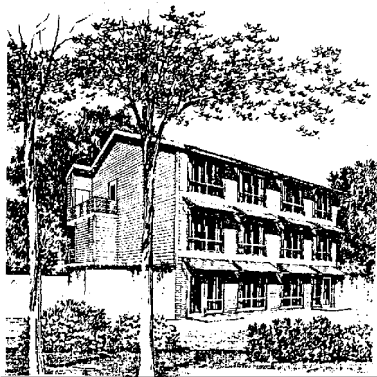




The House That Homer Hurst Built

Innovative, lumber-saving framing techniques that could revolutionize the way we build.

by Paul Hanke

Suppose someone could show you how to "cut" framing costs by 50 percent on your next project. You'd probably be quite interested.

But suppose these techniques required you to use one-inch lumber for framing instead of the conventional two-bys we're all used to. Would you still be interested? Maybe not. In fact, you might say that such a building is impossible—that it couldn't stand up, at least not for long.

If the designer of such a system was a registered professional engineer whose ideas had been proved in the field, however, you might be inclined to reconsider.

Well, reconsider away. The techniques I've been describing not only are real, but they've

actually been tested by their developer, Homer Hurst, P.E., at Virginia Polytechnic Institute and State University (VPI) in Blacksburg, Va.

Hurst, who built his own house using these methods 25 years ago, designed the unique "Hillside Fourplex," a student housing unit at VPI. He entered the design in the Department of Housing and Urban Development's (HUD's) "Building Value into Housing" competition in 1980, and his entry was selected as one of the 19 finalists.

Among the innovative features of Hurst's design was the use of rough-sawn, one-inch-thick yellow poplar for floor joists and wall studs, with floor joists spaced 24 and 32 inches o.c.; the complete elimination of roof sheathing; the use of purlins rather than con-

ventional trusses or rafters for roof framing; suspended ceilings on all levels; and passive-solar features combined with heavier-than-normal insulation for the climate.

Acting as general contractor, Hurst built the fourplex after the design was completed. On a board-foot basis, he used half the materials of a conventional stick-built structure—which translated into a savings of more than \$5,000 in the framing bill alone. (The money he saved later was spent on conservation and passive-solar features).

In fact, the entire 5,616-square-foot, three-level building cost \$111,154—just \$19.79 a square foot. Now *that's* affordable housing, even by the standards of several years ago!

The cost of the total project came to \$144,348, excluding land. For comparison,

bids from two separate contractors at the time came in at about \$167,500. (A good part of Hurst's 26-percent savings probably can be attributed to the fact that he included no overhead or profit in his costs, however. He also used relatively low-cost wage labor during some stages of construction.)

Aside from the savings, other positive results include general user satisfaction (according to a survey conducted by Louise Jones of Miami University) and a calculated solar savings of 44 percent. Subcontractors on the job also were pleased with most of the innovative design features.

Construction Details

The building is set into a hillside, with the south wall exposed on all levels for maximum solar gain. Lower-level units are enclosed by insulated-masonry cavity walls, with brick veneer on the visible exterior portions.

The slab floor also is insulated around the perimeter to minimize heat loss. A load-bearing wall of stack-bond concrete block runs through the center of the building. Interior partitions are framed in wood.

The major structural innovation is not in the masonry construction, however, but in the wood framing. Hurst chose this building to demonstrate the use of both one-inch framing and yellow poplar as alternatives to two-inch framing and southern pine.

Hurst, who had a longstanding relationship with several nonprofit housing groups in Appalachia, had been exploring the use of hardwoods instead of pine as a way to

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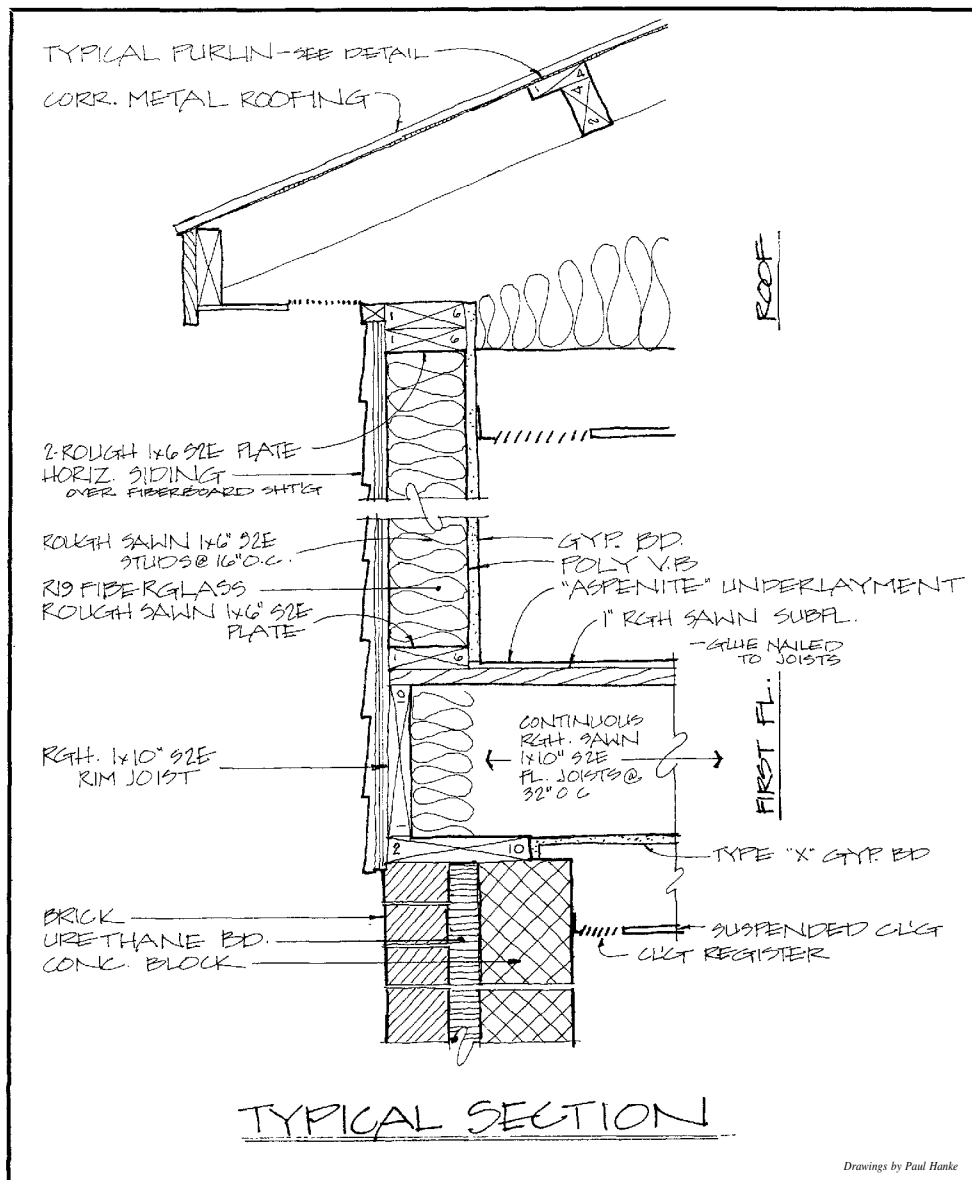
lower building costs. He chose yellow poplar for a number of reasons, the most important of which was the publication of stress-grading figures for the species.

Tests by the Northern Hardwood and Pine Manufacturers Association showed that the modulus of elasticity of poplar was 90 percent that of the stronger pine. The bending stress was rated at 75 percent that of pine, and the shear value, 80 to 83 percent.

Hurst found it difficult to obtain poplar in quantity, however. Finally, with the help of the U.S. Department of Agriculture's Forest Sciences Lab in Princeton, W.Va., and other agencies, he obtained 15,260 board feet of poplar for processing into lumber.

The lumber was planed on two edges (S2E) for dimensional regularity, but it was left rough (1 1/8 inches thick) on the sides. This provided modest extra strength because of the full thickness, and it also made it easier to nail into the one-inch stock during construction.

After the lower-level walls were up, the intermediate-level floor was framed using continuous 1x10 poplar joists. The joists were made continuous by double scab splices,



which also increased the bearing area over support walls. (See illustration.)

Spacings were 32 inches o.c. to support wood floors and 24 inches o.c. on the south side, where a thin concrete slab was poured over corrugated steel decking to provide thermal mass for the solar design. The wood subfloor, also rough one-inch poplar boards, was *glue-nailed* to the joists. "Aspenite" underlayment was applied over the subfloor to even out the surface under carpeting or tile.

(The carpentry subcontractor took exception to this multi-layer approach, arguing that single-layer plywood would have been easier and faster to install; the maximum span rating for 3/4-inch plywood is 24 inches o.c., in any case.)

Hurst notes that he tried 3/4-inch plywood on 32-inch centers in his HUD tests and found that it performed "real well," but neither construction handbooks nor the

not only were built up to a length that crossed several supports, but they were constructed in a way that doubled them over the support points.

According to Hurst, this is important because the wood needs about 1.8 times as much bending resistance close to the bearing point as it does in midspan. The overlap of the 1x10s is typically 20 to 24 inches. Proper nailing of the joints is particularly important to resist the shear and rotation caused by the cantilever effect, which also provides stiffening.

If you still aren't convinced that Hurst hasn't taken leave of his senses, he says he tested a full one-inch subfloor over joists spaced on *five-foot* centers as part of his HUD research, and that the system still performed well by engineering standards. As far as studs are concerned, Hurst points out that "any engineer will tell you" that conventional two-inch studs on 16- or 24-inch centers are

thrust working on the walls (as occurs with conventional rafter construction), so the floor joists also could run in the short span direction parallel to the ridge—they were not needed to act as horizontal ties across the building.

Roof trusses were used to support the purlins at midspan, creating loft space for the upper units. Floor trusses at lower levels also were used in one wide span.

The roof sheathing was totally eliminated by laying the corrugated steel roofing directly across the 24-inch o.c. purlins. Condensation was controlled by a ceiling vapor barrier and by eave-to-peak venting above the 12-inch fiberglass insulation in the ceiling. (Once again, the carpentry sub found the purlin system labor intensive compared to truss construction—but he didn't mention anything about the money saved by eliminating the sheathing.)

South-facing windows permit the winter sun to enter each unit and warm the concrete floors. The only complaint from residents is sound transmission through the concrete floors, even with the suspended ceilings.

Hinged and counterbalanced "sunshades" have been added for summer shading, although some might argue that a better architectural solution could have been found.

Applying Hurst's Methods

Once you get past the unconventional aspects of Hurst's structural system, there are a few practical obstacles builders might face in applying his methods elsewhere.

First is the problem of finding the unique building material (KD S2E rough-sawn lumber in one-inch thickness). Beyond that, getting code approval could prove to be a significant hurdle indeed.

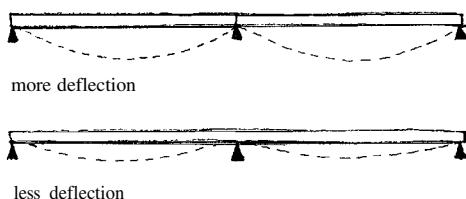
Another consideration is that it is more difficult to hit a one-inch board than a two-incher when nailing. (Hurst acknowledges that this takes some extra care, but "if you come to the site sober, you should be all right," he quips.)

For these reasons and our natural resistance to innovative techniques, Hurst's ideas may never become part of mainstream American building—at least not until the depletion of forests becomes a greater problem than it is today.

But I'm impressed enough with what I've learned to seriously consider using some of Hurst's unconventional ideas in my own house when my family and I begin construction. ■

For readers who are similarly inclined, plans for the "Hillside Fourplex" are available from HUD, or contact Hurst at the Department of Agricultural Engineering, VPI, Blacksburg, Va. 24061.

SINGLE-SPAN BEAM



CONTINUOUS BEAM

A beam continuous over more than one span is stiffer than a single-span beam.

American Plywood Association approves of such uses.

When you consider that we normally use 2x10s on 24-inch spacing or less for floor framing, it's hard to imagine the use of one-inch framing lumber on 24- to 32-inch spacing. How can such thin sticks be used with such wide spacing and still be structurally sound?

Two Critical Elements

There are two critical components in Hurst's floor-framing system: *composite action* and *continuous joists*.

Glue-nailing the subfloor to the one-inch joists makes the entire assembly work as one unit—essentially as a series of T-beams. In the sections with a thin concrete floor, composite action was provided by nailing the corrugated metal decking to the joists with scaffold nails. The protruding nailheads provided a connection directly into the concrete, while the steel decking gave support and tensile strength.

From an engineering point of view, composite action has a great stiffening effect; so does making a joist continuous over two or more supports, even for conventional framing. In Hurst's case, the one-inch poplar joists

"overdesigned."

Consequently, exterior walls were framed with rough-sawn S2E 1x6" studs on 16-inch centers with a double one-inch top plate and a single 1x6 sole plate. Fiberboard sheathing covered the exterior, followed by horizontal siding. Walls were insulated with six-inch fiberglass with a poly vapor barrier and finished inside with gypsum board.

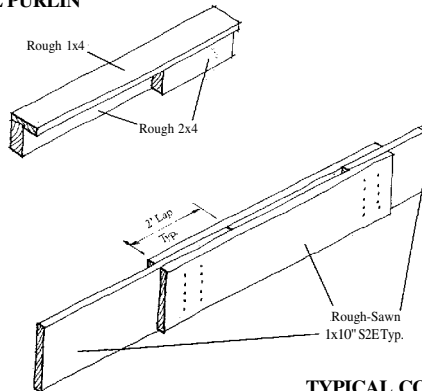
Interior partitions typically were framed with rough-sawn S2E 1x4 studs and plates and covered with gypsum board. The one exception to this was the load-bearing interior walls, where rough S2E 2x4s were used under each joist; however, intermediate studs were 1x4s even here. (Joists were 32 inches o.c.; studs, 16 inches o.c.)

Roofing Innovations

Most of the roof was framed using site-built purlins to support the corrugated metal roofing. Conventional rafters or trusses were not used for structural support. The purlins ran parallel to the ridge, whereas rafters would have run perpendicular.

This feature of the design meant that the gable end walls and some partitions were load bearing. As a result, there was no outward

TYPICAL PURLIN



TYPICAL CONTINUOUS JOIST CONSTRUCTION

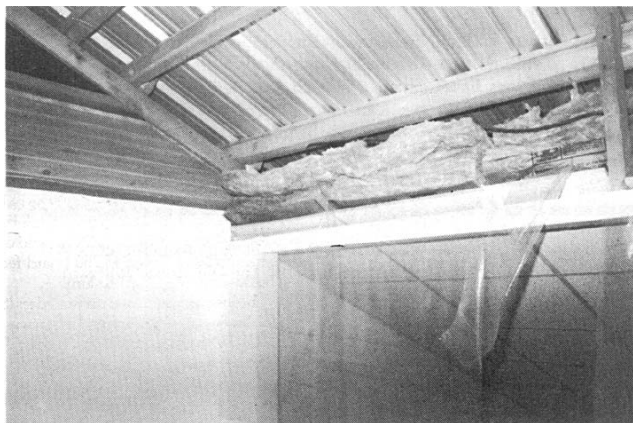
Other Features

Suspended fiberboard ceilings were used on all levels (with fire-rated gypsum board applied to the bottoms of the 1x10s above). The three-inch space between the gypsum board and the suspended ceiling served as a plenum for the transfer of warm air to the north side of the buildings. Finished ceiling heights were seven feet, six inches.

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The plumbing and electrical subs were happy with the dropped-ceiling design, as it eliminated the need to drill through joists and beams and then pull wires through.

Plumbing also was centralized in the units for compactness and efficiency of installation.



A continuous roof purlin supports corrugated metal roofing. Note the absence of sheathing and the fiberglass batts laid over the suspended ceiling.

photo by Paul Hanko