Fitting in with Historic Architecture

Yale Music Library Addition

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The architectural focal point for the new addition is the roof structure, which was deisgned to resemble the gothic window and arch shapes seen throughout the existing building. The six, 10-ton exposed arch/trusses, which span the 53' courtyard, utilize bottom chords made up of tapered and curved plates.

By Geoff Conway, P.E.

When Yale University first decided it needed to expand their Music Library, several different areas were considered, but all were insufficient for the collection of materials that had expanded over a 20-year time period into four different buildings on the university's campus. However, the solution to the Music Library problem was not far away at all. An interior courtyard that was largely unused in Yale's Sterling Memorial Library turned out to be the perfect answer.

During both the design and construction phases, the building team for the Yale Music Library project faced many challenges. Honoring the original Gothic architecture while providing a modern foundation and striking appearance was the fundamental requirement.

The choice of structural steel for the project was an obvious decision from the start. First, steel has superior construction speed and lighter structural loads – an important consideration given that the new addition was to be supported on new pile foundations and existing foundations. Furthermore, the new courtyard addition was to connect at the perimeter to an existing steel building. Finally, the architecturally exposed steel roof trusses were to be a major focal point of the new addition.

The original building, built in 1927, used a steel frame with formed concrete slabs. The area surrounding the courtyard addition had been designed with expansion in mind to allow for future stack levels. Fortunately, these were never built,

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so the existing foundations and columns would easily support the gravity loads of the addition.

The design of the new addition was governed by the Connecticut and BOCA codes. Increasing the seismic forces in any existing structural element due to the addition was strictly limited by code. Therefore, it was critical that the weight of the new structure be minimized.

The new courtyard addition included three floors – one on grade and two framed. Floor to floor heights in the existing building that the new addition had to align with were 11'-0" at the first floor and 11'-10 ½" at the second floor. Maximum ceiling heights were desired while leaving room for ductwork.

A structural system of composite steel beams with 3 ½" light weight

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Erection of the roof trusses was a challenge due to the confined space. Truss sub-assemblies were lifted into the courtyard floor for final assembly. Then, the trusses were hoisted into their final position using a large 300-ton crawler crane positioned in the street. The crane operator was required to lift the trusses "blind" with only inches of clearance on each side of the existing courtyard.

concrete topping on 1 ½" composite metal floor deck was used for the floors. In general, steel beam depths were limited to W8 and girders to W16 with ductwork running parallel to and between the girders. The beams and girders were fire proofed to achieve the required fire rating.

At two areas, the structure was depressed to allow for free-floating, acoustically isolated floor slabs for recording studios.

The lowest level of the addition aligned in elevation with the existing first floor. Existing columns and foundations extended another level down for a basement. Soil conditions in the courtyard consisted of uncompacted fill. Rather than use the difficult and costly procedure of removing the entire fill and replace it with compacted fill, pile foundations were employed. Mini piles were used so that small equipment could be maneuvered inside the tight confines of the existing building. Piles were drilled in to minimize vibrations.

The architectural/structural focal point for the new addition is the roof structure. Six, 10-ton exposed steel arch/trusses, not a conventional type or category of truss, span the 53' courtyard. Much time and effort went in to selecting their final shape and design and addressing complex constructability issues. The bottom chords of the arch/trusses are constructed of tapered and curved plates (varying in width from 24" at the base to 12" at the top) welded together to make a wide flange shape oriented on its side. The top chords and web members are made of curved W-shapes also oriented on their sides. The shape of the trusses resembles the gothic window and arch shapes seen throughout the existing building. The steel roof trusses were fabricated in Canada, while AISC-member Berlin Steel fabricated the remainder of the structural steel, along with providing the erection and detailing.

The upper roof level of the original building, on either side of the roof trusses, was designed to be temporary. The removal was planned when the anticipated stack additions were to take place. The existing columns for this area were constructed from relatively weak steel angles encased in concrete. To minimize disruption to the existing library, which would occur if these columns had to be reinforced, the new roof trusses are supported off the sides of oversized columns, two levels below the "temporary" roof. Positioning of the roof truss reactions at a lower level had the added benefit of reducing the seismic influence of the new addition on the existing structure.

Erection of the roof trusses was also a challenge due to the confined space. Truss sub-assemblies were lifted into the courtyard floor for final assembly. Then, the trusses were hoisted into their final position using a large 300-ton crawler crane positioned in the street. The crane operator was required to lift the trusses "blind" with only inches of clearance on each side of the existing courtyard.

In addition to the new structure in the courtyard, the existing building was also renovated. New mechanical shafts and an elevator shaft were added. Areas of existing floors were reinforced for compact file storage. Cover plating existing steel girders and adding new steel beams accomplished this.

The resulting addition transformed a virtually abandoned courtyard into a first class library space. The original building still retains the natural lighting from the courtyard via the many windows below the roof truss eaves.

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