Study on rock physical interpretation of geophysical data for geotechnical applications

Toru Takahashi[1]

[1] none

In recent years, rock physical interpretation of seismic data has been aggressively used in oil and gas industry for characterizing and monitoring oil and gas reservoirs. In this field, only sedimentary rocks such as sandstone have been modeled using mainly seismic data. In civil engineering and environmental applications, rock physical interpretation of geophysical data has become more important to obtain mechanical and hydrogeological subsurface models. In geotechnical applications, not only sedimentary rocks but also crystalline rocks such as granite must be characterized and modeled for further analysis.

We have therefore started studying rock physics models of wide variety of rocks using many geophysical data for geotechnical applications. We firstly collected the data of physical properties of rocks obtained in laboratory tests and well loggings and then used these data for preliminary study of applicability of the existing rock physics models. In this paper we briefly review the present interpretation technologies of geophysical data for geotechnical applications and rock physics which has been mainly developed in the oil and gas exploration field. Then the lists of physical property data collected are presented with some real data examples. Using the collected data, we have conducted applicability tests of the existing rock physics models. Among the various types of rock data, seismic velocity data of young soft mudstones and crystalline granite which are very common rocks in geotechnical applications in Japan are employed in the tests in order to clarify the problems to be addressed in the future study on rock physical interpretation of geophysical data for geotechnical applications.

The high porosity granular model which has been developed for application to oil and gas reservoir rocks showed its high applicability to Tertiary mudstone in Japan. It was also noticed that use of S-wave velocity data together with P-wave made rock physics modeling more precise and reliable. The test results reveal that for the soft rocks confining pressure and clay content are crucial parameters for precise rock physics modeling and more study on estimation of these parameters will be necessary in future.

P-wave velocity data obtained with sonic logs in fresh granite and those obtained with laboratory velocity measurement of granite sampled at surface outcrops including strongly weathered were used for the applicability tests of the existing rock physics models. The Kuster-Toksoz model (Kuster and Toksoz, 1974), which has been often employed in modeling a cracked hard rock was applied to the P-wave velocity - porosity relation of the fresh granite and showed its high applicability for the rock with the porosity less than around 10%. The velocity - porosity relation of the granite including the weathered granite with high porosity of 30% was well described by a granular model. These test results suggest that further study on any mixed or unified models combining both granular and cracked models.