Abstracts of Papers in English

INVESTIGATION OF THE BEHAVIOR OF SHORT MOMENT-RESISTING STEEL FRAMES WITH RIGID CONNECTIONS DURING EARTHQUAKE DAMAGE IN TWO CASES OF POST-EARTHQUAKE FIRE AND POST-FIRE EARTHQUAKE

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Abstract

The incidences of fire and earthquake are the two serious hazards to buildings that jeopardize the safety of occupants. Much research has been carried out on the effect of seismic loads on structures, but little is known on the concomitant impact of these threats, specifically fire before an earthquake. Besides, many buildings are currently in use after a fire event without any particular retrofitting, which are exposed to future earthquakes like undamaged structures. In this research, the behavior of a moment-resisting steel frame is studied in two cases of damage by fire before an earthquake as well as the post-fire earthquake damage. Accordingly, the structure under study was designed following the Iranian Standard for Seismic Resistant Design of Buildings (Code 2800, 3rd Ed.). A set of ten fire scenarios was considered for thermal analysis. The results indicate that the structure remains stable after seismic loading in the case of post-fire earthquake, given that a maximum temperature of

$600 - 700°C$ is experienced in different fire scenarios based on the Eurocode standard fire curve. However, in the case of post-earthquake fire, the maximum stability temperature after seismic loading lies in the range of $600 - 800°C$ for different fire scenarios, according to the ISO 834 fire curve. In the former case, deflection of the beams increases downward rapidly upon reducing the stiffness and strength of steel as temperature exceeds $600°C$, while in the latter case, the beams deflection increases downward sharply in the temperature range of $650 - 800°C$.

Key Words: Steel moment frame system, earthquake, fire scenarios, stability.

THE EFFECT OF CEMENT AND ZEOLITE ON UNDRAINED SHEAR STRENGTH OF THE EXPANSIVE CLAY

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Abstract

Expansive soils can be problematic in that they impose significant economic damages on the construction projects worldwide due to their high volume change in wet-dry conditions. Annually, many structures have been constructed on expansive soils such that nearly 60 percent of them undergo minor damage such as different kinds of fissure while 10 percent face severe unrehabilitatable damages. In this research, the cement and zeolite have been used as the base and supplementary cementitious stabilizers, respectively, and the undrained behavior of the treated expansive clay has been investigated. Hence, 6, 8, 10, and 12 percent of cement and 10, 30, 50, 70, and 90 percent of zeolite replacement were employed to cast the specimens. In the following, using the unconfined compression strength (UCS) and unconsolidated undrained triaxial (UU) tests, it can be stated that the best geotechnical performance such as maximum UCS, deviator stress in UU tests, secant modulus of elasticity (E50), cohesion, and internal fraction were obtained at 12% cement addition and 30% zeolite replacement after 28 days of curing. In both tests, increase in the cement content led to the increment in the failure strength of the samples. Based on the analysis of the results, it can be stated that the best geotechnical characteristics such as UCS, maximum deviational stress in triaxial test, secant modulus of elasticity (E50), and cohesion and internal friction angle were derived from the specimen stabilized with 12 percent of cement and 30 percent zeolite replacement cured in 28 days. With the above said, it can be noted that the optimum amount of zeolite replacement was 30%. Cement increment led to the enhancement of mechanical performance. Increase in zeolite replacement reduced the brittleness of the samples. In addition, increase in the curing time improved the mechanical behavior of the stabilized samples. The microscopic view justified the improvement of the stabilized samples.

Key Words: Expansive soil stabilization, cement, zeolite, undrained shear strength.

EXPERIMENTAL EVALUATION OF THE EFFECT OF STEEL AND POLYPROPYLENE FIBERS AND RECYCLED AGGREGATES ON THE MECHANICAL PROPERTIES OF CONCRETE

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Abstract

In recent years, a new type of fiber-reinforced concrete, consisting of several different types of fibers, known as hybrid fibers reinforced concrete, has attracted the attention of researchers. The aim of this paper for experimental evaluation of the effect of replacement ratio of recycled aggregates with natural aggregates on the mechanical properties of reinforced concrete with hybrid fibers (steel and polypropylene fibers). To this end, reinforced concrete with hybrid fibers with volume fractions of 0.0% , 0.5% , and 1% of steel fibers and 0.0% and 0.4% of polypropylene fibers and replacement ratios of 0.0% , 25% , and 50% recycled coarse aggregate of natural coarse aggregates were tested for compressive strength, Brazilian tensile strength, and flexural strength by four-point bending tests. The results show that increasing the replacement ratio of recycled aggregate leads to a decrease in compressive, tensile, and flexural strength. If polypropylene and steel fibers are added to concrete containing recycled aggregates, the compressive, tensile, and flexural strengths of concrete increase, whose steel fibers are more efficient in improving the tensile and flexural strength of concrete than polypropylene fibers. The combination of polypropylene fibers with steel fibers increases energy absorption and increases the flexural toughness of concrete containing recycled aggregates. Moreover, reinforced concrete with hybrid fibers does not disintegrate after breaking, and hybrid fibers play an important role in maintaining the cohesion of concrete.

Key Words: Recycled concrete, recycled aggregate, concrete reinforced by hybrid fibers, steel fibers, polypropylene fibers.

EXTENDING A MODEL OF LOSS SEISMIC RISK RESULTING FROM PRODUCTION INTERRUPT AT GAS REFINERY UNITS (CASE STUDY: PARSIAN GAS REFINERY)

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Abstract

Predicting monetary loss models due to production interrupt caused by an earthquake in industrial units is an important tool in making intelligent management decision. This study aims to extend a loss seismic risk model for the aforementioned subject. Production interruption in large industrial units after the earthquake is the cause of significant economic losses. The decline in revenues is the short-term consequence of this production interruption, and the market share loss is the long-term consequence of the earthquake. Earthquake "parametric insurance" offers a promising perspective to overcome this challenge ahead. Parametric insurance is a type of insurance in which the criteria for compensating payments exceed the event intensity parameters of the specified limit. The present method can be used for designing parametric insurance mechanisms to transfer the subsequent risk caused by an earthquake to the insurer. The Parsian gas refinery complex was investigated as a case study located in Zagros, a seismic-prone area in southern Iran. By means of a well-known seismic hazard model and using OQ software, a 50,000-year-old synthetic catalogue for the study area, Parsian Gas Refinery, was developed using the Monte Carlo simulation method. For this purpose, four ground motion models with different weights were applied in the EMME model to predict the resulting ground motions. Seismic source models and ground motion models were considered as inputs to the Open Quake (OQ) platform, and the event-based hazard analysis module was used. The whole gas refinery system was divided into 10 separate production paths and key components were specified in each path. The compatible fragility functions, as well as the restoration functions, based on HAZUS were assigned to different components in each production path and combined with the expected monetary loss related to daily interruption in that path. As a result, a prediction risk model for monetary loss was obtained for the entire refinery as a function of each arbitrary earthquake scenario.

Key Words: Seismic hazard, seismic risk, production interruption, loss, parametric insurance, monte carlo simulation, trigger.

INVESTIGATION OF THE EFFECT OF PRELOAD ON THE MECHANICAL PROPERTIES OF FIBER-REINFORCED GEOPOLYMER CONCRETE

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Abstract

Concrete may be loaded at an early age for a variety of reasons. This loading can have negative and sometimes destructive effects on the hardened properties of concrete. Therefore, in the present study, the mechanical properties of fiber-reinforced geopolymer concrete after loading at an early age have been investigated. In the present study, the effect of preload on compressive strength at the ages of 28 and 90 days for geopolymer concrete containing fibers has been investigated. For this purpose, the samples were loaded at ages of 1, 3, and 7 days, equivalent to 30 and 70% of their compressive strength at the same age. The samples were then treated again in a humid environment and subjected to compressive loading at 28 and 90 days of age. The effect of preload on flexural strength as well as energy absorption of geopolymer concrete containing fibers was also investigated. Steel fibers with volumetric percentages of 0.25, 0.5, 0.75, and 1 and polypropylene fibers with volumetric percentages of 0.25, 0.5, and 0.75 were used in fabricating laboratory samples. The results demonstrate the positive effect of fibers on reducing the destructive effects of preload on compressive and flexural strength. The effect of fibers on reducing the destructive effects of 1-day preload is higher at higher loading percentage (70% pre-loading), such that the samples containing fibers with preload of 30% at the age of one day experienced a 28.8% increase in 28-day compressive strength, while this increase was 33.2% for the samples with preload of 70%. Samples containing 0.75% polypropylene fibers at 28 and 90 days of age compared to those containing 0.25 and 0.5% polypropylene showed less energy absorption on average due to preloading. In general, the design containing 0.25 polypropylene fiber and 1% steel fiber had the best result of flexural strength among preloaded samples.

Key Words: Geopolymer concrete, preload, toughness, steel fibers, polypropylene fibers.

INCREASING THE ACCURACY OF TWO-DIMENSIONAL IMAGE PROCESSING TECHNIQUES TO ESTIMATE STRESS-STRAIN CURVES IN TRIAXIAL TESTS

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Abstract

The triaxial test is one of the most versatile and widely performed geotechnical laboratory tests, allowing the shear strength and stiffness of soil and rock to be determined for use in geotechnical design. In saturated soils, due to the presence of water and soil, the triaxial device can measure changes in sample volume by the amount of water expelled out of the sample during loading. However, in unsaturated soils, in addition to soil and water parameters, the air parameter will also be effective in obtaining soil characteristics. To avoid high demand related to the time and cost of the test on unsaturated specimens by advanced related types of equipment, a simpler method based on 2D image processing is proposed in this study.

Firoozkooh sand No.161 was used as the material, and consolidated drained triaxial tests were performed. Six saturated specimens (3 with a relative density of 85% and 3 with 50%) were loaded with a strain rate of 1 mm/min. Before 15% axial strain, the error calculated in measuring the average diameter of specimens was in the range of 0.001 to 0.002. From the strain of 15% to 20%, the error in some tests increased and reached a maximum of 0.01.

The first achievement of this research is the accuracy of determining volume changes. Though the method is based on two-dimensional image processing, the results are as precise as a three-dimensional processing.

The second achievement is the elimination of the complex calibration process from the image processing steps, making it possible to implement the approach at conventional laboratories. Finally, the third achievement is the possibility of probing diameter changes along the

specimen's height. This feature facilitates better interpretation of the tests' results. These features make the proposed method a proper framework to measure results of triaxial test on any type of soil.

Key Words: Firoozkooh sand, 2D image processing, stress-strain curve, saturated test, triaxial test.

EVALUATION OF LINEAR STATIC APPROACH IN PERFORMANCE-BASED DESIGN OF STEEL BENDING FRAMES

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Abstract

In recent decades, the performance-based design of structures as a design philosophy has been implemented in many works. A performance-based design depends on the performance levels considered for the structure, and the design procedure is accomplished in such a manner that the respective defb01ned demand and capacity of the structure are balanced. Consequently, an analysis should be carried out to specify the structural performance in terms of the deformation and strength capacity of that structure.

Linear static approach is one of the approaches introduced in the guidelines for performance-based seismic evaluation of structures. This approach is superior to nonlinear and dynamic approaches due to the simplicity, high speed, and low computational burden of the related analysis method. The objective of this study is to evaluate the efficiency and accuracy of this approach in the performance-based seismic design of structures. In other words, the purpose of this study is to define that to what extent the linear static approach including the linear static analysis and performance criteria corresponding to the analysis proposed in the guidelines is reliable for design of structures. Moreover, designing a structure with a trial and error process and without a systematic method may lead to attaining a non-economic design in which the design capacities are much more than the design needs. Therefore, for a more appropriate evaluation of the approach, the design of the structure should be done in an optimal manner to avoid the effects of the structure over design in the results. In this study, the optimal designs of two two-dimensional steel bending frames, including a six-story frame and a twelve-story frame, at the performance levels of immediate occupation (IO), life safety (LS), and collapse prevention (LS) at the risk level of one (the earthquake with a 10% probability of exceedance in 50 years) are separately determined according to the linear static approach. Genetic algorithm is employed for solving the optimization problem. Having determined the optimum designs of the frames at any performance level, the nonlinear static approach is used to evaluate the efficiency of the optimum designs. The results show that the optimal designs obtained based on the linear approach meet the criteria of nonlinear approach even at a more conservative level. It means that the performance constraints associated to the linear approach are strict enough to address implicitly the acceptance criteria associated to the nonlinear approach.

Key Words: Performance-based design, genetic algorithm, steel bending frame, linear static approach, nonlinear static approach.

EVALUATION OF THE PERFORMANCE OF A MULTI-LAYER LANDFILL SIDE SLOPE INSULATION SYSTEM UNDER EXTERNAL HYDROSTATIC LOADING

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Abstract

Unscientific waste control and using inflamed masks and gloves in municipal garbage represent a risk of an outbreak. Furthermore, in growing nations, pollutants of the surroundings and groundwater have raised the call for landfills to decrease pandemic risk. Alternatively, municipal strong waste landfill barrier structures regularly contain an aggregate of geosynthetics and mineral layers. Throughout the last 20 years, there were full-size studies on the interactions among the substances and on the overall performance of the geosynthetics consisting of components of durability. This study has led to giant advances in the layout and specification of landfill lining structures. Although many numerical modeling applications are implemented to assess lining system stability and integrity, records to validate those models are presently limited. This paper highlights the records required to validate numerical models and instrumentation strategies that can be used to accumulate this information imposed at the liner (stress cells). The use of numerical analysis to analyze the stability and integrity of landfill liner systems has increased popularity over the last three decades. Internal landfill pressures, on the other hand, are emphasized by the majority of them. The presence of water flows behind the landfill side slope was investigated in four height level codes. The results are compared to on-site landfill data in order to validate the numerical model. This case study is the Miligate dump in the United Kingdom. The Finite Element (FE) model in three dimensions is used. To improve the accuracy of the study, the interfaces and properties of the materials were chosen from the experimental results. The findings revealed that a lining system with a water level up to 3/4 of the side slope was immune to failure, but that when the side slope was filled with respect to the full height, the geomembrane would be ripped.

Key Words: Landfill, side slope lining system, numerical modeling, hydrostatic pressure.