

# Potential for Real-Time Earthquake Monitoring using Optical Fiber Network and DAS Technology

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During the JpGU 2016, I introduced that DAS (Distributed Acoustic Sensing) technology was introduced in 2011 for the demands of pipeline monitoring and intrusion detection in Oil & Gas business, and the latest optical fiber sensing technology using 'differential phase' data now allows DAS to record seismic signal including VSP (Vertical Seismic Profiling). The system is called 'hDVS' (heterodyne Distributed Vibration Sensing).

Unlike conventional seismic recording system, which usually use electro-magnetic sensor or Geophone, hDVS 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 a section defined by the use.

Conventional electro-magnetic seismic sensors have been installed all over the places in Japan after the Great Hanshin earthquake in 1995, and then the network has been expanded including ocean bottom after the Tohoku earthquake and tsunami in 2011. The earthquake monitoring network in Japan is indeed the densest in the world. 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 addition, it has been concerned about the damage of the existing monitoring network hit by a mega earthquake in the future, and then the continuous monitoring would be affected when needed.

In case of hDVS system, any existing optical fiber installations, which have been used for data transmission purpose mainly, would become line shaped seismic sensor. This fact allows installation cost and time minimized. As a part of the IT Revolutions, there have been built the network of optical fibers across Japan and over the ocean between Japan and US or other Asian countries. Since the international ocean bottom optical fiber cables were installed over the seismogenic areas where the boundaries of the plates existing, by using an hDVS system it would be possible to monitor the activities of the plates several tens of kilometers of distance in real-time.

The environmental specifications of optical fiber, 200 degC or even much higher the temperature ratings and over 200,000psi pressure ratings, optical fiber sensor would potentially be installed near the Seismogenic layers in deep wells or near volcanos, which would allow real-time seismic activity monitoring with speed of light.

In addition to the existing earthquake monitoring network, hDVS technology would potentially allow us to have comprehensive real-time monitoring network with speed of light on surface, ocean bottom or subsurface of Japan, where no sensor is available, without requiring high cost and time. Using such comprehensive monitoring network, it is believed that loss of human life would be minimized from upcoming events which we cannot eliminate.

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