Abstracts of Papers in English

INVESTIGATION ON THE BEHAVIOR OF TWO-TIERED MSE WALLS AS BRIDGE ABUTMENTS

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Abstract

Mechanically stabilized earth (MSE) walls are commonly used as bridge abutments to support bridge deck loads. In this type of abutment, the use of a tiered configuration can play a prominent role in reducing induced horizontal stress, reducing lateral deformation, and, consequently, improving the performance of bridge abutments. Despite the importance of this issue, the influence of various factors on the performance of tiered MSE abutments under deck loads is not yet fully understood. Therefore, by simulating a bridge deck on a tiered MSE abutment in the form of a strip footing, the effects of the reinforcement type, the connection type of the deck to the abutment, and the deck location were investigated. For this purpose, three two-tiered mechanically stabilized earth walls (T-TMSEWs) were constructed using three different reinforcements and then loaded with strip footings at three different distances from the wall crest. By preventing and allowing the footings to tilt, the influence of the degree of footing freedom was also examined as the third variable. Particle image velocimetry showed that the use of a two-tiered configuration in MSE abutments and a decrease in the soil-reinforcement interaction and stiffness changed the slip surface geometry and prevented the development of deep slip surfaces in the lower tier. It was found that although the decrease in reinforcement stiffness and its interaction with soil decreased the bearing capacity of the strip footings on two-tiered MSE abutments, they also reduced the lateral pressure induced in T-TMSEWs by strip footing. Also, allowing the footing to tilt was found to be an effective solution for minimizing the deformation of the backfill surface and the induced lateral pressure. Moreover, a comparison of the results with analytical methods showed that

the construction of MSE abutments in a two-tiered configuration reduced the lateral pressure in the upper tier. This became more noticeable with a decrease in the soil-reinforcement interaction and reinforcement tensile stiffness and an increase in the distance from the footing to the wall crest.

Key Words: Physical model test, tiered mechanically stabilized earth wall, particle image velocimetry (PIV), failure surfaces, lateral pressure.

OPTIMIZING THE GEOMETRY OF HUNCHBACKED BLOCK-TYPE GRAVITY QUAY WALLS USING NON-LINEAR DYNAMIC ANALYSES AND SUPERVISED MACHINE LEARNING TECHNIQUE

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Abstract

In the present study, the seismic behavior of hunchbacked block-type gravity quay walls rested on non-liquefiable dense seabed soil layer is investigated, and the optimal geometries for these wall types are proposed by performing non-linear time history dynamic analyses using Lagrangian explicit finite difference method. For this purpose, first, a reference numerical model of the hunchbacked quay wall is developed, and its seismic response is validated against the well-documented physical model tests. Then, the optimal hunch angles corresponding to the minimum horizontal displacement and zero rotation of the hunchbacked quay wall are estimated through the sensitivity analyses on the hunch angle of the wall, the friction angle of the backfill, and the ratio of hunch height to wall height. Subsequently, the statistical relationships are presented to predict the optimal hunch angle of the walls using multiple non-linear regressions based on the supervised machine learning technique. The results of non-linear dynamic analyses show that the deformation pattern, the movement mechanism, and, consequently, the seismic response of the hunchbacked quay wall change considerably with the variation of the hunch angle of the wall. In this regard, the rotation angle of the wall towards the seaside due to seismic loading decreases, and the deformation pattern and the movement mechanism of the hunchbacked quay wall alter from overturning towards the seaside to overturning towards the landside with an increase of the hunch angle. For all considered values of the ratio of hunch height to wall height and the backfill friction angle, increasing the hunch angle in the range of 25 to 35 degrees leads to a significant decrease in wall deformation. While increasing the hunch angle in the range of 35 to 50 degrees has less influence on reducing the wall deformation. For hunch angle values greater than 50 degrees, increasing the hunch angle has the opposite effect on improving the seismic performance of the hunchbacked quay wall and its seismic-induced deformations increase. Additionally, in the ratio of hunch height to wall height equal to 0.7, the optimal hunch angles corresponding to the zero wall rotation and the maximum reduction in the horizontal displacement of the wall decrease from 42.7 to 9. 23 degrees and from 53 to 34.5 degrees, respectively, with an increase of the friction angle of the backfill soil from 15 to 45 degrees.

Key Words: Gravity quay wall, broken-back geometry, geometrical optimization, non-linear dynamic analysis, supervised machine learning.

THE EFFECT OF FIBER LENGTH AND COMPOSITION ON THE COMPRESSIVE AND FLEXURAL STRENGTH OF CONCRETE

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Abstract
The use of fibers is often aimed at increasing the ductility and load-bearing capacity of the desired concrete, and controlling the spread of cracks by adding fibers to the concrete causes this. The fibers improve the behavior of the concrete after the first crack due to the bridging property on the micro-cracks. In this paper, 15 concrete mixing designs in the form of 90 cubic specimens with dimensions (15 * 15 * 15) cm for the compressive strength test and 42 specimens with dimensions (15 * 15 * 60) cm for the flexural strength test have been made. Three mixing designs were made as a reference with 3 water-to-cement ratios (0.24, 0.29, 0.34) without fibers and with fibers with 3 different lengths of polypropylene fibers with lengths of (6, 12, 18) mm, respectively. A mixing scheme with 40 mm long hook metal fibers and another mixing scheme with a combination of 40 mm hooked metal fibers and 12 mm polypropylene fibers were investigated. Microsilica gel and super-lubricant were used to increase the smoothness and efficiency of concrete. The highest average compressive strength of 28 days was related to samples with composite fibers with a resistance of 72.52 MPa, which was 12.9% higher than the reference sample. The concrete sample with metal fibers with an average bending strength of 12.85 MPa has the highest strength among all the concrete mixing designs of this research and shows a 60% increase in bending strength compared to the sample without fibers. In the concrete samples tested with polypropylene fibers, after the compressive strength test, with the increase in the length of the polypropylene fibers, the workability and compressive strength of the concrete decreased, but the plasticity of the concrete samples increased. After the flexural strength test, the flexural strength and ductility of the concrete samples increased with the increase in the length of the polypropylene fibers, but it led to a decrease in the workability of the concrete.

Key Words: Polypropylene fibers, steel fibers, compressive strength, flexural strength.

EVALUATING THE EFFECT OF ADDING RECYCLED FIBERS ON THE STRENGTH OF SANDY SOIL STABILIZED WITH CEMENT AGAINST FREEZE-THAW CYCLES

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Abstract
In this research, the effect of soil stabilization with cement at the same time as its reinforcement with fibers has been studied on the shear strength of sandy soil exposed to freeze-thaw cycles. In order to achieve this goal, laboratory studies were carried out with the help of unconfined compressive strength tests (UCS tests) on different compounds obtained from mixing cement, fibers, and sandy soil. More than 336 cylindrical laboratory models with dimensions including 3.6cm in diameter and 8cm in length have been made. Various modes have been observed during the failure of the samples, including shear, tensile, plastic yielding, and composite failure modes. The fibers used in the present research are waste products of tire factories known as DTY. Percentages of 2, 4, and 6 for cement and 0, 0.5, and 1 for fibers with lengths of 0.5, 1, and 1.5 cm were used relative to the weight of dry sandy soil in making the samples. Uniaxial cylindrical samples were tested for unconfined compressive strength after 7 and 28 days of curing time and under 0, 1, 2, and 3 freeze-thaw cycles. The results show that the act of stabilizing the soil with cement, along with reinforcing it to a certain amount of fibers, improves the uniaxial compressive strength before and after freezing and thawing cycles. This amount depends on the percentage of cement and the curing period. Also, adding cement in a certain curing time increases the unconfined compressive strength before and after applying the cycle, increases stiffness, reduces the ductility and toughness of the sample, and brittle failure when breaking occurs in the soil. Also, the addition of fibers, to some extent, improves the weaknesses caused by soil stabilization, such as reducing the failure axial strain, decreasing the residual strength, and the toughness of the materials in the conditions before and after freezing and thawing.

Key Words: Sandy soil, cement stabilization, fiber reinforcement, freezing and thawing cycle, unconfined compressive strength.

MEASURING THE VOLUME OF WATER PENETRATION INTO CONCRETE AND COMPRESSIVE STRENGTH UNDER ACUTE CONDITIONS WITHOUT BREAKAGE OF THE SAMPLE USING NEW TESTS

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Abstract

To directly measure the strength and permeability of concrete, a core should be separated from the concrete and then tested in the laboratory with destructive methods. For example, to measure the permeability of concrete by existing standards, concrete must be broken and divided into half. Also, acute conditions such as temperature cycles that concrete faces in summer can have negative effects on concrete characteristics. Therefore, in this research, by using innovative tests, in addition to investigating the effect of temperature cycles (40, 80, 120, and 160 cycles) on the permeability and surface resistance of concrete at different ages, measuring the depth of water penetration and resistance Concrete is compressed without breaking it. According to the results, by using the calibration charts and the equations obtained from the methods of the cylindrical chamber and friction transfer, it is possible to obtain the depth of water penetration and the compressive strength of concrete without the need to break the concrete and with a correlation coefficient of over 96%. It was also observed that the cycles of temperature changes have negative effects on the durability and surface resistance of concrete in such a way that the number of 40, 80, 120, and 160 cycles of temperature changes increases the permeability of concrete by 4.1, 8.7, and 7 12.5 and 16.5 have been equaled. Also, the acute conditions of temperature changes have negative effects on the surface resistance of concrete in such a way that the surface layer resistance of concrete has decreased by more than 44% under 160 cycles of temperature changes. Considering that the surface layer of concrete has a direct relationship with the penetration of harmful substances into the concrete, it was observed that with the increase in the strength of the surface layer of concrete, the volume of water penetration into concrete has decreased. By increasing the resistance of the surface layer by 15%, the volume of water infiltration into the concrete has decreased by about 140%.

Key Words: Summer weather, resistance, permeability, regression analysis.

FRAGILITY CURVES PRODUCTION FOR STEEL STRUCTURES BY SEISMIC IMPROVEMENT OF THE HIGH-DIMENSIONAL MODEL REPRESENTATION METHOD

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Abstract

Fragility curves are utilized to evaluate the probability of exceeding the damage index for structures exposed to seismic hazards. The Monte Carlo simulation method,

which involves generating random numbers, is computationally expensive for calculating fragility curves. To address this issue, several methods have been proposed to produce fragility curves at a reduced computational cost. This study presents a method that enhances the seismic representation of high-dimensional models to generate accurate fragility curves for steel structures while significantly decreasing computational costs. This method selects uncertain variable values based on the results of initial incremental dynamic analyses. The fragility curves are divided into three zones, and an equation is proposed to estimate mean damage values associated with the boundaries of these zones. Additionally, polynomial response functions were generated to estimate the fragility curves. The proposed method is applied to generate the fragility curves for three steel structures, one with 4, 9, and 12 stories. Fragility curves are generated for four damage levels: non-structural damage (DS1), structural retrofitting required (DS2), intensive structural damage (DS3), and collapse (DS4). The resulting fragility curves are compared with those generated by the Monte Carlo simulation method and other existing methods. The comparison demonstrates that the proposed method achieves fragility curves with a significant decrease in computational costs compared to the Monte Carlo method while also exhibiting higher accuracy than other methods. The maximum error of the proposed method is approximately 20%, whereas Cornell's and the conventional HDMR methods exhibit errors of up to 80% and 60%, respectively. The errors of other methods increase significantly for fragility curves associated with high damage levels and 9- and-12 story steel structures, where nonlinear structural behavior is pronounced. In contrast, the increase in error is not significant in the proposed method. The findings of this study can be utilized to assess the seismic impact of various stochastic factors, such as random eccentricity or loading-related parameters, on the vulnerability of steel structures.

Key Words: Fragility curve, monte carlo simulation, cornell's method, high-dimensional model representation, seismic assessment.

INVESTIGATION OF THE EFFECT OF FAR-FIELD GROUND MOTION RECORDS ON THE SEISMIC RESPONSE OF MID-RISE HYBRID CONCRETE-STEEL BUILDINGS

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Abstract

Hybrid concrete-steel buildings in height are usually referred to as buildings that have two lower and upper parts of concrete and steel materials, respectively. Due to the change in mass, stiffness, and damping in the vertical direction, these buildings have complex seismic behavior. Therefore, in this study, the seismic behavior of hybrid concrete-steel buildings at mid-rise height against far-field ground motions was considered. Initially, different models in groups of 7 and 13 stories were designed by considering different ratios of the number of concrete to steel floors. The connection of the upper steel section to the lower concrete section was considered a pin joint in nonlinear modeling in Opensees software due to its implementation. Then, incremental dynamic analysis was performed on all models using 22 different far-field records. Also, the maximum structural response diagram at the threshold of complete damage level was obtained according to the outputs of incremental dynamic analysis in different stories under all records, along with their average. Fragility curves were extracted at four damage states based on the HAZUS technical report. The results showed that there was a critical area at the junction of the steel frame with the concrete in which the structural response value underwent a sudden change and made this area inclined to much damage, which in the groups of 7 and 13 stories reached 65.2% and 98%, respectively. Finally, the median collapse capacity was obtained from fragility curves for hybrid buildings at different heights. As the number of concrete floors increased, the median collapse capacity of the model increased, which indicated the better seismic performance of the hybrid concrete-steel building. Among the investigated models, the lowest level of fragility was when the ratio of the number of concrete floors to the total floors of the Hybrid concrete-steel building was almost equal to 0.6.

Key Words: Hybrid concrete-steel buildings, fragility assessment, nonlinear analysis, incremental dynamic analysis, seismic behavior.

INVESTIGATION OF MECHANICAL BEHAVIOR OF ALUMINUM FOAM UNDER UNIAXIAL TESTS USING VORONOI TESSELLATION METHOD

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Abstract

Aluminum foams are among the materials that have many applications in the construction of various building elements, including sandwich panels. This category of materials has unique features due to low density, the presence of small holes, sound insulation, thermal insulation, and corrosion resistance. In this paper, the Voronoi tessellation method is proposed to simulate the porous configuration of aluminum foams, which has the high capability to generate a porous structure with different densities. It is demonstrated that the Voronoi tessellation method can generate porous structures with different densities, hole sizes, and wall thicknesses stably. Moreover, the Voronoi tessellation method has a high speed and can be used to construct different sizes of aluminum foams. A comparison of the configurations obtained from the Voronoi tessellation method and experimental tests demonstrates the capability and competence of this method in generating the porous structure of the aluminum foam. In order to investigate the mechanical behavior numerically, the uniaxial tension test is applied to the aluminum nanofoams using the molecular dynamics (MD) method. The MD analysis is performed in the LAMMPS open-access software using the embedded-atom model (EAM) interatomic potential. The periodic boundary condition is imposed in all the boundaries of the atomistic model to satisfy the essential condition of the representative volume element (RVE) based on the homogenization theory. After minimization and relaxation of RVE, the uniaxial tension test is applied in an increment manner to reduce the strain rate effect. The evolution of the stress-strain curve, along with the stress contours, are presented for the aluminum nanofoam during the uniaxial tension test. Young's modulus of nanofoam obtained by numerical analysis is compared to that of experimental data to confirm the accuracy of the computational modeling. Moreover, the results emphasize the high dependence of the mechanical behavior of aluminum nanofoams on the density and porosity.

Key Words: Sandwich panel, aluminum foam, voronoi tessellation method, atomistic simulation, porous materials, uniaxial tension test.

NUMERICAL STUDY ON SEMI-SUPPORTED STEEL COMPOSITE SHEAR WALL AT THE EDGES UNDER NEAR AND FAR-FAULT LOADING

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Abstract

The shear wall is one of the most important systems to resist lateral loads in the building. In addition to controlling the lateral displacement of the structure and dealing with the lateral force, this system significantly increases the stiffness of the structure. The purpose of this article is to investigate the nonlinear behavior of semi-supported steel composite shear walls at the edges under monotonic and cyclic loading near- and far-fault. In this article, after verification, firstly, the semi-supported steel shear wall is modeled and analyzed using ETABS software to select the boundary members and the critical opening. Then, the base model of the semi-supported steel shear wall is converted to a semi-supported composite shear wall, and finally, it is modeled and checked using ABAQUS software. Among the investigated variables are reducing the thickness of the concrete coating on both sides of the steel plate of the wall, using concrete coating on one side of the steel plate of the wall, and increasing the thickness of the steel plate

of the wall. The results showed that the addition of concrete to the SSSW model (converting the model to SSCSW) increases the initial in-plane hardness by 350%. Also, when concrete was added to the SSSW model, the ductility increased by 150% in two states near and far from the fault. Comparing the ultimate strength (peak of the cyclic diagram) also showed that regardless of the type of cyclic loading pattern, the calculated value for SSCSW is 28% higher than SSSW.

Key Words: Cyclic loading, ABAQUS, semi-supported steel composite shear wall at the edges, bearing capacity, nonlinear analysis.

SEISMIC EVALUATION OF SELF-CENTERING THIN STEEL PLATE SHEAR WALLS, SUBJECTED TO SEISMIC SEQUENCES

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Abstract
Despite the knowledge of steel shear walls for many years, not much attention was paid to it. Steel shear walls without stiffeners and with stiffeners have been used in America in recent years. This system is 50% cheaper compared to the bending frame. After the events of September 11, a number of scientists were thinking of creating resistant and impervious structures against explosive and seismic loads economically by combining this system and the concrete shear wall system. Steel shear walls are easier to implement. Also, the accuracy of the work is at the level of normal executions, and by observing it, the reliability coefficient is many times higher than that other types of systems. The execution speed of steel shear walls is high, and because of this, the execution costs are reduced. Also, the efficiency of the shear wall system is more and more suitable than all the advantages of centralized bracing systems such as X and V shape and off-center steel bracing systems. The resistance against the overturning anchor caused by the lateral loads and the horizontal load of the floor is the most important task of the steel shear wall. The constituent members of the steel shear wall system include a steel plate wall, two boundary columns, and a floor horizontal beam. Also, the horizontal beams of the floor are used as transverse stiffeners in the sheet beam. The goal of centralizing the steel shear wall system is that the beams and columns remain in the elastic range. In this article, five-, ten-, and twenty-story buildings with steel shear walls were designed using the strip equivalent brace method in ETABS, and then seven acceleration maps far from the fault were selected, scaled, and modeled in ABAQUS software. The five-class model was compared with the non-centralized model. According to the results of the push-over analysis of the five-story steel shear wall model, the beams and columns remained in the elastic range in the self-centering model, and according to the hysteresis obtained from the push-over analysis of the steel shear wall, they have more energy consumption. The results showed that the drift, maximum drift, maximum displacement, and the ratio of the maximum acceleration value of the roof to the acceleration of the selected records in the self-centering steel shear wall have increased compared to the non-self-centering ones.

Key Words: Self-Centering steel shear wall, acceleration record, band equivalent brace method, time history analysis.

SPLITTING TENSILE STRENGTH OF CEMENT-STABILIZED AND SURGICAL FACE MASK FIBER-REINFORCED SAND

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Abstract
The tendency towards reinforcement of cement-treated sands with the inclusion of fibers has increased in re-

cent years. This is due to the fact that fibers reduce the brittle behavior and improve the mechanical properties of the sandy soil samples. Since 2019, because of the coronavirus pandemic, the use of disposable surgical face masks has become increasingly popular among the public, and their burial, reproduction, and reuse have become one of the major environmental problems. Therefore, in this research, an attempt has been made to reuse the surgical face fibers in the application of cement-reinforced sands. In this regard, samples with 2, 4, 6, and 8% cement contents, reinforced with different amounts of fibers (0, 0.25, 0.5, and 0.75%) in different relative densities (35%, 50%, and 70% sand) were prepared and after 7 days of the curing period, their tensile behavior using brazilian tensile splitting tests. The results showed that the addition of cement percentage and increasing relative density have a significant effect on improving the tensile strength index of cement sands. The percentage of surgical face mask fibers 0.25% is the optimal amount of added fibers (the maximum tensile strength in this percentage of fibers). The definition of the key parameter (the ratio of porosity to cement content) and several empirical relations for estimating the tensile strength of reinforced and reinforced samples with very good accuracy are presented.

Key Words: Cemented sand, surgical face mask, tensile strength, empirical correlations.

EXPERIMENTAL INVESTIGATION ON THE SEISMIC BEHAVIOR OF HELICAL-SOIL NAILED WALLS

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Abstract

Helical nails are a new type of reinforcement element that has been widely used during the last decade. This has caused that despite their widespread use, the seismic behavior of geotechnical structures reinforced by them is still unknown. Therefore, the present attempted study to evaluate the effects of some structural parameters on the dynamic performance of helical soil-nailed walls (HSNWs) using shaking table tests. For this purpose, eight reduced-scale wall models were constructed with different inclinations, lengths, and arrangements of helical nails and then subjected to input excitations with different durations. The response of each model to base excitation was determined in the form of fundamental frequency, acceleration amplification, facing displacement, and failure mechanism. The results showed that although a uniform increase in the nail length along the wall height significantly improved the seismic performance of the HSNWs, this improvement could also be achieved to some extent by increasing the length of the nails locally in the lower and upper halves of the walls reinforced by horizontal and inclined nails, respectively. The use of inclined nails instead of horizontal ones was an efficient solution to reduce the lateral displacement, acceleration amplification, and changes in the frequency content. The effectiveness of this solution was reduced with the use of shorter nails in the upper half of the wall and eventually minimized by reducing the length of the nails across the wall height. The nails located in the lower half of the wall were identified as having the greatest effect on the seismic performance of HSNWs when horizontal nails were used. The opposite occurred when inclined nails were used. A parabolic failure surface with a specific inflection point was observed to be the potential failure surface of the HSNW. The dimensions of the potential failure surface increased with an increase in the length and inclination of the nails. Also, a combination of overturning and base sliding was identified as the predominant deformation mode in HSNWs, although the base sliding mode faded with an increase in nail inclination.

Key Words: Helical soil-nailed wall, shaking table test, failure mechanism, seismic performance.

INVESTIGATING THE STATIC AND CYCLIC UNDRAINED BEHAVIOR OF THE TIRE-SAND MIXTURE

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Abstract

In recent years, the mixture of sand and rubber particles has been used in various fields of civil engineering, such as the stability of roofs, retaining walls, and drainage materials in landfills due to its durability, cost-effectiveness, and solving environmental problems. The purpose of this study is to investigate the effect of tire crumb on the shear strength and dilation in a static state and the liquefaction resistance in a dynamic state. In this regard, in this research, a static and dynamic undrained triaxial test was performed on a mixture of Babolsar sand and tire crumb (size between 1 and 8 mm) under constant confining pressure. The effect of parameters such as the amount of different tires' crumbs (0, 5, 10, 20, and 30% by weight) and different relative densities on the static and dynamic behavior of the mixture of sand and rubber crumb and the created pore water pressure was investigated. In the static (consolidated-undrained) triaxial test, the relative densities of the sand-tire mixtures were 45, 60, and 80 percent. The tests were carried out on the specimens at 100 kPa cell pressure. Also, the specimen was loaded at a strain rate of 0.30% per minute for all the tests until the axial strain reached 20%. In cyclic triaxial tests, the relative density of the sand-tire mixtures was 45 percent, and the confining pressure of 100 kPa was used in the experiments. The sinusoidal waveform was applied to the specimen with a frequency of 0.5 Hz. For accuracy evaluation, the behavior of the sand-tire mixture, as well as corrections such as membrane penetration corrections, membrane force, and cross-sectional area, were applied. The results showed that adding tire crumb to sand reduces the shear strength and dilation of sand. Also, the ratio of the mean diameter of tire particles to the mean diameter of sand particles affects the behavior of shear resistance and dilation of the sand-tire mixture. As the ratio of the mean diameter of tire particles to the mean diameter of sand particles increases, the shear strength and dilation of the sand-tire mixture increases. Also, increasing the amount of tire crumb in sand reduces the excess pore water pressure and, as a result, reduces liquefaction potential in cyclic loading. This behavior can be attributed to the compressible nature due to the low elastic modulus of the tire crumb.

Key Words: Tire crumb, triaxial test, shear strength, dilation, liquefaction.

INVESTIGATING THE MECHANICAL BEHAVIOR OF CONCRETE CONTAINING RECYCLED CONCRETE AND RUBBER MATERIALS AS A FOUNDATION ISOLATOR

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Abstract

Considering the seismic conditions of Iran and the many damages that occur as a result, it is necessary to change the current performance of structural design to achieve better performance in the seismic system. On the other hand, environmental concerns have prompted civil engineers to identify appropriate methods of reusing construction waste. The purpose of this research is to investigate the behavior of concrete made with recycled materials as a wide foundation, which has the role of seismic isolation for low- or medium-height buildings. In this research, the effect of crumb rubber and recycled concrete aggregate on concrete was examined in a laboratory. The design basis of its resistance is 30 MPa. The first mixture, as a control mixture, does not contain rubber granules, Forta fibers and recycled concrete aggregate. In the other three mixtures, the difference in the amount of recycled concrete aggregate is 40%, 50%, and 60% instead of coarse aggregate. Also, the percentage of rubber granules is constant, about 15% of the total volume, and the amount of Forta fibers is about 0.5% of the total volume. Compressive strength, Flexural strength, and Shear strength tests were performed on the 4 mentioned mixtures at the age of 28 days in a laboratory. The results of the compressive strength test showed that the addition of recycled concrete aggregate, rubber granules, and Forta fibers sig-

nificantly reduced the compressive strength value. The results of the flexural strength test indicated that the additives cause a noticeable reduction in flexural strength, and this reduction intensifies with the change in recycled concrete aggregate percentage. The results of the shear strength test represented a considerable increase with the increase in the percentage of recycled concrete aggregate. Based on the test results, it is concluded that this type of composition material can be used as a foundation isolator, which showed a favorable shear behavior.

Key Words: Concrete, foundation isolator, crumb rubber, recycled concrete aggregate, mechanical strength.