

Chart 1

Rollability of Materials

CARBON AND ALLOY STEELS Proportional Die Life

Material Designation	Thread Finish	Soft	Proportional Die Life			Remarks
			Rc 15-24	Rc 25-32	Rc 33 to	
AISI 1008 - 1095	E	H	H-M	M	L	Excellent Rollability
AISI 1108 - 1151	G	H	H-M	M		These are free machining steels with high sulphur content. The highest sulphur materials-1110,1144 and 1200 series should be avoided when possible.
AISI 1211 - 1215	F	M				
AISI B1111 - B1113	F	H				
AISI 1330 - 1345	E	H	M	M-L	L	
AISI 4012 - 4047	E	H-M	M	M-L	L	
AISI 4118 - 4161	E	H-M	M	M-L	L	
AISI 4320-4340						
AISI 4419						
AISI 4615 - 4626	E	H-M	M	M-L	L	
AISI 4718 - 4720						
AISI 4815 - 4820						
AISI 5015 - 5060						
AISI 5115 - 5160	E	H-M	M	M-L	L	
AISI E51100 - E52100						
AISI 6118 - 6150	E	H-M	M	M-L	L	
AISI 8615 - 8655						
AISI 8720-8740	E	H-M	M	M-L	L	
AISI 8822						
AISI 9255 - 9260						
Stainless 302 304 309-317	E		M-L			These are non-hardenable austenitic steels containing higher quantities of nickel and chromium. High work hardening occurs with higher percent alloys. Also non-magnetic. Recommend Carpenter #10 wherever possible. Material does not seam.
Stainless 305, 321, 347, 348 Carpenter & 12 - 20CB	E		M	L		
Stainless Carpenter #10	E		H-M	M-L		
Stainless 329 - 430F - 446	E		M-L	L		Non-hardenable ferritic chromium stainless but magnetic. Lower work hardening but higher pressures required due to carbon.
Stainless 430 - 443	E		M	L		
Stainless 414 - 420F - 440F	E		M-L	L		Hardenable martensitic chromium steels, magnetic. Most suited for rolling of the stainless grades, low work hardening.
Stainless 410 - 431 - 440C - 501 - 502	E		H-M	L		
High Speed T1, M1, M2	E		M-L	L		Not generally recommended however can be rolled under proper conditions. Not rollable after nitriding.
Nitralloy 135 - 230	E		M	M-L	L	

Letter designations for Finish: E-excellent, G-good, F-fair, P-poor.

Letter designations for Die Life: H-high, M-medium, L-low.

Elongation factor: generally acceptable results can be achieved when percent elongation equals twelve (12) or more.

Chart 2

Rollability of Materials

WROUGHT COPPER AND COPPER ALLOYS

Material Designation		Alloy Name	Max. Hardness	Finish	Die Life	Remarks
SAE No.	ASTM No.					
CA102	B124 #12	Oxygen Free Copper	RF40	E	H	More than 90% copper. Excellent rollability.
CA110	B124 #12	Electrolytic Copper (ETP)	RF40	E	H	
CA122	B124 #12	Phosphorus Deoxidized (DHP)	RF45	E	H	
CA210	B36 #1	Gilding 95%	RB40	E	H	Copper-zinc alloys basically good for rolling except when zinc exceeds 30%. This tends to produce poor finish as indicated in CA270 CA280.
CA220	B36 #2	Commercial Bronze 90%	RB42	E	H	
CA230	B36 #3	Red Brass	RB55	E	H	
CA240	B36 #4	Low Brass 80%	RB55	E	H	
CA260	B36 #6	Cartridge Brass 70%	RB60	E	H	
CA270	B36 #8	Yellow Brass	RB55	F	H	
CA280	B135 #5	Muntz Metal	RB78	P	M	
CA314	B140-B	Leaded Comm. Bronze	RB65	P	M-H	Copper zinc alloys with lead added for improved machining characteristics. Poor to fair for rolling. Higher lead produces poorer thread finish and is not recommend for rolling.
CA335	B121 #2	Low Lead Brass	RB60	G	M-H	
CA340	B121 #3	Medium Leaded Brass	RB60	G	M-H	
CA342	B121 #5	High Leaded Brass	RB55	P	M	
CA345		Thread Rolling Brass	RB75	G	M-H	
CA353	B121 #5	High Leaded Brass 62%	RB55	P	M	
CA356	B121 #6	Extra High Leaded Brass	RB55	P	L-M	
CA360	B16	Free Cutting Brass	RB70	P	L	
CA365						
CA368	B171	Leaded Muntz Metal	RB70	P	M	
CA370	B135 #6	Free Cutting Muntz Metal	RB70	P	L	
CA377	B124 #2	Forging Brass	RB65	P	L	
CA385		Architectural Bronze	RB65	P	L	
CA443 to CA445	B171	Inhibited Admiralty	RB75	E	H	
CA464 to CA467	B124 #3	Naval Brass	RB75	P-F	M	Copper zinc alloy with lead and tin not conducive to good rolling characteristics. Alternate material should be used.
CA485	B21-C	Leaded Naval Brass	RB80	P	L	
CA502	B105	Phosphor Bronze E	RB50	G	H	Copper tin alloy generally good for rolling but increasing tin content reduces rollability. CA544 contains some lead & zinc thereby reducing its rollability.
CA510	B139-A	Phosphor Bronze A	RB65	G	H	
CA521	B139-C	Phosphor Bronze C	RB70	P-F	M-H	
CA524	B139-D	Phosphor Bronze D	RB70	P	M	
CA544	B139-B2	Free Cutting Phosphor Bronze	RB70	P	L	
CA606		Aluminum Bronze	RB70	G	M	Copper aluminum alloy fair to good rolling characteristics. Increased quantities of silicon nickel, introduce work hardening and reduce rollability.
CA614	B150-3	Aluminum Bronze D	RB70	G	M	
CA617	B150-1	Aluminum Bronze	RB70	P	L-M	
CA360	B150-2	Aluminum Bronze	RB70	P	L	
CA639		Aluminum Silicon Bronze	RB75	G	L	
CA651	B98-B	Low Silicon Bronze B	RB70	E	M	Copper with silicon as basic alloy. Average rollability.
CA655	B98-A	High Silicon Bronze A	RB75	FG	M	
CA675 used.	B138-A	Manganese Bronze A	RB70	P	M	High zinc alloy, alternate material should be
CA706	B111	Copper Nickel - 10%	RB70	G	M-H	High nickel alloy reduces rollability proportionally.
CA715	B111	Copper Nickel - 30%	RP70	G	M	
CA745	B151-E	Nickel Silver 65 - 10	RB70	E	H	Copper with zinc and nickel as alloy-rollability good to excellent. As alloy increases, rollability decreases.
CA752	B151-A	Nickel Silver 65 - 18	RB70	G-E	H	
CA754		Nickel Silver 65 - 15	RB70	E	H	
CA757	B151-D	Nickel Silver 65 - 12	RP70	E	H	
CA770	B151-B	Nickel Silver 55 - 18	RB70	G	M	

COPPER CASTING ALLOYS, ANNEALED

Copper casting alloys, in the annealed condition, mostly are rated as poor rollability and poor die life. The copper alloys with basic quantities of tin, zinc or silicon rate slightly better in die life with poor to fair finish. It is recommended that these materials be avoided where possible and should only be considered for low production quantities.

Letter designations for Finish: E-excellent, G-good, F-fair, P-poor.

Letter designations for Die Life: H-high, M-medium, L-low.

Elongation factor: generally acceptable results can be achieved when percent elongation equals twelve (12) or more.

Rollability of Materials

WROUGHT ALUMINUM AND ALUMINUM ALLOYS

Material Designation		Condition	Max. Hardness	% Elongation	Finish	Die Life	Remarks
SAE No.	ASTM No.						
1100-0	990A	Annealed	RB23	45	E	H	99% aluminum recommended for rolling. Work hardens very slowly, cannot be heat treated. Major alloy is silicon.
1100-H12	990A	1/4 Hard	RB28	25	E	H	
110-H14	990A	1/2 Hard	RB32	20	G-E	H	
1100-H16	990A	3/4 Hard	RB38	17	G	H	
1100-H18	990A	Full Hard	RB44	15	FG	M	
2011-T3	CB60A	Heat treated and cold worked	RB95	15	FG	M-H	Lower quality finish is a result of lead and Bismuth alloys, not generally recommended for rolling.
2011-T6C	B60A	Heat treated and aged	RB97	17	F	M-H	
2011-T8	CB60A	Heat treated, cold worked & aged	RB100	12	P-F	M-H	
2014-0	CS41A	Annealed	RB45	18	G	M-H	Copper, silicon, manganese major alloys, higher strength requires greater roll pressure.
2014-T4	CS41A	Heat treated and aged	RB105	20	G-E	M-H	
2014-T6	CS41A	Heat treated and aged	RB135	13	F	M-H	
2017-0	CM41A	Annealed	RB45	22	E	H	Good rollability. Most commonly used for rolling.
2017-T4	CM41A	Heat treated and aged	RB105	22	E	H	
2024-0	CG42A	Annealed	RB47	22	E	H	
2024-T3	CG42A	Heat treated and cold worked	RB120	18	E	H	
2024-T4	CG42A	Heat treated and aged	RB120	18	E	H	
2117-T4	CG30A	Heat treated and aged	RB70	27	E	H	
3003-0	MIA	Annealed	RB28	40	E	H	99% aluminum, recommended for rolling. Work hardens very slowly, cannot be heat treated. Major alloy is manganese.
3003-H12	MIA	1/4 Hard	RB35	20	G-E	H	
3003-H14	MIA	1/2 Hard	RB40	16	G	H	
3003-H16	MIA	3/4 Hard	RB47	14	F	M	
3003-H18	MIA	Full Hard	RB55	10	P-F	L-M	
5052-0	CR20A	Annealed	RB47	30	E	H	Fair to good rollability in the lower hardness condition, major alloy manganese with chromium.
5052-H32	CR20A	1/4 Hard	RB60	18	G	M	
5052-H34	CR20A	1/2 Hard	RB68	14	F	M	
5052-H36	CR20A	3/4 Hard	RB73	10	P-F	L-M	
5053-H38	CR20A	Full Hard	RB77	8	P	L	
5056-0	GM50A	Annealed	RB65	35	E	H	Major alloy magnesium. Recommend rolling in annealed condition only.
5056-H18	GM50A	Strain Hardened	RB105	10	P	L-M	
5056-H38	GM50A	Strain Hardened and Stabilized	RB100	15	P-F	L-M	
6061-0	GS11A	Annealed	RB30	30	E	H	Good to excellent rollability in conditions.
6061-T4	GS11A	Heat treated and aged	RB25	65	G-E	H	
6061-T6	GS11A	Heat treated and aged	RB17	95	G	H	
7075-0	ZG62A	Annealed	RB60	16	F	H	Generally not recommended for rolling.
7075-T6	ZG62A	Heat treated and aged	RB150	11	P	M	

WROUGHT NICKEL AND NICKEL ALLOYS

The nickel alloys in general can be produced with a good to excellent thread finish. The "inconel" and "hastelloy" series result in a poor to fair finish. The higher tensile of nickel alloys requires high roll pressures and, therefore, medium to low die life can be expected. It is recommended that annealed material be used wherever possible.

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Rollability of Materials

[Carbon & Alloy Steel](#)
[Copper](#)
[Aluminum](#)

A

MATERIAL'S yield strength and its percent of elongation factor determines whether it can be plastically and permanently deformed. To be rollable, a given material should have an elongation factor of 12%. Other influencing factors include hardness, its microstructure, and the degree and speed at which it work hardens. Also, its modulus of elasticity, the non-metallic content of steels, and the workpiece diameter and pitch.

Material yield point must be exceeded if it is to be permanently deformed. Obviously, the higher its yield point, the more a material will resist deformation. Higher yield points require that proportionately higher rolling pressures be employed.

What materials can be rolled?

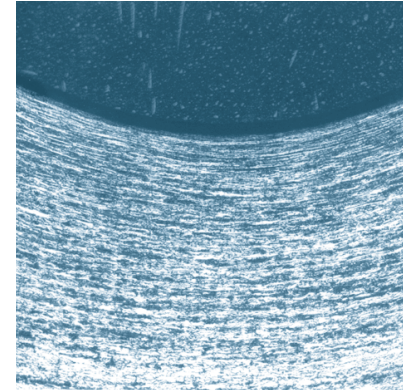
Generally, the hardness and elongation factors are regarded as the routine indices of rollability. Being readily obtainable, hardness is used as comprehensive indicators of yield and reduction of area.

Basic open-hearth steels in the soft state are rollable providing carbon content does not exceed 1.5%. Sulfurized steels are rollable depending upon the severity of cold working to be done and the percentage of sulfur content. While sulfur additives will enhance the machinability of a cutting operation, they are not desirable for cold forming.

Sulfur content should not exceed 0.13%. Higher rates cause extremely hard sulfur inclusions which require higher rolling pressures. In addition to being detrimental to die life, inclusions resist cold forming, cause flaking, and can result in roll breakage.

Soft and malleable leaded steels are naturally thought to have good rollability. While desirable to enhance machinability, additives are not conclusive to cold forming. Softer than the base material, the lead inclusions result in intermittent and varying die loading which contributes to poorer die life. Lead content should be no more than 0.1%.

Figure
1



Cold or hot-working can result in hard spots, seams, laps, voids, and other defects. Refractory residues and other impurities have an abrasive effect on dies. Buying higher grade steels minimizes these conditions and their higher cost is offset by increased tool life and less downtime.

To what degree work-hardening will occur depends upon the analysis of the material, its initial hardness, the severity of deformation, and number of cold working cycles imposed on the workpiece.

The greatest amount of deformation with the greatest hardness increase occurs in the root area, the least on the flanks. Figure 1 shows a rolled thread cross section magnified 75X normal size. This shows that the grain structure

has been flowed along the thread contour. An overall comparison of the entire thread profile would reveal that the structure is of deeper and finer grain in the root which reflects a higher degree of hardness in that area.

Work-hardening resulting from thread rolling is superficial and the material would be at core hardness .030" to .040" beneath the surface. Where a material has higher work hardening tendencies, hardening has been measured at .150" below the surface. Die life will proportionately decrease in direct ratio to the work hardening increase.

The charts on pages 62-64 list the rollability factor for various materials and what degree of die life can be expected.