Attenuation measurements by laboratory tests using rock core samples for earthquake ground-motion estimation

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An applicability of attenuation measurements by laboratory tests using rock core samples (5 cm-diameter and 10 cm-long) is described. The pulse rise-time technique [Gladwin and Stacey, 1974] and the spectral ratio technique [Toksoz et al, 1978] were applied to measure an attenuation of four granite core samples by ultrasonic wave measurements using S-wave transducer of 100 kHz. As a result, the damping factors ranged from 0.009 to 0.014 (Qs=37–54) were obtained from the pulse rise-time technique. Additionally, from the spectral ratio technique, the damping factors ranged from 0.009 to 0.014 (Qs=37–54) were obtained by using aluminum with Qs=150000 [Zamanek and Rundnik, 1961] as a reference sample. These results indicate that almost equal damping factors are estimated by two different techniques used ultrasonic wave measurements. Further, the cyclic uni-axial compression tests using cyclic loading wave of 0.1 Hz were also performed to get stress-strain curves with ten stress-levels for same samples used in ultrasonic wave measurements. From the stress-strain curves, we found that the curves with the strain levels lower than about $2 \times 10^{-5}$ were difficult to provide reliable damping factors because of an unstable and distorted shape of hysteresis loops. Meanwhile, the damping factors with the four strain levels ranged from $2.6 \times 10^{-5}$ to $2 \times 10^{-4}$ were obtained from the stress-strain curves and showed strain-dependent characteristics. The damping factors of minimum strain level of $2.6 \times 10^{-5}$ were obtained from 0.008 to 0.01 (Qs=50–63). From the comparison with the results from ultrasonic wave measurements, we showed that almost the same damping factors of small-strain level were estimated by the two different methods.

Keywords: rock core sample, attenuation measurement, ultrasonic wave measurement, cyclic uni-axial compression test, near surface rock, earthquake ground-motion estimation