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Abstract

Gradual increments of excess pore pressure in saturated soil layers during earthquakes lead to a decrease in effective stress and soil liquefaction. The damage caused by soil liquefaction is divided into three groups: surface damage, settlement damage, and underground structural damage. Generally, the first two cases are visible after the earthquake, regarding which extensive studies have been carried out. But, in the third group, because of the shortage of instrumented field evidence and the complexity of model investigation into underground structural damage caused by ground liquefaction, fewer studies have been implemented. The damage resulting from liquefaction may cause underground structures to be buoyant and settled due to decreases in the bearing capacity and increases in the lateral earth pressure. According to field evidence, linear structures such as tunnels may be destroyed by the liquefaction of ambient soils and uplift pressure. Thus, this phenomenon should be taken into consideration in the designing stage of tunnels. When the surrounding soil of the tunnel is liquefied, large deformations occur in the area, leading to an increase in the internal stresses and deformations of the lining. Thus, if liquefaction occurs in the surrounding soil of the tunnel, by improving its surrounding area, stresses and deformations can be controlled and their magnitudes can be reduced to an allowable limit. Therefore ,evaluation of the liquefaction effects on the tunnel lining should be regarded as an important issue. In this research, the tunnel in the liquefied soil is modeled with Flac2D software, and in the liquefaction state, tunnel uplift and maximum internal forces of the tunnel lining are studied. In another model, cutoff walls are modeled on both side of the tunnel and their effects are studied. The studies show that a tunnel with cutoff walls reduces tunnel uplift and increase the internal forces of the tunnel lining. Then design parameters of cutoff walls, like wall thickness, wall length, and wall distance from the tunnel are evaluated.

Key Words: Liquefaction, tunnel, cutoff wall, flac2D software, fin model.

Abstract

This paper considers the time-dependent environmental parameters that may change during the lifetime of serving structures and which can play an effective role in primary design criteria or in evaluation of seismic performance in structural members. There is less attention paid to these parameters and their effective factors in current codes. The corrosion of steel due to chloride ions (at propagation state) in RC structures is a dominant factor in changing some structural characteristics and reducing the service life of structures.

The purpose of this paper is to develop a modified model to determine bond degradation between steel and concrete and to evaluate the residual flexural capacity of RC beams after the beginning of corrosion caused by chloride ions. Therefore, by analyzing critical parameters in equations proposed by other researchers, a model that considers the effect of rebars confinement is enhanced. Finally, comparison between the results of the modified model and the primary model with the results achieved from a corrosion experiment proved the better precision of the modified model. The importance of progressive variations during the life cycle of members is illustrated with an example about the effects of gradual bond degradation between steel and concrete in various time sections of the life cycle of a RC beam, in order to calculate its residual flexural capacity (in accordance with the Persian Gulf condition).

Key Words: Corrosion, residual flexural capacity, bond degradation between steel and concrete, reinforced concrete, Confinement.

INVESTIGATION OF GEOMECHANICAL PROPERTIES OF COARSE AGGREGATES CONSIDERING STRESS LEVELS

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Abstract

Coarse-grained materials are of great importance in geotechnical engineering practice. They are widely used where a high-strength material is required to support heavy loads; where cyclic loads are encountered or where the abrasive strength controls the design criteria. Unlike fine-grained materials, which are characterized by their plasticity indices or mineralogy, coarse-grained materials are most likely to be characterized by the shape, size distribution and type or origin of the grains. Model parameters in such constitutive models are defined by the material type, shape and size. Material shear strength parameters are also functions of stress level. On the one hand, physical properties, like abrasive strength and breakage ratio, are of great importance, since they are directly (as major design criteria) or indirectly (as independent parameters in constitutive models) required in the analysis and design of geo-materials. Therefore, characterization of coarse-grained material behavior based on the type, shape and size of the grains is worthy of further consideration.

In this research, the relationship between particle type, shape and size and the mechanical and physical properties of coarse-grained materials has been studied. An attempt was made to correlate the stress level effect, the shear strength properties and grain type, shape and size. Also, the abrasive strength and breakage ratio (physical properties) have been studied. Furthermore, it is considered as to how these parameters could have a relationship with each other, and how the critical friction and peak friction angle could have a relationship with the variations of stress level and abrasive strength. Eventually, an experimental program was conducted and some kinds of material, with diverse characteristics in origin, shape, type and etc., were selected and tested. Finally, by gathering other results from prior research, some formulas were recommended.

Key Words: Aggregates, internal friction angle, dilation angle, material type, stress level.

MECHANISM OF CUTOFF WALL ON SHALLOW TUNNEL IN LIQUEFIED SOIL

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different frequencies, but with the same peak acceleration in each case equal to 0.3g. The effect of excitation frequency, soil type, height, and the ratio of height to thickness in the wall was evaluated using the maximum bending moment of the wall (M_{max}) as a criterion for the wall performance. The numerical results show that the effect of the shear wave velocity of the soil and excitation frequency on the dynamic response of the basement wall cannot be ignored. However, these factors are overlooked in the M-O method. This study has also demonstrated that the dynamic interaction of the soil and basement walls is necessary to consider parameters, such as: dynamic excitation frequency, soil type, and geometry of the wall.

Key Words: Basement wall, soil-wall interaction, unreinforced masonry, numerical analysis.

INVESTIGATING THE EFFECT OF MASS ECCENTRICITY ON PROGRESSIVE COLLAPSE IN 3 STORY REINFORCED CONCRETE BUILDINGS UNDER EARTHQUAKE LOADS

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Abstract

One of the most important issues in earthquake and structural engineering is investigation of safety margins against the potential for progressive collapse. Here, the spread of collapse is investigated by tracking down the location and type of collapsed beam and column elements, from the first element to the entire symmetric/asymmetric building, via comparing the results obtained by nonlinear time history analyses. Damage concentrates locally in asymmetric buildings, which intensifies the progressive collapse mechanism. In this paper, we study 3 story reinforced concrete ordinary moment resisting frame buildings in 3 dimensions, with various levels of 0%, 5%, 15% and 25%, one directional mass eccentricity in the presence of earthquake load, with respect to the behavior of story drifts and the number of collapsed hinge criteria. Results show that mass asymmetrical distributions result in further local damage, which, consequently, leads to a larger progressive collapse in the torsional buildings. Therefore, when mass eccentricity increases, the potential of progressive collapse increases, in both stiff and flexible edges, too. By increasing mass eccentricity, the percentage of increments in the number of collapsed hinges in the entire building are similar to the percentage of increments in the story drifts of the mass centers. These percentages are less than those in the story drifts of the stiff and flexible edges. The behavior of the story drifts in the stiff edge is also similar to that of the mass centers. However, the value of story drifts in the mass centers is less than that in the stiff and flexible edges. Our results demonstrate that, as an alternative to a much difficult-to-calculate local response parameter of the "number of collapsed hinges", the "story drift", as a global response parameter, measures the potential of progressive collapse more easily and comfortably.

Key Words: Progressive collapse, nonlinear time history analyses (NLTHA), mass eccentricity, reinforced concrete ordinary moment resisting frame, story drift, stiff and flexible edges.

RESIDUAL FLEXURAL CAPACITY OF RC MEMBERS INFLUENCED BY CORROSION CAUSED BY CHLORIDE ION-A MODIFIED EQUATION OF BOND DEGRADATION

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CONCRETE PRECAST SHEAR WALLS

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Abstract

Nowadays, with growing populations and the need for rapid methods of construction, the use of precast concrete structures is common. These structures have better quality in comparison with in-site ones. Past earthquakes have shown that damage to the precast concrete structure has occurred in their connections. So, the seismic behavior of a precast concrete structure depends significantly on the behavior of connections between the precast segments. Despite the advantages of precasting, using precast concrete shear walls is limited in low seismic regions, due to the lack of knowledge about this type of construction performance under seismic loading conditions. Therefore, the use of precast concrete shear walls needs further study on the seismic behavior of their connections. Due to the high cost of experimental studies, using comprehensive and efficient numerical methods that could predict the seismic behavior of this type of structure can be very effective. In this study, using the finite element software ABAQUS, several precast concrete shear walls with diffferent heights were modeled and the effect of horizontal connection types used between precast concrete shear wall panels (Sleeve & Plate Connectors) is investigated. Finally, a comparison in terms of strength, ductility and energy absorption between similar monolithic and precast walls under seismic loading was undetaken. The results indicate that precast concrete shear walls show lower resistance and initial stiffness in comparison with similar monolithic walls. The main difference between monolithic and prefabricated concrete systems is their connections, so, this difference in stiffness and ultimate strength can be assigned to precast concrete wall connections. Therefore, more attention should be paid to the design of precast concrete shear wall connections. Also, the strength and stiffness of precast walls can be improved by fortifying their connections. The sleeve connector shows better behavior in comparison with plate connectors. Ultimate displacement of precast walls was reduced with plate connections. This is because of the early concrete crushing failure due to an increase in panel rotation, which is due to further plate deformations in comparison with the sleeve. Although flexural cracks develop in monolithic walls, shear crack patterns are observed in precast walls.

Key Words: Concrete precast shear wall, precast connections, nonlinear behavior, strength, ductility.

A STUDY OF THE INTERACTION OF SOIL-UNREINFORCED BASEMENT WALLS

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Abstract

Fundamentally, the stability of masonry structures is dependent on the soil-basement wall interaction. Due to the ease of calculation and design of retaining walls by the quasi-static method of Mononobe-Okabe (M-O), this method has been widely used. However, the results of numerical models and experimental data have shown that this method is not very accurate, and the design is either very conservative or is unsafe. Since, in Iran, the use of masonry structures without reinforcement is predominant, in this study, the dynamic interaction between soil and masonry walls has been evaluated. This study has been conducted utilizing a 2D Plane Strain Finite Element Model. The behavior of the wall before cracking is idealized as elastic plate. After cracking, the strength of the wall drops very quickly, and, in this case, the remaining strength can be ignored, which can be assumed as having collapsed. Considering the geotechnical aspects that normally occur in practice, they have been simulated to produce the state of rest (k_o) in backfill soil for a static situation. This state of stress has been selected for the initial condition in dynamic analysis. Dynamic displacement excitation is applied in a sinusoidal form at bed rock level by three cycles with

Froude numbers of 5.8¡Fr1¡9 were investigated. So, the values of depth and velocity in different points of hydraulic jump were measured. It should be noted that the values of instantaneous velocity in 5 vertical directions and with length intervals of 30 cm in experimental model were measured. The measured velocity profiles indicated that in all three transitions, the values of velocity increased as they were getting away from the bed and after getting to the maximum values of velocity reduced. The main cause of the mentioned phenomenon is the extreme combination of water and air near to the surface of water at the time hydraulic jump. After the analysis of the obtained data, values of maximum and minimum of velocity and length of jump were observed in curved and S-shaped expansions, respectively. On the other hand, the values of maximum and minimum of secondary depth of the jump were observed in curved and S-shaped expansions. The measured values from expansions with direct walls were between the values of the two other expansions. In curved expansions due to the curvature of the walls and gradual increase of the width of the canal at the time of hydraulic jump less combination of water and air occurred than the two other expansions. Therefore, the reduction of velocity in curved expansion was less than the two other expansions. Furthermore, in S-shaped expansions due to the sudden increase in the width of the channel, the values of combination of water and air was higher so that the highest values of velocity reduction near the surface of water occurred in this expansion. The results of the study showed that for the fixed length of the wall of expansions, the curvature of the walls causes gradual reduction of velocity and it leads to the reduction of rate of energy dissipation in hydraulic jump.

Key Words: Expansions, hydraulic jump, length of jump, rate of energy dissipation, secondary depth.

DENSITY EFFECTS ON DYNAMIC EARTH PRESSURE BEHIND INTEGRAL BRIDGE ABUTMENTS UNDER TRAFFIC LOADING

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Abstract
Integral bridges are gaining increasing popularity because of economics and their fast construction process, associated with the omission of bearing supports and expansion joints. In the present study, two objectives are followed: First, investigation of cyclic earth pressure behind integral bridge abutments being compared with that induced behind the abutment of traditional bridges (with isolated deck and abutment, which are called separated bridges in this study). Cyclic traffic load is used as the surcharge in the analysis. Second, investigation is undertaken of changes in the distribution and total thrust of earth pressure, due to different soil densities. Three numerical models are developed using the FLAC package. The first model is a retaining wall. The characteristics of this model are the same as a physical model made in the soil laboratory to study the earth pressure on retaining walls under cyclic surcharges. The first model is used to compare the results of numerical and experimental modeling and in validating the process of the numerical model. The second and third models are models of integral and separated bridges. The induced earth pressure is evaluated on the abutment of both bridges, under static and cyclic conditions of traffic surcharge. Pressure distribution behind the wall, as well as the point of application of the total thrust, was determined and compared between two bridges. The results have shown significant changes in both the quantity and distribution of earth pressure behind the abutment, in the case of integral bridges. In addition, the effect of soil density on cyclic earth pressure is investigated and compared between the two bridges. Three different states of sand, including loose, medium and dense, are used for modeling the granular backfill behind the abutment. Results of earth pressure behind the separated abutment show a similar trend to retaining walls, which experience increasing pressure due to increasing density. Unlike retaining walls and separated abutments, the integral bridge experiences less lateral pressure due to increasing density. More details of the findings and their causes will be discussed in the next sections.

Key Words: Integral abutment, isolated abutment, earth pressure, cyclic surcharge, numerical model, integral bridges, compaction.

NUMERICAL STUDY OF THE NONLINEAR BEHAVIOR OF

and capability of the proposed method in comparison with others.

Key Words: Large deflection of plates, Von Karmen equations, circular plates, deflection function.

NUMERICAL INVESTIGATION OF THE EFFECT OF CURVATURE ON THE BEARING CAPACITY OF SANDY CONVEX SLOPES

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Abstract
The bearing capacity of finite foundations located on slopes that are convex in plan is investigated by three-dimensional models. In this study, we utilized a powerful finite element software, using the Mohr Coulomb constitutive model, in three dimensions, to obtain practical results for the bearing capacity of foundations located on slopes that are convex in plan. The results show that with an increase in the radius of curvature of the convex slopes, the bearing capacity of square foundations located on them also increases. The results are displayed in the form of practical charts for engineer usage. These plots can be utilized for practical purposes by estimating the bearing capacity of equivalent foundations located on straight slopes from limit equilibrium, or finite element codes that are used in soil mechanics, for example, Plaxis software. Although the effect of the radius of curvature on the bearing capacity of foundations is lower than other parameters. When other parameters are obtained with a good degree of precision, these results could be used complementarily for achieving comprehensive results for practical purposes in civil engineering projects. Because Abaqus is a very powerful code that can be used for soil materials, we can trust its calculated results. As the Abaqus code has very advanced techniques for mesh generation, for obtaining results with the most precision, the mesh is generated very carefully with finer elements near the foundation and coarser elements in locations far from the foundation. The primary purpose for generating such mesh is calculation of the bearing capacity of foundations. Not only are the results affected by the radius of curvature of the slope, they also depend on other parameters, like the friction angle of sandy soil, and distance of the foundation from the crest of the slope. Therefore, we studied these parameters in addition to the radius of curvature of the slopes.

Key Words: Bearing capacity, convex slopes in **plan** view, finite element, radius of curvature of convex slopes.

THE EFFECT OF SHAPE OF WALLS OF EXPANSIONS ON THE CHARACTERISTICS OF HYDRAULIC JUMP

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Abstract
Hydraulic jump is one of the most important phenomena in rapid varied flow. Considering the importance of this phenomenon in hydraulic science, in the present study, hydraulic features of the formed jump in expansions with three shapes of S-shaped, straight, and curved, for five

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Abstract

Reliability is the probability that a system will perform its function over a specified period of time and under specified service conditions. Reliability theory was originally developed by maritime and life insurance companies in the 19th century to compute profitable rates to charge customers. An engineering structure's response depends on many uncertain factors such as loads, boundary conditions, stiffness, and mass properties. Each of these requirements is termed as a limit-state or constraint. The study of structural reliability is concerned with the calculation and prediction of the probability of limit-state violations at any stage during a structure's life. The probability of the occurrence of an event such as a limit-state violation is a numerical measure of the chance of its occurring. Once the probability is determined, the next goal is to choose design alternatives that improve structural reliability and minimize the risk of failure. Some of these uncertainties can be identified and others because of unknowing problems are not considered. One of these uncertainties in structures is column base connections. engineers in designing of a structure assume that column base connections been totally pinned or fixed and by using this assumptions the structures are designed, in result of this assumptions columns or beams in structures designed conservative. In present study by considering the sensitivity of mentioned in above, the effect of rotational stiffness and the strength capacity of a base connection evaluated by considering uncertainties in this connection. Results showed that change in parameters of column base connections depends on rotational stiffness and yield moment, also by considering uncertainties and Probabilistic Relations average of rotational stiffness and rotation with specific confidence estimated.

Key Words: Column base connection, uncertainties, rotational stiffness, probabilistic.

ANALYSIS OF CLAMPED CIRCULAR PLATES WITH LARGE DEFLECTIONS THEORY BY EXPONENTIAL SERIES

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Abstract

The bending analysis of thin plates under large transverse loads requires the use of large deflection theory, because, in this case, points on the middle plane, in addition to perpendicular displacement, experience in-plane displacement. In this paper, the field of the boundary value problem is considered as one circular plate under uniform distributed transverse loads with clamped edges. Von Karmen equations respond to the reaction of bending plates under transverse loads from the viewpoint of geometrical nonlinear theory. These equations for circular plates have been provided as two fourth order partial differential equations in a polar coordinate system. The lack of analytic responses for these equations has compelled researchers to use numerical methods for solving them. In the present paper, Von Karmen equations have been analyzed for circular plates with clamped edges using an exponential series and the expansion of Maclaurin. One of the obvious characteristics of the proposed method is the simplicity of its analytical basis in comparison with existing analytical methods, which proves its superiority. The present study has offered a new method for numerical analysis of Von Karmen equations. Therefore, with a logical selection, the value of plate deflections in a geometric nonlinear district has been viewed as a function of plate deflection in the case of small deflection. This approximation is caused to convert partial differential equations to nonlinear algebraic equations, which are easily solved and have high convergence speed. The introduced method in this research can be generalized for different boundary conditions and loadings in circular plates, which is one of the important characteristics of this method. In the present paper, some parameters have been calculated, such as deflection of various points and radial stresses under uniform distributed load for one circular plate with clamped edges. The obtained results by analysis of Von Karmen nonlinear differential equations, using the provided method in the present paper, reveal the power

considered, i.e. the records were scaled to 0.4g, 0.6g and 0.8g. For pushover analyses, four different lateral load distributions were used. Also, to account for the effect of higher modes in the case of a medium-rise isolated building, modal pushover analysis (MPA) was implemented. The results show that for the three-story base-isolated structure, in which the superstructure remains elastic, a triangular load distribution gives better estimation of story drifts. It is illustrated that all load distributions do not provide sufficient accuracy in the case of medium-rise base-isolated buildings. It is shown that the MPA method can provide accurate predictions of seismic demands for base-isolated building frames with hard isolators, but is unable to accurately estimate the seismic responses in the case of buildings with normal and soft isolators.

Key Words: Base isolation, lead rubber bearings, nonlinear dynamic analysis, nonlinear static analysis (pushover), modal pushover analysis (MPA).

EVALUATING SAND BEHAVIOR THROUGH STATE PARAMETERS

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Abstract

It has been understood from experimental studies that granular soil behavior can be highly affected by density and mean principal effective stress. The effect of these factors on sand behavior is of great significance, and defining the nature of the link between them and their controls on the behavior of sand, is carried out in this study.

Sand, in its loose or dense state, before approximating its critical state, obtains a constant stress ratio. Therefore, changes in the stress ratio of shear stress to mean effective stress may be ignored. It is worth mentioning that in loose sand, it is corresponded to phase transformation, but, it happens next to phase transformation in dense sand. The point at which the constant ratio initiates is of great importance and is called Initial Failure Point. The present study tries to outline two noble state parameters; early confining stress ratio, R_{pe}, and early shear stress ratio, R_{se}. Early confining stress ratio and early shear stress ratio are defined as the stress ratio of the current mean effective stress to the mean effective stress of the early point of the failure line, and as the stress ratio of the current shear stress to the shear stress of the early point of the failure line. Furthermore, another state parameter, confining stress ratio, R_{p0}, is defined as the stress ratio of the current stress to the initial mean effective stress.

Finally, through introducing four state parameters including: initial state pressure index, I_{p0}, confining stress ratio, R_{p0} , early confining stress ratio, R_{pe}, early shear stress ratio, R_{se}, two stress spaces of early confining stress ratio-early shear stress ratio and axial strain-early confining stress ratio, are introduced to define sand behavior under undrained monotonic loading in all ranges of confining stress and density, from loose state to dense state. Subsequently, according to these spaces, two relations are offered. Thus, undrained monotonic loadings are simulated. Eventually, in order to evaluate the accuracy of the proposed relations, the resulting simulations are compared with other laboratory tests in the literature of undrained triaxial compression. The results show very good agreement, indicating that the proposed relations are capable of simulating undrained sand behavior under monotonic loading.

Key Words: Sand, state parameter, stress ratio, critical state, undrained loading, stress path.

INVESTIGATION OF PROBABILISTIC RELIABILITY ANALYSIS OF THE COLUMN BASE CONNECTIONS IN STEEL STRUCTURES

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SEISMIC EVALUATION OF BASE-ISOLATED STRUCTURES USING PUSHOVER ANALYSES

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Abstract

Base isolation is one of the modern strategies for reduction of the seismic responses of structures, which reduces the seismic forces rather than increasing the resistance capacity of structures. In recent decades, the efficiency of this system has been confirmed in many research investigations and it has been used in real projects. Nonlinear time history analysis (NTHA) is known as a robust and accurate approach for seismic evaluation of structures, but because of its complexity, the nonlinear static procedure, (NSP) based on pushover analysis (POA), is being increasingly used instead of NTHA. In recent investigations, POA has been mostly used for the seismic evaluation of fixed-base structures and little attention has been paid to the applicability of POA for base-isolated building structures. Therefore, in this study, we attempt to assess the accuracy of pushover analysis methods for base-isolated buildings. For this purpose, two steel moment frame structures, including low- and medium-rise (3 and 9-story) frames, were considered. The structures were isolated with different lead rubber bearing (LRB) isolation systems. Three types of isolator with different stiffness, including hard (H), normal (N) and soft (S) isolators, were taken into consideration. Totally, six isolated structures were obtained. For base-isolated structures, nonlinear time history analyses and pushover analyses were performed. For nonlinear time history analyses, three different seismic intensities were