in estimating the structural response with less computational effort with respect to the other methods. The maximum of %53.76 and %21.74 errors may be observed for NSP and ET method, respectively, concerning high-accuracy of NDP in the estimation of the structural responses as well as much less computational effort. The time taken to perform the ET analysis is only %20 and %25 of the time required for NSP and NDP, respectively. According to the proper accuracy of ET method in predicting the seismic responses, with respect to NSP and NDP, it seems that the ET method can be considered an alternative for the current traditional methods, especially for TFB system.

Key Words: Tunnel form building (TFB); shear wall; endurance time (et); seismic performance.

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Sharif Civil Engineering Journal
Volume 33, Issue 3.2, Page 137-147, Research Note

- Received 4 August 2015; received in revised form 6 February 2016; accepted 23 February 2016.

Abstract

Many approaches are used to monitor landslides. The detection techniques vary depending on the distance between the area of interest (AOI) and receiving devices. In this paper, a technique for predicting and monitoring the landslides in steep areas in the foothills or mountain range, using wireless sensor networks, was introduced, analyzed and simulated. The proposed landslide monitoring system relies on placing an array of wireless sensor nodes as transmitters array, especially in the steep areas, and receiving and analyzing the signals received from the array by two synchronous wireless receiver nodes.

In fact, the proposed system for monitoring the phenomenon "landslide" measures the changes of the phase difference between the two wireless sync receiver nodes, before and after the occurrence of landslides. In addition to the acceptable accuracy and reliability of the proposed monitoring system taken into consideration, it also has acceptable qualification for monitoring the slope foothills in limited areas under critical conditions.

In this study, No ffb01eld test was tried, but there is a complete simulation example to illustrate the technique using an array of six transmitters and two receivers. The accuracy of the results is carefully reviewed and placed on evaluation.

In this paper, an inexpensive and low noise displacement change detection technique based on the phase difference between two coherently demodulated receiving signals is presented. It measures the phase difference of the range between the transmitter (or target) in the AOI and two wireless sync receiver nodes. The area of interest (AOI) refers to the surface area of a sloped hillside, and the receiving devices are at some distance away from the foothill. The transmitter array is either hardwired or programmed to transmit signals in a coordinated sequence. The two receivers are set apart at small distances and demodulate the receiving signals independently, yet coherently. It can detect the early landslide for small, but critical areas, with ranges up to 250 m when popular IEEE 802.11n family devices are used.

Key Words: Landslide real-time monitoring; wireless sensor networks.

ENDURANCE TIME METHOD, A SUITABLE SUBSTITUTE FOR CONVENTIONAL DYNAMIC ANALYSIS IN SEISMIC PERFORMANCE ASSESSMENT OF RC TUNNEL FORM BUILDINGS

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Sharif Civil Engineering Journal
Volume 33, Issue 3.2, Page 149-159, Research Note

- Received 29 September 2015; received in revised form 26 January 2016; accepted 16 February 2016.

Abstract

The reinforced concrete Tunnel Form Building (TFB) is a new industrialized building system in which only the slabs and walls contribute to the lateral load resisting system. Its appellation "the tunnel form" is due to the installation of formworks in box manner. In spite of its superiority in terms of resistance to earthquake excitations, the current seismic code provisions present limited information for the seismic design criteria. The high computational cost is one of the problems facing the structural engineering profession to evaluate the seismic performance of TFBs in the range of nonlinear deformation behavior. It seems that the Endurance Time (ET) method is a solution to remedy this shortcoming. The ET method originally is a time-history based dynamic pushover procedure for seismic analysis of structures. In this procedure, the structure is subjected to a specially designed intensifying accelerogram and its endurance time is measured based on the time interval during which it can resist the imposed dynamic actions. In this study, the seismic performances of five and ten-storey TFBs designed in accordance with Iranian seismic code were examined. To this end, the Nonlinear Static Procedure (NSP) and the Nonlinear Dynamic Procedure (NDP), as well as the ET method, were utilized. The results of this study indicate the attainment of their performances in immediate occupancy performance level under the design earthquake (the return period of 475 years) as well as the high accuracy of the ET method

The emergency transportation aims to transfer the affected population to the safe area, keeps the traffic in order and recovers the normal status in time. Efficiency parameters can embody and affect the emergency transportation and evacuation efficiency in the emergency evacuation, including evacuation time, mean evacuation speed, travel time and vehicle quality. By determining the optimal routes for emergency transportation in the possible shortest time, the highest possible services will be provided resulting in an increase in the capacity for the urban crisis management. The significance of determining and optimizing emergency transporting routes, however, has not been fully appreciated in Iran. The present analytical-descriptive study is aimed at determining the parameters influencing the determination of optimal routes for emergency. Therefore, analytical hierarchy process is used to extract such parameters and implement them in Tehran district No. 1.
As a result, 17 parameters affect on the determining the optimal paths. The major parameters include safety, traffic, length of path and culture. Population density is the most significant factor with 23.55 percent, and the quality of vehicles is the least significant one with 2.13 percent of significance.

Key Words: Indicators; emergency transportation; analytical hierarchy process (AHP); crisis management; district No.1 of municipality of tehran.

ANALYTICAL STUDY OF ACCEPTANCE CRITERIA FOR RETROFITTED BEAMS WITH FRP USING NUMERICAL MODELING

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Sharif Civil Engineering Journal
Volume 33, Issue 3.2, Page 127-136, Research Note

- Received 18 May 2015; received in revised form 14 February 2016; accepted 6 March 2016.

Abstract
In recent decades, composite material has been used in order to increase the effectiveness of reinforced concrete structures. The difficulty of numerical modeling of beams in finite element method is a problem encountered during such a study. Destruction of structures such as buildings and bridges has been reported due to earthquake and time-dependent erosion. Highlighting the need for reinforcing the structures, many researchers have tried to estimate the efficiency limit and strength of reinforced concrete structures.
In order to retrofit concrete structures polymer coating was first developed in Europe and Japan in 1980. In Europe, FRP systems have been used to replace steel sheets, that as a common resisting method, their connection to the tensile concrete parts of the members with different adhesives was popular to increase the flexural strength of the members. Since steel sheets deform under operation, they would destroy the connection of sheets and concrete. On the other hand, their installation is generally difficult and needs heavy machinery, so researchers sought a replacement of steel coatings with FRP. FRP with 20% weight of steel jackets is approximately 8 to 10 times stronger than steel. One of the problems of numerical studies in these systems is their computer modeling in the form of finite element analysis (FEM). On the other hand due to a variety of effective parameters on their behavior, applying lab methods causes problems as they are time-consuming and expensive.
In this research, retrofitting reinforced concrete beams using FRP is studied. At first in order to validate the accuracy of modeling, the analysis results obtained by ABAQUS software are compared with those of experimental studies. Then, beams that need strengthening are retrofitted and the effect of FRP on the curvature and rotational capacity of these beams is investigated. Finally, ductility proportion to the performance levels and the acceptance criteria for retrofitted beams regarding force or displacement control scenarios are obtained. Based on the results, the behavior of beams changes after retrofit, and since the displacement demand to capacity ratio (DCR) is less than 2, force control scenario must be considered regarding their acceptance criteria.

Key Words: Seismic retrofit, performance levels, acceptance criteria, FRP, finite element method.

LANDSLIDE MONITORING USING WIRELESS SENSOR NETWORKS

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HIGH-PERFORMANCE CONCRETE USING ARTIFICIAL NEURAL NETWORKS AND MULTIPLE LINEAR REGRESSION

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Sharif Civil Engineering Journal
Volume 33, Issue 3.2, Page 105-115, Research Note

- Received 20 April 2015; received in revised form 21 December 2015; accepted 12 March 2016.

Abstract

High Performance Concrete is one of the most important masonry buildings created due to recent developments in concrete industry. The structure of this concrete is complicated and its simulation due to wide variation in chemical compositions and physical characteristics of concrete materials is difficult. Slump Test (settlement) is one of the most important field experiments to determine the concrete downfall flow. Several studies have indicated that the high performance concrete slump is dependent not only on the water content and the size of coarse aggregate, but also on the other components of the concrete. In this study the high performance concrete slump was modeled, using feed-forward back propagation artificial neural networks. An artificial neural network (ANN) is a computational model based on the structure and functions of biological neural networks. ANNs are considered nonlinear statistical data modeling tools where the complex relationships between inputs and outputs are modeled or patterns are found. Modeling using artificial neural networks requires large amounts of data. The required data for this research has been referenced to the UCI Machine Learning Repository. In this reference a number of different data sets on different aspects exist. They can be used for related research purposes. The slump test data were used in this research. The workability behavior of HPC is a function of the content of all concrete ingredients, including cement, fly ash, blast furnace slag, water, super plasticizer, coarse aggregate, and fine aggregate. The Feed-Forward Back propagation, Cascade-Forward neural network, and multiple linear regression methods were used to model slump and 28-day compressive strength of HPC. The neural network developed in this paper has seven neurons in the input layer, one hidden layer with seven neurons, and one neuron in the output layer. The assessment of results based on root mean square and the correlation coefficient shows that the Cascade-Forward neural network model performs well for simulation of high performance concrete behavior. Moreover, the proposed methodology provides a guideline to model complex material behaviors, using only a limited amount of experimental data.

Key Words: High performance concrete; compressive strength; slump test; artificial neural network; multiple linear regression.

ASSESSMENT AND DEVELOPMENT OF EMERGENCY TRANSPORTATION INDICATORS (CASE STUDY: INFRASTRUCTURES OF TEHRAN MUNICIPALITY, DISTRICT NO.1)

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Sharif Civil Engineering Journal
Volume 33, Issue 3.2, Page 117-125, Research Note

- Received 10 May 2015; received in revised form 26 January 2016; accepted 8 February 2016.

Abstract

In densely populated urban areas, at the time of earthquake, how to accurately determine the risky zone, to take effective measures to evacuate inhabitants quickly out of dangerous areas and to minimize the unexpected losses are major concerns of urban managers and government authorities. Over the last two decades, there has been considerable interest in modeling emergency transportation and evacuation for a well-defined zone and event scenario. Emergency transportation is one of the issues that become significantly important after a disaster. Once a disaster occurs (particularly earthquakes), the demand for infrastructure reaches its maximum and often leads to a heavy traffic. On the other hand, due to the resulted damages, the roads resiliency is reduced. To expedite the emergency transportation, the most optimal routes should be taken into account.

Sharif Civil Engineering Journal
Volume 33, Issue 3.2, Page 85-94, Original Article

- Received 22 September 2015; received in revised form 13 January 2016; accepted 31 January 2016.

Abstract

Concrete has the lowest ratio of cost with respect to strength compared to other materials, so it is widely used in construction industry. However, it has some disadvantages, such as low tensile strength and high brittleness, which limit its application in some cases. To improve these negative properties of concrete, adding short discontinuous randomly oriented fibers to the concrete mix is an effective way. Among different types of fiber, steel fibers are used in practice more than others. Steel fibers and concrete form a composite, known as steel fiber-reinforced concrete (SFRC), which has an improved post-cracking behavior compared to plain concrete.

In this study, the effect of hooked-end steel fibers on the shear behavior of simply supported concrete beams without stirrups is investigated. Nonlinear finite element method is used to analyze the behavior of specimens under shear. In numerical simulation, the effects of fibers on the tensile strength, compressive strength, compressive and tensile post-peak behavior, and bond between concrete and longitudinal reinforcement are considered. At first, finite element model is validated with experimental data. Then, the effects of adding steel fibers (0, 0.5, 0.75, and 1 percent) and of beam's height (350, 675 and 915 millimeters) on the average ultimate shear stress are studied.

The results demonstrates the considerable effect of fibers on the shear strength. It was observed that adding the maximum amount of % 1 percent of fibers can increase the shear strength about 77, 91, and 131 percent in beam having 350, 675, and 915 millimeters height, respectively. On the other hand, the efficiency of fibers depends on the height of the beam. The deeper the beam is, the more efficient the fibers are. Moreover, using fibrous concrete results in more ductile failure having ultimate deflection 3 to 4 times larger than that of plain concrete. Finally, it was understood that using fibers can mitigate well-known size effect on ultimate shear stress in beams without stirrups.

Key Words: Fibrous concrete, shear strength, size effect, finite element method.

LOCATION AND RELEASE TIME TRACING OF POLLUTION SOURCE IN RIVERS BASED ON COMPOUND MODEL ADJOINT ANALYSIS AND OPTIMIZATION METHOD

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Sharif Civil Engineering Journal
Volume 33, Issue 3.2, Page 95-104, Original Article

- Received 9 November 2015; received in revised form 14 February 2016; accepted 23 February 2016.

Abstract

Pollution source identification is a secure issue, because it threats the health of hundreds of people. To protect river system from accidental spills, we need accurate and efficient tools to identify such sources. Backward Probability Method (BPM) is one of the tools that gives useful information about the prior position and the release time of pollution. The backward model was originally developed in groundwater; therefore, one of the study's goals is the application of BPM to identify the source location and the release time of the pollutant in surface water. In order to apply the model, a numerical code was developed based on adjoint analysis. It has been tried to use this method in a real case. This model is applied to Severn River. The results show that this model is able to trace the pollution source in a river with natural condition accurately. In the second part, pollution source tracing is conducted in river network based on BPM. Three tests have been designed, and pollution source has been traced very well in all tests. All suspected points are determined with just one backward simulation. The results demonstrate that all suspected points determined by BPM can be a possible source point. This method is so fast and does not need any simplification. Since the simulation is done once, this method effectively reduces computational cost and gives a better choice to decrease the damages. It just needs a limited observation data. Therefore, its cost is the least.

Key Words: Pollution source identification, backward probability method, adjoint model, accidental spills.

MODELING THE SLUMP TEST AND COMPRESSIVE STRENGTH OF

the distance between the blocks, on the length of submerged hydraulic jump with baffle blocks. The FLUENT software has been used for 3D RANS simulation. Twenty models with different geometrical conditions according to the mentioned parameters were created.
It was observed that for DSJ regime, the length of the submerged hydraulic jump is reduced more than 40% based on the distance of baffle blocks from sluice gate. It means that, it can be expected to see more reduction in length of the jump as the blocks are installed closer to the gate. However, for RWJ regime, the decrease of the length is limited to less than 14%. So, due to this considerable difference between the operations of these two regimes, the noticeable point is that all the conditions should be in the way so that the flow occurs as a DSJ regime. In addition, it can be concluded from the results that increasing the height of blocks more than the thickness of entrance jet cannot make any effective change in the length of the jump. Furthermore, it was observed that using baffle wall (i.e., a continual wall which spreads along the whole width of a channel), instead of baffle blocks in the same condition, increases the length of the submerged hydraulic jump. The reason is that the vortices that are formed due to submerged jump's conditions become more intense as the baffle wall deflects the whole jet into the surface. Thus, in this situation vortices have more impact on the flow.

Key Words: Length of jump; submerged hydraulic jumps; baffle blocks; numerical simulations; stilling basin.

ROLE OF PARENTAL RISK PERCEPTION & WORRY ON INDEPENDENT TRIP OF CHILDREN TO SCHOOL

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Sharif Civil Engineering Journal
Volume 33, Issue 3.2, Page 75-83, Original Article

- Received 20 September 2015; received in revised form 23 January 2016; accepted 15 February 2016.

Abstract
Primary school children are in the learning phase of their lives and their commuting travelling to and from school can contribute to the growth to maturity, especially when they are trained to travel independently. Besides, school travel generates its own problems, such as the risk of accidents, car congestion at school locations at the beginning and the end of school time, and air pollution. So far, in the analysis of school children mode choice, socio-economic variables were often investigated, and, the existence of probable association between psychological variables, such as parental worry, is implicated. But, identifying, scrutinizing, and quantifying of these factors through data gathering instruments in school children mode choice have not been examined yet. Therefore, this paper analyzes the role of parental risk perception and worry in the parental escort and independence modes of trips besides socio-economic variables. A set of 1078 questionnaires was designed and distributed among Parents of students from grade one to three in 9 elementary schools (including public and private boys and girls schools) in January 2014 (Return Rate: 80%). Based on the data achieved from this field questioning, Multinomial LOGIT Model and MANOVA were used to survey the effectiveness as well as the relationships of parental risk perception and worry and socio-economic factors in use of school trips modes especially parental escort and students' independence mode. The results show that parents who accompany their kids to school are more worried than other parents, and the more the parental worry is, the less independent and active trip modes of school children will be. Thus, this result shows a gap in perceived safety by parents towards modes such as children's walking alone to school, school service and public transportation modes in Rasht. Thus, it is necessary for the related authorities to persuade parents to choose independence mode for their children with some strategies, such as SR2S (Safe Route to School) and increasing security and safety in public transportation modes and routes leading to schools.

Key Words: Risk perception; worry; escort; children independent trip; logit model; questioning.

INVESTIGATION ON THE BEHAVIOR OF STEEL FIBER REINFORCED CONCRETE BEAMS WITHOUT STIRRUPS

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items in present study. For analyzing the equations by finite difference technique, discretization of equations has been conducted in Matlab. The results revealed that the differential surge tanks are more efficient and economical than simple ones up to 40%. Also the half of transmission length at upstream of turbines are determined as the optima position of surge tanks.

Key Words: Water hammer, surge tanks, mass oscillations, optima dimensions, finite difference technique.

BEHAVIOR OF THE PROPOSED DETAILING OF PIPE DAMPER IN MOMENT CONNECTIONS

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Sharif Civil Engineering Journal
Volume 33, Issue 3.2, Page 53-64, Original Article

- Received 25 August 2015; received in revised form 6 February 2016; accepted 16 February 2016

Abstract

Usage of yielding dampers, through an effective guidance of damages to some restricted and predefined special areas of the structure. In addition to the energy dissipation of earthquake, leads to the simplicity and cost reduction of the repairs for the damaged structure after an earthquake. In this paper, a new connection detail with pipe dampers is proposed in which entrance energy is dissipated by the plastic behavior of steel material. The suggested dampers are quickly replaceable, which is a great advantage for serviceability of the structure after an earthquake. In this research, behavior of the suggested connection is compared with other moment resisting steel connections, such as conventional welded connections and moment connections with slit dampers. Results show that by using pipe dampers in beam in column connections, development of undesirable inelastic deflections in the main members, such as beams and columns, is prohibited. Moreover, stiffness, strength, and ductility of these connections stay in a suitable range are compared to the conventional moment-resisting connections. Stiffness, energy absorption, and strength of the connections with pipe dampers vary in the ratios of the capacity of the pipe damper to the plastic capacity of steel beam. This is a controllable parameter in the design of the dampers. Investigations on the effect of the capacity of the dampers show that using pipe dampers with capacity ratios more than 70% will cause plastic deflections in the main members, such as beams and columns. Based on these results, in order to take the optimized usage of the beam bending capacity and prevent the development of unsuitable plastic deflections in beams and columns, it seems that suggested pipe dampers should be designed so that their ultimate bending capacity can be about 50% of the beam plastic bending capacity.

Key Words: Yielding damper; pipe damper; steel moment connection; energy dissipation.

NUMERICAL STUDY OF EFFECTIVE PARAMETERS IN LENGTH OF SUBMERGED HYDRAULIC JUMPS WITH BAFFLE BLOCKS

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Sharif Civil Engineering Journal
Volume 33, Issue 3.2, Page 65-73, Original Article

- Received 29 August 2015; received in revised form 23 January 2016; accepted 8 February 2016.

Abstract

The design of stilling basin always corresponds to the fact that the length of the jump should be restricted to the length of stilling basin. Baffle blocks are hydraulic structures, installed in the basin in order to stabilize the jump and reduce the length of the jump. Flow under the condition of submerged hydraulic jumps with baffle blocks could be observed as two regimes: The deflected surface jet (DSJ) and reattaching wall jet (RWJ). The formation of each regime relates to different factors, such as block shape and location, submergence factor, block size, and Froude number of entrance flow.

In this article, a numerical study was conducted to investigate the influence of some parameters, including blocks height and shape, the distance of blocks from a gate and

Volume 33, Issue 3.2, Page 29-41, Original Article

- Received 28 July 2015; received in revised form 6 February 2016; accepted 25 December 2015.

Abstract

Nowadays, in developing countries, due to city expansion and demand for trips within the city, creating the necessary infrastructures, such as an underground transportation network, is of great importance. But, constructing subterranean structures and underground tunnels carry a high- risk potential due to its surface seismic responses above which the structures are located. However, insignificant information is available in literature to determine the seismic response of the ground surface due to twin side-by-side and parallel tunnels. In this paper, the effects of two long unsupported double tunnels on the seismic response of the ground surface are studied in different frequencies, using the boundary element method in the time-domain. The homogeneous medium is assumed to have a linear elastic constitutive behavior subjected to vertically propagating incident in-plane waves (SV waves). Comparing the results obtained through solving different problems with previous studies can show the results' suitable adaption. In addition, the results indicate that underground twin tunnels can have an effect on the vertical and horizontal components of the ground surface motion more compared to single tunnels. It is evident that the seismic amplification of the ground surface underlain by the shallow circular tunnels increases in long dimensionless periods. Moreover, the embedded depth and spacing distance of the double tunnels have significant influence on the amplification patterns on the ground surface. Creating more wave trapped zones by the double tunnels in comparison to the single tunnel can be one of the main reasons for increasing the seismic amplification of the ground surface. In addition, the interaction between tunnels and, consequently, the ground surface amplification values is decrease in the greater spacing distance of the double tunnels. Finally, some amplification coefficients are presented which could be used while introducing simple preliminary ideas to modify the standard design spectra in building codes and seismic microzonation studies.

Key Words: Underground tunnels; boundary element method; time domain; wave amplification; dimensionless frequency.

INVESTIGATION OF OPTIMUM DIMENSIONS OF SIMPLE AND DIFFERENTIAL SURGE TANKS TO CONTROL THE PRESSURE WAVES DUE TO WATER HAMMER

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Sharif Civil Engineering Journal
Volume 33, Issue 3.2, Page 43-52, Original Article

- Received 17 August 2016; received in revised form 23 January 2016; accepted 8 February 2016.

Abstract

Water hammer is one of the destructive hydrodynamic phenomena which established in most pumping stations, transmission lines and hydroelectric power plants. Fluid distribution systems and hydropower plants can be severely damaged by water hammer. Water hammer is the forceful slam, bang, or shudder that occurs in pipes when a sudden change in fluid velocity creates a significant change in fluid pressure. Since this phenomenon can force destructive effects on transmission lines and hydroelectric power plants (Turbines and pipelines), so it is essential to investigate the influence of water hammer (positive and negative pressure waves) along the transmission lines. One of the methods to reduce the effect of water hammer effects is to establish a surge tank in hydraulic pipelines. Surge problems are encountered in connection with unsteady state of flow of fluids in pipelines. In general a surge tank is designed to reduce the distance between the free water surface and turbine thereby reducing the water hammer effects on penstock and also protect upstream tunnel from high pressure rises. The other function is to serve as a supply tank to the turbine when the water in pipe is accelerating during increased load conditions and as a storage tank when the water is decelerating during reduced load conditions. In the present study, while describing the performance of different surge tanks and their role in adjustment the negative and positive pressures in transmission lines of hydroelectric power, two types of surge tanks (i.e., simple and differential) are selected and investigated their action on variations of flow pressure and velocity along the pipe lines. Also, regarding to the economic considerations, the dimensions of surge tanks have been optimized. Finding the optima position of tanks according the oscillations of water surface is another evaluated of

spandrels on seismic behavior of the buildings is investigated as well. Moreover, fragility curves are determined for studied models by incremental dynamic analysis (IDA). The results show that tunnel-form buildings have high capacity and adequate seismic performance under effect of torsion due to asymmetric distribution of mass in plan, in which both 5- and 10-storey tunnel-form buildings stay in the immediate occupancy performance level in design earthquake (475 years return period). It is also demonstrated that damage in the spandrels does not have considerable effect on overall seismic behavior of the buildings. Additionally, results indicate that mass center is not a reliable control point for displacement provisions, especially in high-rise buildings.

Key Words: Tunnel form system; mass eccentricity; torsion; fragility curve; uncoupled frequencies ratio.

PROBABILISTIC CONFIDENCE LEVEL EVALUATION OF VERTICALLY IRREGULAR STEEL BUILDINGS CONSIDERING SOIL-STRUCTURE INTERACTION

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Sharif Civil Engineering Journal
Volume 33, Issue 3.2, Page 17-27, Original Article

- Received 4 April 2015; received in revised form 16 February 2016; accepted 27 February 2016.

Abstract

In this paper, the seismic performance of vertically irregular steel buildings is evaluated. A ten-story steel building with special moment resisting frames is considered as the superstructure. The sufficiency of structural elements was evaluated by the earlier Iranian Seismic Codes. The three-dimensional finite element model of soil with nonlinear material behavior was attended below the superstructure to incorporate the foundation flexibility effects into the analytical models. The irregularities of mass, stiffness, strength, and concurrently stiffness and strength were assigned to different stories. Irregularity position was limited to the 1st, the 5th, and through the bottom half floors (stories 1 to 5). Through a series of nonlinear incremental dynamic analyses, the flexible-base structural performance levels were evaluated in the framework of probabilistic performance-based earthquake engineering. The confidence level curves of both regular and irregular structures were developed at two performance objectives: collapse prevention and global instability.

It is observed that the mentioned non-geometrical irregularities reduce the confidence levels of irregular structure as the intensity of the ground motion and related displacement demands increase. In comparison to the regular structure, depending on the position of irregular stories through the structure height, the seismic intensity and corresponding demands to a specific confidence level, change. As the structures pass through the collapse prevention performance level 40% to 60% variation is observed in the seismic capacity of no uniform distribution of strength along the structure height. Meanwhile, mass irregularity of the bottom floor has low variations in both demands and seismic intensity compared to the regular model. Generally, at rigorous nonlinear phase of structural behavior, the irregularity effects are highlighted. Among all the irregular structures, an appropriate confidence level of strength irregularity models is obtained at low seismic intensities. The displacement demands are also decreased so that in comparison to the regular structure, 85% differences are observed.

Key Words: Non-geometric vertical irregularity, performance -based earthquake engineering, incremental dynamic analysis, confidence level of performance objectives.

INFLUENCE OF DOUBLE TUNNELS ON SEISMIC AMPLIFICATION PATTERN OF GROUND SURFACE USING BEM

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Sharif Civil Engineering Journal

Abstracts of Papers in English

EVALUATION OF SEISMIC SENSITIVITY OF TUNNEL FORM CONCRETE BUILDINGS TO MASS ECCENTRICITY IN PLAN

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Sharif Civil Engineering Journal
Volume 33, Issue 3.2, Page 3-16, Original Article

- Received 28 February 2015; received in revised form 28 November 2015; accepted 27 February 2016.

Abstract

Torsion is recognized as one of the main failure modes of buildings in preceding earthquakes. Studies on the tunnel-form buildings show the primacy of torsional modes to translational modes in many models. This specification is unique to torsionally flexible buildings that eccentricity of mass, stiffness and torsional component of earthquake lead to an increase in both displacement and force responses. There is much research surrounding asymmetric buildings. However, there are fewer studies reported on asymmetric tunnel form buildings.

Despite its widespread use, there is not enough information regarding this new slab wall reinforced concrete tunnel-form system. Thus, identification and evaluation of performance of these buildings based on reasonable numerical results, including factors affecting response, are highly regarded by seismic codes.

In this study, the sensitivity of tunnel-form buildings with 5 and 10 stories to in-plan one-way mass eccentricity is studied. Mass eccentricities are assumed to be 5%, 10%, 15%, and 20% of the plan dimension. The performance level of these buildings, including different mass eccentricities in design earthquake, is determined by time history analysis with one directional earthquake excitation as well as push-over analysis. The effect of