ESS 512 HW 1

Simon-Hans Edasi

01/09/2023

1 Ch2 Ex3

a.
The first 10 cycles of the surface wave lasts from $20.1 * 10^2$ seconds to $23.5 * 10^2$ seconds, giving a dominant period of $23.5 * 10^2 - 20.1 * 10^2 = 340$ s. This gives us an individual period of 34 seconds.

b.
Frequency $f = \frac{1}{T}$, so our frequency is $f = \frac{1}{34s} = 0.03$ Hz

c.
Reading from the graph the maximum strain recorded on the seismogram looks like ± 310 microns.

d.
A seismic plane wave can be approximated as: $u_z = A \sin[2\pi f(t - (x/c))]$

$$\varepsilon = \frac{\partial u_z}{\partial x} \rightarrow \varepsilon = \frac{-2\pi f A}{c} \cos\left[(2\pi f\left(t - (x/c)\right)\right]$$

The maximum occurs when cosine = -1, so:

$$\varepsilon_{max} = \frac{2\pi f A}{c} \rightarrow \varepsilon_{max} = \frac{2\pi\left(0.03s^{-1}\right)\left(310 * 10^{-6}m\right)}{3.9 * 10^3 m/s} = 1.5 * 10^{-8}$$

2 Ch3 Ex1

Period T is to angular frequency ω $\left(\omega = \frac{2\pi}{T}\right)$ as wavelength λ is to wavenumber k $\left(k = \frac{2\pi}{\lambda}\right)$.

3 Ch3 Ex2

a.
Start out with a plain sine wave with an amplitude: $u_z\left(t\right) = A \sin\left[\omega t - kx + \phi\right]$. There is no phase shift, so $\phi = 0$, and we are given amplitude ($A = 0.04m$), wavelength ($\lambda = 8km$), and wavespeed ($c = 5km/s$). We can find ω and k with given values from Table 3.1: $\omega = 2\pi f = 2\pi\frac{c}{\lambda}$; $k = \frac{2\pi}{\lambda}$

Rewriting the equation with our given and derived values:

$$u_z\left(t\right) = 4 * 10^{-2} \sin\left[2\pi\frac{c}{\lambda}t - \frac{2\pi}{\lambda}x\right] = 4 * 10^{-2} \sin\left[\left(\frac{2\pi}{\lambda}\right)\left(ct - x\right)\right]$$

b.
Strain $\varepsilon = \frac{\partial u_z}{\partial x} \rightarrow \varepsilon = \frac{-4 * 10^{-2} * 2\pi}{\lambda} \cos\left[\left(\frac{2\pi}{\lambda}\right)\left(ct - x\right)\right]$. This equation is maximized when $\left(ct - x\right) = \frac{\lambda}{2}$, or when the argument of cos is π. This leaves:

$$\varepsilon_{max} = \frac{4 * 10^{-2} * 2\pi}{8 * 10^3} = 3.14 * 10^{-5}m$$