# The Historic Trefethen Winery

## Repair and Retrofit in the Aftermath of the Napa Earthquake

*By Marianne Wilson, S.E., Kevin Zucco, S.E., and Brett Shields, P.E.*

Trefethen Family Vineyards is a family-owned estate winery located just to the north of Napa, California, within the Oak Knoll District AVA. Their historic winery building, originally known as Eshcol, was constructed in 1886 by Hamden McIntyre, a Scottish civil engineer, honorary ship captain, and well-known builder of wineries in the Napa Valley (*Figure 1*). McIntyre designed a quartet of similar gravity-fed winery buildings in the Napa Valley during this era: Eshcol, Inglenook, Far Niente, and Greystone, the current home of the Culinary Institute of America. The Trefethen/Eshcol building is unique as an exposed heavy-timber framed structure located on the valley floor, which required a horse-drawn elevator system to hoist grapes to the top level for production. The other three McIntyre wineries were constructed of stone and built against hillsides at the edge of the valley, allowing horse-drawn carts to deliver grapes directly to the upper levels. The Eshcol winery was purchased by the Trefethen family in 1968 and was listed with the National Register of Historic Places in 1987, recognized as the only 19th century, wood-framed, gravity flow winery remaining in Napa County.

*Figure 1. Historic Trefethen Winery building (Eshcol Winery c 1915). Courtesy of Trefethen Family Vineyards.*

## Composition

The three-story winery structure is 125 feet by 60 feet and approximately 18,000 total square feet. Before the 2014 Napa earthquake, the building housed the Trefethen tasting room and offices, though the majority of the space was utilized for storage of wine in barrels. The building utilizes exposed 10- and 12-inch-square timber post and beam construction with exterior wood framed bearing walls. Wood framed floors are topped with layers of straight sheathing, and trussed roof framing is topped with skip sheathing and non-historic plywood. The second-floor diaphragm level is interrupted where the 24-foot-wide center bay is four feet lower than the adjacent primary levels, creating a discontinuity in the diaphragm. While the exterior of the structure is clad in a simple 10-inch painted straight sheathing/siding, the interior spaces are nearly entirely clad with immaculate redwood tongue and groove sheathing. This creates majestic vaulted spaces at the second floor, showcasing timber construction with minimal hardware and let-in connections likely influenced by the builder's maritime experience. The existing lateral force resisting system was limited to the exterior, straight sheathing at the building perimeter.

## Earthquake

In the immediate aftermath of the 6.0 magnitude Napa earthquake on August 24, 2014, the historic structure rested in a precarious tilt with the second and third story shifted approximately four feet to the west (*Figure 2*). Nearby ground motion readings indicate spectral accelerations ranged from 0.4g to 1.7g for low-period, one- to two-story wood framed structures. The largest deflection occurred at the North end of the second-floor level where water-filled tanks and barrels were stored at the time. The filled water tanks constituted a large concentrated mass at the northern end of the second floor, increasing the seismic forces acting in this area where the larger localized horizontal deflections occurred.

With the potential for total building collapse an aftershock away, steel shoring and cribbing were immediately erected to prevent further offset and to support displaced gravity members. The timber-framed gravity system was constructed without positive connection between posts and beams, or posts and foundations, allowing posts at the first level to rotate and "walk" without resistance as the building cycled through deflections. While this lack of connection restraint released the lower level posts and beams from sustaining significant damage at connections, the magnitude of the deflection caused several first-floor posts to disengage completely from beneath the beams. Second level posts adjacent to the diaphragm step at the center bay were constrained within a several-foot-tall pony wall between the diaphragm levels. This resulted in a significant amount of flexural damage to the posts directly above the main second-floor level (*Figure 3*). Multiple posts at the upper levels sustained damage at let-in

*Figure 2. Post-earthquake deflection and localized damage at second-floor level.*

*Figure 3. Damaged post at a step in the second-floor diaphragm.*

beam connections where large splits developed at interior corners of cuts. Significant structural documentation was performed through multiple site visits to understand the existing framing systems and connections fully. A 3D point cloud survey was also taken of the structure in its deformed state to aid in shoring design and erection. When overlain onto a non-deflected Building Information Model, the 3D point cloud helped to illustrate existing atypical framing and provide further insight into the extent of the deformations developed within the structure (*Figure 4*), as well as shape the retrofit strategy.

## Revival

When determining the structural approach for repair and retrofit of the historic structure, extensive coordination with the Trefethen family, a historic preservation architect, and a contractor was critical to ensure new elements improving the stability and resiliency of the structure did not detract from the building's historic fabric. Discussion regarding the preferred design criteria for retrofit ranged from exclusive use of the *California Existing Building Code* (CEBC) and *California Historic Building Code* (CHBC) to minimize addition of new elements in the structure, to a full retrofit utilizing the current *California Building Code* (CBC) to maximize building performance in a future seismic event. Ultimately, the CHBC and CEBC were used to review existing gravity elements, with a voluntary upgrade to current CBC Life Safety level performance for new lateral resisting elements.

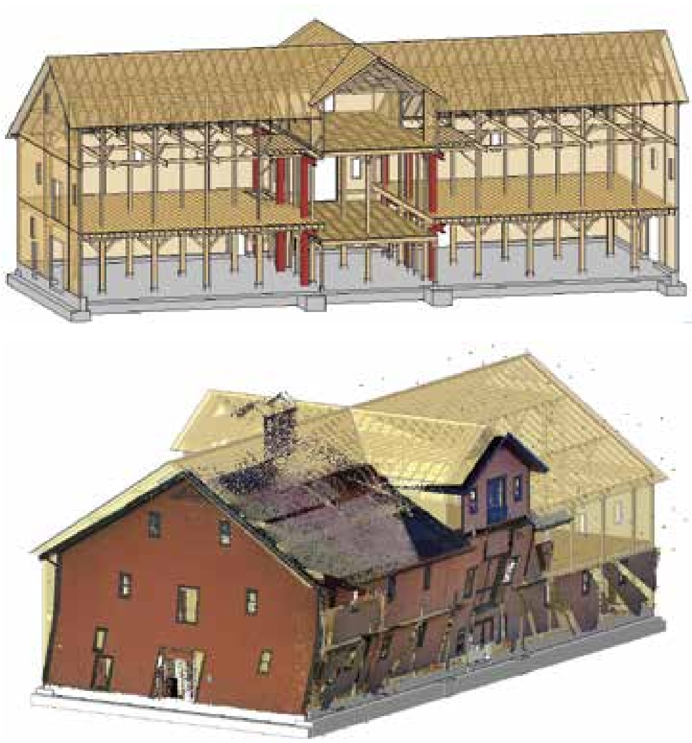

*Figure 4. REVIT model including deflected shape 3D point cloud.*

*Figure 5. Retrofitted gable end wall framing.*

## Rebuilding

While the existing straight sheathing at the exterior of the structure would have been adequate to resist historical building code lateral loading for most locations, plywood shear walls added to the full exterior increase the structure's seismic capacity and resiliency. To preserve the more unique and fragile interior redwood siding, temporary removal of the exterior straight sheathing, which suffered significant damage in the earthquake, allowed for installation of new plywood. Additional wall framing members were added to complete the load path for out-of-plane forces and provide minimum stud spacing for the new shear walls (*Figure 5*). Full height Laminated Strand Lumber (LSL) studs accommodate the stud length required at gable end walls. As an added benefit to exposing the wall framing, rigid insulation was installed improving the energy performance of the structure. The straight sheathing was painstakingly labeled before removal for refurbishment to ensure accurate reinstallation, to maintain the correct historic aesthetic at the exterior, and trim elements within the window openings were coordinated with the historical architect to accommodate the additional ½-inch wall thickness.

A new plywood roof diaphragm replaced non-historical roof sheathing and was installed over the historical skip sheathing, with the addition of flat blocking shims over rafters allowing the historical framing elements to remain. New robust continuous concrete stemwall elements added at the building perimeter, and below interior bearing lines, were designed to match the profile of original stone stemwalls. This preserved the massive existing four-foot-square, mortared granite foundations as coordinated with the geotechnical engineer. The new concrete elements were designed for the full structural demand, transferring bearing and shear forces to the undamaged historic stone foundations through epoxy dowels.

New bolted steel side plates, configured for minimal visual impact, provide positive connections at gravity framing between existing beams, posts, and foundations. Bolted steel flitch plates provide additional flexural strength to floor beams, as required, resulting from occupancy changes at the upper levels. Damaged or split framing members are repaired in-situ with color-matched injected wood epoxy and bolted steel side plates wherever possible. Nearly all original framing members were preserved, with very few completely replaced.

## Strengthening

Due to the length of the building and diaphragm discontinuities at the second level, the existing multi-layered, straight sheathed

*Figure 6. Finished interior at steel moment frame. Courtesy of Adrian Gregorutti and Trefethen Family Vineyards.*

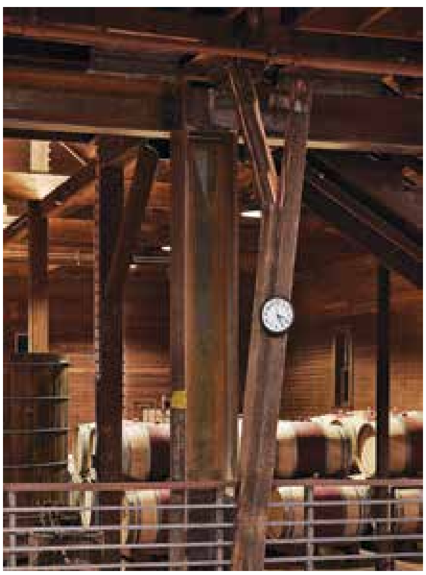

*Figure 7. Remembrance post. Courtesy of Adrian Gregorutti and Trefethen Family Vineyards.*

floor diaphragms were inadequate for seismic design forces as configured. The addition of new interior lateral force resisting elements reduced the existing diaphragm spans, allowing the diaphragm to remain without strengthening. Ordinary steel moment frames were selected to maintain the open post and beam feel of the space and to minimize the prescriptive detailing requirements. The flexible diaphragms in the east/west direction allow the gable end, wood shear walls to be designed for a standard Response Modification Coefficient (R) of 6.5, and interior ordinary steel moment frames be designed for an R-value of 3.5. Third-floor wood framed shear walls over moment frames were designed for the moment frame R-value. Steel frame columns were located immediately adjacent to existing timber posts to reduce their impact on the character of the space (*Figure 6*). Because of installation logistics, including fire risk from welding, the frames are configured into smaller "portal frame" pieces. The moment connections were prefabricated with beam and column stubs, locating bolted splice connections in each beam and welded splices at columns away from the adjacent historical combustible material. This prefabricated portal frame assembly allows smaller pieces to be installed within the confined spaces of the structure with minimal modifications to existing framing. An additional challenge in the design of the moment frame was the offset from the primary bearing line to maintain existing post and beam elements. Custom steel shear transfer plates with vertically slotted holes accommodate the horizontal offset from frame to diaphragm elements, while simultaneously allowing vertical tolerances in existing framing elevation. These were spaced to accommodate the reinstallation of historical knee braces at posts.

## Legacy

The Trefethen family placed high importance on saving as much of the existing structural framing as possible to maintain the historic character of the structure, just as the architectural elements were preserved. This included the straight sheathing and historic windows being repaired and reinstalled to the original aesthetic. Since the family's acquisition,

*Figure 8. Renovations completed in 2017. Courtesy of Adrian Gregorutti and Trefethen Family Vineyards.*

multiple generations have grown up in the winery and, specifically within this building, as children playing amongst the barrels as their parents worked. The family considered the earthquake repair of the structure not as something to be hidden, but as another significant chapter in the life of the historic building. With the structural repairs and improvements, not only did the building survive but was made stronger, continuing its legacy as a living piece of winemaking history in Napa Valley. As a final tribute to the earthquake that rocked the structure, additional steel gravity framing was provided so that a single Remembrance Post could be left in its destructed state to illustrate the magnitude of the event the structure withstood at 3:24 am, on August 24, 2014 (*Figure 7*).

## Rebirth

The structural repair and retrofit were completed in the Fall of 2016. The revitalization of the winery building continued with interior architectural improvements to provide a new guest experience and improved winemaking facilities. The lower level winemaking areas are now showcased through glazed walls on either side of the center bay, with more barrel storage and the tasting room at the second level. These features allow guests to appreciate the two-story vaulted space with historical redwood siding and views of the estate vineyard. Renovations were completed for a grand reopening of the tasting room in May 2017 (*Figure 8*).▪

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### Project Team

**Owner:** Trefethen Family Vineyards
**Structural Engineer:** ZFA Structural Engineers
**Historic Preservation Architect:** Preservation Architecture
**Architect:** Taylor Lombardo Architects
**General Contractor:** Facility Development Company