POWER OFFICE

Structural steel framing transforms a decommissioned electric power plant into contemporary office spaces.

Ali A. K. Haris, Ph.D., P.E., S.E.

Many industrial buildings built in the early 20th century reflect architectural designs that blend with the surrounding buildings in urban areas. The old Commerce Street Power Plant in downtown Milwaukee, a landmark overlooking the Milwaukee River that once generated electricity, has stood unused for over two decades. The exterior of the building is red-brick cladding with wide windows and arched lintels. The building consists of two main bays. The west bay housed the generators, and the east bay contained the coal hoppers and boiler. A 22″-thick load-bearing wall separates the two bays. Each bay measures about 70′ wide and 65′ tall. The roof consists of steel truss supports on brick load-bearing walls spaced about 6′ apart. On the east bay are two rows of interior steel columns supporting the hopper structure and extending to support the trusses at the bottom chord. The bottom chord of the trusses was discontinued at mid-span between the columns to create more space above the hopper. The roof is composed of cast-in-place 4″ concrete slabs spanning between trusses. About 22″from the exterior west wall is a row of interior columns supporting four floors used as offices and storage. The load-bearing walls on the east and west sides as well as the middle wall were in good shape with some cracking near the intersections with the north and south walls.

A renovation plan was proposed by Grunau Project Development to convert the building into a four-story office building with 154,000 sq. ft. of new office space. Because the project was deemed to be a renovation of a historic structure, all major exterior details, such as the arched brick headers over the windows and other articulated brick features, had to be restored to their original condition. New windows and doors were customized to match the original windows and doors.

As the structural engineer, we visited the site as part of the feasibility study. The inside space was a magnificent wide and tall structure. All turbines had been removed, leaving large concrete pads, tunnels and other concrete masses. At the east bay, the existing steel columns and beams, being close to the river, were excessively corroded. At the west side bay, the existing interior columns and beams were in relatively good shape. The columns were built-up from riveted plates and angles. With comprehensive testing and an inspection program of the existing structural materials, we felt that the project was feasible.

The inspection and testing program included the following:

- Testing of samples of the wood piles
- Testing of samples of the brick wall to determine allowable bearing capacity
- Testing of steel samples from columns and beams to determine the steel yield strength

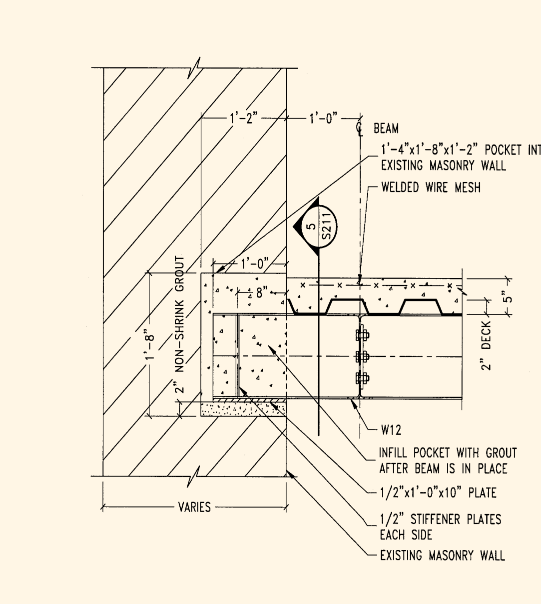
Composite steel beams and concrete over composite deck were an obvious selection for the structural system. With the existing thick brick load-bearing walls, no additional lateral framing was needed. Initially, the existing steel columns at the east bay were for support of the new floors. The testing laboratory took samples of steel from the webs of columns and beams to determine the thickness of steel after corrosion. The results were not encouraging. In addition, the columns were spaced much closer in spacing than desired for office space. Therefore, the decision was made to replace the interior columns and steel framing in the east bay. The architects at Eppstein Uhen requested column-free space on the fourth floor. With the existing ruff truss originally supported on interior columns with discontinuous bottom chords, we analyzed the existing roof trusses with added steel angles at the bottom chord to span the full width of the east bay.

In the east bay, the weight of the 4” concrete roof slab and snow accumulation loading exceeded the capacity of the truss, so we recommended that the concrete roof slab be replaced by a steel roof deck and rigid insulation with a single-ply roofing system. In the west bay, as indicated before, the existing steel columns and beams adjacent to the exterior west wall were utilized. One row of interior columns was added to maintain relatively short spans for the new steel floor framing, keeping the floor-framing depth at a minimum.

The new steel columns in the east bay were supported on the existing

Removal of the large concrete masses, which used to support the electric generators inside the power plant, makes room for the new office spaces.


New steel framing at the fourth level is sheltered under the existing 98-year-old steel roof trusses.



Typical beam to existing masonry wall connection, beam one side of wall.

wooden piles and concrete pile caps. The testing laboratory provided inspection and testing of the existing piles to determine their condition. The actual new column loads were less than the capacity of the original foundation system.

The west bay presented a challenge in that the new interior column line occurred close to the edge of the existing tunnels. With a large number of piles on each side of the tunnels that used to support electric generators, we designed new pile caps that used the existing piles on the east side of the tunnel and new steel-pipe piles driven through the existing tunnel floor to support the west side of the pile caps. The tunnels were later filled-in.

To address the wall cracks, which appeared to be more significant at the interior walls near their intersections with the north and south walls, we designed a post-tensioned system of prestressing cables anchored about 15′ away from the location of the cracks at one end and at the outside face of the north or south walls at the other end. This post-tensioned system provided lateral support of the north and south walls at several elevations.

The existing steel framing bracing the walls at the east bay presented another challenge. Removal of the framing would have exposed the walls to greater unbraced heights during construction until the new floors were erected. Therefore, temporary steel-pipe bracing was designed to brace the east wall as well as the south wall.

During construction, the 4″ roof slab from the east bay roof was removed, exposing the top of steel trusses and revealing that many of the trusses were badly corroded in some areas of the top chord, as well as at the bearing support at the interior wall near the roof drains. A testing program was carried out to gauge the reliable thickness of the top chord, which consisted of double angles. Additional steel plates were placed on top of the double angles and field-welded at all locations of excessive rust. At the ends of the trusses, new steel brackets of angles were designed with through the wall bolts used as additional support for the trusses.

Renovating this old structure presented challenges to the construction manager, architects and engineers from pre-construction through project completion. Construction was started in January 2000 and completed in June 2001. The cost of the project was $26 million ($16.5 million in construction costs). The project was successful and well received by the users as well as the community, as attested to by reporter Whitney Gould with the Milwaukee Journal Sentinel, who wrote: "Time Warner spokeswoman Bev Greenberg says the 500 employees working here love the marriage of old and new—and also love being spared a long commute. 'It's almost like Disney World,' Greenberg says. 'They come in smiling and they're still smiling when they leave.'"

Ali Haris, Ph.D., P.E., S.E., is president of Haris Engineering, Inc., in Overland Park, KS.

DEVELOPER/OWNER
Riverfront Power, LLC, Milwaukee, WI

STRUCTURAL ENGINEER
Haris Engineering, Inc.,
Overland Park, KS

ARCHITECT
Eppstein Uhen Architects,
Milwaukee, WI

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