Designing a Tree House for Books

Beaverton City Library, Beaverton, Oregon

People visit libraries seeking knowledge, entertainment and stimulation. Upon entering the Beaverton City Library, it is immediately apparent that all of these things, and much more, are available inside. The spacious new building covers 70,000 square feet and was designed to accommodate the area's growing population. For the most part, the structural system creates the architectural character of the building. Most of the primary structural elements are exposed to view, creating an exciting space that engages visitors from the moment they enter. Through close collaboration with Thomas Hacker Architects, KPFF engineers developed a structural scheme that both exploits the strengths, and explores the potential, of all of the library's main building materials.

A precast concrete hollowcore plank floor supported on exposed precast concrete girders, and a combination of precast concrete and concrete masonry piers, serve as the structure for the first two floors. The structural and visual strength of the precast system satisfied the need for a high live-load capacity, large open spaces and an ordered, modular building grid. Resistance to seismic and wind forces was achieved through a combination of concrete masonry piers on the exterior perimeter and concrete shafts located in each of the four building corners. A highly articulated, naturally lit wood-framed stair draws users from the solid integrity of the ground floor to the lofty reaches of the main reading room on the second level.

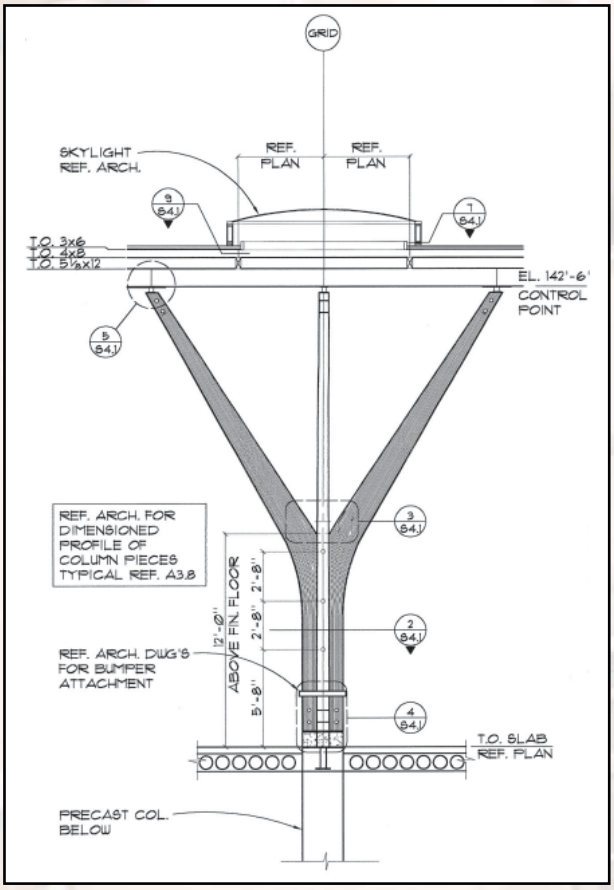

Figure 1: Column elevation. Design by KPFF

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The open and inviting reading room is the focal point of the building. Sixteen glue-laminated columns rise 25 feet from the second floor and gracefully splay out at their mid-height to support a multilayered wood roof structure. Natural light from skylights and clerestory windows illuminates the wood structure and floods the space with warmth and beauty. Each column consists of four curved 8-¾ inch wide glue laminated sections that are tapered in depth from the mid-height curve to the top of the member. At the base, the columns are cruciform shaped, with each section bolted to an adjustable pedestal with blind mortised steel plate connections (*Figure 1*). As they rise upward, each "limb" splays outward to form four distinct support points for the primary grid of glue laminated roof purlins. This grid acts as a tension ring, tying the four limbs of each column together.

The glue laminated beams are overlain by two additional layers of sawn lumber framing, 4 x 8 and 3 x 6 respectively, each of which is offset 45 degrees in plan from the layer beneath it (*Figure 2*). The members of each layer of the roof structure are connected to the layer below with lag bolts and steel straps located on the top of the beams at the bearing points. From below, the roof lattice has a seamless appearance and, the laminated decking with its alternating single span layout, provides visual clarity.

Significant attention was paid to the writing of the project specifications for the library's timber elements. Glulam and laminated decking manufacturers were consulted during the design process in order to ensure the availability of specified materials. The columns were specified as 24FV8 DF/DF Premium Grade glue laminated sections with clear vertical grain face laminations and no edge exposure. To accomplish the curvature of the individual column "branches", ¾-inch x 8-¾ inch laminations were used. The decking is made of 2 x 6 laminated Douglas Fir with clear vertical grain face laminations manufactured by Lock Deck. The 4 x 8 and 3 x 6 sawn lumber purlins are Select Structural grade material with no edge exposure.

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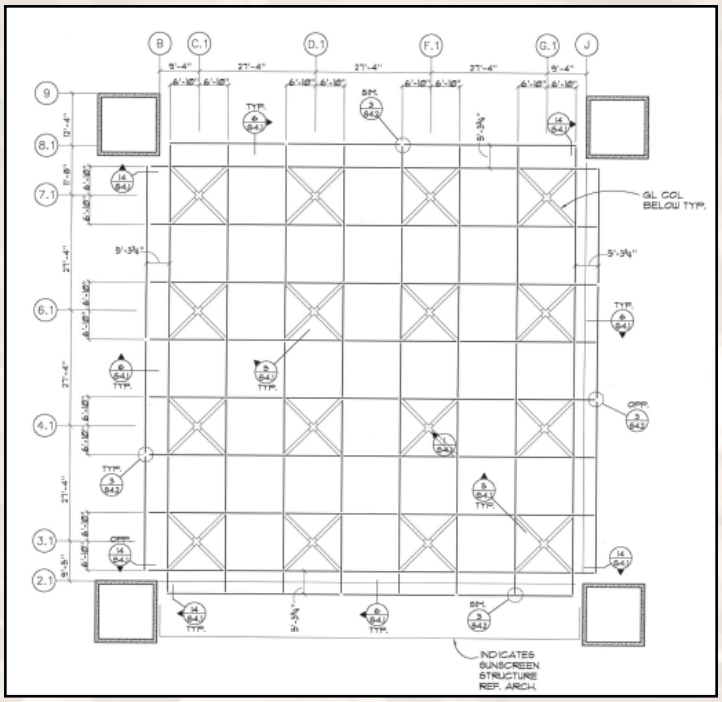


Figure 2: Glulam beam layout, lower layer. Design by KPFF

KPFF's main challenge in developing details for the wood-framed roof structure was achieving connections that addressed all load demands, architectural goals and constructability constraints. The rigor of the multilayered roof structure demanded that each of the four bearing points had a precise coordinate in three-dimensional space, requiring a high degree of precision in the fabrication and erection. Some erection tolerance was built into the column base, which consisted of a precast pedestal with an adjustable steel base (*Figure 3*). Through the extreme care and diligence of both the column fabricator and the carpentry contractor, all bearing points were established to within one-sixteenth of an inch of the specified location.▪

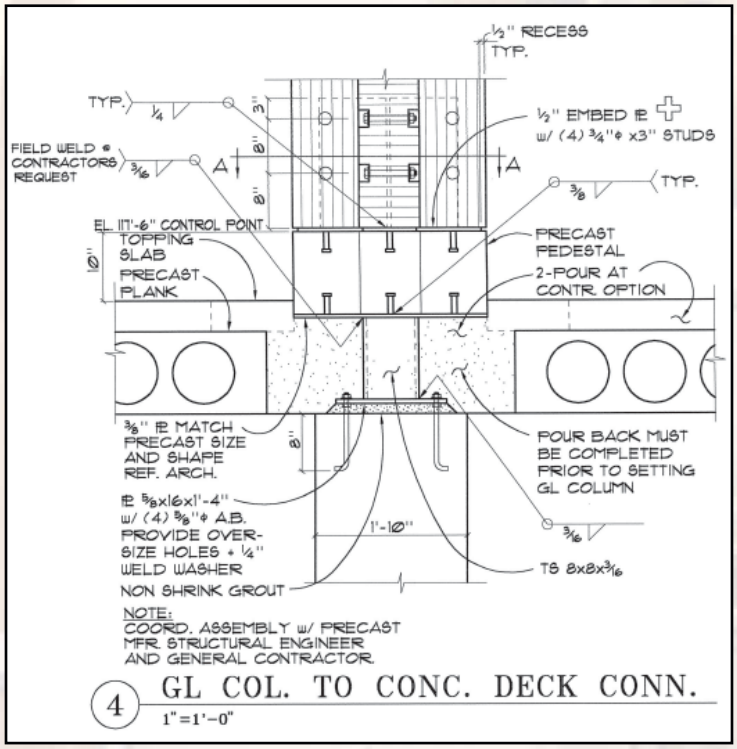


Figure 3: Glulam column connection to concrete deck. Design by KPFF

Project Team

Owner: City of Beaverton, Oregon

Architect: Thomas Hacker Architects Inc., Portland, Oregon

Structural Engineer: KPFF Consulting Engineers, Portland, Oregon

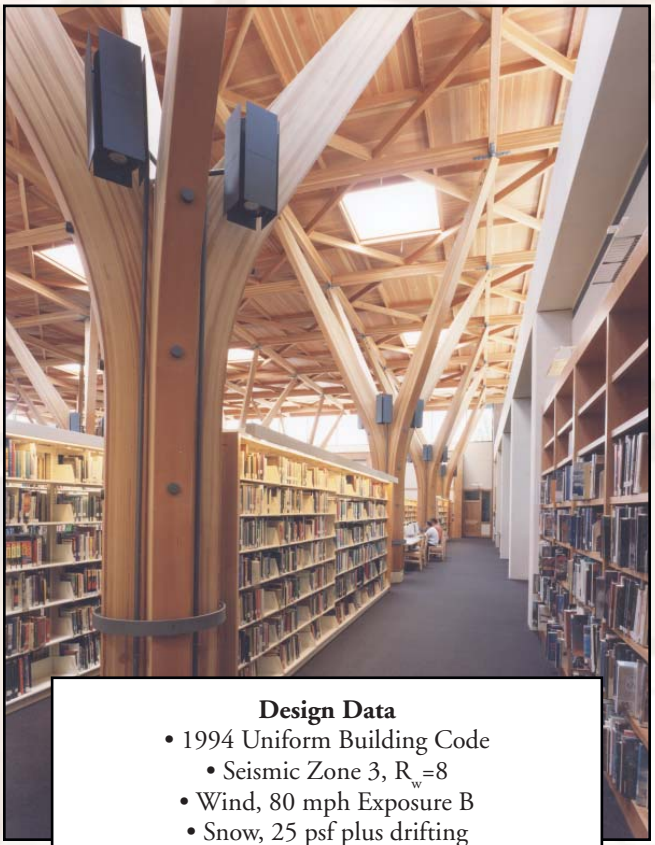
General Contractor: J.E. Dunn Construction, Portland, Oregon

Carpentry Subcontractor: Eagle's View Construction, Estacada, Oregon

Glulam Fabricator/Supplier: Glulam Resources, Chehalis, Washington

Laminated Decking Supplier: Disdero Lumber, Clackamas, Oregon

Precast Subcontractor: Morse Brothers, Eugene, Oregon



Design Data

- 1994 Uniform Building Code
- Seismic Zone 3, R_w=8
- Wind, 80 mph Exposure B
- Snow, 25 psf plus drifting
- Library Floor Live Load, 150 psf unreducible

Honors

- 2003 Wood Engineering Achievement Award, Forest Products Society
- 2002 AIA Portland Merit Award
- 2002 Wood Design and Construction Citation Award
- 2001 AIA Portland Craftsmanship Award
- 2001 AIA Portland People's Choice Award