

# easysteel.™

A FLETCHER BUILDING COMPANY



**SPECIAL STEEL BOOK**  
JANUARY 2020

# Experience our can-do attitude.

**As part of the Fletcher Steel family, the team at Easysteel bring a passion to what we do and how we do it.** Individually and collectively through our diversity, scale and expertise across the business, we become a force to be reckoned with.

We believe in being game changers, delivering excellence in engineering and construction, while bringing together the best products, that showcase our innovation and willingness to doing things differently - bringing your projects to life!

No matter who you talk to, you get someone who cares about giving you what you need; each and every time. That's how we're working together for you.

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1.

**We care.  
Building relationships on trust.**

It's naturally our way. Our team culture is based on caring about our colleagues and customers, caring about getting it right and seeing the end result come to life. Trust in us to deliver you the very best result for your next project.

2.

**Together, the power of one.  
Your service experience.**

We're a diverse bunch of people with expert skills and capabilities. Only by working together can we achieve greatness and success. We all play a part and this ultimately creates a unique experience for you - our customers.

3.

**Getting the details right.  
Saving you time.**

Nothing is better or more satisfying than getting the job right first time. Together, if we're all over the detail, this means a positive experience for you. Every small step taken makes a difference to our customers. We thrive on a challenge and we're always in your corner.

4.

**Our people first culture drives results.  
Everyone is in it for the long haul.**

When we all care about the outcome it drives a culture change among our team. Every one of us is working together to bring you the very best. It's not only in our name but in our actions - experience the difference.

5.

**Making the difference in your projects.  
Sharing in your success.**

We want you to choose Fletcher Steel, and our desire is to make this happen, because when you're happy we're happy. It needs to be an easy decision working with us and choosing our product. We're committed to giving you what you need - after all, steel is our business.



# Introduction

Easysteel is a part of Fletcher Steel Limited. The company prides itself on its position as a leading steel distributor in New Zealand providing a comprehensive range of products and services to meet the needs of this market.

The Steel Book is a directory of products and services available from Easysteel and is provided as a guide to assist customers when determining their requirements.

It is by no means an exhaustive list of the company's service portfolio. For in this dynamic environment, operating within a more prevalent global economy, the range of products and services that Easysteel offers is ever changing.



The Steel Book is a part of our full range of publications outlining our product offer. We also have available, The Special Steels Book and The Steel & Wire Book. See our website or ask your Easysteel Sales Representative for a copy of any of these publications.

Every care has been taken by staff in producing this catalogue. Easysteel has endeavoured to ensure accuracy of the information contained herein, however Easysteel cannot and does not accept responsibility for any loss or damage sustained by any party through use of this information.

# Introduction

## Quality

Easysteel continues to maintain a strong commitment to the principles of total quality management. This results in minimum waste, improved efficiencies and a service promise which meets customer requirements. Easysteel has a philosophy of continuous improvement in all areas of its business.

## Service

At Easysteel, we pride ourselves in providing the best service in the Industry. High standards of service throughout the business is a focus for all our teams.

## Technical Advice

Easysteel provides technical expertise on all products and services it markets. Specialist advice is available on product properties, product selection and specific end use application. Any advice given should subsequently be authorised by a qualified engineer.

## Suppliers

Easysteel has a centrally based supply chain which leverages its strong relationship with suppliers to provide highly competitive offers to its customers. These offers are sourced globally from quality steel mills and suppliers which enables its customers to compete in both domestic and export markets.

## Health, Safety & Environment

At Easysteel, our safety goal is zero harm. Health and Safety is our highest priority, not only for all employees, but also for our customers, suppliers, contractors and visitors. We take a pro-active approach in regards to Health, Safety & Environment, and we are continually developing and implementing systems to ensure our workplace is a safe one. At Easysteel, everyone is responsible for ensuring that we are working in a safe manner -

***Because we want to... not because we have to!***

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# Brand Equivalents Chart

## TOOL & ALLOY STEELS

	Easysteel Shortname	AISI	BS 970 En	BS 970 New	Japan JIS-G	Thyssen	Atlas
Mild Steel	BCQ 1018/1020	1018/1020	EN3B	070M20	4051-S20C		
	BFC 1214/1215	1214/1215	EN1A	230M07	4804-Sum23/25		
		AISI-115Mn30					
	BLB 12L14/12L15	12L14/12L15	EN1A Pb	230M07Pb	4804-Sum23L		
Medium /High Tensile	MT x 1040/45	1040/45	En8	080M40	4051-S40C		CM
	HT x 4140	4140	En19	708M40	4053-SCM440	7225	SPS
	HT x 4340	4340	En24	817M40	4103-SNCM439		Ultimo 200/4
	HT x En25		En25	823M30		6580	
	MHTF x 2767		En30B	835M30	4103-SNCM628	Thyrodur 2767	AHT28
Case Hardening	CASE x En36A	3310	En39A	665M13	4102-SNC815	6587	SuperImpacto
	CASE x En39B		En39B	835M15	4103-SNCM815	Thyroplast 2764	
Cold Work				BS4659			
	D2	D2		BD2	4404-SKD12	Thyrodur 2379	FNS
	A2	A2		BA2	4404-SKD12	Thyrodur 2363	Cromoly
	01	01		B01	4404-SKS3	Thyrodur 2510	Keewatin
			En31				
	MLDH/MHTF x 2767		En30B	835M30	4103-SNCM628	Thyrodur 2767	AHT28
Plastic Mould	MLDF x PDS5						
	MOLD/MLDF x 2311	P20				Thyroplast 2311	
	MOLD/MLDF 2738	P20 + Ni				Thyroplast 2738	
	MLDF x 2312	P20 + S				Thyroplast 2312	Ultimo 200
	PQ x 2083	420		420S45	SUS42 J1	Thyroplast 2083	420PQ
	MLDH/MHTF x 2767		En30B	835M30	4103-SNCM628	Thyrodur 2767	AHT28
Hot Work				BS4659			
	HOT	H13		BH13	4404-SKD61	Thyrotherm 2344	Crovan
	HOTF						
Shock Resisting				BS4659			
	S1	S1		BH13	4404-SKD61	Thyrotherm 2344	Falcon 6
High Speed				BS4659			
	M2	M2		BM2	4404-SKH9	Thyrapid 3343	SIXIX



# Brand Equivalents Chart

Balfour Rochling	Hitachi	VEW	Bohler	Assab	Comsteel	Werkstoff	Kurz-Name
						1.0402	c22
						1.0715	9 SMn 28
						1.0718	9 SMn 28 Pb
1040/45			V945			1.1186	CK40
SD19		V320	VCL140		05	1.7225	40 CrMo4
SD50/Monix15		V155	VCN150		R16	1.6565	40 CrNiMo6
					R4	1.6743	32 NiCrMo16 4
SD12/RABW		V110	Plasmould		R2	1.6747	30 NiCrMo16 6
SD51		E200	ES Special		Q5		
		E204	PPA		R10	1.6723	15 NiCrMo16 5
SC25/RCC Supra	SLD	K105	Special KNL	XW-41	Aidi-150		155 CrVMo 12 1
RSD13/RKCM	SCD	K305	Special K5	XW-10			100 CrMoV 5 1 1
TOH/RUS3	SGT	K460	Amutut S	DF2	Ketos		100MnCrW 4
					M2	1.3505	100 Cr 6
SD12/RABW		K600	NWM		R2	1.6747	30 NiCrMo 16 6
	MPM2	M210	Starmould	718	CSM2		40 CrMnMo 7
							40 CrMnNiMo 8 6 4
PMS/Moulrex A				Holdax			40 CrMnMoS 8 6
		M310	WKW4	Stavax	420MFQ		42 Cr 13
SD12/RABW		V110	Plasmould		R2	1.6747	30 NiCrMo 16 6
ADIC/RD2V	DAC	W302	US Ultra 2	8407	Nu-Die V		40 CrMoV 5 1
							40 CrMoV 5 1
SCX15/00/RTWK	YSR	K450	My Extra	M4			60 WCrv 7
							60 WCrv 7
Giantm5/Capital562	YXMI	S600	SREMo	ASP41		1.1003	Dmo 5

# Carbon Mild Steel



## BRIGHT COMMERCIAL QUALITY ROUND BAR AND FLATS

**Product Shortname:** BCQI, BCQM, BFI, BFM



Bright commercial quality is a general purpose mild steel. Characterised by excellent weldability and machinability with reasonable strength and good ductility.

**Typical Applications:** Suitable for all general engineering parts, fasteners, shafts, threaded bars etc.

**Colour Code:** Metric – Green and Imperial - Purple

**Welding:** Readily weldable with low carbon consumables. Pre-heat heavy sections (over 50mm).

Related Specifications	
Australia	AS 1443-2004 M1020
Germany	W.Nr 1.0402 C22
	W.Nr 1.1151 CK22
Great Britain	BS970 Part 3 – 1991 070M20
	BS 970 – 1955 EN3B
Japan	JIS G 4051 S20C
USA	SAE-AISI J403 – 2014 1018/1020
	ASTM A29/29M – 91 1020
	UNS G 10180/10200

Chemical Composition		
	Min. %	Max. %
Carbon (C)	0.15	0.25
Silicon (Si)		0.35
Manganese (Mn)	0.30	0.90
Phosphorus (P)		0.05
Sulphur (S)		0.05

Typical Mechanical Properties*	
Tensile Strength (MPa)	410 - 490
Yield Strength (MPa)	340 - 370
Hardness (HB)	120 - 235

\*Not guaranteed as mechanical properties are not specified for this grade. Guaranteed mechanical properties are available on request and subject to minimum order quantities.

### Size Range:

Shape	Metric		Imperial		Finish	Tolerance
	Min.	Max.	Min.	Max.		
Rounds	6mm	120mm	3/16"	4 - 1/2"	Cold Drawn	h10
	125mm	180mm	5"	7"	Turned & Polished	h11
Flats	12 x 6mm	200 x 20mm	1" x 1/2"	8" x 1"	Cold Drawn	h11
Squares	10mm	40mm	3/4"	3"	Cold Drawn	h11

Additional sizes and tolerances available on request.

# Carbon Mild Steel

## Heat Treatment:

Forging	1280°C	Hold until temperature remains constant all over and air cool on completion.
Annealing	870 - 910°C	Hold until the temperature remains constant all over then cool in a furnace.
Carburising	880 - 920°C	In suitable environment then hold for sufficient time to produce required carbon content and case depth. Refining/hardening and tempering processes are carried out to optimize core and case properties.
Core Refining	870 - 900°C	Hold until the temperature remains constant all over then quench in water, oil or brine.
Case Hardening	760 - 780°C	Following core refining process re-heat and hold until the temperature is constant all over. Quench in water.
Tempering	150 - 200°C	Re-heat then hold until the temperature remains constant all over. Soak for 1 hour per 25 mm of section then cool in still air. Tempering will improve the toughness of the case and help to reduce grinding cracks.
Normalising	890 - 940°C	Hold until the temperature remains constant all over. Soak for 10 - 15 minutes then cool in still air.
Stress Relieving	650 - 700°C	Hold until the temperature remains constant all over. Soak for 1 hour per 25 mm then cool in still air.

For guidance only.

# Carbon Steels



## BRIGHT FREE CUTTING

**Product Shortname:** BFCI, BFCM, BFCF, BFCH

Free machining steel widely used for parts and components where extensive machining is involved and strength/impact properties are not critical.

The combination of manganese and sulphur form manganese sulphide inclusions which effectively act as “chip breakers” during machining allowing this grade to be machined at high speed with no adverse effect on tool life.

**Typical Applications:** Nuts, bolts, gears and parts exposed to low stress levels etc.

**Colour Code:** Metric – Orange and Imperial - Red

**Welding:** Precautions required due to sulphur content.

Related Specifications	
Australia	AS 1443 – 2004 1214
Germany	W.Nr 1.0715 9SMn28
Great Britain	BS970 – Part 1 – 1972 080A46
	BS970 – 1955 EN1A
Japan	JIS G 4804 SUM22
USA	SAE-AISI J403 – 2014 1213 and 1215
	ASTM A29/A29M – 91 1213 and 1215
	UNS G 12130

Chemical Composition		
	Min. %	Max. %
Carbon (C)		0.15
Silicon (Si)		0.10
Manganese (Mn)	0.75	1.15
Phosphorus (P)	0.04	0.09
Sulphur (S)	0.26	0.35

Typical Mechanical Properties*	
Tensile Strength (MPa)	370 - 480
Yield Strength (MPa)	230 - 350
Hardness (HB)	120

\*Not guaranteed as mechanical properties are not specified for this grade. Guaranteed mechanical properties are available on request and subject to minimum order quantities.

### Size Range:

Shape	Metric		Imperial		Finish	Tolerance
	Min.	Max.	Min.	Max.		
Rounds	6mm	120mm	¼"	4½"	Cold Drawn	h10
	127mm	150mm	5"	6"	Cold Drawn	h11
Hexagon			1-¼"	1-½"	Cold Drawn	h11

Additional sizes and tolerances available on request. Flats and squares are also available on an indent basis. Leaded (12L14) also available on an indent basis.

# Carbon Steels

## Heat Treatment:

Forging	1300°C	Hold until temperature remains constant all over and air cool on completion.
Normalising	900 - 940°C	Hold until the temperature remains constant all over. Soak for 10 - 15 minutes then cool in still air.
Annealing	890 - 920°C	Hold until the temperature remains constant all over then cool in a furnace.

For guidance only.

# Carbon Steels



## MEDIUM TENSILE 1045

### Product Shortname: MTI, MTM

Characterised by fairly good strength and impact properties with good machinability and reasonable weldability.

Black bar available in as rolled or forged bar and bright bar is cold drawn or turned/peeled and polished finishes.

**Typical Applications:** General engineering applications requiring a higher strength than mild steel such as pins, bolts, shafts, axles etc.

**Colour Code:** Yellow

Related Specifications	
Australia	AS 1442 – 2007 1040/45
	AS 1443 – 2004 1040/45
Germany	W.Nr 1.0503 C45
	W.Nr 1.1191 CK45
Great Britain	BS970 – Part 3 - 1991 080A47
	BS970 – 1955 EN43B / EN8
Japan	JIS G 4051: 2009 S45C
USA	SAE-AISI J403 – 2014 1045
	ASTM A29/A29M – 16 1045
	UNS G 10450

Chemical Composition		
	Min. %	Max. %
Carbon (C)	0.37	0.50
Silicon (Si)	0.10	0.35
Manganese (Mn)	0.60	0.90
Phosphorus (P)		0.04
Sulphur (S)		0.05

Typical Mechanical Properties*		
Hot Rolled & Smooth Turned	Tensile Strength (MPa)	570 - 700
	Yield Strength (MPa)	300 - 450
	Elongation (%)	14 - 30
	Hardness (HB)	170 - 210
Cold Drawn	Tensile Strength (MPa)	640 - 850
	Yield Strength (MPa)	500 - 650
	Elongation (%)	8 min
	Hardness (HB)	190 - 270

\*Not guaranteed as mechanical properties are not specified for this grade. Guaranteed mechanical properties are available on request and subject to minimum order quantities.

# Carbon Steels

## Size Range:

Metric		Imperial		Finish	Tolerance on Diameter
Min.	Max.	Min.	Max.		
10mm	120mm	5/16"	4-1/2"	Cold Drawn	h10
125mm	180mm	5"	7"	Turned/Peeled & Polished	h11
40mm	530mm			Hot Rolled	

Additional sizes, tolerances, shapes and finishes including precision ground (h8) available on request.

**Welding:** 1045 steel is readily welded when the correct procedure is followed.

Welding in the hardened and tempered, flame or induction hardened condition is not recommended.

Welding of 1045 should always be carried out using low hydrogen electrodes - please consult your welding consumables supplier.

Suggested Pre-heat Temperature				
Section	25mm	50mm	75mm	150mm +
°C	100	140	200	300

## Post Welding

Cool as slowly as possible in dry lime, ash, sand etc.

If possible – upon cooling to hand warmth, stress relieve at 550°C - 660°C then cool in still air.

## Heat Treatment:

Forging	1250°C	Hold until temperature remains constant all over and air cool on completion.
Normalising	870 - 920°C	Hold until the temperature remains constant all over, soak for 10 - 15 minutes and cool in still air.
Annealing	800 - 850°C	Hold until the temperature remains constant all over then cool in a furnace.
Quenching	810 - 850°C	Hold until the temperature remains constant all over, soak for 10 - 15 minutes per 25mm of section and quench in water or brine.
Tempering	200 - 650°C	Hold until the temperature remains constant all over. Soak for 1 hour per 25mm of section then cool in still air.
Stress relieving	500 - 660°C	Hold until the temperature remains constant all over. Soak for 1 hour per 25mm of section then cool in still air.

For guidance only.

# Alloy Steels



## HIGH TENSILE 4140

**Product Shortname:** HTI, HTM, HTHX, HTGI, HTGM

General purpose high tensile alloy that posse's excellent toughness and is readily machinable. Stocked material is hardened and tempered in the range of 850 – 1000MPa (condition T) and available in a variety of finishes – hot rolled, cold drawn, precision ground or turned and polished.

Where a higher strength is required or where greater surface hardness is required refer to the heat treatment procedure. Suitable for induction or flame hardening.

**Typical Applications:** Medium to heavy duty shafts, gears, axles, rods, spindles, crow bars, nuts etc.

**Colour Code:** White

Related Specifications	
Australia	AS 1444-2007 4140
Germany	DIN 17212 W.Nr 1.7223 Type 41CrMo4
	DIN 17200-1654 W.Nr 1.7225 Type 42CrMo4
	DIN 17200 W.Nr 1.7227 Type 42CrMoS4
Great Britain	BS970 - 1955 EN19A
	BS970 Part 3: 1991 709M40
Japan	JIS G 4053 – 2008 SCM440
	JIS G 4103 – 1979 SNCM4
	JIS G 4105 – 1979 SCM4, SCM440
USA	SAE-AISI J404 - 2009 4140
	ASTM A29/A29M - 16 4140
	ASTM A322 – 13 4140
	ASTM A331 00 4140
	UNS G41400

Chemical Composition		
	Min. %	Max. %
Carbon (C)	0.38	0.43
Manganese (Mn)	0.75	1.00
Phosphorus (P)		0.03
Sulphur (S)		0.04
Silicon (Si)	0.15	0.35
Chromium (Cr)	0.80	1.10
Molybdenum (Mo)	0.15	0.25

Typical Mechanical Properties:		
	Min. %	Max. %
Tensile Strength (MPa)	850	1000
0.2% Proof Stress (MPa)	655	
Elongation (%)	13	
Izod Impact J	54	
Charpy Impact J	50	
Hardness Brinell HB	248	302
Limited Ruling Section	100mm	

Check test cert if critical for end use.



# Alloy Steels

## Size Range:

Shape	Metric		Imperial		Finish
	Min.	Max.	Min.	Max.	
Round	12mm	150mm	½"	6"	Bright
	20mm	100mm	½"	4"	Precision Ground
	24mm	420mm			Hot Rolled
Hexagon		46mm	¾"	2"	Cold Drawn

Additional sizes and finishes available on request.

## Tolerances:

Bright	Cold Drawn	h10
	Peeled & Polished	K12
	Turned & Polished	h10
	Precision Ground	h8
	Rough Machined	K12

## Heat Treatment:

Forging	980 - 1205°C	Hold until temperature remains constant all over. Cool slowly in sand or ash.
Normalising	870 - 900°C	Hold until the temperature remains constant all over, soak for 10 - 15 minutes and cool in still air.
Annealing	815 - 870°C	Hold until the temperature remains constant all over then cool in a furnace.
Quenching	820 - 880°C	Hold until the temperature remains constant all over, soak for 10 - 15 minutes per 25mm of section and quench in oil or water.
Tempering	500 - 680°C	Hold until the temperature remains constant all over. Soak for 1 hour per 25mm of section then cool in still air.
Stress relieving	500 - 550°C 600 - 650°C	Hardened Annealed Cool in still air.
Nitriding	500 - 530°C	Hold for sufficient time to develop the depth of case required. Parts should be pre-hardened and tempered as required and also pre-machined leaving a small grinding allowance only.
Flame and Induction	860 - 890°C	Heat quickly to the required case depth and quench immediately in water or oil. Temper immediately at 150°C – 200°C for maximum hardness.

For guidance only.

# Alloy Steels



## HIGH TENSILE 4340

**Product Shortname:** HTI, HTM, HTGI, HTGM

4340 has a high hardenability enabling it to be used for high tensile applications in large sections. Stocked material is hardened and tempered in the range of 930 – 1080MPa (condition U) and is available in hot rolled condition.

Where a higher strength is required or where greater surface hardness is required refer to the heat treatment procedure. Suitable for induction or flame hardening to produce a surface hardness of approximately 58 HRC.

**Typical Applications:** High strength machine parts, collets, spindles, bolts, studs, gears, pinions, axle shafts etc. Precision ground can be used where tight tolerances are required as well as high tensile strength.

**Colour Code:** Black

Related Specifications	
Australia	AS 1444 – 2007 4340
Germany	W.Nr 1.6565 40NiCrMo6
Great Britain	BS970 - 1955 EN24
	BS970 Part 3: 1991 817M40
Japan	JIS G 4053 – 2008 SNCM439
	JIS G 4103 – 1979 SNCM439, SNCM8
USA	SAE-AISI J404 - 2009 4340
	ASTM A29/A29M - 16 4340
	ASTM A322 – 13 4340
	ASTM A331 - 00 4340
	UNS G43400

Chemical Composition		
	Min. %	Max. %
Carbon (C)	0.38	0.43
Manganese (Mn)	0.60	0.80
Phosphorus (P)		0.03
Sulphur (S)		0.04
Silicon (Si)	0.15	0.35
Nickel (Ni)	1.65	2.00
Chromium (Cr)	0.70	0.90
Molybdenum (Mo)	0.20	0.30

Typical Mechanical Properties:		
	Min. %	Max. %
Tensile Strength (MPa)	930	1080
0.2% Proof Stress (MPa)	740	
Elongation (%)	12	
Izod Impact J	47	
Charpy Impact J	42	
Hardness Brinell HB	269	331
Limited Ruling Section	100mm	

Check test certificate if critical for end use.

# Alloy Steels

## Size Range:

Shape	Metric		Imperial		Finish	Tolerance
	Min.	Max.	Min.	Max.		
Rounds	20mm	100mm	¾"	4"	Precision Ground	h8
	25mm	150mm			Peeled & Polished	h10
	25mm	380mm			Hot Rolled	

Additional sizes, tolerances and finishes available on request.

## Heat Treatment:

Forging	1150°C	Hold until temperature remains constant all over. Cool slowly in sand or ash.
Annealing	800 - 850°C	Hold until the temperature remains constant all over then cool in a furnace.
Quenching	830 - 880°C	Hold until the temperature remains constant all over and quench in oil.
Tempering	450 - 660°C	Hold until the temperature remains constant all over. Soak for 1 hour per 25mm of section then cool in still air. Tempering within 250°C – 450°C range should be avoided as it will result in temper brittleness.
Stress relieving	600 - 650°C	Hold until the temperature remains constant all over. Soak for 1 hour per 25mm of section then cool in still air.
Nitriding	490 - 530°C	Hold for sufficient time to develop the depth of case required. Parts should be pre-hardened and tempered and pre-machined leaving a grinding allowance only.
Flame and Induction	830 - 860°C	Heat quickly to the required case depth and quench immediately in water or oil. Temper immediately at 150°C – 200°C to remove quenching stresses.

For guidance only.

# Case Hardening Steel



## CASE HARDENING - EN36A

### Product Shortname: CASE

EN36A hardened steel is a high core strength case hardening (carburising) steel, combining good toughness and high case hardness following heat treatment. Ideal material for components in highly stressed applications. Supplied annealed to a maximum of 255 HB.

### Size Range: 22mm - 410mm diameter

Additional sizes and finishes available on request.

**Colour Code:** Yellow / Brown

Related Specifications	
Australia	AS 1444 – 2007 X3312 / X3312H
Germany	W.Nr 1.5752 DIN 14NiCr14
Great Britain	BS970 - 1955 EN36A
	BS970 Part 3: 1991 655M13
Japan	JIS G 4052: 2008 SNC815H
	JIS G 4053: 2008 SNC815
	JIS G 4102: 1979 SNC815 / SNCM220
USA	SAE-AISI 3310 / 9310
	UNS G33106 / G93106

Chemical Composition		
	Min. %	Max. %
Carbon (C)	0.10	0.16
Manganese (Mn)	0.35	0.60
Phosphorus (P)		0.04
Sulphur (S)		0.04
Silicon (Si)	0.10	0.35
Nickel (Ni)	3.00	3.75
Chromium (Cr)	0.70	1.00
Copper (Cu)		0.35

Typical Mechanical Properties:	
Tensile Strength (MPa)	700 - 770
0.2% Proof Stress (MPa)	540
Elongation (%)	25
Hardness Brinell HB	255 max.

# Case Hardening Steel

## Heat Treatment:

Thermal Temperature      Remarks:

Process:      Range:

Annealing    820-860°C

For 1 hour per 25mm of section, slow furnace cool at no more than 65°C/hour.

Carburising  880-930°C

The following table indicates approximate case depths achievable:

Time in hours at the stated carburising temperature to produce the given case-depth

Case Depth (inches)	880°C		900°C			925°C	
	Solid	Gas	Solid	Salt	Gas	Solid	Gas
0.01	1.5	0.65	1.2	0.6	0.45	0.8	0.35
0.02	2.4	2.0	2.1	1.8	1.5	1.7	1.0
0.03	6.0	4.5	4.4	4.0	3.2	2.7	2.25
0.04	10.7	8.0	7.8	7.2	5.25	4.8	4.0
0.06	24.0	18.0	17.6	16.0	12.0	10.8	9.0
0.08	43.0	32.0	31.2	-	21.0	19.2	16.0
0.10	67.0	50.0	52.0	-	33.0	30.0	25.0

## Post Carburising Treatments:

**Treatment 'A'**  
(Direct oil quench)

Oil quench direct from carburising temperature and temper at 200°C for 1 hour per 25mm of section.

**Treatment 'B'**  
(For maximum dimensional stability)

Air cool direct from carburising temperature and temper at 200°C for 1 hour per 25mm of section.

**Treatment 'C'**  
(Single refine)

Air cool from carburising temperature. Reheat to 850-880°C and oil quench. Temper at 200°C for 1 hour per 25mm of section.

**Note:** For most applications treatment 'C' would be the recommended procedure.

Typical Results:      Case hardness up to 64 HRC.  
Core strength up to 1300MPa tensile.

# Case Hardening Steel



## CASE HARDENING - 1.6587

**Product Shortname:** CASE

Similar applications to EN36A and is especially suited to larger gears requiring deep case depths.

Annealed condition.

**Size Range:** available on request

**Color Code:** Black / White / Red

Related Specifications	
Australia	AS 1444-2007 X4317/X4317H
Europe	EN 10084 18CrNiMo7-6
Germany	W.Nr 1.6587
	DIN 17210 17CrNiMo6
Great Britain	BS970 – Part 3: 1991 820M17/822M17
	BS970 – 1955 EN354/EN355
USA	SAE-AISI SAE 4317

Chemical Composition		
	Min. %	Max. %
Carbon (C)	0.15	0.20
Manganese (Mn)	0.40	0.60
Silicon (Si)	0.10	0.35
Nickel (Ni)	1.40	1.70
Chromium (Cr)	1.50	1.80
Molybdenum (Mo)	0.25	0.35

Typical Mechanical Properties:	
Tensile Strength (MPa)	700
0.2% Proof Stress (MPa)	520
Elongation (%)	23
Hardness Brinell HB	229 max.

# Case Hardening Steel



## CASE HARDENING - EN39B

### Product Shortname: CASE

A high core strength case hardening steel. Used for highly stressed gears, pins and axles. Supplied annealed to a maximum of 277 HB.

**Size Range:** 40mm - 410mm diameter

Additional sizes and finishes available on request.

**Colour Code:** Orange / Brown

Related Specifications	
Australia	AS 1444 – 2007 X9315
Germany	DIN 15NiCrMo16-5
	W.Nr 1.6723
Great Britain	BS970 - 1991 835M15
Japan	JIS G 4053: 2008 SNCM815
USA	SAE-AISI 9315

Chemical Composition		
	Min. %	Max. %
Carbon (C)	0.12	0.18
Manganese (Mn)	0.25	0.50
Phosphorus (P)		0.04
Sulphur (S)		0.04
Silicon (Si)	0.10	0.35
Nickel (Ni)	3.90	4.30
Chromium (Cr)	1.00	1.40
Molybdenum (Mo)	0.15	0.30

Typical Mechanical Properties:	
Tensile Strength (MPa)	1310 min.
0.2% Proof Stress (MPa)	1000
Elongation (%)	8 min.
Hardness Brinell HB	277 max.

# Phosphor Bronze



## PHOSPHORUS BRONZE LG2

**Product Shortname:** BZHB, BZR

**Characteristics:** Phosphor bronze LG2 (leaded gunmetal) is the common general purpose bearing grade particularly for general resistance to pick up or sticking with ferrous material in slow or medium friction applications. Its excellent machineability, and freedom from gas and porosity enable complicated parts to be made. Excellent resistance to general corrosion.

**Applications:** Bushes and bearings in equipment, irrigation, bearing rings, hydraulic control equipment, hydraulic ram components, crank gears, valve seats, wear rings

**Size Range:** Rounds and hollows available on request

**Welding:** Suitable for being joined by soldering and brazing. Oxyacetylene welding not recommended.

Related Specifications	
Australia	AS 1565-1996 C83600
Germany	DIN 1705 – RG5
Great Britain	BS 1400 LG2
Japan	JIS H511-BC6
USA	SAE 40
	ASTM 83600

Chemical Composition	
	Typical Analysis %
Copper (Cu)	85
Tin (Sn)	5
Zinc (Zn)	5
Lead (Pb)	5
Phosphorus (P)	0.05

Typical Mechanical Properties:	
Maximum Operating Temperature	230°C
Maximum Unit Pressure Load	270MPa
Tensile Strength	270 - 340MPa
Proof Stress	0.2% 100 - 140MPa
Elongation	13 - 30%
Hardness Brinell	75 - 90 BHN
Coefficient of Friction	0.14 - 0.08
Thermal Coefficient of Expansion	19.6 x 10 <sup>-6</sup> per °C



# Phosphor Bronze



## PHOSPHORUS BRONZE PB1

**Product Shortname:** BZHB, BZR

**Characteristics:** BP1 has good machining properties, high strength and good corrosion resistance to seawater and brine, making it suitable for pump and valve components. PB1 is suitable for bearings having medium to high loads and speeds and good resistance to impact loading or pounding. PB1 bearings must have adequate lubrication and good alignment.

**Applications:** PB1 is suitable for heavy duty gears and wormwheels with high working loads, high speeds, adequate lubrication and alignment.

Related Specifications	
Australia	AS 1565-1996 90710
Germany	DIN 1705 – G-CuSn10
Great Britain	PBI
Japan	H5113 - PBC2C
USA	ASTM B505, C90700

Chemical Composition	
Copper (Cu)	Balance
Tin (Sn)	10.5 Nominal
Lead (Pb)	0.25 Max
Zinc (Zn)	0.05 Max
Nickel (Ni)	0.10 Max
Iron (Fe)	0.10 Max
Aluminium (Al)	0.01 Max
Phosphorus (P)	0.7 Nominal

Typical Mechanical Properties:	
Yield Strength	170MPa
UTS	360MPa
Elongation	10%
Typical Hardness	100 - 150 BHN

# Aluminium Bronze



## ALUMINIUM BRONZE 954

**Characteristics:** Alloy 954 is very hard and abrasion resistant, having excellent strength and wear resistance with reasonable machining properties. These physical properties remain good at elevated temperatures. General corrosion resistance is good but under some circumstances may suffer dealuminification.

**Applications:** Alloy 954 is suitable for high strength bearings and has good impact resistance but poor anti seizure properties requiring reliable full film lubrication to prevent metal to metal contact and possible scoring.

Related Specifications	
Australia	AS 1565-1996 C95400
Germany	DIN 1714 G-CuAl11Fe4
USA	SAE J461
	ASTM B505 - C95400

Chemical Composition	
Copper (Cu)	83.5 Nominal
Aluminium (Al)	10.5 Nominal
Iron (Fe)	4.0 Nominal
Nickel (Ni)	1.5 Max
Manganese (Mn)	0.5 Max

Typical Mechanical Properties:	
Maximum Operating Temperature	260°C
Tensile Strength	515 - 580MPa
Yield Strength	205 - 221MPa
Elongation	12%
Hardness Brinell	170-180 BHN

# Aluminium Bronze



## NICKEL ALUMINIUM BRONZE AB2

**Product Shortname:** BZHB, BZR

**Characteristics:** AB2 is widely used for marine applications having superior corrosion resistance to marine conditions, high strength, good wearing and erosion resistance. Corrosion resistance can be further enhanced by annealing of the components [675°C (1250°F) for 6 hours minimum followed by air cooling] before being put into service. AB2 is suitable for gears with heavy loads and slow speeds and having good lubrication and alignment.

**Applications:** Bushes and bearings in equipment, irrigation, bearing rings, hydraulic control equipment, hydraulic ram components, crank gears, valve seats and wear rings.

Related Specifications	
Australia	AS 1565-1996 C95810
Germany	DIN 1714 – G-CuAl10Ni
Great Britain	BS 1400 AB2
Japan	JIS 5121 - CAC703C
USA	B505, C95800

Chemical Composition %	
Copper (Cu)	78 Nominal
Aluminium (Al)	9.5 Nominal
Iron (Fe)	4.8 Nominal
Nickel (Ni)	5.0 Nominal
Manganese (Mn)	3.0 Max
Tin (Sn)	0.1 Max
Lead (Pb)	0.03 Max
Zinc (Zn)	0.50 Max

Typical Mechanical Properties:	
Yield Strength	260 - 280MPa
UTS	680 - 700MPa
Elongation	15%
Typical Hardness	160 - 170 BHN

# Cast Iron



## GREY CAST IRON

**Product Shortname:** CI

**Characteristics:** A continuously cast bar with a uniform partial pearlitic structure from surface to core. Ideally suited to high speed machining and provides significantly longer tool life.

**Typical Applications:** Pistons, bearings, manifolds, brushings, gears, pulleys etc

**Size Range:** 30mm - 250mm diameter

Additional sizes and finishes available on request.

**Colour Code:** Gold

Related Specifications	
Germany	EN 1691 CG30
	EN 1561 GJL-300
Japan	JIS FC300
USA	ASTM A 48 40
	ASTM A159 G 3500
	SAE J 431 G3500
	UNI 5007 G35

Chemical Composition		
	Min. %	Max. %
Carbon (C)	2.95	3.45
Silicon (Si)	2.10	2.90
Manganese (Mn)	0.55	0.75
Sulphur (S)	0.04	0.07
Phosphorus (P)	0.10	0.20

Typical Mechanical Properties:	
Tensile Strength (MPa)	190 - 250
Hardness Brinell (HB)	200 - 290

# Cast Iron



## DUCTILE CAST IRON (SG IRON)

**Product Shortname:** CI

**Characteristics:** A higher strength cast bar due to the spheroidal or nodular nature of the graphite (as opposed to the flake structure of Grey Iron). A ductile and easily machined material.

**Size Range:** 55mm - 420mm diameter

Additional sizes and finishes available on request.

**Colour Code:** Gold / White

Related Specifications	
Germany	EN 1563 GJS-450-10
Japan	JIS FC D45
USA	ASTM A 536 65-45-12
	SAE J 434 D-4512
	UNI 4544 GS 400-12

Chemical Composition		
	Min. %	Max. %
Carbon (C)	3.50	3.90
Silicon (Si)	2.25	3.00
Manganese (Mn)	0.15	0.35
Sulphur (S)		0.025
Phosphorus (P)		0.05

Typical Mechanical Properties:	
Tensile Strength (MPa)	420 - 450
Yield (MPa)	260 - 290
Elongation (%)	10 - 12
Hardness Brinell HB	131 - 217

# Hydraulic Steels



## HARD CHROME BAR

Standard hard chromium plated steel bars with a medium tensile base material supplied in 1045 grade and a 20-micron minimum chrome layer.

Induction hardened (IH) material available in base material grades 38MnVS6 or 4140 Q+T.

**Typical Applications:** Primarily hydraulic and pneumatic cylinders.

**Diameter Tolerance:** ISO f7

**Straightness Tolerance:**  
0.2 mm/m

**Roughness:** Ra 0.07 - 0.20  $\mu\text{m}$

**Micro hardness of the chrome:**  
850-1000 HV<sub>0.1</sub> min

**Packaging:** Supplied in individual cardboard tubes.

### Typical Chemical Composition

	1045		38MnVS6 IH		4140 Q+T IH	
	Min. %	Max. %	Min. %	Max. %	Min. %	Max. %
Carbon (C)	0.37	0.50	0.16	0.22	0.36	0.44
Manganese (Mn)	0.60	0.90	1.20	1.60	0.65	1.10
Phosphorus (P)		0.05		0.035		0.04
Sulphur (S)		0.05		0.025		0.04
Silicon (Si)	0.10	0.35	0.15	0.80	0.10	0.40
Chromium (Cr)				0.30	0.75	1.20
Molybdenum (Mo)				0.08	0.15	0.35
Nitrogen (N)			0.01	0.02		
Vanadium (V)			0.08	0.20		

### Typical Mechanical Properties: Base Metal

	1045	38MnVS6 IH	4140 Q+T IH
Tensile Strength (MPa)	560 - 850	800 - 950	950
Silicon (Si)	275 - 340	≤ 520	800
Manganese (Mn)	10 - 16	12	18

### Size Range

Grade	Metric		Imperial	
	Min.	Max.	Min.	Max.
1045	20mm	100mm	3/4"	6"
38MnVS6 / 4140 Q + T IH	25mm	100mm	1"	4"

Additional sizes and finishes available on request.

# Hydraulic Steels



## HYDRAULIC CYLINDER TUBE

**Product Shortname:** HCTI, HCTM

Hydraulic Cylinder Tube with excellent machinability and weldability. Supplied cold drawn either seamless or welded (ERW DOM) and stress relieved with a minimum yield strength of 520 MPa.

The honed inside diameter is protected with oil antioxidant and plastic caps on tube ends.

**Typical Applications:** Primarily hydraulic and pneumatic cylinders.

### Inside Honed Diameter:

Dividing the internal diameter size by wall thickness value:

< 20mm	h8
20 - 25mm	h9
25 - 28mm	h10
28mm	h11

**Bore Roughness:** Ra Max 0.3 µm

### Wall Thickness:

Seamless	+/- 7.5%
Welded	+/- 3%

### Straightness:

Seamless	1/1000mm of the tubes length
Welded	0.5/1000mm of the tubes length

Skiving and Roller burnishing and honing are two different processes to the same end result (H8 tubes) and therefore should be interchangeable.

### Related Specifications

Europe	EN 10305-1 and 2 E355
	EN 10025-1994 1.0570 S355
Germany	DIN 2391-2 1.058 ST 52
	DIN 2393 & 2394 1.0570 ST 52-3

### Chemical Composition

	Min. %	Max. %
Carbon (C)		0.22
Silicon (Si)		0.50
Manganese (Mn)		1.50
Sulphur (S)	0.02	0.04
Phosphorus (P)		0.03

### Typical Mechanical Properties

Tensile Strength (MPa)	> 600
Yield (MPa)	> 520
Elongation (%)	> 10 - 14

### Size Range

Up to	Imperial		Metric (mm)	
	1 - 1/2	1/2 WT	63	6 WT
8	1/2 WT	120	12.5 WT	

Additional sizes available on request. WT = wall thickness.

# Hollow Bar



## CARBON HOLLOW BAR

### Product Shortname: HB

Hot rolled seamless hollow bar for general mechanical engineering purposes. Features superior machinability at higher speeds with low tool wear making it ideal for all kinds of turned parts. Suitable for a wide range of heat treatments such as normalising or quenching and tempering.

20MnV6 is available in larger diameters with a heavy wall. Material has good machinability and weldability. Stocked in ISO sizes.

**Typical Applications:** bushes, hydraulic cylinders, rollers for conveyors, shafts, nuts, rings etc.

**Size Range:** 30mm - 356mm OD x 15 - 236mm ID

Additional sizes and finishes available on request.

**Colour Code:** Purple

Specifications	
Europe	10294-1 Grade E470
Germany	W.Nr 1.5217 20MnV6

Typical Mechanical Properties			
		E470	20MnV6
Tensile Strength (MPa)		620 - 800	580 - 780
0.2% Proof Stress (MPa)		460 min.	400 min.
Elongation (%)	Long	17 min.	17 min.
	Transv.	15 min.	
Brinell Hardness (HB)		255 max.	180

Chemical Composition				
	E470		20MnV6	
	Min. %	Max. %	Min. %	Max. %
Carbon (C)	0.16	0.22	0.16	0.22
Manganese (Mn)	1.30	1.70	1.30	1.70
Phosphorus (P)		0.03		0.035
Sulphur (S)	0.015	0.05		
Silicon (Si)	0.10	0.50	0.10	0.50
Nickel (Ni)		0.40		
Chromium (Cr)		0.30		
Molybdenum (Mo)		0.08		
Copper (Cu)		0.30		
Nitrogen (N)		0.02		
Aluminium (Al)		0.01		
Niobium (Nb)		0.07		
Titanium (Ti)		0.05		
Vanadium (V)	0.08	0.15	0.10	0.20

Nb + V + Ti 0.21% maximum.

EN 10294-1 Tolerances:					
Delivered OD (mm)	Tolerance	Delivered wall thickness (WT) - OD ≤ 180 (mm)	Tolerance	Delivered WT - OD > 180 (mm)	Tolerance
≤ 75	± 0.5mm	≤ 15	± 12.5% or ± 0.4mm whichever is greater	≤ 30	± 12.5%
75 < OD ≤ 180	± 0.75%				
OD > 180	± 1%	> 15	± 10%	> 30	± 10%



**Size Range:** Sizes listed are clean turned sizes as per EN 10294-1.

Guaranteed CTS Based on OD Chucking			Delivered Size			Guaranteed CTS Based on ID Chucking	
OD (mm)	ID (mm)	WT (mm)	OD (mm)	WT (mm)	weight per metre (kg/m)	OD (mm)	ID (mm)
30	15	7.5	31.8	9.8	5.317	29.5	14.2
35	20	7.5	36.5	9.7	6.411	34.2	19.2
40	20	10	41.3	12.3	8.796	38.8	19.0
	25	7.5		9.6	7.505	39.0	24.2
50	30	10	51.3	12.3	11.829	48.8	29.0
	35	7.5		6.9	7.555	49.3	39.4
55	30	12.5	57.1	15.5	15.901	54.2	28.6
	35	10	57.1	12.7	13.905	54.5	34.0
	40	7.5	57.1	10.0	11.615	54.8	39.2
65	35	15	66.5	17.8	21.377	63.4	33.6
	45	10		12.4	16.543	63.9	44.0
70	40	15	71.3	17.8	22.484	68.2	38.4
	45	12.5		15.1	20.927	68.5	43.6
75	50	12.5	76.3	15.1	22.789	73.5	48.6
	55	10		12.3	19.412	73.8	54.0
	60	7.5		9.6	15.790	74.0	59.2
80	40	20	81.5	22.3	32.555	77.8	40.1
	55	12.5		14.5	23.957	78.5	54.9
85	45	20	86.5	22.3	35.305	82.8	41.5
	55	15		17.2	29.394	83.3	45.8
90	65	12.5	91.5	14.5	27.533	88.5	64.9
	70	10		11.9	23.359	88.8	70.0
95	50	22.5	96.3	24.9	43.965	92.5	50.0
	70	12.5		14.5	29.321	93.5	69.9
100	45	27.5	101.6	30.2	53.174	97.0	44.9
	65	17.5		19.7	39.787	98.0	65.2
105	60	22.5	106.6	24.9	50.167	102.5	60.1
	70	17.5		19.7	42.216	103.0	70.2
	80	12.5		14.5	32.932	103.5	80.0
115	65	25	116.6	27.6	60.575	112.2	65.0
	80	17.5		19.9	47.454	113.0	79.8
120	90	15	121.7	17.3	44.539	118.3	90.0
125	90	17.5	126.7	19.7	51.981	123.0	90.3
	100	12.5		14.6	40.360	123.5	100.1
130	75	27.5	131.7	30.3	75.766	126.9	75.1
	95	17.5		19.9	54.864	128.0	94.9
	100	15		17.3	54.805	128.3	100.0
140	85	27.5	141.8	30.3	83.313	136.9	85.1
	105	17.5		19.8	59.569	138.0	105.4
150	85	32.5	151.8	35.6	102.012	146.4	85.1
	100	25		27.7	84.770	147.2	100.2
	120	15		17.3	57.380	148.2	120.1
160	95	32.5	161.9	35.6	110.878	156.4	95.1
	115	22.5		25.1	84.675	157.5	115.3
180	105	37.5	181.9	40.9	152.212	174.9	105.1
	150	15		17.4	70.584	178.2	150.2
190	160	15	192.4	17.7	76.253	188.2	160.7
200	125	37.5	202.5	41.2	163.880	195.8	125.7
	150	25		28.1	120.850	197.2	150.9
220	155	32.5	222.7	39.1	177.028	214.4	148.8
230	180	25	234.9	32.0	160.112	227.6	174.9
250	170	40	252.9	47.6	240.984	243.2	162.4
	190	30		36.5	194.779	244.8	184.2

Heat Treatment							
Normalising °C		Quenching & Tempering				Stress Relieving °C	
		Hardening °C		Tempering °C			
900 to 960	Cooling in still air	900 to 960	Quenching in water	580 to 700	Cooling in still air	530 to 580	Cooling in still air
<p>The workplaces must be evenly heated to the specified temperature over their entire cross section. No further soaking is required in normalizing and hardening.</p> <p>For stress relieving and tempering a minimum soaking time of 30 minutes is required. However, a total of 150 minutes should generally not be exceeded in the case of multiple annealing. When soaking for more than 90 minutes the temperature should remain close to the lower limit of the range.</p>							

# Tool Steels



## ALLOY COLD-WORK TOOL STEEL – 1.2379 (D2)

**Product Shortname:** D2, D2F

D2 is a high carbon, high chromium cold work steel which is extremely stable in heat treatment and develops high toughness and edge holding qualities in the hardened and tempered condition. D2 exhibits deep hardening characteristics making it suitable for either air or vacuum hardening on most sizes.

**Typical Applications:** Thread rolling dies, cold extrusion tools, blanking and stamping tools, drawing tools, circular shear blades, etc.

**Delivery Condition:** Annealed

**Size Range:** Available on request

Related Specifications	
Germany	W.Nr 1.2379
USA	AISI D2

Chemical Composition		
	Min. %	Max. %
Carbon (C)	1.45	1.60
Silicon (Si)	0.10	0.60
Manganese (Mn)	0.20	0.60
Chromium (Cr)	11.00	13.00
Molybdenum (Mo)	0.70	1.00
Sulphur (S)		0.03
Phosphorus (P)		0.03
Vanadium (V)	0.70	1.00

Heat Treatment									
Soft Annealing °C	Cooling					Hardness HB			
830 - 860	furnace					max. 250			
Hardening from °C	in					Hardness after quenching HRC			
1000 - 1050	oil, air or hot bath 500 - 550°C					63			
Tempering	°C	100	200	300	400	500	525	550	600
	HRC	63	61	58	58	58	60	56	50

Special Heat Treatment									
Hardening from °C	in					Hardness after quenching HRC			
1050 - 1080	oil, air or hot bath 500 - 550°C					61			
Tempering (three times)	°C	100	200	300	400	500	525	550	600
	HRC	61	60	58	59	62	62	57	50

# Tool Steels



## ALLOY COLD-WORK TOOL STEEL - P20/P20 + Ni

**Product Shortname:** MOLD, MLDF

Plastic mould steel predominantly used in tooling applications in the plastic mould industry these steels are also suited for use in applications where a high tensile strength is the prime requirement.

Supplied in the hardened and tempered condition with a tensile strength of 950-1100MPa. Further heat-treatment can produce tensile strength of 1400MPa in sections up to 100mm and 1200MPa in sections as large as 200mm.

**Typical Applications:** Moulds for plastic processing, components for general engineering and tool manufacture.

**Delivery Condition:** Hardened and Tempered (280 – 325 HBW)

**Colour Code:** Red (1.2311 / P20) and Red / Yellow (1.2738 / P20 + Ni)

**Size Range:** Available on request

Related Specifications	
Germany	W.Nr 1.2311 / 1.2738
	DIN 40CrMnMo7 / 40CrMnNiMo8
Japan	JIS PDS5
USA	AISI P20 / P20 + Ni

Chemical Composition		
	Min. %	Max. %
Carbon (C)	0.35	0.45
Silicon (Si)	0.20	0.40
Manganese (Mn)	1.30	1.60
Nickel (Ni)	0.90	1.20
Chromium (Cr)	1.80	2.10
Molybdenum (Mo)	0.15	0.25
Sulphur (S)		0.03
Phosphorus (P)		0.03

Properties	Metric
Hardness, Brinell (typical)	300
Hardness, Rockwell C (typical)	30
Tensile strength, ultimate	965 - 1030Mpa
Tensile strength, yield	827-862Mpa
Elongation at break [in 50mm (2")]	20.00%

# Tool Steels



## ALLOY COLD-WORK TOOL STEEL - 1.2767

**Product Shortname:** MLDH, MHTH

DIN 2767 is supplied in the annealed condition and is capable of being hardened to a tensile strength in excess of 1500MPa.

The chemical make-up of this steel enables it to be air hardened or vacuum hardened with minimum distortion. DIN 2767 also displays excellent polish-ability, high toughness and can be successfully carburised. Ideal for applications where ultra-high tensile strengths are required.

**Typical Applications:** Gears requiring shock resistance, heavy duty shafts, axles etc.

**Delivery Condition:** Annealed

**Colour Code:** Grey / Purple.

**Size Range:** Available on request

Related Specifications	
Germany	W.Nr 1.2767
USA	AISI 6F7

Hardening	
840 - 870°C	Oil, salt bath (300 - 400°C), air
Holding time after temperature equalization	15 - 30 minutes
Obtainable hardness	54 - 58 HRC in oil or salt bath

Typical Chemical Composition		
	Min. %	Max. %
Carbon (C)	0.40	0.50
Silicon (Si)	0.10	0.40
Manganese (Mn)	0.20	0.50
Nickel (Ni)	3.80	4.30
Chromium (Cr)	1.20	1.50
Molybdenum (Mo)	0.15	0.35
Sulphur (S)		0.03
Phosphorus (P)		0.03

# Tool Steels



## ALLOY COLD-WORK TOOL STEEL – 1.2363 (A2)

**Product Shortname:** A2, A2F

2363 fills the gap between 2510 (01) and 2379 (D2) providing an ideal combination of wear resistance, toughness, stability in hardening and machinability for all press tooling applications. It is ideal for applications requiring an improvement over oil hardening tool steels, especially in wear resistance, stability and risk of cracking in hardening without the extra costs associated with high carbon chrome steels. 2363 exhibits deep hardening characteristics making it suitable for either air or vacuum hardening in most sizes.

Low change in size upon heat treatment. High wear-resistance and toughness.

**Typical Applications:** Blanking dies, rolls, shear blades, cold pilger mandrels, cold coining dies. Moulds for the processing of plastics.

**Delivery Condition:** Annealed

**Colour Code:** Light Blue

**Size Range:** Available on request

Related Specifications	
Germany	W.Nr 1.2363
USA	AISI A2

Typical Chemical Composition		
	Min. %	Max. %
Carbon (C)	0.95	1.05
Silicon (Si)	0.10	0.40
Manganese (Mn)	0.40	0.80
Chromium (Cr)	4.80	5.50
Molybdenum (Mo)	0.90	1.20
Sulphur (S)		0.03
Phosphorus (P)		0.03
Vanadium (V)	0.15	0.35

Heat Treatment							
Soft Annealing °C	Cooling				Hardness HB		
830 - 840	furnace				max. 231		
Hardening from °C	in				Hardness after quenching HRC		
930 - 970	oil, air or hot bath 500 - 550°C				63		
Tempering	°C	100	100	200	400	500	600
	HRC	61	62	60	57	59	52

# Tool Steels



## HOT-WORK TOOL STEEL – 1.2344 (H13)

**Product Shortname:** HOT, HOTF

H13 is the most widely used of all the hot die steels. This grade offers a good resistance to softening (up to 600°C), combined with good stability in hardening and high toughness, making it suitable not only for hot die applications but also plastic moulds.

High hot tensile strength, hot wear-resistance and toughness. Good thermal conductivity and insensitiveness to hot cracking. Suitable for limited water-cooling. The Extra Fine Structure (EFS) grade of material offers a more uniform, finer structure with an improved degree of cleanliness, and improved concentration of alloying elements.

**Typical Applications:** Plastic moulds, extrusion and die casting tooling, hot shear blades, parts requiring high tensile strength and high nitrided hardness. Pressure casting and metal extrusion tools for the processing of light metals, forging dies, moulds, worms, and cylinders for the processing of plastics, nitrided ejectors, hot shear blades.

**Delivery Condition:** Annealed

**Colour Code:** Orange / Green

**Size Range:** Available on request

Related Specifications	
Germany	W.Nr 1.2344
	X40CrMoV5-1
USA	AISI H13

Hot Forming	
Hot Forming °C	Cooling
1050 - 850	slow, e.g. in air

Chemical Composition		
	Min. %	Max. %
Carbon (C)	0.35	0.42
Silicon (Si)	0.80	1.20
Manganese (Mn)	0.25	0.50
Chromium (Cr)	4.80	5.50
Molybdenum (Mo)	1.20	1.50
Sulphur (S)		0.02
Phosphorus (P)		0.03
Vanadium (V)	0.85	1.15

Properties	Metric	Imperial
Tensile strength, ultimate (@20°C/68°F, varies with heat treatment)	H1200 - 1590Mpa	174000 - 231000 psi
Tensile strength, yield (@20°/68°F, varies with heat treatment)	1000 - 1380Mpa	145000 - 200000

# Gauge Plate & Key Steel



## GAUGE PLATE

**Product Shortname:** GPI, GPM

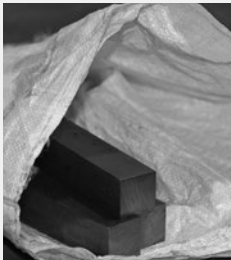
**Delivery Condition:** Annealed

**Hardness:** 229 Brinell Hardness (HB) max.

**Size Range:** Available on request

Related Specifications	
USA	AISI 01
Germany	DIN W.Nr 1.2510
Europe	100MnCrW4
Great Britain	BS4659 B01
Japan	JIS SKS3

Chemical Composition		
	Min. %	Max. %
Carbon (C)	0.90	1.00
Manganese (Mn)	1.00	1.20
Silicon (Si)		0.40
Chromium (Cr)	0.50	0.70
Tungsten (W)	0.50	0.70
Vanadium (V)	0.50	0.25



## KEY STEEL

**Product Shortname:** KEYI, KEYM

**Size Range:** Available on request

Related Specifications	
Great Britain	BS46 Part 1 1958 - Imperial
	BS4235 Part 1 1972 - Metric

Chemical Composition		
	Min. %	Max. %
Carbon (C)	0.42	0.50
Manganese (Mn)	0.50	0.80
Silicon (Si)		0.20

# Silver Steel



## SILVER STEEL

**Product Shortname:** SSRI, SSRM

Centerless ground to extremely tight tolerances and when required can be hardened extending its use in many applications.

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

**Size Range:** Available on request

**Packaging:** Supplied in individual cardboard tubes.

Related Specifications	
Great Britain	BS1407

Chemical Composition		
	Min. %	Max. %
Carbon (C)	0.95	1.25
Manganese (Mn)	0.25	0.45
Silicon (Si)		0.40
Chromium (Cr)	0.35	0.45
Sulphur (S)		0.45
Phosphorus (P)		0.45



## SIZE TOLERANCES (TO ASTM A29)

**Size Tolerances:** for Cold-Finished **Alloy Steel** Bars, Cold Drawn or Turned and Polished

Size - Metric (mm)	Tolerances from Specified Size, Under Only, mm			
	Maximum of Carbon Range 0.28 or Less BCQ	Maximum of Carbon Range Over 0.28 to 0.55 incl. 4140	Maximum of Carbon Range to 0.55% incl. Stress Relief or Annealed After Cold Finishing	Maximum of Carbon Range Over 0.55% or All Grades Quenched and Tempered or Normalized Before Cold Finishing
<b>Rounds - Cold Drawn (to 100mm in size) or Turned and Polished</b>				
To 25, incl, in coils	0.05	0.08	0.10	0.13
Cut Lengths	0.08	0.10	0.13	0.15
To 40, incl	0.10	0.13	0.15	0.18
Over 40 to 60, incl	0.13	0.15	0.18	0.20
Over 60 to 100, incl	0.15	0.18	0.20	0.23
Over 100 to 150, incl	0.18	0.20	0.23	0.25
Over 150 to 200, incl	0.20	0.23	0.25	0.28
Over 200 to 230, incl				
<b>Hexagons - Cold Drawn</b>				
Up to 20, incl	0.08	0.10	0.13	0.18
Over 20 to 40, incl	0.10	0.13	0.15	0.20
Over 40 to 60, incl	0.13	0.15	0.18	0.23
Over 60 to 80, incl	0.15	0.18	0.20	0.25
Over 80 to 100, incl	0.15	...	...	...

# Appendix

## SIZE TOLERANCES (TO ASTM A29)

**Size Tolerances:** for Cold-Finished **Carbon Steel** Bars, Cold Drawn or Turned and Polished

Size - Metric (mm)	Tolerances from Specified Size, Under Only, mm			
	Maximum of Carbon Range 0.28 or Less BCQ/BFC	Maximum of Carbon Range Over 0.28 to 0.55 incl. 1040	Maximum of Carbon Range to 0.55% incl. Stress Relief or Annealed After Cold Finishing	Maximum of Carbon Range Over 0.55% or All Grades Quenched and Tempered or Normalized Before Cold Finishing
<b>Rounds - Cold Drawn (to 100mm in size) or Turned and Polished</b>				
To 40, incl	0.05	0.08	0.10	0.13
Over 40 to 60, incl	0.08	0.10	0.13	0.15
Over 60 to 100, incl	0.10	0.13	0.15	0.18
Over 100 to 150, incl	0.13	0.15	0.18	0.20
Over 150 to 200, incl	0.15	0.18	0.20	0.23
Over 200 to 230, incl	0.18	0.20	0.23	0.25
<b>Hexagons - Cold Drawn</b>				
Up to 20, incl	0.05	0.08	0.10	0.15
Over 20 to 40, incl	0.08	0.10	0.13	0.18
Over 40 to 60, incl	0.10	0.13	0.15	0.20
Over 60 to 80, incl	0.13	0.15	0.18	0.23
Over 80 to 100, incl	0.13	0.15	...	

## SIZE TOLERANCES (TO ASTM A29)

**Size Tolerances:** for Cold-Finished **Carbon Steel** Bars, Cold Drawn or Turned and Polished

Size - Metric (mm)	Tolerances from Specified Size, Under Only, mm			
	Maximum of Carbon Range 0.28 or Less BCQ/BFC	Maximum of Carbon Range Over 0.28 to 0.55 incl. 1040	Maximum of Carbon Range to 0.55% incl. Stress Relief or Annealed After Cold Finishing	Maximum of Carbon Range Over 0.55% or All Grades Quenched and Tempered or Normalized Before Cold Finishing
<b>Squares - Cold Drawn</b>				
Up to 20, incl	0.05	0.10	0.13	0.18
Over 20 to 40, incl	0.08	0.13	0.15	0.20
Over 40 to 60, incl	0.10	0.15	0.18	0.23
Over 60 to 100, incl	0.15	0.20	0.23	0.28
Over 100 to 130, incl	0.25	...	...	...
Over 130 to 150, incl	0.36	...	...	...
<b>Flats - Cold Drawn</b>				
To 20, incl	0.08	0.10	0.15	0.20
Over 20 to 40, incl	0.10	0.13	0.20	0.25
Over 40 to 80, incl	0.13	0.15	0.25	0.30
Over 80 to 100, incl	0.15	0.20	0.28	0.40
Over 100 to 150, incl	0.20	0.25	0.30	0.50
Over 150	0.33	0.38	...	...

# Appendix

## STRAIGHTNESS TOLERANCES (TO ASTM A29)

### Straightness Tolerance for Cold-Finished Bars, A,B

NOTE: All grades quenched and tempered or normalised and tempered to Brinell 302 maximum before cold finishing and all grades stress relieved or annealed after cold finishing. Straightness tolerances are not applicable to bars having Brinell hardness exceeding 302.

Straightness Tolerances, mm (Maximum Deviation) from Straightness in any 3000mm Portion of the Bar					
Size - Metric (mm)	Length (mm)	Maximum of Carbon Range, 0.28% or less		Maximum of Carbon Range over 0.28% and all Grades Thermally Treated	
		Rounds	Squares, Hexagon & Octagons	Rounds	Squares, Hexagon & Octagons
Less than 16	Less than 4500	3	5	5	6
Less than 16	4500 and over	3	8	8	10
16 and over	Less than 4500	2	3	3	5
16 and over	4500 and over	3	5	5	5

- A) The tolerances above are based on the following method of measuring straightness; departure from straightness is measured by placing the bar on a level table so that the arc or departure from straightness is horizontal and the depth of the arc is measured with a feeler gauge and a straightedge.
- B) It should be recognised that straightness is a perishable quality and may be altered by mishandling. The preservation of straightness in cold-finished bars required the utmost care in subsequent handling. Specific straightness tolerances are sometimes required for carbon and alloy steels in which case the purchaser should inform the manufacturer of the straightness tolerances and the methods to be used in checking the straightness.
- C) For centreless ground bars, the maximum deviation straightness shall be less than 0.30mm over 1 metre.

### Straightness Tolerances for Hot-Wrought Bars and Bar Size Sections\*

Straightness Tolerances for Hot-Wrought Bars and Bar Size Sections*	
Standard Tolerances	6mm in any 1500mm or (length in mm/250)**
Special Tolerances	3mm in any 1500mm or (length in mm/500)**

\* Because of warpage, straightness tolerances do not apply to bars if any subsequent heating operation or controlled cooling has been performed.

\*\* Round to the nearest whole millimetre.

# Appendix

## ISO TOLERANCES

Basic Size - Metric (mm)		Limits, $\mu\text{m}$ (microns) (mm/1000)													
		h6		h7		h8		h9		h10		h11		h12	
Above	Up to & incl.	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
	3	0	-6	0	-10	0	-14	0	-25	0	-40	0	-60	0	-100
(3)	6	0	-8	0	-12	0	-18	0	-30	0	-48	0	-75	0	-120
(6)	10	0	-9	0	-15	0	-22	0	-36	0	-58	0	-90	0	-150
(10)	18	0	-11	0	-18	0	-27	0	-43	0	-70	0	-110	0	-180
(18)	30	0	-13	0	-21	0	-33	0	-52	0	-84	0	-130	0	-210
(30)	50	0	-16	0	-25	0	-39	0	-62	0	-100	0	-160	0	-250
(50)	80	0	-19	0	-30	0	-46	0	-74	0	-120	0	-190	0	-300
(80)	120	0	-22	0	-35	0	-54	0	-87	0	-140	0	-220	0	-350
(120)	180	0	-25	0	-40	0	-63	0	-100	0	-160	0	-250	0	-400
(180)	250	0	-29	0	-46	0	-72	0	-115	0	-185	0	-290	0	-460
(250)	315	0	-32	0	-52	0	-81	0	-130	0	-210	0	-320	0	-520

Basic Size - Imperial (")		Limits, microinches (inches/1000)													
		h6		h7		h8		h9		h10		h11		h12	
Above	Up to & incl.	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
(0.2)	0.4	0	-35	0	-59	0	-87	0	-142	0	-228	0	-354	0	-591
(0.4)	0.7	0	-43	0	-71	0	-106	0	-169	0	-276	0	-433	0	-709
(0.7)	1.2	0	-51	0	-83	0	-130	0	-205	0	-331	0	-512	0	-827
(1.2)	2.0	0	-63	0	-98	0	-154	0	-244	0	-394	0	-630	0	-989
(2.0)	3.2	0	-75	0	-118	0	-181	0	-291	0	-472	0	-748	0	-1181
(3.2)	4.7	0	-87	0	-138	0	-213	0	-343	0	-521	0	-866	0	-1378
(4.7)	7.1	0	-98	0	-158	0	-248	0	-394	0	-630	0	-984	0	-1575
(7.1)	9.8	0	-114	0	-181	0	-284	0	-453	0	-728	0	-1142	0	-1811
(9.8)	12.4	0	-126	0	-205	0	-319	0	-512	0	-827	0	-1260	0	-2047

# Appendix

## MACHINING ALLOWANCES

In order to eliminate safely the scale originated during forging, rolling and annealing, the decarburisation and sometimes fine cracks, sufficient machining allowances must be adhered to when manufacturing. Basic sizes and pertinent largest finished sizes for rolled or forged round, square, hexagonal and octagonal bars.

Basic size thickness $D_R^*$	Largest finished size thickness $D_F^*$
10	8.0
12	10.0
14	12.0
15	12.5
16	13.5
18	15.5
20	17.5
22	19.5
25	22.5
30	27.0
35	32.0
40	36.5

Basic size thickness $D_R^*$	Largest finished size thickness $D_F^*$
45	41.5
50	46.0
55	51.0
60	55.5
65	60.5
70	65.0
75	70.0
80	75.0
85	80.0
90	84.0
100	94
110	103

Basic size thickness $D_R^*$	Largest finished size thickness $D_F^*$
120	113
130	123
140	132
150	142
160	151
170	161
180	170
190	180
200	189
210	199
220	209
230	218

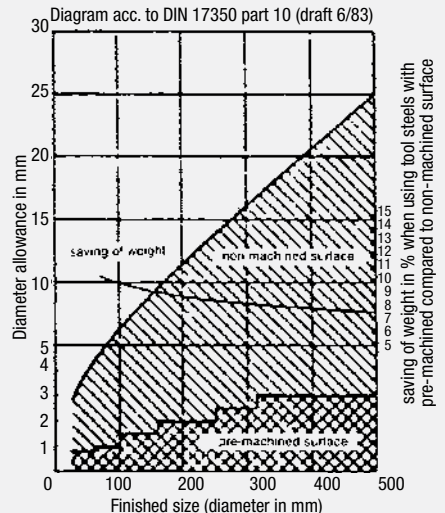
Basic size thickness $D_R^*$	Largest finished size thickness $D_F^*$
240	228
250	237
260	247
300	285
350	333
400	380
450	428
500	476
600	571

\*As thickness and diameter is valid in case of round bars, whereas for square hexagonal and octagonal bars it is the distance of the parallel side faces.

### Premachined Steels

Premachined steels offer the user smooth surface of the bars with machining allowances already strongly narrowed down. The advantages of a premachined surface can be seen from the diagram. Dependent on the size, 7 to 10% of the weight can be saved.

Order Size Above Up To	Permissible dimensional deviation	Material layer to be removed min.
0 — 25	+0.4	0.25
25 — 63	+0.6	0.4
63 — 100	+0.6	0.5
100 — 160	+1.0	0.75
160 — 250	+1.0	1.0
250 — 315	+1.0	1.25
315 +	+1.6	1.5



## USEFUL TABLES WEIGHTS - KG/METRE

### ROUND BARS:

Metric Size mm	Imperial Equivalent Size inch	kg/m
3	0.1181	0.056
3.175	1/8	0.062
4	0.1575	0.099
4.762	3/16	0.140
5	0.1969	0.154
6	0.2362	0.222
6.350	1/4	0.247
7.937	5/16	0.388
8	0.3150	0.395
9.525	3/8	0.559
10	0.3937	0.617
11.112	7/16	0.761
12	0.4724	0.888
12.700	1/2	0.994
13	0.5118	1.042
14	0.5512	1.208
14.287	9/16	1.259
15.875	5/8	1.554
16	0.6299	1.578
17	0.6693	1.782
17.462	11/16	1.880
19	0.7480	2.226
19.050	3/4	2.237
20	0.7874	2.466
20.637	13/16	2.626
22	0.8661	2.984
22.225	7/8	3.045

Metric Size mm	Imperial Equivalent Size inch	kg/m
23.812	15/16	3.496
24	0.9449	3.551
25	0.9843	3.853
25.400	1	3.978
28	1.1024	4.834
28.575	1 1/8	5.034
30	1.1811	5.549
31.750	1 1/4	6.215
32	1.2598	6.313
33	1.2992	6.714
34.925	1 3/8	7.520
35	1.3780	7.553
38.100	1 1/2	8.950
40	1.5748	9.865
41.275	1 5/8	10.504
44.450	1 3/4	12.181
45	1.7717	12.485
47.625	1 7/8	13.984
50	1.9685	15.413
50.800	2	15.911
53.975	2 1/8	17.962
55	2.1654	18.650
57.150	2 1/4	20.137
60	2.3622	22.195
60.325	2 3/8	22.436
63.500	2 1/2	24.861
65	2.559	26.049

Metric Size mm	Imperial Equivalent Size inch	kg/m
69.850	2 3/4	30.081
70	2.756	30.120
75	2.953	34.680
76.200	3	35.799
80	3.149	39.458
82.55	3 1/4	42.013
88.90	3 1/2	48.726
90	3.543	49.939
100	3.937	61.654
101.60	4	63.642
105	4.134	67.973
110	4.331	74.601
114.30	4 1/2	80.547
120	4.724	88.781
127.0	5	99.441
130	5.118	104.19
140	5.512	120.84
150	5.905	138.72
152.40	6	143.19
160	6.299	157.83
180	7.086	199.75
200	7.874	246.61
210	8.267	271.89
220	8.661	298.40
230	9.055	326.14
250	9.842	385.33

### HEXAGON BARS:

6.35	1/4	0.274
7.94	5/16	0.428
9.52	3/8	0.616
11.11	7/16	0.840
12.70	1/2	1.096
14.29	9/16	1.388
15.87	5/8	1.712

19.05	3/4	2.466
20.64	13/16	2.894
20.83	0.820	2.948
22.22	7/8	3.358
23.37	0.920	3.711
25.40	1	4.386
26.99	1 1/16	4.946

28.57	1 1/8	5.550
31.75	1 1/4	6.853
34.92	1 3/8	8.292
38.10	1 1/2	9.868
47.24	1.860	15.166
52.07	2.050	18.379

# Appendix

## APPROX. COMPARISON OF TENSILE STRENGTH\*

tons/in <sup>2</sup>	p.s.i	kg/mm <sup>2</sup>	N/mm <sup>2</sup> or MPa	tons/in <sup>2</sup>	p.s.i	kg/mm <sup>2</sup>	N/mm <sup>2</sup> or MPa
16	37,000	25.8	250	80	180,000	126.0	1236
20	45,000	31.6	309	81	182,000	128.0	1251
23	51,500	36.5	355	84	188,000	132.2	1297
26	58,000	40.8	402	85	190,000	133.6	1313
29	65,000	45.7	448	88	197,000	138.5	1359
30	67,000	47.1	463	90	202,000	142.0	1390
32	72,000	50.6	494	91	204,000	143.4	1405
33	74,000	52.0	510	94	210,000	148.4	1452
35	78,500	55.5	541	95	213,000	149.7	1467
36	81,000	57.0	556	97	217,000	152.6	1498
39	87,500	61.8	602	100	224,000	157.5	1544
40	90,000	63.3	618	104	233,000	163.8	1606
42	94,000	66.0	649	105	235,000	165.4	1622
45	101,000	71.0	695	107	240,000	168.5	1653
46	103,000	72.5	710	110	246,500	173.2	1699
49	110,333	77.3	757	113	253,000	178.0	1745
50	112,000	78.75	772	115	257,600	181.1	1776
52	116,500	82.0	803	117	262,000	184.3	1807
55	123,000	86.5	849	120	269,000	189.0	1853
58	130,000	91.4	896	123	275,500	194.0	1900
60	134,500	94.5	927	125	280,000	197.0	1931
62	139,000	97.7	957.5	126	282,500	198.0	1946
65	146,000	102.6	1004	130	291,000	205.0	2000
68	153,000	107.5	1050	133	298,000	209.0	2054
70	157,000	110.4	1081	135	302,400	213.0	2085
71	159,000	111.8	1097	136	304,500	214.0	2010
75	168,000	118.0	1158	140	313,600	221.0	2162
78	175,000	123.0	1205				

\*A Guide Only



# Appendix

## APPROX. EQUIVALENT HARDNESS NUMBERS AND TENSILE STRENGTH FOR BRINELL HARDNESS FOR STEEL\*

Brinell Hardness No. 10mm ball 3000kg Load	Diamond Pyramid Hardness No.	B-Scale 100kg Load 1/16" dia. Ball	Rockwell Hardness No. C-Scale 150kg Load Brale Penetrator	Tensile Strength in MPa	Brinell Hardness No. 10mm ball 3000kg Load	Diamond Pyramid Hardness No.	B-Scale 100kg Load 1/16" dia. Ball	Rockwell Hardness No. C-Scale 150kg Load Brale Penetrator	Tensile Strength in MPa
-	940	-	68.0	-	255	269	(102.0)	25.4	849
-	840	-	65.3	-	248	261	(101.0)	24.2	826
-	780	-	63.3	-	241	253	100.0	22.8	803
682	737	-	61.7	-	235	247	99.0	21.7	783
653	697	-	60.0	-	229	241	98.2	20.5	764
627	667	-	58.7	2392	223	234	97.3	(18.8)	742
601	640	-	57.3	2261	217	228	96.4	(17.5)	722
578	615	-	56.0	2158	212	222	95.5	(16.0)	706
555	591	-	54.7	2058	207	218	94.6	(15.2)	691
534	569	-	53.5	1962	201	212	93.8	(13.8)	672
514	547	-	52.1	1893	197	207	92.9	(12.7)	658
495	528	-	51.0	1817	192	202	91.8	(11.5)	642
477	508	-	49.6	1738	187	196	90.7	(10.0)	625
461	491	-	48.5	1665	183	192	90.0	(9.0)	612
444	472	-	47.1	1586	179	188	89.0	(8.0)	599
429	455	-	45.7	1513	174	182	87.8	(6.4)	583
415	440	-	44.5	1461	170	178	86.8	(5.4)	570
401	424	-	43.1	1391	167	175	86.0	(4.4)	560
388	410	-	41.8	1330	163	171	85.0	(3.3)	546
375	396	-	40.4	1271	159	167	83.8	(2.1)	535
363	383	-	39.1	1220	156	163	82.9	(0.9)	526
352	372	(110.0)	37.9	1175	152	159	81.7	-	514
341	360	(109.0)	36.6	1133	149	156	80.8	-	504
331	349	(108.5)	35.5	1097	146	153	79.8	-	495
321	339	(108.0)	34.3	1062	143	150	78.7	-	485
311	328	(107.5)	33.1	1029	140	146	77.6	-	475
302	319	(107.0)	32.1	1001	137	143	76.4	-	464
293	309	(106.0)	30.9	975	134	140	75.2	-	455
285	301	(105.5)	29.9	949	131	137	74.0	-	446
277	292	(104.5)	28.8	923	128	134	72.7	-	437
269	284	(104.0)	27.6	896	126	132	72.0	-	431
262	276	(103.0)	26.6	873					

\*A Guide Only

# Appendix

## Conversion Factors:

To calculate the weight of steel bars:		
ROUND	- dia. mm <sup>2</sup> x 0.006165	= Weight in kilograms per metre
ROUND	- dia. mm <sup>2</sup> x 0.004143	= Weight in lbs per foot
HEXAGON	- Size mm <sup>2</sup> x 0.006798	= Weight in kilograms per metre
HEXAGON	- Size mm <sup>2</sup> x 0.00457	= Weight in lbs per foot
SQUARE	- Size mm <sup>2</sup> x 0.00785	= Weight in kilograms per metre
SQUARE	- Size mm <sup>2</sup> x 0.00527	= Weight in lbs per foot
FLAT	- Width in mm x Thickness in mm x 0.00785	= Weight in kilograms per metre
FLAT	- Width in mm x Thickness in mm x 0.00527	= Weight in lbs. per foot
TOOL STEEL	- Width in mm x Thickness in mm x 0.00785	= Weight in kilograms per metre
TOOLING PLATE (Aluminium)	- Width in mm x Thickness in mm x 0.0027	= Weight in kilograms per metre

## General:

lbs. per foot x 1.4880	= kilograms per metre
kilograms per metre x 0.6720	= lbs. per foot
Feet x 0.3048	= metres
Metres x 3.2809	= feet
U.K. tons per sq. inch (tons f/in. <sup>2</sup> ) x 15.4443	= Mega Pascals (MPa)
Mega Pascals (MPa) x 0.064749	= u.k. tons f per square inch
Newton per sq. millimeter (N/mm <sup>2</sup> ) x 0.064749	= U.K. tons f per square inch.
Mega Pascals (MPa) x 145.0377	= pounds per square inch (psi)

## Units of Stress:

This book has used the megapascal (MPa) as the standard unit of stress. The same values may be seen in other publications as Newtons per square millimetre (N/mm<sup>2</sup>). To obtain other units of stress the following conversion factors may be used to get approximate values.

From	To	Multiply by	From	To	Multiply by
MPa	kg/mm <sup>2</sup>	0.102	kg/mm <sup>2</sup>	MPa	9.8
MPa	psi	145	psi	MPa	0.0069
MPa	Tons/in <sup>2</sup>	0.065	Tons/in <sup>2</sup>	MPa	15.4



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