LINFIELD UNIVERSITY – MAC HALL
STRUCTURAL ASSESSMENT

INTRODUCTION

The purpose of this report is to provide a structural assessment on the condition of Mac Hall and comment on the feasibility of renovating the building for use as a science building. Our assessment was based on a walk-through of the building on October 28, 2004, and a review of available existing drawings. There were six original drawings titled “Boy Dormitory Linfield College”

EXISTING STRUCTURE

Mac Hall is a three-story wood and masonry structure built in 1938. The building is rectangular in shape with a double loaded corridor down the center, as was common for a dormitory. The structural system consists of wood framed floors supported on interior wood stud bearing walls at the double loaded corridor and on exterior un-reinforced hollow clay tile bearing walls. The clay tile walls are 8 inches thick at the first floor and 6 inches thick at the second floor. The floors, including first, second, and attic, consist of 2x12’s at 16” o.c. spanning 16 feet from the exterior walls to the corridor walls. The gabled roof consists of 2x6 rafters, and 2x6 ceiling joists supported by the interior corridor walls and exterior 2x6 bearing walls. All walls above the attic are wood framed.

The foundations consist of unreinforced concrete stem walls on unreinforced continuous footings at the interior and exterior bearing walls. At the exterior walls the stem walls are 13½” thick on 20” wide by 10” deep continuous footings. At the interior walls, the stem walls are 6” thick on 18” wide by 10’ deep continuous footings.

The building has a crawl space under the first floor, and the floor to floor height of each floor above is 9’-0” with an 8’-0” ceiling. The building is clad in a single layer of 4” brick veneer with an air space between the back of the veneer and the exterior clay tile of wood stud walls.

STRUCTURAL CONDITION

The building appears to be in fair condition structurally for its age, with no signs of significant distress or settlement. The building, however, would perform very poorly in a seismic event. The clay tile walls are very brittle and unreinforced, so it is likely they would break apart in a seismic event causing portions of the building to collapse. The clay tile walls are not anchored to the foundation so the walls would likely slide off the stem walls leading to further collapse. The seismic performance of this building would be much worse than a building of similar age with all wood framed walls. Any re-use of the building would require a significant seismic upgrade that would require additional in-depth study to fully understand its feasibility.

SEISMIC UPGRADE

The most critical seismic element of the building is the unreinforced clay tile exterior walls. These walls act as bearing walls to support the building and as shear walls to resist lateral loads. However, they were never intended to resist the magnitude of seismic forces required today.

The exterior clay tiles would have to be strengthened by one of the following methods:

- Add 6” to 8” of reinforced concrete (shotcrete) to the entire inside face of all exterior walls.
- Add steel posts and beams around the entire inside perimeter of the exterior walls with steel braced frames at select locations. Metal stud walls would have to be added to brace the clay tile walls out-of-plane.
- Another option could be to add wood stud bearing walls around the entire inside perimeter of the exterior walls with plywood sheathing. However, because of all the window openings additional interior plywood shear walls would likely be required.

All the above options would require significant modifications to the existing foundation, including some new footings. Portions of existing footings would have to be removed and replaced with new spread footings and new concrete stem walls would have to be added under all new walls. Some shoring of the building would be required.

Other elements of a seismic upgrade would include the following:

- Add plywood sheathing to all floors.
- Add plywood sheathing to the roof.
- Anchor floor and roof diaphragms to new exterior elements with ledgers, blocking, bolts and steel straps.
- Anchor brick veneer back to new exterior wall back-up structure with ties at 16” o.c. each way. These ties would have to penetrate through the clay tile walls.

RENOVATE FOR SCIENCE BUILDING

Mac Hall has three significant issues that detract from it being a candidate for a science building:

- Wood Framed Floors – The existing joists are not adequate to support 100psf live loads as is required in some areas of science buildings. Also, wood floors have poor vibration characteristics to support lab equipment.
- Floor to Floor Height – The existing clear height under the structure is only 8’-0” at each floor. Science buildings require significant mechanical ducting and venting. New science buildings typically have 16’ - 18’ floor to floor heights to fit the structure and all the ducts above the ceiling.
- Interior Bearing Walls – The existing building is not open enough for classrooms with the existing interior bearing walls. The interior bearing walls would have to be replaced by new steel columns and beams at each floor. The new steel columns would require new spread footings. The new steel beams would likely be deeper than 12” which would impact the floor to floor clearance even more.

Any one of these issues could possibly be solved, however, with the combination of all three, it does not appear feasible for the building to be renovated into a science building.

Moving the Building

Because of the very brittle nature of the exterior clay tile walls, it is our opinion that it is highly impractical to move the building because it cannot be accomplished without severely cracking and fracturing the load bearing clay tile to the point that the tile would not survive the physical relocation/movement. The clay tile is also not repairable due to the very nature of the brittle material and would have to be replaced. In addition, even if it was possible to move load bearing unreinforced and non-grouted clay tile walls, the material would not comply with current building codes. In fact, the reuse of the clay tile as the primary bearing wall structure would not even be allowed by code and would not be able to be permitted by the Building Department.

For comparison, brick bearing wall buildings can typically be moved, but they usually have much thicker walls, 12-inches or greater, and the bricks are solid with much more mortar to provide strength. The more brittle clay tile walls at Mac Hall are hollow with minimal surface area for the mortar to tie them together. Another major factor is that the exterior brick veneer is only supported at the foundation stem wall, so there is no structural support system between the clay tile and the veneer.

Conclusion

The physical nature of the unreinforced hollow clay tile bearing walls makes both the concept of moving the building or renovating the building to current code standards, regardless of use, highly impractical. This is due to the expected high level of cracking and fracturing, and any repairs of the clay tile would be nearly impossible should one attempt to move the building.

Mac Hall is a seismically hazardous building, not just because of its age, but because of its construction type, unreinforced masonry (URM) bearing walls. Even if it was seismically upgraded it would not be a candidate for a science building. Because of the combination of wood framed floors, floor to floor height, and interior bearing walls, it is our professional opinion that the building is not a feasible candidate for adaptive re-use as a science building.

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