

## Steel Structure

- Steel is the perfect structural material which used to build steel bridges, buildings, towers, and other structures.



## Advantages:

- **High strength** of steel per unit of weight.
- **Uniformity**: properties of steel do not change with time.
- **Elasticity**: The elasticity of a metal refers to the rate at which a given metal sample is able to distort its size and shape under a range of stress and strain forces and



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other externally varying factors. Elasticity can also refer to the measured degree of ductility of a metal.

- **Ductility**: steel can withstand extensive deformation without failure under high tensile stresses.
- **Toughness**: the ability of a material to absorb energy in large amounts.
- **Low cost**

### Disadvantages:

- **Corrosion**
- **Fireproofing costs**
- **Buckling**
- **Fatigue**
- **Brittle fracture**

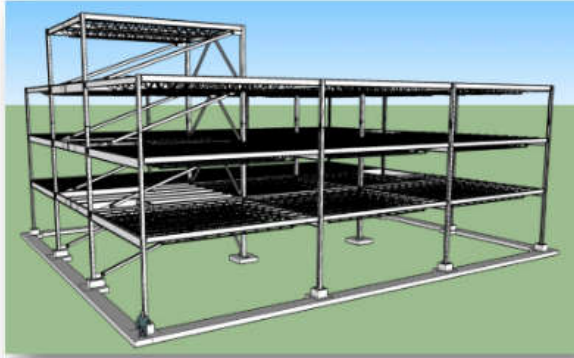


This course covers design of structural steel elements, including **tension members, compression members, flexural members, members subjected to combined loading**. You will be able to design steel components using the AISC Specification for Structural Steel Buildings and to apply your knowledge to the design of steel buildings.





## Parts of a Structure

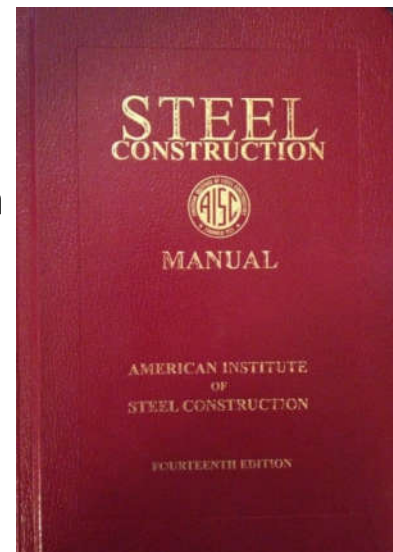


- Tension Members
- Compression Members (Columns)
- Bending Members
  - Shear and Moment
- Combined Force Members (Beam-Column)
- Connections
  - Typically have combination of moment and shear and/or tension/compression

## Required Books

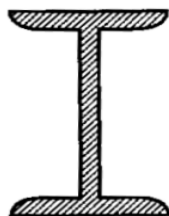
McCormac J. et al.

- Structural Steel Design 5th edition
- Steel Construction Manual 13<sup>th</sup> edition



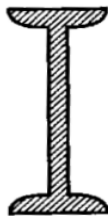


## Standard Rolled Shapes



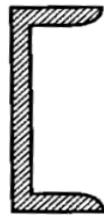
W

(a) Wide-flange shape



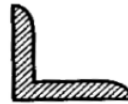
S

(b) American standard beam



C

(c) American standard channel



L

(d) Angle

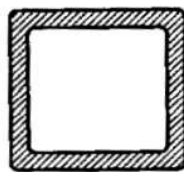


WT or ST

(e) Structural tee



(f) Pipe section



(g) Structural (HSS) tubing



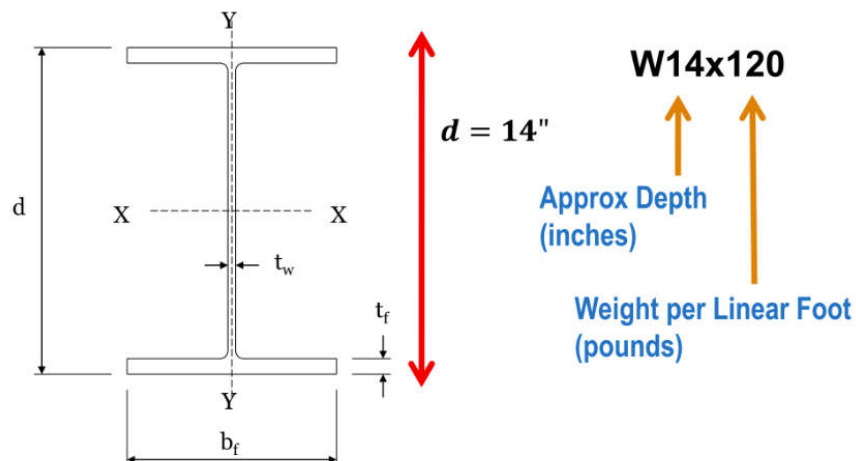
(h) Bars

Bars < 8" wide



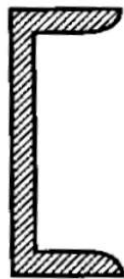
(i) Plates

## W-Shapes





## Channels, Angles, Tees

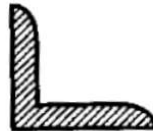


C

(c) American standard channel

C12 x 20.7

C[d]x[weight]

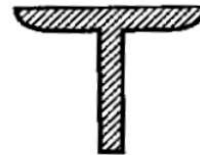


L

(d) Angle

L 6 x 4 x 3/8

L[dim]x[dim]x[t]



WT or ST

(e) Structural tee

WT5 x 44

ST 4 x 9.2

WT[d]x[weight]

## Tension Members



Bars  
(round and rectangular)



Cables

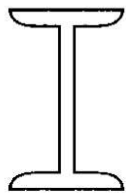


Single and double angles

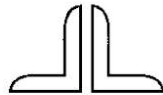
A few examples of shapes typically used for tension members



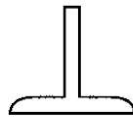
## Compression Members



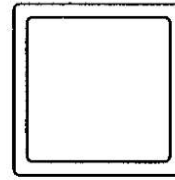
(a) Rolled W- and S-shapes



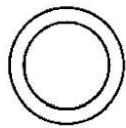
(b) Double angle



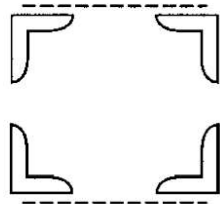
(c) Structural tee



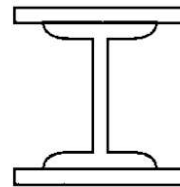
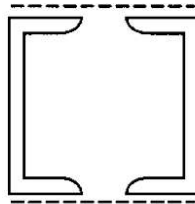
(d) Structural tubing (HSS)



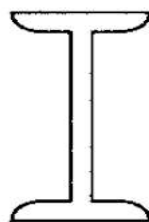
(e) Pipe section



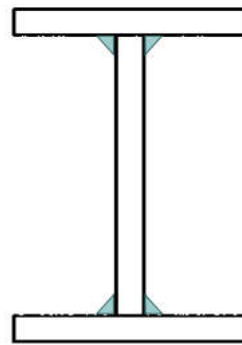
(f) Built-up sections



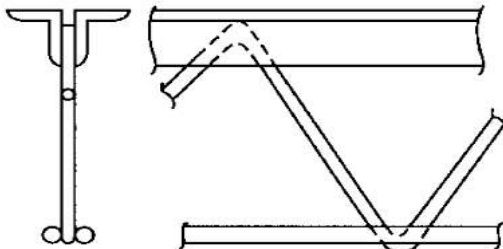
## Flexural Members (Beams)



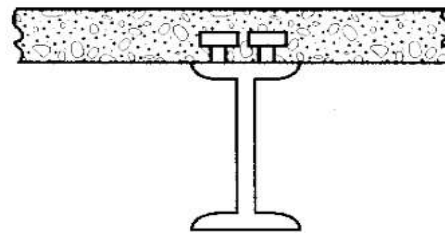
(a) Rolled W- and other I-shaped



(b) Welded I-shape (plate girder)



(c) Open web joists



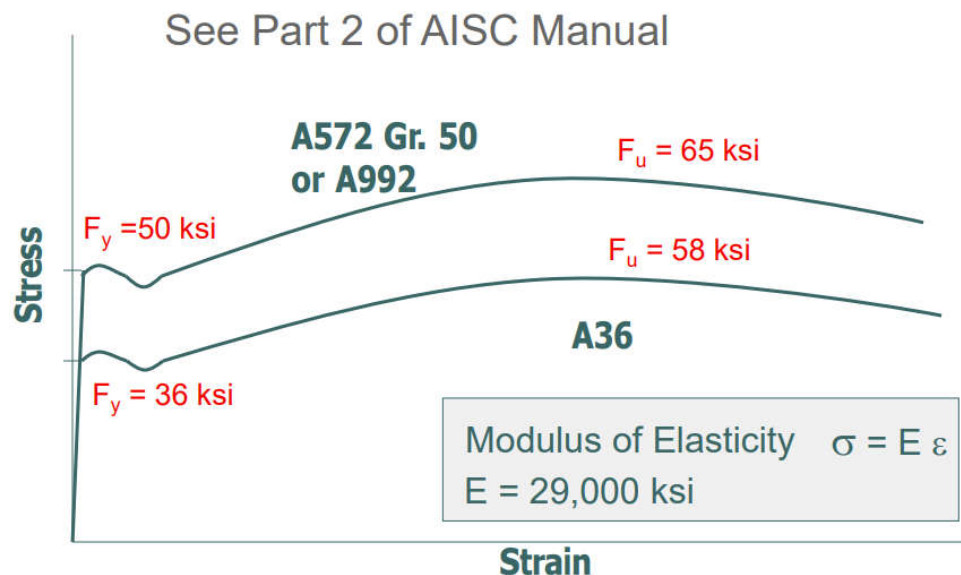
(g) Composite steel-concrete



## Structural Steels

- Carbon Steels
  - Example: **A36** 0.25 – 0.29% carbon  
→ "mild steel"  
36 ksi nominal yield stress
- High-Strength Low-Alloy Steels
  - Examples: **A572 Gr. 50, A992** 40 – 70 ksi, typ.  
Carbon + small amounts of chromium, copper, nickel, etc.
- Alloy Steels
  - Example: A709 80 – 110 ksi, typ.  
Quenched and tempered

## Steel Properties







Part 2 Steel Construction Manual

Table 2-4  
 Applicable ASTM Specifications for Various Structural Shapes

| Steel Type | ASTM Designation | $F_y$ Yield Stress <sup>a</sup> (ksi) | $F_u$ Tensile Stress <sup>a</sup> (ksi) | Applicable Shape Series |       |      |    |   |    |   |     |  |  |  |  |  |  |
|------------|------------------|---------------------------------------|---|-------------------------|-------|------|----|---|----|---|-----|--|--|--|--|--|--|
|            |                  |                                       |   | W                       | M     | S    | HP | C | MC | L | HSS |  |  |  |  |  |  |
|            |                  |                                       |   | Rect.                   | Round | Pipe |    |   |    |   |     |  |  |  |  |  |  |
| A36        | 36               | 58-80 <sup>b</sup>                    |   |                         |       |      |    |   |    |   |     |  |  |  |  |  |  |
| A53 Gr. B  | 35               | 60                                    |   |                         |       |      |    |   |    |   |     |  |  |  |  |  |  |
|            | 42               | 58                                    |   |                         |       |      |    |   |    |   |     |  |  |  |  |  |  |

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|------------|------------------|---------------------------------------|---|-------------------------|-------|------|----|---|----|---|-----|--|--|--|--|--|--|--|
|            |                  |                                       |   | W                       | M     | S    | HP | C | MC | L | HSS |  |  |  |  |  |  |  |
|            |                  |                                       |   | Rect.                   | Round | Pipe |    |   |    |   |     |  |  |  |  |  |  |  |
|            | A36              | 36                                    | 58-80 <sup>b</sup>                      |                         |       |      |    |   |    |   |     |  |  |  |  |  |  |  |
|            | A53 Gr. B        | 35                                    | 60                                      |                         |       |      |    |   |    |   |     |  |  |  |  |  |  |  |
|            | A500             | 42                                    | 58                                      |                         |       |      |    |   |    |   |     |  |  |  |  |  |  |  |
|            |                  | Gr. B                                 | 46                                      | 58                      |       |      |    |   |    |   |     |  |  |  |  |  |  |  |
|            |                  | Gr. C                                 | 46                                      | 62                      |       |      |    |   |    |   |     |  |  |  |  |  |  |  |
|            |                  | 50                                    | 62                                      |                         |       |      |    |   |    |   |     |  |  |  |  |  |  |  |

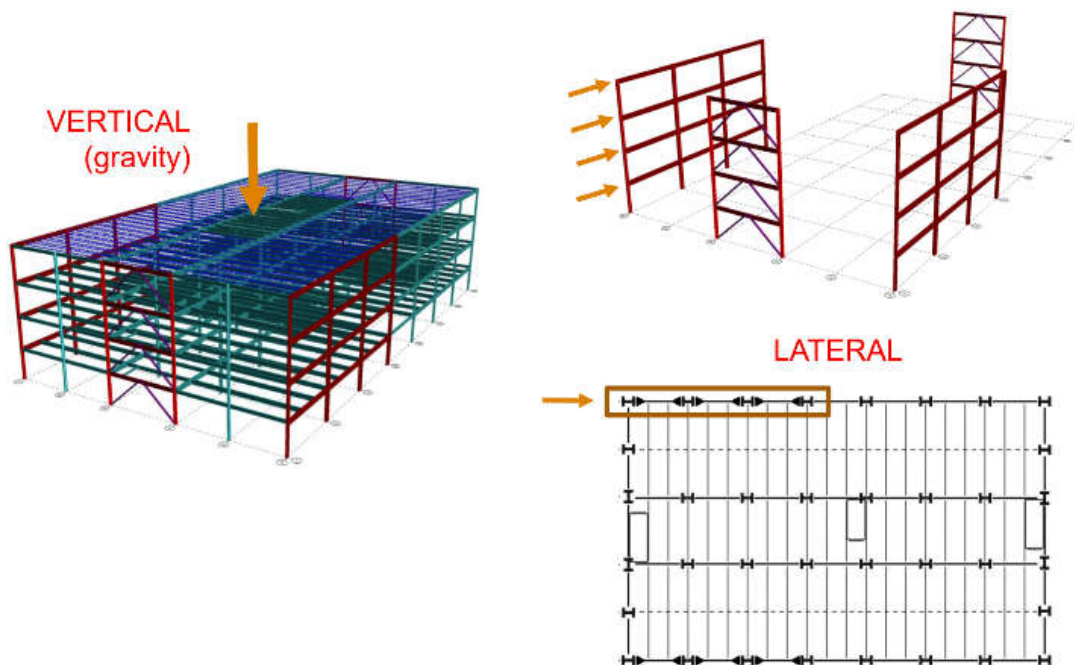
Black shading = preferred specification  
 Gray shading = may be available

Responsibilities of the structural designer

- Safety
- Cost
- Constructability



## Types of Loads

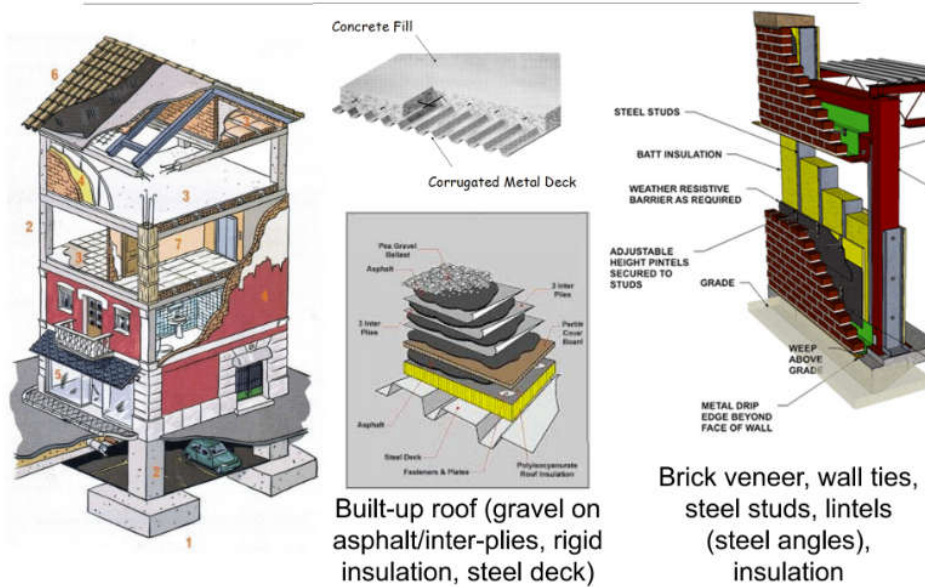


What loads might act on this structure?





## Dead Loads



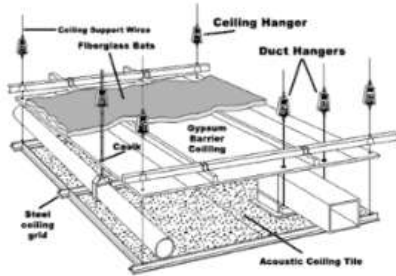
## Dead Loads



Rooftop Units



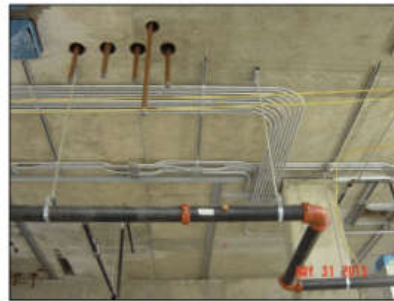
## Dead Loads



HVAC duct-work



suspended ceiling



plumbing, electrical conduit

## Live Loads



## Live Loads



Golden Gate Bridge on its 50th Anniversary in May 1987: a classic example of live loads overload  
AP Photo / Doug Atkins

## Roof Live Loads

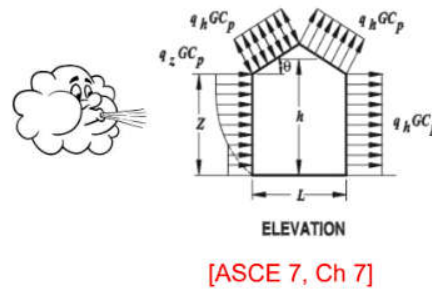
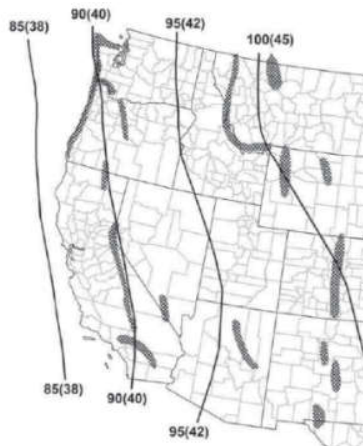




## Snow Loads



## Wind Loads





## Earthquake Loads

