Trusses

Analysis of Statically Determinate Trusses

Analysis of Determinate Trusses

Characteristics

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

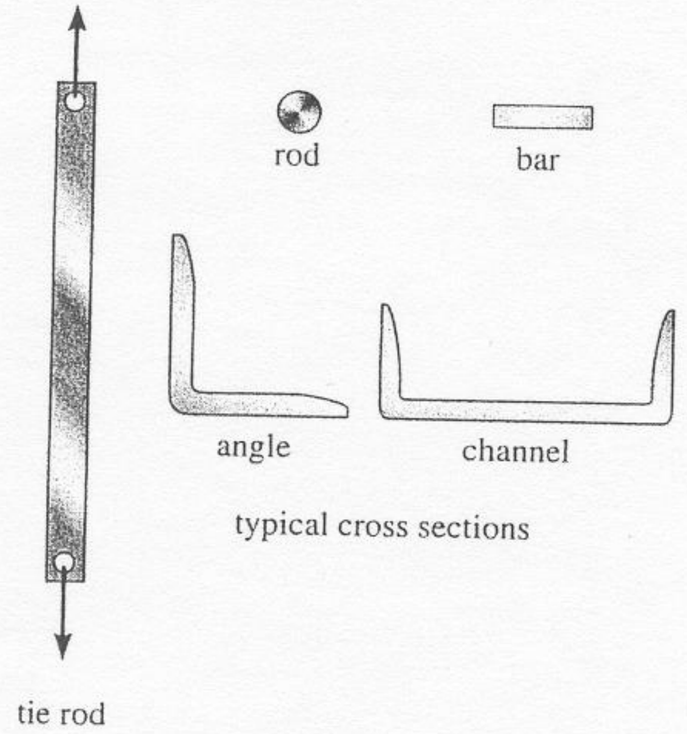
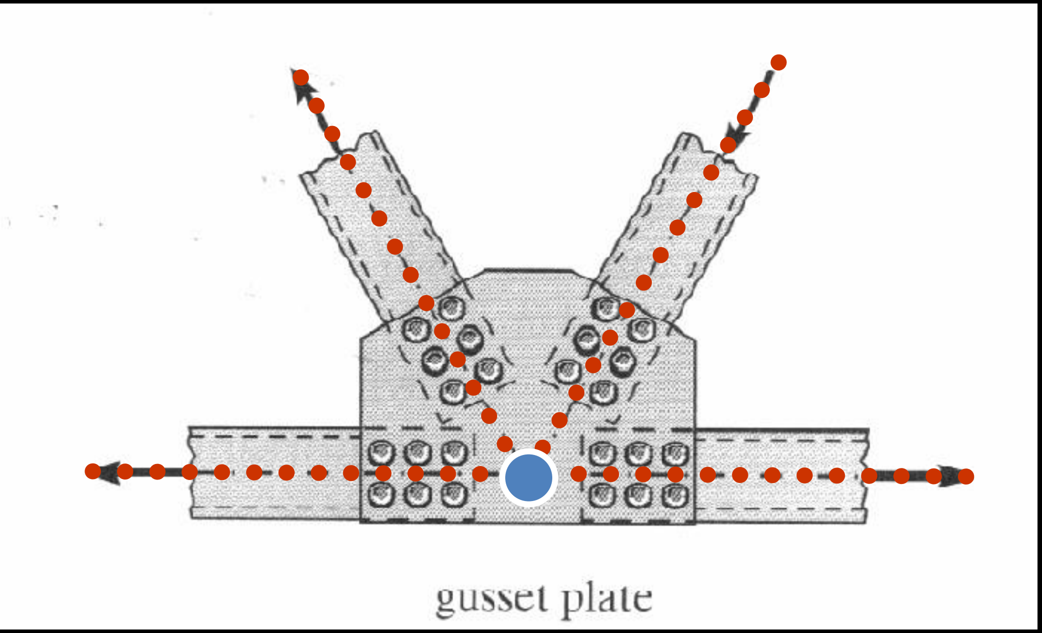


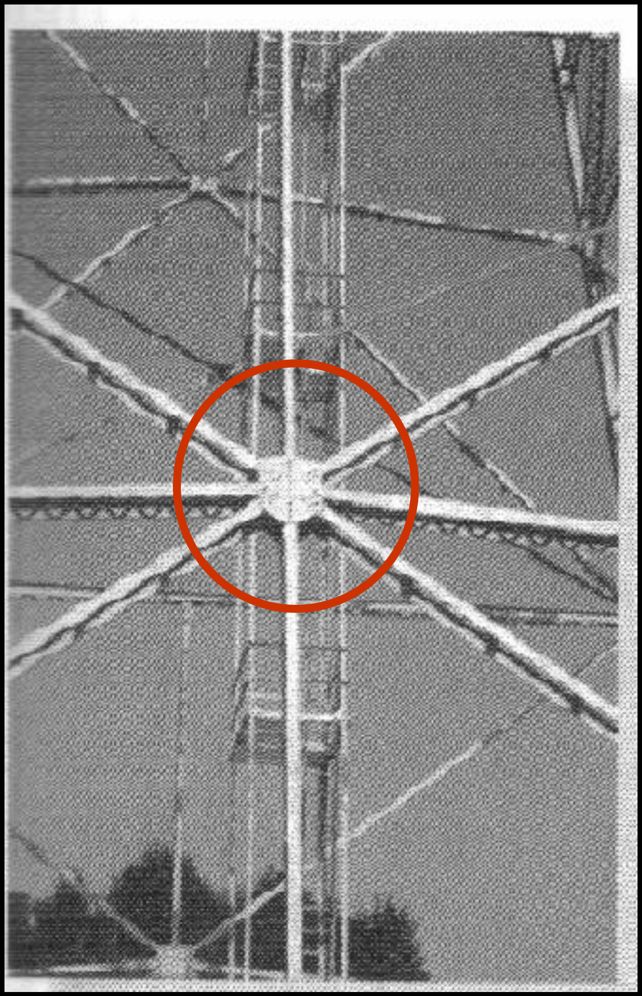
Fig. 1–1

Analysis of Determinate Trusses

Characteristics

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

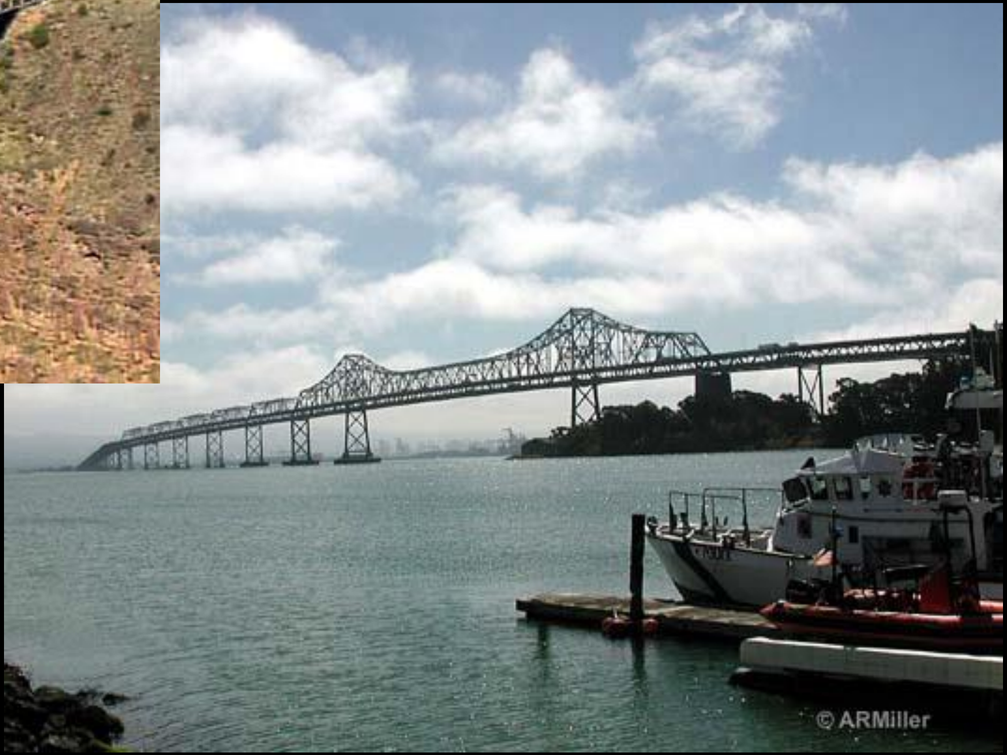




Analysis of Determinate Trusses

- Loads at Joints
- Members in Tension/Compression

Analysis of Determinate Trusses

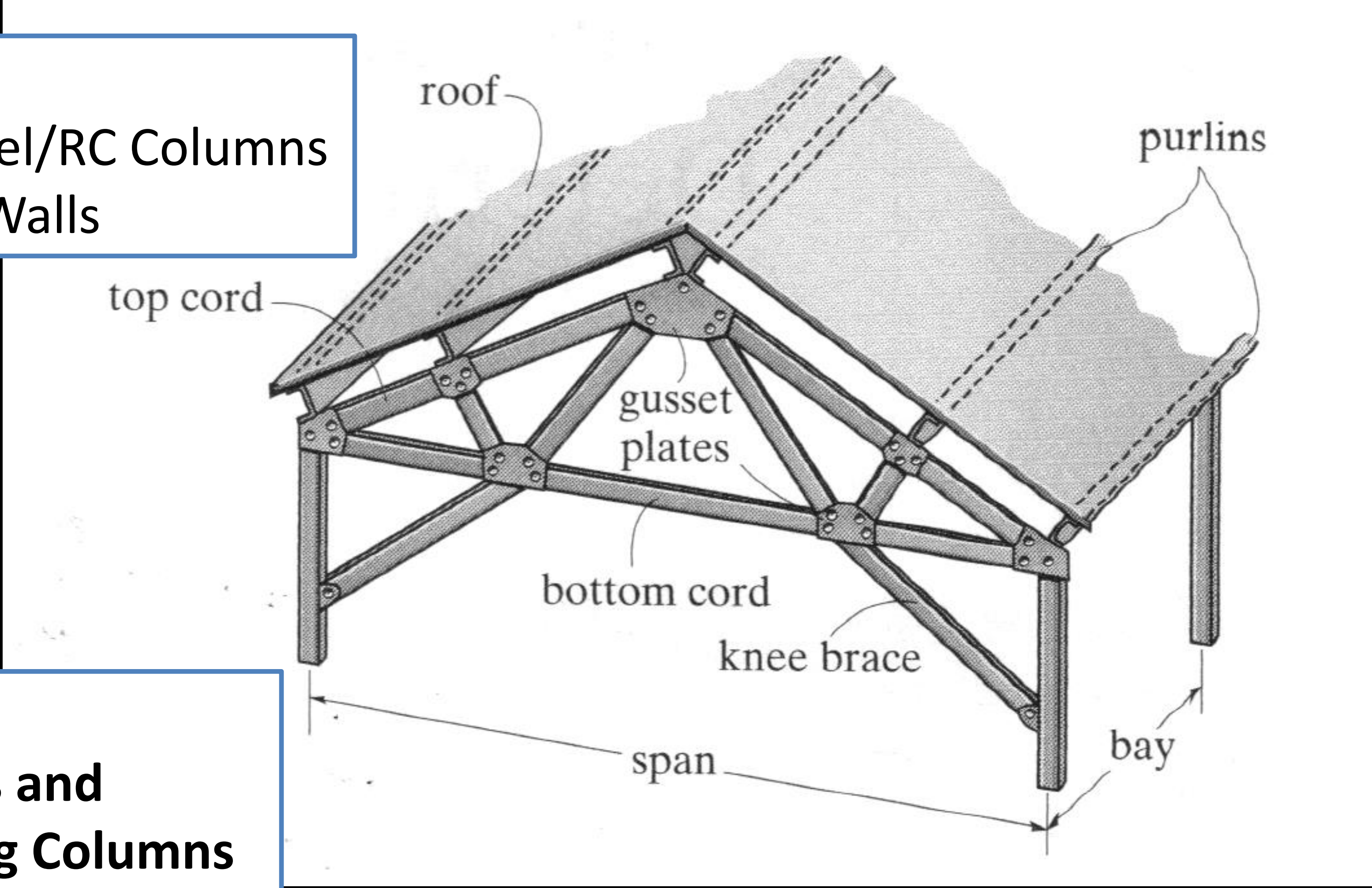


Analysis of Determinate Trusses

Analysis of Determinate Trusses

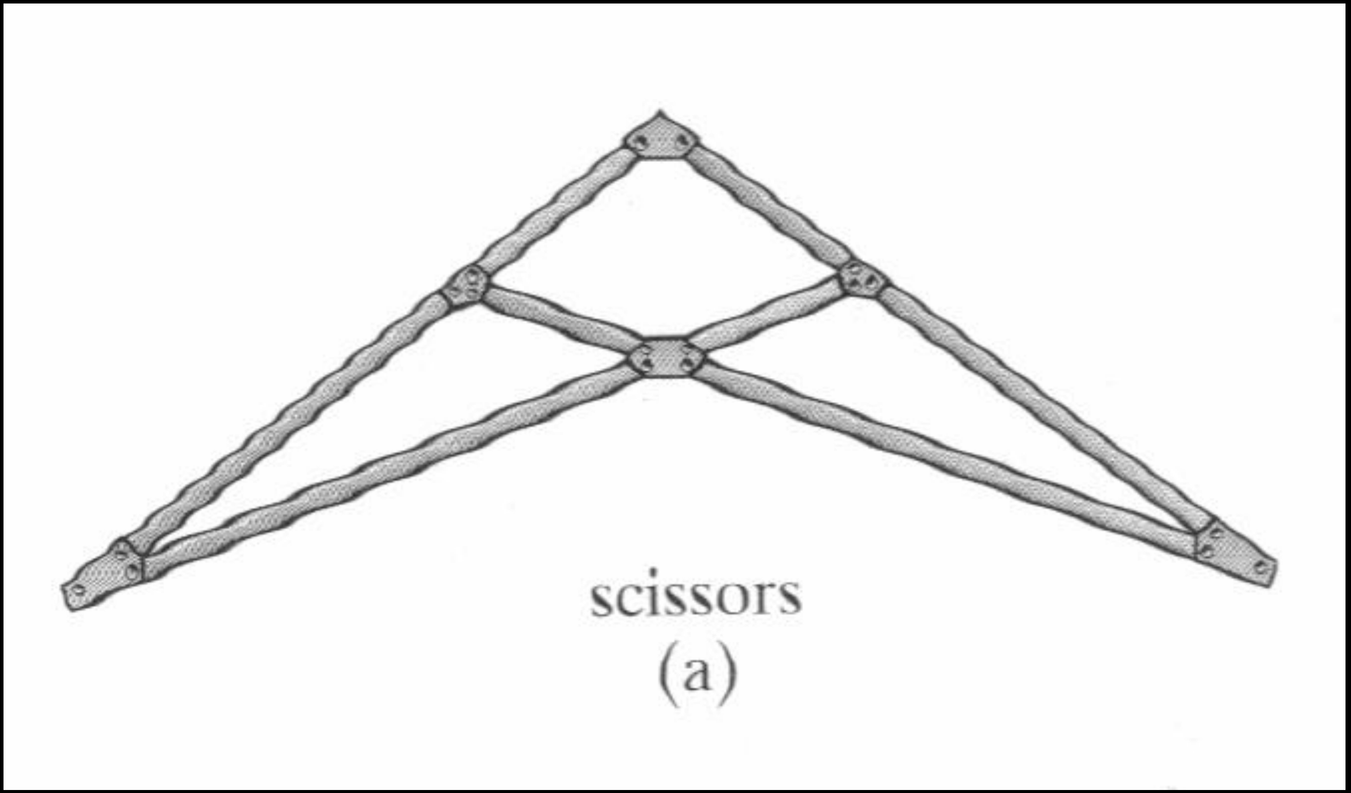
Roof Trusses - Terminology

Supports
Wood/Steel/RC Columns
Masonry Walls



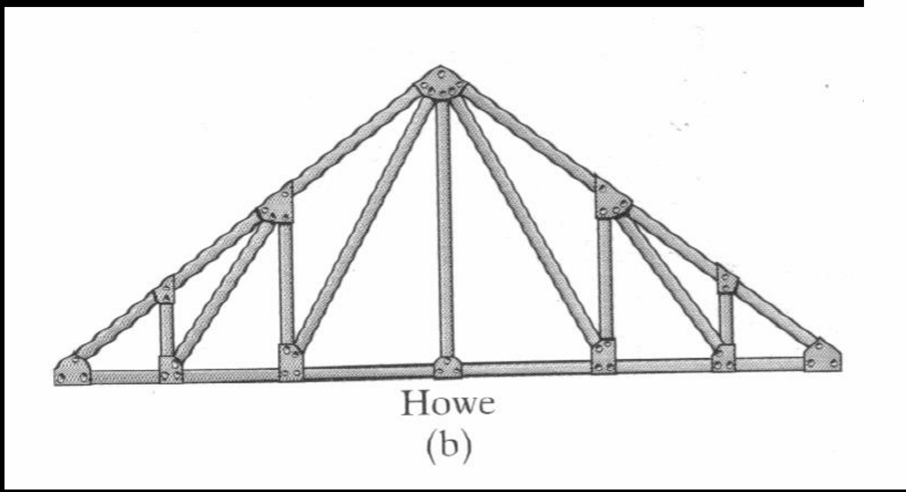
Bent:
Roof Truss and Supporting Columns

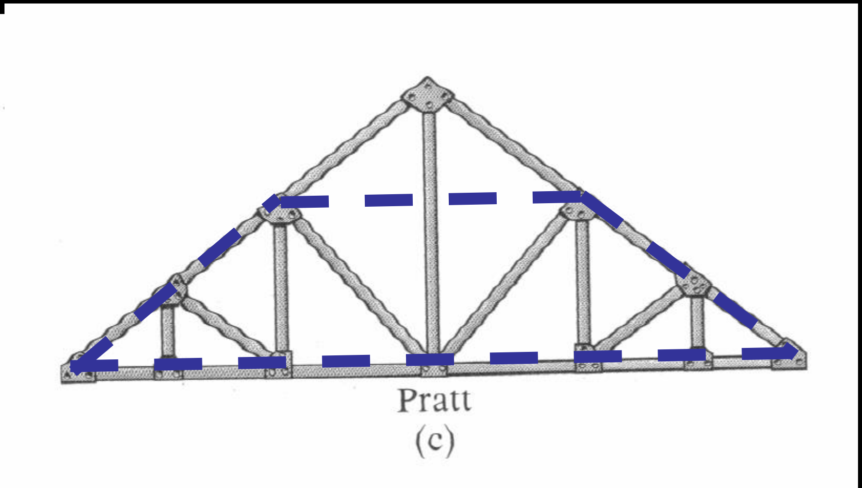
Roof Trusses - Selection



Short Spans (<60 ft)
Requiring Overhead Clearance

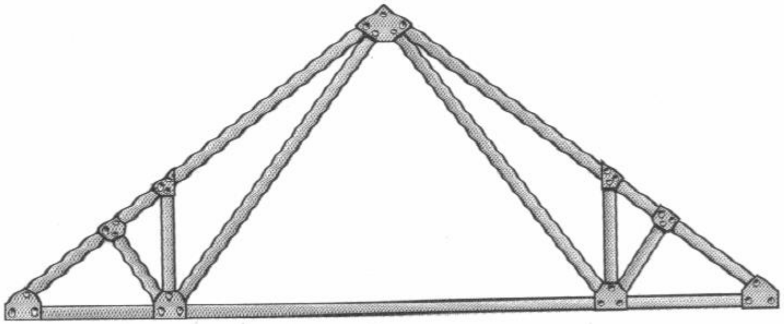
Roof Trusses - Selection



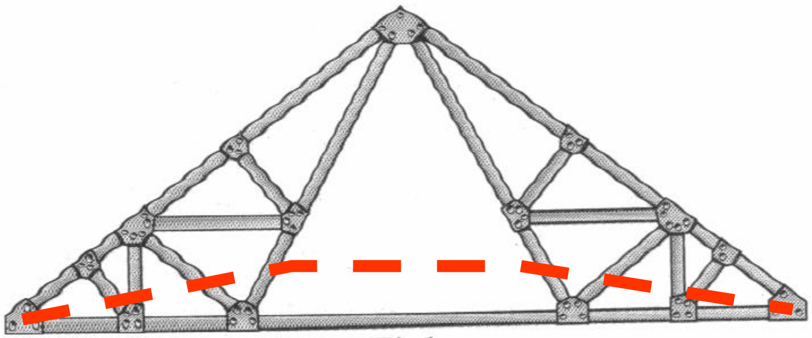


Moderate Spans (60-100 ft)
May be modified for flat roofs

Roof Trusses - Selection



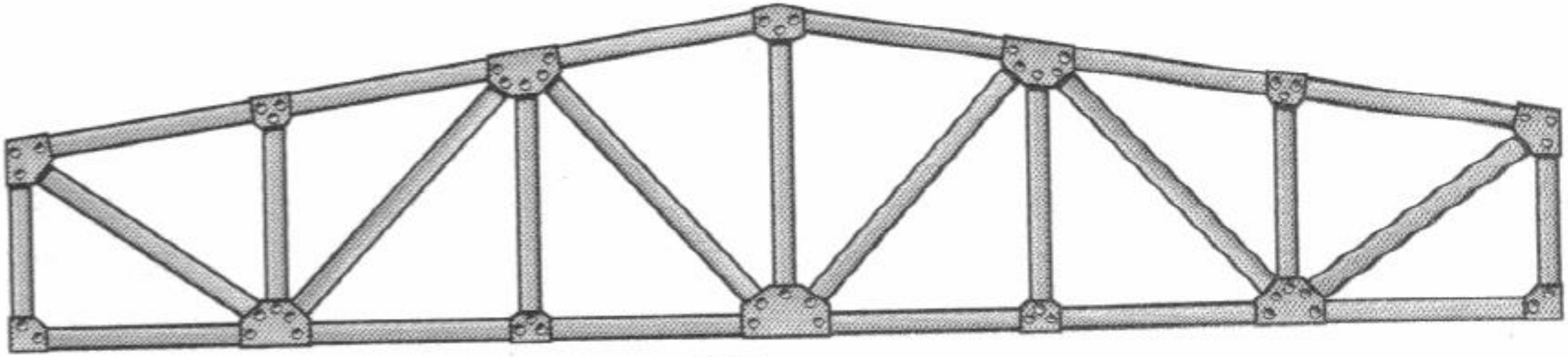
fan
(d)



Fink
(e)

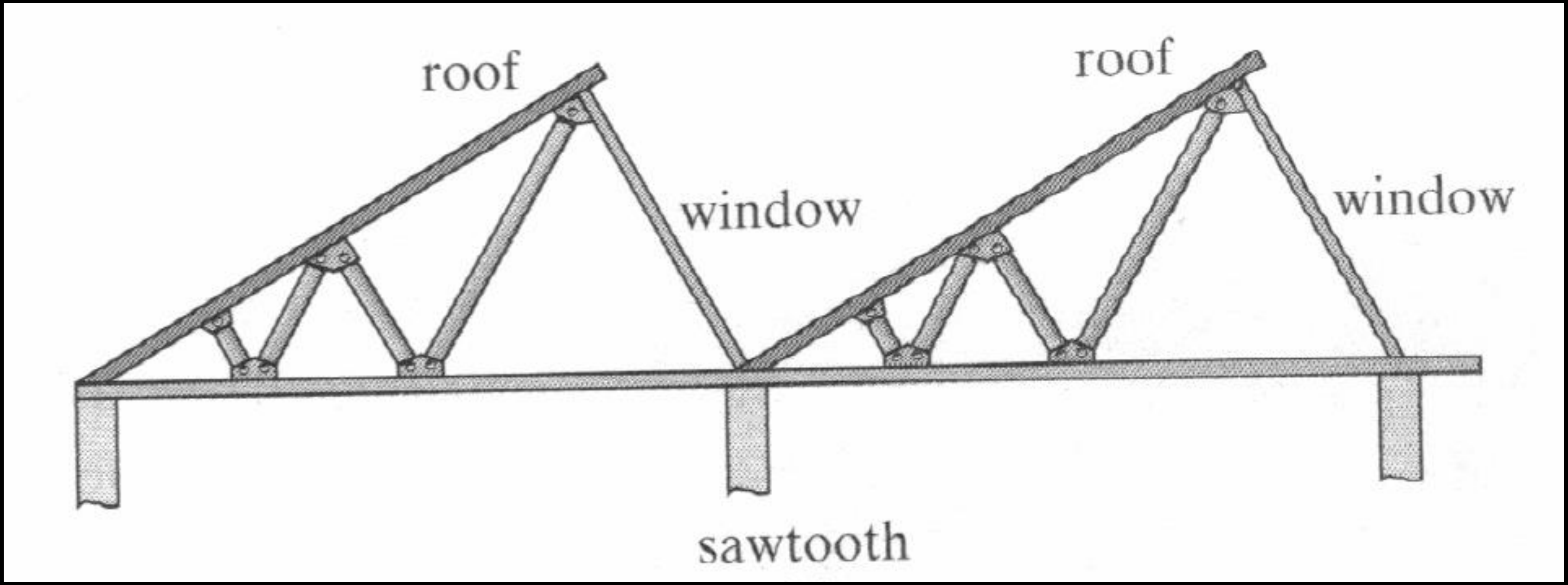
Larger Spans (>100 ft)
May have cambered bottom chord

Roof Trusses - Selection



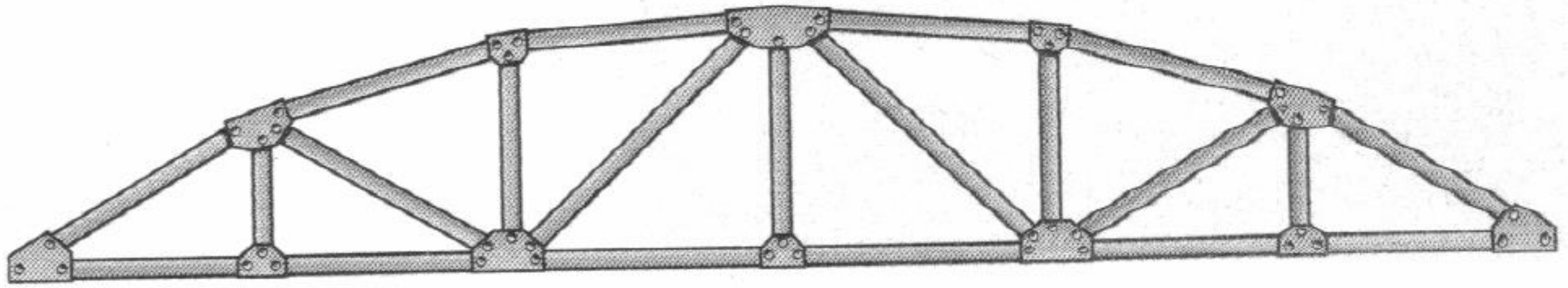
Suitable for flat or nearly flat roofs

Roof Trusses - Selection



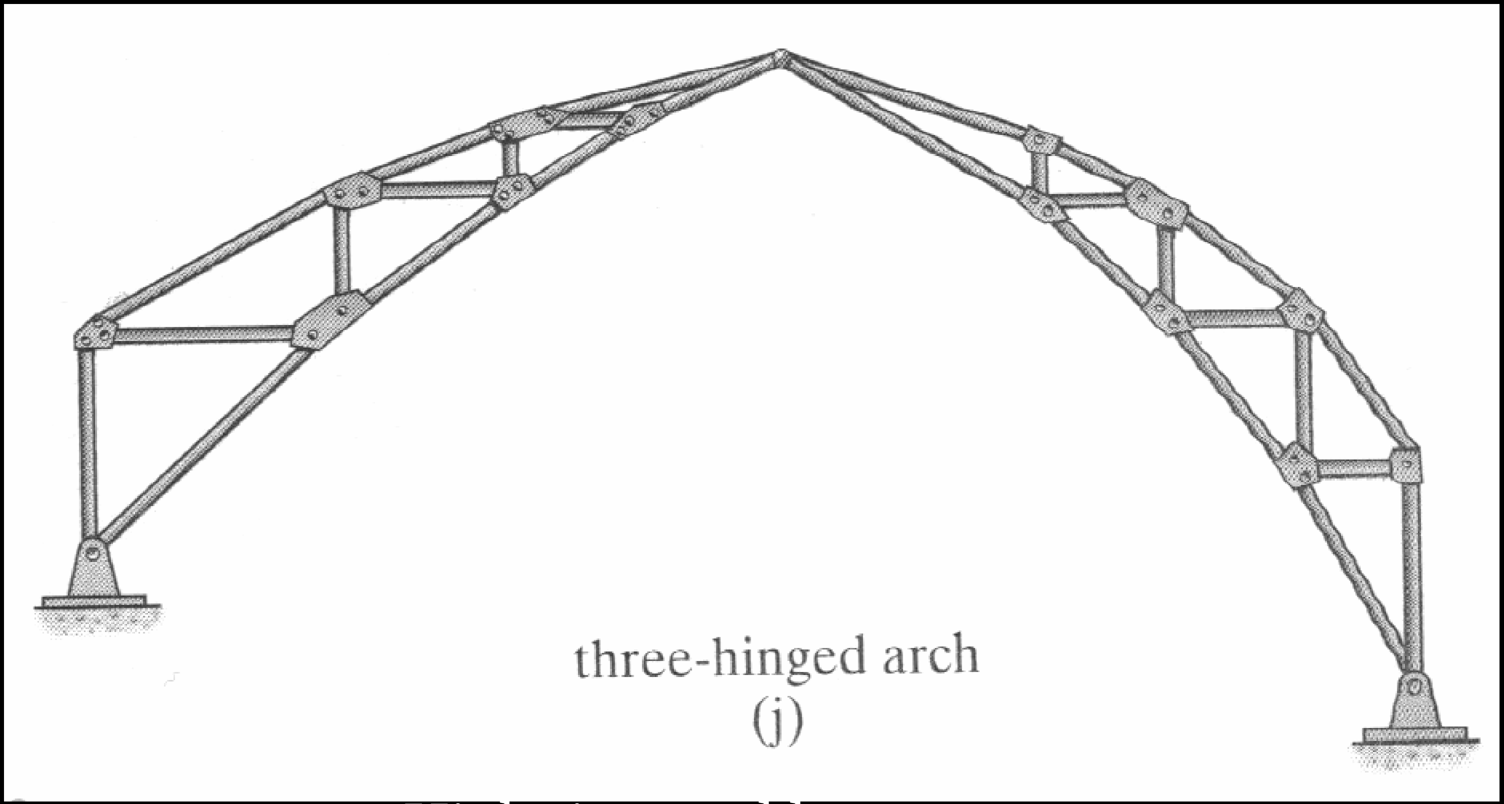
Location of column not an issue
Uniform lighting is important

Roof Trusses - Selection



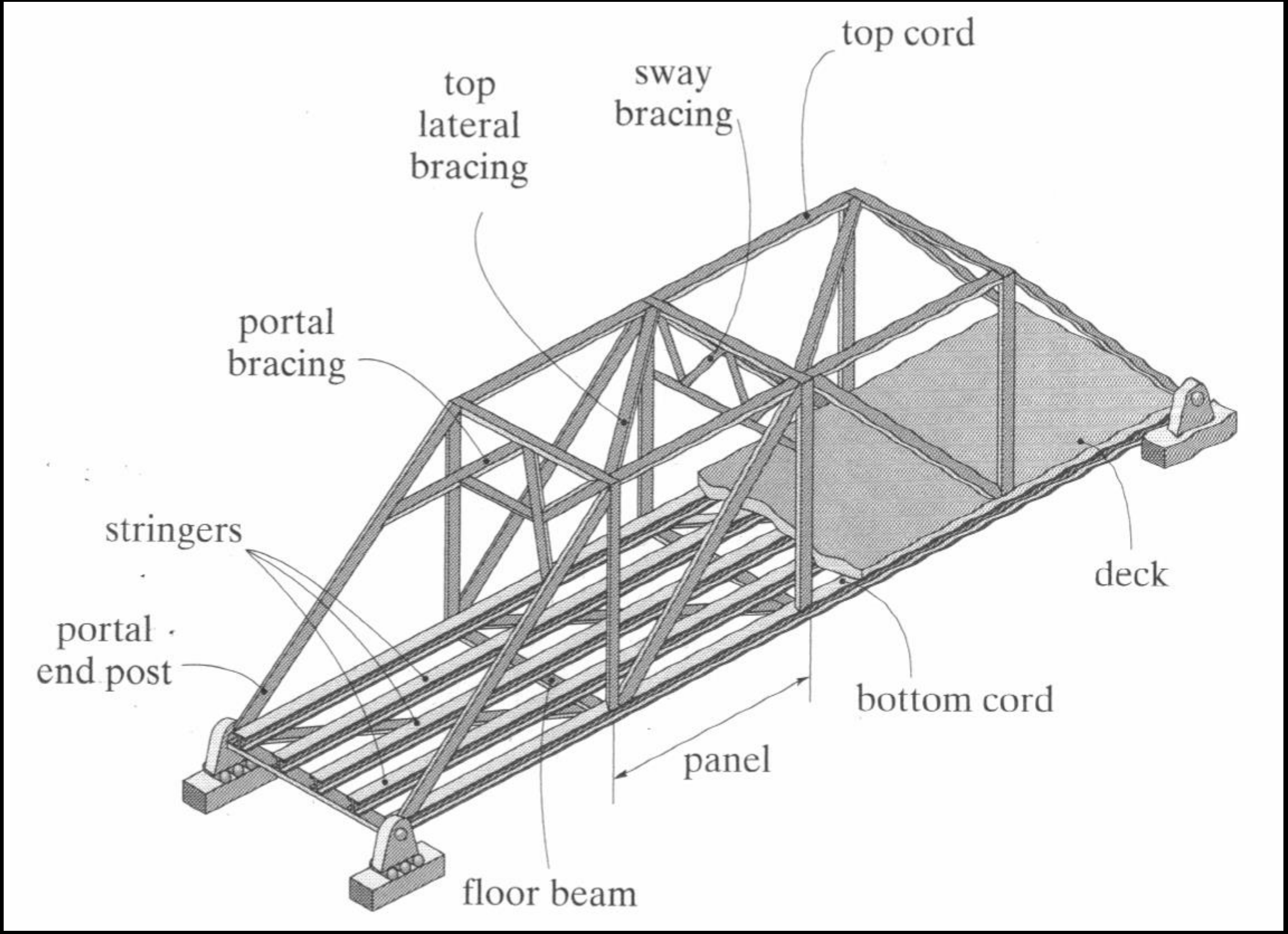
Garages and small airplane hangars

Roof Trusses - Selection

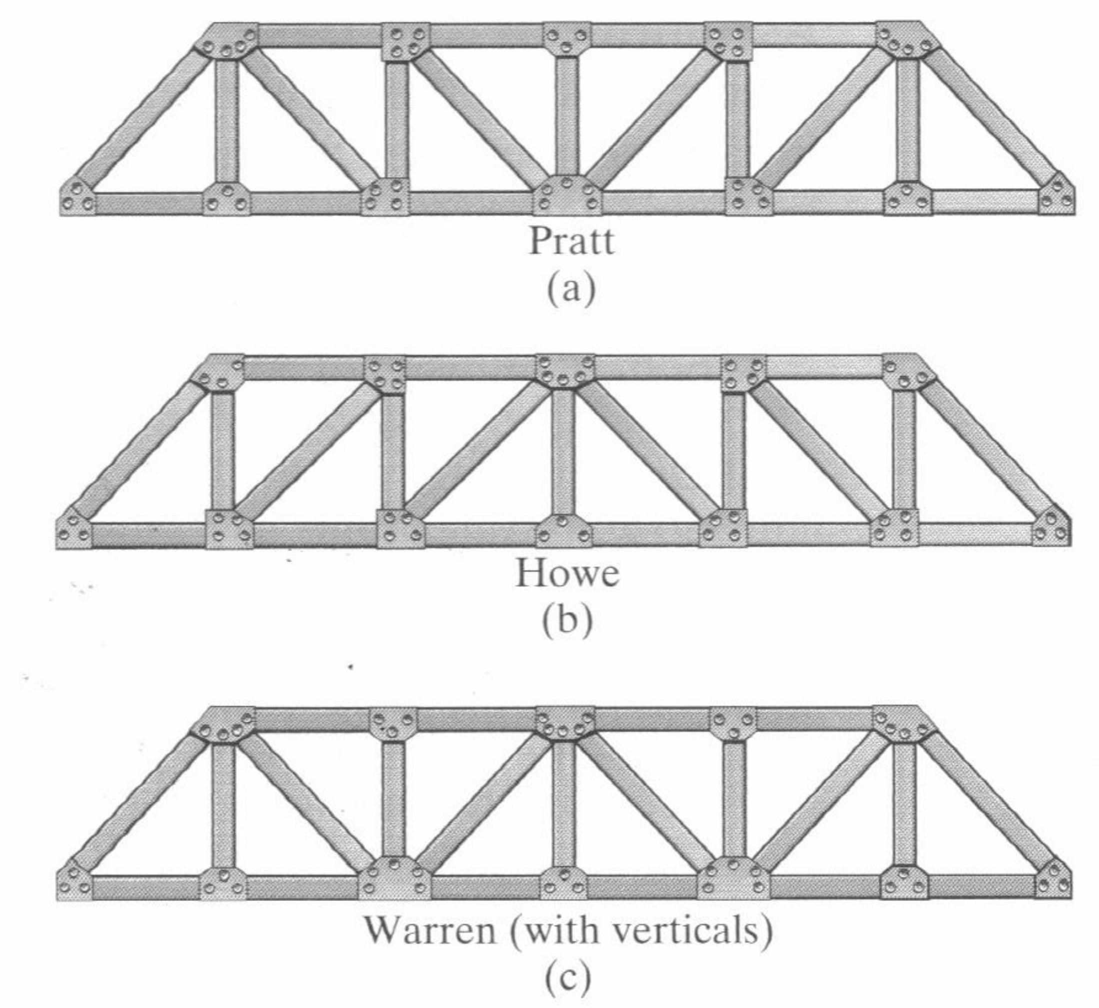


High rises and long spans
Field houses
Gymnasiums etc

Bridge Trusses - Terminology

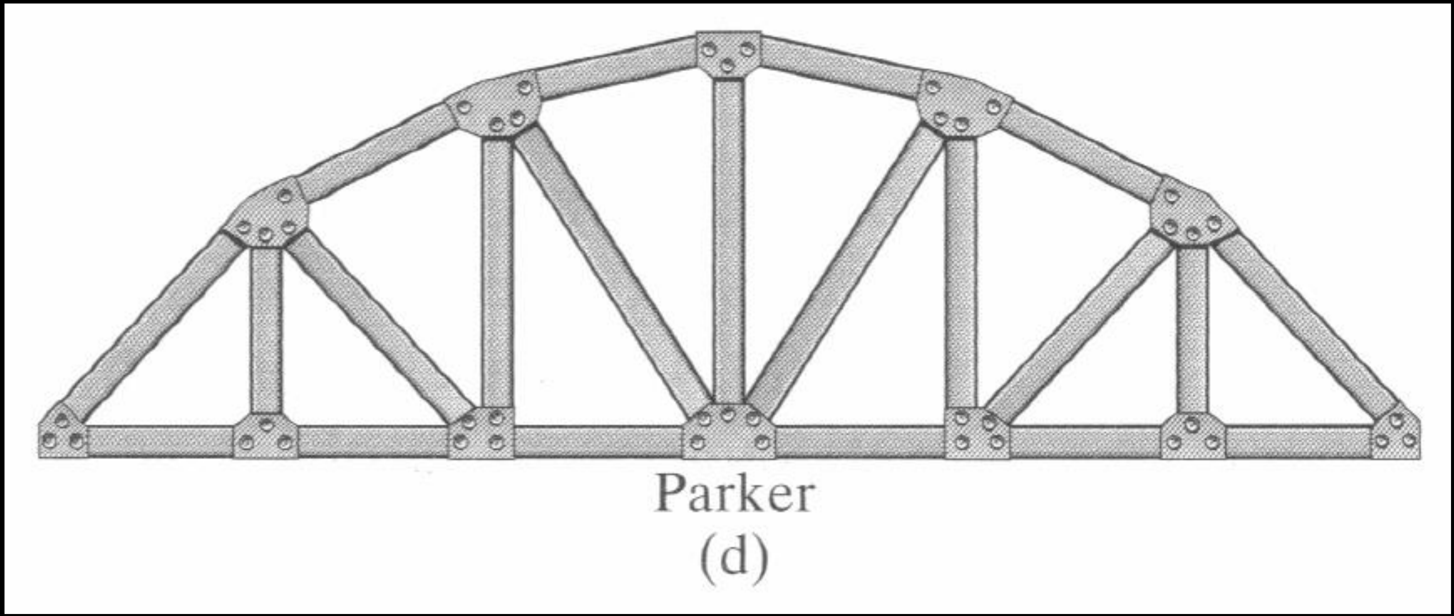


Bridge Trusses - Selection



Spans <200ft

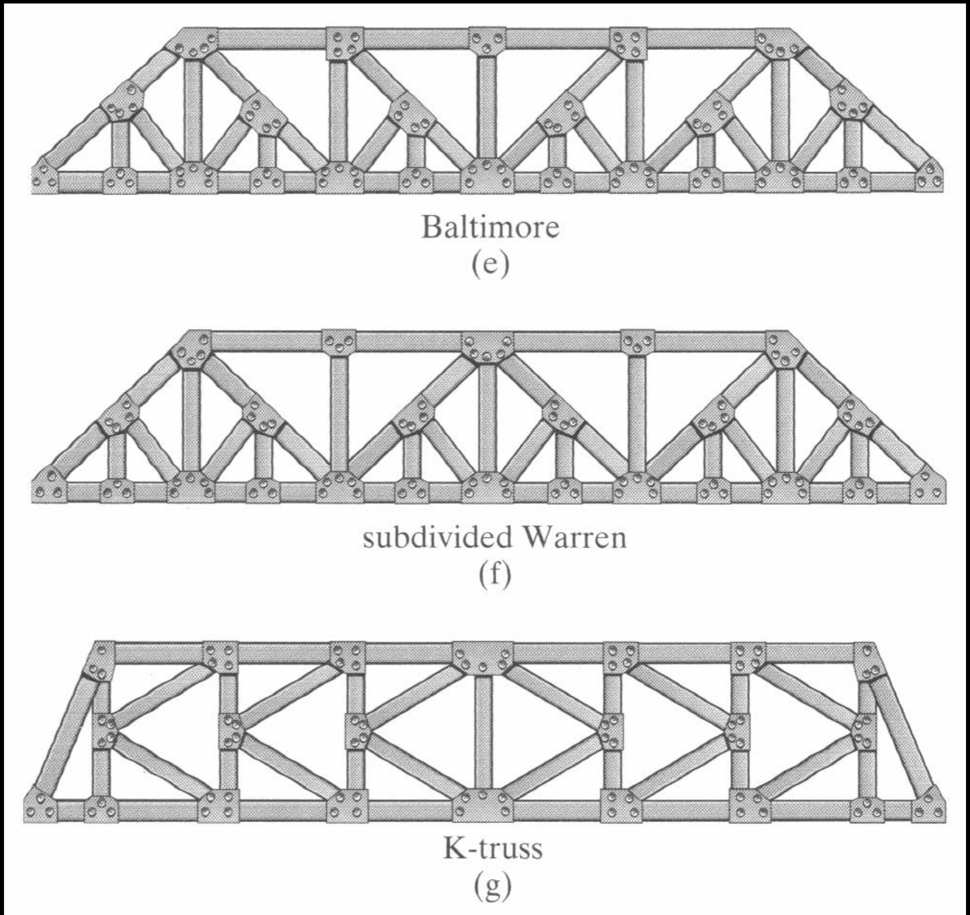
Bridge Trusses - Selection



Spans <300ft

- Warren truss with verticals and polygonal upper chord
- Slope of diagonals 45-60°

Bridge Trusses - Selection



Longer Spans

Subdivided Trusses

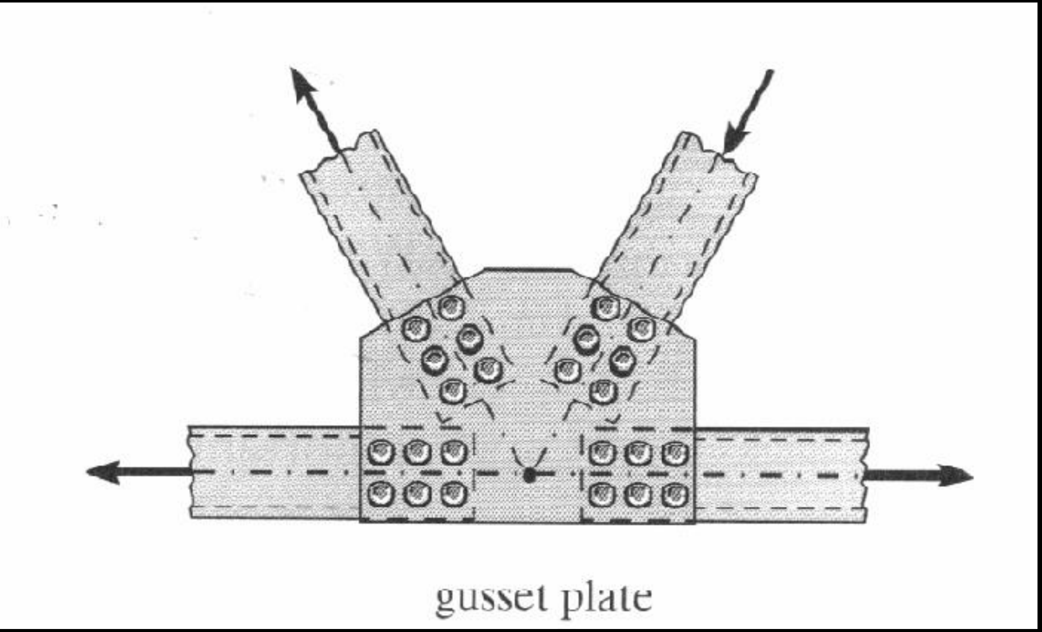
K-Truss

OK 99 Pond Creek Bridge, Osage County

Warren Truss Bridge

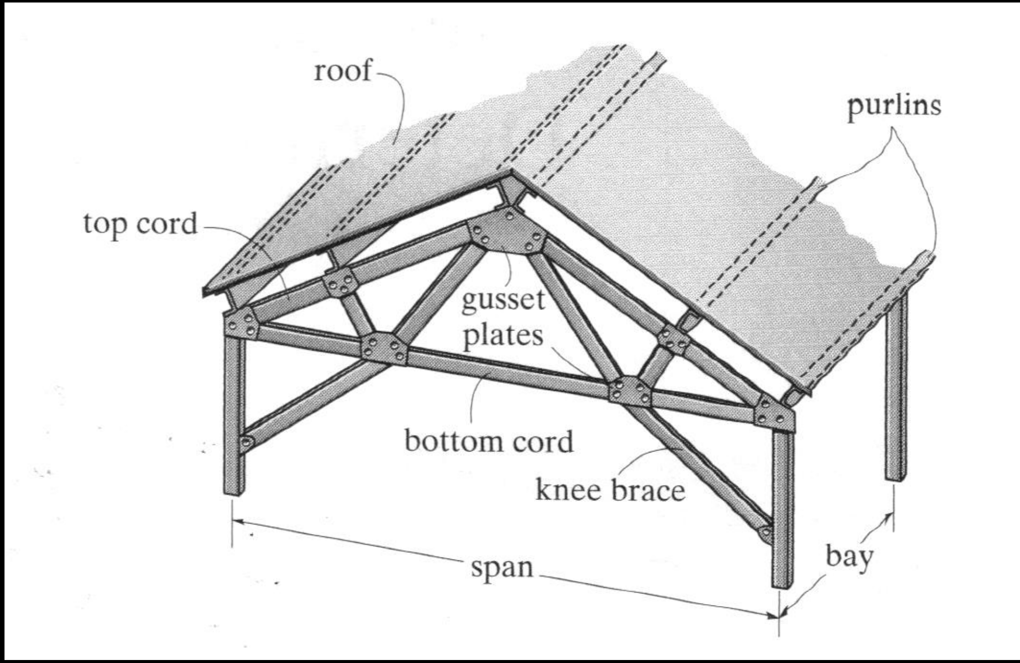
Assumptions for Design

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



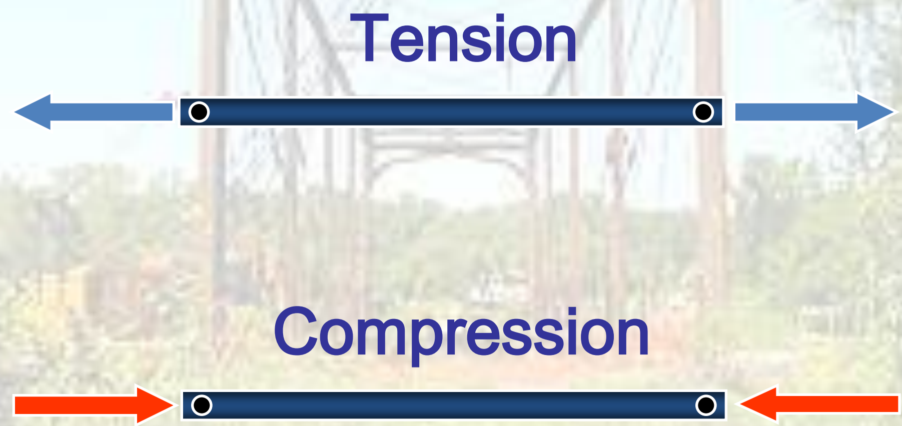
Assumptions for Design

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

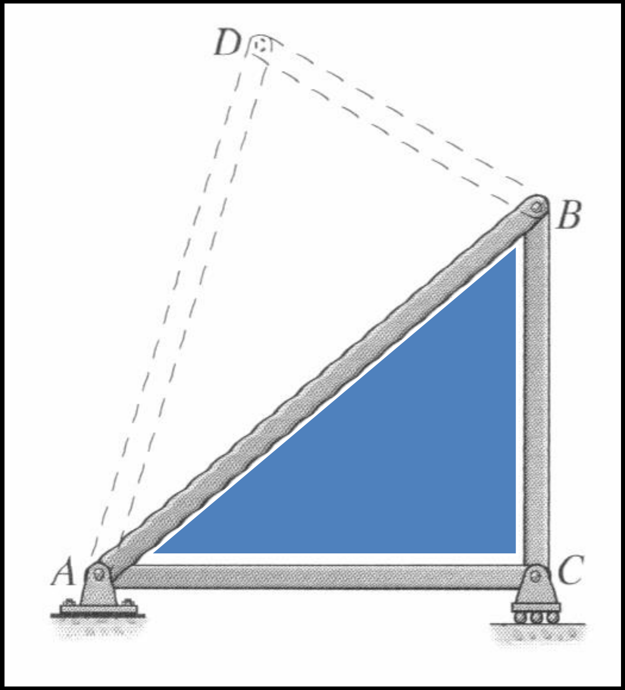


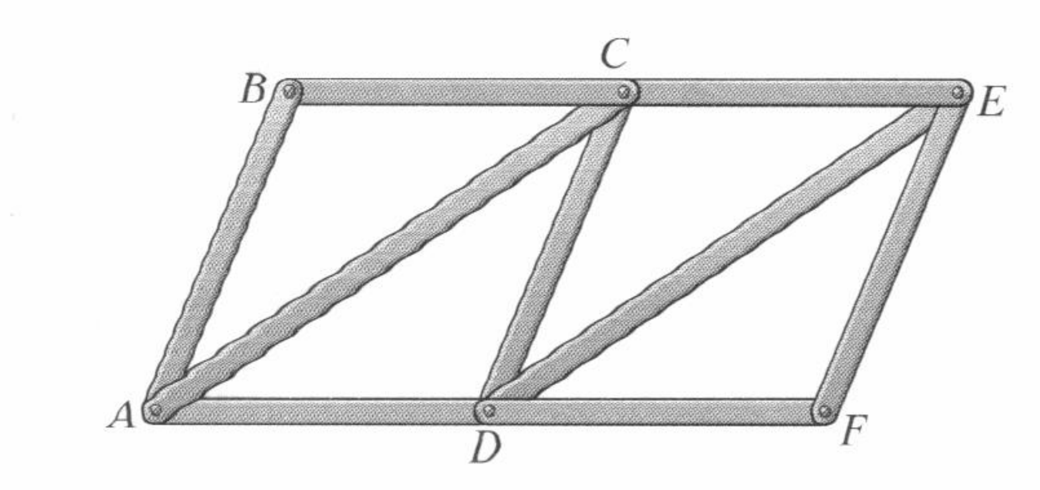
Assumptions for Design

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



Classification of Coplanar Trusses

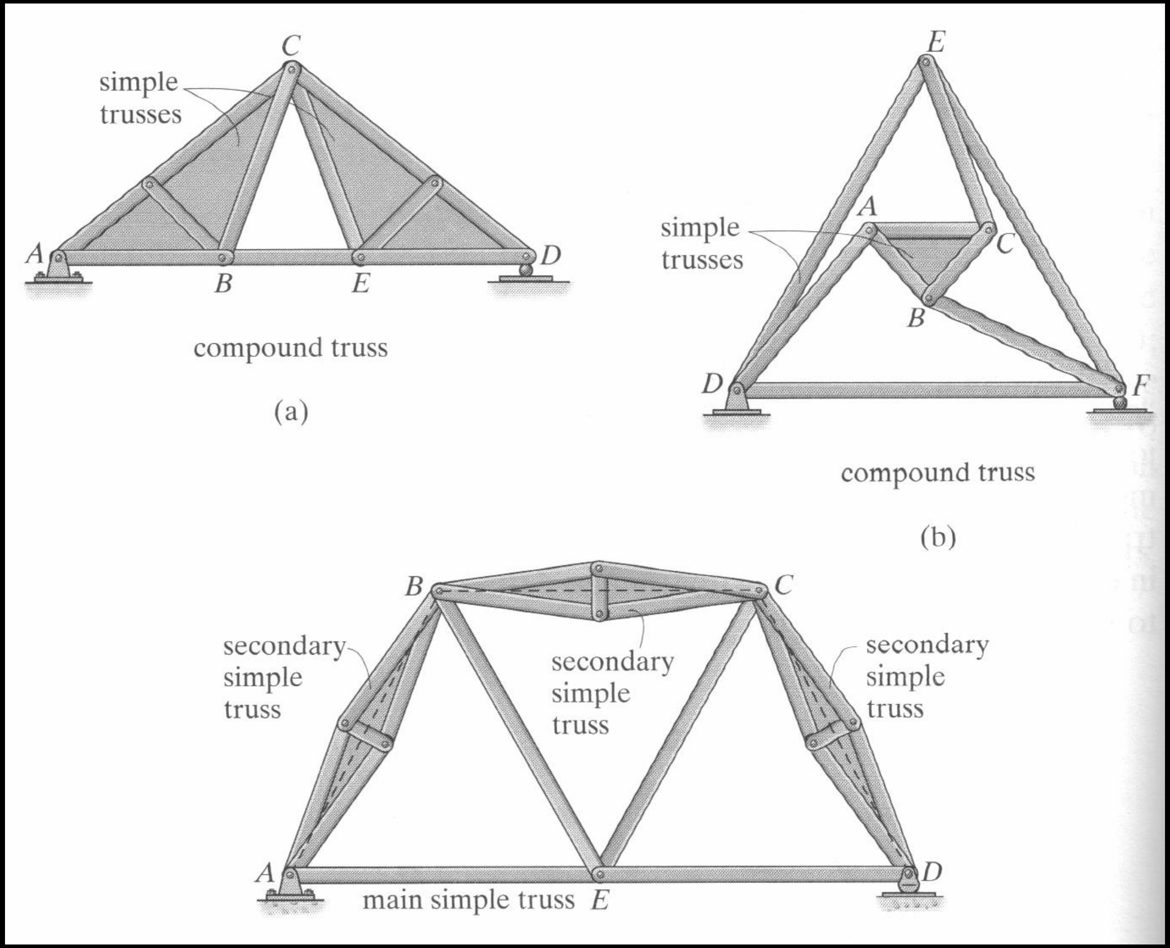




simple truss

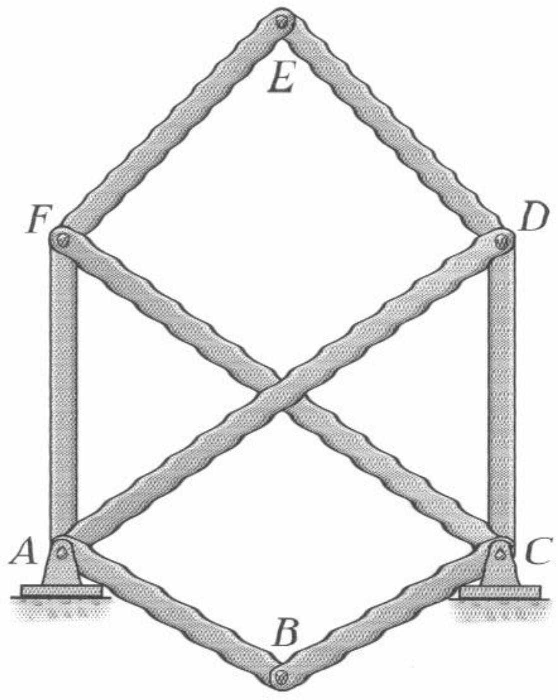
SIMPLE TRUSS - Triangles

Classification of Coplanar Trusses



COMPOUND

Classification of Coplanar Trusses

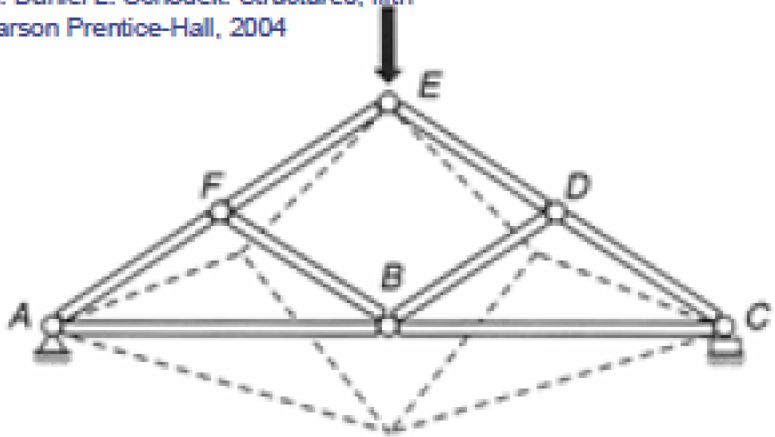


complex truss

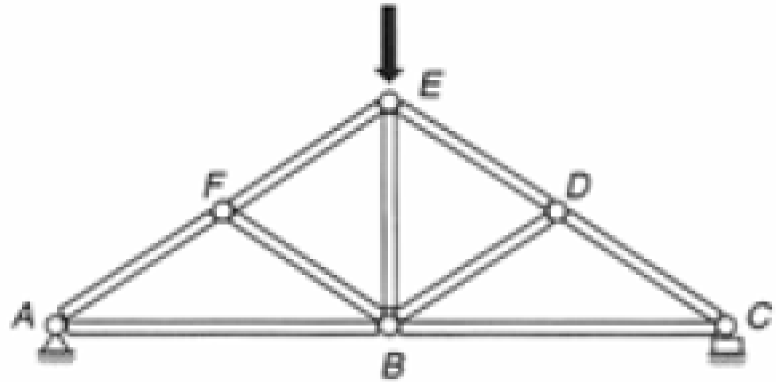
Determinacy

- $n = 2j - 3 \rightarrow$ for determinacy
  - n = Number of truss bars
  - j = Number of joints
- $n > 2j - 3 \rightarrow$ indeterminate
- $n < 2j - 3 \rightarrow$ unstable

Illustrations: Daniel L. Schodek: *Structures*, fifth edition; Pearson Prentice-Hall, 2004



(a) Unstable truss: the nontriangulated central area of the truss will greatly distort under an applied loading, which will lead to a collapse of the entire truss.



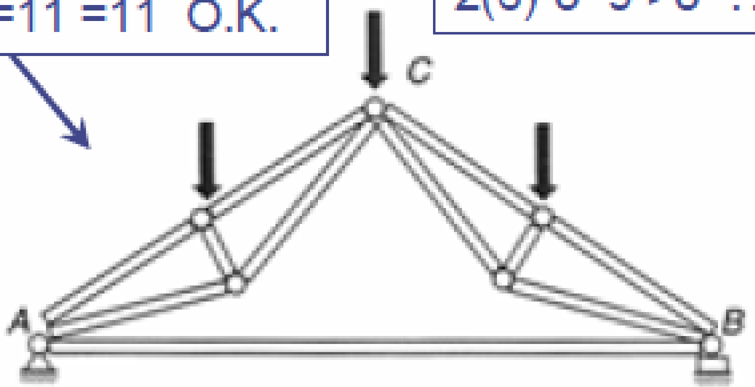
(b) Stable truss: the bar pattern is fully triangulated.

n = 9, j = 6
2(6)-3=9 =9 O.K.

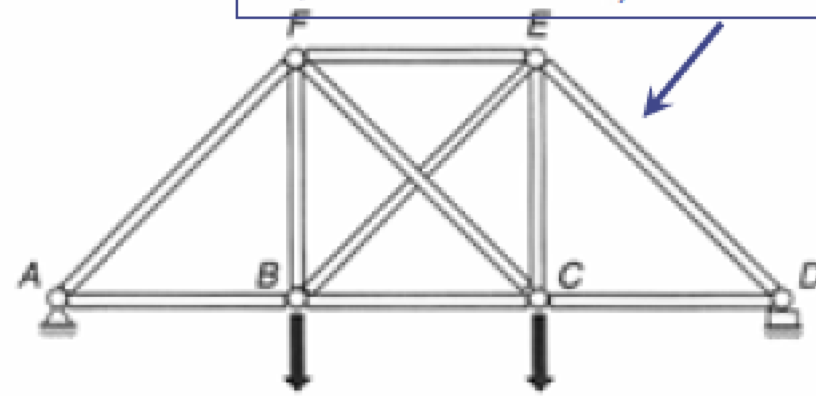
n = 8, j = 6
2(6)-3=9 >8 ∴ Unstable!

n = 11, j = 7
2(7)-3=11 =11 O.K.

n = 10, j = 6
2(6)-3=9 < 10
→ indeterminate, but stable



(c) Nontriangular bar pattern that is still stable.



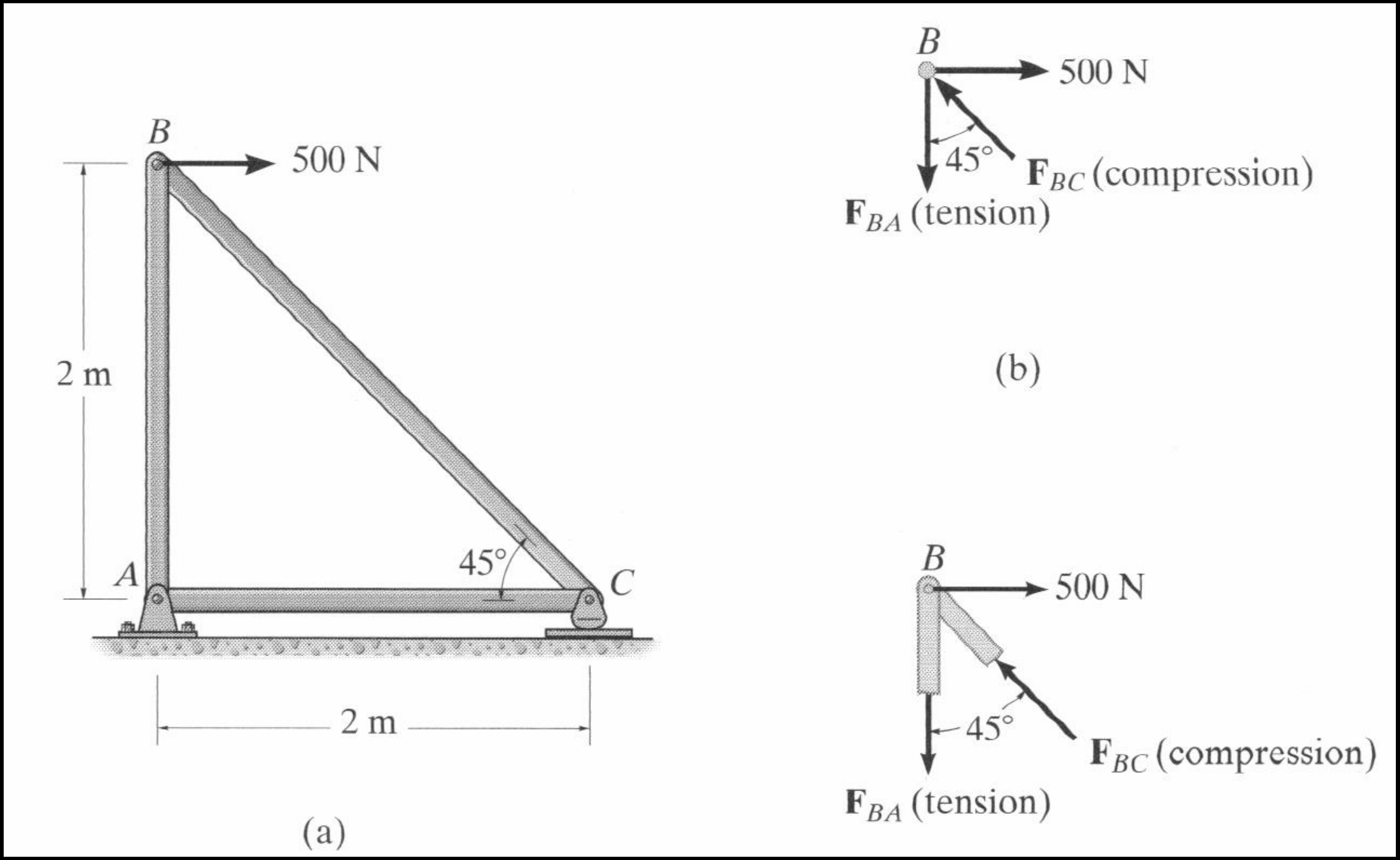
(d) Stable truss with more than the minimum number of bars necessary for stability.

Analysis Methods

- Methods of Joints
- Method of Sections

Method of Joints

Truss in Equilibrium => Each Joint in Equilibrium



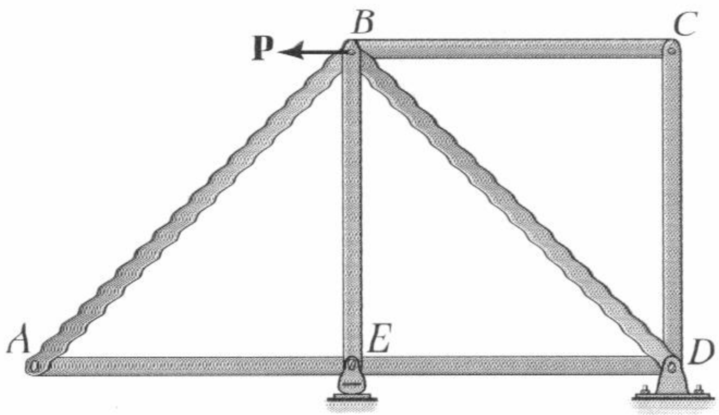
Procedure

- **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

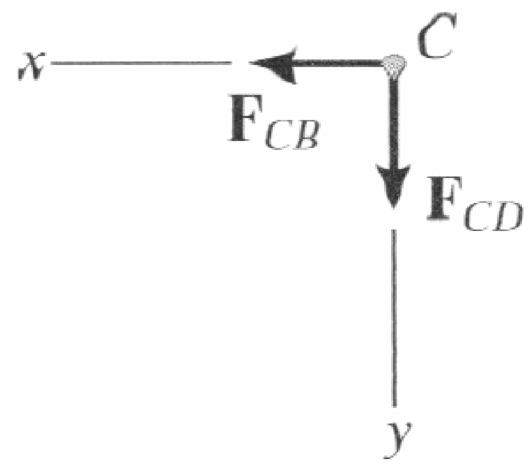
Procedure

- 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



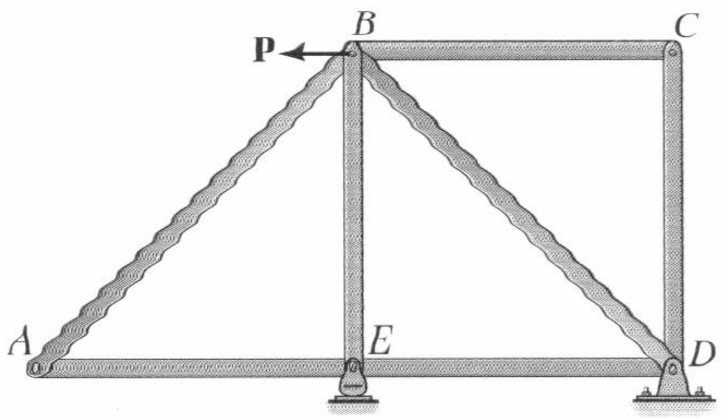
(a)



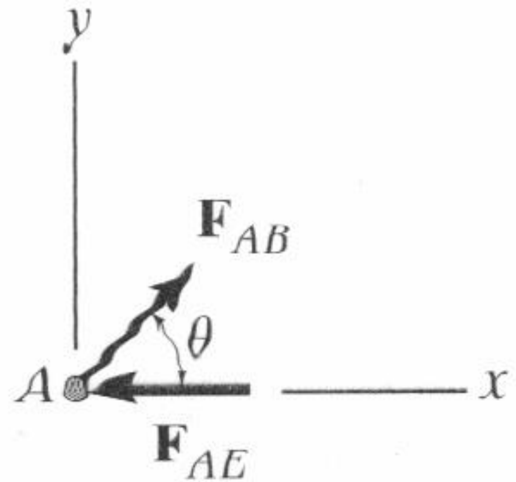
$\overset{+}{\leftarrow} \Sigma F_x = 0;\ F_{CB} = 0$

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

Zero-Force Members



(a)



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

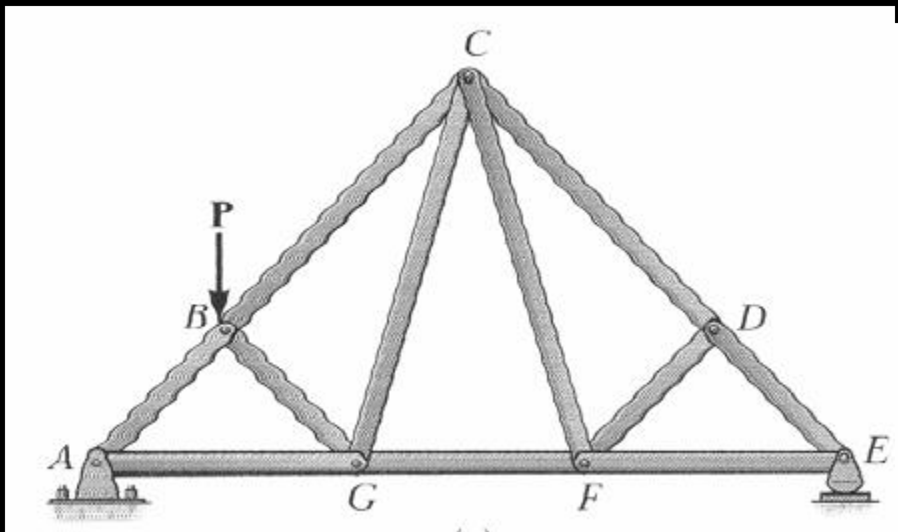
$$F_{AB} = 0 \quad (\text{since } \sin\theta \neq 0)$$

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

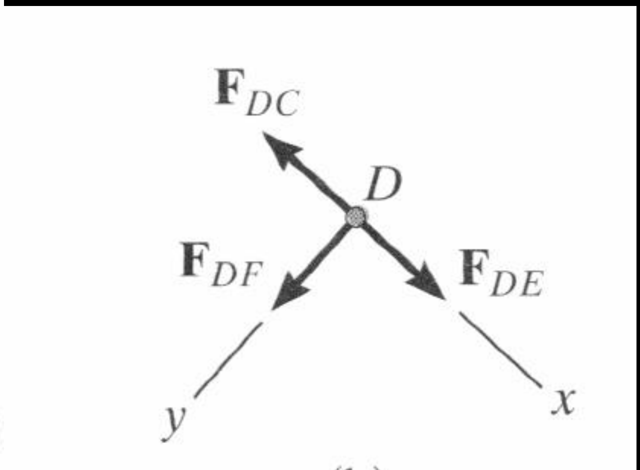
$$F_{AE} = 0$$

(c)

Zero-Force Members



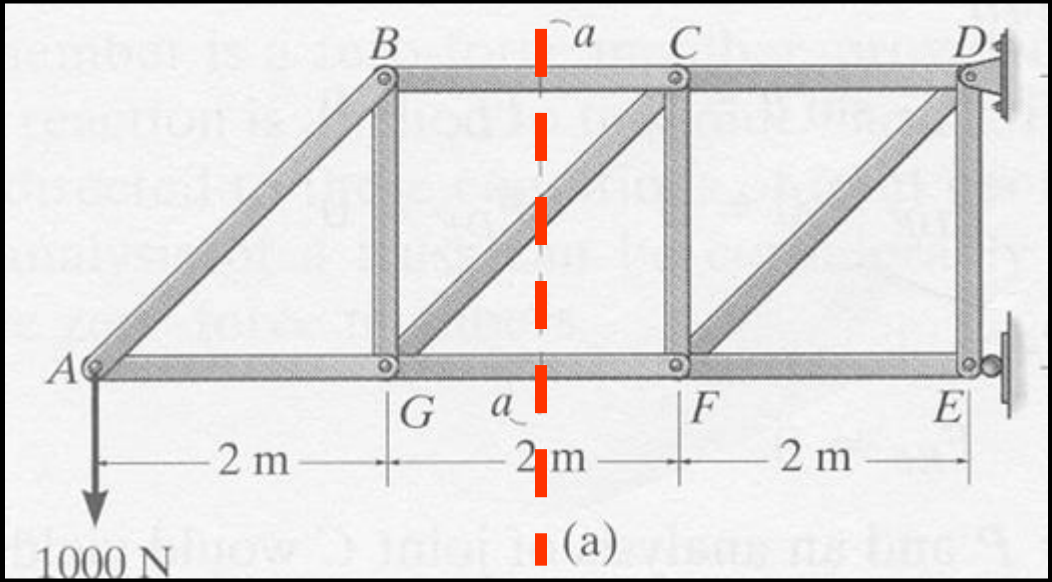
(a)

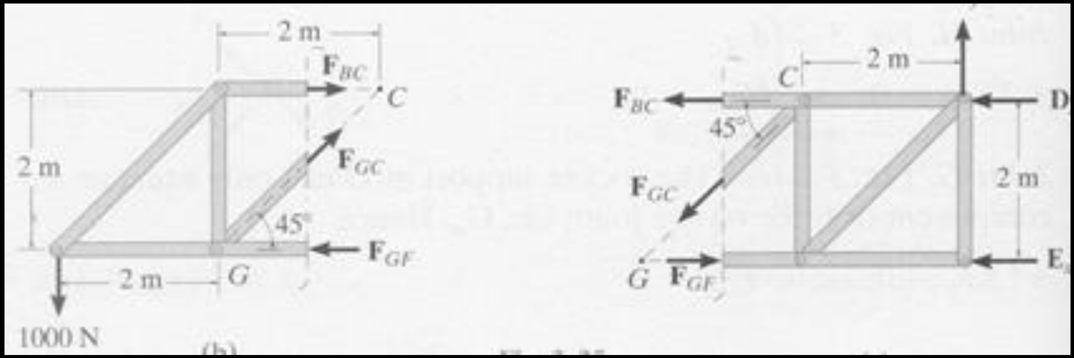


(b)

Method of Sections

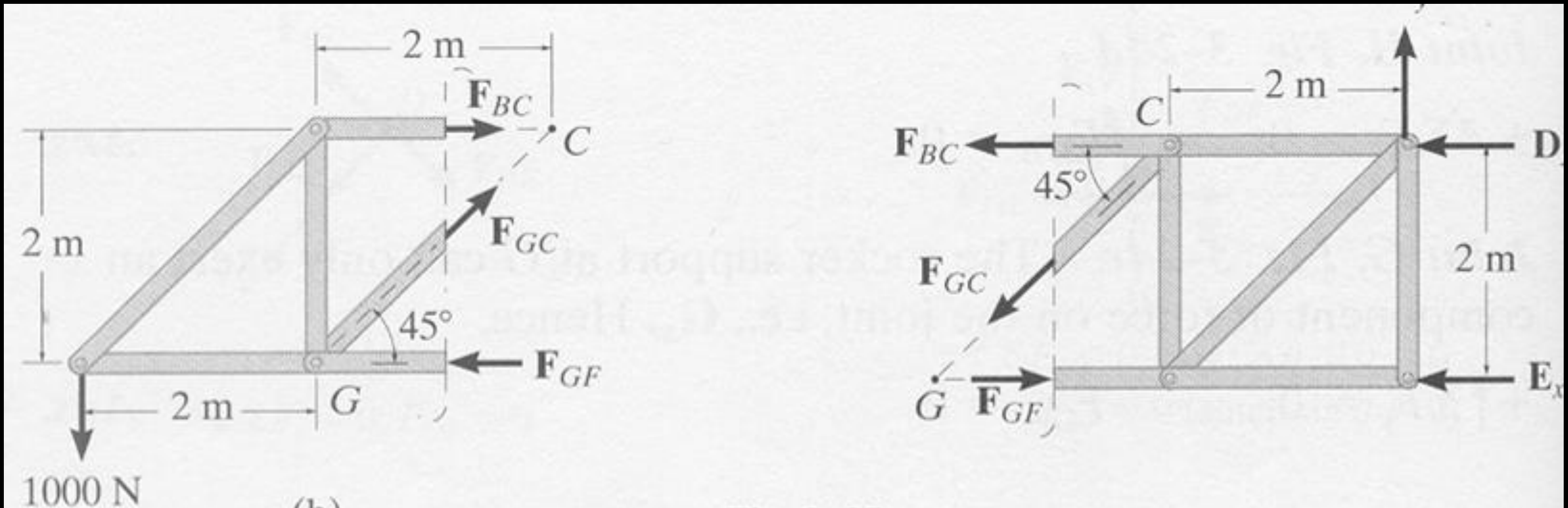
Truss in Equilibrium => Each **PART** in Equilibrium



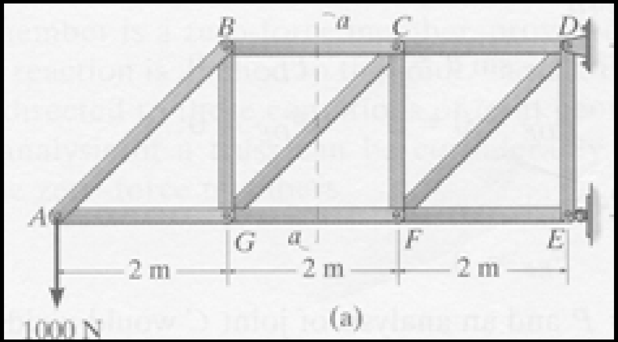


Method of Sections

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



(b) Fig. 3–25 (c)



(a)

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

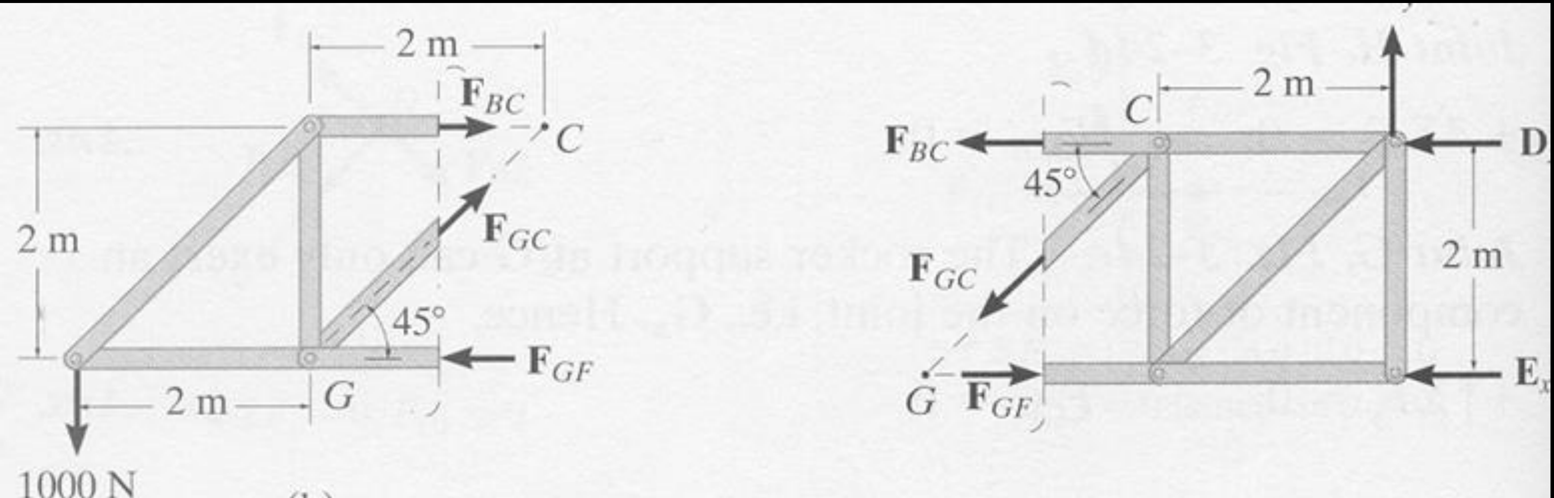


Fig. 3–25

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

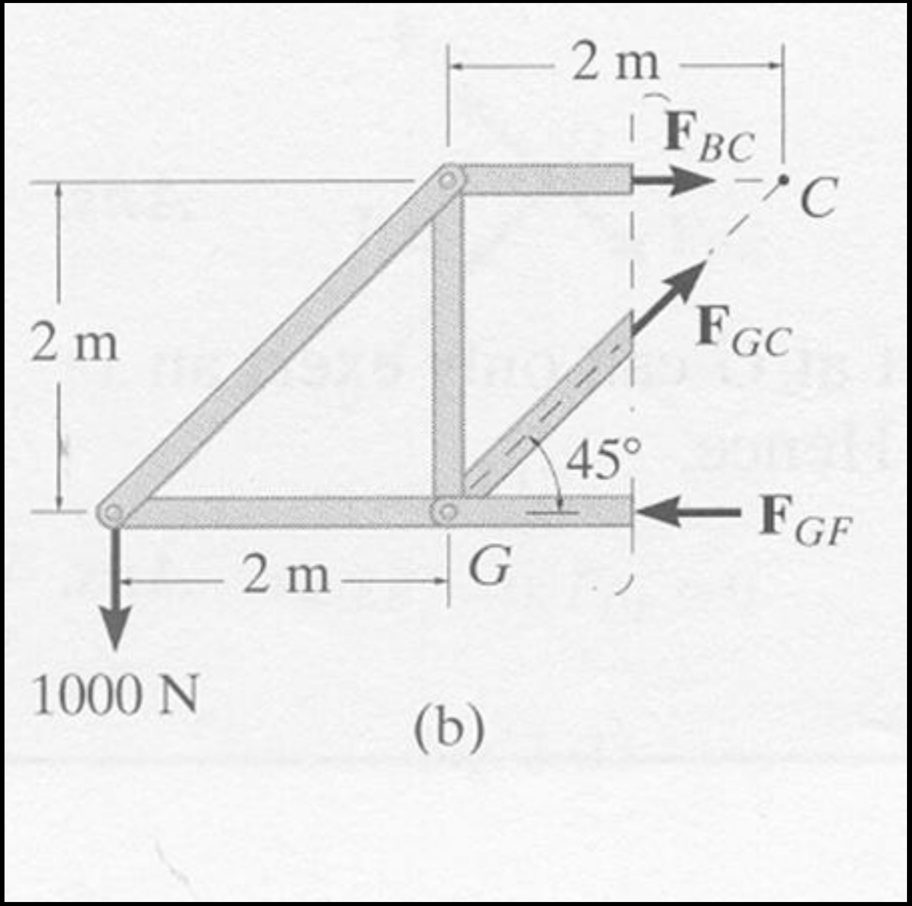
  (a) Guess Direction

  Numerical results: (+) Guess is correct

  (-) Force in opposite direction

Method of Sections – Procedure (cont' d)

Equations of Equilibrium



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