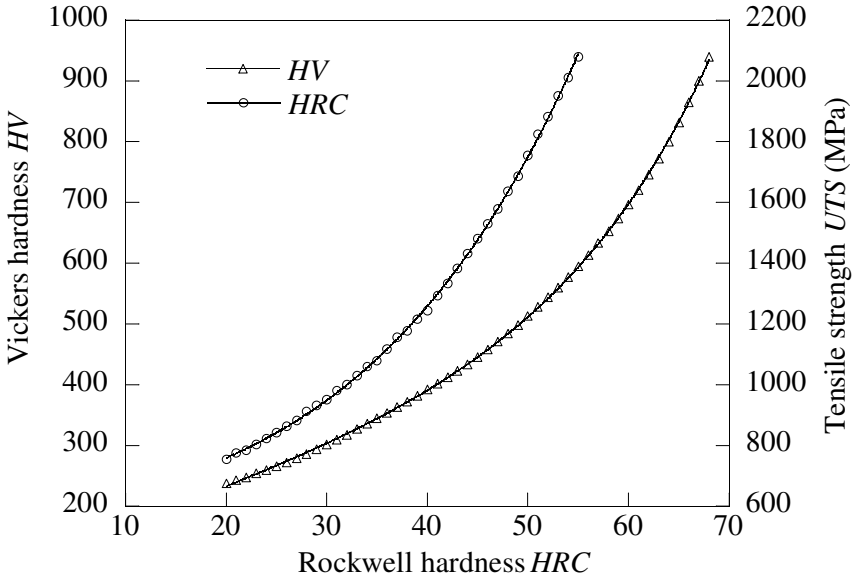
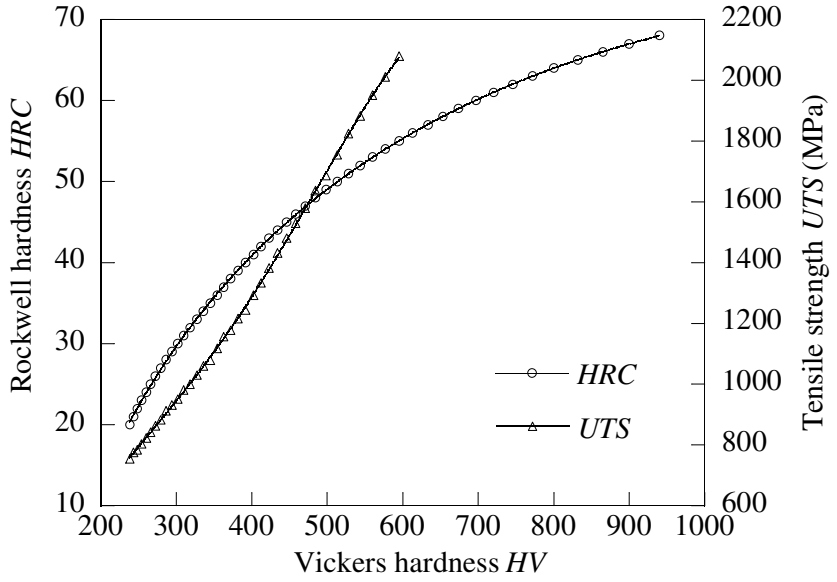
硬さの換算（ASTM E 140 表 2 に準拠）

1．ロックウェル硬さ C（*HRC*）とビッカース硬さ（*HV*）

$$HV = 590.35 + 3.888HRC\exp(0.05134HRC^{0.9073})$$
$$UTS = 107.61 + 6.177HRC\exp(2.089\times10^{-6}HRC^{3.008})$$



$$HRC = -290.39 + (44.281 - 0.001849HV - 6.3941\times10^{-7}HV^2)\ln(HV)$$
$$UTS = -767.52 + 13.268HV - 0.04699HV^2 + 9.0606\times10^{-5}HV^3 - 5.9865\times10^{-8}HV^4$$



２．ビッカース硬さ（*HV*）とブリネル硬さ（*HB*）との関係

２－１）標準 10mm 球

$$HB = 18.799 + 0.73854HV + 7.7886\times10^{-4}HV^2 - 9.3938\times10^{-7}HV^3$$

２－２）Hultgren 球

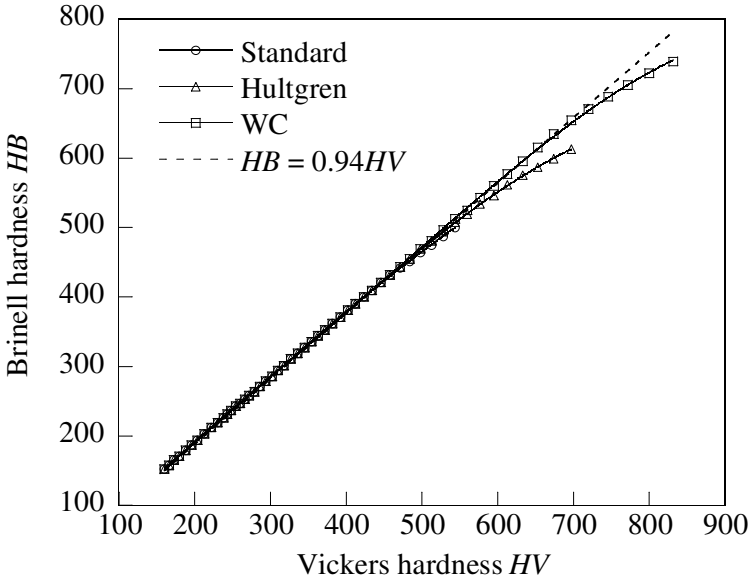
$$HB = (97.088 + 0.086358HV + 4.3235\times10^{-4}HV^2 - 4.234\times10^{-7}HV^3)\ln\frac{HV}{45.227}$$

２－３）WC 球

$$HB = (158.8 - 0.080298HV + 6.7079\times10^{-4}HV^2 - 4.6731\times10^{-7}HV^3)\ln\frac{HV}{63.064}$$

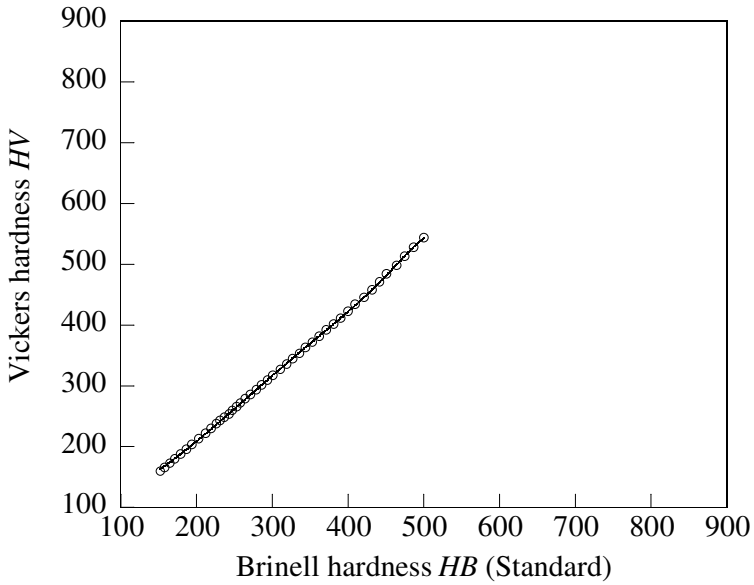
２－４）直線近似

$$HB = 0.94HV$$



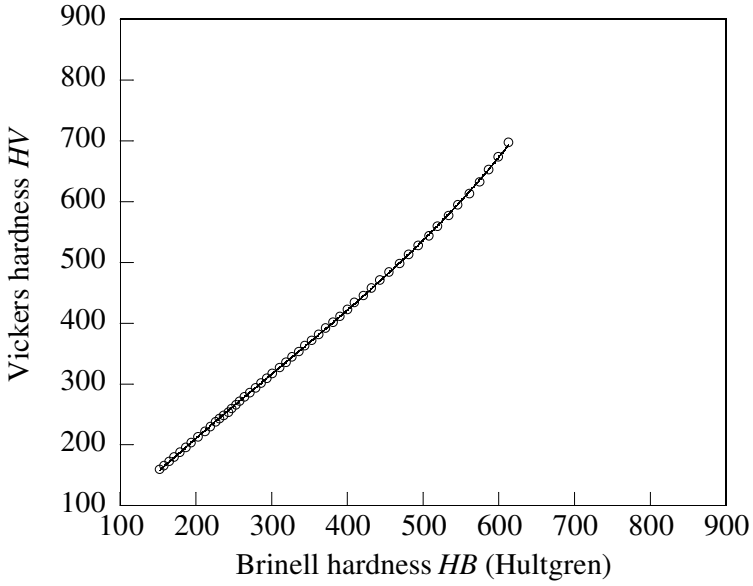
２－５）標準

$$HV = (61.214 - 0.32284HB + 5.9302\times10^{-4}HB^2 - 3.7575\times10^{-7}HB^3) \times \exp\left(\frac{HB}{80.38}\right)$$



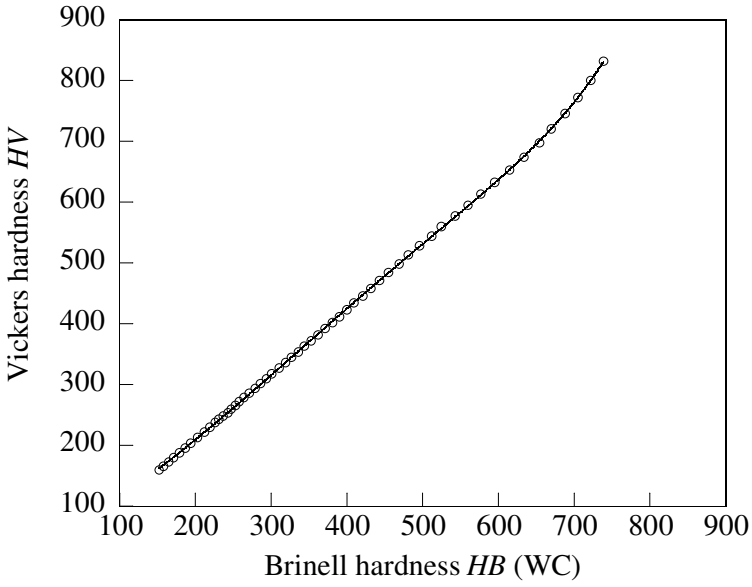
２－６）Hultgren 球

$$HV = (8.2132 - 0.013408HB + 4.0646\times10^{-6}HB^2 - 5.1854\times10^{-9}HB^3) \times \exp\left(\frac{HB^{0.38613}}{2.1491}\right)$$



２－７）WC 球

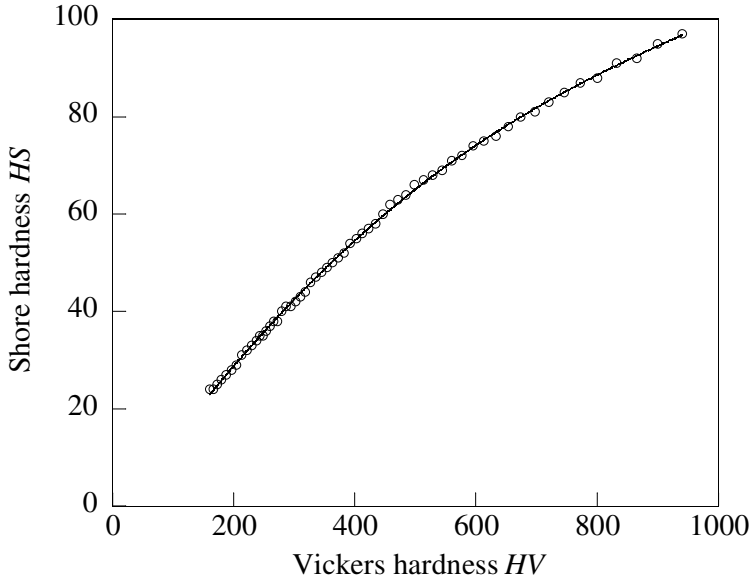
$$HV = (21.717 - 0.037377HB + 1.406\times10^{-5}HB^2 - 6.3303\times10^{-9}HB^3) \times \exp\left(\frac{HB^{0.52501}}{6.0998}\right)$$



３．ショア硬さ（*HS*）と
ビッカース硬さ（*HV*）

$$HS = -4.3032 + 0.18552HV - 1.0581\times10^{-4}HV^2 + 2.4033\times10^{-8}HV^3$$

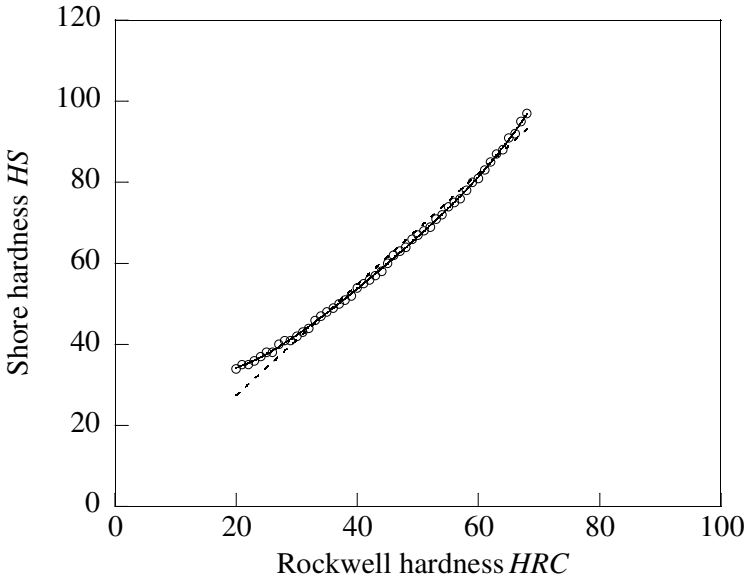
$$HV = -31.454 + 9.5291HS - 0.07532HS^2 + 8.3228\times10^{-4}HS^3$$



４．ショア硬さ（*HS*）と
ロックウェル硬さＣ（*HRC*）

$$HS = 49.861 - 2.6491HRC + 0.12705HRC^2 - 1.9075\times10^{-3}HRC^3 + 1.1199\times10^{-5}HRC^4$$

$$HRC = -69.587 + 4.6726HS - 0.083551HS^2 + 8.0348\times10^{-4}HS^3 - 2.972\times10^{-6}HS^4$$



直線近似

$$HS \approx 1.37HRC$$

付録

Rockwell C	Vickers	Brinell			Rockwell			Rockwell superficial			Shore HS	Tensile strength MPa
HRC 150kg	HV	HB 29.42 kN			HRA 558.4N diamond cone	HRB 980.7N 1/16inch ball	HRD 980.7N diamond cone	15N 147.1N	30N 294.2N	45N 441.3 N		
		Standard	Hultgren	WC								
68	940				85.6		76.9	93.2	84.4	75.4	97	
67	900				85		76.1	92.9	83.6	74.2	95	
66	865				84.5		75.4	92.5	82.8	73.3	92	
65	832			739	83.9		74.5	92.2	81.9	72	91	
64	800			722	83.4		73.8	91.8	81.1	71	88	
63	772			705	82.8		73	91.4	80.1	69.9	87	
62	746			688	82.3		72.2	91.1	79.3	68.8	85	
61	720			670	81.8		71.5	90.7	78.4	67.7	83	
60	697		613	654	81.2		70.7	90.2	77.5	66.6	81	
59	674		599	634	80.7		69.9	89.8	76.6	65.5	80	
58	653		587	615	80.1		69.2	89.3	75.7	64.3	78	
57	633		575	595	79.6		68.5	88.9	74.8	63.2	76	
56	613		561	577	79		67.7	88.3	73.9	62	75	
55	595		546	560	78.5		66.9	87.9	73	60.9	74	2079
54	577		534	543	78		66.1	87.4	72	59.8	72	2010
53	560		519	525	77.4		65.4	86.9	71.2	58.6	71	1952
52	544	500	508	512	76.8		64.6	86.4	70.2	57.4	69	1883
51	528	487	494	496	76.3		63.8	85.9	69.4	56.1	68	1824
50	513	475	481	481	75.9		63.1	85.5	68.5	55	67	1755
49	498	464	469	469	75.2		62.1	85	67.6	53.8	66	1687
48	484	451	455	455	74.7		61.4	84.5	66.7	52.5	64	1638
47	471	442	443	443	74.1		60.8	83.9	65.8	51.4	63	1579
46	458	432	432	432	73.6		60	83.5	64.8	50.3	62	1530
45	446	421	421	421	73.1		59.2	83	64	49	60	1481
44	434	409	409	409	72.5		58.5	82.5	63.1	47.8	58	1432
43	423	400	400	400	72		57.7	82	62.2	46.7	57	1383
42	412	390	390	390	71.5		56.9	81.5	61.3	45.5	56	1334
41	402	381	381	381	70.9		56.2	80.9	60.4	44.3	55	1294
40	392	371	371	371	70.4		55.4	80.4	59.5	43.1	54	1245
39	382	362	362	362	69.9		54.6	79.9	58.6	41.9	52	1216
38	372	353	353	353	69.4		53.8	79.4	57.7	40.8	51	1177

37	363	344	344	344	68.9		53.1	78.8	56.8	39.6	50	1157
36	354	336	336	336	68.4	(109)	52.3	78.3	55.9	38.4	49	1118
35	345	327	327	327	67.9	(109)	51.5	77.7	55	37.2	48	1079
34	336	319	319	319	67.4	(108)	50.8	77.2	54.2	36.1	47	1059
33	327	311	311	311	66.8	(108)	50	76.6	53.3	34.9	46	1030
32	318	301	301	301	66.3	(107)	49.2	76.1	52.1	33.7	44	1000
31	310	294	294	294	65.8	(106)	48.4	75.6	51.3	32.5	43	981
30	302	286	286	286	65.3	(106)	47.7	75	50.4	31.3	42	951
29	294	279	279	279	64.7	(105)	47	74.5	49.5	30.1	41	932
28	286	271	271	271	64.3	(104)	46.1	73.9	48.6	28.9	41	912
27	279	264	264	264	63.8	(103)	45.2	73.3	47.7	27.8	40	883
26	272	258	258	258	63.3	(103)	44.6	72.8	46.8	26.7	38	863
25	266	253	253	253	62.8	(102)	43.8	72.2	45.9	25.5	38	843
24	260	247	247	247	62.4	(101)	43.1	71.6	45	24.3	37	824
23	254	243	243	243	62	100	42.1	71	44	23.1	36	804
22	248	237	237	237	61.5	99	41.6	70.5	43.2	22	35	785
21	243	231	231	231	61	98.5	40.9	69.9	42.3	20.7	35	775
20	238	226	226	226	60.5	97.8	40.1	69.4	41.5	19.6	34	755
(18)	230	219	219	219		96.7					33	736
(16)	222	212	212	212		95.5					32	706
(14)	213	203	203	203		93.9					31	677
(12)	204	194	194	194		92.3					29	647
(10)	196	187	187	187		90.7					28	618
(8)	188	179	179	179		89.5					27	598
(6)	180	171	171	171		87.1					26	579
(4)	173	165	165	165		85.5					25	549
(2)	166	158	158	158		83.5					24	530
(0)	160	152	152	152		81.7					24	520