr}$	critical compressive stress for load condition in Sketch 2.1b and Figure 2 ($f_c = 0$)	N/m ²	lbf/in ²
h	height of triangular plate	m	in
K	buckling coefficient defined by $f_{cr} = KE\left(\frac{t}{2a}\right)^2$		
K_c	buckling coefficient defined by $f_{c,cr} = K_c E\left(\frac{t}{2a}\right)^2$		
K_s	buckling coefficient defined by $f_{s,cr} = K_s E\left(\frac{t}{2a}\right)^2$		
q	uniform reacting shear stress along equal edges of plate due to applied uniform compressive stress, f_s , along base of plate (see Sketch 2.1), $q = f_s(a/h)$	N/m ²	lbf/in ²
t	thickness of triangular plate	m	in
ν	Poisson's ratio		

2. INTRODUCTION

This Data Item provides a method of calculating the initial buckling stress of a flat isosceles triangular plate of uniform thickness subjected to

- (a) a uniform compression $f = f_c$ along the base reacted by compressive stress along the two equal edges of the plate (see Sketch 2.1a), or
- (b) a uniform compression $f = f_s$ along the base reacted by shear stress q along the two equal edges of the plate (see Sketch 2.1b).

The Item also provides a method of calculating the critical total buckling stress, f_{cr} , of a flat isosceles triangular plate of uniform thickness subjected to

- (c) a uniform compression $f = f_c + f_s$ along the base of the triangular plate reacted by a combination of compression f_c and shear q along the two equal edges (see Sketch 2.1c).

The boundary conditions considered are either all three edges clamped (fixed in rotation and out-of-plane displacement) or all three edges simply-supported (free to rotate, fixed in out-of-plane displacement).

The data given in this Item are obtained by FEA (Derivation 3)* for loading cases (a) and (b) above and from the interaction formula, Equation (2.1), for the combined case (c). The shear stress is taken as positive for the load directions shown in Sketch 2.1.

The curves in Figures 1 to 4 are applicable only to plates of isotropic material and have been calculated for $\nu = 0.3$. Results for materials with other Poisson's ratios can be obtained by multiplying the values given by the curves by $(1 - 0.3^2)/(1 - \nu^2)$.

Figure 1 presents curves of K_c versus h/a for uniform compression $f = f_c$ along the base reacted by compressive stress f_c along the two equal edges of the plate (as in Sketch 2.1a).

Figure 2 presents curves of K_s versus h/a for uniform compression $f = f_s$ along the base reacted by shear stress q along the two equal edges of the plate (as in Sketch 2.1b).

Figures 3 and 4 presents curves of K versus f_c/f for combined uniform compression $f = f_c + f_s$ along the base reacted by a combination of uniform compression f_c and shear stress q along the two equal edges (as in Sketch 2.1c) for plates with simply-supported and clamped edge cases respectively.

It may be observed that the value of K_c is consistently low in comparison with K_s : this is because the former corresponds to a state of biaxial compression whereas the latter condition implies a biaxial stress state in which the transverse stress component is tensile.

* The present Data Item supersedes ESDU STRUCT 02.04.06 in which a theoretical solution based on an approximate mode of buckling (Derivations 1 and 2) was found to be insufficiently accurate, and this has now been replaced by a finite element analysis.