

Potential for Monitoring Earth Activities using Optical Fiber Network and DAS (Distributed Acoustic Sensing) Technology

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DAS (Distributed Acoustic Sensing) technology has been introduced more than 5 years ago for the demands of pipeline monitoring and intrusion detection in Oil & Gas business. The latest optical fiber sensing technology now allows DAS to record Seismic signal including VSP (Vertical Seismic Profiling). The system is called 'hDVS' (heterodyne Distributed Vibration Sensing) in order to distinguish from pipeline monitoring system.

Unlike conventional seismic recording system, which usually use electro-magnetic sensor or Geophone, hDVS/DAS uses optical fiber as vibration sensor. It measures dynamic strain of the optical fiber, either SMF (Single-Mode Fiber) or MMF (Multi-Mode Fiber) for entire length or the section defined by the system. In case of SMF, the maximum length of the optical fiber is around 50km, while the maximum length is reduced to around 10km for MMF with current system, depending on the level of optical signal loss and optical sampling frequency.

Conventional electro-magnetic seismic sensors have been installed all over the places in Japan, especially after the Tohoku earthquake and tsunami in 2011, however, the measurement of the conventional sensors are point basis, while installation cost and environmental ratings of the conventional sensors limits the number and location of the sensor installations.

In case of hDVS/DAS system, any existing optical fiber installations, which have been used for data transmission purpose mainly, would become line shaped seismic sensor instantly. This fact allows installation cost and time minimized. As a part of the IT Revolutions last 20 years, there have been built the network of optical fibers across Japan and over the ocean between Japan and US or other Asian countries. Especially, the international ocean bottom optical fiber cables were installed over the Seismogenic areas. If the ocean bottom cables would become seismic sensor instantly, how would you like to use the data?

In terms of environmental specification of optical fiber, the core part is made of high-silica glass, so that high temperature version of optical fiber is widely available over 200 degC where conventional sensors cannot be installed. There are 500 degC or even higher the temperature rating fibers are available using special coating materials. It means optical fiber sensor would potentially be installed near the Seismogenic layers in deep wells, which would allow real-time seismic activity monitoring with speed of light.

hDVS/DAS technology would potentially allow us to have comprehensive real-time monitoring network on surface, ocean bottom or subsurface of Japan without requiring high cost and time in order to minimize loss of human life and our lovely heritages during upcoming events which we cannot eliminate.

During the presentation, overview of hDVS/DAS system and examples of seismic data recorded during Field trials last few years will be explained, followed by vision of Earth Activities monitoring network in Japan.

Keywords: DAS, hDVS, Optical Fiber Network, Earthquake Monitoring, Seismic