CERAMIC TILE INSTITUTE OF AMERICA, INC.

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CTIOA FIELD REPORT 2003-7-21(R 4/04)

Subject: Ceramic Tile Installation on Post-Tensioned Structure Slab

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INTRODUCTION:

We have noticed an increasing number of ceramic tile installations are taking place on post-tensioned concrete slabs, both elevated and ground-supported. Post-tensioned slabs are now commonly found in residential slabs-on-ground, parking structures, condominiums and apartment buildings, office buildings, industrial floors and hotels.
Designed and built in conformance with standard industry practices, many design professionals and contractors feel that post-tensioning is a superior slab construction method. The structural benefits of post-tensioned slabs include: longer spans, thinner slabs, lighter structures, increased crack resistance, deflection control, and improved durability. These qualities can help assure a successful and durable tile installation over time. However, it is important for the contractor to have a basic understanding of post-tensioned slab mechanics and the materials and methods for a successful tile installation.

DISSCUSION:

A post-tensioned concrete slab contains high-strength steel tendons stressed with hydraulic jacks after the concrete has been placed. Stressing usually takes place when the concrete reaches 75% of its 28-day design compressive strength, which typically occurs within 4-7 days after placement. Virtually all post-tensioned tendons used today in commercial and residential building structures in the United States consist of ½-inch diameter, 270 ksi strands, each with a factory-applied coating of corrosion-resistant lubricant contained in an extruded plastic sheath. These are called "unbonded tendons" because the prestressing steel is permanently free to move inside the sheath relative to the concrete. All axial force is applied to the concrete by mechanical wedge anchorages attached at each end of the tendon. Each ½-inch diameter tendon is initially stressed to a jacking force of about 33,000 pounds, and is anchored to the concrete at an initial force of about 29,000 pounds. Stress losses in the prestressing steel reduce this initial force to a long-term effective force of about 25,000 pounds. The following factors affect stress loss in the prestressing steel:

a. Friction between the prestressing steel and the sheath during stressing.
b. Seating loss due to movement of the wedges in the anchorage during stressing.
c. Elastic shortening of the concrete.
d. Creep of the concrete.
e. Shrinkage of the concrete.
f. Relaxation of the steel.

Items a) through c) above are losses that occur during the stressing operation. Items d) through f) are long-term losses that occur after stressing is complete. The axial slab shortening that produces long-term stress losses d) and e) can induce compression into bonded tile and stone, and cause buckling and spalling.

Elevated post-tensioned slabs normally vary in thickness between about 5 and 12 inches depending on loading and spans. Post-tensioned slabs-on-ground vary in thickness between about 4" in ribbed foundations and 18 inches in uniform thickness foundations depending on the expansivity of the soil and other climatic and design conditions. About 50% of all residential post-tensioned slabs-on-ground are built in Texas, about 25% in California, and the remaining 25% distributed throughout the United States with concentrations in Nevada, Louisiana, Arizona, Florida, Georgia and Colorado. In some areas, notably Texas, slabs are typically cast directly on an underlying plastic vapor retarder; in other areas, notably California, slabs are typically cast on a thin sand base, which is placed over the vapor retarder.

In normal building environments post-tensioned tendons are protected from corrosion by the use of materials and installation practices conforming to industry guidelines and specifications published by the Post-Tensioning Institute (PTI). In aggressive environments tendons can be “encapsulated”, a system which completely isolates them from the concrete and the surrounding environment, maximizing corrosion protection. See references below for tendon material and installation specifications including definitions of normal and aggressive environments.

CONCLUSION:

Designers and engineers often choose post-tensioned slab construction because of low cost, ready availability, flexible column spacing and structural depth, soil conditions, and demanding construction schedules. Post-tensioned slabs also offer advantages in fire resistance and reduced sound transmission..

In comparison to non-prestressed concrete slabs, post-tensioned slabs generally have less deflection, less cracking (although the cracks that do develop tend to be wider), and more axial shortening. Tile installations on post-tensioned slabs should conform to the following criteria:

- TCA “method F111 is the preferred method over pre-cast concrete floor systems, post-tensioned concrete floor systems and other floors subject to movement or deflection”.
- TCA “method F113 is suitable for post-tensioned slabs on grade providing the surface of the slab meets all those requirements contained therein.” However, TCA cautions “Special precautions should be taken when tiling over post-tensioned or pre-stress concrete floor systems. The use of an anti-fracture membrane should be considered.” CTIOA recommends the architect use an industry approved anti-fracture membrane with a flexible latex bonding mortar is recommended.
- TCA “method F113 may be suitable for above grade structural slab installations when specific mortar and grout products recommended by the manufacturer are specified. Not all modified mortar and grout products are suitable for this application”. The use of an industry approved anti-fracture membrane with a flexible latex bonding mortar is recommended.
- Movement Joint (Architect must specify type of joint and show location and details on drawings). Follow EJ171 slab-on-grade installations. Above-grade structural slabs: exterior joint spacing; perimeter joints are mandatory.
- Installation Specification: tile – ANSI A108.5; grout – ANSI A108.1.

References:

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