Free-Draining Daylighted Subbases

Free-draining daylighted subbases are the reasonable alternative to rapidly draining permeable subbases with an edge drainage system.

Due to their ability to quickly remove excess water from a concrete pavement structure, permeable subbases (subbases with a permeability from 500 to 20,000 ft/day (152 to 6,100 m/day)) became a popular design element in the 1990's. Despite their intuitive advantage, permeable subbases have exhibited poor field performance. Edge pipe drainage systems have also exhibited poor field performance in some cases, mostly due to postponed or lack of maintenance. Free-draining subbases (subbases with a permeability of 350 ft/day (107 m/day) or less) that are daylighted are a reasonable alternative to the rapidly draining permeable subbase with an edge pipe drainage system. More on this topic is available in ACPA's **EB204P**, "*Subgrades and Subbases for Concrete Pavements*."

Permeable versus Free-Draining

Permeable subbases, also known as "drainable subbases" or "open-graded subbases," became a very popular design element for concrete highway pavements in the 1990's. These subbases are generally characterized as a crushed aggregate (often stabilized with cement or asphalt) with a reduced amount of fines to increase the permeability of the subbase up to levels from 500 to 20,000 ft/day (152 to 6,100 m/day) in laboratory tests. Despite the intuitive advantage of an ability of the permeable subbase to remove excess water from the pavement rapidly, permeable subbases have had a problematic history due to:

- Loss of support caused from aggregate breakdown.
- Loss of support caused from infiltration of the subgrade into the subbase.
- Early age cracking caused by penetration of concrete mortar into the subbase voids during paving.
- Instability as a construction platform.
- Poor cost effectiveness.

Thus, permeable subbases are no longer recommended for concrete pavement structures.

Free-draining subbases (subbases that provide as much as 350 ft/day (107 m/day) in laboratory tests) are preferred over permeable subbases because of their more durable and stable nature (Figure 1). The recommended target permeability (k) for free-draining subbase materials is between 50 and 150 ft/day (15 and 46 m/day) in laboratory tests.

Though free-draining subbases drain slower than permeable subbases (because of the increased fines content) they still drain more quickly than conventional, dense-graded subbases. Stability is enhanced by the use of aggregate that is angular and does not degrade under repeated loading. Recycled concrete aggregate (either from an existing concrete pavement or another source) produces good results in free-draining subbases.

Figure 1. Free-draining, unstabilized subbase with enough fines to be stable during construction but still provide permeability of about 200 ft/day (60 m/day) in laboratory tests. Note that the truck tires are not causing excessive rutting or displacement of the subbase material.

Edge Drains versus Daylighting

An edge drainage system typically consists of a collector pipe and outlet system with redundant outlets (Figure 2, on the back side of this publication). The common application for edge drainage systems is for high volume roadway or highway applications, such as major state roads and interstates. Even then, their use is not always required or suggested. Alternatively, water can be drained by using a daylighted subbase system, where the subbase extends and carries water to the side ditches (Figure 3, on the reverse side of this publication).

Though often disregarded in the past due to the mindset that overgrowth along the ditch line would clog the system, daylighting a subbase directly into the side ditches may yield better long-term performance than piped edge drains due to the lack of periodic maintenance that is required (but oftentimes not regularly performed) for a pipe drain system. Furthermore, studies found that flexible pavements sections with daylighted bases (without edge drains) performed as well as (or better than) any other flexible pavement section. Similar performance should be expected with concrete pavements.

Separators

Separators are geotextile fabrics or filter layers that prevent the migration of fines from the subgrade up and into the free-draining subbase. Geotextile fabrics are commonly used (and strongly suggested) directly below a free-draining subbase layer to prevent fines from infiltrating and plugging the subbase.

Some agencies also place a filter layer (4 to 6 in. (100 to 150 mm)) thick layer of dense-grade unstabilized granular material) below any drainable subbase. This is not considered a necessity when a free-draining subbase material is employed in the design. Where used, the filter layer serves as a construction platform and as a barrier to prevent water from entering the subgrade as it flows through the subbase to the ditch or edge drain piping.

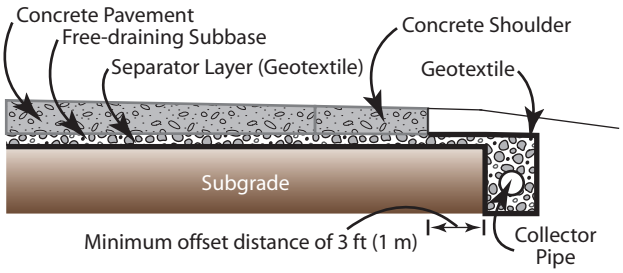

Figure 2. Detail for typical edge drain piping.

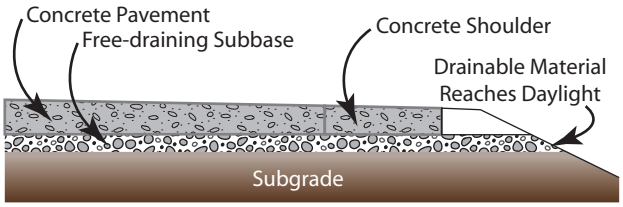

Figure 3. Detail for a typical daylighted subbase.

References

ACPA, Subgrades and Subbases for Concrete Pavements, EB204P, American Concrete Pavement Association, 2007.
FHWA, Drainable Pavement Systems, FHWA-SA-92-008, Federal Highway Administration, 1992.
NCHRP, Performance of Pavement Subsurface Drainage, Project 1-34, National Cooperative Highway Research Program, 2002.