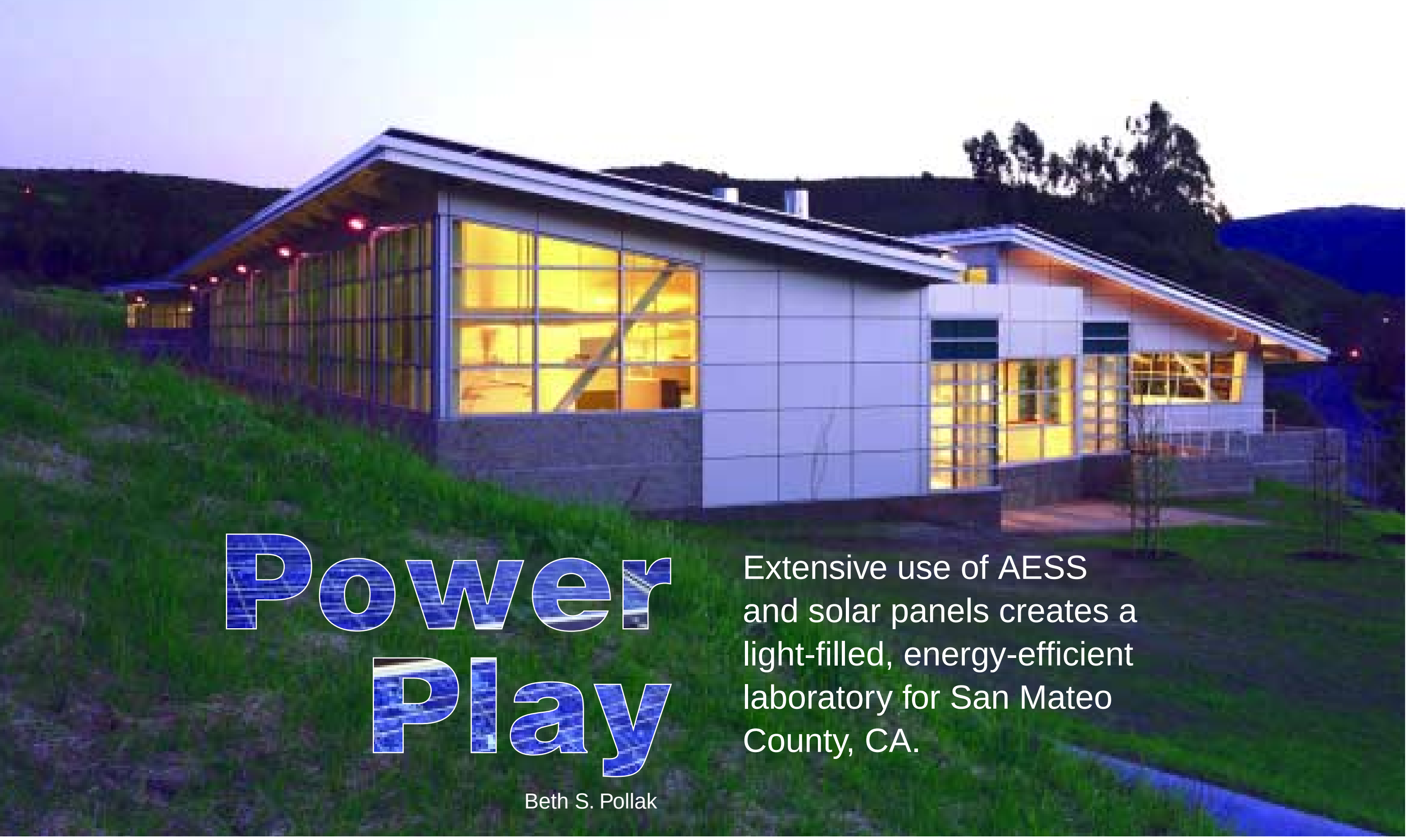

Power Play

Extensive use of AESS and solar panels creates a light-filled, energy-efficient laboratory for San Mateo County, CA.

Beth S. Pollak

Most laboratories require large amounts of energy to meet the needs of their occupants; but the San Mateo County Sheriff's Forensics Laboratory and Coroner's Office, in San Mateo, CA can generate its own power—reducing both its operating costs and negative impact on the environment. The 30,000-sq.-ft, single-story steel-framed building features 22,000 sq. ft of photovoltaic (PV) panels on an angled roof. The panels can provide up to 204 kW of energy, which meets 80 percent of the building's energy needs during times of peak demand.

"The building runs off of the standard power grid [that any building runs off of] in California," said Alan Bright, AIA, project designer for architect HOK. "But once the sun comes out, the PV panels take over and pump energy into the grid system. The more sun there is, the less power is required from the power company." Project Manager Turner Construction even succesfully ran the entire construction site off the PV panels for a day just to test them out.

Other "green" features include natural ventilation, energy-efficient fume hoods, HVAC systems, advanced lighting control, green building materials and a construction-waste recycling plan.

STEEL EXPOSURE

The use of steel was essential to the project, for aesthetic, structural, and sustainability reasons. "The owner wanted a building that was sustainable, open and airy, with natural light filtering in," Bright said. "To do this, you need a good-size span without a lot of columns and beams. Steel was a material that we could do that with—it is thin, and spans long distances."

In addition to column-free space, the owner also chose steel for its architectural appearance. "We could use the steel as part of the architectural expression of the space by exposing everything," Bright said. "AESS is wonderful. From day one, we really wanted to express everything that goes on in the building. We exposed all of the steel and all of the mechanical equipment, and we were able to eliminate extra costs and materials."

Steel's flexibility was also important. "We needed flexible space for the users," Bright said. "Labs change over the years with new information and new equipment. Steel allowed us to have an open, flexible space."

The building's external appearance was enhanced by the use of steel. Exposed brace frames accent the building's front exterior, and the sloped roof is framed with C-shapes. Steel also allows the building to blend into its surroundings. "The county owned a piece of land in a small canyon outside the city of San Mateo," Bright said. "Beyond this land, there's a residential area. It's a very serene setting, and [the goal was] to set the building into the landscape, to be a good neighbor, and to create a quiet building that works with its surrounding context. Because of the steel, we were able to angle the roof up, and pitch it towards the sun. The lightweight spans mimic the angle of the hillside. You can see it as you drive by, but it terraces up the hill, as part of the landscape."

ROOF ANGLE

Structurally, steel's flexibility is key to the design of the building's energy-capturing system: While the roof's angle allowed PV panels to capture the sun's rays, cantilevered roof overhangs blocked sunlight from overheating the building interior.

"We didn't want a lot of glare in the building, and the steel allowed us to have long overhangs without a lot of columns," Bright said. "The overhangs block the south sun, so you get shade in the building. There are also some smaller overhangs on the north side to regulate the sun exposure."

The roof is composed of metal deck over steel framing. The solar panels are supported with a system of wooden sleepers on top of the metal deck. The roof comprises three sections: Two are sloped for the solar panels, and a flat middle area stores heavy equipment. The sloped areas are composed of W16×77 beams, and W18×60 and W18×40 girders. The flat area is composed of W18×35 and W18×71 beams, and W18×60 and W24×62 girders.

Split roof diaphragms are necessary to meet the slope requirements for the solar panels. Collector members consisting of roof beams, clerestory HSS 4×4×1/2 bracing, and added HSS struts (up to HSS8×10×1/2) transfer seismic forces from the diaphragms, from different levels to the braced frames, and down to the foundation system.

An expansion and seismic joint is located at two-thirds of the length of building, due to the structure's length and a change in the direction of the column grid lines. The joint consists of a separation at the roof deck and at the roof framing. Beams with sliding-seat connections are required to avoid using double columns at the joint. "One end of the beam is connected to a column with a simple shear connection, and the other end, at the seismic joint, is connected to another column with a slider that allowed horizontal movement in two connections," said Marco Italia, project structural engineer.

The structural design of the roof helps meet the building's architectural and sustainability goals. Laboratories and other occupied spaces are arranged along the perimeter of the building where views of the natural local hillsides are maximized. Mechanical and storage areas, and labs where light is undesirable, are centrally located under the flat roof. This central mechanical zone allowed for the efficient location of mechanical units and minimized the amount of ducts required.

STRUCTURAL CHALLENGES

A continuous W18×71 with an 18" vertical step supports a stepped roof condition on the north side of the building, where the architect required a column-free hallway view below. At the south end of the building, various HSS5×5×3/8 are located full height from ground to roof and embedded within a 12′ tall 8"-thick masonry architectural wall. These HSS provide lateral support to the masonry wall.

The lateral system is composed of ordinary braced frames using HSS brace sections, typically HSS8×8×1/2. Some beam-to-column connections are collector connections, with double vertical rows of ASTM A490-SC bolts to transfer seismic loads from the roof diaphragms to the braced-frame bays. Typical bolted connections at beams and girders use ASTM A325-N bolts. The building requires no fire protection other than sprinklers throughout.

The use of AESS presented a challenge for the construction team. Dave Burge, project manager from Turner Construction, says that the entire structure was built to AESS tolerances, which are about one-half the tolerances for standard steel construction.

Another challenge was the coordination and application of numerous finishes on the steel beams and columns. All exposed steel was cleaned, filled or ground smooth, and then sand blasted to a uniformly smooth appearance prior to the application of primer. After that, a high level of finish was applied. "There were three different types of finishes used throughout the building," Burge said. "Steel that was not exposed architecturally was coated with a standard SSPC SP2 finish. Steel that was visible, accessible and touchable was prepared with a high-grade SP7 finish. Steel located on the ceiling was prepared with an SP6, just a grade below the SP7."

Some specific coordination challenges were the number of different finishes required on each steel piece. "Many perimeter columns were fabricated with the rafter tails pre-attached to maintain the AESS tolerances," Burge said. "This created pieces with multiple finishes—hidden, exposed interior, and exposed exterior."

Burge says that in order to coordinate and confirm that the correct level of finish prep was included in the right location and on the right pieces, Turner/HOK and the fabricator color-coded shop drawings for approval, and then tinted the finishes so that inconsistencies could be easily identified upon erection. "The close coordination was a success, as only one column required correction in the field," he said.


Exposed structural steel is an integral part of the architecture in this laboratory.

SUSTAINABLE SOLUTION

Bright says that the building is one of the first nationally that uses solar panels to run its power system. "We never lose power," he said. "Sometimes it's reversed, and the building gives power back into the grid!"

As a result, the County can meet the energy costs of the building, and other buildings can benefit by the additional power generated. Further, the building will save about $75,000 annually on energy costs, and after a 10-year payback period for the PV panels, the building's energy system will operate virtually for free.

In addition to its energy-conservation system, the building has many sustainable features. According to Turner Construction, the metal wall panels are made of recycled aluminum and the CMU is made from recycled aggregate. The entry floor is covered in bamboo and the carpet is made from recycled fibers and rubber. Operable windows are located in all office areas and are coordinated with the HVAC system for automatic shutdown when

Roofs are angled to allow the PV panels to catch the sun, while overhangs shade the windows.

windows are opened. All of the excavated soil, drywall debris, concrete, and cardboard/wood-packing materials from construction were recycled. The building uses natural landscaping to minimize irrigation water, and low-flow faucets and showerheads help prevent water waste.

The building was recognized as an AIA Top 10 Green Project of 2003. It is in the process of LEED certification, although LEED criteria were not considered in the initial design stages of the project in 1999. The architects say the lab should meet silver-level LEED criteria. "Once LEED surfaced as a benchmarking standard that we could use to measure ourselves against, we realized that we were meeting and exceeding LEED requirements," Bright said.

Regardless of this, the Forensics Lab was created with the environment in mind. It is the first construction project designed and built as part of the County of San Mateo's Sustainable Building Policy. The policy focuses on promoting environmental, economic and social benefit through the design of structures that incorporate sustainability and renewable energy.

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County of San Mateo, CA

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STRUCTURAL ENGINEER
Crosby Group, Redwood City, CA

PROJECT MANAGER
Turner Construction Company, Sacramento

ENGINEERING SOFTWARE
PFrame and ENERCALC