Numerical investigation of the behavior of approach slabs in transition zone of ballasted track to box culvert in high-speed railway lines

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ABSTRACT

One of the most important issues in operation of high-speed railway tracks is avoiding to sudden variation of the track stiffness. Culverts and bridges are common areas which this problem is occurred along the railway lines. One of the method for applying the gradual variation of the track stiffness in these areas is using the approach slabs in transition zone. Therefore, in this research it has attempted to study this problem using numerical simulation. In this regard, a typical culvert of Tehran-Qom-Esfahan high-speed railway line with 6.6 m length was simulated. Then for studying the effect of transition zones, an approach slab includes of three parts with 6m length and various thicknesses simulated by FE model. In this model the ballasted track and its components such as railpads, sleepers, ballast and subgrade were modeled as lumped mass-dashpot-spring systems and the rails, approach slabs and culvert were modeled by Euler-Bernoulli beam elements. Then the dynamic behavior of the transition zone investigated under the passing of the moving loads same as the axle loads of the ICE high speed train. In this matter a series of sensitivity analyses were carried out on some parameters such as vehicle speed, approach slab thickness as well as damping and stiffness of track. Consequently, the achieved results show that the increasing of damping and stiffness of the track cause to the ballast forces increased and in other side it causes to the acceleration and settlement of the ballasted track and the approach slabs decreased. These aforementioned effects are more obvious in damping values higher than 200 kN.sec/m and the track stiffness values in the range of 120 MN/m to 180 MN/m. Moreover, it was understood that increasing the approach slabs thickness has remarkable effect on improving the dynamic behavior of the transition zone especially in speeds more than 340 km/hr.

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Direct displacement-based design of special composite RC shear walls with steel boundary elements

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ABSTRACT

Special composite RC shear wall (CRCSW) with steel boundary elements is a kind of lateral force resisting structural system which is used in earthquake-prone regions. Due to their high ductility and energy dissipation, CRCSWs have been widely used in recent years by structural engineers. However, there are few studies in the literature on the seismic design of such walls. Although there are many studies in the literature on the Direct Displacement-Based Design (DDBD) of RC structures, however, no study can be found on DDBD of CRCSWs. Therefore, the aim of present study is to evaluate the ability of DDBD method for designing CRCSWs. In this study, four special composite reinforced concrete shear walls with steel boundary elements of 4, 8, 12 and 16 story numbers were designed using the DDBD method for target drift of 2%. The seismic behavior of the four CRCSWs was studied using nonlinear time-history dynamic analyses. Dynamic analyses were performed for the mentioned walls using 7 selected earthquake records. The seismic design parameters considered in this study includes: lateral displacement profile, inelastic dynamic inter-story drift demand, failure pattern and the composite RC shear walls overstrength factor. For each shear wall, the overall overstrength factor was calculated by dividing the ultimate dynamic base shear demand (V_u) by the base shear demand (V_d) as per the Direct Displacement Based-Design (DDBD) method. The results show that the DDBD method can be used to design CRCSWs safely in seismic regions with predicted behavior.

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Influence of outrigger - belt truss on behavior of tall steel buildings with concrete core and circular plan

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ABSTRACT

Lateral displacement is one of the most important factors in the design of tall buildings. Different structural resistance systems proposed for resistance of gravity and lateral loads. One of the appropriate models in tall building design is structural model with concrete core that is the most important factor for structure's lateral displacement and load control. With increasing the height of structures the influence of concrete core on lateral displacement control decrease in topper stories, because the concrete core stiffness decreases. To avoid this weakness, outrigger and belt truss is used with core concrete. In this article three steel structures with 30, 40 and 50 stories and 90, 120 and 150 m height and circular plan with 16 m radius was investigated, steel frame models with concrete core and belt truss-outrigger was modeled, analyzed linearly, designed and investigated. The results showed considerable decrease in structures drift angle with using belt truss and outrigger in steel structure with concrete core, without any important change in materials weight. In addition, structures stress ratio controlled and adjusted, and the number of plastic hinges and performance level was increased.

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Identifying location and severity of multiple cracks in reinforced concrete cantilever beams using modal and wavelet analysis

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ABSTRACT

In this paper, a method of multiple cracks detection in a cantilever reinforced concrete beam based on wavelet transform is presented. For this purpose, different damage scenarios in concrete beam were considered. Then, the four first mode shapes of undamaged and damaged beam using ABAQUS software were extracted. The estimated mode shapes of the beam are analyzed by the continuous and discrete wavelet transform (CWT & DWT) to detect the damage scenarios. It was found that DWT is more sensitive to damage location than CWT in the concrete beam which introduced in this paper. Also, the influence of the mode order and the effect of damage distance from support on the effectiveness of damage detection was evaluated. It was observed that the distance of cracks to each other have no effect on identifying their location.

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Optimization of bearing capacity and unsymmetrical settlement of vertical pile group using genetic algorithm

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ABSTRACT

Capacity of pile group is the summation of the individual piles capacity with influence of spacing between the piles. Pile groups usually have the same length, so if the spacing between piles is too close, the zones of stress around the pile will overlap and the ultimate load of the group is less than the sum of the individual pile capacities especially in the case of friction piles, where the efficiency of pile group is much less. In this research the optimization of bearing capacity and unsymmetrical settlement of cap in the vertical pile group using genetic algorithm were studied. Friction pile in granular soil, with different length and arrangement were investigated to find the best performance of the group for the axial stiffness, bearing capacity and unsymmetrical settlement. The criterion of optimization is the volume of concrete needs for piles and cap. Two patterns of 5×5 pile groups (row variation and squared variation) are studied in this research. The analysis of pile group to find bearing capacity was conducted using the finite element software (Fb-pier) and for optimization used evolutionary genetic algorithm method.

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Numerical and experimental investigation of hollow steel columns strengthened with carbon fiber reinforced polymer

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ABSTRACT

In this research the hollow steel columns that strengthened with CFRP under axial compression has been investigated. Retrofit methods such as the use of steel plates increases the structural weight and in some cases using such method is difficult and impossible. This paper reports experimental and numerical modeling using ANSYS software. To determine the ultimate load of square hollow section (SHS) steel columns, seven samples of SHS steel columns with dimensions of 90 × 90 × 2.5 mm which were strengthened with CFRP and two control samples were tested. The results of numerical model was validated with experimental results. The results showed that, when the coverage of CFRP layers is not complete, CFRP has no effect on increase of the compressive axial load of SHS steel columns. In addition, the results showed that, the number, direction, and the coverage of CFRP layers can be effectively increase the pressure capacity of SHS steel columns.

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Experimental investigation on compressive strength of cement mortar using nano clay and flay ash

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ABSTRACT

In the present paper, compressive strength of cement mortar was investigated through two cases: case I in which just nano-clay (Nano clay to cement proportion equal to 3% and %5) is included, and case II in which both nano-clay and fly ash were considered (with the same values for Nano-clay as case I, and with fly ash to cement proportion equal to 15%). Gradual interaction of fly Ash with calcium hydroxide and alkalins resulted from cement hydration process, produces more C-S-H, spreading through concrete substructure free spaces. Results indicated that, all samples which contain nano-clay are denser than the reference sample. Adding fly ash and nano-clay have resulted in decreasing short term period (relating to three and seven days age) compressive strength of cement mortar. The 28 day age compressive strength of samples of case I, showed a dramatic increase about 27.2% for proportion value equal to 3%, and a considerable increase about 15.1%, for proportion value of equal to 5%. Results, also indicated a considerable increase in the 90 day age compressive strength that was about 28.4% and 22.4% respectively relating to two proportion values, 3% and 5%. The 28 day age compressive strength of samples of case II increased about 1.6% and 4.5% respectively, relating to two values of nano-clay to cement proportion equal to 3% and 5%. The 90 day age compressive strength of samples of case II, showed an increase about 10% and 16% respectively, relating to two values of nano-clay to cement proportion equal to 3% and 5%.

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Approximate evaluation of lateral acceleration in tall buildings with shear-flexural cantilever beam method

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ABSTRACT

In this paper a new method is proposed to estimate the seismic lateral acceleration response in tall buildings. Evaluation of lateral acceleration response in the stories of the structure will allow measures to be taken to reduce the damage on non-structural elements sensitive to lateral acceleration. In this article seismic acceleration response of the structure is obtained by combining mode-acceleration approach with shear-flexural cantilever beams method, and by estimating dynamic components of tall buildings. Quick proposed solutions and equation to calculate the seismic lateral acceleration response, require less information about the structure, which makes analysis easier and faster. The accuracy of the proposed equation is examined by calculating lateral acceleration of 10, 15 story structures during 3 earthquake records using the proposed equation and analyzing the same structures in finite element software, OpenSees. The results show that the proposed equation which does not need simulation and software analysis, offers a good estimation.

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Field studies on the effects of under sleeper pads in lateral resistance of railway

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ABSTRACT

Under sleeper pads are used in several areas, specially, in places where transfer of vibrations to the surrounding areas should be limited. Beside of all advantages of this elements in the field of reducing costs of repair and maintenance of railway, improvement of line geometry, decreasing the thickness of required ballast, reduction of vibrations and disturbing noises coming from passing trains and increasing trip convenience, use of these pads according to thickness and hardness of them could be effective in lateral resistance. Based on international evaluations in the field of under sleeper pads, results of influence of under sleeper pads in lateral resistance of railway are various, because of different reasons including: contact quality and compression of ballast grains, ballast thickness, distance between sleepers and different test for estimating the lateral resistance, therefore application of these pads specially in mountainous ways that lateral resistance is important, influence of these pads must be cleared. So in this field of study, lateral resistance of railway is measured by Single Tie Push Test. In this study 150 polyurethane under sleeper pads with two different stiffness which were produced by Getzner Company (specialize in vibration insulation in the rail), used in real line. Results of this field examinations show utilization of these elements under the sleepers increase 9.6% for the lateral resistance when SLB 3007 G (which are stiffer) attached in comparison to sleepers without pad and 2.54% decrease when SLB 1308 G attached in comparison to sleepers without pad. However decrease in hardness, results in increasing rate of lateral resistance reduction.

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Seismic vulnerability of Yazd

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ABSTRACT

Occurring earthquake in Iran plateau is common due to that Iran is on seismic belt and having a large number of faults. Studying of Yazd's vulnerability in Iranian's seismic code earthquake is the goal of this research. In this study vulnerability of structures depending on the type of soil obtained by HAZUS method and on the basis of the vulnerability of building structures in different regions will be investigated. On the basis of structural damage, levels of damage and loss of life calculated separately for each region. The results showed that in region 1 and 2 because of population density and having most of the old buildings, they have the greatest loss of life and region 3 have a greatest financial and structural damages and it is very vulnerable.

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