CE 415
DESIGN OF STEEL STRUCTURES

LECTURE 1

SEMESTER: SUMMER 2021

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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

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

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:	γ_i = 1.0 [i = 1,2,3.... for dead load, live load etc.]
R_a:	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/ft^3
- 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)		
A992	50 (345)	65 (450)		All

STEEL SHAPES

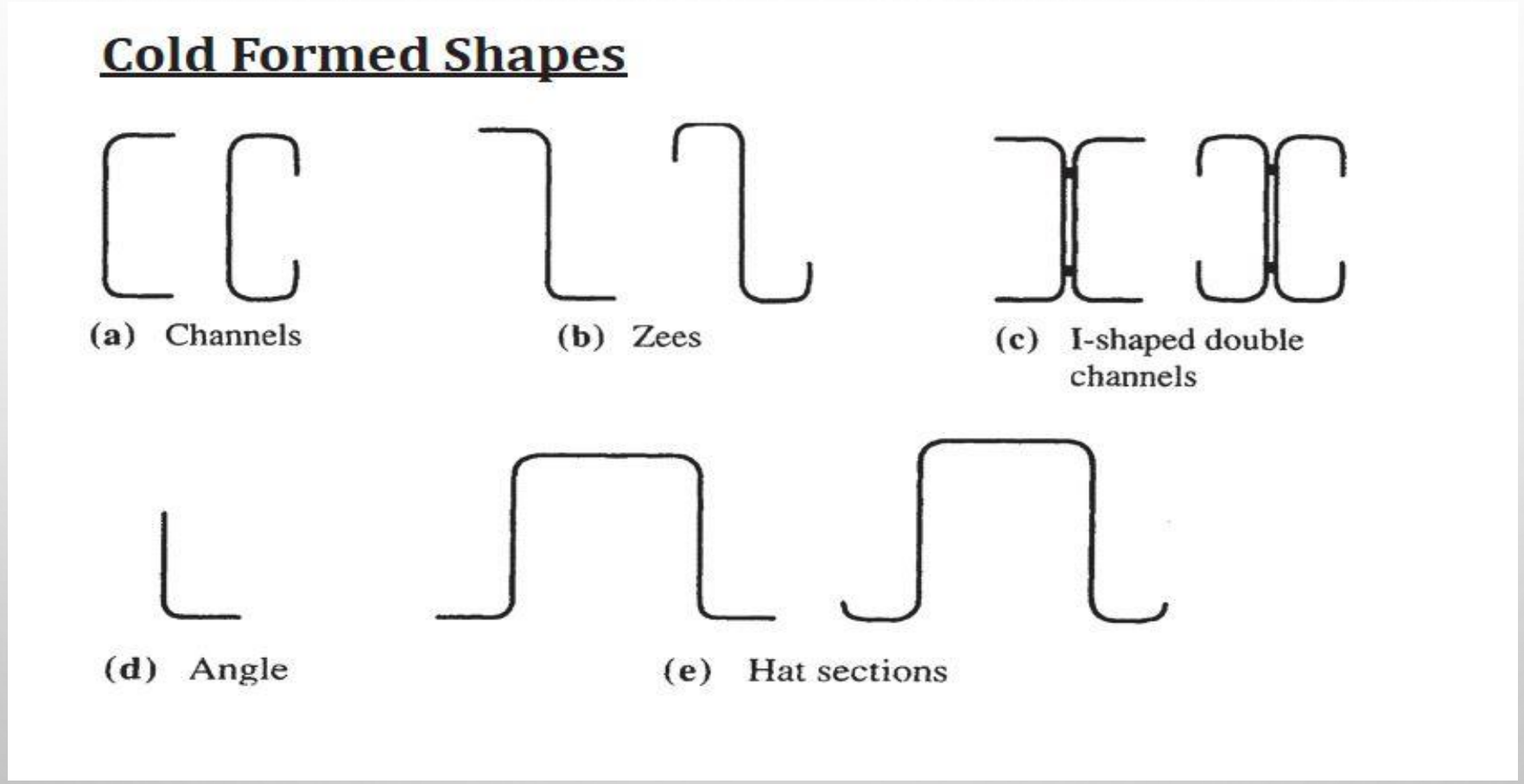
- Cold formed shapes

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



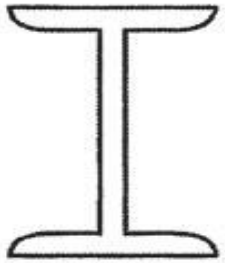
HOT FORM SHAPES

HOT ROLLED STEEL SHAPES: TENSION MEMBERS

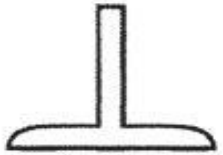
(a) Round and rectangular bars, including eye bars and upset bars

(b) Cables composed of many small wires

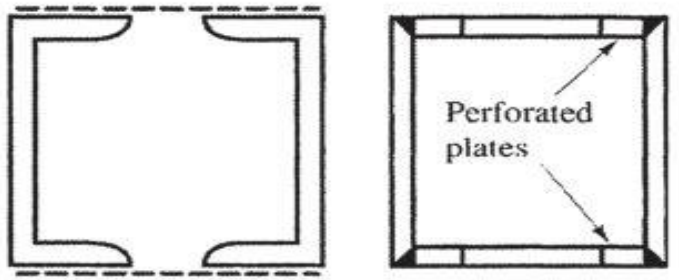
(c) Single and double angles



(d) Rolled W- and S-sections



(e) Structural tee



(f) Built-up box sections

HOT FORM SHAPES