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Y=FDR

Rural route in Missouri perfect scenario for full-depth work

When pavements fail in this country, more often than not engineers with our transportation departments are faced with a dilemma: Do we fix this road? Or do we just patch it up for a while?

These decisions are often completely guided by currently available funding and the predicted available funding for repair needs in the future. The job of the transportation engineer is as much a balancing act as it is designing and building our nation's roads and bridges. So when faced with the decision to maintain, repair or reconstruct, one that should be guided by the needs of that particular road, transportation engineers instead look to their balance sheets to help determine what treatment the road will receive.

All too often funding is short and needs are many. So the road that needs to be reconstructed is instead overlaid with a thin section of asphalt, and that same route will return to the

engineer's desk next year. This cycle continues across the country until funding levels change or the condition of the road gets so bad that it requires additional attention.

Subgrade assassin

The Missouri Department of Transportation (MoDOT) is no different from most of our state DOTs. Like many agencies, MoDOT is staffed with some of the finest engineers you could have the pleasure to work with. The talents of these engineers are put to the test every day as they maintain a network of state lettered and numbered routes with more lane-miles of asphalt pavement than Kansas, Nebraska and Iowa combined.

Many low-volume roads across the state of Missouri are aging and in need of extensive repairs to return them to their desired serviceability. MoDOT funding levels are dropping sharply as their infrastructure needs are increasing. This imbalance has led MoDOT personnel to seek innovative methods to get more life out of their roads and bridges with less cost. It is all about doing more with less.

A 6-mile section of Rte. Y in Cass County,

Mo., is situated about 40 miles south of Kansas City near the Kansas border. A low-volume road well outside of the Kansas City suburbs, Rte. Y serves as a major quarry haul route. There is one stone quarry located within the project limits and another just outside to the northeast. Beyond the quarry haul trucks, this route sees light commuter traffic between the towns of Cleveland and Peculiar. Rte. Y received its first bituminous pavement layer around 1970, and since then it has received several bituminous overlays.

In 2008, project borings revealed 10 to 14 in. of hot-mix asphalt (HMA) over a weak, fat clay subgrade. The aggregate base course that preceded the asphalt pavement had virtually vanished, a victim of years of subgrade pumping and settlement. This stretch of road was in terrible shape. Years of wear and tear from heavy loads had pushed, shoved, rutted and carved out holes in the roadway the size of small vehicles. Rte. Y was in a state of disrepair that could not be fixed with another overlay. MoDOT would be forced to dig deep into its toolbox to find a cost-effective method to rehabilitate Rte. Y.

"If funding was available, this road would have been a candidate for reconstruction," explained MoDOT's Jason Blomberg, P.E. "However, current funding levels do not allow for that option. Instead, we would have most likely milled down to the average depth of the ruts and then capped it with a 3¾-in. HMA overlay. Additional quantities would have been allocated for areas in need of total replacement."

The exploratory borings concluded that complete subgrade failure was the cause of this pavement's distress. Over time, poor subgrade conditions will eventually reveal themselves on the majority of pavements. Rte. Y is burdened with an extremely weak, fat clay subgrade that had moisture contents in excess of 35% in some areas.

This combination is devastating to flexible pavements, and the subgrade conditions on this roadway proved too formidable for any asphalt overlay thickness. To truly fix this road, you had to get to the root of the problem: the

subgrade itself. In traditional pavement construction, the only way to do this is with total reconstruction. Another method of solving this problem at a fraction of the cost of reconstruction is full-depth reclamation, or FDR.

FDR is an asphalt recycling process in which the full flexible pavement section and a predetermined portion of the underlying base and subgrade are uniformly pulverized and blended to provide an upgraded, homogeneous base course. This new composite base is then treated with a cementitious chemical, most commonly portland cement, remixed, compacted and graded. The result is a chemically stabilized base course that provides a much stronger, stiffer and longer-lasting layer for the new pavement or surface layer. As its

FDR may be poised to grow exponentially in the coming years.

FDR is considered by many to be the ultimate recycling process. It is a process done entirely in place and uses 100% of the existing pavement in the process. Rarely does any material leave the project, and only a small amount of the stabilizing agent is brought in. One could argue that the single greatest asset in this nation is our network of roads, highways and interstates. But yet, when it comes time to widen, reconstruct or rehabilitate these assets, the most common approach is to rip it out and put it in a landfill or trickle it into new asphalt mixes. FDR, and other asphalt recycling processes, seek to change this common approach, and many states are beginning to pay attention.



Following pulverization, the section is compacted and graded to a consistent 22-ft width and 2% cross slope. Proper geometry is something that this road has not had in a long time.

name suggests, FDR is a process used to treat full-depth problems. With the subgrade being identified as the culprit in Rte. Y's pavement failure, it is a perfect candidate for FDR.

Making it big

The use of FDR has increased in the U.S. in recent decades. Driven by a demand for longer-lasting pavement rehabilitation methods, a trend toward environmentally friendly road-building practices and raw material conservation,

MoDOT had previously done one small shoulder repair project using FDR in 2008. On Rte. Y, a progressive group of MoDOT engineers saw an opportunity to try FDR on a larger scale.

Construction specifications and a simple design were quickly put together, and the project was put out to bid in early 2009. Chester Bross Construction, Hannibal, Mo., was awarded the contract, and they subcontracted the FDR work to Mt. Carmel Stabilization Group, Mount Carmel, Ill.



The aggregate base course on Rte. Y that preceded the asphalt pavement had virtually vanished, a victim of years of subgrade pumpings and settlements. Mt. Carmel used two Wirtgen WR 2400 reclaimers for pulverization and mixing.

Construction began on Rte. Y in September 2009. In order to maintain the existing grades, 2 in. of the existing pavement was milled off prior to FDR operations. Mt. Carmel Stabilization Group began the FDR operation by pulverizing the existing asphalt pavement, along with a portion of the subgrade soil to a depth of 13 in. With the current mixing equipment, FDR can go as deep as 16 in. On this project, 13 in. was selected because it would allow for ample penetration into the subgrade layer.

Mt. Carmel used two Wirtgen WR 2400 reclaimers for pulverization and mixing. These machines thoroughly pulverize the existing asphalt pavement and mix it with the subgrade soil. After one pass, the new composite base is homogeneously blended and sized to approximately 90% -1 in. Proper gradation is critical to the FDR process and the end product. Following pulverization, the section is compacted and graded to a consistent 22-ft width and 2% cross slope. Proper geometry is something that this road has not had for a long time. Many of the curves on this route had the surface pushed up to the top, and subsequently these steep banks had to be leveled out before the next step in the FDR process.

Following pulverization, compaction and grading, portland cement was

applied on the roadway using Mt. Carmel's custom-built spreader trucks. Prior to the project start, a laboratory mix design was done using the roadbed materials and mixing them with various percentages of cement. In FDR, portland cement acts as the bonding agent that stabilizes the RAP and subgrade soil in a new, stabilized layer. Testing for this project revealed that 4% cement was the proper application rate for the desired strength of the stabilized layer.

After the cement was spread on the grade, the entire section was then remixed to the full depth and width of pulverization, and water was added to hydrate the cement and bring the mixture content to optimum. Immediately after remixing, the area was again compacted and shaped, fine-graded and sealed with a rubber-tire roller and with a double-drum steel-wheel roller on the final pass.

Smoothness was a major point of emphasis, given the new asphalt overlay would be placed directly on top of the stabilized base. The layer was then allowed to cure for three days prior to paving.

6 in 10

The entire FDR process for this 6-mile stretch of Rte. Y, from pulverization to finish rolling on the last section, took

only 10 working days. MoDOT personnel took notice, and several groups from the local district and headquarters in Jefferson City came to see this new process in action. All were impressed with what they saw.

"We expect that the FDR process will give this road a 10- to 15-year service life before the next major rehabilitation treatment is needed," claimed Joe Schroer, MoDOT field materials engineer. "This is well beyond the performance of a simple overlay due to the road's unstable underlying conditions."

The new 2¾-in. HMA overlay on Rte. Y was a 20% RAP mix using millings from the project, which further optimized the use of existing materials from the roadway.

Following the Cass County Rte. Y FDR project, MoDOT has added a new tool to their toolbox for pavement rehabilitation. FDR is an asphalt recycling process that provides reconstruction results at a fraction of the cost. To learn more about FDR and other asphalt recycling processes, go to the Asphalt Recycling and Reclaiming Association's website at www.arra.org. **R&B**

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