Engineering Mechanics : Statics

Chapter 6: Structural analysis

Chapter objectives

- To show how to determine the forces in the members of a truss using the method of joints and the method of sections.
- To analyze the forces acting on the members of frames and machines composed of pin-connected members.

Chapter outline

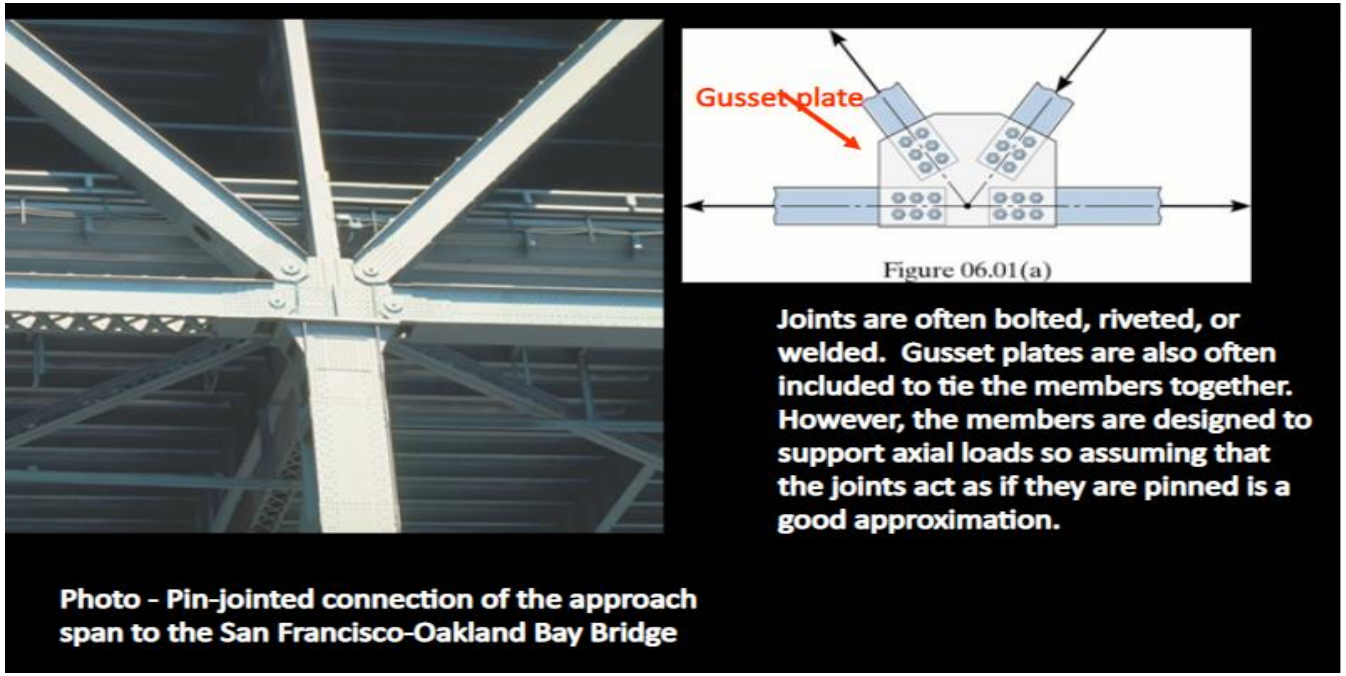
- Simple Trusses
- The Method of Joints
- Zero-Force Members
- The Method of Sections
- Space Trusses
- Frames and Machines

STRUCTURE

- A structure is any connected system of members build to support or transfer forces and to safely withstand the loads applied to it.
- Types Truss, frames, machines
- Truss is a French word “Trusses” *Collection of things bound together*

6. 1 Simple trusses

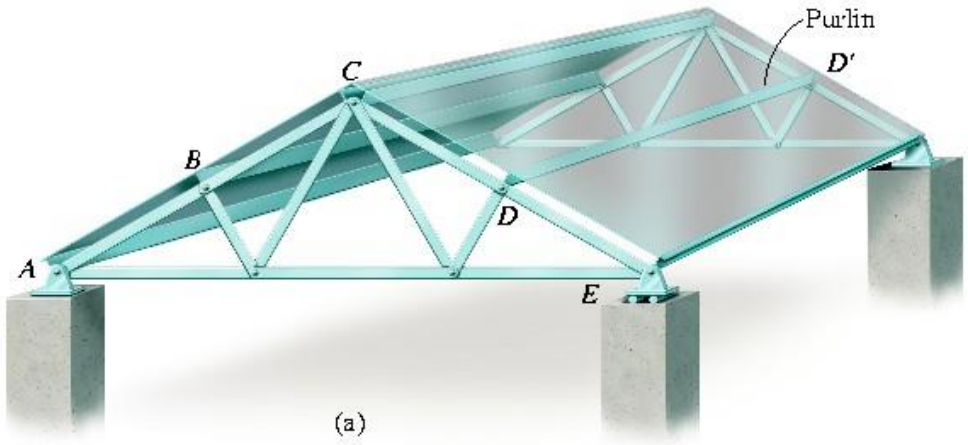
- A truss is a structure composed of slender members joined together at their end points
- Joint connections are formed by bolting or welding the ends of the members to a common plate, called a gusset plate, or by simply passing a large bolt or pin through each of the members



6. 1 Simple trusses

Planar Trusses

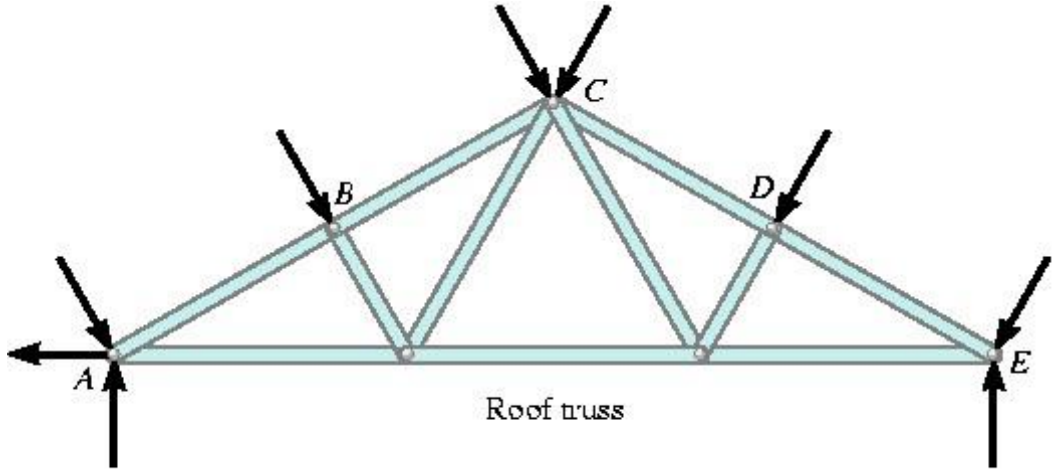
- Planar trusses lie on a single plane and are used to support roofs and bridges
- The truss ABCD shows a typical roof-supporting truss
- Roof load is transmitted to the truss at joints by means of a series of purlins, such as DD’



6. 1 Simple trusses

Planar Trusses

- The analysis of the forces developed in the truss members is 2D

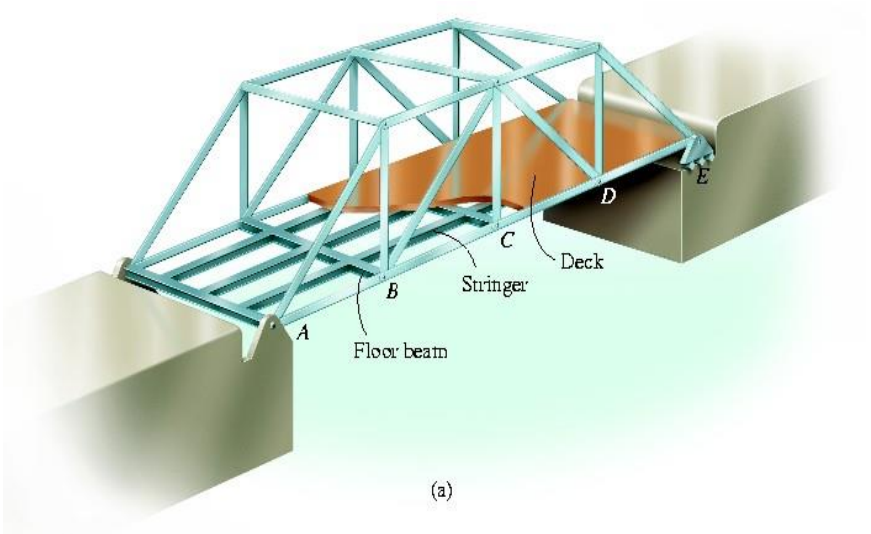


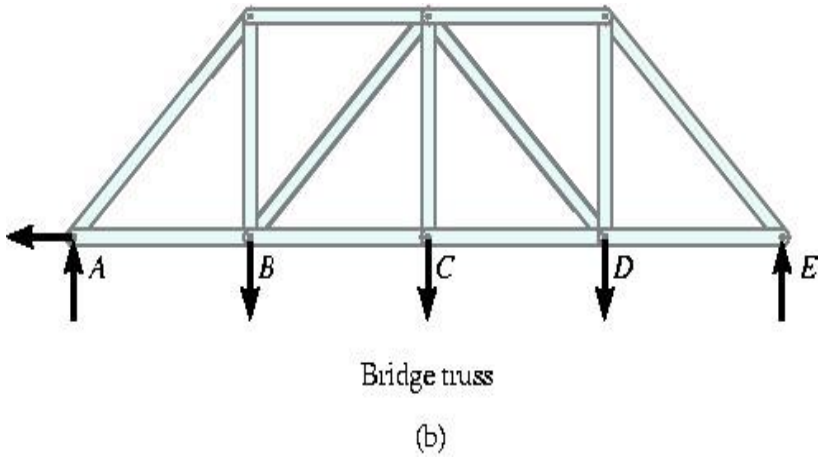
(b)

6. 1 Simple trusses

Planar Trusses

- For a bridge, the load on the deck is first transmitted to the stringers, then to the floor beams, and finally to the joints B, C and D of the two supporting trusses
- Like the roof truss, the bridge truss loading is also coplanar

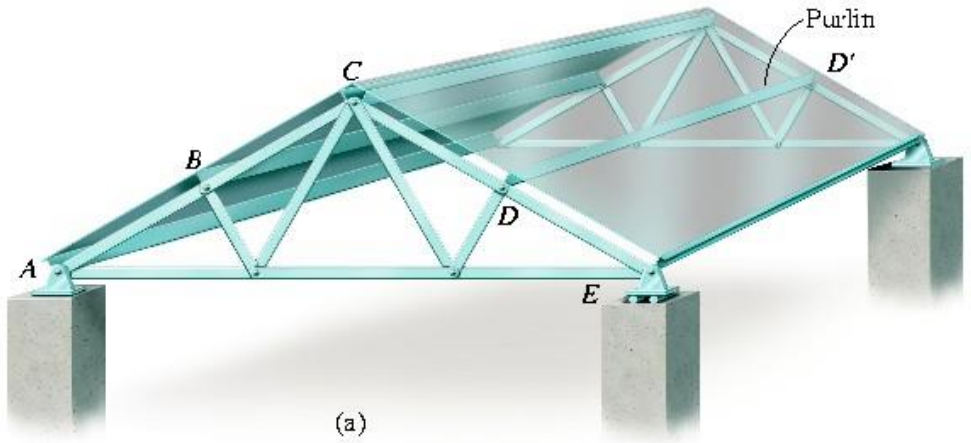


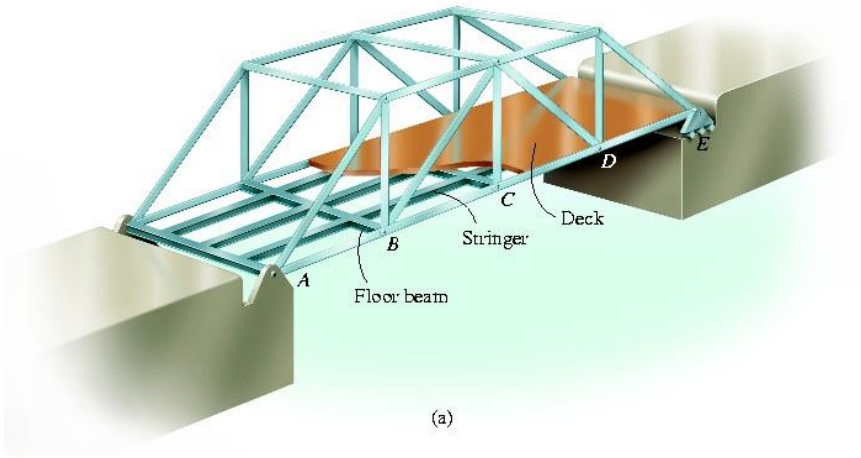


6. 1 Simple trusses

Planar Trusses

- When bridge or roof trusses extend over large distances, a rocker or roller is commonly used for supporting one end, Eg: joint E
- This type of support allows freedom for expansion or contraction of the members due to temperature or application of loads





6. 1 Simple trusses

Assumptions for Design

1. "All loadings are applied at the joint"

- Assumption true for most applications of bridge and roof trusses
- Weight of the members neglected since forces supported by the members are large in comparison
- If member's weight is considered, apply it as a vertical force, half of the magnitude applied at each end of the member

Assumptions for Design

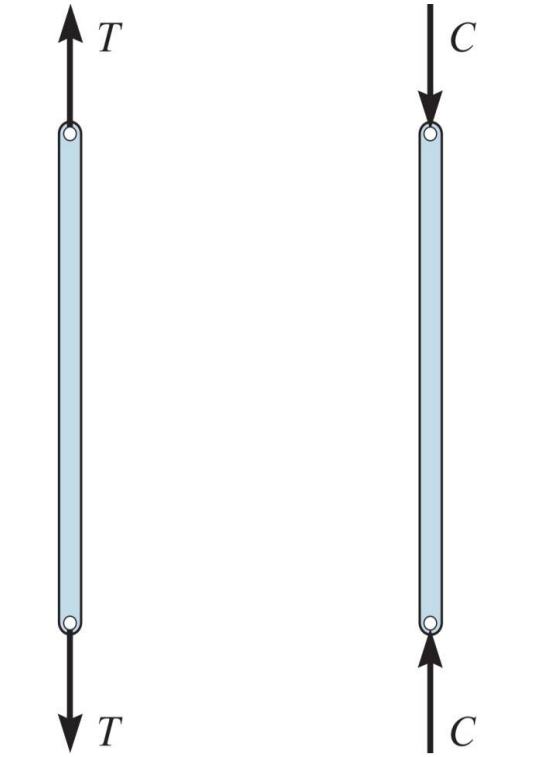
2. "The members are joined together by smooth pins"

- Assumption true when bolted or welded joints are used, provided the center lines of the joining members are concurrent

6. 1 Simple trusses

Assumptions for Design

- Each truss member acts as a two force member, therefore the forces at the ends must be directed along the axis of the member
- If the force tends to elongate the member, it is a tensile force
- If the force tends to shorten the member, it is a compressive force



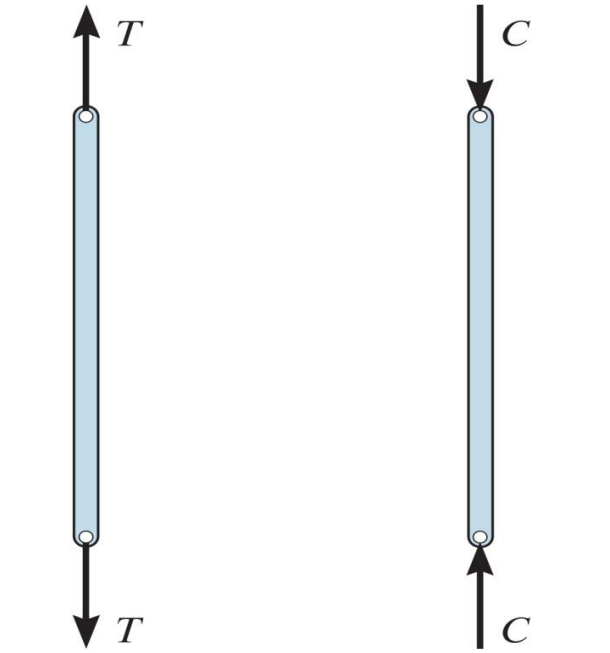
Tension (a)

Compression (b)

6. 1 Simple trusses

Assumptions for Design

- Important to state the nature of the force in the actual design of a truss – tensile or compressive
- Compression members must be made thicker than tensile member to account for the buckling or column effect during compression



Tension (a)

Compression (b)

6. 1 Simple trusses

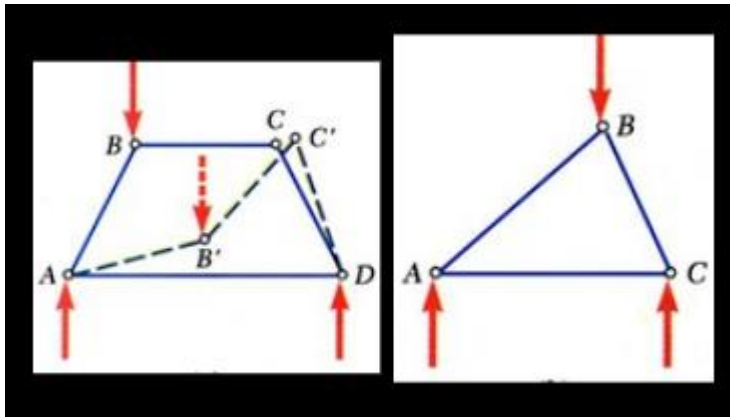
What makes a truss

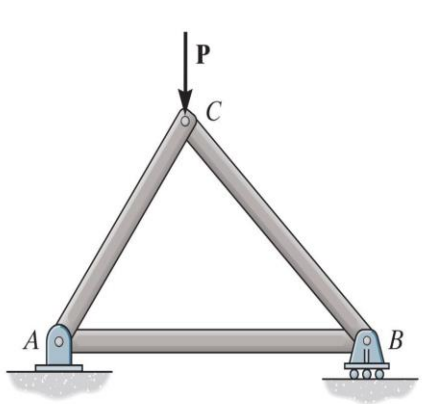
- Two-force members
- All members are pin connected
- Negligible weight
- Loaded only at the joints
- Two methods of solving
  - Method of joints
  - Method of sections

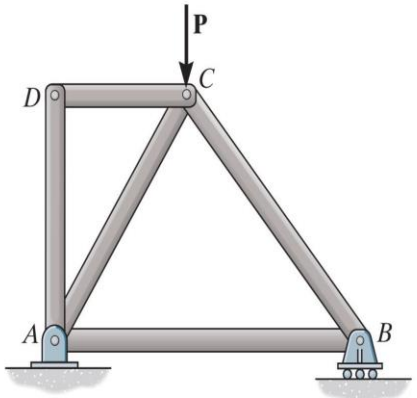
6. 1 Simple trusses

Simple truss

- A rigid truss will not collapse under the application of a load.
- To prevent collapse, the form of a truss must be rigid.





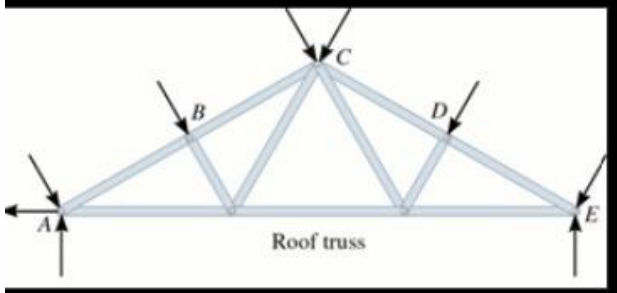


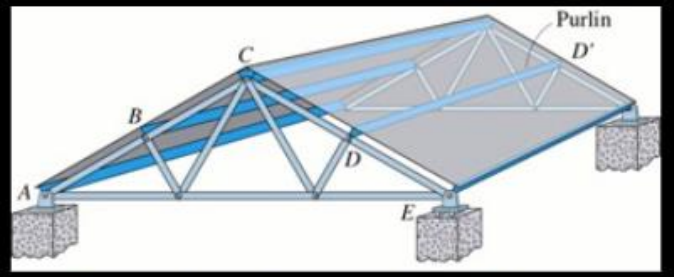
6. 1 Simple trusses

Example of Truss: The use of the metal gusset plates in the construction of these Warren trusses is clearly evident.

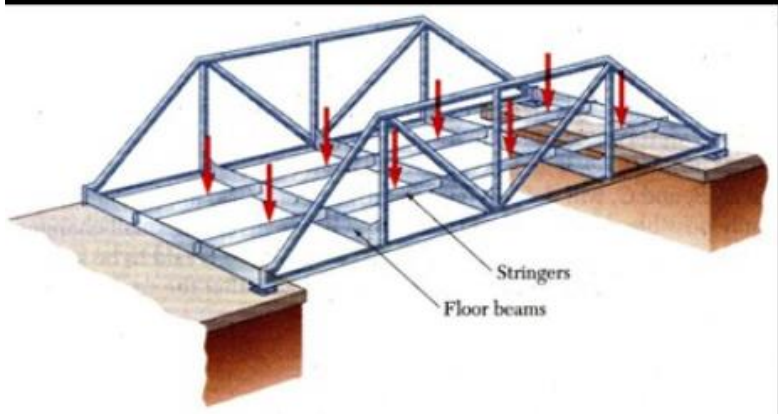
6. 1 Simple trusses

Examples



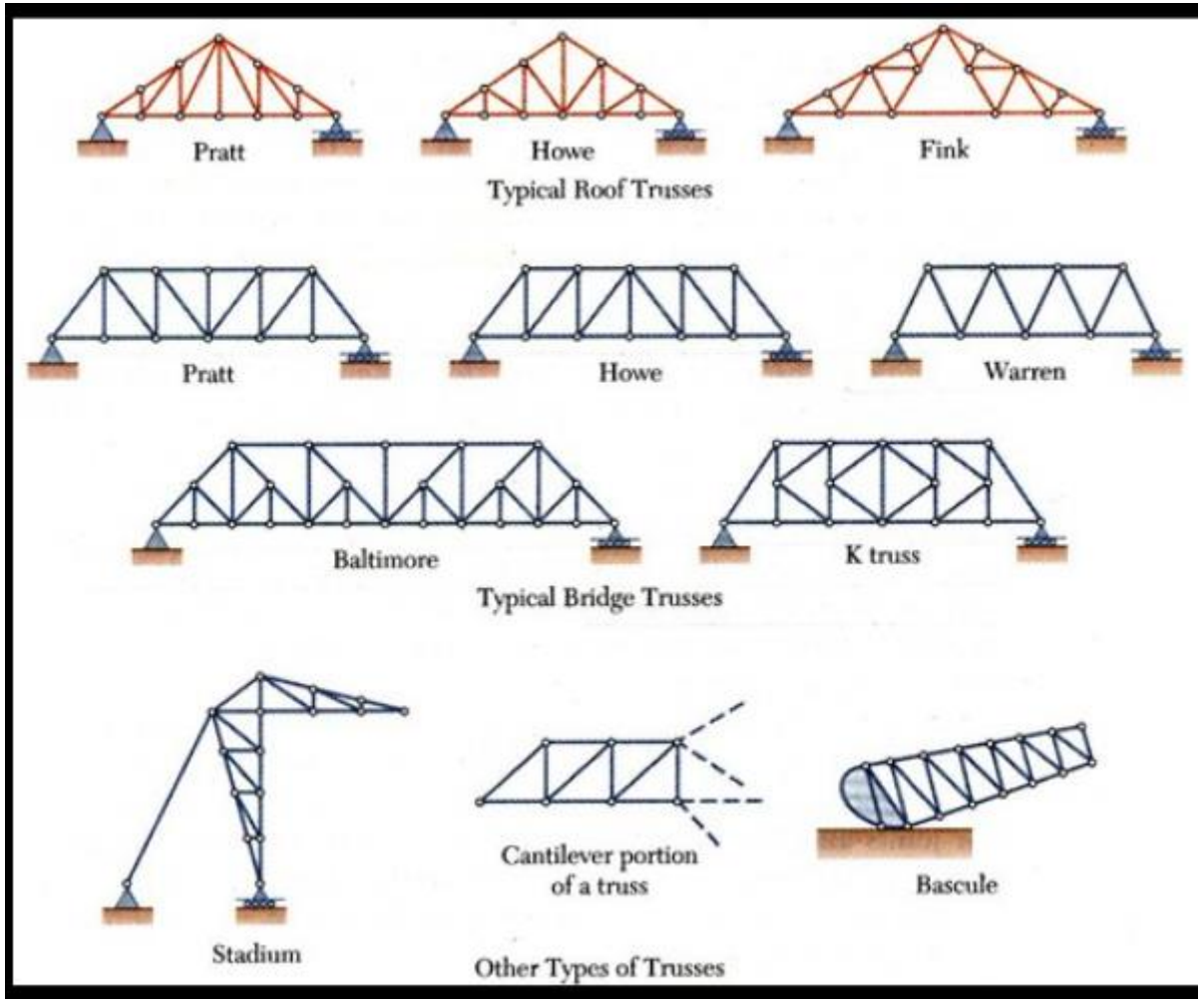


The roof truss shown is formed by two planar trusses connected by a series of purlins.



Members of a truss are slender and not capable of supporting large lateral loads. Loads must be applied at the joints.

6. 1 Simple trusses



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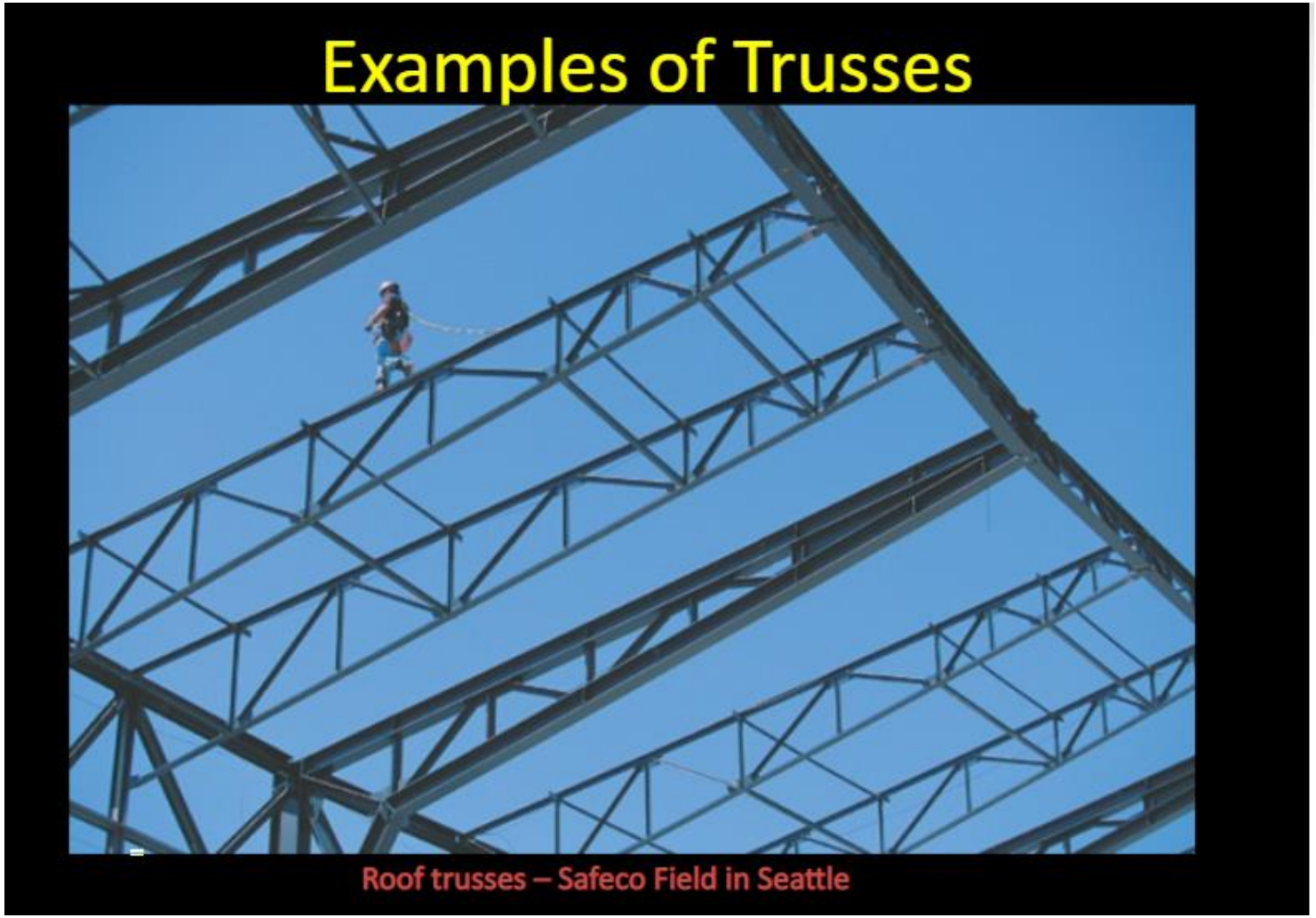

6. 1 Simple trusses

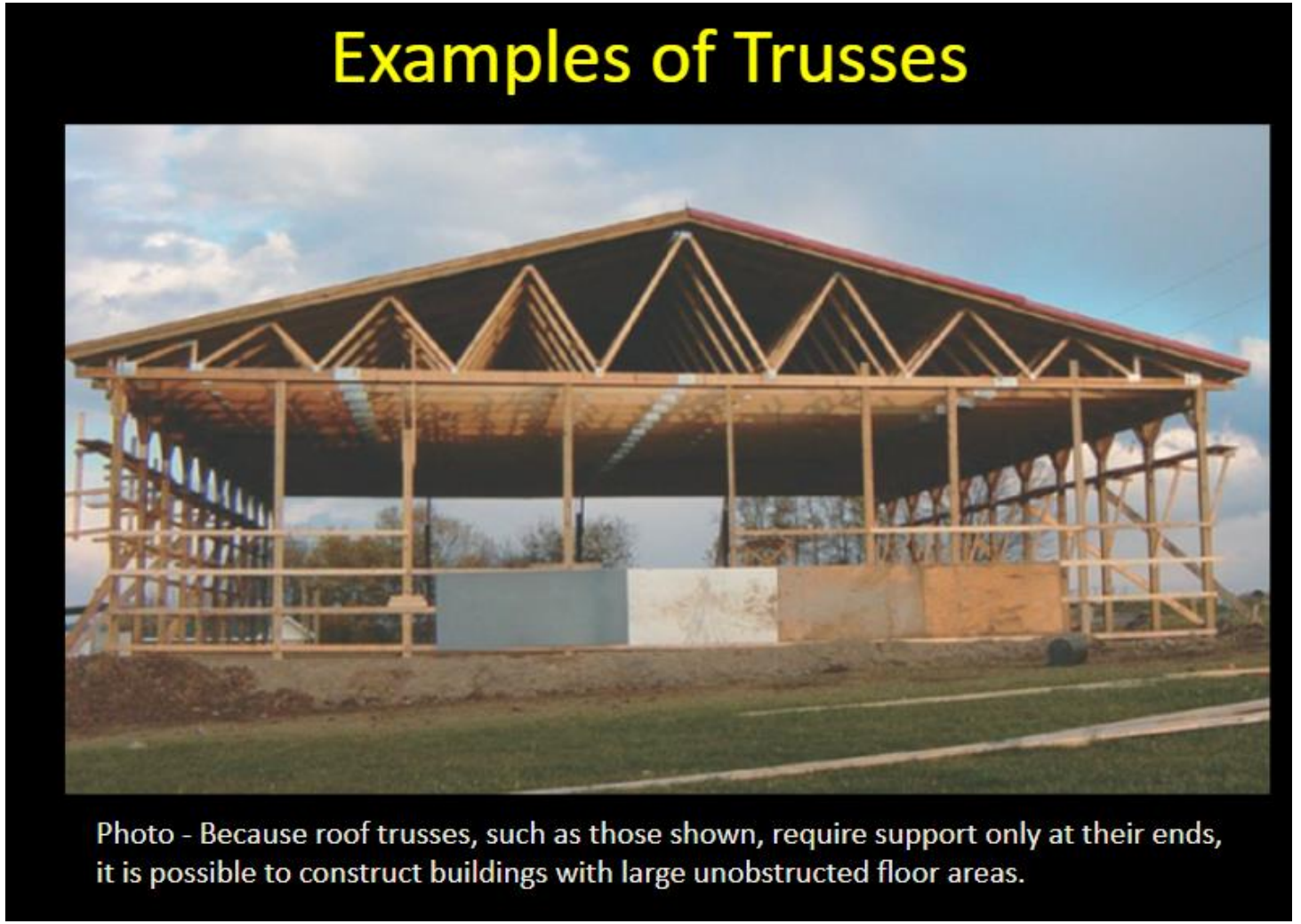

Photo - Because roof trusses, such as those shown, require support only at their ends, it is possible to construct buildings with large unobstructed floor areas.