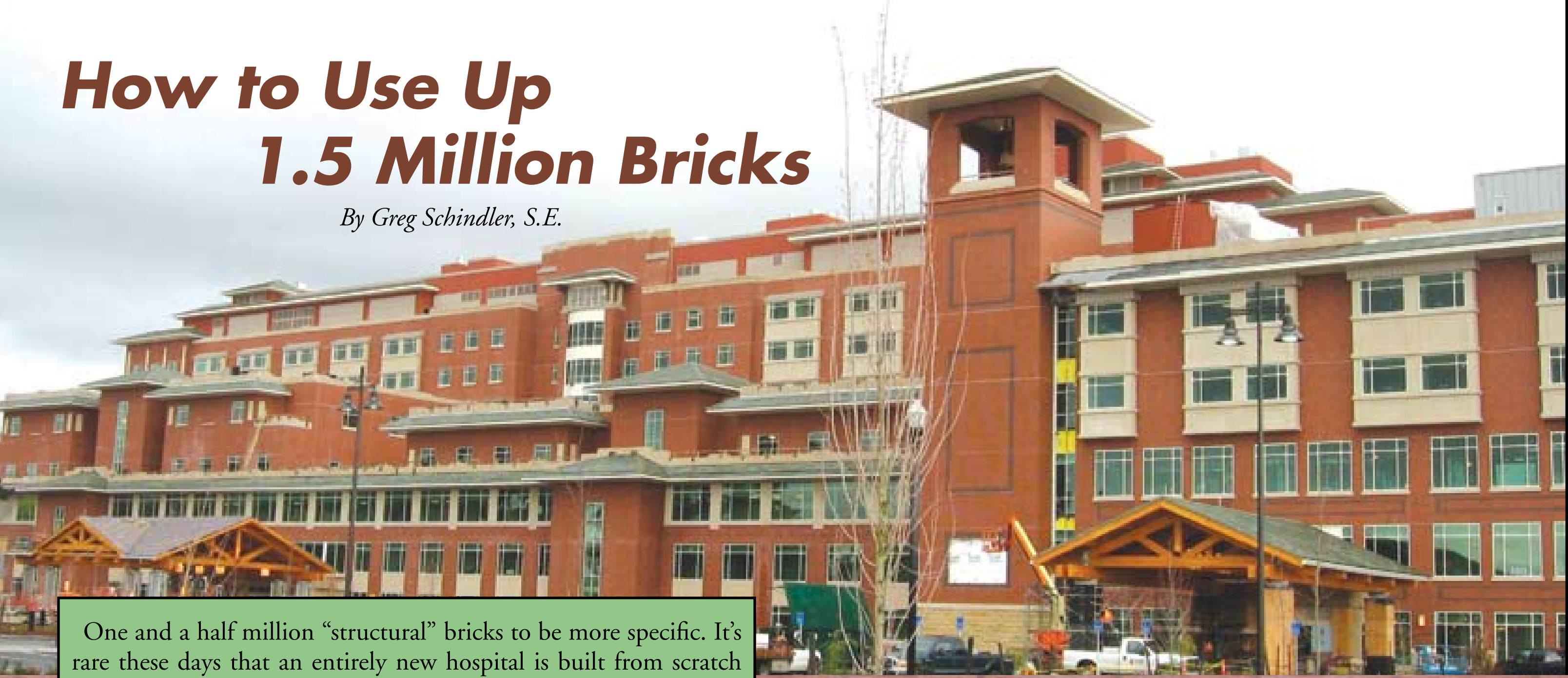
How to Use Up 1.5 Million Bricks

By Greg Schindler, S.E.



West Side of Hospital and OHVI.

One and a half million "structural" bricks to be more specific. It's rare these days that an entirely new hospital is built from scratch on an unobstructed site. The Sacred Heart Medical Center at RiverBend is such a project. Nestled into a bend in the McKenzie River at Springfield, Oregon, it is the largest construction project in the state. At approximately 1.25 million square feet, the project consists of a nine-story hospital for PeaceHealth, and a five-story building called the OHVI (Oregon Heart and Vascular Institute). In addition, a central utility plant, medical office buildings and parking garages are also being constructed on the site.

The architects envisioned a classic brick building, and originally intended to use brick-faced precast concrete as the cladding system. Early in the design process, KPFF proposed the possibility of switching to laid-in-place structural brick panels, as both an improvement in durability and as a reduction of cost

Laid-in-Place Panels

In the northwest part of the United States, the use of reinforced structural brick, or hollow clay masonry, has flourished and has commonly been used in prefabricated, reinforced structural brick cladding panels. These panels are manufactured in a shop production process in which masons lay up a panel as if it were a brick wall on the ground, placing horizontal reinforcing in bond beam courses and vertical reinforcing in the cells of the hollow brick units. Structural bricks differ from common bricks in that they have cells (greater than 1.5 inches square) rather than cores, similar to concrete block (*Figure 1*). Self-consolidating grout is then poured into the cells after each lift of the panel, often a whole story height. The grout flows horizontally and vertically to fill all voids in the brick resulting in a structural panel, similar to a precast concrete panel, which is then shipped to the site and lifted into place on the building.

Laid-in-place structural brick panels are similar in the final result to prefabricated panels, in that they end up as discreet structural panels on the building, supported for gravity at vertical load-bearing connections, and braced for out-of-plane loads, by two or more lateral connections. The primary difference, as the name suggests, is that the panels are laid up in place on the building. However, unlike anchored brick veneer, which generally is continuously supported along the bottom, the structural brick panels may be supported on two individual gravity connection points per panel. The panels are separated by vertical control joints at similar locations as would be used for precast concrete panels.

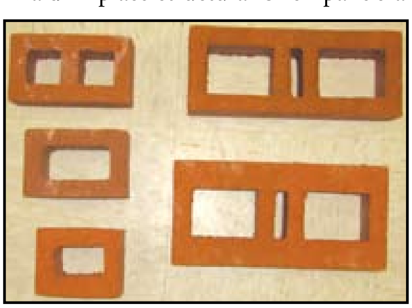


Figure 1: Hollow Clay Bricks.

Horizontal Joints

Also similar to concrete panels, there are horizontal joints, usually at the window head level, to accommodate horizontal building drifts and vertical structural deflections. It is at these horizontal joints that this system becomes interesting and somewhat more complicated than prefab panels. First, since the bricks are laid in place, there must be a temporary support at the horizontal joint on which to start the next panel. This is accomplished by installing a layer of rigid polystyrene foam in place of a mortared bed joint. The stiffness of this material is chosen to be just enough to support the weight of that portion of the brick anticipated to be in place prior to the gravity connections becoming effective. At the window openings, the masons place the foam on the window buck (*Figure 2*). After the panel is complete and

Figure 2: Brick Wall Construction.

Figure 3: View of Wall Cavity.

the grout has set, the foam layer could be removed, but it is left in place and becomes the backing for the joint caulking.

The second issue with the horizontal joints relates to flashing and water control. Although reinforced and grouted structural brick is much less permeable than anchored brick veneer, it is usually assumed that some water may penetrate the panel and run down the inner face. For that reason, flashing is required at the horizontal joints. Here is where close coordination with the architect is required. The flashing must be placed on top of the foam layer, attached to the sheathing and overlapped by the moisture barrier. Similar to the case with anchored veneer, an air gap is required between the sheathing, or insulation if it is used, as it was in this project (*Figure 3*).

A third item to consider at the horizontal joints is the interface of the window head with this joint, which needs to accommodate horizontal in-plane drift and vertical story-to-story deflection. This is similar to precast concrete panels. Generally, window systems span vertically from sill to head. Coordination is required with the window supplier to ensure that their system can connect across this joint at the window head, and still facilitate the structural movements.

Load Support

The most unique aspect of laid-in-place structural brick is that each section, or panel, of brick is supported on only two discreet gravity load support connections, which makes the system more similar to precast concrete than typical brick masonry. As in precast, you only want two points of gravity support per panel to avoid having the vertically stiff panel act as a multiple-span continuous beam. For this project, which has a reinforced concrete structure, embedded steel angles were set in the slab/beam edges at the support points. As shown in *Figure 4*, the connection then consisted of vertical cantilever "fin" plates that were field aligned and welded to the embeds. Shop welded to the outer ends of these plates, a vertical face plate was mated with a short shelf angle with A325-SC bolts in vertically slotted holes. These holes provide for vertical field tolerance. The contractor surveyed for the horizontal alignment of the mating plate and welded the vertical fins to the embeds. When the masons laid up the brick to the course where these bearing connections occurred, the shelf angle was adjusted vertically to lie on the top of the brick and the tension-control bolts were tightened to the standard pre-tensioning requirements. Vertical reinforcing bars were then dropped through the holes in the shelf angle, and the masonry lay-up continued up to the level where the panel was grouted. Only three different gravity connector types were used for the entire project, with the number of fin plates varying according to load capacity.

Several different configurations of lateral connections were used, but most consisted of a WT section with its stem embedded in a mortar joint from the back side of the brick. A pre-formed steel channel was welded to the WT flange with a threaded push/pull rod extending back through the sheathing to an angle that cantilevered down from the concrete beam soffit. These are shown in *Figure 5 (page 36)*, awaiting the brick to be laid up to encase them. Typically, the lateral connectors were located near the bottoms of the panels directly below the gravity supports. The tops of the panels were clipped to the bottom of the panels above with a panel-to-panel connector that allowed in-plane and vertical movement, but resisted out-of-plane loads. This also is similar to precast technology.

Design Considerations

The key to using this system, especially on a project of this size, is careful planning and good documentation. The drawing package for the structural brick system consisted of dimensioned plans locating all of the embeds and connector types, elevations of every wall segment in the project showing the vertical location of the connections, and a series of connection and reinforcing detail sheets

During design, there are some special things to think about. One is cracking of the brick. While the expansive characteristics of brick limit shrinkage cracking, flexural cracking is still an issue, just as with reinforced concrete. As with concrete, in order for the reinforcing to accept load, the masonry must crack to some degree. The difference is that cracks through bricks, while not much of a structural concern, are very much an aesthetic concern. Cracks are assumed to occur mostly at the mortar joints. For the vertical out-of-plane bending action in a panel, the cracks will occur horizontally at the mortar bed joints and are generally not a visual problem. But vertical flexural cracks through running bond brick are a visual problem. For that reason, under horizontal bending action, the panels are designed so they do not exceed the flexural tensile capacity of the brick under normal service loading. In addition, since these cracks would be vertical, they would

Figure 4: Typical Gravity Load Connector.

Figure 5: Panel Connection Points.

run up through a line of head joints. This means that a crack would pass through the middle of a brick at alternate courses in the typical running bond pattern. Therefore, the flexural capacity of the brick panels in the vertical plane is based on one half of the panel height, just counting every other brick course. Doing this assures that, under normal service load conditions, the brick will not develop unsightly flexural cracks. Of course, under more extreme loading like seismic, the panel would potentially crack and the horizontal reinforcing would then resist the tension due to bending forces.

Attention should also be given to the specific fire resistance requirements of the building. The structural brick veneer system is considered a "Masonry Curtain Wall." Careful coordination with the appropriate building department officials is recommended due to the unique character of the panels.

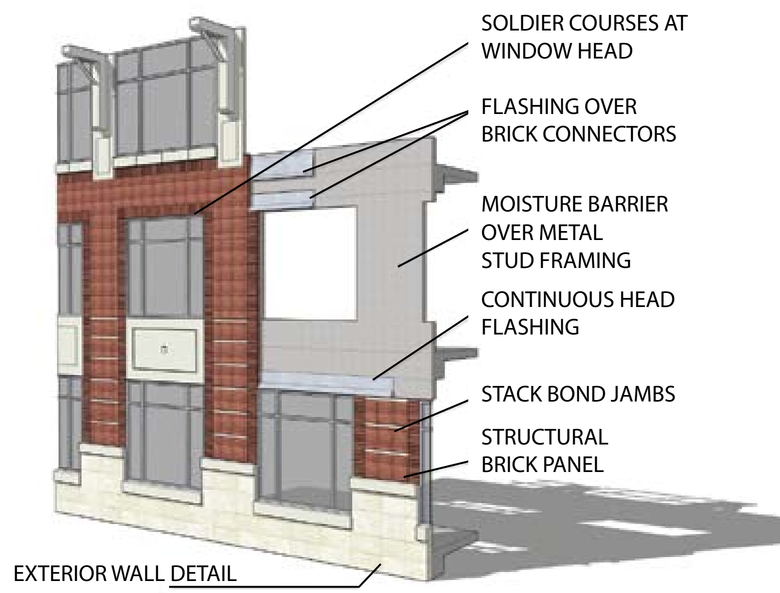
Pros and Cons

This structural brick veneer system has several advantages. It produces a reinforced structural masonry enclosure that is more robust than typical brick veneer systems. It is lighter weight than brick-clad precast concrete panels. It allows the metal stud wall system to be simpler and lighter since it is only supporting the drywall and sheathing. One of the primary advantages is that reinforced veneer is less permeable than typical anchored brick veneer. Unlike concrete, which shrinks over time, clay brick actually expands for the first few years. This expansion works against the tension resistance of the reinforcing, so the brick sort-of "post-tensions" itself, which helps limit water intrusion. This makes the system ideal for long-life buildings like hospitals or other important public facilities.

Another advantage is the laid-in-place panels can allow the architect greater freedom to articulate the brick surface, and create deeper relief features and surface patterns, than with traditional veneer that relies on masonry ties and a back-up structure (*Figure 6*). When the total cost of the wall construction from the outside face to the face of the interior finish is evaluated, the structural brick veneer system is very cost effective and can actually cost less than more traditional brick systems.

Disadvantages might include the need for more coordination with the architectural design, and some education of the owners and architects. It also requires a masonry contractor who is willing and capable of dealing with a bit more intricate and technical brick masonry construction. The vertical and lateral support connections require more attention than simple shelf angles and brick ties. Overall, the advantages outweigh these potential disadvantages.

Whether used in prefabricated panels, ground supported structural walls, or laid-in-place panels as in this project, structural hollow clay masonry presents another option to provide the owner with a very robust and durable exterior skin for almost any type of brick clad building.▪



Architectural Rendering of Wall System, Courtesty of Anshen + Allen Architects.

Figure 6: Closeup of Brick Feature Band.

Project Participants:

Owner: PeaceHealth
Design Architect: Wimberly Allison Tong and Goo
Architect of Record: Anshen + Allen
Structural Engineer of Record: KPFF Consulting Engineers
General Contractor: Turner Construction Co.
Masonry Subcontractor: Davidson's Masonry

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