The P and S wave velocity and geological conditions of shallow surrounding tunnel ground by velocity logging on tunnel side wall

*Kenji OKAZAKI[1], Toshiyuki KURAHASHI[1], Hiroumi NIWA[2]

1. Civil Engineering Research Institute for cold region, Public Works Research Institute, 2. FUJITA corporation

In the tunnel maintenance, the information for the condition of tunnel ground may be necessary to grasp its loosening or deterioration of the surrounding tunnel ground. One way method to estimate these condition is velocity logging. The velocity logging is a method of measuring P and S wave velocity in a borehole, and the condition of the tunnel ground can be estimated based on the velocity distribution. Normally, the S-wave velocity is measured by applying a top load to a thick plate placed horizontally on the ground surface and tapping it. However, in order to measure the S-wave velocity in a horizontal ground in a tunnel, it is necessary to vibrate the concrete surface of the side wall, and it is necessary to fix the thick plate used for its vibration to the side wall surface is there. Touyama et al. 2018 show the results of striking with a thick plate fixed to the ground by a spike of 30 cm in length, and clear and equivalent waveforms are measured compared with the case where it is not fixed by spikes, and the amplitude of the S-wave has been amplified to about 2 times.

In this study, a core drill (Niwa et al. 2017) at the two points A and B on the side wall part covers 5.0 meters at point A, 3.8 meters at point B was excavated and the these core were collected in the tunnel that constructed by the sheet pile construction method. In addition, velocity logging by the downhole method was performed in each hole, and the correspondence between the properties of the excavation core and the P and S wave velocity was compared. The P-wave velocity was measured by directly hitting the concrete surface of the side wall around the boring hole with a steel hammer. The S-wave velocity was measured by driving four anchors on the concrete surface of the side wall, fixing the thick plate so as to be in close contact with a screw type anchor bar, and hitting a thick plate with a hammer from both directions.

As a result of drilling by the core drill, at the point A, the andesite was confirmed on the back side of the liner concrete of 0.87 m. An andesitic rocks were collected as rod-shaped cores that emit metal sounds somewhat by hammer consultation. At point B, we also confirmed the andesitic rocks at the back of the liner concrete of 0.75 m in the same way. The andesite was collected as a short columnar core up to about 40 cm which emits a voiced sound at hammering consultation. As a result of velocity logging, the P-wave velocity at point A was 2170 m/s and the S-wave velocity was 1050 m/s. In addition, it was confirmed that inverted waveforms could be measured symmetrically with S-waves hit from both directions. The P-wave velocity at point B was 980 m/s and the S-wave velocity was 550 m/s, confirming a tendency lower than point A. It is thought that this is due to the fact that the same andesite is distributed at both sites, but the site B is in a situation with more degradation and cracks than at point A. It was confirmed that the inverted waveform of S-wave at point B was also measured symmetrically. In this survey, we measured the S-wave velocity for the ground in the horizontal direction of the tunnel with the vertical surface of the side wall concrete on tunnel, and we were able to obtain good waveform. By the simple method like this survey, we could grasp the velocity distribution of the shallow part of the tunnel and obtained information to evaluate the condition of the surrounding tunnel ground.

Keywords: tunnel, velocity logging, geological survey, core drill

