The Right Choice

For Rebuilding Roads

FULL-DEPTH RECYCLING WITH CEMENT

Deteriorating roads are a constant problem for cities and counties. That's why engineers and public works officials are turning to a process called full-depth recycling with cement.

This process rebuilds worn out asphalt pavements by recycling the existing roadway. The old asphalt and base materials are pulverized, mixed with cement and water, and compacted to produce a strong, durable base for either an asphalt or concrete surface.

Full-depth recycling uses the old asphalt and base material for the new road. There's no need to haul in aggregate or haul out old material for disposal. Truck traffic is reduced, and there is little or no waste.

Recycling saves money and natural resources

Full-depth recycling uses the materials from the deteriorated asphalt pavement, and, with the addition of cement, creates a new stabilized base.

A surface consisting of a thin bituminous chip seal, hot-mix asphalt, or concrete completes the road. The recycled base will be stronger, more uniform, and more moisture resistant than the original base, resulting in a long, low-maintenance life. And most important, recycling costs are normally at least 25% to 50% less than the removal and replacement of the old payment.

PORTLAND CEMENT ASSOCIATION

THE PROBLEMS WITH OLD ASPHALT PAVEMENTS

Asphalt pavements eventually wear out. Just like old cars or clothing, the effects of wear and climate will destroy the pavement. The roads require costly maintenance to stay in service.

Asphalt pavements typically fail in several ways. The most common include:

Fatigue cracking *Traffic causes repeated strain in the surface and eventually the asphalt cracks.*

Rutting *Channelized traffic loads shift the materials in the surface, base, and subgrade, leaving depressions or ruts in the pavement.*

Shoving *The forces created by cars and trucks braking and stopping separate the surface material from the underlying base.*

Loss of base or foundation support *Moisture degradation, traffic overloads, or subgrade failure can cause the pavement base to fail.*

The type of failures mentioned above are especially prevalent in secondary roads, where pavement structures are typically light, and are often not designed for today's increased traffic levels. Repairs can be costly. A typical maintenance treatment, like a thin asphalt overlay, will only temporarily cover up the problem. Other options, such as thick overlays or removal and replacement, are expensive.

Material conservation: A wise choice

Conserving virgin construction materials through recycling with cement makes smart economic and strategic sense. A century of modern growth and urbanization in America has depleted once plentiful aggregate supplies. Frequently, aggregates either come from distant quarries at great expense or from local sources offering only marginal quality. Continuing to exhaust these valuable resources to rebuild existing roads only propagates and accelerates the problem.

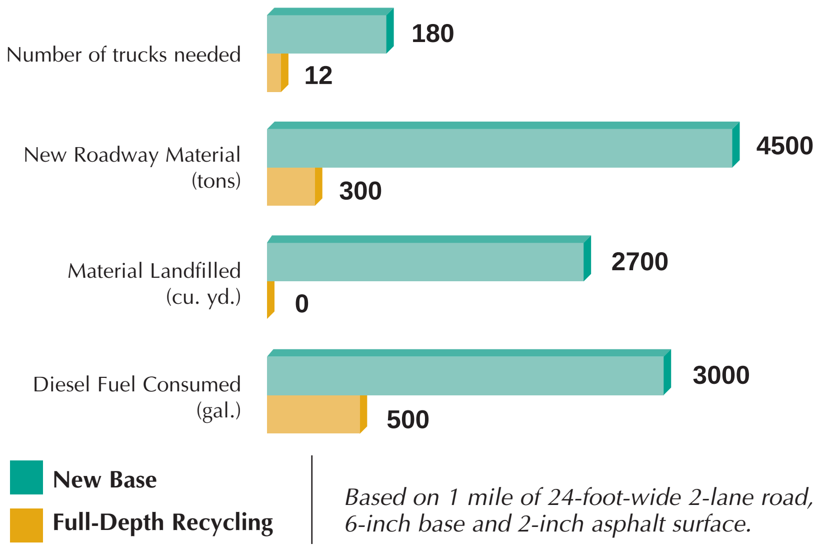
Additionally, if old asphalt and base materials are not recycled, they must be disposed of or stockpiled, increasing transportation costs and utilizing valuable landfill space. In some locales, old asphalt can no longer be landfilled. Environmental laws are becoming stricter, thus adding to the expense of mining new materials and landfilling old.

Recycle, rebuild

Recycling with cement makes the reconstruction of old roads a largely self-sustaining process. The original "investment" in virgin road materials becomes a one-time cost, which is renewed periodically, through cement stabilization and addition of a new, thin surface course.

Savings in Energy Use

Full-Depth Recycling vs. New Base



Old asphalt, new foundation

Stabilizing the old asphalt surface, granular base, and underlying subgrade soil with cement creates a strong foundation for the pavement. Usually, there is little need for material to be removed or added. The old, brittle asphalt, when pulverized, becomes a "black gravel" that will bond to hydrated cement readily. The removed material may be suitable for recycling into a new asphalt surface. In case the existing asphalt pavement does not meet the aggregate requirements for a good stabilized base, additional aggregates can be readily incorporated into the recycled aggregate during construction.

Pulverizing the old road

Pulverized material

Shaping and grading

Spreading dry cement

HERE'S HOW THE PROCESS WORKS:

A pulverizer rips up the old asphalt and base.

A grader brings the road to the desired grade, making it passable for temporary traffic.

Next, a truck spreads a prescribed amount of cement over the pulverized road base.

Hooked up to a water truck, the pulverizer mixes the cement, water, and pulverized roadway down to a depth of 6 to 10 inches.

The base is compacted, cured, and topped with a riding surface, usually a chip seal or hot-mix asphalt.

Design and construction: Simple and fast

The basic procedure is simple. The complete recycling process can be finished in one day, and local traffic can return almost immediately. The procedure includes the following steps:

Thickness Design. Pavement thickness can be determined by using PCA's *Thickness Design for Soil-Cement Pavements* (EB068). Other methods, such as the American Association of State Highway and Transportation Officials (AASHTO) Guide for Design of Pavement Structures can also be used.

Site Investigation. The site should be investigated to determine the cause of failure. Cores or test holes should be used to determine layer thicknesses and to obtain samples of the material to be recycled (which can include asphalt surface, base course aggregate, and subgrade).

Lab Evaluation. Material samples from the site should be pulverized in the lab to create an aggregate-soil mix that will be similar to that expected from the recycling process. The mix design procedure is the same as that performed for soil-cement. Refer to PCA publication EB052 *Soil-Cement Laboratory Handbook*. This includes the determination of maximum dry density and optimum moisture content. If unconfined compressive strength is used to determine cement content, a 7-day strength of 300 to 400 psi (2.1 to 2.8 MPa) is recommended.

Scarification and Pulverization. Depending on the construction equipment available, and the thickness of the existing pavement, the roadway may need to be scarified (ripped) before it can be pulverized. Some equipment, however, is capable of pulverization without scarification first. Quality full-depth recycling is usually performed using equipment especially designed for this purpose. The depth of pulverization is usually 6 to 10 in. (150 to 300 mm), which on secondary roads will typically include all of the surface and base, plus some part of the subgrade. To achieve the proper gradation after pulverization, more than one pass of the equipment may be necessary. The particle distribution should have 100% smaller than 2 in. (50 mm) and 55% passing a No. 4 (6-mm) sieve.

Shaping and Grading. The pulverized material is shaped to the desired cross-section and grade. This could involve additional earthwork in order to widen the roadway. Final base elevation requirements may necessitate a small amount of material removal or addition.

Spreading Cement. Cement is spread in a measured amount on the surface of the shaped roadway, in either dry or slurry form.

Spreading cement (slurry)

Mixing cement, soil, and water

Compaction

Testing for moisture and density

START WITH A GOOD FOUNDATION

A good foundation is important for any structure, especially pavements. The pavement base provides the thickness and stiffness necessary carry heavy traffic loadings.

Stabilized pavement bases, such as soil-cement and cement-treated base have provided economical, long-lasting pavement foundations for over 60 years. These pavements combine soil and/or aggregate with cement and water, which are then compacted to high density. The advantages of stabilization are many:

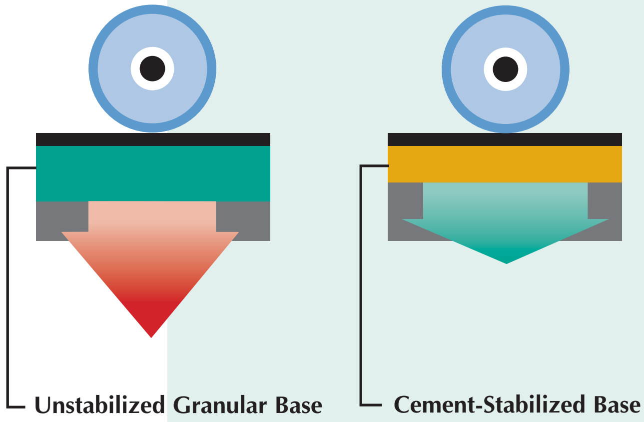
- *Cement stabilization increases the stiffness and strength of the base material. A stiffer base reduces deflections due to traffic loads, which results in lower strains in the asphalt surface. This delays the onset of surface distress, such as fatigue cracking, and extends pavement life.*
- *The strong uniform support provided by cement stabilization results in reduced stresses applied to the subgrade. A thinner cement-stabilized section can reduce subgrade stresses more than a thicker layer of untreated aggregate base. Subgrade failures, potholes, and road roughness are thus reduced.*
- *Moisture intrusion is the nemesis pavement bases. Cement-stabilized pavements form a moisture-resistant base that keeps water out and maintains higher levels of strength, even when saturated.*
- *A cement-stabilized base also reduces the potential for pumping of subgrade fines.*

Water Application. Water is added to bring the aggregate-soil mixture to optimum moisture content (water content at maximum dry density as determined by ASTM D558), either in front of the pulverizer/reclaimer or in the mixing chamber.

Mixing. The aggregate-soil-cement-water mixture is combined and blended with the pulverizing/mixing machinery. Multiple passes of the mixer may be required to achieve a uniform blend of materials.

Compaction. The mixture is compacted to the required density of at least 96% of standard Proctor density (ASTM D558). The compaction is usually performed with smooth-wheeled vibratory rollers. A pneumatic-tired roller may follow to finish the surface. Final compaction should take place no more than 3 hours past initial mixing of the cement. The field density and moisture are monitored for quality control purposes.

A stabilized base spreads loads and reduces stress on the subgrade.



Curing. The surface is kept moist by periodically applying water to the surface, to make sure it does not become dry. This is done continuously through the curing period until the base can support traffic without deforming. The application of the prime coat should occur as soon as possible to ensure that moisture is sealed inside the base.

Pavement Surface. The new pavement surface consisting of a chip seal, hot-mix asphalt, or concrete is constructed to complete the recycling process.

Quality Control. Recycling with cement follows the same basic procedures used for normal soil-cement operations. The success of a recycling project depends upon the careful attention to the following control factors:

✔ Adequate pulverization

✔ Proper cement content

✔ Proper moisture content

✔ Adequate density

✔ Adequate curing

Curing

Applying tack coat prior to paving

Paving

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FOR REBUILDING ROADS

For assistance with your recycling project, call PCA at 847.966.6200, or visit our web site at www.portcement.org. Also, the following useful publications can be ordered via the web site or 800.868.6733.

Soil-Cement Construction Handbook (EB003)

Soil-Cement Laboratory Handbook (EB052)

Thickness Design for Soil-Cement Pavements (EB068)

Suggested Specifications for Soil-Cement Base Course (IS008)

Soil-Cement Inspector's Manual (PA050)

Full Depth Recycling with Cement (VC129)

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