

Let's talk about another contemporary challenge (which also is an old one): earthquakes.

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In Oregon, earthquakes are quite relevant. The Cascadia subduction zone has had massive earthquakes about every 600 years for the last few millenia. The most recent was in 1700, and had a magnitude of 8.7-9.2. Geologists predict a 37% chance of a magnitude 8.2+ earthquake on the Cascadia subduction zone within the next 50 years. This will probably topple Weniger Hall, so students are advised to graduate promptly.

Figure 1: A simulation of the next Cascadia subduction zone earthquake.

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Figure 2: P-waves. Illustration from USGS.

For  $P$ -waves in the ground, the shaking motion is in the direction in which the wave propagates. In this case the differential equation is

$$\frac{\partial^2 u}{\partial x^2} = \frac{\rho}{E} \frac{\partial^2 u}{\partial t^2} \quad (1)$$

where  $u$  is the displacement from equilibrium of the ground,  $\rho$  is the density of the earth's crust, and  $E$  is its Young's modulus, which quantifies how hard it is to compress the crust.

The speed of a  $P$ -wave is about 5 km/s. Estimate the Young's modulus of the crust. Give your answer in units of N/m<sup>2</sup>.