M A S S

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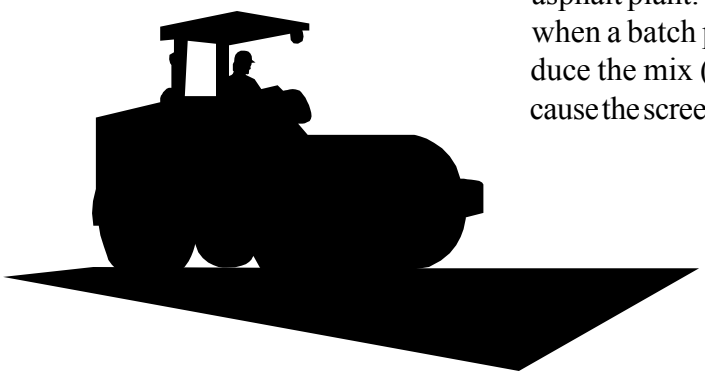
SEGREGATION OF HOT MIX ASPHALT (HMA)

DESCRIPTION

Segregation is the separation of the coarse aggregate from the rest of the mix in an HMA mix. Segregation results from mishandling the mix at any of several points during the mix production, hauling, and placing operations. When segregation occurs in a paving project, it is likely to lead to forms of long-term pavement distress such as wavy surface and poor compaction. It can occur as the mix is delivered from the asphalt plant to a surge silo, as the mix is deposited into the haul truck from the silo, and as the mix is discharged from the truck into the paver hopper. Segregation that is evident behind the paver screed generally takes one of three forms: it may consist of areas of coarse aggregate (rock pockets) that occur randomly across the length and width of the layer; it may occur at a transverse location across the width of the lane (truckload-to-truckload segregation); or it may occur along one side of the paver width (longitudinal or side-to-side segregation).



CAUSES

The cause of segregation behind the paver is directly related to the type of segregation involved. Rock pockets are generally caused by improper handling of the aggregate in the stockpiles, cold-feed bins, or storage of the HMA at the asphalt plant. They seldom occur when a batch plant is used to produce the mix (without a silo), because the screens and hot bins in the plant recombine any segregated material before it is fed into the pugmill. Further, the pugmill blends all the aggregates together and normally eliminates any segregation that might have occurred previously. If a silo is used on a batch plant, however, the mix may segregate for all the same reasons that affect a mix produced in a drum-mix plant and passed through a surge or storage silo.

Rock pockets and random segregation are occasionally found on the roadway when the mix was manufactured in a drum-mix plant. If the loader operator places a bucketful of segregated aggregate in a cold-feed bin, that material can pass through the drum, surge silo, haul truck, and paver without being completely mixed in with the other aggregate. This is because the drum-mix plant operates on a continuous-flow instead of a batch basis. If the aggregate in the cold-feed bins is segregated, that material will show up on the roadway in a random pattern both transversely and longitudinally.

Some mixes are more prone to segregation than others. Asphalt mixes that have large maximum-size coarse aggregate [25 mm (1 in.) or greater], have low asphalt cement content, or are gap-

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Baystate Goes Hands-On.....

Gravel Roads

In our gravel roads classes we walked 1500 feet of a gravel road. After gathering distress and other roadway data, we returned to the classroom to discuss, argue, and finally decide on the best repair strategy. We calculated the cost, discussed politics, and considered citizen opinions. Remember: some people don't want their gravel roads fixed.

For me, the high point (or maybe low point) of these classes happened in Falmouth while we were walking the road. I always insist that everyone wear a vest. So, 30 of us were standing in the road with our bright, mostly new, vests on. While everyone else was looking at the road conditions and listening to the speaker, I was, as always, watching for traffic. It was not too hard a job that day. The neighborhood was quiet and included some very large homes. Traffic was very light and cars that did come were very new and very nice.

A Lexus sport utility vehicle came down the road and slowed as it approached. There was a nicely dressed young couple inside. As they crept by, the man leaned out the window and in a questioning tone said one word to me, "Prisoners?".

I will always wish I had shot back with just the right smart retort, but it was not to be. I was so flustered by the comment that they had driven away before I could even think of a response much less a witty one.

Hey, at least they slowed down.

"Prisoners?"

-woman in a Lexus

Attendees at the Gravel Roads Workshop in South Hadley

....We've moved some of our classes to the field

Concrete Sidewalks

Baystate Roads presented these classes where 30 students worked in groups of 4 to 6 and placed approximately 180' of sidewalk at each location. Each group was responsible for 30' of sidewalk. They shoveled the concrete, troweled it, broomed it and then spray cured it. The instructors demonstrated materials testing methods, gave basic instructions and throughout the day answered questions and gave tips.

For me, the high point of these workshops came in Barnstable where the sidewalk was about 200' from the beach. It was a very nice location. The time was just after lunch. Because we had a little extra time, we decided to eat our box lunches inside the Mattakeese Wharf Restaurant. The restaurant hangs out over the water on pilings and is surrounded by boats. We may have lingered over lunch a little longer than usual because of the location. Anyway, as soon as we could muster the energy, we went outside to make sure our new sidewalk was OK. There had been considerable pedestrian traffic all morning and we were concerned that someone may have stepped in the fresh concrete. Well, no one stepped in it, but as we came around the corner we saw that someone had written names and drawn hearts in one of the slabs. As we surveyed the damage, an elderly woman with a cane came out of her house. She crossed the road as quickly as she could and as she did she was shouting to us that it was kids and she saw them and yelled at them to stop. They ran away, but it was too late, the damage was done. She said she knew it had to be fixed before the sidewalk hardened, but she didn't know whom to call. So she called the police, but they never came. We thanked her for chasing the kids away and trying to find someone and then we all told stories of the stupid things we did as kids.

While we were talking and repairing the damaged slab with our hands and a jack knife, the workshop speaker, Mike doCurral came around the corner. Mike had stayed in the restaurant to take a phone call or was it to eat another piece of cake. Now let me just say that Mike is an extremely nice guy. He is very even tempered and patient. Anyway, he came around the corner to see how the sidewalk was curing. He walked up to us quickly and then stopped quickly when he looked down and saw the damage.

He looked up at the elderly woman. He looked down at the concrete. He looked back up at the elderly woman and exclaimed, "Did you do this?" Well, we all burst out laughing. Thankfully, this senior citizen saw the humor and the situation turned into a very nice, lighthearted moment with a neighbor.

Turns out some townsfolk really do appreciate what you do.

Barnstable Workshop

Wakefield Workshop

continued from page 1

graded will tend to segregate more readily when handled than a dense-graded mix containing optimum asphalt content and a smaller maximum-size coarse aggregate.

Segregation that occurs on one side of the paver (side-to-side segregation) when a batch plant without a silo is used to produce the mix is normally caused by improper loading of the haul truck from the pugmill. If the mix is not loaded in the center of the width of the truck bed, the coarse aggregate particles in the mix may roll to one side of the truck and accumulate along that side. When the mix is delivered to the paver hopper, the segregated mix will be placed on the roadway along the same side, and the segregation will appear as a longitudinal streak on one side of the paver only.

Segregation that occurs on one side of the paver when a batch plant with a silo or drum-mix plant is used to produce the mix is typically caused by improper loading of the mix into the surge silo. As the mix is deposited into the silo from the conveying device (slat conveyors, belt conveyor, or bucket elevator), the mix is thrown to one side of the silo, and the coarse aggregate particles are separated from the finer materials. When the silo is emptied, the coarse aggregate is deposited on only one side of the truck. This segregated material then passes through the paver and is seen on one side of the mix after laydown. Further, as with a batch plant, if the truck is not loaded in the center of its width under the silo, rolling of the coarse aggregate particles may occur, and the longitudinal segregation will then appear on one side of the new mat.

Truckload-to-truckload segregation has many potential causes. The most common is improper loading of the haul truck from the silo. If mix is placed in the truck bed in one drop from the silo, the coarse aggregate particles in the mix have a tendency to run to both the front of the bed and the back tailgate. This rolling of the coarse aggregate is exacerbated if the plant operator continuously opens and closes the silo gates near the end of the truck-loading procedure to ensure that the full weight of the mix is placed on the truck.

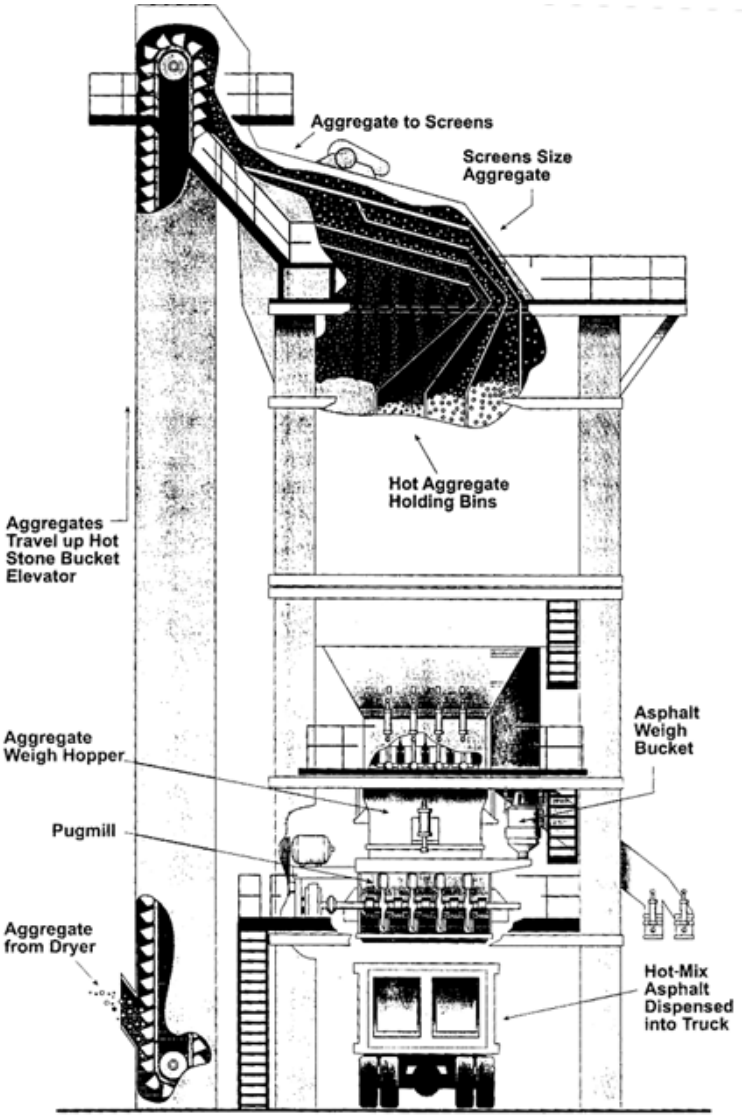


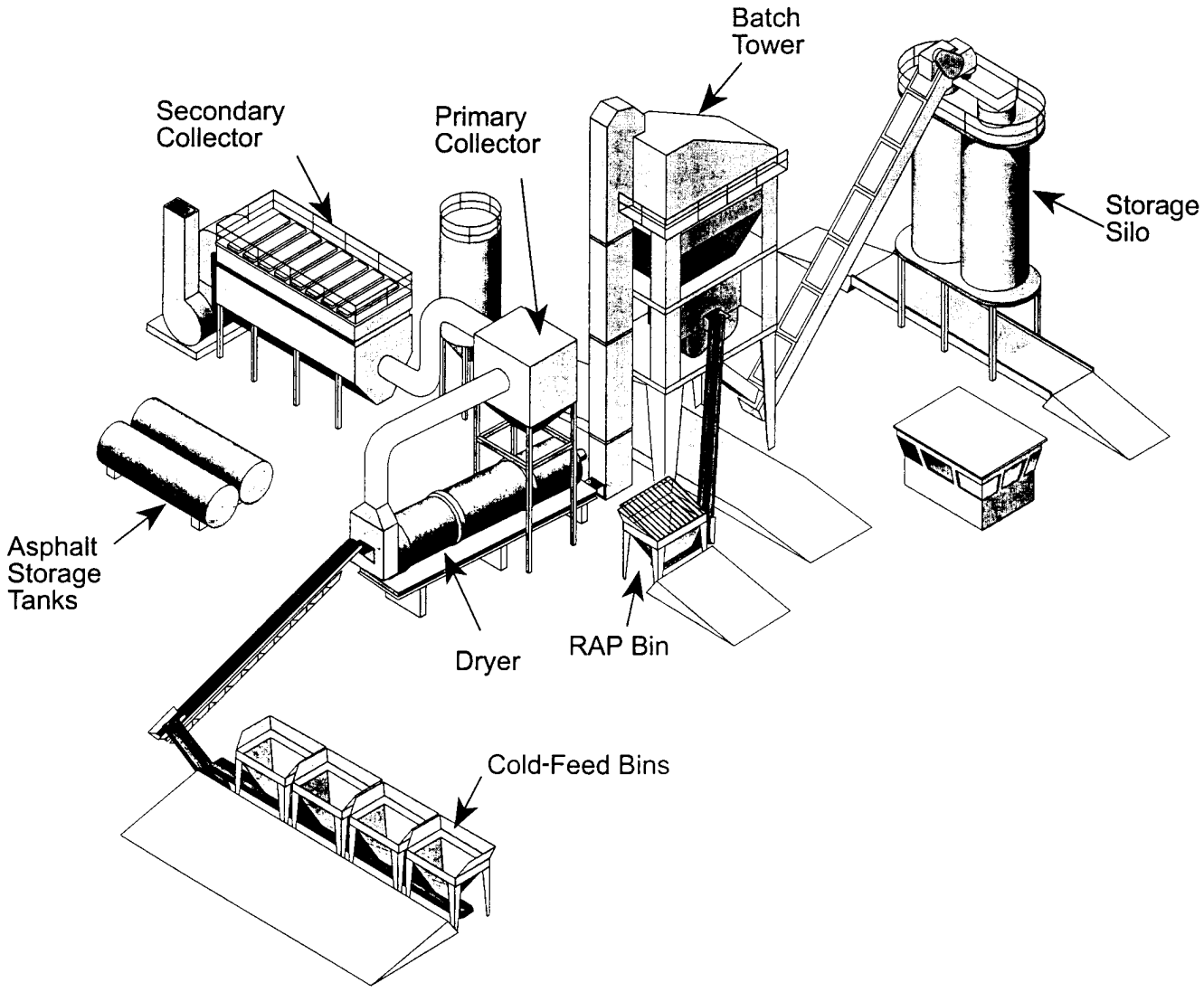
FIGURE 5-3 Flow of materials in batch tower.

Some believe that truckload-to-truckload segregation can also be caused by improper discharge of the mix into the silo. Mix that is dribbled into the silo from the conveying device is said to be susceptible to segregation inside the silo. Even if this occurs, the mix that is segregated in the silo will appear only as random rock pockets in the layer behind the paver, instead of in a systematic manner between the truckloads of mix delivered to the paver. Thus it is doubtful that any segregation of the mix that occurs during the continuous process of loading the silo will appear on the roadway in a discontinuous pattern--only at the beginning or the end, or both, of a truckload of mix.

Temperature segregation of the mix has also been shown to be a problem. The mix cools more quickly near the edge, bottom, and top of the truck during haul. This cooler material is not always remixed with the hotter HMA, leading to temperature segregation during the laydown operation. The result can be more variability in density during construction and a nonuniform surface. This problem can be monitored by infrared technology.

SOLUTIONS

The solution to each type of segregation is related to its cause. For random rock pockets that appear intermittently in the mat, the method of stockpiling the coarse



aggregate at the asphalt plant and the charging of that material into the cold-feed bins by the front-end loader should be checked to ensure that proper aggregate handling techniques are used. Further, all points in the mix-production system at which coarse aggregate particles might accumulate should be inspected to determine whether the flow of the coarse and fine aggregate pieces is uneven. A batcher should be used at the top of the silo to direct the mix into the center of that piece of equipment.

For longitudinal (side-to-side) segregation, the loading of the haul truck from the batch plant pugmill or from the silo at either the batch or drum-mix plant should be monitored to ensure that the mix is being delivered into the center of the width of the vehicle. When a drum-mix plant is used to manufacture the mix and the segregation always appears on one side of the paver, several trucks should be loaded at the silo while facing in the opposite direction from their normal loading procedure. When the mix is passed through the paver, the longitudinal segregation should change sides--go from one side of the paver lane to the other. If the transverse position of the longitudinal segregation does change (and it should), the solution to the side-to-side segregation problem must take place at the top of the silo. The mix deposited into the silo from the conveying device must be directed into the center of the silo instead of to one side, so that the coarse aggregate particles in the mix are not thrown to only one side of the silo. This solution requires some changes in the configuration of the equipment at the top of the silo. If the transverse position of the longitudinal segregation does not change, the segregation is probably caused by a paver problem.

Most truckload-to-truckload segregation can be reduced significantly by using multiple drops of mix to load the haul trucks. If a tandem-axle truck is being loaded, at least three different drops of mix should be made--into the front of the

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Basic Training for New Hires

Statistics reveal that workers are the most susceptible to injuries during their first month on the job. This is an excellent reason to give new hires basic safety training as soon as they come under your supervision.

WELCOME NEW EMPLOYEES

Before assigning new employees tasks, take the time to welcome them into your organization. Walk them around the facility and introduce them to their co-workers. Encourage veteran employees to help newer workers feel at ease. Your efforts will make both new and veteran workers feel more comfortable.

PROVIDE GUIDANCE

As a supervisor, you'll witness new employees trying hard to do things right in the beginning. You want them to feel at ease enough to ask questions and not be so anxious about their performance that they make mistakes or have accidents. New workers are the most likely to be injured during the first month of employment. Your new hires need to know how serious safety training is right from the start.

In your first meeting with your new employees, reinforce the need for caution and appropriate protective equipment for each task. Emphasize that all unsafe conditions, accidents, and "near misses" must be reported. Show them what equipment they can and cannot operate without your authorization.

EMPLOYEE ORIENTATION

Your company's human resource or personnel department can orient new employees in company-wide practices and employee benefits. Perhaps your safety director can instruct new employees in overall safety and accident prevention programs.

Since you're the supervisor, you'll probably have to cover the following issues:

- The proper safety practices to use and hazards to be aware of within your department.
- What to do if there is an accident or injury.
- How to report emergencies.
- How to care for and use personal protective equipment.
- How to use tools, machinery, or hazardous processes.
- Housekeeping and personal cleanup rules.
- The location of emergency equipment, first-aid supplies, and designed smoking areas.

TRAINING BENEFITS

By conducting new employee safety training, new employees can:

- See how concerned your company is about accident prevention
- See how other workers perform safely throughout the facility; and
- Be encouraged to suggest ways to improve their safety.

FOLLOW-UP MEETINGS

Schedule a follow-up meeting a few days after your initial orientation. You can see if new workers understand and are using safe work practices. Answer any questions they may have. Use a checklist to review each of the specific safety practices covered in your meeting. Remember, supervisors also benefit by initiating thorough orientation and safety programs--such programs can help keep employee morale high and reduce accident and employee turnover rates.

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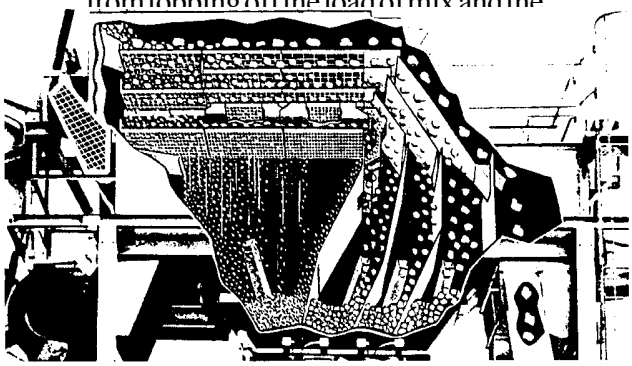
Cutaway Illustration of Screening

truck near the front bulkhead, into the back of the truck near the tailgate, and into the center of the truckbed between the first and second drops. If a larger truck is used, additional drops of mix should be made--the first into the front of the truck bed and the second near the tailgate. One of the main solutions for truckload-to-truckload segregation is to minimize the distance the coarse aggregate particles can roll. This is accomplished by making multiple drops of mix into the truck.

The plant operator should be prohibited from topping off the load of mix and the



accumulation of coarse aggregate particles at the tailgate of the truck, at the front of the bed, or both, the amount of segregation that appears on the roadway can usually be reduced by proper unloading of the haul truck at the paver. First, the truck bed should be raised a short distance, before the tailgate of the truck is opened, so that the mix can shift in the bed and slide against the tailgate. This procedure surrounds any coarse particles that have rolled to the tailgate area with nonsegregated mix. Instead of only the coarse aggregate being deposited first into the paver hopper, a mass of mix is discharged when the truck tailgate is opened, flooding the hopper with mix and typically incorporating the segregated coarse aggregate into the mass of HMA mix.

The operation of the paver can also increase or reduce the amount of segregation that occurs behind the screed. If the paver hopper is emptied of mix, if the slat conveyors are visible, and if the wings of the hopper are dumped after each truckload of mix, any coarse aggregate particles that have collected at the tailgate of the next truckload of mix will be deposited into the bottom of the hopper and then carried directly back to the empty auger chamber in front of the screed. This segregated material will appear behind the screed as soon as the paver moves

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er from the haul truck will be

led with the mix already in the

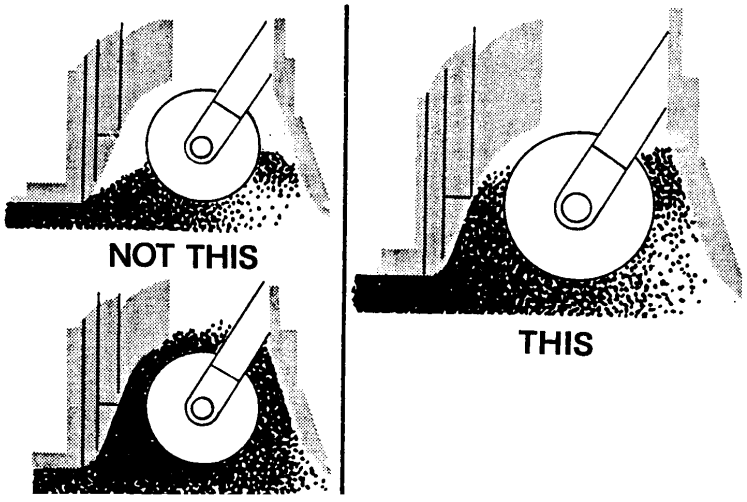
paver hopper. Any segregated material will be further incorporated in the mix that is pulled back to the augers by the slat conveyors and passed under the paver screed. The amount of truckload-to-truckload segregation can be decreased significantly, but not always eliminated completely, by good paver operating techniques. The problems should really be solved during the truck-loading procedure.

The use of material transfer vehicles (MTVs) has also shown some benefit in reducing segregation. The MTV remixes the HMA, and this reduces aggregate segregation, as well as differential temperatures within the mix (also known as temperature segregation).

EFFECTS ON PERFORMANCE

Segregation can affect pavement durability directly by increasing the air void content of the mix in the segregated areas and increasing the potential for moisture damage. Further, the segregated locations are very susceptible to raveling and, if bad enough, to total disintegration under traffic. Segregation, whether in the form of rock pockets, longitudinal (side-to-side) segregation, or transverse (truckload-to-truckload) segregation, is extremely detrimental to the long-term performance of the pavement.

Exerpted from Hot-Mix Asphalt Paving Handbook 2000, U.S. Army Corps of Engineers, AC 150/5370-14A (Appendix 1) pp. 209-211. Available from Baystate Roads:ASP99



Correct and incorrect mix levels in paver auger chamber

Baystate Roads Calendar

Storm Water at Your Garage:
Speakers from U.S. EPA and MA DEP
Sept. 17 Coonamesset Inn, Falmouth
Sept. 18 Andover Inn, Andover
Oct. 1 Holiday Inn, Taunton
Oct. 3 Beechwood Hotel, Worcester

Moving Together 2002
Statewide Bicycle and Pedestrian Conference
Oct. 23-24 Crowne Plaza, Worcester

Chain Saw Operating Techniques
Sept. 24 John Carver Inn, Plymouth
Sept. 25 Westford Regency, Westford

in this issue...

Check our website for workshop updates:

http://www.ecs.umass.edu/baystate_roads/

The Baystate Roads Program, which publishes *Mass Interchange* each quarter, is a Technology Transfer (T2) Center created under the Federal Highway Administration's (FHWA) Local Technical Assistance Program (LTAP). This newsletter is prepared in cooperation with MassHighway and the United States Department of Transportation Federal Highway Administration. FHWA is joined by Mass Highway, College of Engineering at the University of Massachusetts/Amherst, and local public works departments in an effort to share and apply the best in transportation technologies.

In addition to publishing *Mass Interchange*, the Baystate Roads Program facilitates information exchange by conducting workshops, providing reports and publications and videotapes on request, and offering one-to-one technical assistance on specific roadway issues. Because the program relies on input from many sources, inquiries, articles, and ideas are encouraged.

LTAP Local Technical Assistance Program

To contact the Baystate Roads Program call (413) 545-2604 or FAX 413-545-6471.

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