Key Words: Functionally graded beam, thermal buckling, first-order shear deformation theory, differential quadrature method.

STUDY OF BEHAVIOR OF THIN STEEL PLATE SHEAR WALLS UNDER VERTICAL AND HORIZONTAL COMPONENTS OF EARTHQUAKE

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Abstract

The current philosophy of seismic design in codes advises that member stresses, due to the impact of horizontal ground motion acceleration, be determined without consideration of vertical component effects. Nevertheless, the reported forms of structural damage due to near fault earthquakes are in the way that specialists allocate a role for vertical components of earthquakes in the formation of such damage. Thin steel plate shear walls are one of the newest resistant systems, whose behavior until now has not been investigated under vertical components of an earthquake Therefore, in this article, the nonlinear behavior of 3, 10 and 20 story shear wall models is studied under several ground motions of vertical and horizontal components of earthquakes, as well as the formation process of plastic hinges, and different modes of failure are also analyzed. Results show the suitable behavior of this system under vertical components of the earthquake, and even, simultaneously, with a horizontal one. First, damage occurs in the plate of the wall, then beams, and, finally, columns are damaged. In addition, results show that vertical components of earthquakes have a considerable effect on the axial force of columns (1000-1500%). The effect of this component on the axial force of columns in mid-storey and high-storey buildings is much more than in short-storey buildings. In short-storey buildings, the effect of the vertical component of the earthquake is more in the higher stories, but, the effect of this component in mid and high-storey buildings is more in lower stories.
The vertical component of an earthquake has a considerable effect on the bending moment of columns (100-600%), and increasing the height of the building does not influence the effect of this component. In short-storey buildings, the effect of the vertical component of an earthquake on the bending moment of columns is more in the higher stories, but, the effect of this component in mid and high-storey buildings is more in mid-stories.

Key Words: Vertical component of earthquake, thin steel plate shear wall, plastic hinges, failure (damage) modes.

EXPERIMENTAL AND THEORETICAL INVESTIGATION OF STEEL MOMENT FRAMES RETROFITTING USING CABLE BRACING

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Abstract

Steel moment frames have both suitable ductility and high ability to absorb earthquake energy. However, due to insufficient lateral stiffness, under high lateral forces, they undergo large displacements. In this paper, the possibility of using cable bracing to control lateral displacement and to strengthen steel moment frames were studied, including the desire to retain their ductility. In this research, some experimental tests were carried out and several finite element analyses were undertaken for the steel moment frame; retrofitted moment frames with X, and eccentric cable bracing. Frame displacement, base shear hysteresis behavior and column axial forces were also investigated. First, the behavior of the steel moment frame and the moment frame retrofitted by eccentric cable bracing under static loads, was investigated experimentally. Then, the moment frame finite element model was prepared using ABAQUS software, and the results were verified by experimental data. Three models were created, one for the moment frame, one for the moment frame retrofitted by X, and the last for eccentric cable bracing. In these models, the force-displacement hysteresis behavior and frame column axial forces under cyclic loading were determined and compared with each other. Next, ten models were prepared for the moment resisting frame; the moment frame retrofitted with the eccentric and concentric cable bracings. For these frames, the influence of the cable bracing connection to the steel beam situation on frame ductility and its strength was studied. It was observed that the eccentric bracing cables, by maintaining steel moment ductility, created strength, while it was increasing lateral stiffness. It was realized that they had suitable behavior compared with X-bracing cables and, by retrofitting moment frames with eccentric cable bracing, the increasing rate of column axial force was much less than in those retrofitted by X-bracing cables. It means that by using eccentric cable bracing to retrofit steel moment frames, there is little need to retrofit boundary members, such as columns, column bases and foundations.

Key Words: Steel moment frame, Retrofitting, Eccentric cable bracing, Concentric cable bracing, Base Shear, Cyclic loading.

THERMAL BUCKLING ANALYSIS OF FUNCTIONALLY GRADED BEAMS USING DIFFERENTIAL QUADRATURE METHOD

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Abstract

Modern materials such as, laminated composites, functionally graded, etc., are widely used in different fields of engineering. In functionally graded materials, material properties may be varied in thickness direction from steel in one side to ceramic on the other side, which gives high temperature resistance, increases buckling temperature of structures and better performance of the structures subject to high temperature change. In the presented study thermal buckling of moderately thick functionally graded beams is investigated using differential quadrature method. The governing equations are derived based on the first-order shear deformation theory (Timoshenko theory) and plane stress assumption. Differential quadrature method is used to discretize the governing equation and the related boundary conditions. Convergence rate and accuracy of the differential quadrature method, influence of boundary conditions, thickness to length ratio and the other parameters are studied.

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Abstract

Hot Dry Rock geothermal reservoirs differ considerably from conventional geothermal reservoirs which exist only in the geologically privileged regions. In fact, HDR reservoirs are artificially created reservoirs which can be considered at any accessible depth of the Earth's crust with a suitable volume of hot dry rock. One of the main characteristics of HDR reservoirs is enough permeable paths to allow water flow in the region between injection and production boreholes. Hydraulic stimulation is a technique employed to create these permeable paths in such regions. A pair of wells is drilled into the rock, terminating several hundred meters apart. Water is circulated down the injection well and through the HDR reservoir, which acts as a heat exchanger. The fluid then returns to the surface through the production well and, thus, transfers the heat to the surface as steam or hot water.

Knowledge of the shape, size and permeability of the fractured zone created by stimulation is important for assessment of the feasibility of the project and determination of the optimum relative locations of the injection and production borehole. Improving permeability allows the system to reduce its hydraulic resistance. This operational hydraulic parameter, which is called impedance, measures the pressure amount required to force water at unit flow rate through the reservoirs. Another important parameter called the water loss rate is the difference between the rates of water injected and produced. Since stimulation experiments conducted at great depths are very expensive, numerical modeling can play a significant role. In this research, the hydraulic and mechanical response of jointed rock mass in a HDR reservoir is treated under high pressure hydraulic injections using a distinct element code. The code is capable of considering Hydro-Mechanical coupling. A parametric study on different joint specifications is carried out to illustrate how the impedance and water loss rate are varied.

Key Words: Hot dry rock, HDR, hydro-mechanical couplings, stimulation, UDEC.

EVALUATION AND CALIBRATION OF CONCRETE AND STEEL MATERIAL MODELS FOR STEEL PROJECTILE IMPACT ON CONCRETE TARGET

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Abstract

The study of RHT parametric model and its calibration parameters have been used in the simulation affaivs if the concreto strike in Autodyn software.A reliable simulation of the concrete behavior can gain a significant understanding of the real physical mechanisms and the development of practical design guidelines based on parametric investigations using validated numerical models. The RHT model is one of them that widely used in impact and penetration analysis. The RHT model covers essentially all macro features of quasi-brittle materials such as concrete and rocks under high strain rate loading. However, the model was found to exhibit undesirable performance under some loading conditions. In the present study parametric analysis of the RHT model and its parameters calibration is carried out in impact and penetration analysis. The model performance is based on its constants values. These parameters are related to equation of state, strength, failure and erosion models. In the model, strain hardening and tensile and compressive meridian dependent to third invariant are considered. Softening behavior is modeled as nonassociative failure surface. Rate dependent tension and compression strength are considered.The model structure is based on plastic damage .Shear damage due to diavotoric stresses is considered too. Due to nessecary of steel projectile modeling, the Johnsoon-Cook model introduced further. The Johnsoon-Cook model is a strength model for metal response modelling at high strain rate and higt temperature loads.Following introduce of models and their submodels, analyze of an experimental test and parametric studies on concrete model, steel model state of equation and numerical aspects of analysis are presented. The investigated parameters are : mesh size, residual strength constant, residual strength exponent, tensile strain rate exponent, compressive strain rate exponent, intact failure surface constant, intact failure surface exponent, erosion criteria, energy error, friction, vlocity and shape of the projectile. Results show that using deduced modified parameters setting, the RHT model exhibits excellent results in modeling experimental tests.

Key Words: Constitutive model, steel projectile, concrete target, impact ,RHT model.

due to internal erosion, is characterizing the material properties relevant to the rate of failure. Therefore, it is very important to improve the erosion resistance of soils using appropriate and cost effective techniques. Using chemical stabilizers is one effective method of preventing internal erosion in earth dams. In this study, a chemical stabilizer based on lignin; lignosulfonate, has been used for the treatment erodibility of kaolinity clay sand. The new stabilizer, lignosulfonate, is utilized to evaluate its effectiveness in increasing erosion resistance. To conduct this research, kaolinity clay sand has been treated with different dosages of lignosulfonate and tested with hole erosion apparatus under different hydraulic gradients.
The results indicate that the erosion rate of kaolinity clay sand is extremely rapid, and chemical lignosulfonate stabilizer increases the resistance of kaolinity clay sand to erosion. It was also found that the erosion coefficient of erodible soil (kaolinity clay sand) decreased from 0.01020 to 0.000017 with the addition of 3.0extremely rapid to moderately slow erosion.

Key Words: Internal erosion, embankment dams, stabilizers, lignosulfonate.

FUZZY CLUSTERING OF ATTENUATION RELATIONSHIPS FOR SEISMIC HAZARD ANALYSIS IN IRAN

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Attenuation relationship models are key elements within any seismic hazard analysis (SHA). As the results of SHA can be significantly changed by using different attenuation models, it is necessary to select an appropriate attenuation model for SHA. This selection is usually done without enough attention paid to the compatibility of the chosen attenuation model with the historical site database. That is, the selection of an appropriate attenuation model for regions that suffer from lack of their availability is usually a serious challenge. Therefore, the fuzzy C-Mean clustering approach is employed and modified in this study in order to classify available well-known attenuation models into different clusters.
A set of 45 worldwide attenuation models were selected in this research for the purpose of classification. It worth noting, that the input definition for all the chosen models should be consistent, and so, a transformation procedure was needed. They were classified into 14 different clusters, in which, each cluster was defined to have the most dissimilarity with the other clusters, and to have the most similarity within the cluster. The 45 models were then classified into a different numbers of clusters and the corresponding border-models were eliminated. This clustering was iterated until a reasonable clustering was achieved. The final clustering consists of 34 attenuation models put into 14 different clusters.
The resulted clusters were, then, tested for the Iranian ground motion database. The database consists of 28 earthquake events with 78 accelerograms. The root mean of the sum of the squares (RMSE) and the mean absolute error (MAE) indicators were employed, in order to compare the different clusters for the given database. The results show that the best fitted models consist of Takahashi et al. 2004, Zhao et al. 2006, for the crustal and inter-slab zones, and Zafarani et al. 2012. On the other hand, the worst attenuation models, which did not adequately fit the Iranian database, included Khademi et al. 2002, Gulkan and Kalkan et al. 2002 and Ghodrati et al. 2010.

Key Words: Seismic hazard analysis, attenuation relationships, fuzzy clustering, fuzzy c-mean clustering, Iranian ground motion database.

APPLICATION OF NUMERICAL MODELING IN SIMULATION OF HDR RESERVOIR BEHAVIOR DURING HYDRAULIC STIMULATION

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Key Words: Non-linear time history analysis, steel structures, tall buildings, drift controlling criteria.

CHARACTERISTICS CHANGE OF KAOLINITE AND BENTONITE DUE TO HEAT TREATMENT FROM MICRO-STRUCTURAL ASPECTS

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Abstract

Clayey soils may be exposed to different heat gradients which cause permanent or semi-reversible variations in their engineering behaviour. The use of clayey soil in construction materials and the application of bentonite as barrier material in atomic waste disposal are among cases in which clayey soils are subjected to heat gradient from low to high ranges. The review of prior research indicates that previous studies have mainly focused on the mechanical and macro-structural behaviour of soil. In other words, there is little research emphasizing the soil microstructure in this process. This research is aimed to investigate the characteristic changes of kaolinite and bentonite due to heat treatment from micro-structural aspects. To achieve this objective, the soil samples were exposed to different heat regimes; from 25 to 1100 centigrade. After measuring the variations generated in the unconfined compression strength of the heated samples, by a series of XRD and SEM experiments, the microstructural changes in the soil samples were examined and their impact upon the macro-structural behaviour was addressed. The results indicate that the interpretation of variations in the strength of the heated samples can be evaluated by monitoring the soil microstructure, such as de-hydroxylation, and the formation of new minerals after heat treatment. According to the achieved results, the extent of the influence of heat treatment upon soil behaviour is a function of temperature level and clay mineral type. Furthermore, by increasing the temperature up to de-hydroxylation level, an increase in soil strength is observed. This is more noticeable for bentonite, due to the presence of active clay as its main clay fraction. At the de-hydroxylation temperature, by the destruction of the clay fraction, a reduction in XRD peak intensity occurs, which is followed by a large increase in soil strength. Further increase in temperature causes a continued increase in kaolinite strength and a reduction in bentonite unconfined compression resistance. This behaviour is attributed to the type of new mineral that is formed at different levels of temperature.

Key Words: Heat treatment, kaolinite, bentonite, unconfined compression strength, microstructure, XRD, SEM.

INVESTIGATION OF EFFECTIVENESS OF MODERN CHEMICAL STABILIZERS ON INTERNAL EROSION IN EMBANKMENT DAMS

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Abstract

The two most common causes of earthen embankment failure are embankment overtopping and internal erosion. In order for a failure to occur from internal erosion or overtopping, three conditions must be met: There must be an existing flow path, there must be a source of water, and the hydraulic stresses must be great enough to cause the detachment of material. Due to internal erosion of an earth dam, water seeping through it carries soil particles away from its embankment, foundation, or abutments. Internal erosion may be a result of inadequate compaction during construction, differential settlement, desiccation, earthquakes, burrowing animals, and/or vegetation roots. The erodibility of the material in the internal erosion flow path and hydraulic stresses are the most important factors in determining the rate of erosion. The challenge in predicting failure

EXPLICIT AND IMPLICIT INTEGRATION METHODS FOR HYBRID SIMULATION USING ITERATION ON SUBSTRUCTURES

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Abstract

The Hybrid Dynamic Testing Method, as a simulation technique, is a novel process in earthquake engineering that enables one to examine the performance of large structures. In this method, use is made of the substructuring technique, and the system is divided into a number of analytical and experimental substructures. The analytical substructure is analyzed by computer, whereas the experimental substructure is the physical part of the system to be tested in a laboratory. The experimental part is selected to be structural zones having behavior too complicated to be modeled in a computer, e.g., the connections. The equilibrium forces/displacements at the interface of the two parts of the system are applied to the test prototype with force/displacement actuators, while earthquake shaking is applied using a shaking table. This results in consideration of inertial forces. In the analytical substructure, the equations of motion are solved using numerical integration techniques at each time step. As an alternative, a large structure can be divided into analytical substructures only, all for analysis by the parallel processing abilities of new computers. In this paper, the latter technique is utilized and all substructures are modeled by computer. Various substitutes for the numerical integrations are studied using explicit and implicit techniques for considering interface forces. Representative examples of applications are presented for illustrative purposes through simple cases of dynamical systems. As a result, the method for deletion of implicit terms, and iterations for converging responses, is selected as the one resulting in the most accurate solutions. It is shown that the method can be extended to cases of multi degrees of freedom subsystems and also to nonlinear substructures. Future directions and the potential for further research work on the subject are also discussed.

Key Words: Sub-structuring technique, hybrid simulation, numerical integration.

ON THE INFLUENCE OF APPLYING DRIFT CONTROL CRITERIA ON THE SEISMIC BEHAVIOR OF SLENDER STEEL STRUCTURES

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Abstract

Based on Iranian Standard 2800, structures should be controlled for story drift after being designed for applied loads. In this phase, the base shear that causes the drift is determined based on one of these structural periods: 1-the proposed formula of the code (T1) 2-the analytical model of the structure (T2). To study the influence of the assumed period in the drift controlling phase, two similar 5-story buildings were designed. T1 and T2 have been used in the drift controlling phase of these two structures. Nonlinear time history analysis results show that the second structure has better seismic behavior, despite having a lower structural weight.

Furthermore, a method is proposed here to find those elements that should be strengthened to satisfy the drift criteria. In slender tall buildings, some elements should be substituted by stronger ones in order to satisfy drift controlling criteria. There is not a standard method to find these elements, and they are normally found by engineering judgment or experience. To satisfy the drift criteria in some design offices, only the first story columns are changed. The obtained results of nonlinear time history analysis on 6 to 9 story slender buildings show that the proposed method of the present study is efficient in improving the seismic behavior of the buildings. However, changing only the first story columns worsens the seismic behavior of the buildings, despite satisfying the criteria.

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Abstract

In order to analyze masonry structures with a large number of unit walls and joints, application of macro-modeling is compulsory for nonlinear analysis. An accurate nonlinear analysis of masonry structures from a macro-modeling perspective requires a material description for all stress states of behavior. Due to the lack of comprehensive experimental results corresponding to pre-peak and post-peak behavior, and the intrinsic complexity of formulating anisotropic in the inelastic behavior of masonry structures, there are special difficulties in the nonlinear analysis of such structural systems and/or components. The complex behavior of masonry is due to the effect of anisotropy, which arises from the geometrical arrangement of units and mortar; even the properties of these constituents are isotropic. The relatively complex yield surfaces proposed by many authors almost preclude the use of modern plasticity concepts and an accurate representation of inelastic behavior such as the hardening and softening rule. Only a few authors have tried to develop specific macro-models for the non-linear analysis of masonry structures, in which, anisotropic elasticity is combined with anisotropic inelastic behavior. In order to model such orthotropic material behavior, the standard multi-surface plasticity model was developed with Rankine yield criterion for tension and Hill yield criterion for compression, which was presented by Louren. The advantages of a combined yield surface, together with modern plasticity concepts, are strong representations of the behavior of anisotropic, which encompasses various softening/hardening behaviors parallel to the axis of the material. In this paper, formulation and implementation of the method used for the Rankine-Hill model are detailed in the plane-stress numerical code with two major promotions. In the first, the expedited method for nonlinear analysis in localized solutions (return-mapping algorithm) are described for this model, and in the second, for the prevention of numerical singularity, the equivalent stress-strain curvatures are modified using the exponential formulation in tension and compression states. Prototype models were studied for monitoring and verifying the numerical results of the software code with the experimental results of brick walls.

Key Words: Brick walls, nonlinear analysis, orthotropic model, macro-model, proposed algorithm.

BRIDGE SKEWNESS EFFECT ON THE DYNAMIC RESPONSE OF BRIDGES, CONSIDERING DYNAMIC BRIDGE- TRAIN INTERACTION

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Abstract

In recent years, interest in the dynamics of railway bridges, as necessary preliminaries for construction of high-speed railways, has increased rapidly. Increasing train speeds means that bridges are subjected to much higher dynamic effects. Therefore, the bearing capacity of structures must be increased in proportion to demand load, and dynamic effects must be considered in the structural design. In previous design methods, dynamic effects were often considered by introducing dynamic amplification factors, but, it can be seen that, in most cases, where train speed is more than 200 km/h, dynamic analysis of the bridge is required by increasing train speed. Correct understanding of the dynamics of railway bridges results in a realistic assessment of their structural responses under train loads. New bridge designs will be economical and also utilization of existing bridges will be proportional to their capacity. In this study, we have endeavored to specify the dynamic response of a double-track railway bridge to moving trains, and the influence of bridge skewness. Dynamic analysis is based on a three-dimensional model of bridge-train interaction. The Yazdan viaduct is an under construction bridge located on the Qom-Saghe double-track railway. It is also a simple span bridge with 22m span length that has been investigated under different skewness of 0, 15, 30, 45 and 60 degrees. To validate the accuracy of the model and the results of this study, a 30m span bridge from existing models in reputable international papers was used. The results of analysis demonstrated that the vertical displacement and acceleration of the bridge increase under high speed loads. At train speeds close to critical speed, due to moving axle groups, the bridge responses grew considerably as resonance occurred. Skewness was found to increase the fundamental frequency of the bridge, and with an increase in bridge skewness, the dynamic responses of the bridge decreased.

Key Words: Train-bridge interaction, dynamic response, high-speed train, skewed bridge.

2800) and designed on the basis of the Iranian concrete code of practice (ABA). Results indicated that mechanical properties were improved with nano-silicate material. Over 28 days, the compression, flexibility, splitting tensile strength, and the elastic modulus increased by 48, 57, 26 and 79 percent, respectively. Also, the results of nonlinear analysis of all structures with NLWC structural members show that their seismic behavior does not significantly change compared to that of similar normal weight RC structures. Finally, it is recommended to pursue research in this field to produce relevant seismic regulations.

Key Words: Lightweight concrete, mechanical properties, nano-silicate light weight concrete, seismic behavior, nonlinear analysis.

KINETIC STUDY OF OXYTETRACYCLINE REMOVAL IN AQUEOUS SOLUTIONS USING NANOSCALE ZERO VALENT IRON

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Abstract
A large amount of antibiotics consumed ends up in wastewater, in which they may exert selective pressure on or maintain resistance against microorganisms. Antibiotic resistant bacteria and genes encoding antibiotic resistance are commonly detected in wastewater, often at higher rates and concentrations compared to surface water. Wastewater can also provide favorable conditions for the growth of a diverse bacterial community, which constitutes a basis for the selection and spread of antibiotic resistance, including genetic resistance to humans, livestock and poultry. Their elimination is very difficult by traditional biological treatment methods because they are hard biodegradable. Oxytetracycline (OTC) is one of the famous tetracyclines that have environmental risk. Nano zero valent Iron (NZVI) particles can be a new suggestion for OTC remediation. In this study, 155 ppm of OTC by 1000 ppm nano-scale zero valent iron with 200 W, UV-A radiation at pH of 3, were completely removed after 14 hours. The final products were carbon dioxide and water that were measured by a CO_2 analyzer. The iron compound on the surface of the nano zero valent Iron particles was Fe(OOH), which was determined by XRD analysis. Variations of parameter, including ORP, pH, and DO, during the removal process, were investigated for 6.5 hours. After 3 hours, the photocatalytic reaction by Fe(OOH) was started. The mechanism of OTC degradation was proposed by HPLC / ESI-MS and four by-products were obtained. The kinetic models for by-products were first order, and the rate constants, by the first order kinetic model, were found to be equal to 0.0099, 0.0021, 0.0049 and 0.0074 min-1, respectively. The effect of competitive ions, including calcium (Ca^2+), magnesium (Mg^2+), chloride (Cl^-), nitrate (NO_3), sulfate (SO_4^2-) and bicarbonate (HCO_3^-), with 10, 50, 100 and 200 ppm concentration, on OTC removal, were investigated. The results showed the negative effect of OTC removal by increasing the concentration of competitive ions, $NO_3^- > Ca^2+ \approx Mg^2+ > Cl^-$. But SO_4^2- and HCO_3^- had no considerable effect. The kinetic model for OTC removal in the presence of all competitive ion concentrations was first order, but, for 10 ppm of NO_3^-, Ca^2+ and Mg^2+, were pseudo first order.

Key Words: Kinetic, mechanism, ORP, pH, DO, competitive ions.

MODIFICATION TO THE ORTHOTROPIC RANKINE-HILL MACRO-MODEL AND PROPOSED ALGORITHM TO ACCELERATE THE NONLINEAR ANALYSIS OF BRICK WALLS

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Abstracts of Papers in English

ENGINEERING PROPERTIES OF NANO-LIGHTWEIGHT CONCRETE AND ITS EFFECT ON SEISMIC BEHAVIOR OF BUILDING STRUCTURES

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Abstract
The weight of structural and nonstructural building elements is the main part of dead loads, which have a direct and considerable effect on the lateral load induced by earthquakes. The lower the dead load is, the lower are the structural element dimensions, which results in a lower lateral load induced by earthquakes. This is an important design key factor for high seismic countries like Iran. One of the methods to reduce structural weight is the use of lightweight concrete (LWC) for structural and non-structural members. LWC used for structural elements needs to attain the minimum strength recommended by the code of practice. Additives may be used in the mix design to recover the strength reduction caused by the use of light weight aggregates (LWA). To enhance the mechanical properties of LWC, it is recommended to add nano-silicate, which increases the cement hydration rate and reacts with calcium hydroxide to form hydrate calcium silicate gel (C-S-H). This is much stronger than calcium hydroxide. This paper reports the results of experimental and analytical investigation into the mechanical properties of LWC and nano-silicate lightweight concrete (NLWC), with optimum water-cement ratio, and the use of NLWC for structural members of four reinforced concrete moment resisting frames, with medium ductility, of six story building structures. All structures were analyzed according to the Iranian standard for seismic design of buildings (IS-