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9. Onterie Center, Chicago (Illinois, USA)

Owner:	*PSM International Corporation*
Architects/Engineers:	*Skidmore, Owings & Merrill, Chicago, Illinois*
Construction Manager:	*PSM International Corporation*
Works Duration:	*2 years*
Service Date:	*1984*

Introduction

Onterie Center is a multi-use high-rise complex located on the Lake Michigan shore line near the downtown center of the City of Chicago. It is comprised of two towers, a 58 story main tower with a tapering base and a 12 story auxiliary low-rise building (Fig. 1). The total building, with an area of 85,000 m^2, is divided into five distinct areas by function (Fig. 2). On the ground floor of the main tower and the connecting low-rise building is the main public lobby and 1,860 m^2 of commercial space. Parking area occupies the basement and four floors above the lobby. Floors 6 through 10 of the tapering base as well as floors 2 through 11 of the auxiliary tower are devoted to office space and are organized around two interior atriums. The skylobby at level 11 includes a health club, swimming pool, hospitality room and mechanical equipment space. Level 12 through 58 consists of one, two and three bedroom apartments, for a total of 593 units.

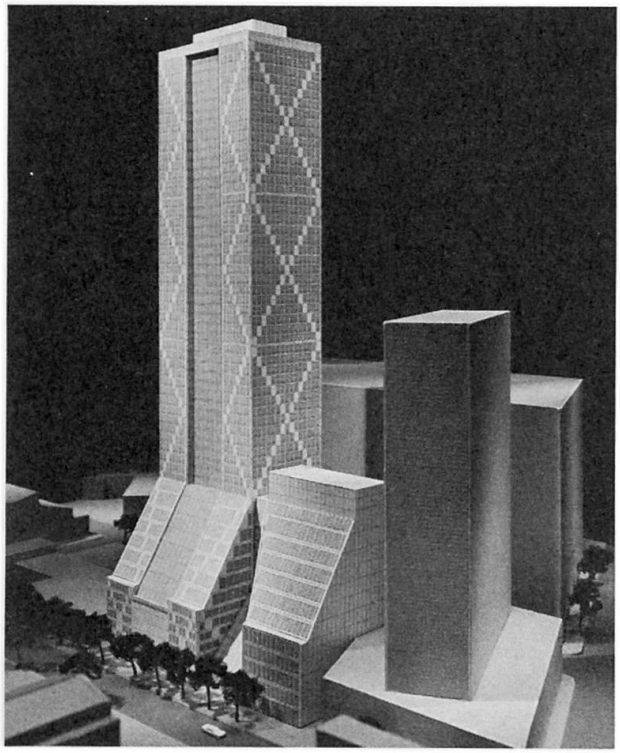


Fig. 1 Onterie Center

The Structure

Mixed use high-rise structures demand flexibility in column spacing and core layout. Therefore, maximum structural efficiency and functional flexibility can be achieved by utilizing the exterior frame of the building only for the lateral force resisting system. In the Onterie Center's main tower, the entire lateral force resisting system is achieved by closely spaced exterior columns and spandrels of reinforced concrete construction. Additional lateral stiffness and structural efficiency was achieved by infilling the window space with concrete in a diagonal pattern. These reinforced concrete infill panels act not only as diagonal braces as in steel high-rise structure but act as a shear panel as well (Detail A). By going diagonally across the building, they tie columns and spandrels together and help to evenly distribute the gravity loads on adjacent columns. They also help to reduce the shear lag in the tube frame and thus contribute to the structural efficiency of the system. As a result the entire lateral stability of the building is achieved by two exterior diagonalized tubular channels located at each end of the tower structure. Interior columns carry gravity loads only thus allowing more flexibility in planning the interior space and eliminating the differential creep between the core walls and adjacent columns, had a core wall been utilized in resisting lateral loads.

Structural Design

A three-dimensional computer model was analyzed for gravity and wind loads. It was found that the lateral drift due to design wind pressures at the top of the building was well below the H/600 design limit. Perimeter columns are 48 x 51 cm and about 1.68 m on center. The 51 cm thick infill panels have diagonal reinforcing bars as well as horizontal and vertical reinforcement (Detail B). The concrete cylinder strength for the exterior tube and the interior columns varies from 7500 psi (52 MPa) at the base to 4000 psi (28 MPa) at the top. The floor structural system is flat slab construction with thicknesses that vary between 17.8 cm for the apartment floors to 21.6 cm for the commercial floors. The concrete strength for the flat slab is 35 MPa. Interior column spans are about 6.71 m on center. Exterior columns, spandrel and infill panels are insulated to minimize temperature deformations between perimeter and interior columns. The building foundation consists of circular concrete caissons founded on the famous Chicago hard pan, a silty clay formation located about 24 m below grade level. The caisson bottoms are flared out in circular and oval bells to afford more bearing area. The allowable soil pressure is 1.95 MPa.

(Mohammad Salem)

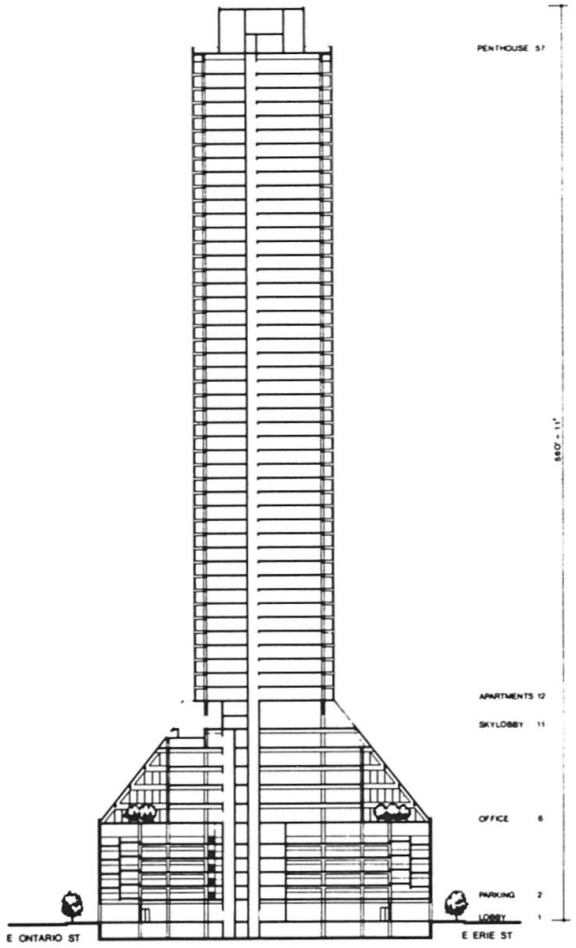
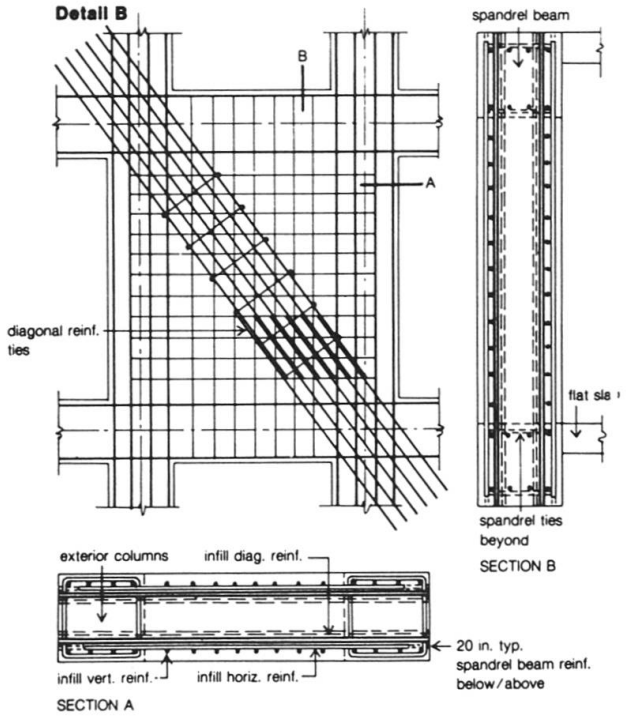
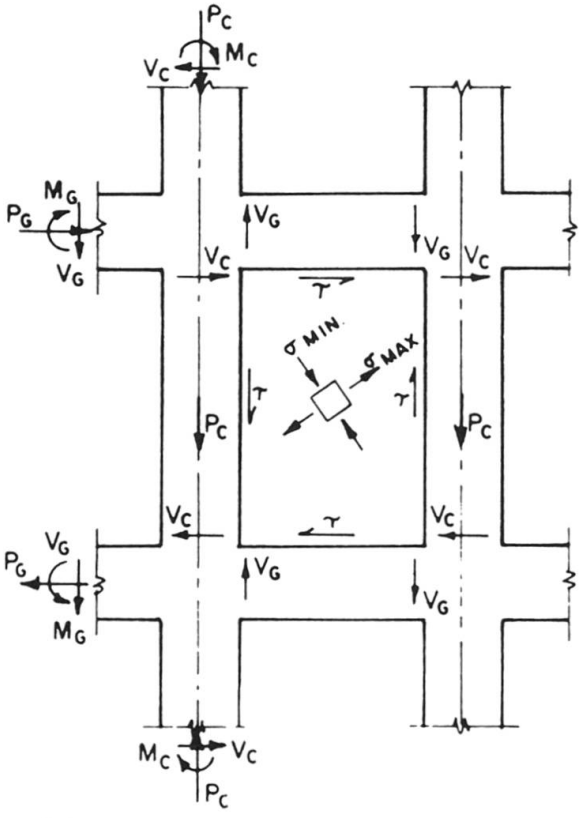


Fig. 2 North-South section



Detail B



Detail A

P_C, V_C, M_C axial, shear and moment in columns
P_G, V_G, M_G axial, shear and moment in spandrel beams
$\sigma_{MIN.}, \sigma_{MAX.}$ principal stresses in infill panel
τ shear stress in infill panel

Forces on Typical Infill Panel Caused by Lateral Wind Loads