different resistance parameters and different groundwater levels, using finite element method for the analysis of deformation and forces, and limits equilibrium method for checking wall stability, has been evaluated. Also the effect of wall height, in two categories with a height of 4 and 8 meters is considered and evaluated. The result showed that reducing the resistance parameters bed of reinforced soil wall, would lead to increase lateral displacement of the wall and tensile load of the geogrids, and to reduce the wall's stability, and as the surface of groundwater level closer to the below of reinforced soil wall, the lateral displacement of the wall will be more and the overall stability of the wall will be less, and this effect of groundwater on the wall's behavior is significant at a distance of zero to one meter below the wall. Also, by observing the stability of the walls, when the strength of the bed decreases from rigid to weak, the wall safety factors will be greatly reduced and the slipping surface will close to the wall surface. This is also evident for the existence of groundwater level, which is more perceptible in the bed with poorly sandy soil.

Key Words: Reinforced soil wall, geosynthetic, bed condition, finite element method, limit equilibrium.

STUDY OF TABRIZ UNDERGROUND RAILWAY

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Sharif Civil Engineering Journal
Volume 35, Issue 4.2, Page 131-140, Research Note

- Received 26 December 2017; received in revised form 21 April 2018; accepted 29 April 2018.

Abstract

In this paper, measured settlements of Tabriz Urban Railway line 2 (TUR2) are presented. TUR2 with a length of about 22 km will connect the eastern part of the city to its western part. The process of excavating TUR2 has begun since 2015 using earth pressure balanced (EPB) TBM with a cutting-wheel diameter of 9.49 m and a steel shield with an external diameter of 9.46 m in front and 9.44 m at the tail. For the lining of the tunnel, 350 mm-thick precast concrete segments with a length of 1.5 m are installed just behind the shield. The data have been recorded during the construction of the tunnel from west-shaft to station-02 (S02). The distance between west-shaft and S02, which has been investigated here, is about 2000 m. In this route, based on conducted studies, the ground mainly consists of sand and gravel (SM) containing minor portion of fine-grained soil (ML). Thus, in general, the ground condition could be assumed to be non-cohesive at this site. The TUR2 tunnel is entirely under water table varying from 14 to 22 m. The data analyzed and discussed throughout this paper have been recorded at 180 green-field surface locations (pins) between west-shaft and S02. Settlement measurements are back-analyzed using Gaussian empirical predictions both in longitudinal and transversal directions. In addition, volume loss has been calculated using final maximum surface settlements. Subsequently, observed and calculated settlement curves have been compared. In addition to settlements, face pressure and tail void grout injection pressure have been recorded during the excavation process of TUR2, as presented in this paper. Janc-secz and Stainer presented an empirical formula for determination of face pressure to investigate the efficiency of the analytical methods in comparison with field data. Then, the development of settlements during shield passage and probable correlation between volume loss and face pressure was investigated. Observations show that a vast majority of the settlements measured at the ground surface falls in the range of allowable values.

Key Words: Surface settlements, volume loss, face pressure, mechanized tunneling, Tabriz underground railway.

NUMERICAL STUDY OF THE EFFECTS OF GROUNDWATER AND BED RESISTANCE CONDITIONS ON THE BEHAVIOR OF GEOSYNTHETIC SOIL WALLS

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Sharif Civil Engineering Journal
Volume 35, Issue 4.2, Page 141-148, Research Note

- Received 20 November 2017; received in revised form 3 April 2018; accepted 29 April 2018.

Abstract

The low soil tensile strength is a major limitation in soil structure, while this limitation can be resolved by reinforcing the soil in a reinforced soil wall system. Geosynthetic reinforced soil walls over the past two decades around the world are considered to be very popular and widely used due to many benefits, such as economic savings, accelerate in construction, apparent beauty and more flexibility, than conventional walls, such as gravity walls. Generally, reinforced soil walls are composed of three parts, the backfill, facing and the reinforcement. The mechanism of the reinforced soil walls is based on the interaction between the reinforcement and the soil, which prevents the soil against ruptures. In most designs of a geosynthetic reinforced soil wall, the bed of the reinforced soil wall is considered rigid. Due to the difference in the behavior of the reinforced soil wall on a compressible or loose bed, relative to rigid bed, investigating the behavior of this system on a compressible bed is considered necessary. In this research, the behavior of geogrid reinforced soil seated on a bed with

ture, distance between structures (d) and soil type, have been thoroughly investigated. The purpose of this paper is to understand the effect of changing each parameter on the nonlinear deflection of structures, investigating the requirements of code and predicting structural behaviour without modelling the adjacent structure. For this aim, six structures of 2 to 15 stories based on two clay samples is modelled with zero, 10 and 25 meters distance and is analyzed using nonlinear time history analysis. Direct method is used for modelling the systems. According to the results, soft base is caused sharp increase in the ratio of the first story drift to the fix-base with a minimum ratio of 1.1 and a maximum of 3.61. The increase of T1 and T2 is led to increase structural deformation so that T1 effects are at least twice T2. For main structures with T1 in the range of 0.7 to 1.5 times the soil period, Structural drift is intensified; but for main structural time period T1 less than 0.7 times the soil period, the effects of structure-soil-structure interaction are negligible. Base on this study, Contrary to the expectation that increasing the distance between structures leads to a reduction in the effects of structural-soil-structure interaction, only for structures with time period more than 3 seconds, increase the distance between structures, is decreased adjacent structures effects. By comparing drift ratio of structure-soil-structure and soil-structure systems, in one third of the upper elevation of the structure, this ratio has a sudden drop that is compensated in the roof, which with decreasing T2 and increasing d, the accumulation of the drift ratio from the roof to the first floor is transferred. Ultimately, what codes are considered for soft support enforcement is unreliable. Finally, by identifying the key parameters of structural-soil-structure interaction, relationships are developed to improve the requirements of the regulations for soft support.

Key Words: Structural-soil-structure interaction, soil-structure interaction, drift, lateral displacement, direct method.

REINFORCING ROLLER COMPACTED CONCRETE WITH METAL AND POLYMERIC FIBERS TO REDUCE REFLECTIVE CRACKING IN COMPOSITE PAVEMENT

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Sharif Civil Engineering Journal
Volume 35, Issue 4.2, Page 119-130, Research Note

- Received 14 August 2017; received in revised form 19 May 2018; accepted 28 May 2018.

Abstract

Due to increase in bitumen prices in the last few years in the country and promotion of the usage of concrete pavements, particularly the usage of Roller Compacted Concrete RCC in urban and suburban roads construction the application of combined pavement has been developed. Also the usage of asphalt overlay to create a suitable surface for deriving on the concrete surface is suggested. The methodology proposed in this study is using metal fibers and polymer fibers, separately, to strengthen the RCC. To increase the bending, tensile and compressive strength of concrete to reduce cracking and failure of the concrete RCC could be a preventive agent. For this study, first, roller concrete mix design was developed and was built as an indicator of tensile strength and compressive and flexural tests were performed on it. The obtained results were recorded as index Results. The following two types of metal fibers with consumption 0.5% and 1% in unit volume and polymer fibers with the use of 0.3 and 0.6% in unit volume in the plans mixture was used this fiber to mix design base were added. Fibers made from blends of standard cylindrical samples with dimensions of 30 x 15 and 50 x 15 x 15 cm prismatic beam samples were made and after processing all the sample tests to determine the compressive strength, flexural and tensile were. The 28 days results indicate that the metal fibers to the RCC at a rate of 0.5% and 1% respectively per unit volume increases the compressive strength of concrete roller 10.1% and 13.9% respectively and increases the tensile strength 29.5% and 45% and increased bending strength up to the 40.6% and 66.5%. And with the addition of polymer fibers at a rate of 0.3% and 0.6% per unit volume increases the compressive strength of RCC by 5.06% and 6.32% and increase the tensile strength of the order of 21.1% and 31% and increased the bending strength of the 29.1% and 42.7% lead.

Key Words: RCC, composite pavement, reflective cracking, fiber.

MECHANIZED TUNNELING-INDUCED SETTLEMENTS IN URBAN ENVIRONMENT: THE CASE

and is considered to be a reliable method for surface water management and protection of surface water quality. Considering the high cost of the treatment of polluted surface water, the present study provides a very useful guidance for authorities to take key management decisions for preventing the uncontrolled expansion of industrial or agricultural zones posing risk of pollution in the sub-basins.

Key Words: Vulnerability, sensitivity, pollution Risk, WRASTIC, NMED.

APPLICATION OF DYNAMIC KINETIC ENERGY AND ARTIFICIAL NEURAL NETWORK TO CRACK IDENTIFICATION IN BEAMS UNDER MOVING MASS

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Sharif Civil Engineering Journal
Volume 35, Issue 4.2, Page 97-106, Original Article

- Received 28 January 2018; received in revised form 29 April 2018; accepted 20 May 2018.

Abstract

In this paper, a novel method has been proposed to identify cracks in beam structures under excitation of moving mass. For this purpose, the dynamic kinetic energy of cracked beam under moving mass were used as criteria to detect crack in structures. Dynamic kinetic energy is depending on the mass and velocities of beam structures under moving mass excitation. The dynamic kinetic energy of cracked beam has been used as input of artificial neural networks in which the crack states as output. This data is acquired by the analysis of cracked structure applying the finite element method (FEM). The artificial neural networks performance has been investigated in training, validation and testing stages. Validation is used to measure network generalization, and to halt training when generalization stops improving. Testing has no effect on training and so provides an independent measure of network performance during and after training. Runge-Kutta 4th Order method has been used to solve the equation of motions of studied beams in Matlab (2015). A validation study has been done with an example that reported in literature. To evaluate the efficiency of the proposed method, two numerical examples consisting of simply supported beam and fixed simply supported beam have been studied. To be more compatible with the real dynamic cases, another examination was performed in which the dynamic kinetic energies with 3% noise are used in crack identification. To perform this, some random noise has been added to the theoretically calculated dynamic kinetic energies. Also, the modeling errors in the analytical model have been studied. It is assumed that the actual tested beam has perturbations of stiffness of 2% at some elements. The obtained results reveal that the presented method is robust and reliable to detect cracks in beam structures under moving mass. Also, the proposed method shows good results using noisy dynamic kinetic energies data.

Key Words: Crack detection, moving mass, beam, dynamic kinetic energy, artificial neural network.

NUMERICAL STUDY OF EFFECTIVE PARAMETERS IN NONLINEAR DEFLECTIONS DISTRIBUTION OF STRUCTURE-SOIL-STRUCTURE SYSTEM WITH FOCUS ON STRUCTURAL RESPONSE CHANGES IDENTIFICATION

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Sharif Civil Engineering Journal
Volume 35, Issue 4.2, Page 107-118, Original Article

- Received 6 February 2018; received in revised form 5 May 2018; accepted 13 May 2018.

Abstract

In this paper, most influential parameters on nonlinear response of structure-soil-structure system, including time period of main (T1) and adjacent (T2) struc-

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Sharif Civil Engineering Journal
Volume 35, Issue 4.2, Page 75-86, Original Article

- Received 3 January 2018; received in revised form 7 April 2018; accepted 23 April 2018.

Abstract

Reinforced concrete buildings constructed before 1970s lack seismic detailing and their longitudinal bars have been implemented in three following manners: without lap splices, with straight lap splices and with hooked lap splices. In this study, the seismic retrofitting of old-type RC columns with plain bars via near surface mounted (NSM) technique as a modern and practical method was experimentally evaluated, and also the effect of different lap splices of longitudinal bars on the behavior of columns was investigated. Six half-scale columns were tested under combined constant axial and quasi-static cyclic lateral loads, including three control specimens with different lap splices and lacking seismic detailing, and three specimens strengthened via NSM technique with steel bars. The results indicated that the retrofitting method has significantly increased the flexural strength and improved the seismic parameters, e.g. energy dissipation, hysteresis damping, and damage index. Due to the formation of struts in the core of the control specimen with hooked lap splices, severe damage was inflicted at the spliced region which decreases the axial loading capacity of these columns after an earthquake. Therefore, their seismic retrofit is a top priority. The proper wrapping of the spliced region of these columns prevents the damage, and the formation of the struts between the hooks increases the lateral strength and improves their seismic performance.

Key Words: Reinforced concrete column, plain bar, lap splice, near surface mounted (NSM), seismic retrofitting.

ASSESSING THE RISK POTENTIAL OF SURFACE WATER POLLUTION BY WRASTIC AND NMED INDICES IN ArcGIS SOFTWARE ENVIRONMENT, CASE STUDY: ASTANE-KUCHESFAHAN REGION IN GUILAN PROVINCE

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Sharif Civil Engineering Journal
Volume 35, Issue 4.2, Page 87-96, Original Article

- Received 15 January 2018; received in revised form 9 April 2018; accepted 23 April 2018.

Abstract

Assessing the pollution Risk Potential of Water resources and its zoning can produce useful information for water resources quality control. Generally, risk includes two features of vulnerability and susceptibility. Accordingly, high vulnerability along with low susceptibility may occur in an area and vice versa. In this study, the surface water pollution susceptibility (Astane-Kuchesfahan region) is analyzed by WRASTIC index and New Mexico Environmental Index (NMED) is devised to address its vulnerability. The required data are provided by the organizations, field studies, geographic information systems and then the surface water risk is assessed by entering this information in ArcGIS software. The results show that different sub-basins have different pollution risk and the existence of the industries, agriculture and household wastewaters are the most important limiting factors in the sub-basins with high pollution risk. According to the numerical values obtained, Sub-basins 1-10 are heavily polluted, Sub-basins 3, 5, 7, 11, and 12 are of low susceptibility, and the other areas are also with low sensitivity. In Sub-basins 1-10, which have a high pollution susceptibility index, the industrial activity factor accounts for the largest share due to industrial activities such as sand and gravel washing plants. It is also a major source of pollution affecting the sub-basin. In other sub-basins, factors like industrial and agricultural activities and untreated urban and rural sewage significantly contribute to pollution. The results obtained by using the NMED method and the number of pollutant sources indicate that in each buffer zone of the sub-basins, Sub-basins 3, 5, and 12 carry moderate vulnerability risk, Sub-basin 6 is of low vulnerability, and the other sub-basins have high vulnerability. According to the results, the method used in the present study is suitable for assessing the risk of surface water pollution

earth load to culvert roof. In addition, the development of positive arching directly above the culvert roof transfers more vertical stresses to adjacent soil columns, leading to larger horizontal stresses applied to buried culvert walls. In this study, by taking benefits of these two common methods, an installation method has been proposed in which the culvert is installed in a trench with a layer of deformable material placed above the box culvert roof, called Trenched Induced Trench Installation (TITI). Firstly, the pressure transferred to the culvert under the weight of soil and surface pressure has been validated using numerical analyses compared with analytical equations that predict the applied pressure. Then, two-dimensional finite element analyses have been performed to explore the effect of various factors on the applied pressure on the roof, sidewalls, and bottom of buried box culvert in TITI method. Results show that soil arching reduces the earth pressure on roof and arching developed between box sidewalls and trench walls; the pressure applied on the culvert side walls can be controlled.

Key Words: Trench installation, induced trench installation, soil arching, transferred stresses, buried box culvert, finite element analysis.

INVESTIGATION OF EXPERIMENTAL BEHAVIOR OF FIXED-ENDED REINFORCED CONCRETE DEEP BEAMS UNDER CYCLIC AND MONOTONIC LOADS

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Sharif Civil Engineering Journal
Volume 35, Issue 4.2, Page 67-73, Original Article

- Received 26 December 2017; received in revised form 4 April 2018; accepted 23 April 2018.

Abstract

Reinforced Concrete (RC) deep beams are a special type of beams due to their geometry, boundary conditions, and behavior compared to ordinary shallow beams. For example, the assumption of a linear strain-stress distribution in the cross section is not valid. In the past decades, considerable research works have studied simply supported concrete deep beams; however, fixed-ended support conditions have scarcely been investigated. Two reasons may be given for this situation: first, fixed-ended conditions are extremely difficult to create in a laboratory; second, fixed-ended conditions introduce additional parameters that add more complexity to the structural model of RC deep beams.

Following the recent tendency for the application of deep beams, the possibility of using fixed-ended deep beams in structures has widely increased. Deep beams are likely to be used as support for upper level columns due to architectural requirements; moreover, the fixed-end connectivity condition will result in experiencing cyclic loads during an earthquake due to the formation of plastic hinges. Therefore, it is necessary to investigate the behavior of this structural element in detail. In this paper, two fixed-ended reinforced concrete deep beams were tested, and their behavior was investigated under monotonic and cyclic loads. The results of these experiments showed that both beams' failures were in shear mode; in addition, the final capacity of fixed-ended deep beam under cyclic load was not significantly reduced compared to " the final capacity" under monotonic loading. The Load-Displacement curvature of this beam under cyclic load showed a hysteretic behavior with low energy dissipation (narrow hysteretic loops), low cyclic degradation (a small increase in displacements under consecutive cycles with constant load amplitude), small residual displacements, and low ductility (the steep drop of resistance after peak load). The crack patterns of the cyclically loaded specimen in the last positive recorded load stage prior to failure were essentially the same as those of the monotonically loaded test.

Key Words: Deep beam, reinforced concrete, fixed-ended, cyclic load, monotonic load.

EXPERIMENTAL EVALUATION OF REINFORCED CONCRETE COLUMNS WITH PLAIN BARS HAVING DIFFERENT LAP SPLICES RETROFITTED VIA NEAR SURFACE MOUNTED TECHNIQUE

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Sharif Civil Engineering Journal
Volume 35, Issue 4.2, Page 43-51, Original Article

- Received 4 December 2017; received in revised form 22 April 2018; accepted 8 May 2018.

Abstract

A vortex settling basin (VSB) is an efficient continuous flushing system to remove sediment in water and wastewater treatment plants. Although many researchers studied this device experimentally, but the complex flow field has not been studied comprehensively. In current study, experimental study was conducted at Ferdowsi University of Mashhad, Iran on a laboratory setup made of Perspex sheet that is comprised of the inlet channel (4 m long, 0.20 m wide, and 0.3m deep), cylindrical chamber (1m m diameter), bottom slope of 1:10 toward the central orifice (0.1m diameter) and outlet channel (3 m long, 0.20m wide, and 0.3 m deep). The 3D velocity field in an experimental VSB was measured by Acoustic Doppler Velocimetry. The effects of vortex generation on basin performance and flow properties (tangential, radial, and axial velocity components) in the VSB were analyzed. Secondary currents were highlighted as important phenomena in settling of sediment particles and their flushing through the bottom orifice. data Moreover, the flow field was calculated using 3-D RANS models including standard k-ε and k-ω models and LES-Smagorinsky model; the SIMPLE algorithm was used for velocity-pressure coupling, and the free surface was simulated using the VOF method. The results of numerical simulation were compared to experimental data including Standard k-ε, k-ω and Smagorinsky models; which Smagorinsky model was superior. The Smagorinsky model satisfactorily simulated the overall pattern of the secondary currents in the VSB although all the simulations had a similar flow field and location of generated vortex and direction of flow were the same. Formation of a force vortex near the bottom orifice and a free vortex in the outer region toward the basin periphery was similar to experimental data. velocity measurements were time averaged value while generated vortex inside the VSB had an unsteady behavior. Therefore, differences between experimental and numerical data are expected.

Key Words: Experimental model, turbulent models, free surface, abstraction ratio, secondary flow.

INVESTIGATION OF APPLIED EARTH LOAD ON BURIED BOX CULVERTS IN TRENCHES USING INDUCED TRENCH METHOD UNDER EMBANKMENT PRESSURE

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Sharif Civil Engineering Journal
Volume 35, Issue 4.2, Page 53-65, Original Article

- Received 23 December 2017; received in revised form 21 April 2018; accepted 30 May 2018.

Abstract

Underground box culverts have been applied to facilitate people's living standard in various ways including municipal sewer lines, water mains, gas and oil lines, electric and telecommunication conduits, and pedestrian and subway tunnels. Design and construction of these conduits demand determining exerted pressure due to the soil and embankment weight above. Several ways have been developed for buried culverts and calculating the soil earth to which the buried culvert is subjected to. Accordingly, the applied load is large and culverts are installed under high embankment; applied pressure becomes more significant. Therefore, the reduction and control of the earth load on culverts is of importance. To date, various methods and theories have been proposed to reduce the applied earth load on these underground structures. Among these, two methods are commonly used: Trench Installation (TI) and Induced Trench Installation (ITI). For the TI method, where the culvert is placed in a narrow trench, the deformable soil tends to settle down, while the adjacent trench walls hold the soil in place due to shearing stresses along the interfaces. This leads to the transfer of load from the fill to the trench walls developing soil arching, hence reducing the vertical pressure transfer to buried box culvert. Another method, ITI, is a construction technique employed to reduce the vertical pressure on buried structure, in which a layer of compressible material is placed directly on the buried culvert to induce positive arching, thus reducing the applied vertical pressure on culvert crown. Meanwhile, researchers have addressed some deficiencies in each method. Trench Installation in comparison with Induced trench Installation transfers larger

of the main concerns is related to the deicer-salt scaling resistance of concrete containing both coarse and fine recycled concrete aggregates (CRCA and FRCA). In this study, two groups of concrete specimens were prepared: (a) mixes containing just CRCA, and (b) mixes containing both CRCA and FRCA. In the first group, coarse natural aggregate was replaced with CRCA at 30% and 50% levels. In the second group, 20% and 40% replacement of natural sand with FRCA was considered in mixes containing 30% and 50% CRCA. The mechanical properties and durability of concrete mixes were examined. Specifically, deicer-salt scaling resistance tests were carried out according to ASTM C 672 and MTO LS-412 R17. All the results showed inferior quality of concrete containing both CRCA and FRCA with respect to concrete containing just CRCA. Similar results were obtained for mixes containing CRCA compared to the reference mix.

Key Words: Coarse recycled concrete aggregate, fine recycled concrete aggregate, mechanical properties, deicer-salt scaling resistance.

IDENTIFICATION OF RIVER GEOMETRIC-HYDRAULIC RELATIONSHIPS USING INVERSE SOLUTION OF THE SAINT-VENANT EQUATIONS AND APPLICATION OF IT

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Sharif Civil Engineering Journal
Volume 35, Issue 4.2, Page 33-42, Original Article

- Received 22 November 2017; received in revised form 13 May 2018; accepted 20 May 2018.

Abstract
This article presents a novel method to identify geometric-hydraulic relationships in rivers. The method is based on inverse solution of the Saint-Venant equations and needs no field-surveyed data about the river cross-sections. Geometric-hydraulic relationships are extracted from cross-sections data and are important in many applications of river such as hydraulic flood routing modeling, sediment transport modeling, contaminant transport modeling, etc. Obtaining cross-sections data needs field survey which is difficult and extensive. In this article these relationships are expressed in terms of mathematical formulas between flow area, wetted perimeter and top width of the river as the dependent variables and water depth as the independent variable and are obtained by inverse problem method. An inverse problem is the process of calculating from a set of observations the causal factors that produced them. Inverse problems are some of the most important mathematical problems in science and mathematics because they tell us about parameters that we cannot directly observe or measurement of them is expensive and difficult. In this method, water level data records are used as an input of the inverse model and then by minimizing the corresponding objective function, the desired outputs will be estimated. The proposed model is validated using hypothetical and real test cases; and in each case the actual and identified geometric-hydraulic relationships are compared. Also application of the method is showed for the case of hydraulic flood routing in conditions where no information is available about river cross sections; and water level data records are used instead of river cross sections data. The results of the flood routing using this method are more accurate and versatile than the ordinary applicable hydrologic methods such as Muskingum. This implies the validity of the proposed inverse model; therefore it can be applied to identify the geometric-hydraulic relationships of rivers by means of easier measurable water level data records than the direct field surveying of the river cross sections.

Key Words: Saint-Venant equations, inverse model, river cross-sections, flow area, wetted perimeter, flow top width.

EXPERIMENTAL AND NUMERICAL MODELING OF FLOW FIELD WITHIN A VORTEX SETTLING BASIN

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tion, it should be used some enhancers to enhance the performance of mechanical performance and in adhesive joints, the adhesion between the fibers in the composite should be increased. One of the ways to increase adhesion between fibers in FRP composites is to use strong resins such as epoxy and also to monitor the proper curing of resins.

Key Words: FRP composites profiles, fiber, resin, bolt connections, adhesive connections.

INVESTIGATING THE EFFECT OF FIBER ON COMPRESSIVE AND SPLITTING TENSILE BEHAVIOR OF CONCRETE VIA EXPERIMENTAL TESTS, DIGITAL IMAGE CORRELATIONS (DIC) AND FINITE ELEMENT METHOD (FEM)

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Sharif Civil Engineering Journal
Volume 35, Issue 4.2, Page 11-20, Original Article

- Received 2 October 2017; received in revised form 16 December 2017; accepted 29 April 2018.

Abstract

The improvement of compressive and tensile strength of concrete has a great importance in the construction industry. In this study, cubic samples constructed in a dimension of 150 × 150 × 150 mm containing different amounts of macro-synthetic (0.1 and 0.15 vol.%) and polymeric fibers (0.2, 0.3, and 0.35 vol.%) by means of seven mix designs. Compressive and splitting tests were performed using a universal testing machine. For each specimen, stress-strain and load-displacement behaviors, absorbing energy, ductility and crack patterns were investigated. In order to analyze the strain variations on the surface of the specimens digital image correlation (DIC) was applied. Moreover, finite element method (FEM) was conducted to evaluate the experimental results. The results of this study show that the presence of fibers in concrete has a significant effect on reducing size and number of cracks, and increases displacement compared to conventional concrete. In addition, displacement at the failure moment in tension and pressure for fiber contained concrete was more than the control specimen. According to the observations, addition of the fibers reduces compressive and tensile strength. However, it is so obvious from the results that by choosing the optimal amount, this reduction would be neglected in comparison with the positive effects of the fibers. Finally, the results indicate an acceptable agreement between the FEM and DIC evaluations. Therefore, considering the low cost and high speed of analysis with FEM and DIC methods, it is possible to combine these two methods as a useful tool to determine the surface characteristics of such specimens.

Key Words: Macro-Synthetic fibers, polymer fibers, compressive and tensile strength, digital image correlation, finite element method.

EVALUATING THE DEICER SALT SCALING RESISTANCE OF RECYCLED AGGREGATE CONCRETE

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Sharif Civil Engineering Journal
Volume 35, Issue 4.2, Page 21-31, Original Article

- Received 9 October 2017; received in revised form 12 March 2018; accepted 5 May 2018.

Abstract

A suitable application for recycled concrete aggregate (RCA) is in concrete pavements. In this regards, one

Abstracts of Papers in English

EXPERIMENTAL EVALUATION OF THE MECHANICAL PROPERTIES AND CONNECTIONS OF THE COMPOSITE PROFILES

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DOI:10.24200/J30.2018.5481.2255

Sharif Civil Engineering Journal
Volume 35, Issue 4.2, Page 3-10, Original Article

- Received 24 December 2017; received in revised form 5 May 2018; accepted 30 May 2018.

Abstract

Due to the increasing need of composite materials to achieve desired properties and functions, the use of composite materials in the construction industry is significantly in a growing trend. In this study, it is tried to introduce the structure and variety of FRP composite materials and then to express about the behavior and mechanical properties of FRP composites and how to find these specifications using tensile testing. The important point in using these materials is their connections. It is tried to initially present about bolted and adhesive connection and then by 3 tests of beam to column connection, using bolted, enhanced bolted and adhesive connections, the performance of these connections have been checked. Innovation used in these study is applying enhanced bolted connection provided by beams and columns. By doing these tests can be seen in terms of strength parameters, the bearing capacity of enhanced bolted connection and adhesive joints is approximately equal and to double amount of corner bolted connection can bear the load. Considering initial stiffness of the frame, enhanced bolted and adhesive was about equal and their initial stiffness was five times more than corner bolted connection. In term of the rotational stiffness, adhesive joints that have the most rotational stiffness with 1.75 times more rather than enhanced bolted connection and 8 times of bolted connection. Adhesive joint has much better performance than bolted connection, but with very little shift rather than bolted connection, will be fragmented (brittle fracture). So in bolted connec-