

CE 415

DESIGN OF STEEL STRUCTURES

LECTURE 1

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COURSE CONTENT

- Behavioral principles and design of structural steel
- Design of tension members
- Bolted and welded connections
- Compression members, residual stress, local buckling, effective length
- Flexural members, lateral torsional buckling
- Design of beam–columns
- Connection design, moment connection, column bases
- Detailing of steel structures

BOOKS AND REFERENCES

SUPPORTING BOOKS AND REFERENCES

1. SPECIFICATIONS FOR STRUCTURAL STEEL BUILDINGS, 2005 (AISC 360-05)

AUTHOR: AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

2. MANUAL FOR STEEL CONSTRUCTION, 14TH EDITION, 2011

AUTHOR: AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

3. DESIGN OF STEEL STRUCTURES, 3RD ED., 1991

AUTHORS: GAYLORD, GAYLORD AND STALLMEYER, PUBLISHER: MCGRAW-HILL

INTRODUCTION

□ Course objective:

To develop advanced knowledge on behavior of structural steel members, code requirements, design of tension and compression members, design of steel frames.

□ The two distinct procedures employed by designers are,

1. Allowable strength design (ASD) &

2. Load & resistance factor design (LRFD).

LRFD & ASD

Load and Resistance Factor Design (LRFD)

Resistance or strength:	R_n
Resistance factor:	$\phi < 1.0$
Load effect:	Q_i [$i = 1,2,3....$ for dead load, live load etc.]
Load factor:	γ_i [$i = 1,2,3....$ for dead load, live load etc.]
R_u :	Factored load effect

LRFD safety requirement

$$\phi R_n \geq R_u (= \sum \gamma_i Q_i)$$

Allowable Strength Design (ASD)

Resistance or strength:	R_n
Safety factor:	$\Omega > 1.0$
Load effect:	Q_i [$i = 1,2,3....$ for dead load, live load etc.]
Load factor:	$\gamma_i = 1.0$ [$i = 1,2,3....$ for dead load, live load etc.]
R_s :	Required strength / allowable strength

ADVANTAGES OF STEEL STRUCTURES

- Steel has a high strength-to-weight ratio.
- The properties of structural steel are uniform and homogeneous, and highly predictable.
- It has high ductility, thus providing adequate warning of any impending collapse.
- It can easily be recycled. In fact, some buildings have a majority of their components made of recycled steel.
- Steel structures are easier and quicker to fabricate and erect, compared with concrete structures.

DISADVANTAGES OF STEEL STRUCTURES

- Corrosion: Steel is susceptible to corrosion and has to be protected by galvanizing or by coating with zinc-rich paint, especially structures exposed to weather or moisture, although corrosion-resistant steels are also available. Consequently, maintenance costs could be high compared to other structural materials.
- Susceptibility to Temperature: Steel itself is incombustible. However its structural properties are adversely affected by high temperatures and therefore often needs to be protected from fire.

PROPERTIES OF STEEL

- Unit weight: 490 lb/ft³
- Young's modulus: 29000 ksi

Different Types of Structural Steel

ASTM [†] designation	F_y Minimum yield stress ksi (MPa) [‡]	F_u Tensile strength ksi (MPa) [‡]	Maximum thickness for plates in. (mm)	ASTM A6 groups* for shapes
A36	32 (220)	58–80 (400–550)	Over 8 (200)	—
	36 (250)	58–80 (400–550)	To 8 (200)	All
A572 Grade 42	42 (290)	60 (415)	To 6 (150)	All
Grade 50	50 (345)	65 (450)	To 4 (100)	All
Grade 60	60 (415)	75 (520)	To 1 $\frac{1}{4}$ (32)	1, 2, 3
Grade 65	65 (450)	80 (550)	To 1 $\frac{1}{4}$ (32)	1, 2, 3
A913 Grade 50	50 (345)	60 (415)		
Grade 60	60 (415)	75 (520)		All
Grade 65	65 (450)	80 (550)		
Grade 70	70 (485)	90 (620)		8
A992	50 (345)	65 (450)		All

STEEL SHAPES

❑ Cold formed shapes

Cold formed shapes are manufactured by bending or folding or cold rolling mild steel sheets of thickness 3mm or less to the desired Shape.

❑ Hot rolled shapes

Hot rolled shapes are formed by heating steel billets to softer state and then passing the billets through carefully shaped and aligned **Rollers to force the billet to achieve the desired shape.**

COLD FORM SHAPES

Cold Formed Shapes



(a) Channels



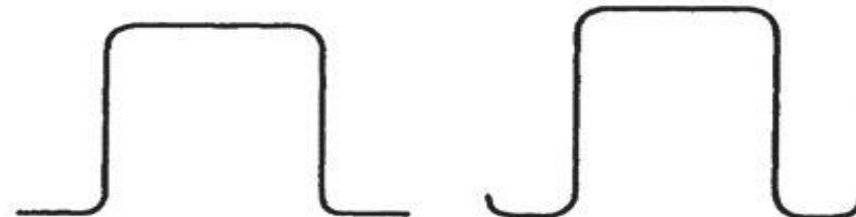
(b) Zees



(c) I-shaped double channels



(d) Angle



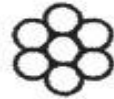
(e) Hat sections

HOT FORM SHAPES

HOT ROLLED STEEL SHAPES: TENSION MEMBERS



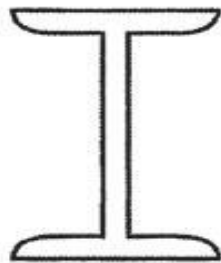
(a) Round and rectangular bars, including eye bars and upset bars



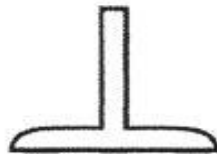
(b) Cables composed of many small wires



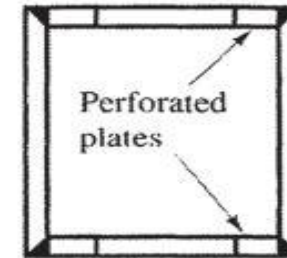
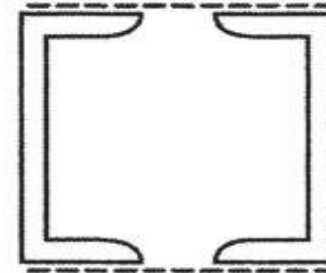
(c) Single and double angles



(d) Rolled W- and S-sections



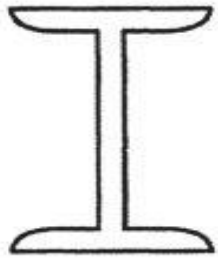
(e) Structural tee



(f) Built-up box sections

HOT FORM SHAPES

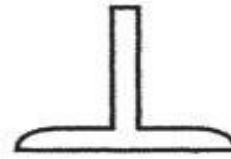
HOT ROLLED STEEL SHAPES: COMPRESSION MEMBERS



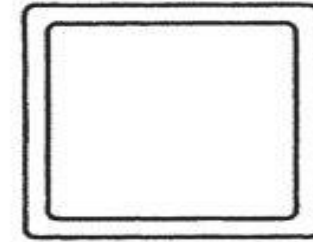
(a) Rolled W- and S-shapes



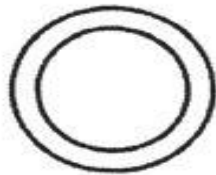
(b) Double angle



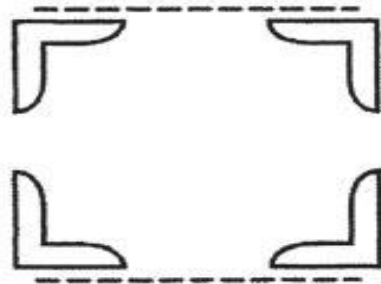
(c) Structural tee



(d) Structural tubing



(e) Pipe section



(f) Built-up sections

