tum. In certain cases, where shallow foundations are not suitable for transferring loads, deep foundations such as pile foundations are used. It is worth mentioning that in most cases, cylindrical piles have been used. However, past research revealed that the bearing capacity and stiffness of tapered piles are more than their cylindrical equivalents. There has been limited experimental research carried out on the bearing capacity of tapered piles, and most studies in this area are based on numerical analysis. Results of the above mentioned research indicate that there is a relationship between the tapered angle and the bearing capacity of the piles. In this study, the bearing capacity and settlement of tapered piles using different tapered angles have been studied. Four different tapered angle piles were installed in two different soils, namely; fine grain sand (regionally named Yazd Windy Sand), and a fabricated coarse angular sand. Using a load cell at the tip of the pile, the transmitted load to the pile base has been measured and the load transferred by skin friction calculated by subtracting the base load from the whole applied load. The results demonstrated a relationship between tapered angle and bearing capacity, which have been compared with their cylindrical equivalents. Available recommended methods have been used to deduce the ultimate bearing capacity of piles from load- settlement curves. Based on acquired results, piles with a 2.45 degree of tapered angle in fabricated coarse angular sand have the maximum bearing capacity. Furthermore, in fine sand, the ultimate bearing capacity reduces with tapered angle after an optimized angle.

**Key Words:** Taper pile, effect of taper angle on bearing capacity, piles, taper pile in sandy soils.

## INVESTIGATION OF THE EFFECT OF NANOTECHNOLOGY PRODUCT (CBR+) ON THE ERODIBILITY OF CLAYEY SOILS USING THE JET EROSION TEST

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**Abstract**

Erodibility of soil is one of the most important factors when dealing with water based projects, such as earthen water canals, earthfill dams and other hydraulic structures. Erosion is the cause of much canal, dam or levee failure and its consequent loss of life and money. Thus, soil erosion has always been a field of interest among hydraulic and civil engineers, and much research has been undertaken in an attempt to find different methods of controlling this phenomenon. Stabilizing soil with chemical additives is the most common method of controlling erosion in fine grained soils, and different stabilizers with different stabilizing mechanisms are produced and used even now. CBR+, also known as CON-AID, is a nanotechnology product designed for stabilizing poor quality soils containing clayey material. This anionic soil stabilizer, originated from petroleum, is a viscous, deep red color liquid, with no smell or taste, which works on the basis of ion exchange. In this study, the effect of this product on the erosional behavior of clayey soils is investigated. For this purpose, specimens stabilized using different amounts of CBR+ were prepared and, after curing periods of 7, 14 and 21 days, their erosional behavior was compared with that of non-stabilized ones. Erosion tests were performed using a submerged jet erosion device (JET). According to the results obtained, different erosional behaviors are obtained when using equivalent values of 0.005, 0.007 and 0.009 litres of CBR+ per 0.15 cubic meters of tested soil. These behaviors vary in procedures of variations of erosion curve, mean erodibility coefficient ($k_d$), and critical shear stress ($\square_c$) of the specimens after the mentioned curing periods, and tend to the behavior of the non-stabilized specimens after 21 days. The cause of these variations in different stabilized specimens must be considered in different mechanisms by which CBR+ affects the soil. These are the most important factors controlling the erosional characteristics of soils, such as the changes of permeability of specimens, the degree of compaction which each stabilized specimen reaches by the same compaction effort, and the sensitivity of stabilized soil to water.

Finally, it is concluded that the use of CBR+ cannot directly affect the erosional characteristics of soil. On the other hand, it's secondary effects, such as an increase in the degree of compaction and permeability of soil and a decrease in its sensitivity to water, will highly affect the erosional characteristics of a clayey soil.

**Key Words:** Erosion, stabilization, nanotechnology, CBR+, jet erosion test.

demands on the connections, and result in lower capacity parameters in comparison with other protocols. Due to the direct influence of loading time history on the imposed equivalent plastic strain, the connections undergo different levels of equivalent plastic strain. Moreover, the connections that are studied under near-field loading history show a strength capacity close to connections that are subjected to monotonic loading.
Finally, a novel loading protocol is developed, according to the target values of loading time history, and considering the fact that in an earthquake, cycle numbers with small deformation ranges are more than cycles with large deformation ranges. Connections subjected to the proposed loading show an increase in deformation capacity and strength capacity parameters.

**Key Words:** Loading protocol, cyclic behavior, steel moment connections, finite element method.

## INVESTIGATION OF SHEAR BEHAVIOR AND MODELING OF DEEP BEAMS USING THE FINITE ELEMENT METHOD

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**Abstract**
In this paper, the behavior of several reinforced concrete deep beams has been studied by means of finite element analysis, and the results are compared with experimental results reported by Arabzadeh, Leonard and Walter. Reinforced Concrete deep beams are structural elements used in dams, offshore piers, rectangular tanks, bridges, floors, diaphragms and high rise buildings. The definition of a reinforced concrete deep beam, by various codes, is based on the span to height ratio of the beam. Generally, the span to height ratio of deep beams is required to not be greater than 2.5. These beams have four different modes of failure: 1) Flexural, 2) Flexural-Shear, 3) Shear, and 4) Bearing. Since the ratio of width to height of deep beams is small and concrete acts unsymmetrically against tension and compression, a plain-stress model and nonlinear analysis are used in the study of these beams.
In this paper, a finite element program is presented for the nonlinear analysis of two-dimensional and asymmetrical problems. In the case of reinforced concrete structures, the plasticity of concrete in compression, the yielding of reinforcement and the cracking of concrete under tension are accounted for. A new algorithm for embedding curved reinforcement in concrete elements is used in the program. NAOC software is a program written in "Visual Basic", which has considerable capability for graphical presentation of input data and output results. In the nonlinear analysis section, program results include the vertical load versus vertical displacement curve, the crack pattern and the ultimate load of analytical models. Solving different examples with the NAOC program, the obtained results were compared with available test results. The comparisons validated the accuracy, efficiency and ability of the NAOC program to investigate shear strength in RC deep beams. Nonlinear stress analysis of reinforced concrete may also be conducted by the finite element method, although careful modeling of the reinforcement and cracking behavior regarding shear effects is needed.

**Key Words:** Reinforced concrete deep beams, shear strength, finite elements method, plasticity, nonlinear analysis.

## EXPERIMENTAL STUDY OF BEARING CAPACITY OF TAPERED PILES IN SANDY SOILS UNDER VERTICAL STATIC LOADS

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**Abstract**
All structures are built on foundations which are used to transfer loads from structures to the bearing stra-

# PLATE LOAD TEST RESULTS: CASE STUDY, BAKHTIARI DAM

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**Abstract**

It is important to determine the deformation properties of rock masses in many dam engineering projects. Previous studies show the dominant effect of discontinuities on the rock mass deformation modulus. Although the discontinuity properties are very important, determination of their real values, even using in-situ or experimental tests, is not always straightforward. The in-situ experiments are mainly based on calculating the overall properties of rock mass, like the deformation modulus. This paper uses a combined numerical and experimental approach to determine the detailed properties of joints in the Bakhtiari Dam site. Many conventional field and experimental rock investigations were carried out in the Bakhtiari Dam project in order to identify the properties of intact rock, rock mass and joints. The deformation modulus of the rock masses was directly evaluated by field plate load tests. However, due to the lack of experimental equipment, the stiffness properties of the discontinuities were not measured. This paper presents a numerical approach to evaluate the stiffness properties of discontinuities, based on the results of plate load tests. To this end, Udec software was applied for modeling and simulations. Udec software uses DEM, which leads to the ability to define different properties of discontinuity. The various elements considered in the simulation of the plate load tests were: loading pattern, geometry, and mechanical properties of the site material. The geometry and process of calculating the deformation modulus were based on ISRM and ASTM methods, in both numerical and experimental approaches. A direct back analysis technique was utilized to estimate joint shear and normal stiffness and their relevant errors. The calculated stiffness has an optimum error of back analysis that shows the relation between modeling and real experiments. The deformation-loading path, in both numerical and experimental results, has enough similarity in values and slopes, but there are differences in curvature. In addition, the modeling results were compared in front of the geological features for different joint sets. It was observed that the tightness of discontinuities has a strong influence on total stiffness, but infilling material could have different effects.

**Key Words:** Rock mass, plate load test, back analysis, normal and shear stiffness.

# CYCLIC BEHAVIOR OF STEEL MOMENT FRAME CONNECTIONS UNDER VARIOUS LOADING PROTOCOLS AND A DEVELOPED LOADING PROTOCOL

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**Abstract**

In this paper, performance of steel moment frame connections is investigated under different cyclic loadings. Three moment frame connections representing light, medium, and heavy connections are modeled in a finite element program. Light, medium, and heavy connections are adopted from existing structural designs of seven, twelve, and twenty story buildings, respectively. The models are loaded with different cyclic loading protocols, and their behavior and capacity parameters are examined and compared. These connections are analyzed under SAC basic, SAC near-field, FEMA, and ATC loading protocols, in addition to a monotonic loading. Deformation capacities are assessed at two strength loss levels of 80% and 50%, for different loading protocols. In addition to strength capacity, the failure mode and equivalent plastic strain of each connection are investigated at the target rotation point (0.04 radian) and during failure.

Connections that are subjected to SAC loading protocols experience demands that are in good agreement with target values of the loading protocol, and these connections show the ability to bear larger rotations. Furthermore, these connections have greater strength capacities in comparison with connections loaded by other protocols. ATC and FEMA loading protocols impose larger

semi-circular form is initially studied using an analytical method. Then, the maximum bearing capacity of the soil-bag system is presented by a new geometric form of semi-elliptical shape. Also, the mechanical behavior of the soil-bag system is analyzed using ABAQUS finite element software in a three-dimensional state, to determine the maximum capacity of its loading with semi-elliptical and semi-circular cross-sections. Results show that when the value of the semi-elliptical eccentric and internal friction angle of the soil increases, the bearing capacity of the soil-bag system, influenced by external loads, will also increase. Therefore, choosing a suitable geometric form can increase its bearing capacity to a great extent. Also, considering boundary conditions in semi-elliptical form, the required surface to construct a polymeric bag, in order to constrain the soil, decreases significantly and, in this respect, a significant saving will occur in the consumed materials. By increasing the vertical displacement of the soil-bag system, the circumference strain of the polymeric bag increases. The yield strain of the polymeric bag was considered to be 0.25. Results of the analytical method showed that when the semi-circular cross-section changes into a semi-elliptical one, the vertical bearing capacity of the soil-bag system will increase by 6.68%. Other characteristics of the soil bags, such as absorption of vibrations resulting from traffic load, can be addressed.

**Key Words:** Soil-bag system, bearing capacity, semi-elliptical cross-section, eccentricity of bag cross-section.

## PERFORMANCE MEASUREMENT MODEL FOR ARCHITECTURAL CONSULTING ENGINEERING COMPANIES, USING THE BALANCED SCORE CARD (BSC)

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**Abstract**

In today's world, most business oriented organizations apply a type of performance measurement in order to measure their capabilities and improve their performance and competitive advantage. Architectural Engineering Consulting firms also face the same fact, and their business, as part of the design process, has a significant impact on the quality and success of construction projects. These organizations have to measure and improve their performance, not only for their own survival, but also for the development of construction industries. Considering these facts, the aim of this paper is to develop a model for the performance measurement of architectural consulting engineering companies.

In this paper, first, using the "Thomas & Chow" approach, the design processes in architectural engineering are investigated. Then, the advantages and disadvantages of different performance measurement models are investigated and compared. The balanced scorecard (BSC) is selected, as the most suitable choice. Finally, a performance measurement model is developed, according to this model, to assess the performance of the organizations. The strategic goals of the organization must be determined and, then, in accordance with these goals, details of four levels of the BSC model, including financial, customer (market), process, and growing and learning aspects, are identified. Moreover, indicators, targets and actions for each level are determined and explained. Based on the proposed model, the main suggested process groups that need evaluating in the performance measurement of the Consulting Engineering Companies are classified in five groups; design, tender, supervision, general and external processes. Design processes include systems such as quality assurance, estimation, sustainability, cost improvement, value engineering and design flexibility systems. Tendering processes include systems such as communication and tender evaluation assurance systems. The construction supervision system includes systems such as site management, inspection and supervision, contract and claim management, and close out systems. General processes refer to project management systems and, finally, external processes cover partnership and out-sourcing management systems. Since, there are only a few studies on this subject, the finding of this research can be useful and be primary steps towards further research into this subject.

**Key Words:** Performance measurement, balanced scorecard, project based organization, project management, architectural consultant organization. architectural design.

## DETERMINATION OF NORMAL AND SHEAR STIFFNESS OF ROCK JOINTS USING BACK ANALYSIS OF

results in delayed failure and smaller displacement. Using the Drucker-Prager failure criterion, all minarets still fail at early stages of earthquakes. The same thing occurs by changing the damping ratio from 5% to 20%, except that the values of the displacements decrease.
Structural analysis of minarets against temperature changes, according to Isfahan's thermal conditions, fire, and a dramatic decrease in temperature, shows that in cases of certain inner and outer temperature differences and very high or very low temperatures, the minarets fail. When the minaret consists of only the outer shell, it has a higher strength than the whole minaret and experiences less damage.
Non-linear static analysis indicates that under Isfahan's design wind load, (with a velocity of 130 km/h) minarets do not fail, but they will fail during winds with a velocity of 165 km/h. A minaret consisting of only the outer shell withstands larger displacements than the whole minaret.

**Key Words:** Minaret, brick masonry materials, time history analysis, non-linear behaviour.

## A COMPARATIVE FIELD STUDY OF THE BEHAVIOR OF RAMMED AGGREGATE PIERS AND CONCRETE PIERS UNDER COMPRESSIVE LOADING

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**Abstract**
Cast-in-place concrete piers and short rammed aggregate piers (RAPs) are suitable semi-deep foundations for improving some urban areas. However, fewer studies have been undertaken on this topic compared to other foundations commonly used in professional cases. The present research offers a comparative in situ study of the behaviors of these two types of foundation on a small scale. For this purpose, two groups of single trial piers were made and tested (on the site), which consisted of rammed aggregate piers and cast-in-place concrete piers with a constant diameter of 135 mm and variable lengths of 400, 600, 750, 900 and 1100 mm. The test site was Bushehr Special Economic Zone, where the testing area was made up of a uniform two-layered soil: a moist 1 meter-thick stiff silt layer over a layer of saturated alluvial clay, with medium strength, 1.4 meters thick. The trial piers were constructed and loaded in a linear path at a sufficient distance from each other. For reaction loading, a mobile reaction beam system, made up of a heavy cart and modular rails, was utilized. Results reveal that as long as the tips of the concrete piers have not entered or approached the soft lower layer of soil, they have a higher design limit load and stiffness modulus compared to the RAPs. The results also show that the design limit load and top settlement of the concrete piers are, on average, 1.1 and 1.4 times the corresponding values for the RAPs. This assessment was carried out on trial piers only, disregarding the effects of implementing RAPs on the surrounding soil. The results also suggest that there is higher agreement between the top settlement values, and the load transferred to the piers' tips at the design limit, with the calculated values, based on the Randolph and Wroth method (1978), in the concrete piers than in the RAPs.

**Key Words:** Rammed aggregate piers, in-situ concrete piers, soil improvement, design limit load, settlement, stiffness modulus, load transfer.

## NUMERICAL AND ANALYTICAL EVALUATION OF THE BEARING CAPACITY OF A HALF-OVAL SOIL-BAG SYSTEM UNDER VERTICAL LOADING

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**Abstract**
The main goal of this paper is to evaluate the effect of the geometric form of a semi-elliptical cross-section on the maximum bearing capacity of a soil-bag system under vertical loading. In the present research, the maximum bearing capacity of a soil-bag system in a geometric

# REMOVAL OF PETROLEUM HYDROCARBONS FROM OIL REFINERY WASTEWATER USING NATURAL ADSORBENTS: ISOTHERM AND KINETIC STUDIES

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**Abstract**

Each year, more than 2000 million tons of wastewater is generated by oil refineries in the Middle East and European Union countries only. Oil refinery wastewater contains a wide range of toxic and non-biodegradable pollutants. Its discharge into the environment has created a major ecological problem throughout the world. An adsorption process for sewage refinery treatment would be an attractive method, if the adsorbent were inexpensive and available. In this study, activated carbon, prepared from almond shell and nut shells, are used as natural adsorbents for the treatment of petroleum refinery wastewater. The effect of pH, contact time and adsorbent concentration on TPH removal efficiency was studied. The results have shown that the effects of pH on the adsorption of petroleum hydrocarbons onto prepared activated carbon are small. It has also shown that about 90% of adsorption occurs in the first 30 minutes of the process and is completed in 60 minutes of contact time when the adsorption reaches equilibrium condition. The experiments demonstrated that an increase in adsorbent concentration leads to adsorbent particles attaching to each other. This reduces surface area and adsorption sites, therefore, decreasing adsorption efficiency per mass unit of adsorbent. The highest TPH removal efficiency obtained was 85% at pH=8, with a concentration of activated carbon=5 gr/L and contact time= 2 hours. Equilibrium sorption data were compared with Langmuir, Freundlich, Temkin and Dubinin-Radushkevich isotherms. The highest $R^2$ value was obtained for the Freundlich model, which indicated the heterogeneity of the adsorbent surface.

Based on the Langmuir model, the maximum monolayer adsorption capacities of almond shell and nut shell activated carbon were estimated to be 83 mg/gr and 59 mg/gr, respectively. The heat of the sorption process for almond shell and nut shell activated carbon was estimated from the Temkin model to be 26.15 J/mol and 15.47 J/mole, respectively, which vividly proves that the adsorption experiment followed a physical process. Adsorption of petroleum hydrocarbons onto activated carbons was followed by pseudo-second-order reactions.

**Key Words:** TPH, langmuir, freundlich, temkin, dubinin-radushkevich, almond shell, nut shell.

# STRUCTURAL ANALYSIS OF HISTORICAL PERSIAN BRICK MASONRY MINARETS

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**Abstract**

In this research, the structural behaviour of nine historical brick masonry minarets in Isfahan, built in the eleventh and twelfth centuries A.D., against weight, earthquake, temperature and wind, is studied. In order to investigate the effect of the central column and spiral staircase on structural behaviour, analyses have been performed for two cases: 1) the whole minaret (including the outer shell, central column and spiral staircase), and 2) only the outer shell.

Frequencies and mode shapes have been obtained by modal analysis. Seven scaled, appropriate, ground motion records have been selected, according to the Iranian Seismic Code, for non-linear time history dynamic analysis. Based on the Willam-Warnke failure criterion, all minarets fail, due to selected earthquakes. Parametric studies have been undertaken to find situations in which the minarets do not undergo failure. Parameters are the height of the minarets, the tensile and compressive strengths of materials, failure criterion, and damping ratio.

By decreasing minaret height, failure is delayed or does not occur. Increase in tensile and compressive strength

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**Abstract**

The problem of fluid-driven fractures in rock arises in various applications ranging from the hydraulic fracturing treatment used in the oil industry to stimulate oil production from underground reservoirs to the formation of intrusive dykes in the earth crust and magma transport in the lithosphere. Other applications include stimulation and heat extraction from geothermal reservoirs, induced caving in mining industry, soil grouting, and etc. In this paper, plane-strain hydraulic fracture propagation is investigated in an impermeable elastic rock under conditions of large toughness. The flow of incompressible fluid in the fracture is unidirectional and laminar. Fracture propagation is described in the framework of linear elastic fracture mechanics (LEFM). The fracture is fully fluid-filled at all times. The net pressure in the fracture, the crack opening, and the fracture half-length are obtained from the proposed analytical solution. On the other hand, the effect of inertia has not received adequate attention. The homotopy perturbation method is proposed for considering this effect on the otherwise toughness-dominated solution of a plane-strain hydraulic fracture. Also, it is equally applicable to either other fracture geometries and/or to evaluate viscosity effects on the solution. Generally, increased fluid inertia parameter, $G\rho$ induces an increase in fluid velocity, the net pressure in the fracture tip, and a decrease in the opening at the injection point. Since the net pressure in the zero-inertia solution has the minimum value at the injection point, the crack may have a tendency to develop a tear-drop shape for larger values of fluid inertia parameter, $G\rho$ The results imply that the tip velocity increases as $G\rho$ increases. In design practice, this important aspect must be given proper attention. These results are compared with asymptotic solution results of Dmitry I. Garagash [Engineering Fracture Mechanics, 2006] and qualitatively, found to be in good agreement.

**Key Words:** Hydraulic fracture; impermeable brittle rocks; toughness; inertia; homotopy perturbation method.

## EFFICIENCY TEST OF THE DISCRETE LEAST SQUARES MESHLESS METHOD IN SOLVING HEAT CONDUCTION PROBLEMS USING ERROR ESTIMATION

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**Abstract**

In recent years, use of meshless methods has been extensively increased. This is probably due to the generality of their applications for the solution of continuous, as well as discontinuous, problems. Nevertheless, discretizetion of problems in many meshless methods, like many other numerical approaches, leads to integral equations, whose solution requires, in turn, numerical integration, definition of Gauss points, and their weight and mesh generation. Among these methods, however, the Discrete Least Squares Meshless (DLMS) method has been developed, gradually, by researchers in recent years, which possesses the ability to delete integral operations from calculations of the coefficient matrix procedure. Moreover, because of its simplicity, high precision and low computational cost, this approach has been known as a real meshless method. The purpose of this paper is to estimate the error of numerical solutions performed with the discrete least squares meshless method for heat conduction problems. To achieve that point, at first, the governing equations of the heat conduction problem in two dimensional space were extended, and specific boundary conditions of each problem were inserted into the formulations. Then, the Discrete Least Squares Meshless shape of the equations was derived for use in the proposed method. Moving the least squares method for computing the interpolation functions was undertaken. Moreover, the error estimate function was determined using the squares of residuals concept. Finally, the two mentioned examples were solved. The obtained results, between the approximated proposed method and the valid exact solution, which was derived from closed form analytical solutions, were compared, and the accuracy of the discrete least squares meshless method formulation was demonstrated. Furthermore, by using the least squares of residuals concept, error estimation was performed and error distribution or the positions of errors were obtained. By solving these examples, the power of this method to solve other engineering branches, like heat conduction problems, and its high internal error diagnostic property, was illustrated.

**Key Words:** Meshless method, discrete least squares, heat conduction, error estimation.

over establishments. Despite all its positive characteristics, however, this method has not reached its goals. Numerous instances can be found where BOT projects have not reached a desirable conclusion. Failure of such projects imposes heavy financial and social expenses on all the contract parties, especially the host country, and this is why governments and private companies seek a structure that can support such projects towards successful achievement of their goals. The basic goal of each BOT project is to make a structure of risk management which can ensure the success of the project. In this article, according to related past events and large numbers of field studies by specialists to gain statistical information, an attempt has been made to study the risk rate and lack of surety in Iran's freeway BOT projects using SPSS software.

**Key Words:** Risk management, lack of definiteness, BOT, freeway project.

## DEVELOPMENT OF A PROCEDURE FOR EVALUATION OF SEISMIC FORCES ON BUILDINGS WITH ISOLATION SYSTEM IN IRAN; BASED ON JAPANESE CODES

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**Abstract**
The base isolation system is a method developed to protect structures against earthquake excitations, which is designed and implemented based on seismic codes. The aim of this study is the development of a procedure in Iran for the seismic design of buildings using an isolation system. For this purpose, the Japanese Code for the design of base isolated buildings is considered the basis of the proposed procedure. The Building Standard Law of Japan and related Enforcement Order and Notifications have been substantially revised since the year 2000 to introduce a performance-based regulatory and deregulation system for building control systems. The verification procedures of seismic performance in the new code are, in essence, a blend of the equivalent single-degree-of-freedom modeling of a building and the site-dependent response spectrum concepts, which make possible prediction of maximum structural response against earthquake motions without using time history analysis. Simplified design procedures, based on the equivalent linear method for seismically isolated buildings, have been issued from the Ministry of Construction. To develop the procedure, we compared the Japanese and Iranian (Standard 2800) codes from different points of view. For example, parameters of soil type, seismic zone, design spectrum, fundamental period and distribution of seismic load in height are compared. By considering both codes, the procedure for seismic design of buildings with an isolation system in Iran is developed. Then, for evaluation of the procedure, several structural models were considered, and results are compared with results of nonlinear time history analyses. Based on analyses results, the responses of the structure models at near field were higher than far field excitations, by two times. In both far and near field records, base displacement responses (at the level of base isolation) were higher than base shear responses. In all models, the response of structures based on the proposed procedure was reliable. Also, it is necessary to consider factors for near field effects in the Iranian seismic code.

**Key Words:** Base isolated buildings, iranian seismic code, japanese building standard, time history analysis, far field and near field records.

## HYDRAULIC FRACTURE PROPAGATION IN IMPERMEABLE ELASTIC ROCK WITH LARGE TOUGHNESS: CONSIDERING FLUID INERTIA PARAMETER EFFECT

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# Abstracts of Papers in English

## STATISTICAL ANALYSIS TO DETERMINE LEVEL OF RISK IN EXISTING UNCERTAINTY OF FREEWAY CONTRACTS BY THE BOT METHOD, CASE STUDY: SAVEH FREEWAY SALAFCHEGAN

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**Abstract**

Since their establishment, governments have been the main suppliers of resources for infrastructure projects, and provide a major source of tax revenue and revenue from national resources. On the one hand, there is a need to implement infrastructure projects in developing countries and increase national welfare, and on the other hand the external debt of Third World countries and the stress state budgets are rising. Further development of the private sector and emphasis on the privatization of government agencies in the 70s and 80s, created new ways to finance infrastructure projects, as an alternative to the use of public funds or borrowing from foreign sources. This resulted in the formation and development of various forms of public-private partnership, one of which is Kian. Also, the shortage of government resources and the extreme need to fund national development have required governments to absorb private sectors in the foundational projects of their countries. BOT can be considered a reliable way of absorbing private assets, which retains the government's strategic control