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Application of Nonlinear Wave Analysis for Evaluation of Micro-Cracks in Concrete Elements

Speaker: Prof. Choi, Hajin
Soongsil University

Recent developments in nonlinear wave analysis, such as fast and slow dynamics, have enabled new levels of non-destructive evaluation for cementitious materials. While linear ultrasonic tests are limited to evaluate micro-cracks in concrete due to relatively large wavelength, nonlinear wave analysis is sensitive to subtle changes in material microstructure. The fast and slow dynamic effect is related to hysteresis stress-train relationship, where friction at crack tip plays give rise to the nonlinearity. The fast dynamic exhibits frequency softening during vibration tests, representing Young's modulus decreases with increasing excitation energy. The slow dynamic shows frequency recover after the excitation source is eliminated. In this research, nonlinearity from both fast and slow dynamics are evaluated through simply designed mechanical vibration tests. The measurements of both nonlinear properties are carried out through several concrete elements with micro-cracking induced damage, where the specimens suffer from freeze and thaw cycles. Sequentially obtained time domain data were transferred to frequency domain using Fourier transform, in order to identify the nonlinearity through the rate of frequency changes. The results illustrate that the applied nonlinear wave analysis enables to evaluate severity of micro-cracks in concrete and possibly provides meaningful information of early damage detection compared to linear ultrasonic results. Further experimental studies of nonlinear wave analysis are conducted through optical microscope. Based on the experiment study, the non-classical theory of elasticity is considered.

School of Urban & Environmental Engineering

- **When :** 2019.11.21. (Thu) 16:00
- **Where:** Bldg.110 (EB4), Room.1007
- **Host :** Prof. Shin, Myoungsu
  ext. 2814, msshin@unist.ac.kr