A Special Geological Disaster: Rock Heap and Stability Evaluation

ZHÜ Dapeng¹,³*, HE Lei¹ and DENG Qinglu²

¹ Southwest Petroleum University, Chengdu 610500, Sichuan, China
² China University of Geosciences, Wuhan 430074, Hubei, China
³ Key Laboratory of Disaster Prevention and Mitigation, Hubei Province( China Three Gorges University ) , Yichang 443002, Hubei, China

Abstracts: Rock heap is a special and rare geological hazard. At present, there are few evaluations on the stability of rock heap, so it is very important to evaluate the stability of rock heap based on model test and granular flow PFC2D to ensure the safety of engineering activities in human rock mass area. Taking the rock heap slope at the entrance of Daqianshiling Tunnel on Tianhuan Railway in Liaoning Province as an example, the deformation of rock mass under freeze-thaw, excavation and fluctuation of reservoir water level is analyzed, and effective and reasonable stability evaluation and control measures are put forward. Rock pile is a kind of remarkable special landform in Huanren area, which is concentrated in Huanxieshan-Daqianshiling-Yantongshan area, Huanren County, Liaoning Province, with an area of nearly 400 km². It consists of quartz sandstone and gravel-bearing quartz sandstone; the rock is hard and angular; the diameter is between 0.5–1.5 m, the larger is 2–3 m and the smaller is tens of centimeters; the block diameter is uniform in general, showing overhead structure; there is no gravel and fine-grained soil filling and no separation (Fig. 1). The rock heap area is in creep deformation state, and some of the bare rock heap trailing edges are loosened and fractured. At the boundary between bare rock heap and overburden rock heap, it can be seen that the bare rock heap is obviously loose, the boundary is clear, and there are tension cracks. The phenomenon of saber trees on the back edge of bare rock mound is common. Model test (Fig. 2) is based on similarity theory and engineering geological conditions of rock heap, the model test of influence of rock pile stability under excavation, freeze-thaw and fluctuation of reservoir water level was carried out. The results show that excavation has no obvious influence on the overall stability of the rock pile; the displacement of the back part of the rock pile slope presents a more obvious step-like development trend, and its trend of “stability–instability–new stability–new instability–stability”; the foot of the rock heap slope and the rock pile in front of the pile have large deformation. But due to the reinforcement of the anti-slide pile, there is no obvious deformation on the slope surface of the rock heap behind the pile. In order to ensure the stability of rock and soil in front of pile, protective measures such as back pressure and backfill should be taken before the pile. Based on granular flow PFC2D (Fig. 3), the evolution of rock heap slope deformation and stress field under reservoir impoundment condition was studied. The results show that the displacement variation law of rock heap slope without reinforcement is: front displacement > middle displacement > back edge displacement, surface displacement > internal displacement; the displacement variation law of reinforced rock heap slope is: front displacement > middle displacement > slope displacement. The displacement of the rear edge, the surface displacement of the slope > the internal

Fig. 1. Overhead structure of bare rock heap.

Fig. 2. Slope model of rock heap after frost heave.
displacement of the slope, the displacement of the rear part of the slope changes relatively little, and some of the positions even have little displacement change. Through PFC2D, the numerical simulation of the unconsolidated and reinforced underlying ice pile slope under the condition of fluctuation of reservoir water level is carried out, and the displacement change of the rock heap slope is analyzed, and the displacement change similar to the model test is obtained. The results show that the stability of rock heap slope can be effectively analyzed by granular flow PFC2D and model test, which is of guiding significance for practical engineering construction.

Key words: geologic hazards, rock heap, stability evaluation, model test, granular flow PFC2D

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References

About the first author
ZHU Dapeng, male, born in 1981 in Hubei Province; doctor; associate professor; master tutor; working in Southwest Petroleum University. He is now mainly engaged in the teaching and research of geological hazard prevention and control theory. Email: zdpcug@126.com; phone: 13666287087.