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Abstract

Internal erosion and scouring have always created many problems for earth dams. Since half of the world's earth dams damages result from internal erosion, this process has been recognized as the second reason for the fracture of these dams and has raised major concerns. Although there have been many proven methods to control this phenomenon for over 50 years, this problem has not yet been completely resolved. It includes different processes such as piping and suffusion. The study of these phenomena is an important topic in many different fields such as hydraulic and geotechnical engineering. One of the ways to alleviate this phenomenon is soil remediation, which requires adding different percentages of additives to the soil. Since these additives may damage the environment or cost a lot, we need to find optimum quantities that reduce cost and environmental problems. In this study two additive substances like cement and nanoclay were added to the soil and according to research, cement and nanoclay were not environmentally and economically suitable in large volumes, respectively. In the present study, low percentages of these materials were used and the Hole Erosion Test (HET) was run to control the phenomenon of internal erosion. Given that the soil used in this study was silty sand, we added 0.25, 0.5, 1, 2, and 3 percent cement and 0.5, 1 and 1.5 percent nanoclay to the soil and after passing the curing time (1, 7, 14, and 28 days), the soil was compressed by the compression hammer and tested. According to the results after 28 days, the erosion rate index increased more than threefold in 1.5% nanoclay and 1% cement compared to the control soil, which changed the soil group from relatively fast to very slow and leads to the reduction of erodibility. Moreover, at all the percentages and intervals, critical shear stress of soil samples with cement was higher than that of nanoclay.

Key Words: Hole erosion test, nanoclay, cement, internal erosion.

sequence. To this end, different types of steel structures with 3, 5, 7, 10, 15, and 20 stories were designed and analyzed based on Iranian codes with and without seismic sequences using Perform-3D software. The fragility curves from non-linear analysis at different performance levels under FEMA356 were obtained and the seismic vulnerabilities were evaluated. The results showed that the effect of earthquakes on higher structures was attenuated as a result of a decrease in the magnitude of the earthquake spectrum within longer periods, leading to a reduction in vulnerabilities. Moreover, the structures performed well at the performance level of Life Safety (LS), intended by the design codes; therefore, designs produced based on such levels in the earthquakes and seismic sequences near-field were assumed to be reliable. According to the results presented in this study, the second earthquake, whose PGA is more than the first earthquake, affects the structural response in the seismic sequence. The probability of the exceedance damage at the performance level (IO) in the far-field earthquakes and seismic sequences is more than that of the near-field earthquakes, while the probability of exceedance damage at the performance levels (LS) and (CP) in 10-, 15-, and 20-story structures in the near-field earthquakes and seismic sequences is higher than that of far-field earthquakes. On average, by applying the second earthquake to the first earthquake scenario with the intensity of 0.6g, the vulnerability of structures under near-fault and far-fault repeated earthquakes caused an increase in the single-earthquake ratio by 15% and 20% at the performance level of (LS), respectively.

Key Words: Concentrically braced frames, near-field and far-fault earthquake, seismic sequence, seismic vulnerability, non-linear dynamic analysis, fragility curve.

PUNCHING SHEAR BEHAVIOR OF FLAT SLABS STRENGTHEND WITH ECC CONCRETE

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Abstract

The present study investigates the punching shear behavior of flat slabs strengthened by ECC concrete. In addition, it studies the effect of magnetic water in a mixture of ECC concrete. In the experimental part of the study, nine reinforced concrete slab specimens with the dimensions of1000×1000 mm with the same reinforcement ratio were constructed and tested. The reinforcement ratio of the slabs was . The slab thickness varied in different specimens. One specimen with mm thickness was made of plane concrete. Six specimens were made by combining the plane concrete and ECC concrete layers with different thicknesses of and mm. Two of the specimens were made by ECC concrete with mm thickness. The mixture of plane concrete incorporated an ordinary Portland cement with a water-cement matrix ratio of . This ratio was for ECC Concrete. In some specimens, the U-shaped shear studs were used for a better connection between the ECC concrete and plane concrete layers. ECC concrete has been used on the tension side of the slabs. Both punching shear strength and displacement of each specimen were measured by a Linear Variable Displacement Transducer (LVDT). During the punching shear tests, the load and maximum deflection were recorded by a data acquisition system and consequently, the load-displacement curves were drawn. The tests were conducted using a testing machine to apply the load at an average rate of kg/sec. A hydraulic jack was fixed to the frame and used to apply the concentric load on the column stub. The hydraulic jack had a maximum capacity of kN. The results of the tests indicated that the ECC concrete enhanced the punching shear strength of slabs. The magnetic water improved the ECC concrete flow and load-carrying capacity of the slabs. U-shaped shear studs increased the load-carrying capacity of the specimens.

Key Words: Punching shear, slabs, ECC, concrete, magnetic water.

COMPARISON IN THE EROSION RATE OF STABILIZED SILTY SAND SOILS WITH CEMENT AND NANOCLAY

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Abstract

Ship collision is one of the most significant marine accidents that threatens the safety of vessels, especially in the straits, waterways, and coastal waters. Since it is quite difficult to assess ship collision based on previous statistics due to the lack of data, the near miss ship collision as an alternative was evaluated. Near miss ship collision refers to those vessels in an encounter course where collision would happen if no maneuver was performed or such a maneuver was not successful. In other words, even though there was no injury or damage in such incidents, a potential impact was still expected that could be transformed into an accident and cause damage or injury. Near miss ship collision for cargo ships or tankers can be assessed using the data obtained from Automated Identification System (AIS). However, there are a number of small vessels devoid of this system; in addition, due to the lack of available data, a few researchers have conducted studies on near miss collision of such vessels. To this end, this paper focused on the traffic simulation of Non-AIS vessels and proposed a model based on one of the methods of Monte Carlo Simulation called Slice sampling method and weighted summation method based on Newton's rules. Furthermore, to determine near miss collision, a model was established based on fuzzy ship domain theory. Finally, the number of near miss ship collision in two states was determined without and with considering the non-conventional vessels. The results showed that the consideration of Non-AIS vessels had a significant effect on the increase in the number of near miss ship collisions in the case study area, which is about 20% for the situation with low conflict severity, 23% for the situation with medium conflict severity, 15% for the situation with high conflict severity, and 11% for the situation with the highest conflict severity.

Key Words: Near miss ship collision, ship domain, non-conventional vessels, automatic identification system (AIS), monte carlo simulation.

ASSESSMENT OF STEEL STRUCTURES WITH A DUAL SYSTEM OF MOMENT FRAME WITH CONCENTRICALLY BRACE INFLUENCING REPEATED EARTHQUAKES

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Abstract

In the seismic active zones, structures are likely to be subject to multiple earthquakes due to the complex stress interactions among the tectonic plates. A large earthquake is usually followed by numerous aftershocks within a short period. Although aftershocks are normally smaller in magnitude, their ground motion intensities are often large and have different energy contents, compared to the mainshock. These aftershocks have a strong potential to cause additional cumulative damages to structures that have been already damaged by the mainshock and threaten life safety even when only minor damage has remained from the mainshock. Seismic design codes provide a design process based on a "design earthquake" and do not take into account the effects of the aftershocks on this design. In the present study, by investigating the effect of seismic sequences on structures with different lateral resisting systems, the existing gap within the design guidelines and codes can be filled. In this regard, the performance of steel structures consisting of dual moment-resisting frames and concentrically braced systems was investigated in the seismic

this study. The soil samples were prepared with different water contents ranging from 8.5 to 14.5% with a similar dry unit weight of 19.3 kN/m3. The direct shear test device with a modified shear box used to perform the interface shear tests under 50, 100, and 150 kPa of vertical stresses with 1mm per minute shearing rate. For unidirectional CFRP sheets, two series of parallel and perpendicular and for bidirectional CFRP sheets, two series of diagonal and parallel interface shear tests with different water contents of the sand were conducted. The results of these investigations showed that the interface behavior of sand and CFRP was anisotropic and was dependent on the direction of the shear displacement. For both unidirectional and bidirectional CFRP sheets, the interface friction angle was maximum when the shear direction was perpendicular to the fibers direction. The variation in the interface friction angle in the direction of the shear force in the unidirectional CFRP sheets was more considerable when compared to bidirectional CFRP sheets. The interface friction angle between sand and bidirectional CFRP sheets was larger than that between unidirectional sheets. Increasing the moisture content reduced the interface friction angle for both types of CFRP sheets; however, its reducing effect was much more considerable for unidirectional CFRP sheets.

Key Words: Shear strength, sand, FRP, friction angle.

NUMERICAL AND EXPERIMENTAL MODELING OF FLOW OVER DROP WITH UPSTREAM CIRCULAR CHANNEL

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Abstract

Vertical drops reduce the flow velocity and increase the energy loss in steep-slope areas. In subsurface networks, the upstream channels in vertical drops are generally circular and the flow regime is supercritical; thus, the flow characteristics are significantly different from those of the rectangular vertical drops with upstream and downstream rectangular sections and subcritical flow. The present investigation aims to numerically and experimentally model a vertical drop with an upstream pipe and a downstream rectangular channel. A vertical drop with the height 0.345 m was built at the Hydraulic Laboratory, Department of Civil Engineering, Isfahan University of Technology, Isfahan, Iran. The diameter of the upstream pipe was 0.19 m and the width of the downstream channel was 0.4 m. A jet box was installed on the upstream pipe to create free surface flow with different Froude numbers and to make the upstream flow fully developed. The flow was also numerically simulated using OpenFOAM software. The interFOAM solver was utilized to solve the two-phase flow. This solver is a two-phase algorithm based on the Volume of Fluid (VOF) method. The brink, pool, and downstream depths and energy dissipation in the supercritical flow with Froude numbers ranging from 1 to 3.8 and relative discharges from 0.25 to 0.5 were investigated. In the numerical model, the fixed velocity was taken into account for the inlet flow at the upstream boundary. For the bottom and sidewalls of the channel, the non-slip boundary condition was considered. At the upper boundary of the simulation domain, the boundary condition of the atmospheric pressure was taken into account. The downstream boundary condition was set to zero gradients for all parameters. The free surface was supposed to be an isosurface with a volume fraction of 0.5. Given that a number of parameters were calculated in numerical simulations, a code was written in the Octave programming language to facilitate calculations. The results showed that the brink depth was approximately 80% of the upstream depth and the difference increased as the Froude number increased. The pool depth was less than that of the rectangular vertical drop. Moreover, by increasing the relative discharge, both pool and downstream depths would increase. The relative head loss of the present model ranged from 50 t0 70% and was approximately 50% higher than that of the rectangular vertical drop. The numerical simulation results are in good agreement with the laboratory observations.

Key Words: Vertical drop, super critical flow, pipe outlet structure, energy head loss, openFOAM software.

EVALUATION OF NEAR MISS SHIP COLLISION WITH CONSIDERATION OF NON-CONVENTIONAL VESSELS IN NORTHEAST OF QESHM ISLAND

HIGH-PERFORMANCE CONCRETE ON CONCRETE RESISTIVITY AGAINST REBAR CORROSION

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Abstract

The main objective of the present study is to investigate the effects of incorporating the low ratios of different Nanosilica types on concrete resistivity against bars corrosion embedded in High-Performance Concrete (HPC). Three ratios of water to binder are considered in the experiment: very low, low, and moderate ratios equal to 0.25, 0.30, and 0.35, respectively. In addition to implementing different ratios of w/b, different types of nanosilica were applied, a coarser and a finer one, respectively, with specific surface areas of 200 and 380 . Moreover, two low ratios of nanosilica 0.75% and 1.50% were considered to replace with cement according to previous studies. Compressive strength test, electrical resistivity, and non-destructive ultrasonic test were conducted in this study. In addition, the workability of the mixtures was kept constant by adjusting the superplasticizer. Although the performance of different types and ratios of nanosilica were variable due to its great activity, it was significant that nanosilica with a lower specific surface area outperformed the control specimen and the specimen with finer one. It should be noticed that due to very much fine size of pyrogenic nanosilica used in this study, it was highly agglomerated. Thus, by using a high shear speed mixer, nanosilica was mixed with partial mixture water. It was shown that a lower water-to-binder ratio had more compressive strength and also, more electrical resistivity was addressed indicating more durability due to lower water-to-binder ratios. It was also noticeable that using nanosilica in mixtures made the HPC more durable and increased compressive strength. Nanosilica of Coarser grade sounded quite better in terms of durability characteristics and also, showed more corrosion resistivity based on ACI222r01. As a result, mixtures of lower water-to-binder ratio with higher replacement of cement (1.5%) with coarser nanosilica (lower specific surface area) had the most compressive strength, electrical resistivity, and non-destructive ultrasonic pulse velocity, indicating the best concrete resistivity against corrosion of deformed bars.

Key Words: High-performance concrete (HPC), nanosilica, compressive strength, electrical resistivity, corrosion resistivity.

EXPERIMENTAL EVALUATION OF THE EFFECT OF MOISTURE CONTENT AND SHEAR DIRECTION ON THE INTERFACE BEHAVIOR OF SAND AND FIBER REINFORCEMENT POLYMER

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Abstract

Carbon fiber polymer reinforcement sheets are available in two types of unidirectional and bidirectional woven sheets. Since the carbon fibers are one-directional tensile elements, any material produced from fibers will be anisotropic material. In this research, the anisotropy of the interface behavior between Carbon Fiber Polymer Reinforcements (CFRP) and sand was investigated at the laboratory. The main objective of this study was to evaluate the effect of the moisture content of the soil and the direction of the shear force on the interface behavior of sand and CFRP. The soil used in this study was a sandy silt collected from Joupar road in Kerman. Two types of CFRP sheets including unidirectional and bidirectional woven carbon fiber polymers were used in

Abstract

In the construction industry, much of the focus is on the design and construction phase, while the most extended and costly phase of building life cycle is related to the operation of the building. Availability, accessibility, reliability, and updating of building information and the appropriate tools to manage this information are critical in facility management. During operation, real-time data of the building (e.g., temperature, humidity) that reflects the actual condition of the building can be measured using sensors. Building Information Modeling (BIM) has the capability of integrating different technologies, thus providing a suitable platform for managing such critical information. Sensor data act as a data repository for the BIM model. The integration of BIM and real-time sensor data provides a powerful platform to visualize, monitor, and process building performance levels in a timely and automated manner. Although integrating sensor data and the BIM model was explored in the previous studies, processing data to be added into the BIM model was performed with a delay. In this study, visualization, monitoring, and processing data are performed in a timely and automated manner by employing an Application Programming Interface (API). Moreover, the developed system provides maintenance information promptly and reduces extra repair context of the BIM. This procedure enhances the efficiency of facility management, emergency management, and maintenance for buildings. The developed framework also reduces the need for monitoring maintenance data manually, resulting in lowering the cost of operating the building and increasing the level of performance of the building simultaneously. The framework was validated in a residential building. Sensor data were added to a database in an automatic and timely manner via a user interface for the sake of visualization and data monitoring. A customized API code was also utilized to process data and evaluate the environmental conditions.

Key Words: Building information modeling (BIM), facility management (FM), sensor data, real-time information.

CLOSED-FORM SOLUTIONS FOR THE ELASTIC FIELDS DUE TO THE MOTION OF A SCREW DISLOCATION AT A CONSTANT VELOCITY ALONG A LINEAR PATH WITH AN ARBITRARY DIRECTION

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Abstract

The present study aims to investigate the elastic fields induced due to the motion of a screw dislocation that moves along a linear path with an arbitrary direction in an infinitely extended isotropic medium. This investigation was performed based on the assumption that the dislocation moves at a constant velocity less than the speed of shear waves in the medium. In the present analysis, from the viewpoint of micromechanics, the dislocation was described using the concept of eigenstrain. The expression of such an eigenstrain field includes a constant to be determined in the sequel of the analysis by applying the jump condition of the displacement on the slip plane of the dislocation. Following the representation of the governing field equations of the problem, a two-dimensional Fourier transform was utilized and then, the closed-form solutions were obtained for the displacement and elastic strain fields of the delineated problem, for the first time. Subsequently, two special cases of the problem, the one pertinent to the motion of the dislocation along its slip plane and the other associated with its motion perpendicular to such plane were addressed. The derived expressions showed that the strain field of the problem has a singularity at the dislocation core. The obtained results demonstrated that at different velocities and in different motion directions, the displacement field of the problem suffers from constant discontinuity on the slip plane of the dislocation. Moreover, it was shown that at distances far away from the slip plane of the dislocation, the components of the strain field vanish. The presented results, in addition, exhibited the effect of the direction of the motion of the dislocation and its velocity on the induced elastic fields. Specifically, it was shown that with an increase in the velocity of the dislocation, the magnitudes of the components of the induced strain field become larger.

Key Words: Screw dislocation, elastic field, uniform motion, eigenstrain.

INVESTIGATING THE EFFECTS OF USING PYROGENIC NANOSILICA IN

the tensile stiffness would decrease as the displacement increased until it reached the corresponding value in the constant-rate displacement test.

Key Words: Pullout apparatus, post-cyclic pullout resistance, geogrid, multi-stage pullout test, maximum apparent coefficient of friction.

DAMAGE REDUCTION DUE TO AIRCRAFT CRASH TO CONCRETE PROTECTIVE STRUCTURES

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Abstract

Terrible environmental effects may be the consequence of aircraft crash into protective concrete structures. Dynamic loading of aircraft crash is defined as pressure-time curves based on analytical methods in related references such as International Atomic Energy Agency (IAEA). It is obvious that impact loading is a function of many variables such as rigidity, mass, and impact angle of projectile and also rigidity and ductility of target that are mostly ignored in simplified analytical solutions. By developing numerical techniques, it is a topic of interest to evaluate the effect of aircraft impact against structures more accurately. Because of its high performance in complex problem analysis such as high velocity impact loading including interaction and large deformations, numerical approach is an appropriate tool for analyzing crash problems. In the numerical simulation method, details of projectiles and target structures, namely geometry, boundary conditions, and interaction between the constituents can be considered to obtain the results with acceptable accuracy. In the crash cases, it is expected to have large variations in results due to huge material and geometric nonlinearities, thus adjusting the accuracy and stability parameters to control element erosion and zero energy mode removal is an important problem. In this paper, RF-4E aircraft crash to concrete protective shell is investigated using nonlinear finite element analyses by applying nonlinear material models for concrete and metals including strain rate for high velocity effects and erosion of elements in large strains to capture penetration and spalling occurrence by ANSYS AUTODYN software. Effects of concrete shell thickness and amount of flexural reinforcement on failure modes were investigated. It was concluded that increasing the concrete shell thickness caused a reduction in scabbing and penetration depth. Optimum concrete thickness is obtained about 1.5 m, in which failure has a significant reduction. In addition, thickness increasing more than 1.5 m has no considerable effect on damage intensity and failure mode. Another result was that variation of flexural reinforcement between minimum and maximum amounts had more protective effect on thinner thickness and penetration depth in thicker shells had lower dependency on flexural reinforcement amount. Sensitivity analyses performed to determine week location showed that the bottom cylindrical wall was more vulnerable than the upper dome shaped roof.

Key Words: Aircraft crash, concrete protective structure, damage patterns, nonlinear finite element using ANSYS AUTODYN, RHT material model for concrete.

INTEGRATION OF BIM AND REAL-TIME SENSOR DATA TO ENHANCE FACILITY MANAGEMENT

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Abstract

One of the biggest environmental challenges in metropolitan areas around the world is removing or recycling waste materials. Waste management is an important issue in every country, while the use of plastics is increasing. Obviously, the effectiveness of sustainable development depends largely on the reduction of destructive activities to the environment and today, the use of renewable energies is a hot topic. One of the ways to reduce the degradation of nature is the use of waste in the industry, which is growing in the construction and concrete industry as one of the most widely used building materials. Considering the disadvantages of asphalt pavement such as increased environmental pollution, high costs due to the price of oil, and viscoelasticity of bitumen, block pavements were put forward as an alternative. This paper examines the effect of addition of PET scum on the mechanical properties and durability of concrete pavements in traffic. Concrete paving blocks were produced with 3%, 5%, 10%, 15%, and 20% replacement aggregates with PET. The method of production of concrete paving blocks was in the form of two-layered masonry and the test performed on concrete specimens included VB test, compressive strength, tensile strength, flexural strength, ultrasonic waves, freeze-thaw resistance, and wear resistance. The results showed that by replacing aggregate with plastic up to about 3%, some parameters such as tensile and flexural strength were improved; however, beyond 5%, the mechanical properties decreased gradually. Also, the results showed that the use of plastic in low percentages did not have much effect on the abrasion resistance and the freeze-thaw resistance. This is despite the fact that the velocity of ultrasonic pulse waves did not change significantly at low replacement levels. Also, the results of mechanical tests and durability of concrete paving blocks with 3% plastic aggregates was able to meet all the requirements of the relevant standards.

Key Words: Recycled fibers (PET), concrete paving block, mechanical properties, durability.

EXPERIMENTAL STUDY ON PULLOUT BEHAVIOR OF EMBEDDED GEOGRID IN UNIFORM SANDY SOIL UNDER STATIC, CYCLIC, AND POST-CYCLIC LOADS

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Abstract

Geosynthetics are mainly used to stabilize and reinforce different types of earth structures such as slopes, retaining walls, bridge abutments, and foundations. In these cases, the interaction between soil and geosynthetic plays a significant role. In order to investigate the factors affecting the static, cyclic, and post-cyclic pullout behavior of a type of geogrid produced in Iran under the brand name of GPGRID80/30 embedded in uniform sand, an experimental study was carried out using a large-scale pullout apparatus. In order to study the monotonic and post-cyclic pullout behavior of geogrid in different conditions, a series of monotonic pullout tests and multistage pullout tests were performed. Given the effect of vertical effective stress on the pullout resistance, the maximum apparent friction coefficient of the surface of the geogrid and soil and deformation along the geogrid was investigated using monotonic tests. In the multistage pullout test, the influence of vertical effective stress, cyclic load amplitude, frequency, and number of tensile load cycle on the post-cyclic pullout resistance was studied. The results indicated that with an increase in the vertical effective stress, the pullout resistance of the geogrid and the maximum apparent coefficient of friction would increase and decrease, respectively. A comparison of the results of the multistage pullout tests and constant rate pullout tests with the vertical stress of 60 kPa showed that the cyclic loading had no significant effect on the post-cyclic pullout strength compared to the static pullout strength of the embedded geogrid in the sandy soil; however, with vertical effective stresses of 20 and 40kPa, a reduction in the maximum post-cyclic pullout strength was more evident than the pullout strength. Increasing the effective vertical stress and cyclic load amplitude in the second stage of the multi-stage test would enhance the cumulative displacements along the geogrid sample. A comparison between the loading-unloading tensile stiffness at the end of the second stage and tensile stiffness at the beginning of the second stage suggested that the cyclic loading would increase the tensile stiffness and finally, at the third stage of the experimental multistage test,

moisture did not significantly influence the mentioned factor.

Key Words: Asphalt pavement, base layer, grangular materials, deflection, compaction.

ESTIMATION OF SCOUR AROUND THE TWIN BRIDGE PIERS USING THE OPTIMIZED ANFIS-FIREFLY MODEL

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Abstract

Identification of the scour pattern around bridge piers is one of the most important issues in optimized designing of such structures. In this study, for the first time, the scour pattern around twin bridge piers was predicted using an optimized hybrid algorithm. The hybrid algorithm (ANFIS-FA) was developed through combining the Adaptive Neuro-Fuzzy Inference System (ANFIS) and the Firefly algorithm (FA). The ANFIS system is often used with a Takagi-Sugeno-Kang (TSK) fuzzy system. The FA has the ability to find optimized values for non-linear problems (e.g. scour depth). This method has a more accurate search procedure than most optimization methods. Due to its high convergence rate and successful applications in various optimization problems, we decided to employ it for this research. Its high convergence rate causes to reduce computation volume as well as reaching to a convergent response in a small number of iterations. After that, four ANFIS and ANFIS-FA models were introduced by means of parameters affecting the scour depth around twin piers. In order to evaluate the accuracy of soft computing models, the Monte Carlo simulations were employed. In addition, the validation of the numerical models was carried out by the k-fold cross validation approach with k=5. In this study, the experimental data obtained by Wang et al. (2016) were used for validating the results of the numerical models. Their experimental model consists of a rectangular channel with a length of 12m, the width of 0.42 and the height of 0.7m. They installed two abutments to report the scour amount around them. It is worth noting that the initial depth of the sediment layer in this experimental study is 15cm, its length is 6m, and the twin abutments were placed with the distance d from each other in the middle of the sediment layer. Based on the modeling results, the analysis of the results indicated that ANFIS-FA models are more accurate than ANFIS models. Then, the superior model was introduced through conducting a sensitivity analysis. The superior model is a function of all input parameters. This model estimated scour values with reasonable accuracy. For example, the values of R2, MAPE and RMSE were calculated 0.991, 5.876 and 0.015, respectively. Furthermore, the error distribution results showed that about 66% of the superior model results have an error less than 5%. Next, the Froude number was detected as the most effective input parameter for estimating the scour hole around twin bridge piers. Finally, by conducting an uncertainty analysis, it was concluded that the superior model has an overestimated performance.

Key Words: ANFIS, firefly algorithm (FA), scour depth, twin bridge piers, uncertainty analysis.

INVESTIGATING THE EFFECT OF ADDING PET SCUM ON THE MECHANICAL PROPERTIES AND DURABILITY OF CONCRETE BLOCK PAVEMENT

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EVALUATION OF INTERACTION BETWEEN MECHANICAL PARAMETERS OF UNBOUND GRANULAR MATERIALS IN BASE LAYER OF ASPHALT PAVEMENT

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Abstract

In a majority of methods used for designing asphalt pavements, the base and sub-base layers have not received enough attention; instead, most researches have focused on the asphalt layers. These layers play a key role in reducing stress on the base layer. Light Weight Deflectometer (LWD) test is commonly used for assessing the bearing capacity of unbound layers of pavements. The present study aims to investigate the simultaneous effects of different variables such as sample thickness, wet content, weight, and compaction on the base layer surface modulus and deflection through LWD test results on the $150 \times 150 \times 60$ cm sample. The results indicated that the maximum compaction value was 97% with a thickness of 40 cm and the minimum compaction value was 10 Kg weight with 20 cm thickness. Furthermore, according to the findings, an increase in the compaction and thickness of the layer led to a decrease in the deflection and an increase in the mass of weight; however,