

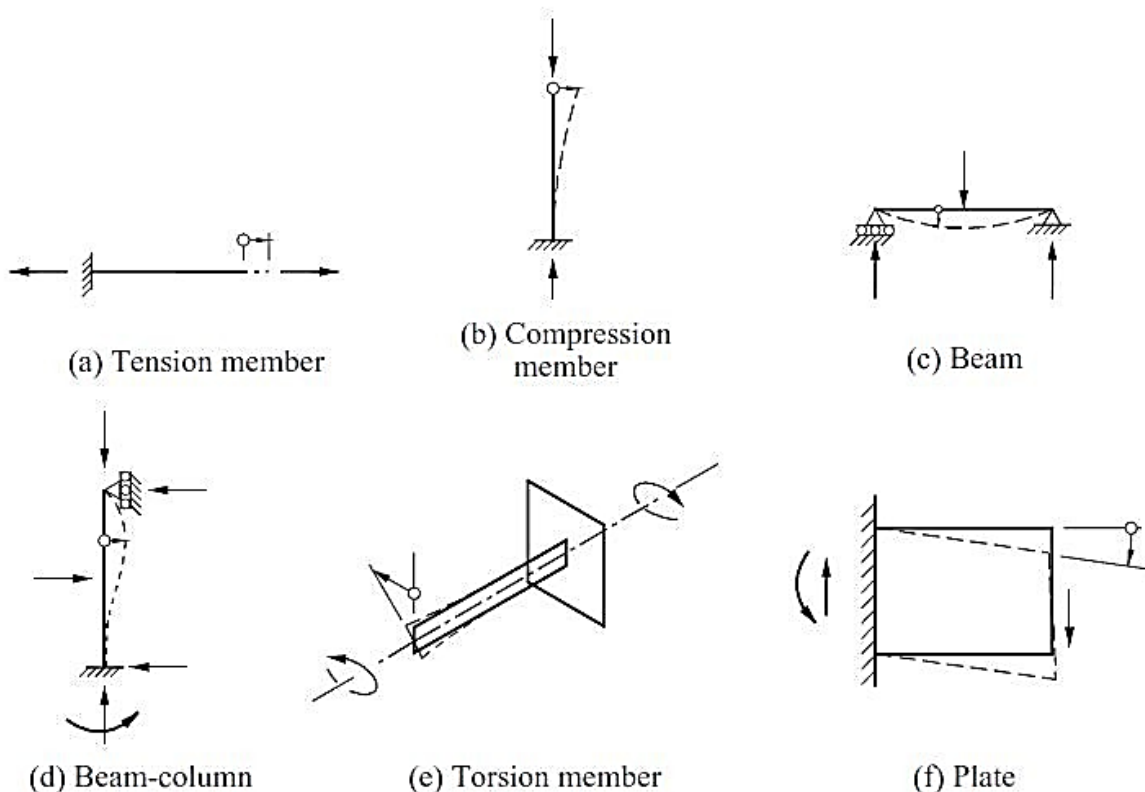


Chapter One: Introduction

1. Introduction

Engineering structures are required to support loads and resist forces, and to transfer these loads and forces to the foundations of the structures.

- ✓ The loads and forces may arise from the masses of the structure, or from human uses of the structures, or from the forces of nature (wind, snow, temperature changes, and earthquakes).
- ✓ Structural members can be classified as tension or compression members, beams, beam-columns, torsion members, or plates.



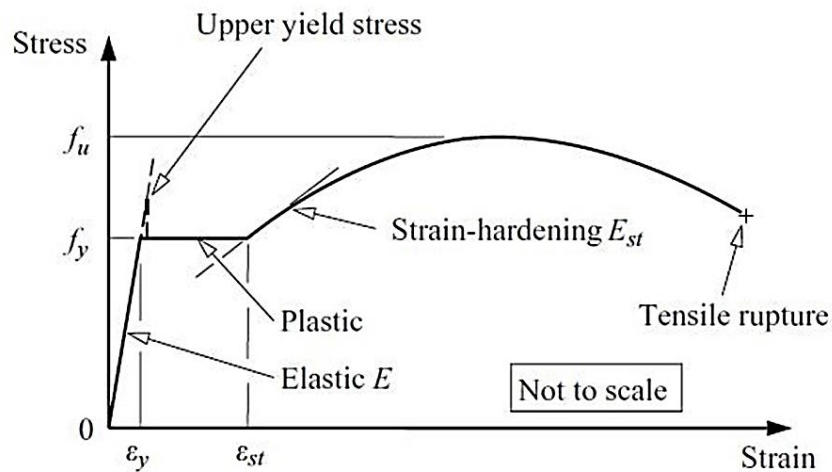
1.1 Advantages of Steel as a Structural Material

- High Strength
- Uniformity
- Elasticity
- Highly Ductility
- Toughness

1.2 Disadvantages of Steel as a Structural Material

- Corrosion
- Maintenance Costs
- Requires Fireproofing
- Susceptibility to buckling
- Brittle Fracture

1.3 Properties of Steel



The most important properties of steel:

- Yield stress (F_y)
- Ultimate stress (F_u)
- Modulus of elasticity (E)
- Percent elongation (ϵ)
- Coefficient of thermal expansion (α)

1.4 Steel Groups

Structural steels are generally grouped into several major ASTM classifications: (ASTM=American Society for Testing and Materials)

- ❖ Carbon steels A36, A53, A500, A501, and A529.
- ❖ High – strength low alloy steels A572, A618, A913, and A992.
- ❖ Corrosion resistant high – strength low alloy steels A242, A588, and A847.

One of the most used structural steels is a mild steel (A36) which has the following properties: Yield stress ($F_y = 36000$ psi (36ksi)), Tensile strength ($F_u = 58000$ psi to 80000 psi (58ksi to 80ksi)). Other commonly structural steels are ASTM A572 Grade 50 and ASTM A992.

Considerable information is presented for each of these steels in Part 2 of the AISC Manual. As shown in the following table.

**Table 2-3
Applicable ASTM Specifications
for Various Structural Shapes**

Steel Type	ASTM Designation	F_y Min. Yield Stress (ksi)	F_u Tensile Stress ^a (ksi)	Applicable Shape Series													
				W	M	S	HP	C	MC	L	HSS		Pipe				
											Rect.	Round					
Carbon	A36	36	58-80 ^b	■	■	■	■	■	■	■	■	■	■	■	■	■	
	A53 Gr. B	35	60	■	■	■	■	■	■	■	■	■	■	■	■	■	
	A500	Gr. B	42	58	■	■	■	■	■	■	■	■	■	■	■	■	■
			46	58	■	■	■	■	■	■	■	■	■	■	■	■	■
		Gr. C	46	62	■	■	■	■	■	■	■	■	■	■	■	■	■
			50	62	■	■	■	■	■	■	■	■	■	■	■	■	■
A501	36	58	■	■	■	■	■	■	■	■	■	■	■	■	■		
A529 ^c	Gr. 50	50	65-100	■	■	■	■	■	■	■	■	■	■	■	■	■	
		55	70-100	■	■	■	■	■	■	■	■	■	■	■	■	■	
High-Strength Low-Alloy	A572	Gr. 42	42	60	■	■	■	■	■	■	■	■	■	■	■	■	
			50	65 ^d	■	■	■	■	■	■	■	■	■	■	■	■	■
		Gr. 55	55	70	■	■	■	■	■	■	■	■	■	■	■	■	■
			60 ^e	75	■	■	■	■	■	■	■	■	■	■	■	■	■
		Gr. 65 ^f	65	80	■	■	■	■	■	■	■	■	■	■	■	■	■
			70	85	■	■	■	■	■	■	■	■	■	■	■	■	■
	A618 ^g	Gr. I & II	50 ^h	70 ^h	■	■	■	■	■	■	■	■	■	■	■	■	
			50	65	■	■	■	■	■	■	■	■	■	■	■	■	■
	A913	Gr. II	50	60 ⁱ	■	■	■	■	■	■	■	■	■	■	■	■	■
			60	75	■	■	■	■	■	■	■	■	■	■	■	■	■
65			80	■	■	■	■	■	■	■	■	■	■	■	■	■	
70			90	■	■	■	■	■	■	■	■	■	■	■	■	■	
A992	50-65 ^j	65 ^j	■	■	■	■	■	■	■	■	■	■	■	■	■		
Corrosion Resistant High-Strength Low-Alloy	A242	Gr. 42	42	63 ^k	■	■	■	■	■	■	■	■	■	■	■	■	
			46 ^l	67 ^k	■	■	■	■	■	■	■	■	■	■	■	■	■
		50 ^m	70 ^l	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	A588	50	70	■	■	■	■	■	■	■	■	■	■	■	■	■	
A847	50	70	■	■	■	■	■	■	■	■	■	■	■	■	■		

**Table 2-4
Applicable ASTM Specifications
for Plates and Bars**

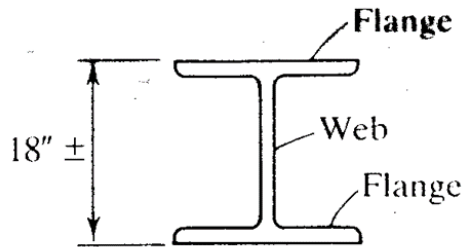
Steel Type	ASTM Designation	F _y Min. Yield Stress (ksi)	F _u Tensile Stress ^a (ksi)	Plates and Bars												
				to 0.75 incl.	over 0.75 to 1.25	over 1.25 to 1.5	over 1.5 to 2 incl.	over 2 to 2.5 incl.	over 2.5 to 4 incl.	over 4 to 5 incl.	over 5 to 6 incl.	over 6 to 8 incl.	over 8			
Carbon	A36	32	58-80													
		36	58-80													
	A529	Gr. 50	50	70-100												
High-Strength Low-Alloy	A572	Gr. 42	42	60												
		Gr. 50	50	65												
		Gr. 55	55	70												
		Gr. 60	60	75												
		Gr. 65	65	80												
Corrosion Resistant High-Strength Low-Alloy	A242	42	63													
		46	67													
		50	70													
	A588	42	63													
		46	67													
Quenched and Tempered Alloy	A514 ^c	90	100-130													
		100	110-130													
Quenched and Tempered Low-Alloy	A552 ^c	70	90-110													

**Table 2-5
Applicable ASTM Specifications for Various Types of Structural Fasteners**

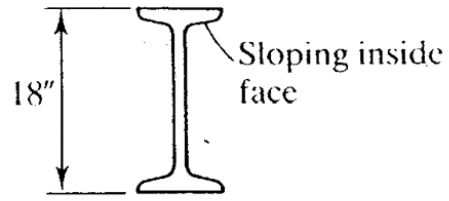
ASTM Designation	F _y Min. Yield Stress (ksi)	F _u Tensile Stress ^a (ksi)	Diameter Range (in.)	High-Strength Bolts											Anchor Rods			
				Conventional	Twist-Off-Type Tension-Control	Common Bolts	Nuts	Washers	Direct-Tension-Indicator Washers	Threaded Rods	Shear Stud Connectors	Hooked	Headed	Threaded & Headed				
A103	—	65	0.375 to 0.75, incl.															
A325 ^d	—	105	over 1 to 1.5, incl.															
	—	120	0.5 to 1, incl.															
A490	—	150	0.5 to 1.5															
F1852	—	105	1, 1.25															
	—	120	0.5 to 1, incl.															
A194 Gr. 2H	—	—	0.25 to 4															
A563	—	—	0.25 to 4															
F436 ^e	—	—	0.25 to 4															
F959	—	—	0.5 to 1.5															
A30	36	58-80	to 10															
	—	100	over 4 to 7															
	—	115	over 2.5 to 4															
A193 Gr. B7 ^e	—	125	2.5 and under															
	Gr. A	—	60	0.25 to 4														
	Gr. C	—	58-80	0.25 to 4														
A307	—	140	2.5 to 4, incl.															
	—	150	0.25 to 2.5, incl.															
A354 Gr. B ^d	—	90	1.75 to 3, incl.															
	—	105	1.125 to 1.5, incl.															
	—	120	0.25 to 1, incl.															
A449	Gr. 42	42	60	to 6														
	Gr. 50	50	65	to 4														
	Gr. 55	55	70	to 2														
	Gr. 60	60	75	to 1.25														
	Gr. 65	65	80	to 1.25														
A588	42	63	Over 5 to 8, incl.															
	46	67	Over 4 to 5, incl.															
	50	70	4 and under															
A687	105	150 max.	0.625 to 3															
F1554	Gr. 36	36	58-80	0.25 to 4														
	Gr. 55	55	75-95	0.25 to 4														
	Gr. 105	105	125-150	0.25 to 3														

1.5 Types of Structural Steel Sections

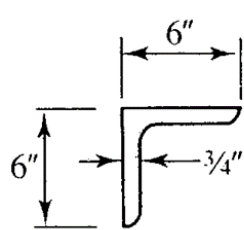
Single Section



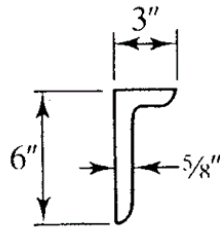
W-shape
(W18 × 50 shown)



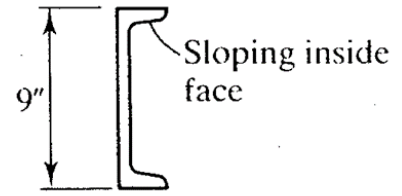
American Standard, S
(S18 × 70 shown)



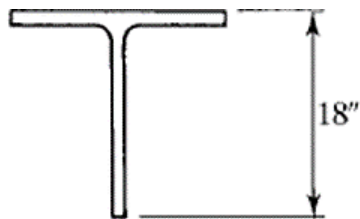
Equal-leg
angle, L
(L6 × 6 × 3/4 shown)



Unequal-leg
angle
(L6 × 3 × 5/8 shown)



American Standard
Channel, C
(C9 × 20 shown)

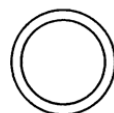


Structural Tee: WT, ST, or MT
(WT18 × 115 shown)

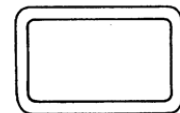
HSS (Hollow Structural Sections)

Rounded

Rectangular

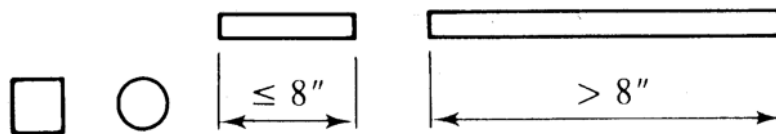


Pipe



Tubes

Solid Rectangular Sections



Bars

Plate

Built-Up Section

W-shape with
cover plates

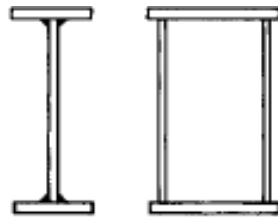


Plate girders



Double angle



Double channel

Examples of this identification system are as follows:

- 1.** W27 × 114 is W section approximately 27 in deep, weighing 114 lb/ft.
- 2.** S12 × 35 is S section 12 in deep, weighing 35 lb/ft.
- 3.** C10 × 30 is a channel 10 in deep, weighing 30 lb/ft
- 4.** HSS14 × 10 × 5/8 is a rectangular hollow structural section 14 in deep, 10 in wide, with a 5/8-in wall thickness. It weighs 93.10 lb/ft. Square and round HSS sections are also available.
- 5.** L6 × 6 × 1/2 is an equal leg angle, each leg being 6 in long and 1/2 in thick.