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PERANCANGAN FONDASI DALAM TOWER TRANSMISI SUTT 150 KV PADA TANAH RAWAN LIKUEFAKSI
Mohammad Althaf Ravi, Dr. Eng. Fikri Faris, S.T., M.Eng.,IPM.
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INTISARI

Keandalan fondasi *tower* transmisi SUTT 150 kV di wilayah rawan likuefaksi menjadi perhatian kritis mengingat fenomena likuefaksi dapat menyebabkan hilangnya kapasitas dukung tanah secara tiba-tiba. Lokasi perancangan berada di Kabupaten Toli-Toli, Sulawesi Tengah yang terindikasi memiliki potensi likuefaksi tinggi berdasarkan karakteristik geologi berupa endapan kuarter material lepas dengan muka air tanah dangkal di zona tektonik aktif. Standar perancangan fondasi yang berlaku, yakni SPLN T5.008-2:2021 secara eksplisit belum mengakomodasi kondisi tanah berpotensi likuefaksi. Perancangan ini hadir untuk melengkapi standar yang ada dengan merancang fondasi tiang pancang yang mampu memikul beban *tower* SUTT 150 kV tipe BB+03 (*double circuit tension tower*) secara aman pada kondisi normal dan kondisi likuefaksi.

Perancangan dilakukan melalui analisis potensi likuefaksi menggunakan metode deterministik berbasis data SPT dan uji laboratorium. Kapasitas dukung aksial tiang tunggal dihitung menggunakan tiga metode empiris dengan nilai paling konservatif sebagai dasar perancangan. Analisis penurunan tiang dilakukan menggunakan metode empiris, sedangkan analisis respons lateral dan kapasitas lateral tiang dilakukan secara numeris dengan bantuan perangkat lunak RSPile berbasis metode *p-y curve*. Dua alternatif desain fondasi tiang diajukan, yaitu Desain 1 (4D600) dan Desain 2 (6D500) yang masing-masing dievaluasi kinerjanya pada kondisi normal dan kondisi likuefaksi. Penyusunan RAB dilakukan menggunakan AHSP dengan pemodelan volume tiga dimensi melalui Autodesk Revit 2024.

Hasil analisis menunjukkan bahwa lapisan tanah di lokasi perancangan berpotensi likuefaksi pada kedalaman 4 – 8 dan 10 meter sehingga kedalaman minimum tiang ditetapkan 11 meter. Kedua alternatif desain memenuhi seluruh kriteria keamanan pada kedua kondisi dengan kontrol paling kritis berupa *safety factor* tarik pasa likuefaksi, yakni sebesar 2,011 untuk Desain 1 dan 2,315 untuk Desain 2. Desain 1 direkomendasikan sebagai desain optimum karena telah memenuhi seluruh persyaratan keamanan minimum dengan biaya konstruksi Rp867.658.127,60 per *tower*, lebih efisien 5,95% dibandingkan dengan desain 2 sebesar Rp919.245.109,99.

Kata kunci: fondasi tiang pancang; likuefaksi; SUTT 150 kV; kinerja fondasi; efisiensi biaya.

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ABSTRACT

The reliability of transmission tower foundations for 150 kV *high-voltage overhead lines* (SUTT) *in liquefaction-prone areas is a critical concern, as liquefaction can cause sudden loss of soil bearing capacity. The design location is situated in Toli-Toli Regency, Central Sulawesi, identified as having high liquefaction potential based on its geological characteristics in the form of quaternary deposits of loose material with a shallow groundwater table in an active tectonic zone. The applicable foundation design standard, SPLN T5.008-2:2021, has not yet explicitly accommodated liquefaction-prone soil conditions. This study therefore aims to complement the existing standard by design a pile foundation capable of safely carrying the loads of a BB+03 type 150 kV SUTT tower (double circuit tension tower) under both normal and liquefaction conditions.*

The design was carried out through liquefaction potential analysis using the deterministic method based on SPT data and laboratory test results. Axial bearing capacity of single piles was calculated using three empirical methods, with the most conservative value adopted as the design basis. Pile settlement analysis was performed using an empirical method, while lateral response and lateral capacity analyses were conducted numerically using RSPile software based on the p-y curve method. Two alternative pile foundation designs were proposed: Design 1 (4D600) and Design 2 (6D500), each evaluated under normal and post-liquefaction conditions. The bill of quantities was prepared using unit price analysis with volume calculations derived from three-dimensional modeling in Autodesk Revit 2024.

Results indicate that the soil layers at the design location are susceptible to liquefaction at depths of 4 – 8 and 10 meters, establishing a minimum pile depth of 11 meters. Both alternative designs satisfy all safety criteria under those two conditions, with the most critical control being the tensile safety factor under post-liquefaction conditions, that is 2,011 for Design 1 and 2,315 for Design 2. Design 1 is recommended as the optimum foundation design, as it fulfills all minimum safety requirements at a construction cost of IDR 867.658.127,60 per tower, which is 5,95% more economical than Design 2 at IDR 919.245.109,99.

Keywords: *pile foundation; liquefaction; 150 kV SUTT; foundation performance; cost efficiency.*