Concrete

Q&A

Anchoring into Housekeeping Pads

Q. *There are many cases where an anchor bolt (cast-in-place [CIP], expansion, undercut, or adhesive) is to be placed in concrete that has a cold joint. A common example occurs when a piece of equipment is installed on a thin (3 to 6 in. [76 to 152 mm]) housekeeping pad. The equipment needs to be anchored for seismic loads, and calculations typically indicate the anchor embedment must be greater than the thickness of the pad. The typical sequence of construction is to place the slab, place the equipment pad at some later date, and install the anchors in the hardened concrete. Whenever possible, I have required that the anchor embedment be measured from the top of the slab, not from the top of the pad. This should be conservative, but is not always possible. Questions:*

- *What does the joint do to the capacity of the anchors if the embedment is measured from the top of the pad and the anchor crosses through the joint?*
- *Can the embedment be measured from the top of the pad and still give the strength capacity for the anchor?*
- *If the slab surface is roughened and is in a saturated surface dry condition when the pad is placed, will that be sufficient to make the pad act monolithically with the underlying slab and allow development of the full capacity of the anchor?*
- *If a mechanical anchor is used, how close to the cold joint can the expansion elements be allowed?*
- *Would an adhesive anchor have an advantage over a CIP or mechanical anchor because the failure cone is coming from the bond length rather than from a point at the bottom of the embedment?*

A. Anchoring through a cold joint can be idealized as anchoring across a horizontal discontinuity in the concrete. For the development of the full concrete cone breakout capacity, the joint must be capable of developing the tensile stress field induced by the anchor. As you have noted, this case arises frequently in the anchorage of mechanical equipment to housekeeping pads and it is not addressed specifically in ACI 318-11.[1] In such cases, reinforcing of sufficient area to carry the full tension load should be provided across the joint, and the joint should be roughened.

In the case of a housekeeping pad, such reinforcing might take the form of dowels that hook into the pad and are developed in the slab below. Although roughening of the slab surface improves adhesion and is advisable to improve shear transfer across the joint, relying on adhesion alone to transfer tensile stresses across the cold joint is not recommended.

With regard to the calculation of the capacity of the anchor in the pad, there are several considerations beyond the embedment depth to be used for design. The minimum thickness requirements for post-installed anchors are in part predicated on the need for sufficient concrete depth to prevent splitting of the concrete—a failure mode indirectly addressed in Appendix D.[1] If the cold joint is capable of transferring shear stresses (roughening the slab will help ensure this), the full depth of the pad plus embedment in the structural slab can be counted for this purpose.

The embedment depth used for the calculation of concrete breakout capacity is a matter of judgment and will in part depend on the location and type of the load-transfer mechanism of the anchor. An expansion anchor with the expansion elements located at or immediately below the level of the cold joint may not benefit (in terms of concrete breakout capacity) from the additional embedment below the joint because the tension failure of the concrete will likely originate at the cold joint (Fig. 1). For this case, the embedment can conservatively be taken from the top of the structural slab. Where this is insufficient, longer undercut or adhesive anchors may be used if it is possible to extend the anchor engagement substantially (at least three anchor

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diameters) into the slab below (Fig. 2). For cases where reinforcing has not been provided in the structural slab to connect the pad, post-installed dowel bars may be used. These are necessarily of small diameter and should be spaced uniformly throughout the pad.

The assumption of a full-depth breakout cone becomes more complicated for near-edge anchors, and for edge breakout in shear due to the step. For such cases, the approach to calculation of the concrete breakout strength should be based on conservative assumptions (Fig. 3).

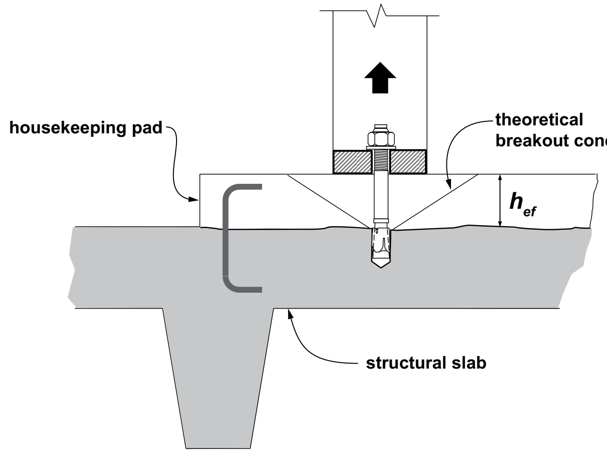

Fig. 1: Expansion anchor in a housekeeping pad with marginal penetration into the structural slab below (h_{ef} is the effective embedment depth that should be assumed for this case)

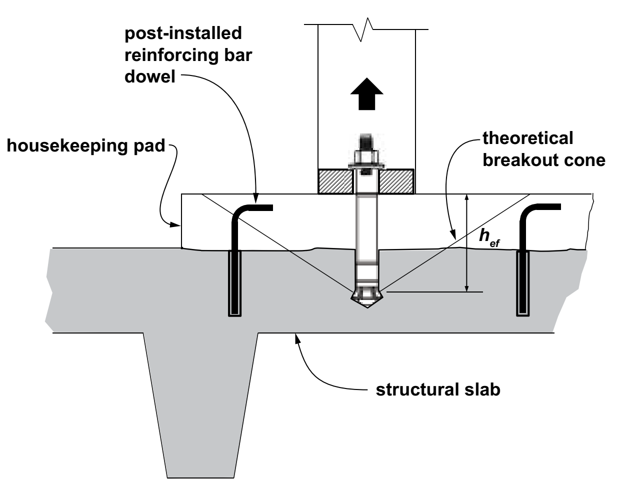

Fig. 2: Undercut anchor in a housekeeping pad anchor with substantial engagement (at least three anchor diameters) into the slab below. Here, post-installed dowels are used to anchor the pad to the structural slab

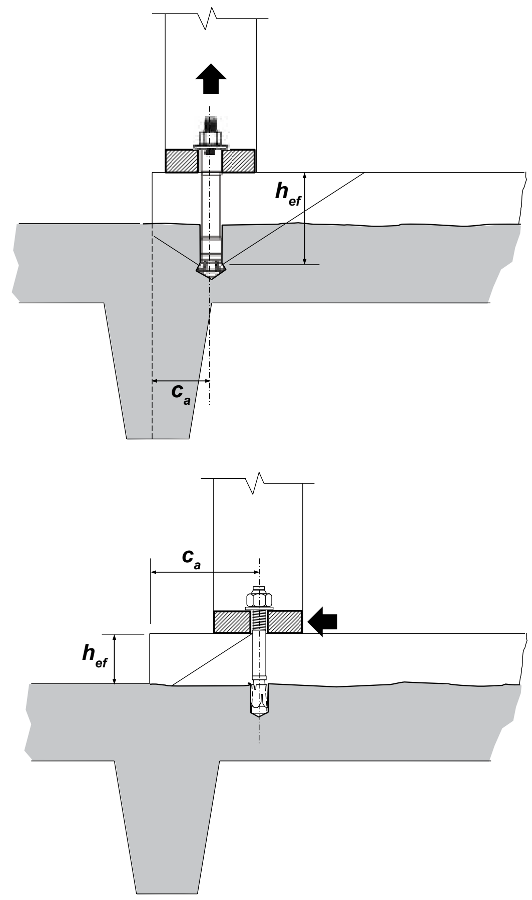

Fig. 3: A full-depth breakout cone may not develop for near-edge anchors. Tension or shear breakout capacities may be limited by the distance c_a measured from the centerline of the anchor to the edge of the housekeeping pad

When extending the anchors into the structural slab, employment of a reliable reinforcing bar detector prior to laying out anchor locations is recommended to avoid damaging primary reinforcement. Also, when establishing the embedment depth for the anchors, allow sufficient distance to the back side of the slab and require the use of appropriately sized drilling equipment to avoid blow-through during drilling.

References

1. ACI Committee 318, "Building Code Requirements for Structural Concrete (ACI 318-11) and Commentary," American Concrete Institute, Farmington Hills, MI, 2011, 503 pp.

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