



INTISARI

Banjarnegara merupakan salah satu daerah di Indonesia yang rawan longsor. BNPB mencatat telah terjadi 130 kejadian longsor di Banjarnegara sepanjang tahun 2016-2020. Salah satu kejadian longsor terbesar adalah longsor di Desa Clapar yang terjadi pada 24, 25, dan 29 Maret 2016. Upaya peningkatan stabilitas lereng perlu dilakukan untuk mengurangi resiko terjadinya longsor di masa mendatang. Metode *bioengineering* dengan penanaman vetiver (*vetiveria zizanioides*) merupakan alternatif metode perkuatan lereng yang ekonomis, ramah lingkungan, dan mudah diterapkan oleh masyarakat lokal. Sebagai metode alternatif perkuatan lereng, efektivitas penanaman vetiver perlu dipelajari, terutama untuk daerah rawan longsor.

Penelitian ini dilakukan dengan tujuan menganalisis stabilitas lereng ditanami vetiver serta menentukan metode analisis yang paling sesuai untuk kasus tersebut. Data yang digunakan merupakan data sekunder berupa properti akar vetiver dan properti tanah. Kekuatan akar vetiver dapat dikuantifikasikan sebagai penambahan kohesi (c_r) pada tanah yang kemudian dimodelkan sebagai lapisan tanah dalam analisis stabilitas dengan metode kesetimbangan batas (*limit equilibrium method*) tiga dimensi pada perangkat lunak Slide3. Untuk mengetahui efektivitas perkuatan akar vetiver, analisis stabilitas dilakukan terhadap lereng dengan penanaman vetiver sampai usia 5 tahun, variasi kemiringan lereng, serta kondisi penjenjuran tanah yang merupakan penyebab terjadinya longsor Clapar. Analisis juga melalui tahap *trial and improvement* dengan membandingkan beberapa algoritma dan metode pencarian untuk menemukan metode analisis yang menghasilkan peningkatan faktor keamanan yang konsisten.

Algoritma pencarian deterministik menghasilkan faktor keamanan dengan peningkatan yang lebih konsisten dibandingkan pada algoritma pencarian metaheuristik. Pemeriksaan tegangan tarik dan pemberian *tension crack* dilakukan untuk mengeliminasi tegangan tarik yang seharusnya tidak terjadi pada lereng. Hasil analisis menunjukkan vetiver dapat meningkatkan nilai faktor keamanan 11-45%, dengan peningkatan tertinggi terjadi pada masa awal penanaman vetiver yang pada masa tersebut akar vetiver mengalami pertumbuhan paling pesat. Kondisi penjenjuran tanah memberikan penurunan faktor keamanan hingga 26%, namun akar vetiver tetap dapat memberikan peningkatan faktor keamanan sebesar 10-30%. Pada kondisi kejenuhan ekstrim, akar vetiver mampu mempertahankan kondisi lereng hingga mendekati stabil.

Kata kunci : perkuatan lereng, *bioengineering*, Slide3, metode kesetimbangan batas, faktor keamanan



ABSTRACT

*Banjarnegara is one of the areas in Indonesia that is prone to landslides. BNPB noted that there had been 130 landslides in Banjarnegara during 2016-2020. One of the biggest landslides was the landslide in Clapar Village which occurred on March 24, 25, and 29 2016. As an address to reduce the future risk of landslides, it is necessary to increase slope stability. The bioengineering method by planting vetiver (*vetiveria zizanioides*) is an alternative slope reinforcement method that is low-cost, environmentally friendly, and easily applied by local communities. As an alternative method of slope reinforcement, the effectiveness of vetiver planting needs to be studied, especially for landslide-prone areas.*

The aim of this study is to analyze the stability of the vetiver root-reinforced slope and determine the most suitable analytical method for this case. The data used is secondary data consisting of vetiver root and soil properties. The strength of vetiver roots can be quantified as the addition of soil cohesion (c_r) which is then modeled as a layer of soil in stability analysis using the three-dimensional limit equilibrium method on Rocscience Slide3 software which produces a factor of safety. To determine the effectiveness of vetiver root reinforcement, stability analysis was carried out on the slopes with vetiver until the age of 5 years, variations in slope, also variations in soil saturation conditions which are the cause of the Clapar landslide. The analysis goes through a trial and improvement stage by comparing several algorithms and search methods to determine an analytical method that results in a consistent increase in the factor of safety.

The deterministic search algorithm produces more consistent in increase factor of safety than the metaheuristic search algorithm's results. Tensile stress checks and adding of tension cracks are carried out to eliminate the tensile stress that should not have occurred in the slope. The results of the analysis show that vetiver root can increase the safety factor by 11-45%. The increase in safety factor is strongly influenced by the depth of the vetiver roots penetrating the soil. The highest increase occurred during the early planting of vetiver, at which time vetiver roots grew rapidly. Soil saturation conditions provide a decrease in factor of safety of up to 26%, but vetiver roots can still provide an increase in factor of safety of 10-30%. In extreme saturation conditions, vetiver roots are able to maintain slope conditions until they are nearly stable.

Keywords : *slope protection, bioengineering, Slide3, limit equilibrium method, factor of safety*