World Academy of Science, Engineering and Technology
International Journal of Geotechnical and Geological Engineering
Vol:14, No:06, 2020

Analysis of Elastic-Plastic Deformation of Reinforced Concrete Shear-Wall Structures under Earthquake Excitations

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Abstract : The engineering analysis of earthquake consequences demonstrates a significantly different level of damage to load-bearing systems of different types. Buildings with reinforced concrete columns and separate shear-walls receive the highest level of damage. Traditional methods for predicting damage under earthquake excitations do not provide an answer to the question about the reasons for the increased vulnerability of reinforced concrete frames with shear-walls bearing systems. Thus, the study of the problem of formation and accumulation of damages in the structures reinforced concrete frame with shear-walls requires the use of new methods of assessment of the stress-strain state, as well as new approaches to the calculation of the distribution of forces and stresses in the load-bearing system based on account of various mechanisms of elastic-plastic deformation of reinforced concrete columns and walls. The results of research into the processes of non-linear deformation of structures with a transition to destruction (collapse) will allow to substantiate the characteristics of limit states of various structures forming an earthquake-resistant load-bearing system. The research of elastic-plastic deformation processes of reinforced concrete structures of frames with shear-walls is carried out on the basis of experimentally established parameters of limit deformations of concrete and reinforcement under dynamic excitations. Limit values of deformations are defined for conditions under which local damages of the maximum permissible level are formed in constructions. The research is performed by numerical methods using ETABS software. The research results indicate that under earthquake excitations, plastic deformations of various levels are formed in various groups of elements of the frame with the shear-wall load-bearing system. During the main period of seismic effects in the shear-wall elements of the load-bearing system, there are insignificant volumes of plastic deformations, which are significantly lower than the permissible level. At the same time, plastic deformations are formed in the columns and do not exceed the permissible value. At the final stage of seismic excitations in shear-walls, the level of plastic deformations reaches values corresponding to the plasticity coefficient of concrete , which is less than the maximum permissible value. Such volume of plastic deformations leads to an increase in general deformations of the bearing system. With the specified parameters of the deformation of the shear-walls in concrete columns, plastic deformations exceeding the limiting values develop, which leads to the collapse of such columns. Based on the results presented in this study, it can be concluded that the application seismic-force-reduction factor, common for the all load-bearing system, does not correspond to the real conditions of formation and accumulation of damages in elements of the load-bearing system. Using a single coefficient of seismic-force-reduction factor leads to errors in predicting the seismic resistance of reinforced concrete load-bearing systems. In order to provide the required level of seismic resistance buildings with reinforced concrete columns and separate shear-walls, it is necessary to use values of the coefficient of seismic-force-reduction factor differentiated by types of structural groups.1

Keywords : reinforced concrete structures, earthquake excitation, plasticity coefficients, seismic-force-reduction factor, nonlinear dynamic analysis
Conference Title : ICSEA 2020 : International Conference on Seismic Engineering and Analysis
Conference Location : Dublin, Ireland
Conference Dates : June 25-26, 2020