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**One Way to a Better Road**  
by Blair Barnhardt

To save time and money, a growing Georgia community in the metropolitan Atlanta area reclaims busy roadways using foamed asphalt base stabilization.

Today's highway engineers and professionals are called upon to champion innovations that are technically sound, economically feasible, and fundamentally safe. In an editorial in the May/June 2004 issue of PUBLIC ROADS, Federal Highway Administrator Mary E. Peters encouraged the transportation industry to act on this challenge: "Moving away from simply building highways the same way the transportation community has built them for decades can be done by using innovative practices and processes, and involving nontraditional partners from outside the highway community...How we—as individuals, as agencies, and as a collective highway community—respond to the call for a new way of looking at transportation and highway projects can mean all the difference."

The newly rebuilt Riverside Road has an added shoulder made from reclaimed asphalt pavement (RAP) that was taken from another phase of the project. The additional platform width provides hikers and bicyclists a smooth path to share with cars.

Practicing innovation can mean working with unfamiliar technologies, materials, or equipment. Construction Supervisor John Indrunas for the city of Roswell, GA, in the metropolitan...
Atlanta area, accepted the challenge when he tested a relatively unconventional technology—the use of foamed asphalt base stabilization—for the reclamation of four highly traveled roads in and around Roswell. Over a period of 4 years, the Roswell Department of Transportation (DOT) reconstructed Houze Way, Jones Road, Hardscrabble Road, and Riverside Road. But first, some historical background to put the Roswell story in context.

This illustration shows how the hot foamed asphalt cement is injected into the reclaimed aggregate and asphalt mixture inside the mixing chamber of specially designed equipment.

Mixing Oil with Water

The potential of foamed (or expanded) asphalt as a binder was developed in the mid-1950s in Iowa. By injecting a small amount of cold water into hot, liquid, petroleum-based asphalt, the resultant foaming action expands the surface area of the asphalt. The binding process is used with reclaimed asphalt pavement (RAP). Other countries adopted the technology relatively quickly and developed supportive technologies and expertise for foamed asphalt with both virgin materials and RAP.

In the 1980s, highway experts in the United States began experimenting with the technology and building on the lessons learned up to that time. The primary motivating factor for the U.S. interest in foamed asphalt was the potential cost savings to agencies that use recycled pavement. “Some agencies use recycling because that approach generally is less expensive than complete reconstruction, conserves natural resources, and reduces energy consumption in the construction process,” says Steve Mueller, pavement and materials engineer with the FHWA Resource Center.

The object of all flexible pavement technology is to “glue” aggregates together using asphalt while still providing sufficient air voids in the mixture. Conventional hot-mix asphalt (HMA) plants completely coat aggregates with liquid asphalt, which can be done only at temperatures hot enough to liquefy the asphalt. To create a well-formed bond, the asphalt must cover the entire surface of the aggregate. In HMA plants, asphalt and aggregate are mixed in large drums under extremely high temperatures to ensure uniform coating of the hot asphalt over the aggregate. The mixture then is trucked to the construction site, placed on the prepared subgrade, and rolled to obtain the proper amount of air voids. As the temperature of the liquid asphalt falls during this process, the material becomes stiffer and glue-like. At the completed stage, a smooth and durable HMA.
layer is achieved. “This proven practice has served our national highway system well,” says Mueller.

Foamed asphalt base stabilization, on the other hand, involves using hot, foamed asphalt cement in combination with damp RAP and/or base course aggregates in situ. As a result, the foamed asphalt cement coats the finer particles and creates a cold-recycled, mortar-type mix, thus “spot-welding” the stones together. At a seminar sponsored by the Georgia Local Technical Assistance Program, Dr. John Emery, president of John Emery Geotechnical Engineering Limited, Toronto, Ontario, recently pointed out that the resultant mastic (pasty material) that forms during compaction of the recycled base courses is one of the main reasons why foamed asphalt flexible pavement bases have high rut resistance and excellent Marshall stabilities, especially at higher ambient temperatures.

Due to the higher air void contents (compared to HMA) in the cold-recycled mixes, Emery recommends HMA wearing surfaces for high traffic counts. Farm-to-market roads, on the other hand, may be well suited for a 150-millimeter (6-inch) foamed asphalt base course and a double or triple surface treatment. Emery adds that layer coefficients for properly designed and constructed (particularly compacted) foamed asphalt bases can be as high as 0.40, thus the thickness of wearing courses often can be reduced to keep project costs on budget.

Specially designed equipment takes up and pulverizes the old base. Once crushed, the mixture of RAP and aggregate is laid down again, and the road graded to near final condition to ensure the correct amount of material is prepared. The pulverizer makes a final pass, picks up the aggregate/RAP mixture, and this time binds it with foamed asphalt.

“Using these existing materials is a significant cost savings on many jobs,” says Mueller. “And many times, the older existing aggregates are higher quality than those being mined today.”

By injecting only a small (and precise) amount of water into liquid asphalt binder heated to 170 degrees Celsius (320 degrees Fahrenheit), millions of bubbles are formed, enhancing the take up of the binder by the fine particles of aggregate and coating them. The asphalt-coated finer particles in turn glue the larger aggregate particles together much like a mortar mix. The water evaporates, and the machine returns the new “old” asphalt to the roadway to be compacted initially by a pneumatic roller and then later by a smooth drum vibratory roller.

The Pathway to Accepting New Practices

Back to the Roswell, GA, story. In the spring of 2000, after Indrunas had exhausted internet searches on the process of using foamed asphalt to build road bases, he went in search of more information during a meeting held in Atlanta and sponsored by the Asphalt Recycling and Reclaiming Association (ARRA). He was joined by then-director of transportation John “Jack” W. Seibert, III, P.E. “I knew if I could get my manager involved with the training, it would be easier to sell to our city council when the time came to utilize this technology,” Indrunas says, reflecting on the initial steps he took when considering a change in the city’s traditional approach to reclamation projects.
In 2001, Roswell became possibly the first city in the Southeast to perform foamed asphalt base stabilization. Indunas' agency accepted a bid from a local contractor for Houze Way, a major shortcut around the Highway 9 corridor. The agency chose the roadway for a trial run using RAP and a foamed asphalt base because the segment was short—about 1.2 kilometers (0.75 mile)—and was heavily traveled both in the volume of cars and the weight of trucks taking products to the commercial businesses in the area.

According to Indunas, approximately 16,000 cars per day traverse many of Roswell's main roads as commuters pass through the city to access Georgia's State Highway 400 to Atlanta. To manage the flow of traffic on Houze Way, the contractor carried out the work with vehicles passing on a single lane running one direction in the morning and reversing in the afternoon.

The reconstruction went better than expected and afforded the opportunity to match not only the existing curb elevations on one side of the road, but also to widen the eastbound lane an additional 0.9 meters (3 feet) at the same time. "Even with the success of Houze Way," said Indunas, "it was still important to become more fully informed about the process." So Indunas attended a seminar on full depth reclamation at the Georgia Department of Transportation (GDOT) Materials and Research Lab in September 2001.

The bucket on the left holds the hot foamed asphalt shortly after it has been extracted from the sample nozzle on the pulverizer. Typically the asphalt cement is expanded to 10 to 12 times its normal volume.
Approximately 45 seconds later, the bubbles subside, and the asphalt cement returns to its normal volume (as shown here). In its foamed state, the asphalt cement coats the finer particles of the reclaimed mixture creating a mortar-type effect to glue aggregates together. Once compacted, the foamed mix is ready for hot-mixed asphalt overlay.

Cost Savings Changes Project Direction

Still not fully satisfied that reclamation was the answer to Roswell's overcrowded and under designed roads, Indunas let a project for conventional construction in the fall of 2001 for the reconstruction of Jones Road. Initial bids came in at more than $1.5 million to complete the work—well over the project's budget. The plan had included removing 40.6 centimeters (16 inches) of base, which meant additional costs to relocate the affected water, gas, and phone utilities that lay beneath the roadbed. The city’s transportation staff decided to take a different approach the following spring and rebid Jones Road as a reclamation project.

"We were shocked when the successful low bidder was awarded the work at just over $270,000," Indunas says. With the new contract, Roswell saw a potential cost savings of more than $1.2 million.

The new bid involved time savings as well. Using reclamation, the roadway was scheduled to reopen after 7 or 8 working days instead of 6 months, because the Roswell DOT did not have to relocate the utilities to accommodate the 30.5 to 35.5 centimeters (12 or 14 inches) of new stone base that would be required if conventional reconstruction techniques were used.

Due to the absence of freeze-thaw conditions in the Southeast, it is not uncommon to encounter utilities at very shallow depths. With reclamation, only 18 centimeters (7 inches) of surface was to be taken up. "We got the strength of a brand new road for a fifth of the
cost [in] substantially less time than conventional reconstruction,” says Indrunas.

Although the use of the full-depth reclamation process has nothing to do with utility replacement, the decision to use one form of construction over another did include the costs of each alternative.

Pulverizers like this one not only grind up the existing roadbase, but they also perform the actual foaming process with specially designed onboard computers and asphalt expansion chambers.

Change of Heart

By 2003, Roswell’s budget planners for street construction accepted reclamation as an option. Based on cost savings alone, the question now was where to use the process rather than whether to use it.

The Roswell DOT made plans in 2003 to reclaim Hardscrabble Road with a combination of 3.9 kilometers (2.4 miles) of foamed asphalt base stabilization and 0.8 kilometers (0.5 mile) of milling and resurfacing. Mix designs were set, and work began to prepare a 125-millimeter (5-inch) stabilized base under 50 millimeters (2 inches) of asphalt overlay. With the road closed to local traffic only, reclamation crews expedited the work in record time—10 days versus 6 to 7 months with conventional reconstruction.

“On a road with a traffic load of 16,000 cars a day, the difference in time is priceless,” says Indrunas. Part of the problem with asphalt patching, overlay techniques, and conventional reconstruction in general is the cost to the public for detours, user delays, and road closures. In addition, with patching and overlay methods that may appear to be quicker and less expensive at the onset, reflective cracking into the new asphalt overlay could occur year after year because the base course asphalt and subgrade problems were not fully addressed in the process.

Conversely, recycling the base with foamed asphalt or another full-depth reclamation technique provides an opportunity to complete a homogenous base course from curb to curb and, at the same time, replace or repair weak spots while the base is being redone. For example, certain areas of weak subgrade on these projects were strengthened with the addition of quick lime (other projects might use portland cement powder instead of quick lime, depending on soil properties) up to 46.7 centimeters (18 inches) deep using a pulverizer. As a result of this all-encompassing approach with full-
depth reclamation as opposed to patching and overlay, the agency expects to achieve a longer pavement life cycle.

A 27-metric ton (30-ton) pneumatic roller follows the foamed asphalt pulverizer to ensure a strong and dense cold inplace recycled asphalt base. According to the National Asphalt Paving Association, asphalt pavement is the most recycled product in America.

Growing Confidence

In 2004 with three successful foamed asphalt base stabilizations completed, the Roswell DOT let a bid for reconstruction of scenic Riverside Road along the Chattahoochee River. This road is more highly traveled than the first three reclamation projects, and part of it includes a lane expressly for bicyclists and joggers. Originally, the 5.6-kilometer (3.5-mile) project was to take place in four phases over 1 year to limit disruptions to traffic flow. However, phase 1 went so fast, the city decided to complete the other three phases all at once.

The engineers realized, however, that several thousand tons of new material would be required to stabilize and build new shoulders in phase 4 of the project. Indrunas explains: "I knew that the surplus reclaimed material in phases 1 and 2 could be utilized in lieu of new material on phase 4, so I was delighted with the city's decision to do all four phases at once."

The engineers added a shoulder to the road where formerly there was none and, though not exclusively for biking and jogging enthusiasts, it provided a "share the road" aspect. For taxpayers and road users alike, the good news was that the project came in $400,000 under budget and a month ahead of schedule.

Saving time and money are helpful factors when it comes to accepting an innovative process, but at what cost in quality? To answer that question, a third party contractor provided quality assurance on the Roswell projects. Comparing the new subbase against international standards of density and mix designs, the contractor determined that Roswell's projects were reaching a target density between 95 and 98 percent. This density resulted not only from the binding of foamed asphalt to the fine particulates, but also the use of a 27-metric ton (30-ton) rubber tire roller, one of the heaviest available to the highway construction industry today.
Fifty millimeter (2 inches) of black HMA overlay is placed upon lighter colored 125 millimeters (5 inches) layer of foamed asphalt base. The paint marks denote the centerline of the road. The cold-recycled base resembles that of a high-quality HMA binder mix.

Increased confidence in an innovation also comes when the engineers have a grasp of conditions that are unique to their situation and find the appropriate adjustments that ensure success for their locale. For example, many of Georgia’s roads are built on semiplastic soils with minimal aggregate base, according to Ron Adderley, Roswell’s construction and maintenance supervisor. “We found that using quicklime stabilized the subbase and prevented the clay from becoming slippery,” he says. (One percent quicklime is also added in conjunction with the foamed asphalt base to increase the Marshall stability of the mix.) Knowing that the subbase failures are properly addressed and that the foamed asphalt base has a long life cycle when properly installed gave Indrunas the confidence to tell city officials that the new approach to reclamation would meet the 20-year life cycle expected for a road base.

With reclamation, the city has an affordable approach to both replacing stretches of roads and completing needed repairs. Roswell experienced unprecedented growth in the last 15 years, with access roads to many subdivisions added to the original highway systems. Development companies did not always connect their access roads to existing roads using optimal highway construction designs. “We can adjust and correct the resultant drainage deficiencies,” said Adderley. “Now with proper drainage, cross slope, width and uniformity, we are giving our taxpayers roads that are new for a third or more of the cost of conventional reconstruction. We can use environmentally sound processes to complete a road in record time under traffic and at a lower cost. That is invaluable.”

On October 18, 2004, the Asphalt Institute presented Director of Transportation Steven D. Acenbrak and the Roswell DOT staff with an award in recognition of their achievements using foamed asphalt base stabilization. Peter Grass, president of the Asphalt Institute, remarked, “All too often, we are reluctant to try newer technologies in our public works projects for a variety of reasons, and in doing so, fail to take advantage of effective techniques that can save both time and money for the taxpayer.” By using this new technique, Roswell reclaimed the four roads in a total of 46 construction days at a cost of just under $1.4 million. Had the Roswell DOT used
traditional methods, the roadwork was estimated to have required 345 construction days with a cost of approximately $6.5 million.

Blair Barnhardt is the operations engineer with Blount Construction Co. Inc. He has been involved with foamed asphalt reclamation for 8 years in North America. Working in conjunction with instructors from the Asphalt Institute, he has taught the National Highway Institute course “Asphalt Pavement Recycling Technologies” (NHI Course #131050A). For more information on this 2-day course, visit www.nhi.fhwa.dot.gov.

The author would like to thank John Indrans for sharing his experiences with foamed asphalt base reclamation. For more information on foamed asphalt base stabilization, contact steve.mueller@fhwa.dot.gov.

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