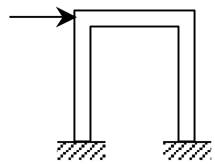
Pinned Frames and Arches

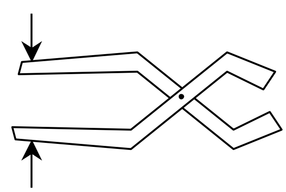
Notation:

F	= name for force vectors	R	= name for reaction force vector
F_x	= force component in the x direction	w	= name for distributed load
F_y	= force component in the y direction	W	= name for total force due to distributed load
FBD	= free body diagram		
M	= name for reaction moment, as is M_R	Σ	= summation symbol

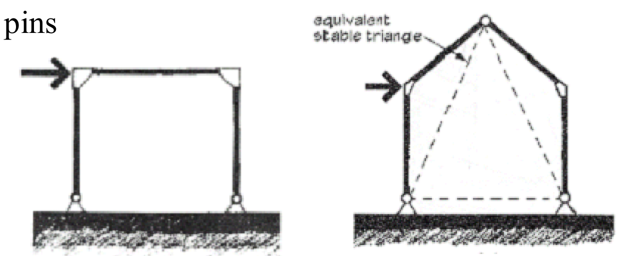
- A FRAME is made up of members where at least <u>one</u> member has more than 3 forces on it
  - Usually stationary and fully constrained



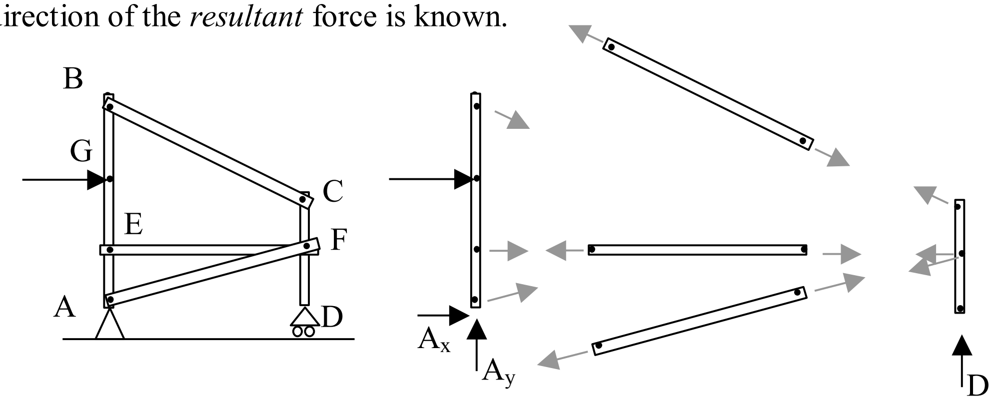
- A PINNED FRAME has member connected by pins
  - Considered *non-rigid* if it would collapse when the supports are removed
  - Considered *rigid* if it retains it's original shape when the supports are removed



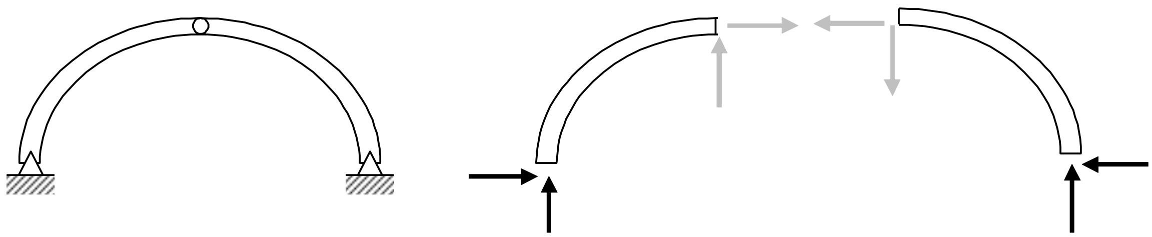
- A RIGID FRAME is all one member with no internal pins
  - Typically *statically indeterminate*
  - **Portal** frames look like door frames
  - Gable frames have a peak.



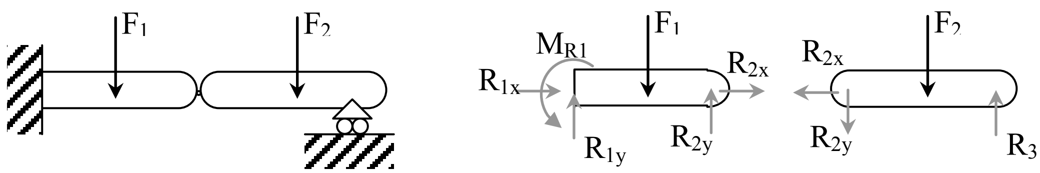
- INTERNAL PIN CONNECTIONS:
  - Pin connection forces are **equal** and **opposite** between the bodies they connect.
  - There are 2 unknown forces at a pin, but if we know a body is a **two-force** body, the direction of the *resultant* force is known.



- AN ARCH is a structural shape that can span large distances and sees compression along its slope. It may have no hinges (or pins), two hinges at the supports, or two hinges at the supports with a hinge at the apex. The three-hinged arch types are statically determinate with 2 bodies and **6** unknown forces.



- CONTINUOUS BEAMS WITH PINS:
  - If pins within the span of a beam over multiple supports result in static determinacy (the right number of unknowns for the number of equilibrium equations), the internal forces at the pins are applied as reactions to the adjacent span.



  - The location of the internal pins can be chosen to increase or decrease the moments in order to make the section economical for both positive bending and negative bending (similar values for the moments).

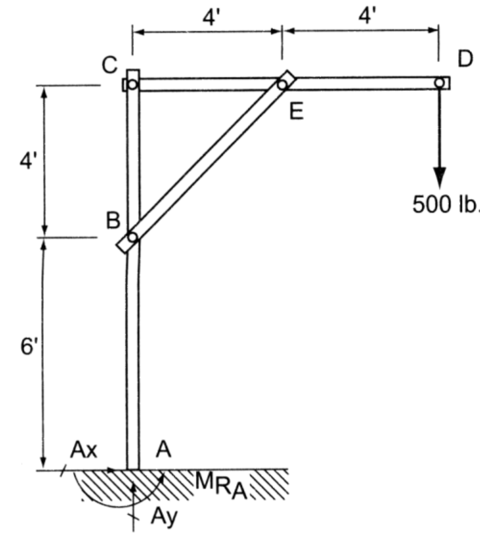
Solution Procedure

1. Solve for the support forces on the entire frame (FBD) if possible.
2. Draw a FBD of each member:
   - Consider all two-force bodies first.
   - Pins are integral with members
   - Pins with applied forces should belong to members with greater than two forces [Same if pins connect 3 or more members]
   - Draw forces on either side of a pin <u>equal</u> and <u>opposite</u> with arbitrary direction chosen for the first side
   - Consider all multi-force bodies
   - Represent connection forces <u>not known</u> by x & y components
   - There are still three equilibrium equations available, but the moment equations may be more helpful when the number of unknowns is greater than two.

Example 1 (pg 114)

Example Problem 4.12

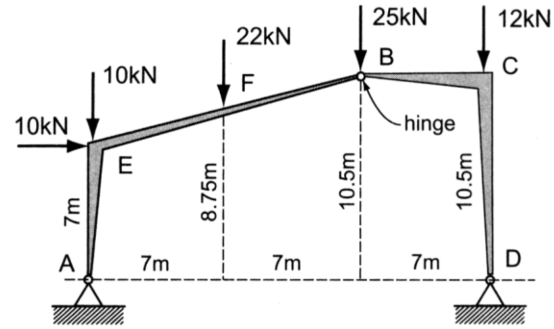
A pinned frame with a fixed base at *A* supports a load at the overhang equal to 500 pounds, as shown in Figure 4.68. Draw free-body diagrams and solve for the support reactions and the pin reactions at *B*, *C*, and *E*.



Example 2 (pg 115)

Example 4.13 (Three-Hinged Arch)

An industrial building is framed using tapered steel sections (haunches) and connected with three hinges (Figure 4.70). Assuming that the loads shown are from gravity loads and wind, determine the support reactions at *A* and *D* and the pin reactions at *B*.



Example 3 (pg 73)

Example Problem 3.16 (Figures 3.44 and 3.45)

A compound beam has three supports at ***A***, ***B*** and ***D*** and an internal hinge at ***C***. Two uniformly distributed loads cover the entire length of the beams. Draw the appropriate FBDs and determine the reactions at the supports and the internal pin forces at ***C***.
Also construct the shear and bending moment diagrams.