# Analysis of Statically Determinate Trusses

# Analysis of Determinate Trusses

## Characteristics

- **Slender Members**
- **Wooden Struts**
- **Metal Bars/Angles/Channels**

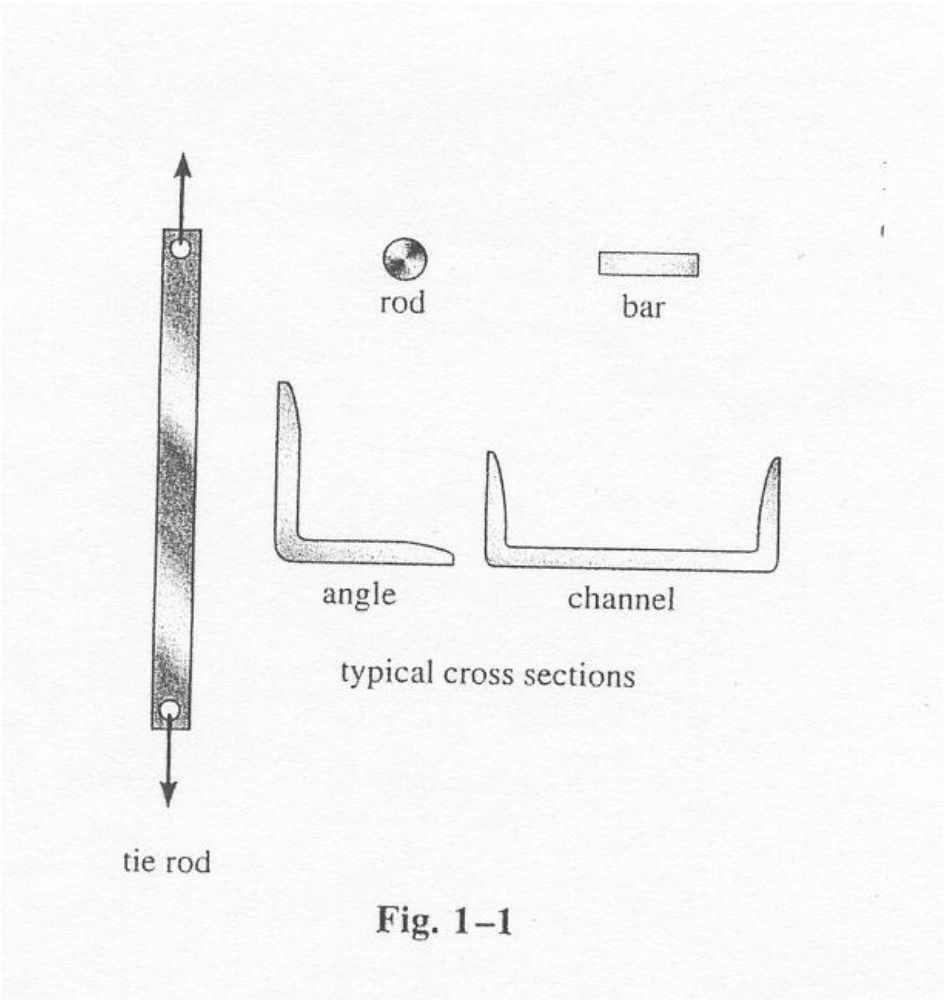
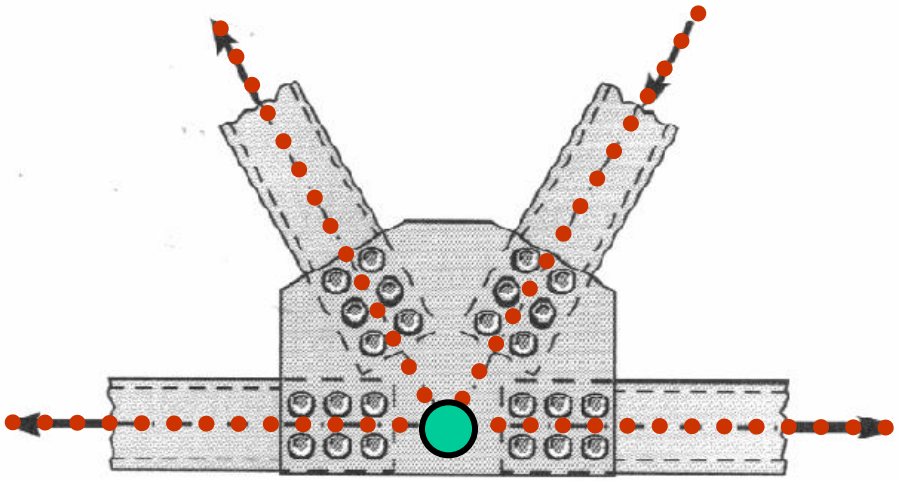



Fig. 1–1

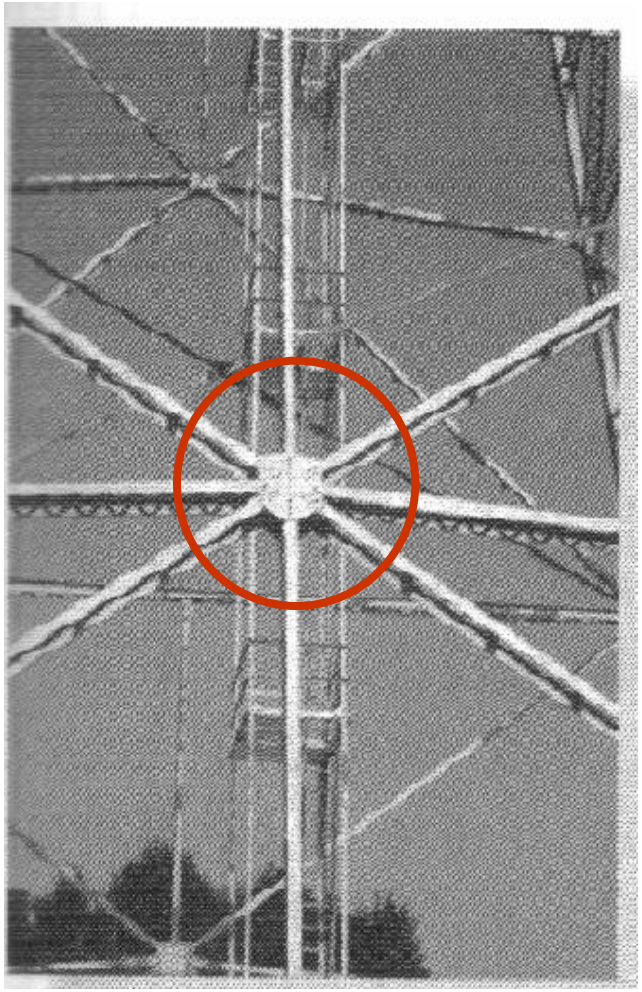
# Analysis of Determinate Trusses

## Characteristics

- **Pinned/Bolted Welded Joint Connections**
- **Gusset Plates**



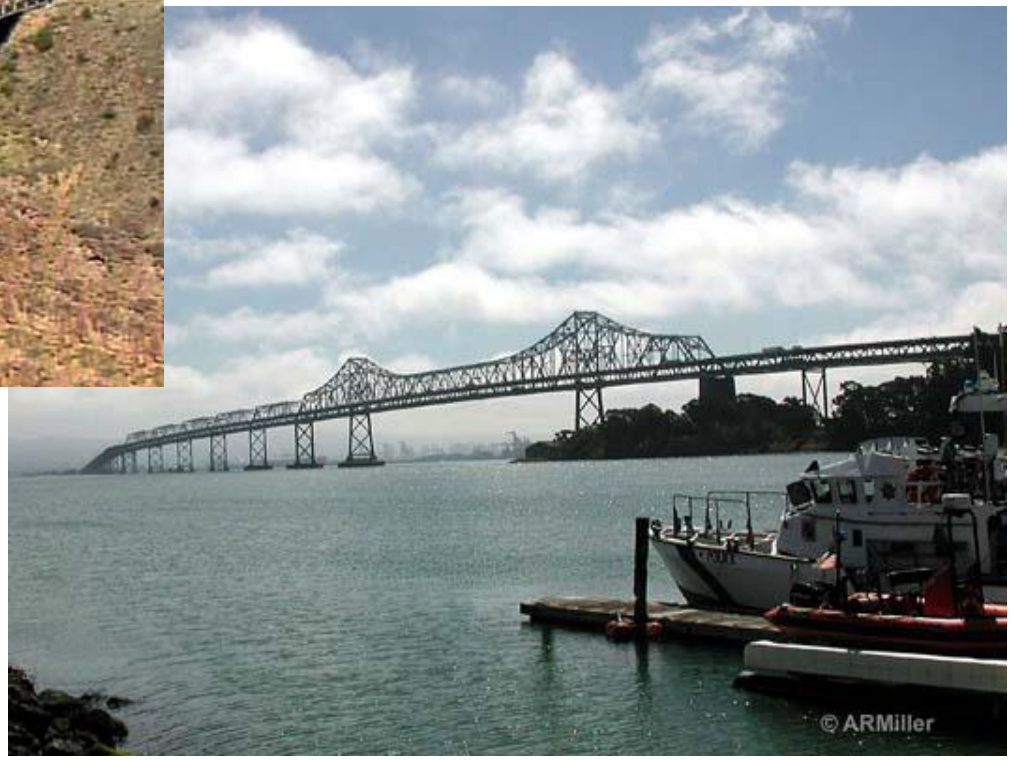
gusset plate



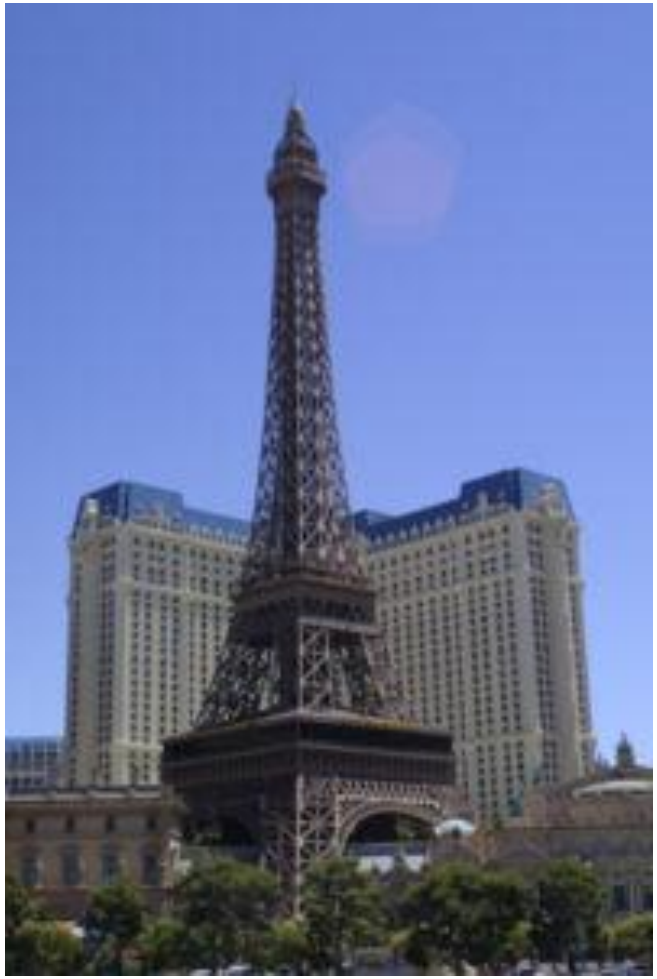
# Analysis of Determinate Trusses

- Loads at Joints
- Members in Tension/Compression

# Analysis of Determinate Trusses



# Analysis of Determinate Trusses



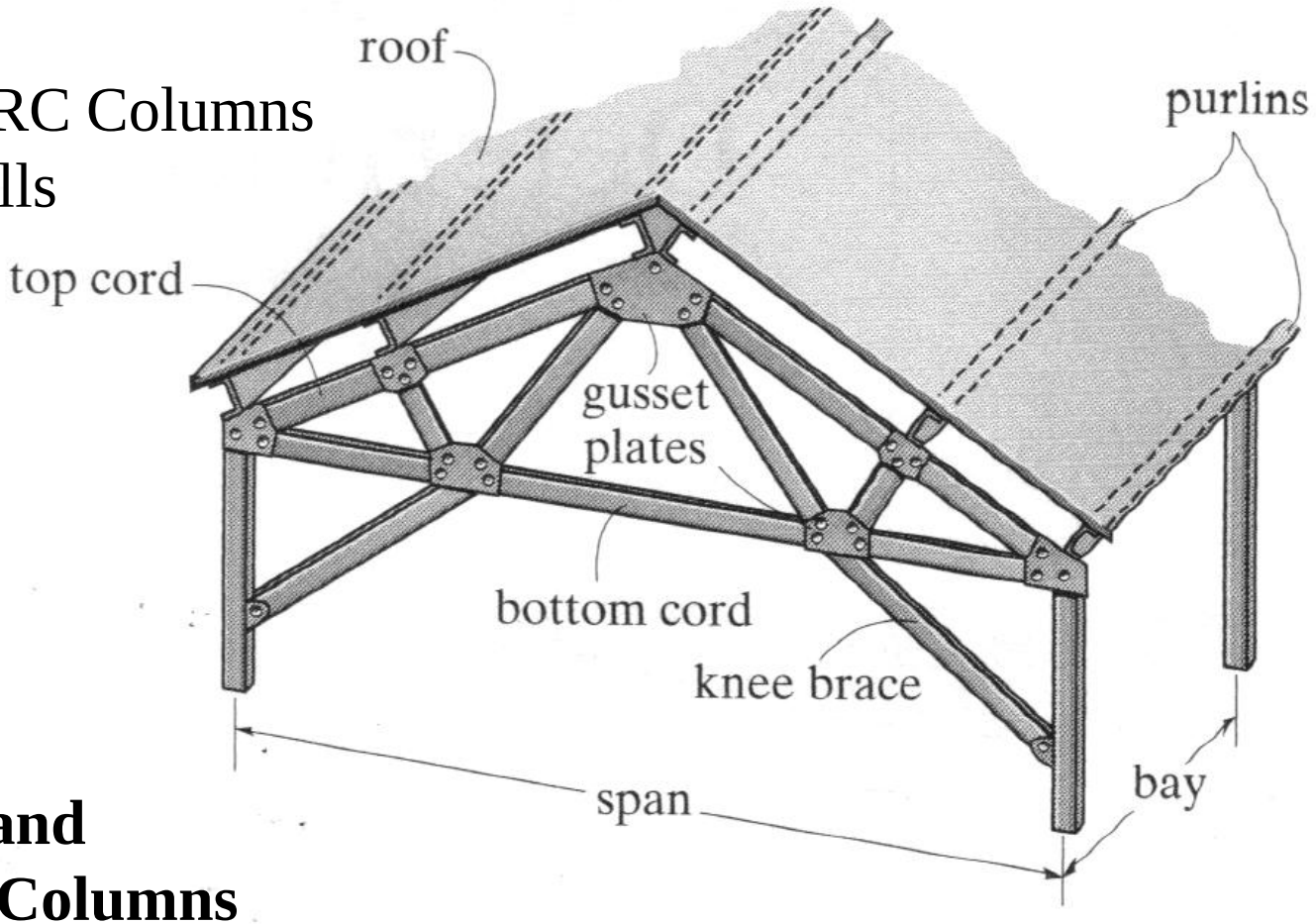
# Analysis of Determinate Trusses

# Roof Trusses - Terminology

**Supports**

Wood/Steel/RC Columns

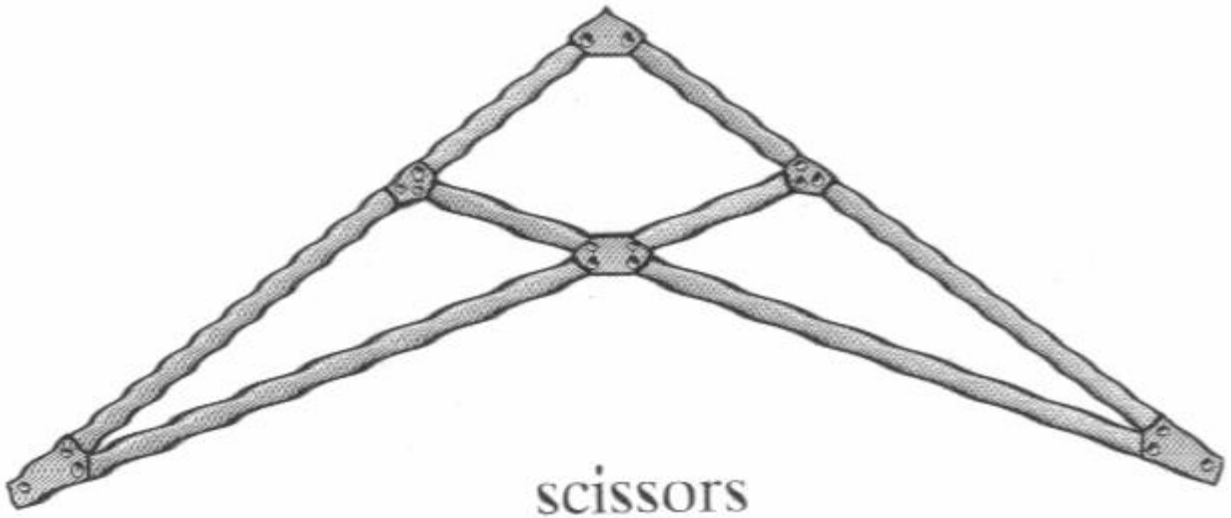
Masonry Walls




**Bent:**

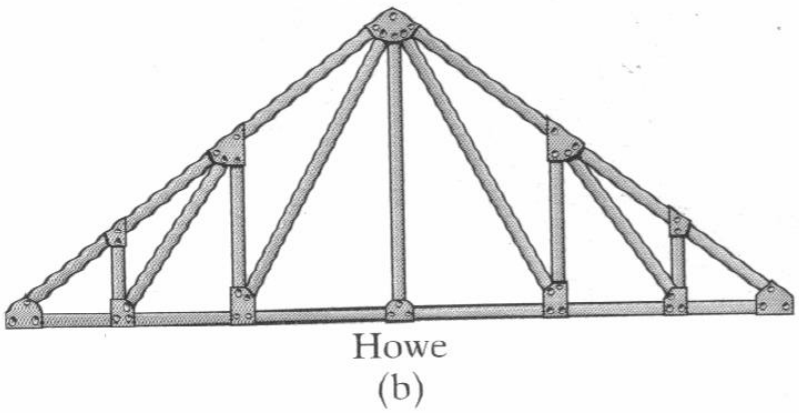
**Roof Truss and Supporting Columns**

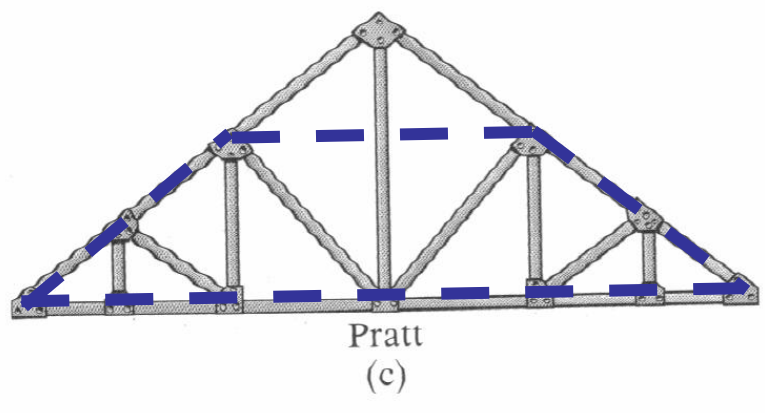
# Roof Trusses - Selection




Short Spans (<60 ft)
Requiring Overhead Clearance

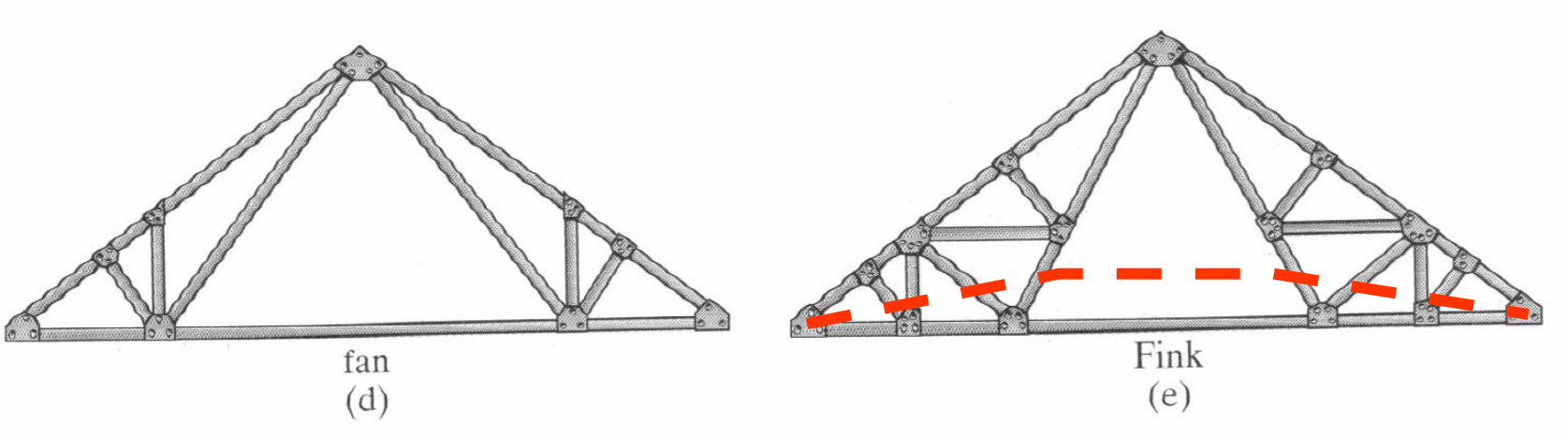
# Roof Trusses - Selection



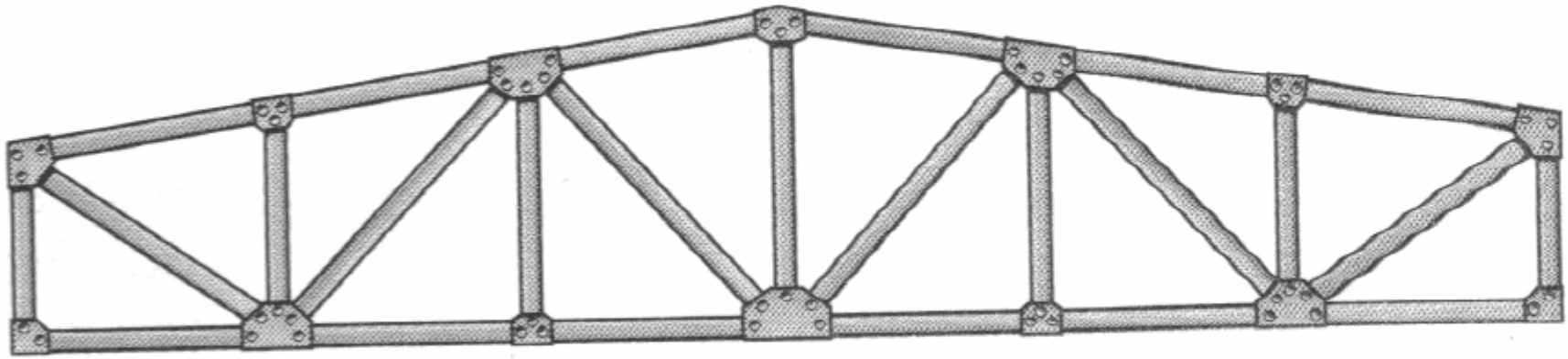

Moderate Spans (60-100 ft)
May be modified for flat roofs

# Roof Trusses - Selection




Larger Spans (>100 ft)
May have cambered bottom chord

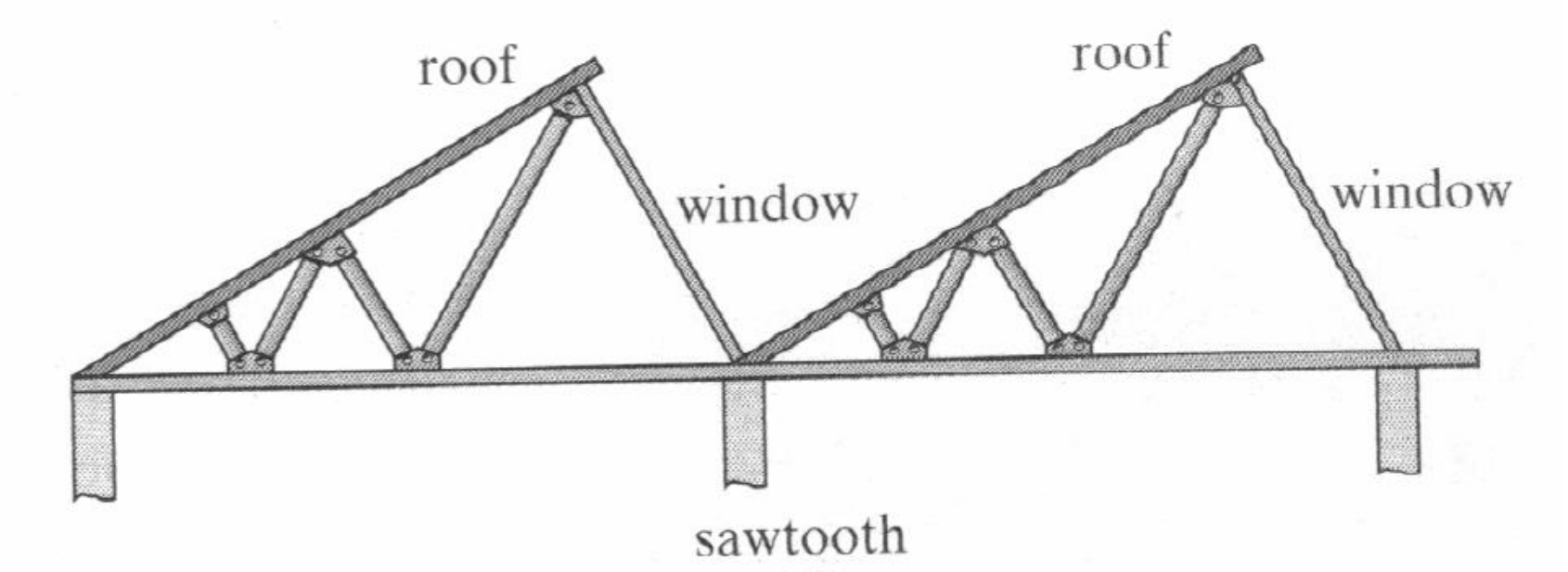
# Roof Trusses - Selection



Warren
(g)

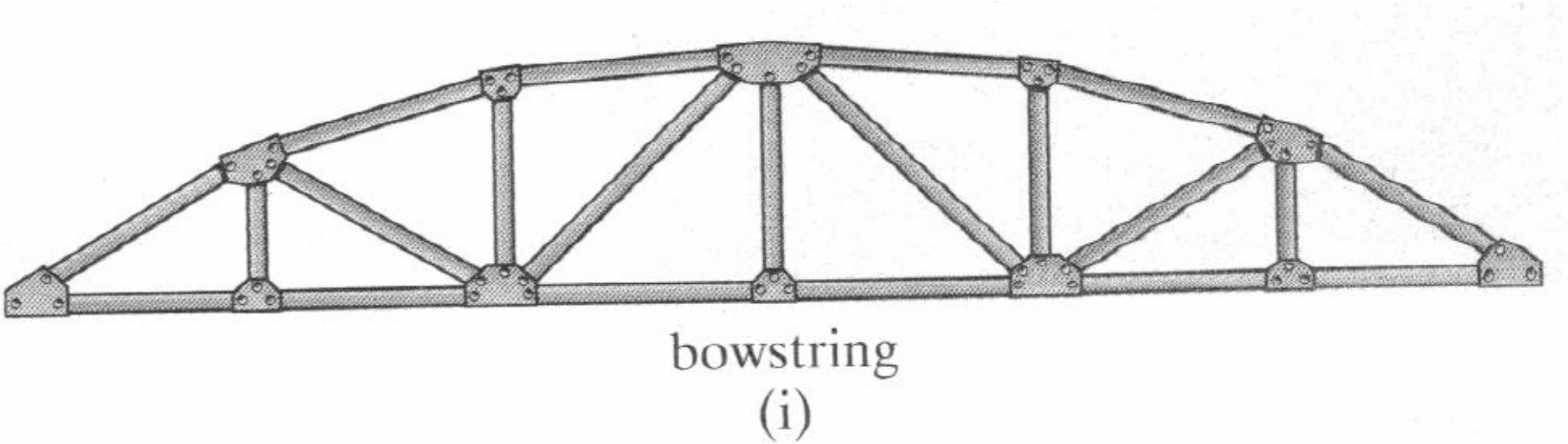
Suitable for flat or nearly flat roofs

# Roof Trusses - Selection




Location of column not an issue
Uniform lighting is important

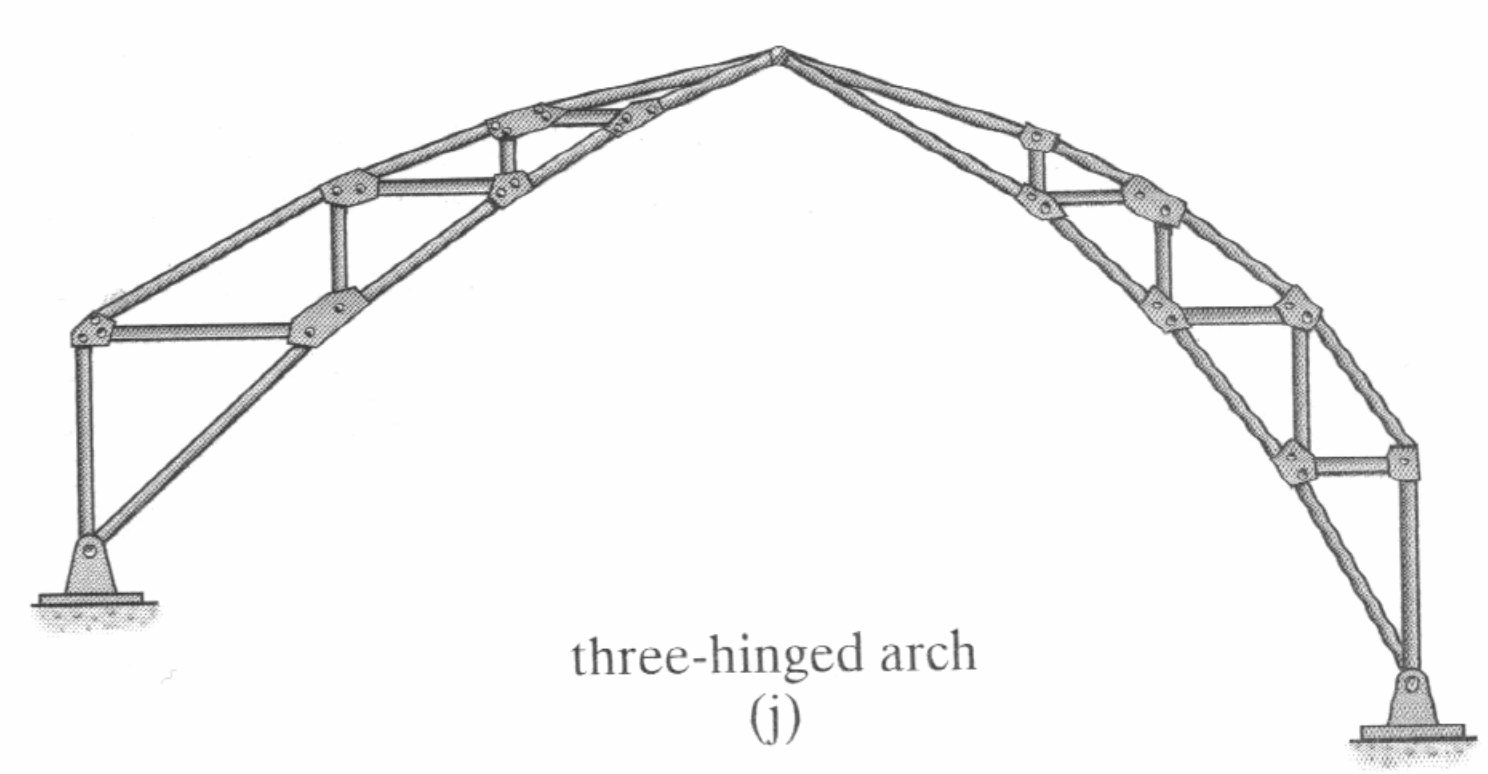
# Roof Trusses - Selection



bowstring
(i)

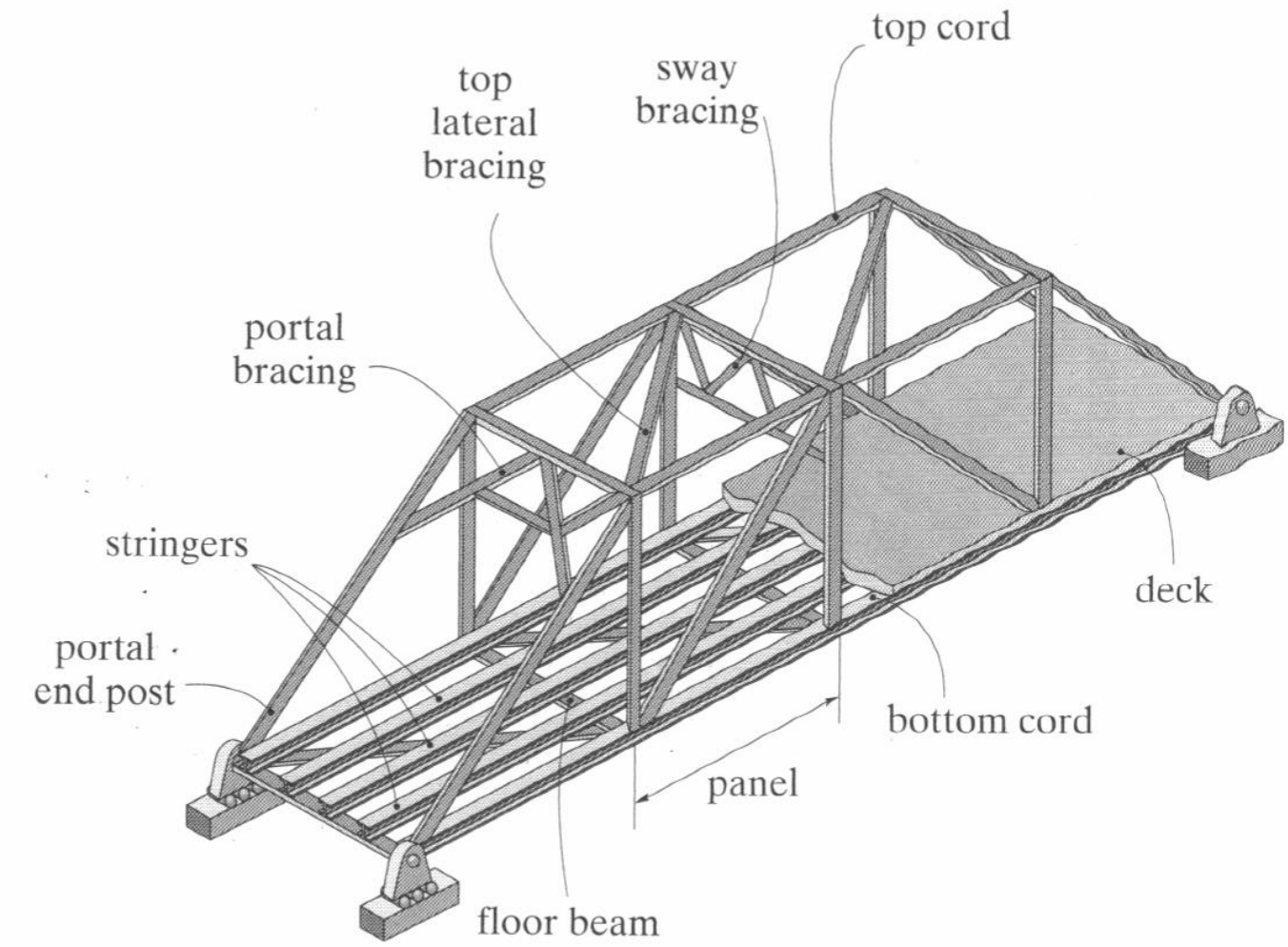
Garages and small airplane hangars

# Roof Trusses - Selection

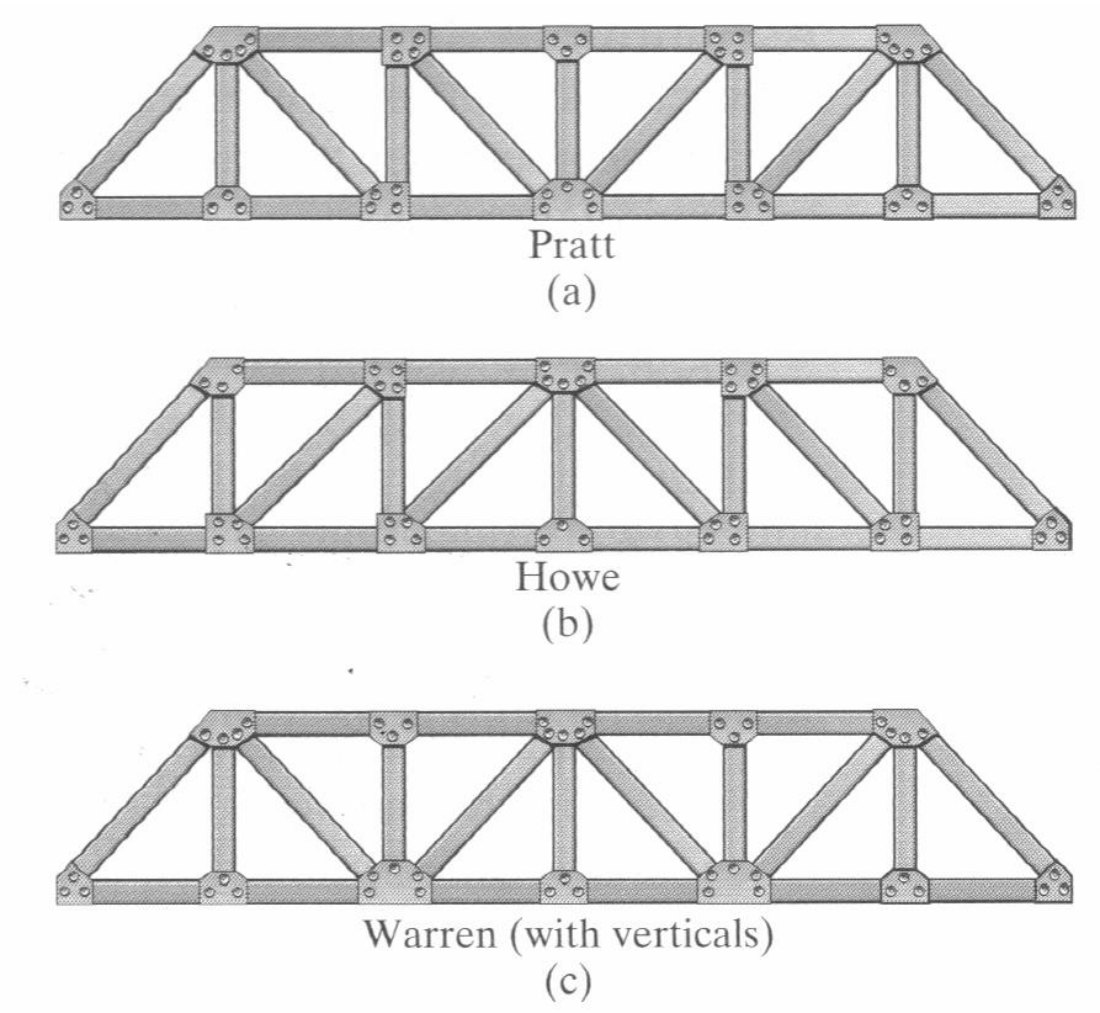



High rises and long spans
Field houses
Gymnasiums etc

# Bridge Trusses - Terminology

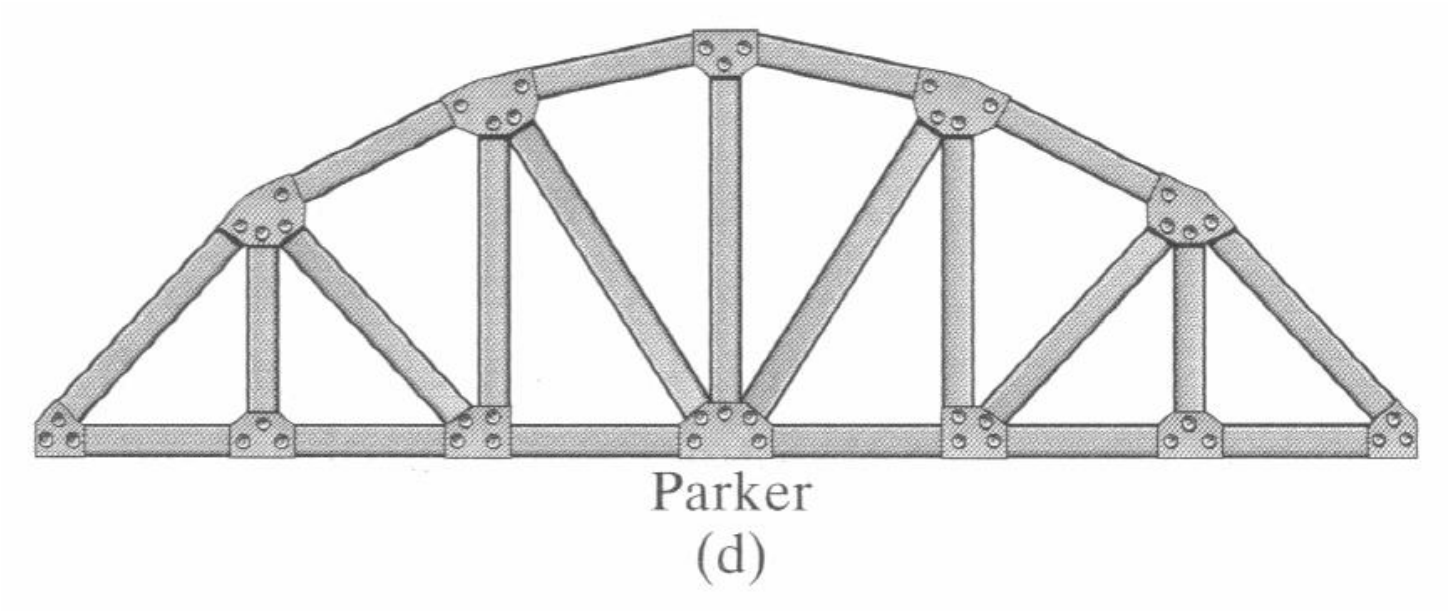


# Bridge Trusses - Selection




Spans <200ft

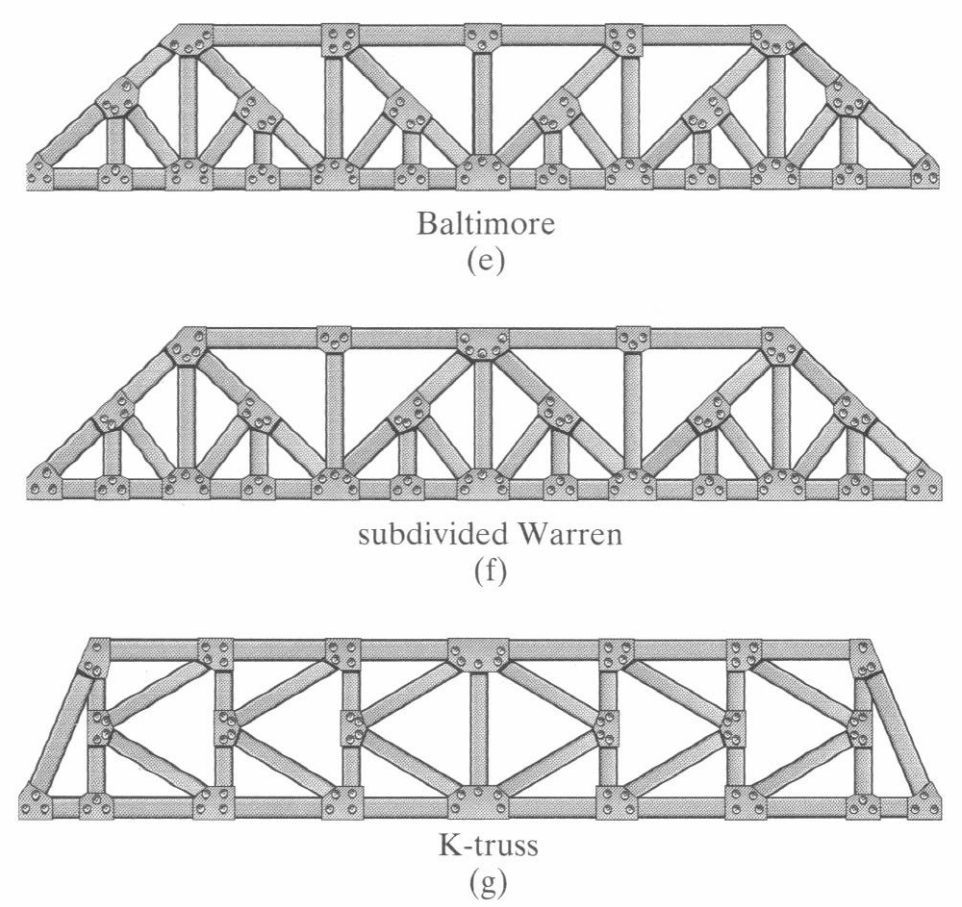
# Bridge Trusses - Selection




Spans <300ft

- Warren truss with verticals and polygonal upper chord
- Slope of diagonals 45-60$^{o}$

# Bridge Trusses - Selection




Longer Spans

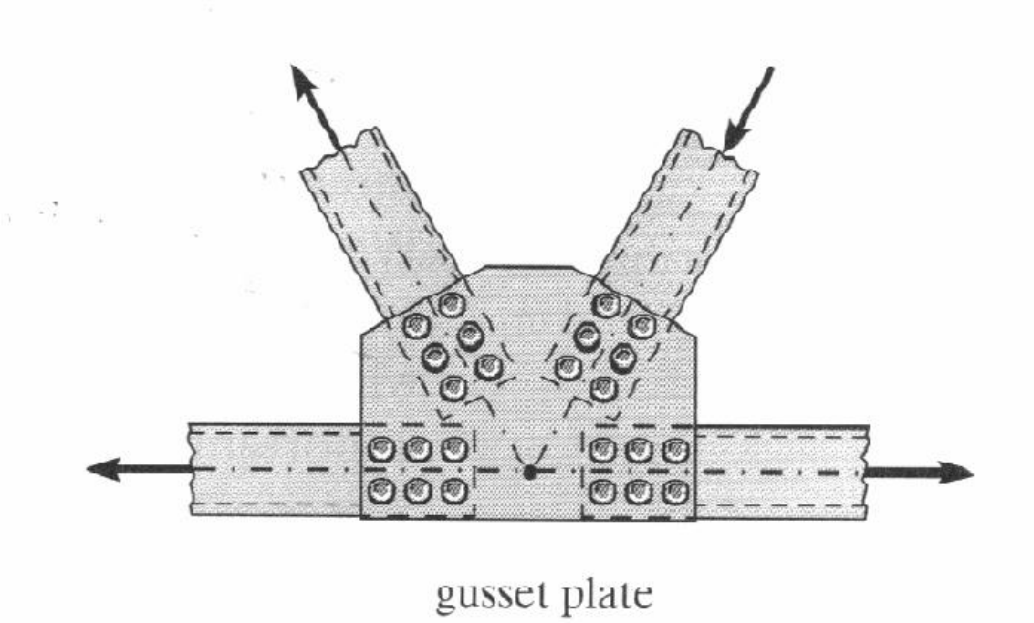
Subdivided Trusses
K-Truss

# OK 99 Pond Creek Bridge, Osage County

# Warren Truss Bridge

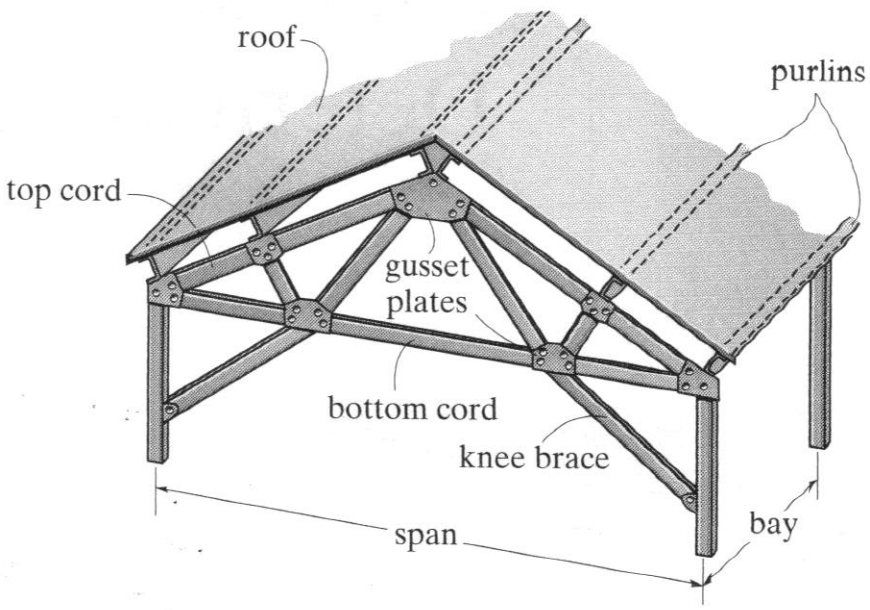
# Assumptions for Design

- **Members are joined together by smooth pins**
  - Center lines of joining members are concurrent at a point
  - In reality some rigidity exists: Secondary stresses



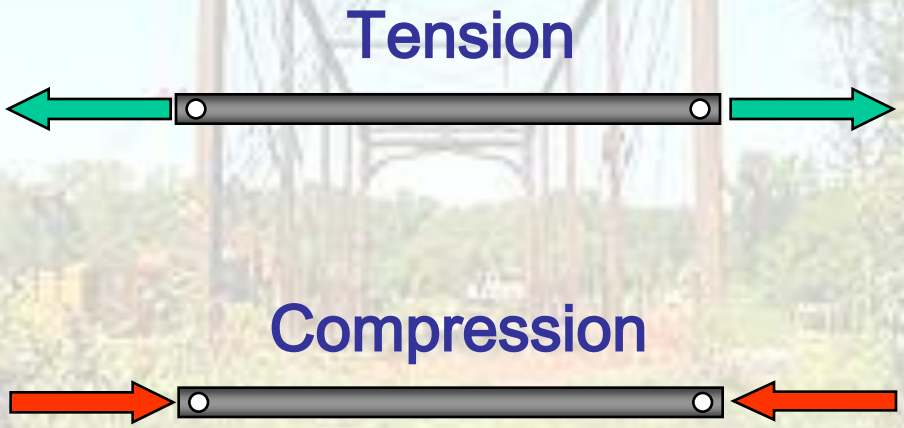
# Assumptions for Design

- **All loads are applied at joints**
  - Self weight is neglected IF small compared to forces

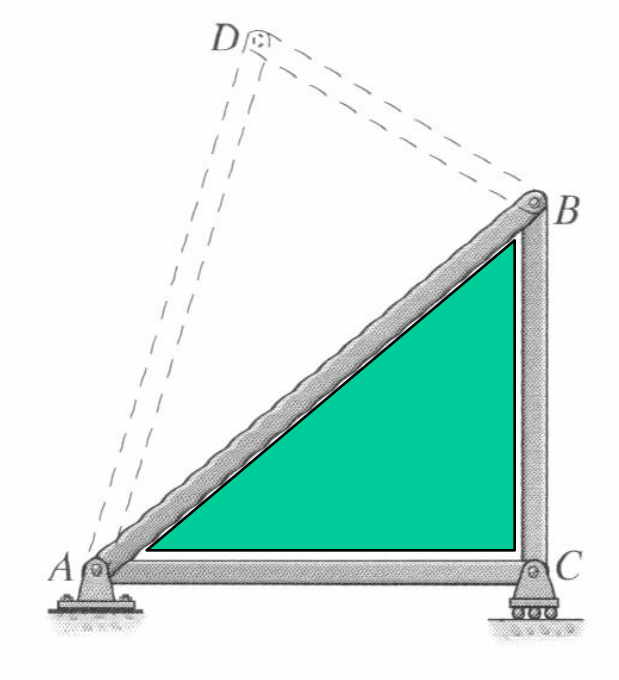


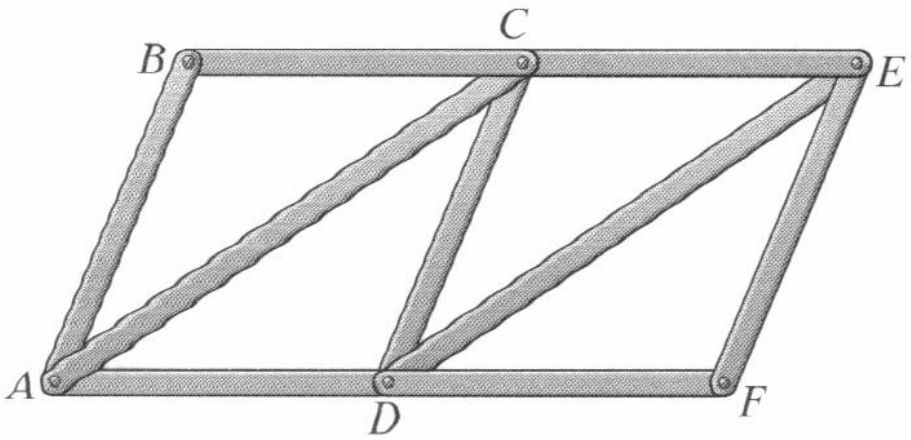
# Assumptions for Design

- **Axial Force Members**
  - **Tension/Compression**
  - **Compression Members Usually Thicker**



# Classification of Coplanar Trusses

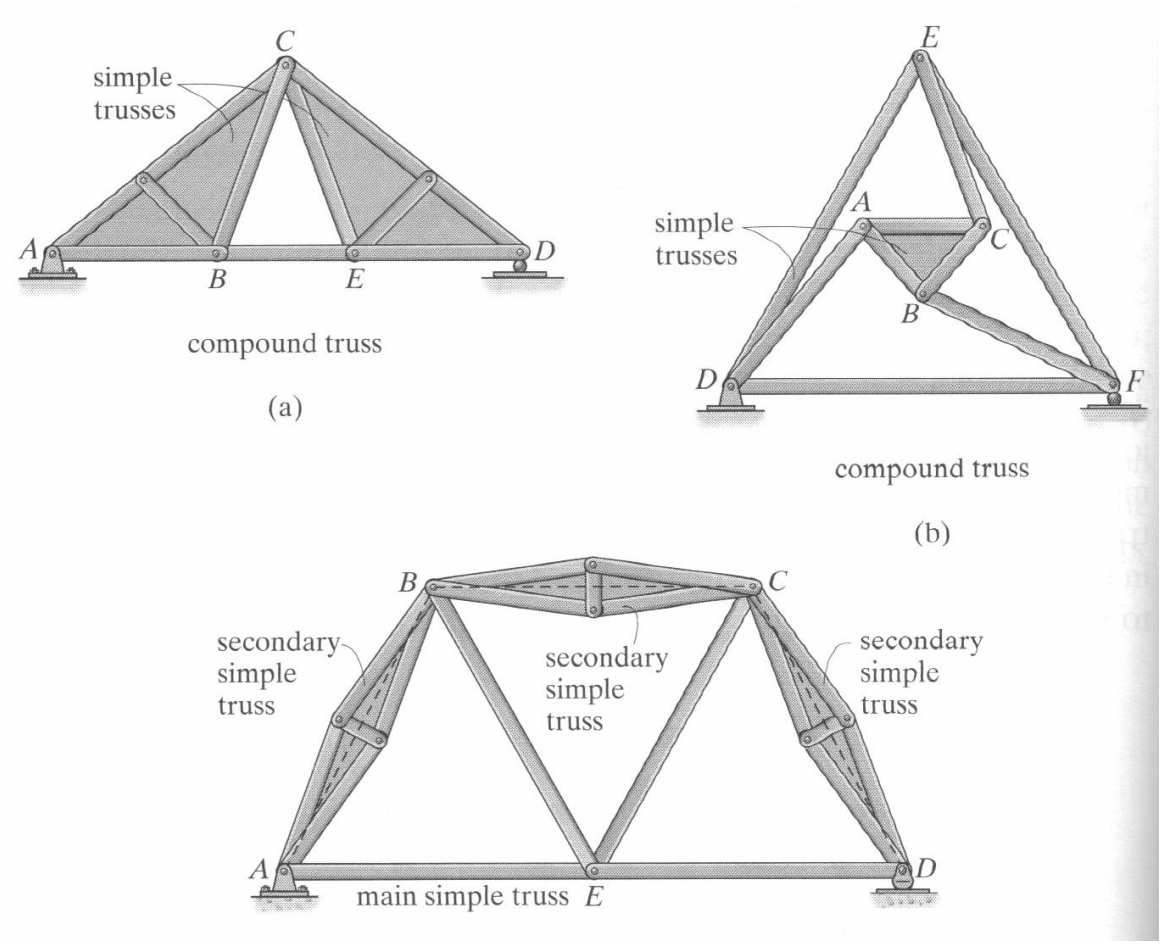



simple truss

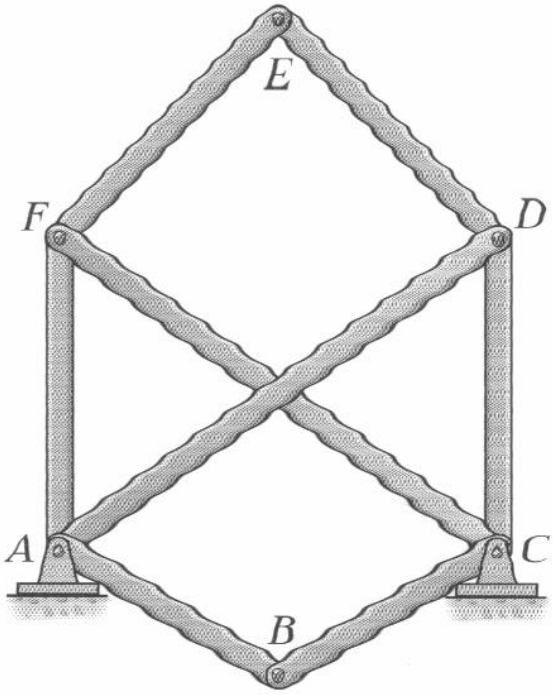
SIMPLE TRUSS - Triangles

# Classification of Coplanar Trusses




COMPOUND

# Classification of Coplanar Trusses

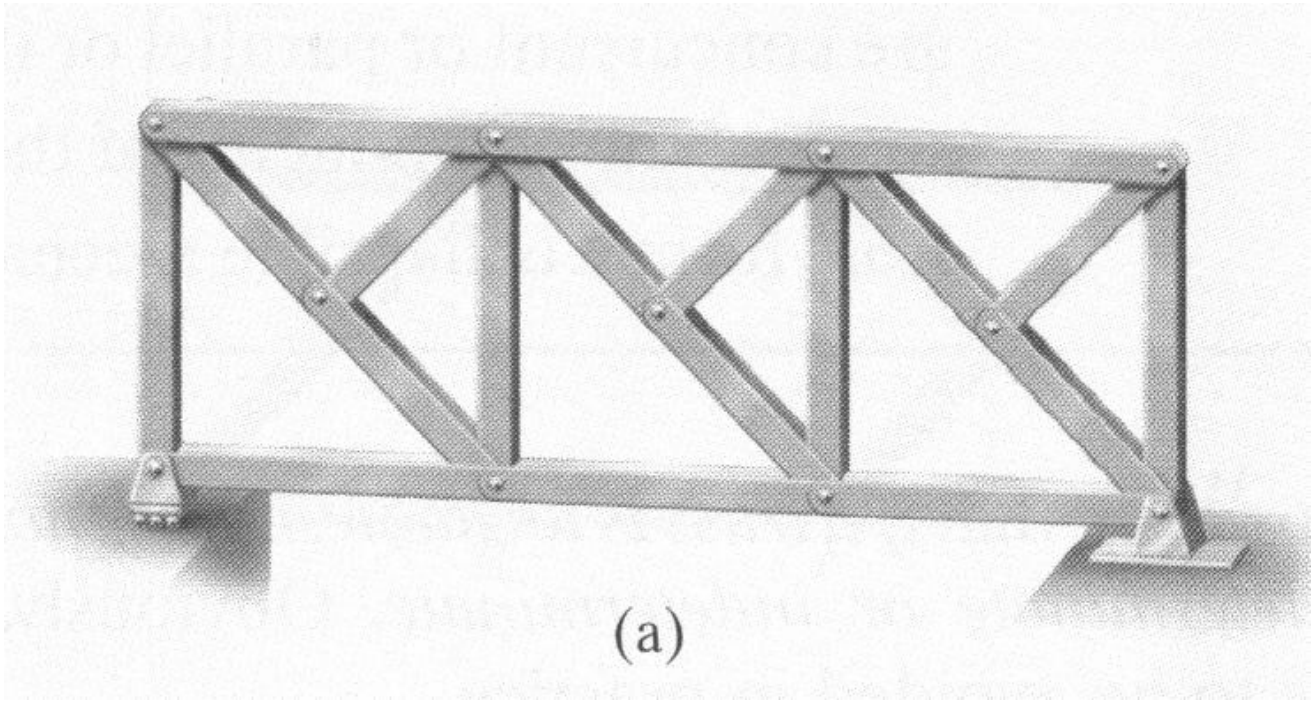



complex truss

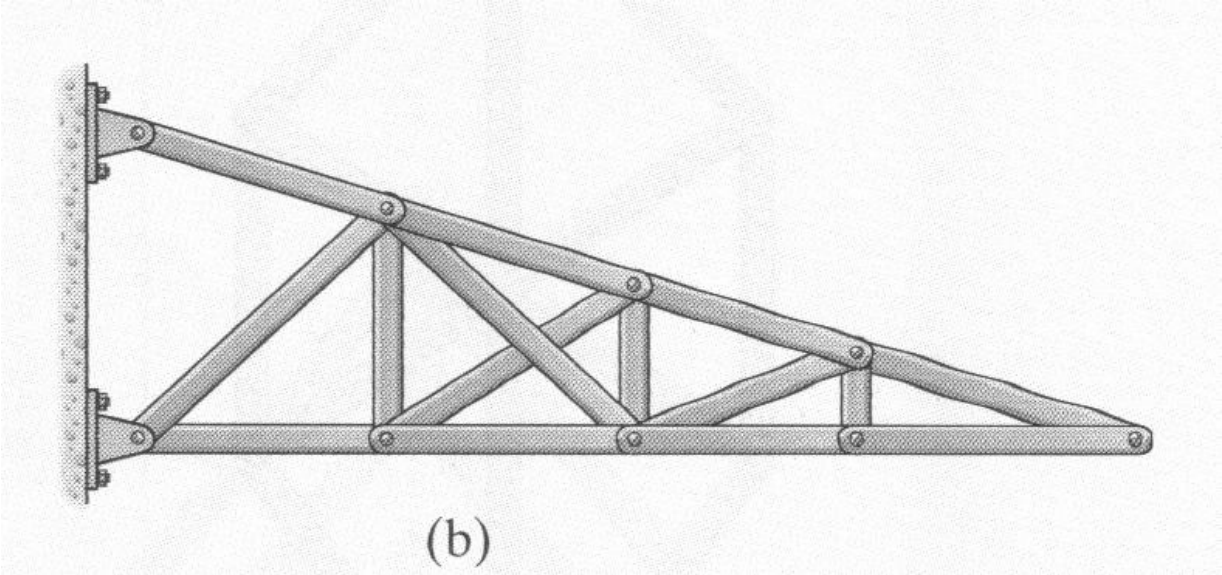
# Determinacy

No of Bars + No of Reactions = 2(no of Joints)

b + r = 2j -> Determinate

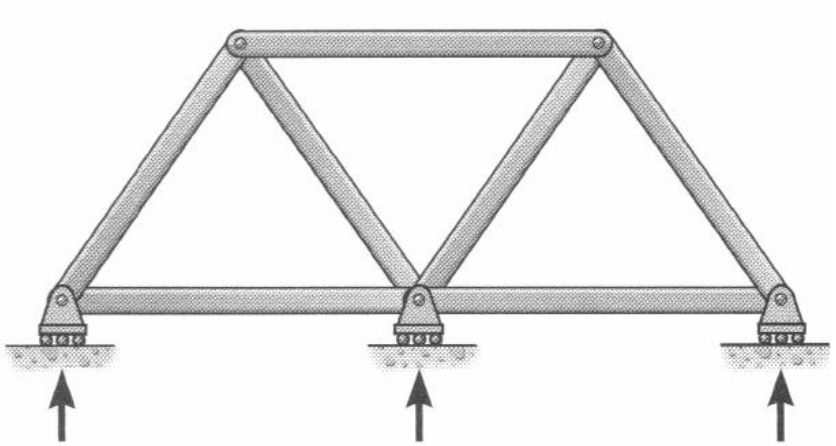


# Determinacy

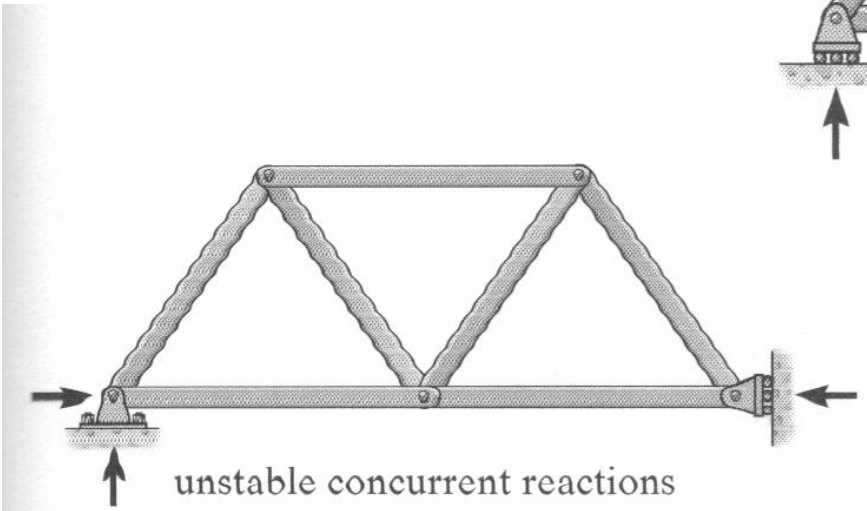


# Stability

External Stability
All reactions parallel or
Concurrent => Unstable



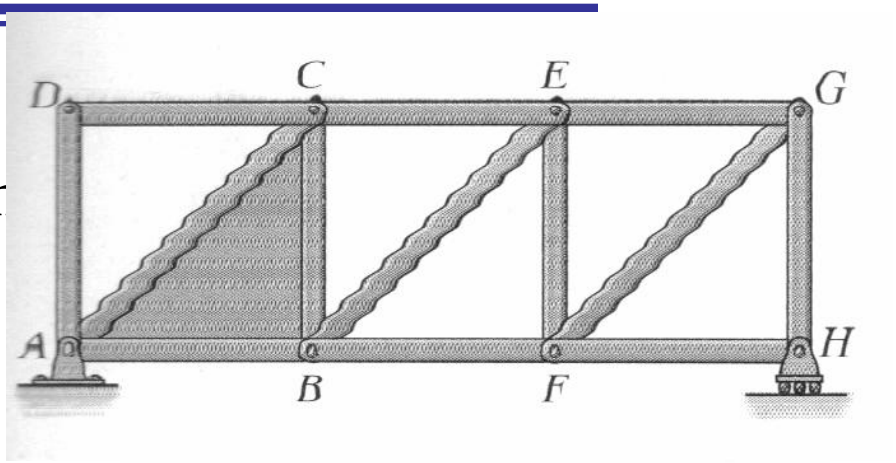
unstable parallel reactions

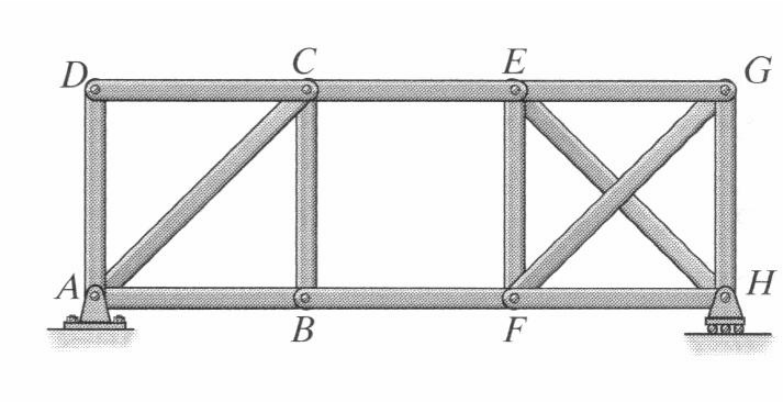


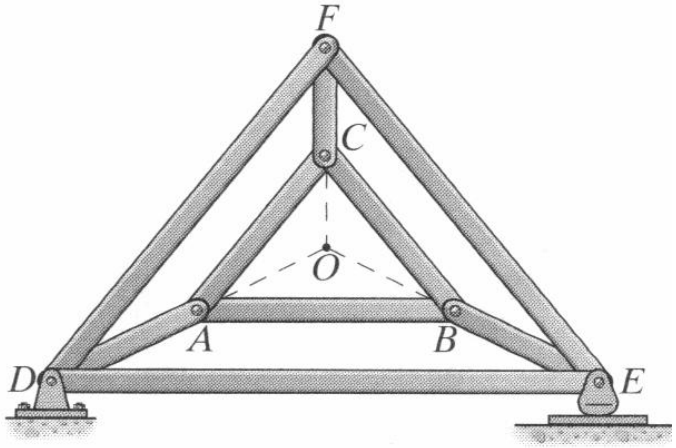
unstable concurrent reactions

# Stability

Internal Stability
Joints do not exhibit rigid motion
Simple truss always stable



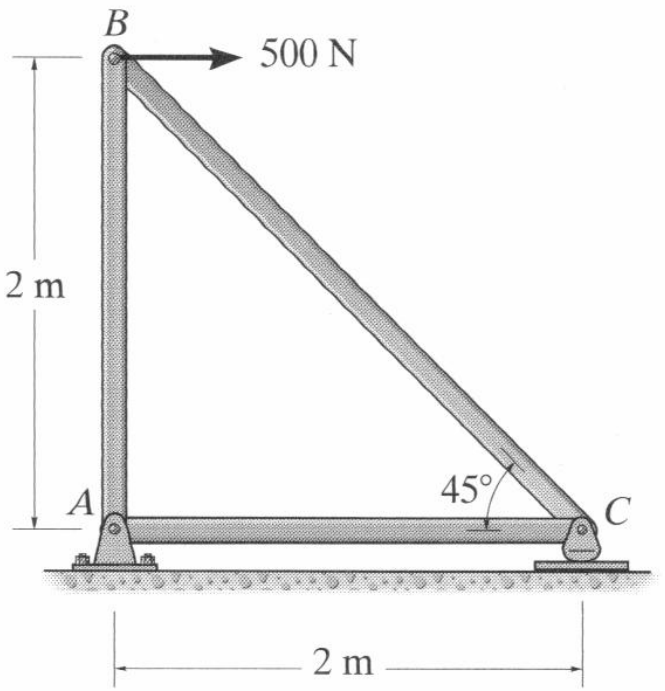



# Analysis Methods

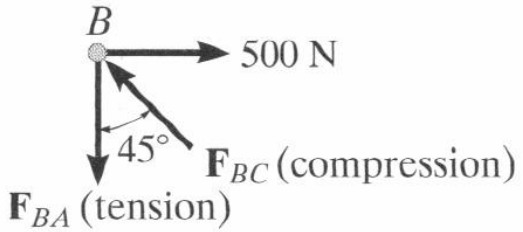
- Methods of Joints
- Method of Sections

# Method of Joints

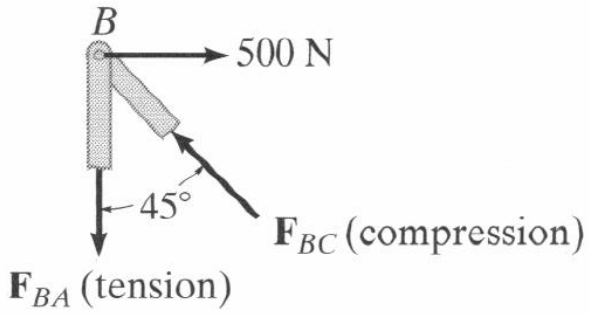
Truss in Equilibrium => Each Joint in Equilibrium




(a)




(b)



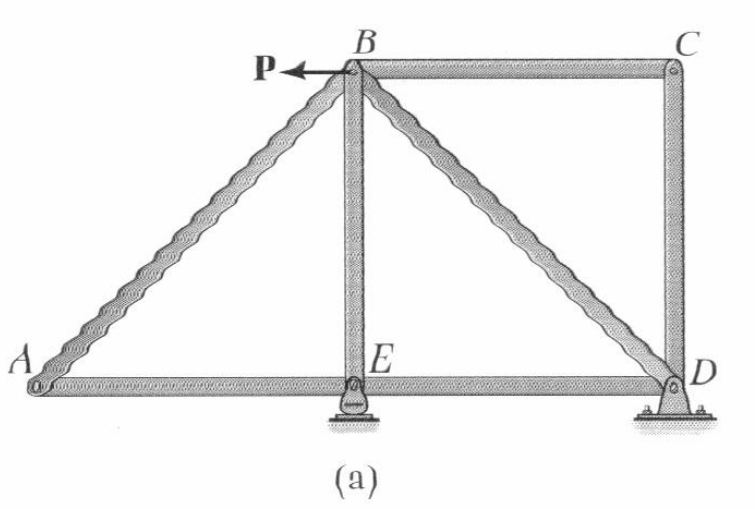
## Procedure

- **Consider one joint at a time – Draw FBD**
  - Condition: At least one known force; at most two unknown forces
- **Establish sense of unknown force**
  - Hint: Assume unknown forces “pulling on pin”; numerical solution (+) tension in member, (-) compression in member

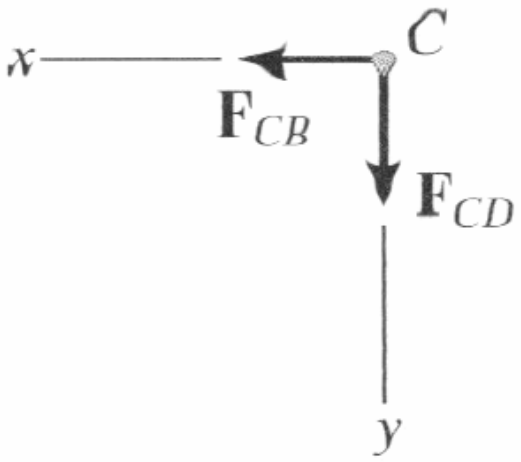
# Procedure

- Write equations of equilibrium of node
  - Hint: Select x-y CS such that forces on FBD can be easily resolved into components
- Take advantage of symmetries
- Identify zero force members
  - (i) only two members form a joint and no loads or supports on joint
  - (ii) three members form a joint; two members colinear => third member zero force

# Zero-Force Members



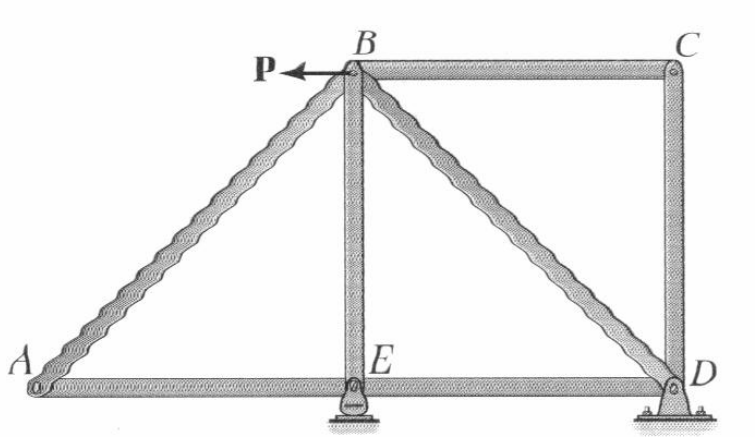
(a)



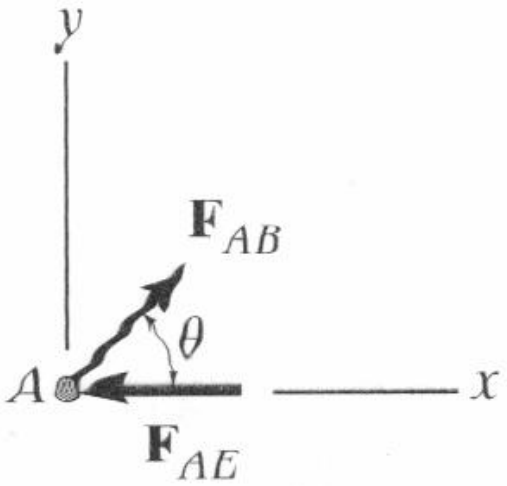

$$\overset{+}{\leftarrow} \Sigma F_x = 0;\ F_{CB} = 0$$

$$+\downarrow \Sigma F_y = 0;\ F_{CD} = 0$$

# Zero-Force Members




(a)




$+\uparrow \Sigma F_y = 0;\ F_{AB} \sin\theta = 0$

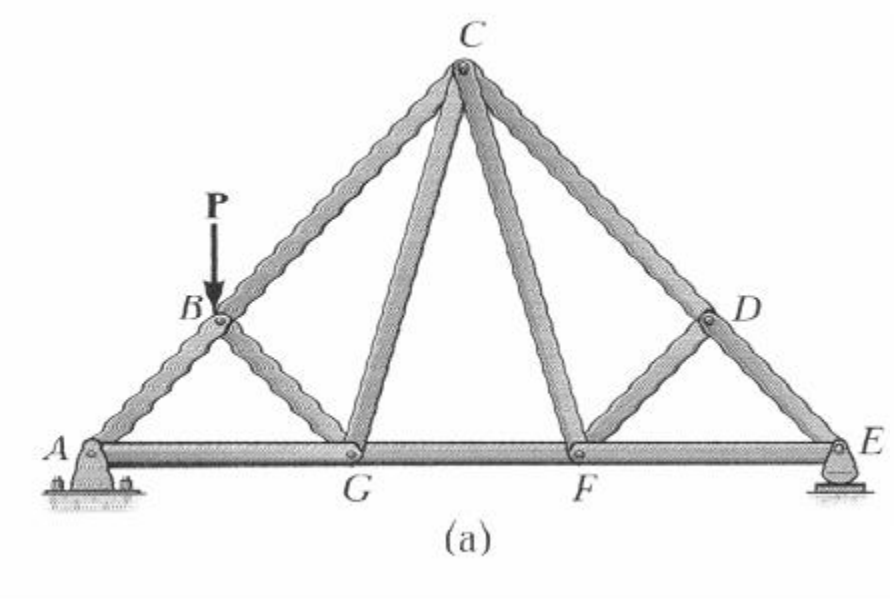
$F_{AB} = 0 \quad (\text{since } \sin\theta \neq 0)$

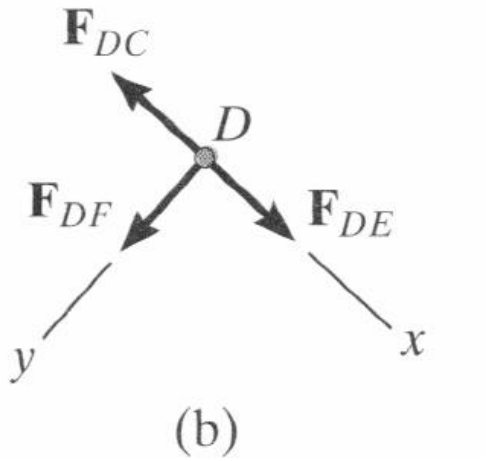
$\pm\rightarrow \Sigma F_x = 0;\ -F_{AE} + 0 = 0$

$F_{AE} = 0$

(c)

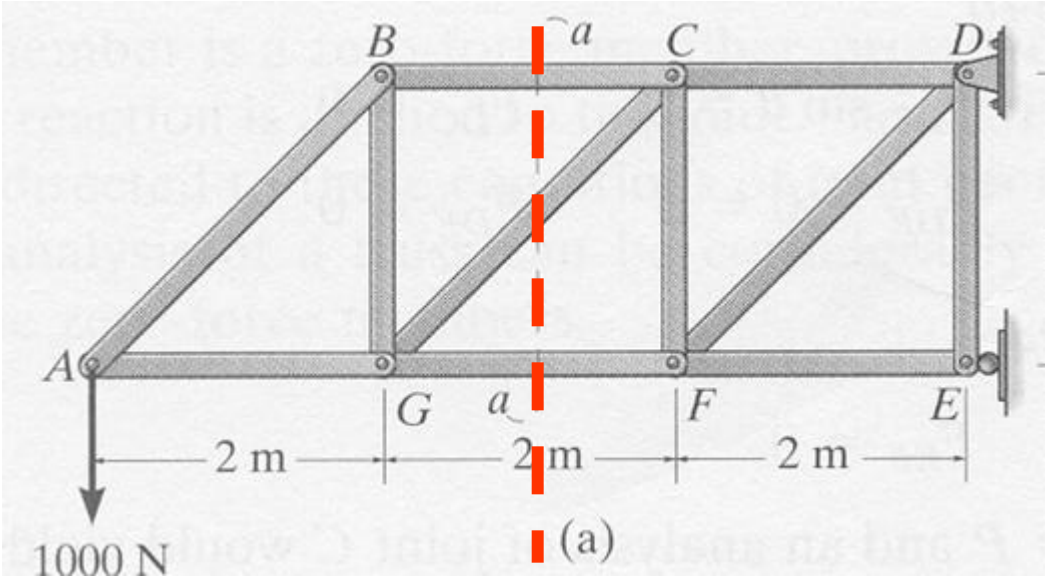
# Zero-Force Members

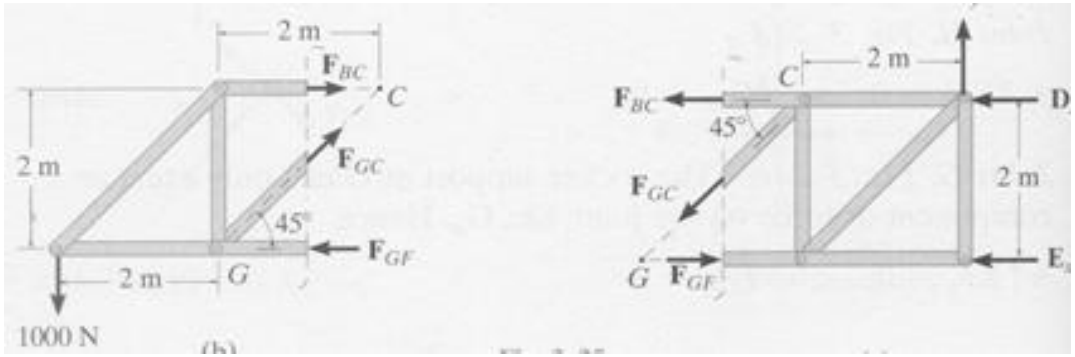


# Method of Sections

Truss in Equilibrium => Each **PART** in Equilibrium



# Method of Sections

Truss in Equilibrium => Each **PART** in Equilibrium

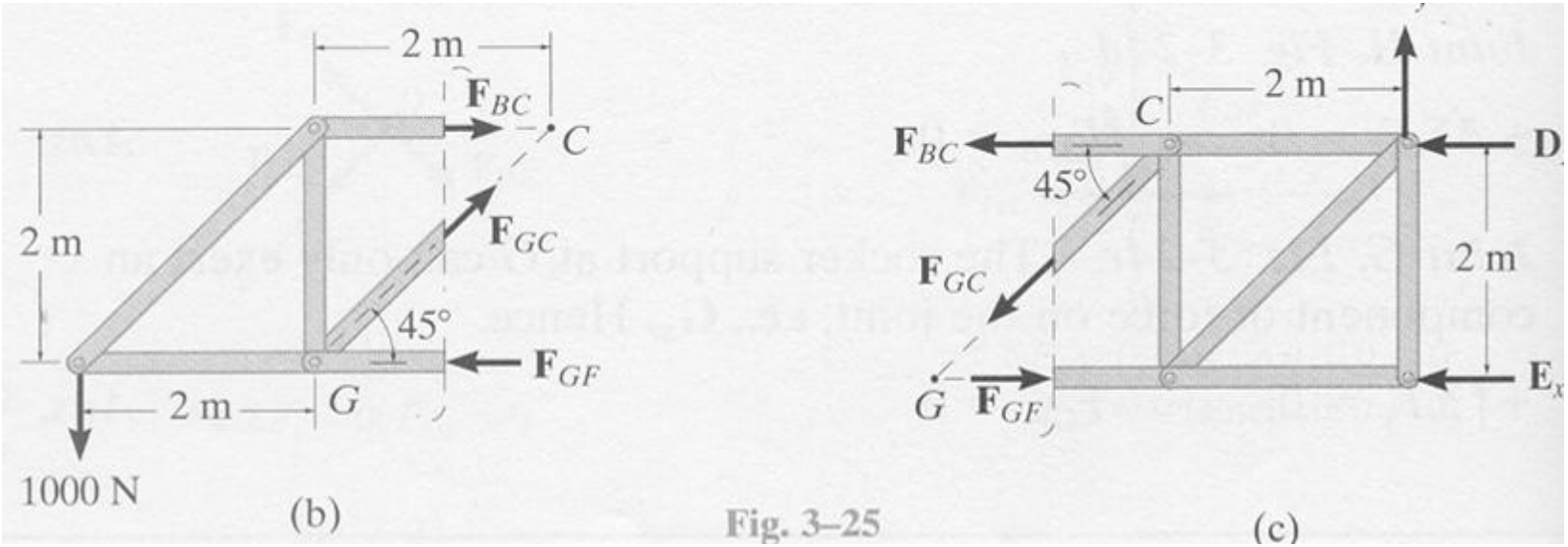
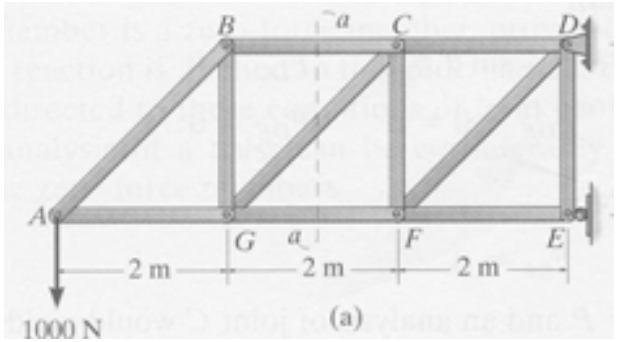



Fig. 3–25




**Efficient when forces of only a few members are to be found**

# Method of Sections - Procedure

***Free Body Diagram***

- Determine external reactions of entire truss
- Decide how to section truss
  *Hint: Three(3) unknown forces at the most*

# Method of Sections – Procedure (cont'd)

***Free Body Diagram***

- Draw FBD of one part
  *Hint: Choose part with least number of forces*

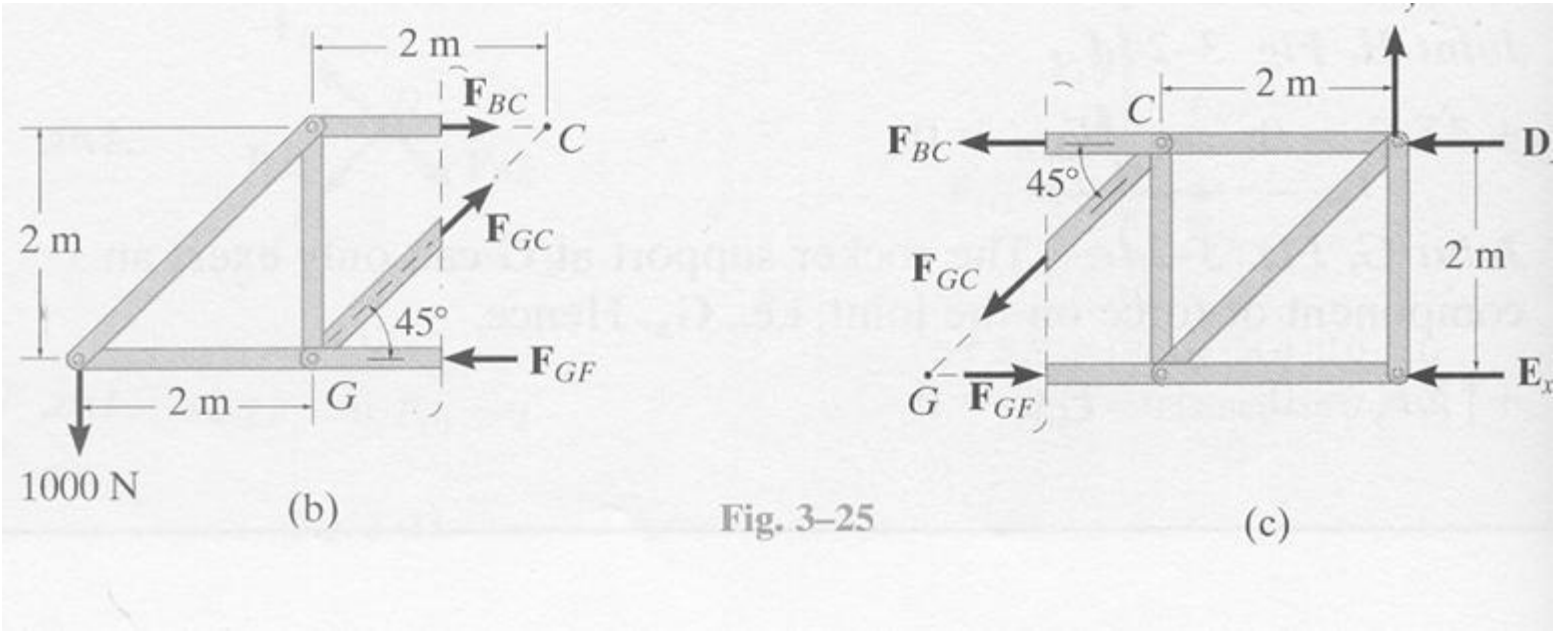



Fig. 3–25

# Method of Sections – Procedure (cont'd)

***Free Body Diagram***

- Establish direction of unknown forces

  *(a) Assume all forces cause tension in member*

  *Numerical results: (+) tension (-) compression*

  *(a) Guess Direction*

  *Numerical results: (+) Guess is correct*

  *(-) Force in opposite direction*

# Method of Sections – Procedure (cont'd)

***Equations of Equilibrium***

$$\sum F_x = 0$$

$$\sum F_y = 0$$

$$\sum M = 0$$

Take moments about a point that lies on the intersection of the lines of action of two unknown forces