# 520 S. El Camino

OWNER / DEVELOPER: WESTLAKE URBAN, LLC
STRUCTURAL ENGINEER: TIPPING STRUCTURAL ENGINEERS
ARCHITECT: RMW ARCHITECTURE & INTERIORS
CONTRACTOR: PANKOW
PEER REVIEW: SHUHAIBAR AND ENGEO
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TIPPING
STRUCTURAL ENGINEERS

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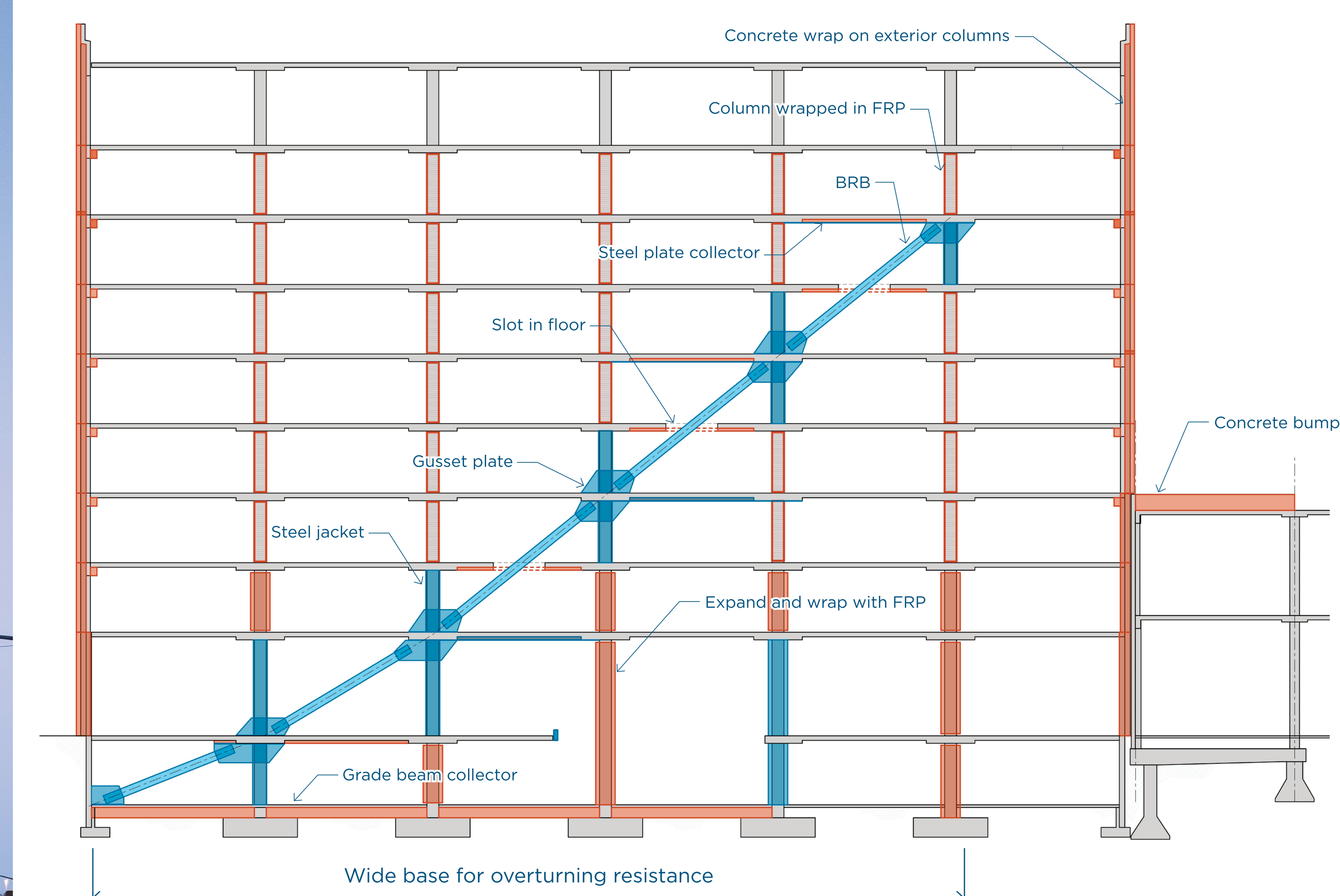
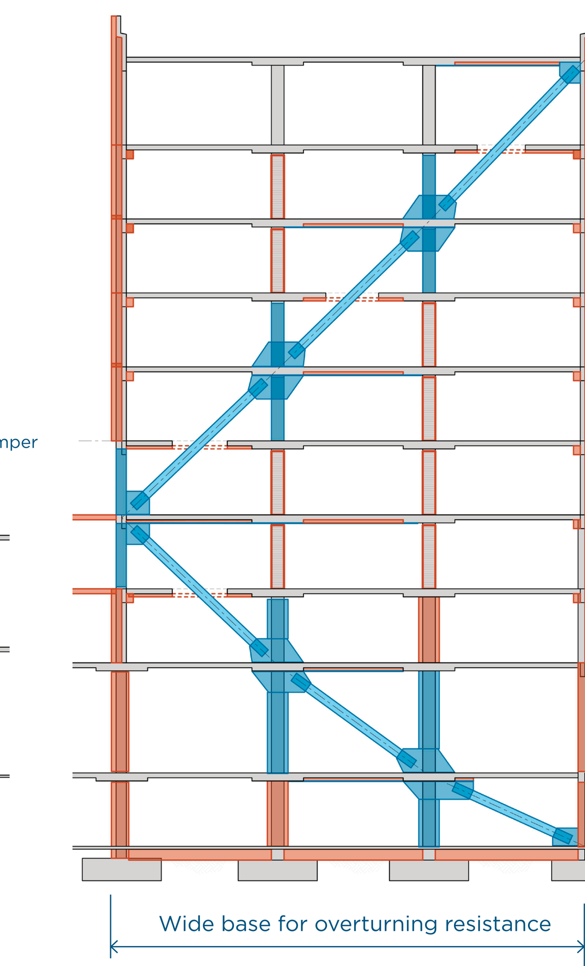
ORIGINAL STRUCTURE BUILT IN 1960S

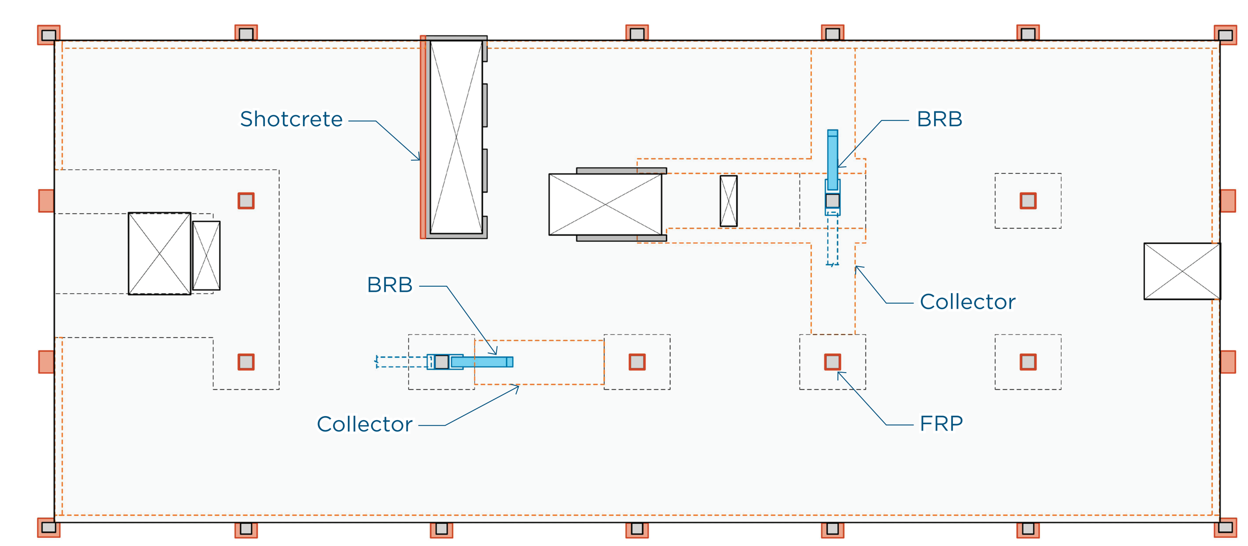
WESTLAKE URBAN'S LONG ESTABLISHED HEADQUARTERS, REINVENTED AS AN ICON OF RESILIENCE



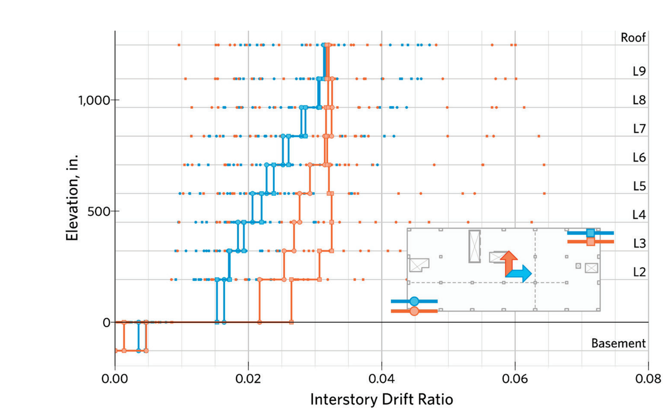

Building Section, Longitudinal



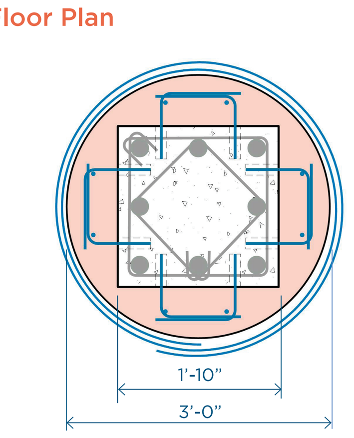

Building Section, Transverse



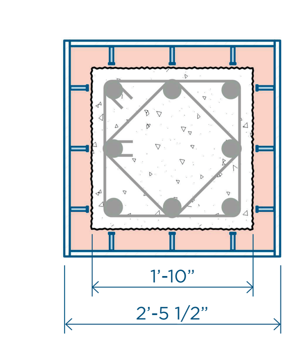

Typical Floor Plan



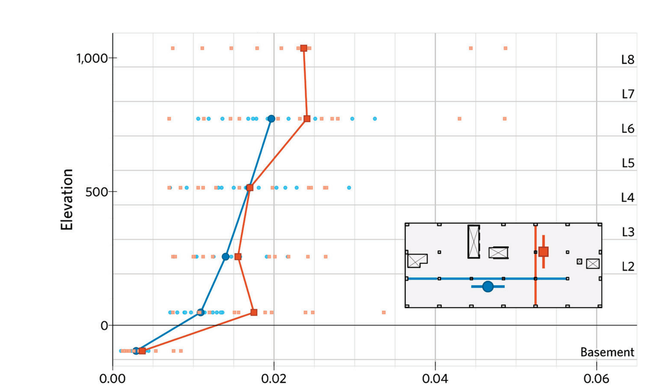

Interstory Drift Ratio, BSE-2N




Column Retrofit: Interior, Expand and Wrap




Column Retrofit: Interior, Steel Jacket




Brace Axial Strain, BSE-2N

## NEW SKIN, STRONGER BONES: BRB RETROFIT OF A CONCRETE BUILDING

### CONTEXT

The building at 520 South El Camino Real in San Mateo, which has served as the headquarters of Westlake Realty since the 1970s, has been radically transformed and upgraded with an innovative structural approach to create prime office real estate providing a modern and resilient workplace.

The building was constructed in the 1960's, prior to the advent of current seismic safety standards. The nine-story structure provides a total of 118,000 gross square feet of space. The existing structure uses two-way concrete floor and roof slabs supported by concrete columns with drop panels. In its original configuration, lateral resistance was provided by interior concrete walls, irregularly arranged around the central circulation core, supplemented by a cast-in-place concrete facade perforated with narrow vertical windows.

As part of the overall renovations, the owners elected to perform a detailed seismic evaluation to identify potential vulnerabilities and voluntarily address critical deficiencies. Ultimately a comprehensive seismic upgrade was included in the overall building rehabilitation and renovation project. The project involved a complete replacement of the exterior facade, removing the existing heavy concrete cladding and replacing it with full-height glazing.

### DETAILED SEISMIC ASSESSMENT

A detailed evaluation revealed a number of serious concerns with regard to expected seismic performance:

1. Shear-critical columns with high axial stress, heavy vertical reinforcement, and little transverse reinforcement;
2. Weak-story response due to vertical discontinuities in concrete cladding;
3. Torsional irregularity due to partial height solid transverse walls on one end of the building;
4. Inadequate lateral strength to resist anticipated ground shaking; and
5. Close proximity to shorter adjacent building that might compromise existing columns due to pounding.

### DETAILED NON-LINEAR ANALYSIS

The response of the existing structure and the effectiveness of the retrofit measures were verified using nonlinear response history procedures in accordance with ASCE 41-13. A full 3D model of the structure was built using CSI Perform 3D. To confirm our process and assumptions, peer review was provided of the analysis and ground motions selection. Ground motions were scaled to match the design spectrum of ASCE 7-10. Analyses were conducted at the BSE-1N and 2N hazard levels, and element demands were compared to acceptance criteria to verify that the Basic Performance Objective Equivalent to New Building Standards (BPON) was met.

The analytical model included all aspects of the structure deemed important to the dynamic behavior of the structures. Nonlinear elements included the existing concrete walls, BRBs, moment-frame action of the existing frame, horizontal and vertical soil springs, and ground floor diaphragm. The short adjacent building was also included to capture the effects of pounding between the structures.

### OVERCOMING CHALLENGES WITH INNOVATIVE DESIGN

Certain aspects of the retrofit, such as strengthening the columns for shear, were obvious, but honing in on a complete approach required more in-depth and detailed consideration. Two effective ways of increasing global lateral strength were explored: adding concrete walls and introducing diagonal bracing using buckling-restrained braces (BRBs). The costs of the two approaches were comparable, and the BRB scheme was preferred due to better flexibility for space planning and construction schedule benefits. However, given existing floor-to-floor heights and bay widths, conventional configurations of diagonal or chevron bracing would have caused the yielding core in the braces to be much too short to effectively dissipate energy without early fracture. As we sketched the geometry of the columns and floors to scale, we were inspired to consider passing the braces through every other floor. With this approach, the brace geometry became nearly ideal at a 45°angle with ample length for the yielding core. The analysis demonstrated that the retrofitted columns and existing concrete walls would be adequate to stabilize floor slabs that are not connected to the braces. The BRBs were arranged such that they maximize the contribution of the gravity frame to overturning and eliminate the need for new deep foundations. These two important design features created significant economies for construction.

The connections between the new steel braces and existing concrete structure presented significant design challenges. Affected columns were strengthened with a steel plates and integrated with side gussets at the brace connections. Steel plate collectors were welded to the brace base plates to transfer horizontal forces into the slabs.

### RETROFIT SOLUTION

The retrofit involved multiple components:

1. Strengthening existing columns for shear and axial loading;
2. Adding new BRBs to increase overall strength without overstressing existing foundations;
3. Replacing existing exterior concrete cladding with a light weight curtain wall system;
4. Strategic demolition of existing concrete walls with vertical saw cuts; and
5. Introducing new contact points against the adjacent building to transfer pounding forces.

### WHY IT MATTERS

The renovation and retrofit of 520 South El Camino Real demonstrates that detailed seismic simulations coupled with an innovative design approach can result in unconventional solutions that create extraordinary value. By addressing the critical seismic concerns with surgical precision, the structural improvements were economically feasible, making it possible to reinvent, modernize, and extend the life of the building. Moreover, the engineering approach and design strategies employed are relevant and replicable for the large inventory of similar seismically-vulnerable non-ductile concrete buildings.

## INNOVATION SUPPORTED BY DETAILED ANALYSIS YIELDS VALUE FOR STAKEHOLDERS