Study on the Relationship between the Law of Crack Propagation of Tunnel Surrounding Rock's Microscope Structure in Dilative Soil Tunnel with the Engineering Properties

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Abstract. According to the white strong expansive soil in Guangxi Zhuang Autonomous Region of China, the relationship between the processes of crack propagation in tunnel face with the engineering properties is investigated by using the scanning electron microscope. It can be observed that the crack of expansive soil in tunnel face is expanded with the increase of water content which is produced by the tunnel face exposed in the atmosphere. The failure and instability of tunnel surrounding rocks are causing the deformation of tunnel, which is leading to the supporting structures being damaged. Those untoward effects are harming the construction of tunnel engineering.

Introduction

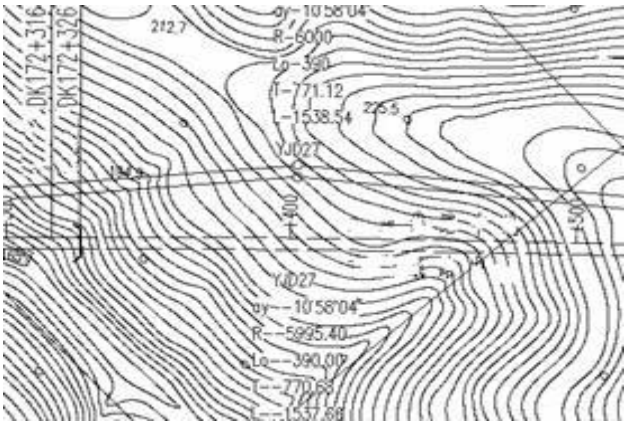
Expansive soil and its engineering problems has been one of the worldwide major issues in the field of geotechnical engineering and engineering geology research. At the same time, it will encounter more roads, railway tunnel and underground engineering through the expansion of geological area along with our country national economy rapid development and transportation construction progress[1, 2]. So, the engineering geological features of expansive soil and its influence on the stability of underground engineering should be researched in order to ensure the safety of underground engineering design and construction, which has important research significance[3]. A lot of research work have been doing at home and abroad. LEI Sheng-you[4] has founded that expansive soil's water flooding process is actually in it fissure and gap and the expansion of soil is producing new fissure and ultimately through the process by using the triaxial shearing process with the CT scan. LU Zai- hua[5] has been studied on the swell-shrink crack evolution of expansive soil during the dry-wet circulation through the CT test. Konrad and Ayad[6] have been presented a clay desiccation of field test results, and the cracking of theoretical model framework has been given on the basis of experimental results under the condition of the surface evaporation clay.

Based on the previous research results[7, 8], in order to master and evaluate the law of crack propagation in tunnel surrounding rock, the microscope structure in dilative soil tunnel is investigated and compared with the engineering properties of local project.

Project Summary

Yungui railroad in Guangxi Zhuang Autonomous Region of China is a primary railway line from the southwest to the southern part of china with overall length of 710.269 kilometers, and the length form Nanning to the boundary of Guangxi is 247.777 kilometers. The total construction period is 6 years, the railroad project form Nanning to Baise with the construction period about 48 months is constructed by the China Railway 14th construction bureau, which concludes 14 tunnels. The 2nd Nada tunnel has a control function, and its length is 924 meters, its maximal buried depth is 36 meters. The levels of the country rock are IV or V, and its surrounding rocks are expansive soil with small stength. Give priority to the pore water and bedrock fissure water, the groundwater growth is weak.

(a) the side-glance of tunnel



(b) the contour of tunne

Fig.1 The Nada 2 Tunnel

Method of Microscope Structure

Test materials are formed from Nada 2 tunnel project's face which are all yellowish-brown expansive soil. In accordance with the "regulations of the road test" (JTG-E40-2007), the basic physical and mechanical parameters of expansive soil is shown in table 1 for the requirements of the relevant experimental study related geotechnical properties[8].

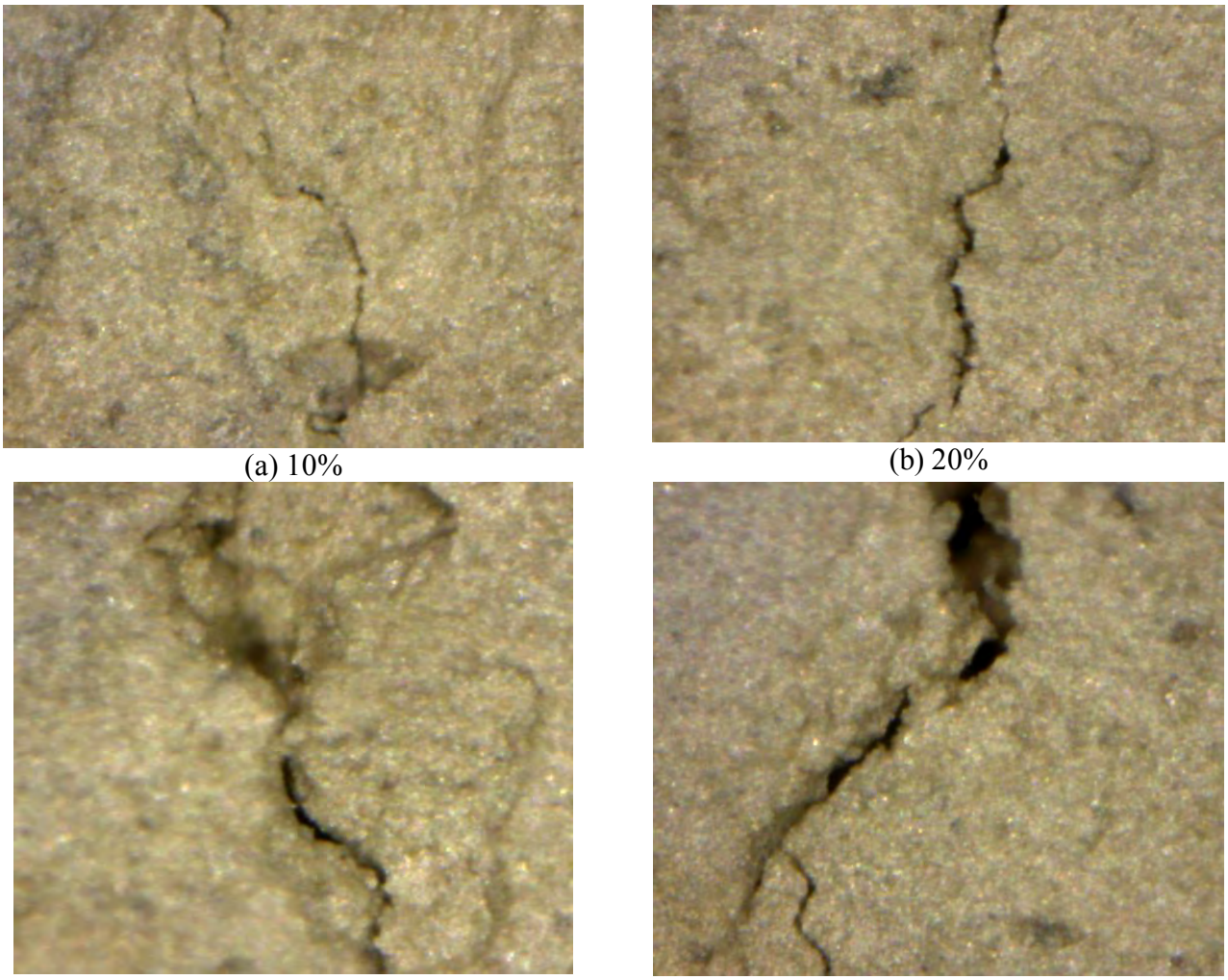
Tab. 1 Indices for Physical Characteristics of Specimen

Free swelling rate /%	Liquid limit W_L/%	Plastic limit W_p/%	plasticity index I_p/%	specific gravity G_s	maximum dry density ρd/ (g/cm3)	Optimum water content Wopt/%	Expansibility /KPa
60	47.9	21.6	26.2	2.72	1.44	25.7	85.38

The developing state of expansive soil's crack is described by using the scanning electron microscope, which is recorded the crack process. Graphics are cutting based on field scale 30mm * 30 mm. The method is mainly carried on the objective description of the expansion soil surface crack. This dry-wet circulation test instrument is using improved contraction under the condition of no load test. At the same time, it is also using oedometer respectively to 5 kPa, 10 kPa, 15 kPa under the action of dry wet cycling test.

Expansive Soil Microstructure Analysis

To reveal the expansive soil in the case of different water content, the analysis of microscopic structure is investigated based on one crack propagation after being dried with different water content. The relationship between crack propagation with water content is showed in figure 2. It can be observed that (1) the crack propagation is expansive and increasing with the increase of water content. (2) The crack is fractured with each other and penetrating deeply into the tunnel surrounding rock. The presence of crack can significantly weaken the engineering properties of soil and rock, and cause various problems during tunnel building. (3) With the increase of water content, the strength of tunnel surrounding rock is weaken and it has to loading the pore pressure, which causes the support system of tunnel to supporting more stresses than those of initial condition. So, it is believed that the mechanical effect and shrinkage potential are the two necessary factors for crack initiation.



(a) 10% (b) 20%

(c) 30% (d) 40%

Fig.2 Relationship of Crack Propagation and Water Content after being Dried

Conclusions

Based on the white strong expansive soil in Guangxi Zhuang Autonomous Region of China, the relationship between the processes of crack propagation in tunnel face with the engineering properties is investigated by using the scanning electron microscope. It can be observed that the crack of expansive soil in tunnel face is expanded with the increase of water content which is produced by the tunnel face exposed in the atmosphere. The failure and instability of tunnel surrounding rocks are causing the deformation of tunnel, which is leading to the supporting structures being damaged. At the same time, to decrease the damage of support system, the big foot of arch is used. Those are effective reducing the deformation of tunnel surrounding rocks.

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