High Strength Carbon and Alloy Die Drawn Steels —SAE J935 JUL81

SAE Recommended Practice
Completely Revised July 1981

THIS IS A PREPRINT WHICH IS SUBJECT TO REVISIONS AND CORRECTIONS. THE FINAL VERSION WILL APPEAR IN THE 1983 EDITION OF THE SAE HANDBOOK.

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PREPRINT

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SAE Recommended Practice

Report of the Iron and Steel Technical Committee, approved September 1965, completely revised July 1981.

Scope—This SAE Recommended Practice is intended to provide basic information on properties and characteristics of high strength carbon and alloy steels which have been subjected to special die drawing. This includes both cold drawing with heavier-than-normal drafts and die drawing at elevated temperatures.

Introduction—Die drawing of hot rolled bars increases the strength and hardness. At the same time, the ratio of yield strength to tensile strength is increased and the notched bar impact values are reduced. Various factors control the degree of change in the mechanical properties. The final properties are dependent upon chemical composition, hot rolled microstructure (except in the case of alloy steel where a normalize treatment is used prior to drawing), size, shape and the amount of reduction in cross-sectional area, die geometry, straightening procedures, and manner or temperature level of the stress relieving operation.

As noted in Table 1, carbon and alloy steels of medium carbon content respond readily to this special processing. Compositional additives may be employed to improve machinability.

In the production of these products, drafts of approximately 10–35% reduction in cross-sectional area are employed at either room or elevated temperatures depending on the practices and facilities of the individual producer. Stress relieving temperatures vary over a similarly wide range, depending on producer facilities and the end product requirements.

Die drawn and stress relieved bars are employed instead of quenched and tempered bars because of their unique combinations of properties. The die drawn and stress relieved bars can be machined more readily than quenched and tempered bars, and except when the latter have high hardenability, the die drawn and stress relieved bars have more uniform hardness throughout the cross section. When dimensional stability is critical during or after machining, or after cold forming operations, the individual producer should be consulted for special processing to meet such conditions.

The torsional strength and endurance limit are similar to those of quenched and tempered grades at the same strength level. The wear resistance of these special processed steels is approximately equal to that of quenched and tempered bars of the same surface hardness.

Hardness—The hardness values for all grades are shown in Table 1. The typical hardness ranges indicated for the 825 MPa tensile strength steels are subject to negotiation between producer and consumer. Hardness determinations are commonly made on a flat ground on the outside diameter or on a cross section from the mid-radius to within 6 mm of the surface. If, when testing the finished product, there is disagreement between the typical hardness and tensile or yield strength values, the latter properties shall govern.

Impact Characteristics—The impact test values of special die drawn bars, as measured by the Izod or Charpy notched bar test, are lower than those of quenched and tempered carbon bars and they are significantly lower than those of quenched and tempered alloy steels. Failures of machine components usually result from fatigue, corrosion, wear or shock loading. With the possible exception of the latter, there is no known correlation between the cases of failure and the notched bar impact test. In the case of shock loading, whatever relation exists must be derived empirically, that is, from experience. When low temperatures or high pressures are involved and where doubt exists as to the suitability of these steels, the design of the part should be reviewed.

Surface Finish—A number of surface finishes are available depending on producers' facilities and end use requirements. Bars can be supplied in the die drawn condition turned and polished, or ground and polished from die drawn or turned bars. The bars frequently have a dark appearance when the last operation is stress relieving. Surface finishes are subject to negotiation with each producer. The following ranges of Arithmetical Average (AA) values are considered normal for each condition.

	μm		μin
Cold Drawn	1.25/3.20	AA	(50/125)
Turned and Polished	0.40/1.00	AA	(15/40)
Cold Drawn-Ground and Polished	0.20/0.50	AA	(8/20)
Turned-Ground and Polished	0.20/0.50	AA	(8/20)

Machinability—Machinability values for any given grade or condition will vary considerably from shop to shop as a function of equipment, tooling grade and design, set up conditions, lubrication, and personnel. The following ratings which are considered typical and which are offered

TABLE 1—MINIMUM MECHANICAL PROPERTIES

Tensile Strength MPa (ksi)	Yield Strength MPa (ksi)	Elongation in 50 mm (2 in), %	Reduction in Area, %[a]	Brinell Hardness	Grades	Size Range mm	Size Range (in)	Tolerance
CARBON STEELS								
825 (120)	690 (100)	10.0	25.0	241/321[b]	1541 1045 1052 1141	up to 80 (round) 6–90 (round)	(3) (1/4–3-1/2)	See Table 2
				248/321[b]	1144 1151	6–120 (round) 6–55 (hexagon)	(1/4–4-1/2) (1/4–2)	See Table 2
965 (140)	860 (125)	5.0	15.0	280	1144	6–60 (round) 6–40 (hexagon)	(1/4–2-1/2) (1/4–1-1/2)	See Table 3
ALLOY STEELS								
860 (125)	725 (105)	14.0	45.0	269	41XX 51XX[c]	12–90 (hexagon)	(7/16–3-1/2)	See Table 4
1035[d] (150)	895 (130)	10.0	35.0	302	41XX[c] 51XX[c]			
1170 (170)	1070 (155)	5.0	20.0	355	41XX[c]			

[a] Typical minimum

[b] Typical hardness ranges, subject to negotiation. Hardness to be taken on a flat below decarb or on the mid-radius. In case of disagreement between hardness and tensile or yield strength, the latter properties govern.

[c] May contain Pb or Te or other additives for improved machinability.

[d] See SAE J429.