

## 《論文獎》

### 地面光達應用於露頭不連續面調查與岩體工程特性評估探討

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**摘要** 岩石工程道路邊坡經現地調查獲得可靠、直接的岩石材料種類與不連續面參數，為確保工程設計施工、設施營運維護及環境水土保持之關鍵資訊。在近年全球氣候變遷與極端氣候事件規模與頻率加大的衝擊下，迅速、精準的工程地質調查工具與作業方法，為落實工程設施與自然環境永續發展的不二法門。本研究利用三維雷射掃描技術（又稱光達技術，LiDAR），運用其可快速取得露頭表面幾何坐標描述點雲的特性，透過 2 處露頭現地地質調查，探討地面光達在工址地質調查之應用，並比較國際岩石力學學會建議工址現地調查作業方法所獲得的參數，分析評估邊坡的穩定特性，據以提出地面光達應用於露頭不連續面調查與岩體工程特性評估的適用性與限制，並提出地面光達應用於露頭調查的作業程序。研究結果顯示，地面光達技術可大幅縮減現地調查作業時間，為露頭不連續面調查與參數評估的新利器，由於室內分析工作量和點雲的精度決定了 LiDAR 應用於露頭不連續面調查的速度與精準度，未來針對調查成果與產出參數的檢核、在地質調查的應用與作業規範，包括點雲解析度、疊合容許誤差以及資料分析與檢核程序等，有待進一步深入研究。

**關鍵詞：**岩石工程、道路邊坡、工址調查、不連續面、參數評估、地面光達技術。

### Application of Ground LiDAR for The Investigation of Outcrop Discontinuities and Estimation of Associated Engineering Characteristics

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**ABSTRACT** Reliable and direct information about rock slope materials and discontinuity parameters from field investigation are keys to engineering design, structure maintenance and soil/water conservation. Under the impact of global climate change and the surge in extreme weather events, rapid and accurate equipment or procedures for geological engineering surveys are necessary to harmonize engineering facilities with natural environment. This study utilizes 3D laser scanning technology (also known as ground LiDAR), which obtains the coordinates of surface geometry rapidly in point clouds, to survey two outcrops. Applying ground LiDAR in a geological survey, we compare the results with those provided by the International Society of Rock Mechanics, and analyze the slope stability. This study also discusses the applicability and limitations of ground LiDAR technology in discontinuity investigation and estimation of rock mass engineering characteristics. Suggested operating procedures for the use of ground LiDAR technology in outcrop surveys are provided accordingly. The results show that ground LiDAR technology reduces the in-situ operation time significantly, thus facilitating efficient discontinuity surveys and outcrop parameters evaluation. However, the quantities of office work and the accuracy of point clouds depend on the velocity and accuracy of ground LiDAR surveys. Therefore, inspection of survey results and output parameters, along with the application and operating specifications of geological surveys, including point cloud resolution, reasonable error of superimposition, inspection procedures and data analysis, still await further research.

**Key Words :** Rock engineering, highway slope, site investigation, rock discontinuities, engineering parameter estimation, LiDAR.

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