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ANALISIS STABILITAS SISTEM FONDASI TIANG PANCANG PADA BANGUNAN HOTEL DI BANTEN
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INTISARI

Bangunan bertingkat menerima beban struktural yang besar, sehingga kelayakan sistem fondasi menjadi penentu utama kestabilan. Dominasi material berbutir halus yang lunak pada lapisan dangkal membuat penggunaan fondasi dangkal tidak memadai. Kondisi ini mengharuskan penerapan fondasi tiang pancang untuk mentransfer beban ke lapisan tanah keras. Provinsi Banten sebagai lokasi penelitian bangunan bertingkat lima lantai dan satu mezanin berada pada zona seismik aktif. Perpaduan tanah lemah dan ancaman gempa ekstrem menuntut perancangan struktur bawah yang andal. Penelitian ini bertujuan memitigasi ketidakpastian desain geoteknik dengan mengevaluasi kestabilan fondasi tiang pancang terhadap daya dukung aksial, lateral, penurunan, dan defleksi, serta menentukan kedalaman optimal dari variasi 10 meter, 14 meter, dan 18 meter.

Skenario desain paling konservatif diterapkan dengan meninjau titik penyelidikan dengan daya dukung tanah paling rendah di lokasi penelitian. Pembebanan struktur disimulasikan dengan perangkat lunak ETABS berdasarkan SNI 1726:2019 dan SNI 1727:2020 untuk memperoleh gaya reaksi dasar. Daya dukung aksial dihitung menggunakan metode Decourt, Briaud, dan Meyerhof. Deformasi lateral dan penurunan dievaluasi dengan metode Broms, Vesic, serta Bowles, lalu divalidasi melalui simulasi numeris menggunakan RSPile.

Pemodelan menghasilkan beban aksial maksimum kelompok tiang sebesar 2621,24 kN pada kondisi layan, 2993,67 kN pada gempa nominal, dan 5139,58 kN pada gempa kuat. Kedalaman 18 meter ditetapkan sebagai desain utama karena kapasitasnya memenuhi standar keamanan minimum SNI 8460:2017 dan TABG-SG DKI Jakarta. Kedalaman 14 meter menjadi alternatif optimasi material sesuai prinsip biaya, mutu, dan waktu. Karena faktor aman pada kedalaman 14 meter belum memenuhi target minimum teoretis saat menerima gempa kuat, alternatif ini wajib disertai validasi kapasitas aktual melalui uji pembebanan dinamis di lapangan. Hasil simulasi membuktikan defleksi lateral dan penurunan pada kedalaman tersebut berada di bawah batas izin, memastikan fondasi tetap stabil.

Kata kunci: fondasi tiang pancang, bangunan bertingkat, kapasitas dukung, pemodelan numeris, skenario desain konservatif, optimasi kedalaman

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ABSTRACT

Multi-story buildings are subjected to massive structural loads, making the adequacy of the foundation system a primary determinant of stability. The dominance of soft, fine-grained materials in shallow layers renders shallow foundations inadequate. This condition necessitates the implementation of driven pile foundations to transfer the loads to the underlying hard soil strata. Banten Province, the research location of this five-story and one-mezzanine building, is situated in an active seismic zone. The combination of weak soil conditions and extreme seismic threats demands a highly reliable substructure design. This research aims to mitigate geotechnical design uncertainties by evaluating the stability of the driven pile foundation concerning axial and lateral bearing capacities, settlement, and deflection, as well as determining the optimal depth among variations of 10 meters, 14 meters, and 18 meters.

The most conservative design scenario was applied by analyzing the investigation point with the lowest soil bearing capacity at the site. Structural loading was simulated using ETABS software in accordance with SNI 1726:2019 and SNI 1727:2020 to obtain the base reaction forces. The axial bearing capacity was calculated using the Decourt, Briaud, and Meyerhof methods. Lateral deformation and settlement were evaluated using the Broms, Vesic, and Bowles methods, which were subsequently validated through numerical simulation using RSPile.

The modeling generated a maximum axial load on the pile group of 2,621.24 kN under service conditions, 2,993.67 kN under nominal seismic conditions, and 5,139.58 kN under strong seismic conditions. A depth of 18 meters was designated as the primary design because its capacity satisfies the minimum safety standards of SNI 8460:2017 and the Building Expert Team for Structural and Geotechnical Engineering (TABG-SG) of DKI Jakarta. A depth of 14 meters serves as a material optimization alternative in accordance with the principles of cost, quality, and time efficiency. Since the safety factor at the 14-meter depth has not met the theoretical minimum target under strong seismic loads, this alternative must be accompanied by actual capacity validation through dynamic load testing in the field. Simulation results demonstrated that lateral deflection and settlement at this depth remain below the allowable limits, ensuring the foundation remains stable.

Keywords: driven pile foundation, multistory building, bearing capacity, numerical modeling, conservative design scenario, depth optimization