

## HYBRID SYSTEMS

Precast concrete components can be combined with other construction materials, particularly steel or cast-in-place concrete, to create a “hybrid” system. Examples include architectural precast concrete cladding supported on a structural steel or cast-in-place concrete frame as well as precast, prestressed double tees or hollow-core used as the floor system on a parking garage where the main structure is steel.



*Mariott Pewaukee West, Pewaukee, Wis.;  
Architect: FRCH Design Worldwide;  
Photo: The Spancrete Group Inc.*

Whenever two materials are combined to create one structural system, the attributes of each material must be evaluated and addressed to ensure the proper outcome. The appropriate steel and cast-in-place concrete standards should be applied in all cases, and it must be remembered that the standards for each material do not apply to buildings of composite construction, such as with concrete floor slabs supported by steel columns or with concrete-encased, structural-steel members or fireproofed frames.

### STRUCTURAL-STEEL FRAMING SUPPORTING ARCHITECTURAL PRECAST CONCRETE CLADDING

Structural-steel-framing tolerances should conform to standards issued by the American Institute of Steel Construction. Precast concrete panels should follow the steel frame as erected, because the allowable tolerances for steel-frame structures make it impractical to maintain precast concrete panels in a true vertical plane in tall structures. The adjustments that would be required to make the connections practical are not economically feasible.

A practical and economical solution is to specify the more stringent AISC elevator-column erection tolerances for steel columns used in the building façade that will receive the precast concrete panels.

A structural-steel-frame building presents different erection and connection considerations from a concrete-frame building. For example, structural-steel beams, being relatively weak in torsion when compared to concrete, generally require the load to be applied directly over the web or that the connection be capable of supporting the induced torsion. This in turn places a greater structural requirement on the connection and creates difficulties during erection if any rolling behavior occurs in the steel beam.

Observations in the field have shown that where precast concrete panels are erected to a greater height on one side of a multistory, steel-framed building than on the other, the steel framing will be pulled out of alignment. Precast concrete panels should be erected at a relatively uniform rate around the perimeter of the structure. If this does not happen, the designer of the structural frame should determine the degree of imbalanced loading permitted.



Meridian, Columbia, S.C.;  
Architect: SWSC; Photo: ©2003 Brian C. Robbins,  
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### **STRUCTURAL-STEEL FRAMING SUPPORTING A PRECAST, PRESTRESSED CONCRETE FLOOR SYSTEM**

At times, it may be beneficial to create a structural-steel frame that supports either double tees or hollow-core plank as the floor and roof system. This has been used in parking structures, office buildings, and other applications. The objective in all cases should be to utilize the positive attributes of each material to its best advantage such as the resistance to corrosion of double tees used in a parking garage.

As noted above, consideration must be given to the different standards governing the materials to be used.

### **CAST-IN-PLACE CONCRETE FRAMES**

Cast-in-place concrete frame tolerances are given in *ACI 117, Standard Tolerances for Concrete Construction and Materials*, unless otherwise stated in the specifications.

These tolerances are not realistic for tall buildings. In addition, greater variation in heights between floors is more prevalent in cast-in-place concrete structures than in other structural frames. This can affect the location or matching of the inserts in the precast concrete units with the cast-in connection devices. Tolerances for cast-in-place concrete structures may have to be increased to reflect local trade practices, the complexity of the structure, and climatic conditions.

It is recommended that precast concrete walls should follow concrete frames in the same manner as for steel frames, if the details allow it and appearance is not affected.

Unless the cast-in-place structure is executed to above normal tolerances, the width of joints must be designed to allow for a large tolerance. The actual joint width may differ in each bay and will certainly require sealants with corresponding flexibility. Joint widths may be adjusted to allow them to be equal at either end of a panel, but equalizing the joints on either side of a column should not be done unless panels can be adjusted horizontally after erection. The problems this can cause are avoided where the cladding passes in front of the columns and the jointing is between the panel edges.