



Elastic stresses in a long circular cylindrical shell with a flat head closure under uniform pressure

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THE PREPARATION OF THIS DATA ITEM

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ELASTIC STRESSES IN A LONG CIRCULAR CYLINDRICAL SHELL WITH A FLAT HEAD CLOSURE UNDER UNIFORM PRESSURE

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1. NOTATION

D	mean diameter of shell	m	in
E	Young's modulus	N/m ²	lbf/in ²
$f_{i\phi}$	maximum total meridional stress in shell inner surface at junction of head and shell	N/m ²	lbf/in ²
$f_{i\theta}$	total hoop stress in shell inner surface at junction of head and shell	N/m ²	lbf/in ²
f_m	radial and tangential stress in median plane of head due to radial restraint applied by shell	N/m ²	lbf/in ²
f_{nom}	nominal hoop stress in median surface of shell, $pD/2t_s$	N/m ²	lbf/in ²
$f_{o\phi}$	total meridional stress in shell outer surface at junction of head and shell	N/m ²	lbf/in ²
$f_{o\theta}$	total hoop stress in shell outer surface at junction of head and shell	N/m ²	lbf/in ²
$f_T, f_{Tr}, f_{T\theta}$	flat plate stresses defined in ESDU 65002	N/m ²	lbf/in ²
L	length of shell	m	in
L_{min}	minimum length of long shell	m	in
p	uniform pressure on shell and head	N/m ²	lbf/in ²
q	shear stress in shell at junction of head and shell	N/m ²	lbf/in ²
t	thickness of head	m	in
t_s	thickness of shell	m	in
λ	effective rotational restraint applied to head by shell	N m/m rad	lbf in/in rad
Convention:	Tensile stresses are positive. Compressive stresses are negative.		

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

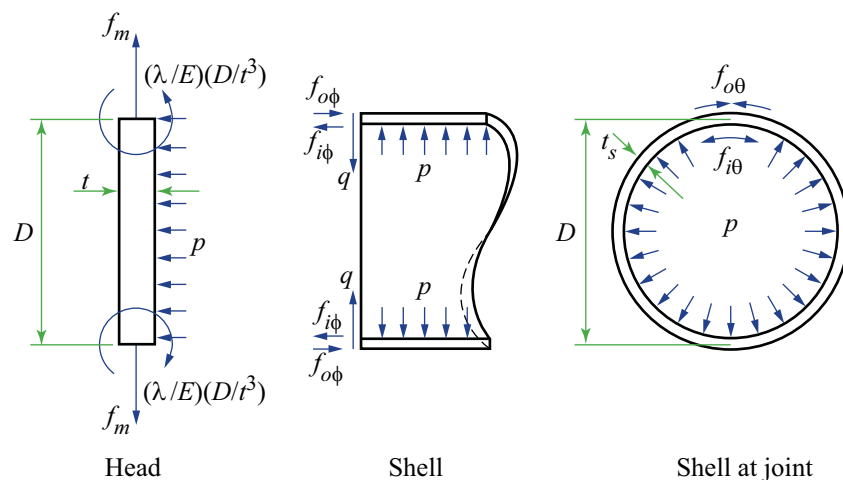
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2. INTRODUCTION

Curves are given that enable the maximum stresses to be determined for a long circular cylindrical shell with a flat head closure under uniform pressure only. The stresses and deflections of the head may be determined using this Item in conjunction with ESDU 65002*. The curves relate equally to shells under internal or external pressure. In the latter case it should be noted that f_{nom} is compressive and therefore negative.

The curves apply only to stresses within the elastic range of the material.

It is assumed that there is no relative movement between the shell and the head at the junction which is idealised as shown in the sketch below.



Sketch 2.1

This sketch shows the stresses in the shell under internal pressure. Under external pressure their senses will be reversed.

The curves are based on thin shell theory and small deflection plate theory and do not therefore extend below $D/t_s = 10$ or $D/t = 4$.

This Item applies only to cylinders of sufficient length that negligible interaction occurs between the discontinuity effects of the two ends of the pressure vessel. The minimum cylinder lengths for which the Item may be used are shown on Figure 1, where L_{min}/D is plotted against D/t_s .

In Figures 2 to 5 f/f_{nom} or q/f_{nom} is plotted against D/t_s for various values of t/t_s . In Figure 6 $(λ/E)(D/t^3)$ is plotted against D/t_s for various values of t/t_s . All the curves are presented in terms of non-dimensional quantities.

The shell stresses obtained from the curves are nominal stresses at the discontinuity. They result from the combination of the bending stresses due to the restraint exerted by the head on the shell with the stresses in the median surface of the shell. There is, in addition, a stress concentration at the corner which is affected by the local conditions of attachment.

* ESDU 65002, "Elastic stresses and deflections for flat circular plates with D/t greater than or equal to 4 under uniform pressure".