

# Barrows Hall, University of California Berkeley

Berkeley, CA



## Team

### Owner:

University of California Berkeley,  
Berkeley, CA

### Architect of Record:

Murakami/Nelson, Oakland, CA

### Engineer:

Degenkolb Engineers, Oakland, CA

### General Contractor:

Rudolph & Sletten, Foster City, CA

### Total Project Cost:

\$20 million

### Total Project Size:

200,000 sq ft

### Photography:

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The University of California, Berkeley contributes \$1.23 billion annually to the Bay Area economy, and the Barrows Hall project is one element in the University's plan to preserve its rank as one of the country's top research universities and safeguard the community from economic and structural devastation. The comprehensive disaster resistance strategy strives to limit operational interruption, loss of intellectual capital, and the negative impact on the community at-large.

Barrows Hall is an existing eight-story reinforced concrete building constructed in 1964 in accordance with the 1958 Uniform Building Code. Using FEMA grants to mitigate post-disaster recovery costs, a solution using exterior reinforced concrete shear walls was developed to strengthen 200,000 sf of space for approximately \$20 million. The added exterior reinforced concrete walls wrap around each end of the building and are interconnected with exterior concrete collector beams on every floor. The focus of seismic strengthening on the building exterior allowed the building to remain occupied during construction, met the University's enhanced performance objective, and improved the appearance and security of the building.

### STRUCTURAL FRAMING SYSTEM

The seismic strengthening work consists of adding full height (8 stories) cast-in-place concrete shear walls that wrap around each end of the building in a "C-shaped" pattern. The walls are heavily reinforced and are approximately 24 to 36" thick to allow the reinforcing bars (rebar) to pass by the outer face of the exterior pilasters. The walls are interconnected with added cast-in-place concrete collector beams on the north and south wall of the building at each floor level. The foundation consists of thickened basement walls and spread footings integrated with the existing walls and footings.

### UNIQUE DESIGN FEATURES

Performance based design principles allowed consideration for the strength benefits from the existing building and the ability for the added walls to meet minimum requirements for adequate ductility through either foundation rocking or flexural yielding in the walls and spandrels. The added collector beams at each level served two goals; to strengthen the diaphragm to span between the end walls and to force the new walls to work together.

### REASONS FOR CHOOSING REINFORCED CONCRETE

Due to the proximity of Barrows Hall to the Hayward Fault (900 yards), high seismic demands resulted in heavy reinforcing and ductile detailing in the walls, piers and spandrels. To reduce congestion and improve constructibility the following detailing strategies were used:

- Couplers were used at all large bar splice locations to avoid added steel required for lap splices.
- Couplers were selected to force yielding in the reinforcement and to achieve high strain levels.
- T-heads were used at the ends of large bars to eliminate large development length requirements.
- Confinement reinforcement (ties) were specially designed with consideration for construction sequencing.
- Additional couplers were added during construction to allow for tolerances in the placement of reinforcement to miss the existing reinforcement.

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