Connections distribution optimization of precast concrete structures

Zheng He*, Bowen Jiang[a], Feng Pan[b]

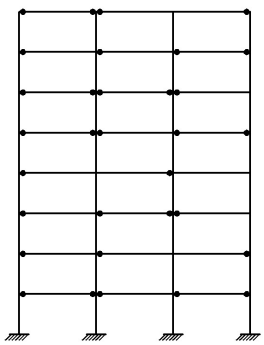
* State Key Laboratory of Coastal and Offshore Engineering, Dalian University of Technology, Dalian, China
Email: hezheng@dlut.edu.cn

[a] Dalian University of Technology, Dalian, China
[b] Shanghai Construction No.5 (Group) Co., Ltd, Shanghai, China

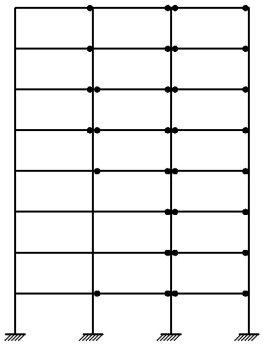
Abstract

This paper presents an optimization method to improve seismic performance of precast concrete frames. Previous researches in this field have mostly focused on proposing new forms of connections and nodes, as well as adding additional supports and damping devices. But it usually takes a long period of time from research and development to use in practice. Cost could usually be another constraint. For this case, considering the defects of insufficient rigidity and ductility of the precast concrete frames, this research aims to find the reasonable arrangement of rigid connections and semi-rigid connections with the help of optimization methods and computational capabilities of modern computers to improve seismic performance of precast concrete frames. Hysteresis models and F-D curves of different kinds of connections are based on experimental data. Parameters related to structural stiffness such as vertex displacements and inter-layer displacements are selected as objectives respectively under frequent earthquakes. And hysteresis energy consumption is chosen as an objective under rare earthquakes. In this process, an improved multi-population genetic algorithm is used for optimization, finite element analysis is used as a structural analysis tool. Convergence of optimization progress usually comes after dozens of generations. In contrast with methods mentioned before, it is a more realistic and versatile design approach as it doesn't need too many testing processes and could be used in almost all kind of conditions theoretically. Results show that most of semi-rigid connections would move to certain areas. Direction of movement is influenced by objectives that have been selected and geometric forms of structures. Besides, there could be a few semi-rigid connections away from the gathering place. This result reveals that the arrangement of different kinds of connections could be more complicated than designers' usually thought. To verify the effectiveness of these optimization processes, this research also tests some representative distributions of connections. But still the optimization results overmatch all kinds of typical distributions.

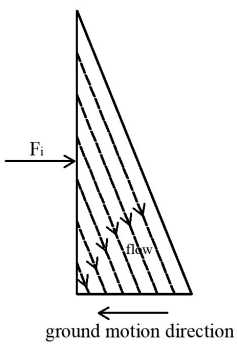
Keywords: structural optimization; precast concrete frame; genetic algorithm; semi-rigid connection



generation 1



generation 40



analysis