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Some New Correlations of Q-Value with Rock Mechanics Parameters in Underground Oil Storage Caverns

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Abstract

Q-system is a preferred alternative method of rock mass classification for underground oil storage caverns where stable lithological rocks are widely distributed. In this paper, correspondences between important input rock mechanics parameters (friction angle, cohesion, tensile strength, Poisson's ratio, deformation modulus) and Q values were investigated, thereby bringing convenient to rapidly obtain available parameters when it's hard to collect measured field data in underground storage projects basically with similar lithology. The proposed correlations were verified through numerical simulation and on-site monitoring measurement. In addition, comparison of different criteria among Q-system and other codes for rock mass classification has been made to help for making a preliminary evaluation of rock mass quality in the practical engineering. Finally, the behaviours of surrounding rock deformations under different Q values were analysed by using FLAC3D code with the calculating parameters suggested in this paper, and the calculation results match well with measured values in situ. Above results will not only guide the construction but also could be relevant to other underground storage engineering under similar geological conditions.

Keywords: Underground Oil Storage Caverns; Rock Mechanics Parameters; Q-System.

1. Introduction

At present, water sealed underground petroleum storage caverns in rock is the main way used for strategic petroleum reserve. Constructing large water sealed underground oil storage caverns in coastal regions where granite, welded stuff and other stable lithological rocks are widely distributed, is no doubt a project with better comprehensive economic effect. It has been reported to have many advantages in construction cost, environmental protection, and operation safety [1-4]. The earliest reference to the use of a rock mass classification system for engineering purposes is the rock load theory that was published by Terzaghi [5]. Since then, many systems have been developed, e.g. the Rock Quality Designation (RQD) system [6], the Rock Mass Rating (RMR) system [7-9], the Norwegian Geotechnical Institute Q-system (Q) [10], the Rock Structure Rating (RSR) system [11], the Geological Strength Index (GSI) [12], and the New Austrian Tunneling Method (NATM) [13], to improve methods for designing structural support systems. Q-system is a preferred alternative method of rock mass classification for oil storage projects.

The Q-system developed originally at the Norwegian Geotechnical Institute by Barton, Lien, Lunde [13], and evolved to its final state by Grimstad and Barton [14] with minor updates by Barton [15]. Some researchers have focused on

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