

ABSTRAK

Jalan Trans Liang Melas Datas yang terletak di lereng Pegunungan Bukit Barisan, Kabupaten Karo, merupakan jalur utama yang menghubungkan enam desa dan tiga dusun di kawasan Liang Melas Datas. Jalan ini memiliki peran strategis dalam menunjang mobilitas masyarakat serta distribusi hasil pertanian, khususnya komoditas jeruk. Namun, kondisi geologi yang labil menyebabkan tingginya potensi kelongsoran lereng, sehingga kerap mengganggu aksesibilitas dan aktivitas sosial ekonomi masyarakat. Oleh karena itu, diperlukan kajian teknis untuk menilai stabilitas lereng dan menentukan perkuatan yang sesuai kondisi geologis dan geometris di lapangan. Penelitian ini bertujuan untuk menganalisis stabilitas lereng serta mensimulasikan metode perkuatan yang efektif. Parameter tanah diperoleh melalui pengujian laboratorium terhadap sampel tanah dari enam titik longsor, sedangkan data geometri lereng diperoleh melalui survei topografi menggunakan alat ukur hypsometer. Analisis kestabilan lereng dilakukan dengan pendekatan analitik menggunakan empat metode keseimbangan batas, yaitu Bishop, Janbu, Spencer, dan GLE/Morgenstern-Price, serta pendekatan numerik berbasis elemen hingga menggunakan perangkat lunak HYRCAN versi 2.0.19. Simulasi perkuatan lereng dilakukan secara numerik menggunakan perangkat lunak HYRCAN untuk menilai efektivitas metode perkuatan dalam meningkatkan nilai faktor keamanan. Hasil analisis menunjukkan bahwa seluruh lokasi tergolong tidak stabil dengan nilai faktor keamanan (FK) $< 1,8$. Nilai FK terendah tercatat sebesar 0,250 pada Lokasi 1 berdasarkan analisis menggunakan metode Spencer dan GLE/Morgenstern-Price. Perbandingan antara pendekatan analitik dan numerik dengan metode Bishop, Janbu, Spencer, dan GLE/Morgenstern-Price berturut-turut adalah 9,34%, 9,45%, 9,02%, dan 9,35% yang mencerminkan sensitivitas masing-masing metode, meskipun tetap konsisten menunjukkan kondisi lereng yang labil. Simulasi perkuatan dengan metode terasering dan pelapisan permukaan menggunakan *shotcrete* menunjukkan bahwa kedua metode mampu meningkatkan nilai FK hingga melebihi batas aman teknis ($FK > 1,8$). Metode terasering terbukti lebih efektif dalam menurunkan kemiringan dan meningkatkan kestabilan secara menyeluruh, sedangkan *shotcrete* direkomendasikan untuk area dengan keterbatasan ruang atau kebutuhan perlindungan terhadap erosi dan pelapukan.

Kata Kunci: Stabilitas Lereng, Metode Analitik, Metode Numerik, Program HYRCAN, Perkuatan Lereng

ABSTRACT

The Trans Liang Melas Datas Road, situated along the slopes of the Bukit Barisan Mountains in Karo Regency, serves as a primary route connecting six villages and three hamlets within the Liang Melas Datas area. This road plays a strategic role in supporting community mobility and the distribution of agricultural commodities, particularly citrus. However, unstable geological conditions result in a high risk of slope failure, often disrupting accessibility and socio-economic activities. In response, a technical assessment is necessary to evaluate slope stability and identify suitable reinforcement measures based on the geological and geometrical conditions observed in the field. This study seeks to assess slope stability under actual site conditions and to simulate appropriate reinforcement methods tailored to the area's specific characteristics. Soil parameters were obtained through laboratory testing of samples taken from six landslide points, while slope geometry was derived from topographic surveys using a hypsometer. The slope stability analysis was conducted using analytical approaches based on four limit equilibrium methods Bishop, Janbu, Spencer, and GLE/Morgenstern-Price as well as a numerical approach utilizing the finite element-based software HYRCAN version 2.0.19. Reinforcement simulations were performed numerically using HYRCAN to evaluate the effectiveness of various techniques in improving the factor of safety (FoS). The results indicate that all sites are classified as unstable, with FoS values below 1.8. The lowest FoS, recorded at Location 1, was 0.250 based on analyses using the Spencer and GLE/Morgenstern-Price methods. Comparisons between analytical and numerical approaches using Bishop, Janbu, Spencer, and GLE/Morgenstern-Price showed differences of 9.34%, 9.45%, 9.02%, and 9.35%, respectively, reflecting the sensitivity of each method while consistently indicating slope instability. Simulations of slope reinforcement using terracing and surface shotcrete application revealed that both methods significantly increased the FoS above the technical safety threshold ($FoS > 1.8$). Terracing proved more effective in reducing slope angle and enhancing overall stability, while shotcrete is recommended for areas with spatial limitations or where surface protection against erosion and weathering is required.

Keywords: *Slope Stability, Analytical Methods, Numerical Methods, HYRCAN Software, Slope Reinforcement*