PENGARUH KADAR AIR TERHADAP KUAT GESER TANAH PASIR YANG DIPERKUAT AKAR VETIVER BERDASARKAN UJI
GESER LANGSUNG DAN PENDEKATAN METODE ROOT BUNDLE MODEL WITH WEIBULL DISTRIBUTION
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INTISARI

Tanah longsor dangkal pada wilayah tropis banyak dipengaruhi oleh perubahan kadar air yang dapat menurunkan kuat geser tanah. Salah satu pendekatan ramah lingkungan untuk meningkatkan stabilitas tanah dangkal adalah penggunaan vegetasi berakar, seperti vetiver (*Chrysopogon zizanioides*). Penelitian ini bertujuan untuk menganalisis pengaruh variasi kadar air terhadap kohesi (c) dan sudut gesek internal (ϕ) tanah pasir yang diperkuat akar vetiver, mengestimasi kontribusi kohesi akar menggunakan metode *Root Bundle Model with Weibull Distribution* (RBMw), serta membandingkan hasil estimasi tersebut dengan hasil uji geser langsung.

Penelitian dilakukan pada skala laboratorium menggunakan pasir dengan variasi *Soil Moisture Content* (SMC) sebesar 0%, 5%, 10%, 15%, 20%, dan 25%. Sampel pasir tanpa akar dan pasir berakar diuji menggunakan alat uji geser langsung. Tanaman vetiver yang digunakan berumur 4 bulan. Karakteristik akar dianalisis melalui distribusi diameter, hubungan diameter dengan gaya tarik, serta *fitting* fungsi survival Weibull untuk menggambarkan kegagalan akar secara progresif. Nilai kohesi akar empiris diperoleh dari selisih kohesi sampel pasir berakar dan tanpa akar pada SMC yang sama.

Hasil penelitian menunjukkan bahwa kadar air memengaruhi parameter kuat geser tanah pasir berakar. Nilai ϕ pada sampel berakar mengalami fluktuasi dan mencapai nilai terendah pada SMC 25% sebesar 25,993°, sedangkan kohesi meningkat hingga nilai tertinggi 46,519 kPa pada SMC 25%. Hasil *fitting* Weibull menghasilkan parameter λ = 3,065 dan ω = 0,758, yang menunjukkan bahwa kegagalan akar berlangsung secara bertahap. Metode RBMw menghasilkan kohesi akar sebesar 10,479 kPa, sedangkan kohesi akar empiris berada pada kisaran 19,133-43,675 kPa. Perbedaan relatif antara kedua metode berkisar 45,23%-76,01%, dengan rata-rata 57,14%. Dengan demikian, RBMw memberikan estimasi kohesi akar yang konservatif dan perlu dilengkapi dengan uji geser langsung untuk menangkap respons komposit pasir-air-akar secara lebih menyeluruh.

Kata kunci: akar vetiver, kadar air, kuat geser, kohesi akar, RBMw

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ABSTRACT

Shallow landslides in tropical regions are strongly affected by changes in soil moisture, which may reduce soil shear strength. One environmentally friendly approach to improve shallow soil stability is the use of root reinforcement, such as vetiver grass (Chrysopogon zizanioides). This study aims to analyze the effect of soil moisture variation on the cohesion (c) and internal friction angle (ϕ) of sand reinforced with vetiver roots, estimate root cohesion using the Root Bundle Model with Weibull Distribution (RBMw), and compare the theoretical estimation with direct shear test results.

The study was conducted at laboratory scale using sand samples with Soil Moisture Content (SMC) variations of 0%, 5%, 10%, 15%, 20%, and 25%. Both rootless and root-reinforced sand samples were tested using a direct shear apparatus. The vetiver plants used in this study were 4 months old. Root characteristics were analyzed based on root diameter distribution, the relationship between diameter and tensile force, and Weibull survival function fitting to describe progressive root failure. The empirical root cohesion was obtained from the difference between the cohesion of root-reinforced and rootless sand samples at the same SMC.

The results show that soil moisture affects the shear strength parameters of root-reinforced sand. The internal friction angle of the root-reinforced samples fluctuated and reached its lowest value at SMC 25%, with 25.993°, while cohesion increased to its highest value of 46.519 kPa at SMC 25%. The Weibull fitting produced $\lambda = 3.065$ and $\omega = 0.758$, indicating that root failure occurred progressively rather than simultaneously. The RBMw method estimated root cohesion as 10.479 kPa, while the empirical root cohesion ranged from 21,856 to 43.675 kPa. The relative difference between the two methods ranged from 45.23% to 76.00%, with an average of 57.41%. Therefore, RBMw provides a conservative estimation of root cohesion and should be complemented by direct shear testing to better capture the composite response of sand, water, and roots.

Keywords: *vetiver roots, soil moisture, shear strength, root cohesion, RBMw*