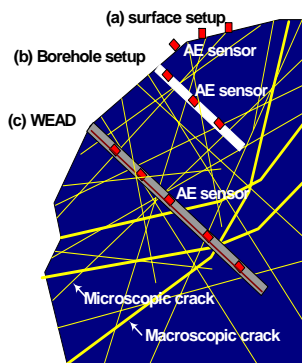


Highlights:

- Rock Failure
- Indispensable Conditions of WG for Rock Slope
- Concept of the WEAD
- AE Data Flow
- Evaluation of AE Signals
- Applications



Methods for installing AE sensors



WEAD applied T-site

Rock Failure

Accidents due to rock failure have become a public concerned object. WEAD, wave-guide for AE waves due to rock deformation, has developed as a prospective method to detect AE signals effectively from deformation of rock slope. When WEAD is applied, reasonable evaluation of fracture status is possible with TAMS software.



Toyohama tunnel accident

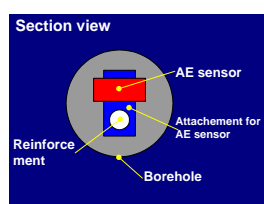
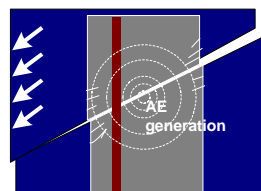
Indispensable Condition of WG for Rock

Deformation due to rock failure expected is so small, wave-guides devised for AE monitoring in geotechnical materials can not apply for rock monitoring. Since continuous field AE data may include considerable amount of noises due to natural phenomena, proper sensor installation should be designed. Moreover, natural rock contains pre-existing joints, resulting AE waves generated within rock are almostly reflected at the joints when they propagate through the joints, irrespective of the frequency characteristics. Thus, the imperative conditions of wave-guide for rock are as follows,

AE signals detected, should not be influenced by the crack condition but should reflect fracture due to rock behavior directly. Additionally, the AE signals can be monitored throughout the final failure.



Joints conditions of rock



Behavior of WEAD under deformation of rock



WEAD

Waveguide for AE Waves due to Rock Deformation



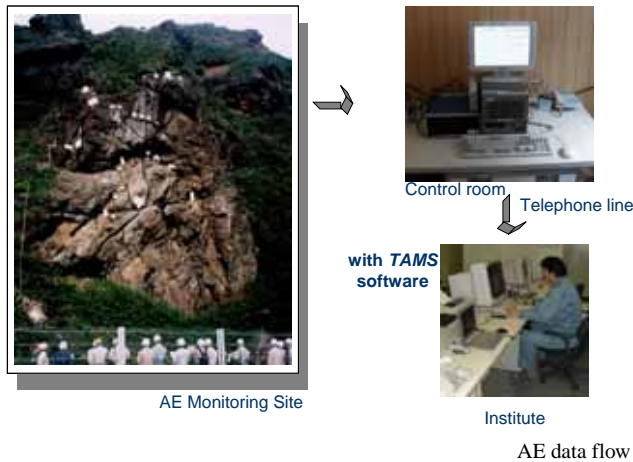
Concept of the WEAD

To meet the above indispensable conditions on the wave-guide for rock materials, WEAD, wave-guide for AE waves due to rock deformation, has successfully developed. The WEAD is composed of cementitious material and reinforcement with AE sensors. The mixture proportion of the cementitious material is designed with reference to the mechanical properties of in actual sampled rock. Applying the WEAD, these can be achieved:

AE waves generated within the WEAD would be compatible to those due to deformation of actual rock. Various fracture tests can be experimentally performed to obtain the AE characteristics associated with fracture. Reasonable fracture-evaluation at the site can be readily performed in comparison with the empirically obtained fracture criteria.

Data Flow of AE signals

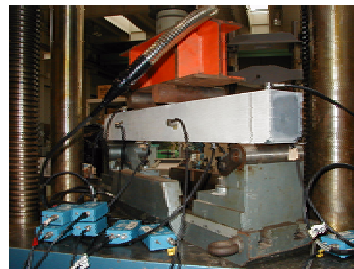
AE data in continuous field monitoring is first stored in a Remote Mistras AE System. Not only to gather the AE data, but changing the monitoring condition, can be executed by a remote PC with a variety of ways of communication, followed by processing the AE data to the analyzing PC with TAMS software.



Reasonable evaluation of AE signals with TAMS software.

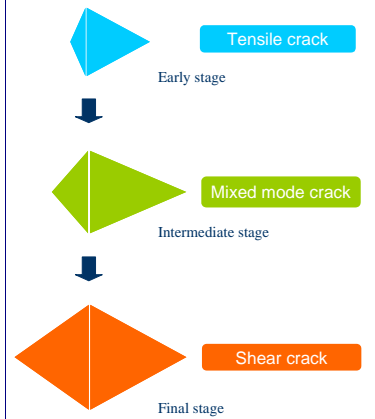
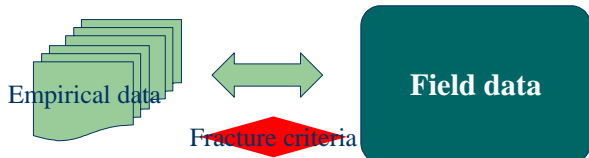
Evaluation of AE Signals

Various fracture tests for the WEAD can be readily carried out because the WEAD consists of cementitious materials of which the mechanical properties have already known. Based on the experimental results of AE activity associated with evolution of fracture, fracture criteria can be established. Concretely, such AE parameters as ring-down count, energy, grade, improved *b*-value are used for classifying fracture levels.



Bending test of WEAD

Grade and improved *b*-value are both original parameters of Tobishima Corporation, relating strongly to fracture types and fracture scale.

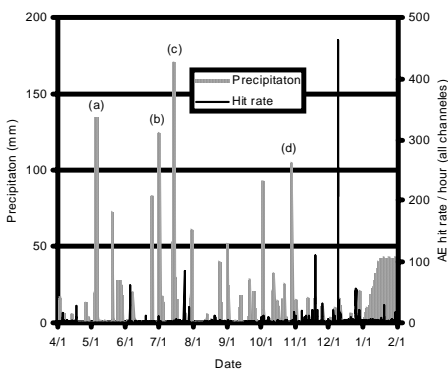


Variation of waveforms expected with progressing fracture

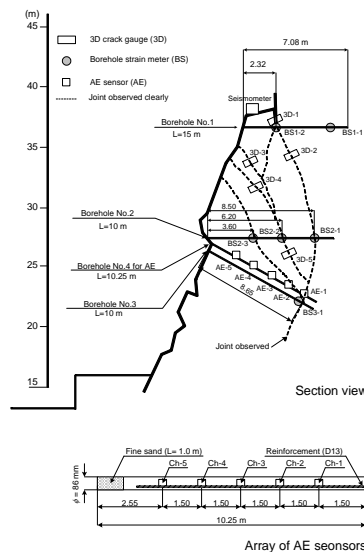
Output filter

Applications

The WEAD has successfully applied to many sites of rock failure monitoring in Japan. Satisfactory reputations have been obtained from many clients. The right figure shows the rock slope to monitor in cooperation with CERI Hokkaido.



AE activity with precipitation



Configuration of sensor setup

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