Old Masonry Schools

Garbage or Gold?

By Ronald G. Vandehey, P.E.

Hollow Clay tile was a popular school construction material in the Western United States during the early 1900s. Clay tile was inexpensive, quick to assemble, and resistant to fire. The material was used to replace many original wood schoolhouses. The longevity of these structures is testimony to the durability and decay resistance of structural clay tile. With ongoing improvements in building codes, and an increased knowledge that the western United States was susceptible to earthquakes, the use of structural clay tile diminished until it finally disappeared. However, the buildings stayed in use for many more years. Two such buildings include Central Elementary School in Newberg, Oregon and the John Gumm Elementary school in St. Helens, Oregon.

Central Elementary School Newberg, Oregon

A seismic study was conducted to determine the requirements to bring the Central Elementary School to the level of the State of Oregon 1993 Structural Specialty Code standards, which were based on the 1991 Uniform Building Code. Originally constructed in 1935, with additions in 1958, the school totalled over 37,000 square feet. The Central Elementary structure was inadequate to resist seismic loads due to unreinforced clay tile walls and inadequate ties between the floors and the walls. Without an elevator to meet ADA standards, outdated mechanical, electrical and classrooms, the school district built a new school and sold the building to the Parks and Recreation District for $1.00. Unable to cost effectively renovate the building without the seismic upgrade, the building remained vacant for nearly 10 years.

John Gumm School Seismic Upgrade
St. Helens, Oregon

Constructed in 1919, the John Gumm School is a three-story building with wood framed floors and roof. The lower floor's basement exterior walls are concrete, and the upper two floors are clay tile bearing walls. The parapets are an assortment of clay tile and wood studs. The original price to upgrade the building using conventional methods was estimated at over 2.5 million dollars. Equating to a cost of over $70 a square foot, it was impractical for the school district to keep the building and a hard to sell the property. After the school district put the building up for sale, many groups tried to purchase the property but withdrew due to the expense of upgrading. The building was eventually sold to the Old School Group for nearly the price of the land.

Seismic Problems with Clay Tile

As shown in *Figure 1*, the cells in hollow clay tile run horizontally without steel reinforcement. Typically, the walls span from floor to floor and the only tie between the blocks is the mortar that binds them. For Central Elementary School, the exterior walls also supported the exterior brick veneer, and the wall had little capacity to resist out-of-plane seismic loads.

In-plane loading the clay tile does not fare much better. The FEMA -178 NEHRP Handbook for Seismic Evaluation of Existing Buildings notes the following:

Figure 1: Typical Clay Tile

Hollow clay tile units are brittle and subject to shattering. Unreinforced masonry units may have cracks, loose blocks, or mortar failure. Door openings are usually weak due to support at the head and inadequate framing at the sides. Spaces at the sides and top of the wall to provide for interaction of the structural system and support angels are often not supported.

Previous Solutions

Previous solutions provided for the buildings involved adding pneumatically placed reinforced concrete tied into the existing clay. This solution added the required out-of-plane and in-plane loading for strengthening the building. However, the disadvantages to the solution were that it was not cost effective; it was heavy and required improvement of the existing footings and the applications; and, curing was very intrusive for the existing building.

Seismic costs were reduced when metal studs were used to strong-back the existing walls for out-of plane loads. Mechanical/adhesive anchors were used to tie the metal stud wall to the clay tile walls for out-of-plane loading. These metal studs provided a space for insulation and new I.T. cabling, a big help in solving the problem of modernization of the building. However, the solutions were still cost prohibitive, and installing anchors into clay tile was difficult. Often, the inside shell of the block breaks out in a cone shape during drilling. After years of practice, I have realized that mechanical anchors that screw into the clay tile do not consistently make pull strength in clay tile, due to the variance in material and condition of the clay tile in the buildings. Since the anchors are applied every two square feet, it is not cost effective to test every anchor. Yet, if an anchor does not hold it can overload the surrounding anchors causing a significant failure.

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Saving the Schools

To save the existing schools, and more importantly to make them safe, it became obvious that a new solution was needed. We liked the metal stud strong-back because it would not shrink, and provided a secondary vertical support for the unreinforced hollow clay tile bearing walls. However, a way to replace the in-plane shear capacity of the concrete was still needed, as well as a better tie to the problematic clay tile.

Our searches led us to a company called Seismic Rehab LLC., a General Contractor based in Portland, Oregon. They installed a patented system called a TR Wall, which created a cavity against the clay tile wall with metal studs and sheathing. The SRfoam injected into the cavity adheres to the exiting clay tile with an allowable adhesion of over 700 psf. The metal or wood sheathing on the studs have values in the 2000 international Building Code. The nominal shear values listed for wood sheathing are up to 2,190 pounds per foot, and 1,170 pounds per foot for steel sheathing.

"…created a cavity against the clay tile wall with metal studs and sheathing."

The SRfoam in the TR wall system fully braces the light gauge studs, allowing for the maximum efficiency for both vertical and out-of-plane loads. The walls allowed for new wiring and cabling to be installed prior to filling. The SRfoam provides a vapor barrier and a R-value of 7 per inch, reducing energy consumption and qualifying for LEED point.

A big advantage of the Seismic Rehab System is the flexibility of the SRfoam, which allowed us to treat the building as a light framed building with a veneer rather than an unreinforced masonry building, significantly reducing the seismic demand of the building.

The Upgrades

Included with the upgrade of Central School, the Parks and Recreation District wanted to restore the original building entrance and remove part of the second floor framing to create a two-story 24-foot high ceiling at the entry. The auditorium was challenging to upgrade due to the sloping floors with walls approximately 22 feet high. Using the Seismic Rehab BW wall system, the use of SRfoam was reduced to 3 inches providing cost savings.

Historical records were researched for the John Gumm School to restore the school back to its original grandeur. It was discovered that the upper floor hallway was originally open to the gymnasium/auditorium as a balcony, and the original bleacher seating was contained below the floor boards. The new owners were converting the building into commercials office space, a bar, and reception hall. The original school configuration worked well with the new tenant's plans.

Cost

The walls of Central Elementary School were seismically upgraded for a little over $21 per square foot. The Seismic Rehab portion of strong backing and tying the floors and roof to the walls was accomplished for less than $8 per square foot. The structural upgrade of the John Gumm School was accomplished for $200,000, which was less than 1/10 the cost of the traditional structural upgrade to the building.

Conclusion

The Seismic Rehab Solution brought life back to old clay tile schools, while preserving the integrity of the respective buildings. Each of these historical landmarks are saved for future generations to enjoy. Thanks to Seismic Rehab, the proprietor of each facility has acquired valuable properties with historical charm for a fraction of the cost of new construction.

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For more information on the Seismic Rehab System, please visit www.seismic-rehab.com; perhaps they can help save one of your favorite buildings!