and calcium oxide, in three different curing times of 7, 14 and 28 days was tested for unconfined compressive strength. The results indicate that samples containing 0.05%, 0.1%, and 0.2% aluminum oxide nanoparticles after 28 days of curing experienced a 24.92%, 46.78%, and 43.28% increase in strength, respectively, compared to the control sample. Similarly, the increase in strength for samples with calcium oxide nanoparticles was 18.73%, 40.43%, and 36.72%, respectively. According to the findings, the curing time did not significantly affect strength improvement, and the optimum percentage for both types of nanoparticles was determined to be 0.1%. Further analysis of stress-strain curves revealed that samples with aluminum oxide nanoparticles exhibited a more brittle behavior compared to those with calcium oxide nanoparticles. Subsequently, the samples were analyzed for microstructural investigations using Field Emission Scanning Electron Microscopy (FESEM). The microstructural examinations demonstrated better compactness among the treated samples, indicating improved microstructural characteristics in the nanoparticle-amended soils.

Key Words: Soil improvement, nanotechnology, calcium oxide, aluminum oxide, unconfined compressive strength.

THE EFFECT OF VARIOUS OIL POLLUTANTS ON THE COMPRESSIBILITY PROPERTIES OF CLAYEY SAND

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Abstract

Soil pollution by oil and its derivatives is a highly controversial environmental problem that also causes geological and geotechnical harm. The effect of oil pollutant type on geotechnical characteristics, especially soil compressibility, is an interesting topic neglected in previous studies, which needs further investigation. The research results on this topic can be used in the compressibility analysis of structures built on soils likely to be contaminated with oil pollutants. Using a one-dimensional consolidation test, this study evaluated the compressibility properties of clayey sand contaminated with 3, 6, and 9% (dry weight of the soil) of four oil pollutants: used motor oil, crude oil, diesel, and kerosene. Scanning electron microscopy (SEM) was also employed to assess the microstructural interaction between the soil and the four oil pollutants. In addition to the low dielectric constant of oil pollutants, their high viscosity played a crucial role in altering the compressibility properties of clayey sand. The SEM micrographs confirmed that oil pollutants change the soil structure into a flocculated but dispersed one. The higher the viscosity of the oil pollutant, the larger the formed clots. Besides increasing the pore space between particles and facilitating water movement by covering the soil particles, oil pollutants reduced the soil's specific surface area (SSA) and water absorption by the soil particles. This caused the water to drain faster, ultimately increasing the compaction coefficient (C_C), consolidation settlement, consolidation coefficient (C_V), and permeability coefficient (k). The higher the viscosity of the oil contaminant, the higher the surface energy at the oil-water interface, which decreases water drainage. The highest compressibility belonged to the samples contaminated with kerosene, followed by those infected with diesel, crude oil, and used motor oil. Thus, special attention should be paid to settling clayey sand contaminated with kerosene in geotechnical plans.

Key Words: Oil-polluted soil, compressibility properties, viscosity, clayey sand.

Key Words: Hybrid optimization vehicle routing-scheduling, vehicle routing problem, time window, cat swarm optimization, genetic algorithm.

LAP SHEAR-PRESTRESSED BOND TEST TO EVALUATE PRESTRESSED FRP CONCRETE JOINT

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Abstract

The use of FRP composites as an effective method for strengthening reinforced concrete structures has been a subject of research due to its numerous benefits. A common failure mode in the application of these composites is the debonding of the FRP sheet from the concrete surface, which can sometimes reduce the capacity of these composites to as low as 10% of their total capacity. As a result, researchers have begun to prestress the FRP sheets and strengthen them with prestressed FRP to optimize the efficiency of these materials. A crucial aspect in the strengthening of a reinforced concrete member with an FRP sheet is the examination of the connection behavior between the FRP sheet and concrete. The significance of this issue has led to dedicated research and experimentation in this field. In this study, a prestress-lab shear test was employed for the first time to investigate the bond behavior of prestressed FRP composites-to-concrete joints. Additionally, the particle image velocimetry (PIV) method was used for result analysis. To verify the effectiveness of this method, eight tests were conducted on prism specimens measuring$150 \times 150 \times 350$ mm. The strengthening methods of the specimens involved the use of external bonded reinforcement (EBR) and external bonded reinforcement on grooves (EBROG) methods. Furthermore, the specimens were prestressed at different levels, including 0%, 20%, and 30% of the ultimate strain of FRP composites. This study examined the specimens in terms of bond strength capacity, failure mode, and stress and strain distribution on the joint surface. The results showed that prestressing increased the bond strength by 70% in the EBR method. Moreover, the bond strength of the EBROG specimen with 20% prestressing increased by 123% compared to the control specimen. These findings indicate that prestressing using the EBROG method is a viable technique for enhancing the performance of FRP-to-concrete joints.

Key Words: Lap shear test-prestressed bond, prestressed FRP composites, bond behavior, externally bonded reinforcement, externally bonded reinforcement on grooves.

SOIL IMPROVEMENT OF CLAYEY SAND USING NANOPARTICLE

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Abstract

The field of nanotechnology encompasses all technologies that operate on a nanoscale, typically ranging from 1 to 100 nanometers. Nano-particles are the most commonly used materials in this technology. Given the provided definition of nanotechnology, there is a growing interest in exploring its applications in the field of geotechnical engineering. Recently, numerous researchers have directed their efforts toward discovering these applications. This intense interest stems from the unique properties of these particles and their potential to enhance the mechanical and structural characteristics of soil. This article explores the impact of different percentages of calcium oxide and aluminum oxide nanoparticles on the compressive strength of clayey sandy soil with a constant clay content. To achieve this, clayey sandy soil comprising 80% sand and 20% clay, after being treated with varying percentages (0.05%, 0.1%, and 0.2% by dry soil weight) of nanoparticles, including aluminum oxide

Abstract

This paper presents a formulation of the attenuated orthotropic time-domain half-space boundary element method for analyzing the orthotropic effect of underground inclusions subjected to transient SH-waves. The stress-free boundary condition at the ground surface is satisfied using wave source image theory. To account for material damping, the Barkan approach is employed to attenuate the half-space by introducing a constant logarithmic reduction into the modified boundary integral equation. This method is easily implemented in a time-domain computer code for analyzing seismic homogeneous orthotropic mediums. To model underground inclusions, a sub-structuring approach is introduced to ensure continuity conditions at interfaces based on node position and normal direction. Several practical examples involving SH-waves are solved and compared with existing literature to validate surface response, particularly focusing on isotropic convergence. A favorable agreement is found between responses, confirming the capability of the proposed method for simple modeling of orthotropic subsurface features. Finally, in the form of an advanced numerical study, the surface motions of orthotropic models, including an underground inclusion embedded in a linear elastic half-space were successfully obtained under transient SH-wave propagation. Utilizing the time-domain boundary element approach, a simple model was developed only by discretizing the boundaries/interfaces. To illustrate responses in the time/frequency-domain, a comprehensive sensitivity analysis is performed considering parameters such as frequency, shape ratio, and isotropy factor, visualized through snapshots, seismograms, and amplification patterns. Results demonstrate that orthotropic anisotropy significantly influences seismic patterns of ground surfaces, highlighting the impact of mentioned parameter variations.

Key Words: Computational seismology, earthquake ground motions, seismic anisotropy, underground orthotropic inclusion, wave scattering and diffraction.

INNOVATIVE HYBRID ALGORITHM FOR SOLVING VEHICLE ROUTING PROBLEM WITH TIME WINDOW

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Abstract

Efficient transportation of goods is crucial for cost reduction, improved delivery time, and enhanced service quality. Advanced logistics systems analyze data to find the most efficient routes. This minimizes fuel consumption and decreases transportation costs. The Vehicle Routing Problem with Time Window Constraints (VRPTW) is a classic optimization problem in the field of operations research and logistics. It is a challenging optimization problem in logistics, classified as NP-hard. Hybrid approaches combine multiple optimization techniques to improve the quality and efficiency of solutions. This paper presents a hybrid cat-swarming algorithm that utilizes genetic operators to effectively address the VRPTW problem. The goal is to determine the optimal routes for the vehicles, considering both the vehicle capacity constraints and the time window constraints at each customer location. In this paper the objective function of the algorithm aims to minimize both the total distance traveled and the number of vehicles utilized, ensuring efficient and cost-effective routing. The hybrid cat swarming algorithm proposed in this study offers a novel approach to tackle the challenges posed by the VRPTW problem. By integrating genetic operators such as crossover and mutation, the algorithm enhances performance and improves the quality of solutions. Its primary objective of minimizing total distance and vehicle usage guarantees efficient and economically viable routing strategies. To evaluate the effectiveness of the algorithm, it was tested using a simulated dataset of salmon samples as a benchmark. For samples comprising 50 customers, an improvement of up to 48 to 59 percent in previous response rates has been achieved. For samples comprising 100 customers, optimal global responses, as obtained from previous articles, have been observed in several instances. The proposed algorithm is suitable for transportation and logistics systems with limited customers and leads to cost reduction, improved delivery times, and increased service quality.

compared with the spectral values corresponding to the constant-velocity mode. On the other hand, in the decelerating condition, the out-of-plane displacement and bending moment spectra are respectively alleviated up to 41.59 and 42.05 percent.

Key Words: Horizontally curved beam (HCB), moving mass, out -of-plane dynamic response, accelerating/decelerating motion, response spectra.

INTELLIGENT ASSESSMENT OF DAMAGE AND PREDICTION OF SEISMIC DAMAGE SPECTRUM UNDER THE EFFECT OF NEAR-FAULT EARTHQUAKES IN IRAN

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Abstract

Predicting seismic damage spectra and capturing both structural and earthquake features are crucial for the design of new buildings and also for the resilience evaluation of existing ones. The research objective of this article is to accurately assess and predict the seismic damage spectrum caused by earthquakes in Iran using gene expression programming. Gene expression programming is a method for learning and optimization rooted in genetic principles and molecular biology. For this purpose, a single-degree-of-freedom nonlinear system is considered, along with a collection of earthquake records from Iran, for the exact computation of the damage spectrum. Subsequently, a mathematical model is developed by applying gene expression programming and genetic programming algorithms. The Park-Ang damage index is used to compute the seismic damage or damage spectra level. Both the structural characteristics and seismic properties are significant factors in predicting the seismic damage spectrum model. Finally, a simplified equation has been suggested for assessing the potential seismic damage spectrum of the structures exposed to ground motions in Iran, capturing both structural and earthquake features. This study demonstrates the significant impact of structural and seismic parameters on the seismic damage spectrum, highlighting that an increase in the resistance reduction factor correlates with a rise in damage spectrum across structures of varying vibration periods. The changes in the damage spectrum indicate that as the ductility coefficient increases, the spectral damage decreases. The impact of the damping ratio on SDOF systems in the damage spectrum demonstrates that an increase in the damping ratio leads to an increase in the damage spectrum. The effects of the post-yield stiffness ratio in SDOF systems for the damage spectrum showed that a higher stiffness ratio results in the structure exhibiting less damage. The relationship between the Park-Ang index constant and the damage spectrum is such that an increase in the Park-Ang index constant leads to a corresponding rise in the damage spectrum. The influence of soil type on the damage spectrum is comparatively less significant than the impacts of the other parameters discussed.

Key Words: Seismic damage spectra, park-ang damage index, gene expression programming (GEP), inelastic one-degree-of-freedom system (SDOF), near field earthquake.

THE ORTHOTROPY EFFECT OF UNDERGROUND INCLUSION ON THE SEISMIC RESPONSE OF GROUND SURFACE

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Abstract

Today, groundwater plays an undeniable role in supplying water for the communities. In recent years, the extensive use of chemical fertilizers and improper wastewater treatment from industrial sites has led to several environmental problems, such as an increase in the concentration of nitrate and sulfate in underground and surface water. Nitrate and sulfate in water sources cannot be easily separated due to their high solubility, so their separation methods are costly. Although permeable reactive barriers (PRB_s) are one of the new methods used for on-site treatment of water sources, the early saturation of the substrate used is one of its disadvantages. One of the methods used to solve this problem is the electrokinetic (EK) process. The purpose of this research, which was conducted on a laboratory scale, was to combine the electrokinetic process and permeable reactive barriers containing modified activated carbon to simultaneously remove nitrate and sulfate from contaminated water. This research used a glass reactor with dimensions of 15*30*100 cm, and the space inside was divided into several sections using a nylon filter. Also, a layer of sand was placed on the reactive substrate, and two graphite electrodes were placed on top of the soil layer and under the reactive substrate to create an electric current and ensure migration conditions. The effect of pH, nitrate, and sulfate initial concentration, activated carbon to sand ratio, and the electrical gradient on the performance of the process was investigated, and the optimal conditions for improving the system efficiency were determined using the OFAT classical method. Based on the results of experiments, using an electrical gradient of 1.5 V/cm in optimal conditions (initial nitrate concentration 200 mg/L, initial sulfate concentration 450 mg/L, inlet flow rate 3.3 ml/min, pH=7 and the ratio of active carbon to sand 1:2) the adsorption capacity increased by 83% for nitrate and 86% for sulfate. In addition, under these conditions and by controlling the concentration of nitrate and sulfate within standard permissible limits, the period of operation of the system for nitrate increased from 40 hours to 100 hours and for sulfate from 45 hours to 110 hours. According to the results, the PRB-EK integrated process is a reliable method for the simultaneous removal of sulfate and nitrate from groundwater.

Key Words: Permeable reactive barrier, electrokinetic, activated carbon, nitrate, sulfate, water resources.

INVESTIGATING THE EFFECT OF ACCELERATING/DECELERATING MOTION OF A MOVING MASS ON THE OUT-OF-PLANE DYNAMICS OF HORIZONTALLY CURVED BEAMS

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Abstract

Horizontally curved beams (HCBs) are not only capable of meeting some architectural and aesthetic requirements but can also offer structural advantages in many engineering applications. Due to inherent complexities existing in the treatment of the problems dealing with dynamic actions on HCBs, the dynamic behavior of such salient elements is not essentially well understood. Therefore, to address the identified gap concerning the motion-type effects of a moving mass on the dynamics of HCBs, the current study deals with assessing how the accelerating/decelerating conditions do contribute to the out-of-plane response of HCBs under the excitation of a moving mass. In this regard, the governing dynamic equations are developed by taking care of the centripetal force, Coriolis acceleration, and inertial actions of the moving mass. Employing the method of separation of variables and exercising sinusoidal modal functions, the discretized system of differential equations in the matrix form are distilled and solved through the application of standard numerical procedures. Spectral responses in terms of the out-of-plane displacement and bending moment are then obtained for various influential parameters. The veracity of the results is also validated against the available data addressed in the technical literature. Through a comprehensive parametric study, the effect of the key parameters, including the central subtended angle and length of the HCB, as well as the mass, initial velocity, and increasing/decreasing acceleration of the moving mass, is evaluated on the out-of-plane displacement and bending moment of the supporting HCB. The results of this study suggest that in the accelerating mode, the out-of-plane displacement and bending moment spectra are magnified up to 18.11 and 27.53 percent

charge coefficient compared to the Polynomial, Linear, and Sigmoid kernels. The results of the correlation coefficient (R), Root Mean Square Error (RMSE), mean percentage Relative Error (MRE%), and Kling Gupta Efficiency (KGE) in the test stage for the SVM model were 0.96, 0.018, 0.90, and 1.92%, respectively. The neighbor coefficient (K) results showed that in the K equal 2, the RMSE and MRE had a lower value and were close to the experimental results. In addition, in the KNN model, among distance criteria measures (Manhattan, Euclidean, Euclidean Squared, and Chebychev), the Manhattan criteria have a higher accuracy in predicting the discharge coefficient than the others. In the testing phase, this model's results were 0.97, 0.016, 0.96, and 1.70%. In addition, the results for the GEP model were 0.98, 0.019, 0.85, and 2.28%, respectively. In the present research, the ANN method is more accurate compared to SVM, GEP, and KNN models, so, for the ANN model, the KGE was in the very good range.

Key Words: Discharge measurement, discharge coefficient, control structure, intelligent models, statistical indicators.

DERIVATION AND PARAMETRIC EVALUATION OF FREQUENCY RESPONSE FUNCTIONS OF ELASTIC AND INELASTIC STRUCTURES UNDER PULSE-TYPE GROUND EXCITATIONS

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Abstract

In this paper, the elastic and inelastic responses of yielding single-degree-of-freedom (SDOF) systems with bilinear hysteretic behavior subjected to pulse-type near-fault ground motions are investigated. The evaluated responses are the relative displacement and total acceleration of the structure in the form of frequency response functions. The analytical pulse model proposed by Mavroeidis and Papageorgiou, whose input parameters have precise physical meanings, is used to represent near-fault ground motions. A parametric study with six dimensionless variables is performed to evaluate the frequency response functions of SDOF structures. Out of these six variables, two variables are related to the input pulse excitation, another two variables are related to the properties of the structure, and the last two involve the ratio between the excitation and the structure; they are the number of pulses, the pulse phase angle (shape), the damping ratio of the structure, the post-yield stiffness ratio of the structure, the excitation-(pulse-) to-structure frequency ratio, and the ratio of the excitation (pulse) amplitude to the yield strength of the structure. The results reveal a notable similarity in the frequency response functions of total acceleration and relative displacement for linear elastic SDOF structures. However, the characteristics of these two responses are completely different when yielding occurs in bilinear SDOF structures. Furthermore, the effect of various parameters of the structure and the input pulse on the structural responses differs depending on the linear or nonlinear behavior of the system. For example, in a linear elastic structure, the maximum frequency responses of displacement and total acceleration always increase with increasing the number of pulses; however, in an elastic-perfectly plastic structure or in a bilinear structure with a small post-yield stiffness ratio, the maximum frequency response of total acceleration remains almost constant regardless of the number of input pulses when yielding occurs. For the displacement response, the number of pulses that cause the maximum frequency response differs at different levels of nonlinear behavior.

Key Words: Pulse-type excitations, near-fault ground motions, frequency response function, displacement, acceleration.

GROUNDWATER TREATMENT BY COMBINING THE ELECTROKINETIC PROCESS WITH PERMEABLE REACTIVE BARRIERS CONTAINING GRANULAR ACTIVATED CARBON

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Abstracts of Papers in English

APPLICATION OF INTELLIGENCE MODELS BASED ON SOFT COMPUTING IN INVESTIGATING THE DISCHARGE COEFFICIENT OF THE SLUICE GATE UNDER FREE-FLOW CONDITION AND SYMMETRICAL SILL WITH THE HELP OF KNN, ANN, GEP AND SVM MODELS

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Abstract

The use of sills with the gates leads to a reduction in the height of the gate. The sills affect the flow and change quantities, especially the discharge coefficient. In the present research, the discharge coefficient of the sluice gate is examined for the first presented theoretical relationship in a non-suppressed sill state to measure its performance using soft computing methods. For the models, 70% of the data were used for the training and the rest for the testing phases. The results of statistical indicators showed that in all SVM, KNN, GEP, and ANN models, the model with all input parameters was recognized as the superior model. In the SVM model, the results of various kernels showed that the Radial Basis Function kernel has better results in predicting the dis-