# Study On Stability Of Dispatching Operation Level Of Jiping Channel In South - North Water Transfer Project

Xiaocheng Su
School of Resources and Environment, University of Jinan, Jinan, China, 250022
suxiaocheng@tju.edu.cn

***Abstract— The domestic and foreign research on the water level change of the channel scheduling involves many aspects at present.The water level fluctuation has an imortant influence on slope stability.In the process of water level fluctuation, the change of soil state from unsaturated to saturated and other problems which should be taken into account in the analysis of slope stability. A typical slope in the south to North Water Diversion Project is calculated by software in this paper. This paper described the simulation of the standard deviation of Mohr - Kulun, and mades a quantitative analysis of the influence of water level change on slope stability. The displacement and safety factor of the slope is obtained after the water level decline. It is of great significance for the design of water level control of all kinds of large-scale water transfer projects in our country.***

**Key words South - to - North Water Transfer Project; channel dispatch; finite element; stability**

## I. INTRODUCTION

South-to-North Water Diversion Project is currently the world's largest water diversion project. East and the middle line project has entered the implementation phase, the transfer line length of 3,000 km. The water diversion channel is the backbone project of the South-North Water Transfer Project, and is the key to realize the north-withering of the Yangtze River. The terrain and geological conditions in the area of the South - to - North Water Diversion Project are complicated, and the hydrology, meteorology and operating conditions are very different. Jiping Main Canal Project is an important part of the Eastern Route of the South-to-North Water Diversion Project, with a total length of 90km. Jiping trunk canal water transmission line to the south of the hilly area, the northern flood plain and depressions, along the complex terrain, the ups and downs by the ginger ditch, Ting Shan Tau, Diao Hill slope, Li Shan Tou, Dr. Hill and Guiping Yamaguchi The maximum height difference between the bottom of the channel and the ground is 40m, the slope is 0-1: 2.5, and the maximum slope is 80m. The erosion of the slope is serious, resulting in soil and water loss, channel siltation, slope instability and other issues. Especially, the maximum dredging depth of Diao Hill section of Jiping main canal is 40m, the area of confluence is larger than that of Quaternary Holocene, the soil is loose and the erosion is serious. High and steep slope stability and safe operation is placed in front of engineering and technical personnel a huge problem. The research on the stability analysis and reinforcement technology of the high slope of the channel can obtain the economic and rational channel structure optimized for the channel slope stability condition, significance. This paper reviews and learns a lot of relevant knowledge, comprehensively analyzes various reservoirs Water level fluctuation experiment in the South-to-North Water Diversion Project, and a typical cross-section in the South-to-North Water Diversion Project is calculated and analyzed by the relevant calculation software, which can provide the basis for the design of water level control of other water conservancy projects.

## II. STUDY ON STABILITY OF CANAL SLOPE

Abroad, there are many early work in this regard, than we lead many in the overall operation of the channel water level control has made many advanced results, and in large, medium and small types and for different functions of the channel scheduling Of the scheduling operation of the corresponding success of the various examples, it is worth our future practice and research work in the reference. Some foreign scholars try to learn from other areas of the model to deal with canal control problem. Attempts have been made to apply the CNN model used in many industrial fields to irrigation canal systems, but so far none of these have been very successful. With the advance of our society, the population is also rising sharply, the economic needs of our future will be in the channel water transfer has higher requirements, more improvements, for the future we will build a variety of large Water transfer project, from the channel's own safety performance and achieve pre-purpose considerations, the need for the overall operation of the overall scheduling control and design.

There have been some scholars through the finite element program combined with the corresponding geotechnical methods of the channel water level changes in the process of reservoir bank slope stability of a detailed analysis [1]. He compared the soil in the drainage and undrained conditions, the two cases, the results showed that the situation of drainage, water level decline, safety performance indicators also decreased, but when the water level dropped 20 meters, the water level and then drop the safety factor There is an increasing trend. In the undrained condition, the water pressure in the slope affects the slope safety performance. Therefore, he

put forward, the actual project the pressure of super-pore water should not be ignored, and corresponding to different reservoirs should be calculated corresponding to the most unsafe water level to be applied in the actual engineering check.

Some domestic scholars, represented by Zhang Yongsheng, studied the stability of soil slopes under the effect of seepage in 2004 by using the corresponding analytical methods in rock mechanics [5], and they used Mohr's model in soil constitutive model - Coulomb criterion, their study considers the tensile yield of soil and the effect of deformation on the stability of the original soil, so it is a further improvement of the yield criterion. The results of their research is a breakthrough in the safety of soil slopes caused by sudden drop in water level.

Later, some researchers in the process of water level decline in the slope of the unsteady seepage has been studied, studies have shown that the decline in water level when the bank slope involving the state of the soil changes in the soil moisture content changes will make the geotechnical So that different boundary conditions must be used to deal with such problems. In the study, according to the law of conservation of energy in water and gas, the new comprehensive theory was used to establish the model of two-phase flow [4]. The transformation of saturated soil and unsaturated soil was realized by exchanging the main variables, and the correctness of the hypothesis is verified by calculation. Therefore, in the future, the safety of the channel should be taken into account in the gas pressure in the rock mass when the water level of the channel operation is decreasing.

## III. CONSTITUTIVE RELATIONSHIP OF SOIL

The elastic ideal plasticity model Mohr-Coulomb model is adopted as the constitutive model of the soil. This model has a fixed yield surface, the yield surface determined by the model parameters, is not affected by plastic strain. The point within the yield surface represents the elastic state of the material, and all the strain can be recovered. The basic criterion of elastoplasticity is that strain and strain increment can be decomposed into two parts: elasticity and plasticity.

$$\varepsilon = \varepsilon^e + \varepsilon^p \quad \dot{\varepsilon} = \dot{\varepsilon}^e + \dot{\varepsilon}^p \tag{1}$$

Hooke's law links stress increments to strain increments, and substituting (1) into Hooke's law yields

$$\dot{\sigma} = D^e \dot{\varepsilon}^e = D^e(\dot{\varepsilon} - \dot{\varepsilon}^p) \tag{2}$$

According to the plasticity theory, the plastic strain increment is directly proportional to the derivative of the stress function. Therefore, the plastic strain increment can be expressed as a vector perpendicular to the yield surface, using the relevant flow rule. For the yield function of the Coulomb-Mohr model, the dilatancy angle of the soil calculated by the relevant flow law is too large. Therefore, the plastic potential function g is introduced in addition to the yield function. Plastic strain increment can be written as:

$$\dot{\varepsilon}^p = \lambda \frac{\partial g}{\partial \sigma} \tag{3}$$

Wherein $\lambda$ is hardening parameter, such as the material only elastic deformation occurs,then $\lambda$ =0, In the case of plastic deformation, $\lambda > 0$ :

$$f < 0 \quad \frac{\partial f^T}{\partial \sigma} D\dot{\varepsilon} \le 0 \quad \text{(elasticity)} \tag{4a}$$

$$f = 0 \quad \frac{\partial f^T}{\partial \sigma} D\dot{\varepsilon} > 0 \quad \text{(plasticity)} \tag{4b}$$

The relationship between the effective stress increment and the strain increment for the following elastoplastic mechanical properties can be deduced from the above equations:

$$\dot{\sigma} = \left( D^e - \frac{\alpha}{d} D^e \frac{\partial g}{\partial \sigma} \frac{\partial f^T}{\partial \sigma} D^e \right) \dot{\varepsilon} \tag{5}$$

In the formula:

$$d = \frac{\partial f^T}{\partial \sigma} D^e \frac{\partial g}{\partial \sigma} \tag{6}$$

## IV. MODEL ESTABLISHMENT

The research object of this paper is a typical cross section in large-scale water transfer project. The corresponding geometrical model is established and analyzed by finite element program. The displacement of the two sides of the dam after water level rise and fall, the stress distribution and the safety performance index are obtained. A typical section in the channel of South - to - North Water Transfer Project is selected, Slope height H=21m, Cohesionc=2.5kPa, Soil bulk density γ natural =16 kN/m$^3$ ; γ saturation =18kN/m$^3$, Internal friction angle =24°, Permeability coefficient kx、ky are 0.002m/d , Poisson's ratio υ Absolute value 0.35, Elastic Modulus E=2000kPa.

6-node or 15-node triangular elements, can be used to simulate the general properties of rock and soil. The 15-node triangular element is the program default. The use of 15-node triangular elements requires large amounts of memory, so there are significant drawbacks in computation and operation that are relatively slow. Thus, a simpler cell type can also be used if necessary. Here we use the 15-node unit, the establishment of the channel cross-section of the geometric model as shown below: