

## **Structural Assessment – Bok Kai Temple**

The Bok Kai Temple was originally constructed in the 1880s in Marysville, California. It is a one-story building with approximate plan dimensions of 40 feet by 85 feet on a level site. The Temple consists of an Altar Hall at the center of the building; Council Chambers at the west end of the building and adjacent to the Altar Hall; a Fortune Reader's Chamber, Storage Area and Gambling Room east of the Altar Hall; and a Storage Room and Kitchen at the east end of the building. The walls around the Altar Hall and the spaces adjacent to the Altar Hall are constructed of unreinforced brick masonry, however the perimeter walls around Storage Room and Kitchen at the east end of the building consist of corrugated metal siding over wood framed walls with an unreinforced brick masonry wall separating these two spaces. It is unknown whether the Storage Room and Kitchen areas at the east side of the building are original to the rest of the building or additions. There is a covered porch over the front entry with unreinforced brick masonry wing walls supported by wood beams and wood columns on each side of the front entry. Covered porches on each side of the front entry porch area were added after the original building was constructed.

The existing building will be assessed for conformance with the structural requirements of the State Historic Building Code, the Uniform Code for Building Conservation (UCBC) and the California Building Code, current editions. Our assessment is based on conditions observed during our site visits, a non-detailed review of available documents and engineering judgement. No analyses were performed, no finishes were removed and no materials testing was done. Two types of structural deficiencies were noted: known structural deficiencies which were observed during the site visit and assumed structural deficiencies which could not be observed, but are assumed to exist given generally accepted details of construction during the period when the buildings were constructed. Further investigation and/or more detailed analyses are required to verify the extent of these deficiencies and to determine if additional structural deficiencies are present.

The foundation of the building under the unreinforced brick masonry walls was not observable, but is assumed to consist of continuous unreinforced brick masonry at the perimeter and interior walls. The foundation of the perimeter wood framed walls at the east side of the building consists of unreinforced brick masonry. Isolated concrete footings support interior wood columns under the ground floor of the Altar Hall. The ground floor of the Council Chambers consists of a concrete slab on grade. The ground floor of the Altar Hall consists of straight wood sheathing over 2x wood joists that span to the interior wood beams at the mid-span of the Altar Hall and interior unreinforced brick masonry walls. The interior wood beams are supported by wood columns. The floor framing in the ground floor for the building areas east of the Altar Hall consists of straight wood sheathing over 2x wood joists that span to perimeter and interior unreinforced brick masonry foundation walls. The wood joists in these areas were in close proximity with existing grade and may have been supported between foundation walls although such supports were not observable.

The roof framing above the Council Chambers was not observable, but is assumed to consist of wood sheathing over wood rafters which span to perimeter and interior unreinforced brick masonry walls. The roof framing above the Altar Hall consists of straight wood sheathing over 2x wood rafters that span to perimeter and interior unreinforced brick masonry walls. The roof

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over the Altar Hall and front entry porch consists of a series of two ridge roofs with a five-foot wide barrel roof in between. The barrel roof area consists of curved 2x wood rafters which span to 2x wood rafters. The roof framing over the area east of the Altar Hall consists straight wood sheathing over 2x wood rafters that span to perimeter and interior unreinforced brick masonry walls. The roof framing above the Kitchen at the east side of the building consists of corrugated metal roof deck over 4x wood roof purlins which span to the interior unreinforced brick masonry wall and the perimeter wood framed wall. The roof framing above the Storage Room at the east side of the building was not observable due to a finished wood ceiling on the underside of the roof framing, but may be the same as the Kitchen roof framing if both were constructed at similar times. The covered porch areas on both sides of the front entry porch consist of wood sheathing over wood rafters that span to a wood ledger to the unreinforced brick masonry wall and a wood beam. Steel pipe columns that bear directly on the concrete slab on grade support the wood beam. The roofing over the Altar Hall and covered porch areas consist of clay tile. The roofing over the remaining roof areas of the building consist of hot mopped roofing.

The lateral (seismic and wind) resisting system consists of the wood sheathing and corrugated metal roof deck at the roofs serving as horizontal diaphragms which transfer lateral forces to the perimeter and interior unreinforced brick masonry walls and the perimeter wood framed walls. The brick and wood framed walls act as shear walls that transfer lateral forces to the foundation.

#### Structural Deficiencies

1. The perimeter unreinforced brick masonry walls may not be sufficient to resist in-plane and out-of-plane code level lateral forces.
2. The connection of the horizontal wood and corrugated metal roof deck diaphragms at the roofs to the perimeter and interior unreinforced brick masonry walls is not adequate to transfer in-plane and out-of-plane code level lateral forces.
3. The corrugated metal siding on the wood framed walls is not adequate to resist in-plane code level lateral forces.
4. The horizontal wood and corrugated metal roof deck diaphragms at the roofs may not be sufficient to resist code level lateral forces.
5. The unreinforced brick masonry wing walls above the both sides of the front entry porch are cracked and may present a falling hazard in the event of an earthquake to building occupants and passersby. The wood beams and wood columns that support the wing walls may be damaged due to dry-rot and may not be sufficient to support the wing walls.
6. The steel pipe columns that support the covered porch framing on both sides of the front entry porch are not positively attached to the concrete slab on grade. In addition, there may not be a concrete spread footing below the steel pipe column.

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7. The wood framed floors east of the Altar Hall are in close proximity to existing grade and may be susceptible to dry rot damage.
8. The anchorage of the wood framed walls to the existing unreinforced brick masonry foundation may not be sufficient to transfer in-plane code level lateral forces.
9. The connection between the wood posts to wood beams and wood posts to isolated spread footings below the Altar Hall floor may not be sufficient to remain positively anchored when subjected to code level lateral forces.
10. The sill plates of the wood framed walls are in close proximity to existing grade and may be susceptible to dry rot damage.
11. The connection of the wood beams to unreinforced brick masonry walls below the Altar Hall are not adequate to resist code level lateral forces.

#### Conceptual Structural Strengthening

1. Add concrete shear walls or steel frames at locations where existing unreinforced brick masonry walls are not sufficient to resist in-plane code level lateral forces. Add vertical or horizontal steel braces against existing unreinforced brick masonry walls at locations where walls are not sufficient to resist out-of-plane code level lateral forces.
2. Add positive connections from the horizontal diaphragms to the unreinforced brick masonry shear walls to resist in-plane and out-of-plane code level lateral forces.
3. Add wood sheathing to the wood framed walls to resist in-plane code level lateral forces.
4. Add plywood sheathing to the existing wood and corrugated metal deck diaphragms to resist code level lateral forces.
5. Repair the cracks in the unreinforced brick masonry wing walls and positively attach the wing walls to the front entry porch roof framing and supporting wood beam.
6. Provide concrete spread footings and positive attachment from the steel pipe columns supporting the covered porch framing on both sides of the front entry porch.
7. Provide adequate clearance and ventilation between the wood framed floors and existing grade to prevent dry-rot damage.
8. Add positive connections from the wood framed walls to the existing unreinforced brick masonry foundation to resist in-plane code level lateral forces.
9. Add positive connections between the wood beams to wood posts and wood posts to isolated spread footings.

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10. Provide adequate clearance between the wood sill plate and existing grade to prevent dry-rot damage.
11. Add a secondary support post at locations where wood beams are supported by unreinforced brick masonry walls.

The structural deficiencies noted for this building are fairly typical for unreinforced brick masonry buildings of their era. In addition to the conceptual structural strengthening recommendations noted above, further investigation and/or a more detailed analysis is required to verify the extent of the deficiencies noted in this assessment and to determine if additional deficiencies exist. As a minimum, the mortar of the brick walls should have in-place mortar shear tests to determine the mortar shear strength in order to evaluate the capacity of the brick walls to resist in-plane and out-of-plane code level lateral forces. Additional analysis should also be performed to determine the capacity of floor and roof diaphragms to resist code level lateral forces.