

Engineering & Waves: Seismic Waves

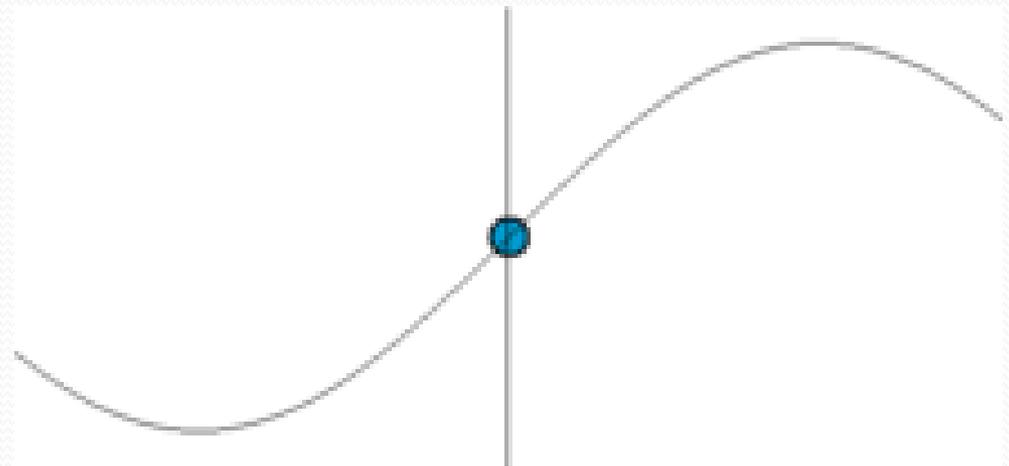
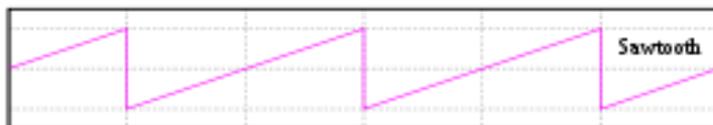
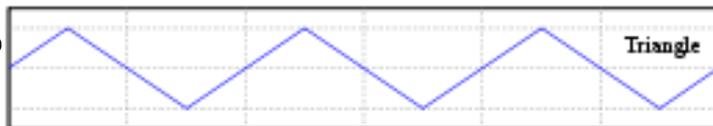
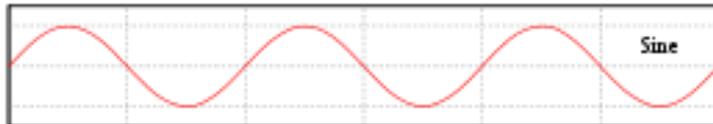


Engineering Waves Overview

- 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

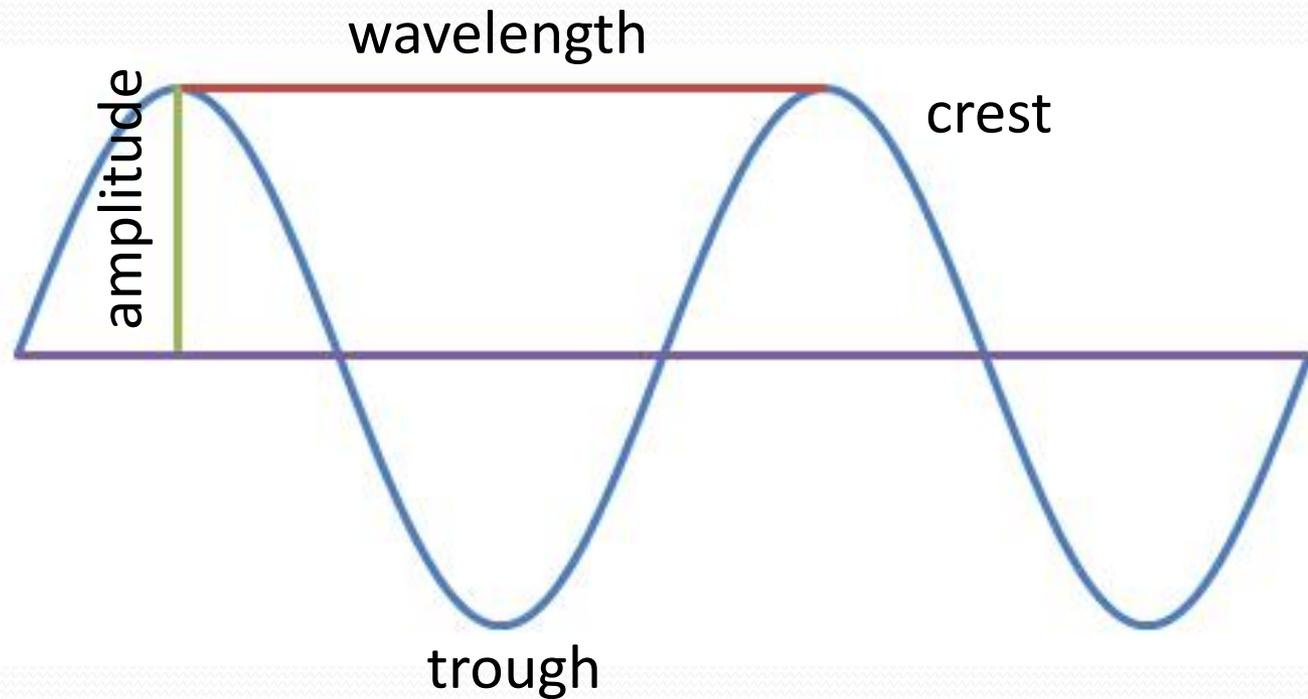
- What is a wave?
 - A disturbance that travels through space or time, usually by the transfer of energy
- Many different types of waves!



Wave Basics

- Important vocabulary:

- wavelength
- amplitude
- crest (ridge)
- trough
- frequency



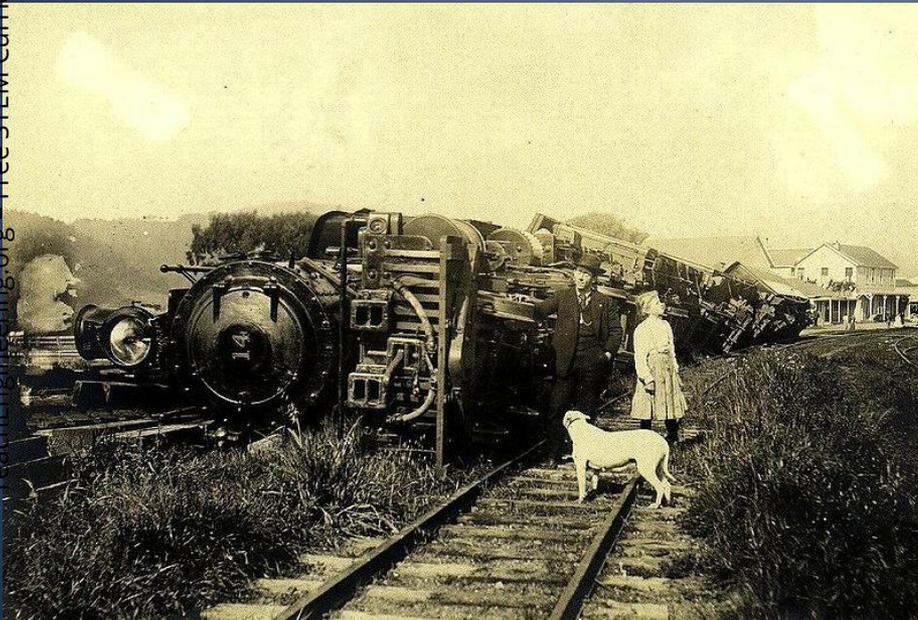
Types of Waves

- 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

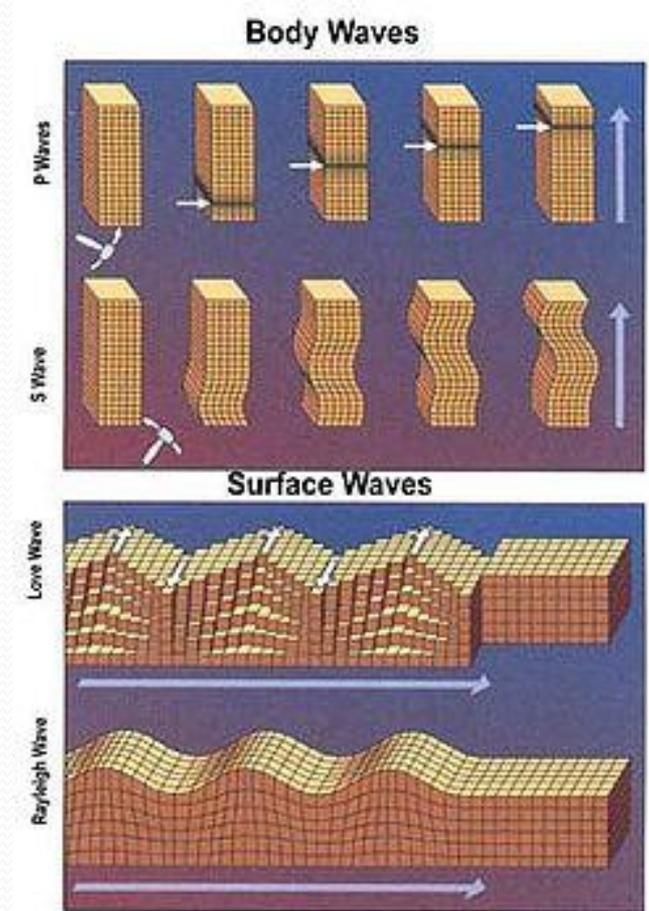


Why are engineers concerned about earthquakes?



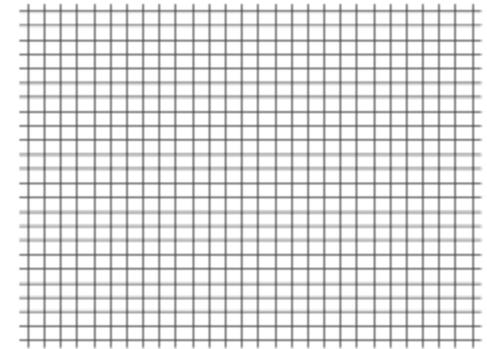
Seismic Waves

- 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

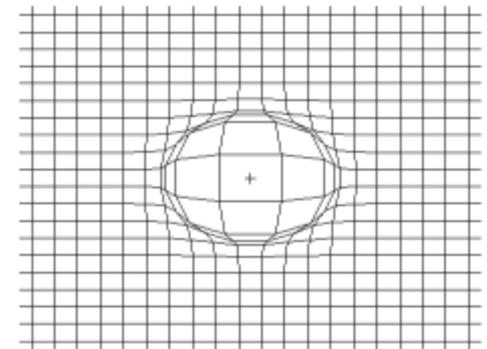


Body Waves: Primary Waves

- 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



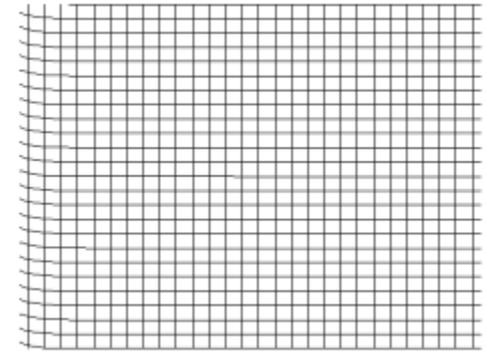
Plane P-wave



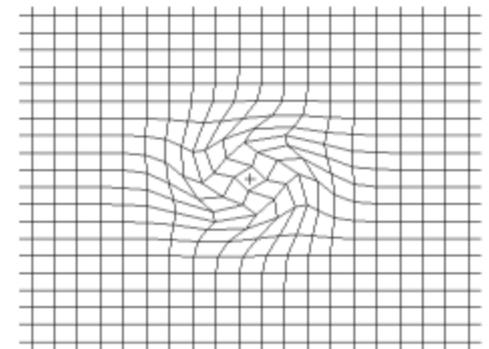
Propagation of a P-wave
on a 2Dgrid

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

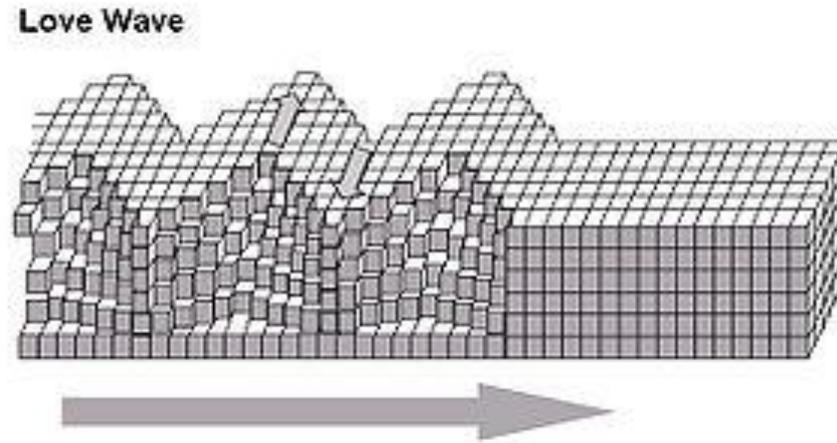


Plane S-wave



Propagation of a spherical S-wave on a 2D grid

Surface Waves: Love Waves

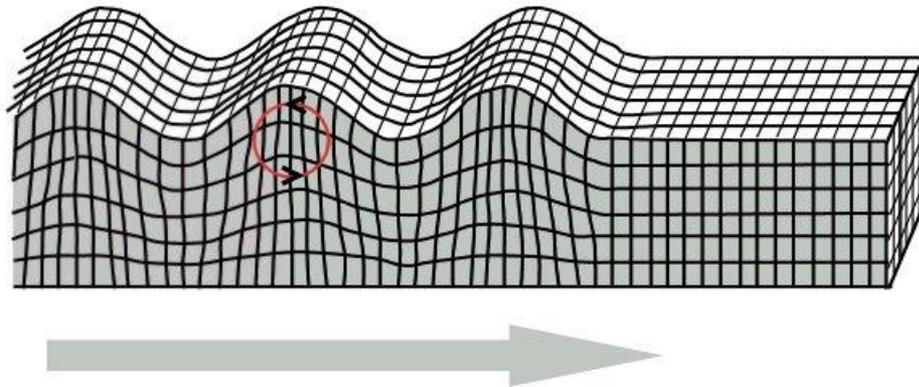


Love waves cause **horizontal shifting** of the Earth during earthquakes

- 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 Wave



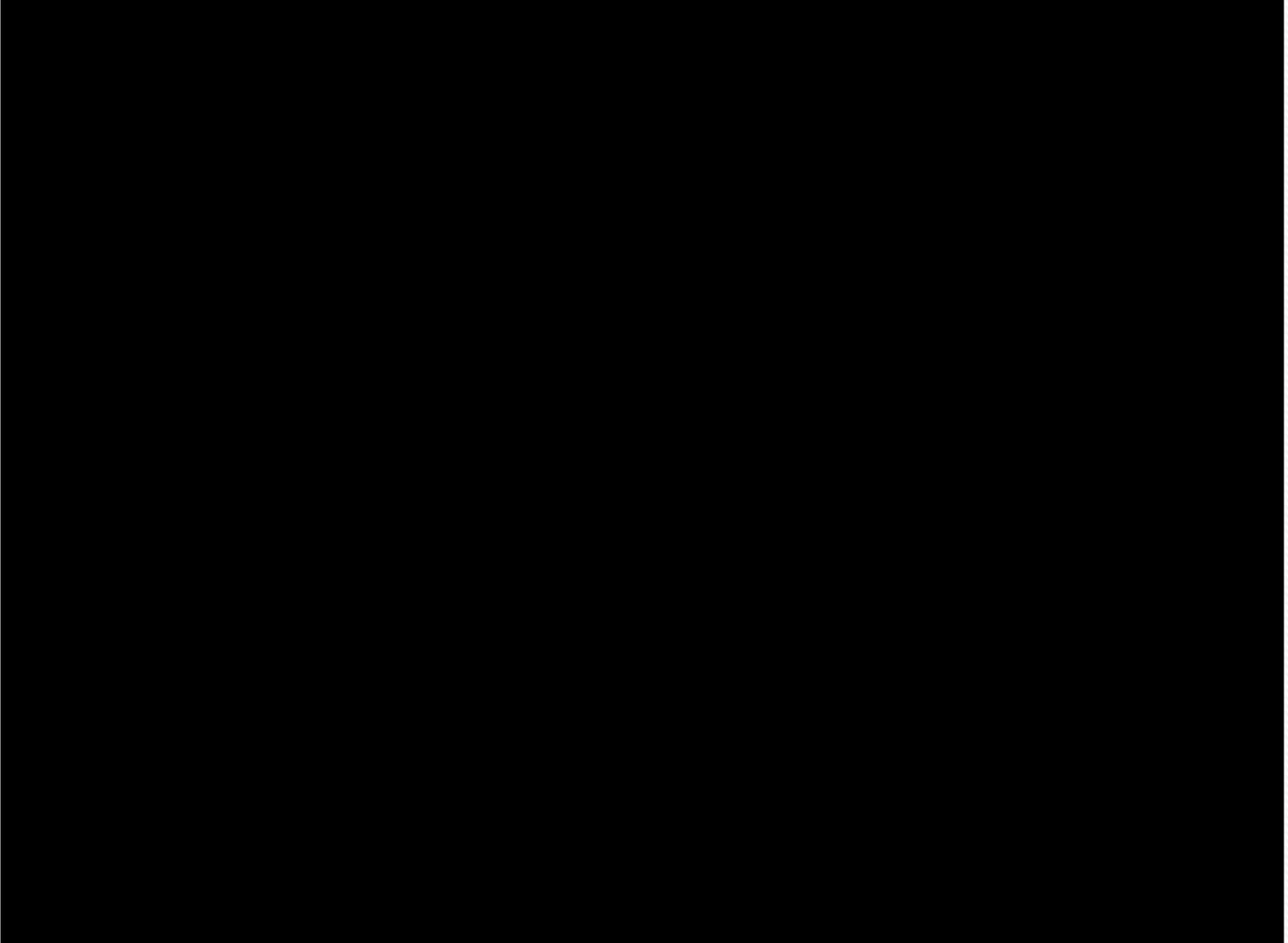
Rayleigh waves cause a **rolling motion**—like ocean waves

- **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

