

LOADBEARING MASONRY RISES HIGH IN CLEVELAND



Schuemann Architectural Photography, Cleveland

At 17 stories, Crittenden Court Apartments becomes the tallest loadbearing masonry building in Cleveland, perhaps in the entire central United States.

New engineered brick curtain wall system eliminates need for scaffolding and shelf angles

By Mark A. Wallace

A job for bricklayers with vertigo, this was not. In October 1995, peering from the edge of the 17th floor of the Crittenden Court Apartments, the bricklayers of L.M.R. Construction laid the last brick on the tallest reinforced loadbearing masonry building in Cleveland, probably in the entire central United States.

In only 17 weeks, they had set \$650,000 worth of precast plank and laid \$2,400,000 worth of masonry: 300,000 brick, 500,000 block, 8,000 bags of mortar, and 5,000 bags of grout cement. They had erected nothing less than a masonry landmark, setting a precedent for other construction to come.

Though the Crittenden went up quickly, it took years of planning, and in the end was possible only because of special financing (see box on page 6) and an innovative brick curtain wall system. From front to back of the building, nine parallel reinforced loadbearing concrete masonry walls support precast floor planks and carry all live loads to the foundation. At-

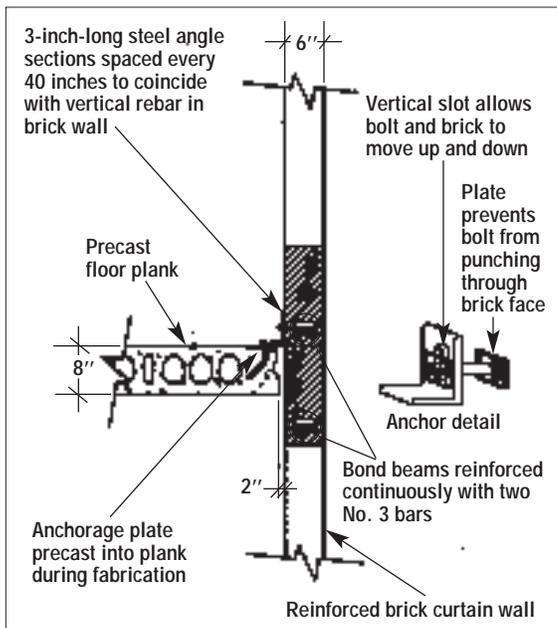


Figure 1. Attachment of 6-inch brick curtain wall to longitudinal side of precast floor planks.

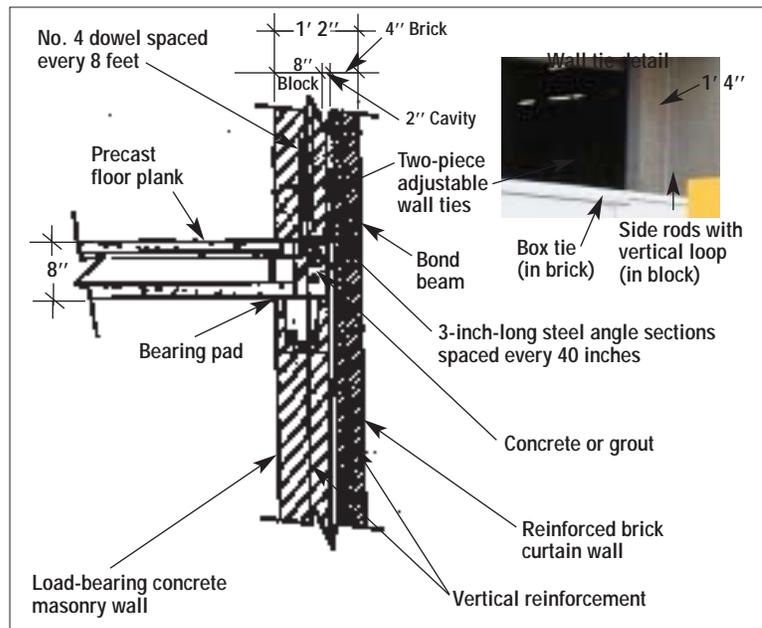


Figure 2. Attachment of 4-inch brick curtain wall to ends of precast floor planks; planks are supported by load-bearing concrete masonry walls.

tached to every floor slab and bearing directly on the footing, reinforced brick curtain walls enclose the entire building. Shelf angles were not used to support the brick, and exterior scaffolding was not used to lay it.

Overcoming differential movements

Differential movement determined the structural design of the Crittenden. Above 10 stories, the differential movement of brick and block walls becomes excessive. Due to creep and shrinkage, the Crittenden's block walls were expected to shorten up to $\frac{3}{8}$ inch. Due to temperature changes, the brick walls were expected to move up and down $\frac{3}{8}$ inch. Due to moisture absorption, they were expected to move another $\frac{1}{2}$ inch. Over the height of the building, the total movement could reach $1\frac{1}{2}$ inches, estimated structural engineer Steve Ebersole of Hach & Ebersole Consulting Engineers, Twinsburg, Ohio.

Ebersole designed the exterior brick so that it can move independently of the precast planks and block walls. "Like hot licorice on a sidewalk, the brick can grow and

stretch without restraint," he says.

Designed as curtain walls, the brick were reinforced vertically with one No. 4 rebar every 40 inches. Reinforced cores of the brick were grouted solid by hand in 4-foot lifts. Tied back to load-bearing concrete masonry walls, the front and back curtain walls were made of 4-inch brick. Running parallel with the precast planks, the side curtain walls

were made of 6-inch brick, completely unconnected to the metal studs and drywall behind them.

Though designed to move up and down freely, laterally the brick walls had to be fixed rigidly to transfer wind and seismic loads to the floors. To accomplish this, the curtain walls were anchored at every floor to the floor planks with special anchors that allowed movement vertically but not horizontally.

For the side curtain walls (Figure 1), a standard plate was precast into the top surface of the adjacent plank every 40 inches, coinciding with the vertical rebar in the brick wall. To connect the brick to the plank, a bricklayer bolted 3-inch-long steel angles to a bond beam in the brick wall at the same 40-inch interval. Then a mason who was certified as a welder welded the horizontal legs of the angles to the plates embedded in the plank.

A vertical slot in the angles allowed the bolts (and thus the brick) to move up and down. Any lateral wind or seismic loads were transferred through the bolts to the floor. To keep the bolts from punching out through the brick face, a plate was welded to the

Project participants

Owner: Crittenden Court Venture II, Cleveland

Development consultant: Devcom Inc., Cleveland

Architect: Richard L. Bowen and Associates Inc., Cleveland

Structural engineer: Hach & Ebersole Consulting Engineers, Twinsburg, Ohio

Construction management: Jacobson/Reliance Joint Venture, Cleveland

Masonry contractor: L.M.R. Construction, Chagrin Falls, Ohio

Craftworkers and laborers: International Union of Bricklayers & Allied Craftworkers, Local 5, and Building Laborers' Union, Local 310, Cleveland

Brick manufacturer: Interstate Brick, West Jordan, Utah

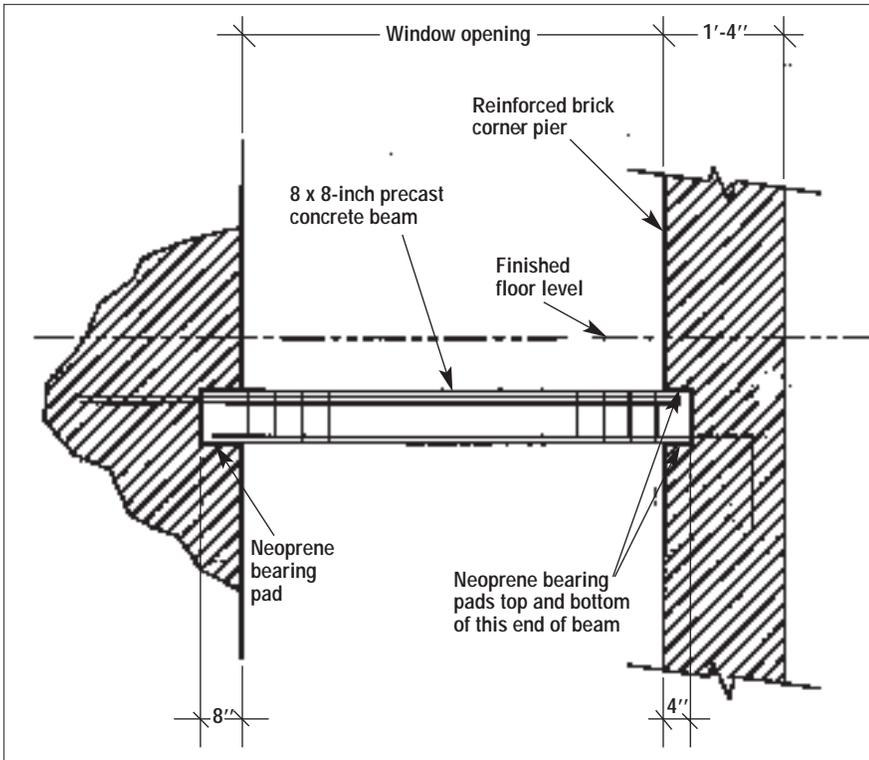


Figure 3. Precast concrete beam spans window opening between load-bearing block wall and brick corner pier.

end of each one, and these plates were buried in the brick bond beam, confined by rebar on each side and grouted solid. This provided a positive anchor.

The front and back curtain walls were anchored to the floors in the same way, except the anchorage plates were embedded in the ends of the planks in the field (Figure 2), not precast into the top surface of the planks during fabrication.

"The connections were simple," says Rick Rickelman, consultant for L.M.R. Construction, the Chagrin Falls, Ohio-based masonry contractor. "The engineer did a good job making them user-friendly."

Because the anchorage plates were field-installed, Ebersole didn't trust that these connections would reach full capacity. Consequently, he also had the front and back curtain walls connected by wall ties to the block backup.

Why not eliminate the floor connections for the front and back

walls and rely solely on the wall ties to transfer wind loads? Ebersole also couldn't trust the adjustable wall ties to carry the wind loads the full height of the building.

The ties are designed in two pieces: one for embedment in the block backup, and one for the brick. One piece slips into the other, allowing the differential vertical movement expected between the two wythes. (These ties typically are used to accommodate misaligned courses between wythes.) Ebersole feared the large expected movements would pull one piece too far out of the other piece, thereby reducing the tie's effective capacity.

In addition, wind loads at the top of the building would exceed the maximum loads that Ohio code allows for this type of tie. So instead of relying on only the wall ties or only the floor connections to transfer wind loads, Ebersole chose to be safe and incorporated both systems.



Northeastern Ohio Masonry Institute

Nine parallel reinforced load-bearing concrete masonry walls support precast floor planks and carry all live loads to the foundation. Attached to every floor slab and bearing directly on the footing, reinforced brick curtain walls enclose the entire building.

Why no shelf angles?

Typically, the brick skin on a high-rise building is designed as a veneer, supported by concrete block or metal studs that sit on the floor slabs. Lateral wind loads are taken by the block or studs, while the weight of the brick is carried by shelf angles anchored to the floor slabs. The slabs and columns of the building are designed to transfer the wind loads and brick weight to the foundation. This is the type of system that was considered at first for the Crittenden.

But the developer and construction manager already had decided the building would be loadbearing masonry. Years before construction began, L.M.R. had submitted estimates showing that masonry could be cost-effective. Loadbearing concrete block walls would be reinforced with one No. 6 rebar every 8 feet. As the block would go up, so too would the brick. In contrast, if a concrete or steel frame were to be used, the brick-

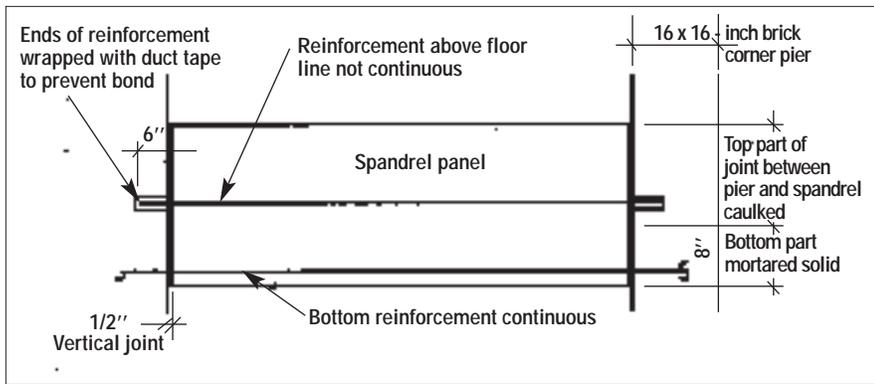


Figure 4. Reinforced brick spandrel spans window opening between brick curtain wall and brick corner pier.

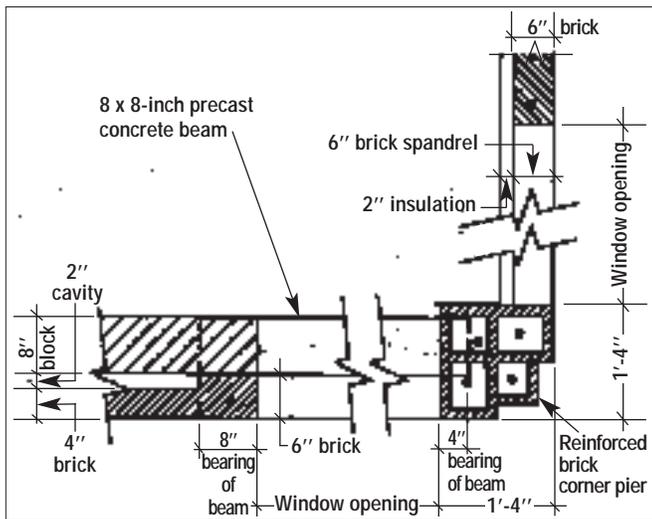


Figure 5. Reinforced and grouted, brick corner pier is made from two custom brick shapes.

work would have to wait until the frame was completed, prolonging construction two to three months.

With loadbearing concrete masonry, there is no concrete frame to attach shelf angles to. The angles would have to be attached to precast planks, and that posed problems. Do you preload the planks to take the camber out of them, or try to attach the straight shelf angles onto cambered planks? Loading only one longitudinal edge of a plank also would create eccentric loading, causing the plank to roll. Ebersole had seen the first plank joint crack because of this in other buildings.

He also wasn't aware of any anchors that could be embedded in

to the edge of a precast plank, let alone an adjustable anchor that could maintain its full load capacity throughout its adjustment range. Moreover, if shelf angles were used, they'd be needed at every floor. Codes allow attaching a shelf angle to every third floor (thereby reducing shelf-angle costs), but this would require

using a larger plank every third floor to carry the extra load. Not only would this increase plank costs, but it also would create an undesirable dropped ceiling inside the apartments.

Designing the brick skin as a curtain wall instead of as a veneer eliminated these shelf-angle problems. Though wall-reinforcement costs consumed any shelf-angle cost savings, the brick curtain wall saved money in other ways. For interior finishing, 4-inch 25-gauge steel studs could be used instead of 6-inch 18-gauge studs. In addition, exterior scaffolding could be eliminated completely. Masons now could lay brick from inside the building, working from

the newly set floor planks. Eliminating scaffolding alone saved \$192,000.

"Laying brick overhand made more sense," says Bob Carpenter, L.M.R.'s bricklayer foreman. Because the site was steep, sloping up 15 feet from front to back, erecting frame scaffolding would have been troublesome. Using a swing-stage scaffold would have required a bigger crane to reach all of the stages. To save money, the crane's reach was kept within the confines of the building perimeter.

To support the additional weight of the brick curtain wall, the perimeter concrete footings did have to be sized wider, but only by 6 to 12 inches, not a significant increase.

Because the curtain wall is tied to the floors and not to metal studs, it also eliminates any concern about corrosion of wall ties to steel stud backups. To prevent corrosion of the curtain wall-floor connections, through-wall flashing was placed through the curtain walls 8 inches above every floor. A 2-inch cavity was left in the curtain walls backed by concrete block.

On the inside of the 6-inch brick walls, 2 inches of rigid insulation was adhered to the brick. Because the insulation is closed cell, the dewpoint should not occur in the insulation, except in the joints between insulation boards. To drain any condensation that does occur in the insulation joints, the flashing was placed through the insulation and turned up.

A brick curtain wall offers benefits for concrete frame buildings, too. With a brick curtain wall, the concrete frame no longer has to carry the weight of brick veneer. Perimeter concrete floor beams and concrete columns can be designed smaller. Shallower perimeter beams might permit floor-to-floor heights to be reduced by a few inches.



Above: The brick curtain walls were anchored at every floor to the floor planks with special anchors that allow movement vertically but not horizontally. This photo shows work up to the 10th floor, prior to construction of the garage.



Right: Materials were moved to the interior of the topped-out building via a hoist.

Corner piers were critical

The most challenging detail in the building was the corner pier. To maximize views, in several places the architect projected the walls enough to give the apartments two corner windows. Between these two windows was a 16x16-inch corner pier that ran the full height of the building. Here a block bearing wall met an exterior brick curtain wall. On one side of the pier, an 8x8-inch precast concrete beam spanned the opening from the pier to the block wall (Figure 3). On the other side, a brick spandrel panel in the curtain wall spanned the other opening (Figure 4).

Ebersole expected all these elements to move a bit differently. He expected the precast beam to cock some, so he had neoprene pads placed under and over the ends of it. In the brick spandrel panels, he had duct tape wrapped around the ends of the top joint reinforcement to prevent bond. The duct tape, he hoped, would let the spandrel move slightly in relation to the pier; so he had this joint caulked, except at the bottom where continuous reinforced bond beams were located. The largest crack Ebersole expected in the bottom 8 inches of mortared

joint was $\frac{1}{32}$ inch. So even if the joint cracked, it would be a tight crack. To date, no one has noticed any cracks.

The corner piers were made from special brick shapes. Early on, L.M.R. realized that building the corner piers from standard brick would require seven or eight units. This was not at all practical. So the brick manufacturer bought new forms and custom-made two special brick shapes that would produce the architect's desired notched corner detail (Figure 5).

The Crittenden showcased three different colors of brick, each in six to seven different shapes. For window headers, bricklayers created a rowlock look, using units with three vertical slots in their 4x16-inch faces. Above the 16th-floor corner windows, where vertical bands of light brick ended, custom-made bullnose units created shadowed accent lines.

Masonry work takes priority

Unheard of on a brick veneer job, on the Crittenden the masonry contractor had first rights to the crane and hoist. "People had to schedule use of this equipment

around masonry needs," says Rickelman.

On an all-masonry job there also are fewer trades to schedule—no iron workers, no formwork crews, no concrete finishers. Fewer trades mean fewer conflicts over crane and hoist use and storage area.

The Crittenden was built on a small downtown site. Traffic was congested by construction of a light rail line nearby and by detours from a closed bridge. A policeman was required at all hours to direct traffic. To keep work moving, the contractors had to closely control material deliveries. Brick came from Utah by rail and was stored off-site. Floor planks came directly by truck from New York, were picked off the truck, and set directly into place.

L.M.R. split every floor into two halves, one for masonry work and one for setting precast planks. Bricklayers were split into crews, too, and the same crew laid the same corners all the way up the building. That way, each crew always knew exactly what was needed. This also contributed to good workmanship, as crews competed over who could build the most

plumb corner. To further ensure quality, Carpenter had corner piers checked and corrected for plumbness at every floor.

Because the brick had large 4x16-inch faces and were 4 or 6 inches deep, masons laid perhaps 10% fewer units a day than would've been possible with 4x4x12-inch utility brick; however, they laid many more square feet of wall per day.

Laying the larger brick units required fewer bricklayers. To Rickelman's dismay, for the past several years Cleveland has had a shortage of skilled bricklayers, and by necessity L.M.R. has had to lay more wall with fewer bricklayers.

New but not untried

While this brick curtain wall system is still new, it's not completely untried. In the 1980s, structural engineer Howard Noziska of Encompass Inc., Bloomington, Minn., designed a similar brick cladding to cover the deteriorating facade of the 20-story Oak Grove Towers in Minneapolis. As a base for the brick, at the first floor level, Noziska had a reinforced concrete perimeter beam added to the building's concrete frame. Bricklayers built a 19-story reinforced brick curtain wall atop this beam, tying the brick wall back to the building's post-tensioned concrete floor slabs at every floor. Adjustable ties allowed the brick to move up and down indepen-

Build it and they will come

The Crittenden was the first apartment building built in downtown Cleveland in 30 years. An initial study for the project was done in 1987, but the building wasn't built until 1995. What took it so long?

The original 290-unit, \$22 million building design had to be reconfigured into a 208-unit, \$14 million model. Interest rates had to fall from 10% to 7.25%, saving \$2 million. The City of Cleveland had to give a low-interest (4.5% to 5%) loan for \$400,000. And the federal government, through an Urban Development Action Grant, had to award the project a no-interest 20-year, \$3 million loan.

Original mortgage funding also came from AFL-CIO Housing Investment Trust, U.S. Department of Housing & Urban Development, Ohio Carpenters Pension Fund, banks, and other investors. As important as the funding was, it took more than just funding. People had to want to live in downtown Cleveland.

"Our timing was fortuitous," says William J. Warzlow, president of Dev-

com Inc., the development consultant for the project. At the same time interest rates fell and funding became available, the area along the twisting Cuyahoga River, called the Flats, coincidentally became an entertainment center. More than 7 million visitors a year now patronize the area's 50 restaurants, bars, nightclubs, and cruise ships. Only footsteps away, the Crittenden has views of the Flats, the Cuyahoga River, Lake Erie, and Cleveland's historic warehouse district.

From the start, the city planning commission, the historic district council, and the state preservation office wanted the facades of the Crittenden to be brick. All of the surrounding buildings were brick, stone, or terra cotta. But brick also served more practical reasons.

"Masonry provides a nice solid wall for sound attenuation," Warzlow attests. "With steel and drywall, you'd hear the neighbors breathing. Masonry is also low-maintenance. The lower we drive operating costs, such as maintenance, the more revenue that falls to the bottom line."

dently of the concrete frame.

If Oak Grove Towers was the Crittenden's predecessor, Cleveland's downtown Hampton Inn is its successor. Builders of the new 14-story hotel were so impressed by how fast the Crittenden went up that they recruited Hach & Ebersole and L.M.R. to adapt the

same loadbearing block, brick curtain wall system to it. Masonry work on the Hampton is due to begin this spring. ■

Mark Wallace is a freelance writer based in Oak Park, Ill., and a former editor of this magazine.