HIGH STRENGTH, LOW ALLOY STEEL—SAE J410a

SAE Recommended Practice

Report of Iron and Steel Technical Committee approved January 1947 and last revised June 1962.

Introduction—High strength, low alloy steel represents a specific group of steels in which enhanced mechanical properties and, in some cases, resistance to atmospheric corrosion are obtained by the addition of moderate amounts of one or more alloying elements other than carbon. Different types are available, some of which are carbon-manganese steels and others which contain further alloy additions, governed by special requirements for weldability, formability, toughness, and economics.

These steels are especially characterized by their mechanical properties, obtained in the hot rolling process. They are not intended for quenching and tempering, and the purchaser should not subject them to such treatment without assuming responsibility for the ensuing mechanical properties. For certain applications these steels are sometimes annealed, normalized, or stress relieved with some influence on mechanical properties; high strength sheet and strip are sometimes cold rolled.

Where these steels are used for fabrication by welding, care must be exercised in selection of grade and in the details of the welding process. Certain grades may be welded without preheat or postheat. These steels may be obtained in the form of sheet, strip, plates, structural shapes, bar and bar size section.

Application—These steels, because of their high strength-to-weight ratio, abrasion resistance and, in some cases, improved atmospheric corrosion are adapted particularly for use in mobile equipment and other structures where substantial weight savings are generally desirable. Typical applications are truck bodies, frames, structural members, scrapers, truck wheels, cranes, shovels, booms, chutes, and conveyors.

Qualification Tests—At the option of the purchaser of a new or modified grade or radically different range of thickness, samples from one to three mill heats may be initially supplied for qualification tests for resistance welding, metallic arc welding, and for notched-bar impact properties of the particular grade or thickness range to be furnished. (The qualification is for information on these and other desired properties and their variance from mill heat to mill heat.)

Mechanical Properties

NOTE: PERMISSIBLE USE OF YIELD POINT—Present steel industry practice is to express the yield of these materials as yield point rather than yield strength, and determination is by drop of beam, dividers, or other method, covered in ASTM A 370. Unless otherwise specified, this practice is acceptable for material suplied to this specification, and use of an extensometer is not required. The yield point shall meet the requirements shown for yield strength in Table 1.

High strength, low alloy steel may be specified annealed or normalized, or otherwise specially prepared for special forming properties. In those cases, mechanical properties should be agreed upon between supplier and purchaser.

TABLE 1—MINIMUM MECHANICAL PROPERTIES[a]

Form	SAE 945				SAE 950			
	Yield Strength[b], psi	Tensile Strength, psi	Elongation in 2 in., %	Elongation in 8 in., %	Yield Strength[b], psi	Tensile Strength, psi	Elongation in 2 in., %	Elongation in 8 in., %
Sheet and Strip	45,000	60,000	22	—	50,000	70,000	22	—
Plates, Shapes, and Bars								
Up to 1/2 in. incl	45,000	65,000	22	18	50,000	70,000	22	18
Over 1/2 to 1-1/2 in. incl	42,000	62,000	24	19	45,000	67,000	24	19
Over 1-1/2 to 3 in. incl	40,000	62,000	24	19	42,000	63,000	24	19

[a] Mechanical properties to be determined in accordance with ASTM A 370, Methods and Definitions for Mechanical Testing of Steel Products.
[b] Yield strength is to be measured at 0.2% offset.

Bend Test—Longitudinal bend test specimens shall stand being bent at room temperature through 180 deg without cracking on the outside of the bent portion. The inside diameter of the bend shall have a relationship to the thickness of the specimen as prescribed in Table 2.

TABLE 2—MINIMUM BEND TEST REQUIREMENT (ASTM A 370)

Thickness of Sample	Up to 1/2 in. incl	Over 1/2 to 1-1/2 in. incl	Over 1-1/2 to 3 in. incl
T	1T	2T	3T

The bend test requirements in Table 2 are for mill acceptance purposes and are made on prepared test specimens. They have no relationship to shop bending practices (see section, General Information) and are not to be used as a basis for fabricating procedures.

Dimensional Tolerances—Standard manufacturing tolerances for dimensions as given in the AISI Steel Products Manual for High Strength-Low Alloy Steel shall apply.

Chemical Composition—Chemical composition of steel furnished to this specification shall conform to Table 3.

TABLE 3—CHEMICAL COMPOSITION[a], LADLE ANALYSIS (MAX)

Grade	C	Mn	P	S	Si
945A	0.15	1.00	0.040	0.050	0.90
945C	0.23	1.40	0.040	0.050	0.90
950A	0.15	1.30	0.040	0.050	0.90
950B	0.22	1.30	0.040	0.050	0.90
950C	0.25	1.60	0.040	0.050	0.90
950D	0.15	1.00	0.150	0.050	0.90

[a] It is generally believed that atmospheric corrosion resistance can be enhanced by the addition of moderate amounts of one or more alloying elements, other than carbon. If this characteristic is a requirement, the addition of such elements within the limits of this specification shall be negotiated.

NOTE: Fully killed steel made to fine-grain practice may be specified by the use of suffix "K." EXAMPLE: 945AK. Each of these grades made to "K" practice may not be available from some suppliers, and this practice should only be specified when improved low temperature notch toughness is important.

Choice of, and limits for, additional elements, other than those specified necessary to attain required or desirable properties, shall be made known to the purchaser and not changed without his full knowledge and consent and in accordance with the requirements implied by the qualification tests previously described.

General Information

Recommended Bending Practice—The recommended fabricating practice for cold forming these steels is to avoid bends in any direction that are more severe than shown in Table 4.

TABLE 4—SUGGESTED MINIMUM INSIDE RADII FOR COLD BENDING

Thickness of Material	SAE 945	SAE 950
Up to 0.180 in. incl	1T	1T
Over 0.180 in. to 0.250 in. incl	1-1/2T	2T
Over 0.250 in. to 0.500 in. incl	2-1/2T	3T

Hot forming is recommended for bending thicknesses over ½ in.

While the recommendations in Table 4 for inside radii for cold bending are minimum, it may be found necessary to increase the radii depending on the strength level of the material and the application.

Description of Grades

Grade 945A—This is a high strength, low alloy steel with excellent welding characteristics, both arc and resistance, and the best formability, weldability, and low temperature notch toughness of the high strength steels. It is generally used in sheet, strip, and light plate thickness.

Grade 945C—This is a carbon-manganese high strength steel with satisfactory arc welding properties if adequate precautions are observed. It is similar to Grade 950C, except that lower carbon and manganese improve arc welding characteristics, formability, and low temperature notch toughness at some sacrifice in strength.

Grade 950A—This is a high strength, low alloy steel with good weldability, both arc and resistance, with good low temperature notch toughness, and good formability. It is normally available only in sheet and strip and light plate thickness.

Grade 950B—This is a high strength, low alloy steel with satisfactory