quake levels, it has not been greatly considered. This research attempts to compare the conversion coefficients of design based earthquake ground motion (10%) to other earthquake acceleration levels (2%, 5%, 20%, 50% and 64%). For this purpose, two susceptible areas of Sari (Elburz zone) and Fereidoonshahr (Zagros zone) were chosen, and their design accelerations relevant to the various seismic levels were determined. Afterwards, the ratios of obtained ground-motion compared to design based ground-motion were calculated. For each of the above mentioned areas, available seismic data were collected and considered in a radius of 200 km for calculating seismic factors, based on the Kijko method. Major fault systems of the sites were reviewed and modeled using suitable attenuation parameters. SeisriskIII was employed as technical software for calculating the ground-motion peaks of different seismic risk levels by applying logic tree coefficients. Isoseismal maps were prepared for both areas, yielding the ratios of acceleration levels for various seismic designs. These ratios are (0.2, 0.28, 0.64, 1.51 & 2.41) and (0.36, 0.43, 0.74, 1.33 & 1.88) for Sari and Fereidoonshahr, respectively. Finally, the results of this study show good correlation with the proposed coefficients of the standard code. The results indicate that the Iranian Code of Practice for Seismic Design (Standard no. 2800) estimates well the design based acceleration for Sari and Fereidoonshahr.

Key Words: Seismic risk analysis, seismic factors, maximum horizontal acceleration, seismic risk levels, Sari, Fereidoonshahr.

fact that the final selection of the project delivery system is done by the owner/employer of the project, this project is approached from the employer's viewpoint.

Key Words: Project delivery system, design-bid-build, management contractor, construction management at risk, design-build, turn-key, analytic hierarchy process.

INVESTIGATIONS INTO THE MECHANICAL PROPERTIES OF CONCRETE CONTAINING CERAMIC FLOOR TILE AND SILICA FUME

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Abstract
Millions of tons of waste are produced each year, most of which is not recyclable or whose recycling process is extremely energy-consuming or polluting. Also, dumping these materials in the countryside has doubled the dangers to the environment. Recycling worn-out materials and using them in concrete making is a good strategy to attain the two goals of getting rid of waste and making high quality concrete. It is a good option for use in concrete as waste ceramic tile has an extremely resistant structure, a physical nature that cannot be processed in any recycling system and the fact that it is produced in huge amounts. Through this study, it is intended to survey the effect of waste ceramic tile powder on the mechanical properties of concrete. First, the waste ceramic tile provided from companies is milled at 325 meshes. After the pozzolan qualities of materials are confirmed and related standard controlled, concrete samples with 10-40 percent of pozzolan substitution are made, and some physical and mechanical qualities are measured for different curing ages. The synchronous effect of silica fume is surveyed, as well as ceramic pozzolan. It had been deduced through measuring the compressive strength of the mentioned samples that substituting ceramic pozzolan for 30 percent of concrete would slightly decrease resistance long term. In addition to its slight decrease of resistance, using ceramic pozzolan considerably decreases the amount of water absorption. With only 5 percent of silica fume, the defects due to ceramic pozzolan usage could be eliminated from concrete. Eventually, after considering economical and environmental aspects, as well as taking concrete qualities into account, it was proven that ceramic pozzolan is suitable for making concrete, and that silica fume could be used to improve the qualities of pozzolan concrete.

Key Words: Waste ceramic tile, silica fume, pozzolan, environment, concrete.

ASSESSMENT OF CONVERSION COEFFICIENTS OF DESIGN BASED EARTHQUAKE ACCELERATION TO ACCELERATIONS OF DIFFERENT SEISMIC RISK LEVELS FOR THE CITIES OF SARI AND FEREIDOUNSHAHR

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Abstract
The aims of considering structural seismic design regarding various seismic risk levels are different. For example, the structure should be serviceable after weak earthquakes and should not collapse after strong motion. Seismic design goals depend on earthquake motion levels and expected performance levels. Therefore, in order to approach certain design objectives, the recognition of a range of seismic levels is highly essential. Based on seismic design codes, design based earthquake ground motion is usually recommended, though, for other earth-

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Abstract

This paper presents the fundamentals of groundwater modeling in fractured media and also the technical details of a desirable modeling method in discontinuous rocks. In this paper, the modeling of fluid flow in rock mass is studied using the distinct fracture network (DFN) concept. A new computational code, "FNETF", has been developed for generating DFN and fluid flow analysis. The FNETF computational code uses a Monte Carlo approach to generate two-dimensional discrete fracture networks, based on the statistics of the geometrical characteristics of the fracture, in terms of location in the generated region, orientation with respect to the coordinate axes, length, and aperture. In this case, individual realizations of hydraulic attribute distribution, which are formed by discrete fractures, are generated from a set of probability distributions describing the geometry of the fractures. Because the generated fractures are finite, a relatively large number of fractures in the network may not be perfectly connected and some do not contribute to the flow process. These hydraulically inactive fractures should be removed from the domain and can be recognized as isolated sub-networks, singly connected fractures, and dead end fractures, which have not complete interconnection between other percolating fractures or flow domain boundaries. Once a fracture network is regularized, a finite element mesh is generated for the percolating graphs, consisting of nodes and elements that are fracture intersections and fracture segments between nodes, respectively. The hydraulic head at each node and steady state flow rate in each element are calculated using a flow network technique, based on the mass continuity equations and cubic law. The validity of the developed computational code is explored by predicting the groundwater inflow to the powerhouse cavern of the Siahbisheh pump storage project in the North of Iran. The main input data for fluid flow modeling through a fracture network were captured from site investigation, detailed measurements of groundwater level, and geometrical characteristics of fracture. A flow domain, 122m wide and 129.75m high, was used to simulate water inflow into the Siahbisheh powerhouse cavern. The simulation of water inflow into the powerhouse cavern for 0+071 to 0+085 chainages was done using the FNETF computational code and field data. Based on direct aperture back calibration, the equivalent hydraulic aperture is considered to be 0.452mm. Comparison of results indicates that there is appropriate correspondence between inflow simulations through the DFN model and those measured. Therefore, DFN models can be utilized for fluid flow analysis in the near-field domains in discontinuous media, showing the appropriate results of rock mass hydraulic modeling.

Key Words: Groundwater modeling, distinct fracture network, discontinuous rock, hydraulic aperture.

SELECTING THE OPTIMUM PROJECT DELIVERY SYSTEM USING ANALYTIC HIERARCHY PROCESS

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Abstract

Development of large infrastructural projects is considered as an important tool for governments to achieve sustainable development. The main features of these projects separating them from other types of projects are requiring enormous financial, high scientific and technological levels, extensive technical knowledge and high amounts of workload and time. These projects have significant effects on economic and technological status, and even on political and social situations in different nations. By considering this importance, selecting appropriate methods for the preparation and implementation of project seems necessary. Otherwise, irreversible losses and high costs could occur. Thus, an appropriate policy in the decision process concerning the implementation of infrastructural projects is vital. This paper was prepared based on an university research project, in which the identification and comparison of different systems is undertaken using expert opinion to determine the importance of factors on the decision process. Using a hierarchical analysis process, a model is proposed for making decisions about the choosing of optimal project delivery system for constructing infrastructures. Because of the

also, the density of the soil, the lateral bearing capacity increases also, but, soil density is more effective than other parameters. In addition, it is shown that the location of the pile rotation point is not affected by changes in diameter and soil density.

Key Words: Short piles, lateral load, bearing capacity, cohesionless soil, rotation point.

PERFORMANCE OF NATURAL ZEOLITES FOR REDUCING THE AMOUNT OF GROUNDWATER SALINITY

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Abstract

Zeolites are microporous, aluminosilicate minerals commonly used as commercial adsorbents and catalysts. Zeolites have a porous structure that can accommodate a wide variety of cations, such as Na^+, K^+, Ca^2+, Mg^2+ and others. These positive ions are rather loosely held and can readily be exchanged for others in a contact solution. Their well-defined pore structure and adjustable acidity make them highly active in a large variety of reactions. The ion exchange properties of zeolites are widely exploited in water industry to remove certain cations including Ca^2+ and Mg^2+ in water softening processes. In this study the application of modified zeolites for removing water salinity was investigated. The raw mineral zeolite used in this research was from mineral sites of Semnan province. The ore contained three-dimensional network structure consisting of tetrahedral $[SiO4]^4$, and $[AlO4]^4$ compound.

The raw mineral rock was grinded and sieved to prepare samples of granular sizes of 0.5 -1 , 1-2 and 1-3 mm diameters. A part of the prepared samples was chemically treated by washing with hydrochloric acid to increase its activity. Activated zeolite was compared to untreated samples in removing water hardness and salinity.

The activation process dissolves and removes some of the salts contained in the mineral structure and increases the adsorption and exchange quality of the mineral.

The experiments were carried out with saline water with known salt concentration. The zeolite concentration ranged from 0.5, 1, 2, 3, 5, 10, 20 and 50 gram per liter. The effect of equilibrium time of 15, 30, 40, 45, 60, 90 and 120 minutes were experimented. As expected lower doses of added zelolite has little effect in salt removal due to low adsorption/exchange capacity of the mineral. It was concluded that equilibrium time of 40-60 minutes is adequate and longer contact time has little effect on the removal efficiency.

The results indicated that zeolites used were of clinoptilolite variety. The untreated samples were found to be ineffective in reducing water salinity and in some cases increased chloride content of the solution. However treated samples showed good quality in removing water hardness and to some extent has the ability to reduce salinity. In this respect untreated zeolite should not be used for water purification but acid-activated zeolite can be used for moderate desalination.

Key Words: Zeolite, clinoptilolite, salt, sodium, chloride, electrical conductivity, salinity, aluminosilicates.

FLUID FLOW MODELING IN DISCONTINUOUS ROCK MEDIA USING A DISTINCT FRACTURE NETWORK

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Abstract

Over time, types of piles and pile installation methods have been considerably developed, and, therefore, engineers have various choices in this regard. So far, some research has been done to analyze and design cast-in-place concrete piles in sandy soil. The methods used to evaluate pile behavior are reliable only when the appropriate results have been observed in the field of numerous data. There are many ways to determine pile bearing capacity, and statistical analysis based on soil strength, the empirical method with in-situ tests results, and pile load tests are some of them. Pile load testing is an exact method to determine pile bearing capacity and is usually used in important projects. Therefore, in the present study, 12 cast-in-place concrete piles with different sizes were loaded in sand and the settlements were measured, in order to determine the ultimate bearing capacity of the piles. Piles were constructed in lab scale and were divided into 4 classes. In this article, first, some past research is reviewed. Then, soil properties and tests used for field investigation are provided. Pile installation methods and equipment used for pile testing in this study are explained. Finally, the bearing capacity of the piles is evaluated. Estimation of pile capacity based on a load-settlement curve is often difficult. There are many ways to explain test results and estimation of the bearing capacity of the piles. Then, in this study using load-settlement diagrams, the ultimate bearing capacity of the piles was estimated by existing empirical methods and the results were compared with each either. The results show that the bearing capacity in Chin's method is considerably higher than the average value obtained from other methods. On the other hand, Davisson's method shows a lower value, and Terzaghi's method is more reliable in this study. Finally, using the pile load test, reliable results for the piles are obtained.

Key Words: Compression Bearing Capacity, Cast in Place Concrete Piles, Sand, Pile Load Test.

EVALUATION OF SHORT PILES BEARING CAPACITY SUBJECTED TO LATERAL LOADING IN SANDY SOIL

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Abstract

Almost all types of pile are subjected to lateral loads. In many cases, however, the applied lateral loads are comparable with gravity loads. Lateral loads and moments are generally induced by wind and earthquake. All piles subject to lateral load are usually divided into two categories: long piles and short piles. The general methods to estimate the lateral bearing capacity of piles are based on ultimate bearing capacity and allowable horizontal displacement for short and long piles, respectively. Several theoretical methods, including Hansen, Broms, Petrasovits, Meyerhof, Prasad and Chari, have been proposed to predict the lateral bearing capacity of piles in cohesion-less soils. All these theories are based on a simplified soil pressure distribution assumption along the pile length. In engineering practice, the Broms method is most popular, since it is simple and applicable for both short and long piles.

In the present research, steel pipe is used as pile in the laboratory to evaluate the lateral capacity of piles subjected to horizontal loads. Steel model piles, with two different outside diameters of 21.7 mm and 27 mm, wall thickness of 2.4 mm, and lengths of 400, 600, 800 mm, were used for tests. The soil, in which the piles were embedded, was fine sand. The lateral load was applied to the pile using a robe and pulley system. The friction angle of the sand, determined by a Direct Shear device, was 33^o and 41.5^o for loose ($\gamma = 13.8kN/m^3$) and medium dense ($\gamma = 15kN/m^3$) states, respectively. The sand container was cylindrical in shape, 0.7 m in diameter and 1.0 m in height. Thin wires, attached to the pile at different levels, were utilized to measure the horizontal displacement of piles within the soil. According to theories and experimental test results, the behavior of piles with different length and diameter embedded in sand was evaluated. A comparison between experimental test results and different theories reveals that the Prasad and Chari method is more suitable for estimation of the lateral bearing capacity. It is shown that by increasing the length and diameter of the piles and,

the compressive strength parameter was applied in order to examine the bearing capacity of rock-socketed piles, since this is much easier to be specified in comparison with others.
A database has been compiled consisting of 63 full scale loading tests applied to rock-socketed piles with unconfined compressive strengths of the surrounding rock. The load bearing rocks include: limestone, mudstone, siltstone, shale and granite, with compressive strengths ranging from 1.1 to 54 (MPa). The embedment length and diameters of the RSP (rock-socketed piles) vary from 0.5 to 6 and 0.5 to 1.6 meters, respectively.
The empirical equations suggested by various researchers were investigated and then compared with the results of the loading tests. For each bearing rock, an exponential equation from the loading test results has been fitted using a statistical approach. Then, the equations have been proposed for each individual type of rock. Also, a general equation was suggested for the determination of the bearing capacity of the shaft for rock-socketed piles, wherein the rock type is unknown or not among those discussed in this research. Finally, in order to consider the effects of the rock mass properties, a correction factor was proposed for the compressive strength, based on RMR (Rock Mass Rating), in which, the accuracy of such a factor was discussed using five case studies.

Key Words: Bearing capacity of shaft, rock-socketed pile, database, full scale, loading tests.

DECOUPLED EQUATIONS METHOD FOR SOLVING TWO-DIMENSIONAL ELASTODYNAMIC PROBLEMS IN THE FREQUENCY DOMAIN

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Abstract
Mathematical models can be used to represent physical phenomena. However, mathematical models may not evaluate physical models sufficiently. Mathematical modeling is an important step in engineering analysis, and many numerical methods may be used for solving and modeling physical phenomena, particularly elastodynamic problems. These numerical methods have advantages and disadvantages. One of the disadvantages of these methods is that the differential equations are coupled. In this paper, a new semi-analytical method, called the Decoupled Equations Method, is developed for solving two-dimensional (2D) elastodynamic problems in the frequency domain. In the frequency domain approach, Fast Fourier Transform (FFT) is implemented to transform a time domain problem into a frequency domain one. Using specific non-isoparametric elements, the boundary of the problem domain is discretized. This new method is based upon a scaled boundary finite element method that has been developed for solving two and three dimensional engineering problems. By employing the advantages of numerical methods (such as SBFEM), and using higher-order Chebyshev mapping functions, special shape functions, the Clenshaw-Curtis quadrature rule, and implementing a weak form of the weighted residual method, coefficient matrices of governing differential equations for elastodynamic problems become diagonal. This fact results in a set of decoupled Bessel differential equations to be used for solving the whole system. This means that the governing Bessel differential equation for each degree of freedom (DOF) becomes independent from other DOFs of the domain. For each DOF, the Bessel differential equation is solved for a specific frequency. Finally, the time history of responses may be obtained by using Inverse Fast Fourier Transform (IFFT). The proposed shape functions have two specific characteristics: (a) The shape functions have a Kronecker Delta property, and (b) Their first derivatives are equal to zero at any given node. In this paper, 2D elastodynamic problems have been solved using the present method and compared with other numerical examples given in the literature and/or exact analytical solutions wherever available.

Key Words: 2D elastodynamic problems, diagonal coefficient matrices, Chebyshev polynomials, non-isoparametric elements, frequency domain analysis, decoupled Bessel differential equation.

EVALUATION OF CAST-IN-PLACE CONCRETE PILES CAPACITY BY COMPRESSIVE PILE LOAD TESTING IN SAND

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superior to the current codified pattern, regarding the abovementioned points especially to prevent progressive collapse, Thus, they may be considered as safer seismic designs than the current practice.

Key Words: Seismic design, smoothed loading pattern, hybrid meta-heuristic optimization, steel frames.

OPTIMUM SEISMIC REHABILITATION OF STEEL MOMENT FRAMES USING THE UNIFORM DEFORMATION METHOD

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Abstract
The rehabilitation of existing buildings or design of new resistant buildings under earthquake conditions, presents an important problem in earthquake prone countries. Different techniques and methods are used to rehabilitate structures such as passive energy dissipating devices. These systems are used to upgrade the performance level of structures and prevent structural damage during earthquakes. One energy dissipating device considered a passive control system, is the metallic-yielding damper. This passive control system is used to upgrade the performance of structures, modifying the stiffness, strength and damping of structures, simultaneously. These metallic seismic energy absorbing devices endure a large deformation in their mild steel plates, thus, yielding a large volume of steel and so increasing structural damping, which can dissipate substantial energy during an earthquake.
According to presented optimization methods, various inelastic moment-resisting steel frames with some flaws in the primary design phase were rehabilitated optimally. In this research, employing the Uniform Deformation theory, a new trend is presented in order to decrease the seismic response of multi-degree moment-resisting steel frames. In this method, the basic aim of optimization is determining the optimum outline of dampers throughout the height of a structure, in such a way that the structure reaches allowable performance at the lowest cost. For modeling metallic-yielding dampers, nonlinear springs with Elasto-Perfectly-Plastic material are inserted into the structure on shevron chevron braces. It was shown that the structure retrofitted by this method has optimum seismic performance and uses its maximum capacity, while the structure satisfies seismic provisions. The effect of various parameters, such as number of stories, asymmetry, earthquake intensity and frequency content, on the optimization process, is studied. It is concluded that the number of iterations, the optimum objective function and the precision of convergence are highly affected by the mentioned parameters. The optimum outline and mechanical properties of dampers are dependent on applied earthquake ground motion.

Key Words: Metallic-yielding damper, optimum outline of dampers, optimization, rehabilitation, performance-based design, uniform deformation.

INVESTIGATION OF EMPIRICAL METHODS FOR DETERMINING BEARING CAPACITY OF ROCK-SOCKETED PILES

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Abstract
Rock-socketed piles can be realized as a suitable solution for the foundation systems of very heavy structures. Due to low settlement and high bearing capacities, these types of substructure are very efficient. The studies conducted by some researchers on the determination of the bearing capacity of shafts for rock-socketed piles, have been focused on parameters such as the compressive strength of rock ($q_u or \sigma_c$), roughness of pile-rock interface and discontinuity in the rock mass. In this study,

liners are constructed in thin layers and, therefore, indicate an oedometric behavior. Experimental study of the at-rest lateral pressure of these soils is an important step in understanding the hydro-mechanical behavior of the abovementioned barriers. Despite the huge amount of research on the oedometric volume change of expansive clay, little work has been done to date on the K0-coefficient of these soils, and the effect of hydraulic loading on their mechanical behavior has been rarely studied.

In this paper, a novel oedometer is introduced to determine the coefficient of the lateral pressure of soil. The almost rigid ring of the modified apparatus has three circular diaphragms, with a diameter of 15mm and a thickness of 0.35mm. Three LVDTs are installed in contact with these diaphragms to measure the horizontal deformation of the thin diaphragms induced by the horizontal pressures. The diaphragms are calibrated using the water hydrostatic pressure, and pressure and deformations are correlated. Adopting the osmotic method to impose the matric suction, the modified oedometer apparatus accommodates the circulation of the PEG solution beneath the soil sample. A semi permeable membrane is introduced between the sample and the PEG solution to prevent the PEG macromolecules from passing towards the sample.

Twenty five percent of the studied material is composed of bentonite and the rest of the soil is well graded sand. The coefficient of the at-rest lateral pressure of the material is determined at various stress states, and the influence of hydraulic loading on the lateral pressure of the soil is discussed in detail. A single effective stress approach is employed to determine the at-rest lateral pressure of the soil particles. The outcomes indicate that the K0-parameter decreases significantly with suction increase. Furthermore, drying-wetting cycles harden the soil, reducing the amount of compressibility indices and the K0-parameter of the material.

Key Words: At-rest lateral earth pressure, sand-bentonite, matric suction, oedometer.

NEW OPTIMAL SMOOTHED BASE-SHEAR DISTRIBUTION PATTERN FOR SEISMIC DESIGN OF PLANAR MOMENT FRAMES

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Abstract

Structural design of building frames depends on the exerted loading. The simplified lateral loading in seismic design codes is, in fact, height-wise distribution of base-shear and depends on the designed section profiles for structural members. The present study seeks for the suitable, meanwhile, smooth and simplified distribution of base-shear for practical seismic design and compares it with the current code practice.

The problem is, thus, two fold. First, a lateral load pattern is sampled using linear combination of a few simplified patterns and their corresponding scale factors, second, the optimal sizing design under such a generated loading is determined.

An integrated optimization platform is presented, including Harmony Search, for the first part, dealing with both continuous and discrete variables and Ant Colony Optimization, with further local search for the second part to do the discrete sizing design of the building frame. Consequently, a penalized objective function is developed to consider not only code-based steel design and drift constraints but also remunerate pioneering plastic-hinge formation to occur at upper levels of the frame.

Using the proposed algorithm, examples of steel moment frames with different width and height are treated. New smooth patterns of base-shear distribution are obtained, including a uniform part at mid-height with a linear increase near the roof and a linear decrease to zero at the base level. Optimal sizing designs under these patterns and the code-based pattern were then provided to be further compared.

It was found that the new designs are closer to the structural constraints, including stress and displacements limits. In another words the code-based pattern resulted in non-economic over-designed structures. The achieved designs are verified employing several static, spectral and time-history analyses. Considering the story displacement and drift response, the corresponding spectral and static results under new-optimal patterns are found to be compatible. Standard deviations of the inter-story drift response for new-pattern designs were generally less than the code-based designed models. Such drift uniformity among the frame stories is desired in seismic design as it leads the entire structure to uniformly participate in resisting earthquake effects. The most critical stress points as the plastic-hinge starting locations, occurred in upper stories of the designed models under optimal patterns with respect to the code-based practice. The new smoothed patterns of base-shear distribution stand

and loose samples conduced under low and intermediate stress levels. It is shown that the mechanical behavior of samples with different fines content can be predicted using a unique set of parameters.

Key Words: Sand, silt, intergranular void ratio, state parameter, steady state, flow liquefaction.

NUMERICAL STUDY OF EFFECTIVE MECHANISMS ON SEISMIC RESPONSE OF UNDERGROUND STRUCTURES BURIED IN LIQUEFIABLE SANDY SOIL

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Abstract
Nowadays, population growth and civil facility development requirements have caused increases in the construction of underground structures in urban residential zones. Previous earthquake observations show that severe damage may occur to underground structures such as pipelines, manholes and even large underground structures, including subway tunnels. However, the seismic performance of subway tunnels buried in loose sandy soil with liquefaction potential needs further investigation, in order to recognize common contributed mechanisms to the seismic responses of underground structures from performance based seismic schemes. In this paper, the seismic responses of a subway tunnel buried in loose soil with liquefaction potential are numerically studied with a three-dimension finite element program called COM3. According to numerical studies, the subway tunnel shows upward movement in the liquefied soil with simultaneous occurrence of two conditions. These include non-uniform excess pore pressure distribution under the subway tunnel and lateral deformation of the structure due to lateral displacement of the surrounding soil. These are necessary and sufficient parameters that affect the amount of liquefied soil moved to the bottom of the structure, as a common mechanism in the uplift response of a shallowly buried subway. Although the subway tunnel is symmetrically simulated, the amount of liquefied soil moved from each bottom side of the structure is not identical because of seismic excitation characteristics. The lateral deformation of the subway tunnel causes the downward movement of the structure in the un-saturated soil condition, due to its inertial force under seismic excitation. Increasing the unit weight of a subway tunnel has a contrary effect on the seismic response of structures in loose soil conditions, and it is rational to consider the influence of both soil conditions on the seismic behavior of subway tunnels in the design stage. The reinforcement ratio variation of a subway tunnel has no significant effect on the seismic behavior of the subway tunnel under a saturated condition, but the reduction of reinforcement ratio may increase lateral deformation and settlement of the structure in an un-saturated condition. The loose soil relative density growth improves the seismic responses of subway tunnels under both soil conditions, and the traditional remedial method, including densification, is numerically verified as a useful procedure.

Key Words: Underground structure, loose sandy soil, liquefaction, seismic response, soil-structure interaction, seismic excitation.

EXPERIMENTAL INVESTIGATION OF AT-REST LATERAL PRESSURE OF AN ARTIFICIALLY PREPARED SAND-BENTONITE MIXTURE

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Abstract
Sand-bentonite mixtures are usually utilized as liners for municipal waste disposal facilities. These widespread

Abstracts of Papers in English

A MODIFIED CONSTITUTIVE MODEL FOR SIMULATION OF SILTY SAND BEHAVIOR

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Abstract

Recent studies have revealed that silty sand subjected to cyclic loadings is relatively more prone to liquefaction. Therefore, application of existing frameworks, mostly built upon experimental observation on the liquefaction behavior of clean sand, may lead to unsafe design. Technically, in silty sand, silt grains fill the empty spaces between the larger sand grains, but their contribution in load bearing structures is less than that of sand grain. As a result, the reduction of void ratio associated with the presence of fines does not lead to the, so-called, denser load bearing structure. In this regard, the intergranular void ratio defined, based upon the void ratio of those grains participating in the load carrying structure, is a more reasonable index of the density of the load bearing structure in silty sand. The existing state dependent constitutive models exhibit deficiencies in systematic simulation of the mechanical behavior of clean and silty sands with different fines content in a unified manner. In this paper, it is shown that replacing the general void ratio by the intergranular void ratio in the existing constitutive models leads to a unified framework for prediction of the mechanical behavior of both clean and silty sands. While a significant scatter is observed in the steady state lines of the samples with different fines contents, depicted in terms of global void ratio, it is shown that steady state lines drawn, based on the intergranular void ratio, are located in a narrow range. Simulations obtained from the modified model are compared with the experimental data on clean and silty sands reported by two independent research teams. Experimental data consist of the results of triaxial tests on dense, medium,