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**Optimasi Perkuatan Lereng Galian Bukit Manyaran Terhadap Variasi Kemiringan, Curah Hujan Rencana,
dan Kondisi Seismik Lokal**
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ABSTRAK

Stabilitas lereng merupakan salah satu aspek krusial dalam menjamin keandalan da keselamatan infrastuktur transportasi pada daerah berbukit. Pembangunan Jalan Akses Tol Bandara Dhoho Kediri memerlukan galian lereng tinggi melebihi 20 meter pada Bukit Manyaran (STA 5+700 - 5+800) dengan variasi kemiringan bertingkat 1:1, 1:1,5, dan 1:2. Namun, pengaruh simultan antara variasi geometri, infiltrasi hujan ekstrem, dan beban gempa belum dievaluasi secara komprehensif pada kondisi paling kritis. Penelitian ini bertujuan menganalisis stabilitas Lereng Manyaran akibat variasi kemiringan, curah hujan rencana, dan beban gempa pseudostatik menggunakan metode elemen hingga, serta menentukan rekomendasi penanganan lereng paling optimal.

Analisis stabilitas lereng dilakukan menggunakan metode elemen hingga (*Finite Element Method*/FEM) 2D untuk memodelkan kondisi statik, infiltrasi hujan *fully coupled flow-deformation* (1–3 hari), dan kondisi gempa pseudostatik. Parameter geoteknik tanah diinput berdasarkan korelasi N-SPT *borelog* BH-STR-204. Analisis frekuensi hidrologi Log Pearson Tipe III menetapkan curah hujan rencana periode ulang 25 tahun sebesar 71 mm/hari, sedangkan beban gempa direpresentasikan sebagai beban gempa pseudostatik dengan koefisien seismik horizontal K_h = 0,2 yang diturunkan dari respon spektrum PUPR.

Hasil analisis menunjukkan lereng 1:1 pada kondisi statik tidak memenuhi kriteria aman SF untuk kondisi permanen (SF ≤ 1,5). Infiltrasi hujan 3 hari menurunkan *matric suction* dan mereduksi SF sebesar 2% - 4%. beban gempa menjadi faktor paling kritis yang menurunkan SF sebesar 36% - 44%, di mana lereng 1:1 dan 1:1,5 tidak memenuhi batas minimum SNI 8460:2017 (SF ≥ 1,1). Berdasarkan hasil analisis lereng pada kondisi statik, hujan, dan gempa, perkuatan yang dievaluasi mencakup pelandaian lereng (1:2), *soil nailing* (L = 12m) dengan *shotcrete,* dan *bored pile* (D = 0,5m, L = 17m). Berdasarkan matriks skoring evaluasi penanganan, perkuatan *bored pile* menjadi rekomendasi utama (skor 18/25) karena unggul pada keandalan umur layan dan efektivitas penahanan bidang gelincir dalam.

Kata kunci: *Bored Pile, Finite Element Method,* Infiltrasi Hujan, *Soil Nailing,* Stabilitas lereng.

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ABSTRACT

Slope stability is a crucial aspect in ensuring the reliability and safety of transportation infrastructure in hilly areas. The construction of the Dhoho Airport Toll Access Road requires deep cut slopes exceeding 20 meters at Manyaran Hill (STA 5+700 – 5+800) with benched slope geometries of 1:1, 1:1.5, and 1:2. However, the simultaneous interplay between geometric variations, extreme rainfall infiltration, and seismic loading has not been comprehensively evaluated under worst-case conditions. This study aims to analyze the stability of the Manyaran Slope subjected to slope geometry variations, design rainfall, and pseudostatic seismic loads using the finite element method, as well as to determine the most optimal slope mitigation recommendation.

Slope stability analysis was performed using the 2D Finite Element Method (FEM) to model static conditions, fully coupled flow-deformation rainfall infiltration (1–3 days duration), and pseudostatic seismic conditions. Soil geotechnical parameters were input based on N-SPT correlations from borelog BH-STR-204. Log Pearson Type III hydrological frequency analysis established a 25-year return period design rainfall of 71 *mm/day, while the seismic load was represented as a pseudostatic load with a horizontal seismic coefficient* $K_h = 0.2$ *derived from PUPR response spectra.*

The analysis results indicate that the 1:1 slope under static conditions does not meet the safety factor criteria for permanent slope conditions ($SF \leq 1.5$*). A 3-day rainfall infiltration reduces matric suction and decreases* SF *by 2%–4%. Seismic loading is the most critical factor, reducing* SF *by 36%–44%, where slopes 1:1 and 1:1.5 fail to meet the minimum threshold of SNI 8460:2017 (*$SF \geq 1.1$*). Based on the slope stability evaluation under static, rainfall, and seismic conditions, the evaluated reinforcement methods include slope flattening (1:2), soil nailing (*$L = 12$ *m) with shotcrete, and bored piles (*$D = 0.5$ *m,* $L = 17$ *m). According to the mitigation evaluation scoring matrix, bored pile reinforcement is selected as the primary recommendation (score 18/25) due to its superiority in long-term serviceability and effectiveness in restraining deep slip surfaces.*

Keywords: Bored Pile, Finite Element Method, Rainfall Infiltration, Slope Stability, Soil Nailing.