Case study on a newly modulus of deformation considering a continuous state of crack in the tunnel ground

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The physical properties concerning the state of the tunnel ground is very important for the accurate re-modification of tunnel ground classification and numerical analysis in the tunnel construction stage. Therefore, the geological properties ahead of tunnel face might be confirmed by the horizontal drilling survey results. And the physical properties, such as P-wave velocity by the velocity logging, the modulus of deformation by the borehole loading test, and the P-wave velocity results, etc., of the laboratory tests of the bore cores were measured for re-evaluation just before the tunnel excavation. Though, P-wave velocity by the velocity logging is different from a P-wave velocity of bore core in method for measurement and a target range, P-wave velocity by the velocity logging was continuously measured value along the all borehole length with influence of the state of the crack in the tunnel ground. Therefore a coefficient of fissures is found from a core and a ratio of P-wave velocity of the tunnel ground, and the item of the ground classification is corrected by this coefficient of fissures. On the other hand, the modulus of deformation is measured at the loading point as a limitation. However, when the modulus of deformation can be grasped as the continuous distribution, we could obtain the more accurate geo physical data.

In this report, we compiled the geological survey results of national highway tunnels which were constructed into the volcanic rock area in Hokkaido. To obtain the modulus of deformation along the borehole, S-wave velocity along the continuously borehole was calculated using the P-wave velocity by velocity logging, the P-wave and S-wave velocity by the bore core test results. Then, the dynamic modulus of elasticity of borehole was calculated using the dynamic shear modulus of elasticity and the dynamic Poisson's ratio based on the P-wave velocity by velocity logging, the S-wave velocity along the continuously borehole and wet density results of the laboratory tests of the bore cores. This determined dynamic modulus of elasticity is correspond to modulus of deformation considering a state of crack in the tunnel ground, due to the S-wave velocity along the continuously borehole is already considered the coefficient of fissures. After that, the dynamic modulus of elasticity along the borehole was compared with the modulus of deformation by the borehole loading test and the dynamic modulus of elasticity by bore core.

As a results, the dynamic modulus of elasticity along the borehole was obtained as 3,000 - 36,000 MPa. These values are lower than the dynamic modulus of elasticity by bore core, 300 - 68,000 MPa, and higher than the modulus of deformation by the borehole loading test, 400 - 10,000 MPa, due to different of the method for measurement and a target range. Moreover, the proportional relation was confirmed between the dynamic modulus of elasticity along the borehole and P-wave velocity by the velocity logging, as a better tendency than the relationship between the modulus of deformation by the borehole loading test and P-wave velocity by the velocity logging. Thus, the P-wave velocity by the velocity logging is thought to be useful for the estimating the modulus of deformation along the continuously borehole and re-design of tunnel.

Keywords: tunnel, ground classification, modulus of deformation

