Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
February 2015, Volume 40, Issue 2, pp 407-419

Using an Artificial Neural Network to Predict Mix Compositions of Steel Fiber-Reinforced Concrete

- Merve Açikgenç , Mustafa Ulaş , Kürşat Esat Alyamaç

Abstract:

An artificial neural network (ANN) has a wide application field for mathematical problems. Specifically, an ANN is successfully applied to problems that are difficult to solve or do not have any information on their operating techniques. In this article, an ANN was applied to predict the concrete mix composition for steel fiber-reinforced concrete (SFRC). Thus, an ANN model was developed and trained with data collected from literature. These data have SFRC mix compositions, workability measurements of fresh SFRC, compressive strength of SFRCs, and additional information that affects concrete quality. Additionally, the ANN included steel fiber volume fraction in the SFRC and steel fiber properties. With the goal of determining the concrete mix composition, which is cement dosage, amount of water, coarse aggregate content, fine aggregate content, and chemical admixture, an ANN model was developed. The inputs for the ANN were consistency class of SFRC, compressive strength of SFRC, maximum size of aggregate, steel fiber volume fraction, steel fiber length, and diameter. At the end of the study, a feed forward ANN model with six inputs and five outputs was successfully trained and used to produce the correct responses to testing data. Designing SFRC requires more trial mixtures to obtain the desired quality than does conventional concrete. In conclusion, artificial neural networks have a strong potential for predicting concrete mix composition for SFRC such that without trial mixes and loss of time, an SFRC design is possible with the desired workability and mechanical properties.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
February 2015, Volume 40, Issue 2, pp 421-430

The Integration of Conflict Probability and Severity for the Safety Assessment of Intersections

- Wael K. M. Alhajyaseen

Abstract:

The use of traffic crash data-based methodologies for safety evaluation is inadequate due to the shortcomings such as unavailability and low quality of historical crash data. Other than crash data-based analysis, the use of empirical vehicle maneuvers and/or the development of micro-simulation models in conjunction with surrogate safety measures has been shown to potentially complement traditional safety analysis. However, several previous works found that existing surrogate measures for intersection safety assessment, such as post-encroachment time, time to collision and speed, fail to simultaneously represent conflict probability and severity. Thus, this study proposes a measurement of the crash hazard that considers crash occurrence probability as well as expected severity. By utilizing the change in the total kinetic energy before and after the collision, angle of collision and PET, the proposed conflict index is derived and its implications are discussed. Several video-recorded signalized intersections in Nagoya, Japan, were utilized to extract vehicle trajectories, through which conflict characteristics are estimated. The relationship between the estimated distributions of the proposed index and the records of severe crashes at the corresponding sites are compared. The proposed safety measure is successful in similarly ranking different signalized intersection to the severity of crashes that occurred at each site. The author expects the new safety assessment measure can be useful in assisting policy makers in prioritizing different sites for safety improvements by identifying hazardous locations which currently lack accurate and historical crash data.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
February 2015, Volume 40, Issue 2, pp 431-442

Roof Isolation with Tuned Mass-based Systems and Application to a Prefabricated Building

- Nicola Nisticò , Eleftheria E. Gkagka , Charis J. Gantes

Abstract:

The earthquake-resistant design of prefabricated buildings is currently the focus of attention, especially for industrial buildings that require a high level of seismic protection. The standard design approach, based on ductility requirements, may succeed in preventing building collapse during a severe earthquake, but at the expense of accepting a high damage level at the column bases. To improve the seismic performance of such buildings, different innovative techniques have been proposed. However, these have not been widely implemented in engineering practice due, among others, to the lack of simple conceptual design methodologies. To achieve this goal, a methodology for the design of a roof isolation system is presented, where the roof isolation serves as non-conventional tuned mass damper (TMD), giving a significantly reduced response in terms of displacements and forces. To that effect, design expressions for the TMD period and damping, depending on the building and soil characteristics, are proposed: The expressions have been calibrated based on numerical parametric time history analyses considering Eurocode 8 spectrum—compatible accelerograms. The application of the proposed methodology is demonstrated for a two-story prefabricated building.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
February 2015, Volume 40, Issue 2, pp 443-450

Mechanical and Thermal Properties of Recycling Lightweight Pervious Concrete

- Prinya Chindaprasir, , Peem Nuaklong , Yuwadee Zaetang , Vanchai Sata

Abstract:

This paper presents an investigation of the use of recycled lightweight aggregate from waste autoclaved aerated concrete block to make lightweight pervious concrete (LWPC). The effects of fine sand (SA) and fly ash (FA) as additive materials on LWPC properties were also studied. The density, total void ratio, water permeability, compressive strength, splitting tensile strength, flexural strength, thermal conductivity, and surface abrasion of LWPC were tested. The results showed that all LWPCs had low density of 775–900 kg/m^3 and low thermal conductivity coefficient of 0.15–0.27 W/m K. The use of SA and FA improved the compressive strength, splitting tensile strength, flexural strength, and abrasion resistance of LWPC, while the total void ratio and water permeability seemed to reduce. The low thermal conductivity and low density of LWPC with reasonable 28-day compressive strength of 1.9–4.1 MPa suggested that it is suitable for use as thermal insulating concrete.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
February 2015, Volume 40, Issue 2, pp 363-379

Cyclic Stress–Strain Relationships of FRP Confined Concrete Members

- Cem Demir, Kutlu Darilmaz

Abstract:

External confinement of columns of existing reinforced concrete buildings using fiber-reinforced polymer (FRP) composites can significantly increase the ductility and compressive strength of structural members against seismic actions. Therefore, knowledge on the behavior of FRP confined concrete/reinforced concrete members under cyclic stresses is vitally important for realistic prediction of seismic performance of retrofitted structures. In this study, available experimental data on the cyclic stress–strain behavior of FRP confined concrete/reinforced concrete members are evaluated in a comparative manner, and accuracy of several stress–strain models proposed for FRP confined concrete is discussed in terms of prediction of the skeleton curves, as well as the unloading–reloading branches of the cyclic stress–strain relationships of the tested samples. Furthermore, a new model is proposed for the prediction of unloading and reloading branches based on the cyclic tests carried out specifically for this purpose. The predictions of the proposed model and two other available models proposed for cyclic loading are compared with experimental data, and a satisfactory agreement is observed between the predictions and experimental data.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
February 2015, Volume 40, Issue 2, pp 329-341

Simulating Nonlinear Behavior of AAR-Affected Arch Dams Including Detection of Crack Profiles

- Mohsen Lamea, Hasan Mirzabozorg

Abstract:

Alkali–aggregate reaction (AAR) is a chemical reaction with known injuries to the old concrete structures. A concrete dam situated in a humid and hot region is commonly susceptible to the occurrence of the reaction. It is a main challenge for the engineers and owners of such structures to make the required rehabilitation measurements. As the primary step, they should estimate future performances of the AAR-affected dams by suitable computer programs. The present study deals with simulation of AAR injuries to the performances of a concrete arch dam. A FE-based computer code, NSAD-DRI, is developed to simulate AAR using a robust mathematical model. On the other side, a nonlinear algorithm has been already implemented in NSAD-DRI for identifying initiation and propagation of crack profiles during the analyses. AMIR-KABIR dam is selected as case study and is modeled by the developed program. The results indicate that AAR may alter various responses of the dam and cause new crack profiles within the dam body. Meanwhile, the current results are in good agreement with those extracted from a similar linear analysis.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
February 2015, Volume 40, Issue 2, pp 343-361

MCPCM: A DEMATEL-ANP-Based Multi-criteria Decision-Making Approach to Evaluate the Critical Success Factors in Construction Projects

- Mehrbakhsh Nilashi , Rozana Zakaria , Othman Ibrahim , Muhd Zaimi Abd. Majid , Rosli Mohamad Zin , Mohammadali Farahmand

Abstract:

Project success is a fundamental issue for any planning, design and construction development. Thus, it effects the stakeholders which involve government, developer, constructor and communities as the end users. Critical success factors (CSFs) have been key aspects of a construction project which are considered to be a means to improve the effectiveness of project. CSF literature has been widely addressed, and many researchers evaluated the gaps in CSFs for construction projects' success. However, this paper highlights the importance levels of interdependency among the CSFs which has rarely been explored in the prior studies. In this study, most influential factors in successfully completing construction projects are used to develop a new integrated model, multi-criteria construction projects CSF model. A novel hybrid multi-criteria decision-making (MCDM) model is used to address the dependence relationships of factors with the aid of grey relational analysis, analytical network process (ANP) and Decision-Making Trial and Evaluation Laboratory (DEMATEL). The initial model of the study is designed by considering five main criteria with 43 sub-criteria. DEMATEL is applied to construct interrelations among criteria and sub-criteria in the integrated model. By using this approach, the interdependencies strength among the criteria and sub-criteria is tested. The ANP method is then adopted in order to determine the relative importance of the CSFs, and used to identify how the CSFs are weighted and prioritized by the construction professionals, who are all working in different areas of the construction industry. The development of this MCDM model helps project parties in Malaysia in identifying the key elements and factors that need to be thoroughly considered and managed for construction project success. The results of this study can also be a guide for the construction organizations to allocate their resources such as financial and time for the construction projects according to the importance level of construction project success factors.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
February 2015, Volume 40, Issue 2, pp 381-395

Computational Modeling of the Hydraulic Jump in the Stilling Basin with Convergence Walls Using CFD Codes

- Hamidreza Babaali, Abolfazl Shamsai , Hamidreza Vosoughifar

Abstract:

The stilling basin has been accepted to be the most powerful hydraulic structure for the dissipation of the flow energy. The size and geometry of the stilling basin affect the formation of flow patterns, which can be influential for hydraulic performance of the whole system. The Nazloo Dam in Iran was selected as the study area. The USBR II stilling basin was conducted for four convergence angles (5 ∘ ,7.5 ∘ ,10 ∘ , and 12.5 ∘). The convergence walls cause the jump to stabilize inside the basin and cause the energy loss to increase in the stilling basin. To simulate the hydraulic jump in the convergence stilling basin conditions in this region, a free surface computational fluid dynamics (CFD) numerical model has been applied. The commercially known software, FLOW-3D ® , was applied to numerically solve the Navier–Stokes equations for solution domains, namely the shout, the stilling basin and the downstream of dam, and to estimate the turbulence flow, the standard k-ε and RNG models was used. These models are based on the volume-of-fluid method, and they are capable of simulating the hydraulic jump. The calculated results such as the pressure, the velocities, the flow rate, the surface height air entranced, the kinetics energy, the kinetics energy dissipated, and the Froude number were compared with the scale model data where available. This allowed a comparison for the use of CFD as a cost-effective alternative to physical models. The physical model and CFD model results showed good correlations.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
February 2015, Volume 40, Issue 2, pp 397-406

Experimental Study on Load-Settlement Behaviour of Cement Stabilised Footing with Different Dimensions on Sandy Soil

- Reza Alijani Shirvani , Issa Shooshpasha

Abstract:

Laboratory tests were done to study the load-settlement behaviour. These tests evaluated rigid square footing on sandy soil and a layered system, stabilised with different dimensions and different cement contents. Nineteen plate load tests were done to make evaluations. The soil type used in tests was poorly graded sand in a box container with the following dimensions; cross section 130 cm × 130 cm and depth 100 cm. The soil was compacted in layers 10-cm thick. Cement was added in percentages of 2.5, 5 and 7.5 % by dry weight of soil. Samples were cured for 28 days, after which they were tested. Experimental data demonstrated effectiveness in terms of increasing bearing capacity and reducing settlement of the stabilised soil–cement layers. Results also showed difference in terms of crack propagation mechanism between samples with different cement contents as evaluations of number and direction. The load-time curves determined from test data showed that the required time to make constant the load variation versus time was more in those samples with 7.5 % cement content compared to those with cement contents of 2.5 and 5%.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
February 2015, Volume 40, Issue 2, pp 313-328

Stress–Strain Model for Low-Strength Concrete in Uni-Axial Compression

- Sohaib Ahmad , Kypros Pilakoutas , Qaiser uz Zaman Khan , Kyriacos Neocleous

Abstract:

One of the most significant problems found in non-engineered reinforced concrete structures is poor quality concrete and can lead to brittle failure modes even for small magnitude earthquakes. The statistics of different post-earthquake surveys indicate that the reinforced concrete building stock in developing countries can have a broad range of low-strength concrete, which can vary between 4 and 20 MPa. The lack of information regarding low-strength concrete mechanical characteristics necessitates a study on low-strength concrete and the development of appropriate stress–strain models to realistically simulate the inelastic behaviour of non-engineered structures. This paper presents the methods adopted to produce low-strength concrete in the laboratory. The stress–strain results obtained from compression tests on cylindrical concrete specimens are presented and new expressions for the modulus of elasticity, peak strain and failure strain are developed, which are used in the development of a stress–strain model for low-strength concrete.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
February 2015, Volume 40, Issue 2, pp 303-312

Impact of Stock Market Indices and Other Regional Exogenous Factors on Predictive Modeling of Border Traffic with Neural Network Models

- El-Sayed M. El-Alfy , Nedal T. Ratrout , Uneb Gazder

Abstract:

This paper analyzes the impact of stock market indices, as indicators of political and economic stability, and other regional exogenous factors on the performance of predictive modeling of border traffic using neural network models. To prove the concept, the Saudi–Bahrain corridor through King Fahd causeway is selected as our area of study. These two countries have strong cultural ties and a wide variety of variables affects the incoming and outgoing traffic flows. Various models of artificial neural networks are constructed for different prediction horizons and look-back periods using a dataset prepared for the period from 2003 till 2013. In our study, stock market indices are proposed, for the first time, to be used in border traffic forecasting. These indices are added as a surrogate measure of the political and economic conditions of the countries which are under study. Their effects on models with varying ranges of time-series inputs and different prediction horizons are studied in detail. It is found that including stock market indices and other most relevant local factors has generally improved the prediction performance of the neural network models in all cases. Additional reduction in the prediction error is achieved by the proposed ensemble model trained with different time lags. Yet, the degree of improvement depends on the look-ahead horizon for prediction.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
March 2015, Volume 40, Issue 3, pp 747-762

Semi-active Vibration Control Using a Magneto Rheological (MR) Damper with Particle Swarm Optimization

- Wei Huang , Da-yong Zhu , Ying-lei Wu , Jian-wei Lu , Kun-lin Lu

Abstract:

Active vibration control based on state feedback using H_∞ criterion for two typical types of engineering equipment (machinery and sensitive equipment) is demonstrated here. Semi-active vibration control was implemented using a magnetorheological (MR) damper, which was guided by optimal output using the active method. Two control strategies based on error feedback are introduced here to achieve current regulation for the MR damper. The first method uses a conventional proportional-integral controller. Another method uses an adaptive fuzzy controller to account for the severe nonlinearity and uncertainty of the MR damper. This method is aimed at making improvements in fuzzy logic control for semi-active vibration control. Apart from this, a novel method was implemented to limit current in the case of the sensitive model used to predict output. Particle swarm optimization technique was used to optimize parameters used in this work.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
March 2015, Volume 40, Issue 3, pp 763-772

Influence of Cement Treatment on Unconfined Compressive Strength and Compressibility of Lean Clay with Medium Plasticity

- Tugba Eskisar

Abstract:

This study presents the experimental results on the use of cement in modification and stabilization of medium plastic clays. Samples of lean clay were mixed with Portland cement in percentages of 5 and 10 % by dry weight of the soils that had water contents of 40 and 60 %. The curing time of the samples varied between 7 and 28 days. The effects of cement addition on the workability, unconfined compressive strength (UCS) and compressibility of lean clay were examined. The plasticity index showed a steady decrease for all samples leading to higher workability especially in higher cement contents. The results of UCS tests demonstrated that UCS increased up to five times by the addition of 10 % cement to the soil at the end of 28 days. Specimens with lower water content had higher peak strengths. Samples exhibited ductile, semi-brittle, and brittle type of failures depending on their water and cement contents. Brittleness index was used to quantify the mechanical behavior of the soil and the brittleness index increased distinctively as a result of cement treatment. Deformability index was proposed as an alternative to evaluate the deformation behavior of specimens. Moreover, a relationship to determine the UCS development with curing time was proposed. The results of consolidation tests indicated that the compression index decreased and preconsolidation pressure increased by increasing the cement content. The preconsolidation pressure values were found to be related to the UCS values by a ratio of 1.4 for the cement-treated clay.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
March 2015, Volume 40, Issue 3, pp 693-704

Site-Specific Detections of Hydroclimatic Changes for Naran Watershed, Pakistan

- Farooq Azim **,** Abdul Sattar Shakir , Habib Rehman , Ghulam Nabi

Abstract:

In this paper, studies have been made to detect the changes in key hydroclimatic variables including precipitation, surface-air temperatures and stream flow with their trends, constructed projection scenarios, and simulated projected climate parameters for Naran watershed. Extreme indices have been determined by least squares and weighted average regression analysis. Temperature extremes have indicated signs of warming trends and increase in variability. Precipitation extremes have depicted decrease in occurrences and magnitudes. The analysis has provided evidence of high confidence about these changes. Trends of from hydroclimatic parameters and stream flows were also determined using Mann–Kendall test for the period 1962–2011. Inter-annual trends have been detected to determine the sensitivity with a base period (1962–1991) by using equal and unequal overlapped moving periods. It has been found that there is a clear trend reversibility during 1996–1997 for temperatures and precipitation pattern. However, the analysis has revealed that no long-term trends are persistent in inter-annual surface-air temperatures and precipitation. Intra-annual trends and variations on the monthly scale from data sets of 1962–2011 have also been detected with their significant values. There seems evidence that variation of parameters in monthly scale is occurring that is affecting the ice melt schedule and evapotranspiration demand.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
March 2015, Volume 40, Issue 3, pp 685-692

Integration of GIS Database and SCS-CN Method to Estimate Runoff Volume of Wadis of Intermittent Flow

- Taha M. Taher

Abstract:

Estimation of runoff volume in Wadis of intermittent flow is very important in order to manage the scarce water resources and mobilize Wadi flows efficiently. In Yemen, the availability of accurate runoff information is rare, which poses a serious challenge for hydrologists. This study used the soil conservation services curve number (SCS-CN) method with conventional database and the geographical information system to estimate the runoff volume of Wadi Zaher, Harad and Al Ghayel. The Wadi is located in the southwest of Sana'a City, the capital of Yemen. The area of the Wadi is 350.24 km^2, and the average annual rainfall is 284 mm. The study area is classified into four hydrological soil groups. The average curve number for normal condition is 77.6, where the averages of the dry and wet conditions are 59.5 and 88.8, respectively. The results, obtained by the SCS-CN method, show that the average annual runoff depth for Wadi Zaher Al Ghayel watershed is 212 mm, and the total runoff volume is estimated to be 75.80 mm^3, which is 76 % of the total annual rainfall. This approach can be applied in other Wadis in Yemen for the purpose of planning and development.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
March 2015, Volume 40, Issue 3, pp 677-684

Application of Numerical Modeling to Assess Geometry Effect of Racks on Performance of Bottom Intakes

- Khosrow Hosseini , Shahab Rikhtegar , Hojat Karami , Keivan Bina

Abstract:

Bottom intakes are frequently used as diversion structures in mountainous regions, because of their simplicity and low costs in comparison with other methods of river diversion. In this study, Flow-3D software is utilized to simulate the flow passing through the racks. Verification tests are performed on the results of numerical method by using the experimental results of Righetti and Lanzoni (J. Hydraul. Eng. 134(1), 15–22, 2008). Also, calibration tests and mesh sensitivity are performed on the mathematical model. The diverted discharge in the numerical model is compared with the experimental data, and a good correlation ($R^2 = 0.99$) was obtained. Among the different existing turbulence models, the $k\varepsilon$ RNG model performed best. Afterward, the racks with eight different cross-sectional geometries are simulated by the numerical method. The diverted discharge, velocity and pressure distributions around the racks for each cross section are obtained and compared with each other. Results revealed that lozenge shape is the most effective geometry in flow diversion.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
March 2015, Volume 40, Issue 3, pp 719-733

A Finite Element Based on the Strain Approach Using Airy's Function

- Mohammed Himeur , Abdesselam Zergua , Mohamed Guenfoud

Abstract:

Plane membrane elements of class C ∘ provide poor deflection and stress for problems where bending is dominant. They also encountered problems of continuity and compliance when connected to plate elements (elements of class C 1). The scope of this paper is to overcome these problems by developing a new triangular plane elastic element based on a strain formulation. The developed membrane element, denoted T43_Eq, has three nodes at the vertices of the triangle and the fourth one at its barycenter. Each node has three degrees of freedom, two translations and one rotation around the normal. The coefficients related to the degrees of freedom at the internal node are subsequently removed from the element stiffness matrix by using the static condensation technique. Interpolation functions of strain, displacements and stresses fields are developed from equilibrium conditions. These polynomial bi-harmonics functions are selected from the development of the Airy function solutions. The elementary stiffness matrix is evaluated by applying the variational principle and the analytical integration method. The results of the validation test show that the developed T43_Eq element is very efficient for treating bending problems. They are competitive compared to the triangular or rectangular elements available in the literature in terms of accuracy and convergence. The performance of T43_Eq element is observed in the presence of both regular and distorted meshes.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
March 2015, Volume 40, Issue 3, pp 659-675

Estimation of Flood Environmental Effects Using Flood Zone Mapping Techniques in Halilrood Kerman, Iran

- Siamak Boudaghpour, Majid Bagheri , Zahra Bagheri

Abstract:

High flood occurrences with large environmental damages have a growing trend in Iran. Dynamic movements of water during a flood cause different environmental damages in geographical areas with different characteristics such as topographic conditions. In general, environmental effects and damages caused by a flood in an area can be investigated from different points of view. The current essay is aiming at detecting environmental effects of flood occurrences in Halilrood catchment area of Kerman province in Iran using flood zone-mapping techniques. The intended flood zone map was introduced in four steps. Steps 1–3 pave the way to calculate and estimate flood zone map in the understudy area while step 4 determines the estimation of environmental effects of flood occurrence. Based on our studies, wide range of accuracy for estimating the environmental effects of flood occurrence was introduced by using flood zone-mapping techniques. Moreover, it was identified that the existence of Jiroft dam in the study area can decrease flood zone from 260 to 225 ha and also it can decrease 20 % of flood peak intensity. As a result, 14 % of flood zone in the study area can be saved environmentally.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
March 2015, Volume 40, Issue 3, pp 705-717

Mechanical and Durability Behaviour of Structural Lightweight Concrete Produced with Volcanic Scoria

- J. Alexandre Bogas , Tiago Gomes

Abstract:

In this paper, the mechanical and long-term durability behaviour of structural lightweight concrete (LWC) produced with natural lightweight scoria aggregate (LWSA) from the Azores is analysed. Among the properties studied are the compressive and tensile strength, modulus of elasticity, shrinkage, capillary absorption, carbonation and chloride resistance. To this end, a comprehensive experimental study was carried out on different concrete compositions involving common and high-performance structural concrete produced with coarse or coarse and fine volcanic scoria aggregate. Generally, all the mechanical properties worsened with the incorporation of LWSA. It is concluded that the most efficient LWC with LWSA can attain compressive strength up to about 35 MPa. On the other hand, the production of LWC of more than 50 MPa implies a marked reduction in compressive strength for a small reduction in density. The long-term shrinkage increased with the replacement of normal-weight aggregate by LWA and was higher when coarse and fine *scoria* were used. However, the early age shrinkage can be counterbalanced by the internal curing effect provided by LWSA. The capillary absorption, chloride and carbonation resistance were affected by the high porosity of LWSA. The absence of the outer shell in scoria aggregate and the surface effects during tests can partly explain the lower performance of the LWC. Nevertheless, it is shown that LWC with scoria can be durable, and even for low- to moderate-strength LWC the corrosion induced by carbonation may not be relevant.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
March 2015, Volume 40, Issue 3, pp 735-746

A Deep Catastrophic Failure Model of Hillslope for Numerical Manifold Method and Multiple Physics Computation

- Hsueh-Chun Lin , Yao-Chiang Kan , Wen-Pei Sung , Yao-Ming Hong

Abstract:

This study was aimed to create an analytical model for simulating deep catastrophic failure of hillslope (or deep-seated landslide) to help determining assessment criteria of potential risk based on numerical manifold method (NMM) and coupled multi-physics computation (MPC), in which the failure status is simulated by the NMM while the risk factors are studied by the MPC. The simulation delivers the landslide results that are compared with a laboratory test for approval. The proposed model includes a small-scale hillslope designed by two-dimensional geometry for the plane strain problem. Thus, the porous materials are considered for coupling fluid–structure interactions in hydraulic and geotechnical analyses. Meanwhile, discontinuous joints are assumed along the potential failure surfaces within the deep-seated layer to simulate collapse behaviors of hillslope once the risk factors, such as effective stress and friction angle, reach the thresholds. Furthermore, the model is initially setup as laboratory scale for comparing with a hydraulic experiment that practices the failure condition caused by seepage. The simulation hence explorers the criteria of potential failure risks due to variations of slope, friction angle, and groundwater level. This study performs feasibility of the proposed model that provides a reliable procedure based on both simulation and experiment to estimate the potential risks for deep catastrophic landslides. In the future, the study can be expanded for evaluating full-scale landslide in a variety of hillslope properties.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
April 2015, Volume 40, Issue 4, pp 1015-1025

Formulation of an Optimal Mix Design of Stabilized Peat Columns with Fly Ash as a Pozzolan

- Leong Sing Wong

Abstract:

As a foundation soil, peat poses a grave threat to civil engineering construction due to its softness and large compressibility in nature. Hence, it is crucial to research on its cementation mechanism, so that relevant materials can be quantified to stabilize the soil. In this research work, fly ash (FA) was utilized as a pozzolan to enhance the long-term strength accumulation of stabilized peat columns at experimental scale. The research focus was primarily centered on the design of a suitable mixture of Portland composite cement (PCC), calcium chloride ($CaCl_2$), FA and silica sand that can be applied for the development of stabilized peat columns. A laboratory-based approach was initiated to investigate the pertinent factors that influenced unconfined compressive strength of the stabilized peat. It was found that stabilization of peat can be optimally achieved with a mix design at 10 % partial replacement of PCC with FA. The engineering performance of the stabilized peat was assessed by performing unconfined compression and permeability tests. There were progressive patterns of increase in unconfined compressive strength and decrease in coefficient of hydraulic conductivity for test specimens formulated at the optimal mix design. Chemical and morphological evidences on cementation effect and pore reduction in the peat stabilization are traceable from the respective X-ray diffraction and scanning electron microscopy results. A key discovery is that water continued to play a role as a cement dissolving agent that triggered reactivity with FA to precipitate cementing crystals for the binding of the stabilized peat.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
April 2015, Volume 40, Issue 4, pp 1027-1044

Structural Damage Identification Using Response Surface-Based Multi-objective Optimization: A Comparative Study

- Tanmoy Mukhopadhyay , Tushar Kanti Dey , Rajib Chowdhury , Anupam Chakrabarti

Abstract:

Non-destructive structural damage identification (SDI) and quantification of damage are important issues for any engineering structure. In this study, a comparative assessment of the damage identification capability of different design of experiment (DOE) methods (such as, 2^k factorial design, central composite design, Box–Behnken design, D-optimal design and Taguchi's OA design) used in response surface methodology (RSM) has been carried out. Three different structures (simply supported beam, spring mass damper system and fibre reinforced polymer composite bridge deck) have been used for various single and multiple damage conditions to access the comparative ability of the aforementioned methods in identifying damage addressing two critically important criteria: accuracy and computational efficiency. The study reveals that central composite design and D-optimal design are most recommendable among the five considered DOE methods for SDI. Two different input parameter screening methods (sensitivity analysis using RSM utilizing 2^k factorial design and D-optimal design, general sensitivity analysis) have been explored in this study, and their comparative performance is also discussed. It is found that both the methods used in sensitivity analysis for the purpose of input parameter screening in the damage identification process work satisfactorily. Performance of RSM-based damage identification algorithm for different DOE methods under the influence of noise has also been addressed in this paper.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
May 2015, Volume 40, Issue 5, pp 1327-1342

Undrained Static Response of Loose and Medium Dense Silty Sand of Mostaganem (Northern Algeria)

- Fethi Belhouari , Karim Bendani , Hanifi Missoum , Mohamed Derkaoui

Abstract:

Critical undrained shear strength of sandy soils is a fundamental parameter in stability analysis. This will help to evaluate the occurrence of flow deformation under liquefaction phenomena. A precise evaluation of the undrained liquefaction strength is very important for the design of soil structures such as earth dams, building foundations and soil densification process which can avoid catastrophic failure due to soil instability. In this work, laboratory investigation on natural and on reconstituted soil specimens of silica sands was carried out to enable the analysis of its mechanical behavior. Several concepts have been proposed by many researchers in order to characterize instability of silty sands. However, a review of studies published in the literature indicates that no clear conclusions can be drawn as to what manner the variation of fine content affects the mechanical behavior. The present paper is an attempt to experimentally describe mechanical behavior and theoretically justify such response of loose and medium dense sand by means of critical state parameters. Two distinct stress path tendencies have been shown in this study. In undrained conditions, loose samples show amplified contractive phase with fine content ranging from 0 to 30%, while medium dense samples exhibit a contractive phase followed by a dilative phase with fine contents beyond 30%. In this study, it has been shown that the strength of sand fabric of carrying loads becomes weaker and the critical state parameter increases with the increase in fine content leading to the reduction of normalized critical undrained shear strength.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
May 2015, Volume 40, Issue 5, pp 1289-1297

Optimal Removal of Cadmium from Heavily Contaminated Saline–Sodic Soil Using Integrated Electrokinetic-Adsorption Technique

- Salihu Lukman , Nuhu Dalhat Mu'azu , Mohammed H. Essa , Abdullahi Usman

Abstract:

Saline–sodic soil inherently exhibits extreme characteristics which challenge getting it remediated from mixed contaminants. In this study, the feasibility of removal of cadmium (Cd) in saline–sodic clay soil in presence of mixed pollutants was investigated. Fifteen (15) experimental runs, each having residence time of three (3) weeks, were designed and conducted according to Box-Behnken design to evaluate the effects of contaminants initial concentration (20–100 mg/kg), voltage gradient (0.2–1 v/cm) and polarity reversal (12–48 h) on Cd removal efficiency. The Cd removal efficiency fitted experimentally verified quadratic model (prediction error of 18.60 %) with insignificant lack of fit based on 5 % significant level (R^2 = 0.9917 and $p < 0.05$). Statistical analysis of the model's parameters shows that the effect of the investigated parameters follows the order: voltage gradient > initial contaminant concentration > polarity reversal rate. The optimal conditions considering optimization of all effecting parameters (both factors and responses) were found to be at voltage gradient = 0.47 V/cm; polarity reversal rate = 19.77 h; initial contaminant concentration = 65.44 mg/kg which yielded highest Cd remedial efficiency of 86 % at 22.45 kWhr/m^3/mg energy expenditure. The study demonstrated the viability of employing integrated-adsorption technology for the removal of Cd from contaminated saline–sodic clays under extreme soil and contamination conditions. It also further underscores the intricacy of obtaining a common optimal remediation conditions for the different pollutants presence in saline–sodic soil contaminated with mixed pollutants.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
May 2015, Volume 40, Issue 5, pp 1299-1307

The Effect of Support Structure on Flow Patterns Around T-Shape Spur Dike in 90° Bend Channel

- M. Vaghefi , A. Ahmadi , B. Faraji

Abstract:

Totally, spur dike is an economical way to preserve morphology of rivers. Numerical methods can be useful for evaluating hydraulic parameters for spur dike because of their reduced simulation time, while experimental ones take a long time and need lots of tools to simulate any models. In this paper, flow patterns around a T-shape spur dike and a support structure, which is located upstream of the T-shape spur dike, is analyzed in 90° bend channel by Flow-3D model. The numerical and laboratory data are compared in longitudinal section to verify numerical model. The results show very good correspondence between numerical and laboratory data. After verification numerical model, a support structure has been installed upstream of the T-shape spur dike with 3, 5, 7 and 9 times distance longer than the length of the T-shape spur dike. The support structure altered flow patterns and hydraulic parameters such as power of secondary flow and separation zone in all of sections. By increasing support structure distance from 3L up to 9L, the power of secondary flow around main spur dike decreases by 40–120% and the length of separation zone increases from 0.8 to 2.5 times bigger than the length of T-shape spur dike.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
May 2015, Volume 40, Issue 5, pp 1309-1326

Analyzing Aggregate Size Distribution of Asphalt Mixtures Using Simple 2D Digital Image Processing Techniques

- Ki Hoon Moon , Augusto Cannone Falchetto , Michael P. Wistuba , Jin Hoon Jeong

Abstract:

In this paper, a simple two-dimensional Digital Image Processing (DIP) technique was used to obtain aggregate gradation curves for a set of 28 asphalt mixtures prepared with different asphalt binders and air void contents, aggregates having various Nominal Maximum Aggregate Size and three percentages of Reclaimed Asphalt Pavement. As part of a larger project, small asphalt mixture beams having the same size of the Bending Beam Rheometer specimens were prepared for images acquisition (Red–Green–Blue: RGB scale). Then, RGB images were converted based on a specific DIP algorithm into binary images, and the area of each aggregate particle was computed. Finally, the diameters of the aggregates in the binary image were determined through a simple calculation and used to generate aggregate size distributions curves, which were then graphically and statistically compared to the original mix design of each of the 28 asphalt mixtures considered. Good predictions of aggregate gradation were achieved for particle sizes equal or larger than 4.75 mm. Differences in mix design across mixtures having various aggregate size distributions could be clearly observed and statistically analyzed. Due to image resolution limits, relatively poor gradation predictions were observed for aggregates equal or smaller than 2.38 mm.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
June 2015, Volume 40, Issue 6, pp 1565-1578

Prediction of Lateral Load Capacity of Pile in Clay Using Multivariate Adaptive Regression Spline and Functional Network

- Sarat Kumar Das, Shakti Suman

Abstract:

This paper discusses the use of multivariate adaptive regression splines (MARS) and functional networks (FN) for prediction of the lateral load capacity of piles in clay. The results obtained from MARS and FN have been compared with different empirical models and artificial neural network in terms of statistical parameters such as correlation coefficient (*R*), Nash–Sutcliff coefficient of efficiency (*E*), absolute average error, maximum average error and root mean square error. Based on the statistical parameters, MARS and FN were found to have a better predictive capacity. Predictive equations are provided based on the MARS and FN model. A sensitivity analysis is also presented to determine the importance of inputs in prediction of the lateral load capacity of piles.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
June 2015, Volume 40, Issue 6, pp 1579-1590

Effect of Bridge Pier Position on Scour Reduction According to Flow Direction

- Adnan Ismael , Mustafa Gunal , Hamid Hussein

Abstract:

An experimental approach was conducted to study the effect of the change in the position of bridge pier on scour reduction with respect to flow direction. The experiments included the study of new method to reduce scour depth in front of bridge pier by changing the position of bridge pier (named after here as downstream facing round-nosed bridge pier). The down flow deflected away from the front of the opposite pier, and the vortex becomes small and does not affect the pier. In this study, three piers—circular 10 cm, upstream facing round-nosed (10–4) cm and downstream facing round-nosed (4–10) cm bridge piers—were tested under live-bed condition with flow intensity of 58 l/s for duration of 3 h. The velocity field measurements were obtained using an Acoustic Doppler Velocimeter. The results showed that the downstream facing round-nosed pier reduces local scour. The reduction in maximum scour depth was 54 % when compared to the circular pier and 40 % compared with upstream facing round-nosed pier. The downstream facing round-nosed pier reduces local scour by a volume of 83 % when compared to the circular pier. Changing the position of bridge pier (as is located downstream facing to the flow) is an effective countermeasure for reducing local scour depth. Empirical relationship was developed on the basis of obtained results. The present experimental study shows that there is no need of any alteration or modification to countermeasure scour like riprap, collar and slot. The present method also reduces costs and improves the hydraulic performance of bridge pier.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
August 2015, Volume 40, Issue 8, pp 2183-2199

Water Hammer Analysis for Khobar–Dammam Water Transmission Ring Line

- Hussain T. Ammar, Muhammad A. Al-Zahrani

Abstract:

Water hammer or hydraulic transient is a common problem in water distribution systems, especially for water transmission pipelines. Hydraulic transient events in water distribution system can cause significant damage and disruption in the system. One major pipeline that connects the water supply of two major cities (Khobar and Dammam) in the Eastern Province of Saudi Arabia is the Khobar–Dammam Ring Line (KDRL). This transmission line is vulnerable to a potential water hammer problem as it is controlled by the water level in the two main tanks at its both ends. In addition, six other subtanks along the KDRL are expected to increase the probability of water hammer occurrences in the system. In this paper, two widely used hydraulic simulation models were adopted to model and analyze the hydraulic and transient (water hammer) behavior in the KDRL. The two hydraulic programs are WaterGEMS and HAMMER. The WaterGEMS was used to simulate the hydraulics of the transmission pipeline under normal conditions, while the HAMMER was used to analyze the occurrence of water hammer and simulate different water hammer protection scenarios. Based on the analysis, several water hammer protection devices were tested and approved to provide a complete protection against the water hammer for the system. Moreover, appropriate operational control measures were proposed to be adopted by the water authority to minimize the probability of water hammer occurrence and to protect the KDRL from any water hammer consequences.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
August 2015, Volume 40, Issue 8, pp 2271-2288

Relationship Between Shear Wave Wavelength and Pseudo-Dynamic Seismic Safety Factor in Expanded Landfill

- Xiaobo Ruan, Hai Lin

Abstract:

Using the pseudo-dynamic limit equilibrium method, the average safety factor for the expanded landfill against the over-berm failure was calculated to replace the true safety factor under the earthquake condition. The effect of the shear wave wavelength on the average safety factor was then studied by considering various parameters. After the analysis of different working conditions, the most unfavorable shear wave wavelength was obtained. Results indicate that the geometric parameters of the landfill strongly affect the most unfavorable shear wave wavelength except for the angle of back slope of berm measured from horizontal. The results, however, show that the property parameters about the landfill slightly influence the most unfavorable shear wave wavelength which generally occurs around 77.5 m. Furthermore, in the seismic design of the expanded landfill against the over-berm failure, the effect of height of berm on the most unfavorable shear wave wavelength should be carefully considered, but the effect of the angle of back slope of berm measured from horizontal, apparent cohesion between liner components beneath block wedge, or interface friction angle of liner components beneath block wedge can be ignored.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
August 2015, Volume 40, Issue 8, pp 2251-2260

Bacterail Calcium Carbonate Precipitation in Peat

- Hanifi Canakci , Waleed Sidik , Ibrahim Halil Kilic

Abstract:

Bacterial calcium carbonate precipitation has been used to improve strength and permeability of granular soil. Indeed, very encouraging results have been obtained. Commercially available bacteria have been used in this treatment method. This laboratory scale work is aimed to investigate the feasibility of this new improvement technique in peat that has low strength and high compressibility. For this purpose, two-stage works were carried out. In the first stage, isolation of calcite precipitating bacteria from local soil has been investigated. In the second stage, bacteria have been induced into the peat with treatment solution. The amount of precipitated calcite was determined at the end of the treatment. A preliminary direct shear test has been performed on treated and untreated sample to observe the effect of calcite precipitation on shear strength of the peat. Test results have demonstrated that ureolytic and calcite precipitating bacteria could be isolated from local soils. The treatment has indicated that solid calcite particles precipitated in the peat were nearly 16 % by weight. The shear strength test results have shown that precipitated calcite caused cementing effect on the peat particles.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
August 2015, Volume 40, Issue 8, pp 2289-2299

Properties of Fibred Sand Concrete Sprayed by Wet-Mix Process

- Imene Benaissa , Bachir , Salima Aggoun , Souad Malab

Abstract:

This paper presents test results of mechanical properties of fibre-reinforced sand concrete (FRSC) formulated to be used in the sprayed wet-mix process, as a substitution to fibre-reinforced concrete (FRC) sprayed by dry-mix process. This process of application of concrete is suitable for diverse applications such underground support and slope stabilization. In FRC, formulated with aggregates up to 8 mm, both material and fibre rebounds are high (from 35 to 50 and 50 %, respectively); this results in economic implications and affects the performances of the mixture negatively. FRSC formulated with low dosage of cement, sand and high content of limestone filler, but without coarse aggregate, seems to be indicated to alleviate most of these problems, because of its fineness, high cohesiveness, high fluidity and better homogeneity. FRSC was investigated and compared with FRC, on the basis of fresh and hardened properties with special emphasis on rebound, compressive strength and drying shrinkage. Results of investigations showed many advantages of this new mixture (FRSC) when compared to FRC: reduction in material and fibre rebounds by approximately 50 %, relatively substantially thicker layers (9 vs 6 cm), good finishing surface, higher early-age compressive strength and long-term drying shrinkage close to that of FRC. On the other hand, the present study showed that a low amount of steel fibre (50 kg/m^3) reduces the drying shrinkage of FRSC by approximately 16 %, while in the case of FRC, the influence is not significant.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
August 2015, Volume 40, Issue 8, pp 2201-2217

Modelling and Assessment of Shear Wall–Flat Slab Joint Region in Tall Structures

- R. S. Surumi, K. P. Jaya , S. Greeshma

Abstract:

This paper explains the investigation carried out to study the seismic behaviour of shear wall–flat slab connections with various reinforcement detailing at the joint region. The modelling and assessment of scaled down exterior wall–slab connection sub-assemblages subjected to static reverse cyclic loading is presented. Three-dimensional nonlinear finite element models with different reinforcement detailing at the joint region were developed using ABAQUS/CAE software. The concrete damage plasticity model was used to model the inelastic behaviour of the concrete material under cyclic loading. Moreover, three specimens with overall dimensions of 1.375 m (height) × 0.625 m (width) were tested under the same seismic-type loading. The validation of the numerical results against the experimental results has shown that the adopted models could predict the joint capacity. This research also confirms the viability of using the proposed type of joint detailing system in construction.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
August 2015, Volume 40, Issue 8, pp 2261-2269

Thermal Behavior of Portland Cement and Fly Ash–Metakaolin-Based Geopolymer Cement Pastes

- Ping Duan, Chunjie Yan , Wei Zhou , Wenjun Luo

Abstract:

Geopolymer specimens were prepared by combination of fly ash and metakaolin activated by sodium silicate (Na 2 SiO 3) and sodium hydroxide (NaOH) solutions. The effect of high temperature on the compressive strength, mass loss and shrinkage of geopolymer cement pastes and ordinary portland cement (OPC) pastes were assessed experimentally. Microstructure formation and development were characterized in terms of pore structure by mercury intrusion porosimetry. The results reveal that at temperatures exceeding 400 ∘ C geopolymer cement paste is superior to OPC paste. Firstly, the compressive strength drops rapidly for the OPC paste to practically zero strength at 600 ∘ C , while it drops slowly for the fly ash–metakaolin-based geopolymer cement paste to 46 MPa at 1000 ∘ C . Secondly, while the mass loss increases for the OPC paste, it is maintained at a constant, lower value for the geopolymer cement paste. Thirdly, shrinkage of geopolymer cement paste is at least three times smaller than that of OPC paste.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
August 2015, Volume 40, Issue 8, pp 2239-2249

A Fuzzy System Methodology for Concrete Mixture Design Considering Maximum Packing Density and Minimum Cement Content

- Parviz Ghoddousi, Ali Akbar Shirzadi Javid , Jafar Sobhani

Abstract:

Concrete mix proportioning could be referred to the process of determining the quantities of concrete ingredients using local materials to achieve specific characteristics of the concrete. Among the most important parameters affecting the performance of concrete are the packing density and the grading curve of the aggregates. Better packing of aggregates improves the strength, durability, elastic modulus and creep of the concrete. Accordingly, by increasing packing density and decreasing cement content, environment pollution will decrease. The present study proposes a fuzzy-based technique for mix proportioning of normal concrete that increases packing density and decreases cement content. The proposed system utilizes four sub-fuzzy systems to quantify the target compressive strength, water-to-cement ratio, ideal grading curve and free water of the concrete. The results from the proposed fuzzy systems were compared with those obtained from the concrete mix proportioned by field experts. The comparison showed strong agreement between the results for the fuzzy and expert-proportioned mixtures. The proposed system used less cement and had a higher packing density than was found using other mixture proportioning methods.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Technical Note - Civil Engineering
August 2015, Volume 40, Issue 8, pp 2301-2307

Seismic Fragility Curves for Steel and Reinforced Concrete Frames Based on Near-Field and Far-Field Ground Motion Records

- Fadzli Mohamed Nazri , Siti Nur Aqilah Saruddin

Abstract:

This study presents the fragility curve for steel and concrete frames based on near-field (NF) and far-field (FF) ground motion records. The fragility curve is calibrated to the incremental dynamic analysis (IDA) curve based on building materials and frame heights. The frames are designed according to Eurocodes. This study uses seven ground motion records for NF and another seven records for FF. The five performance levels prescribed by FEMA-273 are used as structure performance benchmarks in generating the IDA curve. Results based on the NF and FF records indicate that a three-storey steel frame is stiffer than a concrete frame. By contrast, the results for a six-storey structure show that a steel frame is more suitable than low-rise and mid-rise frames. The fragility curve results show that the probability of reaching or exceeding a specified damage state can be determined.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
August 2015, Volume 40, Issue 8, pp 2219-2232

Prevention of Debonding Failure of Intermediate Anchor to Eliminate Premature Shear Failure of Flexurally Strengthened Reinforced Concrete Beams

- Md Ashraful Alam, Mohd Zamin Jumaat

Abstract:

This research proposed an optimal method of intermediate anchor to prevent premature debonding failure of anchor plate for eliminating premature shear failure of CFRP laminate flexurally strengthened reinforced concrete (RC) beam. In the experimental programme, seven RC beam specimens were prepared which included un-strengthened control beam and flexurally strengthened beams with CFRP laminate. The flexurally strengthened beams were further shear strengthened using L-shaped intermediate anchors based on proposed and conventional methods. The experimental results of specimens were compared with the numerical results. Theoretical model had also been proposed to predict the debonding failure of intermediate anchors. Results showed that the anchors obtained based on the proposed design guideline prevented premature debonding failure of anchor plates completely and thus, the proposed intermediate anchored strengthened beams did not show premature shear failures. Whereas beams having the anchor plates based on conventional method failed by premature debonding of anchor plates followed by premature shear. The proposed intermediate anchors significantly increased the ultimate loads and ductility of the beams as compared to conventional one. It also reduced the number and widths of cracks in shear span. The theoretical model could predict the debonding failure load of intermediate anchor which was comparable with the experimental finding. Finally, numerical model predicted the structural behaviour of proposed intermediate anchored strengthened beams satisfactorily.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
August 2015, Volume 40, Issue 8, pp 2233-2238

Aerogel-Assisted Support Pillars for Thermal Performance Enhancement of Vacuum Glazing: A CFD Research for a Commercial Product

- Erdem Cuce, Saffa B. Riffat

Abstract:

Vacuum glazing is an up-and-coming and rapidly developing technology which has a great potential to reduce heating and cooling demand of buildings in winter and summer, respectively. In this paper, the world's first commercially available vacuum glazing product is numerically investigated through a CFD-based research. Accuracy of the CFD model is compared with the manufacturer's thermal performance report, and an excellent agreement is observed. Then, translucent aerogel support pillars are recommended for commercial vacuum glazing, and impact of this replacement on the thermal performance of the glazing is numerically analysed. Number of support pillars at any section is also studied in terms of its impact on the *U*-value. The results indicate that the *U*-value of vacuum glazing can be reduced to 0.67 W/m^2 K with aerogel support pillars, whereas it is 1.20 W/m^2 K for the existing product. Moreover, the *U*-value might be lower than 0.40 W/m^2 K if the number of support pillars at each section is optimized.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
August 2015, Volume 40, Issue 8, pp 2169-2182

Lattice Boltzmann Study of Wake Structure and Force Statistics for Various Gap Spacings Between a Square Cylinder with a Detached Flat Plate

- S. Ul. Islam , H. Rahman , W. S. Abbasi , T. Shahina

Abstract:

A numerical study of uniform flow past a square cylinder in the presence of detached flat plate for various gap spacings using the multi-relaxation-time lattice Boltzmann method (MRT-LBM) has been undertaken. The Reynolds number is kept at 150 for all numerical calculations and the gap spacing (g) ranging from 0 to 11. Analyses of the vortex structure in the wake, the vortex shedding frequency, time-trace analysis of drag and lift coefficients and force statistics have been carried out. The existing results for flow past a square cylinder without detached flat plate are validated with the well-resolved results obtained experimentally and numerically. Numerical results reveal that as gap spacing increases, there exists a critical gap spacing at g = 2–2.25, where the mean drag coefficient, Strouhal number, root-mean-square values of the drag and lift coefficients reach either maxima or minima. Meanwhile, the shed vortices behind the detached flat plate are also affected. The observed results further indicate that there exists three different kinds of flow regimes: (i) extended-body flow regime ($0 \leq g \leq 1.53$); (ii) reattachment flow regime ($1.9 \leq g \leq 4$); and (iii) fully developed flow regime ($4.8 \leq g \leq 11$). The observed critical gap spacing and flow regimes are strongly dependent upon the gap spacings.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
September 2015, Volume 40, Issue 9, pp 2479-2486

Probabilistic Application in Seismic Vulnerability Assessment of Deficient Low- to Medium-Rise Reinforced Concrete Buildings in Pakistan

- Muhammad Usman Ali , Shaukat Ali Khan , Muhammad Yousaf Anwar , Hamza Farooq Gabriel

Abstract:

In many of the recent earthquake events, the collapse of low engineered or deficient reinforced concrete buildings is the major cause of wide spread disaster. After Kashmir earthquake (2005), the pre-earthquake construction and owner built construction is thought to be under immense risk. Thus, the vulnerability assessment of existing reinforced concrete buildings is strongly recommended to mitigate the associated seismic damage. Aim of this study is to develop vulnerability curves for low engineered structures typical to Pakistan. Two typical gravity load reinforced concrete frames with insufficient detailing are considered, and capacity-related (geometric and material) uncertainties are incorporated to account for the probabilistic nature of vulnerability. Framework developed by earlier studies is used for assessment which shows the buildings fail in a brittle manner due to brittle failure modes and underestimation of damage by GESI reports.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
September 2015, Volume 40, Issue 9, pp 2465-2477

Bill of Quantities with 3D Views Using Building Information Modeling

- Abid Nadeem , Andy K. D. Wong , Francis K. W. Wong

Abstract:

An approach for enhancing the production efficiency of bill of quantities (BQ) used on construction projects is presented. The approach was developed to integrate the quantities obtained from a building information model of the project into a suitably prepared electronic format of BQ with 3D views. In this format of BQ, the building information modeling (BIM) technology provides enhanced functionality to a contractor's quantity surveyor whose primary task is to accurately determine the quantities from the project drawings. A review of the traditional BQ preparation methods is presented to highlight their characteristics and to reflect on their benefits and barriers. Questionnaire surveys were conducted with various groups of respondents to obtain their opinions about the proposed BQ format. They included experienced quantity surveyors from the public and the private sectors, postgraduate, and undergraduate students studying in BIM-related courses. The results of the questionnaire survey showed mostly a positive view toward the proposed BQ format. Slight differences in the opinions of these three groups were also present. It is expected that the approach as presented in this paper for the development of BQ with 3D BIM views could usefully be incorporated into the standard quantity surveying practices for quantity takeoffs in various countries.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
September 2015, Volume 40, Issue 9, pp 2447-2455

Strength and Physico-chemical Characteristics of Fly Ash–Bottom Ash Mixture

- Nima Latifi , Aminaton Marto , Ahmad Safuan A. Rashid , Jacky Ling Jia Yii

Abstract:

The quantity of coal combustion products, particularly fly ash (FA) and bottom ash (BA), has been increasing from coal power plants around the world. The major problem of a coal combustion-based power plant is that it produces huge quantities of solid waste. Recently, there have been efforts to use FA and BA together as a mixture in construction works. This paper investigates morphology and chemical and strength characteristics of an FA–BA mixture for various curing periods. Scanning electron microscopy (SEM), X-ray fluorescence (XRF), and consolidated undrained triaxial tests were used to determine the physico-chemical characteristics of the mixture. Based on SEM results, it was found that, with an increasing ratio of BA to FA, the number of irregular particles in the mixture increased. The results of XRF indicated noticeable changes in the surface composition of both FA and BA particles after mixing. The physico-chemical test results indicate the formation of a new gel form product in the mixture, which has been identified as calcium silicate hydrate (C-S-H). From an engineering point of view, the results indicated that the value of modulus of elasticity decreases with increasing BA content, from 30 to 70 %, in the ash mixture. However, the increase in BA from 30 to 70 % did not have any significant effect on the shear strength of the FA–BA mixture.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
September 2015, Volume 40, Issue 9, pp 2457-2463

Bioremediation Modeling of an Aquifer Contaminated by Benzene Using the Slow-Release Oxygen Source Technique

- Xu Zengguang , Li Yanlong , Chai Junrui , Qin Ronggao , Yang Rong

Abstract:

Groundwater contamination caused by petroleum products has become a common problem. These hazardous chemicals themselves soak down into groundwater through the soil or rock and cause significant health risk. Benzene, one species of chemicals, gives rise to specific concerns due to its relatively high water solubility and toxicity. For the removal of benzene in aquifer, natural biodegradation has indicated its limited ability because of the lack of dissolved oxygen (DO) in groundwater. A new method, namely the slow-release oxygen source (SOS) technique, could increase concentration of dissolved oxygen in groundwater and accelerate biodegradation processes. Therefore, the paper first built a transport model including benzene, DO and microbial species. Relevant program codes were developed on the basis of MODFLOW/MT3DMS. Then, a two-dimensional synthetic aquifer with a point source of benzene was simulated by the modified model to analyze the treatment efficiency of SOS. There were seven schemes designed by using different locations of well and oxygen release rates. Their treatment efficiencies were analyzed. The results showed that the modified model can be used to simulate benzene transport under SOS technique where Monod kinetic reactions occur. It was more efficient when placing release oxygen well was close to contamination sources of groundwater. For the same location of well, higher release rate of oxygen would enhance the effect of bioremediation. Enough dissolved oxygen maybe accelerates the growth of microbial species, and more benzene could be consumed by increasing microbial mass.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
November 2015, Volume 40, Issue 11, pp 3075-3098

Effect of Embedment Depth on Response of Machine Foundation on Saturated Sand

- Mohammed Y. Fattah, Nahla M. Salim , Wourood T. Al-Shammary

Abstract:

In this paper, a dynamic analysis of strip machine foundation is carried out. The foundation of multiple thicknesses is placed at different depths above a saturated sand with different states (i.e., loose, medium and dense), and vertical harmonic excitation is applied with build up of the excess pore water pressure being considered. The dynamic analysis is performed numerically by using finite element software, PLAXIS 2D. The soil is assumed as elastic perfectly plastic material obeys Mohr–Coulomb yield criterion. A parametric study is carried out to evaluate the dependency of machine foundation on various parameters including the amplitude of the dynamic load, the frequency of the dynamic load and the embedment of foundation. It was concluded that increasing the embedment ratio causes a reduction in the dynamic response up to a certain embedment depth; when the depth of embedment increases higher than 1 m, the effect become less pronounced and as strength of the soil increases, the effect of embedment depth in reducing dynamic response will decrease also. The vertical displacements decrease obviously by 46, 37 and 40 % for loose, medium and dense sand, respectively, when increasing the embedment of foundation from 0.5 to 1 m, while when the embedment of foundation increases from 1 to 1.5 m, the vertical displacements for loose, medium and dense sand decrease by 45, 38 and 3 %, respectively. Finally, when the embedment of foundation increases from 1.5 to 2 m, the decrements in vertical displacements are also recorded for loose, medium and dense sand by 42, 36 and 18 %, respectively.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
November 2015, Volume 40, Issue 11, pp 3119-3134

A Laboratory-Based Research Study to Investigate the Aggregate Packing Characteristics and Its Influence on Asphaltic Mixture's Performance

- I. Hafeez , M. A. Kamal , M. A. Ishaq , N. Ahmad , S. Khanzada

Abstract:

Targeting the midline of aggregate gradation envelope alone does not guarantee packing of aggregates. Source and consensus properties of aggregates need to be considered while developing a gradation for asphalt mixtures. This paper presents a research study to improve the packing characteristic of an aggregate gradation using Bailey method. Experimental program composed of proposing criteria for limiting values of aggregate gradation with different sizes for a specific quarry. Second phase of the study targets two aggregate gradations at same nominal maximum particle size, one prepared with conventional method and other improved by using Bailey method. Asphalt mixtures were prepared using both the gradations. Performance tests were conducted on the asphalt mixtures to ascertain the rutting, permanent deformation, fatigue characteristics, and asphalt mixture compatibility. The study revealed that Bailey method can successfully be used for the preparation of different aggregate gradations by keeping the limiting criteria within the defined ratios. Also, mixtures prepared using a Bailey method performed better than a mixture with conventional gradation. Optimizing the aggregate gradation using bulk specific gravity and voids in coarse aggregate better control aggregate volumetric than targeting the midline of gradation envelop.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
November 2015, Volume 40, Issue 11, pp 3099-3105

Probabilistic Corrosion Initiation Time Assessment of Existing Concrete Structures Under Marine Environment

- Lingjie Wu , Xinjian Kou , Meng Jiang

Abstract:

Marine environment is one of the most aggressive exposure conditions for concrete structures. The paper presents a probabilistic evaluation of corrosion initiation time of 80-month-old concrete structures under tropical marine environment with optimization method and Monte Carlo simulations. Results indicate that concrete cover depth and diffusion coefficient obey normal distribution and lognormal distribution, respectively. With target probability of failure value of 10%, corrosion initiation time is about 40 years after completion of construction. Compared with Monte Carlo simulations, optimization algorithm is an efficient method applied to the problem of chloride diffusion taking into consideration the time-dependent property of chloride diffusion coefficient. Sensitivity analysis should consider the influence of distribution and coefficient of variation of random variables.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
November 2015, Volume 40, Issue 11, pp 3107-3117

A Damage Constitutive Model for Rock Mass with Nonpersistently Closed Joints Under Uniaxial Compression

- Hongyan Liu , Limin Zhang

Abstract:

As part of the rock mass, both the macroscopic flaws such as joints and the mesoscopic flaws such as microcracks affect the strength and the deformational behavior of rock mass. Existing models can either handle any one of them alone, and a model which can consider the co-effect of these two kinds of flaws on rock mass mechanical behavior is not yet available. This study focusses on rock mass with nonpersistently closed joints and establishes a new damage constitutive model for it. Firstly, the damage model for the intact rock which contains only the mesoscopic flaws is introduced. Second, the expression of the macroscopic damage variable (tensor) which can consider the joint geometrical and mechanical properties at the same time is obtained based on the energy principle and fracture theory. Third, the damage variable based on coupling the macroscopic and mesoscopic flaws is deduced based on Lemaitre strain equivalence hypothesis, and then the corresponding damage constitutive model for rock mass with nonpersistently closed joints under uniaxial compression is set up. Finally, the test data for the intact rock under uniaxial compression are adopted to validate the proposed model. A series of calculation examples verify that the proposed model is capable of presenting the effect of joint geometrical and mechanical properties on the rock mass mechanical behavior.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
November 2015, Volume 40, Issue 11, pp 3057-3066

Seismic Evaluation of Repaired and Retrofitted Circular Bridge Piers of Low-Strength Concrete

- Qaiser-Uz-Zaman Khan, M. Fiaz Tahir , Afaq Ahmad , M. Iqbal

Abstract:

An experimental investigation was carried out to study the effect of retrofitting on change in dynamic properties of 1/4 scaled damaged and undamaged bridge piers of low-strength concrete. Response of three bridge piers, subjected to cyclic lateral loads and free vibration tests under constant axial loading, was evaluated. One of the piers was tested twice: firstly, it was tested up to damaged state, and then it was repaired with single layer of carbon fiber-reinforced polymer (CFRP). This repaired column was then subjected to the same type of loading as the original one. Third pier was retrofitted in undamaged state with single layer of CFRP. It was observed that ductility of retrofitted column at 2% drift level was 39% higher than that of original column. However, ductility of repaired column was improved to original level. Cumulative energy dissipation capacity of retrofitted column was also improved up to 39.38%, whereas energy dissipation capacity of damaged retrofitted was recovered to original state. After subsequent cycles, improvement in energy dissipation capacity was 25.8 and 18% in retrofitted and repaired columns, respectively.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
November 2015, Volume 40, Issue 11, pp 3067-3074

Final Setting Time and Compressive Strength of Fly Ash and GGBS-Based Geopolymer Paste and Mortar

- G. Mallikarjuna Rao , T. D. Gunneswara Rao

Abstract:

Geopolymer binders are attracting the attention of researchers as substitution to cement binder in conventional concrete. In manufacturing 1 ton of cement, 1 ton of CO_2 is released into the atmosphere. Thus, replacement of cement by geopolymer material in construction industry reduces pollution by two ways: reduction in carbon dioxide emission into atmosphere by reducing the consumption of cement and utilization of fly ash, which is another waste product piling in huge quantities in thermal power plants. To examine the use of geopolymer as a replacement to cement, it is essential to investigate normal consistency, final setting time and compressive strength of geopolymer which are routine tests generally conducted for cement. The procedure adopted for determining the normal consistency, final setting time and compressive strength of geopolymer is same as the procedure adopted for cement. In these tests, cement is replaced by geopolymer material and water is replaced by alkaline activator solution. The parameters considered in this investigation are geopolymer source material (fly ash and GGBS) and alkaline activator consisting of sodium meta silicate and sodium hydroxide of different molarities (8, 12, 16 M). The ratio of sodium meta silicate to sodium hydroxide considered in this study is 2.5. The test results indicated that combination of fly ash and GGBS results in decreased final setting time and increased compressive strength. It was also observed that increase in sodium hydroxide increases compressive strength of geopolymer mortar.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
November 2015, Volume 40, Issue 11, pp 3047-3056

Effects of Dam–Foundation Contact Conditions on Seismic Performance of Concrete Gravity Dams

- Djamel Ouzandja, Boualem Tiliouine

Abstract:

This paper presents the effects of dam– foundation contact conditions on seismic performance of concrete gravity dams including base sliding. For illustrative purposes, the Oued Fodda concrete gravity Dam, located in Chlef (northwestern Algeria), is selected as an example and linear as well as nonlinear seismic analyses are performed. In addition, a parametric study based on the friction coefficient is carried out. The Druker–Prager and the multilinear kinematic hardening models are employed in the nonlinear analyses for concrete in the dam and rock in the foundation, respectively. The hydrodynamic pressure of the reservoir water is modeled as added mass using the Westergaard approach. The contact interface in dam–foundation interaction is modeled by contact elements which represent the friction contact. Surface-to-surface contact elements based on the Coulomb's friction law are used to describe the friction. These contact elements use a target surface and a contact surface to form a contact pair. Depending on the component effects of strong ground motion and maximum friction stress characterizing the dam–foundation contact conditions, sliding displacement may occur at the interface causing instability of the dam. The results show that the base sliding displacement depend on the value of friction coefficient at the interface zone. Besides, the sliding displacement decreases the principal stresses in the dam as well as the base shear stress.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
December 2015, Volume 40, Issue 12, pp 3459-3468

Calibration of PARAMICS Model: Application of Artificial Intelligence-Based Approach

- Nedal T. Ratrout , Syed M. Rahman , Imran Reza

Abstract:

The advent and significant improvement in computing technology in the last decades has led to immense popularity of traffic microscopic simulation models in addressing different transportation engineering issues. This paper focuses on the challenges of calibration of microscopic model incorporating the driving behavior for the local traffic conditions in the Kingdom of Saudi Arabia (KSA). One of the state-of-the-art microscopic simulation models, PARAMICS was used for the calibration study. This study proposes machine learning model-based calibration methodology for the PARAMICS model. The developed artificial neural network (ANN) model performs adequately in modeling the queue length as a function of mean target headway and mean reaction time. The selected values of the calibration parameters were finally obtained using the genetic algorithm, which ensures minimum difference with the measured values of queue lengths and the ANN output (i.e., queue lengths). The queue lengths obtained through the ANN- and GA-based approach were used as the input parameters for the PARAMICS model. The conformance of the PARAMICS and the ANN model outputs indicates the validity of the proposed calibration methodology.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
December 2015, Volume 40, Issue 12, pp 3429-3442

Dynamic Response Changes of Seismic Isolated Building Due to Material Degradation of HDRB

- Muna H. Gheryani, Hashim Abdul Razak , Mohammed Jameel

Abstract:

This study investigates the variations in the mechanical properties of high-damping rubber bearings HDRBs on the dynamic response of multi-story seismic base-isolated building subjected to bidirectional near-fault ground motions. Variations in the mechanical properties of HDRB due to temperature, aging and scragging recovery are considered. Nonlinear response analyses of a six-story base-isolated building subjected to seven pairs of bidirectional near-fault ground motions with pulse type were conducted using finite element software. The nonlinear force–deformation behavior of isolator is modeled using a bilinear hysteretic curve considering non-deteriorating and deteriorating properties. Results of analyses are compared in terms of bearing displacement, base shear, force–displacement loops, top floor absolute acceleration and story drift. It was observed that the seismic response of base-isolated multi-story building is significantly influenced by the variation in mechanical properties of rubber bearing seismic isolators.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
December 2015, Volume 40, Issue 12, pp 3417-3427

Experimental and Numerical Investigation on Thin-Walled Single and Starred Angle Sections Under Compression

- G. Beulah Gnana Ananthi, S. Vishuvardhan , G. M. Samuel Knight

Abstract:

This paper presents experimental and numerical investigations on the behaviour of thin-walled cold-formed steel single and starred angles with lips as stub and short columns, subjected to axial compression. A nonlinear finite element model was developed and verified against the ball- and bolted-end conditions. The specimens are modelled precisely for the numerical investigation using finite element analysis as done in the column tests carefully undercontrolled. Both geometric and material nonlinearities are included in the finite element model. The predicted column strengths by the numerical analysis are compared with the design column strengths calculated using the North American Standards for cold-formed steel structures. It is shown that the design column strengths calculated from the specification are generally conservative for cold-formed steel angle sections. Results from the FEA correlate well with experimental data, NAS-2007 and BS: 5950 (Part 5) predictions.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
December 2015, Volume 40, Issue 12, pp 3443-3455

On the FEM Analysis of Higher-Order Shear Deformable Beams: Validation of an Efficient Element

- Rahmat Kazemi Firouzjaei , Reza Attarnejad , Rohollah Abbasi Shanbehbazari , Fardad Aala

Abstract:

Since the accuracy of results obtained through displacement-based finite element method (FEM) considerably depends on the accuracy of shape functions used to interpolate the displacement field within an element, this paper aims at presenting a new efficient element for static and free vibration analysis of higher-order shear deformable beams using FEM with introducing basic displacement functions (BDFs). First, BDFs are introduced and computed. Afterward, new efficient shape functions are developed in terms of BDFs during the procedure based on the mechanical behavior of the element in which presented shape functions benefit generality and accuracy from stiffness and force method, respectively. Finally, deriving structural matrices of the beam with respect to new shape functions, static and free vibration behavior of the higher-order shear deformable beam is studied using FEM. The accuracy and economy of the method are demonstrated through several numerical examples.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
February 2016, Volume 41, Issue 2, pp 443–450

Properties of Low- and High-Strength Concrete Incorporating Clay-Contaminated Microfines

- Zhan-Ao Liu, Ming-Kai Zhou, Zhan-Ao Liu,

Abstract

For the purpose of systematically ascertaining the influence of clay-contaminated microfines (CCM) on concrete properties and feasibility of utilizing waste microfines in concrete, the effects of CCM on fresh and hardened properties of C30 and C60 concrete were investigated by means of incorporating 10 % of microfines containing variable clay contents in two series of constant-slump concretes. The results show that inclusion of CCM significantly increases the amount of water or water reducer required to achieve constant slump and drying shrinkage, and the increases are positively correlated with methylene blue value (MBV) of CCM. For constant-slump concrete of variable water contents (variable water-to-cement ratio), CCM significantly decrease compressive strength and chloride-ion permeability with increasing MBV; however, for constant-slump concrete of variable water reducer amounts (constant water-to-cement ratio), CCM have no adverse effect on compressive strength and chloride-ion permeability of C30 concrete but deteriorate that properties of C60 concrete only when MBV exceeds 10 g/kg. The extent of influence of CCM on properties of C60 concrete is greater than that of CCM on properties of C30 concrete. Qualified concrete with satisfactory mechanical property and durability could be successfully prepared with 10 % incorporation of CCM under the help of water reducer and MBV to be controlled within 10 g/kg, which confirms it is applicable to utilize these waste microfines in concrete production.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Technical Note - Civil Engineering
February 2016, Volume 41, Issue 2, pp 451–460

Load Deflection Characteristics of Sustainable Infilled Concrete Wall Panels

- S. Karthika, K. N. Lakshimikandhan, P. Sivakumar, G. Dhinakaran

Abstract

Development of sustainable concrete has now become a mandatory requirement today due to environmental problems posed by the production of conventional concrete. Many researchers focused their research toward finding alternate materials for cement, sand, steel, etc., and came out with good results. This paper focuses on feasibility of developing sustainable concrete using bamboo as infill, stiffener, and combination of infill and reinforcement in the wall panels. In addition, low-density polyethylene waste also tried as infill material with bamboo as diagonal member. The structural property of bamboo was studied for replacing the conventional steel by designing the wall panels with lower stiffness and weight to avoid the catastrophic effect. The strength and behavior of infill wall panels for different infill cases were studied under uniaxial in-plane loading. Parameters such as maximum load carrying capacity, load–deflection characteristics, and cost effectiveness of bamboo-based wall panel system were considered in the present study. From the experimental results, it was understood that bamboo-based wall panel behaved as a ductile member and failed after due to the formation of micro-cracks. Wall panel specimens were failed with an out-plan buckling and resisted the force such that the sudden collapse was avoided. It was concluded that an infill wall reduced lateral and vertical deflection, thereby decreasing the probability of collapse. Hence, an infill wall panel could be used as a substitute for conventional wall panel.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
February 2016, Volume 41, Issue 2, pp 401–424

Behavior of RC Shallow and Deep Beams with Openings Via the Strut-and-Tie Model Method and Nonlinear Finite Element

- Waleed E. El-Demerdash, Salah E. El-Metwally, Mohamed E. El-Zoughiby, Ahmed A. Ghaleb

Abstract

The strut-and-tie model (STM) has been widely applied for the design of reinforced concrete (RC), members particularly discontinuity regions. In this paper, on the basis of available experimental results of crack patterns, failure modes, and trajectories of internal stresses from elastic finite element analysis (FEA), STMs have been suggested for many shallow and deep beams with openings, which had been tested experimentally. In addition, for comparison purposes, 3-D nonlinear FEA using ANSYS-12 package has been performed for selected beams. Some of the important factors affecting the behavior of RC beams, namely concrete compressive and tensile strength, span-to-depth ratio, shear span-to-depth ratio, physical and mechanical properties of horizontal, vertical web reinforcement and main steel, loading position, opening dimensions, and location, are investigated via a parametric study with the aid of 3-D nonlinear FEA. With such analysis, results of crack pattern, deflection, failure mode, and strain and stress distributions, which cannot be determined using the STM, are obtained. A comparison of the FEA with test results and proposed STMs has been carried out. The present study reveals the reliability of the STM method in obtaining a reasonable lower bound estimate of the load carrying capacity of RC ordinary/deep beams with openings. In addition, the 3-D nonlinear FEA of simple and continuous NSC and HSC ordinary/deep beams with/without openings yields accurate predictions of both the ultimate load and the complete response.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
February 2016, Volume 41, Issue 2, pp 425–431

Cleaning Low-Noise Surfaces as a Basic Condition for Improving Pavement's Acoustic Absorption Capability

- Vitezslav Krivanek, Alena Pavkova, Marek Togel, Jiri Jedlicka, Rudolf Cholava

Abstract

Ongoing noise is a disturbing factor for humans and animals living close to roads, as traffic noise threatens residents' health and well-being. Surfaces with noise absorption as high as 3–6 dB (so-called low-noise surfaces, LNSs) are being developed in many countries. A disadvantage is that their noise absorption decreases through their service lives. Pores become clogged with dirt within 2–3 years, stripping the LNS of its functionality. In the experiment, the noise on two surface types were measured. The first was newly developed Viaphone ® ® LNS containing organic fibres (from paper production waste). The tested surface was on a single carriageway in a residential area and on a multiple-lane carriageway in Prague. The sound pressure level (L_{cpx}) was measured at five testing sections in Prague before and after cleaning with pressurized water. The second road surface was porous asphalt (PA 8) containing crumb rubber (waste from worn tyre treads) and was tested in the town of Skuteč. One lane of the tested section was heavily soiled by agriculture machinery exiting a field during beet harvest. There, the sound pressure levels of the clean and soiled lanes were compared. Changes in surface noise were measured using the close proximity method (according to ISO 11819-2). Cleaning the Viaphone ® ® surface increased its acoustic absorption capability by 0.8–1.0 dB(A) and for very soiled surfaces by up to 1.3 dB(A). Soiling of the PA 8 surface may have decreased noise absorption by as much as 0.9 dB(A). To maintain their noise absorption functions, LNS surfaces must be cleaned periodically.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering F
February 2016, Volume 41, Issue 2, pp 381–391

Soft-Story Effects on the Behavior of Fixed-Base and LRB Base-Isolated Reinforced Concrete Buildings

- Mehmet A. Komur, Mehmet A. Komur

Abstract

In Turkey, the entry stories of reinforced concrete (RC) structures are usually used for commercial purposes because they are slightly higher than other stories. Therefore, these RC structures sometimes exhibit what is called soft-story behavior. The best examples of this behavior are observed in the severe damage or collapse of RC structures with soft stories during the 1999 Marmara and Düzce earthquakes. To prevent this type of damage, seismic isolation systems can be used in the construction of new structures. This study focuses on the soft-story behavior of RC structures with fixed-base and lead core rubber bearing (LRB) systems under different seismic loads. The superstructure is modeled using the Turkish Seismic Regulation (TEC 2007). Because there is no detailed information concerning LRB isolators in the Turkish Seismic Regulations, the Uniform Building Code (UBC 97) is used to model the substructure system under consideration. In this study, four different structural models are designed to study the effect of the soft-story behavior. The dynamic analysis of the time domain on these frame systems is conducted using Ruaumoko software, and the influences of soft-story behavior in fixed-base and LRB base-isolated systems are investigated. The period of the frame system, story accelerations, inter-story drift ratio, base shear forces, and distribution of plastic hinges and their damage conditions are evaluated.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
February 2016, Volume 41, Issue 2, pp 393–400

Investigation on Soil–Geopolymer with Slag, Fly Ash and Their Blending

- Binod Singhi, Aminul Islam Laskar, M. Ali Ahmed

Abstract

Ground granulated blast furnace slag (GGBS)-based geopolymer is an excellent binder that attains high strength by curing at room temperature. Fly ash-based geopolymer binder, on the other hand, attains high strength when heated in particular temperature range. Although literatures on GGBS- and fly ash-based geopolymer are plenty, reported literatures on soil–geopolymer system are limited. An attempt has therefore been made in the present paper to investigate soil–geopolymer incorporating slag, fly ash and blending of slag and fly ash as source materials. It was observed that unconfined compressive strength of soil–geopolymer system increases with the source material content. Molar concentration of alkali activator, alkali-to-source material ratio and percent content of source material altogether affect the unconfined compressive strength of stabilized soil that is not straightforward. Na/Al and Si/Al ratios of the geopolymer mix ultimately govern the strength of stabilized soil. It was also observed that slag content is the most dominating factor affecting unconfined compressive strength rather than Na/Al ratio in case blending of GGBS and fly ash.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
February 2016, Volume 41, Issue 2, pp 433–441

Effect of Adhesive Type on the Measurement of Modulus of Elasticity Using Electrical Resistance Strain Gauges

- Eren Komurlu, Ferdi Cihangir, Ayhan Kesimal, Serhat Demir

Abstract

This study aims to point out the importance of adhesive type on strain measurement and examine the accuracy of the modulus of elasticity determination using the electrical resistance strain gauges glued on solid materials, i.e., rock and concrete. For this purpose, the effect of adhesive type on the strain gauge applications and measurements was investigated as there is no standard adhesive type for such uses in standards. Four different adhesives were used in experiments, three of which (cyanoacrylate, polyester and epoxy-based adhesive) can be widely seen in the literature. Ordinary Portland cement paste was prepared to obtain homogeneous material for sensitive measurements and comparisons. Additionally, rock core samples were tested in this study. Experimental results indicated that strain gauges used with same adhesive gave consistent deformation values for the same type of rock and paste specimens. However, remarkable deformation measurement differences up to 110 % were obtained for same paste and rock specimens when different adhesives were used. Numerical analysis via finite element method was also carried out to examine the type of adhesive and interlayer thickness. Up to 51 % strain loss obtained through the numerical models for the adhesive interlayer also pointed out that adhesive type must be taken into account in experimental studies since there is no adhesive guide for users in standards. According to the obtained results from experimental and numerical analyses, cyanoacrylate suggested the most accurate results among the adhesives owing to the thin and homogenous adhesive interlayer between the strain gauge and specimens.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Review Article - Civil Engineering
April 2016, Volume 41, Issue 4, pp 1183–1198

Fiber–Matrix Interactions in Fiber-Reinforced Concrete: A Review

- Yassir M. Abbas, M. Iqbal Khan

Abstract

A significant breakthrough in concrete technology was achieved using fibers to reinforce concrete. Various researchers have reported that fiber reinforcement can alter the brittleness of concrete. The efficiency of fiber reinforcement is based on the fiber–matrix interactions. The understanding of these interactions is a challenging engineering problem, where the frictional bond governs and the physical/chemical bond plays a minor role. This problem is extremely sophisticated because of the following nonlinear interactions: interfacial debonding, plastic material deformations, mechanical bond deformations, and frictional sliding. This paper reports a comprehensive and up-to-date literature review on the fiber–matrix interactions, and physical and theoretical modeling of the fiber–matrix interactions is reported in detail. In addition, the most important conclusions of the parametric studies of the fiber–matrix interfacial bond are summarized. The information of the pullout test standardization to assess the fiber–matrix behavior of a fiber-reinforced concrete is reviewed. The current research in the area of fiber–matrix interactions of fiber-reinforced concrete are discussed.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
April 2016, Volume 41, Issue 4, pp 1199–1213

Comparison of Local Scour Characteristics around Two Eccentric Piers of Different Shapes

- Subhasish Das, Rajib Das, Asis Mazumdar

Abstract

Local scour at single pier has been extensively studied by several investigators, but scanty work is available on scour around piers placed in close proximity. The present research is concerned with experimental studies of the formation and characteristics of local equilibrium scour around a set of two identical circular-, square-, and triangular-shaped piers placed in longitudinal direction to the flow with a constant eccentricity (transverse distance). The objective is to see the nature of scour evolved due to the effect of mutual interference of one pier on another with the longitudinal spacing between them varying 0.25, 0.375, 0.5, 0.625, and 0.75 times the scour-affected lengths for a single-pier test. Analysis of the results shows the variations of individual non-dimensional equilibrium scour parameters with the effective pier width (diameter of the smallest circumscribing circle of the pier) and increasing longitudinal spacing between the piers.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
April 2016, Volume 41, Issue 4, pp 1215–1224

Effects of Stepped Spillway Geometry on Flow Pattern and Energy Dissipation

- Mahmoud Mohammad Rezapour Tabari, Shiva Tavakoli

Abstract

In order to pass surplus water and inundation from upstream to downstream of dams, structure called spillway is used. Spillway and chutes are among important hydraulic structures which play a significant role in stability of dams. In some cases and when the slope is too steep to build a chute, in order to transfer water from upstream to downstream, a stepped spillway which is remarkably effective in energy dissipation is used. In the present study, in order to ascertain the effect of different parameters such as number of steps (N_s), step height (h), step length (L), and discharge in width unit (q) on energy dissipation in the simple stepped spillway, the model of Flow-3D was used, and the relationship between energy dissipation and flow critical depth in the stepped spillway was investigated. Further, the method of finite volume was used to solve the extant equations, and the model of $K-\varepsilon$ was also used to investigate the flow turbulence. The results revealed that as the flow discharge increases, energy dissipation decreases and as the number of steps increases and their height decreases, energy dissipation decreases. Besides, the obtained findings were compared with the other researchers, empirical and mathematical studies and finally an acceptable coincidence was obtained.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
April 2016, Volume 41, Issue 4, pp 1225–1232

Probability of Failure of Corroding Reinforced Concrete Columns under Eccentric Loading

- Mohammed A. Al-Osta, Abul Kalam Azad

Abstract

The load-carrying capacity of an eccentrically loaded reinforced concrete column affected by corrosion of reinforcement will progressively decrease with time due to the buildup of corrosion-induced damage in the form of loss of reinforcement area, cracking and spalling of concrete cover. Due to the complexity of corrosion problems, a probability-based assessment of failure, instead of a deterministic approach to ascertain safety, is prudently more appealing. An attempt has been made to propose a method for computing probability of failure of corroded eccentrically loaded columns using Monte Carlo simulation (MCS) of a proposed limit state safety function based on a time-dependent strength prediction model for the residual strength. The MCS covers a large number of possible combinations of all governing parameters related to strength within their prescribed distributional characteristics. The results show that MCS can be used to estimate probabilities of failure, and that the corrosion current density and the ratio of eccentricity of the applied axial load to the depth of the section, e/h, are the two significant factors that affect the probability of failure at a prescribed corrosion period the most.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
April 2016, Volume 41, Issue 4, pp 1233–1240

Assessment of Model Consistency for Determination of Soil–Water Characteristic Curves

- Siti Jahara Matlan, Mohd Raihan Taha

Abstract

Characterization of the engineering behavior of unsaturated soil is dependent on the soil–water characteristic curve (SWCC), a graphical representation of the relationship between water content or degree of saturation and soil suction. A reasonable description of the SWCC is thus important for the accurate prediction of unsaturated soil parameters. The measurement procedure for determining the SWCC, however, is difficult, expensive, and time-consuming. During the past few decades, researchers have laid a major focus on developing empirical equations for predicting the SWCC, with a large number of empirical models suggested. One of the most crucial questions is how precisely existing equations can represent the SWCC. As different models have different ranges of capability, it is essential to evaluate the precision of the SWCC models used for each particular soil type for better SWCC estimation. It is expected that better estimation of SWCC would be achieved via a thorough statistical consistency analysis of its applicability within a particular soil class. This paper evaluates the consistency and applicability of using four different SWCC equations for defining the relationship between water content and soil suction. Optimization techniques were used to obtain the best fit of the model parameters for three main soil classes: coarse-textured (i.e., sand), medium-textured (i.e., silt), and fine-textured (i.e., clay) soils. The four SWCC models were evaluated and computed for each sample. The results show that the Brooks and Corey model and modified Gardner model was the most consistent in describing the SWCC for sand soils and clay soils, respectively. Both model predictions also exhibit compatibility with samples ranging from low to high soil water content.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
April 2016, Volume 41, Issue 4, pp 1241–1249

On the Torsional–Translational Response of Wind Turbine Structures

- Triantafyllos K. Makarios, Evangelos Efthymiou

Abstract

In the present paper, the torsional–translational response of a prototype wind turbine tower considered as an irregular structure is studied. As a matter of fact, a plethora of wind turbine towers has collapsed during the last decades due to torsional dynamic actions. An effective numerical model of the prototype irregular wind turbine tower is herein developed which has been verified by the application of the continuous model method considering both a fully fixed and a partially fixed foundation. As known, the higher eigenmodes of the tower strongly affect the structural response and may become critical in the case that the tower is subjected to strong dynamic loading, as is, e.g., wind loading, when simultaneously excited by a strong seismic motion. In order to estimate the role of the fundamental torsional modes of the above-mentioned structure in its overall structural response, three pairs of appropriately selected artificial seismic accelerograms having response acceleration spectra (for equivalent viscous damping ratio 0.03) equivalent to the Eurocode elastic acceleration spectra are used and then, applying a type of backwards analysis, an equivalent dynamic or static torsion loading is defined.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
April 2016, Volume 41, Issue 4, pp 1251–1261

Effect of Nanoclay on Thermomechanical Properties of Epoxy/Glass Fibre Composites

- T. D. Ngo, Q. T. Nguyen, T. P. Nguyen

Abstract

This study investigates the effects of nanoclay on the mechanical properties and fire performance of epoxy/ glass fibre composites. The cone calorimeter test in a horizontal configuration is used as the bench-scale test to determine the heat and smoke production from samples with nanoclay contents ranging from 1 to 5 wt%. All the samples are produced by a vacuum infusion process. Pristine nanoclay is treated with an organic surfactant before adding it to the mixture in the designed procedure. The results show that a low percentage of less than 3 wt% nanoclay produces a scattered nanoparticle dispersion and, therefore, is insufficient for char formation. The combustion of the organic surfactant in nanoclay and the polymeric resin also outperform the effect of nanoclay at this level. At 5 wt% nanoclay replacement, a delay of 7 s in heat release rate, 45 % lower peak of heat release rate, 15 % lower total heat release, and 15 % lower smoke production rate are observed. Scanning electron microscopy (SEM) images of the samples with varied organophilic clay concentration taken before and after the cone tests are presented to reveal the distribution of clay nanoparticles in the composite samples. The mechanical properties such as ultimate strength, Young's modulus of the nanoclay-enhanced composite are acquired from standard tensile test to determine the influences of clay content.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
April 2016, Volume 41, Issue 4, pp 1263–1271

Compressive strength, Bending and Fracture Characteristics of High Calcium Fly Ash Geopolymer Mortar Containing Portland Cement Cured at Ambient Temperature

- Tanakorn Phoo-ngernkham, Vanchai Sata, Sakonwan Hanjitsuwan

Abstract

This article presented the compressive strength, modulus of rupture and fracture characteristics of high calcium fly ash (FA) geopolymer mortars containing Portland cement type I (PC) with different sodium hydroxide (NaOH) concentrations (6, 10 and 14 molars). PC was added at the dosages of 0, 5, 10 and 15 % by weight of solid powder binder. Sodium silicate (Na_2SiO_3) and NaOH solutions were used as the alkali activators. Na_2SiO_3 to NaOH ratio of 2.0, alkaline liquid to binder ratio of 0.60, sand to binder ratio of 1.00 and curing at ambient temperature were used for all mixtures. Test results indicated that the use of PC as additive enhanced compressive strength, modulus of rupture and fracture characteristics of high calcium fly ash geopolymer mortar and NaOH concentrations also had significant affect on these properties. The use of 10 % PC with 14M NaOH resulted in high calcium FA geopolymer mortar with improved modulus of rupture and fracture characteristics.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
April 2016, Volume 41, Issue 4, pp 1273–1281

Ultrasonic Surface Wave Monitoring for Steel Fibre-Reinforced Concrete Using Gel-Coupled Piezoceramic Sensors: A Case Study

- Nadom Khalifa Mutlib, Shahrizan Baharom

Abstract

This paper reports on the result of a case study that used gel-coupled piezoceramic (GCP) sensors to identify cracks in steel fibre-reinforced concrete (SFRC) beams. Surface waves were used in a pitch–catch method to conduct the monitoring process. Experiments were conducted to monitor cracks in SFRC beams and evaluate the performance of the GCP sensors throughout the loading period. The raw data were analysed according to the relative energy of the wave, damage index (DI), and discrete wavelet transform (DWT) decomposition. The relative energy results were sensitive to the material type. Results revealed that the DI and DWT decomposition approach successfully identified and located the first visible cracks that occurred in the SFRC beams. The validity of the adopted GCP sensor was successfully demonstrated.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
April 2016, Volume 41, Issue 4, pp 1283–1290

Effect of Mixing Time on Flowability and Slump Retention of Self-Compacting Paste System Incorporating Various Secondary Raw Materials

- Ali Raza Khalid, Syed Ali Rizwan

Abstract

Good workability at construction site is most important aspect of self-compacting concrete. But long delivery times can cause slump loss, which is more pronounced when mineral additives are incorporated into the concrete system. The aim of this paper is to study the effects of prolonged mixing on the flowability and slump retention under action of a high-performance polycarboxylic (PEC)-based superplasticizer used in self-compacting paste systems (SCPs) incorporating various secondary raw materials (SRMs). Experimentation for this research paper was focused on mixing times and slump retention of SCPs incorporating ASTM Class F fly ash (FA), silica fume (SF) and locally available marble powder (MP). While experimenting with SCPs, total mixing time was first restricted to 3 min of mixing to achieve the target flow of 30±1 cm, which was then prolonged to total mixing time of 10 and 20 min keeping the superplasticizer content constant, which showed a more enhanced flow with reduced timing due to better activation of superplasticizer, or enhanced workability but showed some traces of bleeding in the formulations containing MP. The samples were thereafter prepared for strength measurement as per EN-196. Parameters like flow response, strength and microstructures were studied by varying two basic factors in progression: shear time and hold time. Hydration kinetics were also affected by prolonged mixing, and it also decreased the initial and final setting time. FA showed better rheological behaviour upon extended mixing regimes as compared to SF or any other SRMs.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
April 2016, Volume 41, Issue 4, pp 1291–1310

Seismic Vulnerability of RC Shear Wall Building with a Dome Roof in Moderate Seismic Region of Saudi Arabia

- M. Ajmal, M. K. Rahman, M. H. Baluch

Abstract

Recent seismic events in low-to-moderate seismicity regions of Saudi Arabia have led to concerns on the vulnerability of RC buildings constructed in Saudi Arabia up to mid-1990's. These buildings were designed for gravity loads only, and potential for damage during seismic event is high. Buildings with dome at the roof level are an architectural feature in many buildings. Monolithic dome at the roof of the structure stiffens the upper part of structure requiring special consideration in seismic design. This paper presents the assessment of seismic vulnerability, using nonlinear static pushover analysis, of an eight-story building with shear walls and a large dome at the roof level, under a moderate intensity earthquake. The building is located in western region of Saudi Arabia, which is Region 3 as per Saudi Building Code. Pushover analysis is carried out using the software SAP2000 incorporating inelastic material behavior for concrete and steel, for a typical 2D frame in the building with a shear wall. The shear wall is modeled using the shell element and mid-pier approaches. A 3D pushover analysis of the building is also carried out with mid-pier model for shear walls. The presence of heavy mass at the roof results in yielding of hinges in the roof-level columns supporting the dome. The beams connected to the shear wall and the shear walls of the building are deficient under seismic load. Strengthening of beams, columns at the roof level under the dome and shear walls is warranted to meet the seismic demand.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

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Scour Formation Due to Laterally Inclined Circular Pier

- Mohammad Vaghefi, Masoud Ghodsian

Abstract

The purpose of this paper was to study the local scour formation due to an inclined circular bridge pier. The experiments for two cases of inclined and vertical piers under clear-water condition with four different flow conditions have been performed. The experiments were conducted in the hydraulic laboratory of Tarbiat Modares University in a rectangular channel. Also, for better interpretation of the observed changes, the longitudinal component values of the velocity in a vertical plain with definite distance located downstream of the vertical and inclined piers were recorded using a velocimeter. The results show that although the scour hole shape and its ridge is changed with the inclination angle of pier, the maximum scour depth in a laterally inclined pier is almost equal to that of a vertical pier and the location of the maximum scour depth in vertical pier has transferred from the 0° area to the approximately 30° area in inclined pier state.

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Research Article - Civil Engineering
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Prediction of Compaction Characteristics of Fine-Grained Soils Using Consistency Limits

- K. Farooq, U. Khalid, H. Mujtaba

Abstract

Evaluation of laboratory compaction parameters, i.e., maximum dry unit weight (γ dmax) (γdmax) and optimum moisture content (OMC) of a soil, is an essential task in controlling field compaction for all earthworks construction. Laboratory determination of compaction parameters requires considerable time and effort which can be saved through the use of empirical correlations during early stages of a project. In this paper, correlations between consistency limits, compactive effort (CE) and compaction parameters, i.e., γ dmax γdmax and OMC, for fine-grained soils have been proposed. In order to develop the correlations, 105 soil samples of fine-grained soils representing various classification groups were collected from different areas of Punjab province of Pakistan. Besides classification tests, standard and modified proctor compaction tests were performed on the selected samples. Based on the classification test results, the selected samples are classified as CH, CL, CL-ML, ML with gravel fraction in the range of 0–12 %, sand fraction from 2 to 48 % and silt clay fraction from 50 to 95 %. The laboratory standard and modified compaction tests on the selected samples indicate the γ dmax γdmax in the range of 15.8–19.7 kN/m^3 with OMC varying from 9 to 19.5 %. Multiple regression analyses were performed on the experimental data, and correlations have been proposed to predict the compaction parameters (γ dmax γdmax and OMC) in terms of LL, PI and CE. In order to validate the proposed equations, an independent data set of 37 samples was used for the validation purpose. The comparative results showed that the variation between experimental and predicted values of γ dmax γdmax is within ±2.5 % and that of the OMC (%) is within ±9.5 % at 95 % confidence interval. Based on the correlations developed, predictive curves corresponding to standard and modified proctor energy are proposed for quick estimation of γ dmax γdmax and OMC based on LL and PI without performing the laboratory compaction tests.

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Research Article - Civil Engineering
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A Geospatial Approach for the Development of Hazardous Building Zonation Mapping

- Sruthi Krishnan Vijayakrishnan, Venkata Ravibabu Mandla

Abstract

Building collapse incidents have become quite common in different parts of the world. Even though several reasons and causes have been identified for these incidents, their impact on the environment has not reduced. If proper maintenance and repair works are carried out in time, the risks may be minimized. In this study, a geospatial approach has been developed to identify the hazardous buildings with basic structural properties for municipal areas. Various thematic layers are generated on GIS platform, such as types of building, material of construction, structural defects, age of the building, and number of floors from both satellite imagery and field visit using GPS. Methodology adopted was weighted overlay approach through multi-criteria decision analysis (MCDA). Four models were developed to identify hazardous building zonation (HBZ) using expert opinions from various civil engineers. The results have been validated by conducting field tests using nondestructive testing, i.e, rebound hammer test and ultrasonic pulse velocity (UPV) test on various hazardous buildings. Hence, using geospatial tools (remote sensing, GIS, and GPS), local government and decision makers such as civil engineers and planners can identify the risk involved buildings in an area, so that suitable measures can be adopted to reduce the probable chance of failure or any damage to those buildings.

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Research Article - Civil Engineering
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Laboratory Study on Shear Strength Behaviour of Reinforced Sandy Soil: Effect of Glass-Fibre Content and Other Parameters

- Ismail Benessalah, Ahmed Arab

Abstract

The areas near Chlef Valley (Algeria) and the Constructions built on show many phenomena during the last earthquake (El Asnam 1980). A significant decrease in shear strength of Chlef sandy soil, especially in the presence of water, has been reported in numerous researches. Several methods and techniques of soil stability and capacity are available. However, including geosynthetic material, the use of fibres as reinforcement showed some efficiency due to friction between the synthetic material and the soil particles, which increases the bonding between the grains. In this paper, the influence of the glass-fibres content for medium and high densities on the shear strength behaviour of Chlef sandy soil was studied, highlighting the percentage of fibre content (0.1, 0.3 and 0.5 % as a fibre volumetric content), and this will be investigated by a series of direct shear tests. The results will be compared with those of unreinforced sand. Before this work, a further set of direct shear tests will be performed to study the effect of water content on shear strength behaviour (water content of 0, 1.5, 2.3 and 3 %). The experimental results show that the mechanical characteristics are improved with the addition of glass-fibres, especially for wet specimens. It has been showed also that 0.3 % of fibre content is a critical value for fibre contribution to improve the mechanical characteristics. The addition of fibres not only improves the shear strength of soil, but also provides diversity in the resistance against the deformations imposed load, which can be established by a decrease in the soil dilatancy observed by a minimization of the vertical displacement. For the dry case, the reinforcement with fibre has a negative effect on the residual strength especially for average dense samples which may explain probably by the low specific weight of geosynthetics materials.

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Research Article - Civil Engineering
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Response of Seismically Detailed Beam Column Joints Repaired with CFRP Under Cyclic Loading

- M. Fiaz Tahir

Abstract

Present investigation consists in casting and testing six seismically detailed beam column reinforced concrete joints. All specimens were subjected to quasi-static monotonic loading. These damaged specimens were refurbished with two different configurations of carbon fiber-reinforced polymer laminates. Repaired specimens were again subjected to quasi-static monotonic loading. Results of investigation revealed that ultimate strength of configurations 1 and 2 was increased by 8.6, 6.7 % and ultimate deflection was increased by 54.6, 51.2 %, respectively. However, ductility factor, stiffness and ductility of repaired specimens were decreased by 24.8, 25.6; 60.6, 51.7; 49, 48 %, respectively.

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Research Article - Civil Engineering
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Reliability Evaluation of Dynamic Characteristics of Clean Sand Soils Based on Soft Computing Methods

- Seyfettin U. Umu, Mehmet I. Onur, Volkan Okur

Abstract

This study was conducted to estimate the dynamic characteristics of clean sand under low strains using fuzzy expert systems and neural network approximations. A series of resonant column tests were conducted on clean sand specimens to create a large database. The effects of various factors, such as effective pressure, saturation, void ratio and shear strain levels, were simulated using fuzzy expert systems and neural networks. The neuro-fuzzy inference method was employed to predict the initial shear modulus of clean sand samples as a substitute for time-consuming laboratory testing. Additionally, the maximum shear modulus results were compared with the existing empirical relationships. From these observations, it can be observed that certain relationships significantly underestimate the initial shear modulus. Simple empirical relationships to estimate the initial shear modulus were formulated. It is concluded that neuro-fuzzy-based models provide useful guidelines for the preliminary estimation of the dynamic shear modulus for clean sand soils.

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Floodplain Mapping Using HEC-RAS and ArcGIS: A Case Study of Kabul River

- Muhammad Shahzad Khattak, Faizan Anwar, Tariq Usman Saeed

Abstract

This paper describes the application of HEC-RAS model to the development of floodplain maps for the part of Kabul river that lies in Pakistan. The intent is to assist policy makers and planners in the development of flood mitigation measures for the Khyber Pakhtunkhwa Province, which experienced unprecedented floods in July/August 2010 exposing the vulnerability of the province to this natural catastrophe. Owing to its reasonable accuracy and free availability, shuttle radar topography mission digital elevation model was chosen for the extraction of geometrical data for the river. Conventional flood frequency analysis, involving log-normal, Gumbel's, and log-Pearson type III (LP3) distributions, was used to calculate extreme flows with different return periods. Using Kolmogorov–Smirnov (KS) test, LP3 was found to be the best distribution for the Kabul River. The peak floods from frequency analysis were input into HEC-RAS model to find the corresponding flood levels expected along river reaches extending through Warsak dam to Attock. Results obtained with HEC-RAS model were used in combination with ArcGIS to prepare floodplain maps for different return periods. Through floodplain maps, areas that are vulnerable to flooding hazards have been identified. Analysis of floodplain maps indicated that more than 400 % area is likely to be inundated as compared to the normal flow of the river. Most of the area found to be vulnerable to flooding is currently used for agriculture. Comparison of simulation of 2010 flood with the image of the flood taken by MODIS clearly shows a close agreement between the two.

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A Comparative Study of Meshtype Retrofitting for Unreinforced Masonry Under In-plane Loading

- Navaratnarajah Sathiparan, N. A. A. C. Nissanka, R. L. S. Priyankara

Abstract

Seismic loads directed toward vulnerable masonry structures may cause considerable damage and loss of life. As a result, there is now a desire to increase the seismic resistance of many types of existing masonry structures. Different conventional retrofitting techniques are available to increase the strength and/or ductility of unreinforced masonry walls. Recent years, several researches work on meshtype retrofitting for masonry structures to delay or prevent the collapse of buildings and reduce the number of lives lost during devastating earthquake events. The meshtype retrofitting can be made of any ductile material, including: steel cage, polymer, polypropylene band and plastic carrier bag. In this campaign, six brick masonry wall panels were tested. This was done by applying static horizontal loads on top, combined with a pre-compression level, to obtain information about the failure mode, displacement capacity and strength capacity.

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Research Article - Civil Engineering
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A Comparative Study of Popular Concrete Mix Design Methods from Qualitative and Cost-Effective Point of View for Extreme Environment

- Mohd. Ahmed, Saiful Islam

Abstract

The various methods, developed for concrete mix design, are not universal because design mixes are specific to regional climate, local materials, and exposure. The new-generation mix design method should be developed based on the performance criteria. The concrete strength obtained from the designed concrete mix and minimum cement content should not be considered the only parameter for suitability of concrete mix for harsh environment region. The durability and quality parameters in a cost-effective way should be included into the mix design methods for extreme climate. The strength and relative proportion of ingredient should be given consideration for the concrete coherent mix. This paper presents the basic principles and comparative study of some popular concrete mix design methods namely fineness modulus method, ACI mix design method, and DOE method from qualitative and cost-effective point of view. It is clear from the study that the mix design methods need some adjustment in their basic design parameters for quality and cost-effectiveness. The durability indicators, in terms of denseness indicator, i.e., mix density and fine aggregate-to-total aggregate ratio, quality indicator, i.e., total aggregate-to-cement and fine aggregate-to-cement ratio, and other cementing material/mineral admixtures in addition to minimum cement content are suggested for severe environment. It is anticipated that with detailed experimental investigation on various suggested design factors focusing more on local challenges, present study will pave the way for the development of performance-based extreme environment design mix principles.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

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The Influence of Steam Curing on Early-Age Compressive Strength of Pozzolanic Mortars

- Şemsi Yazıcı, Hasan Şahan Arel

Abstract

This study investigates the effect of steam curing on the early strength of mortars that include mineral admixtures. Instead of CEM I 42.5 R cement, 0, 10, 20 and 30 % of fly ash or 0, 5, 10 and 15 % of silica fume was used in the mortars. In the composition of the mortars, the fine aggregate/binder/water ratios were determined as, respectively, 3/1/0.5 by mass. 40/40/160-mm prismatic specimens were cast and divided into two groups. The first group of specimens was cured in water at 20 ∘ C 20∘C for 1, 2, 3 and 28 days. The second groups of specimens were exposed to 24-, 48- and 72-h curing at procedure temperatures of 35, 50, 65, 80 and 100 ∘ C 100∘C . Following the curing, compressive strength of mortar specimens was determined. In this study, the accelerating curing temperature and time for the early strength of the mortars containing fly ash/silica fume were tried to determine according to compressive strength test results.

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Multi-objective Linear Programming for Optimal Water Allocation Based on Satisfaction and Economic Criterion

- Ijaz Ahmad, Deshan Tang

Abstract

In this study, a simple deterministic water allocation model was developed to optimally allocate limited available water resources among different water-use sectors. The model considers two single-objective functions and one multi-objective function. The first single objective (B_0W_1) optimizes the satisfaction levels among various water demand sectors, whereas the second single objective (B_1W_0) maximizes net economic benefits. The multi-objective (B_1W_1) combines the first two single objectives. For the multiobjective function, the model considers two optimization techniques, a simultaneous compromise constraint technique and a weighting technique to optimize both the satisfaction level and economic benefits. The model is applied to the Hingol River basin in the Baluchistan Province of Pakistan. To evaluate the model's applicability under different situations, different schemes are applied to consider variations in the minimum satisfaction level and to assign priorities to various water-use sectors. The results indicate that the value of economic benefits obtained by B_1W_1 lies between B_0W_1 and B_1W_0. This is a compromise between the two individual objectives. The model is easy to adopt under different conditions, because of its simplicity and flexibility.

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Research Article - Civil Engineering
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A RSM-Based Multi-Response Optimization Application for Determining Optimal Mix Proportions of Standard Ready-Mixed Concrete

- Barış Şimşek, Yusuf Tansel İç

Abstract

In this study, design of experiment methodology was applied to the optimization of mixing the proportions of standard ready-mixed concrete (SC). The mixture proportion modeled by using response surface methodology (RSM) was determined as the function of variables such as aggregate mixture ratio, water-to-cement ratio and the percentage of super plasticizer content. The results show that water-to-cementitious material ratio causing the highest variation in responses is the most important factor, and aggregate mixture ratio is designated as the second most important factor. The results show also that the responses of convection heat transfer coefficient and the percent of air content are significantly affected by the synergistic effect of linear term of water-to-cement ratio and the antagonistic effect of quadratic term of water-to-cement ratio. Early comprehensive strength is significantly affected by the synergistic effect of linear term of ratio of water to cement materials and the synergistic effect of linear terms of aggregate mixture rate. Finally, three variables formulated using regression analyses were simultaneously optimized by utilizing RSM-based desirability function method.

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An Efficient Method for Dynamic Analysis of Spatial Trusses Using Legendre Wavelets

- Seyed Hossein Mahdavi, Hashim Abdul Razak

Abstract

This paper introduces a procedure where the free-scaled Legendre wavelets are improved for dynamic analysis of spatial trusses. The operational matrices of integration for free scales of Legendre wavelets are presented and applied for time history analysis. For this aim, a clear-cut formulation is derived from decomposition of the only transitional responses of structures. The free-scaled operational matrices of Legendre wavelets accurately transfer the second-ordered differential equations of motion into the corresponding algebraic equations. Accordingly, a simple procedure is developed to compute dynamic responses of large-scaled spatial trusses. The applicability and effectiveness of the proposed procedure using Legendre wavelets are demonstrated with two numerical applications. Subsequently, results were compared with those from common time integration schemes such as Wilson-θ, Newmark-β, central difference and Duhamel integration methods. It is deduced that because of the inherent shape functions of Legendre wavelets the dynamic analysis is optimally achieved with the highest accuracy, best computational competency and with the lowest storage capacity.

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Research Article - Civil Engineering
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Rising Groundwater Levels Problem in Urban Areas: A Case Study from the Central Area of Madinah City, Saudi Arabia

- Mustafa Bob, Norhan Rahman

Abstract

In this research, the hydrogeological conditions in the central area of Madinah city, Saudi Arabia, were investigated in an attempt to gain insight into the shallow groundwater table rise problem that has recently been observed in this important location. Four wells were drilled in the study area, and soil samples were collected during the drilling process for lithological characterization. Water level in each well was recorded, and water samples were collected from the wells and analyzed for all important water quality parameters including temperature, pH, turbidity, electrical conductivity, dissolved oxygen, total dissolved solids, biochemical oxygen demand, bacteriological parameters (total coliform, fecal coliform, *E. coli*), major anions and cations, heavy metals, BTEX compounds and organophosphorus pesticides. In addition, geophysical loggings were conducted on two of the wells and a pumping test was conducted on one of the wells. Results revealed that the hydrogeological features in the study area consist of a top impervious layer, followed by a productive confined aquifer that extends over basement complex bedrock. Water quality analyses showed that the groundwater in the study area is not contaminated by leakage from different sources, indicating that these sources are not major contributors to SWTR. Most likely, the partial blockage of groundwater flow by large infrastructure in the study area is responsible for the SWTR. Results obtained from this research provide useful information regarding the hydrogeology of an important area and can aid authorities in preparing well-founded scientific plans to deal with SWTR problem including the appropriate reuse of excess water.

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Research Article - Civil Engineering
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Effects of Aggregate Shapes and Other Factors on ASR-Induced Anisotropic Expansions in Concrete

- Hong-gang Jia, Yu-feng Nie

Abstract

The coupled effects of aggregate shapes and contents, maximum aggregate sizes, and applied mechanical loads on alkali–silica reaction (ASR)-induced expansions in concrete were studied using finite element method and extended finite element method. Most of the previous research works mostly focused on single effects; however, multiple coupled factors such as aggregate shapes, maximum aggregate sizes, and aggregate fractions have often been neglected. In this paper, the innovation point lays in the precise quantification of these coupled effects on ASR-induced anisotropic expansions, especially the effects of aggregate shapes on ASR-induced expansions in concrete.

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Research Article - Civil Engineering
April 2016, Volume 41, Issue 4, pp 1483–1493

A Combined Model for Regional Eco-environmental Quality Evaluation Based on Particle Swarm Optimization–Radial Basis Function Network

- Jiayang Wang, Peizheng Song

Abstract

The eco-environmental quality assessment is a complexity of fuzzy system with multiple indicators and classes, and there are still some limits of radial basis function network evaluation method, so radial basis function network and particle swarm optimization algorithm are combined to establish an improved radial basis function network comprehensive evaluation method for eco-environmental quality assessment. Main limits of radial basis function network are how to choose parameter in the model, so in this method, through optimizing the parameters of the radial basis function by particle swarm optimization algorithm, a neural network model of regional ecological environment is generated to enhance the performance. Additionally, a visualization system of the ecological quality assessment is developed using ArcGIS software, which can be used to display and evaluate the ecological quality of eco-environmental quality. The eco-environmental quality assessment in Sichuan Province of China is taken as an example, and the results show that radial basis function network optimized by PSO is superior to the traditional model, GIS can inquire and display the message and evaluation results, and the hybrid method provides a new approach for the protection and scientific management of ecological quality and worth to be recommended.

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Numerical Modeling of Flow Over Two Side Weirs

- Mohammad Reza Namaee, Reyhane Shadpoorian

Abstract

Nowadays, due to the significant development of hydraulic models, it is possible to investigate miscellaneous hydraulic phenomena and reveal the extent to which their changes in a particular parameter will affect the flow condition without the need of extra experiments. In the present study, flow patterns over a side weir were studied both experimentally and numerically. The experiments were done for a side weir with the length of 4m. However, in the numerical model, the 4m weir was replaced with two side weirs with the length of 2m which were placed within two meters distance from each other. The primary contributions of the paper are to show that a numerical model can be used to simulate the flow over both single and double side weirs, and to quantify the increased discharge from two side weirs relative to discharge from a single side weir having the same crest length as the two side weirs.

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Research Article - Civil Engineering
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Hydroelectric Energy Potential of Turkey: A Refined Calculation Method

- Sadık Alashan, Zekai Şen

Abstract

Turkey is one of the countries with high hydroelectric energy potential, but today only 35 % of this potential is functional. This is due to its geographic position at subtropical climate region with upstream of Euphrates–Tigris Basin. In general, classical calculation methodologies are used for hydropower potential assessments. This paper explains the hydroelectric energy policy and potential of Turkey and suggests a more refined calculation method on the basis of hypsographic curve. Furthermore, currently used hydropower potential calculation formulations are revised in detail, and a new calculation method referred to as the energy tree (ET) is explained and applied to actual data from upper Euphrates River main branch, the Murat River. Comparison of the numerical results in terms of relative error indicates that ET yields about 0.4 % improvement over the DP and about 6.5 % over the SP methods. This means that ET method yields better refined results than the existing methodologies.

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Research Article - Civil Engineering
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Physical and Rheological Characteristics of Polymer Modified Bitumen with Nanosilica Particles

- Dhawo Ibrahim Alhamali, Jiantao Wu

Abstract

This study was conducted to investigate the performance characteristics of polymer modified bitumens (PMB) mixed with nanosilica (NS). PMB, PG 76 and NS were mixed with concentration of binder weight at 0, 2, 4 and 6 %. During the course of the mixing process, the binders were kept at 163 °C and blended using a shear rate of 3000rpm for 1 h. As a result, microstructure examination, effects of NS on storage stability, and physical and rheological properties were investigated. Besides that, requirement tests such as penetration, softening point, ductility, viscosity and rheological analysis, such as isochronal plot, master curves, black diagram and SHRP parameters, are also conducted. SEM result revealed that NS particles disperse well in the bituminous binder matrix and the addition of NS into PMB will enhance the viscosity and ductility. The study result also revealed that nanosilica-modified bitumen binder storage capability is dependent on NS content. Based on the dynamic shear rheometer test, the addition of NS also increased the complex modulus G^* at a lower frequencies and/or high temperatures compared to PMB binder, thus increasing the rut factor, causing higher rutting resistance. In contrast, at high frequencies and/or intermediate temperatures, G^* decreases leading to improved fatigue behaviour at temperatures lower than 40 °C. Overall, the findings from this study can be concluded that the addition of 6 % of nanosilica is the optimum content to improve the performance characteristics of polymer modified bitumen.

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Research Article - Civil Engineering
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Energy Equilibrium During Crushing of Sandy Soils Under Isotropic Compression

- Hamed Farshbaf Aghajani, Hossein Salehzadeh

Abstract

The crushing of sand particles under high stress leads to decrease the shear resistance of the soil. Previously, some theoretical procedures were presented for the quantitative investigation of crushing in sand during shear loading, based on the work equilibrium. However, these equations cannot be applied to crushing in sand under pure isotropic compression due to the absence of a frictional term in the work equation. This paper proposes a theoretical procedure for volumetric strain and consequent work equilibrium in an element subjected to isotropic compression. In this procedure, participant of the rearrangement and crushing in sample volumetric strain is separated, and then, the corresponding work of each contribution is determined. Moreover, isotropic compression tests are conducted on two sands from Hormuz Island and Bushehr Port in the Persian Gulf. The test results showed that the compressibility of both sands increased as density decreased. In addition, the study found that Bushehr sand was more susceptible to compressibility and crushing than Hormuz sand. Moreover, the validity of the new theoretical equation of energy equilibrium was verified by applying it to the experimental data. According to the verification results, the theoretical equation is properly conformed to the experimental data and the analogous parameters were close, with an error of up to 30%. In addition, surface energy parameter in isotropic compression was obtained at a higher magnitude relative to shear loading, which implied that the loading type affected the crushing of sand grains.

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Research Article - Civil Engineering
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OWC-Type Wave Chamber Optimization Under Series of Regular Waves

- Farrokh Mahnamfar, Abdüsselam Altunkaynak

Abstract

Oceans cover more than 70 % of the Earth's surface, and water waves are considered as unlimited sources of renewable energy. The use of fossil fuels may cause undesired challenges such as global warming and climate change in the nature. Advantages of renewable energy include low operational cost, environment friendliness, simple maintenance procedures, and non-polluting nature. In this study, an oscillating water column (OWC) system close to the onshore was investigated in water level for wave parameters which consist of different wave heights and wave periods. Efficient energy transformation is achieved by using air turbines. In this study, 20 experimental sets were carried out by a piston-type wave maker. The experimental results showed that the chamber geometry of the OWC, water depth, and wave parameters are most important factors in terms of achieving maximum wave power for energy harvesting.

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New Software (Multi-flowCAD) Development for Sub-Main Line Hydraulic Design: Computational Algorithm, Computer Visualization and Implementation

- Gürol Yıldırım, Ömer Köse

Abstract

Hydraulic design of multiple outlets sub-mains in a distribution network system, often referred to as manifolds, laterals or gated pipes, which are extensively used in practice, has been a major problem tackled by many authors. The increasing progress in computer technology has led to the development of the improved solutions of analytical and numerical methods. This paper aims to present the new software simulation model based on the stepwise computation algorithm with software application. This model is based on discrete nonuniform outflow distribution approach for evaluating different forms of pressure head-discharge distributions along the sub-main line. In the procedure, the required hydraulic flow characteristics along the energy-grade line, the velocity head change and variation of the Reynolds number, which affects the selection of the proper friction coefficient formula to be applied along the different reaches of the pipeline, are sensitively determined. Based on certain hydraulic parameters and uniformity criteria, an improved user-friendly computer program in *Visual Basic 6.0* language named "Multi-flowCAD" was developed for hydraulic analysis and design of multiple outlets sub-main lines. The present computer-aided computing technique was successfully implemented with the highest accuracy for different forms of pressure head profiles covering various design configurations regarding different flow regimes and uniform line slope situations with respect to alternative computing techniques. In professional practice, the present improved software simulation model is the most suitable, because only the basic equations of the hydraulics of steady-state pipe flow condition were sensitively used in each pipe section between successive outlets. The present model can be efficiently used for hydraulic analysis and design of various types of multiple outlets pipelines in sub-main distribution networks, for all performed simulations.

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Effects of Activator Properties and Ferrochrome Slag Aggregates on the Properties of alkali-activated Blast Furnace Slag Mortars

- Caner Elibol, Ozkan Sengul

Abstract

An innovative way of utilizing ground granulated blast furnace slag is to activate it using alkaline materials. The main objective of this study was to investigate the effects of activator type and curing conditions on the compressive strength and electrical resistivity of alkali-activated ground granulated blast furnace slag mortars. To obtain mortars consisting of waste materials was also an objective of the study. Ferrochrome slag was used as aggregate in some mixtures to investigate the effect of this waste material when used as an aggregate. As a result, both the binder and the aggregates were waste materials in some of the mixtures prepared. Test results indicated that for the standard water curing at 20 ∘ C 20∘C , the compressive strength of the alkali-activated mortars was lower compared to that of the Portland cement, although these strengths may be considered enough for low and moderate strength applications. Higher strengths were obtained with the use of hot water curing. The test results demonstrated that the alkali-activated blast furnace slag containing waste ferrochrome slag as aggregate may achieve strength properties comparable or even higher than the ones produced with ordinary Portland cement and natural aggregates. Electrical resistivities of these alkali-activated mixtures were also significantly higher compared to that of the reference mixture.

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Properties of Heavyweight Concrete for Structural and Radiation Shielding Purposes

- Süleyman Özen, Cengiz Şengül

Abstract

In applications of concrete for shielding against hazardous radiation or for being used as counterweight, as well as in various other applications that involve the use of heavyweight concrete, the most significant method of mix design involves the use of heavyweight aggregates. Concrete mixes that were produced for this work contained iron ore, steel mill scale, two types of barite, and steel slag, which are the heavyweight aggregates available in Turkey. An additional heavyweight concrete mixture was also produced using magnetite as a natural mineral heavyweight aggregate. In all concrete mixes produced, water/cement ratio, cement content, and the maximum aggregate size of the aggregates used were kept constant. In terms of the main mechanical properties, the best performances were obtained when iron ore was used, while the highest fracture energy values were reached in concretes with steel mill scale, magnetite, or with the combination of steel slag, iron ore, and crushed sand. Another important objective of this research was to evaluate the radiation shielding properties of heavyweight concretes containing iron ore, steel mill scale, two types of barite, or steel slag as aggregates. The experimental results showed that the attenuation coefficient varied from 0.224 to 0.265 1/cm, while the unit weight of heavyweight concrete was increased from 3012 to 3820 kg/m^3. On the other hand, there is reasonably good agreement between theoretical and experimental results of linear attenuation coefficients. It can be concluded that the dominant factor in the determination of attenuation coefficient is the unit weight of heavyweight concrete and that the value of the coefficient is independent of the type of heavyweight aggregate used.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
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A Study with a New Device on Compression Properties of Fine-Grained Reconstituted Soils

- H. Yildirim, A. Çelebi

Abstract

For the purpose of examining the settlement behavior of fine-grained soils, a sufficient number of one- and three-dimensional consolidation tests on ten different reconstituted soils were performed in the study. A three-dimensional consolidation test apparatus, which is considered to be a modified form of standard oedometer test apparatus and permits lateral strains to occur, was designed. The consolidation tests were carried out both with standard oedometer and with the new test device so that the effect of different displacement conditions on the test results could be compared. Oedometer tests, by using both the conventional one-dimensional and the new test apparatus, were also carried out with the purpose of understanding the effect of test apparatus on the results. According to the plasticity indexes of the samples, it was found that three-dimensional settlements were greater than one-dimensional settlements at the vertical pressures of 200–300 kPa and higher. The slopes of three-dimensional settlements' curves were found to be steeper than those determined from standard oedometer curves at the pressures of over 150–200 kPa. When comparing the calculated compression moduli for each group of test results, it was found that the three-dimensional moduli values were 50–75 % of the one-dimensional moduli values. On all of the three-dimensional test results, performed, while the central part was being loaded incrementally, small settlements on the surrounding part were observed. During the removal of the applied loads from the central part, the small settlements reached on the surrounding part approximately remained constant.

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Research Article - Civil Engineering
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New Model for Determining Local Scour Depth Around Piers

- Seied Hosein Afzali

Abstract

Since a lot of factors play role in the creation of scouring phenomenon, the exact determination of scouring is considered to be difficult in practice. Consequently, the determination of scouring depth is still conducted mostly based on the empirical relationships though it has been investigated for several decades using numerous methods. Currently, the major estimation of bridge scour calculation has been conducted utilizing the existing software on river engineering based on the available empirical equations. In this study, a new model is proposed using modified honey bee mating optimization algorithm to estimate the scour depth of the piers using various reliable field data. The performance of the proposed model was found more effective comparing with five other conventional and practical present models, which have been widely used in predicting the scour depth of bridge piers.

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Research Article - Civil Engineering
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The Effect of Concrete Strengths Obtained from 2011 Van Earthquake on the Structural Performance of RC Buildings

- Seda Coşkan, Murat Emre Kartal, Turhan Bilir

Abstract

Earthquakes cause a high risk in reinforced concrete (RC) structures with respect to life and property loss. As a result of the earthquake occurred on October 23, 2011, and November 9, 2011, in Van, a large-scale loss of life and property has been observed. A lot of constructive problems were determined after the examinations of demolished or damaged buildings. One of the most important reasons of damage is that concrete strength is much lower than the expected one. The main purpose of this study is to examine the effect of the concrete strength of the demolished or damaged RC buildings on the performance of buildings. For this purpose, various concrete strengths have been selected among the reports which were prepared after the earthquake. In this manner, structural performances of three story buildings with three bays which have various concrete strengths are compared. The damage-limitation limit states are re-calculated with cross-sectional analysis program. Then, static pushover analysis is performed and thereby modal capacity curve is obtained and the target displacement is calculated. In addition to this, damages occurred in the cross sections are examined. National and international specifications such as ATC 40 and TEC-2007 are used in the numerical analyzes and evaluations. According to the obtained numerical results, the concrete strength has significant effects on the behavior of the RC load-bearing system.

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Research Article - Civil Engineering
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Building Construction Information System Using GIS

- Mostafa Abdel-Bary Ebrahim, Ibrahim Mosly

Abstract

The stages of building construction vary with respect to activities and procedures. Execution schedules and two-dimensional (2D) drawings are commonly used to identify hazards in construction. Geographic information systems (GISs) can provide stakeholders, construction engineers and contractors with the required data during building construction. Planners can visualise 2D drawings and three-dimensional (3D) models using a GIS model that logically links their components with the activities in the schedule to establish the construction sequence. This study suggests the use of a GIS in building information modelling to construct a building construction information system by integrating 2D drawings and 3D models with the activities database in the GIS model. GIS modelling can be used to generate and update schedules, databases and geospatial analyses within a single platform, which is a major requirement in the construction industry. Combining a GIS model in construction with its surrounding topography by linking 2D drawings and databases of activities or components of a building can produce a safe execution sequence. If a hazardous situation is identified during the analytical review process, it can be prevented within the GIS platform prior to the actual implementation. If defects are identified during and after construction, the cause of the defects and suitable mitigation can be determined. The methodology is tested using a real-life project in Riyadh in the Kingdom of Saudi Arabia. The results conclude that GIS modelling can be employed to establish an information system for all stages of building construction and to create an archived system for efficient project documentation.

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Research Article - Civil Engineering
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Axial Behaviour of CFRP-Strengthened Circular Steel Hollow Sections

- A. Punitha Kumar, R. Senthil

Abstract

The recent arrival of carbon fibre-reinforced polymer (CFRP) into the construction industry has attracted structural engineers and architects. CFRP is generally applied for concrete structures to increase the strength. Recently, this technology is extended to strengthen the steel structures. This paper presents the behaviour of CFRP-strengthened steel circular hollow sections (CHSs) under axial static loading and axial cyclic loading. It also investigates the axial strength variation of CHS in two different orientations (one and two layers of longitudinal and transverse) of CFRP and three different slenderness ratios (30, 35 and 40). The failure modes, load–deformation and load–strain behaviour of CFRP-strengthened CHSs are also presented in this paper. From the experimental results, it was found that the axial capacity of CFRP-strengthened CHS was enhanced up to 39% in case of static loading and 41% in case of cyclic loading compared with the unstrengthened specimen. Test results clearly demonstrate that the application of CFRP on steel hollow section increases the axial capacity, ductility and stiffness relative to the unstrengthened specimen.

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Research Article - Civil Engineering
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Non-conservative Instability of Shear Flexible Steel Columns Considering Inelastic Effect

- Nam-Il Kim, Jaehong Lee

Abstract

The aim of this paper was to investigate the non-conservative instability behavior of the shear flexible steel columns considering the inelastic effect. The tangent modulus and the effective length factor are newly evaluated using the iterative approach based on the AISC-LRFD and CRC strength curves. The equation of motion of shear flexible inelastic column is derived from the extended Hamilton's principle. The finite element procedure using the Hermite cubic interpolation functions taking into account the shear effect is employed to obtain the mass, inelastic stiffness, geometric stiffness, and load correction matrices. The evaluation procedure for the critical values of divergence and flutter loads are briefly described, and the obtained results are compared with available results through numerical examples. In particular, the effects of various structural parameters such as the material inelasticity, the shear deformation, the rotary inertia, the effective length factor, and the non-conservativeness factor on the non-conservative instability behavior of steel columns are parametrically investigated.

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Research Article - Civil Engineering
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Behaviour of Partially Closed Stiffened Cold-Formed Steel Compression Member

- P. Manikandan, N. Arun

Abstract

Usually, thin-walled open column sections have an intrinsic weakness in their low torsional strength, which is unpleasant for resistance of an open section. The distortion behaviour of cold-formed steel open section has a significant role in structural steel design. Hence, initiativeness is made for converting partially closed section by adding simple spacer plates connected with self-tapping screws. The intend of this work is tested to estimate the competence of this solution by comparing the strength and performance of partially closed and open stiffened complex channel section under axial compression. The buckling characteristics of the section are computed using the linear elastic buckling analysis program CUFSM. The resistance and behaviour of the intermediate columns are examined in detail using finite element analysis software ANSYS. A good conformity between finite element analysis and experiments is found. The nominal design capacities are evaluated using the necessities of the direct strength method, North American iron and steel specification and Indian standard and are compared with those from test and finite element analysis. After this verification of the numerical model, a crucial parametric study is carried out to inspect the effect of vitiations on thickness, depth, spacing and slenderness of spacer plates. The particulars of this study and results are offered in this research article.

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Research Article - Civil Engineering
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Application of Solar Photocatalysis and Solar Photo-Fenton Processes for the Removal of Some Critical Charged Pollutants: Mineralization Trends and Formation of Reaction Intermediates

- M. S. Vohra, M. S. Al-Suwaiyan, M. H. Essa, M. M. I. Chowdhury

Abstract

The present study investigated the efficiency of the titanium dioxide (TiO_2)-assisted solar photocatalytic degradation (SPCD) process and the solar photo-Fenton degradation (SPFD) process for the removal of some critical charged aqueous-phase pollutants under solar radiation conditions in Dhahran. The findings revealed that phenol and its reaction intermediate compounds can be successfully removed via the SPCD process at acidic pH values via a one sun-type re-circulating plug flow-type reactor. A similar trend was noted for the solar photo-Fenton process, which also indicated high phenol degradation at pH of 4 and 6; however, at pH 10, the overall total organic carbon removal was low because of increased Fe-species precipitation and reduced ·OH radical formation. The SPCD process showed greater ammonia removal efficiency than the SPFD process. Based on the successful application of the SPCD process, we further investigated the degradation of other critical charged cationic and anionic pollutants using the SPCD process. Tetramethylammonium (TMA) SPCD-based degradation resulted in near-complete TMA degradation within a reaction time of 4 h. Furthermore, the intermediates produced by TMA solar-energized degradation showed a stepwise de-methylation of TMA into trimethylammonium, dimethylammonium, and methylammonium, followed by mineralization to NH + 4 /NH 3 NH_4^+/NH_3 and NO − 3 NO_3^- . In general, the results of the present work confirmed successful application of the SPCD process for the removal of several important pollutants.

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Research Article - Civil Engineering
October 2016, Volume 41, Issue 10, pp 3889–3896

Measured Settlement of Highways Improved by Lightweight Backfilling Without Road Closure

- Yue-dong Wu, Chui-chang Zeng, Jian Liu

Abstract

Excessive post-construction settlement is often found for highways built on soft soil, slowing driving speed and increasing the risk of traffic accidents. Increasing attention has been paid to lightweight backfill to reduce ground settlement because of its light density, reasonable cost, and ease of construction. However, the existing technology for lightweight backfilling requires road closure, resulting in serious traffic jams and considerable economic losses. In this paper, a new technology is proposed for lightweight backfilling without road closure. A field trial was conducted to verify the practicality of the newly proposed technology. Ground settlements during and after construction were measured in the field trial with lightweight backfilling and in the adjacent zone without lightweight backfilling. The measured results were compared, discussed, and explained. It was found that the ground settlement was significantly mitigated by lightweight backfilling. The total settlement of ground surface was reduced by 36 %, and the average settlement rate was reduced by 40 % with a decreasing trend. It is suggested that the proposed technology with lightweight backfilling could solve the post-construction settlement problem well without road closure in busy highway.

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Research Article - Civil Engineering
October 2016, Volume 41, Issue 10, pp 3897–3909

A Comparative Study in Utilizing the Shell and Solid Elements Formulation for Local Corrosion Simulation at Bearing Stiffener

- Nauman Khurram, Eiichi Sasaki, Usman Akmal

Abstract

Field inspections and surveys highlighted that the environmental exposure conditions induce the irregular and non-uniform corrosion damages on steel plate girder ends. These irregular damage configurations play a vital role in computing the load carrying capacity and buckling pattern. In this study, two simulation techniques, i.e., shell elements and shell–solid coupling elements, were formulated to validate the experimental results and to assess the ultimate load carrying capacity using a powerful finite element (FE)-based software. The geometric and structural imperfections were also incorporated in FE analysis to achieve the accurate results. The numerical study was extended by considering the various damage heights on bearing stiffener up to 100mm. The study revealed that for a very small local corrosion at bearing stiffener, the damage shape and configuration is very important to grasp the actual buckling mode and the ultimate bearing capacity of plate girder.

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Research Article - Civil Engineering
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Nonlinear Finite Element Modeling of Composite Bridge Girders Strengthened with HM-CFRP Laminates

- Muharrem Aktas, Yusuf Sumer

Abstract

Steel composite beams with reinforced concrete deck which are generally used in bridges can be strengthened by high modulus of carbon fiber-reinforced polymer materials due to cross-sectional losses and increased traffic loads. Experimental studies on strengthened beams composed of concrete, epoxy and fiber-reinforced materials are not economical with respect to time and cost. Parametric studies over experimentally verified numerical models can be a solution for research studies when time and cost are at concern. Numerical modeling of four different materials to behave in composite manner as one structural element can be achieved by employing nonlinear finite element modeling techniques. This paper discusses the steps of creating a nonlinear finite element model with explicit dynamic methods to achieve the bending behavior of composite steel beams strengthened by high modulus of carbon fiber-reinforced polymers. The finite element model is verified with the results of three real tests conducted by the authors.

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Research Article - Civil Engineering
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Integrated Disposal Scheme of Heavy Fuel Oil Flyash in Saudi Arabia

- Muhammad H. Al-Malack, Alaadin A. Bukhari, Hassan H. Al-Muhanna

Abstract

Heavy fuel oil is used in power production and water desalination plants, which results in producing large amounts of flyash that needs to be utilized or at least managed properly. If disposed in landfills, heavy fuel oil flyash (HFOF) may have detrimental effects on surrounding environments, particularly, ground and surface waters. Therefore, HFOF must be subjected to leaching tests prior to its disposal in landfills in order to design landfills in proper engineered manners. In the current research, HFOF samples produced by plants firing heavy crude oil were subjected to heavy metals leaching tests in order to investigate its potential environmental hazards. Water extraction, toxicity characteristics leaching procedure (TCLP) and leaching sand columns were used to investigate the leaching of heavy metals from the collected flyash samples. Results of water extraction indicated that concentrations of metals such as chromium, nickel and vanadium, in the extract, were in the range of 1.89–30.5, 55.9–2113 and 270–6260mg/l, respectively. Moreover, results of the TCLP showed that cadmium, chromium, nickel, and vanadium exceeded the regulated concentration. Nickel and vanadium were found to be more than 45 and 700 times, respectively, higher than the regulated concentrations. The leaching sand-column investigation clearly indicated that there are major concerns with the leachate of chromium, nickel and vanadium. Based on the results, an integrated disposal scheme of HFOF was proposed in order to minimize negative effects on surrounding environments.

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Research Article - Civil Engineering
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Performance Evaluation of Hose-Reel Sprinkler Irrigation System

- Sarfraz Hashim, Sajid Mahmood, Muhammad Afzal

Abstract

In Pakistan, surface irrigation methods are commonly used to grow crops to meet the demand of ever-increasing population. The practicing methods of agricultural water applications usually result in excessive losses of water due to non-uniformity, over irrigation etc. To combat such a situation, present-day application methods need to be replaced by efficient ones. Sprinkler is one of methods of irrigation water applications that can bring in more efficiency. However, the sprinkler too needs to be suitably designed and managed under different site-specific conditions. The performance evaluation of a system is the primary need to determine the suitability of a system under a specific crop-growing environment. In order to meet the primary requirement, a hose-reel system was selected and evaluated under this study. In addition to its technical performance parameters, the adoptability by small farmers, ease and simplicity in operation and maintenance etc. were also studied. Application and distribution uniformity were the main parameters, which were determined by adopting standard methods of evaluation. Thus, the major variable was the operating pressures under which the system was operated and results were compiled. Application efficiency and distribution uniformity of hose-reel sprinkler system were found to be varied from 71 to 76% and 66 to 74% with the respective base pressure range of 0.38–0.46MPa, respectively. This sprinkling system has higher efficiency than the traditional flood irrigation methods by saving water more than 30%. It is easy to move and operate, is cost effective, and is suitable for all soil types and small land holdings.

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Research Article - Civil Engineering
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Potential of Fuzzy-ELECTRE MCDM in Evaluation of Cyanobacterial Toxins Removal Methods

- Animesh Debnath, Mrinmoy Majumder, Manish Pal

Abstract

Cyanobacteria blooms and toxins released from cyanobacteria, called cyanotoxins, have become a serious environmental issue because of their potential toxicity toward human health. Several conventional and advanced water treatment methods are available for degradation of cyanotoxins from surface water, but a cost-effective and efficient water treatment technique can greatly reduce the processing time and improve the quality of treated water. Selection of an optimum treatment technique for cyanotoxins degradation is a multi-criteria decision-making problem owing to the involvement of several conflicting criteria and constraints. In this paper, an integrated Fuzzy-ELECTRE model was proposed and its potential toward evaluation of different cyanotoxins removal techniques has been explored to select the most suitable technology. In this integrated model, criteria importance weights were determined by Fuzzy process, while the ranking of alternatives was performed using ELECTRE process. The result obtained from the model shows that ‘advanced oxidation by titanium dioxide (TiO 2) (TiO2) ’ is the most suitable technology among all considered technology for the removal of cyanotoxins. The developed methodological approach was also used to rank the available treatment techniques within the main group of conventional and advanced oxidation methods (AOMs). The results clearly depict that ozonation and photocatalysis by TiO 2 TiO2 are the best methods within the group of conventional and AOMs, respectively. The ability of the proposed model for providing complete and clear ranking of all considered alternatives confirms its potential for evaluation of cyanotoxins removal methods.

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Research Article - Civil Engineering
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Structural Reliability of Reinforced Concrete Beams/Columns Under Simultaneous Static Loads and Steel Reinforcement Corrosion

- Amir Tarighat, Behnam Zehtab

Abstract

Corrosion of steel bars in concrete is a major problem reducing concrete structure lifetime that must be considered in the design of structures. Many parameters involved in corrosion propagation contain different uncertainties; therefore, probabilistic analysis should be performed. In this paper, we proposed a reliability analysis method for RC frames subjected to simultaneous corrosion and static loads. It consists of the analysis of an arbitrary 2D frame at each time step to take into account the steel bars mass loss due to corrosion. We calculated instantaneous load-bearing capacity of elements. Analysis outputs would be extracted, and the probability of failure and reliability index could be calculated in each time step. Moreover, we conducted the sensitivity analysis for some parameters. It is shown that various parameters such as cover thickness, dimensions, strength of materials and reinforcements how could improve vulnerability of concrete structure subjected to corrosion. We obtained outputs based on various corrosion models proposed by different researchers. Obtained results were compared with one another, and they have good agreement with experimental results in the literature. Proposed method shows that corrosion process could decrease strength of structural elements significantly.

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Research Article - Civil Engineering
October 2016, Volume 41, Issue 10, pp 3959–3967

The Use of Genetic Programming and Regression Analysis for Modeling the Modulus of Elasticity of NSC and HSC

- Mustafa Sarıdemir, Metin Hakan Severcan

Abstract

Artificial intelligence has recently drawn the attention of explorers to predict the physical, chemical and mechanical properties of normal-strength concrete (NSC) and high-strength concrete (HSC). This study presents gene expression programming (GEP) and regression analysis (RA) for modeling the modulus of elasticity (E c) (Ec) from the compressive strength (f c) (fc) values of NSC and HSC. In order to create the models, experimental results of NSC and HSC are collected from the published literature. The evaluated results by training, testing and checking of the GEP and RA models are compared with the results obtained from the experimental studies, the formulations presented by some national building codes and the formulations proposed by some authors available in the literature. These comparisons and statistic results show that GEP and RA models are very effective methods for calculating the E c Ec from f c fc of NSC and HSC.

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Research Article - Civil Engineering
October 2016, Volume 41, Issue 10, pp 3969–3981

Complementary Effect of Heat Treatment and Steel Fibers on Mechanical and Microstructural Properties of High-Performance Concrete

- Maan S. Hassan, Zeyad M. Al-azawi, Muntadher J. Taher

Abstract

Concrete heat treatment is commonly used to speed up early gaining rate in mechanical strengths. However, adding some other ingredients can help to improve this desired effect. The aim of this study was to investigate the value-added use of steel fibers in combination with heat curing on some mechanical and microstructural properties (compressive strength, modulus of elasticity, modulus of rupture, splitting tensile strength, direct tensile strength, X-ray diffraction and fracture surface observations) of high-performance concretes. Two categories of high-performance concretes were assessed: fibrous and non-fibrous. Four volume fractions of steel fibers were used: 0, 0.5, 1 and 2%. Replacements of silica fume into the concrete were 0 and 15% by weight of cement, and the reference slump was 170 ± ± 8mm. All concretes were subjected to heat curing and evaluated versus standard cured. The complementary effect of both steel fibers and heat curing succeeds to participate toward improvement of early mechanical properties particularly tensile strengths, increase C–S–H content and develop bonding of the cementitious matrix to steel fibers. This could be attributed to disperse ability of steel fiber scattering heating effects more uniformly throughout concrete section. Among diverse steel fibers content used, 2% provided better dispersions effect.

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Research Article - Civil Engineering
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Performance Analysis of Direct Coal Liquefaction Residue (DCLR) and Trinidad Lake Asphalt (TLA) for the Purpose of Modifying Traditional Asphalt

- Jie Ji, Hui Yao, Xu Yang

Abstract

The properties of asphalt blended with the direct coal liquefaction residue (DCLR) and Trinidad Lake asphalt (TLA) materials were analyzed and compared in order to study the feasibility of using DCLR to replace TLA for asphalt modification. In this study, four DCLR and TLA contents (5, 10, 15, and 20 %) were mixed with the SK-90 base asphalt. The high- and low-temperature performances of the DCLR and TLA modified asphalt were evaluated by the Superpave TM TM and penetration grade systems. The chemical compositions of these materials were analyzed using the Fourier transform infrared spectroscopy and gel permeation chromatography. The test results indicate that (1) the DCLR and TLA materials in the asphalt can improve the high-temperature performance of the modified asphalt; (2) the effect of DCLR on improving the performance of asphalt is better than TLA under high temperatures; and (3) it is possible that most of the DCLR and TLA particles are physically dispersed in the asphalt. Therefore, it is better to use the DCLR material for the replacement of TLA considering the cost and performance of DCLR and TLA modified asphalt.

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Research Article - Civil Engineering
October 2016, Volume 41, Issue 10, pp 3995–4005

Characteristics of Cyclic Shear Behavior of Sandy Soils: A Laboratory Study

- A. Krim, A. Arab, R. Bouferra

Abstract

This paper presents a laboratory study of the influence of relative density on the liquefaction potential of a sandy soil using the triaxial apparatus. The study is based on undrained triaxial tests performed on samples at an initial relative density RD = 15, 50 and 65 % under a confining pressure of 100 kPa using a dry deposition method. Samples were subjected to quasi-static undrained cyclic tests. The paper is composed of three parts. In the first part the used materials and their characteristics are presented. The second part is devoted to the experimental procedures and the device used. The third part investigates the influence of relative density on the liquefaction potential of the three sands (Hostun Rf, Chlef and Rass). This study also explores the influence of particle size on the liquefaction potential. The test results indicate that consistent results were obtained and show clearly that increasing the relative density leads to an important improvement in the liquefaction resistance of sand. This effect is very pronounced when the initial relative density increases from 50 to 65 %.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
October 2016, Volume 41, Issue 10, pp 4007–4018

Dynamic Response of Adjacent Buildings Under Explosive Loads

- Sayed Mahmoud

Abstract

The aim of this paper was to investigate the effect of an explosive load on the dynamic response of adjacent buildings including interaction due to collisions. Two buildings with different dynamic characteristics, to ensure one building behaves as a flexible and the neighboring one behaves as a stiff, are selected for the investigation. For such analysis, two different cases of adjacent buildings are modeled: (1) no interaction between adjacent buildings, sufficient separation gap exists, and (2) interaction between adjacent buildings, insufficient separation gap exists. The nonlinear viscoelastic model is employed to capture the induced force due to collisions. The influence of variations of a number of factors such as (a) separation gaps, (b) natural periods, and (c) peak over static pressures is considered. The response of buildings is studied under blast loads due to a source of explosion near the flexible building. The analysis is repeated using a source of explosion near the heavy and stiff one. Numerical simulations for estimating the dynamic response such as adjacent building structures are carried out using a developed MATLAB code based on the finite element toolbox CALFEM. Displacements and pounding forces due to collisions are determined. The displacements obtained from the analyses of adjacent buildings with insufficient separation gap are compared with those obtained assuming sufficiently separated buildings. It is found that explosive loads can cause excessive displacements leading to collisions between insufficiently separated buildings. Such collisions significantly affect the induced dynamic response of the adjacent two buildings, especially the flexible one.

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Research Article - Civil Engineering
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Analytical Solutions for Timoshenko Beam-Columns on Elastic Foundations

- M. H. Taha, M. A. M. Abdeen

Abstract

In the present work, static and dynamic stability parameters of a Timoshenko beam-column resting on a two-parameter foundation are investigated. Analytical solutions using recursive differentiation method are obtained considering both the angular inertia and shear stress induced from the axial load. Obtained solutions are verified and then used to capture the significance of different beam foundation parameters on the stability parameters. Different approaches dealing with the shear stress induced from the axial load are investigated. Solutions based on Euler–Bernoulli beam and Timoshenko beam theories are compared. The comparison indicated that the solutions of the two theories converge as the slender ratio of the beam increases. In case of beams resting on soils, the soil influence on stability parameters may be neglected for beams with slenderness ratio < 20. It is highlighted that the proposed solutions are simple, straightforward and accurate compared with the available solutions in literature.

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Research Article - Civil Engineering
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Rainfall–Runoff Modeling Using Support Vector Machine in Snow-Affected Watershed

- Fatemeh Sedighi, Mehdi Vafakhah

Abstract

Flood is one of the devastating natural disasters prediction of which is significantly important. Rainfall–runoff process and flooding are physical phenomena that their investigation is very difficult due to effectiveness of different parameters. Various methods have been implemented to analyze these phenomena. The aim of current study is to investigate the performance of the artificial neural network (ANN) (hyperbolic tangent and sigmoid) and support vector machine (SVM) (regression type-1 and regression type-2) models to simulate the rainfall–runoff process influenced by snow water equivalent (SWE) height in Roodak watershed, Tehran province, Iran. So, 92 MODIS images were gained from NASA website for three water years of 2003–2005. Then, snow cover areas in all images were extracted and finally SWE values were calculated. Also, the data of precipitation, temperature and discharge for the mentioned years were used for modeling. According to the results, ANN with the hyperbolic tangent function, rainfall-temperature-SWE inputs, 1-day delay and RMSE and R^2 R2 of 0.024 and 0.77, and the model with the sigmoid transfer function, rain-temperature-SWE inputs and RMSE and R^2 R2 of 0.026 and 0.75 had better prediction capability than the other models. This indicates that the SWE has improved the accuracy of the models. The results of the SVM model indicate that the model with the rainfall-temperature-SWE, 1-delay, type-1 regression, RBF function and RMSE and R^2 R2 of 0.054 and 0.030 had better prediction capability than other models. This also shows that consideration of the SWE enhances the performance and accuracy of the SVM models. Moreover, comparing the results of ANN and SVM models, it can be concluded that ANN model with the rainfall-temperature-SWE inputs, 1-day delay, and the hyperbolic tangent function had better predictions.

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An Advanced Method for Repairing Severely Damaged Beams in Shear with Externally Bonded Steel Plates Using Adhesive and Steel Connectors

- Ali Sami Alshaikhly, Md. Ashraful Alam

Abstract

Repairing and strengthening of damaged reinforced concrete (RC) beams using externally bonded (EB) steel plates has gained universal acceptance. The disadvantage of this method, however, is the premature debonding of the externally bonded strip, which is brittle and an undesired mode of failure. It is also known that the debonding failure of EB steel plates prevents the RC beam from reaching its full strengthening capacity. This study aims to increase the scientific understanding of the behaviour of fully damaged RC beams strengthened/retrofitted in shear by means of EB steel plates. It also concentrates on preventing or delaying premature debonding of the adhesively bonded steel plates using new embedded adhesive and steel connectors. To achieve these objectives, seven beams with a deficient shear design were loaded monotonically up to maximum load capacities and repaired using the proposed connectors. One beam was used as a reference beam; the other six damaged beams were repaired with vertical and inclined steel plates. The presence/absence of the new embedded connectors was investigated with these two types of configurations. Theoretical models were also proposed to predict the effective debonding strain and the shear capacities of beam specimens. A comparison among these beams was done to investigate the efficiency of these connectors to enhance the bond strength between the externally bonded steel plates and the concrete surface on the web sides of the repaired RC beams. It is concluded that using steel and adhesive connectors to fix EB steel plates for repairing severely shear-damaged RC beams can delay the premature debonding failure and restore the original shear capacity of the these beams. Finally, the proposed model was satisfactorily verified through the experimental investigations and with the current design guidelines.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
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A Novel Beam-Elastic Substrate Model with Inclusion of Nonlocal Elasticity and Surface Energy Effects

- Paitoon Ponbunyanon, Suchart Limkatanyu

Abstract

A force-based beam-elastic substrate model incorporating nonlocal elasticity and surface energy effects is developed. The nonlocal elasticity theory is used to capture the nanosized-dependent effect of the beam bulk material while Gurtin–Murdoch surface theory is used to account for the surface energy-dependent size effect. Interaction mechanism between the beam and the surrounding substrate medium is represented by the Winkler-like model. Similarity between the current system and the beam-Winkler–Pasternak foundation system is observed. Consequently, the beam-Winkler–Pasternak foundation element previously proposed by the first two authors can be employed to perform three numerical simulations to investigate the characteristics and behaviors of a beam-substrate system with inclusion of nonlocal elasticity and surface effects.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
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Experimental Investigations on Behaviour of Strip Footing Placed on Chemically Stabilised Backfills and Flexible Retaining Walls

- Nima Latifi, Aminaton Marto

Abstract

The gradual increase in population, as well as rapid development in the construction industry in recent years, has made it more urgent than ever to gain the sufficient knowledge and information needed to improve existing soil for geotechnical engineering purposes. This study focuses on the experimental investigations of small-scale physical model tests to evaluate the performance of selected locally manufactured non-traditional additives (SH-85 and TX-85) in field applications, particularly as the backfill of retaining walls. Unconfined compressive strength (UCS) tests, a set of physical model tests and a field emission scanning electron microscope (FESEM) were conducted. The physical models were different in terms of parameters such as the type of additive and the strip footing distance from the wall. The UCS test results showed that the addition of 9 % (as the optimum amount) of both additives increased more than 80 % of the compressive strength after 7-day curing periods. The results from the physical model tests showed that the ultimate capacity of the footing placed on the stabilised backfill soil increased greatly while the settlement reduced noticeably compared to the untreated backfill. Additionally, by increasing the distance of the strip footing from the wall, it increased the ultimate capacity of the footing. Besides that, the addition of additives in either powder or liquid form to the backfill led to a reduction in wall horizontal displacement and the strain distribution on the wall. Furthermore, less porous and denser soil fabric was observed on the surface of clay particles from FESEM images.

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Research Article - Civil Engineering
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Experimental and Numerical Study of Bearing Capacity and Effect of Specimen Size on Uniform Sand with Medium Density, Reinforced with Nonwoven Geotextile

- Yashar Tavangar, Issa Shooshpasha

Abstract

Reinforced soil is a composite material in which elements of high tensile resistance are implemented to increase the tensile resistance of the soil. Geotextiles are one of the major groups of geosynthetic products that are used for soil reinforcement. This paper deals with the effects of using nonwoven geotextile to improve the ultimate bearing capacity of footings resting on sand with medium density. The plate load tests were performed using 27 cm × 27 cm and 35 cm × 35 cm square plates, and the effects of the depth of the first layer of geotextile, vertical spacing as well as the number of geotextile layers on the ultimate bearing capacity of the footings were studied. Moreover, the impact of plate size and sample size was examined numerically by performing 3-D finite element analyses with different sizes of the square plate. The experimental results showed that the maximum bearing capacity is achieved for the system with four geotextile layers, vertical spacing of 0.3*B* between geotextile layers and geotextile width of 4*B*, where *B* is the width of the plate. The numerical analyses indicated that with increasing the size of the plate up to 65 cm, the values of the bearing capacity ratio (BCR) gradually decrease; however, additional increase in the size of the plate has a little impact on BCR values.

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Research Article - Civil Engineering
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Effect of Recycled Asphalt Aggregates on the Rutting of Bituminous Concrete in the Presence of Additive

- Bordjiba Abdelhak, Hacen-Chaouch Abdelmadjid

Abstract

Under the traffic action, the pavement crumbling occurs rapidly, which leads to severe impairments that are reflected on the surface layers: rutting, cracking, substances rejection, polishing and pulling out the aggregates on surface. This situation often involves the renovation of the surface's layers. It is, therefore, urgent to appeal to a new vision of pavement design based on optimizing the use of local materials, nonrenewable, and respect for the environment. The recycling of bituminous substances is one of the relevant solutions. It has the advantage of reusing building materials by mixing them with a proportion of refined ones to achieve the required performance. This assignment researches for different rates of coated aggregates, the effects of manufacturing temperature and blending time in the mixing of the constituents during production as well as the additive (powder of rubber) on the improvement of the recycled asphalt rutting. Rutting is one of the most encountered degradation phenomena in the Algerian roads. The formulated hypothesis used here assumes that the additive has an influence on the mechanical performance (rutting) of the recycled asphalt and also on the rate of the used asphalt aggregates. To justify this hypothesis, it is mandatory to go through the manufacture of the asphalt with different rate of asphalt aggregates. To reduce the number of experimental tests necessary for this study, we used the experimental approaches method ANOVA.

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Research Article - Civil Engineering
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Turbulent kinetic energy in the upstream of Piano Key Weir

- Harinarayan Tiwari, Nayan Sharma

Abstract

The protrusion of a hydraulic structure constructed in a river bed disturbs the flow and sediment transport. It is very important to investigate the changes on micro-flow behavior (turbulent) from sediment transport point of view. In this paper an attempt has been made to investigate the change in flow turbulent kinetic energy along the flow depth with and without Piano Key Weir (PKW; a type of labyrinth weirs) and try to establish a distribution pattern of turbulent kinetic energy with respect to relative depth. Here, relative depth is defined as ratio of depth of point of measurement and depth of flow. Flow resistance has been increased after introduction of PKW in channel. Turbulent kinetic energy has been fitted with Gaussian distribution of higher order as flow resistance increased. After introduction of PKW in channel, velocities slow down but shifting of centroid indicates relative ease of passing particles through sloping keys.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
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Influence of Organic Fillers on Physicochemical and Mechanical Properties of Unsaturated Polyester Composites

- S. O. Adeosun, O. P. Gbenebor, E. I. Akpan

Abstract

The mechanical and physicochemical properties of polyester reinforced with untreated palm kernel shell (PKS), sugarcane bagasse (SB), and pineapple chaffs (P) are investigated. A simple hand-lay method was used to produce the composites with addition of the fillers in the range of 5–50 vol%. Tensile, flexural, morphology, and FTIR examinations were used to investigate the effect of filler addition. Results show that sugarcane bagasse imparts better properties than palm kernel shell and pineapple chaff fillers. Flexural strength of composites with 10 vol% SB shows considerable improvement (29 %) over that of unreinforced polyester. A maximum tensile strength of 23 MPa was obtained at 20 vol% SB against 19.07 MPa of the unreinforced polyester. The impact strength of composites was also found to improve by 105 % over that of reinforced polyester.

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Research Article - Civil Engineering
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A Study on the Anti-penetration Properties of a Biomimetic Hexagonal Honeycomb Shelter

- Qi-Fan Wang, Shao-Qing Shi, Zhao-Jun Chu

Abstract

Based on an analysis of the strengthening and toughening mechanisms of natural composites (shells and pearls) and the biomimetic principle, a new type of hexagonal honeycomb shelter was designed using concrete-filled steel tubes. Experiments were conducted to investigate the anti-penetration properties of the honeycomb shelter. The experimental results showed that in contrast to a reinforced concrete shelter, damage from an impacting projectile only occurred within a single hexagonal unit of the honeycomb shelter; in addition, the damaged area on the honeycomb shelter was relatively small. Furthermore, the projectile tended to yaw when it penetrated the honeycomb shelter. The results of the experiments on the honeycomb shelter were also analyzed in terms of stress wave propagation, which was examined using a numerical simulation. The analysis showed that due to the restriction and obstruction effects of the hexagonal steel tubes on the concrete within the steel tubes, the resistance on the projectile increased during the penetration process, which reduced the damage caused by the projectile. The experimental results and analysis showed that a honeycomb shelter composed of concrete-filled steel tube components exhibits relatively good anti-penetration properties.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
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An Experimental Study on the Debonding of Steel and CFRP Strips Externally Bonded to Concrete in the Presence of Embedded Shear Connectors

- Md Ashraful Alam, Ali Sami Alshaikhly

Abstract

The problem of debonding failure is a fundamental issue in concrete structures that are externally strengthened with adhesively glued plates. Many standards and studies recommend using single-lap pull-out tests to measure the ultimate force that causes debonding failure. The pull-out test also allows defining and calibrating interface bond-slip relationships between concrete and the bonded plates to obtain the maximum interfacial bond strength. The aim of this research was to enhance bond strength in the presence of embedded shear connectors, which were fabricated at concrete–adhesive interface level to delay debonding of the externally bonded strips from the concrete surface. A new rational model was also proposed to predict the bond strength of adhesively glued plates-to-concrete joints in the presence of connectors. In the experimental programme, 60 concrete prisms with adhesive and steel bar connectors were fabricated. The specimens were divided into two main series of concrete prisms bonded with steel plates and CFRP strips using the new connectors. Different diameters of connectors were used with and without adhesive on the surfaces of concrete prisms to bond the strips for investigating the capacity of the new embedded connectors. The experimental results showed that the interfacial bond strength increased remarkably when these connectors were used. Moreover, it was found that increasing the connector's diameter has a great effect on increasing the bond strength and uniformly distributes the interfacial shear stresses, leading to the minimisation of premature debonding failure of bonded plates. The results exhibited that the steel connectors are more effective at increasing the shear bond strength for all specimens adhesively glued with both CFRP strips and steel plates. Finally, the proposed bond strength model was satisfactorily verified through the experimental investigations.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
October 2016, Volume 41, Issue 10, pp 4187–4194

Effect of Bed and Side Slopes on Flow Measurements in Trapezoidal Free Overfall Channels

- Bahzad M. A. Noori, Safa S. Ibrahim

Abstract

The aim of the present investigation is to study the effect of both side and bed slopes on the flow over free overfalls in trapezoidal channels, three models of trapezoidal free overfall channels have been built and tested in a laboratory flume. These models had 0.1m bed width and 3.7m length with different values of side slope (m = 0.268, 0.577, and 1). Each model had four different bed slopes (S = 0, 0.0033, 0.01, and 0.02). A total of twelve series of the experiments were tested for different ranges of Froude number. Experimental results of all models showed that the variation of (Qm 1.5 /gb 5 $\sqrt{}$) (Qm1.5/gb5) with ($my\ b$ /b) (myb/b) for different values of side slope and different bed slopes is a simple power equation. It was observed that the values of (Qm 1.5 /gb 5 $\sqrt{}$) (Qm1.5/gb5) increase with the increase in ($my\ b$ /b) (myb/b) values. The correlation between ($my\ b$ /b) (myb/b) with ($my\ c$ /b) (myc/b) is found to be linear for different bed slopes. The ratio ($y\ b$ /$y\ c$) (yb/yc) decreases with the increase of slope (S) with an average value of 0.729 for subcritical and supercritical flow on smooth beds of different slopes. An empirical expression is obtained for the variation of (Qm 1.5 /gb 5 $\sqrt{}$) (Qm1.5/gb5) with ($my\ b$ /b), (myb/b), and (S). The results of the present study have been compared with theoretical and experimental results obtained by other investigators showing well agreements.

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Research Article - Civil Engineering
October 2016, Volume 41, Issue 10, pp 4195–4206

Finite Element Analysis and Development of Design Charts for Cylindrical Vessel–Nozzle Junctures Under Internal Pressure

- F. M. Mukhtar, H. J. Al-Gahtani,

Abstract

A detailed study for the stresses around internally pressurized cylindrical vessel–cylindrical nozzle junctures is carried out using the finite element method. Based on thin shell theory, two simplified expressions (functions of the vessel–nozzle geometrical ratios) of stress concentration factor (SCF) are obtained: one for the main vessel and the other for the nozzle, respectively. The analysis was also used to study the location of maximum stresses at the juncture as well as provide a more accurate presentation of design charts than the ρ ρ -SCF plots. Verification is made using some established models available in the literature.

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Research Article - Civil Engineering
October 2016, Volume 41, Issue 10, pp 4207–4215

Optimizing Dosage and Location of Chlorine Injection in Water Supply Networks

- Muhammad A. Al-Zahrani

Abstract

Disinfection of the water in the drinking water supply network is usually done by injecting chlorine to the treated water before it is pumped into the network for distribution. However, such an injection process may not be sufficient to ensure that the chlorine residual throughout the network is within the standard limits. Usually, the residual chlorine is reduced as water moves through the pipe network, due mainly to its reaction with a variety of materials in the bulk water and from the pipe wall. Reduction in residual chlorine in the water supply network may lead to degradation of water quality and, thus, poses potential microbial risks to humans. To meet water quality standards, it is recommended to maintain residual chlorine throughout the water supply network within the desirable levels. This paper presents an optimization model based on the hydraulic simulation model (EPANET) and mixed integer linear programming technique for optimal locations and scheduling of booster chlorination in a real water supply network located in Al-Khobar, Saudi Arabia. The results demonstrate better performance with reduced doses of chlorine when booster chlorination is applied to the water distribution network. The findings may assist in reducing chlorine doses, which is likely to reduce human exposure to potentially harmful disinfection by-products in drinking water.

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Research Article - Civil Engineering
October 2016, Volume 41, Issue 10, pp 4217–4224

Accumulation of Lead-210 and Polonium-210 in the Groundwater of Wadi Nu'man, Mecca Province

- El-Said Ibrahim Shabana, Maher Mohammad Taher Qutub

Abstract

Groundwater of Wadi Nu'man (30 km southeast of Mecca city) of high radon-222 (222 222 Rn) content, emanated directly from the bed rock into the water reservoir, has been analyzed for lead-210 (210 210 Pb) and polonium-210 (210 210 Po), the comparatively long- lived 222 222 Rn progenies, to study the effect of the continuous 222 222 Rn emanation on the accumulation of both radionuclides in this water. Emanation of 222 222 Rn directly from rock to water may be affected seasonally by atmospheric temperature and pressure; therefore, 222 222 Rn and 222 222 Rn progenies were reanalyzed in seasonal samples of the same wells. The obtained results showed 210 210 Pb and 210 210 Po activity levels ranging from <6 to 29.9 and from 0.6 to 18.2 mBq/L, respectively, which was far below the recorded level of their parent radionuclide 222 222 Rn (10.9–99.7 Bq/L). The data have been discussed in detail.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
October 2016, Volume 41, Issue 10, pp 4225–4234

Computation of Momentum Transfer Coefficient and Conveyance Capacity in Asymmetric Compound Channel

- R. Farooq, W. Ahmad, H. N. Hashmi

Abstract

The momentum transfer phenomenon plays a significant role in complex flow structure in compound channel. It mainly depends upon apparent shear stress at a vertical interface between the main channel and the adjoining floodplains, discharge capacity, and the velocity difference. In the present study, experiments were performed in the asymmetric compound channel to investigate the effect of roughness in floodplain on apparent shear stress distribution and momentum transfer coefficient. The apparent shear stress distribution was calculated using modified equations and momentum coefficient was achieved using Wang–Yang relationship. Furthermore, the conveyance capacity of the asymmetric compound channel was calculated by different 1-D approaches, and it was found that Debord gave minimum root-mean-square error and its values were found to be closest to the actual discharges.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
October 2016, Volume 41, Issue 10, pp 4235–4245

Dimensionless Discharge in Supercritical Flow Regime for Different Sizes of Cutthroat Flumes

- Shrikant A. Tekade, Avinash D. Vasudeo

Abstract

Cutthroat flume is a flow measuring device which is commonly used for measurement of open-channel flow because of simple geometry and ease of construction. No experimental data are available for measurement of flow in the supercritical regime by cutthroat flume. Three different sizes of cutthroat flumes having different lengths and throat widths are fabricated and tested in the laboratory for supercritical flow regime. Regression analysis of experimental data is carried out, and it is observed that good correlation between dimensionless discharge and dimensionless head is obtained. Based on these results relation for dimensionless discharge and coefficient of discharge is proposed.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
October 2016, Volume 41, Issue 10, pp 4039–4051

Prediction of River Runoff Using Fuzzy Theory and Direct Search Optimization Algorithm Coupled Model

- M. Mohammad Rezapour Tabari

Abstract

The correct prediction of daily runoff is considerable importance in flood control. The aim of this study is to evaluate the ability of a combined model, fuzzy inference system–direct search optimization algorithm (FIS-DSOA), to forecast the daily runoff in downstream of Taleghan river using data of rain gauge and hydrometric stations which are located upstream of the river. Initially, the measured daily data (6 years from 2008 to 2013) related to rain gauge and hydrometric stations located in Taleghan river upstream (as input variable) and Siahdasht hydrometric station located in downstream of river (as output variable) were collected. Then the structure of proposed FIS-DSOA model was developed. In the proposed model, the variation range and type of membership functions associated with the input and output variable and the type of rules governing time series were taken as decision variable. Also, the objective function of hybrid model is to minimize root-mean-square error between observed and simulated daily runoff. The forecasts of the FIS-DSOA model are tested using the five statistical indicators (i.e., correlation coefficient, efficiency coefficient, mean absolute error, MSE and index of agreement), and the results are compared with those of the ANNs, FIS and ANFIS models. The comparison results revealed that the FIS-DSOA performs with EFF = 0.83, MAE = 0.75 *m* 3 /*s* m3/s , MSE = 26.1 *m* 3 /*s* m3/s and IOA = 0.92 better than the non-hybrid models in daily runoff discharge prediction. It is concluded that the proposed model significantly improved the accuracy in daily runoff discharge forecasting by combining the capabilities of ANFIS and DSOA models.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
October 2016, Volume 41, Issue 10, pp 4029–4037

Effect of the Bed-Sediment Layer on the Scour Caused by a Jet

- Kerem Taştan, Pelin Pinar Koçak

Abstract

Scour caused by a water jet impinging the bed-sediment layer is a significant concern for hydraulic engineers. Although several studies investigated the maximum scour depth on the non-cohesive bed-sediment layer, the effect of the bed-sediment layer's thickness on the scour was not studied. This study investigated the effect of the thickness of the non-cohesive sediment layer at the canal bed on the depth of the scour caused by a water jet. The dimensionless parameters affecting the depth of the scour were obtained via dimensional analysis. Experiments were conducted on two different, non-cohesive bed-sediment layers at the bottom of a rectangular canal for different jet Froude numbers. Experimental results indicated that the depth of the scour increases with the thickness of the bed-sediment layer; this is because as the thickness of the sediment layer increases, the penetration depth of the air bubbles (dragged and enforced by the impinging water jet) through the sediment layer just under the scour hole increases. Due to the buoyancy force, as the air bubbles rise upward, they apply uplift forces and dynamic effects onto sediment particles, dislodging, suspending, and carrying the sediment particles away from the bed. If the thickness of the sediment layer is increased beyond a limiting value for a given flow condition, the maximum depth of the scour does not change (it remains almost constant). The effect of the thickness of the bed-sediment layer on the depth of the scour is present but not excessively large.

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Research Article - Civil Engineering
October 2016, Volume 41, Issue 10, pp 4019–4028

Mechanical Properties of Reinforcing Steel in R/C: Uncertainty Analysis and Proposal of a New Material Factor

- Fatih K. Firat

Abstract

Although the statistical parameters of basic reliability variables such as concrete and reinforcing steel should be determined and its uncertainty sources should be quantified for the reliability analysis, the related studies were carried out about 30–40 years ago. In spite of the upgradation of criteria of reinforced concrete practice and steel production techniques from the past till the present in the world, the material (partial) factor for reinforcing steel is still the same (1.15). To the best knowledge of the author, there is no published work in the literature on this specific work. The main aim of this study is examining the variations in the mechanical properties of reinforcing steel bars, to carry out an uncertainty analysis with the quantification of these variations and proposing a new material factor for reinforcing steel bars based on the uncertainty analysis. In addition to this, considering the mean values and variations of the yield strength, ultimate strength and elongation, and their conformity with the relevant standards, the quality of reinforcing steel bars is investigated from a statistical point of view. The test results consisting 79133 S420a reinforcing steel bar specimens sizing from 8 to 32 mm are evaluated. At the end of this study, it is observed that variations in the mechanical properties are high and the quality of these bars has increased compared to the previous years. In addition, a new material factor (γ S =1.05) (γS=1.05) for reinforcing steel bars is proposed.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
December 2016, Volume 41, Issue 12, pp 4787–4798

Investigation of Waterhammer Problems in Wind-Hydro Hybrid Power Plants

- Ali Ersin Dinçer, Zafer Bozkuş, Ali Ersin Dinçer

Abstract

Sudden flow changes in confined pipe systems generate transient flow (waterhammer) conditions accompanied with very high or sometimes very low pressures traveling back and forth in the system. Depending on the magnitude of those pressures, pipe collapse or pipe bursting may take place at the weakest points of the system, resulting in costly damages as well as loss of human lives in some cases. In general, it may be encountered in the penstocks of hydropower plants, water transmission lines and water networks, etc. It is essential that the safe operation guidelines of the hydropower plants be defined accurately, in advance. To achieve that, detailed numerical simulations should be done with reliable software. In some cases, even physical modeling may also be necessary. In the present study, waterhammer problems in the penstocks of Yahyali Wind-Hydro Hybrid Plant are investigated (the construction of the plant has not started yet). Time-dependent flow conditions in the penstocks are simulated by the help of computer software. It solves nonlinear differential equations by using the method of characteristics that uses the principles of finite difference method. Firstly, hydraulic transients for various operational cases are investigated using some scenarios. Then, a surge tank, protective device, for waterhammer, is added to the system, and for the same operational cases, hydraulic transients are studied again.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
December 2016, Volume 41, Issue 12, pp 4799–4808

The Effect of Palm Oil Fuel Ash as a Supplementary Cementitious Material on Chloride Penetration and Microstructure of Blended Cement Paste

- Wunchock Kroehong, Nattapong Damrongwiriyanupap

Abstract

This article presents the effect of palm oil fuel ash as a supplementary cementitious material on chloride penetration and microstructure of blended cement paste. Palm oil fuel ash (POFA) was ground to obtain two finenesses: one was the same size as the cement and the other was smaller than the cement. Type I ordinary Portland cement (OPC) was replaced by POFA at 0, 10, 20, 30, and 40% by weight of binder. All paste specimens were prepared using the same water to binder ratio as 0.35. The compressive strength, pore size distribution, total chloride content, free chloride content, and X-ray diffraction analysis of chloride penetration into blended cement pastes were investigated. The results indicated that, at 60 and 90 days, the blended cement pastes containing 30% of POFA with high fineness had 1.6 and 4.9% higher compressive strength than that of the OPC paste, respectively. POFA pastes had a lower chloride diffusion coefficient and shallower concentration profile of free chloride than that of the OPC paste. The specimens containing coarse fineness and small particle size POFA had lower chloride diffusion coefficient than OPC paste ranging between 13.2 and 61.0%. In addition, the chloride diffusion coefficient is linearly correlated with the critical pore diameters. Replacement of OPC by the fine-grained POFA resulted in the decrease in free chloride and in the chloride diffusion coefficient.

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Research Article - Civil Engineering
December 2016, Volume 41, Issue 12, pp 4809–4816

A Double-Blade Mixer for Concrete with Improved Mixing Quality

- Yunshi Yao, Zhongxu Feng

Abstract

The paper intends to present a design of a double-blade mixer for the purpose of reinforce concrete mixing quality. The result of comparison experiment on mixing quality of three different types of concrete with the use of different mixers shows that mixing quality of the concrete using a double-blade mixer is better than that of using ordinary biaxial mixer. The compressive strength of C20 with filling rate of 31% is improved by 14.8% and that of C30 by 14.2%. Moreover, the compressive strength of roller compacted concrete is increased by 13.7%. The double-blade mixer used in macrostructure and SEM of the concrete could provide good binding to both the aggregates and the cement paste with few cracks between them which would form crushing destruction of its aggregate instead of interface. Furthermore, the double-blade mixer could provide faster uniform mixing at macro- and microscales, reinforce concrete microstructure and improve its compressive strength.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
December 2016, Volume 41, Issue 12, pp 4817–4826

Experimental Study on the Noise Characteristics Regarding Axial Auxiliary Fans and the Noise Reduction Performance of Mufflers

- Cheng Zhai, Zongqing Tang

Abstract

High-intensity noise not only hurts body and mental health of workers, but also covers sound signs of accidence. To increase the sound absorption and noise reduction performance of axial auxiliary fan noise silencers, the noise strength and frequency distribution of the ambient medium casing of an FBYNo3.0/2.2 (II) axial auxiliary fan were investigated. The noise characteristics at the inlets and outlets were analyzed. Based on this study, a new auxiliary fan bell-type muffler was designed, and its noise elimination ability was tested. The results showed that on the surface of the auxiliary fan casing, the noise intensity exhibited a "V" font distribution in that the maximum noise intensity was located in the air outlet and the minimum noise intensity was located in the middle part of the fan. Mid- and low-frequency noise was presented primarily at the outlets. However, intermediate- and high-frequency noise was presented primarily at the inlets. The muffler performance test revealed that the installation of a muffler can dramatically reduce the intensity of the auxiliary fan's noise. The mean decrease in noise intensity for various positions was 14 dB (A). The noise elimination rate of the muffler was over 15 %. This decreased level of noise was less than the Chinese national standard for maximum noise intensity, 85 dB (A). In addition, optimizing the noise frequency of the inlets and outlets by decreasing the intermediate- and high-frequency noise of the inlets and the intermediate- and low-frequency noise of the outlets can lead to the greatest noise reduction.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Civil Engineering
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Durability of NO Oxidation Effectiveness of Pavement Surfaces Treated with Photocatalytic Titanium Dioxide

- Edoardo Bocci, Luca Riderelli, Gabriele Fava

Abstract

Nowadays, photocatalysis has demonstrated to be a reliable solution in order to purify the atmosphere from the pollutants originated by vehicular traffic. Owing to the primary importance of this problem, the potential of innovative photocatalytic techniques, dealing with the immobilization of titanium dioxide TiO_2 on the surface of the asphalt pavement, has been investigated. In particular, three different products, two bituminous emulsions and a cement mortar, were applied on the right lane and on the emergency lane of a highway section in Italy. The effectiveness of the photocatalytic treatments and its evolution with time were evaluated on cores taken after 1, 17, 46, 88, 218, and 527 days from the application of the products. Two tests were carried out on the cores: The NO degradation was evaluated through continuous flow tests, and the size of the treated areas was quantified by means of digital image analysis methods. The research showed interesting results, as all the techniques, in particular the bituminous emulsion-based products, proved to have a good effectiveness in air de-polluting, even if a decay of performance was noted, depending of traffic and weather conditions.

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Research Article - Civil Engineering
December 2016, Volume 41, Issue 12, pp 4835–4845

Effect of Different Parameters on Properties of Multiwalled Carbon Nanotube-Reinforced Cement Composites

- Tanvir Manzur, Nur Yazdani

Abstract

The exceptional mechanical properties of carbon nanotube (CNT) such as high strength, elastic modulus and aspect ratio reflect its potential to be used as reinforcements in cementitious materials. Nanotubes can be distributed on much finer scale and can act as bridge across void spaces and cracks. This in turn improves the overall mechanical properties of the composite. However, there are certain issues that need to be considered while producing CNT cement composites. With this end in view, an attempt has been made to summarize the effect of different parameters on properties of CNT-reinforced cementitious composites through interpretation of results obtained from a comprehensive study. Different sizes and dosage rates of MWNT were used to conduct parametric study. In addition, untreated and surface-treated commercially available MWNTs were used to make composites. Sonication was done for dispersion of nanotubes within cement matrix. An appropriate mixing technique was suggested after conducting a parametric study by varying the amplitude and time of sonication. In some cases, polycarboxylate-based superplasticizer was used as surfactant to disperse MWNTs in aqueous medium. It was observed that surface treatment of nanotubes and utilization of superplasticizer as surfactant enhance their solubility within water. It was also found that proper dispersion and dosage rates of MWNT have significant effect on composite behavior. A suitable mix proportion in terms of MWNT dosage rate, MWNT size and plasticizer proportion has been found. Moreover, it was suggested that flow values of composite paste is a good indicator of stability of the mix.

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Research Article - Civil Engineering
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Estimation of Reconstructed Strength of Disturbed Biologically Cemented Sand Under Unconfined Compression Tests

- Mohammad Azadi, Saeedeh Pouri

Abstract

One of the most important characteristics of soils is their resistance to structural loads. Improvement of mechanical properties of soils can help to control soil stresses and deformations. There are different methods for this purpose. One of the latest methods for stabilization of soils, which is a combination of chemistry and biological sciences, is the use of calcium carbonate microbiological sediment as a suitable injection material. In this study, the effects of using a bacterium spore called Bacillus pasteurii and production of biological deposition of calcium carbonate on improvement of the mechanical properties of sandy soils through the production of sandstone have been investigated. According to the results, when the calcium chloride in Bacillus pasteurii matrix is injected into the sandy soils, the strength of these soils increases. After this kind of cementation, an increase of considerable amount of water content, which is a kind of disturbance in the samples, can reduce the bio-cemented strength. This time, if we let the samples go for a period of time (about 24 h), the soil will revert to some part of its former strength and it can modify itself. This kind of strength is called reconstructed strength in this study. This research is designed to investigate the reconstructed strength of bio-cemented sands under unconfined compression tests. Results of the study show the strength of disturbed bio-cemented samples is sensitive to the void ratio.

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Experimental Investigation on the Mechanical Behavior of a New Three-Dimensional Pressure Transducer

- Quansheng Liu, Jingdong Jiang

Abstract

Accurate measurements of in situ stress in deep soft rocks are needed to design the tunnel support system and to evaluate the stress redistribution process. Due to the difficulty and weakness of current methods in deep soft rock stress measurement, a new one, rheological stress recovery method to determine the three-dimensional stress tensor is proposed. It is supposed that rock stresses will recover gradually with time and can be measured by embedding transducers into the borehole. According to this method, an original three-dimensional pressure transducer to measure rock stresses is designed and manufactured. In order to investigate the accuracy of the measurement, calibration test and model test have been performed. Both uniaxial and tri-axial calibration tests are conducted to evaluate the transducer performance. For model test, the cement mortar was used to simulate the effect of the surrounding materials. This test considered different rock strengths as well as different types of loading. The results indicate that this transducer is good for stress measurement.

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Areal Change Detection and 3D Modeling of Mine Lakes Using High-Resolution Unmanned Aerial Vehicle Images

- Mehmet Ali Yucel, Recep Yavuz Turan, Mehmet Ali Yucel

Abstract

This study focuses on the Etili and Comakli open-pit coal mines, where mine lakes are most densely located within the Can Coal Basin (northwestern Turkey). The aim of our study was to create 3D terrain models of these mine lakes using high-resolution images from an unmanned aerial vehicle (UAV) and to quantify areal changes linked to anthropogenic and meteorological effects over the study period. In November 2014 and October 2015, a DJI F550 hexacopter was flown at elevations of 30–100 m, and images were acquired using a 12-megapixel camera. Nineteen flights were completed, with each flight acquiring between 109 and 554 images. 3D modeling of UAV images was carried out with Agisoft software, using the most common structure from motion algorithm. Its workflow, involving image matching, georeferencing, digital elevation modeling, orthomosaics, 3D point cloud, and 3D textured model creation, was used to generate our 3D terrain model for the mine lakes. Orthomosaics with 1–6 cm/pixel resolution were used to assess areal change in the mine lakes. Area was calculated using two different methods (digitization and classification) within the ArcGIS package; results of these two methods were compared. Our UAV study of open-pit mines rapidly and precisely determined changes in topography linked to anthropogenic and meteorological effects. It also proved to be an effective method of visualizing such effects over the short term.

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Appropriate Engineering Measures with Participation of Community for Flood Disaster Reduction: Case of the Tha Chin Basin, Thailand

- Chaiyuth Chinnarasri, Kittitouch Phothiwijit

Abstract

This research aims to assess the performance of engineering measures applied in the flat area in order to reduce flood disaster in the Tha Chin basin, Thailand. The integrated 1D–2D linked mathematical model (ISIS model) was used to simulate the flood inundation with the Digital Elevation Model. The upstream boundary condition, which was the runoff at the basin inlet, was calculated from flow hydrograph data of the 2011 flood in Thailand. The downstream condition was the time series of the sea water levels. The flood area images taken by remote sensing technique were used to calibrate the model. With the integrated 1D–2D linked mathematical model, the simulated flood areas in the complex topographies could be successfully compared with the 2011 flood. The difference between simulated flood areas and those taken from the satellite images was about 7.11 %. The appropriate engineering measures were proposed based on simulation results and comments of stakeholders. The management for flood disaster reduction could be classified into three different zones, i.e., areas of the upstream, middle, and downstream of the basin. Based on seminars and the participation of the stakeholders in the basin, most of the respondents agreed with the proposed project.

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Development and Laboratory Confirmation of Innovative Self-Reliance Controller

- Ming-Hsiang Shih, Wen-Pei Sung

Abstract

Raising the structural seismic-resistant capability by ductility design and structural control to alleviate the structural response to earthquake are two main concepts of modern structural design. Ductile designed building is subjected to nonlinear status to dissipate energy, thus eliminating the crisis caused by resonance amplification effect. Although it can avoid much base shear and survive an earthquake without collapse, the tremendous structural deformation will lead to much structural damages. To improve such shortcomings by altering the dynamic characters of a structure, the structural response of building subject to strong earthquake needs to be minimized to ensure building within the elastic region. A novel self-reliance control technology combined with the hydraulic interface is proposed in this research. This technology will provide autonomous controls similar to those achieved by using a semi-active control system but without the use of electronic sensors and controllers. Three-stage experimental tests are planned to test and verify the energy-dissipation ratio of this technology, connected to hydraulic jack of hydraulic dampers with various conditions and subject to different external force with various amplitude and frequency. Test results exhibit that (1) this proposed technology may exhibit the hysteretic phenomenon but still show a certain energy-dissipating effectiveness without using computer, and the reliability for using the structural deformation as sensor and also performing continuous control of these proposed controllers has been confirmed in this research, (2) the input energy from the external forces can be converted to produce control actions of this proposed technology, (3) the energy-dissipating efficiency of this technology increases with higher vibration amplitude.

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Influence of the Aggregate–Cement Ratio on the Electrical and Transport Properties of Cement Mortars

- Juan Lizarazo-Marriaga, Sergio Ramírez

Abstract

This paper summarizes the results of a research that has been carried out aiming to assess the effects of the cement paste content on the transport and electrical properties of mortars using the electrochemical impedance spectroscopy (EIS) method. Six mortar samples using different proportions of aggregate (different cement paste fractions) and a constant size of aggregate were used. The microstructure transport properties were investigated using the EIS method and an equivalent circuit model, which allowed determining effectively the physical behaviour of conductive and non-conductive pores. Some other experiments, such as the compressive strength and rapid chloride penetrability tests, were also carried out. Results showed proper relationships between the pore microstructure and the electrical conductivity of mortar samples, explaining some complex relationships among them. Additionally, relationships between transport properties and the volumetric fraction of cement paste were also identified.

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Effect of Inflow Class Selection on Multi-Objective Reservoir Operation Using Stochastic Dynamic Programming

- H. H. Jaafar, F. Al-Awar, F. Ahmad

Abstract

A combined simulation optimization model was developed to derive optimal operational policies for a multi-objective reservoir in a semiarid environment. Stochastic dynamic programming was selected as the optimization technique. Different scenarios were considered to optimize the current operational policy as well as different possible future uses of the reservoir. The first scenario was used to maximize hydropower production within the framework of the current operational policy. Other scenarios were used to address multiple objective operation of the reservoir including hydropower, agricultural, and domestic uses. Generated policies for all the scenarios were simulated in real time using historical inflow data for the Qar'awn reservoir within the Litani Basin in Lebanon. Sensitivity analysis on number of inflow classes was performed. Results showed that the newly derived policies decrease failure by a range of threefold to sixfold and improve hydropower production by more than 15 %. The model was able to derive policies that decreased system failure and shortages to less than 10 %. Best inflow classes were found to be in the range of 3–5.

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Effects of Gate Lip Orientation on Bottom Pressure Coefficient of Dam Tunnel Gate

- Taha M. Taher, Awat O. Anwar

Abstract

Vertical-lift tunnel-type gates are subjected to hydrostatic and hydrodynamics forces created as a result of operation conditions of a wide range of partial openings, discharges and heads. Among these forces is the uplift hydrodynamic force resulting from the effects of flow issuing below the gate bottom. The evaluation of this force requires the determination of bottom pressure coefficient (K_b) which is based mainly upon the measurements of the jet flow velocity across the vena contracta, the pressure head distribution along and across the bottom gate surface and pressure head of flow just downstream the gate shaft. In the present research, a random hydraulic model was created to identify the effect of twelve gate lips orientation on the behavior of flow and consequently on the bottom pressure coefficient. The main conclusion is that the values of bottom pressure coefficient (K_b) are inversely proportional to gate opening ratios (Y/Y_0) and range from high values with small gate openings ratios and low values for ($Y/Y_0 >$ 30%). The study finds that the bottom pressure coefficient (K_b) and the fluctuations flow pattern below the gate surface are influenced mainly by the gate geometry.

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Development of Metakaolin as a Pozzolanic Material from Local Natural Material, Soorh

- Abdullah Saand, Manthar Ali Keerio, Daddan Khan Bangwar

Abstract

This research aims to investigate and present the effect of extent of temperature and duration of heating on the pozzolanic properties and reactivity of the local available natural material, Soorh. The Soorh is activated by heating in a furnace chamber at temperatures 650, 700, 750 and 800 ∘ C 800 ∘C for 2, 3 and 6 h and at 900 and 1000 ∘ C 1000 ∘C for 2-h duration. The energy-dispersive spectrometry and X-ray diffraction (XRD) are conducted to verify the presence of silica content and amorphous silica in developed metakaolin. The strength activity index (SAI) of developed metakaolin is determined with 20 % replacement of cement with metakaolin as per ASTM. The obtained results of SAI verdict that the optimal activation temperature is 800 ∘ C 800 ∘C with 2-h duration. The XRD analysis confirmed pozzolanic activity of developed metakaolin and validated the results of SAI. Moreover, it is observed that the activated metakaolin has an appreciable influence on the increase in compressive strength of the mortars.

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A Methodology for Assessing Extreme Precipitation Trends Applied to Three South Texas Basins, 1898–2011

- John F. Joseph, Hatim O. Sharif

Abstract

A statistical scheme based on the Kendall τ τ statistic, Fisher's method, the modified Welch *t* test, and the Gumbel distribution as a special case of the general extreme value distribution was developed to explore the causes of the apparent trends in environmental variables. Daily precipitation data extending as far back as 1898 for gauges in the Nueces, Guadalupe, and San Antonio river basins indicate that the annual maximum daily precipitation depths and the annual 5-day maximum precipitation depth have been generally increasing. The statistical analysis reveals that urbanization, the Pacific Decadal Oscillation, and localized random effects do not contribute to these trends. The results indicate that climate change or other unknown regional phenomena would be the main cause for the increasing trend. The methodology developed can be employed in global change studies to identify the contribution of climate change and other factors, such as societal dynamics, on observed trends in environmental variables.

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Use of Water Tank as Tuned Liquid Damper (TLD) for Reinforced Concrete (RC) Structures

- Muhammad Jamil Ahmad, Qaiser uz Zaman Khan

Abstract

This paper describes the experimental study investigating the suitability of water tank as passive tuned liquid damper for reinforced concrete (RC) structures against earthquake's vibrations. Two 4-storey RC frame structural models with symmetrical in plan and vertical with water tank monolithically attached on top were constructed and tested on uni-axial freedom shaking table with different levels of water in water tank. El Centro earthquake time history 50 % was applied to both structures to investigate the response acceleration and deflection of the structures at fourth floor level. The efficiency of quantity of water has been investigated with reference to response acceleration and deflection recorded by data acquisition software through accelerometers and displacement transducers installed at level of fourth floor of models. It was found that the weight of water 2.5 and 2.0 % weights of structures gave minimum response acceleration and deflection for Model 1 and Model 2, respectively.