The benefits of using a stabilized subbase in a concrete pavement structure are many; even still, the designer must consider the subbase stiffness and potential bonding with the concrete.

Common on high volume roadways such as interstate highways, stabilized subbases provide erosion (pumping) resistant and uniform foundations for concrete pavement structures. Stabilized subbases typically are stabilized with either cement, in the form of cement-treated subbases (CTB) and lean concrete subbases (LCB, econocrete), or asphalt, in the form of asphalt-treated subbases (ATB). CTB and ATB are best controlled during construction using compactive efforts and LCB is best controlled using strength. Typical minimum thicknesses are 4 in. (100 mm) for CTB and LCB and 2 in. (50 mm) for ATB. Because of their increased rigidity relative to unstabilized subbases, pavement designers must consider the potential for bond at the stabilized subbase/concrete pavement interface. More on this topic is available in ACPA's **EB204P**, "*Subgrades and Subbases for Concrete Pavements*."

Introduction

Stabilized subbases generally refer to subbase materials that are bound by either cement or asphalt binders. Stabilized subbases include:

- cement-stabilized subbases (cement-treated subbases (CTB) or lean concrete subbases (LCB), both of which may include fly ash and/or slag) and
- asphalt-treated subbases (ATB).

The primary benefit of stabilized subbases is that they provide relatively strong, uniform support and are resistant to erosion (pumping). Table 1 lists the erosion potential of various subbase materials under undowelled joints.

Compared to unstabilized subbases, stabilized subbases provide a higher degree of support to the pavement slabs (i.e., higher k-value). While this does not alter the required pavement slab thickness for a given load appreciably (Figure 1), it does strengthen the overall pavement structure.

Stabilized subbases provide an excellent construction platform for constructing concrete pavement. The bound subbase surface drains water quickly, providing an all-weather working platform that expedites construction operations after rainfall. Stabilized subbases also aid in improving the final pavement smoothness because they provide firm, stable support for the concrete forms or the slipform paver's trackline.

Other benefits of stabilized subbases include: minimizing post-construction subbase consolidation under traffic; minimizing intrusion of hard granular particles into the bottom of pavement joints; providing a more erosion resistant subbase material; and permitting greater use of local materials, substandard aggregates, and recycled materials (recycled concrete from either an existing concrete pavement or another source, reclaimed asphalt pavement, etc.), which can result in conservation of aggregates and savings in material and hauling costs.

Table 1. Erosion Potential of Various Subbase Materials under Undowelled Joints

Erosion Potential	Material Types
Extremely resistant	Lean concrete with 7-8% cement. Asphalt-treated subbase with 6% asphalt or greater.
Resistant	Cement-treated subbase with 5% cement.
Resistant under certain conditions	Cement-treated subbase with 3-5% cement. Asphalt-treated subbase with about 3% asphalt.
Fairly erodible	Cement-treated subbase with less than 3% cement. Unstabilized granular subbase.
Very erodible	Contaminated untreated granular materials. Unstabilized fine subbase.

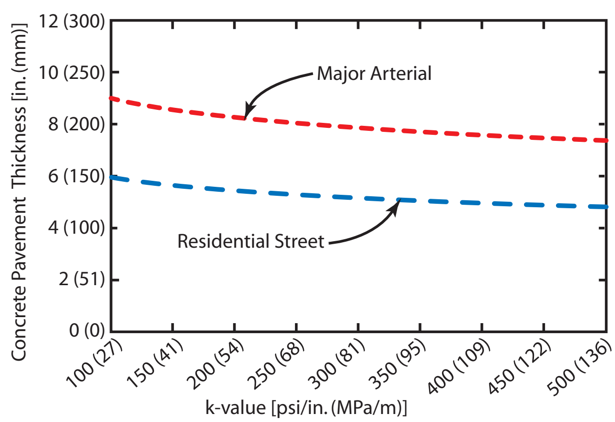

Figure 1. Sensitivity of concrete pavement thickness to k-value for a residential street and a major arterial. Assumptions for the residential street include: 12 ft (3.7 m) joint spacing, no dowel bars, 20 year design life, ADTT of 3, and a flexural strength of 600 psi (4.1 MPa). Assumptions for the major arterial include: 15 ft (4.6 m) joint spacing, 1.25 in. (32 mm) diameter dowel bars, 20 year design life, ADTT of 10,000, and a flexural strength of 600 psi (4.1 MPa).

Stabilized Subbase Requirements

Recommended minimum subbase thicknesses are 4 in. (100 mm) for CTB and LCB and 2 in. (50 mm) for ATB.

There is typically no strength requirement for cement-treated subbases because a CTB is best controlled using compaction and/or density requirements. However, when specified, a target 7-day compressive strength range of 300 to 800 psi (2.1 to 5.5 MPa) is typical to ensure long-term durability to repeated cycles of wetting and drying or freezing and thawing, while keeping the layer from getting too stiff, minimizing curling and warping stresses in pavement slabs.

Strength of a LCB should be limited to 1,200 psi (8.3 MPa) or less to keep the subbase from getting too stiff, again minimizing curling and warping stresses in pavement slabs. If this strength is exceeded, measures may need to be taken (i.e., scoring joints into the lean concrete subbase) to mitigate any potential problems.

Material requirements oftentimes may be relaxed for cement-stabilized subbases when compared to unstabilized subbases. For example, granular material used in a CTB may have a larger percentage of particles passing the No. 200 (75 µm) sieve and a higher Plasticity Index than material used in unstabilized subbases.

More detailed requirements for each stabilized subbase type are available in ACPA's EB204P, "Subgrades and Subbases for Concrete Pavements."

Precautions

Despite the advantages of stabilized subbases, one can not simply substitute a stabilized subbase for an unstabilized subbase and expect enhanced performance. There are well-documented occurrences of erratic uncontrolled cracking on projects with lean concrete, cement-treated, asphalt-treated and permeable treated subbases that were known to have bonded to the concrete pavement. Cores examined from these projects typically revealed that the cracks traveled around coarse aggregate particles, indicating very early formation. These cracks are usually due to two factors:

- High friction between the pavement and the subbase (Table 2).
- Increased curling stress in the pavement.

Figure 2. Coefficient of Friction for Various Subbase Materials.

Subbase	Coefficient of Friction
Natural Subgrade	1.0
Chemically-modified clay soil	1.5
Unstabilized (granular) subbase	1.5
Bituminous surface treatment	3.0
Unstabilized crushed stone subbase	6.0
Asphalt-treated subbase (smooth)	6.0
Cement-treated subbase	10.0
Asphalt-treated subbase (rough)	15.0
Asphalt-treated permeable subbase	15.0
Cement-treated permeable subbase	15.0
Lean concrete subbase (econocrete)	15.0

By themselves, these two factors may not be significant enough to cause random, uncontrolled cracking on a new construction project. However, when combined with other factors such as improper materials selection, poor concrete mixture design and/or too much distance between transverse joints, the risk for unwanted cracking increases.

To minimize the potential for random, uncontrolled cracking, the following three factors must be considered in selecting materials for stabilized subbases, and for designing concrete pavements with stabilized subbases:

- Potential bonding of plastic concrete to the subbase surface.
- Strength of stabilized subbase materials.
- Joint spacing (panel size dimensions).

The potential for bonding between the concrete and subbase can be minimized with the application of a bond-breaking medium. For lean concrete subbases, current practice includes two heavy spray applications of wax-based curing compound on the subbase surface. Though there are no common bond-breaker recommendations for cement-treated subbases or asphalt-treated subbases, various other alternatives of reducing friction or bond between the concrete pavement and stabilized subbase exist, including sand, bladed fines, asphalt emulsion, non-woven geotextiles, polyethylene sheets, tar paper, and choker stone.

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