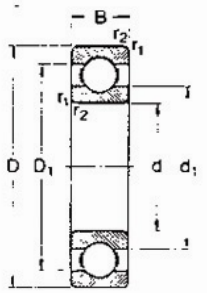
Lampiran 1 : Konversi satuan SI

Conversion Factors for SI Units (symbols of SI units given in parenthesis)

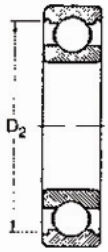
To convert from	To	Multiply by
atmosphere (normal)	newton/meter^2 (N/m^2)	1.013250×10^5
British thermal unit (Btu)	joule (J)	1.055056×10^3
Btu/hour	watt (W)	2.930711×10^{-1}
Btu/ft^2-minute	watt/meter^2 (W/m^2)	1.891489×10^2
centipoise	newton-second/meter^2 (N·s/m^2)	1.000000×10^{-3}
centistoke	meter^2/second (m^2/s)	1.000000×10^{-6}
cubic foot	meters^3 (m^3)	2.831685×10^{-2}
cubic inches	meters^3 (m^3)	1.638706×10^{-5}
cubic foot/minute	meters^3/second (m^3/s)	4.719474×10^{-4}
cubic foot/second	meters^3/second (m^3/s)	2.831685×10^{-2}
cubic inches/minute	meters^3/second (m^3/s)	2.731177×10^{-7}
degree (angle)	radian (rad)	1.745329×10^{-2}
degree Celsius (i.e. centigrade)	kelvin (K)	$t_K = t_C + 273.15$
degree Fahrenheit	degree Celsius (i.e. centigrade)	$t_C = (t_F - 32)/1.8$
degree Fahrenheit	kelvin (K)	$t_K = (t_F + 459.67)/1.8$
degree Rankine	kelvin (K)	$t_K = t_R/1.8$
fluid ounce (U.S.)	meter^3 (m^3)	2.957353×10^{-5}
foot	meter (m)	3.048000×10^{-1}
foot/second	meter/second (m/s)	3.048000×10^{-1}
foot/second^2	meter/second^2 (m/s^2)	3.048000×10^{-1}
foot-pound-force	joule (J)	1.355818
foot-poundal	joule (J)	4.214011×10^{-2}
foot-pound-force/hour	watt (W)	3.766161×10^{-4}
foot-pound-force/minute	watt (W)	2.259697×10^{-2}
foot-pound-force/second	watt (W)	1.355818
gallon (U.S. liquid)	meter^3 (m^3)	3.785412×10^{-3}
gallon (U.S. liquid)/minute	meter^3/second (m^3/s)	6.309020×10^{-5}
horsepower (550 ft-lb-f/s)	watt (W)	7.456999×10^2
hour (mean solar)	second (s)	3.600000×10^3
inch	meter (m)	2.540000×10^{-2}
inch of mercury (32° F)	newton/meter^2 (N/m^2)	3.386389×10^3
inch of mercury (60° F)	newton/meter^2 (N/m^2)	3.376850×10^3
inch/second	meter/second (m/s)	2.540000×10^{-2}
inch/second^2	meter/second^2 (m/s^2)	2.540000×10^{-2}
kelvin	degree Celsius (i.e. centigrade)	$t_C = t_K - 273.15$
kip	newton (N)	4.448222×10^3
kip/inch^2	newton/meter^2 (N/m^2)	6.894757×10^6
kilowatt-hour	joule (J)	3.600000×10^6
mile (U.S. statute)	meter (m)	1.609344×10^3
mile/hour (U.S. statute)	meters/second (m/s)	4.470400×10^{-1}
mile/hour (U.S. statute)	kilometer/hour	1.609344
minute (angle)	radian (rad)	2.908882×10^{-4}
moment of inertia (lbm-ft^2)	kilogram meter^2 (kg·m^2)	4.214012×10^{-2}
moment of inertia (lbm-in.^{2})	kilogram-meter^2 (kg·m^2)	2.926397×10^{-4}
moment of section (second moment of inertia) (in.^{4})	meter^4 (m^4)	4.162314×10^{-7}
poise (absolute viscosity)	newton-second/meter^2 (N·s/m^2)	1.000000×10^{-1}
pound-force (lbf avoirdupois)	kilogram-force	4.535924×10^{-1}
pound-mass (lbm avoirdupois)	kilogram (kg)	4.535924×10^{-1}
pound-force/inch	newton/meter (N/m)	1.751268×10^2
pound-force/foot	newton/meter (N/m)	1.459390×10^1
pound-force-inch	newton-meter (N·m)	1.129848×10^{-1}
pound-force-foot	newton-meter (N·m)	1.355818
pound-force-inch/inch	newton-meter/meter (N·m/m)	4.448222
pound-force/foot^2	newton/meter^2 (N/m^2)	4.788026×10^1
pound-force/inch^2 (psi)	newton/meter^2 (N/m^2)	6.894757×10^3
pound-force/inch^2 (psi)	kilogram-force/mm^2	7.030696×10^{-4}
pound-mass/foot^3	kilogram/meter^3 (kg/m^3)	4.882428
pound-mass/foot^3	kilogram/meter^3 (kg/m^3)	1.601846×10^1
pound-mass/inch^3	kilogram/meter^3 (kg/m^3)	2.767990×10^4
pound-mass/minute	kilogram/second (kg/s)	7.559873×10^{-3}
pound-mass/second	kilogram/second (kg/s)	4.535924×10^{-1}
second (angle)	radian (rad)	4.848137×10^{-6}
section modulus (ft^3)	meter^3 (m^3)	2.831685×10^{-2}
section modulus (in^3)	meter^3 (m^3)	1.638706×10^{-5}
stoke (kinematic viscosity)	meter^2/second (m^2/s)	1.000000×10^{-4}
statute mile (U.S.)	meter (m)	1.609344×10^3
square foot	meter^2 (m^2)	9.290304×10^{-2}
square inch	meter^2 (m^2)	6.451600×10^{-4}
square foot/second	meter^2/second (m^2/s)	9.290304×10^{-2}
ton (short, 2000 lbm)	kilogram (kg)	9.071847×10^2
watt-hour	joule (J)	3.600000×10^3
watt-second	joule (J)	1.000000
year (calendar)	second (s)	3.153600×10^7

Lampiran 2 : Tabel *Bearing*

Deep groove ball bearings
single row
d 2,5–12 mm



With full outer ring shoulders



With recessed outer ring shoulders

Principal dimensions			Basic load ratings dynamic	static	Fatigue load limit	Speed ratings Lubrication grease	oil	Mass	Designation
d	D	B	C	C_0	P_u				
mm			N		N	r/min		kg	-
2,5	8	2,8	319	106	4	67 000	80 000	0,0007	**60/2.5**
3	10	4	488	146	6	60 000	70 000	0,0015	**623**
4	9	2,5	540	180	7	63 000	75 000	0,0007	**618/4**
	12	4	806	280	12	53 000	63 000	0,0022	**604**
	13	5	975	305	14	48 000	56 000	0,0031	**624**
	16	5	1 110	380	16	43 000	50 000	0,0054	**634**
5	11	3	637	255	11	53 000	63 000	0,0012	**618/5**
	16	5	1 110	380	16	43 000	50 000	0,0050	**625**
	19	6	1 720	620	26	36 000	43 000	0,0090	**635**
6	13	3,5	804	315	13	48 000	56 000	0,0020	**618/6**
	19	6	1 720	620	26	36 000	43 000	0,0084	**626**
7	14	3,5	956	400	17	45 000	53 000	0,0022	**618/7**
	19	6	1 720	620	26	38 000	45 000	0,0075	**607**
	22	7	3 250	1 370	57	32 000	38 000	0,013	**627**
8	16	4	1 330	570	24	40 000	48 000	0,0030	**618/8**
	22	7	3 250	1 370	57	34 000	43 000	0,012	**608**
9	17	4	1 430	640	27	38 000	45 000	0,0034	**618/9**
	24	7	3 710	1 660	71	32 000	38 000	0,014	**609**
	26	8	4 620	1 960	83	28 000	34 000	0,020	**629**
10	19	5	1 380	585	25	36 000	43 000	0,0055	**61800**
	22	6	1 950	750	32	34 000	40 000	0,010	**61900**
	26	8	4 620	1 960	83	30 000	36 000	0,019	**6000**
	28	8	4 620	1 960	83	28 000	34 000	0,022	**16100**
	30	9	5 070	2 360	100	24 000	30 000	0,032	**6200**
	35	11	8 060	3 400	143	20 000	26 000	0,053	**6300**
12	21	5	1 430	670	28	32 000	38 000	0,0060	**61801**
	24	6	2 250	980	41	30 000	36 000	0,011	**61901**
	28	8	5 070	2 360	100	26 000	32 000	0,022	**6001**
	30	8	5 070	2 360	100	26 000	32 000	0,023	**16101**
	32	10	6 890	3 100	132	22 000	28 000	0,037	**6201**
	37	12	9 750	4 150	176	19 000	24 000	0,060	**6301**

SKF

Lampiran 3 : Data Bahan

(based on a 1 in. diameter specimen)

AISI Type	Condition	Tensile Strength, ksi	Yield Strength, ksi	Elongat. in 2 in., %	Reduction in Area, %	Hardness, BHN	Machinability (Based on 1112 = 100)
1010	HR	64	42	28	67	107	45
	CD	78	68	16	63	129	55
	CDA	64	48	28	65	131	55
1020	HR	65	43	36	59	143	50
	CD	78	66	20	55	156	65
	A	57	52	37	66	111	90
	N	64	50	36	68	131	75
1030	HR & turned	72	44	31	63	140	—
	CD	84	76	16	57	179	65
	A	67	50	31	58	126	—
	N	76	51	32	61	149	—
1040	HR	91	58	27	50	201	63
	CD	100	88	17	42	207	65
	A	75	51	30	57	149	—
	N	85	50	28	55	170	60
1045	HR	98	59	24	45	212	56
	CD	103	90	14	40	217	60
	A	90	55	27	54	174	60
	N	99	61	25	49	207	—
1050	HR	105	67	15	—	—	—
	CD	114	104	9	—	—	54
	A	92	43	24	40	187	—
	N	109	62	20	39	217	—
1095	HR	142	83	18	38	295	—
	A	95	38	13	21	192	—
	N	147	73	10	14	293	—
1118	HR	75	50	35	55	140	—
	CD	85	75	25	55	170	80
	A	65	41	35	67	131	80
	N	69	46	34	66	143	80
2330	CD	105	90	20	50	212	50
	A	86	61	28	58	179	50
	N	100	68	26	56	207	—
3140	CD	107	92	17	50	212	55
	A	100	61	25	51	197	55
	N	129	87	20	58	262	—
4130	HRA	86	56	29	57	183	65
	CDA	98	87	21	52	201	70
	N	97	63	26	60	197	50

SOURCE: *ASME Handbook-Material Properties*, McGraw-Hill Book Co., 1984; *Ryerson Data Book*, Joseph T. Ryerson

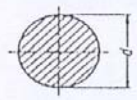
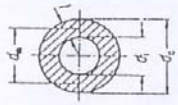
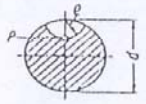
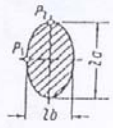
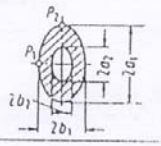
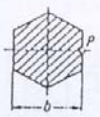
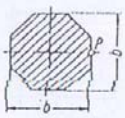
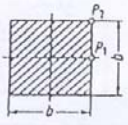
Lampiran 4 : ***Bearing***

Tipe bearing

Nomor bantalan			Ukuran luar (mm)				Kapasitas	Kapasitas
Jenis terbuka	Dua sekat	Dua sekat tanpa kontak	*d*	*D*	*B*	*r*	nominal dinamis spesifik *C* (kg)	nominal statis spesifik C_0 (kg)
6000			10	26	8	0,5	360	196
6001	6001ZZ	6001VV	12	28	8	0,5	400	229
6002	02ZZ	02VV	15	32	9	0,5	440	263
6003	6003ZZ	6003VV	17	35	10	0,5	470	296
6004	04ZZ	04VV	20	42	12	1	735	465
6005	05ZZ	05VV	25	47	12	1	790	530
6006	6006ZZ	6006VV	30	55	13	1,5	1030	740
6007	07ZZ	07VV	35	62	14	1,5	1250	915
6008	08ZZ	08VV	40	68	15	1,5	1310	1010
6009	6009ZZ	6009VV	45	75	16	1,5	1640	1320
6010	10ZZ	10VV	50	80	16	1,5	1710	1430
6200	6200ZZ	6200VV	10	30	9	1	400	236
6201	01ZZ	01VV	12	32	10	1	535	305
6202	02ZZ	02VV	15	35	11	1	600	360
6203	6203ZZ	6203VV	17	40	12	1	750	460
6204	04ZZ	04VV	20	47	14	1,5	1000	635
6205	05ZZ	05VV	25	52	15	1,5	1100	730
6206	6206ZZ	6206VV	30	62	16	1,5	1530	1050
6207	07ZZ	07VV	35	72	17	2	2010	1430
6208	08ZZ	08VV	40	80	18	2	2380	1650
6209	6209ZZ	6209VV	45	85	19	2	2570	1880
6210	10ZZ	10VV	50	90	20	2	2750	2100
6300	6300ZZ	6300VV	10	35	11	1	635	365
6301	01ZZ	01VV	12	37	12	1,5	760	450
6302	02ZZ	02VV	15	42	13	1,5	895	545
6303	6303ZZ	6303VV	17	47	14	1,5	1070	660
6304	04ZZ	04VV	20	52	15	2	1250	785
6305	05ZZ	05VV	25	62	17	2	1610	1080
6306	6306ZZ	6306VV	30	72	19	2	2090	1440
6307	07ZZ	07VV	35	80	20	2,5	2620	1840
6308	08ZZ	08VV	40	90	23	2,5	3200	2300
6309	6309ZZ	6309VV	45	100	25	2,5	4150	3100
6310	10ZZ	10VV	50	110	27	3	4850	3650

Lampiran 5 : Tahanan Momen Torsi

Tabelle 7. Torsionsflächenmomente I_t und -widerstandsmomente W_t Untuk momen torsi

	Querschnitt	I_t	W_t	Bemerkungen
1		$\frac{\pi d^4}{32} = I_p$	$\frac{\pi d^3}{16} = W_p$	τ_{max} am Umfang
2		$\frac{\pi (d_a^4 - d_i^4)}{32} = I_p$ Für geringe Wanddicken, d.h. $\left(\frac{t}{d_m}\right)^2 \ll 1$: $\pi d_m^3 t/4$	$\frac{\pi (d_a^4 - d_i^4)}{16 d_a} = W_p$ $\pi d_m^2 t/2$	τ_{max} am Umfang
3		$\frac{\pi d^4}{32} = I_p$	$\frac{W_p}{\lambda} = \frac{\pi d^3}{16\lambda}$ $\lambda = \frac{2-\xi}{1-2\xi^2+(16/3\pi)\xi^3}$ Für kleine ξ: $\lambda \to 2$	τ_{max} am Kerbgrund (in P) $\xi = \frac{\rho}{d/2}$
4		$\frac{\pi a^3 b^3}{a^2+b^2} = \frac{\pi n^3 b^4}{n^2+1}$	$\frac{\pi a b^2}{2} = \frac{\pi n b^3}{2}$	Voraussetzung: $a/b = n \geq 1$ τ_{max} in P_1 in P_2: $\tau_2 = \tau_{max}/n$
5		$\frac{\pi n^3 (b_1^4 - b_2^4)}{n^2+1}$	$\frac{\pi n (b_1^4 - b_2^4)}{2 b_1}$	Voraussetzung: $a_1/b_1 = a_2/b_2 = n \geq 1$ τ_{max} in P_1 in P_2: $\tau_2 = \tau_{max}/n$
6		$\frac{b^4}{46{,}19} \approx \frac{h^4}{26}$	$\frac{b^3}{20} \approx \frac{h^3}{13}$	τ_{max} in Mitte der Seiten (P_1) in den Ecken (P_2): $\tau_2 = 0$
7		$0{,}1330\, b^2 A = 0{,}115\, b^4$	$0{,}2170\, bA = 0{,}188\, b^3$	τ_{max} in Mitte der Seiten (P)
8		$0{,}130\, b^2 A = 0{,}108\, b^4$	$0{,}223\, bA = 0{,}185\, b^3$	τ_{max} in Mitte der Seiten (P)
9		$0{,}141\, b^4$	$0{,}208\, b^3$	τ_{max} in Mitte der Seiten (P_1) in den Ecken (P_2): $\tau_2 = 0$

Lampiran 6 : Tahanan Momen Bending

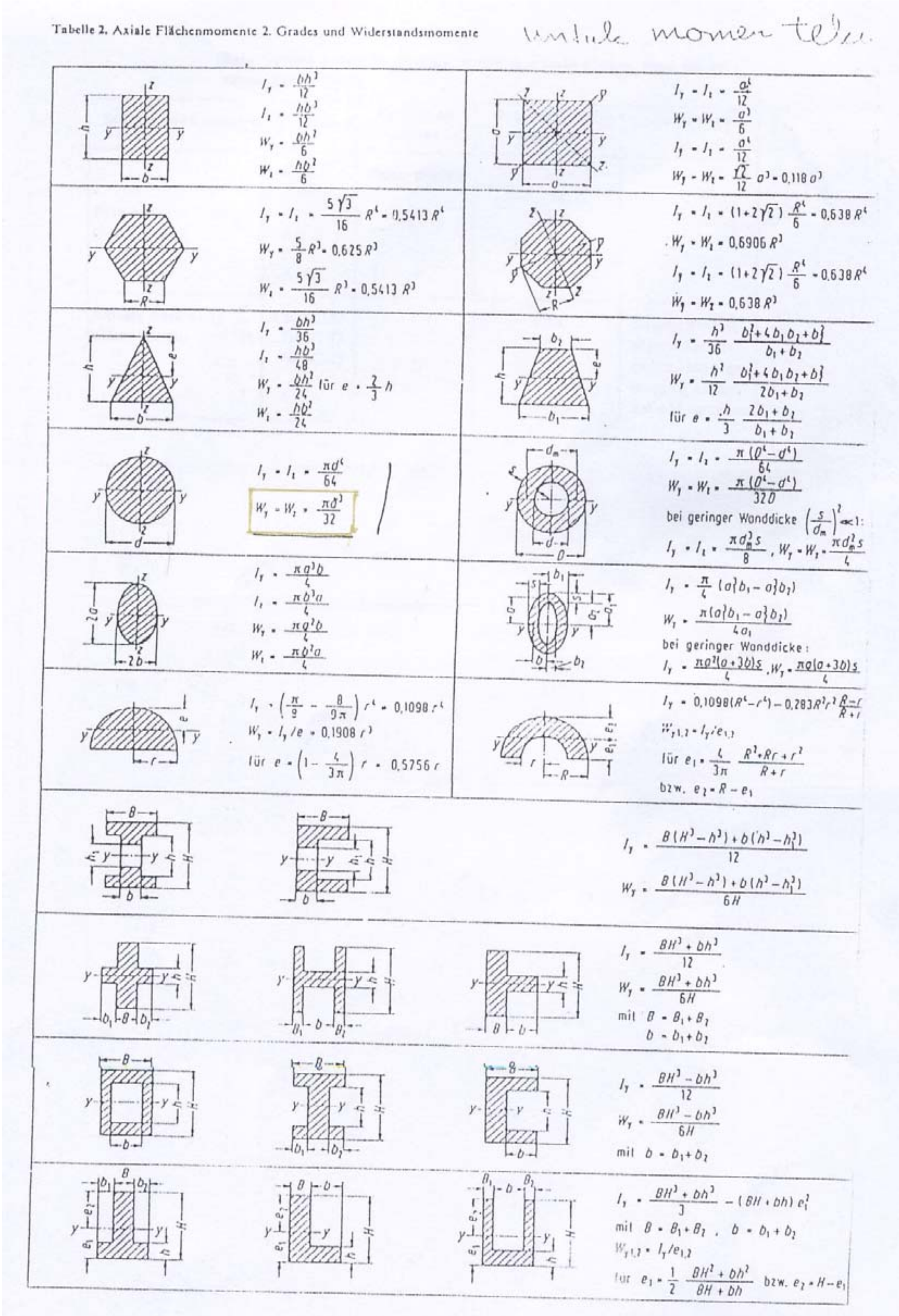


Tabelle 2. Axiale Flächenmomente 2. Grades und Widerstandsmomente — untuk momen tekuk

$I_y = \frac{bh^3}{12}$, $I_z = \frac{hb^3}{12}$, $W_y = \frac{bh^2}{6}$, $W_z = \frac{hb^2}{6}$

$I_y = I_z = \frac{a^4}{12}$, $W_y = W_z = \frac{a^3}{6}$, $I_\eta = I_\zeta = \frac{a^4}{12}$, $W_\eta = W_\zeta = \frac{\sqrt{2}}{12} a^3 = 0{,}118\, a^3$

$I_y = I_z = \frac{5\sqrt{3}}{16} R^4 = 0{,}5413\, R^4$, $W_y = \frac{5}{8} R^3 = 0{,}625\, R^3$, $W_z = \frac{5\sqrt{3}}{16} R^3 = 0{,}5413\, R^3$

$I_y = I_z = (1+2\sqrt{2}) \frac{R^4}{6} = 0{,}638\, R^4$, $W_y = W_z = 0{,}6906\, R^3$, $I_\eta = I_\zeta = (1+2\sqrt{2}) \frac{R^4}{6} = 0{,}638\, R^4$, $W_\eta = W_\zeta = 0{,}638\, R^3$

$I_y = \frac{bh^3}{36}$, $I_z = \frac{hb^3}{48}$, $W_y = \frac{bh^2}{24}$ für $e = \frac{2}{3} h$, $W_z = \frac{hb^2}{24}$

$I_y = \frac{h^3}{36} \frac{b_1^2 + 4 b_1 b_2 + b_2^2}{b_1 + b_2}$, $W_y = \frac{h^2}{12} \frac{b_1^2 + 4 b_1 b_2 + b_2^2}{2 b_1 + b_2}$ für $e = \frac{h}{3} \frac{2 b_1 + b_2}{b_1 + b_2}$

$I_y = I_z = \frac{\pi d^4}{64}$, $W_y = W_z = \frac{\pi d^3}{32}$

$I_y = I_z = \frac{\pi (D^4 - d^4)}{64}$, $W_y = W_z = \frac{\pi (D^4 - d^4)}{32 D}$; bei geringer Wanddicke $\left(\frac{s}{d_m}\right)^2 \ll 1$: $I_y = I_z = \frac{\pi d_m^3 s}{8}$, $W_y = W_z = \frac{\pi d_m^2 s}{4}$

$I_y = \frac{\pi a^3 b}{4}$, $I_z = \frac{\pi b^3 a}{4}$, $W_y = \frac{\pi a^2 b}{4}$, $W_z = \frac{\pi b^2 a}{4}$

$I_y = \frac{\pi}{4} (a_1^3 b_1 - a_2^3 b_2)$, $W_y = \frac{\pi (a_1^3 b_1 - a_2^3 b_2)}{4 a_1}$; bei geringer Wanddicke: $I_y = \frac{\pi a^2 (a + 3b) s}{4}$, $W_y = \frac{\pi a (a + 3b) s}{4}$

$I_y = \left(\frac{\pi}{8} - \frac{8}{9\pi}\right) r^4 = 0{,}1098\, r^4$, $W_y = I_y / e = 0{,}1908\, r^3$ für $e = \left(1 - \frac{4}{3\pi}\right) r = 0{,}5756\, r$

$I_y = 0{,}1098 (R^4 - r^4) - 0{,}283 R^2 r^2 \frac{R - r}{R + r}$, $W_{y1,2} = I_y / e_{1,2}$ für $e_1 = \frac{4}{3\pi} \frac{R^2 + Rr + r^2}{R + r}$ bzw. $e_2 = R - e_1$

$I_y = \frac{B(H^3 - h^3) + b(h^3 - h_1^3)}{12}$, $W_y = \frac{B(H^3 - h^3) + b(h^3 - h_1^3)}{6H}$

$I_y = \frac{BH^3 + bh^3}{12}$, $W_y = \frac{BH^3 + bh^3}{6H}$ mit $B = B_1 + B_2$, $b = b_1 + b_2$

$I_y = \frac{BH^3 - bh^3}{12}$, $W_y = \frac{BH^3 - bh^3}{6H}$ mit $b = b_1 + b_2$

$I_y = \frac{BH^3 + bh^3}{3} - (BH + bh) e_1^2$ mit $B = B_1 + B_2$, $b = b_1 + b_2$, $W_{y1,2} = I_y / e_{1,2}$ für $e_1 = \frac{1}{2} \frac{BH^2 + bh^2}{BH + bh}$ bzw. $e_2 = H - e_1$