Frequently Asked Questions

Slab-on-Ground Construction

Answers from the PTI Slab-on-Ground Committee *July 2001 • Issue No. 3*

QUESTION: Is the placement of a vapor retarder recommended beneath a post-tensioned slab-on-ground foundation and, if it is, should it be placed on top of or below the leveling sand?

ANSWER: There have been several articles[1] published concerning the use of vapor retarders (often incorrectly referred to as "vapor barriers"), with a range of conclusions from "absolutely no" to "yes, without exception," and different opinions as to its placement on top of or below the leveling sand. There is no clear-cut answer to this often-asked question.

This is not a question that has a definitive consensus recommendation from regulatory and/or advisory organizations. The International Residential Code (IRC) 2000 (with exceptions) requires a vapor retarder ". . . *placed between the concrete floor slab and the base course or the prepared subgrade where no base course exists.*" (R506.2.3). The use of vapor retarders is also addressed in several ACI committee reports (including committees 302, 311, 332 and 360). ACI has modified its position, previously expressed in 302.1R-96, Section 4.1.5, that vapor retarders be placed ***under*** granular fill, pointing out problems that have occurred with such placement and recommending instead that each proposed installation be independently evaluated based upon project conditions and the potential effects of slab curling and cracking (*Concrete International*, April 2001, p. 72–73). ACI Committee 302 is revising 302.1R-96, addressing the various factors that may affect vapor retarder placement, but the current draft of this document (March, 2001) makes no definitive recommendation as to a universal placement; instead, it provides guidance for designers based on the specifics of the slab under consideration. In light of the above, comments were solicited from PTI Slab-on-Ground committee members, as well as consultants and associates of these committee members. Of the responses received, the clear majority recommended the use of a vapor retarder and its placement directly beneath the concrete.

Uniformly, the consistent positive comment was the benefit that the vapor retarder provided in minimizing vapor transmission through the concrete. The placement of the vapor retarder on top of the leveling sand also provided a better base for the support of the tendons and eliminated the possibility for field problems that occur when the leveling sand is on top. When the sand is on top of the vapor retarder, displacement of the sand during concrete placement can result in reduced slab thickness and/or beam properties, mixing of sand with concrete, and an uneven underside surface of the concrete slab, increasing the effects of subgrade friction.

Uniformly, the consistent negative comment was that the vapor retarder caused the retention of moisture in the bottom of the slab, allowing the top (exposed to the air) to cure differentially. This caused the slab edges to curl and, in some cases, shrinkage cracks to form. Curling and cracking could be minimized by placing the sand layer on top of the vapor retarder; however, this causes greater concerns for the performance of the foundation, as listed above. As recommended in Section 4.3 of PTI's "*Construction and Maintenance Procedures Manual for Post-Tensioned Slab-on-Ground Construction*," 2nd Edition, cutting the vapor retarder in the bottom of the ribs will aid in water egress from the bottom of the concrete during curing. The major concern for the placement of the sand layer on top of the vapor barrier is the displacement of the sand during concrete placement.

Based on comments that were received, the consensus opinion of specialists in the design and construction of post-tensioned slabs-on-ground is that a vapor retarder be placed beneath all post-tensioned slab-on-ground foundations used for residential applications and that the vapor retarder be placed on top of the leveling sand. Designers should evaluate each installation on a case-by-case basis and make their own decisions about vapor retarder use and placement as they see fit, based upon the information available to them and the conditions and history that exist in their geographic area.

For industrial floors and special-use foundations, the use of a vapor retarder may reduce slab subgrade friction; however, the negative effect of slab curling due to differential curing rates must be anticipated.

One additional factor that may be of special note is that in areas with low humidity and low annual rainfall, vapor retarders may be eliminated and in some cases may not be allowed by local regulatory agencies. In these cases, a granular fill should be placed beneath the slab to provide a barrier against capillary action. If the vapor retarder is eliminated, the subgrade should be pre-wetted so that it does not accelerate the reduction of water from the bottom surface of the concrete during curing.

[1]*Concrete Construction Magazine*, March 1999, pp. 23–31; July 2000, pp. 53–55; February 2001, p. 178.

QUESTION: What is the maximum height of a step in a foundation where a continuous tendon can be used? Figures 12 and 13 of the Construction and Maintenance Manual currently show this as 6 inches.

ANSWER: Architectural and existing grade elevations often require the use of steps in foundations that are greater than 6 inches. The use of discontinuous tendons at these stepped locations can present several construction difficulties:

- The anchors cannot be attached to the floating form since this form is removed during the pour once the concrete has reached its initial set and the vertical face can be held. If the anchors are attached to the form, they will be dislodged from the concrete when the form is removed.
- There is not sufficient supplemental reinforcing to which the fixed-end anchorage can be tied (in lieu of attaching them to the form) in order to prevent dislocation during the pour.
- In residential applications, providing discontinuous tendons would result in very short tendons. These are difficult to stress and often result in low effective forces.

The committee is now aware of much successful experience with continuous tendons through vertical slab steps of up to and, in some instances, greater than 12 inches. Based upon this successful experience, the committee recommends a modification to Figures 12 and 13 in the Construction and Maintenance Manual increasing the 6-inch vertical step dimension to 12 inches.

Supplemental reinforcing may be added by the engineer to prevent spalling of the upper edge and to provide continuity through the stepped transition.

The transition ratio of step height to transition length shall be a minimum of 1:6. The tendon should be placed with a straight profile through the stepped area to avoid pullouts caused by upward tendon forces exerted at the step. Minimum cover should always be provided for the tendon through the transition.

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