



表-12 円板、円筒の計算式

状態	最大変形量Y	最大応力S	最大たわみ率
 均等な荷重を受ける円板 (周辺固定)	$Y = \frac{3pR^3(1-\mu^4)}{16Et^3}$	$S = \frac{3pR^3(1+\mu)}{8t^2}$	$= \frac{S}{E} = \frac{3pR^3(1+\mu)}{8t^2} \cdot \frac{16t^3Y}{3pR^3(1-\mu^2)(1-\mu)R^2} = \frac{2tY}{R}$
 均等な荷重を受ける円板 (周辺自由支持)	$Y = \frac{3pR^3(5-4\mu-\mu^2)}{16Et^3}$	$S = \frac{3pR^3(3+\mu)}{8t^2}$	$= \frac{S}{E} = \frac{3pR^3(3+\mu)}{8t^2} \cdot \frac{16t^3Y}{3pR^3(5-4\mu-\mu^2)(5-4\mu-\mu^2)R^2} = \frac{2(3+\mu)Y}{R}$
 内圧を受ける薄肉円筒	$Y = \frac{R}{E} \left(1 - \frac{\mu}{2}\right) \frac{pR}{t}$	$S = \frac{pR}{t}$	$= \frac{S}{E} = \frac{Sh - \mu Sz}{E} = \frac{Sh}{E} \left(1 - \frac{\mu}{2}\right) = \frac{Sh \left(1 - \frac{\mu}{2}\right) Y}{R \left(1 - \frac{\mu}{2}\right) Sh} = \frac{Y}{R}$

$\mu$ :ポアソン比 D:単位面積当りの荷重(内圧) S:最大応力 Sh:フープ・ストレス Sz:軸方向の応力  
Y:最大変形量(円筒の場合は半径の増加量) P:圧力

表-13 コイルスプリングの計算式

状態	変形量Y	剪断応力Ss	たわみ率
 コイル・スプリング (円形断面)	$Y = \frac{8NPD^3}{Gd^4}$ $G = \frac{E}{2(1+\mu)}$	$Ss = k \frac{8PD}{d^2}$ $k = \frac{4C-1}{4C-4} + \frac{0.615}{C}$ $c = \frac{D}{d}$	$= \frac{Ss}{G} = K \frac{8PD}{d^3} \cdot \frac{d^4}{8NPD^3} = \frac{Kd}{ND^2}$

Y:変形量 N:有効巻数 P:軸荷重 D:コイル中心径 G:横弾性係数 E:縦弾性係数 d:線径  
 $\mu$ :ポアソン比 Ss:剪断応力

7.13 各種断面形の断面二次モーメント

表-14 各種断面形の性質

面積A、断面二次モーメントI、断面係数Zおよび断面二次半径k

番号	断面形	A	I	Z	k <sup>2</sup>
1		bh	$\frac{1}{12}bh^2$	$\frac{1}{6}bh^2$	$\frac{1}{12}h^2$ k=0.289h
2		$b(h_2 - h_1)$	$\frac{1}{12}b(h_2^3 - h_1^3)$	$\frac{1}{6}b \frac{(h_2^3 - h_1^3)}{h_2}$	$\frac{1}{12} \frac{h_2^3 - h_1^3}{h_2 - h_1}$
3		h <sup>2</sup>	$\frac{1}{12}h^4$	$\frac{1}{6}h^3$	$\frac{1}{12}h^2$
4		$h_2^2 - h_1^2$	$\frac{1}{12}(h_2^4 - h_1^4)$	$\frac{1}{6} \frac{(h_2^4 - h_1^4)}{h_2}$	$\frac{1}{12}(h_2^2 + h_1^2)$
5		h <sup>2</sup>	$\frac{1}{12}h^4$	$\frac{2}{12}h^3$	$\frac{1}{12}h^2$
6		$h_2^2 - h_1^2$	$\frac{1}{12}(h_2^4 - h_1^4)$	$\frac{2}{12} \frac{h_2^4 - h_1^4}{h_2}$	$\frac{1}{12}(h_2^2 + h_1^2)$
7		$\frac{1}{2}bh$	$\frac{1}{36}bh^3$	$e_1 = \frac{2}{3}h, e_2 = \frac{1}{3}h$ $Z_z = \frac{1}{12}bh^2, Z_z = \frac{1}{12}bh^2$	$\frac{1}{18}h^2$ (k=0.236h)
8		$\frac{3\sqrt{3}}{2}b^2 = 2.60b^2$	$\frac{5\sqrt{3}}{16}b^4 = 0.5413b^4$	$e = \frac{3}{2}b = 0.866b$ $Z = \frac{5}{8}b^3 = 0.625b^3$	$\frac{5}{24}b^2$ (k=0.456b)

番号	断面形	A	I	Z	k <sup>2</sup>
9		$\frac{3}{2} \sqrt{3} b^2 = 2.60b^2$	$\frac{5}{16} \sqrt{3} b^4 = 0.5413b^4$	$e=b$ $\left(\frac{5}{16} \sqrt{3} b^4 = 0.5413b^4\right)$	$\frac{5}{24} b^2$ (k=0.456b)
10		2.8284r <sup>2</sup>	$\frac{1+2}{6} \frac{2}{r^4} = 0.6381r^4$	0.6906r <sup>3</sup>	0.2256r <sup>2</sup> (k=0.475r)
11	正多角形 n=辺の数 a=辺の長さ r2=外接円の半径 r1=内接円の半径 (軸は上記の八角形と同様)	$\frac{1}{2} nar_1$	$\frac{A}{24} (6r_2^2 - a^2)$ $\frac{A}{48} \times (12r_1^2 + a^2)$	$\frac{I}{r_2 \cos \frac{\pi}{n}} \frac{Ar_2}{4}$ (nが大きいととき)	$\frac{1}{24} (6r_2^2 - a^2)$
12		$h \left( b \frac{1}{2} + b_1 \right)$	$\frac{6b_2^2 + 6bb_1 + b_1^2}{3 \times (2b + b_1)} h^3$	$e_1 = \frac{1}{3} \frac{3b + 2b_1}{2b + b_1} h$ $Z_1 = \frac{6b^2 + 6bb_1 + b_1^2}{12(3b + 2b_1)} h^2$	$\frac{6b^2 + 6bb_1 + b_1^2}{18(2b + b_1)^2} h^2$
13		$b_2h_2 - b_1h_1$	$\frac{1}{12} (b_2h_2^3 - b_1h_1^3)$	$\frac{b_2h_2^3 - b_1h_1^3}{6h_2}$	$\frac{1}{12} \frac{b_2h_2^3 - b_1h_1^3}{b_2h_2 - b_1h_1}$
14		$b_1h_1 + b_2h_2$	$\frac{1}{12} (b_1h_1^3 + b_2h_2^3)$	$\frac{b_1h_1^3 + b_2h_2^3}{6h_2}$	$\frac{1}{12} \frac{b_1h_1^3 + b_2h_2^3}{b_1h_1 + b_2h_2}$
15		$b_1h_1 + b_2h_2$	$\frac{1}{3} (b_3e_2^3 - b_1h_1^3 + b_2e_1^3)$	$e_2 = \frac{b_1h_1^2 + b_2h_2^2}{2(b_1h_1 + b_2h_2)}$ $e_1 = h_2 - e_2$	$\frac{b_3e_2^3 - b_1h_1^3 + b_2e_1^3}{3(b_1h_1 + b_2h_2)}$
16		$b_1h_1 + b_2h_2 + b_3h_3$	$\frac{1}{3} (b_4e_1^3 - b_1h_1^3 + b_2e_2^3 - b_3h_3^3)$	$e_2 = \frac{b_2h_2^2 + b_3h_3^2 + b_1h_1(2h_2 - h_1)}{2(b_1h_1 + b_2h_2 + b_3h_3)}$	

番号	断面形	A	I	Z	k <sup>2</sup>
17		$\frac{\pi}{4} d^2$	$\frac{\pi}{64} d^4$	$\frac{\pi}{32} d^3$	$\frac{1}{16} d^2$
18		$\frac{\pi}{4} (d_2^2 - d_1^2)$	$\frac{\pi}{64} (d_2^4 - d_1^4)$	$\frac{\pi}{32} \frac{d_2^3 - d_1^3}{d_2 - d_1} \times 0.8d_m^2 t$ (t/d <sub>m</sub> が小さいとき)	$\frac{1}{16} (d_2^2 - d_1^2)$
19		$\frac{\pi}{2} r^2$	$\left(\frac{8}{8} - \frac{8}{9}\right) r^4 = 0.1098r^4$	$e_1 = 0.5756r$ $e_2 = 0.4244r$ $Z_1 = 0.190r^3$ $Z_2 = 0.2587r^3$	$\frac{9}{36} \frac{r^2 - 64}{r^4} = 0.0697r^2$ (k=0.264r)
20		$\frac{\pi}{2} (r_2^2 - r_1^2)$	$\frac{0.1098(r_2^4 - r_1^4) - 0.283r_2^2 r_1^2 (r_2 - r_1)}{r_2 + r_1} - \frac{0.3tr_m^3}{(t/r_m \text{が小さいとき})}$	$e_2 = \frac{4(r_2^2 + r_2r_1 + r_1^2)}{3(r_2 + r_1)}$ $e_1 = r_2 - e_2$	0.096r <sub>m</sub> <sup>2</sup> (k=0.31r <sub>m</sub> )
21		ab	$\frac{\pi}{4} a^3b$	$\frac{\pi}{4} a^2b$	$\frac{1}{4} a^2$
22		$(a_2b_2 - a_1b_1)$	$\frac{\pi}{4} (a_2^3b_2 - a_1^3b_1)$ $\frac{\pi}{4} a_2^2(a_2 + 3b_2)$	$\frac{\pi}{4} \frac{a_2^3b_2 - a_1^3b_1}{a^2}$ $\frac{\pi}{4} a_2(a_2 + 3b_2)$	$\frac{1}{4} \frac{a_2^3b_2 - a_1^3b_1}{a_2b_2 - a_1b_1}$ $\frac{1}{4} \times \frac{a_2^2(a_2 + 3b_2)}{a_2 + b_2}$
23		$\frac{\pi}{2} ab$	0.10975a <sup>3</sup> b	$e_1 = 0.4244a$ $e_2 = 0.5756a$ $Z_1 = 0.2586a^2b$ $Z_2 = 0.1907a^2b$	
24		$\frac{4}{3} bh$	$\frac{16}{175} bh^3 = 0.0914bh^3$	$e_1 = \frac{2}{5} h, e_2 = \frac{3}{5} h$ $Z_1 = 0.2286bh^2$ $Z_2 = 0.1524bh^2$	$\frac{12}{175} h^2 = 0.0686h^2$