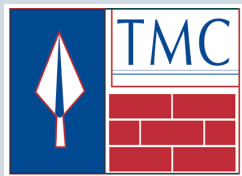


**School
Construction
Report**

August 2010

Masonry vs. Tilt-up in Texas School Construction



Texas Masonry Council

11659 Jones Rd. PMB 350

Houston, TX 77070

(281) 894-5100

www.texasmasonrycouncil.com

OVERVIEW

Since the downturn of the U.S. economy in the last half of 2008, many types of new construction projects have been shelved indefinitely. But school districts in Texas continue to build and renovate to catch up with population growth. Much of this growth is in or near the metro areas of Austin, Dallas, Fort Worth, Houston and San Antonio.

Because of its long life, low maintenance, fire resistance, and flexibility, load-bearing masonry has been a strong choice for school construction for hundreds of years. Tilt-up concrete walls have been recently introduced as a competitor to load-bearing masonry. While this report uses two specific schools in Central Texas as examples, the information contained herein accurately compares masonry wall systems with tilt-up concrete walls for school construction in all of Texas.

In 2006, construction began on two nearly identical elementary schools in Leander ISD, Leander, Texas – a community of approximately 20,000 residents 30 miles north of Austin. Texas Masonry Council followed that construction with interest and learned that the final cost and construction time for the two schools was very close. Both schools were completed on schedule and opened in September 2008. There were significant differences in the sites and neighborhood locations that are worth noting. The masonry school #20 was built in a hilly site with elevation differences between several portions of the building. The tilt-up school #21 was built on a more level site. The masonry school is highly visible near the entry to its community, while the tilt-up school is located in a less visible location within its community. And finally, the masonry school #20 had a larger window area than the tilt-up school #21, which significantly increases occupant performance, but could also affect energy performance.



Masonry school #20 front view



Tilt-up school #21 front view

In this report, we have prepared an objective comparison between school construction using load-bearing masonry with tilt-up concrete walls. The data available to us include the final cost and construction times for the two projects in LISD. Because of competition between these two construction methods, there are strong opinions on both sides. Several key issues should be considered when choosing the appropriate system for future school construction: (1) initial cost and life-cycle cost, (2) speed of construction and skilled labor, (3) site flexibility, (4) energy efficiency, and (5) aesthetics. We have considered each of these issues and hope that you find this information useful for making future school construction plans and recommendations. Comparisons between masonry and tilt-up walls with the same type and thickness were made. Energy comparisons were based on the known properties of the respective materials in each wall system. Also, we interviewed several teachers who expressed an aesthetic preference for the masonry school, but beyond that we must leave aesthetic judgments to the reader.

MYTHS AND FACTS

Masonry has been the material of choice for all types of buildings for more than a thousand years, but today it is often considered to be a façade or cladding material not capable of supporting an entire structure. Of course, this is a myth. The fact is that structurally engineered masonry can bring great physical and economical strength to any structure, especially with a brick and concrete masonry cavity wall.

Tilt-up did not begin to be a viable construction method until after World War II when the mobile crane was developed and ready-mix concrete was introduced. Since then, tilt-up has been used successfully in various types of buildings, large and small, but is especially popular in warehouse and strip mall construction where aesthetics are not a primary concern.

Cost of Construction

This is a big issue for school districts, in no small part because of the use of taxpayer money. The myth is that tilt-up wall construction is less expensive than masonry. The fact is that there is, in most cases, very little, if any, cost difference – but when you consider that there are no long-term, maintenance issues with masonry; masonry may well have a lower life-cycle cost.

There were two significant differences between the two schools that would have affected the costs on these projects: (1) The masonry site was not level. While that was not a major obstacle for the masonry school, it would have been a major issue for tilt-up construction. Masonry adapts well to almost any terrain while tilt-up requires a flat surface and sometimes considerable in-fill. Still, there was probably additional site work that would have increased the masonry school cost. (2) The masonry school had a greater window area. Since windows cost more per square foot than masonry, this would increase the cost of the masonry school.

If the tilt-up panels had included embedded thin brick, brick veneer, or applied stone veneer, to improve their appearance, that would have significantly increased costs relative to masonry. It appears that the tilt-up school #21 had such details around the windows to make the panels look more like masonry. Considering all of this, the total cost of construction for the masonry school was within two percent of the tilt-up school according to LISD construction reports. This makes the masonry school a real bargain. If the two buildings had been identical in finish, arrangement and design of windows and doors, and building sites, the construction cost of the masonry school would undoubtedly have been significantly less than the tilt-up.



Masonry school #20 east side view



Tilt-up school #21 east side view

Long-term or life-cycle costs of maintenance are often overlooked when calculating cost. However, the total cost of a school is realized when you examine what it costs to maintain the exterior wall system over the years. Since there basically is no long-term maintenance of masonry wall systems, the cost of washing and repainting tilt-up walls would add to the overall cost of construction. For example, school #20 was constructed with masonry so there are no long-term maintenance costs. Another school #22 (also in the LISD) was constructed using tilt-up walls and opened in 2009. After just one year, the walls were repainted. The cost of painting this school just once could add two to three percent to the construction cost.



Tilt-up school #22 repainting

Speed of Construction

There is a preconception that tilt-up is faster than masonry. This is another myth. Because tilt-up walls are erected in just a few days, tilt-up buildings seem to be built faster than masonry. There are several reasons why this is not so.

First, load-bearing masonry construction can begin the day the footings are poured. Tilt-up panels must have a flat, level casting surface, which is typically the floor slab of the building. Because this slab must be poured before the panels are cast, and all of the under-slab utilities must be in place before that, a masonry building will be well along in construction by the time tilt-up panels can be formed and poured.

Second, forming for tilt-up panels is exacting and time-consuming. If panel dimension tolerances are not tightly held, panels will not fit together properly and will have to be replaced.

Third, panels must be cured for 7 to 28 days to gain sufficient strength to be lifted. Lifting creates the highest stresses the panel will ever see, and insufficient strength will result in cracking or collapse.

Finally, masons and other trades can work side-by-side so that the school's interior and exterior progress together. Tilt-up schools are not faster to build. School #20 and #21 started within days of each other and both finished on time.

Skilled Labor

Often a selling point for tilt-up wall construction is the belief that there is a shortage of qualified masons and masonry contractors. This is a myth. The reality is that skilled masonry contractors are building schools all over Texas on time and within budget. Throughout Texas – in cities such as Dallas, Houston, San Antonio, Lubbock and Corpus Christi – mason training is in progress each month. Masonry work is done by highly skilled craftsmen and there are more than enough skilled masons to handle current and future work in Texas.

Energy Performance

Concrete masonry cavity walls have been a standard construction method for more than 100 years. As energy performance requirements have increased and suitable insulating materials have become available, this system has evolved to include continuous closed-cell foam insulation in the cavity, giving it exceptional resistance to heat losses. Many tilt-up structures are built with plain concrete slabs tilted and placed to create perimeter walls. The tilt-up sandwich panel construction typically used for schools provides continuous insulation except at the panel ends where solid concrete forms hot spots. Masonry walls have continuous insulation.

The air space in the cavity gives masonry a slight advantage in energy performance. The masonry wall will have a slightly greater thickness, but this can include attractive, durable masonry finishes on the interior face that do not have to be covered with furring and gypsum board, which must be painted and maintained. Consider the following comparison between a typical tilt-up sandwich panel and a masonry cavity wall:

Tilt-up Sandwich Panel			Masonry Cavity Wall		
Thickness	Wall Element	R-Value	Thickness	Wall Element	R-Value
5.00"	Concrete slab	R 0.50	7.625"	8" CMU backup wall	R 2.00
2.00"	Polyiso board	R 13.00	2.00"	Polyiso board	R 13.00
3.00"	Concrete topping	R 0.30	1.00"	Reflective air space	R 3.00
	Boundary air layers	R 0.84	3.625"	4" masonry veneer	R 0.50
				Boundary air layers	R 0.84
10"	Total Wall	R 14.64	14.25"	Total Wall	R19.34

Comparing these two popular wall systems, we see that: (1) the masonry cavity wall offers the greater total insulation and is the better combination of energy performance, cost and aesthetics, and (2) the tilt-up sandwich panel offers a thinner profile, but with less insulation at a similar cost.

Both of these wall systems can meet all energy code requirements in all Texas climate zones. In a classroom building with windows occupying 40 percent of the wall area, the above masonry cavity wall would account for only 11 percent of the building's total heat gain or loss. The tilt-up wall would account for 15 percent. Windows and roof insulation account for the remaining 85 to 89 percent. Both wall systems provide adequate insulation for walls with the capacity to increase that insulation beyond the point of diminishing returns. The amount of wall insulation for either system should be evaluated carefully on a life-cycle cost basis to determine the most cost-effective insulation levels. Since schools have a service life of 50 years or more, it is recommended to use a 50-year life cycle instead of a shorter return on investment when making this important evaluation.

Both wall systems do a more than adequate job when compared to other systems. Energy bills from a masonry school compared to a tilt-up school should not be considered in isolation as a determining factor of the type of wall system to utilize for future school construction.

Site Flexibility

It is doubtful that a school planner or architect would select a masonry wall system or a tilt-up wall system based solely on flexibility, yet flexibility of construction materials is important – if not to the school planner, almost always to the architect. With masonry it is easy to build offsets, curved walls or change wall directions. This is not easily accommodated with tilt-up.

Bobby Kincaid, project manager for Pfluger Associates Architects, L.P., the full service architectural, planning and interior design firm specializing in educational facilities that designed school #20, offered the following comment about the school: “Ultimately, we were tasked to design a school that reinforced Leander ISD’S unique learning model. The flexibility of masonry allowed us to design to the contour of the site, as well as place windows that share daylight and views between classrooms and common spaces.”

Site selection is critical in school construction. Clearly, school planners look to acquire land that is basically flat where little, if any, in-fill or excavation is required. This would allow the construction of either a tilt-up or a masonry building without additional site expense. But when flat land is not available, masonry becomes the obvious choice because of its adaptability to all terrains.



Hilly terrain at masonry school #20

Building height, opening sizes, and plan revisions, small or large, are easily made in the field with masonry (often without additional cost) as opposed to shop drawings and delivery for other systems including steel, precast and metal panel systems.

Construction can begin almost immediately with masonry, with products often available at hand. Early enclosure can allow other trades to work efficiently instead of waiting for delivery and erection of structural steel and tilt-up exterior walls. While tilt-up offers fast erection times, a masonry project could be enclosed before the tilt-up walls are ready to go up. Also, masonry does not require large staging areas for cranes or access for trucks delivering other materials.

Environmental Impact

Tilt-up construction typically requires large staging areas on level sites, completely destroying the habitat of not only the building footprint, but surrounding landscape. Existing flora and fauna are destroyed and displaced to build sprawling boxes with impervious concrete aprons that increase runoff and destroy the biological diversity of the site.

A masonry construction site requires minimal staging and site disruption beyond the building footprint, allowing construction on existing site profiles without stripping and leveling the entire site. Masonry landscape products can also be used to create permeable paving and vegetated parking areas to reduce runoff. Segmental masonry earth retaining walls drain freely and allow maximum use of hilly terrain without excessive excavation. This helps retain natural habitats and create wildlife corridors to maintain continuity of local ecosystems.



Masonry school #20 west side view



Tilt-up school #21 west side view

Aesthetics

What will the neighbors say? School planners often start (and complete) the construction of a school before there are any surrounding neighborhoods. They have to look ahead to see where the residential development is coming from and plan accordingly. An attractive school building can be the centerpiece of a neighborhood and can determine whether future residents will build there – and what type of homes they will build. This can have a very significant effect on property values and the tax revenues needed to sustain the schools and local government. According to a representative of a home builder in the community where the masonry school #20 is built, “Of course, having the convenience of a school in our community is a big selling point, but most people don’t even notice this school because it blends so well with the surrounding homes and environment.”

Homeowner associations (HOA) are also concerned about the appearance of the schools in their respective neighborhoods. “Sometimes a school might be the first building a prospective homeowner sees when driving in. The school’s appearance reflects on the value of its neighborhood,” according to an HOA management representative of Goodwin Management, Inc.

What do the teachers say? In an informal survey, 75 percent of teachers said the masonry school #20 was more attractive. We know that an attractive school adds value to the surrounding homes, but does it add value to the overall educational experience? One Leander ISD teacher said, “From my own experience, I would say the exterior appearance of a school affects a student’s learning experience. The schools I attended in the suburbs of Chicago were ugly and prison-like. No one wanted to go inside those buildings.” An assistant principal commented, “The exterior appearance of a school building tells students that they are valued. When students enter a school that is unattractive or not well-maintained, that may tell them that the community doesn’t put much value on education. On the other hand, when students enter a school building with a nicer appearance, they have great pride in their school.”

Tilt-up walls are by nature plain and boxy. Extraordinary and expensive measures must be taken to dress them up and make them look more like masonry. So why not just build with masonry from the start?

We think it is fitting that a topic as important as aesthetics should have the last word. So we will leave that to you, the reader, to evaluate. Look closely at the pictures of the two Leander schools in this report. You be the judge!

SUMMARY AND CONCLUSIONS

When construction on these two Leander elementary schools began, it was clear there would be a good opportunity to compare the two methods of construction from many different perspectives. Advocates of tilt-up concrete construction have recently promoted their system by claiming that it was faster and cheaper to build. The results are in and that is clearly not the case. Both schools were completed in the same amount of time and at virtually the same price. But on closer examination, the masonry school seems to offer significantly more value, including equal or better energy performance, better site flexibility, lower environmental impact, no long-term maintenance and a much better looking building.

Although much has been done in recent years to improve the look of the exterior tilt-up walls such as painting the panels and using an embedded thin brick veneer system, which gives the appearance of masonry and helps to comply with many cities' masonry ordinances, there is no comparison to the classic beauty of hand-laid brick, architectural concrete masonry and stone.

Obviously, aesthetics are subjective, and we at Texas Masonry Council may have a bias on that issue. "Beauty is in the eye of the beholder." So, go see for yourself.

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