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Shoring a Precast Concrete Parking Garage

A Photo Essay

The garage has three levels, one on the ground and two framed levels. There is a separate cast-in-place concrete ramp structure in the rear.

The garage framing consists of precast concrete "single tees," 11'-5" wide by 3'-4" deep, spanning 65 feet, with the stem of each tee being supported on a precast concrete column on the exterior, and on a cast-in-place concrete column on the interior. There is a 6 inch concrete topping over the tees.

At the accesses to the ramp structure, the single tees are supported on cast-in-place concrete girders. Each girder has two brackets with each bracket supporting a single tee. The bottom of the girder is flush with the bottom of the single tees.

As the photo shows, the ends of the single tees are dapped at the girders, and are supported on reinforced concrete brackets that project from the girders and were cast integrally with the girders. The vertical load from the end of the single tee tries to twist the bracket off of the beam. This action is normally resisted by reinforcing steel in the bracket and girder; however, vertical hoop reinforcing (closed stirrups) in the girder, which would resist this action, was omitted from the design and the construction, causing the cracks shown.

Another view of the cracking. The single tee is on the right of the photo. Zallen Engineering investigated this problem and recommended that the garage be shored near the brackets. This recommendation was accepted and Zallen Engineering designed the shoring system.

The shoring supported the stems of the second and third floor single tees near the girder brackets. This photo shows the shoring on the first floor at the access to the up ramp. There was additional shoring above on the 2nd floor supporting the third level single tees.

From top to bottom, there is an oak pad between the stem of the single tee and a 12" x 12" Southern Pine shore, then a steel fixture which spreads the load to oak wedges, then timber spacers, then a bottom steel fixture which spreads the load to timber cribbing. The cribbing is below the ground surface due to the proximity of large column footings.

This photo shows a close-up of the wedges, and the jack that was used to lift the single tees. When the jack lifted the steel fixture and the single tee, transferring load into the shoring system, the wedges were driven into the space between the steel fixture and the timber spacers.

Another close-up view of the shoring.

This photo shows the system used on the second floor. The oak beams with the screw jacks transfer load from the third level single tees to a steel beam consisting of two spaced channels. The center of the stems of the single tees of the third floor do not line up with the center of the stems of the single tees of the second floor. The beam prevents eccentric load on the shores below.

A different style of shoring was used at a location where the span of the single tees are relatively short and the load is lighter. The shore is supported by an oak beam with cast-steel inserts engaging a pair of screw jacks. As the jacks were turned to lift the load (the jack handles are not shown), wood wedges were driven below the oak beam to support the load.

Principal Rubin M. Zallen, P.E. investigated this failure, and designed the shoring and its installation

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