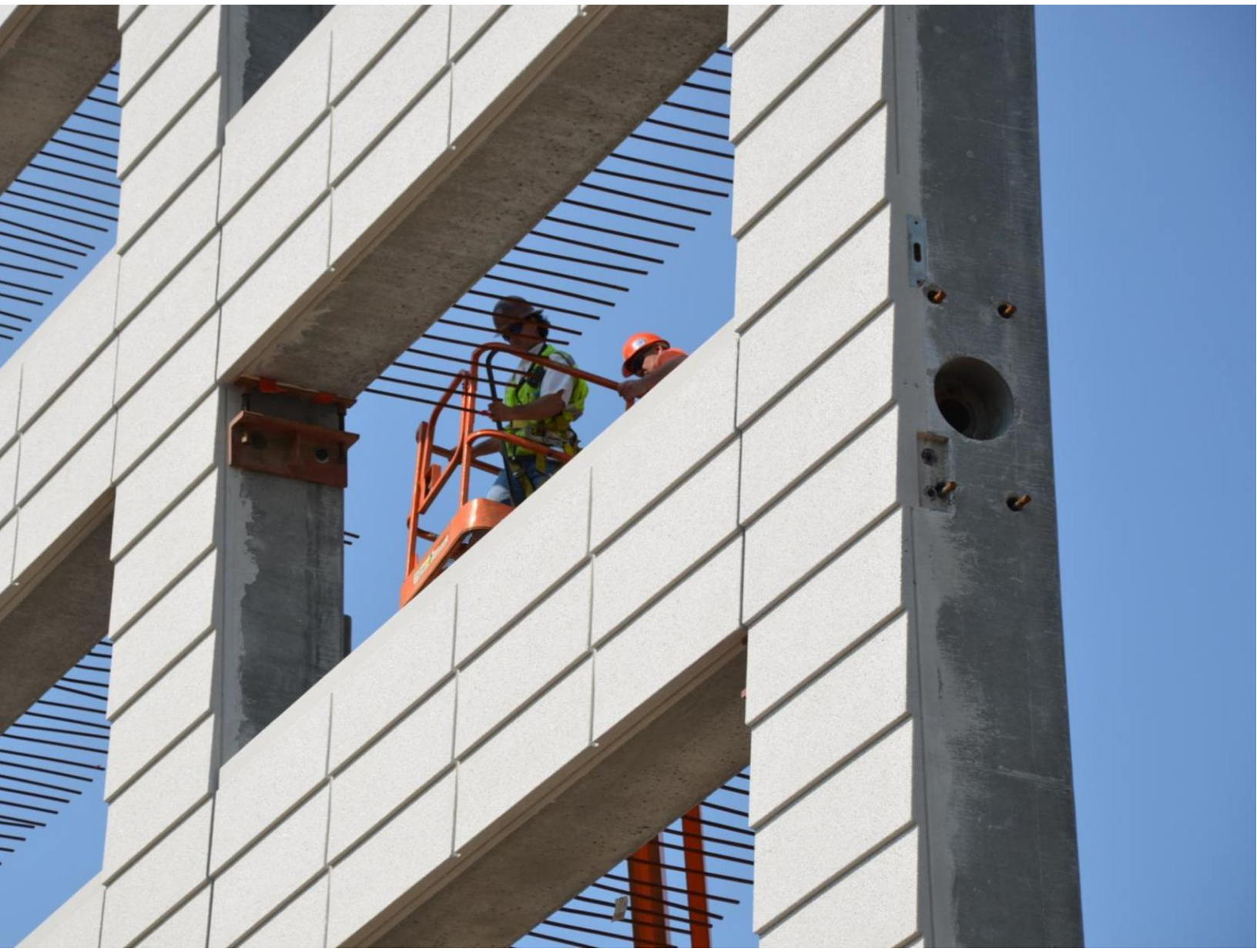


PRECAST HYBRID MOMENT FRAME

CLARK PACIFIC
Precast. Building for Life.

The Precast Hybrid Moment Frame System

Summary

The precast hybrid moment frame (PHMF) system represents the latest seismic-resistance technology (developed over the last fifteen years) and is deemed to be one of the best performing lateral resistance systems available today.

The system offers the construction speed and relative simplicity of steel construction, the durability and mass-building benefits of concrete construction, and a seismic performance superior to either steel or concrete due to its *unique ability to self-right after a major seismic event,* enabling immediate re-occupancy of the structure.

This benefit is invaluable to hospitals, government buildings, and other essential services structures, and of high interest to any owners or developers in high seismic areas interested in protecting their building investment and their tenants.

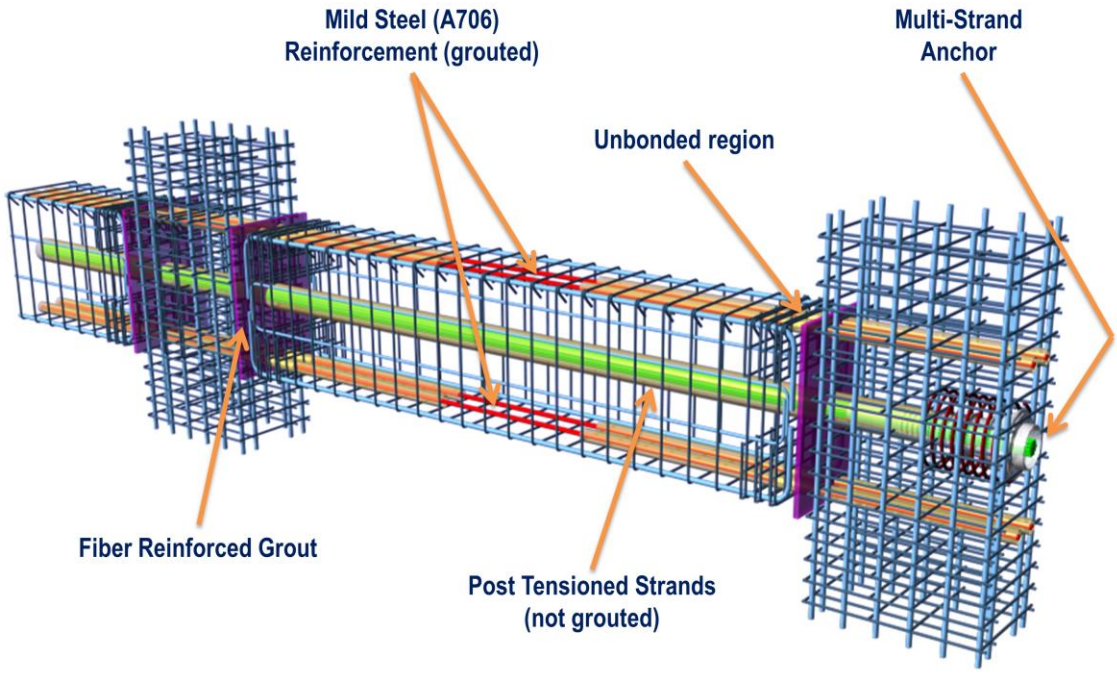
Resilient Structure

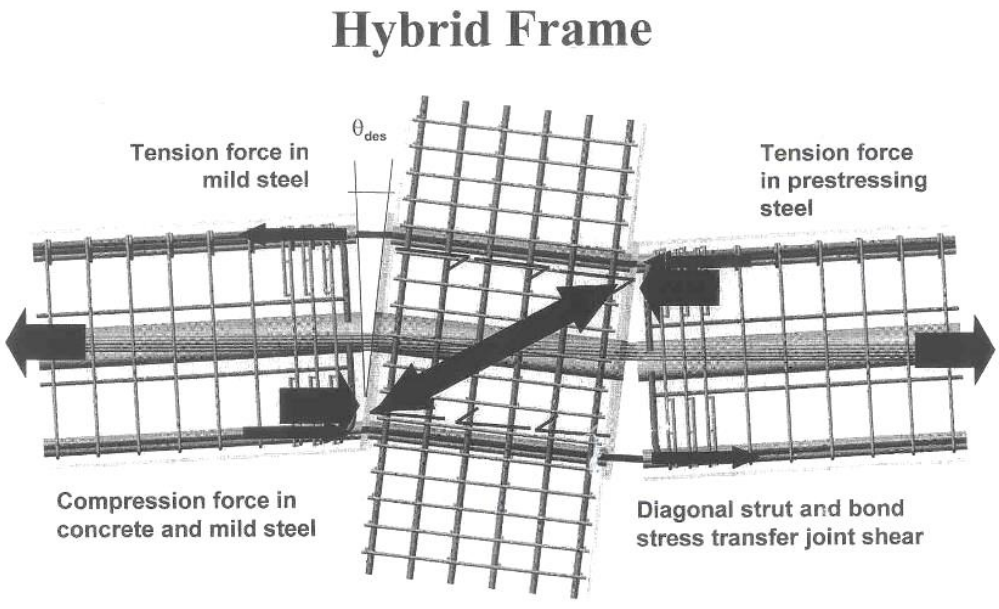
The Precast Hybrid Moment Frame comprises high quality precast column and beam elements, produced under factory-controlled conditions, that are connected together using traditional construction methods and materials: rebar, post-tensioning steel, and grout. Rebar and post-tensioning provide strength to the connection, with the rebar also acting to dissipate energy as in a traditional special moment frame.

Most seismic systems dissipate energy through yielding, and it is not unusual for a building to lean after a major earthquake. As a unique feature, the elastic, unbonded post-tensioning used in the PHMF system is designed to overcome yielding in the frame and pull it back to a righted position.

Exterior facing elements of the system are classically finished architectural precast – offering an all-in-one efficiency whereby structural elements function as architectural elements as well.

HYBRID FRAME COMPONENTS





During a Seismic Event

Key Benefits

- Superior seismic performance in an earthquake compared to conventionally framed steel and concrete structures. The precast ductile frame is designed to handle significant seismic drift while experiencing minimal damage due to its post-tensioned, self-righting mechanism. Truly a "resilient" structure.

- Better aesthetic appearance for the structure than other traditional frame and skin cladding systems due to high quality integrated architectural precast finishes and the use of hidden connections.

- Faster installation than other traditional frame and skin cladding systems.

- No interior shear walls or x-braces – allowing for greater interior visibility and security.

- Inherent fire-resistant qualities of concrete structure.

- Lower long-term maintenance, for both the exterior and interior.

- Superior vibration control (performance characteristics).

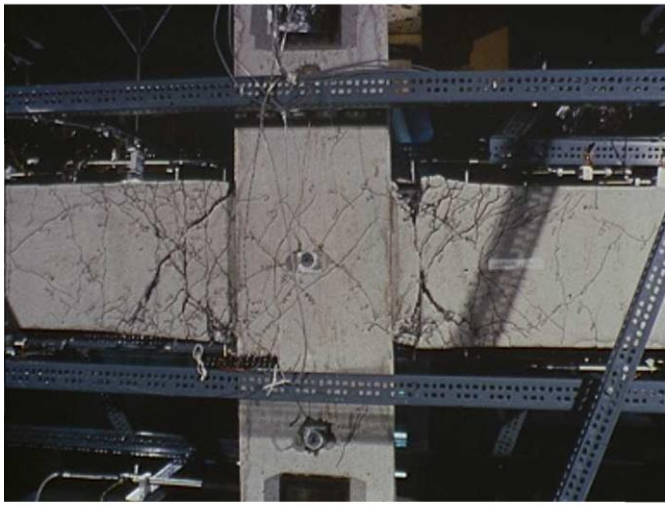
- Environmentally-friendly use of locally and regionally extracted and manufactured materials (concrete) vs. structural steel and fireproofing.

Codes and Standards

The precast hybrid moment frame is classified as a Special Moment Resisting Frame and is governed by the 2010 California Building Code (CBC). Other significant and referenced design standards for the system include:

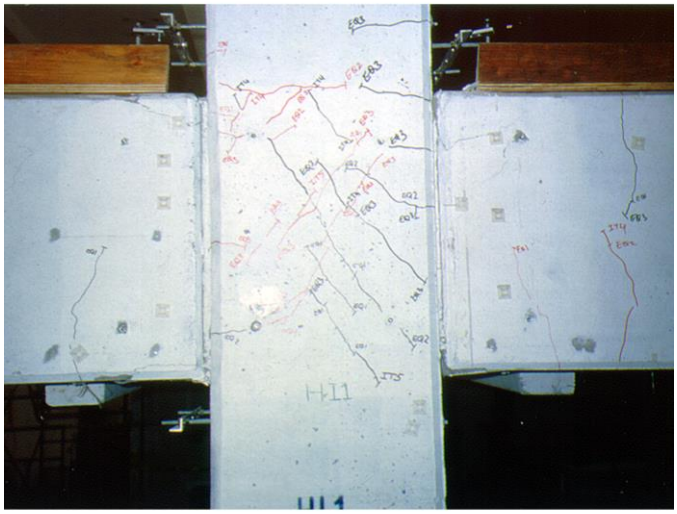
1. ACI Building Code and Commentary (ACI 318-02)
2. ACI 550.3-13: Design Specification for Unbonded Post-Tensioned Precast Concrete Special Moment Frames
3. Post-Tensioning Manual By Post-Tensioning Institute, latest edition.
4. PCI Design Handbook for Precast Prestressed Concrete, latest edition.
5. Minimum Design Loads for Buildings and Other Structures (ASCE 7-02).
6. Recommended Provisions for Seismic Regulations for New Buildings (NEHRP 2003).
7. Load and Resistance Factor Design for Structural Steel Buildings (AISC, third edition, 2001).
8. Structural Welding Code – Structural Steel (ANSI/AWS D1.1 – 2002).
9. Structural Welding Code – Reinforcing Steel (ANSI/AWS D1.4 – 2005)

PROTECTING YOUR INVESTMENT



Cast-in-Place SMRF

(Structural Cracking and Residual Drift)



Precast Hybrid Moment Frame

(Non-Structural Cracking, No Residual Drift)

Background of the System

The Precast Hybrid Moment Frame System has undergone extensive testing since its introduction in the latter half of the 1990s.

Tests conducted by the National Institute of Standards and Technology (NIST) showed that the precast frame "proved to be at least equal to monolithic frames in all respects, and superior in most." (PCI Journal, March/April 1997)

In September, 1999, a 60% scale 5-story structure (the PRESSS structure) was erected and put to extensive seismic load testing at the University of California, San Diego, funded by the National Science Foundation and other academic and construction industry support. From its report synopsis (PCI Journal, Nov/Dec 1999), the research team found "…no significant strength loss in the frame direction, despite being taken to drift levels up to 4.5 percent, more than 100 percent higher than the design drift level."

Regarding the self-righting aspect of the frame, John F. Stanton (University of Washington) and Suzanne Dow Nakaki (The Nakaki Bashaw Group, now KPFF) found in their 2002 PRESSS Report No. 01/03-09, that the system offers "a characteristic that is not available in the framing systems presently recognized in the 1997 UBC, namely zero residual drift. The choice of conferring this characteristic on the building lies within the control of the designer."

PHMF Projects

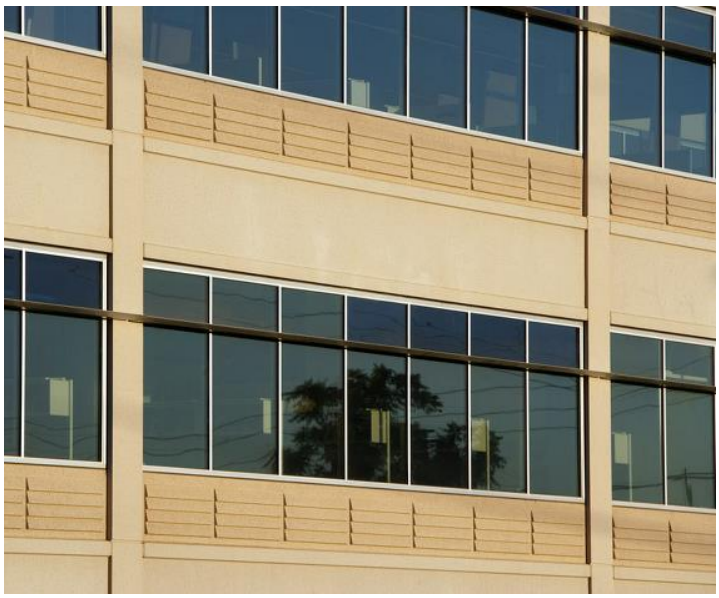
The Precast Hybrid Moment Frame has been used successfully on projects since 1997

- *Pearl Street Parking Structure,* Eugene, OR (1997) – 3 elevated, 2 future levels
- *Stanford Shopping Center Garage No. 2,* Palo Alto, CA (2000) – 2 elevated levels
- *Westside Media Center Office Building,* Los Angeles, CA (2000) – 5-story
- *Pacific Plaza Office Building,* San Francisco, CA (2001) – 9-story, located adjacent to the San Andreas fault
- *The Paramount Apartments (3rd and Mission),* San Francisco, CA (2001) – 39-story apartment complex
- *800 J Lofts*, Sacramento, CA (2005) – 8-story, mixed-use tower
- *Lovejoy Block 1,* Portland, OR (2006), 9-story, mixed use structure
- *Mills Peninsula Hospital Parking Structure,* Burlingame, CA (2006), one below grade, 3 elevated levels;
- *Citizens Bank Arena (Ontario Events Center)* in Ontario, CA (2008);
- *Caltrans District 3 Headquarters Office Building,* Marysville, CA (2008) – 5-story - First state office project to utilize precast hybrid moment frame system
- *CalISO Office Building,* Folsom, CA (2009) – 3-story operations center
- *Clovis Community Medical Center Parking,* Clovis, CA (2010), 4 elevated levels
- *UC Davis Medical Center Parking Structure III,* Sacramento, CA, (2012) 6 levels
- *Hoover Pavilion Parking Structure,* Palo Alto, CA (2013) – 7 levels
- *Moffett Park Parking Structure (Garage B),* Sunnyvale, CA (2014) – 4 levels
- *316 Vernon St. Office Building,* Roseville, CA (2016) – 4-story office building

UC San Diego Test Facility – 60% Scale 5-Story Structure

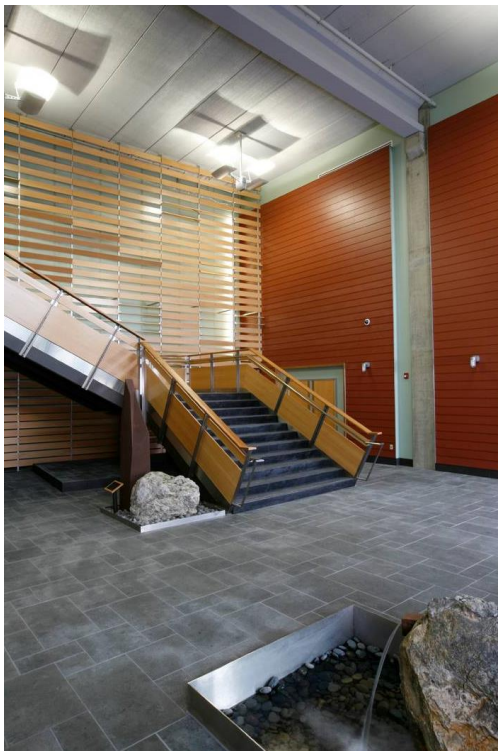
Caltrans District 3 Headquarters Building (Marysville, CA)
PHMF Case Study

Project Description: 230,000 SF – Office Building



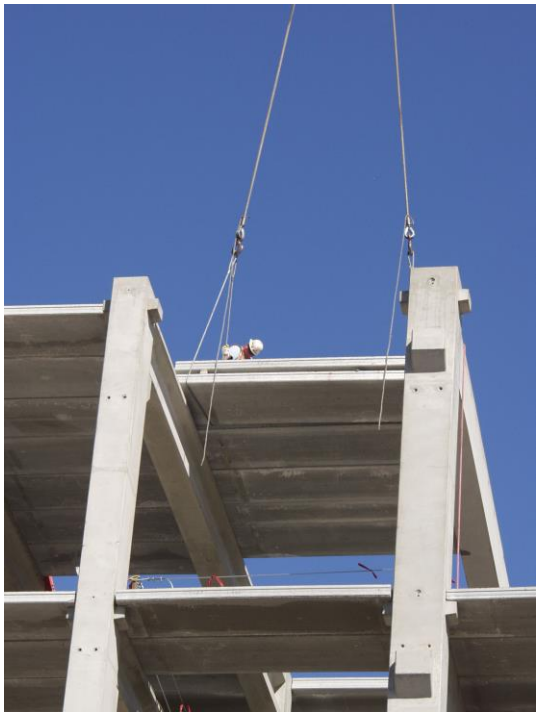
Architecturally finished structural columns and beams

Exposed precast concrete throughout structure to take advantage of the passive thermal storage capacity of the system.



Wide open floor plan with deeply penetrating daylighting made possible by Precast Hybrid Moment Frame: No shear walls, no X- or K-braces across.

Erecting Structure – Structure erected in only 12 weeks.



Mills Peninsula Hospital Parking (Burlingame, CA)
PHMF Case Study

When it was time to replace the Mills-Peninsula Hospital, Sutter Medical Group's planners asked themselves a simple question: "What's the use of building a first-class replacement hospital designed to withstand seismic zone 4 events if our parking structure gets red-tagged and our patients and staff have nowhere to park?"

After reviewing competing systems, the design team chose the Precast Hybrid Moment Frame system from Clark Pacific for its 800-stall, 300,000 SF structure.

Precast Hybrid Moment Frame Columns

Precast Hybrid Moment Frame Beams

Completed Frame

Completed Project

Northern California
West Sacramento, CA
Woodland, CA
916.371.0305

Southern California
Fontana, CA
909.823.6978

Irwindale, CA
626.962.8751