




















**AmbroSteel**

A MEMBER OF THE *Hudaco* GROUP



## **TECHNICAL INFORMATION**

**If you want to go fast go alone,  
if you want to go far, go together**

SUPPLIERS OF THE LARGEST RANGE OF SPECIAL STEELS IN S.A.			
COLOUR	QUALITY OF STEEL	NEW 6 DIGIT NO.	TENSILE STRENGTH
	EN 1A BRIGHT LEADED STEEL HEX AND ROUND	9SMnPb28	36-50 kg/mm <sup>2</sup> (23-32 tons/inch <sup>2</sup> )
	EN 1A BRIGHT FREE-CUTTING STEEL	220M07	36-50 kg/mm <sup>2</sup> (23-32 tons/inch <sup>2</sup> )
	EN 3B - BRIGHT MILD TURNED & DRAWN STEEL	070M20	44-50 kg/mm <sup>2</sup> (28-32 tons/inch <sup>2</sup> )
	EN 8 BRIGHT TURNED & DRAWN STEEL HEX AND ROUND	080M40	50-60 kg/mm <sup>2</sup> (32-38 tons/inch <sup>2</sup> )
	BRIGHT MILD STEEL FLATS AND SQUARES		44-55 kg/mm <sup>2</sup> (28-32 tons/inch <sup>2</sup> )
	EN 3A - BLACK	070M20	44-50 kg/mm <sup>2</sup> (28-32 tons/inch <sup>2</sup> )
	EN 8 BLACK HEX AND ROUND	080M40	50-60 kg/mm <sup>2</sup> (32-38 tons/inch <sup>2</sup> )
	EN 8 NORMALISED	080M40	50-60 kg/mm <sup>2</sup> (32-38 tons/inch <sup>2</sup> )
	EN 9" 55" CARBON STEEL	070M55	70-86 kg/mm <sup>2</sup> (45-55 tons/inch <sup>2</sup> )
	EN 9 NORMALISED	070M55	70-86 kg/mm <sup>2</sup> (45-55 tons/inch <sup>2</sup> )
	EN 19 HEATED TREATED STEEL TO CONDITION	709M40	86-102 kg/mm <sup>2</sup> (55-65 tons/inch <sup>2</sup> )
	EN 19 AS ROLLED	709M40	86-102 kg/mm <sup>2</sup> (55-65 tons/inch <sup>2</sup> )
	EN 24 HEAT TREATED STEEL TO CONDITION	817M40	86-102 kg/mm <sup>2</sup> (55-65 tons/inch <sup>2</sup> )
	EN 24 AS ROLLED	817M40	86-102 kg/mm <sup>2</sup> (55-65 tons/inch <sup>2</sup> )
	EN 36B CASE HARDENING STEEL	655M13	102 kg/mm <sup>2</sup> (65 tons/inch <sup>2</sup> )
	HOLLOW BAR		55 kg/mm <sup>2</sup> (35 tons/inch <sup>2</sup> ) Minimum
	KEYSTEEL	C45K	

**Other materials and services offered are:**

- Forgings • Keys • Non-Ferrous • Ultrasonic and Chemically Analysed Materials • Precision Bandsawing  
(This service is extended to the sawing of customers' own material)

# TOOL STEEL CHART

Colour Code	Type	Sanderson	Related Spec's			Recommended Hardness	Werkstoff Number
	High Speed	Saben 652	Thyrapid 3343	S600	Gigan M5	63-64 HRC	1.3343
		Saben Wunda	Thyrapid 3243	S705	Gigan M5co	65-66 HRC	1.3243
	Cold Work	476	Thyrodur 2379	K110	Rcc Supra	58-60 HRC	1.2379
		Newhall	Thyrodur 2510	K460	Rus 3	60-62 HRC	1.2510
		Pax No 2	Thyrodur 2542	K450	RTW2H	52-54 HRC	1.2547
		476 Special	Thyrodur 2436	K107	RCC Extra	60-64 HRC	1.2436
		LTB	Thyrodur 2767	K600	RABW	54-56 HRC	1.2767
	Hot Work	CMV	Thyrotherm 2344	W302	RDC2V	54-56 HRC	1.2344
		DBS	Thyrotherm 2714	W500	RGS 4	48-52 HRC	1.2714
	Plastic Mould	PMS	Throplast 2312	M210	-	As Supplied 28-23 HRC	1.2312
		IMPAX	Throdur 2767	K605	-	50-52 HRC	1.2767
		PVC	Throdur 2316	M300	Bp42	48-50HRC	1.2316
	Silver Steel	Silver Steel	Thyrodur 2210	K510	-	60-64 HRC	1.2210
	Flat Ground Stock	GFS	-	K460	-	58-62 HRC	1.2510
	High Tensile Steel	MCV	-	V155	-	As Supplied 28-32 HRC	1.6582
		AISI 4140	-	-	-	31-32 HRC	1.2313
	Stainless Steel	AISI 440C	-	-	-	50-54 HRC	1.4568
		SAE 8620	-	-	-	58-60 HRC	1.6523

AT **AMBRO STEEL** (A MEMBER OF THE HUDACO GROUP)  
OUR CORE BUSINESS CONCENTRATES ON THE  
STOCKING, SUPPLYING AND PRECISION CUTTING OF THE  
SPECIAL STEEL RANGE LISTED IN THIS BOOKLET.

THROUGH OUR LOCAL AND INTERNATIONAL NETWORK OF  
SUPPLIERS, WE CAN OFFER THE ADDITIONAL SERVICE OF  
LARGE FORGINGS, SEMI FINISHED COMPONENTS AND  
SOLID OR BORED BAR UP TO **1300mm** DIAMETER  
IN CARBON, ALLOY, NITRIDING AND STAINLESS STEEL.

THIS BOOKLET HAS BEEN COMPILED TO COVER MOST OF  
THE TECHNICAL INFORMATION REGARDING SPECIAL  
STEELS.

OUR MANAGEMENT AND STAFF HOPE THAT YOU FIND IT  
USEFUL AND INFORMATIVE.

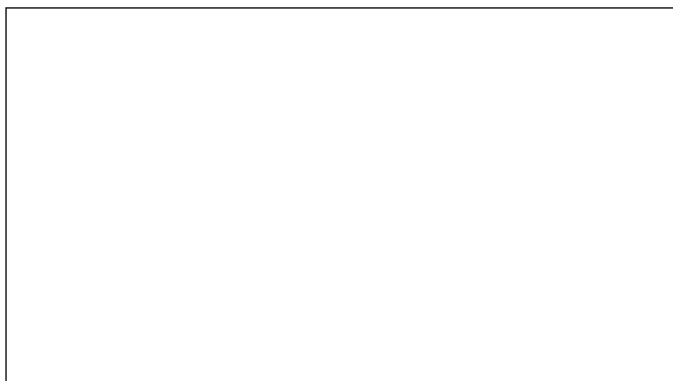
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**Telephone: 011 824 4242**

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# BRIGHT MILD STEEL STANDARD SIZES

SIZE X SIZE	SIZE X SIZE	SIZE X SIZE	SIZE X SIZE	SIZE X SIZE	SIZE X SIZE
6 x 2	15 x 4	20 x 16	30 x 20	40 x 16	50 x 40
6 x 3	15 x 5	20 x 18	30 x 25	40 x 18	50 x 50
6 x 4	15 x 6	20 x 20	30 x 30	40 x 20	55 x 3
6 x 5	15 x 8	22 x 3	32 x 4	40 x 25	55 x 4
6 x 6	15 x 10	22 x 4	32 x 5	40 x 30	55 x 5
8 x 2	15 x 12	22 x 5	32 x 6	40 x 35	55 x 6
8 x 3	15 x 15	22 x 6	32 x 8	40 x 40	55 x 8
8 x 4	16 x 2	22 x 8	32 x 10	45 x 3	55 x 10
8 x 5	16 x 3	22 x 10	32 x 12	45 x 4	55 x 12
8 x 6	16 x 4	22 x 12	32 x 15	45 x 5	55 x 15
8 x 8	16 x 5	22 x 15	32 x 16	45 x 6	55 x 18
10 x 2	16 x 6	22 x 16	32 x 18	45 x 8	55 x 20
10 x 3	16 x 8	22 x 18	32 x 20	45 x 10	55 x 25
10 x 4	16 x 10	22 x 20	32 x 25	45 x 12	55 x 30
10 x 5	16 x 12	25 x 3	32 x 30	45 x 15	55 x 35
10 x 6	16 x 15	25 x 4	35 x 3	45 x 16	55 x 40
10 x 8	16 x 16	25 x 5	35 x 4	45 x 18	60 x 3
10 x 10	18 x 2	25 x 6	35 x 5	45 x 20	60 x 4
12 x 2	18 x 3	25 x 8	35 x 6	45 x 25	60 x 5
12 x 3	18 x 4	25 x 10	35 x 8	45 x 30	60 x 6
12 x 4	18 x 5	25 x 12	35 x 10	45 x 35	60 x 8
12 x 5	18 x 6	25 x 15	35 x 12	45 x 40	60 x 10
12 x 6	18 x 8	25 x 16	35 x 15	45 x 45	60 x 12
12 x 7	18 x 10	25 x 18	35 x 16	50 x 3	60 x 15
12 x 8	18 x 12	25 x 20	35 x 18	50 x 4	60 x 16
12 x 10	18 x 15	25 x 25	35 x 20	50 x 5	60 x 18
12 x 12	18 x 16	28 x 28	35 x 25	50 x 6	60 x 20
14 x 2	18 x 18	30 x 3	35 x 30	50 x 8	60 x 25
14 x 3	20 x 2	30 x 4	35 x 35	50 x 10	60 x 30
14 x 4	20 x 3	30 x 5	40 x 3	50 x 12	60 x 35
14 x 5	20 x 4	30 x 6	40 x 4	50 x 15	60 x 40
14 x 6	20 x 5	30 x 8	40 x 5	50 x 16	60 x 50
14 x 8	20 x 6	30 x 10	40 x 6	50 x 18	60 x 60
14 x 10	20 x 8	30 x 12	40 x 8	50 x 20	65 x 3
14 x 12	20 x 10	30 x 15	40 x 10	50 x 25	65 x 4
15 x 2	20 x 12	30 x 16	40 x 12	50 x 30	65 x 5
15 x 3	20 x 15	30 x 18	40 x 15	50 x 35	65 x 6



Sizes currently stocked



Availability on request

# BRIGHT MILD STEEL STANDARD SIZES

SIZE X SIZE	SIZE X SIZE	SIZE X SIZE	SIZE X SIZE	SIZE X SIZE	SIZE X SIZE
65 x 8	75 x 35	100 x 6	120 x 35	150 x 20	220 x 15
65 x 10	75 x 40	100 x 8	120 x 40	150 x 25	220 x 20
65 x 12	75 x 50	100 x 10	120 x 50	150 x 30	220 x 25
65 x 15	80 x 3	100 x 12	120 x 60	150 x 40	220 x 30
65 x 16	80 x 4	100 x 15	125 x 8	150 x 50	250 x 8
65 x 20	80 x 5	100 x 16	125 x 10	150 x 60	250 x 10
65 x 25	80 x 6	100 x 18	125 x 12	160 x 8	250 x 12
65 x 30	80 x 8	100 x 20	125 x 15	160 x 10	250 x 15
65 x 35	80 x 10	100 x 25	125 x 20	160 x 12	250 x 20
65 x 40	80 x 12	100 x 30	125 x 25	160 x 15	250 x 25
65 x 50	80 x 15	100 x 35	125 x 30	160 x 20	250 x 30
70 x 3	80 x 16	100 x 40	130 x 8	160 x 25	250 x 40
70 x 4	80 x 18	100 x 50	130 x 10	160 x 30	250 x 50
70 x 5	80 x 20	100 x 60	130 x 12	160 x 40	250 x 60
70 x 6	80 x 25	110 x 5	130 x 15	160 x 50	300 x 8
70 x 8	80 x 30	110 x 6	130 x 20	160 x 60	300 x 10
70 x 10	80 x 35	110 x 8	130 x 25	180 x 8	300 x 12
70 x 12	80 x 40	110 x 10	130 x 30	180 x 10	300 x 15
70 x 15	80 x 50	110 x 12	130 x 40	180 x 12	300 x 20
70 x 16	80 x 60	110 x 15	130 x 50	180 x 15	300 x 25
70 x 20	90 x 4	110 x 20	130 x 60	180 x 20	300 x 30
70 x 25	90 x 5	110 x 25	140 x 8	180 x 25	300 x 40
70 x 30	90 x 6	110 x 30	140 x 10	180 x 30	300 x 50
70 x 35	90 x 8	110 x 35	140 x 12	180 x 40	300 x 60
70 x 40	90 x 10	110 x 40	140 x 15	180 x 50	350 x 10
70 x 50	90 x 12	110 x 50	140 x 20	180 x 60	350 x 12
70 x 60	90 x 15	110 x 60	140 x 25	200 x 8	350 x 15
75 x 5	90 x 16	120 x 5	140 x 30	200 x 10	350 x 20
75 x 6	90 x 20	120 x 6	140 x 40	200 x 12	350 x 30
75 x 8	90 x 25	120 x 8	140 x 50	200 x 15	400 x 10
75 x 10	90 x 30	120 x 10	140 x 60	200 x 20	400 x 12
75 x 12	90 x 35	120 x 12	150 x 8	200 x 25	400 x 15
75 x 15	90 x 40	120 x 15	150 x 10	200 x 30	400 x 20
75 x 18	90 x 50	120 x 16	150 x 12	200 x 40	400 x 30
75 x 20	90 x 60	120 x 20	150 x 15	200 x 50	400 x 40
75 x 25	100 x 4	120 x 25	150 x 16	200 x 60	
75 x 30	100 x 5	120 x 30	150 x 18	220 x 12	



Sizes currently stocked



Availability on request

# C45K KEYSTEEL

BS 970	SAE (A1S1)	WERKSTOFF NO
080 A46	1045	1.1191

## CHEMICAL COMPOSITION

CARBON	: 0,42 - 0,50
SILICON	: 0,17 - 0,37
MANGANESE	: 0,50 - 0,80
SULPHUR	: 0,035 MAX
PHOSPHORUS	: 0,035 MAX

## STANDARD STOCK SIZES

SIZE	SIZE	SIZE	SIZE
4 x 4	12 x 10	22 x 22	32 x 18
5 x 5	14 x 14	22 x 14	36 x 36
6 x 6	14 x 9	25 x 25	36 x 20
8 x 8	16 x 16	25 x 14	38 x 38
8 x 7	16 x 10	28 x 28	40 x 40
10 x 10	18 x 18	28 x 16	40 x 22
10 x 8	18 x 11	30 x 30	40 x 25
12 x 12	20 x 20	32 x 32	45 x 45
12 x 8	20 x 12	32 x 16	50 x 50

## TYPICAL USES:

MANUFACTURE OF VARIOUS KEYS.



# 230M07 LEADED

## 9S Mn Pb 28

BS 970	SAE (AISI)	WERKSTOFF NO
230M07 LEADED	12 L 14	1.0718

## 9S Mn Pb 36

BS 970	SAE (AISI)	WERKSTOFF NO
ENIA LEADED	12 L 14	1.0737

## CHEMICAL COMPOSITION

CARBON : 0,14 MAX  
 SILICON : 0,05 MAX  
 MANGANESE : 0,90 - 1,30  
 SULPHUR : 0,24 - 0,32  
 PHOSPHORUS : 0,10 MAX  
 LEAD : 0,15 - 0,30

## CHEMICAL COMPOSITION

CARBON : 0,15 MAX  
 SILICON : 0,05 MAX  
 MANGANESE : 1,00 - 1,50  
 SULPHUR : 0,32 - 0,40  
 PHOSPHORUS : 0,10 MAX  
 LEAD : 0,15 - 0,30

## STANDARD STOCK SIZES

### ROUND

SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m
6mm	0,222	16mm	1,578	28mm	4,824	50mm	15,413
7mm	0,302	17mm	1,782	30mm	5,549	55mm	18,650
8mm	0,395	18mm	1,998	32mm	6,313	60mm	22,195
9mm	0,499	19mm	2,226	35mm	7,553	65mm	26,049
10mm	0,617	20mm	2,466	36mm	7,990	70mm	30,210
11mm	0,746	22mm	2,984	38mm	8,903	75mm	34,680
12mm	0,888	24mm	3,551	40mm	9,865	80mm	39,458
1/2"	0,994	25mm	3,853	42mm	10,876		
14mm	1,175	1"	3,978	45mm	12,485		
15mm	1,387	26mm	4,168	48mm	14,205		

### HEXAGONS

SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m
10mm	0,680	24mm	3,916	41mm	11,428
11mm	0,823	25mm	4,250	42mm	11,995
13mm	1,149	27mm	4,956	46mm	14,385
14mm	1,332	28mm	5,331	50mm	16,996
17mm	1,965	30mm	6,118	55mm	20,565
19mm	2,455	32mm	6,963		
20mm	2,719	36mm	8,811		
22mm	3,291	38mm	9,817		

**SQUARES AND FLATS ALSO AVAILABLE ON ENQUIRY.**

## TYPICAL USES:

FOR HIGH SPEED PRODUCTION OF REPETITION WORK EG. MANUFACTURE OF BUSHES, PINS, BOLTS, NUTS, STUDS AND COUPLINGS, WHERE THE MAJOR REQUIREMENTS ARE RAPID MACHINING AND MAXIMUM TOOL LIFE.

CUTTING SPEEDS AND FEEDS CAN BE INCREASED CONSIDERABLY DUE TO THE HIGHER LEAD CONTENT.

# 220MO7 (En 1A)

BS 970	SAE (AISI)	WERKSTOFF NO
220 M 07	1112	1.0711

## CHEMICAL COMPOSITION

CARBON	: 0,07 - 0,15
SILICON	: 0,10 MAX
MANGANESE	: 0,80 - 1,20
SULPHUR	: 0,20 - 0,30
PHOSPHORUS	: 0,07 MAX

## MECHANICAL PROPERTIES

PROPERTY	SIZE: (Diameter or Width across flats) mm			
	13,5mm or less	13,5mm to 38mm	38mm to 63,5mm	63,5mm to 100mm
Tensile Strength, MPa	490	430	385	355
Elongation percent, Min	10	14	14	14

## STANDARD STOCK SIZES

SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m
6	0,222	13	1,042	24	3,551	35	7,553
7	0,302	14	1,175	25	3,853	36	7,990
8	0,395	15	1,387	26	4,168	38	8,903
9	0,499	16	1,578	27	4,495	40	9,865
10	0,617	18	1,998	28	4,824	45	12,485
11	0,746	20	2,466	30	5,549	50	15,413
12	0,888	22	2,984	32	6,313	55	18,650

**SQUARES AND FLATS ALSO AVAILABLE ON ENQUIRY.**

### TYPICAL USES:

FOR HIGH SPEED PRODUCTION OF REPETITION WORK (E.G. MANUFACTURE OF BUSHES, PINS, BOLTS, NUTS, STUDS, AND COUPLINGS) WHERE THE MAJOR REQUIREMENTS ARE RAPID MACHINING AND MAXIMUM TOOL LIFE.

CUTTING SPEEDS ON BRIGHT DRAWN FREECUTTINGS STEEL BAR ARE CONSIDERABLY ABOVE THOSE OF ORDINARY MILD QUALITY STEEL, AND COMPONENTS ARE PRODUCED OF SIMILAR MECHANICAL PROPERTIES WITH A FAR SUPERIOR SURFACE FINISH.

# 070M20 (En3B) BRIGHT

BS 970	SAE (AISI)	WERKSTOFF NO
070 M 20	1020	1.0402

## CHEMICAL COMPOSITION

CARBON	: 0,25 MAX
SILICON	: 0,35 MAX
MANGANESE	: 1,00 MAX
SULPHUR	: 0,06 MAX
PHOSPHORUS	: 0,06 MAX

## MECHANICAL PROPERTIES

PROPERTY	NORMALIZED
Tensile Strength, MPa, Min	430
Elongation percent, Min	17

## STANDARD STOCK SIZES

SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m
6mm	0,222	20 mm	2,466	38 mm	8,903	70 mm	30,210	125 mm	96,337
7 mm	0,302	21 mm	2,719	1.1/2"	8,950	75 mm	34,680	127 mm	99,441
8 mm	0,395	22 mm	2,984	40 mm	9,865	3"	35,799	130 mm	104,195
9 mm	0,499	7/8"	3,045	42 mm	10,876	80 mm	39,458	135 mm	112,364
10 mm	0,617	24 mm	3,551	1.3/4"	12,181	85 mm	44,545	140 mm	120,841
11 mm	0,746	25 mm	3,853	45 mm	12,485	3.1/2"	48,726	145 mm	129,627
12 mm	0,888	1"	3,978	48 mm	14,205	90 mm	49,939	150 mm	138,721
1/2"	0,994	26 mm	4,168	50 mm	15,413	95 mm	55,642	6"	143,195
14 mm	1,175	28 mm	4,824	2"	15,911	100 mm	61,654	155 mm	148,123
15 mm	1,387	1.1/8"	5,034	2.1/8"	17,962	4"	63,642	160 mm	157,833
5/8"	1,554	30 mm	5,549	55 mm	18,650	105 mm	67,973		
16 mm	1,578	1.1/4"	6,215	2.1/4"	20,137	110 mm	74,601		
17 mm	1,782	32 mm	6,313	60 mm	22,195	4.1/2"	80,547		
18 mm	1,998	35 mm	7,553	2.1/2"	24,861	115 mm	81,537		
19 mm	2,226	36 mm	7,990	65 mm	26,049	120 mm	88,781		

## TYPICAL USES:

SHAFTS, BOLTS, NUTS, STUDS, COUPLINGS AND MACHINERY COMPONENTS WHERE A LOW TENSILE STRENGTH MATERIAL IS REQUIRED.

# 080M40 (En8) BRIGHT

BS 970	SAE (AISI)	WERKSTOFF NO
080 M 40	1043	1.0503

## CHEMICAL COMPOSITION

CARBON	: 0,36 - 0,44
SILICON	: 0,05 - 0,35
MANGANESE	: 0,60 - 1,00
SULPHUR	: 0,06 MAX
PHOSPHORUS	: 0,06 MAX

## MECHANICAL PROPERTIES

PROPERTY	
Limited Ruling Section Min	150
Tensile Strength, MPa, Min	540
Yield Stress, MPa, Min	277
Elongation percent, Min	17
Izod Impact Value, Joule, Min	-
Brinell Hardness Number	152/207

## STANDARD STOCK SIZES

SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m
6mm	0,222	20 mm	2,466	38 mm	8,903	70 mm	30,210	125 mm	96,337
7 mm	0,302	21 mm	2,719	1.1/2"	8,950	75 mm	34,680	127 mm	99,441
8 mm	0,395	22 mm	2,984	40 mm	9,865	3"	35,799	130 mm	104,195
9 mm	0,499	7/8"	3,045	42 mm	10,876	80 mm	39,458	135 mm	112,364
10 mm	0,617	24 mm	3,551	1.3/4"	12,181	85 mm	44,545	140 mm	120,841
11 mm	0,746	25 mm	3,853	45 mm	12,485	3.1/2"	48,726	145 mm	129,627
12 mm	0,888	1"	3,978	48 mm	14,205	90 mm	49,939	150 mm	138,721
1/2"	0,994	26 mm	4,168	50 mm	15,413	95 mm	55,642	6"	143,195
14 mm	1,175	28 mm	4,824	2"	15,911	100 mm	61,654	155 mm	148,123
15 mm	1,387	1.1/8"	5,034	2.1/8"	17,962	4"	63,642	160 mm	157,833
5/8"	1,554	30 mm	5,549	55 mm	18,650	105 mm	67,973		
16 mm	1,578	1.1/4"	6,215	2.1/4"	20,137	110 mm	74,601		
17 mm	1,782	32 mm	6,313	60 mm	22,195	4.1/2"	80,547		
18 mm	1,998	35 mm	7,553	2.1/2"	24,861	115 mm	81,537		
19 mm	2,226	36 mm	7,990	65 mm	26,049	120 mm	88,781		

## TYPICAL USES:

DYNAMO AND MOTORSHAFTS, HEAT-TREATED BOLTS, CRANKSHAFTS, CONNECTING RODS, DRIVING RINGS AND FLANGES, RAILWAY COUPLINGS, AXLES, BRACKETS, HOUSINGS, MISCELLANEOUS GUN CARRIAGE AND SMALL ARMS PARTS NOT SUBJECTED TO HIGH STRESSES OR SEVERE WEAR.

# (En1A) HEXAGONS (En8)

BS 970	SAE (AISI)	WERKSTOFF NO
220 M 07	1112	1.0711

BS 970	SAE (AISI)	WERKSTOFF NO
080 M 40	1043	1.0503

## CHEMICAL COMPOSITION

CARBON	: 0,07 - 0,15
SILICON	: 0,10 MAX
MANGANESE	: 0,80 - 1,20
SULPHUR	: 0,20 - 0,30
PHOSPHORUS	: 0,07 MAX

## CHEMICAL COMPOSITION

CARBON	: 0,36 - 0,44
SILICON	: 0,05 - 0,35
MANGANESE	: 0,60 - 1,00
SULPHUR	: 0,06 MAX
PHOSPHORUS	: 0,06 MAX

## MECHANICAL PROPERTIES

En 1A		En 8
100	Limited Ruling Section Min	150
355	Tensile Strength, MPa, Min	540
	Yield Stress, MPa	278
14	Elongation percent, Min	20
	Izod Impact Value, Joule, Min	
103	Brinell Hardness Number	152/207

## STANDARD STOCK SIZES

SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m
10	0,680	18	2,203	36	8,811
11	0,823	20	2,719	38	9,817
12	0,979	21	2,998	41	11,428
13	1,149	24	3,916	46	14,385
14	1,332	26	4,596	50	16,996
15	1,530	27	4,956	55	20,565
16	1,740	30	6,118		
17	1,965	33	7,403		

## TYPICAL USES:

**En 1A:** FOR HIGH SPEED PRODUCTION OF REPETITION WORK (E.G. MANUFACTURE OF BUSHES, PINS, BOLTS, NUTS, STUDS AND COUPLINGS) WHERE THE MAJOR REQUIREMENTS ARE RAPID MACHINING AND MAXIMUM TOOL LIFE.

**En 8:** DYNAMO AND MOTORSHAFTS, HEAT-TREATED BOLTS, CRANKSHAFTS, CONNECTING RODS, DRIVING RINGS AND FLANGES, RAILWAY COUPLINGS, AXLES, BRACKETS, HOUSINGS, MISCELLANEOUS GUN CARRIAGE AND SMALL ARMS PARTS NOT SUBJECTED TO HIGH STRESSES OR SEVERE WEAR.

# 070M20 (En 3A) BLACK

BS 970	SAE (AISI)	WERKSTOFF NO
070 M 20	1020	1.0402

## CHEMICAL COMPOSITION

CARBON	: 0,15 - 0,25
SILICON	: 0,05 - 0,35
MANGANESE	: 0,40 - 0,90
SULPHUR	: 0,06 MAX
PHOSPHORUS	: 0,06 MAX

## MECHANICAL PROPERTIES

PROPERTY	NORMALIZED
Limited Ruling Section mm	152
Tensile Strength, MPa, Min	432
Elongation percent, Min	21

## STANDARD STOCK SIZES IN THE AS ROLLED OR NORMALIZED CONDITION

SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m
20	2,466	65	26,049	115	81,537	200	246,614
25	3,853	70	30,210	120	88,781	210	271,893
30	5,549	75	34,680	130	104,195	220	298,403
35	7,553	80	39,458	140	120,841	230	326,148
40	9,865	85	44,545	150	138,721	240	355,125
45	12,485	90	49,939	160	157,833	250	385,336
50	15,413	95	55,642	170	178,179		
55	18,650	100	61,654	180	199,757		
60	22,195	108	71,846	190	222,570		

## TYPICAL USES:

SHAFTS, BOLTS, NUTS, STUDS, COUPLINGS AND MACHINERY COMPONENTS WHERE A LOW TENSILE STRENGTH MATERIAL IS REQUIRED.

# 080M40 (En 8) BLACK

BS 970	SAE (AISI)	WERKSTOFF NO
080 M 40	1043	1.0503

## CHEMICAL COMPOSITION

CARBON	: 0,36 - 0,44
SILICON	: 0,05 - 0,35
MANGANESE	: 0,60 - 1,00
SULPHUR	: 0,06 MAX
PHOSPHORUS	: 0,06 MAX

## MECHANICAL PROPERTIES

PROPERTY	CONDITION		
	Normalized	Hardened & Tempered	
		Q	R
Limited Ruling Section mm	254	65	22
Tensile Strength, MPa	510/540	620/770	690/850
Yield Stress, MPa, Min	245	385	465
Elongation percent, Min	17	22	20
Izod Impact Value, Joule, Min	20	33,4	33,4
Brinell Hardness Number	152/207	179/229	210/255

## STANDARD STOCK SIZES IN THE AS ROLLED OR NORMALIZED CONDITION

SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m
20	2,466	65	26,049	115	81,537	200	246,614
25	3,853	70	30,210	120	88,781	210	271,893
30	5,549	75	34,680	130	104,195	220	298,403
35	7,553	80	39,458	140	120,841	230	326,148
40	9,865	85	44,545	150	138,721	240	355,125
45	12,485	90	49,939	160	157,833	250	385,336
50	15,413	95	55,642	170	178,179		
55	18,650	100	61,654	180	199,757		
60	22,195	108	71,846	190	222,570		

**ALL  
SIZES**

## TYPICAL USES:

DYNAMO AND MOTORSHAFTS, HEAT-TREATED BOLTS, CRANKSHAFTS, CONNECTING RODS, DRIVING RINGS AND FLANGES, RAILWAY COUPLINGS, AXLES, BRACKETS, HOUSINGS, MISCELLANEOUS GUN CARRIAGE AND SMALL ARMS PARTS NOT SUBJECTED TO HIGH STRESSES OR SEVERE WEAR.

# 080M40 (En8) BLACK HEXAGONS

BS 970	SAE (AISI)	WERKSTOFF NO
080 M 40	1043	1.0503

## CHEMICAL COMPOSITION

CARBON	: 0,36 - 0,44
SILICON	: 0,05 - 0,35
MANGANESE	: 0,60 - 1,00
SULPHUR	: 0,06 MAX
PHOSPHORUS	: 0,06 MAX

## MECHANICAL PROPERTIES

PROPERTY	NORMALIZED
Limited Ruling Section mm	150
Tensile Strength, MPa, Min	510/540
Yield Stress, MPa, Min	245
Elongation percent, Min	17
Izod Impact Value, Joule, Min	-
Brinell Hardness Numbers	152/207

## STANDARD, STOCK SIZES IN THE AS FORGED CONDITION

SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m
<b>60</b>	25,10	<b>85</b>	50,37	<b>120</b>	100,39
<b>65</b>	29,45	<b>90</b>	56,47	<b>130</b>	117,82
<b>70</b>	34,16	<b>95</b>	62,92		
<b>75</b>	39,21	<b>100</b>	69,71		
<b>80</b>	44,62	<b>115</b>	92,20		

## TYPICAL USES:

BOLTS, NUTS AND STUDS WHERE A HIGHER TENSILE STRENGTH MATERIAL IS REQUIRED.



# 070M55 (En 9)

BS 970	SAE (AISI)	WERKSTOFF NO
070 M 55	1055	1.1209

## CHEMICAL COMPOSITION

CARBON	: 0,50 - 0,60
SILICON	: 0,05 - 0,35
MANGANESE	: 0,50 - 0,80
SULPHUR	: 0,06 MAX
PHOSPHORUS	: 0,06 MAX

## MECHANICAL PROPERTIES

PROPERTY	NORMALIZED
Limited Ruling Section mm	254
Tensile Strength, MPa	600/700
Yield Stress, MPa, Min	310
Elongation percent, Min	13
Brinell Hardness Number	201/255

## STANDARD STOCK SIZES IN THE AS ROLLED OR NORMALIZED CONDITION

SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m
20	2,466	65	26,049	115	81,537	200	246,614
25	3,853	70	30,210	120	88,781	210	271,893
30	5,549	75	34,680	130	104,195	220	298,403
35	7,553	80	39,458	140	120,841	230	326,148
40	9,865	85	44,545	150	138,721	240	355,125
45	12,485	90	49,939	160	157,833	250	385,336
50	15,413	95	55,642	170	178,179		
55	18,650	100	61,654	180	199,757		
60	22,195	108	71,846	190	222,570		

## TYPICAL USES:

SPROCKETS AND SPRINGS, CYLINDERS, CAMS, CRANKSHAFTS, KEYS, SMALL ARMS PARTS SUCH AS RIFLE BARRELS, SMALL GEARS, MACHINE TOOLS, BALLS FOR BALL MILLS, BALLRACES, MACHINED PARTS REQUIRING MODERATE WEAR RESISTANCE.

# 709M40 (En 19)

BS 970	SAE (AISI)	WERKSTOFF NO
709 M 40	4140	1.7225

## CHEMICAL COMPOSITION

CARBON	: 0,35 - 0,45
SILICON	: 0,10 - 0,35
MANGANESE	: 0,50 - 0,80
CHROMIUM	: 0,90 - 1,20
MOLYBDENUM	: 0,20 - 0,40
SULPHUR	: 0,05 MAX
PHOSPHORUS	: 0,05 MAX

## MECHANICAL PROPERTIES

PROPERTY	HARDENED & TEMPERED CONDITION				
	R	S	T	U	V
Limited Ruling Section mm	254	152	102	64	29
Tensile Strength, MPa	690/850	770/930	850/1000	930/1080	1000/1160
Yield Stress, MPa, Min	480	570	665	740	835
Elongation percent, Min	15	15	13	12	12
Izod Impact Value, Joule, Min	34	54	54	47,5	47,5
Brinell Hardness Numbers	201/255	223/277	248/302	269/321	293/341

## STANDARD STOCK SIZES IN AS ROLLED AND HEAT TREATED CONDITION

SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m
20	2,466	60	22,195	100	61,654	170	178,179
25	3,853	65	26,049	108	71,846	180	199,757
30	5,549	70	30,210	115	81,537	190	222,570
35	7,553	75	34,680	120	88,781	200	246,614
40	9,865	80	39,458	130	104,195	210	271,893
45	12,485	85	44,545	140	120,841	220	298,403
50	15,413	90	49,939	150	138,721	230	326,148
55	18,650	95	55,642	160	157,833	250	385,336

## TYPICAL USES:

AXLE SHAFTS, CRANKSHAFTS, CONNECTING RODS, GEARS, HIGH TENSILE BOLTS AND STUDS, PROPELLER SHAFT JOINTS, RIFLE BARRELS AND BREECH MECHANISMS FOR SMALL ARMS PARTS, INDUCTION HARDENED TRACKPINS.

# 817M40 (En 24)

BS 970	SAE (AISI)	WERKSTOFF NO
817 M 40	9850	1.6565

## CHEMICAL COMPOSITION

CARBON	: 0,35 - 0,45
SILICON	: 0,10 - 0,35
MANGANESE	: 0,45 - 0,70
NICKEL	: 1,30 - 1,80
CHROMIUM	: 0,90 - 1,40
MOLYBDENUM	: 0,20 - 0,35
SULPHUR	: 0,05 MAX
PHOSPHORUS	: 0,05 MAX

## MECHANICAL PROPERTIES

PROPERTY	HARDENED & TEMPERED CONDITION					
	T	U	V	W	X	Z
Limited Ruling Section mm	254	102	64	29	29	29
Tensile Strength, MPa	850/1000	930/1080	1000/1160	1080/1240	1160/1310	1540
Yield Stress, MPa, Min	635	740	835	925	1005	1130
Elongation percent, Min	13	12	12	11	10	5
Izod Impact Value, Joule, Min	40,7	47,5	47,5	40,7	34	11
Brinell Hardness Numbers	248/302	269/321	293/341	311/375	341/388	444 min

## STANDARD STOCK SIZES IN AS ROLLED AND HEAT TREATED CONDITION

SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m
20	2,466	60	22,195	100	61,654	170	178,179
25	3,853	65	26,049	108	71,846	180	199,757
30	5,549	70	30,210	115	81,537	190	222,570
35	7,553	75	34,680	120	88,781	200	246,614
40	9,865	80	39,458	130	104,195	210	271,893
45	12,485	85	44,545	140	120,841	220	298,403
50	15,413	90	49,939	150	138,721	230	326,148
55	18,650	95	55,642	160	157,833	250	385,336

## TYPICAL USES:

AUTOMOBILE MAIN SHAFTS, AXLE SHAFTS, CONNECTING ROD BOLTS, SYNCHRONISING CONES, PUSH RODS, STUDS, DIFFERENTIAL SHAFTS, MOTORCYCLE KICK STARTER RATCHETS, PINION SLEEVES, MANDREL BARS FOR TUBE MANUFACTURING, GUN BARRELS, BREECH MECHANISM PARTS, HIGH DUTY ENGINE CONNECTING RODS, HIGH TEMPERATURE BOLTS IN OIL REFINING AND STEAM INSTALLATIONS, VARIOUS PARTS OF MACHINE TOOLS SUCH AS SPINDLE GEARS, COMPENSATING WASHERS, POWER TRANSMISSION GEARS, SLIDE RACKS AND SLIDE CAMS.

# 835M30 (En 30B)

BS 970	SAE (AISI)	WERKSTOFF NO
835 M 30	-	1.6747

## CHEMICAL COMPOSITION

CARBON	: 0,26 - 0,34
SILICON	: 0,10 - 0,35
MANGANESE	: 0,40 - 0,60
NICKEL	: 3,90 - 4,30
CHROMIUM	: 1,10 - 1,40
MOLYBDENUM	: 0,20 - 0,40
SULPHUR	: 0,05 MAX
PHOSPHORUS	: 0,05 MAX

## MECHANICAL PROPERTIES

PROPERTY	CONDITION Z
Limited Ruling Section mm	152
Tensile Strength, MPa, Min	1540
Yield Stress, MPa, Min	1125
Elongation percent, Min	7
Izod Impact Value, Joule, Min	20
Brinell Hardness Numbers	444 min

## STANDARD STOCK SIZES IN THE ANNEALED CONDITION

SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m
20	2,466	60	22,195	100	61,654	170	178,179
25	3,853	65	26,049	108	71,846	180	199,757
30	5,549	70	30,210	115	81,537	190	222,570
35	7,553	75	34,680	120	88,781	200	246,614
40	9,865	80	39,458	130	104,195	210	271,893
45	12,485	85	44,545	140	120,841	220	298,403
50	15,413	90	49,939	150	138,721	230	326,148
55	18,650	95	55,642	160	157,833	250	385,336

## TYPICAL USES:

GEARS, SHAFTS, HIGH DUTY BOLTS, HIGH DUTY SPINDLES AND OTHER PARTS DEMANDING MAXIMUM STRENGTH, TOUGHNESS OR WEAR RESISTANCE.

THIS STEEL IS STOCKED IN THE ANNEALED CONDITION, TO RENDER MACHINING POSSIBLE, AND MUST BE HEAT TREATED AS FOLLOWS:

HARDEN IN AIR (OR OIL FOR LARGER SECTIONS OVER 2½" DIAMETERS) FROM A TEMPERATURE OF 810° / 830° C. TEMPER, IF DESIRED, AT A SUITABLE TEMPERATURE NOT EXCEEDING 250° C.

# 655M13 (En 36B)

BS 970	SAE (AISI)	WERKSTOFF NO
655 M 13	3316	1.5752

## CHEMICAL COMPOSITION

CARBON	: 0,12 - 0,18
SILICON	: 0,10 - 0,35
MANGANESE	: 0,30 - 0,60
NICKEL	: 3,00 - 3,75
CHROMIUM	: 0,60 - 1,10
SULPHUR	: 0,05 MAX
PHOSPHORUS	: 0,05 MAX

## MECHANICAL PROPERTIES

PROPERTY	
Tensile Strength, MPa, Min	1000
Elongation percent, Min	9
Izod Impact Value, Joule, Min	30

## STANDARD STOCK SIZES IN THE AS ROLLED CONDITION

SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m	SIZE	Kg/m
20	2,466	60	22,195	100	61,654	170	178,179
25	3,853	65	26,049	108	71,846	180	199,757
30	5,549	70	30,210	115	81,537	190	222,570
35	7,553	75	34,680	120	88,781	200	246,614
40	9,865	80	39,458	130	104,195	210	271,893
45	12,485	85	44,545	140	120,841	220	298,403
50	15,413	90	49,939	150	138,721	230	326,148
55	18,650	95	55,642	160	157,833	250	385,336

## TYPICAL USES:

HIGH DUTY GEARS FOR AIRCRAFT, AUTO AND HEAVY VEHICLE TRANSMISSION COMPONENTS, STEERING WORMS, TRACK ROD PINS, GUDGEON PINS, TIMING WHEELS, BREECH MECHANISMS AND SMALL ARMS PARTS.

# HOLLOW BAR SIZE AND WEIGHT CHART

## ST 52

OD	ID	Wall thickness mm	± Weight Kg/M	OD	ID	Wall thickness mm	± Weight Kg/M	OD	ID	Wall thickness mm	± Weight Kg/M
32	16	8	4,74	125	90	17,5	46,4	273	223	25	154
32	20	6	3,85	125	100	12,5	34,7	273	228	22,5	140
36	16	10	6,41	132	71	30,5	76,3	292	228	32	206
36	20	8	5,52	132	90	21	57,5	292	242	25	165
36	25	5,5	4,14	132	106	13	38,2	292	252	20	135
40	20	10	7,40	140	80	30	81,4	298	198	50	307
40	25	7,5	6,01	140	100	20	59,2	298	208	45	282
40	28	6	5,03	140	112	14	43,5	298	218	40	255
45	20	12,5	10,1	150	80	35	99,3	298	226	36	234
45	28	8,5	7,65	150	106	22	69,4	298	234	32	210
45	32	6,5	6,17	150	125	12,5	42,4	298	238	30	199
50	25	12,5	11,6	160	90	35	107,9	318	228	50	331
50	32	9	9,10	160	112	24	80,5	318	228	45	303
50	36	7	7,42	160	132	14	50,4	318	238	40	275
56	28	14	14,5	170	100	35	115,8	318	254	32	226
56	36	10	11,3	170	118	26	92,3	318	268	25	182
56	40	8	9,47	170	140	15	57,3	318	275	20	147
63	32	15,5	18,2	180	100	40	138,2	318	293	12,5	94
63	40	11,5	14,6	180	125	27,5	103,4	324	224	50	338
63	50	6,5	9,06	180	150	15	61,0	324	234	45	310
71	36	17,5	23,1	190	106	42	153,6	324	244	40	280
71	45	13	18,6	190	132	29	115,1	324	260	32	231
71	56	7,5	11,7	190	160	15	64,7	324	274	25	185
75	40	17,5	24,8	200	112	44	169,5	324	284	20	150
75	50	12,5	19,3	200	140	30	125,8	355	255	50	376
75	60	7,5	12,5	200	160	20	88,8	355	265	45	343
80	40	20	29,6	212	125	43,5	181,0	355	275	40	310
80	50	15	24,0	212	150	31	138,0	355	291	32	254
80	63	8,5	15,0	212	170	21	98,9	355	305	25	203
85	45	20	32,1	224	132	46	202,0	355	315	20	165
85	55	15	25,9	224	160	32	151,5	355	330	12,5	105
85	67	9	16,9	224	180	22	109,6	406	306	50	439
90	50	20	34,5	236	140	48	223,0	406	316	45	401
90	63	13,5	25,5	236	170	33	165,1	406	326	40	361
90	71	9,5	18,9	236	190	23	120,8	406	342	32	295
95	50	22,5	40,2	250	150	50	247,0	406	356	25	234
95	67	14	28,0	250	180	35	185,5	406	362	22,5	207
95	75	10	21,0	250	200	25	138,7	406	366	20	189
100	56	22	42,3	254	154	50	252	419	319	50	455
100	71	14,5	30,6	254	184	35	189	419	329	45	415
100	80	10	22,2	254	204	25	142	419	339	40	374
106	56	25	49,9	267	167	50	268	419	355	32	305
106	71	17,5	38,2	267	187	40	224	419	369	25	245
106	80	13	29,8	267	217	25	150	419	379	20	197
112	63	24,5	52,9	267	228	19,5	120				
112	80	16	37,9	273	167	53	288				
112	90	11	27,4	273	173	50	276				
118	63	27,5	61,4	273	183	45	253				
118	80	19	46,4	273	193	40	231				
118	90	14	35,9	273	201	36	211				
125	71	27	65,3	273	217	28	170				

**ALL  
SIZES**

**476/K110®**

Colour Code: White &amp; Black

**D2****1.2379**HIGH DUTY TOOL STEELSAIWERKSTOFF No

<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>Cr</b>	<b>Mo</b>	<b>W</b>	<b>V</b>	<b>Co</b>
1.55			12.0	0.85		0.28	

**Features and Uses**

Being of the high carbon, high chromium type this steel offers very high wear resistance, yet it is tough and machinable. It hardens in air up to large sections with a low order of movement and offers a measure of corrosion resistance when polished.

"476" is used for tools operating under conditions of severe wear and abrasion or as an alternative to oil hardening tool steels when longer runs are required.

Applications include blanking dies and punches for steel sheet and plate, high silicon transformer materials, stainless steel and iron, brass, copper, zinc and hard abrasive metals generally. Deep drawing dies, cupping dies, forming dies. Sheet metal forming rolls, shear blades for strip and sheet including flying shears. Circular cutters for cold rolled strip. Trimmer dies, thread rolling dies, cold extrusion dies. Broaches, plug gauges, ring gauges, special taps, staybolt taps. Brick and tile mould liners. Master hobs for cold hobbing, plastic moulds. Cut moulds for plastics.

**Working and Heat Treatment Forging**

Pre-heat at 900°C / 950°C. then raise temperature to 1050° / 1100°C. Soak until uniformly heated. This steel is relatively hard at elevated temperatures, therefore, initial hammer blows must be light and the temperature must not be allowed to fall below 1020°C. until the metal begins to flow. Final forging should not be done below 900°C.

**Annealing**

"476" is supplied in the annealed and machinable condition. Re-annealing will only be necessary if the steel has been forged by the toolmaker or if it is desired to machine a hardened tool. To anneal, heat slowly and uniformly to 900°C. in a protective gas atmosphere. Soak for three to four hours and allow to cool in the furnace to shop temperature. Then, without removing the steel from the furnace, re-heat to 800°C and again soak for three to four hours. Allow to cool in the furnace to shop temperature.

**Stress relieving**

When tools are heavily machined, ground or otherwise subjected to cold work, the relief of internal strains is advisable before hardening to minimize the possibility of distortion. Stress relieving should be done after rough machining. To stress relieve, heat carefully at 600° / 650°C. Soak well and cool in the furnace or in air. The tools may then be finish-machined before hardening.

**Hardening**

It is preferable to heat the tools in a controlled atmosphere. This material is ideal for vacuum hardening and also suited to salt bath hardening. If this is not possible, pack hardening is recommended. A reducing atmosphere is desirable. Pre-heat slowly to 750° / 800°C. and allow to soak at this temperature. The tools may then be brought up to 1000° / 1020°C. for air-cooling, or 980°C. for oil quenching. Soak thoroughly at the temperature for twenty to thirty minutes per inch of ruling section, then cool or quench accordingly. It is important not to exceed 1020°C. when heating for hardening. Exceeding this temperature will cause indifferent hardening. A deterioration in magnetic properties indicates that the steel has been overheated in hardening. Tempering will always be necessary.

**Martempering**

Martempering is an alternative hardening procedure, which may be used when suitable salt bath equipment is available. By this method internal strain, distortion and risk of quench cracking are reduced to the minimum. Pre-heat dry at 300°/400°C. Pre-heat in salt at 800° / 850°C. holding in the salt for ten minutes per 25 mm of ruling section. Raise to the hardening temperature of 1000° / 1020°C. holding in the salt for ten minutes per 25 mm of ruling section.

Marquench in salt at 230° / 250°C. , holding in the bath for twenty minutes per 25 mm of ruling section. Cool in still air. Tempering will be necessary.

**Tempering**

Double tempering is recommended. Tempering should be done with the least possible delay after hardening, preferably when the tools are still hand warm. Refer to the tempering curve and select a suitable temperature bearing in mind the service requirements. Heat slowly and uniformly. When the tool has reached the desired temperature, soak for at least sixty minutes, withdraw from the furnace and allow to cool in air. The second tempering should be a repetition of the first.

**Guide to Tempering Temperatures**

**TOOLS FOR LIGHT SHOCK APPLICATIONS** when maximum wear resistance is required, e.g. moulding dies, thin sheet-punching dies. Temper 190° - 250°C. Hardness Rockwell C60-63.

**MEDIUM DUTY APPLICATIONS** slitting cutters, plate punching dies, master hobbing tools, trimming dies, cold extrusion dies. Temper 500°-520°C. Hardness Rockwell C57-60.

**MEDIUM TO HEAVY DUTY APPLICATIONS** slitting cutters, shear blades, punching tools, forming tools, trimming dies, cold extrusion dies, and bolt cutters. Temper 520°-540°C. Hardness Rockwell C55-58.

**HEAVY DUTY APPLICATIONS** heavy shear blades, flying shears, heavy plate punching tools, punching and forming tools. Temper 540°-560°C. Hardness Rockwell C52-56.

**Final Grinding**

Select the correct grade of wheel in consultation with the grinding wheel manufacturer. Keep the wheel in good condition by means of a suitable dressing tool. Wet grinding is preferable using a copious supply of coolant. If dry grinding is resorted to, use a very soft wheel.

**K110 is a registered trade mark**

# “476 SPECIAL” 2% Carbon 12% Chromium

Colour Code: White/Black/Green

## D6

## 1.2436

HIGH DUTY TOOL STEEL

SAISI

WERKSTOFF No

C	Si	Mn	Ni	Cr	Mo	W	V	Co
2.1				12.0		0.7		

### Features and Uses

476 SPEC a high carbon high chromium steel noted for its resistance to abrasion. It offers excellent dimensional stability in hardening.

After heat treatment 476 SPEC is hard, durable and dense and is immune from sinking in use. It offers a measure of corrosion resistance when polished.

Applications: complex blanking and forming tools for long runs and for hard and abrasive materials. Brick and tile mould liners, master hobs for cold hobbing plastic moulds, tableting punches and sleeves for corrosive powders.

In general the applications of 476 SPEC resemble those of 476 but it should be remembered that 476 is the tougher of the two steels and is preferred for such items as shear blades. Owing to its higher wear resistance, 476 SPEC is somewhat more difficult to grind than 476

**Working and Heat Treatment Forging**  
Pre-heat at 900°/950°C, then raise temperature to 1050°/1100°C. Soak until uniformly heated. This steel is relatively hard at elevated temperatures; therefore, initial hammer blows must be light and the temperature must not be allowed to fall below 1020°C until the metal begins to flow. Final forging should not be done below 900°C.

### Annealing

476 Special supplied in the annealed and machineable condition. Re-annealing will only be necessary if the steel has been forged by the tool maker or if it is desired to machine a hardened tool. To anneal, heat slowly and uniformly to 900°C in a closed container. Soak for three to four hours and allow to cool in the furnace to shop temperature. Then, without removing the steel from the tube or container, re-heat to 800°C and again soak for three to four hours. Allow to cool in the furnace to shop temperature.

### Stress Relieving

When tools are heavily machined, ground or otherwise subjected to cold work, the relief of internal strains is advisable before hardening to minimise any possibility of distortion. Stress relieving should be done after rough machining. To stress relieve, heat carefully at 600°/650°C. Soak well and cool in the furnace or in air. The tools may then be finish-machined before hardening.

### Hardening

The tools must be protected against decarburisation by heating in a neutral salt bath or by pack hardening. For pack hardening the tools must be wrapped in oiled brown paper then packed into a lidded iron box with cast iron ships or turnings then heated to the hardening temperature. Pre-heat slowly to 750°/800°C and allow to soak before raising to the hardening temperature of 950°/980°C. Sufficient time must be allowed for the heat to penetrate the box and packing so that the tools attain full temperature. Soak for thirty minutes per inch of section of the container. Withdraw the container from the furnace and quench the tools in oil.

Tempering will then be necessary.

### Martempering

Martempering is an alternative hardening procedure which may be used when suitable salt bath equipped is available. By this method internal strain, distortion and risk of quench cracking are reduced to the minimum. Pre-heat dry at 300°/400°C. Pre-heat in salt at 800°/850°C holding in the salt for ten minutes per inch of ruling section.

Marquench in salt at 230°/250°C, holding in the bath for five minutes per inch of ruling section. Cool in still air. Tempering will be necessary.

### Tempering

Tempering between 180°/260°C, will give a hardness of C60/64 Rockwell, but tempering below 400°C is recommended for shock-free applications only. For maximum toughness, temper between 400°/540°C. Brick liners, temper at 180°C to Rockwell C62/64.

Blanking thin hardened and tempered strip, temper at 200°C to Rockwell C61/63.

Lamination dies, gauges, temper at 240°C to Rockwell C60/62.

General blanking and press tools, temper at 420°C to C59/58 Rockwell.

Heat slowly and uniformly. When the tool has reached the desired temperature, soak for at least sixty minutes, then withdraw from the furnace and allow to cool in still air away from draughts. Double tempering is beneficial. The second tempering should be a repetition of the first.



C	Si	Mn	Cr	Mo	W	V	Co
0.38	1.05	0.35	5.25	1.35		1.00	

### Features and Uses

C.M.V. is reliable hot work steel with a wide variety of applications. It combines very good red-hardness with toughness and tools made from it may be water-cooled in service.

C.M.V. may be cold hobbled in the annealed condition.

Applications include:

Die casting dies for aluminium, magnesium and zinc.

Extrusion dies for aluminium and glass.

Liners, mandrels, pressure pads, followers, bolsters, die cases, die holders and adaptor rings of copper and brass extrusion.

Hot stamping and press forge dies.

Split hot heading dies, gripper dies.

Hot punching, piercing and trimming tools. High speed wood turning, cutting and shaping.

Plastic moulds.

Shear blades for hot work.

Hot swaging dies.

### Work and Heat Treatment Forging

Preheat slowly to 750°C. then increase temperature more rapidly to 1050° / 1100°C. Do not forge below 850°C. It is essential to cool slowly after forging either in a furnace or in vermiculite.

### Annealing

Soak thoroughly at 840° / 860°C. before furnace cooling at a maximum rate of 20°C. per hour down to 600°C. followed by cooling in air. To avoid scaling, box annealing in cast iron chips is preferred.

### Stress Relieving

Heat carefully to 700°C, allow a good soaking period (2 hours per inch of ruling section) cool in furnace or in air.

### Hardening

Preheat to 780° / 820°C, soak thoroughly then increase rapidly to the hardening temperature

of 1000° / 1030°C. When the part has attained this temperature, soak for 20 to 30 minutes, cool in air. Large sections may be quenched in oil.

To reduce scaling or decarburisation we recommend isothermal molten salt bath treatment. Preheat in salt at 780° / 820°C then transfer to salt bath standing at 1000° / 1030°C, soak and quench into salt standing at 500° / 550°C, allow to equalize, withdraw and cool in air. Alternatively the steel may be vacuum hardened or pack hardened.

Tools should be tempered as soon as they become hand warm.

### Tempering

Heat uniformly to the required temperature allowing a soaking time of 2 hours per inch of ruling section, withdraw from the furnace and allow to cool in air. A second tempering is strongly recommended, the tool being allowed to cool to room temperature between tempers. The usual tempering range is 530° / 650°C. , depending on the hardness requirements and the operating temperature of the tool.

### Nitriding

C.M.V. will respond to Nitriding whether gas Nitriding (cracked ammonia) or liquid Nitriding (Tuftriding and Sulfinuz). The object of Nitriding is to increase the surface hardness of hardened and tempered parts, for example die casting dies, and to improve resistance to scaling or erosion.

It is important to note that with increase in penetration of the Nitriding there is a reduction in resistance to thermal shock and an increase in embrittlement.

### Welding

In general we do not advise the welding of parts or tools but users sometimes prefer to weld in order to avoid the cost of retooling.

It should be remembered that C.M.V. is an air hardening steel and that in welding, the area of the weld attains a temperature of about 1000°C. Cracking is likely to occur during cooling unless proper precautions are taken.

The most popular methods of welding are:

- a) Atomic Hydrogen
- b) Argon Arc

### Welding Procedure

- 1) It is desirable to anneal the tool prior to welding but with care welding may be done on hardened and tempered tools.
- 2) It is important to preheat the die to 300° / 500°C and to maintain this temperature during welding.
- 3) After the weld has been completed, maintain at 300° / 500°C for one hour, then cool the die slowly in a furnace or in insulating material.
- 4) If the tool has been annealed prior to welding, stress relieve at 700°C. before re-hardening.
- 5) If the tool has not been annealed prior to welding re-temper at 550° / 600°C for a minimum of 2 hours.

### Hot Hobbing

A number of die casting blocks in C.M.V. have been successfully hot hobbled.

# PITHO / GROUND FLAT STOCK SIZES

WIDE	1	1.5	2	2	4	5	6	8	10	12	15	20	25	30	50
10	●	●	●	●	●	●	●	●	●						
15	●	●	●	●	●	●	●	●	●	●	●				
20	●	●	●	●	●	●	●	●	●	●	●	●			
25	●	●	●	●	●	●	●	●	●	●	●	●	●		
30	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
40	●	●	●	●	●	●	●	●	●	●	●	●	●		
50	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
60	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
80	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
100	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
125	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
150	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
200	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
250			●	●	●	●	●	●	●	●	●	●	●	●	
300			●	●	●	●	●	●	●	●	●	●	●	●	
SQUARE	6	8	10	12	15	20	25	30	40	50	60	80			

**METRIC TOLERANCES:**

Thickness + 0.05 -0.00mm  
 Width up to 30mm +0.20 - 0.00mm  
 over 30mm to 120mm +0.30 -0.00mm  
 over 120mm to 300 mm +0.40 - 0.00mm

**LENGTHS:**

500mm & 1000mm

**IMPERIAL SIZES:**

+/-10 working days delivery

**NON-STANDARD SIZES & TOLERANCES:** available upon request

# SABEN 652

Colour Code: Pink

HIGH SPEED STEEL

# M2

SAISI

# 1.3343

WERKSTOFF No

C	Si	Mn	Cr	Mo	W	V	Co
0.83			4.1	5.0	6.4	1.9	

## Features and Uses

This is general-purpose high-speed steel and is a standard material with leading toolmakers for the manufacture of high-class cutting tools.

It has excellent wear resistance combined with toughness and is readily machinable in the annealed condition.

Applications include turning planning and slotting tools, reamers, drills, cutters, hobs, taps, punches and dies, blanking dies and punches for steel sheet and plate, high silicon transformer materials, stainless steel and iron, brass, copper, zinc and hard abrasive metals generally. Deep drawing dies, cupping dies, forming dies. Sheet metal forming rolls, shear blades for strip and sheet including flying shears. Circular cutters for cold rolled strip. Trimmer dies, thread rolling dies, cold extrusion dies. Broaches, plug gauges, ring gauges, special taps, staybolt taps. Brick and tile mould liners. Master hobs for cold hobbing, plastic moulds. Cut moulds for plastics.

## Working and Heat Treatment

### Forging

Pre-heat at 900°C / 950°C. then raise temperature to 1050° / 1150°C. Soak until uniformly heated. The temperature must not be allowed to fall below 880° / 900°C. Cool very slowly after forging and protect from draughts.

### Annealing

Saben 652 is supplied in the annealed and machinable condition. Re-annealing will only be necessary if the steel has been forged by the toolmaker

or if it is desired to machine a hardened tool.

To anneal, heat slowly and uniformly to 850°C. in a closed container. Soak for three to four hours and allow to cool in the furnace to shop temperature.

### Stress relieving

When tools are heavily machined, ground or otherwise subjected to cold work, the relief of internal strains is advisable before hardening to minimize the possibility of distortion. Stress relieving should be done after rough machining. To stress relieve, heat carefully at 650° / 700°C. Soak well and cool in the furnace or in air. The tools may then be finish-machined before hardening.

### Hardening

Very slow initial heating is essential when hardening high speed steels and the steel should be warmed through on the furnace top then pre-heated slowly to 840° / 860°C. and allow to soak at this temperature. It is preferable to heat the tools in a controlled atmosphere. If this is not possible, pack hardening is recommended. A reducing atmosphere is desirable. The tools may then be brought up to 1200° / 1240°C. Avoid undue soaking at the hardening temperature but remove when the tools are soaked through.

Hardening in a neutral salt bath is advantageous when treating cutters or other tools with delicate teeth or edges as it will minimize decarburisation. The tools should be air quenched from the hardening temperature in a dry air blast or oil, removed, and left to cool until hand warm before tempering.

## Martempering

Martempering is an alternative hardening procedure, which may be used when suitable salt bath equipment is available. By this method internal strain, distortion and risk of quench cracking are reduced to the minimum. Pre-heat dry at 300° / 400°C. Pre-heat in salt at 850 / 900°C holding in the salt for ten minutes per inch of ruling section. Raise to the hardening temperature of 1200° / 1240°C. holding in the salt until heated through.

Marquench in salt at 550° / 580°C, allow to equalize, remove and cool in still air until hand warm. Tempering will be necessary.

## Tempering

Double tempering is recommended. Tempering should be done with the least possible delay after hardening, preferably when the tools are still hand warm. Refer to the tempering curve and select a suitable temperature bearing in mind the service requirements usually 540° / 560°C. Heat slowly and uniformly. When the tool has reached the desired temperature, soak for at least sixty minutes, withdraw from the furnace and allow to cool in air. Double tempering is essential for maximum tool performance. The second tempering should be a repetition of the first.

## Final Grinding

Select the correct grade of wheel in consultation with the grinding wheel manufacturer. Keep the wheel in good condition by means of a suitable dressing tool. Wet grinding is preferable using a copious supply of coolant. If dry grinding is resorted to, use a very soft wheel.

**LTB** Colour Code: Orange & Grey

AIR HARDENING TOOL STEEL

**A6**

AISI

**1.2767**

WERKSTOFF No

C	Si	Mn	Ni	Cr	Mo	P	S
0.47	0.20	0.36	4.0	1.30	0.18	0.013	0.003

### Features and Uses

"LTB" die steel hardens in air at a low temperature and as a result distortion is kept to a minimum. It can be vacuum hardened, salt bath hardened and even pack hardened. This material superceded the well-known Sanbold 30 and "L.T.A.H." grades, the production of which has been discontinued. The hardening properties are almost identical to "L.T.A.H.", however, with the addition of Nickel and lower carbon content, "L.T.B." is tougher with a slightly lower maximum hardness of about 57/58 HRC.

"L.T.B." can also be hardened with a cutting torch flame for use as an emergency tool during a break down where maintaining production is critical. In this case, the whole of the tool is heated to a light red colour and allowed to cool in still air. In the case of large tools, the cutting edge only can be flame hardened. At a later stage the tool may be removed from service, thoroughly annealed and re-hardened by conventional methods such as salt bath or vacuum processes.

Applications include heavy forming dies, blanking dies, trimming dies, coining dies, notching dies, mandrels, retaining rings, rim rolls, bending tools, cold shears, plastic moulds, drive shafts and almost any application where extreme toughness coupled with wear resistance is desired.

**This material is becoming increasingly popular in the plastic moulding industry due to its mirror polishability, stability during hardening and toughness.**

### LTB offers:

- Outstanding freedom from size change and distortion.
- Capacity to through harden up to 90 mm thick
- Toughness with good hardness and wear resistance
- Good machinability
- Good polishability

### Working and Heat Treatment

#### Forging

Forge at 1050° / 1100°C. Reheat slowly when temperature fall below 850° / 900°C Slow cooling is necessary after forging. Allow to cool down with furnace if possible, otherwise cover with dry lime or ashes.

#### Normalising

Normalising is not recommended for this steel.

#### Annealing

Pack anneal in a tube or other closed container with clean cast iron borings at 640° / 650°C for at least 2 to 3 hours. Cool very slowly in the furnace. Brinell hardness after annealing will be approximately 255

#### Stress relieving

For applications where distortion must be at a minimum, we recommend stabilizing just before tools are finish machined in order to relieve machining strains. Heat to 620° / 650°C and allow to slow cool.

#### Hardening

Heat the steel to 840° / 870°C (upper limit for larger sizes). Soak for at least twenty minutes at the temperature.

### Quenching

Air, air blast, oil or Marquench at 300° / 350°C. Hardness obtainable in salt or oil is higher than that of air or vacuum

### Tempering

Immediately after hardening, re-heat, preferable in an air circulating tempering furnace, to the required tempering temperature and soak for one hour. Cool in air.

A suitable tempering temperature may be selected by reference to the Tempering Graph usually between 150° / 300 °C

### Guide to Tempering Temperatures

**TOOLS FOR LIGHT SHOCK APPLICATIONS** when maximum wear resistance is required, e.g. moulding dies, thin sheet-punching dies. Temper 150° / 200°C. Hardness Rockwell C54-57.

**MEDIUM DUTY APPLICATIONS** slitting cutters, plate punching dies, master hobbing tools, trimming dies, cold extrusion dies. Temper 250° / 300°C. Hardness Rockwell C52-54.

**MEDIUM TO HEAVY DUTY APPLICATIONS** slitting cutters, shear blades, punching tools, forming tools, trimming dies, cold extrusion dies, and bolt cutters. Temper 300°-320°C. Hardness Rockwell C50-52.

**HEAVY DUTY APPLICATIONS** heavy shear blades, flying shears, heavy plate punching tools, punching and forming tools. Temper 450° - 500°C. Hardness Rockwell C42-45.

# NEWHALL

Colour Code: White

OIL HARDENING TOOL STEEL

# O1

AISI

# 1.2510

WERKSTOFF No

C	Si	Mn	Cr	Mo	W	V
0.95		1.20	0.55		0.55	0.20

## Features and Uses

This moderately priced oil hardening tool steel hardens in oil from a low temperature, offers pronounced non-deforming characteristics and retains its original dimensions after oil hardening and tempering. It gives excellent wear resistance, holds a good cutting edge and is relatively easy to machine. Due to these properties, Newhall is excellent general-purpose tool steel often used where the expenses of high carbon high chromium steels would not be justified.

Typical applications of Newhall include medium run dies, intricate press tools, drawing punches, broaches, bushings, lathe centers, chuck jaws, master cavity sinking hobs, paper cutting machine knives, plug gauges, thread gauges and precision measuring tools generally, cams, cloth cutting knives, cold taps, reamers, collets, cutting hobs, strip slitting cutters, trimmer dies, tube expander rolls, plastic moulds and wood working knives.

## Working and Heat Treatment

### Forging

Heat slowly and begin forging at 980° / 1000°C. Do not allow temperature to fall below 800°C reheating if necessary. Slow cool.

### Normalising

Normalising is not recommended for this steel.

## Annealing

Pack anneal in a tube or other closed container with clean cast iron borings at 740°/760°C for at least 2 to 3 hours. Cool very slowly with the furnace until the temperature falls below 500°C. With draw from box or tube and allow to cool to shop temperature. Brinell hardness after annealing will be approximately 229.

## Stress relieving

Where tools are heavily machined, ground or subjected to cold work, the relief of internal strains is essential before hardening. Stress relieving should be done after rough machining. To stress relieve, heat carefully to 670°/700°C soak well and allow to cool in air.

## Hardening

Heat slowly and if possible pre-heat to 300° / 500 °C before raising to the hardening temperature of 780° / 820°C. Pre heating is especially desirable for complex sections. Soak thoroughly, allowing 30 minutes per inch of ruling section before quenching. Light sections should be quenched in oil from the lower end of the temperature range.

Long slender sections should always be suspended in the furnace for heating and quenched by plunging vertically into the oil bath.

Tempering is always necessary after hardening.

## Martempering

Martempering is an alternative hardening procedure, which may be used when suitable salt bath equipment is available. By this method, internal strain, distortion and risk of quench cracking is reduced to the minimum.

Pre heat at 360°C then reheat to 800°C for sections 3.5 mm or less, or 820°C for sections over 3.5 mm. Soak according to section, then quench into molten salt held at 210°C. Allow sufficient time for the center of the piece to reach bath temperature, withdraw and cool in the air. Tempering will then be necessary. Hardness obtainable in salt or oil is similar but salt bath quenching reduces distortion. Only sections of less than 10 mm thick can be vacuum hardened.

## Tempering

Temper between 150°C and 350°C according to the requirements of the job and by reference to the tempering curve. Soak for one hour at the tempering temperature. Where possible, use an air-circulating Furnace.

**Tempering Curves and stock range are printed on the reverse of this data sheet.**

**PAX No 2** Colour Code: Red & black

SHOCK RESISTING TOOL STEEL

**S1**

AIISI

**1.2547**

WERKSTOFF No

<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>Cr</b>	<b>Mo</b>	<b>W</b>	<b>V</b>
0.50	0.65	0.30	1.50		2.25	0.20

### Features and Uses

PAX 2 is an alloy shock-resisting tool steel for both hot and cold work applications. The tungsten content of this steel confers fatigue resistance, the chromium content gives depth of hardness and resistance to abrasion.

PAX 2 is suitable for cold work tools subject to heavy shock and uneven loading, for example, press tools used for punching heavy gauge material, shear blades, nut blanking tools, perforating and piercing punches.

This steel is also used with great success for chisels, punches and sates required for heavy work on hard tough materials.

PAX 2 is resistant to heat checking. It is suitable for hot-work applications where high fatigue strength in combination with medium hot hardens is desirable. Tools made from this material may be water cooled in service with little risk of cracking. Typical hot work applications include mandrel bars for drawing steel tubes, hot heading, swaging, forming and gripper dies used in medium temperature work, punching, piercing, and trimming dies and shear blades working at medium temperature including flying shear blades.

### Working and Heat Treatment

#### Forging

Heat slowly to 1000° / 1050°C and forge with light rapid blows. Reheat when temperature falls below 900°C. Slow cool, preferably in the furnace, to shop temperature.

#### Normalising

Normalising is not recommended for this steel.

#### Annealing

Pack anneal in a tube or other closed container with clean cast iron borings at 800°/810°C for at least 2 to 3 hours. Cool slowly with the furnace

#### Stress relieving

For applications where distortion must be kept to a minimum or where the machining operations have been severe, we recommend stabilizing just before the tools are finish machined in order to relieve machining strains. Heat slowly to 700°C and allow to cool in air.

### Hardening

Preheat at 650°C followed by rapid increase of temperature to 900 / 950°C quench in oil. When it is not intended to grind after hardening, tools should be packed into a container with clean cast iron borings for heating for hardening, or heated to the hardening temperature in a neutral salt bath or gas atmosphere furnace followed by quenching in oil.

### Tempering

The hardened steel must always be tempered. Heat slowly to the required tempering temperature, soak thoroughly for 2 hours per 25 mm of ruling section and allow to cool in still air. For hot work applications a minimum tempering temperature of 550°C should be used.

# PITHO/NEWHALL

GROUND FLAT STOCK / GAUGE PLATE

# O1

AISI

# 1.2510

WERKSTOFF No

C	Si	Mn	Cr	Mo	W	V
0.95		1.20	0.55		0.55	0.20

## Features and Uses

This material is supplied precision ground, coated in a rust preventative and wrapped in paper to protect the material from damage. It is normally supplied in standard lengths of 500 mm and 1000 mm but non-standard sizes will be specially manufactured upon request with a delivery time of about 10 working days.

This moderately priced oil hardening tool steel gives excellent wear resistance, holds a good cutting edge and is relatively easy to machine. It is excellent general-purpose tool steel often used where the expenses of high carbon high chromium steels would not be justified.

There are thousands of applications for this product and it has the advantage of already being ground to size thereby saving the toolmaker many hours in preparing the material.

It is well known as a paper knife material and also for ejectors and slides in tool making. Cams. Punches, dies and other profiles are wire cut or water jet cut either prior to hardening or afterwards. It is advisable to stress temper items that have been wire cut after heat treatment as the wire cutting process causes secondary hardening which can lead to cracking.

## Working and Heat Treatment

### Normalising

Normalising is not recommended for this steel.

## Annealing

Pack anneal in a tube or other closed container with clean cast iron borings at 740° / 760°C for at least 2 to 3 hours. Cool very slowly with the furnace until the temperature falls below 500°C. With draw from box or tube and allow to cool to shop temperature. Brinell hardness after annealing will be approximately 229.

## Stress relieving

Where tools are heavily machined, ground or subjected to cold work, the relief of internal strains is essential before hardening. Stress relieving should be done after rough machining. To stress relieve, heat carefully to 670° / 700°C soak well and allow to cool in air.

## Hardening

This material hardens in oil at a low temperature with minimum movement. Quench in oil from 780 / 820°C. Long slender sections should always be suspended in the furnace for heating and quenched by plunging vertically into the oil bath. Resultant hardness will be Rockwell C63/64.

Tempering is always necessary after hardening.

## Martempering

Martempering is an alternative hardening procedure that may be used when suitable salt bath equipment is available.

By this method, internal strain, distortion and risk of quench cracking is reduced to the minimum.

Pre heat at 360°C then reheat to 800°C for sections 3.5 mm or less, or 820°C for sections over 3.5 mm. Soak according to section, then quench into molten salt held at 210°C. Allow sufficient time for the center of the piece to reach bath temperature, withdraw and cool in the air. Tempering will them be necessary. Hardness obtainable in salt or oil is similar but salt bath quenching reduces distortion. Only sections of less than 10 mm can be vacuum hardened.

## Tempering

Temper between 150°C and 350°C according to the requirements of the job. Soak for one hour at the tempering temperature. Where possible, use an air-circulating Furnace.

150°C to obtain Rockwell C62.
200°C to obtain Rockwell C60.
250°C to obtain Rockwell C58
350°C to obtain Rockwell C56.

**Tempering curves and size range are printed on the reverse of this data sheet.**

**PMS** Colour Code: Orange  
PLASTIC MOULD STEEL

**P20**  
AISI

**1.2312**  
WERKSTOFF No

<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>Cr</b>	<b>Mo</b>	<b>S</b>	<b>P</b>
0.37	0.30	0.80	1.50	0.20	0.05	0.06

### Features and Uses

PMS is premium quality Cr-Mo alloyed steel, which is supplied, in the hardened and tempered condition offering the following benefits:

- No hardening risks
- No hardening costs
- Time saving (no waiting for heat treatment)
- Lower tool cost (e.g. no distortion to rectify)
- Modifications easily carried out
- Can be subsequently Nitrided or Tuftrided to reduce surface damage.
- Good polishing & photo etching properties.
- Good machinability
- Uniform Hardness

PMS may be used in the following applications:

Injection mould for thermoplastics  
 Extrusion dies for plastics  
 Blow moulds  
 Forming Tools, press brake dies (possibly flame hardened or Nitrided)  
 Structural components and shafts

### Heat Treatment

#### Annealing

Anneal in a protective gas atmosphere at 700°C for at least 2 to 3 hours. Cool at 10°C per hour with the furnace until the temperature falls below 600°C. Withdraw from the furnace and allow cooling to shop temperature.

### Stress relieving

Where tool are heavily machined, ground or subjected to cold work, the relief of internal strains is essential before hardening. Stress relieving should be done after rough machining. To stress relieve, heat carefully to 550°C soak well and allow to cool slowly to room temperature.

#### Hardening

The steel should be fully soft annealed before hardening. Pre-heat to 500° / 600 °C before raising to the hardening temperature of 850°C. Pre heating is especially desirable for complex sections. Soak thoroughly, allowing 30 minutes per inch of ruling section before quenching.

#### Quenching Media

Gas or vacuum quenching is only suitable for small sections up to approximately 35 mm thick.

Oil produces the desired hardness but distortion should be allowed for in the design.

Martempering is advised by means of a salt bath at 450° / 550 °C for a maximum of 4 minutes, then air cool.

#### Tempering

Temper the tool for a minimum of 2 hours as soon as it reaches 50° / 70 °C between 180°C and 300°C according to the requirements of the job and by reference to the tempering curve. Where possible, use an air-circulating Furnace.

### Flame and Induction Hardening

PMS can be hardened in this way to a maximum of approximately 50 HRC. Cooling in air is preferable.

#### Case Hardening

In order to increase the surface hardness PMS can be case-hardened however allowances must be made for the brittle nature of the case near sharp corners and also for dimensional changes. Our Heat Treatment Department will be glad to advise you.

#### Nitriding and Tuftriding

Nitriding gives a very hard surface, which is resistant to wear and erosion. A Nitrided surface also increases corrosion resistance.

For best results the following steps should be followed:

1. Rough Machining
2. Stress tempering
3. Grinding
4. Nitriding

The following surface hardness and depths should be achieved after Gas Nitriding.

Temp-in °C	Time in Hours	Surface Hardness Vickers	Depth of case mm
525	20	650	0.30
525	30	650	0.35
525	60	650	0.50

A comprehensive range of round bar is held in stock. Flat sizes are cut to suit customer's requirements from mother blocks.



**PVC** Colour Code: Orange & green  
PLASTIC MOULD STEEL

**P42**  
AIISI

**1.2316**  
WERKSTOFF No

<b>C</b>	<b>Si</b>	<b>Mn</b>	<b>Cr</b>	<b>Mo</b>	<b>Ni</b>
0.38	0.40	0.65	16.0	1.00	0.80

**Features and Uses**

PVC is classified as a heat treatable stainless steel as it contains in excess of 12% Chromium and sufficient carbon to harden upon quenching.

It is supplied in the heat-treated condition and can be used in any application where strength coupled with corrosion resistance is required. It is particularly suited for use in the manufacture of moulds where chemically aggressive materials such as PVC and amino plastics are used.

**Benefits:**

- No Hardening costs
- Time saving (no waiting for heat treatment)
- Lower tool cost (e.g. no distortion to rectify)
- Modifications easily carried out
- Can be subsequently Nitrided or Tufftrided to reduce surface damage.
- Good polishing & photo etching properties.
- Fair machinability
- Uniform Hardness

PVC may be used in the following applications:

- Extrusion tools for window frames
- Blow moulds
- Sheet moulds
- Sizing tools
- Hunting knives
- Structural components and shafts

**Heat Treatment**

**Annealing**

Anneal preferable in a gas atmosphere at 760° / 800°C for at least 2 to 3 hours. Cool at 10°C per hour with the furnace until the temperature falls below 400°C. Withdraw from box or tube and allow cooling to shop temperature.

**Stress Relieving**

Where tools are heavily machined, ground or subjected to cold work, the relief of internal strains is essential before hardening. Stress relieving should be done after rough machining. To stress relieve, heat carefully to 550°C soak well and allow to cool slowly to room temperature.

**Hardening**

The steel should be fully soft annealed before hardening. Pre-heat to 500° / 600 °C before raising to the hardening temperature of 1020° / 1050°C. Pre heating is especially desirable for complex sections. Soak thoroughly, allowing 30 minutes per inch of ruling section before quenching.

**Quenching Media**

Gas or vacuum quenching is only suitable for small sections up to approximately 50 mm thick. Oil produces the desired hardness but distortion should be allowed for in the design.

**Martempering**

This is advised where distortion levels must be minimized. The job is quenched into a salt bath at 500° / 550 °C and held for a maximum of 10 minutes, then air-cooled.

**Tempering**

Temper the tool for a minimum of 2 hours as soon as it reaches 50° / 70 °C usually between 600°C and 700°C according to the requirements of the job and by reference to the tempering chart. Where possible, use a protective atmosphere or salt bath.

**Nitriding and Tufftriding**

Nitriding gives a very hard surface, which is resistant to wear and erosion. A Nitrided surface also increases corrosion resistance.

For best results the following steps should be followed:

1. Rough Machining
2. Stress tempering
3. Grinding
4. Nitriding or Tufftriding

The following hardness should be achieved after tempering.

Temperature in °C	Surface Hardness Rockwell C
100	49-50
200	47-48
300	46-48
400	45-46
500	46-47
600	32-35
700	30-32

# SABEN SILVER STEEL

PRECISION GROUND DOWELL ROD

B.S.1407

# 1.2210

WERKSTOFF No

C	Si	Mn	Cr	Mo	W	V	Co
1.20		0.40	0.40				

## Features and Uses

Saben Silver Steel is bright finished rod produced from hot rolled bar by means of centreless grinding.

The high carbon content of this steel means that it can be hardened to give considerable wear resistance and the chromium content adds to the strength and hardenability. As supplied however, the steel is machinable owing to the annealing treatment given to it prior to grinding. Saben silver steel is spheroidise annealed for best machinability, the annealed hardness being in the region of 270 Brinell (Rockwell C27). On hardening and tempering a hardness of up to Rockwell C64 can be obtained. Being in the spherodised condition, the material offers maximum response to hardening and the chromium content ensures deep hardening.

## Applications

Saben silver steel finds innumerable uses in the tool room and in general engineering. The user can select a size suitable for his purpose, thereby reducing or eliminating the need for grinding or machining the finished part.

Applications include screwdrivers, punches, shafts, axles, pinions, pins, die posts, instrument parts, model parts, taps and drills for mild steel, engravers tools, and fine cutters.

## Hardening

It is preferable to heat the tools in a controlled atmosphere. If this is not possible, pack hardening is recommended. A reducing atmosphere is desirable.

Heat to 770 / 780°C and when thoroughly soaked through, quench in water. (sizes up to 8 mm diameter may be oil hardened from 800 / 810°C) Tempering will be necessary.

## Tolerances

### B.S. 1407/1959 conforms with I.S.O. H8

Up to and including 3mm  
+0.00 – 0.014 mm  
Over 3mm and including 6mm  
+0.00 – 0.018 mm  
6mm and including 10 mm  
+0.00 – 0.022 mm  
10mm and including 18 mm  
+0.00 – 0.027 mm  
18mm and including 30 mm  
+0.00 – 0.033 mm  
30mm and including 50 mm  
+0.00 – 0.039 mm

## Tempering

Temper according to the purpose for which the parts are required generally between 150 / 300°C

Rockwell C	Temperature
63/65	as quenched
63/65	120°C
64/62	150°C
62/61	200°C
59/58	250°C
56/55	300°C
54/53	350°C
50/48	400°C

STOCK	SIZES	DIA
2 mm	15	1/16"
2.5	16	3/32"
3	17	1/8"
3.5	18	5/32"
4	19	3/16"
4.5	20	7/32"
5	21	1/4"
5.5	22	5/16"
6	23	3/8"
6.5	24	7/16"
7	25	1/2"
7.5	26	9/16"
8	27	5/8"
8.5	28	3/4"
9	29	13/16"
9.5	30	7/8"
10	35	15/16"
11	40	1"
12 45	1/4"	
13 50	1.1/2	
14		
<b>Non standard sizes available in +/- 10 working days</b>		

# SYMBOLS FOR HARDNESS

SYMBOL	TON f/SQ IN.	MPa Newtons/sq	HARDNESS (Brinell)
P	35/45	540/695	152/207
Q	40/50	618/772	179/229
R	45/55	695/849	201/255
S	50/60	772/926	223/277
T	55/65	849/1004	248/302
U	60/70	926/1080	269/331
V	65/75	1004/1158	293/352
W	70/80	1080/1235	311/375
X	75/85	1158/1312	341/401
Y	80/90	1235/1390	363/429
Z	100MIN.	1544 MIN.	444MIN.

# REVISED HARDNESS CONVERSION CHART FOR STEEL

N.B. These conversions may not apply to austenitic steels in the cold worked condition

*These conversions must not be used for Copper/Brass*

Vickers/ Pyramid Diamond Hv 10/30 Allowable error ± 2%	BRINELL		ROCKWELL		Shore Sclero- scope No.	TENSILE STRENGTH	
	Impression Dia 10mm Ball error ± 3%	H.B. 10/ 3000 kgs error ± 3%	'B' Scale 100 kgs 1/16 in. dia Ball error ± 2 Units	'C' Scale 150 kgs Diamond Cone error ± 1,5 Units		tons/ sq. in.	kilo/ sq. mm
965			-	70	106		
936			-	69	103		
908			-	68	100		
880			-	67	97		
853			-	66	95		
826			-	65	93		
799			-	64	91		
773			-	63	89		
747			-	62	87		
718	2.35	682	-	61	84	147	232
687	2.40	653	-	59	82	142	224
660	2.45	627	-	58.5	81	137	216
633	2.50	601	-	57	78	132	208
608	2.55	578	-	56	76	127	200
584	2.60	555	-	55	75	122	192
562	2.65	534	-	53.5	72	117	179
541	2.70	514	-	52	70	112	176
521	2.75	495	-	51	68	108	170
502	2.80	477	-	50	67	105	165
485	2.85	461	-	48	65	101	160
467	2.90	444	-	47	63	98	155
452	2.95	429	-	45.5	61	95	150
437	3.00	415	-	44.5	59	92	145
422	3.05	401	-	42	55	88	139
408	3.10	388	-	41	54	85	134
395	3.15	375	-	40	52	82	130
382	3.20	363	-	39	51	80	126
371	3.25	352	-	37.5	50	77	122
359	3.30	341	-	36.5	49	75	118
348	3.35	331	-	35.5	48	73	114
338	3.40	321	-	34	45	71	111
327	3.45	311	-	33	44	68	107
318	3.50	302	-	32	43	66	104
308	3.55	293	-	31	42	64	101
300	3.60	285	-	29.5	40	63	99
292	3.65	277	-	28.5	38	61	96
283	3.70	269	-	27	38	59	93
276	3.75	262	-	26	37	58	91
268	3.80	255	-	25	37	56	89
261	3.85	248	-	24	36	55	87
254	3.90	241	-	23.5	35	53	84
247	3.95	235	-	21.5	34	51	81

## HARDNESS CONVERSION (Continued)

Vickers/ Pyramid Diamond Hv 10/30 Allowable error ± 2%	BRINELL		ROCKWELL		Shore Sclero- scope No.	TENSILE STRENGTH	
	Impression Dia 10mm Ball error ± 3%	H.B. 10/ 3000 kgs error ± 3%	'B' Scale 100 kgs 1/16 in. dia Ball error ± 2 Units	'C' Scale 150 kgs Diamond Cone error ± 1,5 Units		tons/ sq. in.	kilo/ sq. mm
241	4.00	229	-	20.5	33	50	79
235	4.05	223	99.9	19.5	33	49	77
228	4.10	217	98.7	-	32	48	76
223	4.15	212	98	-	32	46	73
218	4.20	207	97	-	31	45	71
213	4.25	202	95.5	-	31	44	70
207	4.30	197	95	-	30	43	68
202	4.35	192	94	-	30	42	66
197	4.40	187	93	-	29	41	65
192	4.45	182	92	-	29	40	64
188	4.50	179	91	-	28	40	62
183	4.55	174	90	-	28	39	60
179	4.60	170	88	-	27	38	57
175	4.65	166	88	-	26	37	55
172	4.70	163	87	-	26	36	55
167	4.75	159	85.5	-	25	35	55
164	4.80	156	84	-	25	34	54
161	4.85	153	84	-	25	34	52
157	4.90	149	82	-	24	33	51
154	4.95	146	81	-	23	33	50
151	5.00	143	81	-	23	32	49
147	5.05	140	79	-	22	32	49
144	5.10	137	78	-	22	31	48
141	5.15	134	76	-	21	30	48
138	5.20	131	74	-	20	30	47
135	5.25	128	73	-	20	29	47
133	5.30	126	72	-	-	28	46
131	5.35	124	72	-	-	28	45
127	5.40	121	70	-	-	27	44
124	5.45	118	68	-	-	27	43
122	5.50	116	67	-	-	26	43
120	5.55	114	66	-	-	26	41
118	5.60	112	64	-	-	26	41
115	5.65	109	64	-	-	25	40
113	5.70	107	61	-	-	25	40
111	5.75	105	61	-	-	24	39
108	5.80	103	-	-	-	24	39

## TABLES

mm	SIZES		ROUND		SQUARE		HEXAGON	
	fractions of an inch	decimals of an inch	kgs/m	lbs/ft	kgs/m	lbs/ft	kgs/m	lbs/ft
3		0,1181	0,056	0,0373	0,071	0,0477	0,061	0,0401
3,175	1/8	0,1250	0,062	0,0418	0,079	0,0531	0,069	0,0464
3,5		0,1378	0,076	0,0507	0,096	0,0645	0,083	0,0558
3,9687	5/32	0,1563	0,097	0,0653	0,124	0,0833	0,107	0,0719
4		0,1575	0,099	0,0663	0,126	0,0846	0,109	0,0732
4,5		0,1772	0,125	0,0839	0,159	0,1068	0,138	0,0927
4,7625	3/16	0,1875	0,140	0,0939	0,178	0,1196	0,154	0,1035
5		0,1969	0,154	0,1036	0,196	0,1317	0,170	0,1142
5,5		0,2165	0,187	0,1253	0,237	0,1593	0,206	0,1384
5,5562	7/32	0,2188	0,190	0,1279	0,242	0,1626	0,210	0,1411
6		0,2362	0,222	0,1492	0,283	0,1902	0,245	0,1646
6,3500	1/4	0,2500	0,247	0,1670	0,317	0,2130	0,274	0,1841
6,5		0,2559	0,261	0,1750	0,332	0,2231	0,287	0,1928
7		0,2756	0,302	0,2030	0,385	0,2581	0,333	0,2238
7,1439	9/32	0,2813	0,315	0,2114	0,401	0,2695	0,347	0,2332
7,5		0,2953	0,347	0,2330	0,442	0,2970	0,382	0,2567
7,9375	5/16	0,3125	0,388	0,2610	0,495	0,3326	0,428	0,2876
8		0,3150	0,395	0,2652	0,502	0,3373	0,435	0,2923
8,5		0,3346	0,445	0,2993	0,567	0,3810	0,491	0,3299
8,7312	11/32	0,3438	0,470	0,3158	0,598	0,4018	0,518	0,3481
9		0,3543	0,499	0,3356	0,636	0,4272	0,551	0,3702
9,5		0,3740	0,556	0,3739	0,708	0,4757	0,614	0,4126
9,5250	3/8	0,3750	0,559	0,3759	0,712	0,4784	0,617	0,4146
10		0,3937	0,617	0,4143	0,785	0,5275	0,680	0,4569
10,3787	13/32	0,4063	0,657	0,4411	0,836	0,5618	0,724	0,4865
10,5		0,4134	0,680	0,4567	0,865	0,5812	0,750	0,5040
11		0,4331	0,746	0,5130	0,950	0,6384	0,823	0,5530
11,1125	7/16	0,4375	0,761	0,5116	0,969	0,6511	0,840	0,5644
11,5		0,4528	0,815	0,5479	1,038	0,6975	0,899	0,6041
11,9062	15/32	0,4688	0,874	0,5873	1,113	0,7479	0,964	0,6478
12		0,4724	0,888	0,5966	1,130	0,7593	0,979	0,6578
12,5		0,4921	0,963	0,6473	1,227	0,8245	1,062	0,7136
12,6998	1/2	0,5000	0,994	0,6682	1,266	0,8507	1,096	0,7365
13		0,5118	1,042	0,7001	1,327	0,8917	1,149	0,7721
13,4937	17/32	0,5313	1,123	0,7543	1,429	0,9602	1,238	0,8319
13,5		0,5315	1,124	0,7550	1,431	0,9616	1,239	0,8325
14		0,5512	1,175	0,7896	1,539	1,034	1,332	0,8950
14,2875	9/16	0,5625	1,259	0,8456	1,602	1,076	1,388	0,9327
14,5		0,5709	1,296	0,8710	1,650	1,109	1,429	0,9692
15		0,5906	1,387	0,9321	1,766	1,127	1,530	1,028
15,0812	19/32	0,5978	1,402	0,9423	1,785	1,199	1,546	1,039
15,5		0,6102	1,481	0,9953	1,886	1,267	1,633	1,097
15,8750	5/8	0,6250	1,554	1,044	1,978	1,329	1,713	1,151
16		0,6299	1,578	1,061	2,010	1,351	1,740	1,169
16,5		0,6496	1,678	1,128	2,137	1,436	1,851	1,244
16,6687	21/32	0,6563	1,713	1,151	2,181	1,466	1,889	1,269
17		0,6693	1,782	1,197	2,269	1,525	1,965	1,320
17,4625	11/16	0,6875	1,880	1,263	2,394	1,609	2,073	1,393
17,5		0,6890	1,888	1,269	2,404	1,615	2,082	1,399
18		0,7087	1,998	1,342	2,543	1,709	2,203	1,480
18,2562	23/32	0,7188	2,055	1,381	2,617	1,758	2,266	1,523
18,5		0,7263	2,110	1,418	2,687	1,806	2,327	1,564
19		0,7480	2,226	1,496	2,834	1,904	2,454	1,649

**TABLES (Continued)**

mm	SIZES		ROUND		SQUARE		HEXAGON	
	fractions of an inch	decimals of an inch	kgs/m	lbs/ft	kgs/m	lbs/ft	kgs/m	lbs/ft
19,0500	3/4	0,7500	2,237	1,503	2,849	1,914	2,467	1,658
19,5		0,7677	2,344	1,575	2,985	2,006	2,585	1,797
19,8431	25/32	0,7813	2,426	1,630	3,091	2,077	2,677	1,799
20		0,7814	2,466	1,657	3,140	2,110	2,719	1,827
20,6375	13/16	0,8215	2,626	1,764	3,343	2,246	2,895	1,945
21		0,8264	2,719	1,827	3,462	2,326	2,998	2,015
21,4312	27/32	0,8438	2,832	1,903	3,605	2,422	3,122	2,098
22		0,8661	2,984	2,005	3,799	2,553	3,290	2,211
22,2250	7/8	0,8750	3,045	2,046	3,875	2,604	3,358	2,256
23		0,9055	3,262	2,192	4,153	2,791	3,596	2,416
23,0187	29/32	0,9063	3,267	2,195	4,159	2,795	3,602	2,420
23,8125	15/16	0,9375	3,496	2,349	4,451	2,991	3,855	2,590
24		0,9449	3,551	2,386	4,522	3,039	3,916	2,631
24,6062	31/32	0,9688	3,733	2,508	4,753	3,194	4,116	2,766
25		0,9843	3,853	2,589	4,906	3,297	4,249	2,855
25,4000	1	1,0000	3,978	2,673	5,065	3,403	4,352	2,924
26		1,0236	4,168	2,801	5,307	3,566	4,596	3,088
27		1,0630	4,495	3,020	5,670	3,846	4,956	3,330
28		1,1024	4,824	3,248	6,154	4,135	5,330	3,581
28,5750	1.1/8	1,1250	5,034	3,383	6,410	4,307	5,551	3,730
29		1,1417	5,185	3,484	6,602	4,436	5,717	3,842
30		1,1811	5,549	3,729	7,065	4,747	6,118	4,111
31		1,2205	5,925	3,981	7,544	5,069	6,533	4,399
31,7499	1.1/4	1,2500	6,215	4,176	7,913	5,317	6,853	4,605
32		1,2598	6,313	4,242	8,038	5,401	6,961	4,677
33		1,2992	6,714	4,512	8,549	5,745	7,403	4,974
34		1,3386	7,127	4,789	9,075	6,098	7,859	5,281
34,9249	1.3/8	1,3750	7,520	5,053	9,575	6,434	8,292	5,572
35		1,3780	7,553	5,075	9,616	6,461	8,328	5,598
36		1,4173	7,990	5,369	10,174	6,836	8,811	5,921
37		1,4567	8,440	5,671	10,747	7,221	9,307	6,254
38		1,4961	8,903	5,982	11,335	7,617	9,817	6,597
38,0999	1.1/2	1,5000	8,950	6,014	11,395	7,657	9,868	6,631
39		1,5354	9,378	6,302	11,940	8,023	10,340	6,948
40		1,5748	9,865	6,629	12,560	8,440	10,877	7,309
41		1,6142	10,364	6,965	13,190	8,867	11,428	7,679
41,2749	1.5/8	1,6250	10,504	7,058	13,373	8,986	11,582	7,783
42		1,6535	10,876	7,308	13,847	9,304	11,992	8,058
43		1,6929	11,400	7,660	14,515	9,753	12,570	8,446
44		1,7323	11,936	8,020	15,198	10,21	13,162	8,844
44,4499	1.3/4	1,7500	12,181	8,185	15,510	10,42	13,432	9,028
45		1,7717	12,485	8,389	15,896	10,68	13,767	9,251
46		1,8110	13,046	8,766	16,611	11,16	14,385	9,666
47		1,8504	13,619	9,151	17,341	11,65	15,017	10,09
47,6249	1.7/8	1,8750	13,984	9,397	17,805	11,96	15,419	10,36
48		1,8898	14,205	9,545	18,086	12,15	15,663	10,52
49		1,9291	14,803	9,947	18,848	12,66	16,323	10,97
50		1,9685	15,413	10,36	19,625	13,19	16,996	11,42
50,7999	2	2,0000	15,911	10,69	20,258	13,61	17,544	11,79
51		2,0079	16,036	10,78	20,418	13,72	17,682	11,88
52		2,0472	16,671	11,20	21,226	14,26	18,383	12,35
53		2,0866	17,319	11,64	22,051	14,82	19,096	12,83
53,9749	2.1/8	2,1250	17,962	12,07	22,869	15,37	19,805	13,31

**TABLES (Continued)**

mm	SIZES		ROUND		SQUARE		HEXAGON	
	fractions of an inch	decimals of an inch	kgs/m	lbs/ft	kgs/m	lbs/ft	kgs/m	lbs/ft
54		2,1260	17,978	12,08	22,891	15,38	19,824	13,32
55		2,1654	18,650	12,53	23,746	15,96	20,565	13,82
56		2,2047	19,335	12,99	24,618	16,54	21,319	14,33
57		2,2441	20,031	13,46	25,505	17,14	22,088	14,84
57,1499	2.1/4	2,2500	20,137	13,53	25,639	17,23	22,204	14,92
58		2,2835	20,740	13,94	26,407	17,74	22,868	15,37
59		2,3228	21,462	14,42	27,326	18,36	23,665	15,90
60		2,3622	22,195	14,91	28,260	18,99	24,474	16,45
60,3249	2.3/8	2,3750	22,436	15,08	28,567	19,20	24,740	16,62
61		2,4016	22,941	15,42	29,210	19,63	25,296	17,00
62		2,4409	23,700	15,83	30,175	20,28	26,133	17,56
63		2,4803	24,470	16,44	31,157	20,94	26,982	18,13
63,4999	2.1/2	2,5000	24,861	16,71	31,653	21,27	27,412	18,42
64		2,5197	25,253	16,97	32,154	21,61	27,846	18,71
65		2,5591	26,049	17,50	33,166	22,29	28,723	19,30
66		2,5984	26,856	18,05	34,195	22,98	29,613	19,90
66,6749	2.5/8	2,6250	27,408	18,42	34,898	23,45	30,222	20,31
67		2,6378	27,676	18,60	35,239	23,68	30,518	20,51
68		2,6772	28,509	19,16	36,298	24,39	31,435	21,12
69		2,7165	29,353	19,72	37,374	25,11	32,367	21,75
69,8499	2.3/4	2,7500	30,018	20,21	38,300	25,74	33,169	22,29
70		2,7559	30,210	20,30	38,465	25,85	33,312	22,38
72		2,8347	31,961	21,48	40,694	27,34	35,242	23,68
73,0249	2.7/8	2,8750	32,878	22,09	41,861	28,13	36,253	24,36
74		2,9134	33,762	22,69	42,987	28,89	37,227	25,01
75		2,9528	34,680	23,30	44,156	29,67	38,240	25,70
76		2,9921	35,611	23,93	45,342	30,47	39,267	26,39
76,1999	3	3,0000	35,799	24,06	45,580	30,63	39,474	26,52
78		3,0709	37,510	25,20	47,759	32,09	41,361	27,79
80		3,1496	39,458	26,51	50,240	33,76	43,509	29,24
82,5499	3.1/4	3,2500	42,013	28,23	53,494	35,95	45,204	30,37
85		3,3465	44,545	29,93	56,716	38,11	49,118	32,93
88,8998	3.1/2	5,5000	48,726	32,74	62,040	41,69	53,728	36,10
90		3,5433	49,939	33,56	63,585	42,73	55,066	37,00
95		3,7402	55,642	37,39	70,846	47,60	61,355	41,23
95,2498	3.3/4	3,7500	55,936	37,59	71,219	47,86	61,678	41,44
100		3,9370	61,654	41,43	78,500	52,75	67,983	45,68
101,5998	4	4,0000	63,642	42,76	81,032	54,45	70,175	47,15
105		4,1339	67,973	45,67	86,546	58,15	74,951	50,36
107,9489	4.1/4	4,2500	71,846	48,28	91,477	61,47	79,222	53,23
110		4,3307	74,601	50,13	94,985	66,51	82,259	55,27
114,2998	4.1/2	4,5000	80,547	54,12	102,556	68,92	88,816	59,68
115		4,5276	81,537	54,79	103,816	69,76	89,907	60,41
120		4,7244	88,781	59,66	113,040	75,96	97,895	65,78
120,6498	4.3/4	4,7500	89,745	60,90	114,526	76,78	98,958	66,49
125		4,9213	96,337	64,73	122,656	82,42	106,223	71,38
126,9998	5	5,0000	99,441	66,82	125,612	85,08	108,649	73,68
130		5,1181	104,195	70,01	132,665	89,14	114,891	77,20
133,3498	5.1/4	5,2500	109,634	73,67	139,590	93,80	120,888	81,23
135		5,3150	112,364	75,50	143,066	96,13	123,899	83,25
139,6998	5.1/2	5,5000	120,323	80,85	153,201	102,9	132,676	89,15
140		5,5180	120,841	81,20	153,860	103,4	133,247	89,54
145		5,7087	129,627	87,10	165,046	110,9	142,934	96,04



**TABLES (Continued)**

mm	SIZES		ROUND		SQUARE		HEXAGON	
	fractions of an inch	decimals of an inch	kgs/m	lbs/ft	kgs/m	lbs/ft	kgs/m	lbs/ft
146,0497	5.3/4	5,7500	131,511	88,37	167,445	112.5	145,011	97,44
150		5,9055	138,721	93,31	176,625	118.7	152,962	102,8
152,2997	6	6,0000	143,195	96,22	182,321	122.5	157,895	106,1
155		6,1024	148,132	99,53	185,960	126.7	163,329	109,7
158,7497	6.1/4	6,2500	155,376	104,40	197,809	132.9	171,327	115,1
160		6,2992	157,833	106,06	200,960	135.0	174,036	116,9
165		6,4961	167,852	112,79	213,716	143.6	185,084	124,4
165,0997	6.1/2	6,5000	168,055	112,92	213,975	143.8	185,307	124,5
170		6,6929	178,179	119,73	226,865	152.4	196,471	132,0
171,4497	6.3/4	6,7500	181,231	121,78	230,751	155.1	199,836	134,3
175		6,8898	188,814	126,87	240,406	161.5	208,198	139,9
177,7997	7	7,0000	194,904	130,97	248,160	166.8	214,913	144,4
180		7,0866	199,757	134,23	254,340	170.9	220,265	148,0
184,1497	7.1/4	7,2500	209,075	140,49	266,202	178.9	230,538	154,9
185		7,2835	211,010	141,79	268,666	180.5	232,672	156,3
190		7,4803	222,570	149,56	283,385	190.4	245,418	164,9
190,4997	7.1/2	7,5000	223,742	150,34	284,799	191.4	246,711	165,8
195		7,6722	234,438	157,53	298,496	200.6	258,505	173,7
196,8497	7.3/4	7,7555	238,907	160,53	304,186	204.4	263,433	177,0
200		7,8740	246,614	165,71	314,000	211.0	271,932	180,7
203,1996	8	8,0000	251,509	171,06	324,127	217.8	280,702	188,6
205		8,0709	259,100	174,10	329,896	221.7	285,98	192,0
210		8,2677	271,893	182,70	346,185	232.6	299,805	201,5
215		8,4646	284,994	191,5	362,866	248.3	314,251	211,2
215,8996	8.1/2	8,5000	287,384	193,11	365,909	245.9	316,886	212,9
220		8,6614	298,403	200,51	379,940	255.3	329,038	221,1
225		8,8858	312,122	209,73	397,406	267.0	344,164	231,3
228,5996	9	9,0000	322,189	216,49	410,244	275.7	355,264	238,7
230		9,0551	326,148	219,16	415,265	279.0	359,630	241,7
235		9,2520	340,483	228,73	433,516	291.3	375,436	252,3
240		9,4488	355,125	238,63	452,160	303.8	391,582	263,1
241,2996	9.1/2	9,5000	358,981	241,22	457,070	307.1	395,834	266,0
245		9,6457	370,076	248,87	471,196	316.6	408,068	274,2
250		9,8425	385,336	258,93	490,125	329.7	424,894	285,5
253,996	10	10,0000	397,768	267,28	506,433	340.3	438,583	294,7
255		10,0394	400,903	269,39	510,446	343.0	442,059	297,0
260		10,2362	416,779	280,05	530,660	356.6	459,565	308,8
265		10,4331	432,963	290,93	551,266	370.4	477,410	320,8
266,6995	10.1/2	10,5000	435,534	294,87	558,380	375.2	483,553	324,9
270		10,6299	449,455	302,01	572,265	384.5	495,596	333,0
275		10,8268	466,256	313,30	593,656	398.9	514,121	345,5
279,3995	11	11,0000	481,294	323,41	612,803	411.8	530,702	356,6
280		11,0236	483,365	324.8	615,440	413.5	532,986	358,1
285		11,2205	500,782	336,50	637,616	428.4	552,192	371,0
290		11,4174	518,508	348,41	660,185	443.6	571,737	384,2
292,0995	11.1/2	11,5000	526,042	353,47	669,779	450.1	580,045	389,8
295		11,6142	536,541	360,53	683,146	459.0	591,622	397,5
300		11,8110	554,883	372,85	706,500	474.7	611,847	411,1
304,7995	12	12,0000	572,780	384,88	729,286	490.0	631,580	424,4
305		12,0079	573,534	385,39	730,246	490.7	632,421	424,9
310		12,2047	592,492	398,12	754,385	506.9	653,316	439,0
315		12,4016	611,759	411,07	778,916	523.4	674,561	453,3
317,4995	12.1/2	12,5000	621,506	417,62	791,327	531.7	685,301	460,5


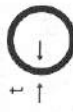



**TABLES (Continued)**

		<b>SIZES</b>		<b>ROUND</b>		<b>SQUARE</b>		<b>HEXAGON</b>	
<b>mm</b>	<b>fractions of an inch</b>	<b>decimals of an inch</b>	<b>kgs/m</b>	<b>lbs/ft</b>	<b>kgs/m</b>	<b>lbs/ft</b>	<b>kgs/m</b>	<b>lbs/ft</b>	
320		12,5984	631,334	424,22	803,840	540,1	696,146	467,8	
325		12,7953	651,217	437,59	829,156	557,2	718,070	482,5	
330		12,9921	671,409	451,15	854,865	574,4	740,334	497,5	
330,9994	13	13,0000	672,220	451,70	855,898	587,1	741,229	498,1	
335		13,1890	691,909	464,93	880,966	592,0	762,933	512,7	
340		13,3858	712,717	478,91	907,460	609,8	785,883	528,1	
342,8994	13.1/2	13,5000	724,924	487,11	923,003	620,2	799,343	537,1	
345		13,5827	733,833	493,1	934,346	627,8	809,167	543,7	
350		13,7796	755,258	507,5	961,625	646,2	832,791	559,6	
355		13,9764	776,991	522,10	989,296	664,8	856,775	575,7	
355,5994	14	14,0000	779,617	523,86	992,640	667,0	859,650	577,6	
360		14,1733	799,032	536,91	1017,360	683,6	881,059	592,0	
365		14,3701	821,381	551,93	1045,816	702,7	905,703	608,6	
368,2994	14.1/2	14,5000	836,298	561,95	1064,809	715,5	922,150	619,6	
370		14,5670	844,039	567,15	1074,665	722,1	930,687	625,4	
375		14,7638	867,005	582,58	1103,906	741,8	956,010	642,4	
380		14,9607	890,279	598,22	1133,540	757,7	981,674	659,6	
380,9993	15	15,0000	894,968	601,37	1139,510	765,7	986,843	663,1	
385		15,5575	913,862	614,07	1163,566	781,9	1007,677	677,1	
390		15,3540	937,753	630,12	1193,985	802,3	1034,021	694,8	
393,6993	15.1/2	15,5000	955,627	642,13	1216,743	817,6	1053,729	708,1	
395		15,5512	961,952	646,38	1224,796	823,0	1060,704	712,7	
400		15,7481	986,459	662,85	1256,000	844,0	1087,727	730,9	
405		15,9449	1011,275	679,53	1287,596	865,2	1115,091	749,3	
406,3993	16	16,0000	1018,275	684,23	1296,509	871,2	1122,808	754,5	
410		16,1418	1036,399	696,41	1319,585	886,7	1142,794	767,9	
415		16,3386	1081,831	726,94	1351,966	908,5	1170,837	786,7	
419,0993	16.1/2	16,5000	1082,911	727,66	1318,807	926,5	1194,080	802,4	
420		16,5355	1087,571	730,79	1384,740	930,5	1199,219	805,8	
425		16,7323	1113,620	748,39	1417,906	952,8	1227,942	825,1	
430		16,9292	1139,977	766,01	1451,465	975,3	1257,005	844,6	
431,7993	17	17,0000	1149,537	772,43	1463,637	983,5	1267,545	851,7	
435		17,1260	1166,642	783,93	1485,416	998,1	1286,408	864,4	
440		17,3229	1193,616	802,05	1519,760	1021,2	1316,150	884,4	
444,4992	17.1/2	17,5000	1220,855	820,35	1550,999	1042,2	1343,203	902,6	
445		17,5197	1222,285	821,31	1554,496	1044,5	1346,233	904,6	
450		17,7166	1248,487	838,92	1589,625	1068,1	1376,655	925,0	
455		17,9134	1276,386	857,67	1625,146	1092,0	1407,417	945,7	
457,1992	18	18,0000	1288,754	865,98	1640,894	1102,6	1421,054	954,9	
460		18,1103	1304,592	876,62	1661,060	1116,1	1438,519	966,6	
465		18,3071	1333,107	893,78	1697,366	1140,5	1469,962	987,7	
469,8992	18.1/2	18,5000	1361,346	914,76	1733,313	1164,7	1501,098	1008,7	
470		18,5040	1361,930	915,15	1734,056	1156,2	1501,744	1009,1	
475		18,7008	1391,062	934,47	1771,156	1190,1	1533,866	1030,7	
480		18,8977	1420,501	954,51	1808,640	1215,3	1566,327	1052,5	
482,5992	19	19,0000	1435,927	964,87	1828,281	1228,5	1583,335	1063,9	
485		19,0945	1450,249	974,49	1846,516	1240,8	1599,129	1074,5	
490		19,2914	1480,305	994,69	1884,785	1266,5	1632,271	1096,8	
495		19,4882	1510,670	1015,09	1923,446	1292,5	1665,756	1119,3	
495,2991	19.1/2	19,5000	1512,496	1016,32	1925,771	1294,0	1667,764	1120,7	
500		19,6851	1541,343	1035,71	1962,500	1318,7	1699,574	1142,0	
505		19,8819	1572,323	1056,52	2001,946	1345,2	1733,734	1165,0	
507,9991	20	20,0000	1591,055	1069,11	2025,795	1361,2	1754,388	1178,9	

# CONVERSION TABLE

TO CONVERT	INTO	MULTIPLIER	RECIPROCAL
Inches .....	Millimetres .....	25.4	.0394
Inches .....	Centimetres .....	2.540	.3937
Feet .....	Metres .....	.3048	3.2809
Yards .....	Metres .....	.9144	1.0936
Miles .....	Kilometres .....	1.6093	.6214
Sq. Inches .....	Sq. Centimetres .....	6.4514	.155
Sq. Feet .....	Sq. Metres .....	.0929	10.7643
Cubic Inches .....	Cubic Centimetres .....	16.3862	.0610
Cubic Feet .....	Cubic Metres .....	.0283	35.3166
Gallons .....	Litres .....	4.5459	.220
Lbs (av) .....	Kilograms .....	.4536	2.2046
Feet/Lbs .....	Kilo/Metres .....	.1382	7.2331
Lbs per Sq. Inch .....	Kilo per Sq. Centimetre .....	.0703	14.223
Lbs per Sq. Foot .....	Kilo per Sq. Metre .....	4.8826	.2048
Lbs per Yard .....	Kilo per Metre .....	.4961	2.0159
Megapascals (Mpa) Tons/Sq. Inch	Tons/Sq. Inch Megapascals (Mpa)	15.430	15.430

# FORMULAE FOR THEORETICAL MASS CALCULATIONS

Section	Formula x Spec	Steel	Stainless	Brass	Bronze	Copper
 <b>Round</b>	$D \times D \times$	0.00616	0.00631	0.006657	0.006924	0.007010
 <b>Hollow</b>	$(D - t) \times t \times$	0.02466	0.0253	0.026	0.02778	0.028
 <b>Flat</b>	$D \times t \times$	0.00786	0.00804	0.00848	0.00882	0.00889
 <b>Square</b>	$D \times D \times$	0.00786	0.00804	0.00848	0.00882	0.00889
 <b>Hexagon</b>	$D \times D \times$	0.0068	0.006963	0.007344	0.007638	0.00776

# CONTINUOUS CAST IRON BAR

## DESCRIPTION

Continuous Cast Grey Iron, high grade, close grain structure to specification BS. 1452 Grade 17

## CHEMICAL ANALYSIS

TOTAL CARBON : 3,35%  
 SILICON : 2,5%  
 SULPHUR : 0,01%  
 PHOSPHORUS : 0,7%  
 MANGANESE : 0,55%  
 IRON : Balance

## MECHANICAL PROPERTIES

Tensile Strength	13 - 19 TSI	200,8 - 293,4 MPa
Hardness	200 - 240 Brinell	
Compression Strength	50 - 70 TSI	772,2 - 1 081 MPa
Transverse Bending Strength	25 - 38 TSI	386,1 - 587 MPa
Defection (in a bar of 30mm diameter at 600mm centres)	10 - 14 mm	
Modulus of Elasticity	15,5 t 18,5 x 10 <sup>6</sup> p.s.i.	10 900 - 13 000 kg/mm <sup>2</sup>

## SOLID ROUNDS

mm	Mass/m
25	3,7
30	5,2
35	8,9
40	9,2
45	11,6
50	14,3
55	17,3
60	20,6
65	24,2
70	28,1
75	32,2
80	36,7
85	41,4
90	46,4
95	51,7
100	57,3

mm	Mass/m
105	63,2
110	69,3
115	75,8
120	82,5
130	96,9
140	112,3
150	128,0
160	147,7
170	165,6
180	185,7
190	206,9
200	229,2
210	252,7
220	277,4
230	303,1
240	330,1

mm	Mass/m
250	258,2
260	387,4
270	417,8
280	449,3
290	481,9
300	515,8
320	586,8
340	662,5
360	742,7
375	805,9







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