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Suitable coupling guideline for propagation ability using embedded vibration sensor

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Sensors based on vibration measurement (e.g., acoustic emission or micro seismic) have been used to monitor the safety of underground rock. These sensors can be utilized to detect crack generation or deformation due to cyclic loading or sudden stress on the underground structure such as tunnel, energy storage cavern, and radioactive waste disposal.
For using this technique, the sensors should be embedded with the coupling materials (e.g. cement paste) in drilled hole of the structure when the sensors are installed in the target rock medium. This is because the influence of external noise should be minimized that the signal generated by cracking in the rock are not disturbed by external noise. In addition, the coupling material performs an important role to ensure the reliability of acquired signals such as minimizing the attenuation of propagated vibration signal through coupling medium. If the coupling process is imperfect, the reliability of monitoring quality is not guaranteed by attenuation of elastic wave energy propagated from rock medium to sensor.
The coupling characteristics in terms of propagation ability depend on the impedance of coupling material. For example, the coupling design in terms of propagation ability is considered as excellent conditions when the difference of impedance between coupling medium and target rock medium is minimized. Therefore, it is important to understand the relation of impedance between coupling material and target medium for successful damage monitoring.
For coupling materials based on the cement, the characteristics of the coupling material depend on the water-cement ratio. The water-cement ratio is an impact factor to determine the impedance (i.e. wave velocity and density) of the coupling medium. Therefore, the proper water-cement ratio of a coupling material should be designed to minimize the difference between coupling medium and target rock medium.
This study carry out to suggest the suitable coupling guideline in terms of propagation ability for improving the reliability of measured vibration signal in drilled hole. Portland cement was selected as a coupling material. Experiments were performed to investigate the impedance of cured Portland cement with the four types water-cement ratio in a range 0.5 - 2.0. In addition, to estimate the difference of impedance between coupling medium and target rock medium, two weathered granite specimens were considered as references. This study is considered to be useful to decide the suitable coupling design in terms of the propagation ability for sensor coupling installation in the field based on the underground rock.

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