Detroit Public Schools Embrace “Shovel-Ready” Masonry to meet accelerated schedule, exceed energy expectations & gain exorbitant added value

by Dan Zechmeister, PE, AIA Detroit Honorary Affiliate Member, and Elizabeth Young, LEED Green Associate

The Detroit Public Schools (DPS) is in the process of undergoing an extreme makeover. Thanks to the $500.5 million federal stimulus bond financing under the American Recovery and Reinvestment Act of 2009, 18 aging and under-capacity schools will be rebuilt, replaced, relocated or completely renovated, creating new, safe, state-of-the-art learning environments in neighborhoods chosen to better meet the needs of Detroit’s 84,000 students.

In a city hard hit by recession, hand-laid masonry puts more local people to work than any other building system...and at a lower cost

Under conditions of the stimulus, all construction must be complete by the end of 2012, giving the District just three years to implement its plans. Part of the plan includes building eight new schools and renovating ten. Detroit Public Schools wanted to ensure that this funding would have positive effects on all parts of the community. The goal was to hire Detroit-based design and construction companies to put Detroiters to work. According to the DPS Master Facilities Plan, this project has the potential to invest more than $1 billion throughout the city and create nearly 11,000 jobs. As a result, more than 70% of prime contracts have been awarded to Detroit-headquartered firms. District leadership is committed to creating economic impact far and wide.

Velocity of Money The role of masonry in this master plan was the foundation for success, as schools are constructed of masonry for the longevity and durability it provides. But masonry has a lot to offer in helping the district meet its economic impact goals, as well. Low initial and life-cycle costs save DPS money over the life of the buildings. And, in a city hard hit by recession, hand-laid masonry puts more local people to work than any other building system!

- Brick, block, stone, mortar and grout are produced locally of regional and locally extracted materials
- Masonry materials are delivered to the job site by local workers
- Masonry materials are laid in place by local craftpersons
- Nearly every dollar allotted to the masonry wall system remains in the local economy

Economists estimate that every dollar generated in the local economy multiplies a minimum of four times! The Masonry Institute of Michigan (MIM) estimated that if the eight new schools relied on masonry for structure and cladding, it would require approximately 324,000 bricklayer hours and 178,000 laborer hours, totaling 502,000 hours for a total of $27,724,000 figured at prevailing wage. Masonry materials – brick, block, mortar and grout – for those eight schools would total $14,876,000. The total dollar benefit to the Detroit economy would be approximately $42.6 million. Factoring in the velocity of money (multiplying $42.6 million by a minimum of 4) would provide a total economic benefit of $170.4 million. Just from the masonry alone!

Structural Decisions The aggressive schedule imposed by the DPS for its construction projects was cause for everyone involved to hit the ground running. The Bridging Method of project delivery awarded a design/build contract with a strong set of design documents. This ensured objectives were being met with consistent systems and a consistent level of quality across all projects.
Martin Luther King High School, the first of 18 public school projects under construction in Detroit, was converted from steel frame to loadbearing masonry, in part, because there were enough bricklayers to get the job done on schedule.

Detroit Public Schools

Architects and Structural Engineers | ALBERT KAHN AND ASSOCIATES | Detroit
CASH & ASSOCIATES | Detroit | DESAI/NEER DESIGN GROUP | West Bloomfield, MI
HAMILTON ANDERSON ASSOCIATES | Detroit | KRAEMER DESIGN GROUP | Detroit
KSA ARCHITECTS, ENGINEERS AND PLANNERS | Farmington Hills, MI
PES GROUP | Detroit | RESENDES DESIGN GROUP | Detroit | SDG ASSOCIATES | Detroit
SHW GROUP | Berkley, MI | TMP ARCHITECTURE | Bloomfield Hills, MI
URS CORP | Detroit

Construction Managers | BRAUN CONSTRUCTION GROUP | BRINKER/CHRISTMAN JV
CLARK’S DIMARIA JV | COLASANTI/DCI | DUMAS CONCEPTS | JENKINS CONSTRUCTION
JENKINS GRANGER LLC | KEO/MCCARTHY & SMITH | MIG/ACH
O’BRIEN EDWARDS CONSTRUCTION CO | TOOLES CLARK | TURNER/O’BRIEN EDWARDS JV
W-3 CONSTRUCTION CO/ AZ SHMINA | WHITE/TURNER

MIM Mason Contractors | DIXON INC | Detroit
D’ALOISIO MASONRY | Farmington Hills | DAVENPORT MASONRY | Holt
LEIDAL & HART MASON CONTRACTORS | Livonia
Quality Assurance Consultant | MARIO DIGIOVANNI

MIM Masonry Material Suppliers | ALPHA FOAM | BASF | BEST BLOCK
DOW | FENZT | GRACE CONSTRUCTION PRODUCTS | GRAND BLANC CEMENT
HOLCIM | LAFARGE NA | MORTAR NET | NATIONAL BLOCK | QUIKRETE/SPEC MIX
ST MARYS CEMENT | WIRE-BOND | WILLIAMS PRODUCTS

Project Facts

New Construction: FINNEY CROCKETT HIGH SCHOOL
MARTIN LUTHER KING JR SENIOR HIGH SCHOOL | MUNFORD HIGH SCHOOL
CLARK PARK PreK-8 | GOMPERS PreK-8 | MACKENZIE PreK-8 | MUGER PreK-8
OFFICE OF PUBLIC SAFETY HEADQUARTERS & OPERATIONS CENTER

Renovation: DENBY HIGH SCHOOL | HENRY FORD HIGH SCHOOL
NORTHEASTERN HIGH SCHOOL | WESTERN INTERNATIONAL HIGH SCHOOL
BETHUNE-FITZGERALD PreK-8 | BUNCH PreK-8
DUKE ELLINGTON AT BECKHAM PreK-8
JOHN H KING ACADEMIC & PERFORMING ARTS ACADEMY
MARCUS GARVEY ACADEMY | MARK TWAIN PreK-8 | RONALD BROWN PreK-8

Total Construction Budget $500.5 MILLION
Total Completion Date FALL 2012

MIM was instrumental in meeting with design teams bidding DPS projects to discuss how using Masonry for ALL Its Worth would greatly impact an accelerated schedule, tight budget and the local economy when using CMU for:

• SmartStructure – bearing gravity and shear loads
• the most efficient and cost effective energy performance
• fire ratings | acoustic performance
• sound separation
• contribution to LEED points | durability

The Michigan Masonry Coalition (Coalition), formed in 2009 as a partnership between MIM, International Masonry Institute (IMI), labor organizations and industry suppliers, provides a structural engineer and quality assurance consultant to A/E/C. They offer training and technical support to structural engineers in designing loadbearing masonry, as well as performing project reviews and other masonry-related training. The Coalition held meetings with design teams before bridging documents, created by the joint venture of Walbridge/Fanning Howey/Brailsford & Dunlavey, were released. At this stage, design detailing was approximately 25% complete. Preliminary designs illustrated a structural steel frame, but load analysis had not yet been performed. CMU infill and brick veneer were specified at this stage. DPS also required a guaranteed maximum price and a project labor agreement for all projects. Fifteen presentations to architectural, engineering and construction management firms were held. All members of the design build team were invited so that all aspects of masonry design and installation could be addressed at once.

Martin Luther King Jr High School (MLK) was the first new construction project with a budget of $46.4 million. Representing the Coalition, Pete Loughney of the IMI and Zechmeister, representing MIM, met with the bid team of TMP Architecture,
Detroit Public Schools

Desai/Nasr Consulting Engineers and Jenkins Granger Alliance Construction Managers.
Economics, thermal performance, energy savings, structural redundancy, impact resistance, sustainability and more were discussed.

What struck a chord with the team was ultimately how a masonry structure could impact the budget and schedule. Each firm and each team is experienced with school construction and loadbearing masonry applications. Desai/Nasr recently completed a multistory loadbearing residence hall at Michigan Technological University in Houghton using software to structurally engineer the entire six-story, 77,500 sf masonry bearing building in 40-50% less time than by the traditional hand method. Given the opportunity to pursue a complete redesign away from loadbearing steel structure to SmartStructure -- loadbearing masonry -- the Coalition hired a structural masonry engineering consultant to have the entire school structure modeled for pure loadbearing masonry. The model, then shared with Desai/Nasr Consulting Engineers, project engineer of record, was ultimately accepted.

High School  Martin Luther King Jr High School was redesigned, eliminating all structural steel from the walls. The exterior envelope is now 8" loadbearing CMU with 2" spray foam insulation and burnished block and brick veneer, with a prescriptive wall R-value of nearly 17. Interior masonry exposed in hallways, classrooms, staircases and most other public spaces is finished in brightly colored paint. Surfaces are welcoming and cheerful, yet durable. Athletic facilities utilize the additional durability and low maintenance of burnished block. Block produced about nine miles away were ready for immediate delivery without the need for shop drawings and fabrication, allowing the project to begin without delay.

Project designer with TMP Architecture, Gary Jelin, AIA, REFP explains, “a massive amount of work happened very quickly. The 200,000 sf high school was awarded in June 2010 with occupancy planned for August 2011. That is a reasonable schedule for an elementary school, but very tight for a large high school.” Part of the team’s decision to remove the steel was that they knew there would be plenty of masons available for the job. In fact, there were as many as 40 to 50 masons and tenders on site on a daily basis. Once the first floor was enclosed and hollow precast plank flooring for the second story was installed, people could begin working indoors. That was greatly beneficial to the schedule.

“We have been very impressed with the speed of construction and quality of the masonry. Good site superintendents maintained quality and safety with an aggressive schedule,” Jelin continues.

Construction Administrator, John Burhenn, LEED AP, CDT, adds that not having to accommodate both masonry and steel trades onsite enhanced the schedule, but also provided savings, allowing one material to serve two purposes: structure and enclosure. In total, the use of masonry bearing walls reduced the amount of steel from 800 tons to 300 tons. Steel remained in the roofing system. Elimination of the steel frame system meant that precast concrete plank for the second deck structure was used in lieu of steel beams and composite slabs. A side benefit was the elimination of significant amounts of spray fire proofing, an additional product with additional cost and transportation.

Elementary Schools  In addition to MLK, 3D masonry models were created for two prototype PreK-8 schools by the Coalition. The speed and skill with which the consulting engineer could go from blueprint drawing to 3D model was essential as the schedules were so condensed. A 3D whole building finite element analysis breaks the design down into shells with each shell being individually calculated and analyzed for the best, most cost-effective, optimum and accurate design. Results were made available to design teams upon request.

After meetings with Coalition consulting engineer Scott Walkowicz, PE, architect and structural engineer of record URS Corp opted to remove steel from the exterior envelope, in favor of loadbearing masonry for the second and third new construction schools, Gompers and Clark Park PreK-8 buildings. From presentations, Coalition estimations of a loadbearing masonry schedule for a 123,000 sf structure with a crew of 14 bricklayers and 10 laborers was approximately 32 weeks (160 days). Mason contractor Dixon Inc (Dixon) had to take advantage of this speed on both Gompers and Clark Park projects because poor soil conditions at one and buried fiber optic cable lines linking Detroit and Chicago at the other caused delays from the start. In fact, because the cables were immovable and shallowly buried, the building had to be redesigned and resituated on the site to accommodate the cables underground! In each case, Dixon was able to get the projects back on schedule by having the block enclosure up in 60% of the allotted time. Approximately 86,000 CMU were laid in six weeks by 22 masons and 12 laborers.

More than 250,000 block containing at least 70% recycled content are used in construction of MLK High School.

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“If we saw things we could change to expedite schedule or save money, we would suggest them as part of the design assist team,” explains Mike Harman of Dixon Inc/Leidal & Hart Mason Contractors. For both Gompers and Clark Park, 240 new engineered masonry
hollow carbon reinforced lintel forms were fabricated off-site as the walls were being constructed and then delivered for just-in-time installation, contributing to the schedule enhancement. This innovative product was developed due to the schedule challenges the contractor faced. (Read Engineering a New Lintel in MasonryEdge/theStoryPole vol 6 no 1.)

"Traditionally, it takes almost half a day to shore one lintel," explains Bob Henderson, project manager for Dixon. “These pre-fabricated lintels were being lifted into place in as little as 15 minutes with minimal shoring and they required less plank and other equipment. That allowed us to use our manpower and materials (like plank) elsewhere. We have been keeping our guys moving fast.”

**#1 Priority** DPS made it clear from the beginning that budget was their number one priority. Dollars were fixed and deadlines hard, leaving little room for error, change orders or other unplanned obstacles. Masonry is a known cost-effective quantity in the equation. Exterior wall cost with loadbearing masonry was estimated at approximately $26-28/sf of wall, including labor and materials for a typical 16" wall with 2" closed cell rigid insulation. Interior wall cost for classroom partitions, corridors, stairwells and more was estimated at only 9-11/sf, not including premium finishes. By eliminating steel from MLK, more than $1 million was saved, based on steel prices from 2010 and labor estimates.

In addition to initial budget expectations, DPS kept an eye to their investments for the long term. Coalition total (70 year) life cycle cost estimates for an exterior insulated masonry cavity wall, present worth, ranged from $35 to $41/sf depending on wall composition, including materials. Analysis shows that while initial cost of CMU and brick cavity wall is less than metal stud and brick, total life cycle costs for the CMU and brick wall are approximately 25% less per sf, again depending on wall composition. Insulated precast panels are about 115% higher initial cost than comparable CMU and brick with approximately 80% more total life cycle cost. Total life cycle estimates include energy, fuel, maintenance and repair costs from interior finished surface to exterior finished surface. These are based on National Institute of Standards and Technology’s Life Cycle Costing Manual for the Federal Energy Management Program (NIST Handbook 135) standard actuarial tables.

**Stacking Up to LEED** Each new building is registered in the LEED for Schools program, which is based on LEED New Construction, but with additional consideration for unique needs of school environments and students’ health. LEED Certification requires a minimum 40 of 110 possible points. Masonry can contribute up to 40 points (more for masonry materials used in landscape applications), in combination with all other building materials. MLK is expected to achieve a minimum of a Silver rating (50 to 59 points). While the team is still determining which credits to submit for, masonry will likely contribute to Energy and Atmosphere’s Optimize Energy Performance credits. At this point in construction, they are expecting the school to be operating at 24% higher energy efficiency than the prerequisite for the category requires, worth seven points.

1International Masonry Institute Life Cycle Cost Analysis
Masonry contributes greatly to the category of Materials and Resources. While MLK is retaining the auditorium and music instruction spaces from the original facility, largely intact, LEED requires a minimum of 75% of existing walls, floors and roof be maintained for credit. MLK will not qualify, but the team should be commended for saving what is still working and integrating old with new.

### Total life cycle costs for CMU and brick walls are 25% less than for metal stud and brick

Brick, block, mortar and grout are regional materials to almost every metropolitan area in the US. Block, mortar and grout producers can be found in every state, while brick is manufactured in 38 states, so meeting the 500 mile requirement is easy. Innovation and Design points can be earned for greatly exceeding a requirement, such as 250,000+ CMU from a mere nine miles away. While masonry has always been produced regionally to the area in which it is used, finding recycled content in the materials is becoming just as expected. Standard grey block used for MLK contained a minimum of 70% post-industrial recycled content.

A report by the University of Florida’s Powell Center for Construction & Environment states that approximately 7 lbs of waste is produced for every sf of new construction. Renovation and demolition produce up to 70 lbs of waste per sf. While TMP’s internal research shows a correlation closer to 1 lb to 1 sf, the team was acutely aware of waste generation throughout the MLK project. Some of the masonry building materials from the demolished structure will be crushed for use as parking lot underlayment at this or other DPS projects. The remainder of construction waste is being recycled.

LEED’s Indoor Environmental Quality category includes myriad ways of ensuring occupant comfort, health and productivity. Masonry materials used as exposed interior surfaces can contribute to the credits for Low-Emitting Materials (paints and sealants), Thermal Comfort-Design, Enhanced Acoustical Performance and Mold Prevention for as many as seven more points.

Additionally, the MLK team is considering submitting an Innovation and Design Process credit for masonry’s ability to reduce the overall amount of structural material required, and make use of building materials in a more efficient manner (eliminating the need for steel.)

**Community Spirit** Investment in the future of Detroit and preservation of the history of DPS buildings were part of the district’s master plan, too. A program was set up in order for high school students to obtain skill training.
and job placement on construction crews building new schools (see sidebar). IMI, in conjunction with the ACE (Architecture, Construction, Engineering) Mentor Program, held a field day at the BAC Local 1 Training Center in Warren, MI to introduce interested DPS students to masonry and give them some hands on experience. Loughney talks about the fact that the pre-apprentice program currently is training some recent DPS graduates who are eager to learn the skill and ready to work full time in the bricklaying trade.

It is a bittersweet development for graduates to see their alma maters disappear. Buildings that were demolished will be remembered in various ways. The district, in conjunction with the Detroit Public Schools Foundation, will auction brick and other items salvaged from selected schools as a fundraiser to support supplemental school programing. A grant received by a non-profit artists group created the opportunity for limestone archways and brick salvaged from another former school to be used at entrances and as walkways at a community garden planned on the grounds of a nearby Detroit Public Library. My own high school, Denby, (Zechmeister, 1971 graduate)

DPS is reinventing itself and the way it can educate the youth of Detroit. The district’s Summer Student Worker Program, open district-wide to currently enrolled or recently graduated DPS students, and the ACE mentor program provide real-world opportunities for these students to achieve success and gain experience.

Elmer Dixon, owner of Dixon Incorporated, mason contractor in Detroit, beams as he talks about his current opportunity to mentor young people from the DPS. Holding the contract for eight of the 18 schools either being newly constructed, expanded or renovated in the city of Detroit is a source of pride. Serving as an example to which young can Detroiters aspire is what makes his heart sing.

The eldest of six children, Dixon grew up in Mississippi and was the first in his family to go to college. He excelled in college basketball at Louisiana State University and graduated with a degree in Political Science. Before beginning law school, while working retail, he met a man who thought he had strong potential. Bob Rensi Sr brought Dixon aboard at Lafarge NA. He moved to Detroit and soon had an opportunity to become a mason contractor. “I learned so much so fast.”

Now, Dixon has the opportunity to work with young people to encourage them to stay in school, to earn their diplomas, to think beyond the microwave mentality of “I want it now”, to adopt a different mindset that works in the real world.

“Failure is never an option,” Dixon explains. “At a very young age, I learned to lift my head, to think positively, to do good work and develop relationships. I hope I can convey all that to these young people in Detroit. Two students from the Randolph Career & Technical Center, where they learn the trades, shadowed me for six weeks to understand the business. One invited me to his high school graduation and will be starting at Henry Ford Community College this fall.

“Would Bob Rensi have ever invited me to come to Detroit if I did not look him in the eye the day we met? That is what I am teaching these young people. To become successful, you must get involved, think beyond yourself, think beyond the moment, keep the faith and never slow down. Opportunities are out there waiting for you to seize the moment. Go for it!

“Masonry is a good job and can be a good career for life. It is both art and science. Technology is advancing the masonry industry quickly. Craftsmanship is so important to the aesthetic. There are good hard-working people in construction. Working for the city of Detroit requires 65% residents on the job. We need more dedicated young Detroiters to become bricklayers, tenders and mason contractors.”

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Dixon Masonry Offers Encouragement, Opportunity to City Youth

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