

Stanford University Medical Center Parking Structure (No. 4)

Stanford, CA



Team

Owner:

Stanford University Medical Center
Stanford, CA

Architect:

Watry Design, Inc., Redwood City, CA

Engineer:

Watry Design, Inc., Redwood City, CA

General Contractor:

Vance Brown, Inc., Palo Alto, CA

Reinforcing Bar Fabricator:

Regional Steel Corporation, Tracy, CA

Total Project Cost:

\$25,950,000

Total Project Size:

425,000 sq ft

Photography:

Matthew Millman Photography

STRUCTURAL FRAMING SYSTEM

The University Parking Structure has four below grade parking levels and a substantial plaza deck at grade. The structural framing is a one-way post-tensioned slab spanning 17'-9" typically across 62'-0" long post-tensioned beams. The columns are cast-in-place concrete. Concrete walls retain the soil and provide lateral restraint. The foundation consists of spread and continuous footings. The project contains approximately 18,530 yards of concrete and 2,956,000 pounds of reinforcing.

UNIQUE STRUCTURAL AND/OR ARCHITECTURAL DESIGN FEATURES

The major challenge on this project was to develop a seismic analysis procedure appropriate for the unique characteristics of a subterranean system in a high seismic region of California. The parking structure is located completely underground and lies within four miles of the active San Andreas Fault System. There are currently no provisions in the code for the lateral design of an underground building. Collaboration among the structural engineers, geotechnical engineers, and the independent plan checker resulted in consensus on the design approach. In addition to the prescribed 1997 DBC lateral inertial forces of the building, earthquake loading from the soil face was applied along the full height of the structure to incorporate dynamic lateral soil interactions.

Given the rectangular proportions of the building plan, two different mechanisms for resisting lateral forces were required. The floor diaphragms in the short direction behave as a rigid system and in the long direction as flexible. Accordingly, loading on the short face was transferred into the perpendicular walls as shear forces. On the long face, this approach was followed for 60-ft at each end. In the remaining 338-ft middle region, the basement walls resist the lateral loads through out-of-plane bending between the floor slabs. Soil properties were included in the analytic models to represent the resistance due to soil stiffness on the opposing side of the parking structure. Where the continuity of the floor diaphragms is interrupted by the ramps, horizontal "strut" beams, detailed as ductile column compression elements, transfer these forces across the floors and interior shear walls to the opposing foundation walls.

Another unique aspect of this project was the framing for the upper level plaza. The finished surface treatment included numerous planters, Governors Lane, and fire truck access; and the additional framing for these elements was accomplished without adversely affecting the parking efficiency below. Governors Lane cuts diagonally across the parking structure and will be lined with large trees. In order to incorporate a 5-foot soil depth for these trees, the upper level slabs and beams were profiled with a trough that wraps across several bays.

CHOOSING REINFORCED CONCRETE

From a cost perspective, reinforced concrete was the only choice that made any sense for this project. But not only was it less expensive, it also performs better in high seismic locations than other material choices. Due to the large seismic forces in addition to the lateral earth pressures present on a subterranean structure, reinforced concrete was the natural choice.



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