BY TED CUSHMAN

Insulating Foundations In Earthquake Country

California's energy code (known as Title 24) has long been one of the strictest in the nation. That fact helps to explain why the state's per capita electric power consumption has stayed flat for 40 years as the rest of the nation has consumed more power per person almost every year since 1975.

Given the mild climate in the state's most populous regions, California's code authorities have tended to focus on power consumption items—setting tough standards for lighting and HVAC efficiency, but sticking with relatively modest requirements for envelope airtightness and insulation.

But that has been changing. In 2008, then-governor Arnold Schwarzenegger set California on a path to net-zero energy consumption for new homes by 2020. In response to that challenge, the 2013 edition of Title 24 boosted required wall and roof R-values statewide, and the 2016 edition, which took effect January 1, continued to ratchet requirements up.

As the state's code gets stricter, the gap between code-compliant homes and above-code protocols such as the Passive House standard narrows. California's Title 24, in other words, is catching up to Passive House—but it's not there yet.

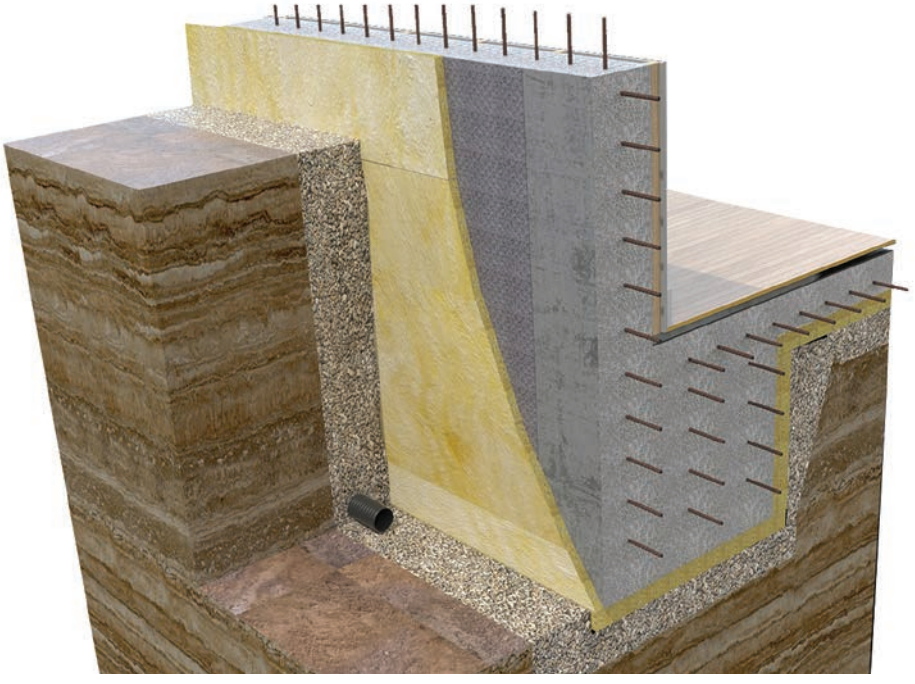
For a 2016 publication called "California's Energy Future," Passive House designer Graham Irwin modeled code-compliant homes (using the 2013 version of Title 24) versus Passive House–compliant designs in each of California's 16 climate zones, in an effort to focus on the key differences between the two approaches. Irwin added Passive House measures to the code-compliant designs one by one, to isolate the incremental effect.

"Air leakage reduction, from the code assumption of 5 ACH50 to the Passive House maximum of 0.6 ACH50, was the most effective first measure in every climate," Irwin reported. Interestingly, however, foundation insulation also made a big difference. "Another extremely effective upgrade, universally, was insulating the slab," wrote Irwin. "In some cases, the improvement from slab insulation exceeded that of airtightness."

But insulating a foundation in California brings up a question: What about the seismic analysis?

A showcase multifamily retrofit still under construction by San Francisco developer Tyson Dirksen will add three stories of concrete and steel structure under an existing historic wood-framed house. Engineers okayed EPS insulation around the new lower portion's reinforced footings.

Dan Hruby/Visualize It Built



This rendering by California architect Dan Hruby shows the insulated footing detail for developer Tyson Dirksen's project in San Francisco's Russian Hill neighborhood. The heavily reinforced footing supports three stories of concrete and steel construction set underneath an existing wood-frame house, which was lifted one story to create a four-unit multifamily building. Two inches of EPS insulation isolates the building's lower apartments from the surrounding earth.

"California's Energy Future" profiles dozens of Passive House projects in the state, and in at least two cases, the seismic issues influenced the design process when it came to insulating the foundations. For an ambitious retrofit project in San Francisco, engineer Erevan O'Neill (onedesignsf.com) gave developer Tyson Dirksen the okay for insulation around a massive footing buried in a the hillside. But for an addition in Los Angeles, architect Sylvia Wallis (who is also the homeowner) opted to break the conditioned space away from the ground, framing the insulated floor system atop an unconditioned crawlspace set on a pier-and-grade-beam foundation, rather than challenge her engineer with evaluating an unfamiliar insulated foundation assembly.

LIFT AND INSULATE

With its limited available land and its population of cash-rich tech entrepreneurs, San Francisco has some of the nation's highest-priced living space. For an investment project in that market, developer Tyson Dirksen (evolve-us.com) went to considerable lengths to squeeze more living space into a tight footprint, and he added luxury touches (including a three-car garage elevator). But he also took the opportunity to explore the energy-efficiency frontier, pushing for a Passive House-compliant envelope.

"There's a lot of cool stuff going on there," says project architect Dan Hruby (visualizeitbuilt.com). "We're on a hillside there. And we're carrying five stories, so half of that is underground, essentially, with just the one end open. We've got a view of the Golden Gate Bridge straight out of the west side, with balconies on that end." But along with the view comes direct afternoon sun.

Code required the new lower stories to be Type I noncombustible concrete and steel construction, and the engineering analysis resulted in a structural requirement for massive reinforced concrete footings and concrete walls. Passive House consultant Katy Hollbacher (who is also a civil engineer) recommended insulating the concrete elements with 2 inches of exterior EPS foam.

Foam around a foundation can be a hard sell in a seismic zone. In a previous Passive House project, Hollbacher says, a different engineer refused to even consider putting insulation under the thickened edge of a structural slab—even for a one-story house on a flat site. "Some people just like to have a quick reason to say no," says Hollbacher, "because they're not used to doing it."

In that case, Hollbacher dropped the issue—even though the uninsulated slab edge accounted for 4% or 5% of the one-story home's calculated heating load. "You have to pick your battles," she says. But for the Tyson Dirksen project, she says, "Erevan just said, 'Okay, I understand what you're trying to go for, and we will make it work.'"

Hollbacher herself is on the fence about insulating foundations in the California climate. "The engineering part shouldn't be a challenge," she says. "I think more of a challenge is the constructability—just the phasing of getting insulation in there, and the dirt not falling in ... it's something people haven't done before,

and it's tedious. It's doable, but it's a pain. And the energy savings is small, so the cost-effectiveness argument is serious. Realistically, you're probably only saving a few dollars a year."

Still, says Hollbacher, "What I love about this mind-set of Passive House is, hey—just do the envelope right from the start. It's going to be there for a long time, and the added cost to do some of this detailing is negligible on the scale of the project. Don't even spend the money to do all these software runs and calculate the cost effectiveness—spend that money on mitigating it instead. Just do it."

GETTING OUT OF THE GROUND

Architect Sylvia Wallis chose a different path for her project, a deep energy retrofit with a large addition to an existing home on a Los Angeles hillside. Wallis, who works for the architecture firm Harley Ellis Devereaux (harleyellisdevereaux.com), learned about Passive House in 2009 while she was planning her remodel, and ended up taking the organization's nine-day consultant course. She applied Passive House principles to her own project (which has ended up taking years to finish).

"It's important to understand that this project had already completed plan check before it was modified for Passive House," said Wallis in an email to *JLC*. "If we had been starting from a blank slate, some simpler options might have been possible. But conditions at the site include California seismic conditions, moderately steep slope, expansive clay soil over bedrock, and bedding planes somewhat parallel to the slope, producing a tendency towards creep. As a result, moderately deep piles were required at the low side of the addition, with spread footings sitting on the bedrock on the high side of the house. Everything is supported on the bedrock, not sitting on loose soil above the bedrock."

"The soils report called for a combination of passive earth pressure and friction from the piles and footings to resist the lateral forces (primarily seismic)," Wallis continued. "So the connection of the foundation against the bedrock was significant. All foundation excavations had to be hand-cleaned of all loose material to maintain this connection."

"The standard Passive House solution is an unvented basement or slab on grade, either of them completely surrounded by insulation," said Wallis. "You can see how difficult it would have been to try to insulate around them, even if the structural engineer had allowed it."

"So instead," Wallis concluded, "the insulation was moved up to the underside of the raised floor. The difficult detail then is the connection of the floor to stem wall (impossible to have continuous insulation and difficult to do the air barrier). But in the benign L.A. climate, the thermal bridge is not huge and can be calculated into the model without a terrible penalty."

Ted Cushman is a senior editor at JLC.

Above, foundation workers set rebar cages for deep structural piers into the hillside for Sylvia Wallis' high-performance addition.

Above, a worker shovels out the trench for grade beams that will support the stem wall for the unconditioned crawlspace under Sylvia Wallis' addition.

Photos: Sylvia Wallis