Engineering & Waves: Seismic Waves
Engineering Waves Overview

• In this lesson, we will learn about:
  • What are waves?
  • What are different types of waves?
  • How do waves travel?
  • How do waves relate to engineering?

• Our focus is on:
  • Seismic waves
Wave Basics

- **What is a wave?**
  - A disturbance that travels through space or time, usually by the transfer of energy

- **Many different types of waves!**

![Wave Diagrams](image)
Wave Basics

- Important vocabulary:
  - wavelength
  - amplitude
  - crest (ridge)
  - trough
  - frequency
Types of Waves

- electromagnetic waves
  - light waves
  - radio waves
- sound waves
- ocean waves
- seismic waves
- standing waves

↑ In this animation of a standing wave, the red dots represent the nodes.
Engineering & Waves: Seismic Waves
Why are engineers concerned about earthquakes?
Seismic Waves

- Waves that travel through the Earth

Classifications:

- **Body Waves**
  - Faster, travel through the interior of the Earth
  - P-waves (primary)
  - S-waves (secondary)

- **Surface Waves**
  - Slower, travel along the surface of the Earth
  - Cause more damage
  - Similar to water waves
  - Love waves
  - Rayleigh waves
Body Waves: Primary Waves

- P-waves cause the ground to have vibrations along or parallel to the direction of the wave
  - **Fast!** The first type of seismic wave to arrive at a point away from the epicenter
  - Can travel through **any medium**
  - Typical speeds:
    - In air: 330 m/s
    - In water: 1450 m/s
    - In granite: 5000 m/s
Body Waves: Secondary Waves

- S-waves cause the motion of the ground to be perpendicular to the direction of the wave
  - Can only travel through solids
  - Speed is about 60% of a P-wave in a material
  - Arrives second at a point away from the epicenter
Surface Waves: Love Waves

- Love waves cause **horizontal shifting** of the Earth during earthquakes
  - Move **slower** than P-waves and S-waves, but **faster** than Rayleigh waves
  - Named for A.E.H. Love, the man who predicted this type of seismic wave in 1911
Surface Waves: Rayleigh Waves

- Rayleigh waves cause a rolling motion—like ocean waves
- Slowest of the seismic waves (travel at around 3 km/s)
- Produced by the interaction of P- and S-waves at the Earth’s surface
- Can be used to characterize the Earth’s interior and oil deposits
All Seismic Waves

- Intensity depends on:
  - Size of earthquake
  - Distance to the earthquake
  - Depth of the earthquake
  - Geological structure of the crust

- The amplitude decreases with increasing depth of the earthquake and with distance traveled
More information on Seismic Waves
Engineering Design and Shake Tables
The World’s Largest Shake Table