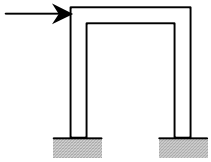
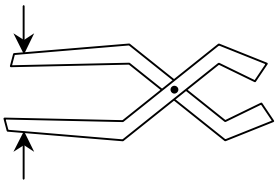
Pinned Frames and Arches

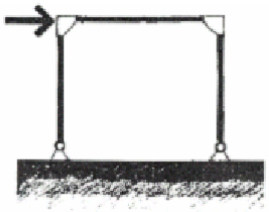
- A FRAME is made up of members where at least one member has more than 3 forces on it
  - Usually stationary and fully constrained

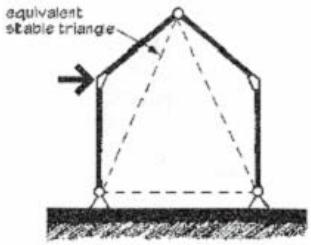


- A PINNED FRAME has member connected by pins
  - Considered *non-rigid* if it would collapse when the supports are removed
  - Considered *rigid* if it retains it's original shape when the supports are removed

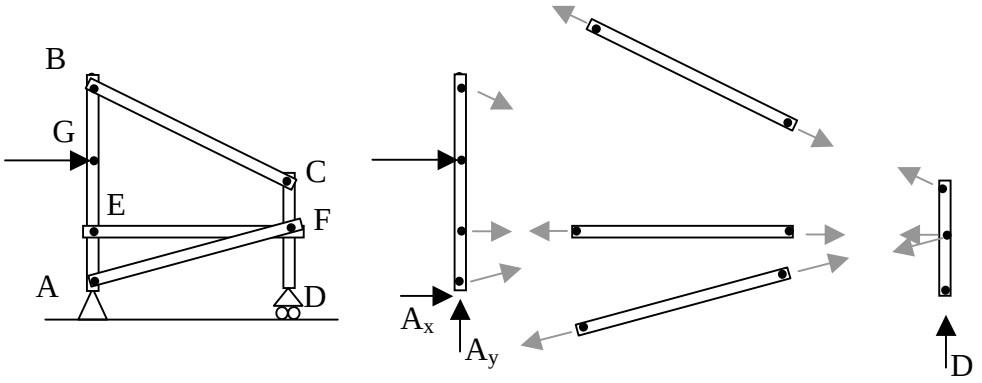


- A RIGID FRAME is all one member with no internal pins
  - Typically *statically indeterminate*
  - _____frames look like door frames
  - Gable frames have a peak.

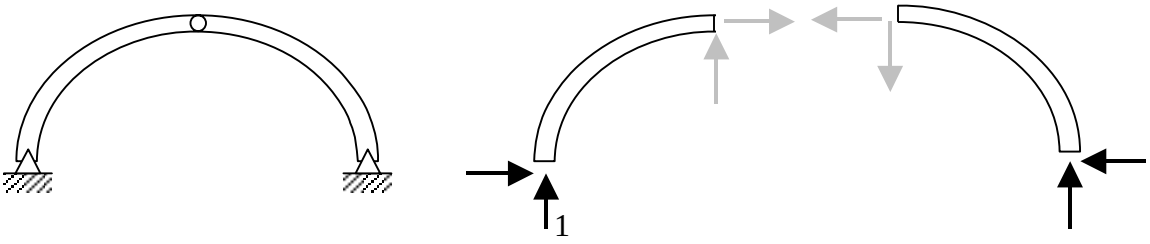




- INTERNAL PIN CONNECTIONS:
  - Pin connection forces are equal and _____between the bodies they connect.
  - There are 2 unknown forces at a pin, but if we know a body is a _____ body the direction of the *resultant* force is known.



- 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 _____unknown forces.



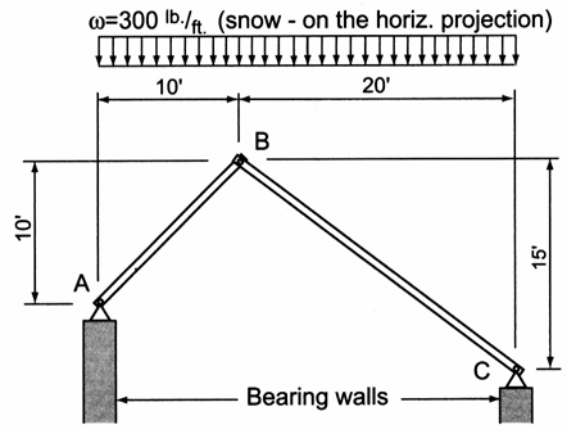
Solution Procedure

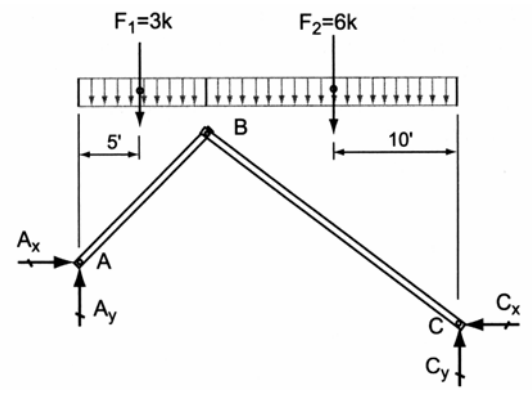
1. Solve for the support forces on the entire frame (FBD) if possible.
2. Draw a FBD of each member:
   - Consider all two-force bodies first.
   - Pins are integral with members
   - Pins with applied forces should belong to members with greater than two forces [Same if pins connect 3 or more members]
   - Draw forces on either side of a pin equal and opposite with arbitrary direction chosen for the first side
   - Consider all multi-force bodies
   - Represent connection forces not known 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 112)

Example Problem 4.11 (Pinned Frame with Multi-Force Members)

Two inclined roof beams support a snow load equal to $300^{lb.}/_{ft.}$ on the horizontal projection (Figure 4.64). All three joints, *A*, *B*, and *C*, are pins. Supports at *A* and *C* are attached to rigid bearing walls. Determine the support reactions at *A* and *C* and the pin reactions at *B*. Draw all of the appropriate free-body diagrams. This particular framework configuration is often referred to as a *three-hinged arch.*

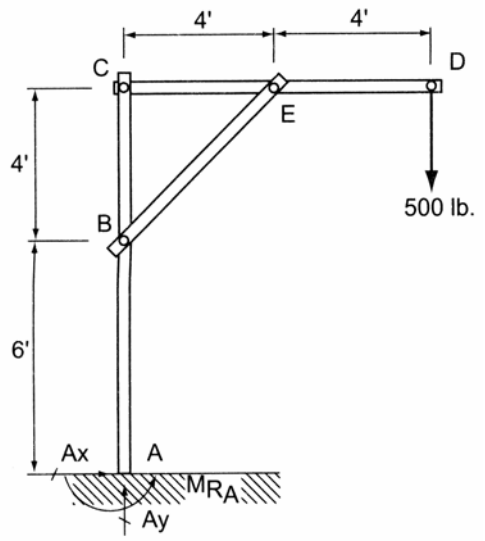




Example 2 (pg 114)

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 3 (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*.