NAME:
SURNAME: ID:

ME 307 FORMULAS

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$$T = K \cdot i \quad \text{where} \quad i = 0.45 \cdot \sqrt[3]{D} + 0.001 \cdot D, \quad D = \sqrt{D_1 \cdot D_2} \quad , \quad K = 10 \cdot 1.6^{(ITn - IT6)}$$

$$\sigma_x = \frac{\left[E \cdot \varepsilon_x \cdot (1-\upsilon) + \upsilon \cdot E \cdot \left(\varepsilon_y + \varepsilon_z\right)\right]}{1 - \upsilon - 2\upsilon^2} \qquad \tau = \frac{V \cdot Q}{I \cdot b} \qquad Q = \int_{y_o}^{c} y dA$$

$$\sigma_y = \frac{\left[E \cdot \varepsilon_y \cdot (1-\upsilon) + \upsilon \cdot E \cdot \left(\varepsilon_x + \varepsilon_z\right)\right]}{1 - \upsilon - 2\upsilon^2} \qquad I = \frac{\pi \cdot d^4}{64} \qquad I = \frac{b \cdot h^3}{12} \qquad J = \frac{\pi \cdot d^4}{32}$$

$$\sigma_z = \frac{\left[E \cdot \varepsilon_z \cdot (1-\upsilon) + \upsilon \cdot E \cdot \left(\varepsilon_x + \varepsilon_y\right)\right]}{1 - \upsilon - 2\upsilon^2}$$

$$\sigma(y) = \frac{M \cdot y}{A \cdot e \cdot (r_n - y)} \quad , \quad r_n = \frac{A}{\int \frac{dA}{r}} \quad , \quad \sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \tau_{max} \quad , \quad \tau_{max} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^{\ 2}}$$

$$\sigma^3 - (I_1)\sigma^2 + (I_2)\sigma - (I_3) = 0$$

$$I_1 = \sigma_x + \sigma_y + \sigma_z \qquad \cos 3\theta = \frac{2I_1^{\ 3} - 9I_1 I_2 + 27I_3}{2(I_1^{\ 2} - 3I_2\ )^{\frac{3}{2}}}$$

$$I_2 = \sigma_x\sigma_y + \sigma_x\sigma_z + \sigma_y\sigma_z - \tau_{xy}^{\ 2} - \tau_{yz}^{\ 2} - \tau_{zx}^{\ 2}$$

$$I_3 = \sigma_x\sigma_y\sigma_z + 2\tau_{xy}\tau_{yz}\tau_{zx} - \sigma_x\tau_{yz}^{\ 2} - \sigma_y\tau_{zx}^{\ 2} - \sigma_z\tau_{xy}^{\ 2}$$

$$\sigma_i = r \cdot \cos\theta_i + \frac{I_1}{3} \qquad r = \frac{2}{3} \cdot \sqrt{I_1^{\ 2} - 3I_2}$$

$$\sigma = \frac{p_i \cdot r_i^2 - p_o \cdot r_o^{\ 2} \pm \dfrac{r_i^{\ 2} \cdot r_o^{\ 2} \cdot (p_o - p_i)}{r^2}}{r_o^{\ 2} - r_i^{\ 2}} \qquad \left| \begin{array}{l} - \quad \text{for} \ \ \sigma_t \\ + \quad \text{for} \ \ \sigma_r \end{array} \right.$$

$$p = \frac{E \cdot \delta}{R} \cdot \frac{\left(r_o^{\ 2} - R^2\right)\left(R^2 - r_i^{\ 2}\right)}{2R^2\left(r_o^{\ 2} - r_i^{\ 2}\right)} \quad , \quad P_{cr} = \frac{C \cdot \pi^2 \cdot E \cdot A}{\left(\frac{l}{k}\right)^2} \quad \text{where} \quad k = \sqrt{\frac{I}{A}}$$

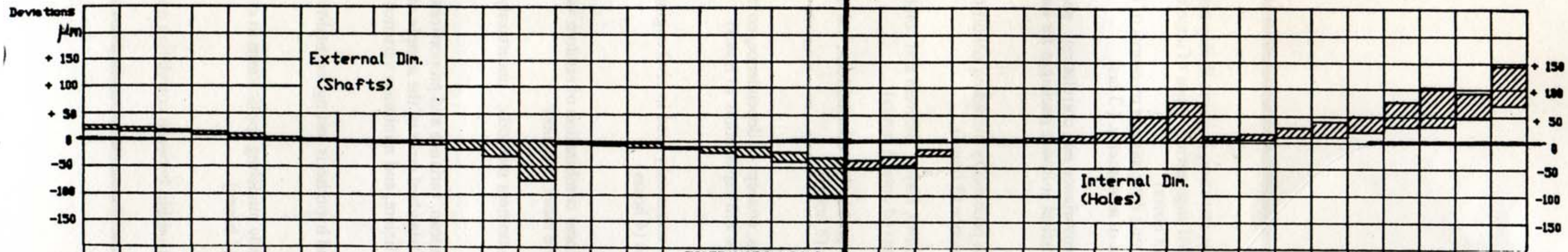
$$\sigma' = \sqrt{\frac{(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2}{2}} = \frac{1}{\sqrt{2}}\left[\left(\sigma_x - \sigma_y\right)^2 + \left(\sigma_y - \sigma_z\right)^2 + \left(\sigma_z - \sigma_x\right)^2 + 6\left(\tau_{xy}^{\ 2} + \tau_{yz}^{\ 2} + \tau_{zx}^{\ 2}\right)\right]^{1/2}$$

$$C = \frac{k_b}{k_b + k_m} \qquad F_b = F_i + C \cdot P \qquad F_m = -F_i + (1 - C) \cdot P \quad \text{for} \ F_m < 0$$

$$F_i'' = \frac{T \cdot A_i \cdot r_i}{\sum_1^n A_i \cdot r_i^{\ 2}} \qquad \tau'' = \frac{T \cdot r}{J} \qquad J = \sum_1^n A_i \cdot \left(\frac{L_i^{\ 2}}{12} + r_i^{\ 2}\right)$$

$$\tau = K \cdot \frac{8 \cdot F \cdot D}{\pi \cdot d^3} \qquad K_s = \frac{2C + 1}{2C} \qquad K_w = \frac{4 \cdot C - 1}{4 \cdot C - 4} + \frac{0.615}{C} = K_s \cdot K_c \qquad k = \frac{G \cdot d^4}{8 \cdot D^3 \cdot N_a} = \frac{G \cdot d}{8 \cdot C^3 \cdot N_a}$$

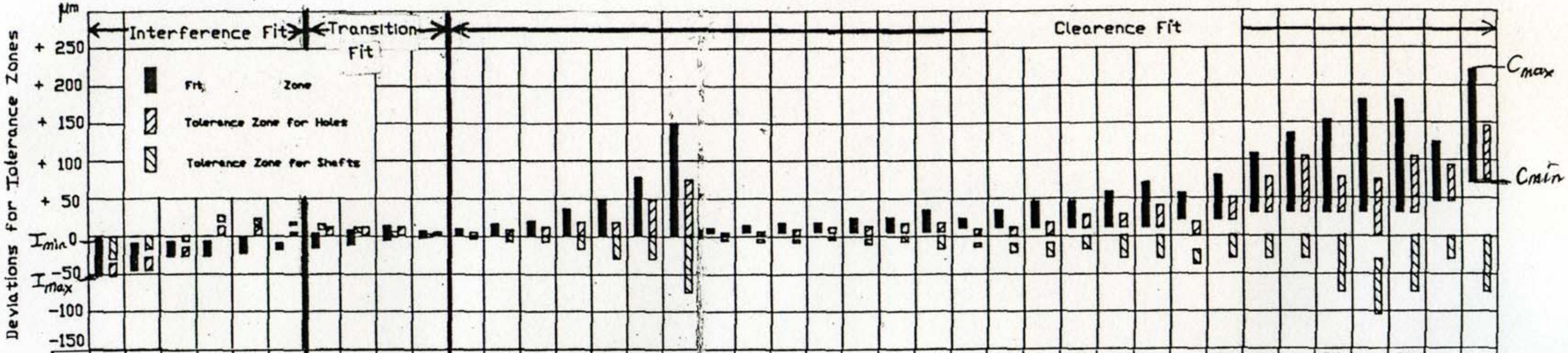
Nominal dimensions, Tolerance Symbols and Deviations



TOLERANCE SYMBOLS

Nom. Dim.	s6	r6	r4	n6	m6	j6	j5	h4	h5	h6	h8	h9	h11	g3	g5	g6	f5	f7	f8	e8	d11
> 1	+20	+16	+13	+10	+8	+4	+2	0	0	0	0	0	0	-2	-2	-2	-6	-6	-6	-14	-20
≤ 3	+14	+10	+10	+4	+2	-2	-2	-3	-4	-6	-14	-25	-60	-4	-6	-8	-10	-16	-20	-28	-80
> 3	+27	+23	+19	+16	+12	+6	+3	0	0	0	0	0	0	-4	-4	-4	-10	-10	-10	-20	-30
≤ 6	+19	+15	+15	+5	+4	-2	-2	-4	-5	-8	-18	-30	-75	−6,5	-9	-12	-15	-22	-28	-38	-105
> 6	+32	+28	+23	+19	+15	+7	+4	0	0	0	0	0	0	-5	-5	-5	-13	-13	-13	-25	-40
≤ 10	+23	+19	+19	+10	+6	-2	-2	-4	-6	-9	-22	-36	-90	−7,5	-11	-14	-19	-28	-35	-47	-130
> 10																					
≤ 14	+39	+34	+28	+23	+18	+8	+5	0	0	0	0	0	0	-6	-6	-6	-16	-16	-16	-32	-50
> 14	+23	+23	+23	+12	+7	-3	-3	-5	-8	-11	-27	-43	-110	-9	-14	-17	-24	-34	-43	-59	-160
≤ 18																					
> 18																					
≤ 24	+48	+41	+34	+28	+21	+9	+5	0	0	0	0	0	0	-7	-7	-7	-20	-20	-20	-40	-65
> 24	+35	+28	+28	+15	+8	-4	-4	-6	-9	-13	-33	-52	-130	-11	-16	-20	-29	-41	-53	-73	-195
≤ 30																					
> 30																					
≤ 40	+59	+50	+41	+33	+25	+11	+6	0	0	0	0	0	0	-9	-9	-9	-25	-25	-25	-50	-80
> 40	+43	+34	+34	+17	+9	-5	-5	-7	-11	-16	-39	-62	-160	-13	-20	-25	-36	-50	-64	-89	-240
≤ 50																					
> 50	+72	+60	+49																		
≤ 65	+53	+41	+41	+39	+30	+12	+6	0	0	0	0	0	0	-10	-10	-10	-30	-30	-30	-60	-100
> 65	+78	+62	+51	+20	+11	-7	-7	-8	-13	-19	-46	-74	-190	-15	-23	-29	-43	-60	-76	-106	-290
≤ 80	+59	+43	+43																		
> 80	+93	+73	+61																		
≤ 100	+71	+51	+51	+45	+35	+13	+6	0	0	0	0	0	0	-12	-12	-12	-36	-36	-36	-72	-120
> 100	+101	+76	+64	+23	+13	-9	-9	-10	-15	-22	-54	-87	-220	-18	-27	-34	-51	-71	-90	-126	-340
≤ 120	+79	+54	+54																		
> 120	+117	+88	+75																		
≤ 140	+92	+63	+63																		
> 140	+125	+90	+77	+52	+40	+14	+7	0	0	0	0	0	0	-14	-14	-14	-43	-43	-43	-85	-145
≤ 160	+100	+65	+65	+27	+15	-11	-11	-12	-18	-25	-63	-100	-250	-22	-32	-39	-61	-83	-106	-148	-395
> 160	+133	+93	+80																		
≤ 180	+108	+68	+68																		

Z8	X8	S7	H4	H5	H6	H7	H8	H10	H11	G6	G7	F8	F9	E9	D10	D11	CD10	C11	Nom. Dim.
-26	-20	-14	+3	+4	+6	+10	+14	+40	+60	+8	+12	+20	+31	+39	+60	+80	+74	+120	> 1
-40	-34	-24	0	0	0	0	0	0	0	+2	+2	+6	+6	+14	+20	+20	+34	+60	≤ 3
-35	-28	-15	+4	+5	+8	+12	+18	+48	+75	+12	+16	+28	+40	+50	+78	+105	+94	+145	> 3
-53	-46	-27	0	0	0	0	0	0	0	+4	+4	+10	+10	+20	+30	+30	+46	+70	≤ 6
-42	-34	-17	+4	+6	+9	+15	+22	+58	+90	+14	+20	+35	+49	+61	+98	+130	+114	+170	> 6
-64	-55	-32	0	0	0	0	0	0	0	+5	+5	+13	+13	+25	+40	+40	+56	+80	≤ 10
-50	-40																		> 10
-77	-67	-21	+5	+8	+11	+18	+27	+70	+110	+17	+24	+43	+59	+75	+120	+160	-	+205	≤ 14
-60	-45	-39	0	0	0	0	0	0	0	+6	+6	+16	+16	+32	+50	+50		+95	> 14
-87	-72																		≤ 18
-73	-54																		> 18
-106	-87	-27	+6	+9	+13	+21	+33	+84	+130	+20	+28	+53	+72	+92	+149	+195	-	+240	≤ 24
-88	-64	-48	0	0	0	0	0	0	0	+7	+7	+20	+20	+40	+65	+65		+110	> 24
-121	-97																		≤ 30
-112	-80																	+280	> 30
-151	-119	-34	+7	+11	+16	+25	+39	+100	+160	+25	+34	+64	+87	+112	+180	+240	-	+120	≤ 40
-136	-97	-59	0	0	0	0	0	0	0	+9	+9	+25	+25	+50	+80	+80		+290	> 40
-175	-136																	+130	≤ 50
-172	-122	-42																+330	> 50
-218	-168	-72	+8	+13	+19	+30	+46	+120	+190	+29	+40	+76	+104	+134	+220	+290	-	+140	≤ 65
-210	-146	-48	0	0	0	0	0	0	0	+10	+10	+30	+30	+60	+100	+100		+340	> 65
-256	-192	-78																+150	≤ 80
-258	-178	-58																+390	> 80
-312	-232	-93	+10	+15	+22	+35	+54	+140	+220	+34	+47	+90	+123	+159	+260	+340	-	+170	≤ 100
-310	-210	-66	0	0	0	0	0	0	0	+12	+12	+36	+36	+72	+120	+120		+400	> 100
-364	-264	-101																+180	≤ 120
-365	-248	-77																+450	> 120
-428	-311	-117																+200	≤ 140
-415	-280	-85	+12	+18	+25	+40	+63	+160	+250	+39	+54	+106	+143	+185	+305	+395	-	+460	> 140
-478	-343	-125	0	0	0	0	0	0	0	+14	+14	+43	+43	+85	+145	+145		+210	≤ 160
-	-310	-93																+480	> 160
-	-373	-133																+230	≤ 180



1. Fit	Z8/h9	X8/h8	-	-	H7/r6	-	-	H7/m6	H7/j6	-	-	-	H7/h6	H8/h8	H8/h9	-	-	-	-	-	-	-	G7/h6	-	-	H7/f7	-	F8/h8	F8/h9	F9/h9	-	E9/h9	D10/h9	-	D10/h11	-	D11/h11	CD10/h9	-
2. Fit	-	-	S7/h6	H7/s6	-	H5/r4	H7/n6	-	-	H5/j5	H5/h4	H6/h6	-	-	-	H10/h9	H11/h11	H4/g3	H5/g5	H6/g5	G6/h5	H7/g6	-	G7/h8	H6/f5	-	H8/f8	-	-	-	H8/e8	-	-	D11/h9	-	H11/d11	-	-	C11/h11
> 1	-1	-6	-8	-4	0	-6	+6	+8	+12	+6	+7	+12	+16	+28	+39	+65	+120	+7	+10	+12	+12	+18	+18	+26	+16	+26	+34	+34	+45	+56	+42	+64	+85	+105	+120	+140	+140	+90	+180
≤ 3	-40	-34	-24	-20	-16	-13	-10	-8	-4	-2	0	0	0	0	0	0	0	+2	+2	+2	+2	+2	+2	+2	+6	+6	+6	+6	+6	+6	+14	+14	+20	+20	+20	+20	+20	+34	+60
> 3	-5	-10	-7	-7	-3	-10	+4	+8	+14	+7	+9	+16	+20	+36	+48	+78	+150	10,5	+14	+17	+17	+24	+24	+34	+23	+34	+46	+46	+58	+70	+56	+80	+109	+135	+153	+180	+180	+124	+220
≤ 6	-53	-46	-27	-27	-23	-19	-16	-12	-6	-3	0	0	0	0	0	0	0	+4	+4	+4	+4	+4	+4	+4	+10	+10	+10	+10	+10	+10	+20	+20	+30	+30	+30	+30	+30	+46	+70
> 6	-6	-12	-8	-8	-4	-13	+5	+9	+17	+8	+10	+18	+24	+44	+58	+94	+180	11,5	+17	+20	+20	+29	+29	+42	+28	+43	+57	+57	+71	+85	+69	+97	+134	+166	+188	+220	+220	+150	+260
≤ 10	-64	-56	-32	-32	-28	-23	-19	-15	-7	-4	0	0	0	0	0	0	0	+5	+5	+5	+5	+5	+5	+5	+13	+13	+13	+13	+13	+13	+25	+25	+40	+40	+40	+40	+40	+56	+80
> 10	-7	-13																																					
≤ 14	-77	-67	-10	-10	-5	-15	+6	+11	+21	+11	+13	+22	+29	+54	+70	+113	+220	+14	+22	+25	+25	+35	+35	+51	+35	+52	+70	+70	+86	+102	+86	+118	+163	+203	+230	+270	+270	-	+315
> 14	-17	-18	-39	-39	-34	-28	-23	-18	-8	-5	0	0	0	0	0	0	0	+6	+6	+6	+6	+6	+6	+6	+16	+16	+16	+16	+16	+16	+32	+32	+50	+50	+50	+50	+50	-	+95
≤ 18	-87	-72																																					
> 18	-21	-21																																					
≤ 24	-106	-87	-14	-14	-7	-19	+6	+13	+25	+13	+15	+26	+34	+66	+85	+136	+260	+17	+25	+29	+29	+41	+41	+61	+42	+62	+86	+86	+105	+124	+106	+144	+201	+247	+279	+325	+325	-	+370
> 24	-36	-31	-48	-48	-41	-34	-28	-21	-9	-5	0	0	0	0	0	0	0	+7	+7	+7	+7	+7	+7	+7	+20	+20	+20	+20	+20	+20	+40	+40	+65	+65	+65	+65	+65	-	+110
≤ 30	-121	-97																																					
> 30	-50	-41																																					+440
≤ 40	-151	-119	-18	-18	-9	-23	+8	+16	+30	+16	+18	+32	+41	+78	+101	+162	+320	+20	+31	+36	+36	+50	+50	+73	+52	+75	+103	+103	+126	+149	+128	+174	+242	+302	+340	+400	+400	-	+120
> 40	-74	-58	-59	-59	-50	-41	-33	-25	-11	-6	0	0	0	0	0	0	0	+9	+9	+9	+9	+9	+9	+9	+25	+25	+25	+25	+25	+25	+50	+50	+80	+80	+80	+80	+80	-	+450
≤ 50	-175	-136																																					+130
> 50	-98	-76	-23	-23	-11	-28																																	+320
≤ 65	-218	-168	-72	-72	-60	-49	+10	+19	+37	+20	+21	+38	+49	+92	+120	+194	+380	+23	+36	+42	+42	+59	+59	+86	+62	+90	+122	+122	+150	+178	+152	+208	+294	+364	+410	+480	+480	-	+140
> 65	-136	-100	-29	-29	-13	-30	-39	-30	-12	-6	0	0	0	0	0	0	0	+10	+10	+10	+10	+10	+10	+10	+30	+30	+30	+30	+30	+30	+60	+60	+100	+100	+100	+100	+100	-	+330
≤ 80	-256	-192	-78	-78	-62	-51																																	+150
> 80	-171	-124	-36	-36	-16	-36																																	+610
≤ 100	-312	-232	-93	-93	-73	-61	+12	+22	+44	+24	+25	+44	+57	+108	+141	+227	+440	+28	+42	+49	+49	+69	+69	+101	+73	+106	+144	+144	+177	+210	+180	+246	+347	+427	+480	+560	+560	-	+170
> 100	-223	-156	-44	-44	-19	-39	-45	-35	-13	-6	0	0	0	0	0	0	0	+12	+12	+12	+12	+12	+12	+12	+36	+36	+36	+36	+36	+36	+72	+72	+120	+120	+120	+120	+120	-	+620
≤ 120	-364	-264	-101	-101	-76	-64																																	+180
> 120	-265	-185	-52	-52	-23	-45																																	+700
≤ 140	-428	-311	-117	-117	-88	-75																																	+200
> 140	-315	-217	-60	-60	-25	-47	+13	+25	+51	+29	+30	+50	+65	+126	+163	+260	+500	+34	+50	+57	+57	+79	+79	+117	+86	+123	+169	+169	+206	+243	+211	+285	+405	+495	+555	+645	+645	-	+710
≤ 160	-478	-343	-125	-125	-90	-77	-52	-40	-14	-7	0	0	0	0	0	0	0	+14	+14	+14	+14	+14	+14	+14	+43	+43	+43	+43	+43	+43	+85	+85	+145	+145	+145	+145	+145	-	+210
> 160	-	-247	-68	-68	-28	-50																																	+730
≤ 180	-	-373	-133	-133	-93	-80																																	+230

TABLE A-23 CHARTS FOR THEORETICAL STRESS-CONCENTRATION FACTORS K_t

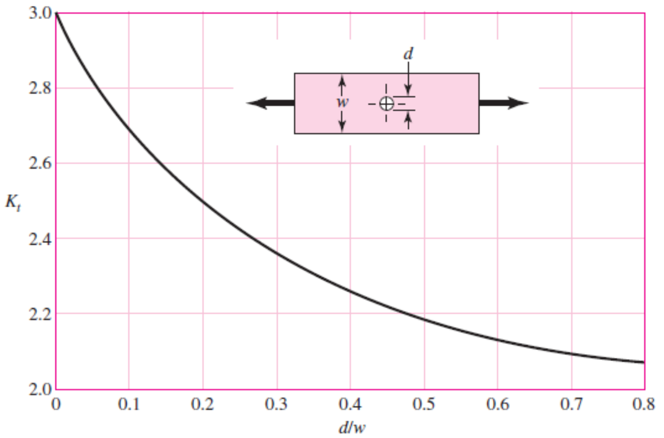


FIGURE A-13-1 Bar in tension or simple compression with a transverse hole. $\sigma_0 = F/A$, where $A = (w - d)t$ and t is the thickness.

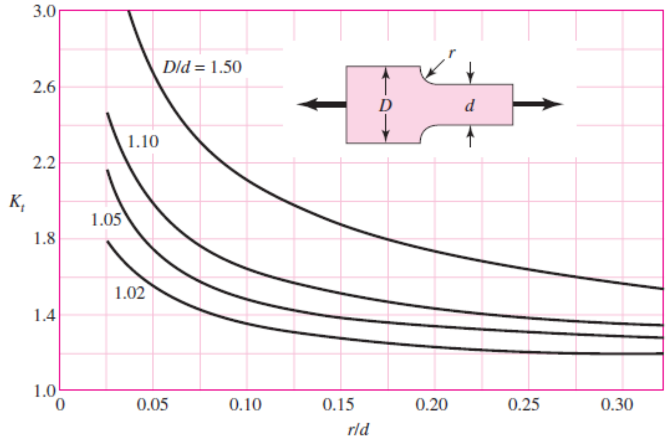


FIGURE A-13-5 Rectangular filleted bar in tension or simple compression. $\sigma_0 = F/A$, where $A = dt$ and t is the thickness.

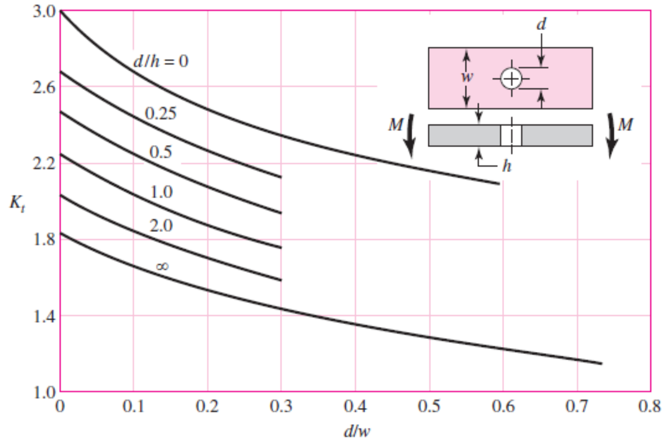


FIGURE A-13-2 Rectangular bar with a transverse hole in bending. $\sigma_0 = Mc/I$, where $I = (w - d)h^3/12$.

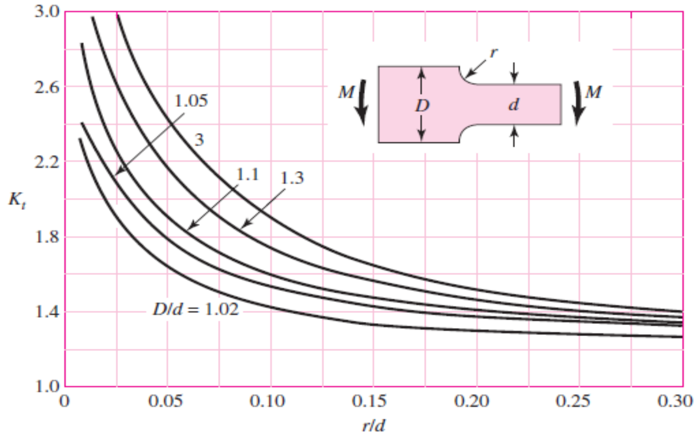


FIGURE A-13-6 Rectangular filleted bar in bending. $\sigma_0 = Mc/I$, where $c = d/2$, $I = td^3/12$, t is the thickness.

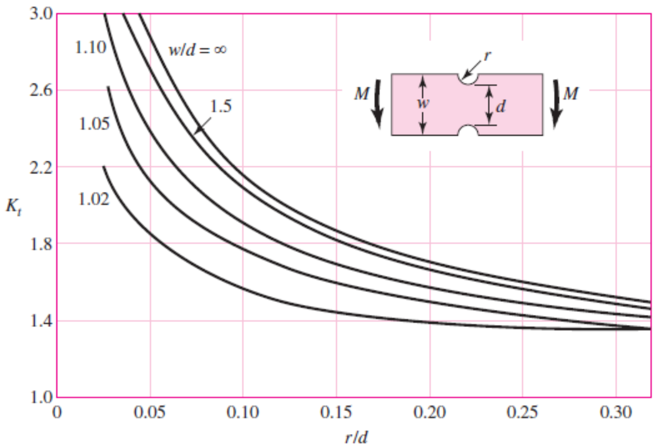


FIGURE A-13-4 Notched rectangular bar in bending. $\sigma_0 = Mc/I$, where $c = d/2$, $I = td^3/12$, and t is the thickness.

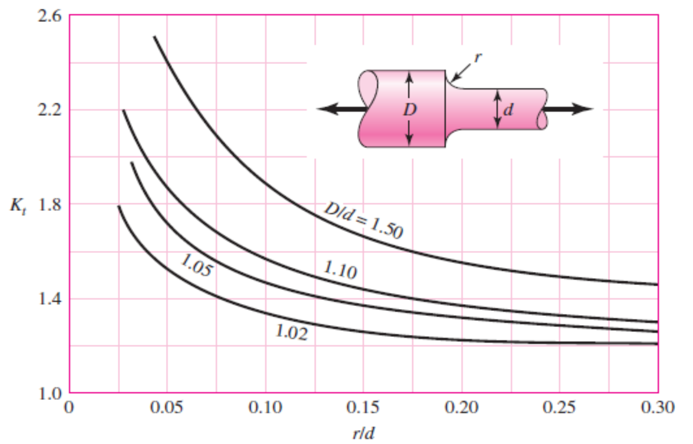


FIGURE A-13-7 Round shaft with shoulder filet in tension. $\sigma_0 = F/A$, where $A = \pi d^2/4$.

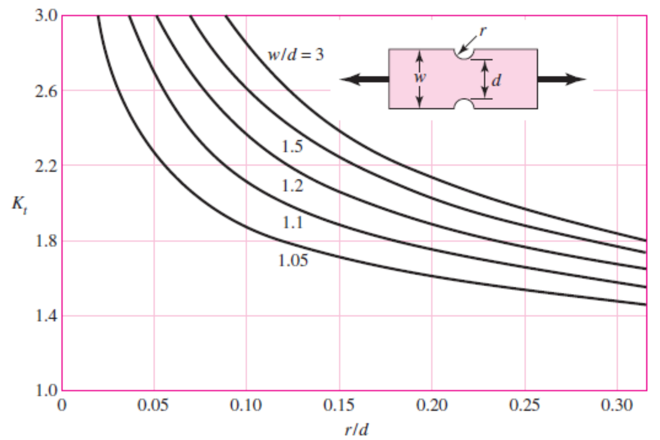


FIGURE A-13-3 Notched rectangular bar in tension or simple compression. $\sigma_0 = F/A$, where $A = dt$ and t is the thickness.

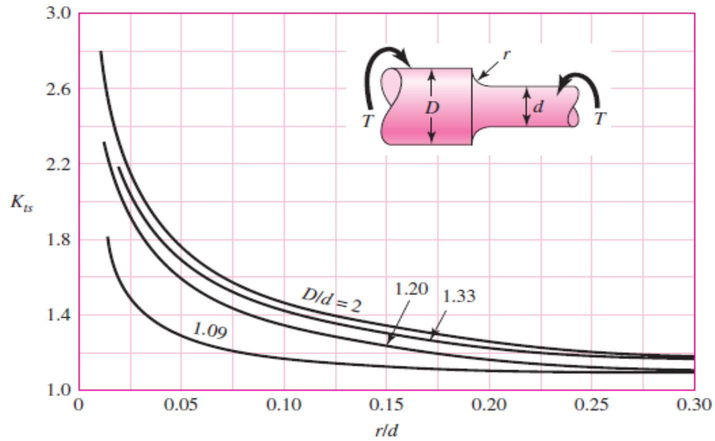


FIGURE A-13-8 Round shaft with shoulder filet in torsion. $\tau_0 = Tc/J$, where $c = d/2$ and $J = \pi d^4/32$.

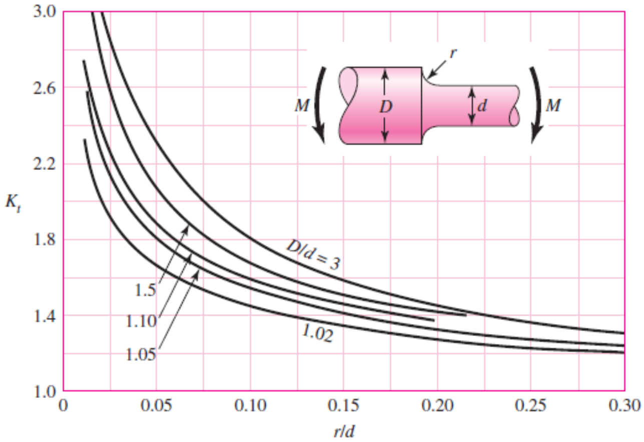


FIGURE A-13-9 Round shaft with shoulder filet in bending. $\sigma_0 = Mc/I$, where $c = d/2$ and $I = \pi d^4/64$.

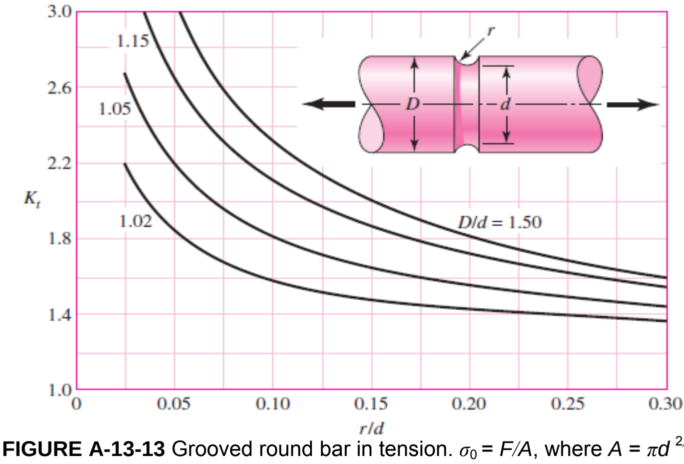


FIGURE A-13-13 Grooved round bar in tension. $\sigma_0 = F/A$, where $A = \pi d^2/4$.

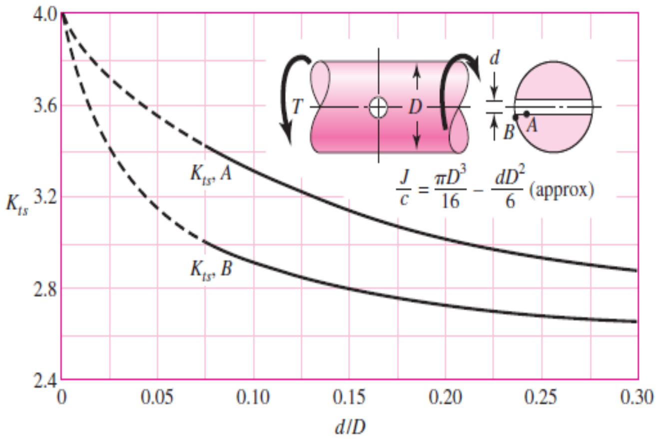


FIGURE A-13-10 Round shaft in torsion with transverse hole.

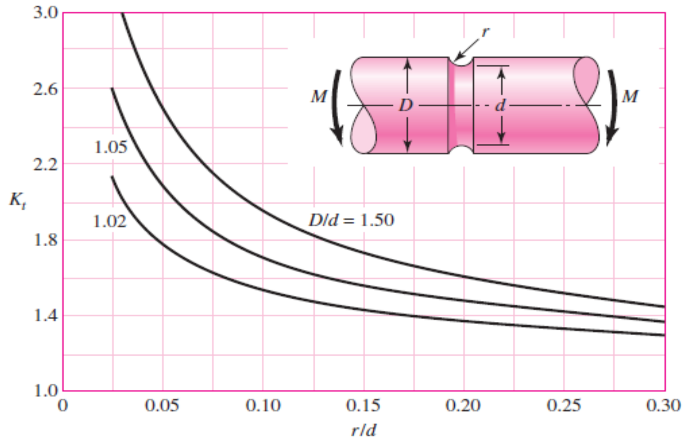


FIGURE A-13-14 Grooved round bar in bending. $\sigma_0 = Mc/I$, where $c = d/2$ and $I = \pi d^4/64$.

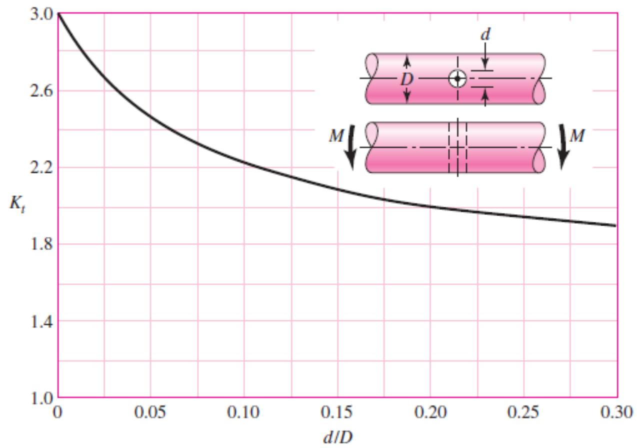


FIGURE A-13-11 Round shaft in bending with a transverse hole. $\sigma_0 = M/[(\pi D^3/32) - (dD^2/6)]$, approximately.

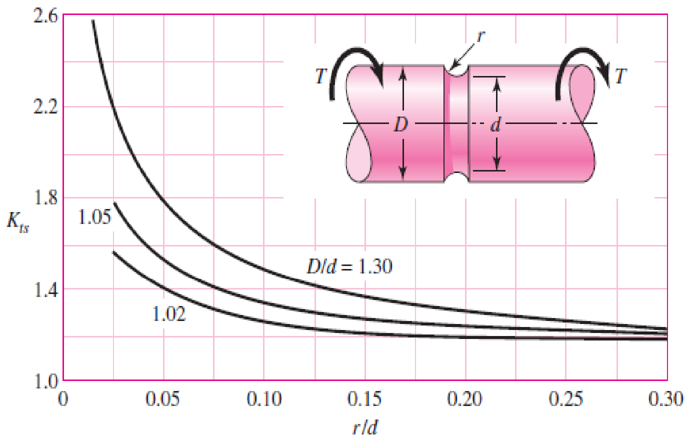


FIGURE A-13-15 Grooved round bar in torsion. $\tau_0 = Tc/J$, where $c = d/2$ and $J = \pi d^4/32$.

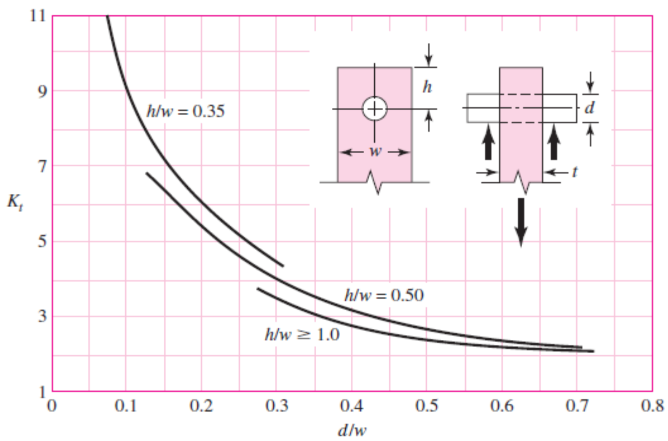


FIGURE A-13-12 Plate loaded in tension by a pin through a hole. $\sigma_0 = F/A$, where $A = (w - d)t$. When clearance exists, increase K_t 35 to 50 percent. *(M. M. Frocht and H. N. Hill, "Stres Concentration Factors around a Central Circular Hole in a Plate Loaded through a Pin in Hole," J. Appl. Mechanics, vol. 7, no. 1, March 1940, p. A-5.)*

ENDURANCE-LIMIT MODIFYING FACTORS

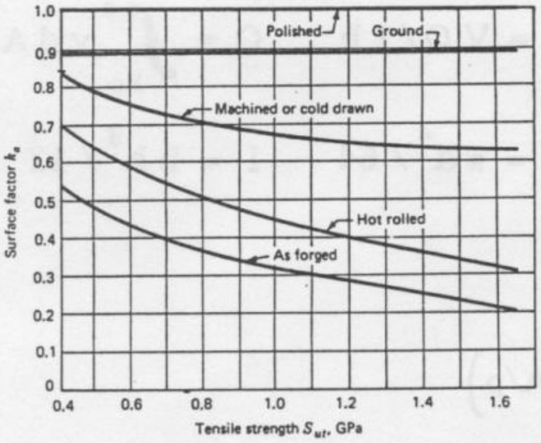


FIGURE 7-8 Surface-finish modification factors for steel. These are the k_a factors for use in Eq. (7-15).

Size Factor :

1) For Tension-Compression :
$k_b = 1.0$ for all dimensions.

2) For torsion of Bending

$k_b = 1.0$	$d \le 8$ mm
$k_b = 0.85$	$8 \text{ mm} \le d \le 50$ mm
$k_b = 0.75$	$d > 50$ mm

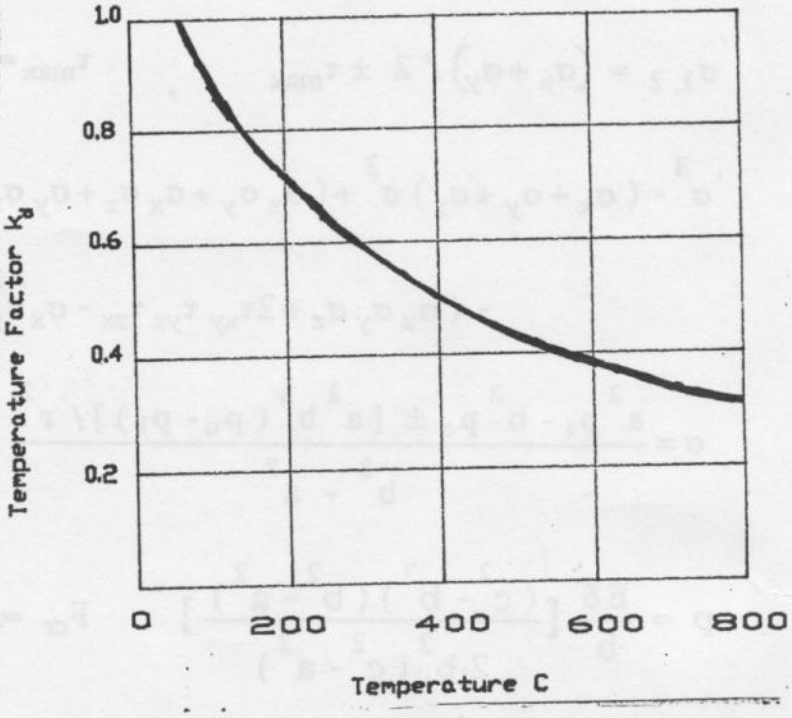


Table 7-7 RELIABILITY FACTORS k_c CORRESPONDING TO AN 8 PERCENT STANDARD DEVIATION OF THE ENDURANCE LIMIT

Reliability R	Standardized variable z_r	Reliability factor k_c
0.50	0	1.000
0.90	1.288	0.897
0.95	1.645	0.868
0.99	2.326	0.814
0.999	3.090	0.753
0.999 9	3.719	0.702
0.999 99	4.265	0.659
0.999 999	4.753	0.620
0.999 999 9	5.199	0.584
0.999 999 99	5.612	0.551
0.999 999 999	5.997	0.520

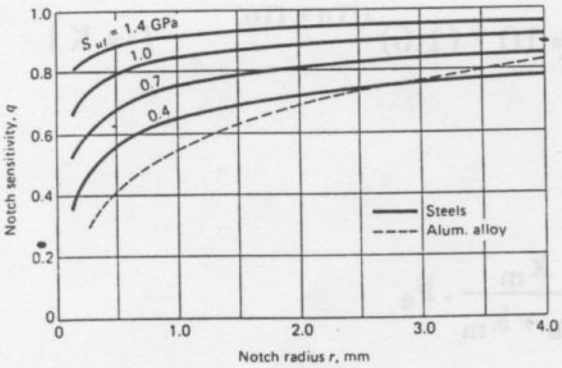


FIGURE 7-13 Notch-sensitivity charts for steels and 2024-T wrought aluminum alloys subjected to reversed bending or reversed axial loads. For larger notch radii use the values of q corresponding to $r = 4$ mm. *(By permission from George Sines and J. L. Waisman (eds.), Metal Fatigue, McGraw-Hill, New York, 1959, pp. 296–298.)*

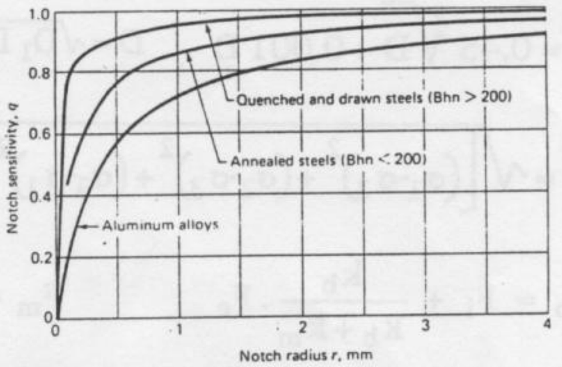


FIGURE 7-14 Notch-sensitivity curves for materials in reversed torsion. For larger notch radii use the values of q corresponding to $r = 4$ mm.