Adding Up

A new second story on independent footings straddles an old house

by Eric K. Rekdahl

In my neighborhood, second-story additions are sprouting like weeds. The reason is simple enough: few people can afford to buy a larger home in today's inflated housing market, and adding a few rooms to a small house can be a solution for the growing family with limited funds. Usually, the easiest way to expand a home is horizontally, but many houses, especially in cities, are on tiny lots that won't allow spreading out. Building up is the only other way to go.

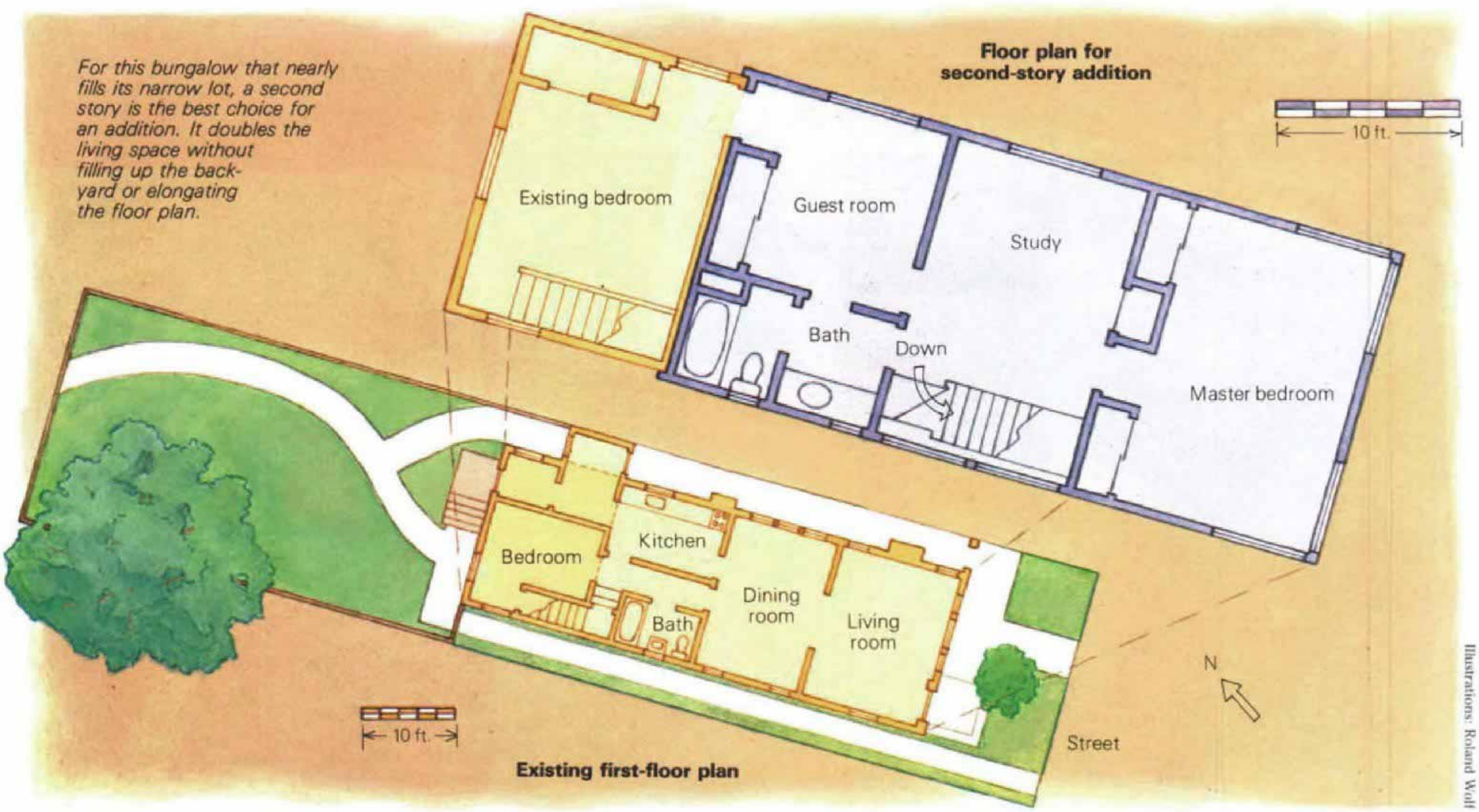
My client, Tom Rankin, faced a similar dilemma in deciding where to add about 600 sq. ft. of living space to his pre-war bungalow. As a self-employed lawyer with his office at home, Tom needed more space for both work and family. His house had a box-car floor plan that suited the shape of its urban lot. Adding to the back end was out of the question because it would further accentuate the long, narrow plan and severely complicate the traffic pattern within the house. Equally important, such an addition would have engulfed the small backyard.

It was clear that a second floor would be the best solution to Tom's remodeling problem, as well as a thoughtful response to the design of the existing house and its place in the neighborhood. We decided to extend the original one-room second story over the entire first floor to gain space for a bedroom, a study, a guest room and a bath. The extension would have an exposed ridge beam, skylights and a cathedral ceiling throughout, all of which would make for a spacious feeling.

Downstairs, the living room was too small for living and the dining room too big for eating, so we planned to remove the partition between them and combine their functions. The floors would be linked by a new stairway from the dining room to the new upstairs study. Leaving the stairwell open would also let some much needed light penetrate to the first floor.

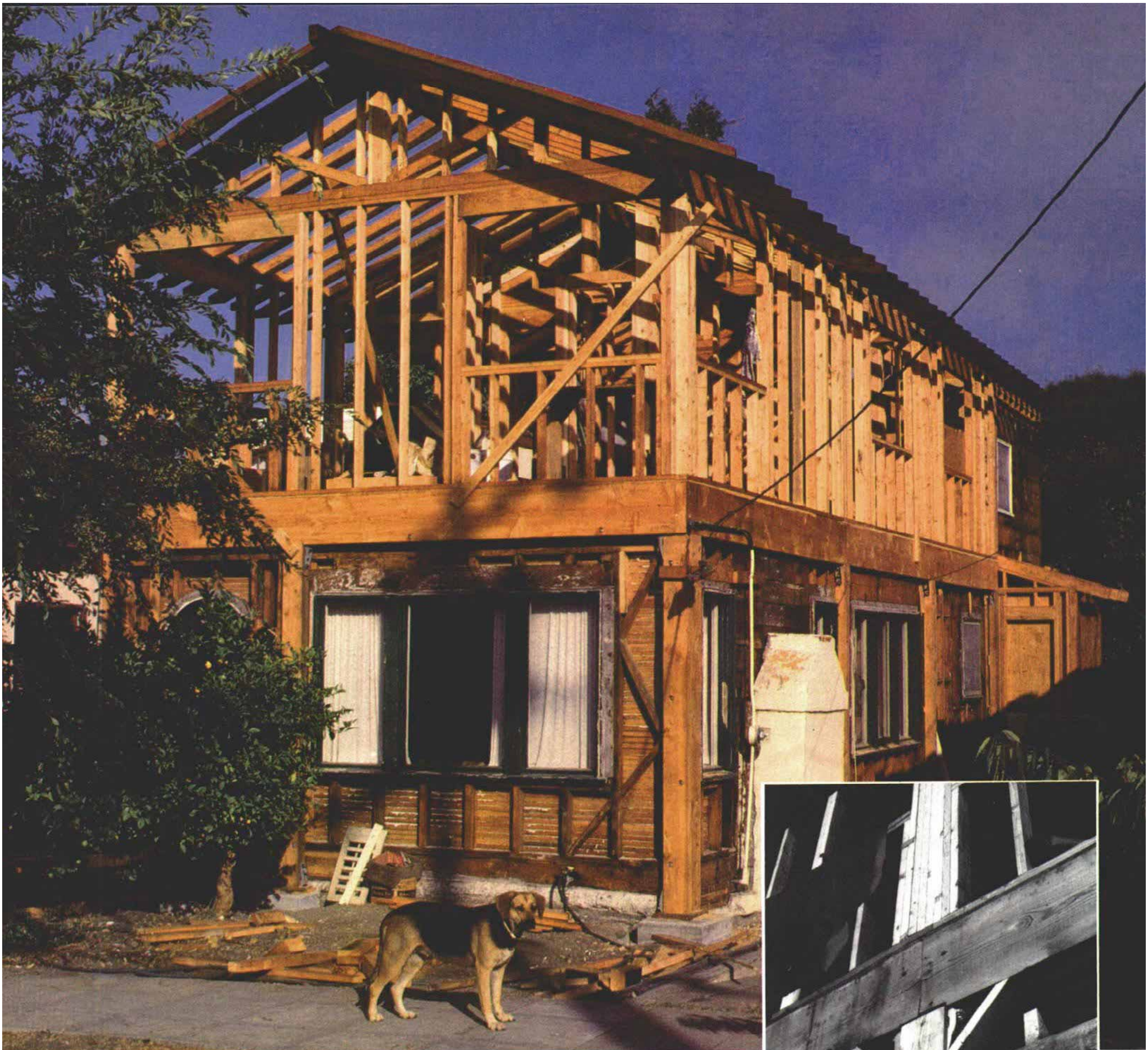
The plan we developed was straightforward and modest. But building the addition economically and in compliance with local building codes would require solutions to three distinct problems. The foundation would have to be enlarged; a cathedral ceiling without benefit of collar ties or interior bearing walls would have to be engineered; and the requirements for racking resistance for the added structure in this earthquake-prone area would have to be calculated and resolved.

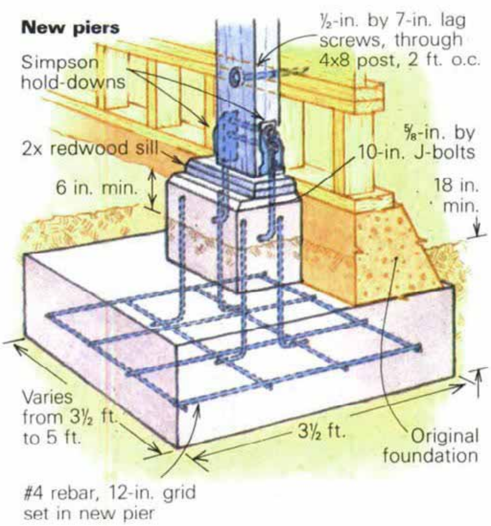
New piers—Two-story houses require footings that are both wider and deeper than single-story houses do. Since it is rare for a one-story house to be constructed on more than a minimal foundation, most existing houses need beefed-up footings to support a second floor. Tom's house was no exception. We investigated removing the original perimeter foundation and replacing it with a two-story version, but the cost was so high that we devised an alternate plan. We decided to make the second story entirely self-supporting. This meant enveloping the downstairs with an independent framework of posts and footings and tying these to the old house for structural and visual integrity. Built above and around the old house, the new structure would stand like a spider holding its prey underneath, while supporting



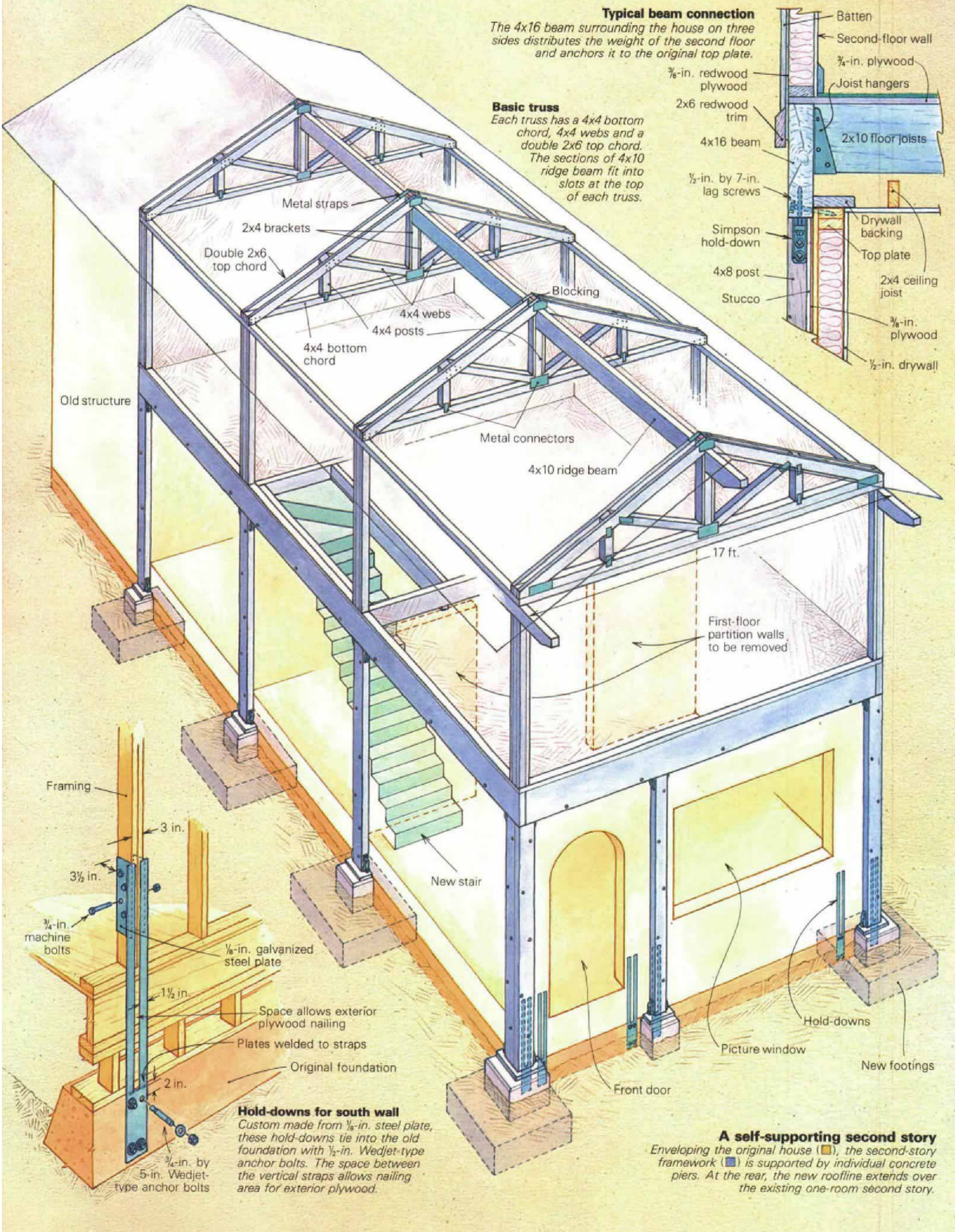
For this bungalow that nearly fills its narrow lot, a second story is the best choice for an addition. It doubles the living space without filling up the backyard or elongating the floor plan.

Illustrations: Roland Wolf





An independent post-and-beam skeleton. **Lag-bolted to the first-floor framing, 4x8 posts rest on individual piers (drawing and photo, left). Atop the posts, 4x16 beams form a structural perimeter to hold floor joists and walls of the second story (inset, above). The badly deteriorated original stucco finish has been removed from the first-floor walls (top). They will be restuccoed. The exterior on the new second story will be board and batten.**



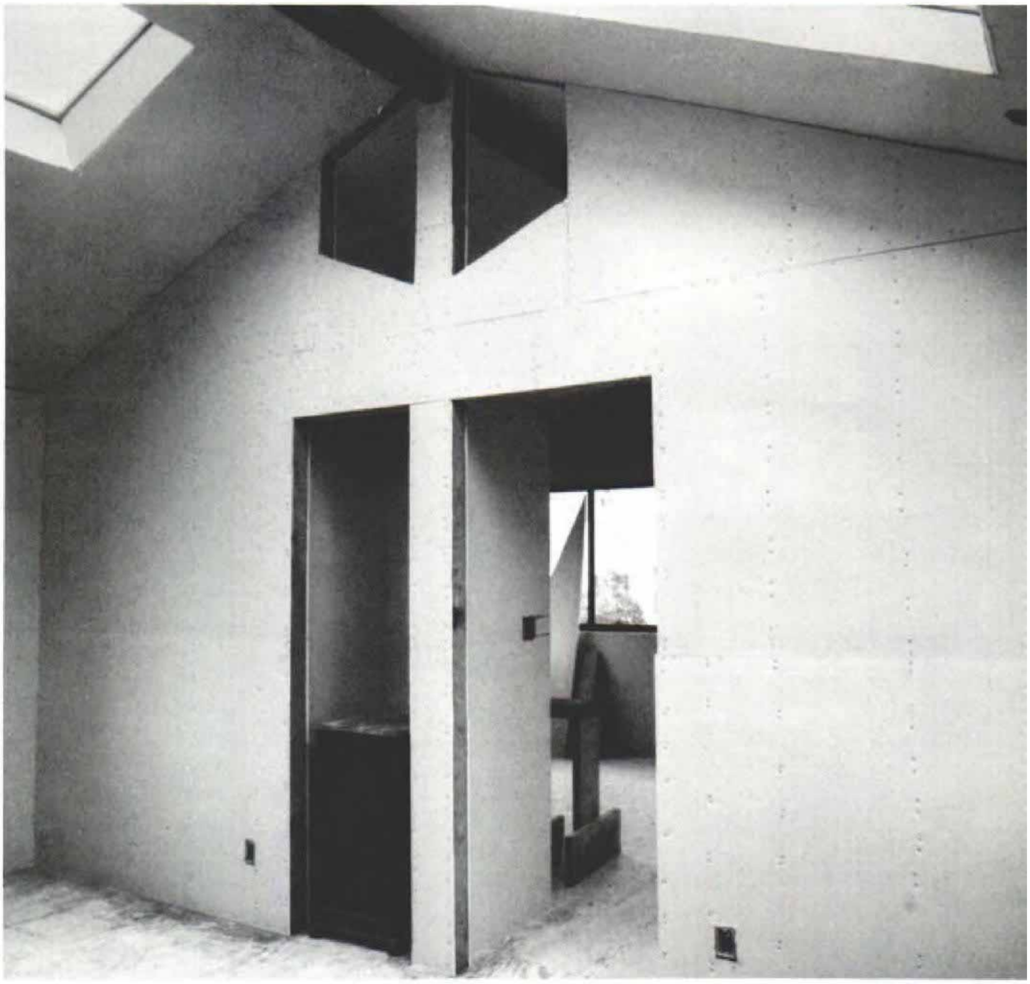
Typical beam connection
The 4x16 beam surrounding the house on three sides distributes the weight of the second floor and anchors it to the original top plate.

Basic truss
Each truss has a 4x4 bottom chord, 4x4 webs and a double 2x6 top chord. The sections of 4x10 ridge beam fit into slots at the top of each truss.

Hold-downs for south wall
Custom made from ⅛-in. steel plate, these hold-downs tie into the old foundation with ½-in. Wedjet-type anchor bolts. The space between the vertical straps allows nailing area for exterior plywood.

A self-supporting second story
Enveloping the original house (■), the second-story framework (■) is supported by individual concrete piers. At the rear, the new roofline extends over the existing one-room second story.

Trapezoidal windows over the doorways, right, follow the truss structure and add unexpected angularity, as well as allowing airflow to adjoining rooms. The double top chord of the trusses makes solid backing for drywall at the ceiling corners and holds the 4x10 ridge beam in slots.



the combined weight on its 4x8 legs. (Try using that explanation on a building inspector.)

Our structural engineer, Gene St. Onge, calculated the combined live and dead loads of the addition, and designed concrete piers to support the new load. Placement of the piers was influenced by the need to anchor the new posts to the original framing. We figured that the most likely place to find sturdy connections was the partition framing the intersections of interior walls and the exterior bearing walls.

Each pier had to extend under the existing foundation for 16 in., which meant undermining the original footing in sections up to 5 ft. in length. Before excavating for the piers, the builders removed the old roof to lessen the load on the foundation. Our guess that the stucco and sheathing on the walls would act as a beam to distribute the loads over the unsupported parts of the foundation proved to be correct. There were no problems with cracking or settling before the new concrete was poured to fill the voids.

When the builders tried to lag-bolt the posts to the existing partition studding, it became apparent that the studs we expected to tie into just weren't there. They removed the stucco to find an odd assortment of blocking, lath nailers and dry rot where we expected plate-to-plate framing. Other excavations into the stucco revealed thriving colonies of termites, so the builders removed the entire layer of stucco rather than settle for an equally costly patch job, and repaired or replaced the missing or damaged framing.

To carry the weight of the addition and to help connect the original framing to the second floor, 4x16 beams were set on the new posts. A 4x16 is deep enough to accommodate the new 2x10 floor joists of the addition at the top and still cover the original 2x4 first-story ceiling joists and top plate on the bottom. These beams were anchored securely to the 4x8 posts with lag screws and two steel angle braces per post. The same 7-in. lag screws were angled through the beam into the top plate of the first floor.

With the skeleton built up to the second-floor level, work could start on the floor framing and walls of the new addition. Two-by-ten floor joists 16 in. on center were laid across the 17-ft. width of the house. They were fastened to the 4x16 beams with joist hangers. To frame the opening for the new stairway, 4x10 joists were used for extra strength.

Once the ¾-in. plywood subfloor had been nailed down, wall framing began. The builders used 2x4 studs throughout, but doubled up at the corners and above each 4x8 post. These built-up posts on the second floor would hold the roof trusses for the cathedral ceiling. Aligning the first and second-floor posts ensured that the roof load would be transferred directly to the new piers below.

Trusses—The decision to build a cathedral ceiling with an exposed ridge beam meant some rearranging of the usual flat ceiling layout. In the typical flat ceiling, the ceiling joists act as collar ties to prevent the load of the roof from pushing the walls apart. Without collar ties or joists, a ridge beam has to carry half the roof load. Usually such a structural ridge beam is supported at various points by interior posts, but Tom's house lacked adequate foundations under the center of the house to carry the ridge beam. Instead, our engineer designed trusses, which could be built from standard framing lumber, to carry the ridge-beam load to the outside walls, then to the new footings.

So they could deliver their concentrated loads, the trusses were located directly over the new posts. Since the posts are in line with the existing partition walls, the spacing of the original floor plan could be carried upstairs. We were also able to put the upstairs bathroom over the first-floor bath, reducing plumbing runs.

Tying the addition to the ground—The second-floor addition made the house slightly top-heavy, a condition that can be dangerous in this part of the country. The forces generated by an earthquake or by high wind are erratic and can vary rapidly in direction and intensity. These forces can cause the two levels of the house to respond in different ways. This oscillating, alternating pattern of motion between the upper and lower floor can produce racking and uplifting forces in magnitudes the original house never had to resist.

The east and west walls are longer than they are high, and had enough shear value in the stucco and sheathing to cope with any second-floor gyrations, but the south wall presented the biggest problem. We wanted to keep the original front door (3 ft. wide) and the picture window (8 ft. wide), which left only three narrow panels to resist any east/west movement. Tremendous uplift develops at the lower corners of these slender panels during a racking motion. To restrain this uplift, our engineer devised an elaborate hold-down for each corner. These custom steel hold-down plates were to be made at a local metal shop.

Enveloping the original house with an essentially independent structure accomplished several goals. For one, the concrete piers cost a little less than $3,000, well below the $8,000 to $10,000 estimates for shoring up the house and replacing the original foundation. Second, the entire addition was framed and secured before the first-floor ceiling needed opening for stairs and service connections, which left the downstairs largely undisturbed during much of the construction. And finally, changes still to come on the first floor can now be accomplished without concern for the loads induced by a new second story. □

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