Structural Design of High-Rise Modular Building Systems

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Summary

This study presents the development process of high-rise modular systems for residential buildings. The vertical stacking construction methods of unit modular frame systems for low-rise buildings by simple column connections in the vertical load transfer should be modified for consideration of lateral loading due to wind and earthquake as the height of the buildings increases. Mega-bracing systems and floor diaphragm truss systems are adopted to meet the design criteria for the high-rise modular systems subjected to such lateral loads. This study investigates feasibility of possible lateral resisting subsystems including core wall systems and plane lateral bracing systems. The subsystems involve concrete core systems, steel bracing systems, and mega truss systems to connect with unit modular systems. The comparison study shows that mega-truss systems compatible with unit modular systems from the view point of construction sequence show structural efficiency. The assembly sequence of various modular units of frames and bracings critical to the minimization of field works depend on the connection design satisfying for different requirements. The proposed connection for these requirements must be satisfied with the structural performance and the ease of fabrication. To increase the integrity of whole modular systems a unique connection system of four blocks is proposed for structural performance with four parts of unit frames against lateral loading.

Keywords: high-rise modular system, lateral loading, mega-bracing, connection block, floor diaphragm.

1. Introduction

Recently, increasing demands for sustainable buildings require design criteria for reusability of construction material and easy dismantlement of connections of structural and non-structural components It is a main concept for sustainable buildings how to recycle the materials of existing buildings and new building to be constructed. To this end with these trends, modular building systems have had several advantages, including shorter construction periods and reusability of up to 90% of steel modular frame units by relocation. Therefore, the efficiency of modular building systems depends on how to connect components to be disassembly as much as possible. To extend the application of modular designs to various residential and commercial buildings, several feasible connections of subsystems for high-rise modular building systems to meet the requirement of the lateral resistance performance have been proposed. This study begins with the design of structural systems of 12-story modular systems. The key factor pertaining to the intended level of performance of a modular building system depends on the structural performance of its connection. Thus, the ultimate goal of this research is to investigate the performance of the proposed connections for the modular systems and to extend the application of the connections to other

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