

Article

The Stability of Slopes and Building Structures Using an Energy Visualization Procedure

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Abstract: Many building structures in the southwest of China are constructed on slopes due to its mountainous terrain characteristics. Therefore, it is crucial to accurately study the stability of slopes and building structures during the construction and operation stages. Traditional numerical simulation methods for slope stability often analyze from the perspectives of stress and strain. However, due to the complex changes in stress and strain inside the slope, the traditional methods are not only complex but also result in some errors. The slope failure is essentially a procedure of energy transformation, dissipation, and mutation. Therefore, the slope stability can be analyzed more effectively from the perspective of energy changes. In this paper, an energy field visualization procedure is developed and applied to analyze the failure mechanism of slopes. First, the energy calculation principle of slopes was derived based on the principle of thermodynamics. Then, FLAC3D7.0 was used to develop the energy visualization procedure for slope. It was applied to a classical two-dimensional slope to calculate the safety factor of slopes and then compared with the traditional methods. Finally, the procedure was applied to two practical slopes and building structure engineering cases to study their stability and provide suggestions for practical construction. The research results show that the energy visualization procedure can correctly simulate the energy evolution principle in the procedure of slope failure. The sudden change of energy can be used to determine the safety factor and sliding surface of slopes. The error of the slope safety factor calculated by this procedure is only 0.02, indicating that the procedure is correct. The deformation and failure of slopes are essentially driven by energy. There are corresponding relationships between the energy stability stage and the slope equilibrium stage, the energy dissipation stage and the slope deformation stage, and the energy mutation stage and the slope failure stage. The preferred backfill scheme of high-fill slope engineering is one with less variation in gravitational potential energy and a greater increase in elastic strain energy. Pile foundation and building structure are effective methods to increase slope stability. Therefore, the energy visualization procedure developed in this paper can more intuitively and accurately analyze the stability of slopes and building structures.

Keywords: subgrade engineering; slope; energy visualization procedure; energy principle; slope failure mechanisms; building structure



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1. Introduction

The southwest of China is mountainous and hilly. Many building structures in its urban development are built along mountains, requiring necessary excavation, filling, and reinforcement of the original slope landforms. Therefore, it is crucial to accurately evaluate the stability of slopes and building structures during the construction and operation stages. The research of slope stability has always been a hot topic in geotechnical engineering. Its research methods are also constantly developing and progressing [1–6]. The traditional

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