Numerical stability analysis of heterogeneous rock masses of right shaft slope in Siah Bishe Dam, North Iran

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Abstract

Siah Bishe pumped storage power plant with capacity of 1000 MW is the first pumped storage power plant that is located in the northern part of the Alborz mountain range in Iran. There are two parallel pressure shafts in the slope which both of them are 450m long and their diameters are 6m with 65 degree inclination relatively south-north trend. The pressure shafts slope is highly tectonically disturbed. The site area and especially the area of the pressure shaft are characterized by the presence of three important thrust faults which cut through the whole stratigraphic series. The shafts are arranged in sedimentary and volcanic highly jointed rocks of Triasic and Jurasic ages. In addition, based on several results of site investigations, there are lithologically varied rock masses. These have led to complicated situations and complexities for the project, especially for excavating the pressure shafts. In order to predict and also analyze the stability condition of the shafts, numerical modeling has been used. The results show instabilities within the slope, especially the boundar of Elika and Nesen formations which have highly different permeabilities. The permeabilities diversity has prevented underground water discharge in the boundary. This has led to instabilities in the shafts excavation process. Also, this boundary was severely techtonized; hence, it was very potential to have such huge instabilities. Numerical modeling results show the same instabilities, and they prove that by means of numerical modeling, it is possible to predict and estimate instabilities in geotechnical projects.

Key Words: Jointed rocks, crashed zones, lithology, various rock masses, numerical analysis, Siah Bishe Dam.

Introduction

Iran Water and Power Resources Development Company was entrusted 1983 with the design of Siah Bisheh pumped storage scheme. The waterways of the plant, which are now under construction (Fig. 1), are located in the northern part of the Alborz Mountain, at a distance of 80 km from the Caspian Sea (Moshanir Consultant Engineer, 2002).

The pumped storage plant passes through Jurassic Shemshak, Triassic Elika layers, and the strata of Permian age, called Dorud, Ruteh, and Nessen formation. The Main Thrust Fault (MTF) separates the Jurassic formation from the Triassic one (Darvishzadeh, A., 2003). The shafts are being constructed in Elika, Nesen, Routheh, and Doroud formations. These formations consist of shale, slightly sandy siltstone, sandstone and thin layered limestone and intrusions of igneous rock such as spilitic basalt partially bedding parallel orientated.

The stability of pressure shafts slope of Siah Bisheh Dam is discussed in this paper. The geology of the pressure shaft slope continuously raised discussions since end of 2003. An extensive investigation program was thereafter initiated in April/May 2006 by authors with the aim to investigate the geological conditions of shaft area in more detail. A few boreholes were drilled from the main access tunnel, the intermediate access tunnel, and the surface (Hassani, H., Arshadnejad, 2009).

Geology and structural settings

The area of the pressure shaft slope of Siah Bisheh Dam is characterized by the presence of non-metamorphic or very low metamorphic stratigraphic series. The oldest rocks outcropping in the area belong to the Early Permian Dorud Formation (Sandstones and shales). The series continues with a late Permian limestone (Ruteh Formation) and interbedded limestones and shales (Nesen formation). Both formations are intercalated with volcanic rocks of the Melaphyre complex (Hassani, H., Arshadnejad, 2009).

In the pressure shaft area, this stratigraphic series is in some cases complicated by thrusts and faults that has produced repetitions and/or lacks within the stratigraphic series. The main geological features observed on both sides of the pressure shaft slope are two major sub-vertical fault zones