M A S S

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SHARP SHOULDER DROPOFFS

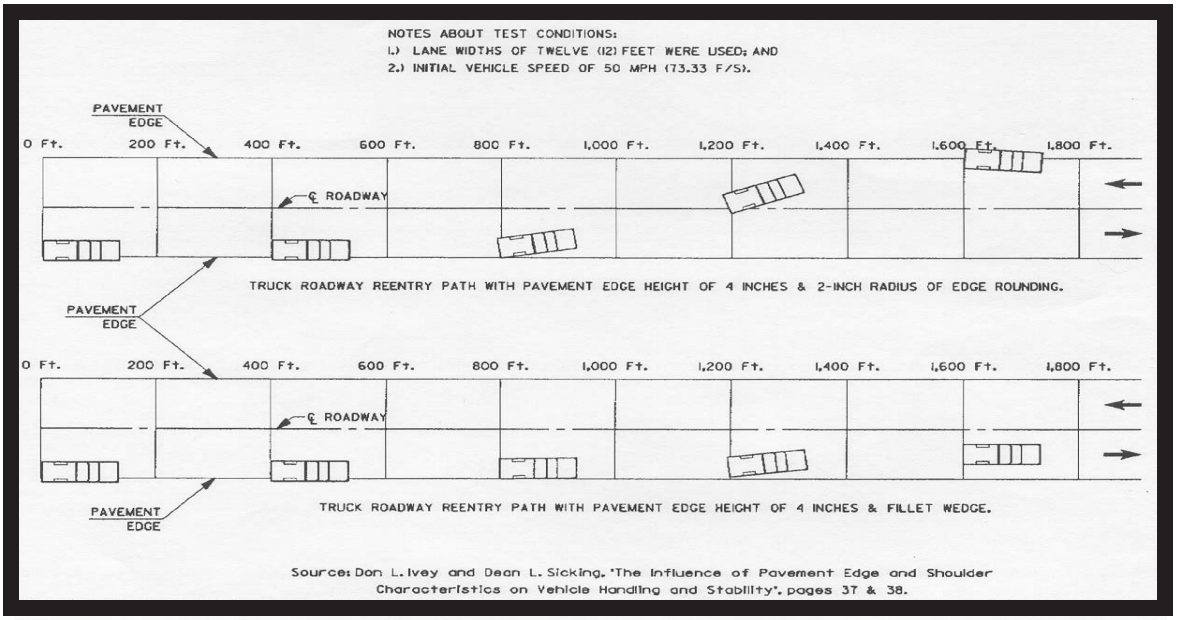

Figure 1: Influence of different pavement edges on vehicle reentry path

The "Scrubbing Effect", as the term was originally defined in 1976, has been recognized as a significant safety problem. The phenomenon known as the "Scrubbing Effect" and resultant loss of vehicular control was described in the following scenario:

1. A vehicle is under control in a traffic lane adjacent to a pavement edge where an unpaved shoulder is lower than the pavement.
2. Through inattention, distraction or some other reason the vehicle is allowed to move into a position with the right wheels on the unpaved shoulder and just off the paved surface.
3. The driver then carefully tries to gently steer the vehicle to gradually bring the right wheels back up onto the paved surface without reducing speed significantly.
4. The right front wheel encounters the pavement edge at an extremely flat angle and is prevented from moving back onto the pavement. The driver further increases the steer angle to make the vehicle regain the pavement. However, the vehicle continues to scrub the pavement edge and does not respond. At this time there is equilibrium between the cornering force to the left and the edge force acting to the right.
5. The driver continues to increase the steer input until the critical steer angle is reached and the right front wheel finally mounts the paved surface. Suddenly in

continued on page 6

John P. Sonia
Fifth Master Roads Scholar

Congratulations to John Sonia on his achievement as a Master Roads Scholar. John has been with the Lancaster DPW since 1975 when he started as a truck driver. One year later he was promoted to highway foreman and assumed supervision of ten employees in the Highway and Sanitation Divisions. In 1984 the town was still hooked on John and elevated him to Superintendent of the DPW where he overseas the highway, cemetery, water, and parks sections.

John has been instrumental in finding creative ways to improve the transportation infrastructure in Lancaster for over twenty-five years. His application to MassHighway for a complete reconstruction of the Main Street Bridge (Rt. 70) was submitted in 1985 and completed in 1987. MassHighway funded the engineering design and construction while recent builders of the 1930 bridge included children of the original contractors.

Bridges have fared extremely well under John's care. In 1988 he applied to MassHighway to replace the historical Bolton Road Bridge that crosses the Nashua River. The bridge had been closed to traffic for 20 years due to historical concerns. John was able to obtain land easements upstream to relocate a vital new bridge. The state engineered and constructed a new bridge at no cost to the town in 1990.

Continuing with his success at repairing or replacing bridges, John applied to MassHighway in 1993 for replacement of the Center Bridge and…."bingo"….a new crossing appeared , again, at no cost in 1995. The Mill Street bridge required complete replacement in 1994 and…."bingo"…..the new, no-cost bridge opened in 1996.

The bridge on Rt. 117 (a major route that carries 10,000-15,000 vehicles daily) was deteriorating rapidly in 1998. The town wanted to allow traffic to operate on half of the bridge during replacement but the state and contractor determined that by closing the road completely, construction time could be cut in half to six months. The project was approved and completely funded by MassHighway and opened in 2001.

"During construction of all bridges, I add a new 12" ductile iron water pipe through the bridges and off the limits of the construction site. On some, the pipe was immediately necessary but others are for future use. Utility and gas companies were also asked to install their equipment during the building to eliminate prospective excavation," according to John.

Lancaster residents have no problems reaching the other side of water thanks to John Sonia's expertise and hard work.

Edward Kukkula
Sixth Master Roads Scholar

Baystate Roads is pleased to announce that Edward Kukkula, the highway superintendent at the Town of Townsend, is our sixth Master Roads Scholar. Ed was raised in Fitchburg but moved to Florida in 1985 where he received a degree in civil engineering at the University of South Florida/Tampa in 1990. He was employed by the Florida DOT as a project engineer until May 1997 when he also earned a Professional Engineer License for that state.

Returning to Massachusetts, he worked on the Big Dig as a field engineer for over a year until 1998 when his attention turned to "smaller roadways" in the Town of Townsend. Ed reports that he has enjoyed working for the town and has been able to attend some very interesting training seminars presented by Baystate Roads. "I have learned a great deal about how you can stretch a dollar and get a lot of work done while keeping roads in better shape for a longer period of time. Since I have been here, our department has started road and bridge maintenance programs and a volunteer program called Operation Neat Streets, a volunteeer litter pick-up effort."

"We have even been able to incorporate a Sign Inventory Management Program to keep track of town signs. We are currently working on paving about 1 1/2 miles and installing granite curbs and concrete sidewalks near the town common," according to Ed. "This type of work sure has its challenges and the biggest seems to be finding enough money to improve the infrastructure. Our department does the best with what we have, and I work with a bunch of guys who do an outstanding job year in and year out. I also can't forget my departmental assistant, Pat, who makes our office run effectively and smoothly. This has been a great experience and I look forward to working in Townsend for years to come."

Congratulations to Ed Kukkula and the Town of Townsend.

The Cotton Road

Cotton Road-1935 photo of Route 31...But where's the cotton?

The Cotton Road was an experimental, one-mile long project, which took place in the summer of 1935 or 1936 when there was a surplus of cotton in the country. Someone came up with the rather eccentric idea that the cotton could be used to keep the road smooth and prevent frost heaves from appearing in the late winter and early spring. Fred Otterson, who still lives in Washington, NH, and was a worker on this section of Rt. 31, related the information on which this article is based.

Piles of sand from the Windsor sand pit were put along the side of the road in preparation. Then oil or tar was spread on the road and some of the sand from the piles was "fanned out" onto the tar. Next came the messy job. Citizens of Washington, Fred and Earl Cilley, were about the same height so they formed a team to carry the cotton, which was put down in three layers. They ran a pole through a big roll of cotton mesh, probably 12 feet wide and about all two young men wanted to lift. They walked on the slippery tar and sand, unrolling the mesh onto the surface. When they reached the end of the roll, they got another roll of a coarse and not too fluffy cotton, so thick that their arms would not quite reach around it.

They put the rod through the second roll and unrolled it onto the first layer. This process was repeated with a third layer of fine cotton. All of this was then sealed with more tar and sand.

Fred laughed when he thought of how messy the job was. The gauntlet type gloves they used would get covered with tar, not to mention their boots. One day Earl got quite a bit of tar on his neck and the side of his face from holding the pole on his shoulder. Upon arriving home that afternoon he asked his wife, Zaida, if she had something which would remove the tar. She sure did! Fred couldn't remember what it was, but it was strong enough to take off the tar as well as a couple layers of skin, which created a very unhappy husband for a few days.

Fred's brother Bill was made foreman of that section of the road when it was finished and it was his job to "fix" the bumps that inevitably came up each spring. When they would not smooth out, Bill and his crew would cut across the middle of the bump with an axe-like tool. They then made a cut at right angles to the first, like cutting a pie in quarters. They next folded the layers of cotton and tar back, dug out the material causing the bump, smoothed it out, replaced the cotton and tar and then sealed the spot with more tar and sand. After about five years of this "foolishness" as Fred called it, the project was given up as a bad idea.

On another section of Route 31, constructed 100 years earlier than the Cotton Road portion, the road had been "corduroyed". It was a swampy, always wet area, where logs had been laid side-by-side and chained in place to keep them from sinking or moving around. The surface was laid on top of these logs. It apparently served the purpose for many years when travel was done by horses drawn by carriages and oxen carts, but the author remembers seeing bumps made by the logs, which were still evident at the edge of the road, into the 1950s.

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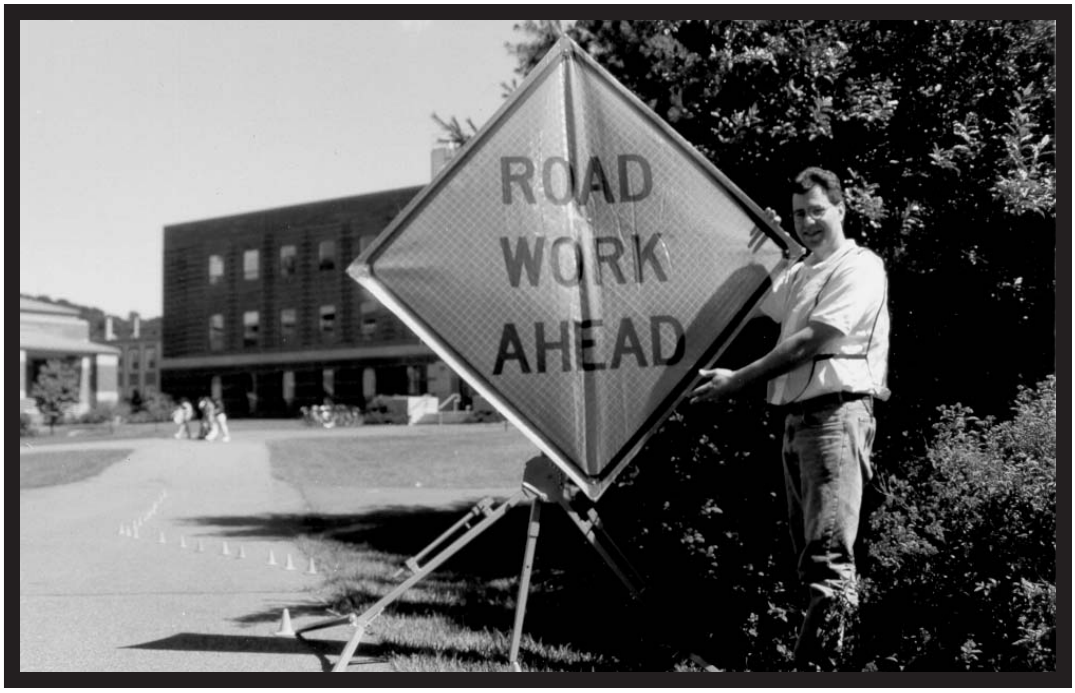
Program Manager of Baystate Roads Recognized For Outreach Award At UMass



Chris practicing safety procedures on campus

Chris Ahmadjian was nominated for an annual UMass Distinguished Academic Outreach Award for his "unflagging efforts over the past 10 years to bring the University to highway agencies from Barnstable to North Adams," said Paul W. Shuldiner, Director of the Baystate Roads Program.

Chris's job requires that he be a technical and training resource to both municipal highway departments and MassHighway. However, not simply satisfied with being a resource, Chris has become an agent for change. The highway field is an area where things are still being done the way they were 30, 50, even 100 years ago because people in the field are resistant to change. Chris has worked hard to break through old thinking and closed minds, persisting until new methods and attitudes are adopted. An excellent example of his persistence and tenacity has been in a new ice and snow management technique called "Anti-icing." After six years of training, promotion, and networking most towns have established successful programs incorporating this new technology. The result is that Chris has changed the way many highway departments operate. His extra efforts have saved money for the Commonwealth and greatly improved the services highway departments provide to their citizens.

According to Dr. Shuldiner, Baystate Roads is Chris's true passion. He works hard for change. That change is central to advancing highway practice in Massachusetts and central to the safety and convenience of all who use our roads. "It is for this reason that I recommend him for this award: he has not been content simply to meet the formal requirements of his job but has dedicated himself to fundamentally improving policies and procedures in the highway field."

continued from page 1

less than one wheel revolution, the pavement edge force has dissappeared and the cornering force of the right front wheel may have doubled because of increases in the available friction on the pavement and the increases in the right front wheel load caused by cornering.

6. The vehicle yaws radically to the left, pivoting about the right rear tire, until that wheel can be dragged up onto the pavement surface. The excessive left turn and yaw continues and it is too rapid in its development for the driver to prevent penetrating the oncoming traffic lane.
7. A collision with oncoming vehicles or spin out and possible vehicle roll may then occur.

When a vehicle leaves the road, drop-off or rutting at the pavement edge can contribute to the driver losing control. A significant difference in elevation between the shoulder and pavement may cause the driver to overcorrect as he or she steers back onto the roadway, sending the vehicle into the opposing lane where it may spin out or hit an oncoming vehicle. Properly maintaining pavement edges and shoulders can help prevent such crashes, improving motorist safety and reducing tort liability claims.

Pavement and shoulder edge drop-offs commonly occur as the result of overlays, pavement replacement, or shoulder construction. The depth of these elevation differentials can vary from approximately one inch when a flexible pavement overlay is applied to several feet when major reconstruction occurs. The potential hazards associated with pavement edge differentials depend on several factors including depth of the drop-off, shape of pavement edge, distance from traveled way, vehicle speed, traffic mix, volume, and other factors. The most serious shoulder deterioration usually occurs in the first two feet from the pavement edge.

Several factors can cause or exacerbate edge drop-off or rutting:

- Erosion caused by surface drainage runoff, by wind, or by wind currents created by large, fast moving commercial vehicles
- Settlement of the shoulder or degradation of shoulder granular materials by wind, or by wind currents created by large, fast moving commercial vehicles
- Settlement of the shoulder or degradation of shoulder granular materials
- High traffic volumes, particularly heavy commercial traffic
- Off tracking by wide vehicles.

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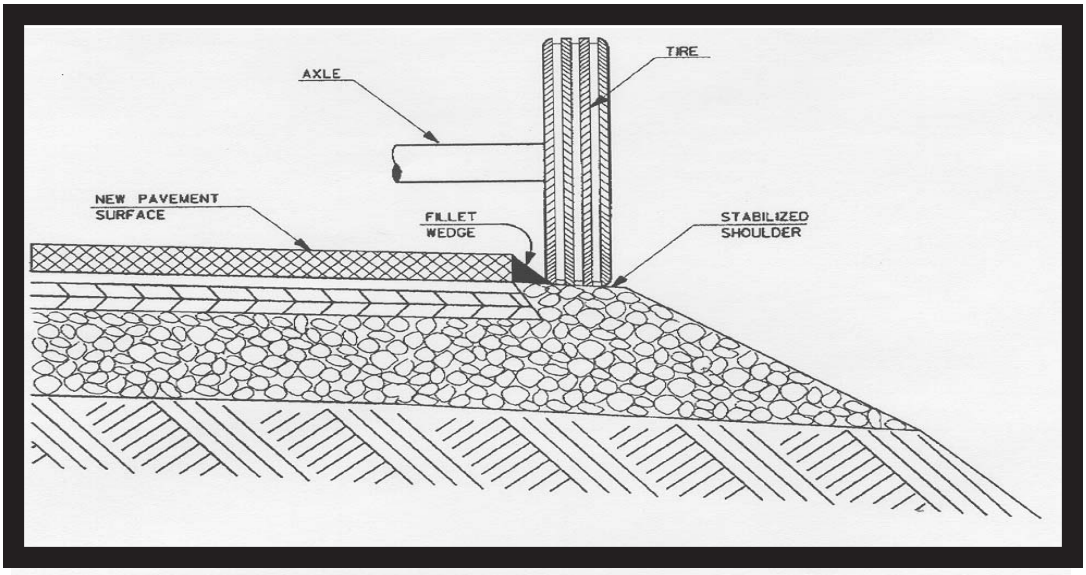

Figure 2: Tire Against Pavement Fillet Wedge

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Certain locations along roads with earth or granular shoulders may be especially prone to edge rutting. Steep hills, the low side of super elevated curves, and intersections commonly exhibit more severe edge rutting than relatively flat, straight locations. Although pavement edge drop-off is most common with unpaved shoulders, settlement of paved shoulders can also result in a difference in elevation between the shoulder and adjacent pavement.

Edge drop-offs can also occur during asphalt overlay operations but can be corrected with appropriate design procedures that avoid significant differences. Corrections can include the use of sloped fillets along the overlay edge along with shoulder rehabilitation.

Drop-offs of four or more inches are unsafe if the roadway edge is at a 90-degree angle to the shoulder surface. Drivers whose tires slip off a resurfaced road and onto an unimproved shoulder are likely to lose control as they attempt to climb back onto the roadway, especially if the drop-off is four inches or greater in depth. The pavement edge creates a "scrubbing" condition that must be overcome through over-steering. Drivers lose control as they over-steer to climb back onto the road. At the same time, their rear wheel catches the edge of the shoulder and swings the car around. This action brings them into the next lane, where they may then strike oncoming cars head-on or in a side-swipe type of collision or lose control of their own vehicle.

Using a 45-degree angle fillet of asphalt provides a surface that vehicles can use to climb back onto a roadway with no loss of control. Road contractors can attach a special edging device to their resurfacing equipment and by using less than one percent additional paving material, can lay down a 45-degree angle fillet that allows car tires to climb the edge safely without over-steering. Figure 2 illustrates how a vehicle can more easily reenter the roadway without over-steering into oncoming traffic with the addition of a fillet wedge.

Installation of this asphaltic fillet can be easily accomplished with today's modern paving equipment. By simply attaching a device known as a "moulding shoe" to the paving machine, the asphaltic fillet can be formed along the pavement edge as the overlays are placed on the roadway surface. The moulding shoe not only forms the shape of the asphalt fillet, but also reduces the amount of hand work required to finish the pavement edge.

Compaction of the asphalt fillet can then be accomplished by the use of an edge compacting device attached to the compaction rollers. This device consists of a hydraulically powered wheel which rolls alongside the compaction's drum while simultaneously pinching the edge of the mat towards the drum and providing lateral resistance.

Shoulder maintenance activities should include:

- Regularly repairing bituminous shoulders
- Sealing edge ruts, and
- Replacing aggregate and blading unpaved shoulders.

At locations prone to rutting or erosion, consider installing low-cost asphalt widening units, approximately two feet wide. This improvement can be made by agency maintenance staff on a flexible schedule and can significantly reduce future maintenance needs in these often troublesome locations.

Solutions to the pavement edge drop-off hazards are to:

- Perform shoulder resurfacing at the same time as the roadway resurfacing resulting in no shoulder drop-off, or
- Require contractors, in areas where resurfacing must be bid separately, to provide a 45 degree angle fillet along the edge of the roadway as part of the scope of work, and
- Install signs warning the motorists of the existence of a low shoulder condition (short-term solution only).

The National Research Council's Transportation Research Board has determined "that pavement edge drop hazards are greater than previously believed" and that "pavement edge drops are a common source of tort claims against highway agencies." Properly maintaining pavement edges and shoulders can help prevent crashes, improve motorist safety and reduce tort liability claims against cities and towns.

Baystate Road Scholars

Congratulations to the newest Baystate Roads Scholars on your fine achievement. Keep saving those certificates and you, too, could be listed here!

Craig C. Young, Brockton DPW
James M. Angelo, Holliston DPW
William Davis, Ashby DPW
John Pews, Wenham DPW
Harold Brown, Bolton DPW

in this issue...

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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