RESEARCH AND IDEAS

Chicago's Little Green Gem

As building sites go, the empty lot at 1917 North Keeler in Chicago, Illinois, doesn't appear to hold much promise. It's almost as if the urban neighborhood grew up around it and left it there by default because no one could figure out what to do with it. The plot is extremely narrow (25 feet) and unusually long (125 feet), with a two-story house wedged in on either side.

But against all odds, this is going to be the site of a very lovely and energy-efficient home designed by Doug Ross, architect and principal in Ross Architecture (Chicago). In fact, the design is so clever and well tuned to the site that it was selected by Green Homes for Chicago as one of the five best designs in a field of 70 competitors. Green Homes for Chicago, a joint initiative of the city's Departments of Commerce and Environment, launched the competition to identify affordable, environmentally friendly housing designs that would work well on vacant city lots. The base case budget of $125,000 was augmented with $50,000 to pay for environmental upgrades.

As shown in Figure 2 and the sidebar on page 9, Ross' winning design is a two-story house with a third-story penthouse and roof garden. It features a central atrium that admits natural light and helps circulate heated air in the winter and draw in fresh air in the summer. The roof garden is flanked by a pair of large solar photovoltaic arrays that should meet about half the home's annual electricity needs (see Figure 3 on page 10).

Design Features

At every juncture, Ross opted for designs and materials that will make the house energy efficient and environmentally kind (see Spec Sheet). The crawlspace, for example, is insulated inside and out with two inches of rigid insulation. The 14-inch open web floor joists above the crawlspace are insulated to R-30 using unfaced fiberglass bats (see Figure 4 on page 11). The home's 2x6 walls will be framed at 24 inches on center to conserve lumber and insulated with blown-in-batt (BIB) to R-19. BIB will also be used in the attic (15 inches/R-60). *[Editor's note: while the drawings shown in this article show fiberglass batt insulation in the wall and attic details, a late decision was made to use BIB instead.]*

Ross shows similar care in his plans to air-seal the home, which include a poly vapor retarder throughout and instructions to foam-seal every crack and cranny. "We also decided not to put any electrical boxes in the exterior walls," Ross points out. "Where a receptacle is needed on the perimeter, it will be installed in the floor."

The greatest potential weakness in the envelope is the sliding glass door in the penthouse that opens onto the rooftop garden. Sliders, of course, are notoriously leaky

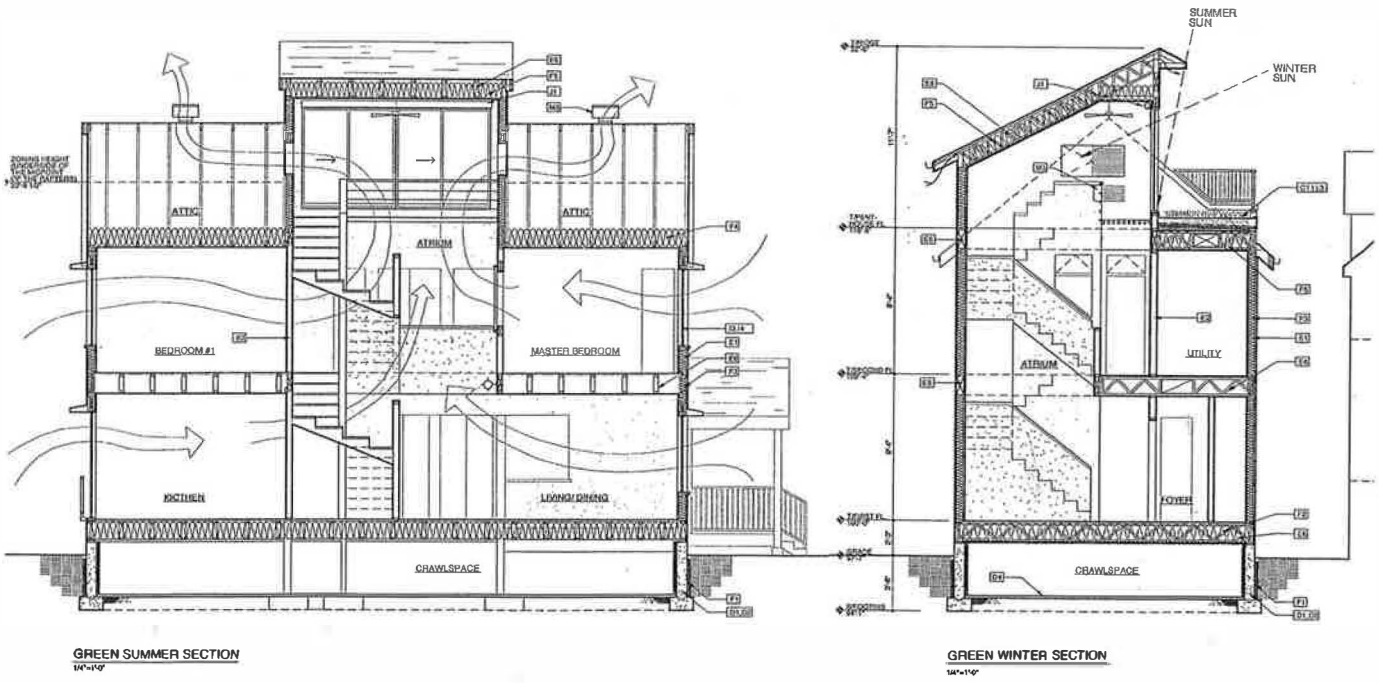
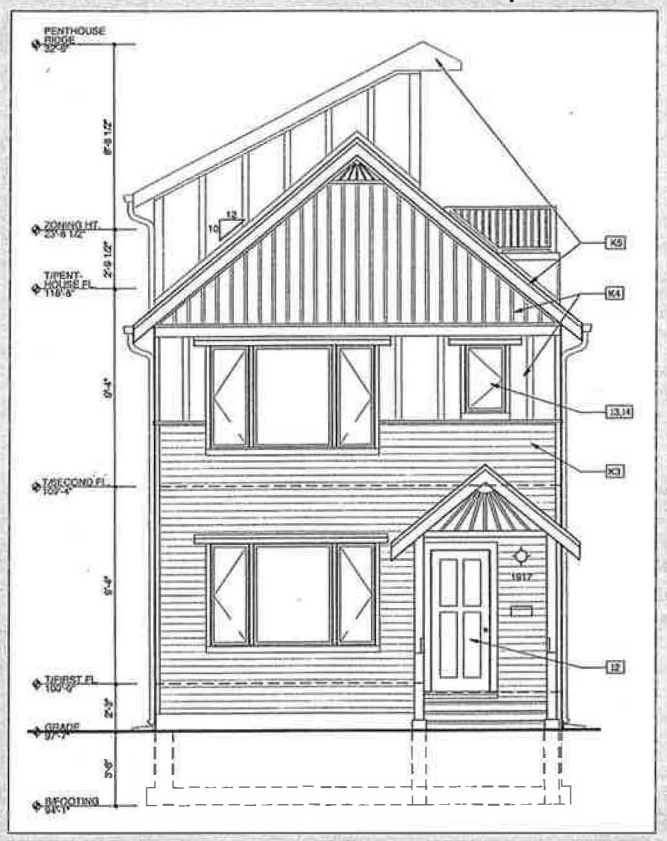


Figure 2 — The summer cooling and ventilation plan depends on the stack effect and roof fans to draw air from the lower floors up through the atrium. The openings between the penthouse and the attics are fitted with motorized dampers for summer operation and an airtight cover to seal them in the winter. Note the return air grilles for the forced-air heating system (M7 on the right), which draws preheated air from the atrium.

Spec Sheet: Ross Home



GENERAL

Size: 1,450 ft² (135 m²)

Garage: No garage

Style: Regional two-story house with penthouse and roof garden

Location: Chicago, IL

Lot Size: 25 x 125 ft (7.5 x 37.5 m)

Price: $175,000

ENVELOPE

Crawlspace: Unvented with 2-inch mud slab; 2 inches of rigid insulation on both sides of the foundation wall. Floor cavity above the crawlspace insulated to R-30 with unfaced batt insulation. (See Figure 4.)

Floor system: 14-inch deep open web truss joists; HVAC, electrical, and plumbing routed through open webs.

Walls: 2 x 6 studs @ 24 inches o.c. with blown-in-blanket (BIB) cellulose insulation (R-21); ⅝-inch exterior gypsum board sheathing.

Attic: Gable trusses @ 24 inches o.c. with 15 inches of BIB cellulose (R-60) ceiling insulation; 14-inch open web truss joists under the roof garden with fiberglass batt insulation (R-40).

Roof: Asphalt shingles over OSB sheathing.

Attic venting: Two Broan 1,600-cfm attic fans with thermostatic switch (see main text).

Windows: Wood casement windows with aluminum cladding; ⅝-inch low-e glazing w/argon fill.

Siding: Beveled fiber cement siding on lower portion of house; 4 x 8 ft hardboard panels with 1 x 2 inch battens on top portion.

Exterior doors: Fiberglass- or metal-clad with insulated cores. Wood slider in penthouse has ¾-inch low-e glass, argon fill, and motorized insulation blind (R-4.5); blind is controlled by photocell to reduce heat loss at night.

Air sealing details: 6-mil vapor retarder throughout; no perimeter wall electrical penetrations (floor outlets used instead); interlocking thresholds; all crevices and penetrations foamed.

Interior partitions: 2x4s @ 24 inches o.c. with ⅝-inch gypsum board.

HVAC

Heating: Carrier gas-fired furnace (AFUE 90) with humidifier.

Cooling: Carrier central air (14 SEER) with chlorine-free refrigerant.

Ductwork: Sealed, insulated metal trunk line with round, insulated flex branch lines.

Water heating: State gas-fired, 50-gallon high-efficiency water heater (PR6-50-NXRT); Energy Factor: 60. Recovery Efficiency: 85%.

Spot ventilation: Carrier 150-cfm heat recovery ventilator pulls air from bathrooms; supplies fresh air with heat recovery at 76% efficiency (at 32°F).

Whole-house mechanical ventilation: Two Broan 1,600-cfm attic fans with thermostat switch; ceiling fan at the top of atrium.

OTHER FEATURES

- Small dimension lumber and finger-jointed trim used throughout. Diagonal bracing eliminates the need for plywood sheathing
- Stacked plumbing
- Natural ventilation and light provided from central solar atrium
- Rooftop garden
- Photovoltaic panels: 2-kilowatt array, offset-mounted over the attic portions of the roof; AC-DC inverter
- HERS rated: 90.3

compared to other types of doors, especially after they've been through a couple of years of wear and tear. With that in mind, a top-quality, French-style door with excellent weatherstripping would be an interesting alternative. Ross does recognize the potential for heat loss through the slider and has specked a motorized honeycomb blind (R-4.5) behind it to beef up the insulation. The blind is equipped with a photocell control so it can automatically close at dark.

Heating and (Maybe) Air Conditioning

As detailed in the Spec Sheet, the Ross house will have a high-efficiency Carrier gas furnace (AFUE 90) that will draw its return air from the top of the atrium. In the winter, direct solar gain coming through the slider will heat the air in the penthouse, providing preheated air to the furnace, which should boost its efficiency even further.

Though the specs include a 13 SEER air conditioner, Ross isn't convinced that the house really needs it. "We think the natural ventilation scheme could work well enough that electric air conditioning won't be needed most of the time," he says. "The marginal period will be just a week or two in Chicago, during the hottest days of summer."

In summer, the stack effect will facilitate natural cross-ventilation and create internal breezes. The house is also equipped with two roof-mounted, 1,600-cfm exhaust fans that are wired to a pair of motorized dampers that open into either side of the penthouse (see Figure 2). The fans can be manually controlled or thermostatically set to come on when the attic temperature hits 85°F. When the fans are on, the motorized dampers are open into the penthouse, drawing air up through the central atrium from the floors below.

"We realize that for this cooling and ventilation strategy to work well, the owners are going to have to understand how it works and be willing to open windows at certain times to admit cool fresh air," Ross says. "We're developing an owner's manual that will explain how the house works. We'll also spend some time with the new owners walking them through the system."

In the winter, the motorized dampers remain closed and are further sealed off from the penthouse by air-tight hatch covers. Fresh, conditioned air is provided to the house by a 150-cfm Carrier heat recovery ventilator.

Ross tells *EDU* that the total annual energy bill for the house — gas and electric combined — should be about $850 a year. Of course, there's a major "free" contribution from the 2-kilowatt photovoltaic array, which will spin the electric meter backwards much of the time. The system, engineered by Spire Corp. (Bedford, Massachusetts), will be mounted on standoff rails. About 60% of its total cost will be covered by a renewable energy credit provided by the state of Illinois.

Fresh Veggies from the Roof

One of the home's neatest features is a small balcony and roof garden accessible from the penthouse (see Figure 4). Of course, any time you're building a flat roof in a relatively wet climate the warning buzzers should start to sound. And even more so when you're covering a section of the roof with 12 inches of moisture-retaining soil.

The insulation and waterproofing system that Ross selected for the garden is designed and manufactured by American Hydrotech (Chicago). It consists of multiple layers of materials, built up from the bottom as follows:

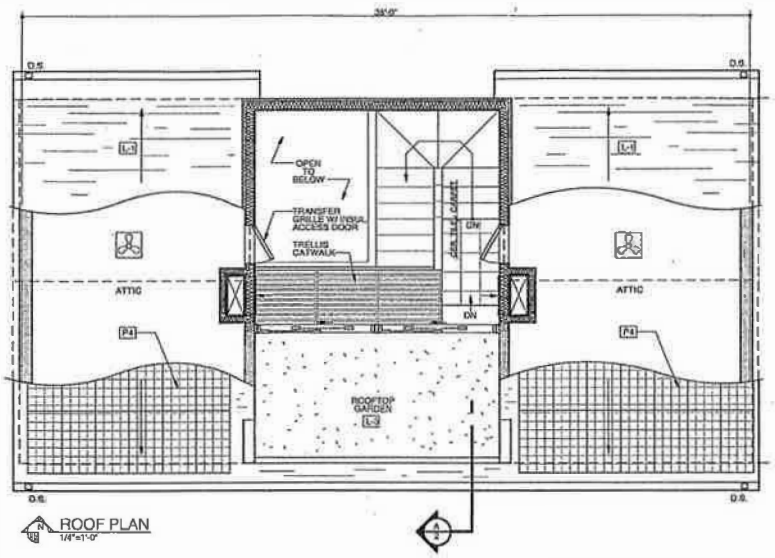


Figure 3 — Roof plan showing the 2.5-kilowatt photovoltaic array (P-4) and the sliding glass doors that access the rooftop garden. These features will be oriented due south, maximizing the solar-electric performance and admitting direct solar gain through the slider. Architect Doug Ross points out that the solar atrium, projecting above the roof line, can be rotated so that no matter which direction the house is placed in the urban setting, the core of the house reaches directly to the southern sky.

- OSB sheathing is nailed over the 14-inch roof joists.
- Continuous sheet metal flashing is installed down the knee wall and over the flat plane of the roof, terminating at the eaves.
- 2 inches of polisocyanurate insulation is set down over the flashing. This is tapered at ¼ inch per foot, sloping from the inboard side of the garden to the eaves.
- A layer of rubber-modified bituthane ("Hydraflex") is torched down over the insulation as waterproofing. It conforms to the taper of the underlying insulation, so that any water reaching this plane will flow to the edge and weep out through the perforated gravel stop.
- FloraDrain (corrugated plastic panels) lets water flow easily to the edge of the roof.
- Filter fabric lets water pass into the corrugated panels below but keeps soil and roots out.
- A foot of soil is added.

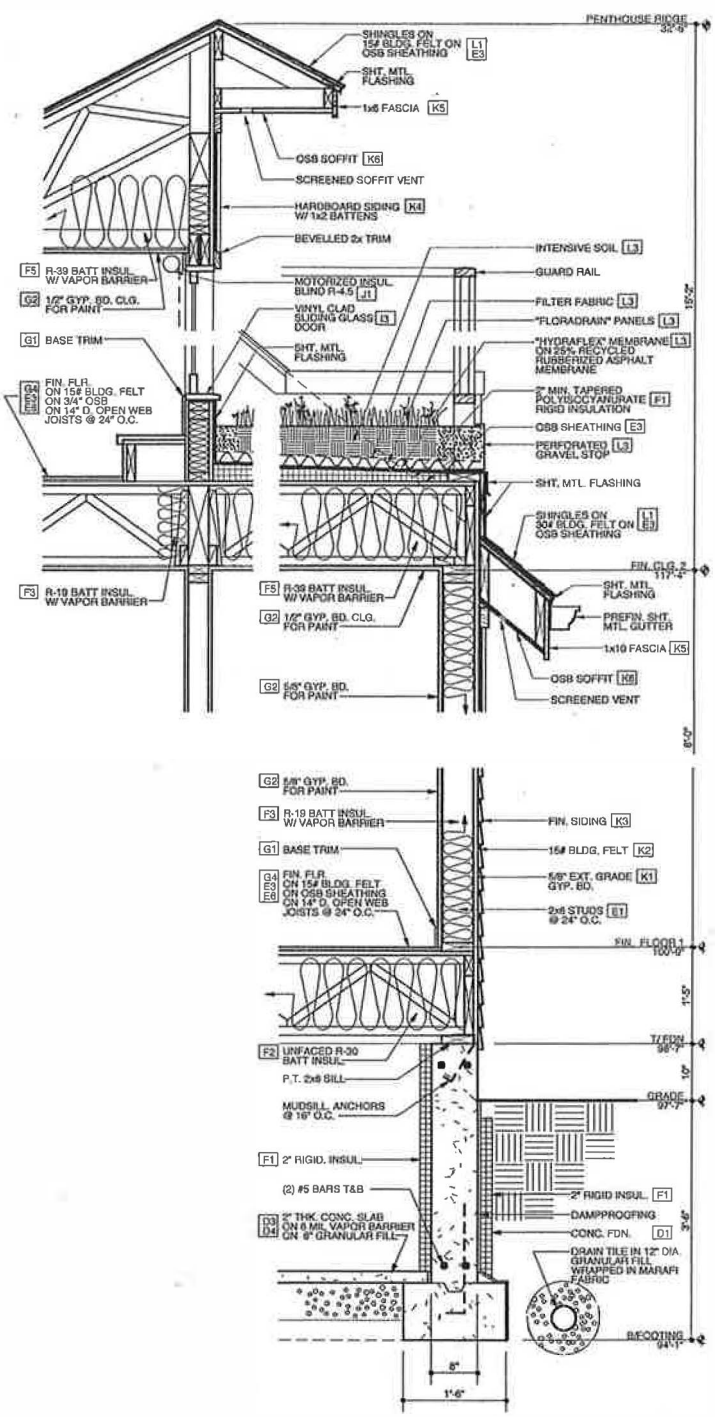


Figure 4 — Details of the crawlspace and penthouse/roof garden (with second floor detail omitted). The insulation and waterproofing system for the garden is designed and manufactured by American Hydrotech (Chicago, Illinois).

Ross says that he's confident the system will perform well and won't leak. One thing is certain, the room below the roof garden isn't going to be experiencing much heat loss through the ceiling, considering all that fiberglass batt, polyiso, and soil that's sitting overhead.

Parsing Shades of Green

One of Ross' biggest challenges in completing his prize-winning design was to select "green" materials while adhering to the budget restraints. In fact, he created an affordable/sustainable materials index for the project that tracks options and costs.

"I always felt good about the general design and concept for this house," he says. "But we've gone back and forth on material choices a lot. There are so many issues to consider that the choices become very, very complex."

As an example, Ross cites his decision to use Hardiplank cement siding for most of the exterior walls. "Hardiplank gets great reviews from subcontractors, is a low-maintenance siding, and has great durability," he says. "But it's not made locally, so the transportation costs are high and the material throws off silicon dust when it's cut, which can present a health danger to unprotected [unmasked] workers. Then, of course, you can get into the embodied cost of making cement versus the embodied cost of making vinyl and other materials, source pollution at the manufacturing site, and so on."

Interestingly, Ross thinks local building officials could take some steps to help designers and builders in the process. "I think zoning boards could reexamine some of their regulations to make them more environmentally friendly," he says. "With this design, for example, we could substantially reduce costs, increase energy efficiency, and conserve land if we could build several of these houses together in a rowhouse configuration with common walls. That's not permitted here under current law."

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NEW PRODUCTS

New AirCycler: A Big Plus for Combo Systems

Armin Rudd, building scientist and inventor, has introduced a new version of his patented AirCycler control that integrates the latest technology in whole-house ventilation with enhanced control of combination space and domestic hot water heating systems (combo systems). (See Figure 5.)