Use of Rayleigh Waves as Reference for Determining Setback Distances for Explosions near Shorelines

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ABSTRACT: The use of explosives in engineering works, such as stone quarries, may produce negative effects not only on structures and people, but also on the environment. Usually only the direct compression waves are considered in assessing the damage to fish and marine mammals in the vicinity of the explosion. Rayleigh waves can be transmitted from solid to liquid and, consequently, affect the marine environment. Rayleigh waves (the surface waves) travel on the free surface of the earth or water to a depth of about 1.5 times the wavelength. However, they attenuate more slowly than the compression and shear waves (the body waves). The key parameters from a quarry blast are the peak particle velocity (PPV) and the dominant frequency. The low frequencies are characterised by wavelengths which may involve the upper 100m of the sea. The relationship among the several factors which influence the attenuation phenomenon (i.e., distance and depth of explosion, weight of the charge, ground conditions, shape of excavation) is analysed and the results are compared with other laws proposed in the literature. The difference in the geometrical attenuation laws of body waves and Rayleigh waves implies that, at a certain distance from the explosion, the peak particle velocity (or, equivalently, the overpressure) is higher for Rayleigh waves than for body waves. In order to respect the upper limit of PPV and overpressure imposed by the prevailing guidelines (for example, 1.3cm/s and 100kPa, respectively, in the Fisheries and Ocean Canada guidelines), the required setback distance from the centre of the explosive to fish habitat will be greater for Rayleigh waves than for body waves.

1) Rayleigh waves can transmit vibrations caused by blasting to marine life

2) Rayleigh waves travel farther than Body waves (ref. 2)

3) Attenuation law of peak particle velocity PPV with distance D and weight, W, of explosive

4) The formulas for determining the setback distance of explosion from fish habitat

5) The setback distance is significantly greater for Rayleigh waves than for Body waves

6) The setback distance is smaller using limit 2 than for limit 1

7) The example refers to a proposed rock quarry near the Bay of Fundy shoreline. For Rayleigh waves the setback distance for the example is about 4km compared to 300m for Body waves

8) The importance of Rayleigh waves in environmental impact of explosions near shorelines has been demonstrated.

9) The principal References used for the study.

References

(4) Roma, V. (2001): “Soil properties and site characterization by means of Rayleigh waves”, Ph.D Dissertation, Structural and Geotechnical Engineering Department, Technical University of Turin (Italy)