

## LEC Helps Bradley University Expand:

**By David Larsen, PE, SE.** Losch Engineering Corporation has recently been engaged as precast specialty engineer for two projects on the campus of Bradley University in Peoria, Illinois. These projects represent a broad cross section of precast applications. The first, which has already been erected, is the university's new parking structure. The second, which is still under construction, is the new arena facility adjacent to the parking structure.

The parking structure consists of a mixture of both structural and architectural precast components as well as structural precast components with an architectural finish. The structural precast includes double tees, inverted tee beams, ledger beams, columns, horizontal light walls, horizontal shear walls, interior ledger spandrels, interior wall panels, and stairs. While these components are typically seen in parking garage construction, the exterior envelope is unique to the project. The east and west exterior elevations include both level and sloping structural load bearing pocket spandrels with an architectural finish that peek out through rib framed openings formed between heavily rusticated cladding panels, column covers, and spandrel covers. The edges of the precast stairs do likewise at the towers on the northeast and southeast corners of the building. These architectural panels also support the stairs and landings. The north and south exterior elevations are made up of horizontal panels with punched openings that share the heavily rusticated nature of the cladding panels on the east and west but also serve as the major shear walls for this direction.



*New Parking Structure for Bradley University in Peoria, IL.*

In order to fabricate the wide variety of product types and to complete the project on schedule, we worked together with our client, MPC Enterprises, Inc. as well as several other precasters, including Lombard Architectural Precast Products, Co., ATMI Precast, and Mid-States Concrete Products, Co.

As work was completed on the parking structure, work was beginning on the arena with another client, Mid-America Precast, Inc. While the precast for this building is primarily cladding, at three stair locations the panels also support a joist and metal deck roof structure. Although these panels share the heavily rusticated, ribbed appearance used for the garage, that is where the similarity ends. Some of these panels are over 40 feet tall and vary from as much as 20" thick around the openings to as little as 9" thick at mid-height. They are conventionally reinforced, without prestressing, for ease of production. In addition, 3" of expanded polystyrene insulation was required to meet the R-value desired by the architect. To make this work, the insulation is centered on the minimum panel thickness and the wythes are connected together to act compositely. The rigidly defined rustication pattern demanded creative re-panelization of the elevations in order to provide a structurally sound solution within their context.

These projects highlight many of the uses of precast concrete in construction, including using structural components to provide an aesthetically pleasing envelope. They also demonstrate Losch Engineering Corporation's wide range of experience in working with different types of products and clients. Feel free to contact us if we can be of assistance on your next precast project.



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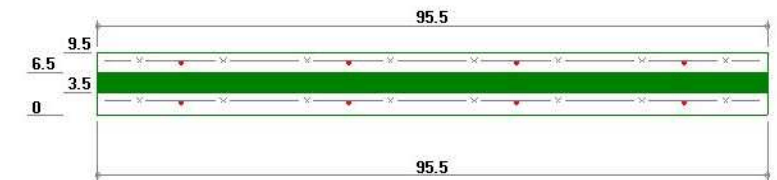
(847) 705-1396 Info@LoschEng.com www.LoschEng.com  
Offices in Palatine, IL, and Omaha, NE



## The Losch Letter Fall, 2008

### Precast/Prestressed Concrete Sandwich Walls, Part 1:

**By Edward Losch, PE, SE.** Precast sandwich wall panels have gained in popularity over the years, but some engineers are still not very familiar with them. A typical panel has two outer concrete layers, or "wythes", separated by rigid insulation (Fig 1), and is cast in a long-line form in a plant. One or both wythes are usually prestressed to reduce cracking and improve performance. The panels are trucked to the job site and erected with a crane. Panels can carry roof and floor loads or just act as cladding (load-bearing vs. non-loadbearing, Fig 2).



*Figure 1: Typical sandwich wall section*



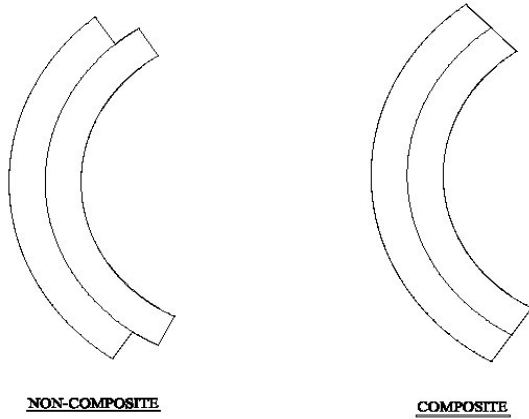
*Figure 2:  
Loadbearing  
panels carry a  
steel roof*

There are different types of panel designs to consider:

**Non-Composite**

In non-composite panels, the concrete wythes act independently (Fig 3).

Figure 3: Concrete wythe behavior:



This design is used when a high insulation value is required, such as for a cooler or freezer building. The wythes are isolated by high-performance rigid insulation and are connected together solely by thermally non-conductive pin connectors (Fig 4). The pins are proprietary, made of either a fiberglass and vinyl ester or polypropylene plastic or other non-conductive material.

Figure 4: Non-composite wythe connector



**Fully-Composite**

In fully-composite panels. The wythes act together as a unit for full horizontal shear transfer. A typical composite panel is eight times stiffer, can take three times the stress without cracking and has twice the ultimate strength of a non-composite panel of similar thickness. Composite panels are typically less expensive to make than non-composite panels, can carry more load and can be made taller and thinner. This is the most commonly used panel type. One drawback is that horizontal shear transfer between wythes is normally accomplished by adding zones of solid concrete and/or metal trusses (Fig 5).

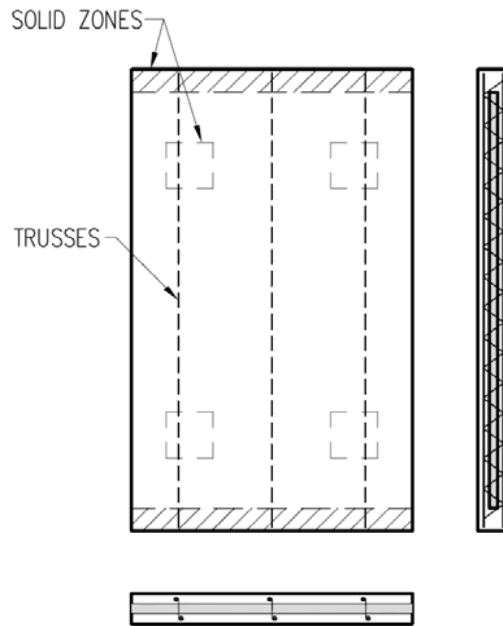


Fig 5: Wall panel with solid zones and metal trusses

These can create thermal bridges in the panel, reducing its effective "R" value. This is somewhat mitigated by the beneficial thermal mass effect of concrete.

Composite panels often bow outward when exposed to direct sunlight, due to the temperature increase and subsequent expansion of the outer wythe. This characteristic is normal, but should be

taken into account if panels are attached to or butt up against an intermediate floor near mid-height. On one project, the suspended ceiling track was attached directly to the precast panels at a southern exposure. When the sun hit the panels, they'd bow out and ceiling tiles would fall out of the track. The tiles would be replaced, then fall out again the next day. This went on for a while until the precast manufacturer was called in and identified the problem.

Shrinkage cracking can occur in composite panels when one concrete wythe is more than twice as thick as the other wythe. The thin wythe shrinks faster and acts like a canvas stretched on a frame. For this reason, wythes should be kept close to equal thickness for composite designs.

**Partially Composite**

Partially-composite panels provide less than full shear transfer between wythes. They behave in a manner in-between composite and non-composite. The degree of composite action is determined by load tests performed by an independent testing lab. Partial composite action can provide sufficient strength for most typical applications.

We have been involved in the development of a proprietary partially-composite wall system from Composite Technologies Corp which

combines the high insulating value of non-composite panels with the strength and slenderness of composite panels. This is accomplished using nonconductive bar connectors between the wythes for shear transfer (Fig 6).


Figure 6: Partially composite wythe connector



The Thermomass C-Wall Composite Connector is designed to provide a high level of composite action in tall, slender sandwich wall panels without compromising thermal efficiency. Losch Software assisted in creating a software design tool for this system. Instead of guessing, the engineer is able to determine exactly how much composite action is provided by the C-Wall connector system, using this new software.

**Summary:**

It is important to keep the above design types in mind when determining a standard wall thickness for a particular project. Since the panels are cast in a form that is usually several hundred ft. long, the thickness should ideally be the same for all the panels on a particular project, to avoid excessive setup costs. Occasionally a designer will select a panel thickness based on the assumption of full composite action, but then insist on thermal performance that can only be achieved with a thicker, more expensive, non-composite design. We would be glad to work with you in specifying an appropriate panel thickness and design type for a particular project.



LECWALL

Software For Precast/Prestressed Sandwich Wall Design

LECPRES

Software For Precast/Prestressed Beam and Slab Design