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For the Government/Contractor Project Team

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Rebuilding by Reclaiming– the FDR Process

An illustrated guide to the basic full-depth reclamation process

Like most road construction technologies, full-depth reclamation can be applied in many different forms, depending on the physical properties of the old road and the performance requirements for the new one. In most jobs, however, there are eight basic phases, from pulverization and moisture conditioning to the laying of the final surface course.

Full-depth reclamation starts with a road reclaiming machine pulverizing and mixing the old bituminous pavement layers and a predetermined amount of base or sub-base material. The size of the pulverized material is determined by the reclaimer's forward motion speed, cutting rotor speed, gradation control beam position, and the front and rear door position of the mixing chamber.

While the reclaimer is not a crushing machine and cannot reduce pavement to any size smaller than the original aggregate - or the stone in the base material - it does leave a homogenous, well-graded material in its wake. According to Caterpillar's Full Depth Reclamation handbook, on a typical job the reclaimer can be set up to leave a maximum particle size of two inches, with 95% of the material passing a 1.5-inch screen.

Moisture - usually water - is added during the pulverization process to achieve the required density of material. In some cases, the moisture is metered into the mix by the reclaimer's liquid additive system, though it can be sprayed directly on the surface after the reclaimer's first pass.

Just one reclamation pass is usually required in applications where the pavement is less than 6 inches thick, no stabilizing additives are required, and major geometric corrections are not needed.

Conversely, multiple passes are called for if one or more stabilizers are to be added, or if major grade or profile corrections are required. Multiple passes are sometimes used when the job involves pavements that are more than 6- inches thick, and when the pavement is being widened.

In a typical multiple-pass application, after the first reclamation pass the material is pre-shaped and compacted, then the stabilizing additives are applied and mixed in a second, blending pass. In some jobs requiring more than one stabilizer additive, a third pass may be required.

Breakdown compaction follows the last reclamation pass. The goal is to achieve a more consistent material density in the reclaimed layer prior to shaping with the motor grader. Depending upon the thickness and composition of the new base, the tools of choice range from a single-drum vibratory padfoot roller (at least 52,000 pounds, centrifugal force) to a 25-ton (minimum) pneumatic roller.

Shaping is the process in which a motor grader sculpts the mat's grade and cross slope. This

is one of the important advantages of full-depth reclamation, since it allows major corrections to be made in older roads constructed under design parameters that may no longer be adequate for the usage they receive.

Road widening, another potential benefit of full-depth reclamation, can also be accomplished during shaping. In order to maintain sectional thickness, additional granular materials are usually required.

Intermediate compaction comes next. Again, depending upon the thickness and composition of the mat, this step uses either a pneumatic roller to knead the material or a heavy smooth-drum vibratory compactor to seat any loose aggregates left by the motor grader. The pneumatic roller is probably the more common choice, and some light shaping with a motor grader may be required after this pass.

Finish rolling is accomplished with a 12- to 14-ton single or double-drum roller operating in the static mode.

After the final compaction pass, the reclaimed road bed is sealed with an asphalt emulsion or some other specified sealer. This fog seal is applied to the surface to bind loose particles and protect the reclaimed layer against weather and traffic. The reclaimed layer can generally be open for traffic as soon as the seal coat dries.

Since the reclamation process converts the old pavement and part of the base into a new, structurally stronger base, the final step in a full-depth reclamation project is to place a new surface treatment on the improved base. Four surface treatments are the most common: double chip seal, single or double chip cape seal, cold-mix overlay, or hot-mix overlay.

Asphalt-treated reclaimed material makes an especially strong base and that can make it possible to use a less expensive surface treatment and achieve the same or better economical life than would be possible with any other repair alternative. In some cases, this might mean using one of the chip and seal treatments instead of asphalt; in others, it might mean using thinner layers of asphalt.

Structural strength

Many variable factors contribute to the structural strength coefficient for pavements, bases and sub-bases, so calculating the advantages of an FDR base needs to be done on a project-specific basis. Still, a series of examples published in Caterpillar's Full Depth Reclamation Handbook illustrates how dramatic the FDR advantage can be.

In these examples, three different rehabilitation techniques are examined for a 15-year-old road with a surface of 5 inches of deteriorated hot mix asphalt, a base of 6 inches of decompacted (due to age) stone, and a sub-base of 8 inches of decompacted sand and gravel. Its structural number is 1.44, well below is terminal serviceability level of 2.00.

In example one, by simply adding a 3-inch hot-mix asphalt overlay, the road's structural number increases to just 2.85 - only a little over its terminal serviceability level.

The second alternative is reconstruction - the removal of the old asphalt surface course, reshaping and recompacting the crushed stone base, then applying a 5-inch hot-mix asphalt overlay. This treatment, far more expensive, produces a structural number of 3.50.

Full-depth reclamation is the third alternative. In this example, the road is reclaimed to a depth of 8 inches and stabilized with asphalt emulsion. The asphalt-treated base then receives a 3-inch asphalt overlay. Because the asphalt-treated base has a much higher structural

coefficient than either of the crushed stone bases in the other examples, the reclaimed road has a significantly higher overall structural number - 4.01 - than either of the other two alternatives.

Other Benefits

In addition to its structural advantages, full-depth reclamation costs substantially less than reconstruction - 40 to 60% less, according to FDR contractors and their customers.

That economy is the product of several FDR benefits, starting with the fact that this is a recycling technology, so most of the materials used are already present in the old roadway. The improved base makes it possible to economize on the surface treatment without sacrificing engineering integrity. And full-depth reclamation can generally cover more lane miles in less time than reconstruction.

How fast can FDR advance? Production rates can vary from a few hundred yards per day to more than a mile of two-lane highway per day. The main variables: composition of the old pavement, depth of material, gradation requirements, and the number and type of additives required. Production rates of a half-mile to a mile of two-lane road per day are not unusual.

Applying FDR

Full-depth reclamation is the management alternative for pavements that are too distressed to be good candidates for simple overlay or mill-and-fill solutions. Major indicators include frequent deep cracking, reflective cracking in overlays, heavy pothole patching, severe rutting, frost heaves, parabolic shape, and insufficient base strength.

Other recycling techniques can be used to address some of these maladies at a lower up-front cost, but the more the pavement has degenerated, the more likely it is that full-depth reclamation will provide the lowest-cost solution over a period of years.

As a case in point, severely cracked pavement —where the cracks penetrate all the way to the base —can be milled and overlaid for less cost than an FDR treatment. However, since the overlay rests on top of cracked pavement, it will be prone to reflective cracking in a few years. Full-depth reclamation should provide a much longer lasting solution because it eliminates the cracking and creates a new, stronger base for the new surface treatment.

Today, full-depth reclamation is being widely used on city streets and state highways, as well as secondary roads. It is also being specified for some interstate highway applications. Beyond road applications, FDR is used for private and regional airport pavements, and for parking lots.

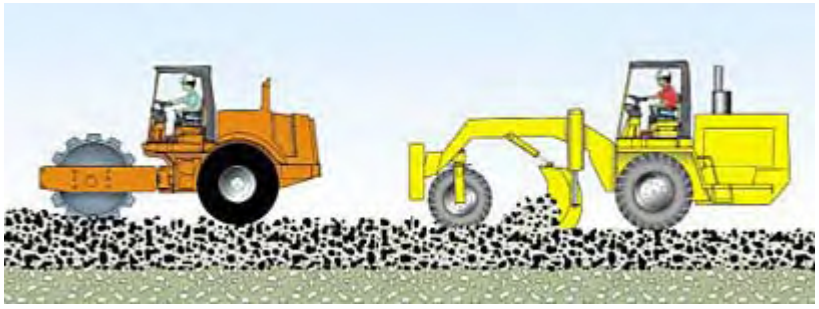
Illustrations by Edd Hickingbottom.

Pulverization

A road reclaimer pulverizes in-situ pavement layers and blends asphalt material with a predetermined amount of underlying material. Additional materials and stabilization agents can be added during this process, usually requiring multiple passes by the reclaimer.

Moisture Conditioning

Moisture is added to the pulverized material to aid in compaction. Though moisture can be surface-added after pulverization, the preferred method is to use the reclaimer's integrated fluid injection systems which provide precise moisture conditioning during the pulverization process.



Breakdown Compaction

Breakdown compaction immediately follows the reclaimer to achieve consistent material density in the reclaimed mat prior to any shaping with the motor grader.

Shaping

Grade and cross-slope adjustments are made by a motor grader after breakdown compaction. Widening can also be accomplished at this point, though it may require multiple reclaimer passes if extra stone or RAP is added in the pulverizing process.

Moisture

Surface-added moisture is usually necessary to correct drying that occurs during the shaping process.

Intermediate Rolling

Intermediate rolling follows shaping and moistening. It involves either a pneumatic roller to knead loose aggregates from the shaping process, or a heavy vibratory smooth roller to seat them.

Finish Rolling

After intermediate rolling, there is a final grading pass, then final rolling is done by a 12- to 14-ton static single or tandem steel drum roller.

Sealant

A fog seal of asphalt emulsion or specified sealer is applied to the surface to bind any loose particles and protect the reclaimed layer against weather and traffic. The reclaimed layer can generally be open for traffic as soon as the seal coat dries.

New Surface Course

Reclamation is followed by a new surface course, ranging in cost from a double chip seal for low-traffic roads to hot-mix asphalt for roads with more demanding loads.

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