

# Progress of Seismic Monitoring System using Optical Fiber and DAS Technology

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During the JpGU 2016, I introduced that DAS (Distributed Acoustic Sensing) technology has been used since 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). Now, new tier-3 hDVS system has introduced in H2 2016.

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 a section defined by the user. In case of SMF, the maximum length of the optical fiber is around 40km with tier-2 hDVS system, while the maximum length is reduced to around 10km for MMF, depending on the level of optical signal loss and optical sampling frequency. With using new tier-3 hDVS system, it would be able to record longer (50km or longer) the length of SMF (100km is theoretical maximum length for hDVS/DAS). In addition, the S/N ratio of the data was improved by 15dB in Lab environment.

There are several advantages of hDVS/DAS system compare with current seismic monitoring system such as:

- a) Able to use existing optical fiber installations as seismic sensor.
- b) One system can measure line sensor over 50km rather than dot sensor.
- c) Easier to expand as monitoring network by using existing optical fiber network.
- d) Spatial resolution and gauge length can be set as parameters.
- e) Core part of optical fiber is made of high-silica glass which can be installed at harsh environment over 200 degC where conventional sensors cannot be used.
- f) Optical fiber is a passive component and no high risk of failure.
- g) In the case sensing fiber is broken by earthquake/tsunami, seismic monitoring can still be continued from the damaged point.
- h) Using WDM (Wavelength Division Multiplexing), there is a potential to use one fiber for both communication and seismic monitoring.

There would be more benefits can be identified.

Keywords: DAS, hDVS, optical fiber, seismic monitoring, earthquake, tsunami