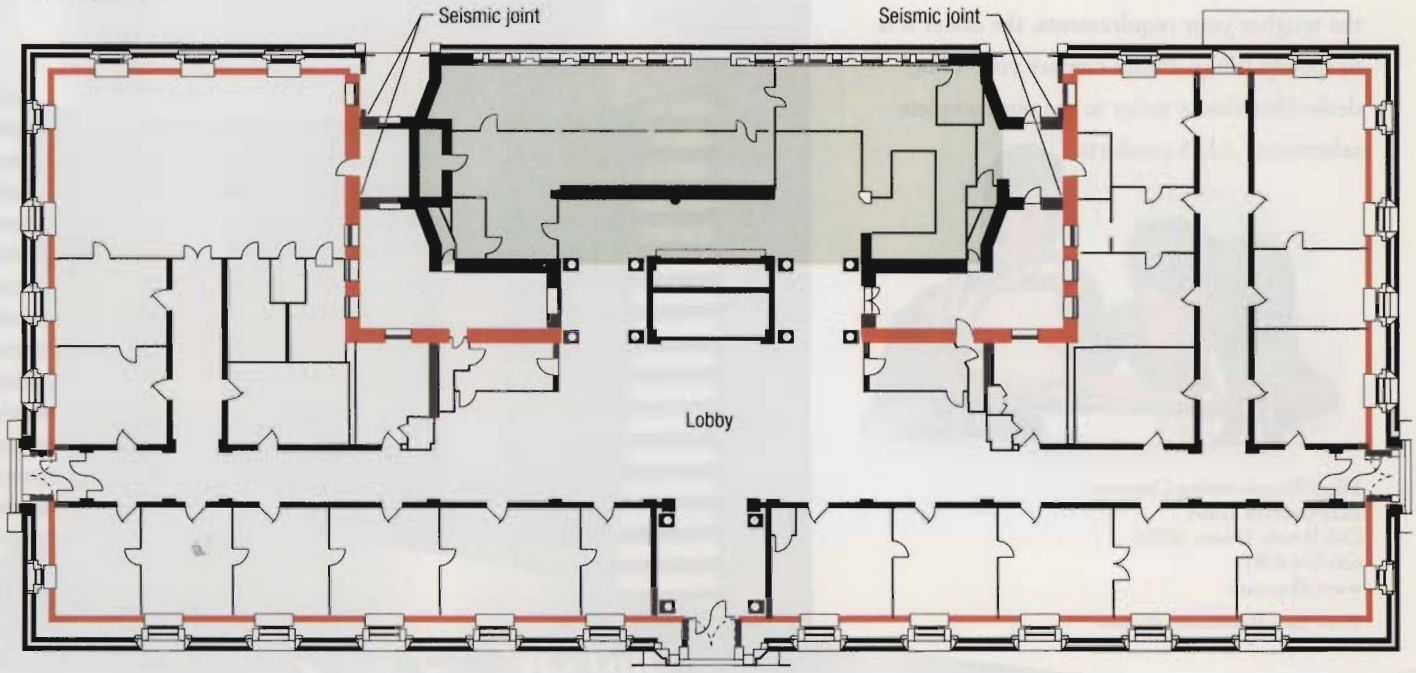



Rich in historic marble, plaster and granite finishes, the U.S. Customs House also contained its original 1906 steel structural system. Seismically upgrading this landmark involved creating new shear walls around the building's perimeter, installing new piles and adding connecting steel.

*Photos: (left) Sarah Beach; (top) Nan Park*

First Floor Plan



# According to custom

## Seismic upgrades at San Francisco's U.S. Customs House preserve its historic character

**By Renée Young, Associate Editor**

San Francisco's U.S. Customs House is accustomed to earthquakes. The building's foundation had just been laid when the devastating 1906 quake hit. While the five-story, U-shaped building and its adjoining two-story 1911 appraiser annex have survived more than 80 years of minor quakes, the 1989 Loma Prieta event stirred the owner, the U.S. General Services Administration, to upgrade the complex to comply with current California seismic standards.

Although the building sustained only minor visible damage in that 7.1 magnitude earthquake, unseen damage significantly weakened it. "Because an event of that size breaks the bond between each brick and stone, the building would not likely have resisted the next quake effectively," said David Hobstetter, director with San Francisco-based project architect Kaplan McLaughlin Diaz (KMD).

Connected by four walkways on two levels, the buildings have dissimilar structural systems. The two-story structure, where the public has their imports and exports evaluated, is constructed of unreinforced masonry. The five-story building, which houses customs offices, is steel-framed to support gravity loads and infilled with brick. Granite panels ranging from 4 inches to 3 feet thick cover its exterior walls on three sides, with glazed white brick on its fourth — the courtyard of its U-shape plan.

A significant constraint was that both buildings are rich in historic marble, plaster and granite finishes and listed on the National Register of Historic Places. As a result, seismic upgrades could not impact their historic characteristics.

The structural solution for the appraiser building, which was completed under a separate construction contract, involved installing steel supports 20 feet from the top of the parapet on the building's 12-in.-thick exterior walls down to the brick foundation, then grouting the bars in place to handle lateral forces. "The solution is imperceptible, since the upgrade all takes place within the wall itself," said Hobstetter.

Lateral reinforcement of the 137,000-sq.-ft. office building proved much more challenging. With base isolation ruled out because of cost, the structural solution involved creating concrete shear walls around the building's entire perimeter, installing new steel piles to better anchor the building, and adding of connecting steel to tie all existing beams together.

In order to access the areas where this work would occur, all interior finishes were removed from those sections. "We removed and cataloged everything from the wood trim and windows to the marble columns and balustrades, then stockpiled them in rooms that were not going to be touched," said Joel Josehart, project manager with the San Francisco office of Morse

**CONSTRUCTION COSTS**

| | |
|---|---|
| General conditions | $2,300,000 |
| Demolition | 2,400,000 |
| Excavation/shoring/piling | 600,000 |
| Concrete | 3,000,000 |
| Masonry | 2,800,000 |
| Structural steel | 870,000 |
| Finishes | 820,000 |
| Waterproofing | 110,000 |
| Drywall/plaster | 1,200,000 |
| Tile/carpet | 220,000 |
| Painting | 777,000 |
| Specialties | 45,000 |
| Elevators | 32,000 |
| Plumbing/mechanical | 1,030,000 |
| Electrical | 1,600,000 |
| **Total** | **$17,804,000** |

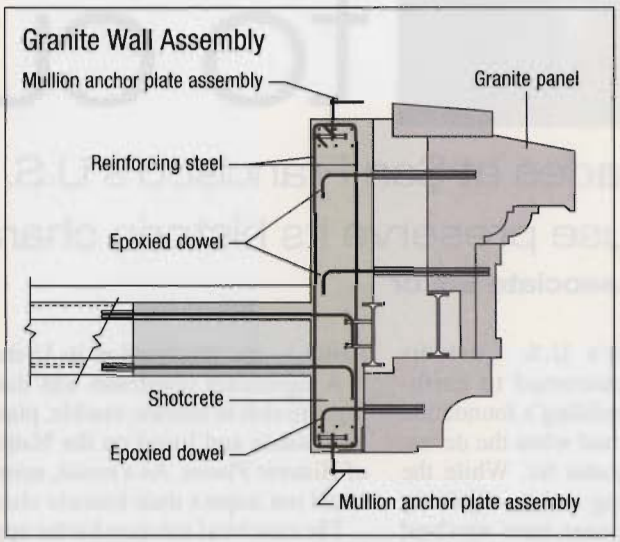
## Steel H-piles supplement original wooden piles

Diesel International Inc., the general contractor. Epoxy molds were made of items such as the ornamental plaster to allow for recasting. Further, a protection plan was developed that restricted trades to their respective work areas.

One historically significant area not off limits was the lobby. With its marble fixtures and much of its floor removed, the lobby hosted a tracked pile driving rig brought in through 14-ft.-tall bronze entrance doors. "All materials needed to be brought into the building through existing entrances. As a result, we had rebar delivered through the windows and the pile driver was squeezed through the ornate entry doors with only half an inch to spare between rubbing the noses on the lion head door knockers," said Josehart.

Originally supported on wooden piles, the building now rests on a series of 36, 70-ft. deep steel H-piles under the main lobby. Because of the lobby's limited ceiling heights, which were further constrained when the hammer head was mounted on to the rig's boom, the piles were driven in 8-ft. sections and then welded together.

"The piles resist the overturning forces of the new 28-in.-thick, cast-in-place concrete shear walls that replaced the brick walls in the building's courtyard. The brick walls were removed in their entirety except for a portion under the roof," said Steven Brokken, a structural engineer with San Francisco-based URS Greiner Inc. While the shear walls were being formed, a network of temporary X-bracing was employed to shore up the courtyard area to provide protection if an earthquake occurred during construction. "Since the original steel frame was not designed to carry the load of the unsupported roof, the steel X-braces also supported the roof until the new walls were completed," said Brokken. Upon completion, ceramic brick veneer was secured to the new shear walls to simulate the original brick.




### Interior solution

Since the Customs House had historic granite cladding on three sides, new shear walls needed to be installed without displacing the panels. The panels and walls also needed to be tied together so that during an earthquake, they would move as one unit. Performed in stages so it

**To provide lateral support, shear walls were installed around the building's perimeter. Courtyard walls (above) were completely demolished and replaced with cast-in-place concrete walls. The remaining perimeter walls (right) were demolished to their granite cladding from inside the building and replaced with shotcrete shear walls.**

*Photos: Perretti & Park Pictures*

Wiring/cable channels in the new walls eliminate surface-mounted units

**The historic finishes in the director's office include floor-to-ceiling wood and leather paneling and gilded ceiling plaster that were restored to their original specifications.**

*Photos: (top) Perretti & Park Pictures; (bottom) Nan Park*

PROJECT SUMMARY

**U.S. Customs House Seismic Upgrade and Restoration**
**San Francisco, Calif.**

■ **Building team**

*Owner/developer:* U.S. General Services Administration

*Architect:* Kaplan McLaughlin Diaz

*General contractor:* Morse Diesel International Inc.

*Structural engineer:* URS Greiner Inc.

*Construction manager:* CRSS Constructors Inc.

■ **General information**

*Area:* 137,000 gross square feet

*Number of floors:* 5

*Construction time:* September 1995 to April 1997

*Construction cost:* $17.8 million

*Delivery method:* Construction management

would not weaken the building, the plan consisted of removing the historic finishes from the interior of the three exterior walls on all five floors, demolishing 8 inches of the wall's brick infill to allow for new reinforcing steel, and cutting a 4-ft. swath in the floor around the perimeter of each wall to accommodate the thickness of the new shear walls. "At one point I could stand on the fifth floor and look down to the first — all the time knowing we had to put this all back together to look exactly the same as before," said Josehart.

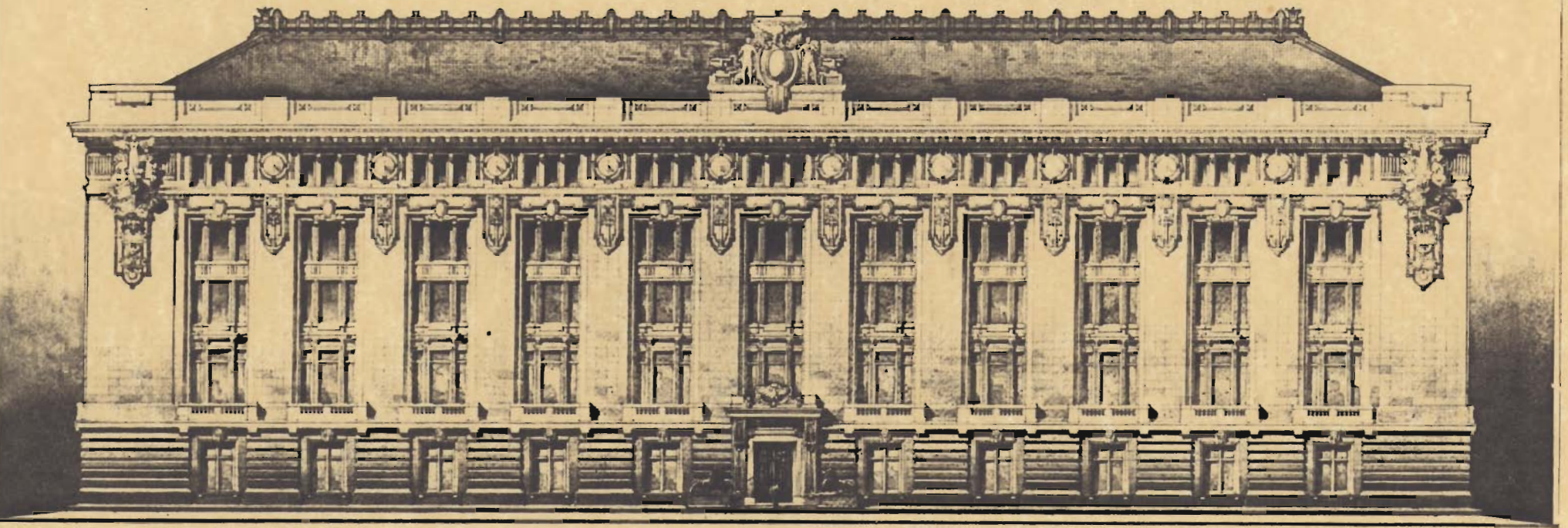
Reconstructing the walls first required stainless steel dowels to be drilled from the interior and epoxied into the back side of each granite panel. The dowels were then attached to new steel reinforcing bars placed within the wall and secured to the original structural steel. According to Josehart, the dowels and steel bars were "woven" together to form a dense structural component resembling a 10-in.-thick mesh fence. Shotcrete was applied from the ground level up to form a 14-in. shear wall. "The rooms lost about 6 inches of floor space because of the thicker walls. But after the finishes were replaced the only tell-tale sign that any work had been done was that the window sills and trim are deeper," said Josehart.

One area where measurements could not be altered was on the third floor in the historic director's suite. The corner office's finishes, which included floor-to-ceiling wood and leather paneling, needed to be restored to their exact dimensions. Hence, the shear wall assembly was reduced to 6 inches in this area before being spread out to the full 14 inches on the adjoining floors.

Before the finishes were replaced, 6-in.-diameter steel telecommunications channels were installed throughout the exterior walls. The channels will allow electrical and data wiring to be easily installed and removed for subsequent upgrading. "With the finishes removed, we had a novel way to install these systems without using surface-mounted units that would detract from the historic nature of the building," said Mel Schenck, director and project architect with KMD.

To enable the Customs House and the appraiser building to move independently during an earthquake, a 6-in. seismic joint was created between them at the two main 15-ft.-long connecting walkways. According to Josehart, the newly reinforced five-story structure could possibly have pulled the two-story structure apart. The seismic joint will permit the buildings to move up to 6 inches in opposite directions.

"You walk into the building today and it looks exactly like it did before we started construction," said Hobstetter. And with the extensive structural upgrades, it should look pretty much the same after another earthquake. ■



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BATTERY STREET ELEVATION

SCALE ½ IN. EQUALS 1 FT.

# UNITED STATES CUSTOM HOUSE

## SAN FRANCISCO CALIFORNIA.

U S CUSTOM HOUSE.
SAN FRANCISCO, CAL.
Drawing E Y. No. 5

RETURN TO ROOM 411

300