This research is to shed more light on the secondary flow parameter and its accurate estimation effect on the results. As the first step, the exact experimental values for $\Gamma$ were calculated based on SERC-FCF data, Series No. 2. Then the distribution of $\Gamma$ across the channel was extracted for each sub-section. In opposition to current procedure of SKM calculation, the exact values of $\Gamma$ showed that this parameter is not really constant and follows a distribution of almost third order of the lateral channel coordinate. In the next step, the best function of $\Gamma$ for each experiment was calculated and the results of Shiono and Knight's analytical solution for velocity and shear stress, with and without using the suggested model for secondary flow effect, were compared with the observation data. The comparison certified a good agreement between the results of new model and the experimental data, especially in the border region between main channel and floodplain, where the current procedure on calculation of SKM does not work correctly. Comparison of relative errors between calculated and observed velocities showed that the suggested model was competent to reduce the average of errors from 9.1% to 2.3%.

**Key Words:** Compound channel, shiono and knight method, secondary flow, depth averaged velocity, bed shear stress.

based on the SPO method, is about 8 percent more than the corresponding curve obtained from the IDA method. Generally, for all structural models and all damage states the probability of exceedance obtained from the SPO method is about 12 percent more than that obtained from the IDA method.

**Key Words:** Fragility curve, static pushover analysis, precast reinforced concrete frames, incremental dynamic analysis.

## COMPARISON OF PROJECT COST ESTIMATION WITH CONVENTIONAL METHOD AND DYNAMIC AND SMART MODEL BASED ON BIM BASED ON LIST PRICE

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Sharif Civil Engineering Journal
Volume 36, Issue 2.1, Page 141-150, Research Note


- Received 9 September 2018; received in revised form 25 December 2018; accepted 31 December 2018.

**Abstract**

Since the construction industry is one of the industries that consumes lot of resources, reducing the time and cost in this industry is very noticeable. In recent years, several methods have been proposed to control the time and cost of projects, which has led to the emergence of new technologies in this field. Building information modeling (BIM) is one of these new technologies in the construction industry. Important features of BIM technology are the elimination of conflicts in information related to structures, architectures and facilities, which provides good bases for accurate project cost estimation that are not possible in the traditional estimation. In this paper, using the BIM technology capacity through programming and linking the List Price to it, a dynamic and intelligent model is presented to estimate the project cost (Autodesk Revit software used for modeling and using Autodesk Dynamo software for programming and obtaining project cost estimation, which ultimately enters the outputs in Microsoft Excel software.). To validate it by modeling a building and measuring the results, the superiority of the proposed model Compared to the usual methods of project cost estimates are approved. According to results, the developed model has some capabilities such as increasing the speed and precision of estimation, reducing the deviation from the initial estimation at the end of the project, estimating online with regard to changes (volumes And price).

**Key Words:** Building information modeling (BIM), building quantity take-off, project cost estimation, intelligent model.

## AN ACCURATE MODEL FOR SECONDARY FLOW EFFECT ON LATERAL DISTRIBUTION OF DEPTH AVERAGED VELOCITY IN COMPOUND CHANNELS

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Sharif Civil Engineering Journal
Volume 36, Issue 2.1, Page 151-159, Research Note


- Received 15 September 2018; received in revised form 26 November 2018; accepted 15 December 2018.

**Abstract**

The analytical solution of the lateral distribution of depth averaged velocity in compound channels is known as the Shiono and Knight method (SKM). In comparison with 1-D methods (such as “Divided Channel Method”, “Coherence Method” and “Exchange Discharge Model”), SKM as a 2-D method enjoys the advantage of computing the distribution of local velocity across the channel. SKM uses three coefficients f, $\lambda$ and $\Gamma$ as the representatives of bed resistance, lateral viscosity and secondary currents, respectively. Obviously, accurate estimation of these parameters plays an important role on approaching to exact values. The estimation of f, $\lambda$ and $\Gamma$ has been the subject of numerous researches, but all of them have assumed constant values for $\Gamma$ in width of channel.

**Abstract**

Depreciation of kinetic energy of flow in the stilling basin is one of the most important topics considered by hydraulic engineers. Since hydraulic jump has known as one of the important factors to energy loss in the stilling basin, it is important to form and control it in the basin. The use of expanding section can be one of the ways to ensure the formation of a jump in the basin. This way in comparison to the prismatic channels, increased energy loss of current and reduced the secondary depth and the length of the hydraulic jump. On the other hand, given that the rough bed decreases the secondary depth and the jump length, in the present study, S-jump characteristics on non-continuous trapezoidal roughness elements at two relative roughness height of $1.15 \leq H/y1 \leq 1.68$ and $2.3 \leq H/y1 \leq 3.37$ in the non-prismatic channels were analyzed. The experiments were performed in a in the horizontal rectangular channel which is 30 cm wide, 45 cm deep and 5 m long. A total of 99 experiments were carried out in prismatic channels and non-prismatic channels with expanding ratios of 0.67, 0.5 and 0.33 and range of Froude numbers from 4 to 12. The results of present study show that the shear stress of rough non-prismatic channels in relative height of roughness elements of $1.15 \leq H/y1 \leq 1.68$ was about 11.12 times that on the smooth prismatic channels. Also, rough bed caused a 12 to 17 percent reduction in the conjugated depth and a 7 percent decrease in jump length in comparison to the smooth bed. For the relative height of $2.3 \leq H/y1 \leq 3.37$, the shear stress of a rough non-prismatic channels was 13.2 times that on smooth prismatic channel. The conjugated depth and length of jump in the rough expanding section decreased by 20-30% and 13% respectively. The rough non-prismatic channel at an expanding ratio of 0.33 in comparison to smooth prismatic channel caused 59.5% reduction in the secondary depth and increased jump efficiency about 29%.

**Key Words:** Trapezoidal elements, hydraulic jump, expanding section, depth ratio, energy loss.

# DEVELOPMENT OF FRAGILITY CURVES FOR PRECAST CONCRETE FRAMES COMPARING THE METHODS OF STATIC PUSHOVER AND INCREMENTAL DYNAMIC ANALYSIS

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Sharif Civil Engineering Journal
Volume 36, Issue 2.1, Page 129-140, Original Article


- Received 22 October 2018; received in revised form 30 December 2018; accepted 9 January 2019.

**Abstract**

Fragility curves provide damage probability as a function of ground motion characteristics and design parameters. In this study, we developed fragility curves for the precast reinforced concrete system, used in the construction of buildings in some high earthquake-prone zones in Iran. For accurate seismic demand estimation, we developed a numerical model for the precast beam-to-column connection based on the experimental results presented in the relative research. Incremental Dynamic Analysis (IDA) of the 3 and 5-story frames was conducted under the appropriate ground motion records set. The records database includes 10 far-fault records and10 near-fault records in which 5 records have pulses and 5 records do not have pulses. In IDA, multiple nonlinear dynamic analyses of the frames were performed using the OpenSees software under the ground motion records, each record scaled to several levels of seismic intensity from 0.1g up to the level at which structural collapse occurred. Based on the IDA results, the median and standard deviation values for the construction of the fragility curves were proposed at the four damage states of slight, moderate, extensive and complete. Results demonstrate that for a given seismic intensity level, the precast frames are more seismic vulnerable than the cast-in-place moment resisting frames. At a given level of seismic intensity, seismic vulnerability at four damage sates increases with increasing the height of the frames. The probability of exceeding the complete damage state at the design earthquake level was obtained to be 0.56 and 0.63 for the 3 and 5-story precast concrete frames, respectively.

Considering that incremental dynamic analysis requires large computation efforts, we evaluated the possibility of using the static pushover analysis (SPO) in the development of fragility curves. For this purpose, the fragility curves were derived based on the pushover curves using the SPO2IDA algorithm. The results show that for all considered models at four damage states, the SPO method provides an acceptable approximation of the fragility curves. The accuracy of the SPO method in the development of fragility curves is improved at higher levels of response. The fragility curve of the 3 and 5-story frames for the complete damage state, developed

25% recycled aggregates and 5% microsilica have closer properties to the control mixture and can be a proper alternative to the control mixture.

**Key Words:** Self-Compacting concrete, recycled aggregates, microsilica, mechanical properties, rheological properties.

## FINITE ELEMENT ANALYSIS OF LINEAR VISCOELASTIC PROBLEMS USING THE PROPOSED GAUSSIAN-FOURIER SHAPE FUNCTIONS

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Sharif Civil Engineering Journal
Volume 36, Issue 2.1, Page 103-117, Original Article


- Received 3 September 2018; received in revised form 1 January 2019; accepted 12 January 2019.

**Abstract**

In this paper, an enhanced finite element method is proposed for two-dimensional linear viscoelastic problems using new Gaussian-Fourier elements, and the results are compared with those obtained by classical Lagrange quadrilateral elements. Shape functions in Gaussian-Fourier elements are obtained by the enrichment of the proposed Gaussian-Fourier Radial Basis Functions with polynomial function fields. The idea for Gaussian-Fourier Radial Basis Functions came from the integrating Gaussian Radial Basis Functions with Complex Fourier Radial Basis Functions to be more efficient than each individually. In these proposed shape functions, there is a shape parameter, which is a constant unknown parameter that is selected to increase approximation's accuracy. It is shown that Gaussian-Fourier shape functions over an element satisfy all the requirements necessary for the assurance of convergence to the actual solution as the number of elements is increased, and their size is decreased. The Patch test is performed by utilizing Gaussian-Fourier elements in advance. In this study, based on the experience of the authors, it is proposed that a suitable shape parameter for each problem is adopted based on an acceptable approximation of the problem's geometry by a Gaussian-Fourier element. The Finite element formulation proposed by Zocher for linear viscoelasticity is adopted in this article. In this numerical algorithm, the constitutive equations, expressed in an integral form involving the relaxation moduli, are transformed into an incremental algebraic form prior to the development of the finite element formulation. In order to illustrate the validity and accuracy of the present approach two numerical examples, with available analytical solutions, are examined. The Results showed that Finite element solutions obtained by the proposed approach were in great agreement with analytical solutions even though noticeable fewer elements are required in comparison to the classic Finite Element method; therefore, the computational costs are reduced effectively. This fact may be attributed to the robustness of the proposed shape functions and their efficiency in viscoelasticity.

**Key Words:** Finite element method, viscoelasticity, gaussian-fourier radial basis functions, gaussian-fourier shape functions, shape parameters.

## EXPERIMENTAL STUDY OF THE ROUGHNESS BED WITH NON-CONTINUOUS TRAPEZOIDAL ELEMENTS ON S-JUMP CHARACTERISTICS IN THE NON-PRISMATIC RECTANGULAR CHANNEL

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**DOI:10.24200/J30.2018.51630.2423**

Sharif Civil Engineering Journal
Volume 36, Issue 2.1, Page 119-128, Original Article


- Received 9 September 2018; received in revised form 15 December 2018; accepted 22 December 2018.

Volume 36, Issue 2.1, Page 79-90, Original Article


- Received 26 August 2018; received in revised form 21 November 2018; accepted 23 January 2019.

**Abstract**

Rockfill dams that are made by dumping and compacting rockfill materials are known as one of the most economical and safe dams. The main mechanical characteristics of rockfill depend on particle breakage. Particle breakage occurs when the stress levels are high enough or when the size of the particles is high enough as the rockfill particles. Particle breakage causes a change in grain size distribution of the media and causes a change in the mechanical properties of the granular media. Particle breakage is widely studied experimentally by classical laboratory tests, which need large and expensive equipment that is rarely available. Although numerical methods that are based on the continuum mechanics, such as finite element method, have been developed to be able to account for discontinuities; nevertheless, the internal discrete structure of the rockfill cannot be considered and physically modeled in this way. In addition, the fact is that these methods are not capable to simulate particle breakage to predict the mechanical properties of the rockfill materials. Discrete Element Method (DEM) can overcome these problems. In this research, discrete tri-dimensional modeling of rockfill behavior considering the particle breakage using DEM is studied. Particle breakage is modeled by a bonded particle model and, to consider particle breakage, a mechanical threshold criterion combined with a contact density of particles and a probabilistic criterion is used. PFC3D code and programming in FISH language were performed by investigating the resistance and deformation behavior. In addition, the effects of particle breakage during the tests were considered by providing a failure criterion. The model is compared with the experimental tests on Purulia rockfill dam materials, and the obtained results show good concordance with the obtained experimental results. Finally, the model and the presented failure criteria, whilst it has a simple computational procedure and high accuracy, were validated.

**Key Words:** Discrete element method, particle breakage, three-dimensional modeling, rockfill.

## EVALUATION OF THE MECHANICAL AND RHEOLOGICAL PROPERTIES OF RECYCLED SELF-COMPACTING CONCRETE AND REINFORCEMENT WITH MICROCILICA

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Sharif Civil Engineering Journal
Volume 36, Issue 2.1, Page 91-102, Original Article


- Received 28 August 2018; received in revised form 28 November 2018; accepted 4December 2018.

**Abstract**

Self-compacting concrete (SCC) is highly flowable concrete that can fill formwork without any mechanical vibrationis and able to flow under its own weight. In recent years, use of SCC has increased for placement in congested reinforced concrete structures with difficult casting conditions. On the other hand, environmental protection and waste recycling have become hot issues of common concern in the international community. The generated construction waste due to the global building (structure) removal and demolition, war, earthquakes etc. is becoming huge. In addition, the concrete with recycled aggregate is economically justifiable. In this study, the effect of replacing different percentages of fine and coarse recycled aggregates on the mechanical and rheological properties of SCC is evaluated. For this purpose a self-compacting concrete control mixture with natural aggregates is prepared in the first step. Then in the second step, recycled fine and recycled coarse aggregates with levels of 25, 50, 75 and 100 percent, replacing natural fine and natural coarse aggregates, in two distinct phases, and fresh and hardened concrete tests are done. Fresh concrete tests include: diameter of the slump, slump T50, funnel V, Box U, L-box tests and hardened concrete tests include: compressive, tensile and flexural strength tests. In each phase, a mixture that has the least negative changes in terms of mechanical and rheological properties compared with the control mixture, is selected for the next step of the research. Results showed that the mixture with 25% replacement of fine recycled aggregates and the mixture with 25% replacement of coarse recycled aggregates have the least negative changes compared with the control mixture. In the next step, to improve the weakened properties of the mixtures with 25% replacement of coarse or fine recycled aggregates, cement is replaced by microsilica with levels of 5, 7.5 and 10 percent. Results show the mixtures with

by cracking along the interface of cold-joint are higher. This paper presents a model to simulate the cold-joint in concrete elements in the ABAQUS finite element package. Simply supported beams under three-point bending with the same compressive strengths of concrete on both sides of the cold-joint are considered, and three different sizes of geometrically similar cold jointed interface specimens are evaluated to consider the size effect using the Bazant's size effect model of concrete. The Mode-I of fracture mechanics is working in the three-point bending tests by notched beams in plain concrete. In order to achieve the best results of numerical modeling on the concrete beam, a number of stress-strain relations of concrete for compression and tension in different combinations were evaluated on the beam with monolithic concrete and, among them, the pair had the best results, compared to the experimental result, which was used for the modeling of concrete beam with a cold-joint. In addition, negligibly small thickness of the cohesive element with a linear softening relationship in the traction-separation law was used for modeling the cold-joint. The comparisons are made for load-deflection and load-crack mouth opening displacement (CMOD) plots. The finite element analysis results are in good agreement with the observations and data in experimental testing.

**Key Words:** Cold-Joint, numerical modeling, concrete fracture mechanics, stress-strain curves of concrete for compression and tension, three-point bending concrete beam model.

## EXPERIMENTAL INVESTIGATION OF EXPANSIVE GROUT EFFECT ON NAIL PULLOUT RESISTANCE IN SANDY SOILS

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Sharif Civil Engineering Journal
Volume 36, Issue 2.1, Page 71-77, Original Article



- Received 24 July 2018; received in revised form 16 November 2018; accepted 9 December 2018.

**Abstract**

By growing of urban life and increasing demand for construction, as well as requirement of appropriate space for parking and facilities, excavation has become an integral part of most construction projects. One of the new and effective methods for stabilizing excavation is nailing method. One of the important parameters of the design in this method is bond strength, which is significantly influenced by the grouting process. The grouting process depends on various parameters such as grouting pressure, grouting algorithm and mortar components, but due to the lack of studies on the effect of mortar components on bond strength, the effect of an expansive additive in the grout on the bond strength investigated by a pullout box in the laboratory. The pullout box has different parts such as overburden pressure unit, grouting unit, loading unit and monitoring unit. First the soil strength parameters obtained by direct shear test. Also grout's compressive strength obtained by grout compressive strength test with UTM. In the pullout test, first the soil with optimum moisture, compacted layer by layer while a steel casing embedded in the middle of the box. After applying overburden pressure with an airbag for 24 hours and setting equilibrium in the soil, the steel casing removed and the steel bar placed in the hole, then grouting process started. Finally, after 5 days, the loading process started, by pulling out the grouted nail using speed of 1 mm/min. Also the grout compression strength tests have done to investigate how expansive additive influences on mortar. The results showed that the use of expansive additive to a certain and optimum extent, despite of reduction in mortar compression strength, causes increase in bond strength in the laboratory sample. Also by increasing the grouting pressure, the pullout resistance increases to high extent, which is recommended in projects.

**Key Words:** Nailing, pullout box, expansive grout, grout pressure.

## THREE-DIMENSIONAL MODELING OF ROCKFILL USING DEM CONSIDERING PARTICLE BREAKAGE

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Sharif Civil Engineering Journal

# SYSTEMS - CASE STUDY: EASTERN CATCHMENT OF TEHRAN

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Sharif Civil Engineering Journal
Volume 36, Issue 2.1, Page 49-60, Original Article


- Received 11 July 2018; received in revised form 6 October 2018; accepted 11 November 2018.

**Abstract**

Nowadays, design/rehabilitation of urban stormwater drainage systems has become a challenging issue due to more frequent severe floods in urbanized areas. These severe floods may cause significantly crucial social problems as well as financial damages. Also, regarding considerable advance in soft computing, optimization frameworks can provide a valuable computational tool for storm management. In the present study, using NSDE (Non-dominated Sorting Differential Evolution) algorithm and EPA-SWMM (Environmental Protection Agency - Stormwater Management Model) software, a coupled numerical and multi objective optimization model was developed to rehabilitate eastern part of Tehran metropolis drainage system. Not only is this part of Tehran Stormwater Drainage System (TSDS) the biggest drainage network of TSDS, but also its eastern part is dealing with a significant lack of capacity. In this direction, different mitigating strategies including combinations of relief tunnels and/or storage units were evaluated and optimal rehabilitation strategies were suggested according to minimizing conflicting objective functions of costs and flooding. For this purpose, formerly suggested rehabilitation solutions introduced by Mahab Ghodss consulting engineering company have been evaluated and extra relief tunnels considered to enhance their performance in relation to reduce volume of flooding in the network. Therefore, the total number of four different layouts of rehabilitation strategies have been assumed in order to rehabilitate eastern part of TSDS. Results have revealed considerable reduction of costs with respect to previous rehabilitation proposals for the study area stating the desirable performance of proposed coupled numerical and optimization framework of the present study. Moreover, regarding application of storage units in upstream of the network, although these units reduced rehabilitation costs significantly compared to other strategy by reducing length of required relief tunnels, relief tunnels slightly outperformed than upstream storage units in relation to the flood volume reduction. It seems possible to enhance the performance of storage units by relocating them.

**Key Words:** Urban stormwater drainage systems, numerical, optimization, relief tunnels, storage units.

# NUMERICAL MODELING FOR SIMULATION OF OPENING MODE IN FRACTURE MECHANIC OF CONCRETE COLD-JOINT

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Sharif Civil Engineering Journal
Volume 36, Issue 2.1, Page 61-70, Original Article


- Received 16 July 2018; received in revised form 12 January 2019; accepted 23 January 2019.

**Abstract**

A cold joint is a plane of weakness in concrete caused by an interruption or delay in the concreting operations. It occurs when the first batch of concrete has begun to set before the next batch is added so that the two batches do not intermix. Sometimes, cold joints occur because of emergency interruptions and delays and sometimes because of the work stoppage at the end of the day; however, they can occur due to poor consolidation. Usually, the latter condition can be seen at the top and bottom of columns in concrete frames because of the traditional construction method. Basically, the interface of the cold-joint is relatively weaker than both sides of materials. For this reason, the performance of concrete elements with the cold-joint is under the influence of that behavior. In a system with a cold-joint, the chances of failure

these structures, numerical methods are required due to the fact that the governing equations are complicated. The meshless method was well implied for many structural problems in recent decades. In this method, the scattered nodes with regular or irregular distributions are used to discretize the field functions in local subdomains. Because of using the nodes rather than the elements, the application of meshless method in some problems yields to more accurate results. To interpolate the fields' variables in terms of its nodal values, the radial point interpolation method (RPIM) with radial basis function (RBF) is used. The radial point interpolation method (RPIM) is employed to construct the shape functions. Because of the fact the interpolation function type affects the results of meshless approach, various interpolation functions are investigated. Then, the most proper one is selected for analyzing the porous material structure. To verify the presented method, the result of cylinders made of saturated porous materials using MLPG method under dynamic loading is compared to the analytical results. A good agreement between the presented method and analytical result is achieved. It is worthwhile to mention that damping should be included in dynamic analysis. Hence, the modeling of damping effect on the behavior of porous material is conducted. According to the obtained results, for the usual damping ratios of the porous materials, increasing the damping ratio leads to reduction in the displacement amplitude and stress. Also, it is observed that the period of the porous material are independent from its damping ratio.

**Key Words:** Radial basis functions, porous materials, rayleigh damping, MLPG method, dynamic loads.

## CIRCULAR HYDRAULIC JUMP OVER THE BEDS WITH ADVERSE SLOPE

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Sharif Civil Engineering Journal
Volume 36, Issue 2.1, Page 37-47, Original Article



- Received 26 June 2018; received in revised form 3 November 2018; accepted 17 November 2018.

**Abstract**

One of the most common energy dissipator structures is the hydraulic jump-type stilling basins, in which the flow excess kinetic energy is dissipated by the generation of a hydraulic jump, changing the flow regime from super- to sub-critical flow. Due to the extensive use of stilling basins in hydraulic systems and irrigation and drainage networks, their study was the focus of several investigations. For the hydraulic design of stilling basins, three parameters including the length, sequent depth, and head loss of the jump are the major parameters having great effects on designing economical stilling basins.

In the present study, analytical and experimental investigations were performed to study the profile of circular hydraulic jumps on slopped beds with adverse slope. The study mainly focused on the conjugate depth ratio, relative head loss, and relative length. In the analytical model, we applied a series of reasonable assumptions and used integral equations governing the fluid dynamics to derive relationships for the conjugate depth ratio and the relative head loss, which are applicable to both classical and circular hydraulic jumps. Experimental study was carried out in a cubic reservoir, in which a circular bed of 2 m in diameter was applied as the circular bed in its center. In the experimental study, flow discharge, initial and secondary depth, and length of the jump were measured. According to the results, by increasing the ratio of the conjugate radius and the bed slope, the ratio of the conjugate depth and jump length decrease and the relative head loss increases. The accuracy of the analytical relationships compared to the experimental was checked, applying four error functions including; coefficient of determination, normalized root mean square, weighted quadratic deviation, and efficiency function, showing a relatively good correlation between the experimental and the analytical results. Furthermore, by using the experimental data, the length of the circular hydraulic jump was investigated. Results show that, in this type of jump, the length of the hydraulic jump is approximately half that of the classical hydraulic jump.

**Key Words:** Stilling basin, circular hydraulic jump, adverse slope, conjugate depth.

## DEVELOPMENT OF A COUPLED NUMERICAL AND MULTI-OBJECTIVE OPTIMIZATION MODEL TO REHABILITATE URBAN STORMWATER DRAINAGE

nificant reduction in brittleness and showed better ductility. The response of beams significantly depends on the method of confinement by transverse reinforcement and also the distribution of longitudinal reinforcement.

**Key Words:** Prestressed concrete beams, transverse and longitudinal bars, ultimate strength, cracking, ductility.

## THE EFFECT OF GAP BETWEEN REINFORCED CONCRETE WALL AND THE STEEL PLATE ON BEHAVIOR OF THE BUCKLING-RESTRAINED STEEL PLATE SHEAR WALL

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Sharif Civil Engineering Journal
Volume 36, Issue 2.1, Page 13-25, Original Article


- Received 22 April 2018; received in revised form 22 July 2018; accepted 4 November 2018.

**Abstract**

Steel shear wall is one of the relatively new resistant systems that has been used in designing and reinforcing high-rise buildings in the last four decades. Due to the optimal performance of this type of lateral load system, including high hardness, good ductility, and high energy dissipation, this system can also be used to rebuild non-lethal structures. The composite steel shear wall consists of a steel plate surrounded by slats by beams and columns and concrete coverings on either side or both sides of the steel plate. In this system, the reinforced concrete coating, by inhibiting the steel plate and preventing its buckling, raises the shear capacity of the steel shear wall to the extent that it is submitted to the inside of the sheet plate instead of stretching along the tensile field (which occurs in thin steel shear walls). In this research, a new type of composite steel shear walls, in which the concrete covers, instead of the complete bond with the sheet, is studied numerically. Accordingly, the steel shear walls with concrete coatings of zero and 15 mm between steel sheets and concrete coatings have been studied parametrically after the verification. In addition, these studies have been carried out between concrete casing and perimeter frame in two cling-and-seamed modes. The results of numerical studies of more than 160 finite element models showed that increasing the distance between concrete and steel sheet reduced the strength and hardness of the system. Moreover, in the case where there is a gap between the concrete and the steel sheet, the coefficient of behavior is 11.21 on average and 8.11in the non-distant state. In addition, concrete casting on both sides of the steel plate in a non-distant area with boundary elements causes a 45% increase in hardness.

**Key Words:** Bowhard steel shear wall, concrete cover gap, hardness, resistance, coefficient of behavior.

## MODELING RAYLEIGH DAMPING AND VARIOUS RADIAL BASIS FUNCTIONS OF CYLINDERS MADE OF SATURATED POROUS MATERIALS USING MLPG METHOD UNDER DYNAMIC LOADING

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Sharif Civil Engineering Journal
Volume 36, Issue 2.1, Page 27-35, Original Article


- Received 26 May 2018; received in revised form 11 August 2018; accepted 13 November 2018.

**Abstract**

Porous materials are widely applied in different engineering fields such as chemical engineering, materials engineering, environmental geomechanics, biomechanics, soil structure interaction and geomechanics. For this reason, dynamic and static analysis of the stress and strain of structures and continuum made of these materials have attracted the attention of researchers. To analyze

# Abstracts of Papers in English

## EXPERIMENTAL INVESTIGATION OF THE EFFECT OF THE AMOUNT AND ARRANGEMENT OF LONGITUDINAL AND TRANSVERSE BARS IN PRESTRESSED CONCRETE BEAMS, UNDER BENDING

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**DOI:10.24200/J30.2018.5271.2224**

Sharif Civil Engineering Journal
Volume 36, Issue 2.1, Page 3-11, Original Article


- Received 18 October 2017; received in revised form 20 October 2018; accepted 9 December 2018.

**Abstract**

The recent changes in urban communities and consequently the need for thinner strong concrete structures has caught researchers' attention. Structural performance characteristics such as ultimate loads, maximum loads, and ductility along with formation and propagation of cracks in prestressed concrete beams have been studied by many researchers. In this paper, an experimental study was carried out to investigate the effect of amount and arrangement of non-prestressed longitudinal and transvers bars on improving the performance of six prestressed concrete beams with identical geometry and concrete properties under static loads. Cracking strength, formation and propagation, ultimate load carrying capacity and ductility of beams were determined. Unbonded post-tensioning is applied to 7-wire strand tendons with Grade 270 and diameter of 0.5in that are positioned with constant eccentricity within the beam. The test results indicate that adding non-prestressed reinforcement to concrete beams generally has a significant effect on properties of prestressed concrete beams such as ultimate load, maximum load, ductility and pattern of crack formation and propagation and also have a sig-