T³S Quarterly

Proper Drainage Reduces Roadway Problems

Editor's Note: *This article is reprinted, with permission, from the Spring 2002 Nevada Milepost, the newsletter of the Nevada Technology Transfer Center.*

Inadequate drainage not only causes driving problems, it also causes roads to deteriorate rapidly.

Pavement drainage requires consideration of surface drainage, gutter flow and inlet capacity. The design of these elements depends on storm frequency and the allowable spread of storm water on the pavement surface.

Design Frequency and Spread

- The classification of the highway is a good starting point in the selection process because it defines the public's expectations regarding water on the pavement surface.
- Ponding on traffic lanes of high-speed, high-volume highways is contrary to the public's expectations. Therefore, the risks of accidents and the costs of traffic delays are high.
- Design speed is important to the selection of design criteria. At speeds greater than 40 mph, water on the pavement can cause hydroplaning.
- Projected costs of traffic delays and accidents increase with increasing traffic volumes.
- The intensity of rainfall may significantly affect the selection of design frequency and spread.

  Risks associated with the spread of water on pavements may be less in arid areas subject to high intensity thunderstorms than in areas accustomed to frequent but less intense storms.
- Cost considerations make it necessary to formulate a rational design criteria.

The elevation of the highway and surrounding terrain is an additional consideration when water can be drained only through a storm drainage system, as in underpasses and depressed sections.

Spread on traffic lanes can be tolerated to greater widths where traffic volumes and speeds are low. Spreads of one-half of a traffic lane or more usually are considered a minimum type design for low-volume local roads.

The selection of design criteria for intermediate types of facilities may be the most difficult. For example, some arterials with relatively high traffic volumes and speeds may not have shoulders that will convey the design runoff without encroaching on the traffic lanes.

The recommended design frequency for depressed sections and underpasses where ponded water can be removed only through the storm drainage system is a 50-year frequency event.

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In This Issue…

T^{3}S Welcomes New Staff Member

We would like to welcome Debbie Lipscomb to the T^{3}S staff. Debbie joined us in February as Program Coordinator. You will have the opportunity to get to know her as you register for conferences and workshops as well as meet her at workshop locations throughout the state. Debbie will also be managing the video and publications library for T^{3}S so you will have many opportunities to talk with her and welcome her to the program.

She is a South Carolina native, but just recently returned to the upstate. Her employment history includes an area in the transportation industry as a Petty Officer in the United States Coast Guard, stationed in California. We are excited about having Debbie "on board" with T^{3}S.

You can reach Debbie at 864.656.1456 or toll free at

888.414.3069. She can also be reached at her direct e–mail address, dragon@clemson.edu (which is not reflective of her personality!), or at t3s@ces.clemson.edu.

So, Where's Sandi?

Sandi is still here but has been promoted to Program Manager for T^{3}S. In this position Sandi will have primary responsibility for liaison with all T^{3}S customers to ensure that we are meeting their needs. She will now be responsible for developing our future workshop topics and schedules.

Sandi will also head up our major conference activities, including the SE Local Roads Conference later this year and the SC State Highway Conference each year. She also will have primary responsibility for additional duties that T^{3}S has taken on to assist the SCDOT Research Unit.

Sandi will continue to be involved with seminars as time permits, and is only a phone call away. She can be reached directly at her new phone number, 864.656.6141, or via the T^{3}S toll–free number, 888.414.3069. Her e–mail address is priddy@clemson.edu.

T^{3}S Will Host SE Local Roads Conference Sept 22–24 at the Wyndham Myrtle Beach Resort

The 2002 conference will be hosted by your SC LTAP Center (T^{3}S) and is a collaboration of the Federal Highway Administration and the southeastern LTAP Centers. More information regarding the Conference will be available at the conference web site that can be reached via the T^{3}S web site: www.ce.clemson.edu/t3s. The details of the conference are being finalized and additional information will be published at the web site as it becomes available. The Wyndham Resort is located directly on the beach, and we have an excellent conference room rate of $65 per night, plus tax and a small resort fee.

While the agenda is not yet finalized, the Conference will include a wide array of presentations related to local roads topics that will be of interest to city, county, and DOT personnel, as well as local elected officials and private sector employees. The conference will also include a vendor exhibit area, as well as a welcome reception, continental breakfast each day, and a luncheon. A golf outing is also planned for the 22nd. Please visit our web site often for updated information.

This is an excellent opportunity for South Carolina municipal and county roads personnel to obtain up–to–date information on a number of important topics relating to local roads. ***Please put these dates on your calendars and plan to attend this important conference.***

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Check Storm and Spread

A check storm should be used any time runoff could cause unacceptable flooding during less frequent storms. Inlets also should always be evaluated for a check storm when a series of inlets terminates at a sag vertical curve where ponding to hazardous depths could occur.

Criteria for spread during the check storm are: 1) one lane open to traffic during the check storm, and 2) one lane free of water during the check storm. These criteria differ substantively, but each sets a standard by which the design can be evaluated.

Hydroplaning

The hydroplaning potential of a roadway surface can be reduced.

- Design highway geometries to reduce drainage path lengths of water flowing over the pavement. This prevents flow build up.
- An increase of pavement surface texture, such as grooving or grinding, will increase the drainage capacity at the tire pavement interface.
- The use of open-graded asphalt pavements greatly reduce the hydroplaning potential of the roadway surface because this forces water through the pavement under the tire.
- Drainage structures to capture the flow of water over the pavement will reduce the thickness of the film of water and reduce hydroplaning potential.

Design guidance

The recommended minimum values of roadway longitudinal slope given in the AASHTO Policy on Geometric Design include three general guidelines.

1. A minimum longitudinal gradient is more important for a curbed than for an uncurbed pavement because water is constrained by the curb. Flat gradients on uncurbed pavements can lead to a spread problem if vegetation is allowed to build up along the pavement edge.
2. Desirable gutter grades should not be less than 0.5 percent for curbed pavements with an absolute minimum of 0.3 percent. Minimum grades can be maintained in very flat terrain by using a rolling profile or by warping the cross slope to achieve rolling gutter profiles.
3. To provide adequate drainage in sag vertical curves, a minimum slope of 0.3 percent should be maintained within 50 feet of the low point of the curve.

Cross/Transverse Slope

Cross slopes of 2 percent have little effect on driver effort in steering or on friction demand for vehicle stability. In areas of intense rainfall, a somewhat steeper cross slope of 2.5 percent may be used to facilitate drainage.

On multi-lane highways where three lanes or more are sloped in the same direction, it is desirable to counter the resulting increase in flow depth by increasing the cross slope of the outermost lanes.

The two lanes adjacent to the crown line should be pitched at the normal slope, and successive lane pairs or outward portions should be increased by about 0.5 percent to 1 percent. The maximum pavement cross slope should be limited to 4 percent.

Curb and gutter

Normally curbs are used at the outside edge of pavements for low-speed highways, and in some instances, adjacent to shoulders on moderate to high-speed highways. They serve the following purposes:

- Contain the surface runoff within the roadway and away from adjacent properties
- Prevent erosion on fill slopes.
- Provide pavement delineation.
- Enable the orderly development of property next to the road.

Gutters formed in combination with curbs are available in 12- through 39-inch widths. Gutter cross slopes may be the same as that of pavement or may be designed with a steeper cross slope, usually 1 inch per foot steeper than the shoulder or parking lane. AASHTO geometric guidelines state that an 8 percent slope is a common maximum cross slope.

Channels

Roadside channels are commonly used with uncurbed roadway sections to convey runoff from the highway pavement and from areas that drain toward the highway. Due to right-of-way limitations, roadside channels cannot be used on most urban arterials. They can be used in cut sections and other locations where sufficient right-of-way is available and driveways or intersections are infrequent.

To prevent drainage from the medians from running across the

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travel lanes, slope medians and inside shoulders to a center swale. This design is particularly important for high speed highways and for highways with more than two lanes of traffic in each direction.

Bridge Decks

Bridge deck drainage is similar to that of curbed roadway sections. Effective bridge deck drainage is important for the following reasons:

- Deck structure and reinforcing steel is susceptible to corrosion from deicing salts.
- Moisture on bridge decks freezes before surface roadways.
- Hydroplaning often occurs at shallower depths on bridges due to the reduced surface.

Bridge deck drainage is often less efficient than roadway sections because cross slopes are flatter, parapets collect large amounts of debris and drainage inlets or typical bridge scuppers are less hydraulically efficient and more easily clogged by debris.

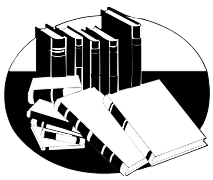
Because of the difficulties in providing for and maintaining adequate deck drainage, gutter flow from roadways should be intercepted before it reaches a bridge. For similar reasons, zero gradients and sag vertical curves should be avoided on bridges.

Additionally, runoff from bridge decks should be collected immediately after it flows onto the subsequent roadway sections where larger grates and inlet structures can be used.

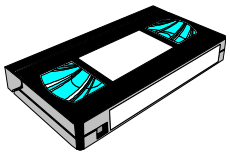
Median Barriers

Slope the shoulder areas adjacent to median barriers to the center to prevent drainage from running across the traveled pavement.

Where median barriers are used, and particularly on horizontal curves with associated super elevations, it is necessary to provide inlets or slotted drains to collect the water accumulated against the barrier.



Publications and Video Tapes Available



The publications described below are free to any individuals employed by any city or county government agency in South Carolina. You can obtain a single free copy of some publications or borrow a a copy of one of the "for loan" publications or videos

Videos

It's About Time—Traffic Signal Management Cost Effective Street Capacity. Demonstrates the importance and benefits of maintaining optimized and current traffic signal timing plans, and investing resources in traffic signal systems. *FHWA.*

Tips from the Pros—Backhoe Loader. Backhoe operators need to be educated in standard trenching and backfilling techniques before starting any construction project. This video details four valuable lessons for the beginner. The areas of emphasis described are planning, trenching and backfilling, managing a spoil pile, and lifting with the backhoe. *VISTA.*

Night Lights. Describes how bright, reflective material on roadways and traffic safety devices saves lives by improving the roadway in a variety of scenarios. *ATSSA.*

The Right Choice for Rebuilding Roads——Full Depth Recycling with Cement. Defines the process of full depth recycling. FDR rebuilds worn out asphalt by recycling the existing roadway. *Portland Cement Assoc.*

Publications

Maintenance of Signs and Sign Supports for Local Roads and Streets. *FHWA.*

Retroreflective Sheeting Identification Guide. *FHWA.*

Pavement Preservation Forum II: Investing in the Future. *FHWA.*

Highway Infrastructure: Protecting the Nation's Investment. *FHWA.*

Computer Software

Pedestrian/Bicycle Safety Resource. *FHWA.*

Editor's Note: the publications and videos shown here can be ordered by completing the form on page 7 and faxing it to us.

Guide to Culvert Repair

Editor's Note: Reprinted, with permission, from the Spring 2002 Nevada Milepost, the newsletter of the Nevada Technology Transfer Center.

Poorly working culverts can cause flooding during heavy rains that significantly damages roads and bridges.

Even during normal wet weather a crushed or plugged culvert that allows water to back up in roadside ditches will contribute to the deterioration of the road as the standing water prevents further drainage from the road base and subgrade.

Inspect your culverts at least once a year. After the inspection prioritize the repair and maintenance they need and schedule the work through spring, summer and fall.

Culvert Ends		
What you observe	***What the reason may be***	***How to fix it***
Scouring or erosion at the inlet	Ditch is too steeply graded Pipe is poorly located or aligned No headwalls Pipe is clogged	Line the inlet with stone Realign the pipe Install headwalls Clean and flush the pipe
Scouring erosion at the outlet	Pipe is sloped too much No endwalls or aprons Pipe is too small	Build a stone splash pad Install endwalls or aprons Check size and replace with larger pipe
"Ponded" water	Inlet is too high Ditch grade is too flat	Reset the pipe; match the inlet to the channel bottom Regrade the ditch to maintain correct flow
Dented or crushed ends	Vehicles or snowplows are hitting the ends	Fix, mark and protect the pipe ends
Heavy corrosion	Water flowing through the pipe is acidic	Install a sleeve of PVC in the pipe, or replace the steel pipe with PVC, aluminum, or concrete pipe
"Piping" around outlet	Pipe is incorrectly installed, causing water to flow along the outside surface of pipe	Reinstall the pipe on suitable properly compacted bedding. Install a head wall
Inside Culvert		
Sediment buildup	Pipe isn't sloped enough Objects blocking the pipe to the culvert	Reinstall the pipe at a slope of at least 1/4 inch per foot Remove the blockage. Install check dams upstream of the culvert
Sagging bottom	Foundation material has settled or has low bearing capacity	Reinstall the pipe on a suitable, properly compacted bedding
Crushed top	Cover is inadequate Soil around pipe isn't compacted sufficiently Traffic load is too great	Add cover Reinstall pipe more deeply and use suitable, properly compacted bedding and backfill or install multiple small pipes or a pipe with a different shape Replace pipe with a stronger one
Heavy corrosion	Water flowing through the pipe is acidic	Install a sleeve of PVC in the pipe with PVC, aluminum or concrete

Apply Cold Packs to a Strain

When you strain a ligament or a muscle, applying cold packs for the next 1 to 3 days is the best treatment. Don't use heat. Hot soaks or a heating pad may increase swelling and inflammation. Use cold because:

- ❑ Cold reduces swelling and inflammation. Cells may be damaged because swelling decreases the oxygen supply to surrounding tissues. Cold applications lower the metabolism within the cells and allow the tissue to survive a temporary lack of oxygen, according to the Mayo Clinic. This promotes the repair of cells and speeds healing.
- ❑ Cold constricts blood vessels, which helps control bleeding within the injury.
- ❑ Cold relieves pain and acts as a local anesthetic.

Bruising usually stops within 1 to 3 days after an injury. To relieve muscle spasms and the pain of minor sprains and strains, it's best to apply cold for about 20 minutes at a time every 4 to 6 hours for the first 1 or 2 days. Commercial cold packs are safer than using ice. Prolonged exposure to ice can result in frostbite. When should you use heat? Heat is better for chronic pain or for muscle relaxation. It could be helpful after the first 3 or 4 days.

Gasoline is Explosive

Gasoline is so volatile that one gallon is equivalent to 14 sticks of dynamite in explosive force. Vapors from gasoline are very dangerous. They are heavier than air and will flow invisibly along the ground. They will ignite from a flame, spark, or static electricity, causing an explosion.

- ♦ Never use gasoline around a flame source such as matches, cigarettes, or pilot lights on stoves and water heaters.
- ♦ Only use gasoline outdoors or in a well ventilated area.
- ♦ Fill the tanks of gasoline-powered equipment when engines are turned off and cold.
- ♦ Don't carry gasoline in your car. A fiery explosion can result if there is a collision or if vapors escape.
- ♦ If gasoline is spilled on clothing, remove it immediately. Place clothing outdoors for several days before washing and drying so that gasoline vapors can evaporate. (Clothes driers can catch fire if vapors are not allowed to evaporate first, even if the clothing has been washed.
- ♦ Never store gasoline inside a building.
- ♦ Use only approved safety cans, which have flame arrestors and pressure release valves.
- ♦ Keep gasoline locked up and away from children when not in use.

Home Safety Stressed

The National Safety Council wants employers to put more emphasis on off-the-job safety. They say that organizations must now think about the safety of their people and their families in a broader context. Safety Council President Alan McMillan reports that about 5,200 people died at work in the year 2000, while nearly 52,000 died in the home and community and 43,500 died in motor vehicle crashes. During more difficult business times, it's even more important to improve safety away from work. One nationwide employer described in Safety & Health magazine reports that 34 percent of the benefits it pays are injury related, and indirect costs of injuries can be as much as two times the direct costs. What happens at home has a direct impact on what happens at work. When a person is injured at home, it means time away from work. If a child is injured or sick, parents could miss work or the parents' thoughts may be with the child even if they are at work.

Bumper sticker snickers

If you can't change your mind, are you still sure you have one?

Hire teenagers while they still know everything

I is a college student

Caution, I drive like you do

If you can read this, I've lost my trailer

Information Request and Address Change Form

To order any of the publications, videos, or other materials listed in this or other issues of *T³S Quarterly*, complete this form and mail it or fax it to **Debbie Lipscomb** at the address or phone number shown below.

Transportation Technology Transfer Service
Civil Engineering Department
Clemson University, Box 340911
Clemson, SC 29634-0911

Phone: **864.656.1456**
Fax: **864.656.2670**

Publications and Software

- ❑ Maintenance of Signs and Sign Supports for Local Roads and Streets
- ❑ Retroflective Sheeting Identification Guide
- ❑ Pavement Preservation Forum II: Investing in the Future
- ❑ Highway Infrastructure: Protecting the Nation's Investment
- ❑ Pedestrian/Bicycle Safety Resource

Videos

- ❑ It's About Time—Traffic Signal Management Cost Effective Street Capacity
- ❑ Tips from the Pros—Backhoe Loader
- ❑ Night Lights
- ❑ The Right Choice for Rebuilding Roads—Full Depth Recycling with Cement

Other

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Title: _____

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Phone _____ Fax _____

❑ ***This is a new address***

❑ ***Please add my name to your mailing list***

Suggestions for Possible Future Workshop Topics

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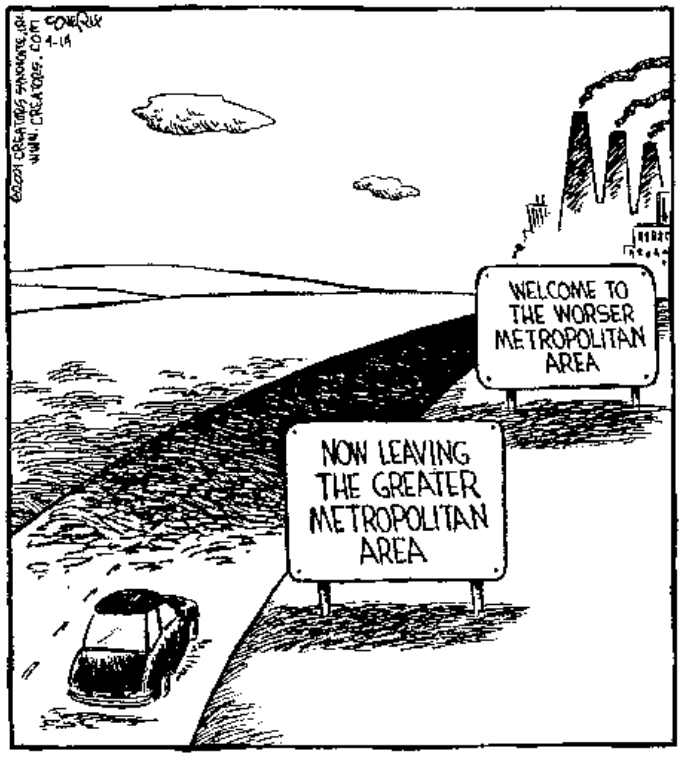
SPEED BUMP **Dave Coverly**



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How to Contact Us

SC Transportation Technology Transfer Service
Civil Engineering Department
Clemson University — Box 340911
Clemson, SC 29634–0911
Phone: 888-414-3069 Fax: 864-656-2670
e-mail: t3s@ces.clemson.edu

Director:	**Jim Burati**	**864-656-3315**
Program Manager:	**Sandi Priddy**	**864-656-6141**
Program Coordinator:	**Debbie Lipscomb**	**864-656-1456**

Transportation Technology Transfer Service
Civil Engineering Department
Clemson University
Box 340911
Clemson, SC 29634-0911

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