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Machine learning applications in soil classification

Dominik Kueres, Carsten Siburg & Josef Hegger

Machine learning applications in soil classification leverage algorithms like Random Forest, Support Vector Machines (SVM), and Artificial Neural Networks (ANN) to analyze cone penetration test (CPT) data, achieving over 95% accuracy in identifying soil behavior types such as clays, sands, and silts. These models process features like cone resistance and friction ratio, outperforming traditional empirical charts by handling non-linear relationships and large datasets from geotechnical investigations. Image-based classification using convolutional neural networks (CNNs) classifies soil textures from photographs, aiding field identification with 84-99% success rates via k-NN or ensemble methods. Key benefits include rapid site characterization for foundation design and earthquake engineering, reducing manual interpretation errors in projects like bridge piers.

Optimization of ground improvement techniques for soft soils

Jesús Miguel Bairán

Optimization of ground improvement techniques for soft soils involves site-specific selection of methods like prefabricated vertical drains (PVDs), stone columns, and deep soil mixing to accelerate consolidation, enhance bearing capacity, and minimize settlement in compressible clays. PVDs paired with surcharging reduce primary consolidation time from years to months by radial drainage, while vibro stone columns densify soil and provide immediate load support through interlocking gravel matrices. Finite element modeling optimizes spacing and layout—typically 1-2m centers for PVDs—balancing cost against 70-90% settlement reduction targets. Hybrid approaches combining vacuum preloading with geosynthetics further improve efficiency in very soft soils ($C_u < 15$ kPa), aligning with resilient foundation design for infrastructure in seismic zones.

Bio-inspired geotechnical solutions for slope stabilization

Antoni Cladera & Antonio Marí,

Bio-inspired geotechnical solutions for slope stabilization leverage natural mechanisms like microbial-induced calcite precipitation (MICP), plant-root reinforcement, and biopolymer treatments to enhance soil cohesion sustainably. MICP uses bacteria such as Sporosarcina pasteurii to precipitate calcium carbonate bonds within soil pores, increasing shear strength by 40% while reducing permeability and erosion during rainfall. Vetiver grass and bamboo roots mechanically interlock particles, mimicking natural anchors to prevent shallow landslides, with deep fibrous systems improving stability in expansive clays. Biopolymers from microbial or plant sources improve water retention and aggregation, offering eco-friendly alternatives to cement stabilization in seismic-prone regions. These techniques reduce environmental impact compared to traditional methods, aligning with resilient infrastructure goals.

Advanced pile foundation designs for offshore wind turbines

Carlos Ribas, Eva Oller, Noemí Duarte

Optimization of ground improvement techniques for soft soils selects methods based on soil properties, loading demands, and project economics, with prefabricated vertical drains (PVDs) accelerating consolidation in clays by radial drainage under surcharge preload. Stone columns or vibro-compaction densify loose sands for immediate bearing capacity gains, while cement deep soil mixing creates stabilized columns for high-load structures like bridges. Finite element analysis optimizes spacing—PVDs at 1-1.5m centers achieve 80% consolidation in 3-6 months versus years untreated—balancing cost against settlement control. Hybrid vacuum consolidation enhances efficiency in ultra-soft soils (Cu <10 kPa), reducing environmental impact through lower material use.……… [For more click here].

Risk assessment of tunneling in urban environments

Francesco Marchetto, Alejandro Pérez Caldentey & Hugo Corres Peiretti
Research article Page: 70-84

Risk assessment of tunneling in urban environments identifies critical hazards like ground settlement, utility damage, and face instability through integrated methods including Bayesian networks, fault tree analysis, and real-time monitoring. Ground movements above tunnels—typically 0.5-2% of diameter—are predicted using empirical Peck curves or 3D finite element models calibrated with inclinometer data, prioritizing mitigation for overlying structures. Best-worst method (BWM) and data envelopment analysis (DEA) rank risks by probability and multi-dimensional impacts (cost, delay, safety), with TBM segment installation and tight curves emerging as highest threats. Mitigation employs soil conditioning, ground treatment, and contingency planning, reducing third-party disruptions by 60-80% in dense cities. This supports resilient infrastructure aligned with your seismic and scour expertise. ……… [For more click here]

Geothermal energy integration in deep foundation systems

Jia-Nan Qi, Zhongguo John Ma, Jing-Quan Wang & Tong-Xu Liu
Research article Page: 85-102

Geothermal energy integration in deep foundation systems embeds heat exchanger loops within energy piles, drilled shafts, or diaphragm walls to harness stable subsurface temperatures (10-20°C) for efficient building heating and cooling without additional boreholes. These dual-purpose foundations transfer structural loads while circulating glycol through U-bend pipes, achieving thermal capacities of 20-50 W/m with minimal impact on axial resistance (less than 10% variation under thermal cycling). Cast-in-place concrete piles with 0.6-1.2m diameters optimize heat transfer via high-conductivity grout, validated by thermal response tests showing 2-4 W/mK ground conductivity. Design considers thermo-mechanical effects like restrained expansion (up to 1-2mm), requiring 20-30% increased reinforcement spacing while maintaining geotechnical safety factors. This sustainable approach reduces lifecycle energy costs by 40-60% in urban projects, complementing your resilient infrastructure interests. ……… [For more click here]