When to Include a Subbase

If unnecessary, a subbase can add cost to the price of a concrete pavement structure without a comparable increase in performance. But when is a subbase necessary?

Subbases typically are necessary on major, heavily-traveled concrete pavement structures that are designed to carry a large number of trucks. In practice, however, subbases might be included in more typical roadways in an attempt to provide a stronger, more uniform structure and/or prevent pumping. Various advances in concrete pavement design, materials, and construction, however, have made subbases an unnecessary and costly addition to many typical designs. This publication details the scenarios that require a subbase as well as the typical subbase types and best practices. More on these topics is available in ACPA's **EB204P**, "*Subgrades and Subbases for Concrete Pavements*."

Subbase Background/Requirements

Engineered subbases are appropriate when a stable and uniform construction platform is needed to achieve the specified levels of pavement smoothness and/or when the combination of subgrade soil type, water availability, and high-speed, heavy vehicle traffic are at a level that is conducive to cause pumping and any associated distresses. Therefore, a subbase is a required element for concrete pavements designed for major, heavily-traveled pavements, particularly those carrying large numbers of trucks.

Pavements for slow-moving trucks or light-traffic pavements, such as residential streets, secondary roads, parking lots, and auto-only (high-speed) roadways, are not prone to the development of pumping. A subbase is not warranted for pumping protection in such applications because these facilities are not subject to the pavement deflection and rebound that high-speed, heavy wheel loads cause. Specifically, the following conditions render subbases unnecessary with regards to pumping:

- Traffic — A pavement expected to carry 200 trucks per day or fewer generally does not require a subbase to prevent pumping. Also, pavements that are designed to carry less than 1,000,000 18-kip (80 kN) ESAL's during their service life do not require subbases to prevent pumping damage.
- Natural Drainage — A subgrade soil that is naturally free draining typically will not pump because water percolates through the subgrade and does not remain directly underneath the pavement where it can transport fine materials in suspension. Pavements may be built directly on natural subgrade soils with this characteristic as long as the soil is satisfactory in other critical regards (e.g., frost action and expansion).
- Qualified Subgrade Soils — Subgrade soils with less than 45% passing a No. 200 (75 µm) sieve and with a plasticity index of 6 or less are adequate for moderate volumes of heavy truck traffic without the use of a subbase layer. In these cases, it is advisable to use dowelled joints — even in slabs that are just 7 or 8 in. (175 or 200 mm) thick — to prevent differential deflections at slab joints.

It should be noted that these exceptions, which allow for a concrete pavement to be placed directly on a subgrade, are highly dependent on an accurate estimate of heavy truck-traffic volumes over the life of the pavement.

In no case is increasing the thickness of a concrete pavement slab an acceptable measure to prevent pumping. Without proper preventive measures, pumping may occur on any thickness of concrete pavement if the right combination of factors exists. A nonerodible subbase and load transfer dowels at the transverse joints are necessary whenever heavy truck volumes are anticipated.

As mentioned, another important consideration with regard to the use of a subbase is the influence it may have on construction of the surface pavement. Subbases provide a stable, smooth track-line or pad-line for the paving machine and stable support for fixed form construction. The track or pad lines for slipform paving machines are about 3 ft (1 m) to either edge of the width of the pavement. These are the paths along which a slipform paving machine's tracks will ride while placing the pavement (Figure 1). Many agencies recognize the value of constructing on a stable, uniform trackline, so they require an extension of the subbase beyond the edge of the pavement in their concrete pavement design template. Extending the prepared subgrade and subbase layers beyond the edge of the pavement slabs also contributes to edge support, which reduces edge stresses and prevents settlement of shoulders or curb-and-gutter sections.

Figure 1. Trackline for slipform paving machine.

Subbase Type Options

If a subbase is deemed appropriate, the following types of subbases that have been used successfully in concrete pavement structures may be good candidates:

- Unstabilized (granular) subbases (Figure 2).
- Stabilized subbases, which include:
  - cement-stabilized subbases (cement-treated subbases [CTB, Figure 3]) or lean concrete subbases [LCB], both of which may include fly ash or slag cement) and
  - asphalt-treated subbases.

Unstabilized subbases are more common for low to medium volume (e.g., city and municipal streets) roadways and stabilized subbases are more common for high volume (e.g., interstate highways) roadways. Also, specific subbase type selection often is the responsibility of the contractor, a policy decision that allows for the most economical solution to be utilized.

With any subbase, it is possible to utilize recycled concrete (either from an existing concrete pavement or another source) or a variety of waste materials as aggregate.

Figure 2. Placement of an unstabilized (granular) subbase.

Figure 3. Placement of a cement-treated subbase (CTB).

Best Practices for Subbases

Regardless of specific subbase considerations, the best results are obtained by:

- Selecting subbase materials and combinations of layers that adequately prevent pumping of subgrade soils for the life of the pavement.
- Selecting subbase materials that will not contribute to excessive pavement deflections under traffic loadings, and will remain stable over time.
- Treating the subbase surface to ensure that it does not cause excessive friction or induce bonding to the pavement slabs.
- Specifying gradation or material controls that will ensure a reasonably consistent subbase material quality throughout an individual project.
- Building the subbase to grade controls that foster a pavement of consistent thickness and smoothness.