

ENR

Engineering News-Record

New Jersey library

**Reading, 'rithmetic,
redesign pay off**

LIBRARY'S FRAMING IS AN OPEN LOOK

When a New Jersey township considered architect Eliot Goldstein to design its \$4-million library, it didn't factor in his reading habits. But as it turned out, those habits paid off. Motivated by a forecast of skyrocketing lumber prices, Goldstein redesigned the 19,000-sq-ft building's barnlike timber frame. In doing so, he increased structural efficiency by 22% and cut 35 tons of lumber. Not only did Mont-

ville Township's new library design cost \$100,000 less, it enhanced constructibility.

It was late in 1992, soon after pricing the first design, that Goldstein, a partner with his architect-engineer-father in The Goldstein Partnership, West Orange, N.J., read that wood costs were about to "go crazy" (ENR 9/28/92 p. 26). The building's two sections had a total of forty, laminated-timber, scissor-like trusses, 30-ft-long and up to 12-ft-deep, plus columns, beams, braces and timber decking. Goldstein thought, "This is going to kill us."

He didn't waste any time. By New Year's 1993, he had reduced the wood's equivalent thickness—a measure of efficiency that relies on theoretically spreading the wood evenly over the footprint—by 1 in. to 3.5 in., or about 10 psf. "In the 24,000 sq ft of ceiling decking alone, we saved 2,000 cu ft," says Goldstein. That was good. Lumber prices actually rose 36% from 1991 to '93, according to ENR.

Cruciform. The single-level library section has a 170 x 30-ft axis crossed by a 130 x 30-ft axis. The cruciform plan is thickened by 15-ft-wide side bays, under shed roofs. The upper roof peaks at 27 ft and slopes 9:12 along the top truss chord. The shed roof slope is 3:12, extending beyond the ends of the bottom chord.

The timber framing is exposed on the interior and visible from the outside through a mostly glass curtain wall. Daylight also streams in through a continuous skylight along the

Timber on high: Laminated timber trusses were fine-tuned after initial design was completed based on the architect reading reports that lumber prices were about to skyrocket. The redesign cut weight and quantity, saving \$100,000 on the \$700,000 timber contract. Falsework was required before lifting the last piece of the atrium-area puzzle—the cupola (right).



Fine dimensioning of all members, fabricated with bolted steel connectors (right), combined with tight tolerances, made erection of the exposed-on-the-inside framing that much more demanding. Scissor-like trusses in a row form peaked roofline with continuous skylight (below). Like ants, workers climb over the roof to install decking, which provides diaphragm action.



peak and clerestories. A cupola tops the crossing of the axes. Alongside, a 7,000-sq-ft, independent assembly section matches the 12,000-sq-ft library but has shorter axes.

"I've been working on this for 25 years," says Raymond C. Mariash, president of the Montville Township Public Library's board of trustees. But he adds "the timing was right about six years ago." Then, the library left the Morris County system and became independent. All the while, population was increasing because of a housing boom that had anticipated the recent completion of a strategic stretch of Interstate 287.

Earlier, the township, just 35 miles west of New York City, had been sleepy farmland dotted by some bedroom communities. The library wanted a timber building in keeping with the rural tradition, says the 39-year-old Goldstein, who has considered himself a student of wood structures since college.

The library commission would test his knowledge and then some. The original concept called for the exposed scissor-like trusses with bolted steel connectors and decking spanning 10 ft between top chords. The 10-ft span called for 2.5-in.-thick decking. The direction made it necessary for top chords to resist the combined loading of axial forces and bending. Also, according to the prevailing code for heavy timber construction, the bottom

chords have to be braced one to the other. In the original, there was conventional horizontal bracing.

In the initial redesign, Goldstein added a row of Glu-lam 3x9 purlins at each panel point of the trusses, which allowed him to change the direction of the decking from longitudinal—truss to truss—to transverse—purlin to purlin. That reduced the decking span from 10 ft to an average 5 ft. The shorter span allowed the sawn-lumber decking to be 1.5 in. thick, which costs less per running foot than 2.5 in. And as combined loading was no longer needed, the top chord went from a GL3x12 to a GL3x7, says Goldstein.

There's more. The GL3x9 purlin was still too hefty for the architect. So he conceived of replacing the horizontal braces with chevron braces. They span from bottom chord panel point to midspan of the purlin above, or, in one case, from ring connector to purlin to adjacent ring connector.

Hitting. Chevrons, by hitting purlins midspan, cut the purlins' effective span in half and allowed their reduction in size to GL3x7. Also, "a chevron's two diagonals total length is longer than 10 ft but each member is shorter, so the chevron is less likely to buckle, says Goldstein. That means diagonals could be smaller than the horizontal braces. Reducing any member's size made it easier to lift and handle in the field, saving on labor, says Goldstein.

He adds that the purlins could have been even smaller, but the code requires a nominal 4x8 to classify the structure as a heavy timber building, which the library wanted for fire resistance and other reasons. The 3x7 is the closest in Glu-lam, says Goldstein.

All along the way, the architect bounced ideas off the project structural engineer. "It was challenging to make things work with the shapes and the architecture," says Fred Severud, just retired after 34 years with New York City-based Severud Associates.

The frame became very efficient because it acts like a two-directional truss, with scissors in one direction and the chevrons and purlins in the other, explains Severud. Continuity and bracing in two directions is needed in seismic zone 2 and on a windy site with a fairly large wind surface, he adds.

Severud calls the axis crossings the trickiest to frame. In each, a cupola caps a 30-ft-square atrium space, framed by scissor trusses. The ends of adjacent trusses share "corner" columns, which are heavier than the rest. Because the framing there "acts more like a space truss," says Severud, it was analyzed in three dimensions.

In general, and especially under the cupola, "the architect was looking for consistency in member sizes," he adds. It was not simple to have a stable cupola with standard members, but "the roof diaphragm action helped." To simplify erection, workers built the cupola on the ground and lifted it.

Both Goldstein and Severud maintain that the frame's repetition made it relatively painless to put up. But not everyone agrees. "Getting it bolted together in the field was very tough engineering-wise," says William Mara-

kovits, project manager for the timber contractor, Dajon Associates Inc., Westwood, N. J.

For example, Dajon had to coordinate with the foundation contractor to make sure footings and anchor bolts were in the right position so that 20-ft-tall columns would be upright to receive the other members. "We gave the foundation contractor a plan to follow," says Marakovits.

Using cranes and forklifts, Dajon erected the roof structure from last April to August, starting at one end and moving toward the other. Because the deck diaphragm came last, temporary bracing was necessary.

Fit. "There were a couple minor problems because a few bolt holes were too close to the edge" of the member, says Marakovits. Those were redone in the field. Other than that, the pieces fit together well, he says.

The \$700,000 timber contract was let directly by the library to save on the general contractor's markup. Marakovits says Dajon made money on the job.

No such luck for the sprinkler subcontractor. Asked what he would do differently, Stephen R. Cashmore, the president of All Safe Fire Equipment Inc., Wanaressa, N. J., says, "Charge more."

"We've done other exposed

piping jobs but not with varying elevations and 16 different and odd angles," caused by the piping following the roof slope. "It was labor-intensive," he says.

And because piping is exposed, the architect did not want any couplings or any grooved fittings, adds Cashmore. That eliminated most standard fittings.

To help, Cashmore designed the sprinkler layout on CAD, using the timber fabricator's shop drawings. It was the firm's first use of CAD. "Then we

had to field-verify everything prior to fabricating the pipe," he says.

The general contractor also labels the job unique. The visible framing and almost all-glass curtain wall required a higher level of detailing and field coordination, says Robert J. Conklin, president of The Conklin Corp., Franklin Lakes, N.J. With tolerances of 1/8 to 1/4 in., dimensional control and coordination of subs was the name of the game. "We put a coordination drawing on CAD for the subs," says Conklin. It included timber, mechanical and electrical drawings. Conklin adds that the up to 36 x 30-ft glass panels are taking wind load, so their aluminum frames have structural steel reinforcement, tied into the timber. All that had to be concealed.

Conklin also notes that the harsh 1994 winter "shut us down" for January, February and March after footings and 6 in. of stone were in. But "nothing was at risk," adds Conklin. The library will open late, on March 5.

Meanwhile, Edward Allen, the professor who triggered Goldstein's interest in timber structures, recently came upon a photo of the library's frame while reading a timber guide. He was impressed enough to look for the architect's name. When Allen saw whose job it was, he contacted Goldstein—after a lapse of 15 years. That's about the highest mark a student can get. ■

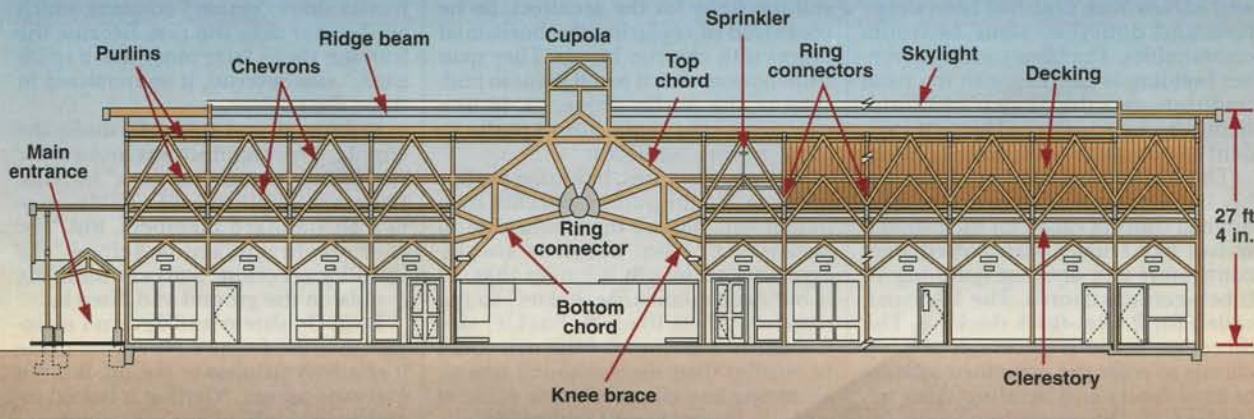
By Nadine M. Post in Montville



Angles, elevations complicated the exposed sprinkler piping. To cope, the sprinkler subcontractor had put the piping layout on a CAD file. Still, the job, with almost no standard fittings, was even more labor intensive than anticipated. Piping comes through column, runs along angled member.



Splendor in the glass



Redesign added purlins, chevrons and switched decking direction but maintained initial concept, shown in model of original cupola area (top).