

# THE BEST OF BOTH WORLDS

**Combining the strength of steel with the beauty of wood creates both an aesthetically pleasing and structurally functional building**

**By Zareh B. Gregorian, P.E.**



**W**OOD, AN ACCESSIBLE MATERIAL THAT IS AESTHETICALLY BEAUTIFUL, has been used in buildings since ancient times. It has the capability to provide forms desired by architects similar to steel, and like steel, it has the advantage of easy erection and modification. However, wood lacks the strength of steel, especially when it comes to covering large spans and achieving rigidity in connections to resist lateral loads. Fortunately, steel can help a wood structure overcome its problems with large spans and connections. The combination of wood and steel as primary structural materials allows designers to achieve the desired building aesthetics.

## **UNIVERSITY OF MAINE, GEOLOGICAL SCIENCE CENTER**

The Geological Science Center, located on the University of Maine—Orono campus, is a three-story steel frame structure with a partial basement. Designed by Payette Associates Architects in Boston, the building required a pitched roof system with two large dormers on the east and west side of the building, along with bar joist, steel deck and concrete slab floor construction.

To achieve the desired architectural form of the roof, moment frames in certain bays are used for lateral resistance of the building in both directions. The



*A combination of wood and steel proved most effective for the Geological Science Center at the University of Maine.*

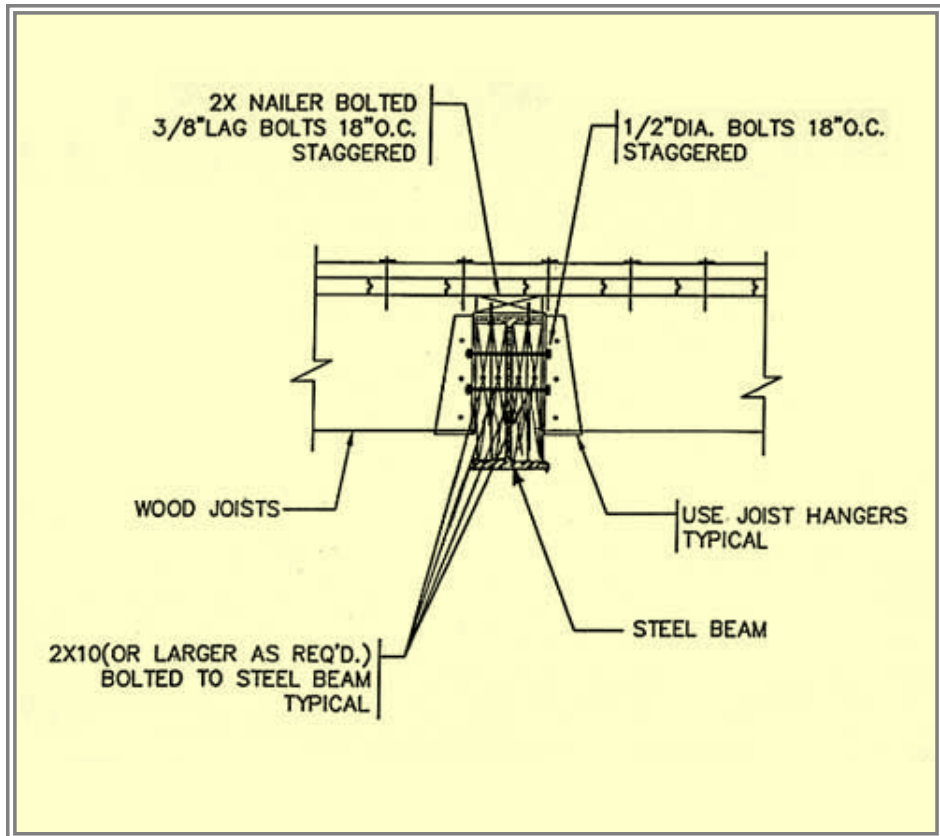
pitched roof framing was constructed with steel girders and wood purlins, providing a cost-effective solution.

The main architectural feature of the building are two large, 40' span barrel vault shape dormers installed in the entrance areas, which cover a 3200-sq.-ft. area, and intersect with the pitched roof to create a segmental barrel vault roof form. Many solutions were discussed and studied. The obstacles faced included:

- The roof had to be constructed in a complicated curved shape.
- The dormers had to be installed at the highest point of the building, making construction difficult and costly.
- Curved construction shapes were susceptible to errors in erection, and may need some modifications to the erected structures.

Concrete came to mind first because of the curved form, but in this case, it was eliminated due to its expensive formwork, high weight and difficult erection requirements. In addition, the time period being considered for construction would have made curing difficult due to the cool temperatures. After several coordination meetings with the architects, the most effective solution was determined to be to use steel curved girders and wood purlins.

Curved girders were shop fabricated with attached gussets ready to accept the purlins. Due to the arched shape of the girders, the size of the girders was small and they were easy to bend. Wood purlins were pre-erected at the site with the curved shape. The purlins were secured by solid blocking in-groups of 10 to 15, which formed a comb shape assembly. The purlins were lifted up and installed in place and fastened to curved steel girders with the least amount of labor. Misalignments were corrected by using wood shims. A curved plywood section was used resting and nailed to wood purlins creat-



*Shown at top is another view of the Geological Science Center under construction.*

*Pictured above is a typical wood-to-steel connection.*



ing the desired architectural shape of the large barrel vault dormers.

The whole roof has a uniform structural system. The combined use of steel girders, wood purlins and plywood roofing was ideal to avoid horizontal load transfer problems due to the non-uniform expansion and contraction and non-uniformity of the roof diaphragm. A considerable amount of expense was saved, and an ideal architectural form was achieved, by using a combination of wood and steel to construct the roof structure.

#### THE OMNI TRAVEL BUILDING

The Omni Travel Building is located in Cambridge, MA at Bow Street, in the heart of Harvard Square – a busy area of the city adjacent to the main campus of Harvard University. The four-story old concrete block building was completely renovated by adding a modern five-story office building at the front, reinforcing the rear portion of the building, and adding a new penthouse apartment at the top floor residence for the owners. The architects were Line Company Architects of

Cambridge, MA. Throughout the construction, there were several cases where the combination of steel and wood helped the architects to achieve the following desired goals:

1. Aesthetics
2. Compatibility with the required zoning codes, especially height restrictions
3. Cost-effectiveness

In the front office building area, steel frames with moment connection bays were used to form the steel frame of the building. Wood joists and plywood floors were used to span between steel frame girders. The joists were flush framed to minimize the depth of the floor structure. By the same token, steel girders with shallow depths were used in a large span area, where a column-free space was required for an employee gym and cafeteria at the fourth floor.

The rear penthouse apartment is constructed with steel columns, and girders supported the existing renovated and reinforced CMU walls of the lower floors. Wood purlins and plywood are used to cover the roof. The steel frame solution with moment connection bays was the ultimate solution for the picture windows installed around the penthouse apartment. Steel girders are also used to create the pyramid shapes designed at various levels of the roof, which provides an architectural identity for the building.

Lightweight steel columns and girders combined with wood purlins and plywood floors eased the construction in the congested area of the Harvard Square. It also provided a cost-effective and aesthetically beautiful building without violating the strict zoning laws (especially the height limitations) of the City of Cambridge.

#### WARREN HOUSE

The Warren House, located in Woburn, MA, and designed by architects Steffian Bradley



*The Omni Travel Building also utilized both wood and steel for its structural system.*

Associates of Boston, is a housing community for individuals who have suffered head injuries and have special lifestyle needs. It was necessary to have a column-free space at the basement level to accommodate an exercise gym and assembly hall, as well as to provide adequate space for individuals maneuvering in wheelchairs. While studying the preliminary stages of the project, the decision was made to use large microlam girders to span the required 24' column free space at the basement. In addition to carrying the basement ceiling loads, the microlams also supported the upper two-floor living room wood structure with conventional wood framing systems. However, the size of the 24' girders exceeded the depths anticipated for the project, and created a zoning problem because it increased the height of the structure to a size that was not accepted by the town of Woburn. Also, the large size of the microlams required raising the overall height of the basement, creating additional costs for the project.

The solution was to use W16x57 and W16x89 steel girders, supported by 6" diameter Lally columns, to support both the basement ceiling loads and the upper two-story wood structure.

Wood joists with joist hangers were used with flush-framed systems to create a minimum ceiling structure thickness, as required by the architects. Special details were used for installation of joist hangers and the first floor plywood. Wood web filler plates were installed inside the web of the girder on both faces of the steel girders and through bolted with staggered bolt patterns, which created a vertical flush surface for mounting the joist hangers. Also, a top plate nailer was installed over the top flange of the steel girder, and through bolted through the flange, to create a sill plate for installation of wood studs of the upper floor structure.



*The Warren House in Woburn, MA, utilized steel to help create column-free space in the basement. Photos by Dimitri Papadimitriou.*

A special detail providing a  $\frac{1}{2}$ " gap between the plywood and the wood top plate was provided to compensate possible shrinkage of wood. Also, to help construct the entrance turret, and distinguish the building from adjoining residential buildings, 2 x 8 radiating rafters with steel gusset plates were installed which converge to a steel compression ring at the peak of the turret.

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