Analysis and Design of Pressure Tunnels, Utilizing Common FEM Based Softwares

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Abstract

Pressure tunnels are used to transfer water under high pressure values. Considered deterministic terms and conditions contributed in design of such tunnels significantly affect results of any related analysis, resulting in necessity of a realistic modeling containing any possible situation. In this paper, modeling, discussion, analysis and design process of a pressure tunnel is presented regarding practical conditions usually available. This procedure contains initial data which must be provided, discussion on functionality of common support systems in variable executional conditions, modeling details and tips, seepage analysis in potential cases, stress/strain analysis and design of liner based on reinforced concrete design concepts.

Keywords: pressure tunnel, design, Phase 2.0, Geostudio

1.Introduction

Pressure tunnels and shafts in layout of powerhouse transfer water from upper sources (lake) to turbine. The amount of water pressure is one of the important design parameters. The change in stresses in the rock mass generated by the internal loading of a pressurized conduit, has traditionally been estimated assuming that the rock mass is impermeable and that the internal pressure in the tunnel can be treated as a mechanical load applied to the walls of the opening [1].In fact this viewpoint is not realistic, because under high internal pressure, water penetrates into rock mass through cracks and cavities. Conclusively, this phenomenon must be taken into account during related analyzes.

Pressure tunnels provide the greatest design challenges between underground openings. Failure to understand and address the technical issues of pressure tunnel design often leads to excessive leakage, water loss, slope failure and/or groundwater contamination. Specialization needed to design such tunnels generally include geology, rock mechanics, hydrogeology, seepage and contaminant assessment, tunnel lining design, grouting, and rock stress measurement. However, the decisions always involve a certain degree of risk [2],[3].

In this paper, a practical design method is proposed based on available data from some of recently executed pressure tunnels and the results are discussed based on assumed possible conditions and characteristics.

2.Initial Data

In order to obtain a realistic viewpoint of any problem, it's needed to provide adequate precise initial data to be used as an input for subsequent analysis. This data contains present material characteristics and possible field conditions [4].

Most pressure tunnels are lined with concrete to reduce head loss due to friction at the tunnel boundary, to reduce water loss through seepage, and to stabilize broken rockmass adjacent to the excavation surface. Such linings are generally unreinforced for tunnels with low internal pressures. However, reinforcement must be provided in the lining, even for such pressure tunnels, at tunnel intersections, at the enlargements, at inlet and outlet ends, in plug areas, and in those areas where the tunnel passes through a relatively weaker rockmass or where the rock cover is inadequate to counterbalance the water pressure [5].