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RENOVATED OFFICE BUILDING AT 215 FREMONT STREET

SAN FRANCISCO, CALIFORNIA

The existing building was expanded by adding two floors to the structure, raising the building from seven to eight stories totaling nearly 400,000 sq. ft. in size, and converting the existing basement storage space into a useable parking area. The existing concrete structure required fitting with a dynamic new skin, a new core, and complete new building systems that embody sustainable design goals of energy efficiency. Additionally, to engage public interaction into the neighborhood and further animate the building, a retail arcade was added at the street level, and roof-top terraces were integrated into the design.

INTRODUCTION

The Structural Engineers for 215 Fremont Street project won the prestigious "Excellence in Engineering Award" from the Structural Engineering Association of California for the use of conventional structural engineering technologies in a building retrofit. The renovation and expansion of 215 Fremont Street were completed in early 2001. The transformation of the building had an immediate, positive impact on the neighborhood business culture, and quickly attracted a leading national corporate enterprise, which occupied the entire building. In this project, innovative foundation design, seismic retrofit, and creative architectural expression resulted in a measurable improvement in the financial value of the building and a desirability of the neighborhood as a corporate location.

The project at 215 Fremont Street was a renovation and expansion of an existing office building in downtown San Francisco, California. The project goal was to provide quality office space for tenants in the growing digital market at a prime location in the city's rapidly developing "Media Gulch."

One of the project's major challenges was to transform the early twentieth century industrial building (which had been significantly damaged in the 1989 Loma Prieta earthquake and vacant for more than ten years) into a distinctive architectural statement that would create a focal point for the neighborhood, as well as an office space signifying growth into the twenty-first century. Besides the extensive seismic retrofit necessary to bring the structure up to current standard building codes, other vital work was required.

The 215 Fremont Street building was built in 1927, and was originally a seven-story, L-shaped office building consisting of large floor plates of about 46,000 sq. ft. The existing structure was a reinforced concrete flat slab floor system bounded by a column grid of 20 foot o.c. The total building area was approximately 320,000 gsf. To meet current building code requirements and achieve the goal of renovating the building and developing additional space, evaluation of the existing building, as well as analysis and design of the retrofitted structure and foundation, were necessary.

METHODOLOGY

The project team began the design process by analyzing the requirements and determined the appropriate workplan to meet the needs of this project. This included identification of consultants, specialists, and surveys necessary to evaluate existing conditions, and the gathering of data necessary for the design. The team collaborated to share professional experience and develop solutions that would most successfully meet the project goals.

The first step was a review of the original design drawings. This review provided an initial assessment of the building's construction. The design drawings supplied the following information:

- Column sizes and reinforcement
- Slab reinforcing quantity and layout
- Size and location of existing spread footings and grade beams
- Thickness and depth of perimeter framing

While the drawings proved useful, certain important information was either illegible or not included. To verify the information provided and determine the unknown structural parameters, an engineering survey was required to perform a physical and visual inspection of the existing building, in addition to geotechnical investigation of existing soil conditions.

The survey included a detailed evaluation of both superstructure and substructure data necessary for the design of the building. The original foundation system consisted of truncated pyramid-shaped spread footings at interior columns and grade-beam foundations, with strap beams along the building perimeter. Although some wood piles were discovered during the building survey, the building had a shallow foundation system. The building's underlying soil conditions included different regions of dense, silty sands and stiff silts. Since the original construction, the building had experienced differential settlements of up to 5 inches. Core samples and dynamic load tests of the existing floor slabs provided data necessary to evaluate the viability of components of the existing structure.

This report verified the findings of the field survey, noting the following:

- The soils were subject to differential deflection.
- The shallow sandy soils were susceptible to liquefaction and would not support earthquake loading.

With this information in hand, the project team concluded that to meet the goals of the project and provide a viable structural design, this project would require an extensive effort to coordinate the work of each discipline and evaluate the entire building using a computer model.

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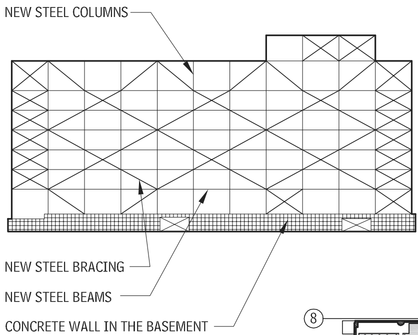
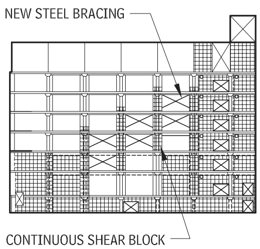
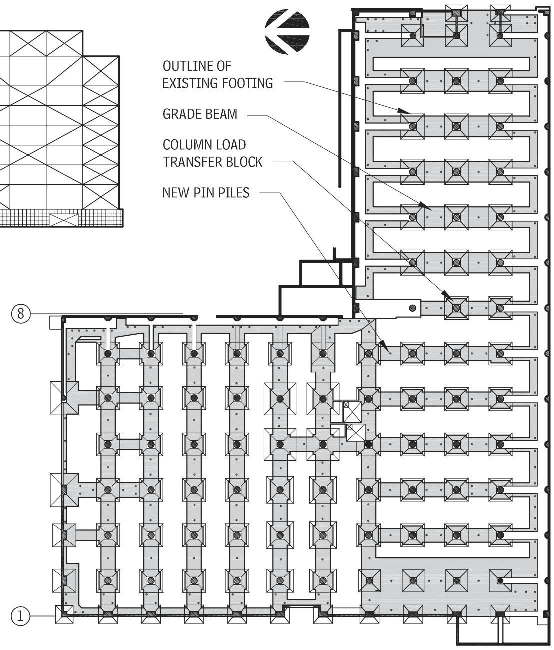


ELEVATION ON LINE 1



ELEVATION ON LINE 8

LATERAL BRACING DIAGRAMS



FOUNDATION PLAN

LATERAL BRACING DIAGRAM: Besides accommodating architectural facade considerations, attention was given to formulating a structural system that would use the full length and width of the building to minimize seismic overturning forces on the foundation. The solution chosen was a combined system of concrete shear walls and perimeter steel-braced frames, and steel framing for the additional two floors of office space.

FOUNDATION PLAN RENOVATED: The innovative solution for the new foundation system given the constraints and geotechnical conditions was to enhance the existing foundations, underpinning where needed, with a combination of "column load transfer blocks" to grade beams with pin piles. The building loads would, therefore, be transferred from the columns/walls to the existing footings by the transfer blocks, which then transfer the loads to the pin piles through the grade beams spanning between footings.

TECHNICAL SYSTEMS

Based on the information acquired from the existing drawings and field surveys, a computer model combining ETAB 1997 v6.2 for Dynamic and Static Analysis and SAP 2000 for Three-dimensional Design of Structures was generated to determine the performance of the existing structure under gravity and seismic loading. From the computer model, it was determined that the existing structure was inadequate for gravity support and for resisting seismic forces.

Since the existing structure would not be able to accommodate the high seismic force because of the large building weight and 1997 UBC seismic-force coefficients, a new structural system was necessary. This system needed to be consistent with the architectural concept of transparent curtain wall skin on key facades, as well as the long spans required for an effective office floor plan layout of the new additional floors.

New infill concrete slabs, dowelled into the existing slabs, were also added at the new curtain wall elevation to create a unified diaphragm to integrate the steel-braced frame into the existing structure.

The challenges faced by the Structural Engineer working with the Geotechnical Engineer included creating a foundation system that could support the existing concrete building with the additional two floors, without exceeding differential settlement limits, while resisting the large horizontal forces defined by UBC 1997 requirements for seismic activities. Interpretation of the survey data indicated that the saturated, cohesion-less soil underneath the existing shallow foundations could liquefy as it experienced strong seismic ground motion, and would experience temporary loss of shear strength created by a transient rise in excess pore pressure. Therefore, the vertical forces from gravity loads, combined with overturning forces generated from a seismic event, could not be resisted by shallow foundations.

A deep foundation system was required that would allow the loads to pass through the liquefiable soil layers. Alternative shallow foundation systems such as grade beams footings with combined spread footings and mat foundations were not feasible solutions. The solution for deep foundations had to also account for the relatively close column spacing of the existing concrete structure, and the limited vertical clearances within the existing basement. Therefore, standard driven piles were not feasible, and special foundations such as base isolation did not address the issue of transferring seismic load to bearing soil layers.

The grade beams (which were 5 ft 10 in. wide by 3 ft 6 in. deep) were designed to resist the gravity loads and overturning loads during an earthquake from the existing columns and transfer them to the pin piles by shear and flexure. A minimum of four longitudinal reinforcing bars were drilled, and epoxy was grouted through the existing columns to transfer loads directly into the grade beams with steel couplers. The balance of longitudinal reinforcement was placed symmetrically on either side of the existing columns to minimize penetrations through the existing elements.

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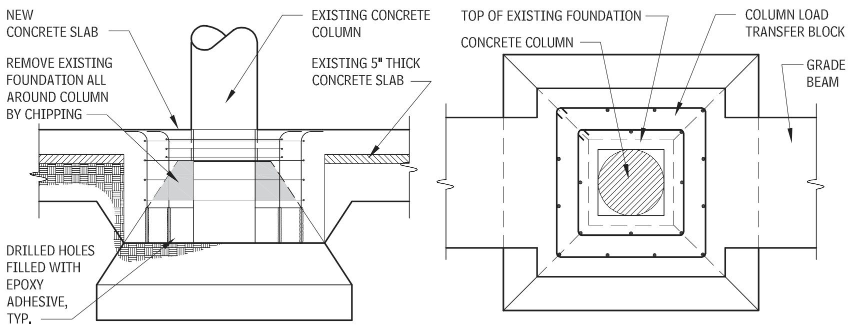
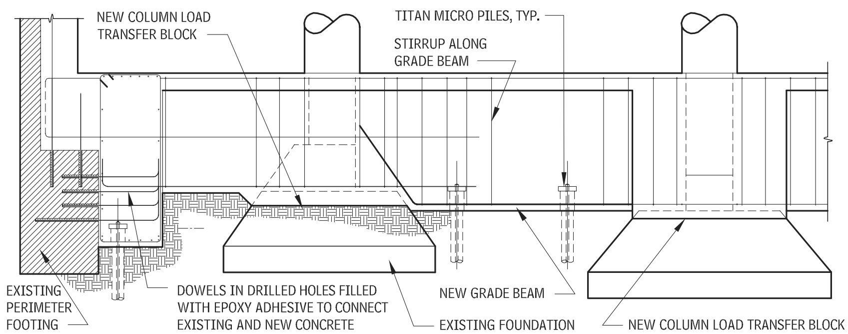


COLUMN LOAD TRANSFER – TYPICAL SECTION AND PLAN



GRADE BEAM – SECTION

GRADE BEAM SECTION: At the east and west ends of the building footprint, mat footings that are 4 ft-6 in. thick were used in lieu of the grade beams to support the high seismic overturning forces. Additional basement shear walls were also added to aid the eccentric load transfer from the walls to the pin piles.

COLUMN LOAD TRANSFER: The transfer blocks, typically 11 ft-0 in. by 11 ft-0 in., were constructed by chipping away the existing footings around the columns to allow for the installation of vertical dowels embedded into the grade beams. The column loads are transferred to the grade beams by these dowels, which tie all columns together.

SUMMARY

The Architects and the Structural Engineers learned that to achieve the goals of the project, successful collaboration and rigorous application of a design process were required. This included identification of key issues, as well as the use of specialists to evaluate existing conditions and to gather data necessary for the design, and to arrive at solutions for a viable structural design that fit integrally into the architectural expression.

Given the damage the building suffered in the 1989 Loma Prieta earthquake and the high seismic forces determined from the 1997 UBC, a new structural system needed to be developed for the project that would be sufficiently stiff to alleviate the induced internal forces in the existing floor slabs and punched exterior walls.

Additionally, the structural system needed to use the full length and width of the structure to minimize the seismic overturning forces applied to the foundation, while simultaneously being compatible with the architectural considerations for the building facade. This retrofit of an early twentieth century building led to the creation of a unique connection between steel braces and concrete columns, as a combination structural system comprised of steel-brace, frame-and-concrete shear walls was developed to meet all critical requirements.

In conjunction with the new structural system, other important changes occurred. They included repairs and modification to the concrete slabs, a redesign of the foundation system, the addition of two new floors, and the demolition and rebuilding of feature elevations to accommodate a new curtain wall.

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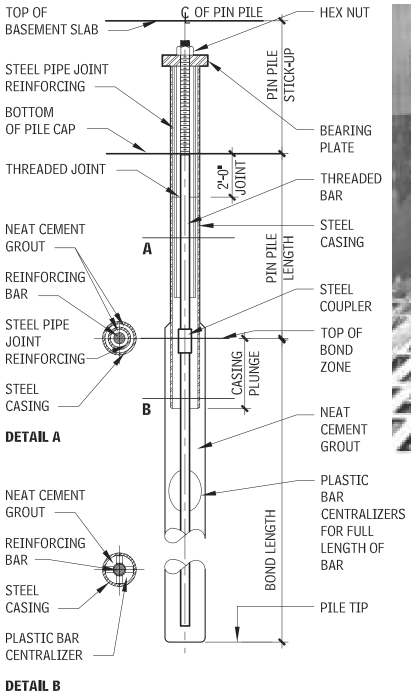

PIN PILE SECTION AND DETAILS

GRADE BEAM CONSTRUCTION

PIN PILE SECTION AND DETAILS: Circular pin piles 7 in. in diameter were used to support the gravity and seismic loads. Pile load tests were performed to determine ultimate pile capacity, length, and placement, and to limit differential settlement to 1/2 in. The pin piles were confirmed to require an average length of 67 ft in length below grade. They were installed in about 10-ft sections (determined by available working height) and reinforced with continuous threaded steel rebars and couplers between each section. They were post-grouted directly to the noncased soil borings at the bottom sections to achieve an average ultimate capacity of 550 kips.

GRADE BEAM CONSTRUCTION