Project of the Year 2012

Low-Rise Category

The Todd Bolender Center for Dance and Creativity

Kansas City, MO

Submitted by Structural Engineering Associates, Inc.

During the first half of the twentieth century, trains were a primary mode of transportation for people, freight, and livestock across the United States. The Union Station complex in Kansas City, MO, with its passenger terminal, express facilities, and rail yards, was a main terminal for this transportation. Millions of people traveled through this station, including soldiers for both WWI and WWII.

The "Union Passenger Station Power House," as it was originally named, provided energy for the train station and a number of surrounding buildings. It was constructed during 1913 and 1914 and was designed by the famous period architect Jarvis Hunt from Chicago, IL. Hunt also designed the Kansas City Union Station, as well as a number of other notable railroad terminals in the country. The Structural Engineer of Record was Ritter & Mott Engineers, also based in Chicago, IL. The original owner and developer was the Kansas City Terminal Railway Company of Kansas City, MO.

The Power House was designed and constructed as the primary source of coal-fired, steam-generated power to the entire rail-yard area. This area included Union Station and the Railway Express Administration buildings and warehouse and, later, the Kansas City Main Post Office (now part of the IRS regional facility) and the Liberty Memorial complex. Large concrete tunnels, most of which are still in use today as pedestrian and utility corridors, continue to connect these buildings below grade.

The building had sufficient capacity for eight boilers in the boiler room (south) half of the building. Each boiler had a coal bunker and hopper delivery system above it that could store up to 100 tons (90.8 metric tons) of coal, which was fed by a constantly moving coal conveyor system. The engine room occupied the north half of the building and contained three large turbine generators, air compressors, refrigeration units, and assorted support machinery. The roof of the Power House is profiled by a "Texas Skylight" element that runs the length of the building. Rising above the roof was the prodigious 250 ft (76.2 m) high brick smokestack that was supported by four massive concrete pilasters founded on the bedrock below.

The building's structural steel frame is composed of hot-rolled, built-up steel sections with riveted connections and load-bearing, multi-wythe brick masonry exterior walls. These walls are complemented with architectural terra cotta bands and façade inlays, which are supported by exposed reinforced concrete foundation walls that are over 2 ft (0.6 m) thick. The building's exterior dimensions are approximately 94 ft (28.7 m) wide along the east and west elevations and 198 ft (60.4 m) long along the north and south elevations for a gross building area of about 18,612 ft^2 (1729 m^2).

The building was vacant for over four decades. With its age and exposure, the structural components of the building experienced moderate-to-severe corrosion and deterioration of the interior and exterior structural concrete, masonry, and steel framing elements. In an effort to make a new home for the Kansas City Ballet while reusing an existing historic structure, the Power House would require significant historic restoration to achieve this. However, with a carefully programmed renovation and structural modifications, the design team was able to save the building and meet the requirements of the performing arts organization.

STRUCTURAL INVESTIGATIONS AND TESTING

Prior to preparing the construction documents for the repairs, restoration, and renovation of the abandoned Power House, an extensive condition study was prepared by the Structural Engineer of Record. The study scope included structural assessments of the interior and exterior; extensive forensic testing and evaluation of the original concrete, masonry, and structural steel materials; and distressed conditions mapping and photo documentation. Additionally, new construction bracing and shoring needs were developed. Then, selective demolition requirements were reviewed and restoration costs were projected for the proposed Kansas City Ballet adaptation. This adaptation was developed by the design team's architect.

Engineering evaluations included:

- Review of original design drawings and historical survey documents;
- Physical structural condition survey of exterior brick and terra cotta façade, roof, and penthouse elements, as well as interior structural concrete, masonry, and steel framing elements;
- Documentation of deterioration on structural elements and façade;
- Temporary shoring and bracing of basement columns and failing skylight;
- Testing the exposed concrete foundation walls for the depth of carbonation;
- Forensic testing of the existing structural steel framing to determine yield and tensile strengths, weldability to new A36/A992 grade steel sections, and surface preparation requirements, and assessment of the existing steel for later repairs and strengthening or replacement;
- Ultrasonic testing to evaluate both temporary shoring and strengthening needs;
- Petrographic laboratory analysis of original brick masonry mortar to provide a historical match to the original mortar contents for the repointing work needed on the exterior façade masonry and interior brick walls; and
- Preparation of a final condition report identifying deterioration mechanisms, recommended repairs, quantities of repairs, and cost estimates for programming.

Typical deterioration of exterior brick and terra cotta cornices

Deterioration of existing column section

View of basement demolition

STRUCTURAL DEMOLITION AND CONSTRUCTION PHASES

The first goal of the client, developer, design team, and contractor for this building was to render the structure safe for early stages of selective demolition and environmental abatement work by the project team. At first glance, this building was an invitation to invoke the word "implosion."

The building had many open floor and interior brick holes, 2 in. (50 mm) of pigeon droppings on the slabs, high coal bunkers with concrete slabs that were so severely delaminated that chunks of concrete were falling, a water-filled basement, a leaking roof and its failing skylight, and numerous façade distresses. In addition, all of the structural steel framing was covered with lead paint (which actually helped to protect the robust steel framing above the basement level) and there was a good deal of electrical switchgear and wiring with asbestos insulation.

The design team prepared demolition construction documents first so that the environmental abatement contractors working with the general building contractor could get started. This required pumping out the basement with its highly fouled water and other detritus and initial selective demolition of equipment and debris to enable access for evaluation.

Due to the nature of the existing building with its dimensional and elevational constraints, the design team decided to prepare the construction documents using *Revit* Building Information Modeling (BIM)

Interior after selective demolition

Existing coal conveyor boiler feed system

Restored conveyor system

software. This production tool allowed all disciplines to coordinate the building's adaptation.

An example of the modifications included removing the engine room slab that was some 9.5 ft (2.9 m) above the boiler room floor and extending the boiler room to the north to create the new Studio 1. Weekly progress checks and modeling management were necessary while the selective demolition and abatement work continued and field condition and dimensional verifications evolved.

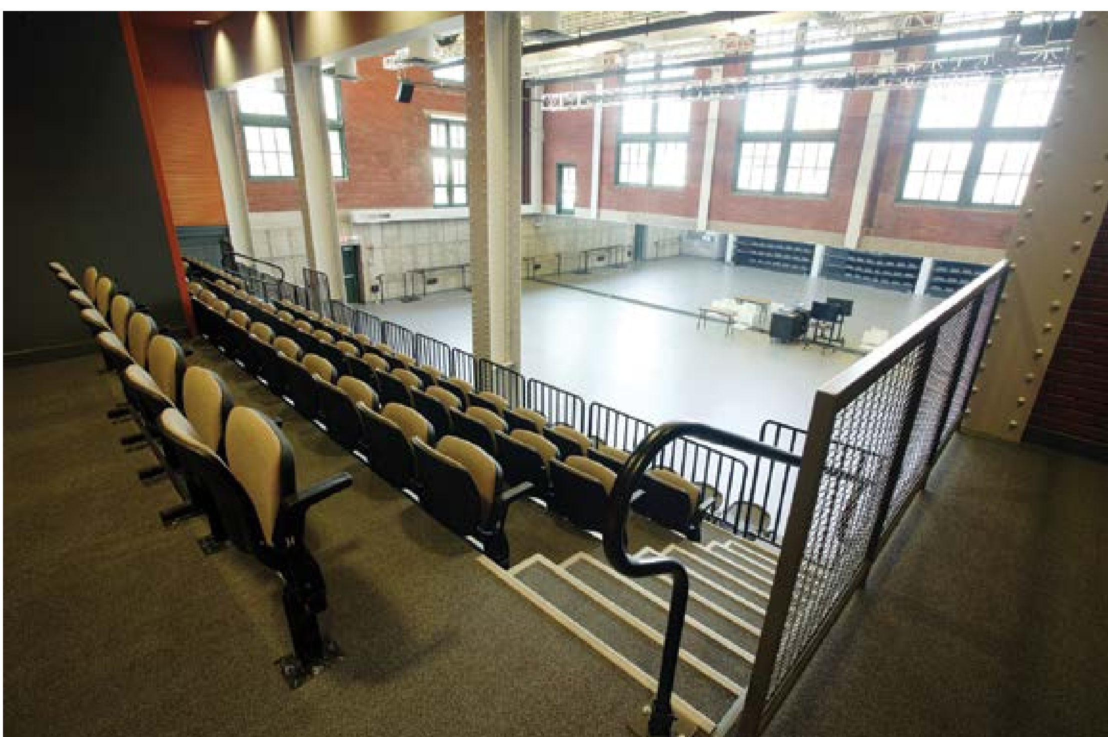
Work proceeded upward through the building as selective demolition continued to remove the remnants of large equipment, electrical and plumbing works, mass concrete pilasters that supported the turbine generators in the original engine room (north half of the building), ash hoppers and coal conveyor systems, and conflicting concrete and steel framing elements. Most of the steel-rolled sections and built-up plate girders were covered in concrete encasement—a typical period fireproofing method. All of that concrete also had to be removed to abate the lead paint and verify the structural integrity of these framing elements, many of which had to be repaired or replaced. Construction of the deep pile foundations and new interior framing started several months later.

The exterior brick façade, penthouse, and chimney base were to be 100% repointed (158,000 ft [48,158 m] of brick joints). In addition, much of the original architectural terra cotta had to be repaired or replaced. Nearly every cornice assembly needed to be re-anchored due to severe corrosion degradation of the existing anchor rods. During the masonry restoration of the structure, some 17,500 period bricks were removed and replaced (the project team was able to locate matching bricks from the original kiln in Oklahoma) along with 268 pieces of terra cotta (replaced with matching glass fiber-reinforced concrete sections). A total of over 134,000 ft^2 (12,449 m^2) of brick and terra cotta was restoratively cleaned and sealed.

Before any of the work in the badly deteriorated basement level could be started, 16 in. (406 mm) of standing water had to be pumped out. Many of the very large, heavily loaded steel basement columns had experienced severe corrosion and section loss of the bottom 2 ft (0.6 m) as the result of having been submerged in the equivalent of a wet-cell battery for over four decades. Severe corrosion delamination repairs on the concrete foundation walls and large tunnel connecting this site to the adjacent National Archives and Records Administration building were also required.

The interior renovations included the construction of seven ballet and dance studios, with Studio 1 being the largest performance stage capable of providing seating for up to 180 people. To construct Studio 1 and new offices, the entire elevated slab in the engine

Restored interior view of hallway and upper mezzanine



Restored interior view of dance studio

room was demolished so the existing boiler room (south half of the building) floor could be extended to the north half. A new Mezzanine Level extension was added with stairs to allow access to the upper seating of Studio 1, and to Studios 2 and 3, which are all connected by a large walkway.

A new elevated floor was designed and constructed as Level Two in the building, rising some 30 ft (9.1 m) above the Level One main gallery below. Four studios (4 through 7) are accessed via an elevated, well-illuminated catwalk that allows the visitor to see the restored coal bunkers and funnels. In addition, the restored chimney vault at the center of the building, with its dramatic archways and view up the chimney base, can be seen.

During the construction phase, many unforeseen conditions surfaced as the building was emptied of equipment and piping, concrete slabs were demolished, beam encasements were removed, and access to difficult spaces was facilitated. This made it necessary for the structural engineering team to design and adapt supplemental concrete, masonry, steel repairs, and new construction installations to accommodate the findings. "After all," as one of the engineers observed, "this was a Power House and we are building a ballet facility, and it feels like we are fitting a square peg in a round hole."

The interior and exterior transformation of this 100-year-old Power House into a world-class ballet facility with 60,000 ft^2 (5574 m^2) of program space was praised by many during its recent grand opening in late August of 2011. The construction cost for the new Kansas City Ballet facility was approximately \$32 million. The building has also been listed in the National Register of Historic Places.

WHAT MADE THIS PROJECT WORTHY OF AN AWARD?

The new Kansas City Ballet facility defines an adaptive reuse of an abandoned, severely distressed 100-year-old former power plant into an historic restoration and preservation achievement dedicated to the performance art of ballet by the following:

- A unique architectural period building was saved and restored to its original façade and principal interior appearances and spaces;
- Extensive structural condition surveys in advance of the selective demolition and construction phases identified critical structural deficiencies and material properties that allowed the design team to work with the contractors early on in stabilizing and restoring the exterior and interior building structure;
- Adaptation of the Kansas City Ballet to the Power House saved millions of dollars in new construction costs and enabled a sustainable reuse of a historic building; and
- The historical restoration included significant, almost-daily challenges to repairing the corrosion and moisture damage to all of the concrete, masonry, and steel while ensuring compliance with the design restoration and programming goals.

The Todd Bolender Center for Dance and Creativity

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Exterior view of restored structure