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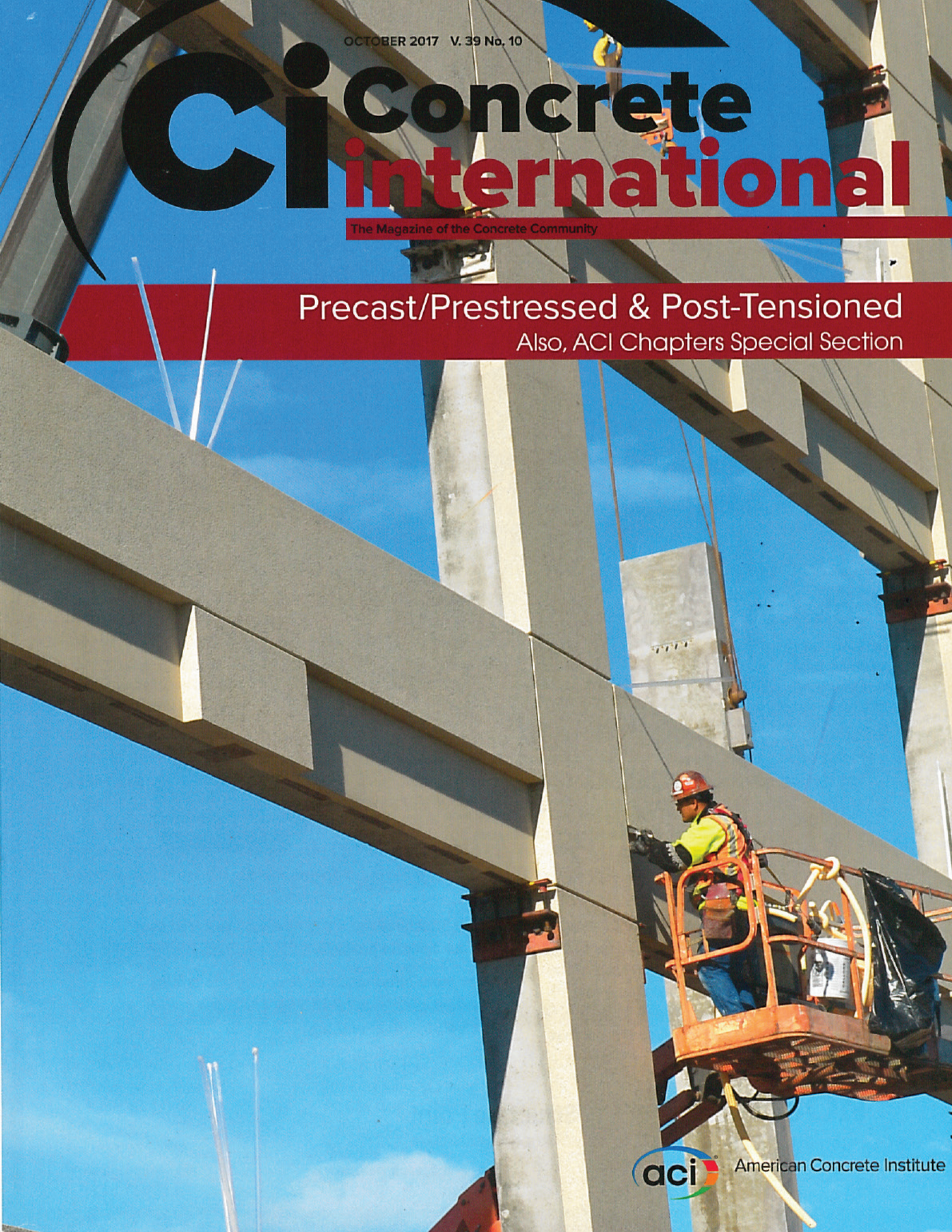

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Integrating Precast Cladding and Structure

Benefits include efficiencies in cost and schedule

by Farid Ibrahim

Building construction has traditionally involved installing the primary structural frame, followed by installing a separate cladding system that attaches to the exterior of the primary structure. Precast concrete nonstructural cladding has been used extensively in traditional construction, as it provides a cost-effective, durable, and low-maintenance solution that allows for a quick enclosure of the building without the use of scaffolding. Although this methodology has served the construction industry well, precast concrete systems have evolved into a more comprehensive and efficient solution—the integrated precast concrete system.

Many designers and engineers may be unaware of the benefits that can be achieved by integrating a building's cladding and structure. As with systems comprising independent precast cladding, casting a high-quality architectural finish on the exterior precast structural frame allows for a quick enclosure of the building without the use of scaffolding (Fig. 1). Integrated systems also eliminate the need for secondary crane operation, and they provide opportunities for additional prefabrication, including installation of continuous insulation and glazing units. Thus, integrating the precast cladding with the structure of a building can increase safety, drive efficiency, reduce cost, and improve quality.

Fig. 1: Typical architectural precast cladding is installed after the building frame has been erected (and, in this case, fire-proofed). "Archi-structural" precast framing eliminates these activities from the construction schedule *(photo courtesy of Clark Pacific)*

Integrated Precast Systems at Work

Particularly in regions with high seismic risk, the precast hybrid moment frame (PHMF), shown in Fig. 2, is an optimum system for combining cladding and structure. A PHMF comprises high-quality precast column and beam elements, produced under factory-controlled conditions, that are connected using traditional construction methods and materials—reinforcing bars, post-tensioning steel, and grout. The reinforcing bars and post-tensioning provide strength to the connection. As with most seismic force-resisting systems, the reinforcing bars dissipate energy through yielding. However, unlike a conventional building, which may lean after a major earthquake, a PHMF system is self-righting—the elastic, unbonded post-tensioning is designed to overcome yielding in the frame and pull the building back to a righted position (Fig. 3).

The following sections provide a few examples of PHMF buildings with integrated cladding produced by Clark Pacific, an industry-leading design-build manufacturer of complete building systems. These structures have all benefited—in construction efficiencies, asthetics, and resilience—from the use of this elegant, integrated precast system.

Caltrans District 3 Headquarters

In 2007, the state of California initiated the design and construction of a $65 million, 230,000 ft² (21,400 m²) Class A

office building in Marysville, CA. The project delivery started with a stipulated sum design-build competition. Early on, one of the competing teams invited Clark Pacific to help develop the most cost-effective solution. Their decision to go with a total precast system was instrumental in winning the project.

Working with the precaster early in the design allowed the team to incorporate a structurally resilient PHMF into the design. This resulted in a facility that delivers wide open (X-brace free) and well-lit interior spaces (Fig. 4). By integrating the cladding with the structure, the team also eliminated the need for installation of a secondary façade system, allowing erection of the precast structure in just 12 weeks. This shaved a month off the overall construction schedule and resulted in significant cost savings.

The exterior frame elements include colored concrete with patterns and textures, making it aesthetically appealing (Fig. 5). The use of concrete throughout the interior and exterior will minimize maintenance and save the state money over the lifespan of the building. Leaving the concrete exposed on the interior also resulted in energy savings, as the concrete mass helps to modulate diurnal temperature swings. The energy savings, resilient design, reduced staging, and local sourcing, made possible through the use of precast concrete, contributed to the building's LEED Silver rating.

Roseville City Hall Annex

The recently completed Roseville City Hall Annex (Fig. 6(a)) is an 82,000 ft^2 (7600 m^2), four-story office building designed to house the growing city's departments, as well as classrooms for a nearby community college. Originally designed with steel framing and a portland cement plaster exterior finish,

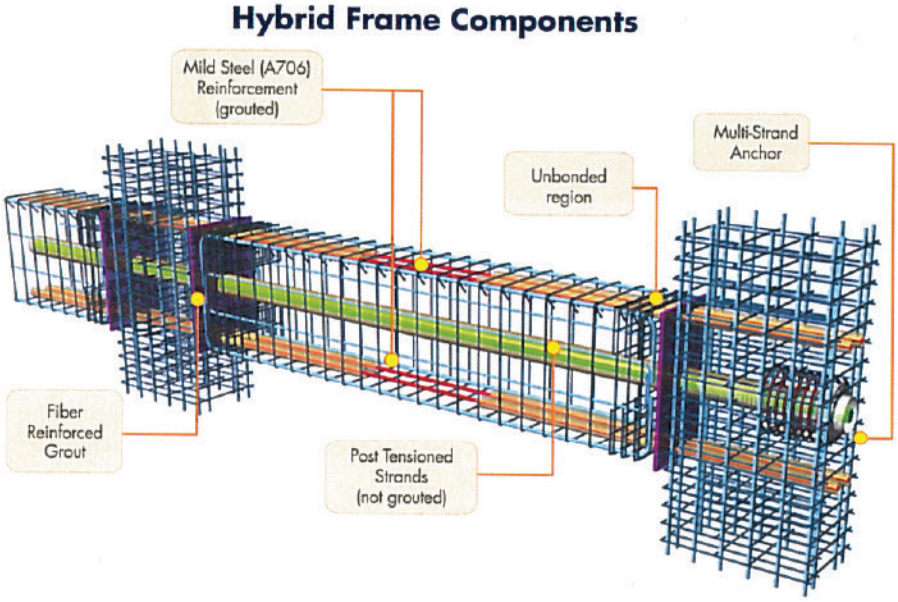

Fig. 2: The internal components of the precast hybrid moment frame (PHMF) include ungrouted post-tensioning strands passing though the beam and column elements *(illustration courtesy of Suzanne Nakaki)*

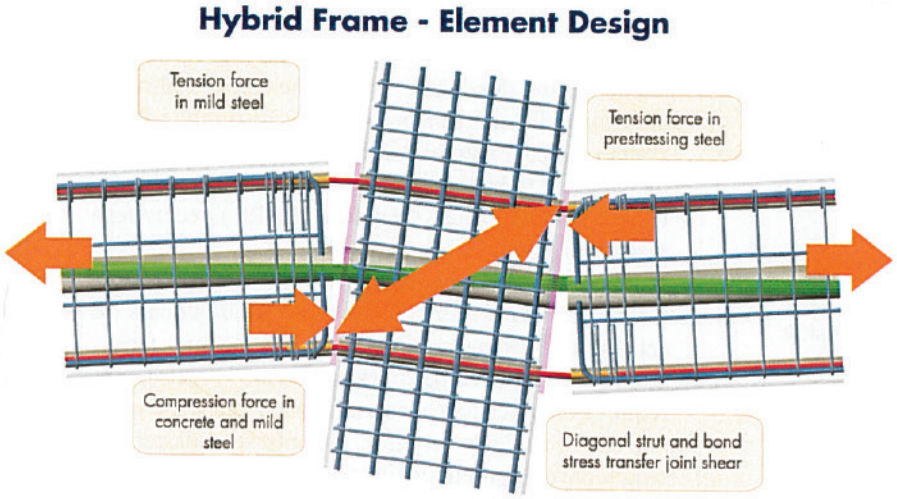

Fig. 3: During an earthquake, the joints in a PHMF dissipate energy through yielding in the reinforcing bars at the top and bottom of the beams. The self-righting action results from the force generated by the ungrouted post-tensioning strands in the beam *(illustration courtesy of Suzanne Nakaki)*

Fig. 4: Incorporating PHMF into the Caltrans District 3 Headquarters design allowed the designers to deliver a wide open and well-lit interior *(photo courtesy of Clark Pacific)*

Fig. 5: Precast elements for the Caltrans District 3 Headquarters façade were fabricated with multiple finishes: (a) the PHMF structure provides wide-open window areas with no bracing or solid panels; and (b) an end view of a spandrel panel shows how different concrete mixtures were layered to create a structural element with two distinct architectural finishes *(photos courtesy of Clark Pacific)*

the project design was changed to a total precast system. The annex soon became the first precast building constructed for the city of Roseville, CA.

The decision to use a precast system was based on a number of factors, including aesthetics. According to Mike Isom, Development Services Manager for the City of Roseville, "This is the most prominent building on the town square, and it was important that we had an architectural look and finish that would stand the test of time and truly be a hallmark for our downtown."

The precast system also gave the City more flexibility for space layout and future modifications. Further, the selection of total precast construction was driven by the system's resilience and durability. As with the earlier Caltrans project, the City Hall Annex incorporates a self-righting PHMF. This system, and the natural durability of precast concrete, allowed the building to be the first to be rated and accredited by the United States Resiliency Council (USRC), receiving a platinum rating.

According to Isom, the city was also focused on life cycle costs: "How do we stretch our construction dollars the best we can—not just focus on first costs? It is the long-term maintenance that comes back to bite us!" Precast concrete requires only periodic cleaning, which keeps the maintenance and life cycle costs very low. In contrast, a plaster finish would have required repainting every 5 years.

While a project like this might typically take 14 months, the city was obligated to open the building in time to meet the community college's schedule. This forced a much tighter construction schedule than it would have had for an annex that

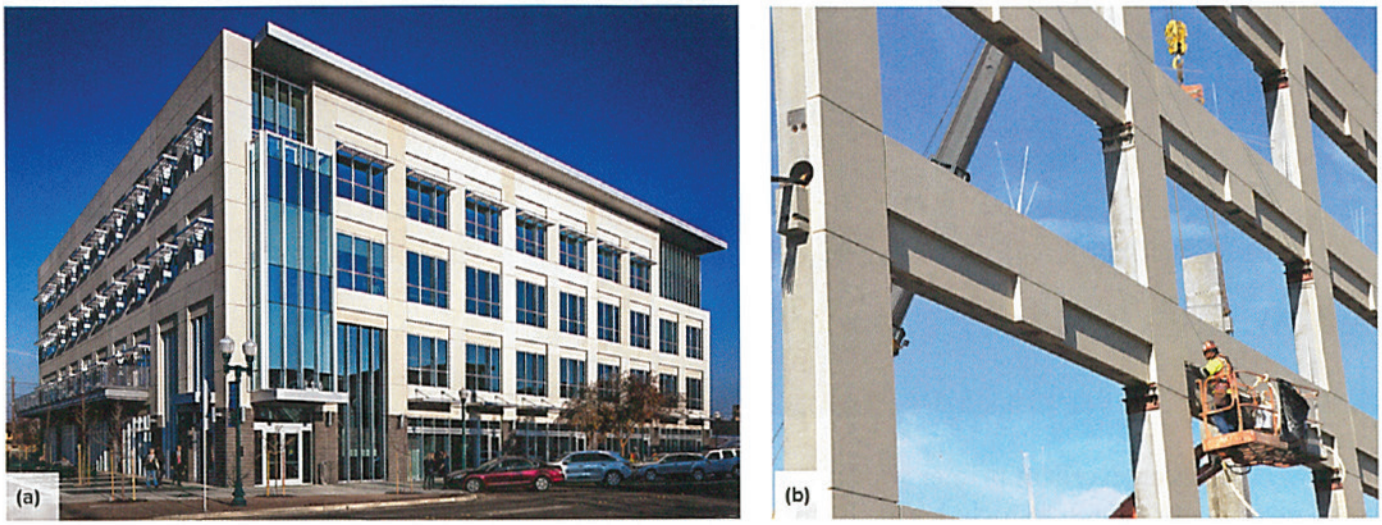

Fig. 6: The Roseville City Hall Annex included integrated architectural finishes on a PHMF structure: (a) view of the completed building *(photo courtesy of John Swain Photography)*; **and (b) a view of the erection of the exterior frame. Post-tensioning strand extensions can be seen at the leftmost column** *(photo courtesy of Clark Pacific)*

would be used only for city operations. Integrating the cladding with a PHMF structure (Fig. 6(b)) allowed the building to be erected within 38 days, and that left plenty of time for interior buildout. The project was delivered on budget and ahead of schedule—overall construction time was only 7 months. Coupled with offsite prefabrication, the shortened schedule helped to minimize local traffic disruptions, yielding yet another bonus for area workers and businesses.

800 J Lofts

The 800 J Lofts in Sacramento, CA, is a highly visible, downtown mixed-use residential project that implements the latest seismic technology and integrates high-end architectural finishes on structural elements (Fig. 7). The project was one of the first total precast mixed-use structures in California to employ the PHMF as its chief means of seismic resistance. Because of the self-righting mechanism inherent in the PHMF design, the building will be available for immediate re-occupancy after a major seismic event.

The building system blurs the lines between what is structural precast and architectural precast. The street-exposed structural elements that form the skin of the building were crafted with architectural finishes—including multiple mixture designs and different levels of texture—providing a rich tapestry for the downtown location.

Athletic and Aesthetic

As these projects demonstrate, integrated precast cladding and structural systems can speed up construction time, increase safety, and lower costs. These benefits go hand-in-hand with great aesthetics, high durability, and minimal required maintenance.

Selected for reader interest by the editors.

Fig. 7: Sacramento's 800 J Lofts combines seismic resilience with aesthetic brilliance *(photo courtesy of John Swain Photography)*

Farid Ibrahim is the Director of Building Systems Innovation at Clark Pacific. He has over 30 years of experience in helping owners, designers, and builders achieve success with innovative design and cost-effective precast concrete solutions. Ibrahim excels at design-assist and design-build teamwork and has provided his personal service and expertise on hundreds of projects requiring integrated precast concrete solutions. Ibrahim is a licensed professional engineer and LEED AP accredited.