Concrete Pavement Progress

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This month ...

ACPA provides the latest information about pre-paving construction practices.

Next month...

ACPA revisits the basics of concrete pavement technologies in a special Concrete Pavements 101 issue ...

The Subgrade Factor

Quality pavements start from the ground up

Among many factors in placing a quality concrete pavement, the subgrade is an important one often overlooked. The subgrade has a substantial impact on base and subsurface drainage requirements, as well as long-term pavement ride quality and overall performance.

It is widely understood that a stable 'platform' is necessary to construct a smooth, uniform pavement. However, subgrade stability and strength are often misunderstood as part of design and construction requirements. Concrete pavements, unlike asphalt pavements, distribute loads through slab action. In other words, the load is spread over a large area. This means that a concrete slab is able to bridge an isolated weak area in the subgrade (or subbase). However, the bridging effect varies depending on the location of a weak spot. Lack of uniform support at slab corners and edges is much more likely to result in deterioration of the pavement than if the weak area is under the slab center.

Terms of the art:
Cross haul - Excavating soil from one location to another and blending it in place.
Soil modification - Modifying characteristics of soil through additions of stabilization agents, granular materials, or soils with improved properties.
Soil stabilization - The addition of chemicals such as cement, cement kiln dust, lime, lime kiln dust, fly ash, or others to improve the quality and support characteristics of the soil.

Photo of a subgrade trimmer. The machine trims the compacted subgrade to tight tolerances while using a stringline for guidance.

Uniformity of subgrade soils affects both design and construction. Concrete pavements can be designed for relatively poor soil conditions, as long as the level of support is consistent and accounted for in design. The AASHTO design procedure is only moderately sensitive to subgrade support values (in terms of "k" or modulus of subgrade reaction).

Several options are available to produce a uniform subgrade including cross hauling, soil modifying or stabilizing, removing and replacing, and others. The most desirable option is one that minimizes cost while providing improved constructability and performance.

Soil stabilization is sometimes required to facilitate construction by drying a subgrade soil and stabilizing the working platform for the subbase or pavement. Depending on the soil type, portland cement, hydrated lime, quicklime, fly ash, kiln dust (cement or lime), or other agents may be used. Laboratory testing is almost always necessary to determine the effectiveness of the soil stabilizer in reducing plasticity of the soil (plasticity index value), increasing strength, determining the optimum addition, and establishing density requirements. If a pavement design is based on a stabilized subgrade strength value, the long-term durability of the material must be considered (i.e., consider if the stabilized soil will retain its strength for the life of the pavement).

Concrete pavements can be designed and constructed for all soil types. The key is to provide a uniform, stable subgrade platform for construction equipment, as well as the rest of the pavement structure. This will make for a constructible pavement that provides excellent long-term performance.

The Subbases Factor

Enhancing concrete pavement performance

The importance of a subbase (or base) is often overlooked during the design phase of a pavement. Specifying the right subbase will enhance concrete pavement performance. A number of factors must be considered while specifying a subbase, including traffic, environmental conditions, and *in situ* soil conditions. A subbase imparts many benefits for moderate- to heavily-trafficked concrete pavements. For example, subbases will:

- Provide a stable platform for construction operations. Attention to the trackline is critical.
- Reduce the tendency for pumping, particularly if an undoweled pavement is used. An undoweled pavement is appropriate for pavement carrying low volumes of truck traffic.
- Minimize differential movement resulting from frost action and shrinking/swelling soils.
- Promote uniformity of support--a critical element for good long-term pavement performance.

In spite of their importance, they are not emphasized, nor are they addressed in great detail, in the commonly-used 1993 AASHTO Pavement Design Guide. One reason is because certain combinations of subases have relatively little influence on the required slab thickness.

For example, A heavily-trafficked, rural interstate highway built over a relatively weak subgrade might have a design thickness of 11.1 inches if a 6-in. low-quality, unbound granular subbase were used. A high-quality unbound granular subbase could reduce the thickness to 11 inches.

On the other hand, a 6-inch layer of high-quality cement-treated subbase could reduce the thickness requirement to 10.7 inches. (Note that a pavement built directly on the subgrade with no subbase would still require the 11.1-inch thickness.) Clearly, the addition of a subbase cannot be justified solely on the basis of reducing the required thickness of pavement.

Subbases can be stable enough to attach dowel assemblies and support construction vehicles and paving equipment. They can also contribute to the long-term performance of the pavement.

When incorporating subbases in low volume roads, cost effectiveness should be considered. Otherwise, low volume roads generally do not require subbases. Choosing a subbase type is dependent upon availability of materials, subgrade type, anticipated construction operations, budget, and numerous other factors. The use of drainable subbases is somewhat controversial because they are not believed to have a material effect on pavement performance. Therefore, drainage should be analyzed thoroughly on a project-by-project basis. It's also important to consider that a drainage system requires a long-term commitment to maintaining that system.

Subbase material stability is another important consideration. Densely-graded granular materials and materials stabilized with cement or asphalt create firm support for construction equipment. Unstabilized permeable layers, which became popular in the 1990's, have caused some construction and pavement performance problems (in particular, cases of early cracking).

An important balance must be met between the degree of drainage and the stability of the unstabilized subbase layer. Subbase stability should not be sacrificed for the sake of drainage. A target permeability of 200-300 ft/day (60 to 90 m/day) has been found to produce a stable, draining layer that will support the paving equipment, construction vehicles, and the pavement in the long-term.

Addressing Cracks During Overlay Preparation

A common question during whitetopping preparation is whether it is necessary to repair cracks in distressed asphalt prior to overlayment. The short answer is it depends on the severity of the cracking.

Cracks in asphalt do not reflect through concrete overlays. The reason the asphalt cracks usually do not cause a crack in a concrete surface is a result of the two materials' difference in modulus of elasticity. Concrete has significantly higher modulus of elasticity, which means it can withstand more elastic pressure than asphalt. When bonded, the concrete is more likely to crack the asphalt.

As a result, it is usually not necessary to repair cracks. Otherwise, it is usually not necessary to use a synthetic fabric or stress-absorbent interlayer to prevent reflective cracks in a concrete overlay of asphalt.

However, serious asphalt distresses in advanced stages, i.e. severe rutting, shoving, or potholes, must be repaired. Areas showing subgrade failure, which, in turn, will not provide uniform support of the overlay, should be removed and replaced.

After repair, there are a few options for addressing a distorted surface before placing the overlay. They are:

- Sweeping and direct placement.
- Evening surface distortions by milling.
- Placing a leveling course.

Table 1 provides guidelines for repairs required for existing asphalt distresses.

General Pavement Condition	Repair Work to be Performed
Rutting or shoving < 50 mm (2 in.)	None (Consider increased joint sawing depth.)
Rutting or shoving > 50 mm (2 in.)	Milling or leveling
Potholes	Fill with crushed stone, cold mix or hot mix, and compact
Subgrade failure	Remove and replace subgrade
Alligator cracking	None
Block Cracking	None
Transverse cracking	None
Raveling	None
Longitudinal cracking	None
Bleeding	None

For more information about repairing distressed asphalt prior to overlay pavement, refer to "Whitetopping - State of Practice," (catalog number EB210.02P). To order, go to www.pavement.com; call toll-free 1-800-868-6733; or fax requests to 847-966-9666.

Setting Fixed Forms Before Concrete Placement

Properly setting forms (alignment and elevation) is key to producing a smooth pavement. Fixed-form concrete paving is often used for streets and local roads, parking lots, short paving segments, and irregularly-shaped pours. Here are some tips to keep in mind while setting fixed-forms.

Good Form
First, forms should be straight, clean, and in acceptable condition. Ten-foot (3-meter) steel forms are most common, particularly for straight sections, but wooden forms also can be used on small jobs, if they are not reused too many times. Plywood forms also are used frequently for short-radius turns, where they can be bent to the radius of the curve.

Setting the Form
Next, the quality of the support beneath the forms should be assessed. Settlement of the forms under paving equipment can be a source of built-in roughness. The base of the form should bear against the subbase or subgrade surface completely and not lie on any clumps of dirt or rocks.

Forms should be set in place according to the stringline and grade and fastened to the subbase with three pins or stakes. The forms should not be shimmed up more than 1/4 inch (6 mm), to reduce the deflection of the form caused by paving equipment.

Forms should rest on a level surface and be securely pinned in place.

Before Concrete Placement
Next, the wedges and form locks should be driven tight, and the horizontal and vertical alignment of the forms checked either with a straightedge or by eye. The forms should be given a light application of form-release agent to permit easy form removal after the concrete has hardened. The last step, before concrete placement, usually involves final preparation and shaping of the subbase or subgrade.

Report: Asphalt Slippery Even When Not So Wet

Skidding can occur on moderately wet asphalt roads, even at low speed, because of a sealing action caused by tires. This was the key finding of a recent research journal, called Nature Materials, which explained that water becomes trapped in the asphalt, and the rubber of a passing tire effectively seals it in place. This has the effect of smoothing the road surface and, in turn, reducing friction.

Even the smoothest-looking asphalt road has tiny peaks and valleys in the surface. Under dry conditions, the rubber of a tire will deform slightly as it penetrates the valleys and then hits the peaks. These pulsating deformations, multiplied countless times as the tire moves along, create friction.

When the asphalt is wet, however, the valleys become tiny lakes. The passing tire can't form into the valleys because the water is there, and it can't push the water out because the rubber hitting the peaks forms a seal. So the road, in effect, is smoother but there are fewer deformations and thus less friction, according to the study.

The researchers, a team of scientists in Germany and Italy, say their calculations can account for the 20 to 30 percent loss of friction that occurs at low speeds (below about 35 miles an hour) on wet but unflooded roads.

ACPA Product Showcase

TB011P

Subgrades and Subbases for Concrete Pavements

This 24-page technical publication provides guidance for the proper construction and design of support layers for concrete pavement. It emphasizes the major objective of obtaining uniform support for the pavement that will prevail throughout its service life.

The publication also features solutions to soil problems (expansion, heaving, etc.), as well as options for subbases, including free-draining permeable layers. The cost of this publication is $13.50. To order TB011P, go to www.pavement.com; call toll-free 1-800-868-6733; or fax requests to 847-966-9666.

Concrete Pavement News Digest

Voigt Named ACPA Chief Executive

The American Concrete Pavement Association's Executive Committee recently named Gerald F. "Jerry" Voigt, P.E., as President and Chief Executive Officer.

Voigt served previously as ACPA's Chief Operating Officer and Sr. Vice President of Technical Services.

Making the announcement was Dan Keys (Berns Construction Co., Inc.), ACPA's 2005 Chairman of the Board.

"We are very pleased to have Jerry continue in a leadership role with ACPA and look forward to a long and prosperous future," he said.

Voigt joined ACPA in 1988 after serving as a design engineer with a leading midwestern engineering firm. He has held numerous positions within ACPA, notably senior technical and operations positions.

Voigt succeeds the late Valentin J. Riva as only the fourth chief executive in ACPA's almost 42-year history.

Jerry Voigt was named new ACPA Chief Executive.

Society for Concrete Pavements Announces International Conference

The International Society for Concrete Pavements (ISCP) released its brochure for the 8th International Conference on Concrete Pavements in Colorado Springs, Colo.

A registration brochure includes full details about the conference, from technical topics to be discussed to available recreational activities. The event, co-sponsored by ACPA, will be held August 13 - 18, in Colorado Springs, Colo.

The ISCP is still seeking papers to be presented at the conference, "Innovations for Concrete Pavement: Technology Transfer for the Next Generation." It is focused on federal, state, and municipal engineers; consulting engineers; contractors; materials suppliers; and academia.

For more information, contact Jason Weiss, Purdue University, at iscp8@ecn.purdue.edu.

Research Board calls for Divided-Highways Proposals

The National Cooperative Highway Research Program of the Transportation Research Board's has issued a request for proposals to recommend improvements to rural median intersection and crossover design information.

The recommendations are intended for use in the American Association of State Highway and Transportation Officials' Policy on Geometric Design of Highways and Streets (Green Book) and the Manual on Uniform Traffic Control Devices for high-speed (50 mph and faster) divided highways with partial or no control of access.

Recommendations will cover geometric plan layout and traffic control devices. Proposals are due February 17. For more information, visit the TRB website at http://trb.org/news/blurb_detail.asp?id=4496

Census Bureau Report Pinpoints Increased Highway, Roadway Use

The U.S. Census Bureau's latest glimpse of life in the United States underscores the importance and dependence on safe, durable highways and roadways.

Drivers in a typical household travel some 21,200 miles per year, according to the latest edition of the Census Bureau's Statistical Abstract of the United States, a 1,000-page synthesis of recent statistics collected throughout the United States.

The Associated Press reported yesterday the average miles driven by U.S. motorists is enough to travel between New York and Los Angeles almost eight times per year.

ACPA Concrete Pavement Progress is published 12 times per year and covers the latest information about concrete pavement technologies, as well as transportation industry news. CPP is distributed monthly to more than 19,000 public officials and ACPA members worldwide.

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