increasing load, the metastable structural bonds of the soil will break, and sudden large excessive deformations and collapse of the soil occur, which may lead to severe damages to or total destruction of the structures built on such soils.

Many researchers have studied this behavior mainly using double oedometer tests to assess the amount of anticipated collapse under certain loads. However, few of them studied the behavior of such collapsible soils in an unsaturated soil mechanics context. Most of such researches were conducted on reconstituted specimens and very few among them studied undisturbed or intact samples. However, in order to assess the hydro-mechanical behavior of this type of soils, numerous unsaturated triaxial tests have been conducted using a modified unsaturated triaxial device at Sharif University of Technology on undisturbed loessial samples taken from the city of Gorgan. In this paper, the results of some of the performed tests under applying constant matric suction and variable mean net stresses were re-analyzed by considering classical unsaturated soil mechanics concepts, and a new modified hydromechanical constitutive model was presented to predict the hydromechanical behavior of collapsible soils. The outcome of this research was proved promising, and the comparison between the results of the tests and the predicted values using the proposed method showed very good agreement.

Key Words: Collapsible soils, loess, undisturbed specimen, unsaturated triaxial device, load-collapse curve, unsaturated constitutive model.

A BOUNDING SURFACE PLASTICITY MODEL TO SIMULATE SHAKEDOWN PHENOMENON IN EXPANSIVE UNSATURATED CLAYS UNDER CYCLIC HYDRAULIC LOADING

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Abstract

Numerous constitutive models have been developed to date based on the effective stress principle to perform qualitative and quantitative simulations of the hydro-mechanical characteristics of the unsaturated non-expansive soils observed in the experiments. However, the hydro-mechanical behavior of expansive clays has been rarely investigated through the theory of plasticity. The aim of this paper is to simulate the shakedown incident in expansive unsaturated clays under drying-wetting cycles within the framework of a plastic bounding surface model.

To achieve the objective, the versatility of the shape parameter of the plastic potential is used: in shakedown phenomenon, the dynamic response of the soil structure is elastic-plastic followed by the recoverable response to the imposed cyclic loading. Hence, during the drying-wetting cycles, as the peak of the plastic potential converges to the horizontal stress path, plastic volumetric strain decreases until there is no further plastic strain and behavior of the soil is purely elastic. The plastic potential shape parameter changes with the number of cyclic loading: therefore, the size of plastic potential reduces and peak of the plastic potential converges to stress path.

The role of the suction on the hydro-mechanical behavior of soils is also briefly explained, and effective stress is carefully chosen as the single stress state variable to develop the stress-strain constitutive relationships. A novel method is proposed to determine the effective stress parameter of unsaturated soils from the volume change behavior. In addition, suction plays the role of the hardening parameter in the proposed model besides the plastic volumetric strain.

The elastic-plastic relationships of the proposed bounding surface for unsaturated geo-materials are described. The model is calibrated using the experimental data, and the results are discussed in detail. Results of the research show that as stress path gets close to the peak of plastic potential, shakedown occurs by a less number of loading cycles. As a result, different stress histories can postpone or anticipate the shakedown response.

Key Words: Expansive unsaturated clay, shakedown, bounding surface.

A MODIFIED HYDROMECHANICAL MODEL FOR UNSATURATED BEHAVIOR OF COLLAPSIBLE SOILS UNDER CONSTANT MATRIC SUCTION AND VARIABLE MEAN NET STRESS

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Abstract

Many parts of the world mainly in arid and semiarid zones, including Iran, are covered with Aeolian deposits of collapsible loessial soils. This kind of soil exists in many parts of Iran especially in Eastern part of the country from North to South. Loessial deposits are characterized with high void ratio, visible root type open pores, low density, and low water content. The natural slopes in Loessial deposits are nearly vertical and this geomorphological feature is an indication of the presence of Loess in that area. Loessial deposits normally have high strength and low deformability under natural water content or dry conditions. However, when they are subjected to excessive wetting while under a present or

and numerical methods for estimating these settlements were studied and presented by several researchers. However, experimental and semi-experimental methods are not able to include all parameters; so they cannot perform detailed calculation in complex problems. For this reason, the use of numerical methods was developed in order to accelerate and increase the accuracy of calculations, beside methods was developed.
In the present work, the effect of tunnel support on surface settlement has been studied by using finite- element method after verification of the model results made with ABAQUS software along with the experimental results and observations of sections s5-28 of the Milan underground line1. As the thickness and length of the concrete lining as geometric parameters that affect the support system stiffness, they can affect the surface settlements caused by tunnel excavation. Therefore, it is important that the support have the optimum size to have the greatest effect on reducing the settlements. Finally, in the present work, the effect of thickness and length of concrete segments installed with EPB-TBM ,has been studied. Keywords: settlement, EPB-TBM, concrete segment, tunnel, finite element.

Key Words: Settlement, EPB-TBM, concrete segment, tunnel, finite element.

EVALUATION OF CENTRAL FORCE OPTIMIZATION ALGORITHM IN MULTI-RESERVOIR SYSTEM OPERATION AND PROVIDING NEW OPTIMIZATION METHOD OF REPETITIVE CENTRAL FORCE ALGORITHM

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Abstract

In recent years, optimization of multi-reservoir systems operation is taken into consideration among water resource researchers. Optimization problems and highly increased computation time are the problems that caused by increasing the number of periods, as well as, reservoirs. In recent years, the water resource researchers have paid attention to the multi-reservoir systems operation that have been optimized using different algorithms such as Genetic algorithm, Harmony search algorithm, Honey bee mating optimization algorithm, Particle swarm optimization and Ant colony optimization. The central force optimization (CFO) is another metaheuristic algorithm which has been applied in various optimization areas such as improving bandwidth in electronics, micro strip antenna design, and optimization of drinking networks. The results indicate that CFO method is able to solve the optimization complex problems. CFO with its major application in the field of electronics, nothing has been reported on its application in multi-reservoir systems operation thus far.

In this paper, CFO has been applied to optimize the multi-reservoir systems operation. Despite the great capability of CFO in solving the optimization problems, it did not come to acceptable results in optimization of multi-reservoir systems operation. This algorithm has difficulty in solving the constrained and multi-dimensional problems. Also it is trapped into local optimum. For this purpose, some changes in the structure of the algorithm including normalization of the acceleration, mutation usage, history location, adding the main repetition cycle, and Repetitive Central Force Optimization algorithm (RCFO) were proposed. Most of these changes are made to prevent the above mentioned local optimum problem. After introducing the new algorithm was applied to optimize a four-reservoir system. The objective function in CFO and RCFO algorithms had a difference of 0.45 and 0.01% with the absolute optimum respectively. After the success in the case of four-reservoir system, RCFO algorithm has been applied to a ten-reservoir system. The value of the objective function in CFO and RCFO algorithms has a difference of 7.1 and 0.13% with the absolute optimum respectively. In both cases, the running time in CFO was approximately twice the running time of RCFO. And due to the occupation of the system memory in CFO method, the duration will be far longer in large repetitions. According to the success of RCFO algorithm in solving the problems in four- and ten-reservoir system, it can be concluded that this algorithm has an appropriate potential to be applied in solving complicated problems of real multi-reservoir systems operation.

Key Words: Central force optimization, heuristic algorithm, optimization of multi reservoir systems, linear programming model.

THEIR CHILDREN WALKING TO SCHOOL

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Abstract

Educational travel, due to the impact on health, safety, security, achievement, and personality of the child, forms an important part of children's daily activities. Such trips are also related with other social problems such as traffic congestion, consumption of non-renewable resources, and the environmental pollutions. According to international studies and despite a clear advantage of the active transportation (walking and cycling), the share of active transport of educational purposes has been decreasing. Recent studies have suggested that, in addition to demographic and traditional characteristics (such as social and environmental variables), parents' attitudes towards walking and safety may have a key role in children mode in school trips. For the lack of studies assessing safety and walking attitude, this study aims to seek the role of parental attitudes toward walking and safety on the preferences of using walking as a mode in school trips. 820 questionnaires were designed and distributed among 28 public and private elementary schools, both boys and girls in Mashhad in mid-February 2014. 625 fully completed questionnaires were returned. Using factor analyses (exploratory and confirmatory) and structural equation modeling, assessment of the psychological and socioeconomic variables was conducted. Results suggest that there is a strong positive relationship between parental attitudes towards walking and walking as a preferred mode in their children daily school trips ($P < .001$), although parental attitudes towards safety were insignificant with parental tendency of using walking as the mode in school trips ($P > .05$). Also, results show that the number of vehicles the household owns, the father and mother driving license status, mothers' educational status, and average annual household income were all recognized to be statistically significant in the mode type preferred for the daily educational students trips ($P < .001$), although the coefficients of these variables were small. Finally, it is worth noting that the findings of this research can be useful in the planning of schools to help a sustainable transport.

Key Words: Educational travel, elementary school student, walking, safety attitude, walking attitude.

THREE-DIMENSIONAL ANALYSIS OF THE EFFECT OF THE GEOMETRY OF CONCRETE SEGMENTS ON SURFACE SETTLEMENT INDUCED BY TUNNELING WITH EPB-TBM METHOD

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Abstract

In recent years, the need to make greater use of urban spaces on the one hand and the lack of these spaces in comparison with the ever- increasing demand of urban society are reasons for optimum utilization of available spaces with underground constructions such as tunnels. Most of these excavations with large volume of drilling are located at shallow depths and close to surface which cause displacements in the ground and effect of these movements can be seen as surface settlements in the soil. Surface settlements can be very influential in surface structures such as buildings and facilities that are located in densely populated urban areas and the vicinity of the excavated tunnels. The control of these settlements in order to protect surface structures during tunnel excavation, is the most important issue considered by design engineers. Analytical, experimental,

Abstract

In recent years, micro tunneling method has been developed quickly in comparison to other open excavation methods. Micro tunneling is a method for installing the pipelines, channels and underground conduits.In recent years, micro tunneling method has been developed quickly compared to other open excavation methods. In this method, hydraulic jacks are used for pipe driving with a special design. The pipes are placed behind the excavation drill, driven into the ground along with the ground excavation simultaneously. The result of this method is a flexible, impermeable and resistant structure construction pipelines. The micro tunneling method reduces the requirement number of transporting materials for operation activities and the machines traffic and devices. Too As a result, its events are reduced. According to this method, almost all the activities are performed underground. Hence, the negligible interferences are occurred with environment. Thus, the amount of environmental deterioration is very low. In some cases, performing the operation, increases the negative effects of vibrations from pipe driving and causes the problems such as settlements or swelling (heaving) of the ground surface. Upon analysis, some parameters have more influences rather than others, and some of them could be ignored due to low importance in the model. Therefore, investigating the effect of various independent parameters is important, i.e. sensitive analysis. The aim of this study is to compare the actual deformations occurred in ground surface due to behavior survey with the values of numerical modeling. In addition, this study aims to investigate the effect of various parameters on soil settlement values.

Key Words: Micro tunneling, pipe driving, soil deformation, numerical modeling, sensitivity analysis.

PRODUCTIVITY PREDICTION USING HYBRID SYSTEM DYNAMIC AND AGENT-BASED SIMULATION

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Abstract

Productivity is one of the most important factors affecting the project performance which has a great impact on the project cost and duration. Productivity is affected by different factors with different natures. On one hand, productivity is affected by different factors with a continuous behavior over time. On the other hand, it is affected by the interactions between different labors working in the site. The Previous researches did not account simultaneously for the effects of these two types of factors. This paper presents a new approach to the prediction of productivity in construction projects by integrating system dynamics and agent-based modeling methodologies. System dynamics is a continuous simulation approach, which uses feedback loops, stocks and flows to simulate the complicated behavior of complex systems over time. Agent-based modeling is a simulation methodology which uses some specified rules to simulate the behavior of agents in their surrounding environment. Agents interact in their environment and they cooperate to accomplish a project according the specified rules. Features of both of approaches can be used in simulation by integrating system dynamics and agent-based modelling. Application of system dynamics and agent based modeling enable us to account for the both types of influencing factors simultaneously. In this research, first different factors affecting the productivity are identified. Different factors having a continuous behavior over time are simulated using system dynamics approach. Agent-based modeling is used to consider the effects of interactions between different workers. In addition, agent-based modelling enables us to consider cooperation of workers in the task accomplishment. Finally, a hybrid model is presented by integrating system dynamics and agent based modeling methodologies to predict the value of productivity taking into account all the influencing factors. Finally, the proposed model is implemented on a real case study project to evaluate its applicability and performance.

Key Words: Productivity, system dynamics, agent based modeling, hybrid simulation.

IMPACT OF PARENTS' ATTITUDES ON THEIR TENDENCY TOWARDS

energy dissipation capacity, failure mode, out-of-plane deformation, and ductility of the shear wall models are compared and analyzed. The numerical results show that the proposed slit shapes models decrease the stiffness and improve the strength, ductility, and energy dissipation capacity. Furthermore, although the literature shows that the width of edge stiffener has negligible effects on the stiffness and strength of steel slit shear wall, this paper shows that the edge stiffener type significantly improves the stiffness, strength, and energy dissipation capacity.

Key Words: Steel slit shear wall, FEM analysis, energy dissipation, hysteresis curve.

DURABILITY OF DRY PRESSED CONCRETE CURBS AGAINST FREEZINGE AND THAWING FOR VARIOUS CEMENT STRENGTH GRADES

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Abstract

High quality precast hydraulic dry concrete curbs may affect the properties of concrete materials consisting of aggregates, cement, water-cement ratio, production method, technical principles during construction, production, and environmental conditions. To achieve high-quality pre-cast pressed concrete curbs, this study investigate various cement types, quantity of cement as well as water to cement ratio, which have not been studied before.

Usually, the hydraulic pressing is based on a six-mould hydraulic press, with up to 400 ton of pressing force. This process consists of filling a mould with a wet mix concrete, and then applying excessive water pressure nest is then expelled and compaction is complete. Moreover, immediately after pressing, curb is strong enough to be handled and is removed from the press, and then stacked near the machine within a dry atmosphere of the building for an overnight curing.

The present study investigates freeze-thaw resistance of dry concrete curb. For this purpose, 27 concrete mixes are designed and casted by dry pressing method for concrete curb that is uses low water- to- cement ratios. Mixes were constructed by different cement strength grades (352-2, 425-1, and 525-1 based on which the 28-day strength of cement mortar in Kg/cm^2 for water to cement ratio is 0.485.), cement quantity, various water to cement ratios, and cement to fine aggregate ratios.

The results show that the types of cement can significantly affect compressive strength, flexural strength, and durability of dry pressed concrete curb. In all cycles of freezing and thawing of specimens, compressive strength is shown to be lower with constant water to cement ratio, and with the increase of the amount of cement, the flexible strength increases. The mix design of row 25 with cement strength grade 525, cement quantity of 400, and water to cement ratio of 0.27 is the most optimal mix design selection.

Key Words: Durability, dry pressed curbs, freeze-thaw cycles, flexural strength, compressive strength.

SENSITIVITY ANALYSIS ON THE EFFECTIVE PARAMETERS OF GROUND DEFORMATION VALUE BY MICRO TUNNELING METHOD WHILE PIPE JACKING OPERATES

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INUNDATED WITH WATER OR SODIUM SULPHATE SOLUTION

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Abstract

In the current research the effects of random polypropylene fibers and lime addition on swelling behavior and expansive pressures of kaolinite using odometer were investigated. Samples were prepared using optimum moisture contents and maximum dry densities determined by conducting standard Proctor compaction tests. Clay samples were mixed with 0.05, 0.1 and 0.2% fibers and stabilized with 1, 3 and 5 % lime as dry weight of soil. After preparation and setting up samples in odometer, they were inundated with water or 10000-ppm sodium sulphate solution. Results showed that lime addition reduces maximum dry density and increases optimum moisture content of samples whereas fiber addition does not affect these characteristics significantly. Fiber and particularly lime addition substantially reduced swelling potentials and pressures. Optimum lime and fiber percentages determined in this research were 3 and 0.1%, respectively, and the lime showed a much more effective additive than polypropylene fibers in reducing swelling and the associated pressures. This indicates that chemical compounds formed because of lime ـ clay reactions are more effective in reducing swelling potential than the physical interactions between polypropylene fibers and clay particles. Inundation of lime-stabilized kaolinite samples with sodium sulphate solution as compared to those samples saturated with water significantly increased swelling potential and pressure. Calcium silicate hydrate (CSH) and calcium aluminate hydrate (CAH) compounds formed as a result of dissolution of SiO_2 and Al_2O_3 from clay particle structure in the environment with a high pH of 12.3 binds clay particles together, reduces their affinity for water absorption and thus swelling. The presence of sodium sulphate results in the formation of ettringite with a substantial potential for water absorption in lime-stabilized kaolinite samples, thus promoting swelling. Ettringite forms in environments with high pH and active sulphates.

Key Words: Kaolinite, lime, polypropylene fiber, swelling, sodium sulphate.

EVALUATION OF SLIT SHAPE AND EDGE STIFFENER ON STEEL SLIT SHEAR WALL

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Abstract

Every building needs a system that resists the horizontal demands from lateral forces such as wind and earthquakes. Such systems are commonly known as Lateral Force Resisting (LFR) Systems. The steel slit shear wall is a new LFR system intended for zones of high seismicity. The essential component of the steel slit shear wall system is the slit. The shear wall has columns of slits forming links in between them. In the presence of lateral forces, these links work as a series of small flexural members in parallel and behave in double curvature reaching yield at both ends. The most notable advantages of such a system are its ductile behavior and high ability to dissipate energy. In addition, the system is very versatile in terms of placement. Furthermore, the dimensions of the system are convenient and the openings -required to install windows and doors can be easily accommodated. In the event of an earthquake, all damaged panels can be easily removed and replaced by new ones. The steel slit shear walls are entirely fabricated at factory. and then fully bolted at construction site. Thus, costly field welds are not necessary for installation of the system, which can be significantly functional in design and retrofit of structures.

In this paper, numerical analysis using Abaqus is performed to evaluate the effect of slit shape and edge stiffener on behavior of steel slit shear wall. In order to verify the efficiency and accuracy of the employed finite-element method, Cortes and Liu tests are conducted. Then, three steel shear wall models with different slit shapes and three steel shear wall models with different edge stiffeners are established. The hysteresis curves,

stress waves cause a significant increase in pore water pressure and a decrease in effective stress that may cause soil liquefaction. Therefore, understanding the mechanism of explosion-induced soil liquefaction development and how to decrease its damages can be vitally important for geotechnical and passive defense engineers. Because of the complex structure of soil, high amplitude blast loading, short time of detonation, high strain and pore water pressure, the numerical modeling of explosion-induced liquefaction is very complicated. Moreover, experimental results are highly dependant on the site condition and methods of experiment. In this paper, an explosion-induced soil liquefaction phenomenon has been simulated in three-dimensional space using LS-DYNA V971 R4.2 explicit dynamic nonlinear finite-element analysis code. To model soil properties in these analyses, MAT-FHWA-SOIL saturated sandy soil has been used which is available in LS-DYNA code with the modified Mohr-Coulomb behavior. To apply blast loading, a buried cylindrical explosive charge located on the axis of symmetry of the model has been used. The JWL equation of state has been applied to simulate blast phenomenon. In addition to numerical modeling of explosion-induced soil liquefaction phenomenon, parametric studies have been conducted for the investigation of effects of parameters in relation to soil properties and loading conditions on the generation of residual excess pore water pressure. The obtained results from this research demonstrate that increasing the skeleton bulk modulus of the soil leads to the increasing residual excess pore water pressure. Soil parameters, such as cohesion, maximum, and residual internal friction angle, are the factors that have no effect on the generation of residual excess pore water pressure.

Key Words: Explosion-induced liquefaction, LS-DYNA, underground blast, numerical modeling, saturated sand.

NON-LINEAR ANALYSIS OF MASONRY WALLS UTILIZING MULTI-LAMINATE FRAMEWORKS

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Abstract

Masonry behaviors are non-isotropic, and orthotropic models were represented in the past to simulate masonry behavior in macro scale, but, because of being complex and dependent on an enormous amount of parameters, these models were not welcomed by engineers. To resolve these disadvantages, simplify the analysis process, and increase its accuracy, a new initiative method has been used to analyze masonry walls, known as multi-laminate framework. The concept of multi-laminate framework is based on a numerical approximation of a certain physical property distributed over the volume of a media. This approach can be numerically achieved by summing up the multiplications of the property values by the specified weighted coefficients for those points and considering them as an approximate representative value for the media. Substantially the overall macroscopic quantities, such as strain, stress, and their rates, should be expressible in terms of the relevant semi-microscopic quantities by means of a systematic averaging process. Accordingly, based on this framework, the behavior of a three-dimensional porous medium is averaged and approximated into the appropriate summation of slipping behavior of sampling planes. Consequently, this slip feature must be representatives of the real variations that are taken place through the structural units. Therefore, the preciseness of the solution is highly related to employed constitutive relation for frictional slip. Two general aspects are known using frictional boundary conditions. The first concerns itself with the strength of a structure that contains joints on which slip may occur; the second is the question of stability of motion once slip deformation does occur. The well-known Mohr-Coulomb's law, as the simplest constitutive relations which may satisfy the expected features in material behavior after some modifications, can be the best choice. Multi laminate framework is an applicable and strong method in predicting anisotropy of material behavior (inherent and imposed). So far, this method has been used to model materials such as soil, stone and concrete. In this paper, for the first time, it is used to model masonry structures. All the data, represented in this paper, have been produced through codes written in MATLAB software.

Key Words: Nonlinear analysis, masonry, multi-laminate frameworks, finite-element method.

SWELLING BEHAVIOR OF LIME STABILIZED AND FIBER REINFORCED KAOLINITE SAMPLES

cal simulations were carried out using Sap2000 program and the nonlinear dynamic behaviors of the different systems were compared to those of the conventional reinforced concrete shear wall equipped structure. Results indicated that the TADAS devices exhibited excellent energy dissipation and ductility leading to a massive increase in period of the first mode of vibration accompanied with up to 40 percent decline in peak values of base shear and absolute accelerations of the stories.

Key Words: RC shear walls, TADAS yielding dampers, seismic behavior, energy dissipation, base shear.

AN INVESTIGATION ON THE EFFECTS OF ADDING NANO-SIO_2 PARTICLES WITH DIFFERENT SPECIFIC SURFACE AREAS ON THE PHYSICAL AND MECHANICAL PARAMETERS OF SOIL-CEMENT MATERIALS

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Abstract

Soil cement is a mixture of Portland cement, soil and water, in which hydration of cement and compaction causes the materials' constituents to bond together, making a dense and durable composition with low permeability and abrasion resistant. According to the definition of ACI 116R, soil-cement is a mixture of soil and a certain amount of cement and water which has been compacted to a high density. A more comprehensive definition has been provided in ACI 230 IR, which defines the soil-cement as a hard material with specific engineering properties produced by mixing, compaction and curing of soil, aggregate, Portland cement, additives and water. All types of soils can be used in soil-cement construction, except the organic and plastic soils and reactive sands. The most efficient soils for soil cement are those containing 5 to 35% of fines passing sieve 200. However, the soils containing more than 2% of organic materials are strictly unacceptable. Soil-cement application in dams and pavements construction has grown rapidly in recent years. These mixtures are similar to concrete, the main difference being the type and size of aggregate particles used. Soil-cement is principally made of round natural fines, while concrete is made of aggregates. Because most of the recent researches are focused on the addition of nano-SiO_2 on concrete, in this paper, we decided to use nano-SiO_2 particles in soil-cement and observe the out coming effects. Since there are no particles passing sieve 200 in concrete and this restriction does not apply to soil-cements, some tests were carried out on thenano-SiO_2 + soil-cement matrix because of the meaningful difference between concrete and soil-cement. The test procedure consists of moisture-dry density, unconfined compressive test, and hydraulic conductivity. In these tests, silica fume (with specific surface area of $21m^2/g$) and, nano-SiO_2 (with specific surface areas of 200 and $380m^2/g$) were added to soil-cement. The results show that adding certain amounts of nano-SiO_2 particles to soil-cement matrix can improve compressive strength and reduce impermeability and speed hydration reactions in the matrix in the presence of nano-SiO_2 particles.

Key Words: Soil cement, nano-SiO_2, Compaction test, UCS, Hydrulic conductivity.

NUMERICAL MODELING AND PARAMETRIC STUDIES OF EXPLOSION-INDUCED SOIL LIQUEFACTION

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Abstract

Detonation of explosives in saturated sandy soils generates high-intensity compressive stress waves. These

Abstracts of Papers in English

APPLICATION OF TADAS DAMPERS TO IMPROVE THE BEHAVIOR OF STRUCTURES WITH RC SHEAR WALLS

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Abstract

The use of concrete shear walls in lateral resistance systems comes with certain disadvantages. Low ductility against lateral loadings due to their high stiffness and low vibration period of these systems can be mentioned as their drawbacks. Inadequate attention to shear capacity of the connecting region of roof and shear wall is also worth noting. These problems can increase the vulnerability of the structure when subjected to lateral loads. Previous studies have demonstrated the benefits of providing energy dissipation devices to improve structure behavior. Metallic dampers, such as Added Damping and Stiffness (ADAS) and Triangular Added Damping and Stiffness (TADAS), are among the simplest energy dissipating devices that are being used in design of the new generation of earthquake-resistant structures. Application of such devices in the lateral resistance system of a structure imposes a reduced maximum on internal forces. In this article, a more practical arrangement of yielding metal dampers has been proposed to reduce the base shear of the structure and improve its response and, as a result, diminish the seismic damages caused by earthquakes. The proposed arrangement is designed in a way that can allow the largest displacements and cause the highest energy dissipation.

To demonstrate, a numerical example of optimal damper designs with different excitation inputs was presented. Ground acceleration records of the Imperial Valley, Kobe, Loma Prieta, and Northridge earthquakes were used as the disturbing ground motion in a series of numerical simulations of a multi-story steel building. The numeri-