Classification of Steels for Structures

TASK GROUP 5, COLUMN RESEARCH COUNCIL

DURING THE PAST two decades, the steel industry has emphasized the development and application of higher strength steels for structures. As new metal alloys were being developed, the Column Research Council was concerned with the effect of the properties of these alloys on the stability of compression members. Because the Council could not consider the numerous higher strength steels that were being introduced, Task Group 5 was formed to suggest a classification of steels for structures that would identify the major types of steel and analyze trends of future development.

As the group was collecting the necessary data, the grouping of steels according to metallurgical characteristics became simpler because the American Society for Testing and Materials (ASTM) developed and published specifications for types of steel that had only been available as trade-marked products from individual producers. However, the Task Group shared the feeling of a number of designers, that their problem, as well as the problem of selecting steels for broad areas of structural research, would be simplified if steels could be grouped according to broad strength bands. These strength ranges are not intended to replace ASTM and similar specifications, but are suggested as a general guide for the Council and, in general, the structural engineering profession.

The present report lists steels currently available for structures. It seems that time will serve to modify current offerings, some of which will prove to be popular and useful while others will be discontinued because of lack of use. The Task Group hopes that by arranging these steels into strength bands, it may be able to point the way to bring improved order in this matter. The properties of the steels presented in the tables are based on the information supplied by the manufacturers at the time of the survey. Because steels are frequently modified, the reader should check with the the respective manufacturer before using the data shown for a specific steel.

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SUGGESTED DESIGN STRENGTH RANGES

Among the different types of steels, there is considerable overlap of available strength characteristics. In seeking to set optimum design strength ranges, the chemical analysis and the method of manufacture do not provide any clear ranges of differentiation. The Task Group recognized that the task of the structural designer and structural-research investigator would be simplified if the yield stresses* of the different steels would follow a progression of preferred levels, such as 36, 42, 50, 60, 72, 85, and 100 ksi.

From a review of the available yield-stress levels, it became clear that a listing in accordance with a progression of preferred levels is not feasible at present. It was decided to list the steels in the following ranges: 42 and under, 43–55, 56–75, 76–100, and over 100 ksi. Practice has shown these to be very usable ranges from a design and construction standpoint. Although numerous steels fall within each range, those steels that are most economical will undoubtedly dominate the range. Although many combinations of number of steps and range of yield stress are available, the suggested scheme, which contains a progression of about 30 percent per step, is offered as one which may be found practical.

CATEGORIES OF STEELS FOR STRUCTURES

Steels that are presently available as plates, bars, and structural shapes for use in structures can be grouped in the following four categories:

1. Structural carbon steels
2. High-strength and high-strength low-alloy steels
3. Heat-treated carbon steels
4. Heat-treated alloy steels

* *In accordance with the nomenclature used in the CRC Guide, the term "yield stress" is used to denote either yield point or yield strength, whichever is applicable.*

These general types are arranged approximately in order of increasing yield stress level, although there is a degree of overlap in yield stress, as will be discussed later. These steels are produced to their specified properties at the mill and, in general, no further heat treatment to alter the properties is performed. The tables in the Appendix list available steels according to the above four types. For each type, separate tables for the suggested strength ranges are presented.

In addition, steel sheet and strip of structural quality are finding increasing use in structures. Carbon and high-strength low-alloy steels are available in this product area. Sheet or strip are cold formed to shape for load-carrying purposes in structures. A table for steels in this area also appears in the appendix.

Structural Carbon Steels (Type 1)—For many years ASTM A7 steel was the basic structural carbon steel and was produced to a minimum yield point* of 33 ksi. For welded structures, ASTM A373 steel with a minimum yield point of 32 ksi was frequently specified. In 1960, ASTM A36 steel was introduced with a yield point of 36 ksi, and with improved weldability over A7 steel. A36 steel provides engineers with a structural carbon steel of reliable welding characteristics and a slightly higher yield point at a minimum cost. Both of the earlier specifications (A373 and A7) have now been discontinued as ASTM standards. In Canada, improved structural carbon steels are covered by specifications CSA G40.8 and G40.12.

High-strength and High-strength Low-alloy Steels (Type 2)—The high-strength low-alloy steels are predominant in this category. They include a rather wide variety of steels with yield points ranging from 42 ksi to 70 ksi. Some of these steels have been available for over 30 years, but new grades or variations of existing grades are still being introduced. These steels are generally furnished in the as-rolled condition, exhibit ferrite-pearlite micro-structures, and derive their strength from moderate alloy additions. The elements generally added are chromium, nickel, molybdenum, zirconium, vanadium, and columbium, as well as copper, phosphorus, and silicon in a wide variety of combinations. Under this type the following four groups are encountered.

(*A*) *Manganese-copper Group*—The high-strength steels in this group are generally covered by ASTM A440 and are intended for riveted and bolted structures. The yield point of A440 steel is 50 ksi in thicknesses not exceeding $\frac{3}{4}$-in. and is reduced for thicker sections.

(*B*) *Manganese-Copper-Vanadium Group*—The high-strength low-alloy steels in this group are generally covered by ASTM A441 and are intended for welded structures. The yield point of A441 steel is 50 ksi in thicknesses not exceeding $\frac{3}{4}$-in. and is reduced for thicker sections.

(*C*) *Multiple Alloy Group*—The main feature of the high-strength low-alloy steels in this strength range is their good resistance to atmospheric corrosion, which frequently permits use in the unpainted condition. ASTM Specification A242 has limited application in this group, although many steels exceed the requirements of this specification. Steel producers have made progress in developing steels that maintain a 50 ksi yield point in thick sections. Some steels of this group have this yield point for thicknesses up to 4 in., inclusive, and are now covered by ASTM A588. Canadian Standards Association Standard G40.11 covers steels in this group that have defined corrosion resistance.

(*D*) *Columbium or Vanadium Group*—Most of the recently introduced steels are included in this group. Initially, steels in this group were offered with yield points ranging from 45 to 70 ksi, with increments of 5 ksi. However, the recent trend is to increase the increments. Some steel companies now emphasize the availability of steels with yield points of 42, 50, 60, and 70 ksi. Steels in this group with yield points up to 65 ksi, inclusive, are covered by ASTM Specification A572. A new trend gaining some strength in the industry, and one which designers will heartily endorse, is to tailor the composition according to section thicknesses, so that the specified yield points can be maintained over a wide range. For example, 42 ksi yield point steels are now available in thicknesses to 8 in., inclusive, and the 50 ksi yield point steels are available in thicknesses to 4 in., inclusive. The steels with higher yield points are available only in lighter sections, $1\frac{1}{2}$ in. and under for the 60 ksi yield point steels, and $\frac{1}{2}$-in. and under for 70 ksi yield point steels. Availability of these steels with relation to thickness and yield points is constantly changing.

Heat-treated Carbon Steels (Type 3)—The first steel of this type was introduced in 1964. It was developed to fill the need for a constructional steel intermediate between the 50 ksi yield point of heavy section high-strength low-alloy steels and the 100 ksi yield strength of heat-treated alloy steel. Heat-treated carbon steel filled this gap by providing a yield strength 80 ksi in thicknesses of $\frac{3}{4}$-in. and less, and 70 ksi in thicknesses over $\frac{3}{4}$ to $1\frac{1}{2}$ in., inclusive. The steels are available from the mill in the quenched and tempered condition and are intended for welded structures.

Heat-treated carbon steels for low-temperature applications in tanks and pressure vessels are covered by

* *The term "yield point," as used in this report, is understood to mean the specified minimum value.*

ASTM Specification A537. The specified yield point of these steels in the quenched and tempered condition is 60 ksi.

Heat-treated Alloy Steels (Type 4)—The first steel of this type was introduced in 1953. The development marked a major advance, because the new steel provided a yield strength three times that of conventional carbon steels used at that time and twice that of the previously available high-strength low-alloy steel, and yet exhibited good weldability and toughness. Since 1964, these steels have been covered by ASTM specifications. A514 provides for structural quality plates with 100 ksi yield strength to 2½ in., inclusive, and 90 ksi yield strength over 2½ in. to 4 in., inclusive, in thickness. A517 provides for pressure vessel quality plates with 100 ksi yield strength to 2½ in., inclusive, in thickness. These steels are available from the mill in the quenched and tempered condition.

Sheet and Strip Steels of Structural Quality—As indicated in the final table in the Appendix, hot-rolled carbon steel sheet and strip of structural quality are covered by ASTM Specifications A245, A303, and A570. However, Specification A570 replaces A245 and A303, so that A570 should be used in the future. High-strength low-alloy steels are covered by Specification A374 for cold-rolled sheets and strip and A375 for hot-rolled sheets and strip. In addition, most of the proprietary steels listed in this report as Type 2 are also available in hot-rolled or cold-rolled sheet and strip form. Exceptions, where they exist, are likely to be due to commercial, rather than technical, considerations. Such exceptions can be determined by consulting the producer.

Corrosion protection of light-gage cold-formed structural members is often provided by zinc-coating (galvanizing). ASTM Specification A446 covers galvanized carbon steel sheets. Again, many proprietary steels of Type 2 are available as galvanized sheets and strip.

STRESS CONSISTENCY REGARDLESS OF THICKNESS

Mention was made of a new trend in the industry to alter the chemistry of a steel to maintain its strength characteristics over its entire available thickness range. This makes a great deal of sense from the designer's point of view. Consistency in chemistry is of interest to no one but the mill crew who maintain the analysis, regardless of the thickness into which it will be rolled. Everyone else involved with the design and the use of structural steel is concerned only with its mechanical properties and welding characteristics. If these qualities of a given steel could be maintained over its entire thickness range, the benefits would far outweigh the inconvenience of carefully programming the heats and billets to predetermined thicknesses. The steel industry should be encouraged to proceed further along these lines.

FUTURE DEVELOPMENTS

As indicated above, the structural steels that are commercially available at present have yield points or yield strengths as high as 100 ksi. However, the development of steels with higher yield points is progressing rapidly. A weldable 5 Ni-Cr-Mo-V steel suitable for plates through 4 in. thick, structural shapes, forgings, castings, and bar stock, has been developed to meet very stringent requirements of the U. S. Navy. It is anticipated that this steel will be the basis for development of steels for less stringent structural application.

Task Group 5, in offering the attached tabulation of steels and the more important suggested grouping into design stress ranges, realizes that these are only beginning steps in a progression that bids fair to outstrip our imaginations. Having conquered the 100 ksi plateau, structural steel makers are daily reaching further and further toward the 200 ksi level. When these steels are available, more design stress levels will be created. The problem facing the designer will become even more complex, but we believe the design-strength-range steps concept will still be valid. This report is submitted to the Council as a guide and is offered as a suggested chart for future progress. The Task Group believes that this course will result in helping to bring some order out of the multitude of presently available steels and will eventually work to the benefit of the steel industry, as well as materially assisting those who seek to incorporate modern structural steel into the world of tomorrow.

STRUCTURAL STEEL CLASSIFICATION

PREPARED BY
TASK GROUP 5
COLUMN RESEARCH COUNCIL

LIST OF STEEL MANUFACTURERS

MAKERS CODE

AW = ALAN WOOD STEEL CO.
ALG = ALGOMA STEEL CORP.
ARM = ARMCO STEEL CORP.
B = BETHLEHEM STEEL CORP.
DF = DOMINION FOUNDRIES AND STEEL LTD.
GC = GRANITE CITY STEEL CO.
IN = INLAND STEEL CO.
IA = INTERLAKE (ACME) STEEL CO.
IH = INTERNATIONAL HARVESTER (WISCONSIN STEEL DIV.)
IIW = ISAACSON IRON WORKS
JL = JONES AND LAUGHLIN STEEL CORP.
K = KAISER STEEL CORP.
L = LUKENS STEEL CO.
MCL = MCLOUTH STEEL CORP.
N = NATIONAL STEEL CORP.
O = OREGON STEEL MILLS
P = PHOENIX STEEL CORP.
PGH = PITTSBURGH STEEL CO.
R = REPUBLIC STEEL CO.
SC = STEEL CO. OF CANADA LTD.
US = UNITED STATES STEEL CORP.
Y = YOUNGSTOWN SHEET AND TUBE CO.

STRUCTURAL STEEL CLASSIFICATION

TYPE OF STEEL	STRENGTH INDEX (KSI)
1. STRUCTURAL CARBON STEELS	UP TO 42, INCLUSIVE
2. HIGH STRENGTH AND HIGH STRENGTH LOW-ALLOY STEELS	
GROUP (A) MANGANESE - COPPER	43-55
(B) MANGANESE - VANADIUM	43-55
(C) MULTIPLE ALLOY	43-55, 56-75
(D) COLUMBIUM OR VANADIUM	UP TO 42, 43-55, 56-75
3. HEAT TREATED CARBON STEELS	56-75, 76-100
4. HEAT TREATED ALLOY STEELS	56-75, 76-100, 101 AND OVER

GENERAL NOTE (APPLIES TO ALL TABLES)
MAXIMUM VALUES FOR COMPOSITION (LADLE ANALYSIS) ARE LISTED EXCEPT WHERE RANGES, MINIMUM, OR TYPICAL VALUES ARE INDICATED. AN ASTERISK IS PLACED AFTER TYPICAL VALUES.

TYPE 1

**STRUCTURAL CARBON STEELS
STRENGTH INDEX, TO AND INCLUDING 42 KSI YIELD

		MECHANICAL PROPERTIES			COMPOSITION 0/0									
NAME	MAKERS CODE	ASTM SPECS.	YIELD POINT KSI	TENSILE STRENGTH KSI	ELONGATION 0/0-2 INCH	C	MN	P	S	SI	CU	MO	CR	NI	OT (M
CARBON STEEL	-	A36 CSA + SPEC.	36	58-80	23	0.25		0.04	0.05		0.20(X)				
CARBON STEEL	-	G40-8A	40-36 ***	65-85	20(A)	0.22	0.80-1.50	0.03	0.05	-					0.008
CARBON STEEL	-	G40-8B	40-36 ***	65-85	20(A)	0.20	0.80-1.50	0.03	0.05	0.35					0.008
CARBON STEEL	-	G40-12	44-40 ***	62 MIN.	23	0.22	1.50	0.04	0.05	0.15-0.30					

(X) MINIMUM WHEN COPPER IS SPECIFIED.
** PROPERTIES LISTED ARE FOR PLATES 3/4 INCHES AND LESS IN THICKNNESS.
*** YIELD POINT VARIES WITH THICKNESS (PLACED BELOW RANGE).
+ CANADIAN STANDARDS ASSOCIATION SPECIFICATIONS.
(A) ELONGATION IN 8 IN. MINIMUM PERCENT.

TYPE 2

HIGH-STRENGTH STEELS
**MANGANESE-COPPER GROUP A
STRENGTH INDEX, FROM 43 KSI TO 55 KSI YIELD

NAME	MAKERS CODE	ASTM SPECS.	MECHANICAL PROPERTIES YIELD POINT KSI	TENSILE STRENGTH KSI	ELONGATION 0/0-2 INCH	COMPOSITION 0/0 C	MN	P	S	SI	CU (MIN)	MO	CR	NI	OTHER (MIN)
HIGH-STRENGTH D	ARM	A440	50	70	18(A)	0.28	1.10-1.60	0.04	0.05	0.30	0.20				
MED. MN (A440)	B	A440	50	75	18(A)	0.28	1.10-1.60	0.04	0.05	0.30	0.20-0.35				
HI-MAN	IN	A440	50	70	18(A)	0.28	1.10-1.60	0.04	0.05	0.30	0.20				
JALTEN - 3S	JL	A440	50	70	22	0.25	1.60	0.04	0.05	0.30	0.20				
KAISALOY 50MM	K	A440	50	70	18(A)	0.27	1.10-1.60	0.035	0.04	0.30	0.20				
LUKENS 440	L	A440	50	70	18(A)	0.28	1.10-1.60	0.04	0.05	0.30	0.20				
ML-M	MCL	A440	50	70	22	0.25	1.10-1.60	0.045	0.05	0.30	0.20				
NAX-HI MANG	N	A440	50	70	22	0.22*	1.25*	0.011*	0.018*	0.30	0.22*				
ORELLOY 440	O	A440	50	70	18(A)	0.19*	1.28*	0.020*	0.030*	0.23*	0.35*				
REPUBLIC M1	R	A440	50	75	20	0.25	1.10-1.60	0.04	0.05	0.30	0.20				
MAN-TEN (A440)	US	A440	50	70	18(A)	0.28	1.10-1.60	0.04	0.05	0.30	0.20				
YO MAN	Y	A440	50	75	25	0.28	1.60	0.04	0.05	0.30	0.20				
DOFOSCOLOY M	DF	A440	50	70	22	0.25	1.50	0.04	0.05	0.30	0.20				
STRENLITE (440)	SC	A440	50	70	22	0.27	1.10-1.60	0.04	0.05	0.30	0.20				
ALGOMA 440	ALG	A440	50	70	18(A)	0.28	1.10-1.60	0.04	0.05	0.30	0.20				

* TYPICAL
** PROPERTIES LISTED ARE FOR PLATES 3/4 INCHES AND LESS IN THICKNESS.
(A) ELONGATION IN 8 IN. MINIMUM PERCENT.

TYPE 2

HIGH-STRENGTH LOW-ALLOY STEELS
**MANGANESE VANADIUM GROUP B
STRENGTH INDEX, FROM 43 KSI TO 55 KSI YIELD

NAME	MAKERS CODE	ASTM SPECS.	MECHANICAL PROPERTIES YIELD POINT KSI	TENSILE STRENGTH KSI	ELONGATION 0/0-2 INCH	COMPOSITION 0/0 C	MN	P	S	SI	CU (MIN)	MO	CR	NI	OTHER (MIN)
AW-441	AW	A441	50	70	22	0.22	1.25	0.04	0.05	0.30	0.20				0.02V
HIGH STRENGTH B	ARM	A441	50	70	18(A)	0.22	1.25	0.04	0.05	0.30	0.20				0.02V
MN-V A441	B	A441	50	70	18(A)	0.22	1.25	0.04	0.05	0.30	0.20				0.02V
TRI-STEEL	IN	A441	50	70	22	0.22	1.25	0.04	0.05	0.30	0.20				0.02V
JALTEN 1	JL	A441	50	70	22	0.22	1.25	0.04	0.05	0.30	0.20				0.02V
KAISALOY 50MV	K	A441	50	70	22	0.22	1.25	0.035	0.04	0.30	0.20				0.02V
MN-V	L	A441	50	70	-	0.22	1.25	0.04	0.05	0.30	0.20				0.02V
GLS-441	N	A441	50	70	22	0.22	1.25	0.04	0.04	0.30	0.20				0.02V
MLF (A441)	MCL	A441	50	70	22	0.22	1.25	0.04	0.05	0.30	0.20				0.02V
ORELLOY 441	O	A441	50	70	22	0.22	1.25	0.04	0.05	0.30	0.20				0.02V
CLAY-LOY (A441)	P	A441	50	70	-	0.22	1.25	0.05	0.05	0.35	0.20				0.02V
REPUBLIC A441	R	A441	50	70	22	0.22	0.35-1.25	0.04	0.05	0.30	0.20				0.02V
TRI-TEN	US	A441	50	70	18(A)	0.22	1.25	0.04	0.05	0.30	0.20				0.02V
Y.M.S. A441	Y	A441	50	70	22	0.22	1.25	0.04	0.05	0.30	0.20				0.02V
DOFOSCOLOY M.V.	DF	A441	50	70	22	0.22	1.25	0.04	0.05	0.30	0.20				0.02V
STELCO-VANADIUM	SC	A441	50	70	22	0.22	1.25	0.04	0.05	0.30	0.20				0.02V
ALGOMA 441	ALG	A441	50	70	18(A)	0.22	1.25	0.04	0.05	0.30	0.20				0.02V

* TYPICAL
** PROPERTIES LISTED ARE FOR PLATES 3/4 INCHES AND LESS IN THICKNESS.
(A) ELONGATION IN 8 INCHES MINIMUM PERCENT.

TYPE 2

HIGH-STRENGTH LOW-ALLOY STEELS
MULTIPLE ALLOY GROUP C

NAME	MAKERS CODE	ASTM SPECS.	MECHANICAL PROPERTIES (B) YIELD POINT KSI	TENSILE STRENGTH KSI	ELONGATION 0/0-2 INCH	COMPOSITION 0/0 C	MN	P	S	SI	CU	MO	CR	NI	OTHER (I (MIN)
STRENGTH INDEX, FROM 43 KSI TO 55 KSI YIELD															
KAISALOY 45FG	K	-	45	60	25	0.12	0.60	0.035	0.04	0.50	0.30	0.10	0.25	0.60	0.02V 0.005TI
DOFOSCOLOY NO.2	DF	-	45	5		0.15	1.00	0.04	0.05	0.30	0.60	-	-	0.90	-
HIGH STRENGTH A	ARM	A242	50	70	24	0.12	0.60	0.045	0.05	0.25-0.70	0.30-0.50	0.10	0.50-1.00	0.80	0.07TI MAX
HI-STEEL	IN	A242	50	70	18(A)	0.12	0.50-1.00	0.12	0.05	0.15	0.55-1.30	0.18	-	0.30-0.75	-
NI-CU-TI	JL	A242	50	70	22	0.15	1.00	0.04	0.05	0.50	0.30 MIN.	-	-	0.70	0.05TI
PITT-TEN NO.1	PGH	-	50	70	22	0.20	0.55-0.95	0.07	0.05	0.20	0.30-0.50	-	0.20-0.50	0.45-0.95	-
KAISOLOY 50CR	K	A242	50	70	22	0.20	1.25	0.035	0.04	0.75	0.35	0.15	0.25	0.60	0.02V 0.005TI
PX-50	P	A242	50	70	18(A)	0.12	0.20-0.60	0.07-0.16	0.05	0.25-1.00	0.25-0.55	-	0.30-1.20	0.20-0.65	0.02AL
NAX-HIGH TENSTLE	N	A242	50	70	22	0.18	0.50-0.90	0.04	0.04	0.60-0.90	-	-	0.40-0.80	-	0.03-0.12ZR
REPUBLIC 50	R	A242	50	70	22	0.15	0.50-1.00	0.04	0.05	-	0.30-1.00	0.10 MIN.	0.30	0.40-1.10	-
COR-TEN A	US	A242	50	70	22	0.12	0.20-0.50	0.07-0.15	0.05	0.25-0.75	0.25-0.55	-	0.30-1.25	0.65	-
COR-TEN B	US	A588	50	70	21	0.10-0.19	0.90-1.25	0.04	0.05	0.15-0.30	0.25-0.40	-	0.40-0.65	-	0.02-0.10V
YOLOY	Y	A242	50	70	22	0.15	1.25	0.04	0.05	0.45	0.50-1.00	0.10-0.25	-	0.75-1.25	-
ALGOTUF 50B	ALG	A242	50	70	18(A)	0.20	0.80-1.40	0.03	0.05	0.35	0.20 MIN.	-	0.25	0.50	0.10V I
DOFOSCOLOY NO.1	DF	A242	50	70	22	0.18	1.00	0.04	0.05	0.30	0.60	-	-	0.90	-
STELCOLOY S	SC	-	50	70	22	0.15	1.35	0.03	0.04	0.30	0.20-0.50	-	0.37*	0.35*	0.01V
MAYARI R	R	A242	50	70	22	0.12	0.50-1.00	0.12	0.05	0.20-0.90	0.50	-	0.40-1.00	1.00	0.10ZR
MAYARI R-50	R	A588	50	70	21	0.10-0.20	0.75-1.25	0.04	0.05	0.15-0.30-	0.20-0.40	-	0.40-0.70	0.25-0.50	0.01-0.10V
STRENGTH INDEX, FROM 56 KSI TO 75 KSI YIELD															
COR-TEN C	US	-	60	80	21	0.12-0.19	0.90-1.35	0.04	0.05	0.15-0.30	0.25-0.40	-	0.40-0.70	-	0.04-0.10V
MAYARI R-60	R	-	60	80	21	0.10-0.20	0.75-1.35	0.04	0.05	0.15-0.30	0.20-0.40	-	0.40-0.70	0.25-0.50	0.01-0.10V
KAISOLOY 70MB	K	-	70	85	-	0.15	0.60	0.04	0.04	0.35	-	0.60	-	-	0.001B
NICUTEN 70 (K)	ALG	-	70	75	23	0.06	0.35	0.04	0.04	0.35	1.0	-	-	0.70	0.02V

* TYPICAL

(A) ELONGATION IN 8 INCHES MINIMUM PERCENT.

(B) MECHANICAL PROPERTIES ARE FOR HOT ROLLED PLATE UP TO 1/2 INCH THICK AND ARE MINIMUMS. SOME PRODUCERS ARE SUPPLYING STEELS OF GREATER THICKNESS WITH SIMILAR MECHANICAL PROPERTIES. WHEN A THICKNESS GREATER THAN 1/2 INCH IS AVAILABLE, THE MECHANICAL AND CHEMICAL PROPERTIES SHOULD BE CHECKED WITH THE PRODUCER BEFORE ESTABLISHING DESIGN STRESSES.

(I) MINIMUM UNLESS OTHERWISE SPECIFIED.

(K) AGE HARDENED.

TYPE 2

HIGH-STRENGTH LOW-ALLOY STEELS
COLUMBIUM OR VANADIUM GROUP D

NAME	MAKERS CODE	ASTM SPECS.	MECHANICAL PROPERTIES (C) YIELD POINT KSI	TENSILE STRENGTH KSI	ELONGATION 0/0-2 INCH	COMPOSITION 0/0 C	MN	P	S	SI	CU (MIN)	MO	CR	NI	OTHER (I) (MIN)
STRENGTH INDEX, TO AND INCLUDING 42 KSI YIELD															
HIGH STRENGTH C-42	ARM	A572	42	60	24	0.21	1.35	0.04	0.05	0.30	OPT.				0.005CB OR 0.01V
V-42	B	A572	42	63	20(A)	0.22	1.25	0.04	0.05	-	OPT.				0.02V
INX-42	IN	A572	42	63	20(A)	0.20	0.90	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
JLX-42	JL	A572	42	57	25	0.20	1.00	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
KAISOLOY 42-CV	K	A572	42	65	24	0.20	0.90	0.035	0.04	0.30	OPT.				0.005CB OR 0.005V
X42W	R	A572	42	60	24	0.21	1.25	0.04	0.05	0.30	-				0.01CB OR 0.01V
EX-TEN 42	US	A572	42	60	24	0.21	1.35	0.04	0.05	0.30	OPT.				0.01CB OR 0.02V
YSW-42	Y	A572	42	62	25	0.20	1.10	0.04	0.05	-	OPT.				0.01CB OR 0.01V
HI-YIELD 42	GC	A572	42	63	24	0.21	0.90	0.04	0.05	-	-				0.005CB
STRENGTH INDEX, FROM 43 KSI TO 55 KSI YIELD															
AWX-45	AW	A572	45	63	24	0.12*	0.45*	0.02*	0.03*	0.04*	-				0.02CB*
HIGH STRENGTH C45	ARM	A572	45	60	19	0.22	1.35	0.04	0.05	0.10	OPT.				0.005CB OR 0.01V
V-45	B	A572	45	65	19(A)	0.22	1.25	0.04	0.05	-	OPT.				0.02V
HI-YIELD 45	GC	A572	45	60	22	0.22	1.25	0.04	0.05	-	-				0.005CB
HIX-45	IN	A572	45	65	19(A)	0.20	1.25	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
ANSCOL 45	IA	A572	45	60	30	0.16	0.70	0.04	0.05	-	-				0.015CB
IHX-45	IH	A572	45	60	22	0.20	1.00	0.04	0.05	0.10	-				0.01CB OR 0.01V
JLX-45	JL	A572	45	60	24	0.20	1.10	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
KAISOLOY 45CV	K	A572	45	60	22	0.20	1.15	0.035	0.045	0.30	OPT.				0.005CB OR 0.005V
MLX-45	MCL	A572	45	60	25	0.15	1.00	0.04	0.05	0.10	-				0.005CB OR 0.02V
GLX-45W	N	A572	45	60	22	0.20	1.20	0.04	0.05	0.10	OPT.				0.01-0.04CB
SKA-45	P	A572	45	65	19(A)	0.22	1.25	0.04	0.05	0.10	OPT.				0.02V
PITT-TENX45W	PGH	A572	45	60	24	0.20	1.00	0.04	0.05	0.10	-				0.01CB
X45W	R	A572	45	60	22	0.22	1.25	0.04	0.05	0.30	-				0.01CB OR 0.01V
EX-TEN-45	US	A572	45	60	19(A)	0.22	1.35	0.04	0.05	0.30	OPT.				0.01CB OR 0.02V
YWS-45	Y	A572	45	60	25	0.20	1.25	0.04	0.05	-	OPT.				0.01CB OR 0.01V
CB/V45	ALG	A572	45	60	19(A)	0.22	1.35	0.04	0.05	0.30	-				0.005CB OR 0.01V
DOFOSCOLOY 45W	DF	A572	45	65	22	0.25	1.25	0.04	0.05	0.10	-				0.01CB
STELCO CB45	SC	A572	45	60	25	0.20	1.20	0.04	0.05	-	-				0.005CB
KAISOLOY 50CV	K	A572	50	65	22	0.22	1.35	0.035	0.40	0.30	OPT.				0.005CB OR 0.005V
AWX-50	AW	A572	50	67	22	0.14*	0.50*	0.02*	0.03*	0.04*	-				0.02CB*
AW-TEN	AW	A572	50	70	18	0.18*	0.75*	0.02*	0.03*	0.04*	0.25*				0.02CB*
MLX-50	MCL	A572	50	65	22	0.20	1.00	0.04	0.05	0.10	-				0.005CB OR 0.02V
HIGH-STRENGTH C50	ARM	A572	50	65	18(A)	0.23	1.35	0.04	0.05	0.30	OPT.				0.005CB OR 0.01V
V50 (D)	B	A572	50	70	19(A)	0.22	1.25	0.04	0.05	-	OPT.				0.02V
HI-YIELD 50	GC	A572	50	65	20	0.22	1.25	0.04	0.05	-	-				0.005CB
INX-50	IN	A572	50	70	18(A)	0.22	1.25	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
ANSCOL-50	IA	A572	50	63	30	0.18	0.70	0.04	0.05	0.04	-				0.015CB
IHX-50	IH	A572	50	65	20	0.22	1.10	0.04	0.05	0.10	OPT.				0.01CB OR 0.01V
JLX-50	JL	A572	50	65	22	0.22	1.20	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
JLX-50CC	JL	A572	50	65	26	0.12	0.90	0.04	0.05	0.10	OPT.				0.01CB
MLX-50	MCL	A572	50	65	22	0.20	1.00	0.04	0.05	0.10	-				0.005CB OR 0.02V

(CONTINUED)

* TYPICAL

(A) ELONGATION IN 8 INCHES MINIMUM PERCENT.
(C) IN GENERAL THE MECHANICAL PROPERTIES LISTED FOR COLUMBIUM TREATED STEELS APPLY TO THICKNESS UP TO 3/8 INCH.
(D) V50, V55, V60, V65 CONTAIN UP TO 0.015N.
(I) MINIMUM UNLESS OTHERWISE SPECIFIED.

STRUCTURAL STEEL CLASSIFICATION (cont'd)

TYPE 2, GROUP D (CONTINUED)

HIGH-STRENGTH LOW-ALLOY STEELS
COLUMBIUM OR VANADIUM GROUP D

NAME	MAKERS CODE	ASTM SPECS.	MECHANICAL PROPERTIES (C) YIELD POINT KSI	TENSILE STRENGTH KSI	ELONGATION 0/0-2 INCH	COMPOSITION 0/0 C	MN	P	S	SI	CU (MIN)	MO	CR	NI	OTHER (I) (MIN)
STRENGTH INDEX, FROM 43 KSI TO 55 KSI YIELD															
GLX-50W	N	A572	50	65	22	0.22	1.20	0.04	0.05	0.10	OPT.				0.01-0.04CB
SKA-50	P	A572	50	70	18(A)	0.26	1.30	0.04	0.05	0.10	OPT.				0.02V
PITT-TEN X50W	PGH	A572	50	65	22	0.21	1.00	0.04	0.05	0.10	-				0.01CB
X50W	R	A572	50	65	22	0.22	1.35	0.04	0.05	0.30	-				0.01CB OR 0.01V
EX-TEN 50	US	A572	50	65	18(A)	0.23	1.35	0.04	0.05	0.30	OPT.				0.01CB OR 0.02V
YSW-50	Y	A572	50	65	22	0.22	1.25	0.04	0.05	-	OPT.				0.01CB OR 0.01V
CB/V50	ALG	A572	50	65	18(A)	0.23	1.35	0.04	0.05	0.30	-				0.005CB OR 0.01V
DOFOSCOLOY 50W	DF	A572	50	70	22	0.25	1.25	0.04	0.05	0.10	-				0.01CB
STELCO CB50	SC	A572	50	65	22	0.20	1.20	0.04	0.05	-	-				0.005CB
AWX-55	AW	A572	55	70	20	0.16*	0.55*	0.02*	0.03*	0.04*	-				0.02CB*
HIGH STRENGTH C-55	ARM	A572	55	70	17(A)	0.25	1.35	0.04	0.05	0.30	OPT.				0.005CB OR 0.01V
V55 (D)	R	A572	55	70	17(A)	0.22	1.25	0.04	0.05	-	OPT.				0.02V
HI-YIELD 55	GC	A572	55	70	18	0.25	1.35	0.04	0.05	-	-				0.01CB
INX-55	IN	A572	55	75	17	0.22	1.35	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
IHX-55	IH	A572	55	70	18	0.24	1.40	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
JLX-55	JL	A572	55	70	20	0.24	1.20	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
YSW-55	Y	A572	55	70	20	0.25	1.35	0.04	0.05	-	OPT.				0.01CB OR 0.01V
MLX-55	MCL	A572	55	70	22	0.24	1.20	0.04	0.05	0.30	-				0.005CB OR 0.02V
CLX-55W	N	A572	55	70	20	0.22	1.20	0.04	0.05	0.10	OPT.				0.01-0.04CB
PITT-TEN X55W	PGH	A572	55	70	20	0.20	1.00	0.04	0.05	0.10	-				0.01CB
X55W	R	A572	55	70	20	0.25	1.35	0.04	0.05	0.30	-				0.01CB OR 0.01V
EX-TEN-55	US	A572	55	70	17(A)	0.25	1.35	0.04	0.05	0.30	OPT.				0.01CB OR 0.02V
CB/V55	ALG	A572	55	70	17(A)	0.25	1.35	0.04	0.05	0.30	-				0.005CB OR 0.01V
STELCO CB-55	SC	A572	55	70	20	0.20	1.20	0.04	0.05	-	-				0.005CB
DOFOSCOLOY 55W	DF	A572	55	70	20	0.25	1.25	0.04	0.05	0.10	-				0.01CB
KAISOLOY 55VC	K	A572	55	70	20	0.25	1.35	0.035	0.045	0.30	OPT.				0.005CB OR 0.005V
STRENGTH INDEX, FROM 56 KSI TO 75 KSI YIELD															
NORMALIZED HS LA V-N STEEL FOR STRUCT. APPL.	-	A633	60	80-100	23	0.22	1.15-1.50	0.04	0.05	0.15-0.30	OPT.				0.04-0.11V 0.01-0.03C' (CB OPT.)
HIGH STRENGTH C-60	ARM	A572	60	75	16	0.26	1.60	0.04	0.05	0.30	OPT.				0.005CB OR 0.01V
V60 (D)	R	A572	60	75	16(A)	0.22	1.25	0.04	0.05	-	OPT.				0.02V
INX-60	IN	A572	60	80	16(A)	0.24	1.35	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
IHX-60	IH	A572	60	75	18	0.26	1.55	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
JLX-60	JL	A572	60	75	18	0.25	1.35	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
KAISOLOY-60CV	K	A572	60	75	18	0.26	1.35	0.035	0.04	0.30	OPT.				0.005CB OR 0.005V
MLX-60	MCL	A572	60	75	20	0.26	1.50	0.04	0.05	0.30	-				0.005CB OR 0.02V
GLX-60W	N	A572	60	75	18	0.26	1.35	0.04	0.05	0.10	OPT.				0.01-0.04C
PITT-TEN X60W	PGH	A572	60	75	18	0.20	1.00	0.04	0.05	0.10	-				0.01CB
X60W	R	A572	60	75	18	0.26	1.35	0.04	0.05	0.30	-				0.01CB OR 0.01V

(CONTINUED)

* TYPICAL

(A) ELONGATION IN 8 INCHES MINIMUM PERCENT.

(C) IN GENERAL THE MECHANICAL PROPERTIES LISTED FOR COLUMBIUM TREATED STEELS APPLY TO THICKNESS UP TO 3/8 INCH.

(D) V50, V55, V60, V65 CONTAIN UP TO 0.015N.

(I) MINIMUM UNLESS OTHERWISE SPECIFIED.

TYPE 2, GROUP D (CONTINUED)

HIGH-STRENGTH LOW-ALLOY STEELS
COLUMBIUM OR VANADIUM GROUP D

NAME	MAKERS CODE	ASTM SPECS.	MECHANICAL PROPERTIES (C) YIELD POINT KSI	TENSILE STRENGTH KSI	ELONGATION 0/0-2 INCH	COMPOSITION 0/0 C	MN	P	S	SI	CU (MIN)	MO	CR	NI	OTHER (I) (MIN)
STRENGTH INDEX, FROM 56 KSI TO 75 KSI YIELD															
EX-TEN 60	US	A572	60	75	16(A)	0.26	1.35	0.04	0.05	0.30	OPT.				0.01CB OR 0.02V
YSW60 (E)	Y	A572	60	75	18	0.26	1.35	0.04	0.05	-	OPT.				0.01CB OR 0.01V
CB/V60	ALG	A572	60	75	16(A)	0.26	1.35	0.04	0.05	0.30	-				0.005CB OR 0.01V
DOFOSCOLOY 60W	DF	A572	60	75	18	0.25	1.25	0.04	0.05	0.10	-				0.01CB
STELCO CB60	SC	A572	60	75	18	0.20	1.20	0.04	0.05	-	-				0.005CB
HIGH STRENGTH C-65	ARM	A572	65	80	15(A)	0.26	1.35	0.04	0.05	0.30	OPT.				0.005CB OR 0.01V
V65(D)	R	A572	65	80	15(A)	0.22	1.25	0.04	0.05	-	OPT.				0.02V
INX-65	IN	A572	65	85	15(A)	0.25	1.35	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
IH-65	IH	A572	65	90	18	0.22	1.65	0.04	0.05	0.70	0.20				0.01CB OR 0.01V
IHX-65	IH	A572	65	80	17	0.25	1.60	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
JLX-65	JL	A572	65	80	16	0.26	1.50	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
GLX-65W	N	A572	65	80	16	0.26	1.35	0.04	0.05	0.10	OPT.				0.01CB
X65W	R	A572	65	80	16	0.26	1.35	0.04	0.05	0.30	-				0.01CB OR 0.01V
EX-TEN 65	US	A572	65	80	15(A)	0.26	1.35	0.04	0.05	0.30	OPT.				0.01CB OR 0.02V
YSW65 (E)	Y	A572	65	80	18	0.26	1.35	-	-	-	OPT.				0.01CB OR 0.01V
HIGH STRENGTH C-70	ARM	-	70	85	14(A)	0.26	1.35	0.04	0.05	0.30	OPT.				0.005CB OR 0.01V
INX-70	IN	-	70	90	14(A)	0.26	1.35	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
IHX-70	IH	-	70	85	16	0.26	1.65	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
JLX-70	JL	-	70	85	14	0.26	1.65	0.04	0.05	0.30	OPT.				0.01CB OR 0.01V
X70W	R	-	70	85	14	0.26	1.65	0.04	0.05	0.30	-				0.01CB OR 0.01V
EX-TEN 70	US	A572	70	85	14(A)	0.26	1.35	0.04	0.05	0.30	OPT.				0.01CB OR 0.02V
YSW-70 (E)	Y	-	70	85	18	0.26	1.50	-	-	-	OPT.				0.01CB OR 0.01V

(A) ELONGATION IN 8 INCHES MINIMUM PERCENT.
(C) IN GENERAL THE MECHANICAL PROPERTIES LISTED FOR COLUMBIUM TREATED STEELS APPLY TO THICKNESS UP TO 3/8 INCH.
(D) V50, V55, V60, V65 CONTAIN UP TO 0.015N.
(E) YSW60, YSW65, AND YSW70 MAY CONTAIN UP TO 0.012 PERCENT N.
(I) MINIMUM UNLESS OTHERWISE SPECIFIED.

TYPE 3

HEAT-TREATED CARBON STEELS

NAME	MAKERS CODE	ASTM SPECS.	MECHANICAL PROPERTIES (F) YIELD POINT KSI	TENSILE STRENGTH KSI	ELONGATION 0/0-2 INCH	COMPOSITION 0/0 C	MN	P	S	SI	CU	MO	CR	NI	OTHER (I) (MIN)
STRENGTH INDEX, FROM 56 KSI TO 75 KSI YIELD															
RQC-60	B	A537	60	80-100	23	0.20	0.70-1.35	0.04	0.05	0.15-0.50	-				
CHAR-PAC	US	A537	60	80-100	22	0.20	0.70-1.35	0.035	0.04	0.15-0.50	0.35	0.08	0.25	0.25	
LT-75	L	A537	60	80-100	23	0.20	0.70-1.35	0.04	0.05	0.15-0.30	-				
SUPER LO-TEMP	ARM	A537	60	80-100	23	0.20	0.70-1.35	0.04	0.05	0.15-0.50					
LUKENS-80FG	L	-	75	95-115	18	0.22	1.10-1.60	0.04	0.04	0.20-0.60	0.20-0.40				
STRENGTH INDEX, FROM 76 KSI TO 100 KSI YIELD															
LUKENS-80	L	-	80	100-120	18	0.20	1.10-1.60	0.04	0.05	0.20-0.60	0.20-0.40				
CON-PAC-80	US	-	80	95	18	0.20	1.35	0.04	0.05	0.15-0.40	-				
QTC	ARM	-	80	100-120	18	0.20	1.15-1.50	0.04	0.05	0.20-0.50	OPT.				
RQC-80	B	-	80	100-120	18	0.20	0.70-1.35	0.04	0.05	0.15-0.50	-				

(F) FOR PLATE UP TO 1-1/4 INCH INCLUSIVE.

STRUCTURAL STEEL CLASSIFICATION (cont'd)

TYPE 4

HEAT-TREATED ALLOY STEELS

NAME		MAKERS CODE	ASTM SPECS.	MECHANICAL PROPERTIES YIELD POINT KSI	TENSILE STRENGTH KSI	ELONGATION 0/0-2 INCH	COMPOSITION 0/0 C	MN	P	S	SI	CU	MO	CR	NI	OTHER (I) (MIN)
STRENGTH INDEX, FROM 56 KSI TO 75 KSI YIELD																
REPUBLIC-65	(H)	R	-	65	85	20	0.15	1.00	0.04	0.04	0.15	0.90-1.40	0.20-0.30	-	1.00-1.50	-
REPUBLIC-70	(H)	R	-	70	90	18	0.20	1.00	0.04	0.04	0.15	1.00-1.50	0.20-0.30	-	1.20-1.75	-
NI-MO		IIW	-	75	95	20	0.26	0.15-0.45	0.02	0.02	0.15-0.35		0.60	-	2.75-3.25	-
STRENGTH INDEX, FROM 76 KSI TO 100 KSI YIELD																
N-A-XTRA-80		N	-	80	95	20	0.21	0.60-1.10	0.04	0.04	0.40-0.90		0.30	0.50-0.80	-	0.05-0.15Z 0.0025B
PX80 PLUS		P	-	80	95	18	0.15-0.21	0.80-1.10	0.035	0.04	0.40-0.90		0.23	0.50-0.90	-	0.03ZR 0.0025B MA
NICUTEN 85	(K)	ALG	-	85	90	20	0.06	0.35	0.04	0.04	-	1.50	-	-	1.00	0.02V
I90		IIW	-	90	100	20	0.16-0.20	0.60-0.90	0.03	0.03	0.20-0.30		0.60	0.50-0.75	1.10-1.40	0.06V
JALLOY S-90		JL	-	90	100*	18*	0.10-0.20	1.10-1.50	0.04	0.04	0.15-0.30		0.30	-	-	0.0005B
N-A-XTRA-90		N	-	90	105	18	0.21	0.60-1.10	0.04	0.04	0.40-0.90		0.30	0.50-0.80	-	0.05-0.15Z 0.0026B
PX90 PLUS		P	-	90	105	18	0.15-0.21	0.80-1.10	0.035	0.04	0.40-0.90		0.28	0.50-0.90	-	0.05ZR 0.0025B MA
ALGOMA 90	(G)	ALG	-	90	115	18	0.12	1.60	0.04	0.04	0.15-0.45		0.40	3.00-3.75	-	0.02V
T-1	(L)	US/L	A514	100	115-135	18	0.10-0.20	0.60-1.00	0.035	0.04	0.15-0.35	0.15-0.50	0.40-0.60	0.40-0.65	0.70-1.00	0.002-0.006B 0.03-0.08V
SSS-100		ARM	A514	100	115-135	18	0.20	0.40-0.70	0.035	0.04	0.20-0.35	0.20-0.40	0.40-0.60	1.40-2.00	-	0.04-0.10 TI OR V 0.0015-0.0050B
SSS-100A		ARM	A514	100	115-135	18	0.20	0.40-0.70-	0.035	0.04	0.20-0.35	0.20-0.40	0.15-0.25	0.85-1.20	-	0.04-0.10 TI OR V 0.0015-0.0050B
SSS-100B		ARM	-	100	115-135	18	0.20	0.40-0.70	0.035	0.04	0.20-0.35	0.20-0.40	0.25-0.40	1.15-1.65	-	0.04-0.10 TI OR V 0.0015-0.0050B
JALLOY S-100		JL	A514	100	110*	18*	0.10-0.20	1.10-1.50	0.04	0.04	0.15-0.30		0.30	-	-	0.0005B
N-A-XTRA-100		N	A514	100	115	18	0.21	0.60-1.10	0.04	0.04	0.40-0.90		0.30	0.50-0.80	-	0.05-0.15Z 0.0025B
PX100 PLUS		P	A514	100	115	18	0.15-0.21	0.80-1.10	0.035	0.04	0.40-0.90		0.28	0.50-0.90	-	0.05ZR 0.0025B MA
T-1 TYPE A	(J)	US/L	A514	100	115-135	18	0.12-0.21	0.70-1.00	0.035	0.04	0.20-0.35		0.15-0.25	0.40-0.65	-	0.0005-0.0058 0.01-0.03T 0.03-0.08V
T-1 TYPE B	(J)	US/L	A514	100	115	18	0.12-0.21	0.95-1.30	0.035	0.04	0.20-0.35		0.20-0.30	0.40-0.65	0.30-0.70	0.0005B 0.03-0.08V
RQ-100A		R	A514	100	115-135	18	0.12-0.21	0.45-0.70	0.035	0.04	0.20-0.35		0.50-0.65	-	-	0.001-0.005B
RQ-100B		R	A514	100	115-135	18	0.12-0.21	0.45-0.70	0.035	0.04	0.20-0.35		0.45-0.60	-	1.20-1.50	0.001-0.005B
NICUTEN 100	(K)	ALG	-	100	105	18	0.06	0.35	0.04	0.04	-	2.00	-	-	1.35	0.02V
STRENGTH INDEX, 101 KSI AND OVER YIELD																
JALLOY S-110		JL	-	110	120*	17*	0.10-0.20	1.10-1.50	0.04	0.04	0.15-0.30		0.30	-	-	0.0005B
N-A-XTRA-110		N	-	110	125	18	0.21	0.60-1.10	0.04	0.04	0.40-0.90		0.30	0.50-0.80	-	0.05-0.15Z 0.0025B
PX110 PLUS		P	-	110	125	18	0.15-0.21	0.80-1.10	0.035	0.04	0.40-0.90		0.28	0.50-0.90	-	0.05ZR 0.0025B MA
HY-130(T)		US	-	130	150*	15	0.12	0.60-0.90	0.01	0.01	0.20-0.35		0.30-0.65	0.40-0.70	4.75-5.25	

* TYPICAL

(H) STRESS RELIEF ANNEAL REQUIRED TO MEET PHYSICALS.
(I) MINIMUM UNLESS OTHERWISE SPECIFIED.
(J) COPPER OPTIONAL.
(K) AGE HARDENED.
(G) NORMALIZED.
(L) FOR PLATE FROM 3/16 TO 2-1/2-INCH INCLUSIVE.

STRUCTURAL STEEL CLASSIFICATION (cont'd)

SHEET AND STRIP STEELS OF STRUCTURAL QUALITY

NAME	ASTM SPECS.	MECHANICAL PROPERTIES (MIN) YIELD POINT KSI	TENSILE STRENGTH KSI	ELONGATION 0/0-2 INCH	COMPOSITION 0/0 C	MN	P	S	SI	CU	N	OTHER (MIN)
HOT-ROLLED CARBON STEEL SHEETS AND STRIP	A570-C	33	52	23(M)	0.25	0.25-0.60	0.04	0.04		(I)		
	-D	40	55	21(M)	0.25	0.60-0.90	0.04	0.04		(I)		
	-E	42	58	19(M)	0.25	0.60-0.90	0.04	0.04		(I)		
HOT-ROLLED AND COLD-ROLLED STEEL SHEET AND STRIP, HIGH-STRENGTH LOW-ALLOY WITH IMPROVED CORROSION RESISTANCE	A606	50(R)	70(R)	22(M)	0.22	1.25		0.05				(N)
HOT-ROLLED AND COLD-ROLLED STEEL SHEET AND STRIP, HIGH STRENGTH LOW-ALLOY COLUMBIUM AND/OR VANADIUM	A607-GR45	45	60	25(M)	0.22	1.35	0.04	0.05		(I)		0.005CB OR 0.01V
	-GR50	50	65	22(M)	0.23	1.35	0.04	0.05		(I)		0.005CB OR 0.01V
	-GR55	55	70	20(M)	0.25	1.35	0.04	0.05		(I)		0.005CB OR 0.01V
	-GR60	60	75	18(M)	0.26	1.50	0.04	0.05		(I)		0.005CB OR 0.01V
	-GR65	65	80	16(M)	0.26	1.50	0.04	0.05		(I)	0.012	0.005CB OR 0.01V
	-GR70	70	85	14	0.26	1.65	0.04	0.05		(I)	0.012	0.005CB
ZINC-COATED (GALVANIZED) STEEL SHEETS (P)	A446-A	33	45	20	0.20	(+)	0.04	0.04		(I)		
	-B	37	52	18	0.20	(+)	0.10	0.04				
	-C	40	55	16	0.25	(+)	0.10	0.4				

PROPRIETARY STEELS

SEE TYPE 2 STEELS LISTED IN PREVIOUS SECTIONS

MOST OF THE PROPRIETARY STEELS LISTED IN THIS REPORT AS TYPE 2 HIGH-STRENGTH AND HIGH-STRENGTH LOW ALLOY STEELS ARE ALSO AVAILABLE IN HOT-ROLLED SHEET AND STRIP FORM. EXCEPTIONS, WHERE THEY EXIST, ARE LIKELY TO BE DUE TO COMMERCIAL RATHER THAN TECHNICAL CONSIDERATIONS. SUCH EXCEPTIONS CAN BE DETERMINED BY CONSULTING THE PRODUCER.

(I) MINIMUM 0.20 CU WHEN COPPER STEEL IS SPECIFIED.
(M) SPECIFIED MINIMUM ELONGATIONS VARY ACCORDING TO THICKNESS, REFER TO ASTM SPECIFICATION FOR THIN GAGES.
(+) MANGANESE RANGE (NOT SPECIFIED) IS AT MANUFACTURERS OPTION.
(N) ADDITIONAL ALLOY ELEMENTS (NOT SPECIFIED) ARE USED AT MANUFACTURES OPTION TO SATISFY MECHANICAL PROPERTIES AND CORROSION RESISTANCE REQUIREMENTS.
(P) PROPERTIES SHOWN ARE FOR THE BASE METAL. SEE ALSO ASTM SPECIFICATION A525.
(R) REDUCE BY 5 KSI FOR HOT-ROLLED MATERIAL DELIVERED IN COILS AND FOR COLD-ROLLED MATERIAL.