

**TABLE 13.2 Shear, moment, slope, and deflection formulas for long and short thin-walled cylindrical shells under axisymmetric loading**

NOTATION:  $V_0$ ,  $H$ , and  $p$  = unit loads (force per unit length);  $q$  = unit pressure (force per unit area);  $M_0$  = unit applied couple (force-length per unit length); all loads are positive as shown. distance  $x$  from the left end, the following quantities are defined:  $V$  = meridional radial shear, positive when acting outward on the right hand portion;  $M$  = meridional bending moment, positive compressive on the outside;  $\psi$  = meridional slope (radians), positive when the deflection increases with  $x$ ;  $y$  = radial deflection, positive outward.  $\sigma_1$  and  $\sigma_2$  = meridional and circumferential membrane stresses; positive when tensile;  $\sigma'_1$  and  $\sigma'_2$  = meridional and circumferential bending stresses, positive when tensile on the outside;  $\tau$  = meridional radial shear stress;  $E$  = modulus of elasticity;  $\nu$  = Poisson's ratio;  $R$  = mean radius;  $t$  = wall thickness.

The following constants and functions are hereby defined in order to permit condensing the tabulated formulas which follow:

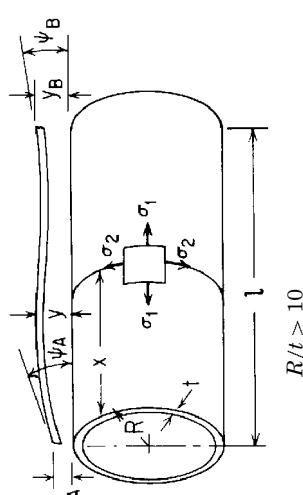
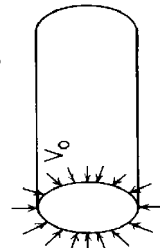
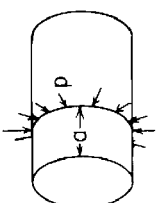
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$\lambda = \left[ \frac{3(1 - \nu^2)}{R^2 t^3} \right]^{1/4}$   $D = \frac{Et^3}{12(1 - \nu^2)}$  (Note: See page 131 for a definition of  $\langle x - a \rangle^n$ ; also all hyperbolic and trigonometric functions of the argument  $\langle x - a \rangle$  are also defined as zero if  $x < a$ ) (Note: when the limitations on maximum deflections discussed in paragraph 3 of Sec 13.3)

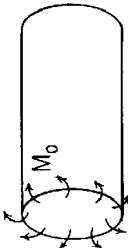
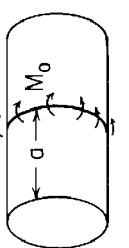
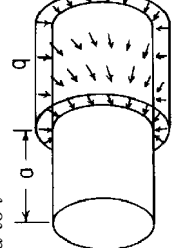
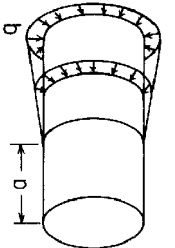
$F_1 = \cosh \lambda x \cos \lambda x$	$C_1 = \cosh \lambda l \cos \lambda l$	$C_{11} = \sinh^2 \lambda l - \sin^2 \lambda l$	
$F_2 = \cosh \lambda x \sin \lambda x + \sinh \lambda x \cos \lambda x$	$C_2 = \cosh \lambda l \sin \lambda l + \sinh \lambda l \cos \lambda l$	$C_{12} = \cosh \lambda l \sinh \lambda l + \cos \lambda l \sin \lambda l$	
$F_3 = \sinh \lambda x \sin \lambda x$	$C_3 = \sinh \lambda l \sin \lambda l$	$C_{13} = \cosh \lambda l \sinh \lambda l - \cos \lambda l \sin \lambda l$	also
$F_4 = \cosh \lambda x \sin \lambda x - \sinh \lambda x \cos \lambda x$	$C_4 = \cosh \lambda l \sin \lambda l - \sinh \lambda l \cos \lambda l$	$C_{14} = \sinh^2 \lambda l + \sin^2 \lambda l$	
$F_{a1} = \langle x - a \rangle^0 \cosh \lambda \langle x - a \rangle \cos \lambda \langle x - a \rangle$	$C_{a1} = \cosh \lambda(l - a) \cos \lambda(l - a)$		
$F_{a2} = \cosh \lambda \langle x - a \rangle \sin \lambda \langle x - a \rangle + \sinh \lambda \langle x - a \rangle \cos \lambda \langle x - a \rangle$	$C_{a2} = \cosh \lambda(l - a) \sin \lambda(l - a) + \sinh \lambda(l - a) \cos \lambda(l - a)$		
$F_{a3} = \sinh \lambda \langle x - a \rangle \sin \lambda \langle x - a \rangle$	$C_{a3} = \sinh \lambda(l - a) \sin \lambda(l - a)$		
$F_{a4} = \cosh \lambda \langle x - a \rangle \sin \lambda \langle x - a \rangle - \sinh \lambda \langle x - a \rangle \cos \lambda \langle x - a \rangle$	$C_{a4} = \cosh \lambda(l - a) \sin \lambda(l - a) - \sinh \lambda(l - a) \cos \lambda(l - a)$		
$F_{a5} = \langle x - a \rangle^0 - F_{a1}$	$C_{a5} = 1 - C_{a1}$		
$F_{a6} = 2\lambda \langle x - a \rangle \langle x - a \rangle^0 - F_{a2}$	$C_{a6} = 2\lambda(l - a) - C_{a2}$		
$A_1 = \frac{1}{2} e^{-\lambda a} \cos \lambda a$	$B_1 = \frac{1}{2} e^{-\lambda b} \cos \lambda b$		
$A_2 = \frac{1}{2} e^{-\lambda a} (\sin \lambda a - \cos \lambda a)$	$B_2 = \frac{1}{2} e^{-\lambda b} (\sin \lambda b - \cos \lambda b)$		
$A_3 = -\frac{1}{2} e^{-\lambda a} \sin \lambda a$	$B_3 = -\frac{1}{2} e^{-\lambda b} \sin \lambda b$		
$A_4 = \frac{1}{2} e^{-\lambda a} (\sin \lambda a + \cos \lambda a)$	$B_4 = \frac{1}{2} e^{-\lambda b} (\sin \lambda b + \cos \lambda b)$		

Numerical values of  $F_1$ ,  $F_2$ ,  $F_3$ , and  $F_4$  for  $\lambda x$  ranging from 0 to 6 are tabulated in Table 8.3, numerical values of  $C_{11}$ ,  $C_{12}$ ,  $C_{13}$ , and  $C_{14}$  are tabulated in Table 8.4.

**TABLE 13.2 Shear, moment, slope, and deflection formulas for long and short thin-walled cylindrical shells under axisymmetric loading**  
(Continued)

Short shells with free ends			
 <p style="text-align: center;"><math>R/t &gt; 10</math></p>		<p>Meridional radial shear = <math>V = -\gamma_A 2D\lambda^3 F_2 - \psi_A 2D\lambda^2 F_3 + LT_V</math></p> <p>Meridional bending moment = <math>M = -\gamma_A 2D\lambda^2 F_3 - \psi_A D\lambda F_4 + LT_M</math> (Note: The load terms <math>LT_V</math>, <math>LT_M</math>, etc., are given for each of the following cases)</p> <p>Meridional slope = <math>\psi = \psi_A F_1 - \gamma_A \lambda F_4 + LT_\psi</math></p> <p>Radial deflection = <math>y = \gamma_A F_1 + \frac{\psi_A}{2\lambda} F_2 + LT_y</math></p> <p>Circumferential membrane stress = <math>\sigma_2 = \frac{\gamma E}{R} + \nu \sigma_1</math></p> <p>Meridional bending stress = <math>\sigma'_1 = \frac{-6M}{t^2}</math></p> <p>Circumferential bending stress = <math>\sigma'_2 = \nu \sigma'_1</math></p> <p>Meridional radial shear stress = <math>\tau = \frac{V}{t}</math> (average value)</p>	
Loading and case no.	End deformations	Load terms or load and deformation equations	Selected values
1. Radial end load, $V_o$ lb/in  If $\lambda l > 6$ , see case 8	$\psi_A = \frac{V_o}{2D\lambda^2} \frac{C_{14}}{C_{11}}$ $\gamma_A = \frac{-V_o}{2D\lambda^3} \frac{C_{13}}{C_{11}}$ $\psi_B = \frac{V_o}{2D\lambda^2} \frac{2C_3}{C_{11}}$ $\gamma_B = \frac{V_o}{2D\lambda^3} \frac{C_4}{C_{11}}$	$LT_V = -V_o F_1$ $LT_M = \frac{-V_o}{2\lambda} F_2$ $LT_\psi = \frac{-V_o}{2D\lambda^2} F_3$ $LT_y = \frac{-V_o}{4D\lambda^3} F_4$	$\sigma_1 = 0$ $\psi_{\max} = \psi_A$ $\gamma_{\max} = \gamma_A$ $(\sigma_2)_{\max} = \frac{\gamma_A E}{R}$
2. Intermediate radial load, $p$ lb/in  If $\lambda l > 6$ , consider case 9	$\psi_A = \frac{p}{2D\lambda^2} \frac{C_2 C_{a2} - 2C_3 C_{a1}}{C_{11}}$ $\gamma_A = \frac{-p}{2D\lambda^3} \frac{C_3 C_{a2} - C_4 C_{a1}}{C_{11}}$ $\psi_B = \psi_A C_1 - \gamma_A \lambda C_4 - \frac{p}{2D\lambda^2} C_{a3}$ $\gamma_B = \gamma_A C_1 + \frac{\psi_A C_2}{2\lambda} - \frac{p}{4D\lambda^3} C_{a4}$	$LT_V = -p F_{a1}$ $LT_M = \frac{-p}{2\lambda} F_{a2}$ $LT_\psi = \frac{-p}{2D\lambda^2} F_{a3}$ $LT_y = \frac{-p}{4D\lambda^3} F_{a4}$	$\sigma_1 = 0$

**TABLE 13.2 Shear, moment, slope, and deflection formulas for long and short thin-walled cylindrical shells under axisymmetric loading**  
**(Continued)**

<p>3. End moment, <math>M_o</math> lb-in/in</p>  <p>If <math>\lambda l &gt; 6</math>, see case 10</p>	$\psi_A = \frac{-M_o}{D\lambda} \frac{C_{12}}{C_{11}}$ $\gamma_A = \frac{M_o}{2D\lambda^2} \frac{C_{14}}{C_{11}}$ $\psi_B = \frac{-M_o}{D\lambda} \frac{C_2}{C_{11}}$ $\gamma_B = \frac{-M_o}{D\lambda^2} \frac{C_3}{C_{11}}$	$LT_V = -M_o \lambda F_4$ $LT_M = M_o F_1$ $LT_\psi = \frac{M_o}{2D\lambda} F_2$ $LT_\gamma = \frac{M_o}{2D\lambda^2} F_3$	$\sigma_1 = 0$ $(\sigma_2)_{\max} = \frac{\gamma_A E}{R}$ $M_{\max} = M_o$ $\psi_{\max} = \psi_A$ $\gamma_{\max} = \gamma_A$ <p>(at <math>x = 0</math>)</p>
<p>4. Intermediate applied moment, <math>M_o</math> lb-in/in</p>  <p>If <math>\lambda l &gt; 6</math>, consider case 11</p>	$\psi_A = \frac{-M_o}{D\lambda} \frac{C_2 C_{a1} + C_3 C_{a4}}{C_{11}}$ $\gamma_A = \frac{M_o}{2D\lambda^2} \frac{2C_3 C_{a1} + C_4 C_{a4}}{C_{11}}$ $\psi_B = \psi_A C_1 - \gamma_A \lambda C_4 + \frac{M_o}{2D\lambda} C_{a2}$ $\gamma_B = \gamma_A C_1 + \frac{\psi_A C_2}{2\lambda} + \frac{M_o}{2D\lambda^2} C_{a3}$	$LT_V = -M_o \lambda F_{a4}$ $LT_M = M_o F_{a1}$ $LT_\psi = \frac{M_o}{2D\lambda} F_{a2}$ $LT_\gamma = \frac{M_o}{2D\lambda^2} F_{a3}$	
<p>5. Uniform radial pressure from <math>a</math> to <math>l</math></p>  <p>If <math>\lambda l &gt; 6</math>, consider case 12</p>	$\psi_A = \frac{q}{2D\lambda^3} \frac{C_2 C_{a3} - C_3 C_{a2}}{C_{11}}$ $\gamma_A = \frac{-q}{4D\lambda^4} \frac{2C_3 C_{a3} - C_4 C_{a2}}{C_{11}}$ $\psi_B = \psi_A C_1 - \gamma_A \lambda C_4 - \frac{q}{4D\lambda^3} C_{a4}$ $\gamma_B = \gamma_A C_1 + \frac{\psi_A C_2}{2\lambda} - \frac{q}{4D\lambda^4} C_{a5}$	$LT_V = \frac{-q}{2\lambda} F_{a2}$ $LT_M = \frac{-q}{2\lambda^2} F_{a3}$ $LT_\psi = \frac{-q}{4D\lambda^3} F_{a4}$ $LT_\gamma = \frac{-q}{4D\lambda^4} F_{a5}$	
<p>6. Uniformly increasing pressure from <math>a</math> to <math>l</math></p> 	$\psi_A = \frac{-q}{4D\lambda^4(l-a)} \frac{2C_3 C_{a3} - C_2 C_{a4}}{C_{11}}$ $\gamma_A = \frac{-q}{4D\lambda^5(l-a)} \frac{C_3 C_{a4} - C_4 C_{a3}}{C_{11}}$ $\psi_B = \psi_A C_1 - \gamma_A \lambda C_4 - \frac{q C_{a5}}{4D\lambda^3(l-a)}$ $\gamma_B = \gamma_A C_1 + \frac{\psi_A C_2}{2\lambda} - \frac{q C_{a6}}{8D\lambda^5(l-a)}$	$LT_V = \frac{-q}{2\lambda^2(l-a)} F_{a3}$ $LT_M = \frac{-q}{4\lambda^3(l-a)} F_{a4}$ $LT_\psi = \frac{-q}{4D\lambda^4(l-a)} F_{a5}$ $LT_\gamma = \frac{-q}{8D\lambda^5(l-a)} F_{a6}$	$\sigma_1 = 0$ $(\sigma_2)_{\max} = \frac{\gamma_B E}{R}$ $\gamma_{\max} = \gamma_B$ $\psi_{\max} = \psi_B$

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**(Continued)**

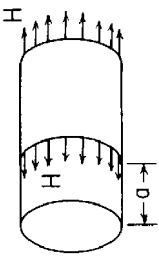
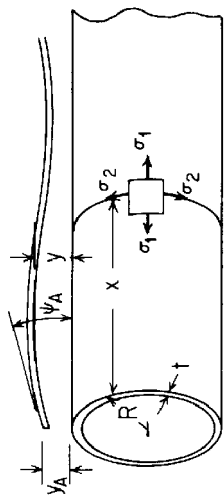
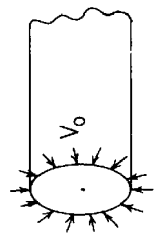
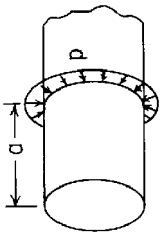
Loading and case no.	End deformations	Load terms or load and deformation equations	Selected values
7. Axial load along the portion from $a$ to $l$ only 	$\psi_A = \frac{vH}{2D\lambda^3 R} \frac{C_2 C_{a3} - C_3 C_{a2}}{C_{11}}$ $\gamma_A = \frac{-vHR}{Et} \frac{2C_3 C_{a3} - C_3 C_{a2}}{C_{11}}$ $\psi_B = \psi_A C_1 - \gamma_A \lambda C_4 - \frac{vHR\lambda}{Et} C_{a4}$ $\gamma_B = \gamma_A C_1 + \frac{\psi_A C_2}{2\lambda} - \frac{vHR}{Et} C_{a5}$	$LT_V = \frac{-vH}{2\lambda R} F_{a2}$ $LT_M = \frac{-vH}{2\lambda^2 R} F_{a3}$ $LT_\psi = \frac{-vHR\lambda}{Et} F_{a4}$ $LT_\gamma = \frac{-vHR}{Et} F_{a5}$	$\sigma_1 = \frac{H}{t} (x - a)^0$
<p>Long shells with the left end free (right end more than <math>6/\lambda</math> units of length from the closest load)</p>  <p style="text-align: center;"><math>R/t &gt; 10</math></p>			
<p>(Note: The load terms <math>LT_V</math>, <math>LT_M</math>, etc., are given where needed in the following cases)</p>			
<p>Meridional radial shear = <math>V = -\gamma_A 2D\lambda^3 F_2 - \psi_A 2D\lambda^2 F_3 + LT_V</math></p> <p>Meridional bending moment = <math>M = -\gamma_A 2D\lambda^2 F_3 - \psi_A D\lambda F_4 + LT_M</math></p> <p>Meridional slope = <math>\psi = \psi_A F_1 - \gamma_A \lambda F_4 + LT_\psi</math></p> <p>Radial deflection = <math>y = \gamma_A F_1 + \frac{\psi_A}{2\lambda} F_2 + LT_y</math></p> <p>Circumferential membrane stress = <math>\sigma_2 = \frac{\gamma E}{R} + v\sigma_1</math></p> <p>Meridional bending stress = <math>\sigma'_1 = -\frac{6M}{t^2}</math></p> <p>Circumferential bending stress = <math>\sigma'_2 = v\sigma'_1</math></p> <p>Meridional radial shear stress = <math>\tau = \frac{V}{t}</math> (average value)</p>			
8. Radial end load, $V_o$ lb/in 	$\psi_A = \frac{V_o}{2D\lambda^2} \frac{-V_o}{2D\lambda^3}$ $\gamma_A = \frac{-V_o}{2D\lambda^3}$	$V = -V_o e^{-\lambda x} (\cos \lambda x - \sin \lambda x)$ $M = \frac{-V_o}{\lambda} e^{-\lambda x} \sin \lambda x$ $\psi = \frac{V_o}{2D\lambda^2} e^{-\lambda x} (\cos \lambda x + \sin \lambda x)$ $y = \frac{-V_o}{2D\lambda^3} e^{-\lambda x} \cos \lambda x$	$V_{\max} = -V_o \quad \text{at } x = 0$ $M_{\max} = -0.3224 \frac{V_o}{\lambda} \quad \text{at } x = \frac{\pi}{4\lambda}$ $\psi_{\max} = \psi_A \quad \gamma_{\max} = \gamma_A$ $\sigma_1 = 0$ $(\sigma_2)_{\max} = \frac{-2V_o \lambda R}{t} \quad \text{at } x = 0$
9. Intermediate radial load, $p$ lb/in  <p>If <math>\lambda a &gt; 3</math>, consider case 15</p>	$\psi_A = \frac{-p}{D\lambda^2} A_2$ $\gamma_A = \frac{-p}{D\lambda^3} A_1$	$LT_V = -p F_{a1}$ $LT_M = \frac{-p}{2\lambda} F_{a2}$ $LT_\psi = \frac{-p}{2D\lambda^2} F_{a3}$ $LT_y = \frac{-p}{4D\lambda^3} F_{a4}$	$\sigma_1 = 0$

TABLE 13.2 Shear, moment, slope, and deflection formulas for long and short thin-walled cylindrical shells under axisymmetric loading  
(Continued)

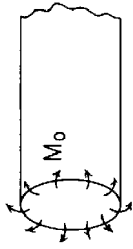
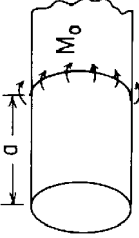
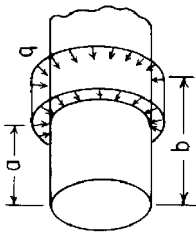
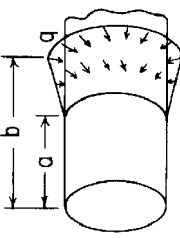
10. End moment, $M_o$ lb-in/in 	$\psi_A = \frac{-M_o}{D\lambda^3} \frac{M_o}{2D\lambda^2}$ $\gamma_A = \frac{M_o}{2D\lambda^2}$	$V = -2M_o\lambda e^{-\lambda x} \sin \lambda x$ $M = M_o e^{-\lambda x} (\cos \lambda x + \sin \lambda x)$ $\psi = \frac{-M_o}{D\lambda} e^{-\lambda x} \cos \lambda x$ $\gamma = \frac{-M_o}{2D\lambda^2} e^{-\lambda x} (\sin \lambda x - \cos \lambda x)$	$V_{\max} = -0.6448M_o\lambda \quad \text{at } x = \frac{\pi}{4\lambda}$ $M_{\max} = M_o \quad \text{at } x = 0$ $\psi_{\max} = \psi_A, \quad \gamma_{\max} = \gamma_A$ $\sigma_1 = 0$ $(\sigma_2)_{\max} = \frac{2M_o\lambda^2 R}{t} \quad \text{at } x = 0$
11. Intermediate applied moment, $M_o$ lb-in/in  If $\lambda a > 3$ , consider case 16	$\psi_A = \frac{-2M_o}{D\lambda^3} A_1$ $\gamma_A = \frac{M_o}{D\lambda^2} A_4$	$LT_V = -M_o\lambda F_{a4}$ $LT_M = M_o F_{a1}$ $LT_\psi = \frac{M_o}{2D\lambda} F_{a2}$ $LT_\gamma = \frac{M_o}{2D\lambda^2} F_{a3}$	$\sigma_1 = 0$
12. Uniform radial pressure from $a$ to $b$ 	$\psi_A = \frac{-q}{D\lambda^3} (B_3 - A_3)$ $\gamma_A = \frac{-q}{2D\lambda^4} (B_2 - A_2)$	$LT_V = \frac{-q}{2\lambda} (F_{a2} - F_{b2})$ $LT_M = \frac{-q}{2\lambda^2} (F_{a3} - F_{b3})$ $LT_\psi = \frac{-q}{4D\lambda^3} (F_{a4} - F_{b4})$ $LT_\gamma = \frac{-q}{4D\lambda^4} (F_{a5} - F_{b5})$ <p>For values of <math>F_{bi}</math> to <math>F_{b6}</math> substitute <math>b</math> for <math>a</math> in the expressions for <math>F_{ai}</math> to <math>F_{a6}</math></p>	$\sigma_1 = 0$
13. Uniformly increasing pressure from $a$ to $b$ 	$\psi_A = \frac{q}{D} \left[ \frac{B_4 - A_4}{2\lambda^4(b-a)} - \frac{B_3}{\lambda^3} \right]$ $\gamma_A = \frac{q}{2D} \left[ \frac{B_3 - A_3}{\lambda^5(b-a)} - \frac{B_2}{\lambda^4} \right]$	$LT_V = \frac{-q}{2} \left[ \frac{F_{a3} - F_{b3}}{\lambda^2(b-a)} - \frac{F_{b2}}{\lambda} \right]$ $LT_M = \frac{-q}{2} \left[ \frac{F_{a4} - F_{b4}}{2\lambda^3(b-a)} - \frac{F_{b3}}{\lambda^2} \right]$ $LT_\psi = \frac{-q}{4D} \left[ \frac{F_{a5} - F_{b5}}{\lambda^4(b-a)} - \frac{F_{b4}}{\lambda^3} \right]$ $LT_\gamma = \frac{-q}{4D} \left[ \frac{F_{a6} - F_{b6}}{2\lambda^5(b-a)} - \frac{F_{b5}}{\lambda^4} \right]$ <p>See note in case 12</p>	$\sigma_1 = 0$

TABLE 13.2 Shear, moment, slope, and deflection formulas for long and short thin-walled cylindrical shells under axisymmetric loading  
(Continued)

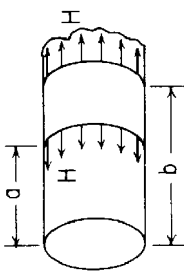
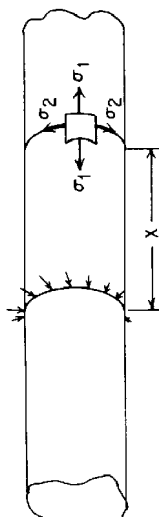
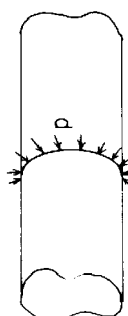
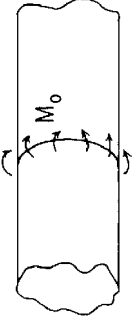
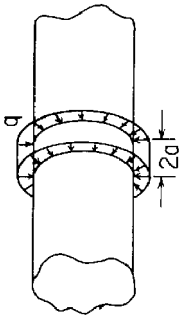
Loading and case no.	End deformations	Load terms or load and deformation equations	Selected values
14. Axial load along the portion from $a$ to $b$ 	$\psi_A = \frac{-\nu H}{RD\lambda^3}(B_3 - A_3)$ $\gamma_A = \frac{-\nu H}{2RD\lambda^4}(B_2 - A_2)$	$LT_V = \frac{-\nu H}{2R\lambda^3}(F_{a2} - F_{b2})$ $LT_M = \frac{-\nu H}{2R\lambda^2}(F_{a3} - F_{b3})$ $LT_\psi = \frac{-\nu H}{4RD\lambda^3}(F_{a4} - F_{b4})$ $LT_\gamma = \frac{-\nu H}{4RD\lambda^4}(F_{a5} - F_{b5})$	$\sigma_1 = \frac{H}{t}(x - a)^0 - \frac{H}{t}(x - b)^0$
Very long shells (both ends more than $6/\lambda$ units of length from the nearest loading)  $R/t > 10$			
Circumferential membrane stress $= \sigma_2 = \frac{\nu E}{R} + \nu \sigma_1$ Meridional bending stress $= \sigma'_1 = \frac{-6M}{t^2}$ Circumferential bending stress $= \sigma'_2 = \nu \sigma'_1$ Meridional radial shear stress $= \tau = \frac{V}{t}$			
Loading and case no.	Load and deformation equations	Selected values	
15. Concentrated radial load, $p$ (lb/linear in of circumference) 	$V = \frac{-p}{2}e^{-\lambda x} \cos \lambda x$ $M = \frac{p}{4\lambda}e^{-\lambda x}(\cos \lambda x - \sin \lambda x)$ $\psi = \frac{p}{4D\lambda^2}e^{-\lambda x} \sin \lambda x$ $\gamma = \frac{-p}{8D\lambda^3}e^{-\lambda x}(\cos \lambda x + \sin \lambda x)$	$V_{\max} = \frac{-p}{2} \quad \text{at } x = 0, \quad \sigma_1 = 0$ $M_{\max} = \frac{p}{4\lambda} \quad \text{at } x = 0$ $\psi_{\max} = 0.0806 \frac{p}{D\lambda^2} \quad \text{at } x = \frac{\pi}{4\lambda}$ $\gamma_{\max} = \frac{-p}{8D\lambda^3} \quad \text{at } x = 0$	

TABLE 13.2 Shear, moment, slope, and deflection formulas for long and short thin-walled cylindrical shells under axisymmetric loading  
(Continued)

16. Applied moment 	$V = \frac{-M_o \lambda}{2} e^{-\lambda x} (\cos \lambda x + \sin \lambda x)$ $M = \frac{M_o}{2} e^{-\lambda x} \cos \lambda x$ $\psi = \frac{-M_o}{4D_o \lambda} e^{-\lambda x} (\cos \lambda x - \sin \lambda x)$ $y = \frac{-M_o}{4D_o \lambda^2} e^{-\lambda x} \sin \lambda x$	$V_{\max} = \frac{-M_o \lambda}{2} \quad \text{at } x = 0, \quad \sigma_1 = 0$ $M_{\max} = \frac{M_o}{2} \quad \text{at } x = 0$ $\psi_{\max} = \frac{-M_o}{4D_o \lambda} \quad \text{at } x = 0$ $y_{\max} = -0.0806 \frac{M_o}{D_o \lambda^2} \quad \text{at } x = \frac{\pi}{4\lambda}$
17. Uniform pressure over a band of width $2a$ 	Superimpose cases 10 and 12 to make $\psi_A$ (at $x = 0$ ) = 0 [Note: $x$ is measured from the midlength of the loaded band]	$M_{\max} = \frac{q}{2\lambda^2} e^{-\lambda a} \sin \lambda a \quad \text{at } x = 0$ $y_{\max} = \frac{-q}{4D_o \lambda^4} (1 - e^{-\lambda a} \cos \lambda a) \quad \text{at } x = 0$ $\sigma_1 = 0$