Upon reading the article you will:

1. Identify building applications and scenarios particularly well suited to loadbearing masonry structural systems.
2. Recognize ways masonry helps to speed up construction.
3. Describe some of the benefits derived from the conversion of a steel frame structure to loadbearing masonry.

L’Anse Creuse Schools’ Pellerin Center will be the home of alternative and adult education. The conversion from steel frame to loadbearing masonry kept the project on schedule and gave cleaner lines and more interior space with no bump outs and no X braces.

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Right Place – Right Time
A “catch phrase” signifying optimum opportunity when I was growing up happened again in early August 2008 when I was contracted to design two multi-story masonry loadbearing buildings. I have known Dan Zechmeister of the Masonry Institute of Michigan (MIM) since 1991 when I attended a masonry design class that he was teaching at Lawrence Technological University. That was another right place-right time experience. I took the course which was attended primarily by architectural and a few engineering students. I remember Dan graded the engineers and architects differently on certain issues, primarily in design. Architects had to understand the concepts, but the engineers had to understand the theory and be able to perform calculations. Once you have experienced Dan’s incredible masonry knowledge, you quickly come to rely on his expertise. Since that time, I have always taken advantage of Dan as a resource and even attended his first masonry certified inspectors course and testing. I turned to Dan with questions about the feasibility of loadbearing masonry for another unique project that I am involved with when these other projects evolved.

Structural Sense
Many projects I have worked on have lent themselves very well to loadbearing masonry. Large retail stores, for example, have a track record of using masonry loadbearing walls for both vertical and lateral load resistance. At Wakely Associates A/E, the majority of our work is in retail and school markets. Schools use masonry for durability. So it just makes sense to use masonry for load resistance as well.

Masonry is excellent for structural use. When projects use masonry veneer for durability, it makes good sense to use masonry for the structural backup. The loadbearing capability coupled with the lateral in plane stiffness is a no-brainer. Masonry (in plane) is much stiffer than steel and to achieve comparable steel frame stiffness, diagonal braces are generally chosen. Architects typically do not like these elements due to door and/or window openings. Masons and carpenters don’t like the X braces for construction interferences. Additionally, the designer must take into account any movement between different construction materials.

First Software User
Within a week of my meeting with Dan, it had been decided that yet another project already designed and under construction would be changed from steel frame to masonry loadbearing. A quick meeting with Dan put me in touch with Pete Loughney, director of market development and technical services at the International Masonry Institute (IMI), who provided me with the latest design software from Bentley, RAM Advanse v9.5.2.

IMI and MIM were just beginning a statewide effort to promote masonry design by providing design software and training to engineers. Being in the right place at the right time allowed me the privilege of receiving the first version released by IMI of RAM Advanse. It contained a masonry design module developed through extensive collaboration. David Biggs, PE, who served as consultant for the software development of the masonry design portions of RAM Advanse and helped write the manual for the Bentley training, was directly available to me for any help or questions. The manual was still in draft form and the first hands-on training session was not scheduled until mid October. David was very helpful by phone and email for technical assistance. I even emailed my RAM model for his review and assistance, which he generously gave.

“The entire model was converted in less than one day”

Originally, lateral stability was achieved by a combination of masonry infill shear walls, a reinforced masonry shear wall “core” and a steel braced frame. The design was complete and out for bid in March 2008. Anchor bolt shop drawings and foundation reinforcing steel shop drawings were received and reviewed in early June. The first steel shop drawings were reviewed in early August. Schedules noted the steel would be arriving in mid November which brought the mason back on site in December (earliest) after weeks of steel erection.

Just days later, mason contractor Dave Sherman, general manager of Brend Contracting, raised the question of converting to loadbearing masonry to Ron Curtis construction manager of Barton Malow and architect Brian Smilnak of Wakely Associates. He had projected constructing only the elevator shaft and toilet rooms and would then be off site until after the steel arrived.

Smilnak and I discussed the feasibility of making the conversion. The benefits proved very positive. The decision to proceed was made quickly. Initial questions needed to be answered immediately to keep the mason working efficiently. Which steel columns and beams were to be removed? Were any changes required in reinforcing? What are the beam bearing elevations and are any changes required for the lintels located at the second floor level and below? The same questions for the roof level and below were to follow. This conversion to loadbearing masonry allowed the mason to lay up the entire structure while the remainder of the project was being revised. All changes were made in advance of actually issuing a formal bulletin. The team worked very well together with minimal interruptions to work schedules. All parties involved had faith that the appropriate contract changes would be made.

The major item that pushed this change was the schedule of steel delivery and erection. This would have had the mason back (as it turns out) working through a harsh winter. The anticipated cost was in excess of $50,000 for winter conditions not originally budgeted. Very cold temperatures, averaging 24° in December and 14° in January, combined with higher than average snowfall and additional days lost due to extreme weather conditions were not an issue as the building enclosure was complete.

The decision to convert to loadbearing masonry was based primarily on the fact that the mason could be finished with the loadbearing walls, including the veneer, by mid November. The design team worked to

DiAnne Pellerin Center, L’Anse Creuse Schools, Clinton Twp

ARCHITECT Wakely Associates, Inc, Warren
ENGINEER Wakely Associates A/E, Bay City
CONSTRUCTION MANAGER Barton Malow, Southfield
MASON CONTRACTOR Brend Contracting, Shelby Township
MASONRY MATERIALS Belden Brick Sales, Dow, Grand Blanc Cement Products, Masonpro, St Marys Cement, Wire-Bond, WR Grace Dry Block

Schedule Necessitated Change
The DiAnne Pellerin Center, named for the district superintendent, will be the home of alternative and adult education for the L’Anse Creuse school district. The building sits on the prominent corner of Gratiot and FV Pankow Boulevard and next to the district’s Frederick V Pankow Center for Career and Technical Education. The two-story structure of approximately 37,000 sf will house offices, classrooms, a media center and a two-story circular stair and two-story entry vestibule.

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V Pankow Center for Career and Technical Education. The two-story structure of approximately 37,000 sf will house offices, classrooms, a media center and a two-story circular stair and two-story entry vestibule.

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make the conversion as easy as possible. There would be no re-submittal of steel drawings. Changes were to be documented on the original shop drawings. The mason would be informed of necessary changes to allow him to move forward.

**Technical Changes**

The added reinforcing was mostly “prescriptive” to achieve classification as intermediate reinforced masonry shear walls which have larger coefficients and, therefore, reduce seismic shear loads to shear walls (R factor is in the denominator of the equation). Intermediate shear walls are expected to have larger capacities and better ductility during seismic events. **“The solution was to utilize a single lintel over multiple adjacent openings”**

Both of the ordinary and intermediate shear walls rely on reinforcing for tensile stresses. Both categories have minimum amounts of prescriptive reinforcing around openings, at corners, at floor and roof levels and at control joints. The additional limit for the intermediate masonry shear wall is that vertical reinforcing is limited to a MAXIMUM spacing of 48” on center (oc) where ordinary masonry shear walls can have vertical spacing of 120” oc. Infill walls were originally classified as ordinary reinforced since the majority of the stability was obtained by the braced frame and masonry core. Original reinforcing was set at 32” oc for out of plane loading. It could have been increased with the loadbearing option, but the decision was made to maintain the 32” oc for simplicity. Bond beam elevations were determined for the second floor bearing level and individual steel beam bearing elevations determined for the beam pockets.

The vast majority of the original lintels were designed as masonry since I like to keep these in the mason’s “hands” for construction. That eliminates an additional trade interface. With the change to the loadbearing system, some of the larger openings changed to stiffer steel lintels (to help load transfer to small masonry piers). Other larger openings merely increased the number of courses of the bond beam and made for deeper masonry lintels.

**In Less Than One Day**

The original computer model was completed using RAM Structural Systems, another Bentley product, which made converting to masonry loadbearing an easy task. I systematically removed the necessary columns and beams and replaced them with walls. I worked in

**Conversion to Loadbearing CMU Saves Schedule**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>ORIGINAL</th>
<th>PRE-CONVERSIONAwaiting Steel</th>
<th>CONVERTED TO LOADBEARING MASONRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Out For Bid</td>
<td>March 2008</td>
<td></td>
<td>No Change</td>
</tr>
<tr>
<td>Mason Contractor Hired</td>
<td>April</td>
<td></td>
<td>No Change</td>
</tr>
<tr>
<td>Anchor Bolt &amp; Foundation Reinforcing Steel Shop Drawings</td>
<td>June</td>
<td></td>
<td>No Change</td>
</tr>
<tr>
<td>First Steel Shop Drawings</td>
<td>Mid August</td>
<td></td>
<td>No Change</td>
</tr>
<tr>
<td>Steel Scheduled For Erection</td>
<td>November</td>
<td></td>
<td>No Change</td>
</tr>
<tr>
<td><strong>LOADBEARING MASONRY CONVERSION DONE</strong></td>
<td></td>
<td></td>
<td><strong>LATE AUGUST 08</strong></td>
</tr>
<tr>
<td>Perimeter CMU Laid</td>
<td>September/October 08</td>
<td>November/December 08</td>
<td>September/October 08</td>
</tr>
<tr>
<td>Brick Veneer Installed</td>
<td>December 2008</td>
<td>February/March 09</td>
<td>December/January 09</td>
</tr>
<tr>
<td>Interior Steel Set</td>
<td>November/December 08</td>
<td>January/February 09</td>
<td>November/December 08</td>
</tr>
<tr>
<td>Roof Installed</td>
<td>February/March 09</td>
<td>April/May 2009</td>
<td>February/March 09</td>
</tr>
</tbody>
</table>
finite areas at a single time and utilized the
data check function to identify any unsup-
ported members or other errors/warnings. I
anticipated that an entire model change would
generate several errors, so the finite working
areas limited the search for any required model
changes. The entire model was converted in
less than one day, even at the calculated pace.

“The total change from steel bearing to masonry bearing was completed within five days”

All control joints were modeled in the walls
as gaps and then connected with gravity steel
members (short beams). This more accurately
models the actual behavior of the walls (gaps)
and satisfies framing requirements of the
RAM Structural program. Control joint (CJ)
locations were simplified for modeling purposes
and all openings were accurately located.
Several window openings are separated by
masonry “piers” of 16” in width. The actual
control joints are typically located at the corner
of the window and jogged around the lintel.
My choice for modeling was either small piers
(CJ at center of pier) or a window opening at
the edge of a panel creating a large cantilever.
Width of the modeled gaps for control joints
also added to the small piers. Additional areas
of small piers were between louvers and
window openings within a single wall panel.

Lateral loads were determined by the Frame
module of RAM Structural Systems. This model
was then imported into RAM Advanse for the
masonry design module. After adding wind
pressures on the face shells, the model was
analyzed and representative walls were reviewed
in the masonry design module. Predictably,
small piers were a problem based on computer
output. The Advanse program meshes the
walls into strips for the finite element analysis.
Small piers between openings failed. The
solution was to utilize a single lintel over
multiple adjacent openings. The lintel, designed
to be sufficiently stiff to span the entire width
of the openings, minimized the gravity load
transferred to the piers which were then
simply designed for out of plane loading. The
small piers also failed in the strips directly
from the sill level down.

This was rationalized as loads would begin to
redistribute at the sill level and not only be
resisted by the idealized width of the pier.
This was also checked against adjacent piers
between windows with no control joints.
The “actual” width piers performed fine
with the imposed loads.

BIG Benefits

After conversations with Barton Malow, it
was determined that the actual dollar cost
changes in contracts was a NET add of only
$508 to the project (excluding design fees by
the architect and engineer). The 2 1/2 months
in savings on the schedule and the minimum
of $50,000 savings in winter protection were
huge benefits to the decision. As it turned
out, the unseasonably cold and snowy
January would have lost many more masonry
construction days, even with tenting according
to Curtis. All in all, the construction is much
further ahead due to the decision.

Although the masonry design module was not
utilized to its fullest capacity for optimized
reinforcing, the program did show its ability
to quickly design the components and check
various design options. The use of RAM Frame
to generate load combinations and lateral load
distribution was a huge time savings for load
tracking. The total change from steel bearing
to masonry bearing was completed within five
days. Actual changes to the shop drawings,
construction drawings and details took longer
than the engineering. I am looking forward to
using the vast capability of the program and
masonry design modules on multi-story
projects. The capability to export masonry
wall elevations with required reinforcing into
the AutoCAD program is also a huge potential
time saver. The ability to generate quicker,
easy to understand drawings will also make
it easier for the mason to construct.

Michael A Klein, PE, SECB, is president,
COO and director of engineering services at
Wakely Associates A/E. In his role, Klein works
closely with the architectural design team
and enhances project
coordination, communication and cost control.
From new construction, structural analysis of
existing facilities and adaptive reuse of existing
structures, he works to develop numerous
solutions appropriate to clients’ needs and
budgets. In addition to providing in-house
structural design at Wakely Associates A/E,
Klein has more than 20 years of consulting
experience with clients in the metro Detroit
area. He holds a Bachelor of Science in
Construction Engineering from Lawrence
Technological University and an associate
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