step, the coordinates of each node of these slices are determined. To compute the safety factor, a process should be taken that satisfies the force and moment equilibrium equations simultaneously. To achieve this goal, the iterative method (trial and error) is used in this study. In order to evaluate the proposed method and the efficiency of the developed model, several tests with different conditions are solved. The mentioned test results are in good agreement with the results of other methods that satisfy all of the equilibrium equations.

Key Words: Earth slope stability, factor of safety, limit equilibrium method, slip surface.

TRANSFORM AND COLONIAL COMPETITIVE ALGORITHM

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Abstract

The active control of structures has a special place in the controlling of linear systems vibrations. Finding the optimum control force, considering the capacity limitation of active control equipment, is the main objective of the design of control systems and one of the most important subjects in active control of structures. Traditional methods, such as LQR, calculate control forces without considering the external loads, such as earthquakes, which make finding of the optimal solution difficult for optimal control problems. Metaheuristic optimization methods, such as colonial competitive algorithm, are powerful algorithms because of their special capabilities which can be used in solving complex problems, but they have not been used coherently in the active control of structures. In this study, an optimization-based control approach for the active control of building structures is proposed against artificial earthquake excitations using wavelet transform and the Colonial competitive algorithm. The 10% in 50 years earthquake was generated and decomposed via wavelet transform into different frequency levels. Then, in each frequency band, the elements of the gain matrix were searched in the search space with the aim of minimizing the performance index by using the colonial competitive algorithm. Then, the gain matrices obtained from optimization process would be used to calculate control forces. Iterative process of the present method and does not need to solve the Riccati equation, considering external force effects in the calculation of the control forces. In order to evaluate the effectiveness of the proposed controller, vibration of Single-Degree and Multi-Degree of Freedom (SDOF and MDOF) examples against artificial earthquake with the proposed and LQR controller was controlled and compared. Numerical simulation based on the 10% in 50 years uniform hazard artificial earthquake showed that the performance of the presented control algorithm is better than the LQR controller approach in finding optimal control forces.

Key Words: Optimal control, colonial competitive algorithm, wavelet transform, uniform hazard earthquake, artificial accelerogram.

A NEW APPROACH FOR STABILITY ANALYSIS OF SOIL SLOPES USING A LIMIT EQUILIBRIUM METHOD

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Abstract

Slope stability analysis is used in a wide variety of geotechnical engineering problems such as embankments, road cuts, open-pit mining, excavations, canals, landfills, etc. The limit equilibrium method is the most popular approach in slope stability analyses. In this study, a new limit equilibrium method is proposed that can satisfy the forces and moment without any assumptions. In this method, circular or non-circular slip surface has been considered and slices are intended along the radius of the slip surface. Innovation of this research is in the form of slices in circle sector which could eliminate the common simplifying assumptions in the equilibrium equations. The forces and moment equilibrium equations have been applied without any simplifying assumptions and expected that this method can achieve lower error in determining the safety factor. In order to calculate the safety factor using the proposed method, a numerical model has been developed. In this model, the soil slope characteristics such as slope geometry, soil strength properties, seismic coefficient and also water level are considered as input. Then sliding wedge is introduced and on the basis of number of divisions that the user defines, sliding wedge is discretized. In the next

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Abstract

Nowadays, mass production of construction waste is one of the most important environmental issues. Construction industry consumes a large amount of materials and resources, especially in developing countries. Inefficient usage of bulk materials results in production of construction waste. According to sustainable development guidelines, mass production of construction waste is one of the issues of focused concern. In Iran, there is no clear record or valid data about different aspects of construction waste production. Quantification of the construction waste production is one of the new concepts in waste management. Therefore, the aim of this research is to quantify construction waste production of bulk materials in residential buildings. The focus of this study is on rebar, concrete, brick, and cement waste produced in the buildings.

The urban developers may utilize the results to regulate more detailed and precise rules to control the production of construction waste. The dependent variable of the study is the amount of waste produced for every type of material in percent. The independent variables of the study are location of residential buildings, type of contract, area of every story, and number of stories in every residential building. Furthermore, two frequent types of contracts for residential buildings cost-plus and lump-sum contracts are investigated. Obtained data is analyzed by SPSS software using linear regression, and then are verified and validated to extract the best and most convenient regressions. The criteria for validation and verification of the quantitative equations are derived from statistical references and the most recent and related studies. The result is four valid and verified quantitative models describing the amount of waste materials produced in terms of independent variables. Results show that choosing cost-plus contract leads to more construction waste production than lump-sum contract. The positive and negative effects of other dependent variables, such as location, number of stories, or area of each story are determined too.

Key Words: Quantification, construction waste, bulk materials, residential buildings, tehran.

THE EFFECT OF ADMIXING OF NANO-CLAY TO NAZLOO CLAY AND FIROOZKOUH SAND FOR CLAYEY LINER APPLICATIONS

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Abstract

Recently, the nano-materials have been used to improve soil properties. When the modified soil is used as the moisture and contaminant barriers in solid waste landfill liners, soil should minimize the flow of moisture and contaminants and should have acceptable geotechnical characteristics. In this study the effect of nano-clay material on the improvement of the characteristics of the Nazloo clayey soil of Urmia city, and Firoozkouh sand mixed with nano-clay, as the alternative soil in the absence of clayey soil, was investigated. For Nazloo clay, nano-clay caused the soil optimum water content and plasticity index to increase and the maximum dry density to decrease. For Firoozkouh sand, nano-clay did not have significant effect on the soil optimum water content but slightly increased the maximum dry density. The results of the hydraulic conductivity tests on Nazloo clay and Firoozkouh sand showed that the addition of nano-clay decreases the soils hydraulic conductivity. In Nazloo clay the hydraulic conductivity decreased to the standard level as for the landfill liner material but in Firoozkouh sand it did not decrease to the standard level. The results of the diffusion tests on Nazloo clay showed that nano-clay does not have significant effect on the soil chloride diffusion coefficient and this coefficient remains at its standard level. The results of this study showed that the addition of nan-clay has positive effect on the improvement of the soil geotechnical characteristics so that it could be used in the landfill liner construction; however, it does improve the Firoozkouh sand properties so that it can be used as alternative landfill liner material in the absence of clayey soil.

Key Words: Nazloo clay, firoozkouh sand, nano-clay, landfill liner, compaction, hydraulic conductivity, molecular diffusion.

OPTIMAL VIBRATION CONTROL OF STRUCTURES USING WAVELET

and 55^0C under stress of 100 and 200 kpa were tested, in 3 different loading times and 2 rest times. Test results and Matlab software were used to produce permanent deformation model based on the AASHTO 2002 model. As a result, the numerical model was obtained with a correlation coefficient of 0.9077. Based on the analysis carried out on the results, it was found that the most influential factor in the development of deterioration in flexible pavement is temperature and changes in loading and stress. Despite the positive effect of the increase in rest time on reducing asphalt pavement failure, this parameter can cope with the devastating effects of stress on the sample and speed deceleration of the vehicle. The growth of about 76% in the rut depth associated with increasing loading time of 100 ms to 1000 ms was observed. Finally, to reduce damage of asphaltic pavements in the tropics, minimum speed of vehicles was determined 20 kilometers per hour.

Key Words: Permanent deformation, hot mix asphalt, viscoelastic, MEPDG model.

ON THE EFFECT OF WASTE COPPER SLAG ON MECHANICAL PROPERTIES OF PRECAST CONCRETE KERB MANUFACTURED WITH WET PRESS PROCESS

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Abstract
Natural resources, including materials, water, energy and fertile land, are the basis for our life on Earth. However, humanity's rapidly growing consumption of these resources is causing severe damage. According to the Brundtland Report, sustainable development is a development that meets the needs of the present time without compromising the ability of future generations to meet their own needs. One of the ways to achieve sustainable development is the reuse of waste industries.

Concrete is one of the most widely used material in the world. Due to greenhouse gas emissions originating from cement production and excessive using of natural aggregates, the concrete industry become one of two largest producers of carbon dioxide (CO2), creating up to 5% of worldwide man-made emissions of this gas. Therefore, in recent decades, researchers tend to use industrial waste in concrete and reduce the amount of cement in concrete mixture.

Copper slag is a by-product obtained during smelting and refining of copper. The waste copper slag can be used as abrasive tools, road construction, and ballast. Despite increasing rate of reusing copper slag, the huge amount of its annual production is disposed in dumps or stockpiles to date all over the world and also in Iran. This waste material can be utilized as a substitute for fine aggregate (¡3mm) in the precast concrete kerb manufactured using wet press process. Although this range of fine aggregate is necessary for concrete kerb blocks, it is more expensive and unavailable due to its complicated production process. Therefore, the substitution may remove the problem and also can reduce environmental pollution.

A set of experimental tests including compressive test, flexural test, abrasion resistance test together with useful chemical tests and aggregate grading test was conducted to obtain mechanical properties of these kerbs. The obtained results show that compression and flexural strength firstly increased and then remained approximately constant. However, abrasion resistance of the kerbs was reduced very slightly. Subsequently, it is possible to substitute the whole fine aggregate with waste copper slag from the technical and operational perspective.

Key Words: Waste copper slag, fine aggregate, precast concrete kerb, mechanical properties.

QUANTIFICATION OF CONSTRUCTION WASTE PRODUCTION OF BULK MATERIALS (CASE STUDY: RESIDENTIAL BUILDINGS IN TEHRAN)

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INTEGRATED FRAMEWORK FOR PROJECT PERFORMANCE EVALUATION FROM THE VIEWPOINT OF CONSTRUCTION INDUSTRY CONTRACTORS

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Abstract

In the variable situations of today's projects, project managers need comprehensive and structured information for making decisions in the areas of project management. One of the most effective strategies employed in recent civil projects is use of the concept of Project Management Dashboard. Project Management Dashboard is a set of key performance indicators of the project that improves integration process and exhibits information required for project manager. The purpose of this article is to collect the whole set of information indicators for project management dashboard framework, so that the selected indicators can have the ability to display all aspects of project performance.

For this purpose, after studying various information indicators suggested in the literature, 60 important indicators of performance evaluation in projects have been collected and classified. Then, in a field study, applied indicators in contracting systems of some large-scale projects in the construction industry have been identified and added to previous studies. Based on observational studies and objective observations conducted in this area, a questionnaire was designed based on the Likert scale and given to a group of managers and construction project management professionals. In this questionnaire, the sampled people, who have studied, prioritize 60 indicators in 10 fields of Project Management (based on PMBOK2012). The data obtained from the questionnaires using Friedman prioritized test are analyzed.

The findings of this research offer a list of the most commonly used indicators in the 10 management fields of construction industry projects, such as Time Management, Cost Management, Quality Management, Procurement Management, Safety Management, Claim Management and Environmental management, based on international studies and terms of internal projects. Project Management Dashboard that is designed using these indicators enables contractor project managers to identify and manage the most important issues which influence the performance of the project.

Key Words: Information index, performance evaluation, project management, decision-making, contracting system.

COMPARING THE PERFORMANCE OF HOT MIX ASPHALT BASED ON MECHANISTIC - EMPIRICAL PAVEMENT DESIGN GUIDE (MEPDG) AGAINST CREEP AND COMPUTING MINIMUM SPEED OF HEAVY VEHICLES

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Abstract

Creeps of flexible pavement are common failures in hot climates. One of the aggravating factors in this type of failure is the speed of the vehicles. This study aims to evaluate the rutting at different speeds based on Mechanistic-Empirical approach test of the AASHTO pavement structure deals. For this purpose, 48 samples of hot mix asphalt were made in accordance with the No. 5 seed based on issue 234 of Iranian code. Samples at 40

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Abstract

One of the issues in river engineering is bridge protection in a way that bridges suffer the minimum damage during a flood. In many cases, due to the limitations, bridges are constructed on a river bend. The purpose of this research is to investigate the effect of constructing convergent and divergent (V-shaped & A-shaped) coupled bridge piers and their position in parallel to the flow on a steep 180-degree bend bed topography. This research was performed on a laboratory channel at Persian Gulf University of Bushehr, Iran. The channel has a width of 1 meter, and a steep bend with a central radius to channel width ratio of 2 and a 180-degree bend. In the upstream and downstream of the bed, there are direct routes with lengths of 6.5 and 5.1 meters, respectively. For the experiments, PVC piers with 5 cm diameter a 21-degree angle to the vertical axis, materials with an average diameter of 1.5 mm and standard deviation of 1.14 were used. All the experiments were performed with flow velocity to critical velocity ratio of 0.98 (U/Uc=0.98) and constant depth of 18 cm at the beginning of the bend and 70 l/s discharge. The results show that the maximum depth of the scour hole occurs adjacent to the V-shaped coupled piers established at the position of 90 degree. By changing the piers from V-shaped to A-shaped at 60 and 90 degrees positions, the maximum scour hole is transfered from the adjacency of the upstream pier to the adjacency of the downstream pier, and by changing the position of the piers from the bend's upstream towards the downstream, the development of the maximum scour hole decreases. The highest scour depths were measured in the main hole and the second scour hole and also the highest sedimentation were measured as 0.97, 0.93 and 0.58 times the flow depth at the starting point of the bend respectively. In this paper, the results are discussed and analyzed.

Key Words: Scour, inclined twin bridge piers, 180 degree steep bend, relative balance time, bed topography.

GRAVITATIONAL SEARCH ALGORITHM TO SOLVE OPTIMAL OPERATION PROBLEM OF SINGLE RESERVOIR SYSTEM, CASE STUDY: DEZ RESERVOIR

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Abstract

In this paper, the optimal solution of a single reservoir system operation optimization problem is determined using new Meta heuristic algorithm. Generally, various methods have been proposed to solve this problem. These methods are classified as: 1) Linear Programming (LP) 2) Non-Linear Programming (NLP) 3) Dynamic Programming (DP) and 4) Meta heuristic algorithms. Most recently, Meta heuristic algorithms, because of intelligent performance of them, are more useful method to solve optimization problem. Meta heuristic algorithms such as Genetic Algorithm (GA), Honey Bee Mating algorithm (HBMO), Ant Colony Optimization algorithm (ACO) and Particle Swarm Optimization algorithm (PSO) are new classification of optimization methods in which they are usually proposed based on the swarm behavior of social insects and real phenomena. Gravitational search algorithm is one of these newest algorithms that is based on the Newton's law of gravity. In the Gravitational search algorithm, a collection of masses is considered as searcher agents, in which these masses interact with each other based on the Newton's law of gravity and motion. In this paper, the simple and hydropower reservoir operation optimization problems of Dez dam have been solved for 5 and 20 operation periods proposing two different formulations. In the first formulation, the water releases from the reservoir and in the second formulation the reservoir storage volumes are taken as decision variables of the problem. The results are presented and compared with each other and with other available results. Comparison of the result with other existing results indicates better performance of the gravitational search algorithm to solve reservoir operation optimization problem. Furthermore, while both proposed formulations show good performance to solve this problem, the first formulation is shown to produce better results with the same computational effort and to be less sensitive to the randomly generated initial guess presented by the scaled standard.

Key Words: Reservoir operation optimization problem, gravitational search algorithm, water releases, reservoir storage volume, dez reservoir.

compaction of soil, it increases the dry-specific weight and reduces the optimum water content. In addition, adding the Anthracene also changes the unconfined compressive strength of soil, and it reduces strength of soil. Although adding cement increases the strength of the contaminated soil, the amount of increase in the strength depends on the percent of cement and curing time. Scanning electronic microscopy also is done on the natural soil, contaminated soil with cement, soil-cement and contaminated soil with Anthracene that is stabilized with cement with 10 and 20 percent of cement with 28 days of curing time. The results indicate that adding the Anthracene to the soil changes its structure to flocculated shape, but the decreasing of friction between soil particles due to adding Anthracene, leads the soil particles to moving easily together. Moreover, the results of this research show that the cement can stabilize contaminated soil with Antracene.

Key Words: Unconfined compressive strength (UCS), scanning electron microscope (SEM), diffuse double layer (DDL), soil flocculation structure, microstructure.

BEHAVIOUR OF STRIP FOOTINGS ON SANDS REINFORCED BY GEOCELL AND RUBBER PARTICLES SUBJECTED TO CYCLIC LOADING

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Abstract

Geosynthetics have been extensively used as soil reinforcements under footings especially in soft grounds. Geocell is a form of three-dimensional reinforcement which is able to provide greater bearing capacity due to confinement compared to planar types of reinforcements like geogrids and geotextiles. On the other hand, using tire shreds, in addition to improving soil properties would have favourable environmental effects that causes a great tendency for its utilization in engineering projects. In order to study the cyclic and post-cyclic behaviours of strip footings on sands reinforced by geocells and rubber particles, a small-scale physical model in soil mechanics laboratory of Amirkabir University of Technology has been developed. Main parts of the laboratory apparatus include the footing model, the soil container, raining system, loading equipment and data acquisition system. Geocells with different geometrical dimensions, yet the same material have been used in a specific location in sand layers. To investigate the effect of rubber particle size mixed with sand as the geocell infill material, the geocell pockets have been filled with different materials; namely pure sand, pure rubber particles and mixture of rubber particles and sand at desired densities. Then a static loading is applied to the footing followed by a cyclic loading up to 1000 load cycles. Finally, the static loads are re-applied until failure occurs. The study's results indicate that in similar compaction condition, substituting a percentage of sand with rubber particles of greater size leads to reduction in plastic settlement and increment in elastic settlement. In the case of mixing sand with rubber powder with the smaller particle size, the settlement would increase while the bearing capacity decreases. Therefore, it is concluded that using the mixture of soil and rubber particles of greater particle sizes compared to soil grains would improve the cyclic behaviour of reinforced soil by decreasing the permanent or plastic settlements.

Key Words: Geocell, strip footing, bearing capacity, tire shreds, tire particles, plastic settlement, elastic settlement, cyclic loading.

EXPERIMENTAL INVESTIGATION OF SCOUR PATTERN DUE TO THE LOCATION OF TWIN CONVERGENT AND DIVERGENT BRIDGE PIERS PARALLEL TO FLOW IN DIFFERENT LOCATIONS OF A 180 DEGREE BEND

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Abstract

Tensile cracks at the upstream face of concrete gravity dams, especially at the dam base as induced by tensile stresses, due to the reservoir hydrostatic load are the most likely type of Damage in this type of structures. Given the possible intrusion of water under the reservoir heading into such tensile cracks, considering an actual distribution of water pressure inside the crack may intensively affect the stress state around the crack tip. Eventually, propagation of the crack, and hence, a change of COD profile mutually modifies the water pressure distribution along the crack. This coupled hydro-mechanical process has played an important role in design and safety assessment of concrete gravity dams. If this interaction is not considered in the stress analysis or safety assessment of concrete gravity dams, results of analyses can be misleading.

The aim of this paper is to present a simple 2D model to simulate the process with hydro-mechanical interaction based on nonlinear fracture mechanics (NLFM) and Biot effective stress concept. The proposed model includes: 1) the modified smeared crack model for the mechanical behavior of cracking concrete; 2) the effective stress equation in which both terms of pore pressure and effective porosity are increased linearly with tensile damage index in a cracked element.

The proposed model is validated by the wedge-splitting test of a concrete cube specimen under a displacement control loading. The specimen is subjected to a mechanical load as well as to an internal hydrostatic pressure of 0.5 MPa. Next, the Koyna Dam as a well-known example of a concrete gravity dam, was analyzed under flood loading considering water-crack interaction; moreover, cracking status of the dam and the maximum sustainable reservoir level before dam collapsing were studied. Numerical analysis results confirm the significant effect of water pressure inside the cracks on the overall response of the dam. In fact, considering hydrostatic pressure inside the cracks has significant effects on the scenario of dam collapse and the maximum sustainable reservoir level.

Key Words: Water pressure inside the crack, concrete gravity dam, cracking, flood loading, hydraulic fracture.

INVESTIGATION OF THE EFFECT OF CEMENT ON THE STABILIZATION OF CONTAMINATED SOIL WITH ANTHRACENE

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Abstract

Soil pollution by hydrocarbon is a significant Geo-Environmental problem that can affect the environmental quality of soil, groundwater and air. Some physical properties of the soil such as stress, bearing capacity, permeability, etc., have changed due to entry of this contamination. On the other hand, requirement of appropriate soil is increasing due to development of urbanization and construction in recent decades. Sometimes a project must be founded at a site with hydrocarbon-contaminated soil, and providing appropriate soil may be difficult, due to economic or environmental issues, so stabilization of the contaminated soil is an appropriate method to treat the soil and change contaminated-soil into a useable material. Researchers have different opinions about the ability of stabilization of hydrocarbon-contaminated soil with cement: for example, some researchers believe that the cement cannot stabilize the hydrocarbon-contaminated soil. They consider that the particles of contamination cover the surface of cement and decrease its efficiency of stabilization. In the current research, the effect of adding cement to the contaminated clay soil with Anthracene is investigated. Anthracene is a representative of one group of hydrocarbon, called PAHs (Polycyclic Aromatic Hydrocarbons). PAHs are created due to incomplete combustion of fossil fuels or wastes.

In order to investigate the effect of cement on the stabilization of clay contaminated soil with Anthracene, the specimens of natural clay soil, contaminated soil with Anthracene, soil-cement and Anthracene-contaminated that is stabilized with different percentage of cement (5, 10, 15, 20 and 30%) in different curing times (3, 7, 14 and 28 days) were prepared by static compaction method at maximum dry density and optimum moisture. Unconfined compressive strength (UCS) tests were conducted on the specimens. The results of the experimental work showed that adding Anthracene to clay soil, changes the compaction parameters; for example, the dry-specific weight of soil is reduced and the optimum water content is increased. Although adding cement to the Anthracene-contaminated soil improves the

excavation machines which are usually used in subway projects are taken into account. All projects' risks related to cost, time, and environment are identified considering the capital costs which should be spent on each combination. Delphi method was applied in order to figure out the failure events and their associated probabilities. Finally, some graphs which can be used for optimization of combined excavating machinery are presented. The results show that it can be employed efficiently by construction managers.

Key Words: APRAM, machinery combination, subway project, risk management.

INVESTIGATION OF THE EFFECT OF ANISOTROPY ON THE PORE WATER PRESSURE GENERATION OF LOOSE ANISOTROPIC CONSOLIDATED BABOLSAR SAND

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Abstract

Direction of loading and magnitude of the intermediate principal stress have significant effect on the soil responses. In many of in-situ loadings, the direction of major principal stress does not coincide with the deposition direction of the soil. In addition, the magnitude of the intermediate principal stress should be exerted in the three-dimensional loading condition. A reliable assessment of the soil behavior and a good estimation of the soil parameters need to do tests in similar condition with in-situ. Therefore, the testing apparatus should be able to control the loading direction in various stress paths. Typical equipment used in the geotechnical laboratory does not have the ability to control the magnitude and direction of principal stresses. The cyclic hollow cylinder apparatus can control the magnitude and direction of the principal stresses and impose minimum non-uniformity on the specimens. The hollow cylinder apparatus used in this study is fully automated and can simultaneously control the five loading axe (i.e., the vertical load, torque, inner cell pressure, outer cell pressure and back pressure). The main specifications of the specimens are as follows: 100mm outside diameter, 60mm inner diameter, and 200mm height. Babolsar sand obtained from the South coast of the Caspian Sea was selected as test materials. The consolidation control options allow the various anisotropic consolidation statuses. Moreover, the load could be exerted as cyclic or monotonic. In this paper, the effects of major principal stress direction, induced shear stress during consolidation, and cyclic stress ratio on the pore water pressure were investigated. Therefore, the undrained cyclic hollow cylinder tests were performed on the loose anisotropic consolidated specimens. Results showed that, the major principal stress direction during consolidation has no significant effect on the excess pore water pressure generation. However, increases of cyclic stress ratio and shear stresses during consolidation would increase the residual excess pore water pressure. The empirical model proposed by Booker et al. and a dissipated energy-based model were used to predict residual excess pore water pressure of loose anisotropic consolidated Babolsar sand. The regressions analysis was led to modification of the model of Booker at al. and simplification of the dissipated energy-based model.

Key Words: Sand, anisotropic consolidation, hollow cylinder apparatus, excess pore water pressure.

EFFECT OF WATER PRESSURE INSIDE THE CRACKS ON THE BEHAVIOR OF CONCRETE GRAVITY DAMS UNDER FLOOD LOADING

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Abstracts of Papers in English

OPTIMUM COMBINATION OF EXCAVATING MACHINERY USING ADVANCED PROGRAMMATIC RISK ENVIRONMENT AND MANAGEMENT MODEL

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Abstract

Since the proper use of construction machinery in infrastructure projects is so important, it is essential to employ an optimum machinery selection in these projects, because a successful project is usually identified by its ability to be completed on time and within budget in conformance with technical requirements. In order to achieve these objectives, construction managers need to be equipped with efficient decision-support tools which can help them to improve the distribution of the allocated project resources considering cost, time, and quality while simultaneously minimizing the risks of project failure. In addition, the environmental risks in projects' analysis may play an important role. Complicated as this is, balancing resource allocations and the risk of project failure becomes even more complicated as the project's resources become more constrained. Advanced Programmatic Risk Analysis and Management Model (APRAM) is one of the recently developed methods which can be used for risk analysis and management purposes considering schedule, cost and quality risks simultaneously. In this paper, first the APRAM method is modified in order to consider the environmental risks. This method can consider potential risks that might occur over the entire life cycle of the project, including technical and managerial failure risks. Therefore, the model can be used as an efficient decision-support tool for construction managers in machinery selection in infrastructure project where various alternatives might be available, technically. Three possible combinations of