

## **EMPIRICAL METHODS FOR STABILITY ASSESSMENT IN CAVES: A REVIEW**

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Empirical methods are useful for assessing both natural and artificially created caves (e.g. mine tunnels); they help predict collapse or identify unstable areas that require additional reinforcement. Ensuring rock mass stability in caves is essential for mining, underground infrastructure, and tourism activities, as millions of economic losses and thousands of people are affected annually. This study analyzes the current state-of-the-art empirical methods for assessing cave stability using bibliometric indicators and a systematic review to understand research hotspots and directions of development in the field. Based on the Scopus database, the methodology begins with a bibliometric analysis of 228 contributions to the literature from 1980 to 2023. Subsequently, a statistical analysis of the bibliographic data and literature review established the scientific contribution, collaboration, and trends. China, Italy and the United States (US) are the countries that produce and collaborate the most in this area of knowledge. This study also identified three key research areas: i) geomechanical criteria and parameters for calculating safety factors, ii) numerical analysis and finite element methods, and iii) geomechanical methods for rock mass assessment. Empirical methods for assessing rock mass stability in caves allow for a reliable assessment of rock mass behaviour. Although they have limitations and can be complemented by more advanced techniques (e.g. numerical modelling), they remain integral to subsurface stability analyses.