

A new tool of borehole laser scanner for stress direction measurements

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A new sensor tool for borehole deformation using laser displacement sensor was developed for stress direction measurements at shallow.

Stress directions around earthquake fault depend on the amount of stress drop on fault plane and the distance between measuring point and the fault. The directions also vary along the strike of the fault because of the stress concentration at the fault edge. Therefore, we can estimate the ratio of stress drop on a fault plane to far field stress by the dense measurements of stress directions around earthquake faults. For stress direction measurement, Kuwahara et al.(2004) have proposed to measure the creep deformation of the borehole just after drilling in the anisotropic stress field at the depth of about 10 m where the disturbance caused by thermally induced stress from surface does not reach.

For designing a new tool for the measurement, we estimated the creep strain at 10 m depth in 24 hours just after drilling to be about $1.0E-6$. Laser displacement sensor is chosen to measure the above strain. Stacking of several thousands data obtained by laser sensor makes the resolution of about 0.1 μm possible.

The laser displacement sensor located at the bottom of the tool is rotated around 360 degrees continuously to measure radial displacement of borehole wall. Two centralizers are located to fix the tool in a borehole during measurement. The tool is designed to be applicable to the borehole of 116 mm in diameter because of the focus distance and a size of laser displacement sensor. The radial displacement is measured at each 2 degrees in rotation and the maximum stacking number is 7500 at 200 us sampling rate. It takes about 6 minutes to rotate the laser sensor in one cycle. The anisotropic stress field causes the cross section of the borehole to deform elliptically. We can fit the ellipse to the borehole cross section and determine the direction of axes of the ellipse, which coincide with the stress directions.

We have conducted several operational tests in the laboratory so that the new tool has the essential performance expected. We will conduct a field performance test in a former stone quarry mine. We also have plans to measure stress directions around earthquake faults.