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Optimizing pavement bases for good drainage

Two new tools are available to assist pavement designers in calculating the characteristics of drainage materials, plus a set of recommendations for construction.

Background

Proper drainage extends the life of pavements. Most pavement designers include subsurface drainage layers, which drain excess water from the surface of the pavement.

However, subsurface drainage layers are only effective when the pavement designer is able to accurately calculate the characteristics of the subsurface drainage materials. In addition, aggregates used in pavement bases must be carefully selected and properly handled to provide permeability and uniform stability.

David White, assistant professor of civil engineering at ISU, and his research team developed some tools and recommendations for designers and construction contractors.

Tools

The tools are an Excel spreadsheet and a permeability testing device:

- **Pavement Drainage Estimator (PDE)**. The PDE, an Excel-based spreadsheet program, was developed to help pavement designers estimate the drainage characteristics of subsurface drainage materials. When the pavement designer inputs factors such as aggregate properties, pavement dimensions, rainfall intensity, and amount of drainage desired, the PDE can calculate the minimum required hydraulic conductivity of a pavement base layer and/or the time required to achieve a given percentage of drainage.
- **Permeability testing**. In-situ testing of permeability and stability is important for quality assurance/quality control. The air permeameter test (APT) device was developed to determine the hydraulic conductivity of pavement bases in just seconds; see Figure 1. In an hour, one operator can perform about 50 tests. Several tests of a base layer can ensure uniformity.

Figure 1. Air permeameter test (APT) device

Figure 2.

The new APT device is the only rapid permeability testing device in the world. This device weighs 40 pounds and can be carried by one person.

Segregation of fines in base layer

Construction recommendations

The research team found that several steps could be taken to make the characteristics of subsurface drainage materials more predictable:

- Use recycled portland cement concrete (PCC) with caution. Recycled concrete aggregate samples were found to have a lower permeability, lower strength, and lower resistance to particle degradation compared with limestone and gravel samples. Don't use recycled PCC for permeable granular base in areas where construction traffic must haul over the placed aggregate.
- Deliver aggregate to the site with sufficient water content (7–10 percent) so that fine aggregate particles don't settle to the bottom of the layer.
- Aggregate placement and spreading operations can contribute to the segregation of fines; see Figure 2. Instead of spreading aggregate longitudinally along the pavement section, use a motor grader to push the aggregate transversely.
- Use a motor grader with stakeless, GPS-guided grading control as an alternative to trimming equipment.

Trimming operations appear to contribute the most to aggregate segregation, leading to spatial variation. Trimmers add to segregation problems in several ways. During trimming, they shake the aggregate, causing fine particles to migrate to the bottom of the layer. Then they remove the top, relatively coarse aggregate and leave behind finer aggregate.

For more information

This project was sponsored by the Iowa Highway Research Board (TR-482). Contact David White, 515-294-1463, djwhite@iastate.edu.

The report, *Determination of Optimum Base Characteristics for Pavements*, is available online.