Abstracts of Papers in English

NUMERICAL STUDY OF CORRUGATED HONEYCOMB DAMPERS

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Abstract

In this study, a new metallic damper, the Corrugated Honeycomb Damper (CHD), is presented. The CHD is designed for ease of manufacturing and implementation in various structures, with a stable energy dissipation characteristic when subjected to lateral loading. The basic configuration of the CHD consists of two steel plates that are bent to form trapezoidal corrugations. The plates are then welded together along the bent lines to build the honeycomb geometry. To investigate the behavior of the CHD, a closed-form expression for the elastic stiffness was first obtained using the matrix analysis method. A verified numerical model was then developed in ABAQUS software to study the non-linear behavior of the CHD, considering both material and geometric non-linearity as well as the potential for ductile steel damage. A comprehensive parametric study was performed, analyzing 12 CHDs with different geometric characteristics, and evaluating both monotonic and cyclic responses. Force-displacement and cumulative dissipated energy curves were extracted, and relevant elaborations were presented. Additionally, the equivalent stiffness and equivalent damping of the CHDs during cyclic loading were calculated, taking into account the principles of dynamics of structures. The results demonstrated that the CHD has stable and symmetric dissipative loops of energy, and that increasing the depth and thickness of the CHD can enhance its energy absorbing and load bearing capacities. Minimizing the width of the damper can fatten the hysteresis loops, but may also affect the ductility of the damper. Recommendations were given for the total height of the damper

and the angle of bents to maintain stable hysteresis loops with respect to the target drift of the CHD.

Key Words: Metallic yielding damper, honeycomb geometry, non-linear analysis, cyclic behavior, finite element method.

COMPARISON OF FLEXURAL BEHAVIOR AND CRACKING PATTERN OF RC AND SFRC BEAMS REINFORCED WITH MINIMUM AND MAXIMUM LONGITUDINAL TENSILE BARS

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Abstract

The flexural performance of steel fiber reinforced concrete (SFRC) is significantly influenced by fiber properties such as fiber quality, shape, aspect ratio, orientation, and distribution. Digital image processing is an optical and non-contact measurement method that can determine the extent of sample size and deformation under any loading conditions. In this paper, eight reinforced concrete beams with and without steel fibers were selected, including four separate groups containing different volumetric percentages of steel fibers, designed and loaded with four-point bending test in accordance with the rules of ACI 318-19 design regulations. The first group consisted of two ordinary concrete beams as reference samples and six other concrete beams reinforced with steel fiber with a percentage of 0.5, 1.0, and 1.5%. Different longitudinal reinforcements (one state of minimum reinforcement and one state of maximum reinforcement in accordance with the provisions of the design regulations) were examined and analyzed in these specimens. Strain gauges were installed on the longitudinal bars to measure the strain during the loading process. Experimental results showed that the loads, flexural strength, ductility, and energy absorption of fiber-reinforced concrete beams were improved compared to similar conventional concrete beams. The highest ductility ratio among the samples made with tensile reinforcement was observed in the beam with a minimum longitudinal bar and 1.0% of fibers. The ductility of this sample was 30% higher than the similar non-fibrous sample with minimum longitudinal tensile reinforcement. The results showed that the ratio of ductility of the sample with maximum tensile reinforcement was decreased up to 46% compared to the companion beam with minimum tensile reinforcement. Significant increases in flexural strength, equal to 16, 23, and 29%, respectively, were observed in beams with minimum tensile reinforcement and containing steel fibers 0.5, 1.0, and 1.5%.

Key Words: Steel fibers, ductility, flexural strength, fiber concrete, energy absorption, minimum tensile reinforcement.

LABORATORY STUDY OF IMPACT EFFECTS ON LIGHTWEIGHT CONCRETE CONTAINING BAGASSE AND LECA

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Abstract

Concrete quality control tests usually focus on the compressive strength of concrete, while neglecting other important properties such as impact and explosion resistance, which are essential for creating resilient concrete structures. Additionally, in the process of refining sugarcane, Bagasse, a yellow fiber that is considered a waste product, is produced. Khuzestan province alone produces around one million tons of Bagasse annually, which leads to environmental concerns. To address these issues, this research investigates the mechanical properties and impact resistance of concrete containing lightweight LECA aggregates and Bagasse fibers under compressive

and impact loads. Initially, a target mix scheme is determined, and samples are made and tested after curing without the addition of Bagasse and LECA. Then, samples are made with the mentioned mixing design and the combination of Bagasse and LECA by weight ratio of (Bagasse unit, LECA unit). Additionally, samples using LECA (without Bagasse) with 10%, 20%, and 30% replacement of aggregates are made and tested after curing. Compressive and impact tests are performed on all samples in accordance with regulations using appropriate testing machines and procedures. Results indicate that concrete containing lightweight LECA and Bagasse fibers has a higher impact resistance than ordinary concrete, and that the use of LECA in concrete can create structural lightweight concrete.

Key Words: Impact resistance, compressive strength, bagasse, LECA, lightweight concrete.

DAMAGE DETECTION OF STEEL STRUCTURES THROUGH FEM UPDATING BASED ON STRAIN DATA

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Abstract

This article proposes a new approach for identifying damage in structures through model updating. The approach is based on principal component analysis (PCA) of strain-based power spectral density (PSD) data. The proposed method detects damage, identifies damage location, and quantifies damage severity using an innovative sensitivity equation of strain-based data on a least square optimization. The data is obtained from incomplete measured structural responses, and the approach utilizes frequency domain data where changes in stiffness matrix of elements model damage. One of the crucial components for successful model updating is evaluating an accurate sensitivity relation. Highly sensitive structural indices such as PSD data require a valid sensitivity relation to yield satisfactory results. The PCA technique provides an advantage by transforming PSD data to PCs with the most significant changes and ignoring PCs that correspond to low changes caused by measurement errors. The presented approach embeds the PCA of incomplete PSD data and measured strain data for a damaged structure into a mathematical formulation to obtain an appropriate sensitivity equation. To prevent weakening the sensitivity equation, the proposed formulation does not employ derivatives of the PCs. The proposed method is applied to two steel structures, a 2-D truss and a 2-D two-story two-bay frame, to demonstrate its performance as a strong damage identification algorithm, even in the presence of measurement errors. Comparative observations indicate that the results obtained by the provided sensitivity equation and strain-based PSD data are more appropriate than the results of other strain-based methods such as PCA-FRF or using only PSD data.

Key Words: Damage identification, model updating, strain data, principal components analysis, SVD (singular value decomposition), and power spectral density.

INVESTIGATION OF THE EFFECT OF ELEMENTS IN INDUSTRIAL WASTES USED IN CLAY STABILIZATION BY GEOPOLYMER METHOD

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Abstract

Climate change and global warming pose significant threats to life on earth, leading governments worldwide

to enact laws restricting carbon dioxide emissions. Traditionally, the use of Portland cement is a typical approach to increasing the bearing capacity, minimizing settlement, and improving seismic behavior of problematic soils. However, the cement industry's high energy consumption, uncontrollable emission of greenhouse gases, large carbon footprint, further depletion of natural resources, and high cost have become enormous challenges for all countries. Therefore, researchers continually seek new materials to replace ordinary Portland cement, contributing towards sustainable development. In this regard, the use of environmentally friendly, cheap, and readily available additives in modern soil methods of the construction cycle, particularly soil stabilization, is crucial. Geopolymer materials have recently emerged as serious alternatives to cement. This study aims to investigate the innovative reuse of eggshells through the geopolymerization process for engineering improvement of clayey soil. Alkali-activated binders are inorganic polymers that form repeated polymeric chains by polymerizing alumina and silica, sharing all oxygen atoms and using the alkaline cation. The combination of sodium hydroxide and sodium silicate was used as an alkaline activator in this study. The unconfined compressive strength (UCS) was the primary criterion for assessing the quality and effectiveness of the proposed solutions. This test was performed on selected combinations to assess the strength of the stabilized clay with different binder dosages and after different curing times. Moreover, the direct shear test was used to study the Mohr-Coulomb criteria parameters of the stabilized soil, namely the cohesion and angle of internal friction. Scanning Electron Microscope (SEM) microstructure observations of the natural and treated soil were conducted to investigate the strength development. The results showed that using 5, 7.5, 10, and 12.5% eggshell by dry weight activated by sodium hydroxide increases the UCS to 1.24 MPa, 1.21 MPa, 1.18 MPa, and 849 kPa, respectively, after 45 days of curing. The microstructural analysis results highlighted the reaction between the eggshell and the alkaline activator, resulting in the formation of an aluminosilicate gel.

Key Words: Clay, soil stabilization, geopolymer.

TREATMENT OF TARTERAZINE DYE WASTEWATER BY A COLD ATMOSPHERIC PLASMA PROCESS

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Abstract

Plasma is a subgroup of advanced oxidation technology (AOP) that has received considerable attention. It is currently being used to degrade persistent pollutants and inactivate organisms in environmental bodies. The objective of the present study is to decolorize tatrtrazine aqueous dye solution using cold atmospheric plasma technology. The main parameters selected for the study were initial dye concentration (4-20 mg/L), pH of the solution (2.2-9), input AC voltage (70-110), treatment time (10-30 minutes), and the electrode distance, which was kept at 8 mm throughout the experiment. The primary parameters investigated through the optimization tool of response surface methodology (RSM) software were color concentration, solution pH (2.2-9.4), power supply voltage (70-110 V), and detention time (10-30 minutes). The experimental reactor had a capacity of 15 ml. The color removal study of the plasma process showed that the optimal condition occurred at an initial concentration of 14 mg/L, voltage of 86 V, pH = 4.1, and plasma irradiation time of 18.7 minutes, resulting in a color removal percentage of 99.78%. According to half-life and efficiency yield calculations, the process was suitable for application in water pollution decontamination, with the lowest half-life achieved at the optimum condition (1.18) and the highest efficiency yield (108.3 mg/Kwh). The results extracted from the quadratic model illustrate the direct effect of retention time and initial voltage and the inverse effect of pH and initial concentration of industrial dye on the removal efficiency. The contact time had the major influence on efficiency via its coefficient in the model equation, while among interactive parameters, pH and contact time had the most interactive influence on the process. The reaction rate could also be described by the first-order kinetic model with an R2 value of over 95%.

Key Words: Cold plasma, optimization, tartrazine, dye removal percentage, yield energy.

ANALYSIS OF BARRIERS TO IMPLEMENTING BIM IN AEC PRIVATE PROJECTS: AN IRANIAN APPROACH

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Abstract

Building Information Modeling (BIM) plays a crucial role in managers' decision-making processes, as it has been proven to increase productivity, reduce costs, and improve the quality of construction projects. However, BIM implementation faces barriers in Iran and other parts of the world due to its novelty. This paper aims to analyze and identify these barriers in the Iranian AEC industry. A literature review identified 27 international barriers, which were categorized into four categories: Organizational/Cultural, Contractual, Legal, and Technical. Case studies of 28 private companies, including owners, consultants, and contractors, were conducted to identify 17 barriers to BIM implementation in Iran. Data was collected through document reviews, participation in meetings, semi-structured interviews, and direct observation, and then analyzed using N-Vivo. The barriers identified in the Iranian market had similarities and differences from those summarized in the literature review. Similar barriers included a lack of top management support, resistance to change, unwillingness to share data, lack of efficient workflows, lack of standard contractual frameworks, lack of interoperability of software, technical limitations in BIM software, lack of parametric objects library, and time and expenditure of model development. Seven new barriers were identified, including failure to complete tasks by other professional task groups, high salary expectations of BIM professionals, non-compliance with BIM Execution Plans (BEP), low value of incentives/penalties, difficulty in measuring work progress in BIM services, lack of efficient Common Data Environments (CDE), and internet connectivity issues. The identification and categorization of barriers is an essential step toward removing them and improving the implementation of BIM in projects.

Key Words: Building information modelling, barriers, case study.

REDUCING THE NEGATIVE EFFECTS OF CONSTRUCTION JOINTS IN ROLLER COMPACTED MASS CONCRETE STRUCTURES USING ZEOLITE

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Abstract

Roller compacted concrete is a dry, hard concrete with zero slump, typically used in mass concrete structures where casting is done in stages with time intervals between each stage. However, the formation of joints in these concretes increases the penetration of destructive ions, leading to eventual failure and instability of mass concrete structures. This study aims to evaluate the impact of replacing part of cement with zeolite in reducing the destructive effects of joint formation in roller compacted concrete structural members.

Samples were made with hot, warm, and cold joints, with zeolite replacing cement at percentages of 0, 15%, 30%, and 40%. Results showed that at 15% replacement percentage, samples had the highest compressive strength, so roller compacted concrete samples were made with 15% zeolite to test for Rapid Chloride Permeability Test (RCPT), water penetration depth, water absorption, ultrasonic pulse velocity (UPV), and electrical resistivity. The tests showed that replacing 15% of the cement weight with zeolite improves compressive strength in warm joint areas and reduces destructive effects of warm and cold joints on durability properties. The electrical resistivity test revealed that replacing 15% of cement with zeolite significantly reduces the permeability of specimens. Zeolite also reduces the permeability of roller compacted concrete specimens based on the

results of water penetration depth, RCPT, and electrical resistivity tests, but increases water absorption and decreases UPV.

Key Words: Zeolite, roller-compacted concrete (RCC), construction joints (cold and warm joints), durability properties, mechanical properties.

MICRO-STRUCTURAL EVALUATION OF THE IMPACT OF CURING METHOD ON THE PROCESS OF CEMENT BASED STABILIZATION/SOLIDIFICATION OF PB ION-CONTAMINATED BENTONITE

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Abstract

Cement-based stabilization/solidification is a commonly used method to prevent the transportation of heavy metal ions in soils. The main objective of this paper is to investigate the controlling mechanisms in cement-based stabilization/solidification of Pb ion-contaminated bentonite under two different curing conditions: closed and open systems. In an open system, the stabilized/solidified sample continues to have access to free water, while in a closed system, the stabilized/solidified sample is prevented from accessing any external water after initial mixing. To achieve this objective, a series of geo-environmental experiments, including pH, solubility measurements, TCLP, and XRD, were performed. In the first step, the bentonite sample was contaminated with 100 cmol/kg-soil of lead nitrate. After achieving equilibrium, the contaminated sample was stabilized/solidified with 15% cement. The results indicate that when 15% cement is applied to the contaminated bentonite, the pH ranges from 10.5 to 11.5, which is a safe domain for lead precipitation. In other words, the minimum required percentage of cement for stabilization/solidification is the quantity in which the pH of the system is in the necessary range for heavy metal precipitation. This quantity is generally a function of the type and concentration of the heavy metal contaminant. According to the experimental results of this research, the method of curing does not have a noticeable impact on the stabilization process of stabilized/solidified contaminated bentonite. However, the XRD results show that more pozzolanic components have formed in the closed system. Therefore, the achievement of EPA criteria for TCLP experiments in cured samples in the closed system is attributed to the more significant progress in pozzolanic interaction and more formation of C-S-H and C-A-S-H components at 28 days for cured samples under closed conditions.

Key Words: Stabilization/Solidification, TCLP, XRD analysis, contaminated bentonite, cement.

HIGHER MODE EFFECTS ON FRICTION PENDULUM BASE ISOLATED ASYMMETRIC BUILDINGS

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Abstract

When a structure's fundamental period lengthens, often shear and floor acceleration increases. The contribution of higher modes in the dynamic response of structural systems with multiple degrees of freedom is significant in both the design of new structures and the evaluation of existing structures.Few research have looked at the impact of higher modes on base isolation systems in structures. To investigate the effects of higher modes on a building with a friction pendulum base isolation, a study was conducted on four different types of buildings: one with an L-shaped plan with two, four, and six floors; another eccentricities of buildings 5%, 10%, 15%, and 20%; and two others with a building with an L-shaped plan, where the second floor is half the mass of the first floor and next S shape plan. Eight layouts of the pendulum base isolation are considered for each building and their first mode, the second mode, and the mass participation rate of the first mode, the second mode, and higher modes are derived. Finally, in a linear time history analysis, the change in the maximum displacement of the base level is compared to the percentage of mass participation on the modes. The findings show that in four models, the percentage of first mode mass participation is decreased if the center of stiffness of the base isolation is aligned to the center of cumulative mass of the building, and the percentage of mass participation is increased in the second or third modes. The responses of the structure are thus determined by the second mode or higher modes. In general, the stiffness center of the base isolation must line up with the center of the base cumulative mass to produce the optimal design. And this pendulum base isolation layout's displacement of the base level is also reduced.

Key Words: High modes, mass participation ratio, center of stiffness of pendulum, center of the curvature radius of pendulum.

STUDY OF WETTING AND DRYING CYCLE EFFECT ON THE CLAYEY SANDY SOIL PERMEABILITY

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Abstract

Drought and moisture reduction can weaken and crack soil structure, altering its shear strength and permeability. This paper investigates changes in permeability of clayey sandy soil undergoing drying and wetting cycles, which are often overlooked during the design and construction of earth structures such as embankments and dams. To conduct the investigation, a sandy soil called Firoozkooh sand No. 161 and a kaolinite clay soil were selected and mixed in varying ratios to produce soil samples. Two mixtures of sand and clay were prepared with 20% and 30% clay and 80% and 70% sand by weight, respectively. The sand used was poorly graded and the clay was low plastic. Test samples were created using the maximum dry unit weight and optimum moisture content obtained from standard compaction tests. Permeability tests were then conducted on the prepared samples in both drying and wetting directions using a common triaxial apparatus. In addition, some Scanning Electron Microscope (SEM) images were taken of the soil combinations. Results from the permeability tests revealed that the drying and wetting process initially has a significant effect on the water entrance to the sample due to soil cracking, and the soil permeability reduces over time as water passes through the soil and is absorbed by clay minerals, closing voids and cracks. Eventually, the permeability of all samples, including those that underwent drying and wetting, reached a relatively constant value, and seepage became stable. Moreover, the samples that underwent the drying and wetting processes showed higher permeability than the initial samples prepared with optimum moisture content. The test results also indicated that completely dried samples do not necessarily have the highest permeability. Furthermore, SEM images revealed that samples with 20% clay content had more voids compared to those with 30% clay.

Key Words: Soil permeability, clayey sand. drying, wetting.

OPTIMIZATION OF CABLE PRE-TENSIONING FORCE IN CABLE-STAYED BRIDGES BY SIMPLIFYING THE STRUCTURAL

MODEL WITH A CASE STUDY OF LALI BRIDGE

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Abstract

Cable-stayed bridges are bridges in which the deck is connected directly to the towers by diagonal cables. These bridges are mainly known by the length of the middle span, which often falls between the span lengths of suspension bridges and bridges without cables. They are also known for their light weight, beauty, and elegance. Cable-stayed bridges are highly indeterminate and are considered significant structures, which makes their optimization a major and costly challenge for designers. The deflection and distribution of the bending moment on the deck and towers depend on the pretensioning force applied to the cables, making the calculation of tensile force in cables one of the most critical optimization parameters. Typically, cable pre-tensioning force is calculated through an optimization process that requires extensive analysis, which in turn requires a significant amount of time and computational power. This research aims to reduce the optimization process time by improving the analysis speed. Instead of analyzing a complete three-dimensional model of the structure, this research uses a separate two-dimensional model of the deck and tower without considering the cables. The Lali cable-stayed bridge located in Khuzestan, Iran, serves as the case study for this research. Results show that calculating tensile forces using this method induces an insignificant error compared to optimization using a complete model. The proposed model eliminates the repetitive process of updating the stiffness matrix, significantly reducing the time required to calculate cable pretensioning forces during the optimization process. Additionally, the proposed model produces negligible errors both in the optimization process and in the calculation of tensile forces in the cables compared to results obtained through three-dimensional modeling.

Key Words: Cable stayed bridge, optimization, particle swarm optimization algorithm, lali bridge, cable force.