



# **Civil Engineering**

# Objectives

- Define *civil engineering*.
- Describe structural forces, loads, and components.
- Identify different types of bridges.
- Understand the structure of a skyscraper.
- Describe the purpose of land surveying.

# Civil Engineering

- Build safe facilities to meet societal needs
- Public works projects
  - Roads, bridges, dams, municipal water systems
- Subfields include structural, water resources, transportation, environmental, construction, geomatics engineering

# Professional Aspects

- Bachelor's degree required
- Associate's degrees for technicians
- American Society of Civil Engineers
- Also International Association for Bridge and Structural Engineers (IABSE), Institute of Transportation Engineers (ITE), American Planning Association (APA)

# Civil Engineering Principles

- Covers large base of knowledge
- All civil engineers must understand structures



rkriminger/Shutterstock.com

# Structures

- Arrangement of parts built to remain stable while withstanding forces
- Structural loads
- Structural forces
- Structural components
- Structural materials
- Structural analysis



Action Sports Photography/Shutterstock.com

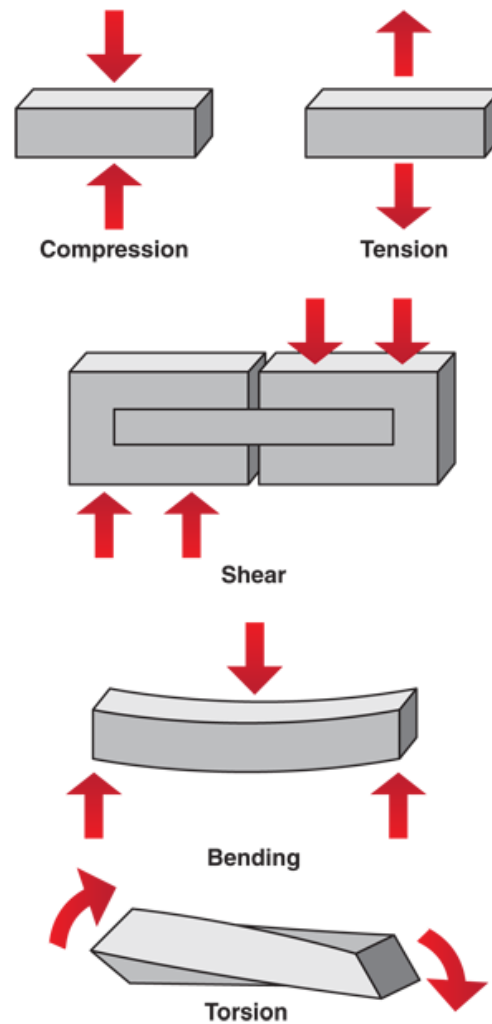
# Structural Loads

- Structures transmit load from structure to ground
- Static loads, dynamic loads
- Equilibrium
  - Oppose external forces
  - Transfer load throughout structure



TFoxFoto/Shutterstock.com

# Structural Forces





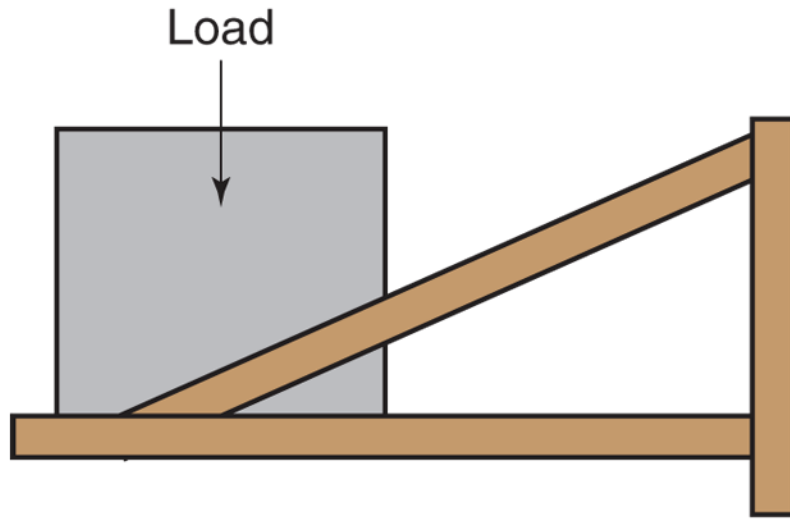
# Structural Components

- Beams
  - Floor joist
- Columns
- Braces
  - Struts
  - Ties
- Joints

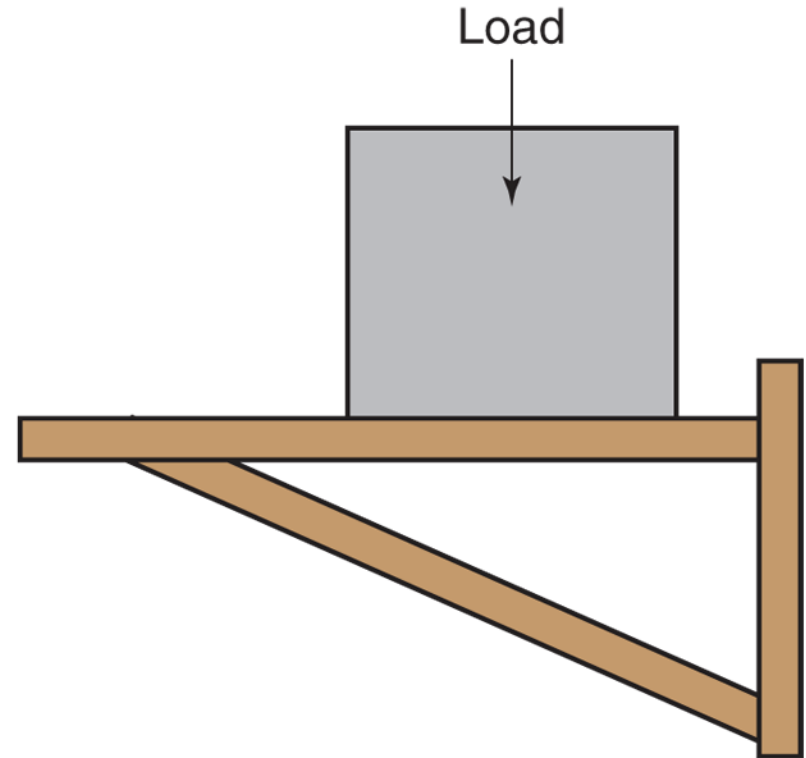


3drenderings/Shutterstock.com

# Ties and Struts



**Tension Tie**



**Compression Strut**

# Structural Materials

- Stone
- Bricks
- Wood
- Concrete
- Steel
- Reinforced concrete
- Carbon fiber
- All materials have advantages, disadvantages based on properties

# Structural Analysis

- Responsibility of structural engineer
- Ensures structure has sufficient strength
- Ensures structure is as efficient as possible
  - Makes best use of materials
- Incorporates physics, especially mechanics
  - Statics
  - Dynamics

# Design

## Civil Engineering Software

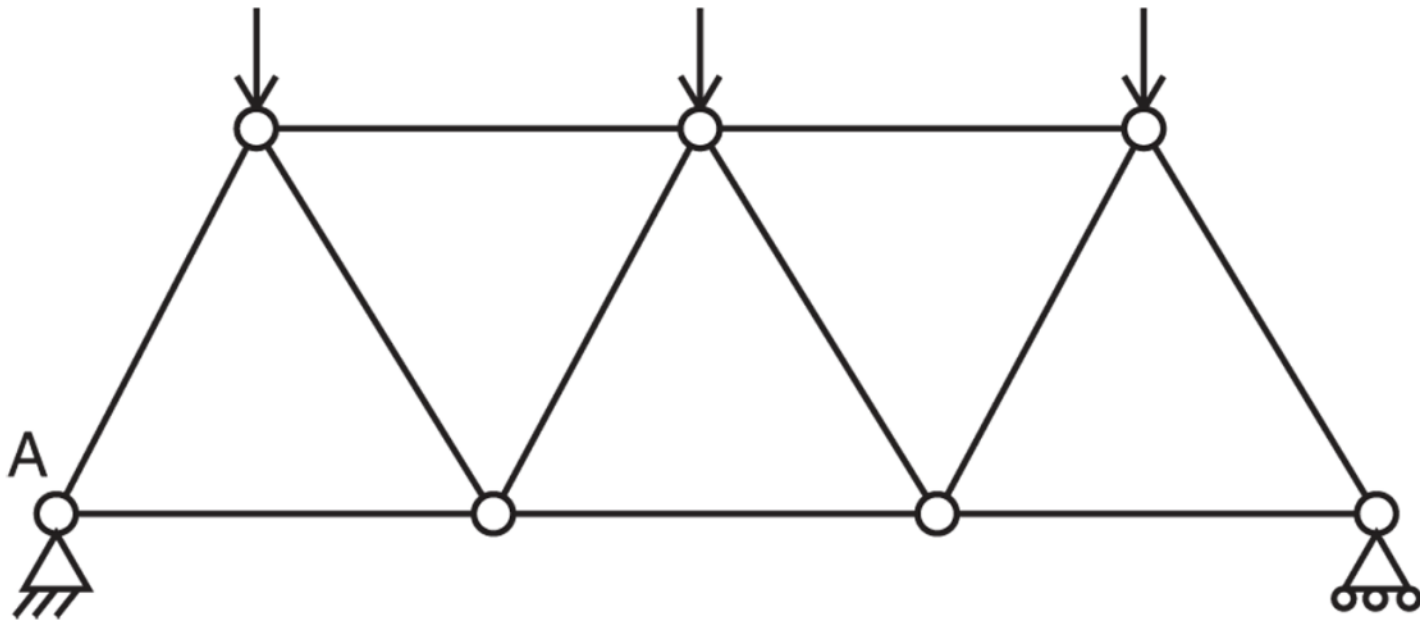
- Field specific
  - Planning
  - Drawing
  - Organization
  - Simulation
- Typically includes symbols

# Truss Structural Analysis

- Simplest truss is triangular
- Structural members pinned together at joints
- Truss analysis
  - Begins with free body diagram
  - Determine structural stability of truss
  - Calculate reactions, internal forces
  - Complex calculations done by computer software

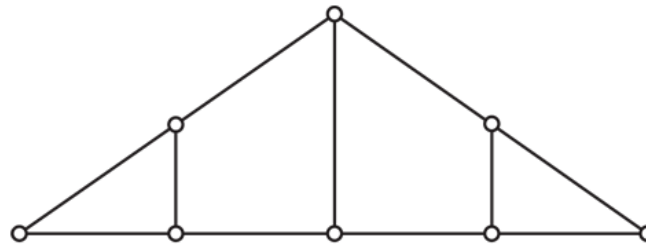
# Free Body Diagram

- Structural members, joints
- Supports
- Loads or forces applied

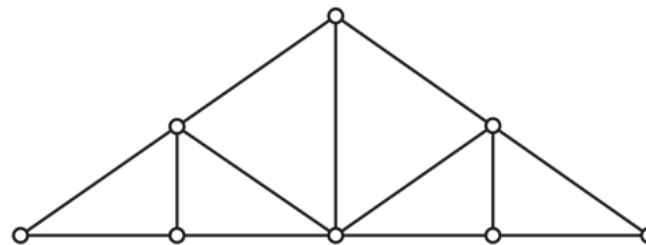


# Stability Formula

- $2j = m + 3$



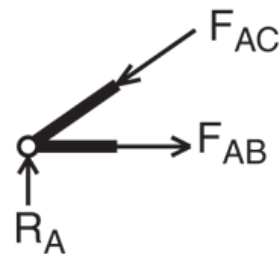
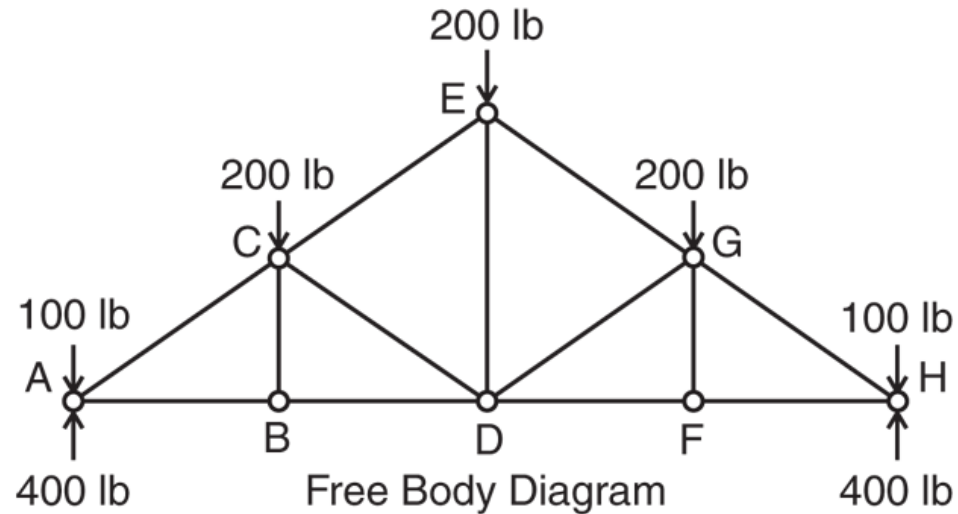
Unstable Truss  
 $2j = m + 3$   
 $2 \times 8 = 11 + 3$   
 $16 = 14$



Stable Truss  
 $2j = m + 3$   
 $2 \times 8 = 13 + 3$   
 $16 = 16$



# Reactions and Internal Forces



Free Body Diagram Detail

# Civil Engineering Applications

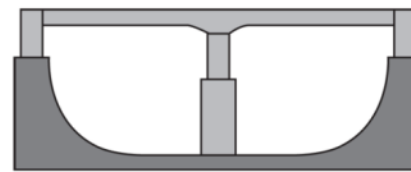
- Bridges
- Skyscrapers
- Geomatics engineering



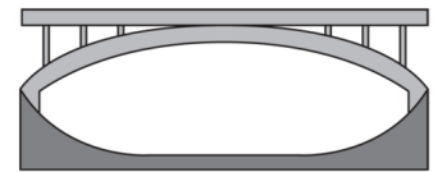
dvoevnore/Shutterstock.com

# Bridges

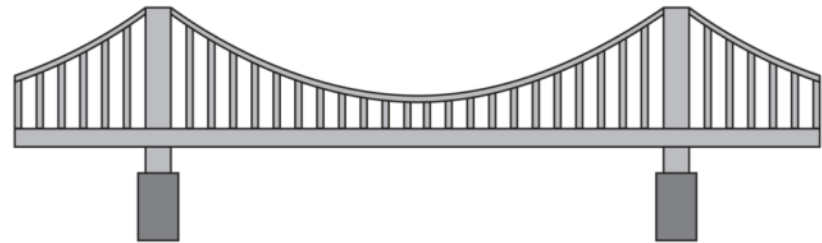
- Design considerations
  - Length of span
  - Type of foundation
  - Environment
  - Available materials
- Basic components
  - Piers
  - Abutments
  - Roadway



Beam

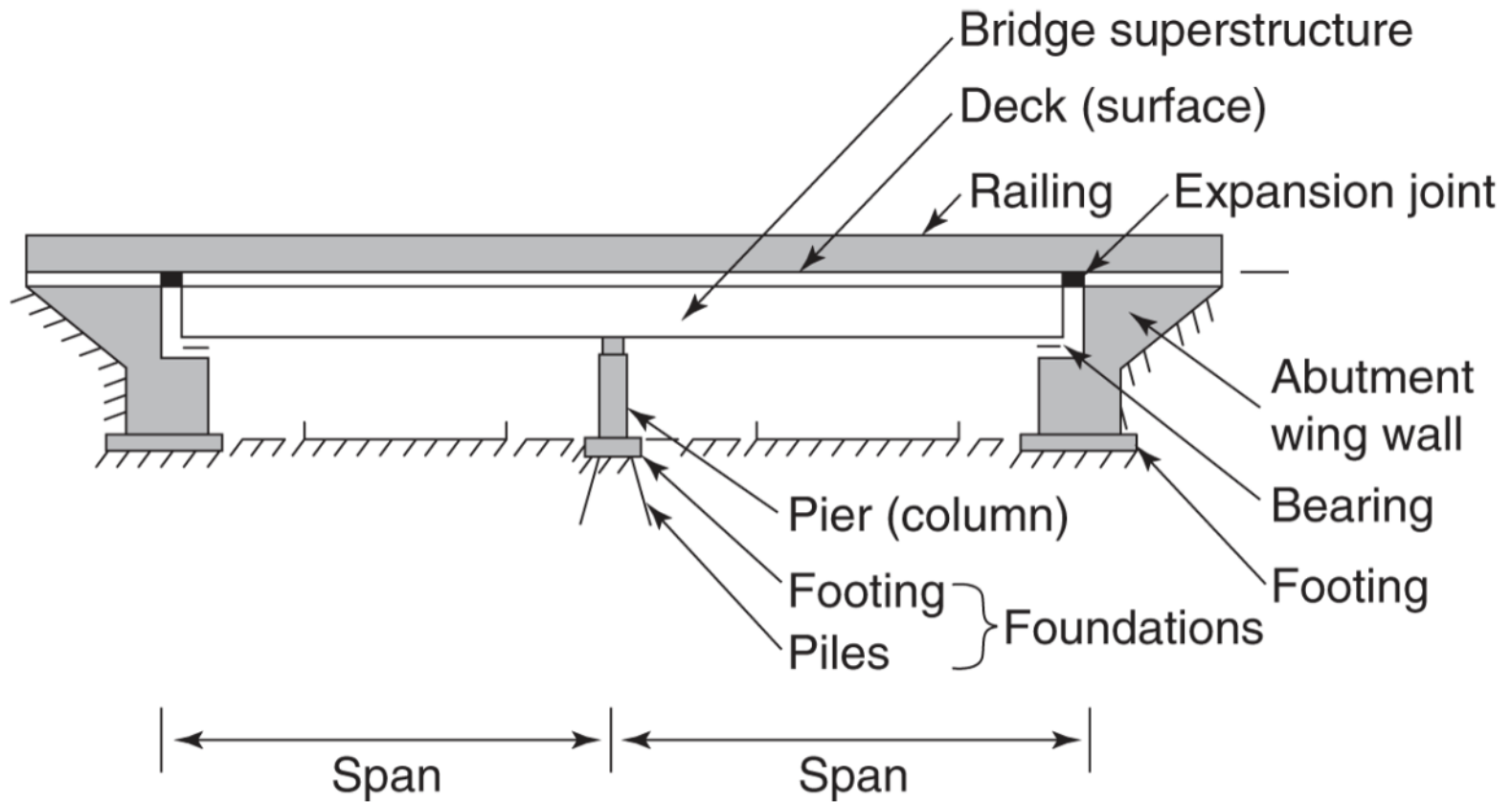


Arch



Suspension

# Bridge Components



**Typical Bridge Elements**

# Beam Bridges

- Span short distances



Gary Fowler/Shutterstock.com

## Beam Bridge



StockCube/Shutterstock.com

## Cantilever Bridge



Alexeye30/Shutterstock.com

## Truss Bridge

# Arch Bridges

- Rely on arch strength, rigidity
  - Structural members in compression
  - Distribute load to abutments
- Arch can support deck from above or below



Dan Costa/Shutterstock.com

# Suspension Bridges

- Main section similar to inverted arch bridge
- Use tension forces
- Main components
  - Towers
  - Main cables
  - Anchorages

# Specialty Bridges

- Combination bridges
- Movable bridges



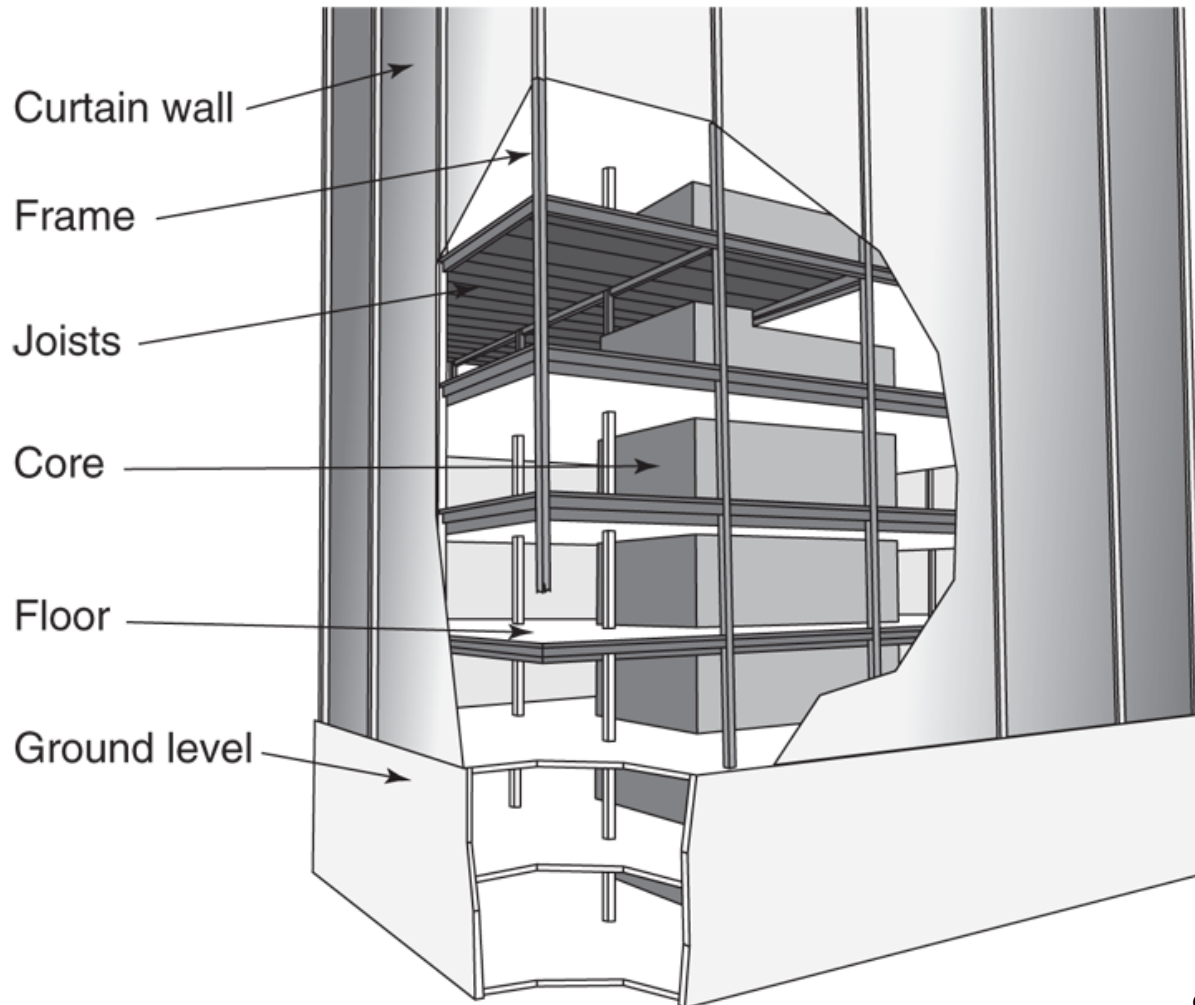
TheresaSc/Shutterstock.com



# Skyscrapers

- Structural frame (skeleton)
  - Withstands building dead load
  - Attached to footings, piers extend deep into earth
- Outer surface does not carry weight
- Central core
  - Helps resist wind
  - More resistant to earthquakes
  - Contains elevator shafts, mechanical systems

# Skyscraper Components



Goodheart-Willcox Publisher

# Other Structural Civil Engineering Applications

- Dams
- Tunnels
- Geomatics engineering



Andy Z./Shutterstock.com

# Geomatics Engineering

- Determine location of objects on earth
- Engineers create land, resource maps
  - Conduct boundary, other land surveys
- Design, use GIS

# Land Surveying

- Measurements used to determine size, shape of piece of land
- Measure distance, angles
- Total station instrument
  - Includes electronic distance meter (EDM)
  - Total robotic station

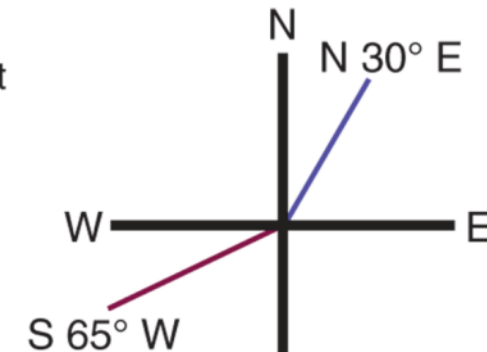
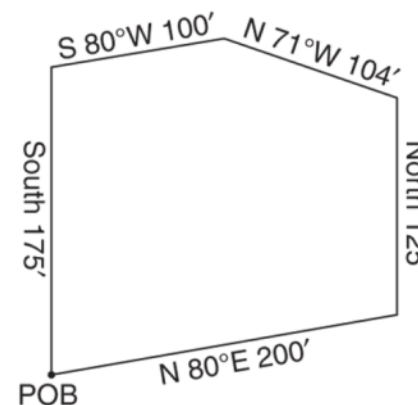
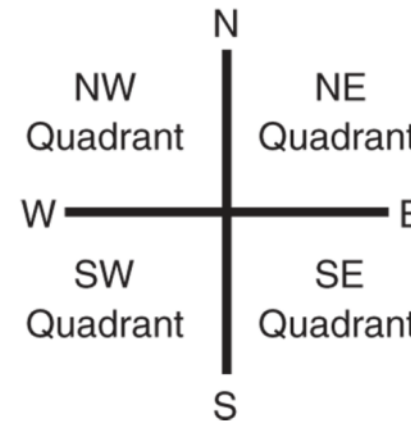


Robert Adrian Hillman/Shutterstock.com

# Tools

## Surveying Bearings

- Bearings express line directions
- Quadrant system
  - North, south, east, west
- Angles found, measured from north-south axis



# Civil Engineering in Action

- Civil engineers work in teams
  - Ethics
- US Army Corps of Engineers
  - Military works, government projects
  - Civil works projects
  - Used in combat



Frontpage/Shutterstock.com