



**FOCUS  
CONCRETE**

# Concrete pavement restoration reduces need for costly repairs

**C**oncrete pavement restoration is a series of engineered techniques developed over the past 35 years to manage the rate of pavement deterioration. CPR is a nonoverlay option used to repair isolated areas of distress in a concrete pavement without changing its grade.

This preventive procedure restores the pavement to a condition close to original and reduces the need for more costly repairs later. In fact, recent reports from the Transportation Research Board state that for every dollar invested in appropriately timed preventive pavement maintenance, three to four dollars in future rehabilitation costs are saved.

Ideally, CPR is the first rehabilitation procedure applied to concrete pavement. Usually it is applied early when the pavement is in reasonably good condition with only slight deterioration.

CPR is typically used to replace isolated sections of deteriorated pavement or to prevent or slow overall deterioration as well as to reduce the impact loadings on the pavement. If the pavement needs more load carrying capacity or has deteriorated to poorer conditions, other procedures—such as bonded concrete overlay, unbonded concrete overlay or reconstruction—may be better alternatives.

CPR also can be applied to a mildly deteriorated concrete pavement that already has an asphalt overlay. It is quite feasible to remove the existing asphalt, repair the underlying concrete using CPR, then open it to traffic without a new asphalt overlay.

Table 1 shows the available CPR techniques. Each technique is designed specifically to repair or prevent the recurrence of a certain distress or a combination of distresses. Although each technique can be used individually, typically they are more effective when several are used together.

CPR does not necessarily increase structural

capacity of a pavement, but it does extend the pavement's service life.

**Table 1: Available Concrete Pavement Restoration Techniques**

Concrete Pavement Restoration Technique	Used to:
Full-Depth Repairs	Repair cracked slabs and joint deterioration
Partial-Depth Repairs	Repair joint and crack deterioration and surface distress
Diamond Grinding	Extend serviceability; improve ride and skid resistance; reduce noise
Dowel-Bar Retrofit	Restore load transfer at joints and cracks
Joint and Crack Resealing	Minimize infiltration of water and incompressible material into joint system
Slab Stabilization	Fill small voids underneath the concrete slab
Cross-Stitching	Repair low and medium severity longitudinal cracks
Grooving	Reduce wet weather accidents and prevent hydroplaning
Retrofitting Edge Drains	Add a longitudinal drainage system
Retrofitting Concrete Shoulder	Decrease pavement edge stresses and corner deflections

**Advantages**

Traditionally, asphalt overlays often have been used on concrete pavements that have deteriorated. However, CPR has several advantages over asphalt overlays:

**IN THIS ISSUE**

- This edition of the *Milepost* is devoted primarily to concrete applications and restoration. Repair methods include patches, joint resealing, stitching cracks and joints and diamond saw slot cutting (pp. 1, 3–9).
- The *In Nevada* section looks at concrete applied in heavy traffic areas in Reno, previous concrete helping to protect water clarity at Lake Tahoe and ultra-thin whitetopping used to rehabilitate distressed asphalt at a Sparks truck stop (pp. 10–12).
- Not to be outdone **Recycle Michael** shares with you a new Federal Highway Administration study on the uses of recycled concrete (p. 14).

**ROUTING SLIP**

*Don't file this Quarterly in your in-box. Please—read it, photocopy what you want, initial below, and send it on, especially to the frontline troops.*

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FROM THE EDITOR



Maria Ardila-Coulson  
T<sup>2</sup> Center Director

# From the director

helping you find answers to your transportation-related questions is just one of the ways the Nevada T<sup>2</sup> Center can help you and your agency.

Aunt Jenny has been nagging me to remind you, that one of the services we provide is maintaining a lending library covering the gambit of roadway transportation topics. Although our library consists of traditional printed publications, books and manuals, we also have videos and CD-ROMs.

In addition to running the library, ol' auntie is able to access several different online lending services, conduct Internet searches, utilize other T<sup>2</sup> centers and contact other partner organizations to help locate the information you need.

The cost to you? All of the materials from our library are available free of charge. The only cost you may incur is mailing back the materials to the Center after the two-week loan period. However, some publications are for you to keep.

Aunt Jenny encourages you to check out our Website [www.T2.unr.edu](http://www.T2.unr.edu) to see a complete listing of available materials, as she is constantly adding new items. You also may contact auntie, alias Lisa Cody, at 775/784-1433 for more information.

It should not surprise you that even with her own column Aunt Jenny wants to get in the last word. "In these days of tightening budgets, isn't it nice, sweeties, to know that some things are still free?"

## Tipped-towed truck

*A semi truck tipped over on the 90-degree turn just inside of Goldfield. The driver apparently approached the corner too fast and was unable to slow down in time to make the turn. There were no serious injuries. Conservation crews spent the morning cleaning up the area before the truck was towed.*



Before...



After...



# Concrete patches extend pavement's performance life

**a**lthough most transportation agencies recognize concrete is the longest-lasting, most durable paving material, some do not realize that concrete pavements are relatively simple to repair. The common misconception is that concrete is an unyielding, hard material that cannot be removed for repairs or utility cuts.

Because of this, some agencies are reluctant to build concrete roadways. They feel that they cannot afford to build non-repairable pavement. The reality is concrete pavement repairs are easily made with readily available equipment and materials.

Most concrete pavements needing repairs have served well for more than 20 years, often carrying up to three times their design traffic, with little or no maintenance. When these concrete pavements finally need repairs, often they are fixed with improper materials and techniques.

Such short-term solutions only cover the problem but do not fix it. By using quality concrete and following proper full-depth repair techniques, it is relatively easy to construct long-lasting, durable patches that can extend the concrete pavement's life for many years.

## Purpose and procedures

Full-depth repair corrects concrete pavement structural problems early in their development and repairs them with a long-lasting, low maintenance patch. By removing and replacing isolated areas of deterioration, full-depth repairs delay or stop further deterioration and restore the pavement close to its original condition.

Full-depth repairs also restore the structural integrity and smooth ride of a concrete pavement after utility cuts. When done at the right time, full-depth repairs are cost effective, fast and cause minimal disruption of traffic.

Full-depth repair consists of five basic steps:

1. Locating and isolating the patch area
2. Removing the deteriorated concrete
3. Preparing the patch area
4. Placing and finishing the new concrete
5. Opening to traffic

## Locating and isolating the patch area

Selecting the appropriate areas for repair is very important. Only those sections of pavement with

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# Concrete pavement restoration reduces need for costly repairs

*Continued from page 1*

- a. CPR addresses the cause of a pavement distress, minimizing further deterioration. Covering the distress with an asphalt overlay does not correct the cause of the distress. Eventually, the distress manifests itself again, usually as a larger, more expensive problem. This fundamental difference makes CPR more effective and less costly than asphalt overlays.
- b. CPR is quicker and causes less traffic disruption. Because CPR maintains the existing grade, features such as curbs and gutters, bridge clearances, approach slabs and roadside appurtenances do not need adjustment. Furthermore, CPR repairs only those areas that need improvement, such as the driving lane or the keel section of a runway. It does not have to be placed over the entire pavement width, as does an asphalt overlay. This accelerates the entire construction process, requires

less traffic control measures and causes less traffic disruption.

- c. CPR preserves the safety of concrete pavements. Concrete does not rut, washboard or shove. These defects can cause serious safety problems for asphalt pavements at intersections or other locations where traffic is starting, stopping and turning. Furthermore, because of their light color, concrete pavements reflect light better than asphalt pavements. This improves vision and makes driving safer at night and in inclement weather.
- d. Studies have shown that the number of street lights can be reduced by one-third when streets have concrete surfaces. The light surface also keeps urban areas cool. Concrete pavements and trees can reduce temperatures by 10 degrees. Further, the hard concrete surface makes vehicles more fuel efficient.

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## ■ Report on the cost of bad roads to motorist

The Road Information Program released a report stating that motorist pay \$42.5 billion a year in additional vehicle operating costs to drive on roads in need of repair. The report said each motorist pays \$222 in repairs to vehicles as a result of driving on pot-hole-laden roads. This includes extra cost due to additional tire wear, damage to shock absorbers, wheel alignment and extra fuel consumption.

## Concrete patches...

*Continued from page 3*

medium to severe structural and material problems need repair. A field survey shortly before construction looking at the type, location and severity of each problem establishes the total number of repairs to perform.

Good judgment is essential in defining the limits for full-depth repairs. Each repair should be large enough to replace all significant distress, resist rocking under traffic and be easy to work in, yet small enough to minimize the patching material. Typically, a patch that is a full-lane width wide and a half-a-lane width long meets these criteria.

For utility cuts the patch length and width should be slightly larger than the planned trench length and width. This creates a shoulder around the utility cut that keeps the excavation from undermining the existing concrete during the utility repair and helps support the concrete patch after placement.

Isolating the patch area from the existing concrete is a simple and relatively fast procedure. It consists of making a full-depth diamond saw cut around the patch boundaries to separate the patch from the adjacent concrete. These full-depth saw cuts sever any existing reinforcing steel and tie bars and create smooth joint faces at the patch edges with no load transfer capabilities. Because of this and because the isolated concrete may rock if large amounts of traffic travel over it, the patching should begin within two days of sawing.

### Removing the deteriorated concrete

There are two procedures to remove the old concrete: the lift-out method and the break-up and clean-out method. With the lift-out method the concrete is removed in large sections. In the break-up and clean-out method, the concrete is broken into small pieces and removed. Generally, the lift-out procedure is faster and causes less subbase disturbance.

The most common lift-out procedure is done by connecting the old concrete to some type of heavy equipment, such as a backhoe, with a chain and then vertically lifting it out of the patch area. A second procedure uses a claw-like attachment that slides beneath the concrete slab and grabs it before lifting. If completed correctly, both operations leave a smooth undamaged joint face.

The break-up and clean-out method removes severely deteriorated concrete that the lift-out method cannot remove. The procedure consists of using mechanical concrete breakers to fracture the concrete and then a backhoe, small earth moving equipment or hand tools to remove the broken concrete.

To avoid damaging the adjacent concrete during the breaking operations, it is necessary to create a buffer zone in the patch area. This is done by making a secondary set of full-depth saw cuts slightly in from the patch edges. Because this procedure may damage the subbase, it may require more subbase repair than the lift-out method.

### Preparing the patch area

Preparing the patch area consists of repairing the base course and providing load transfer. With the lift-out method the base repair generally consists of shoveling up the deteriorated excess material from the opened concrete area. With the break-up and clean-out procedure, base repair includes recompacting the subgrade and adding granular subbase layers as needed. Both methods require placing dowel baskets or other reinforcement, if necessary.

For utility cuts flowable fill is an ideal alternative to base repair. Flowable fill is a low-strength, self-leveling material made with cement, fly ash and sand that flows in and around repairs, then hardens. Because it is designed not to become too hard, it is easy to remove later.

Load transfer is the ability of a patch to transfer part of its load to the adjacent concrete. Good load transfer reduces the load on the new patch and prevents it from rocking and moving. This ensures a long-lasting, durable patch. Depending on the amount of truck traffic, it is possible to obtain good load transfer either with aggregate interlock or with dowels.

Usually, when slabs are greater than 8 inches thick, dowel bars are required to provide load transfer. Dowel bars are smooth, round bars that extend from one side of a joint to the other, transferring the load across the joint. They are placed into holes drilled into the joint face with some type of concrete drill, such as a gang drill. Gang drills are capable of drilling three or four holes at a time and maintaining proper alignment.

When a pavement carries little truck traffic, like many city and residential streets, aggregate interlock load transfer is sufficient. Aggregate interlock load transfer is the interlocking action between the roughened face of the in-place concrete and the face of the patch. To create the roughened face, the repair crew chips along the patch edges of the existing concrete with a light pneumatic hammer. Ideally, the roughened edges are vertical or slightly slanted out, creating a cup that holds the patch in and keeps it from punching into the subgrade.

*Continued on page 5*

## Diamond saw slot cutting versus carbide milling

**T**he difference between diamond saw slot cutting and carbide milling is in the way that the concrete is removed. Diamond saw slot cutting uses two diamond saw blades per slot to cut the edges of the slot, allowing the “fin” of the concrete that is left to be removed with a lightweight jack-hammer.

In the carbide milling process, a large carbide-tipped wheel saw (3 to 4 inches wide) demolishes the concrete, leaving a roughened, variable-width slot that may or may not be within the tolerance required. The strict tolerances are a function of the dowel-bar chair size that is used to align the dowel bars properly in the slot. If the bars are not aligned properly, the joint may lock up or the patch may fail.

### Diamond cutting

Diamond sawed slots maintain a constant width throughout the operation. The consistent slot width combined with the specially designed dowel assemblies restrict unwanted movement of the assembly during the backfill and vibration pro-

cedures. This assures that every dowel will be aligned properly.

### Carbide milling

Carbide milling (also referred to as rotomilling) is a demolition technique, not a concrete pavement restoration technique. Carbide mills (wheel saws) *should not* be used to form slots for dowel retrofit installations. Although carbide milling of slots may appear to be less expensive than diamond saw slot cutting, most transportation agencies throughout the United States have concerns that the milling operation will cause microcracking, which may decrease the long-term durability of the dowel retrofit.

Another shortfall of the slot milling technique is the rapid wear rate of the carbide teeth. Milled slots must be oversized in order to account for this wear.

The oversized slots are unable to secure the specially designed dowel assemblies during the backfill and vibrating operations, increasing the risk of dowel misalignment. Misaligned retrofit dowels may cause the repair to fail by restricting the natural horizontal movement at the contraction joint.

*Adapted from Special Report, Concrete Pavement Technology and Research, American Concrete Pavement Association and International Grooving and Grinding Association, 2001.*

## Concrete patches...

*Continued from page 4*

### Placing and finishing the new concrete

After preparing the patch area, place the new concrete. Generally, the patch thickness is the same as the existing slab thickness. Normal portland cement concrete, high early strength concrete and proprietary materials have all been used successfully. Asphalt concrete is not a good patching material because it does not last and leads to further deterioration of the surrounding concrete.

Before placing the concrete, install a fiber-board bond breaker between the longitudinal joints of the existing concrete and the patch. Placing the portland cement in the patch is similar to any other on grade situation. Proper mix design and good concrete consolidation along the patch perimeter are important to long-term performance.

After placing the concrete, screed and finish the patch to match the existing concrete using normal finishing equipment and procedures. Keep the finishing operations to a minimum to avoid overworking the surface. Once the surface sheen has

disappeared, apply a broom finish as a surface texture on the new patch.

Proper curing of the patch is important. It is best to begin curing operations as soon as possible after completing the finishing operations. Typically, either a clear or white-pigmented curing compound is used. For high early strength patches that will open quickly to traffic, place insulation mats over the repairs during curing to increase the strength gain of the concrete. In all curing operations make sure the entire patch surface and exposed edges are covered.

### Opening to traffic

The proper time to open a patch to traffic depends on the strength gain of the patch material itself. Usually, full-depth repairs can be opened when they have gained at least 3000 psi compressive strength. Most normal mixes obtain this strength in 24 to 72 hours. Several of the high early strength mixes and propriety mixes can reach this strength as early as four hours after placement.

## Concrete pavement ready for traffic in four hours

When the California Department of Transportation needed a concrete pavement that would deliver a surface ready for traffic in a very short time, different admixture manufacturers experimented with various combinations to try to achieve this goal.

Master Builders came up with what it calls “4x4 Concrete,” an innovative mixture that develops 400-psi flexural strength in just four hours after placement. This material costs about half as much as other fast-setting hydraulic cement concrete and can be produced with standard locally available materials.

California’s need for a four-hour turnaround for concrete paving arises from its serious traffic challenges. The state’s commuters have little patience for highway workers causing a tremendous need for fast work. In Los Angeles County contractors can be fined as much as \$1000 for each minute they are late in reopening a freeway.

You can learn more about 4x4 Concrete at [www.masterbuilders.com](http://www.masterbuilders.com) or by calling Master Builders, Inc. at 1-800-MBT-9990.

*Adapted from Guidelines For Full-Depth Repair, American Concrete Pavement Association, 1995.*

■ **Running red increasingly = dead**

Drivers who run red lights are responsible for an estimated 260,000 crashes each year, according to an Insurance Institute for Highway Safety study. Of those crashes, approximately 750 are fatal.

The violators involved in fatal red light-running crashes were most likely to be under age 30.

## Stitching concrete pavement cracks and joints

There are two stitching methods used to repair and strengthen cracks or joints in concrete pavement. The first, and most common, is cross stitching.

### Cross-stitching technique

Cross stitching is a repair technique for longitudinal cracks and joints that are in reasonably good condition. The purpose of cross stitching is to maintain aggregate interlock and provide added reinforcement and strength to the crack or joint. The tie bars used in cross stitching prevent the crack from vertical and horizontal movement or widening.

Cross stitching uses deformed tie bars inserted into holes drilled across a crack at angles of 35 to 45 degrees depending upon the slab thickness. A 0.75-inch diameter bar is sufficient to hold the joint tightly together to enhance aggregate interlock.

The bars are spaced 24 to 36 inches from center to center and alternate from each side of the crack. A 36-inch spacing is adequate to effectively repair highways or roadways. Heavy truck traffic requires a 24-inch bar spacing for added strength.

The process of stitching requires the following steps and considerations:

1. Drill holes at an angle so that they intersect the longitudinal crack or joint at about mid-depth. *(It is important to start drilling the hole at a consistent distance from the crack or joint in order to consistently cross at mid-depth.)*
2. Select a drill that minimizes damage to the concrete surface, such as a hydraulic powered drill. Select a drill diameter no more than 0.375 inches larger than the tie bar diameter. Choose a gang-mounted drill if higher productivity is needed for larger jobs.
3. Air blow the holes to remove dust and debris after drilling.
4. Inject epoxy into the hole, leaving some volume for the bar to occupy the hole. *(Pouring the epoxy is acceptable for small quantities.)*
5. Insert the tie bar into the hole, leaving about 1 inch from the top of the bar to the pavement surface.
6. Remove excess epoxy and finish flush with the pavement surface.

### Slot-stitching technique

Slot stitching is a repair technique for longitudinal cracks or joints. Slot stitching is an extension of the more recent dowel bar retrofit technique,

which is used to add dowel bars to existing transverse joints.

The purpose of slot stitching is to provide positive mechanical interconnection between two slabs or segments. The deformed bars placed in the slots hold the segments together, serving to maintain aggregate interlock and provide added reinforcement and strength to the crack or joint. These bars also prevent the crack or joint from vertical and horizontal movement or widening. Larger diameter bars more than 1 inch also serve to provide long-term load transfer capabilities.

Slot stitching requires the following steps and considerations:

1. Cut slots approximately perpendicular to the longitudinal joint or crack using a slot cutting machine or walk-behind saw. Unlike dowel bar retrofit, precision alignment is not critical because deformed bars will hold the joint tightly together preventing the slabs from separating.
2. Prepare the slots by removing the concrete and cleaning the slot. If the slabs have separated, consider using a joint reformer and caulking the joint or crack to prevent backfill materials from flowing into the area between the slabs.
3. Place deformed bars into the slot.
4. Place backfill material into the slot and vibrate it so it thoroughly encases the bar. Select a backfill material that has a very low shrinkage characteristic.
5. Finish flush with the surface and cure.

### Common questions

#### Which stitching method should I choose?

Either method is effective. However, cross stitching generally holds these advantages over slot stitching:

- Less intrusive to the slab.
- Less exposed surface area.
- Less backfill material.

Your agency should evaluate the costs and use the method that provides the optimal combination of strength, installation time and cost. Because more materials are required, slot stitching is usually more expensive than cross stitching.

#### Is stitching needed for all uncontrolled cracks?

#### How do I know if the cracking is too severe?

Stitching is an excellent non-intrusive procedure

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## Stitching concrete...

Continued from page 6

to repair uncontrolled longitudinal cracking. In some cases, however, it may not be advisable or necessary. Some cracks can perform well simply by sealing and maintaining the crack properly.

Neither method of stitching is intended for severely deteriorated cracks. If the cracks are in moderate or fair condition, stitching is effective. Stitching is not a substitute for slab replacement if the degree of cracking is too severe.

### Can I stitch transverse cracks?

Do not stitch transverse cracks. They often form active boundaries to slabs or segments of concrete and undergo thermal expansive and contraction movements (opening and closing). Cross stitching prevents opening or closing of joints and cracks.

If joint movement is restrained, stresses can build within the slab and result in spalling and cracking near the ends of the bars. These effects have been observed on highway applications where stitching was tried on transverse working cracks.

### Should I move drifted slabs together before stitching?

Do not attempt to move drifted slabs back into position against adjacent slabs. First, there is usually no real concern or maintenance expense if slabs drift apart. Therefore moving the slabs may be a waste of resources. Second, the mechanical energy required to push the slabs would make this impractical in most cases.

### How do I connect drifted slabs?

Of primary concern in connecting slabs that have drifted apart is preventing the backfill (either epoxy or grout) from flowing into the space between slabs. To prevent this, clean and fill the space between the slabs before stitching. A sand-cement grout is a suitable backfill for this purpose.

### Can I use cross stitching to tie new lanes?

Do not use cross stitching to tie a new lane to an existing one. Wherever possible it is advantageous to drill laterally into the side of an existing lane and then epoxy tie bars into the holes rather than to use a diagonal configuration as in cross stitching.

### Is slot stitching better suited for multi-lane cross sections?

There is no evidence that either stitching method is better when applied within a multi-lane

cross section. In theory slot stitching may be better suited than cross stitching for a crack in a panel tied to three or more lanes because it has a longer length of embedded steel to distribute tensile stresses. However, there are no field experiences to substantiate this theoretical advantage and cross stitching has performed well on multi-lane cross sections.

### What are the backfill material requirements for slot stitching?

Backfill materials for slot stitching should have little or no shrinkage, should gain sufficient strength in the period before loading and should have a Coefficient of Thermal Expansion similar to the surrounding concrete.

### How do I treat the joint adjacent to a stitched crack?

After stitching a longitudinal crack it may be necessary to treat a nearby longitudinal joint. The primary concern is whether a crack has formed below the saw cut for the longitudinal joint. If a crack has occurred, and the joint functions properly, then no treatment other than joint sealing is warranted.

However, if there is no crack extending below the joint cut, then it is advantageous to fill the saw cut with epoxy to strengthen the slab at this location. If the joint is not functioning, but a joint sealant has already been installed, then no further action is recommended.

A careful review of the joint is necessary to render a decision on whether epoxy treatment is necessary. Several cores should be taken along the joint to determine the prevailing condition (cracked or not). If the joint warrants epoxy filling, then the following process obtains best results:

- Clean the saw cut with water. Allow reservoir to dry.
- Drill plug holes at any location where the crack crosses the non-functioning joint to a depth below the saw cut.
- Place compression plugs or cement grout plugs into plug holes.
- Pour epoxy into a saw cut using a properly sized nozzle. (Do not overfill.)

## Correct tire pressure boosts gas mileage

We could save 4 million gallons of gasoline a day by properly inflating our tires, according to the Department of Energy. If your tires are under inflated by just 4 pounds, it will cost you a half-mile per gallon. Under inflation also shortens tire life.

## ■ Why red and green?

Why do red traffic lights mean stop and green traffic lights mean go? Why those two particular colors?

It started by chance. Long before automobiles were invented, the first traffic signals for trains in England happened to be red for stop and green for go.

Years later when electric traffic signals for automobiles were introduced, the two colors continued to be used.

## Five steps to follow in joint resealing

The purpose of joint sealant is to minimize infiltration of surface water and incompressible material into joints. Preparation is essential in joint resealing during concrete pavement restoration. Successful resealing consists of five steps:

1. Old sealant removal.
2. Shaping the reservoir.
3. Cleaning the reservoir.
4. Installing the backer rod.
5. Installing the sealant.

Anticipating the time of year a pavement will be resealed is an important step in designing a resealing project. The time of year or temperature influences the amount and direction of joint movement after job completion. For example, installing a sealant during a region's warmest weather ensures that the sealant always will be in tension. This is because the joints will be fully closed during installation.

However, a sealant installed during moderate regional temperatures also will undergo compression. The designer must verify that the sealant will be capable of handling the full range and direction of movement based on the anticipated installation temperature. Probably the most favorable times of year are spring and fall because daily temperatures are moderate.

Another very important component of resealing joints and cracks is construction inspection. It improves the knowledge of agency personnel which heightens the level of competence and project quality.

### Old sealant removal

Adhesion will not develop by simply filling over an existing sealant. Removal of the old sealant and joint face cleaning are essential. These procedures provide a surface to which a new sealant can bond. It is imperative that methods for removing old sealant do not damage the joint reservoir. The following provide acceptable results:

- **Manual Removal.** Typically, manual removal is easy for compression seals. This simple method provides a quick result whenever feasible and does not leave much material on the reservoir sidewalls.
- **Sawing.** The most common removal and efficient method is sawing with diamond blades. It is efficient because sawing also shapes the reservoir for the new material.
- **Plowing.** Plowing can be very effective for removing most of the old sealant. A small

plow pulled through the reservoir dislodges the material. Avoid V-shaped plows. The V-shape tends to scour the reservoir corners and easily can spall surrounding concrete. Very little damage occurs with a rectangular plow.

- **Cutting.** Cutting requires running a knife blade along the faces of the joint. Afterward the sealant easily pulls free by hand.

### Shaping the reservoir

Sawing shapes the reservoir after sealant removal. Saws with dry or wet diamond blades are acceptable. The blades remove any remaining old sealant and provide the proper dimensions for the new sealant.

In certain instances eliminating this step may be acceptable. Shaping is unnecessary if sealant removal was by hand, and the existing reservoir provides adequate dimensions. Sawing out the old sealant typically provides an adequate reservoir and should not require this step either.

Some minor spalling along the joint face will not inhibit performance of most sealants. However, some patching is likely for larger spalls. The specifications should detail areas requiring patching so that it can be completed before reservoir cleaning and sealant installation operations.

Resealing pavements with plastic or metal joint inserts requires first removing the insert. Afterward sawing provides smooth vertical faces for the new sealant.

### Cleaning the reservoir

Cleaning is the most important aspect of joint sealing. For every liquid sealant, manufacturers require essentially the same cleaning procedures. Likewise the performance claims of any liquid sealant product is predicated on those cleaning procedures.

Reservoir faces require a thorough cleaning to be sure of good sealant adhesion and long-term performance. No dust, dirt or visible traces of old sealant should remain on the joint faces after cleaning. The ability to attain this condition may depend on the reservoir width. It is easier to consistently get joints clean if they are at least 3/8 inch wide.

Proper cleaning requires mechanical action and pure water flushing to remove contaminants. Do not use chemical solvents to wash the joint reservoir. They can carry contaminants into pores and surface voids on the reservoir faces. Contaminants will inhibit bonding of the new sealant.

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## Five steps... *Continued from page 8*

### Backer rod installation

Backer rod installation is made after cleaning and before liquid sealant installation. It must be compatible with the liquid sealant with a diameter about 25 percent greater than the reservoir width. Backer rod inserts easily with a double-wheeled steel roller or any smooth blunt tool that will force it uniformly to the desired depth.

Rehabilitation work with slightly faulted joints may require a single-wheeled roller. The tool must not puncture or stretch the material. A steel roller allows exchange of the center insertion wheel for different depths and provides the most consistent results. Ensuring that the backer rod is at the proper depth cannot be over emphasized. Good practice is to roll the insertion wheel over the backer rod twice.

### Sealant installation

Installation requirements are slightly different for each sealant type.

**Liquid.** Liquid sealants require uniform installation. Over filling or completely filling the reservoir is not desirable. Filling the reservoir from the bottom upward avoids trapping at pockets. Remember to recess the sealant at least 1/4 to 3/8 inch below the surface of the pavement.

It is important to pump the sealant through a nozzle sized for the width of the joint reservoir. The nozzle should fit into the reservoir to allow pumping to the bottom. The injection nozzle forms the sealant bead. Good practice is to draw the nozzle toward the operator. Pushing the nozzle may result in voids and nonuniform sealant cross sections.

Special attention to the heating temperature is vital at the start of a work day. No sealant should be installed before reaching proper installation temperature. About the first one gallon of material is unusable because cooled sealant and flushing oil remains in the pumping unit hoses and nozzle. Discard this material and begin pumping only after fresh sealant is ejected from the nozzle at an acceptable temperature.

It is extremely important that the reservoir wall be dry before installing any liquid sealant. Moisture will boil in contact with hot-pour materials, forming steam that will bubble the sealant. Moisture will inhibit silicone sealant adherence. Moisture is not as critical for compression sealants.

The sequence of installation is important where transverse joints are sealed with silicone and longi-

tudinal with hot-pour material. It is good practice to seal transverse joints first. This prevents hot-pour material from flowing into and contaminating the transverse reservoirs. Some contamination of the longitudinal reservoirs will occur while placing the transverse reservoirs. However, silicone is somewhat more viscous than hot-pour, and the extent of longitudinal joint contamination is tolerable.

**Compression.** A compression sealing operation requires application of an adhesive to the sealant edges or reservoir sidewalls. The compression seal is then mechanically compressed and inserted into the reservoir. The adhesive eases sealant insertion and forms a weak adhesive to help hold the seal in place.

Sealant stretch of 3 percent or less is desirable. Some neoprene seals are capable of stretching by as much as 50 percent. Stretching reduces the cross section and compression recovery. More than 5 percent stretch is excessive and could be detrimental. Some sealants can later break into pieces if stretched excessively during installation. Special attention during installation is essential to avoid twisting, nicking or stretching the sealant.

Most compression seal manufacturers make equipment for accurate seal installation. The most common are compress-eject machines. The machines compress and insert a seal to a desired depth in continuous motion. The most advanced equipment automatically applies adhesive along the sealant edges. Compress-eject machines remove most stretching and twisting problems that accompany hand installation.

Burrs along the sawed joints may make seal installation difficult. Dragging a blunt pointed tool along sawed joints removes sharp edges. A mechanized wire brush also will remove burrs and provides consistent results. Although the simple step eases seal installation, it may contaminate clean joints and should be done ahead of reservoir cleaning only when needed.

Avoid splicing compression seals as much as possible. Splices are discontinuities prone to moisture infiltration and dislodging by traffic. Use only one length of compression seal for transverse joints less than 25 feet long. For transverse joints on wider pavements, one splice is acceptable. For longitudinal joints, cut the compression seal at the transverse joint crossings.

## ■ Slow drivers are accident prone

Does speed really kill? A study by the Federal Highway Administration revealed some surprising statistics. Contrary to popular logic, the slowest 5% of all drivers have the highest accident rates, while those who drive 10–15 mph above the speed limit have the lowest.

Slower drivers appear to be less attentive behind the wheel than faster drivers who are more aware of cars around them, more careful due to their high speed and more watchful of police cars.

## ■ Bumper sticker snickers

These are actual bumper stickers spotted on Nevada vehicles. Some are taken from beat-up old pickup trucks which have gained national notoriety for outrageous bumper wit.

Thanks to those of you who provided us with bumper sticker humor for this issue of the *Milepost*.

To share bumper sticker snickers you've seen, simply write the snickers on the **No-Brainer Mail-In Page**.

"Cover me. I'm changing lanes."

"Forget about world peace. . . . Visualize using your turn signal."

"Change is inevitable, except from a vending machine."

"We are Microsoft. Resistance is futile. You will be assimilated."

### Community Profile

## "The Loneliest Town on the Loneliest Road in America"

**U.S. Highway 50** across Nevada gained the reputation of being the "Loneliest Road in America" from an article many years ago in *Life* magazine. Eureka soon dubbed itself the "Loneliest Town on the Loneliest Road in America."

Established in 1864, the Eureka Mining District is the birthplace of the silver-lead smelting industry in the United States. From 1869 to 1879 Eureka was a major producer of domestic pig lead. However, Eureka ores also contained precious metal.

Initially, ore from Eureka was transported to smelters in Salt Lake City. But soon Eureka began building its own smelters. Large smelters were constructed at the northern and southern ends of town. By the end of 1871 they were producing silver at an astonishing rate. The slag heaps still can be seen today.

The mining boom in Eureka ended almost as quickly as it began. By 1885 most of the accessible high-grade ore had been mined, and the smelters ceased operation by 1891.

During the mining boom the rush was on, and the settlement of Eureka was hectic. Quickly tents and crude log cabins gave way to board and brick storefronts. By the late 1860s there were 250 buildings. With a population of 9000, Eureka claimed to be the second largest community in Nevada, only behind another boom town, Virginia City. Eureka has fewer than 500 residents today.

Between 1876 and 1880 Eureka had four major fires causing major damage to the town. It rebounded after each fire and built many brick buildings with iron fire doors and installed fire hydrants.

The community pulled together and built bigger and fancier structures including the Eureka County Courthouse, Sentinel newspaper building and the Opera House. Much of the late 1870's character felt in Eureka today can be attributed to the devastating fires that caused the town to rebuild.

### Economy

Eureka's economy is still based partly on mining with proceeds from the mining boom in the 1990s paying for restoration of the courthouse and opera house. Since the '90s mining has been in a slump, but locals believe it will boom again.

Ranching and farming are also a large part of the economy with 40,000 acres of rich land in Diamond Valley just outside Eureka. With plentiful water the farmers are able to raise a variety of crops. Cattle and sheep also are raised in the region.

Tourism is important to the community with the Opera House offering live performances and hosting conferences and meetings.

County government also plays a part in the economy. Eureka is the county seat for Eureka County.

### Climate

At 6500 feet the high temperature averages in the 80s in the summer with nights cooling off to the 50s. In the winter the high temperatures average around 40 degrees, and the lows range in the teens. There are about 90 days in the growing season, and the annual precipitation averages 9.66 inches.

### Attractions

With its 19<sup>th</sup> Century charm, Eureka is a great place to explore. A walk down main street is a journey into the past.

Eureka has an archery and pistol range, two baseball fields, an indoor/outdoor swimming pool,

*Continued on page 11*

### Profile

## Former NDOT research manager will study to become a minister

**ALAN HILTON** recently retired from NDOT with 27 years of service. As the Research Division manager he was responsible for making sure the T<sup>2</sup> Center received state funding. The Center is funded by the Federal Highway Administration with matching money from NDOT.

Because of his many contributions to the success of the T<sup>2</sup> Center, including serving on its Advisory Board, Alan was made the first Honorary Roads Scholar. This honor was bestowed on him at his retirement luncheon by T<sup>2</sup> Center Director Maria Ardila-Coulson.

Alan began his career with NDOT as a highway maintainer for two years in Virginia City. For the balance of his time at NDOT he was in the Planning and Research Division in Carson City.

Alan and his wife, Kathy, will be moving to Indiana where he will attend seminary for three years studying to become a Lutheran pastor. After graduation Alan hopes for a call to a church somewhere in the Western United States.

Alan will be missed by those at NDOT and by us at the T<sup>2</sup> Center, but we wish him the best in his new higher calling.



***Keep Lake Tahoe blue***

**Pervious concrete reduces runoff helping to protect water clarity**

**t**housands of hours of research, along with millions in taxpayer dollars, have gone toward the efforts to keep Lake Tahoe's waters clean and blue.

The concrete industry may provide an important tool in this environmental protection endeavor.

The Sierra Nevada Concrete Association assisted the Tahoe Resource Conservation District, which recently installed a pervious concrete "drive-way pad" in its Backyard Conservation Exhibit at the South Lake Tahoe Demonstration Garden at Lake Tahoe Community College. The pervious concrete was laid to educate the public about asphalt alternatives for driveways and walkways.

Last winter the new pervious concrete demonstration was monitored to study the effects of freeze-thaw on strength, functionality and appearance. The effects of the study and information on asphalt alternatives are being discussed at various workshops.

Many of the efforts to protect Lake Tahoe water clarity aim to reduce the runoff of sediment which makes the water cloudy and carries chemicals and minerals that promote algae growth, such as fertilizers.

"The ability of pervious concrete to allow storm water to percolate through the soil is a huge benefit for the Lake Tahoe environment by reducing runoff pollutants, using the soil's natural filtration qualities," according to Rick Reed, president of the Sierra Nevada Concrete Association. "Pervious concrete can be one of the answers to keep Lake Tahoe clear and clean for generations to come."

**The Loneliest Town...**

*Continued from page 10*

two parks and playgrounds, a tennis court and trap and sporting clay range. The old Sentinel newspaper office operates as a museum. Fishing and hunting are nearby.

The Eureka County Airport is just outside town and has a 7400-foot-long paved runway.

**Events**

The Opera House offers a concert or other type of live performance nearly every month. The Eureka County Fair is held in August and features a horse show, roping events and exhibits.

**Historic Winnemucca Bridge reconstructed**

**b**uilt in 1910 the Bridge Street Bridge over the Humboldt River in Winnemucca is one of only two earth-filled arch structures in the state.

NDOT had three choices as what to do with the old bridge: demolish it and not replace it, demolish it and replace it with a new one or rehabilitate the old structure. The desire to maintain a piece of history prevailed, and the bridge was rehabilitated.

The bridge rehabilitation included removing the pavement and preserving the two concrete and steel-reinforced arches. It also consisted of damming the river above and below the bridge to gain access to the sides. They were then removed and micropiles were placed next to the existing piers. New footings were placed and tied to the existing piers by high-strength post-tensioned bars.

Micropile is a specialized approach utilized when drilled shafts prove too costly. It not only saved \$650,000 but also minimized the impact to the bridge. No increase was needed on the depth of the footings and less post tensioning was required. In addition, micropiles are easier to drill and can be used where vertical clearance is a problem.

The reconstructed Bridge Street Bridge retains its character as an earth-filled arch structure while meeting today's safety standards.



**Winnemucca's Bridge Street bridge.**



## ■ Reno uses concrete to tackle heavy traffic problems

The Longley Lane reconstruction project in Reno is done. The cones are gone, and they won't be back for a long time, which is good news!

Better news! The section from McCarran Boulevard to Peckham Lane has been resurfaced with durable Portland cement concrete pavement—a recommended material for roads that need to handle heavy traffic volume and heavy loads put on them by tractor-trailers. The Longley Lane project was sponsored by the Regional Transportation Commission of Washoe County.

The Longley project also calls for a cement-treated base for the asphalt surface being laid from Peckham to Mira Loma, again because of the heavy truck traffic and high auto volumes.

RTC engineer Warren Call says that the decision to use concrete was a “cost-to-benefit” strategy. He says that “the intensity and weight of the traffic led us to this decision. . . we don't want to have to go back and have to do the whole thing again 15 years from now.”

## Sparks truck stop adopts ultra-thin whitetopping

**T**he Alamo Truck Stop in Sparks did not know what to do with the failing asphalt behind its truck scales. The milling and filling of asphalt was just recently done, yet nine months later there were already five-inch-deep ruts caused by the weight of trucks.

Asphalt material at a heavily used truck stop basically fails within six to nine months. So what to do? An option is UTW or ultra-thin whitetopping, as it is known throughout the concrete industry. First developed 25 years ago, UTW is used to rehabilitate failing asphalt pavement by milling three to four inches off the top of the asphalt pavement.

This process is followed by the placement of a thin layer of concrete placed over the distressed asphalt. This process bonds to the asphalt and utilizes the structure of the underlying asphalt providing a very long-term, durable wearing surface that will last anywhere from 10 to 30 years.

“What we did at the truck stop scales in Sparks,” says Andy Youngs of the California-Nevada Cement Promotions Council, “is use a rapid strength concrete mix that attains its full strength within 24 hours.

“Not only is the quick drying time a huge benefit, but UTW is also the most cost-effective process to be used on intersections and parking lots.

Cities and counties seem to benefit most by UTW due to lower life-cycle costs, easing budget burdens.”

The area at the Sparks truck stop selected for the UTW project was a 40-foot by 70-foot area. Concrete placement began immediately after the removal of asphalt. A high early-strength mix using air entrainment and fiber reinforcement was designed and lab tested to provide 400 psi flexural strength within six to eight hours and more than 700 psi in seven days.

“This mix provided enough strength to allow saw cutting with early entry saws within an hour or two after placement,” says Richard Moore, field representative for the Western States Chapter of the American Concrete Pavement Association.

The thickness design concept for UTW differs from the traditional design concept for other concrete pavements, according to Moore. Essentially UTW is a maintenance strategy which is constrained by existing pavement factors.

If you would like to obtain more information on ultra-thin whitetopping, and other issues pertaining to concrete pavements, log onto the American Concrete Pavement Association Website at [www.pavement.com](http://www.pavement.com) or contact Richard Moore at 775/882-6088.

## Crossing flags catching on

**A**s reported in the spring issue of the *Milepost*, the City of Elko is experimenting with a low-cost pedestrian safety concept at a busy uncontrolled intersection in its downtown.

Four containers for 16 flags are fastened to light poles at each of the four corners. As pedestrians prepare to cross the street, they take an orange flag to signal approaching drivers to slow down or stop.



*The pedestrian safety flags are found in containers fastened to light poles at busy intersections.*

This system has been in place now for about 10 months, and the city's Public Works Director Delmo Andreozzi believes it is working. He says, “Even though we have to replace the flags occasionally, the program has highlighted the pedestrian problem at the intersection and raised public awareness.”

The City of Fallon has followed suit and installed crossing flags at two intersections near an elementary school.



### Man of letters

## Silver State's alphabetical hillsides

I hit the road recently to attend NDOT's State Bicycle and Pedestrian Conference in Las Vegas and to make my rounds across the state to the different highway agencies.

As I drove through Nevada's cities and towns, my attention was drawn to the letters on hillsides above the communities. "C" for Carson City, "T" for Tonopah, "E" for Elko and so forth. I've been looking at such letters for many, many years and often have wondered why they were there and when and how the tradition began.

With a little research I learned that the hillside letter that started the craze can be traced back to Berkeley. The 70-foot-high "Big C" in the Berkeley Hills was built by University of California freshman and sophomore students in 1905 for the annual Charter Day Celebration. Other colleges around the West soon followed suit.

University of Nevada students constructed a 150-foot-high and 140-foot-wide block "N" in 1913 to become the first in the state to be in vogue. It was composed of rocks covered with whitewash and took the honor as the largest hillside letter in the country until 1925.

The first high school letter in Nevada was the Elko "E" built in 1916 to commemorate a high school teacher who died that year in a snow storm while hiking in the Ruby Mountains. The next high school letter probably was the Tonopah "T" the following year. It was constructed to recognize the school's championship girls' basketball team.

Most of the state's other high schools were not far behind in building hillside letters for the town or



Carson City's C-Hill with flag.

Carson City followed in the early 1920s. The Sparks "S" and the Battle Mountain "BM" came on the scene in 1925, the Virginia City "V" in 1926, the Lincoln County "L" at Panaca in 1927 and the Virgin Valley "V" in Mesquite in 1929.

May more hillside letters appeared over the

years. Dozens are scattered across the state giving Nevada the distinction of having more than any other state.

Although some of the letters have been neglected, most are still maintained. They remain a source of school spirit and community pride, especially in Nevada's rural areas where high schools are an integral part of the towns' social fabric.

Carson City's "Big C" received a lot of recognition when the community pulled together and built a large American flag just above the letter soon after September 11. This was a symbol of pride for the community at a time when a show of patriotism was important to pull the nation together.

A different scenario played out in Battle Mountain a few years ago when the town gained national notoriety in the *Washington Post*. It designated Battle Mountain the winner of a contest for the "Armpit of America." The *Post* espoused that the large BM summed up everything that was bad about the town.

Despite the bad press on Battle Mountain, the hillside letters are symbols of community spirit that needs to be treasured as part of a Nevada tradition. This is particularly true at a time when much of rural Nevada is facing economic hardship.



### Only in America . . .

- As the Fourth of July approaches, some ironies to ponder about our great country.
- Only in America can a pizza get to your house faster than an ambulance.
- Only in America are there handicap parking places in front of a skating rink.
- Only in America do drug stores make the sick walk all the way to the back to get their prescriptions while healthy people can buy cigarettes at the front.
- Only in America do people order a double cheeseburger, large fries and a diet coke.
- Only in America do banks leave both doors open and then chain the pens to the counters.
- Only in America do we leave cars worth thousands of dollars in the driveway and put our useless junk in the garage.
- Only in America do we use answering machines to screen calls and then have call waiting so we won't miss a call from someone we didn't want to talk to in the first place.
- This last discrepancy especially applies as we look forward to celebrating Independence Day. Only in America do we buy hot dogs in packages of 10 and buns in packages of eight.

### Douglas County comes out money ahead



When the sales office for Winhaven Homes in Minden outlived its usefulness, the Syncom Company donated it to Douglas County.

The county had planned on spending about \$200,000 for a modular building to gain additional office space for the road maintenance and utility divisions. But the need is satisfied with the acquisition of the 2500-square-foot building.

It was moved from Minden to the county yard near the Minden-Tahoe airport at a cost of approximately \$20,000. All told the building will cost about \$50,000, including moving costs and foundation. This is a substantial savings to Douglas County at a time of tight budgets.

## ■ Concrete workshop scheduled

Mark your calendars. The second annual Nevada Infrastructure Concrete Workshop will be held in Reno on November 2 and in Las Vegas on November 4.

For more information, mark the **No-Brainer Mail-In Page**.

## Pavement performance data available on CD-ROMs

**a** new edition of data from the *Long-Term Pavement Performance Program Database, Standard Data Release 17*, is available from the Federal Highway Administration.

*Data Release 17*, which comes on five CD-ROMs, contains the latest LTPP pavement performance data in Microsoft Access format. The CD-ROMs also include information on how to use the database, as well as a description of what is new since the last data release.

To obtain a copy, contact LTPP Customer Support Services at 865/481-2967 (email: [ltppinfo@fhwa.dot.gov](mailto:ltppinfo@fhwa.dot.gov)).

To learn more about the state RCA reviews or the guidance information being developed, contact Jason Harrington at FHWA, 202/366-1576 (email: [jason.harrington@fhwa.dot.gov](mailto:jason.harrington@fhwa.dot.gov)).

## RECYCLE MICHAEL

*Recycle Michael is as tight fisted as his ol' buddy The Practical Man is tight lipped. He has the first dollar he ever earned and expects the government to be frugal as well. He's always on the lookout for ways to reuse things to save a little money while helping to preserve the environment.*

## Study of recycled concrete identifies uses and practices



**t**he Federal Highway Administration's Pavement Recycling Team recently completed a year-long review of recycled concrete aggregate state-of-the-practice use by five state transportation departments.

Among the recommendations found by the FHWA study for using RCA is that compaction of the material in a base should be in a saturated state to aid in the migration of fines throughout the mix. It also is recommended that steel wheel rollers be used to compact RCA, as minor amounts of steel present in the material can interfere with rubber-tired equipment.

The Texas Department of Transportation has been using RCA in portland concrete cement highways and streets and as a base material for the past 10 years and has found that it provides economic and environmental benefits. In addition to eliminating the need for solid waste to go to landfills, RCA primarily is generated and used within the same urban areas.

In Houston, for example, the total amount of concrete rubble generated is being consumed as RCA. This saves time and money when compared to hauling aggregate from quarries.

Since 1983 the Michigan Department of Transportation has used recycled concrete aggregate in numerous road projects. Currently, U.S. Highway 41 in Michigan's Upper Peninsula is being reconstructed using RCA as the base material. RCA also

is being used as a base material on two projects in the Detroit area.

MDOT's experience has shown that RCA used in base and subbase material can provide performance comparable to or better than using virgin aggregate. This is due to the cementitious action that can still occur within the compacted base, adding higher supporting strength for the highway.

The agency also has found that incorporating RCA can reduce costs. For example, using it for the U.S. Highway 41 reconstruction project has resulted in savings of \$114,000.

MDOT notes that quality control and quality assurance procedures are vital when using recycled concrete aggregate. Among the areas the agency is looking to gain additional experience in are RCA's effect on drainage systems and documentation of RCA's long-term performance as a base material.

The Virginia Department of Transportation's use of RCA has been limited to date. In one application, VDOT used RCA in the subbase aggregate for a \$140-million reconstruction of a section of Interstate 66. Portable concrete crushing equipment was set up in the work zone at a closed truck weighing station. This eliminated the need to truck aggregate to the construction zone.

The Minnesota Department of Transportation uses nearly 100 percent of the concrete removed from its pavements as dense graded aggregate base. Research is now underway to establish laboratory performance parameters for RCA used in aggregate for bases and subbases.

*Continued on page 16*

# No-Brainer Mail-In Page

Your Name: \_\_\_\_\_

Phone: \_\_\_\_\_ FAX: \_\_\_\_\_

Company/Organization: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_ State: \_\_\_\_\_ ZIP: \_\_\_\_\_

## Circle **Yes** where appropriate

Do you want a list of publications and videos related to concrete? ..... Yes

Do you want to receive information on the Nevada Infrastructure Concrete Workshop? ..... Yes

## Bumper sticker snickers

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T<sup>2</sup> Center/257  
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## Nevada Milepost

is published quarterly by the Transportation Technology Transfer Center at the University of Nevada, Reno. Its purpose is to provide the latest information on transportation in a way that is useful to local and county highway personnel.

*Nevada Milepost* contains original and rewritten material compiled from reliable sources. It assumes no responsibility for the correctness of the information.

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*Nevada Milepost*  
Nevada T<sup>2</sup> Center/257  
University of Nevada,  
Reno  
Reno, NV 89557  
Ph: 775: 784-1433  
FAX: 775: 784-1429  
<http://www.t2.unr.edu>



### Staff: T<sup>2</sup> Center:

Director: Maria Ardila-Coulson  
Assoc. Director: Peter Sebaaly  
Staff Engineer: Edgard Hitti  
Field Representative: Larry Lunz  
Program Assistant: Lisa Cody

### Nevada Milepost:

Editor: Maria Ardila-Coulson  
Photojournalist: Larry Lunz  
Graphic Designer: Syd Brown



RECYCLED PAPER



## Keep your cool

**a**fter a long wet winter, we are all ready for summer, but remember, working under the hot rays of summer could be deadly.

Excess heat creates abnormal stress on the body. When body temperature rises a few degrees above normal (98.6 degrees Fahrenheit) people may experience muscle cramps, weakness, disorientation and can become dangerously ill unless they cool down. Body temperature above 105° F can be fatal. Workers in hot environments, such as road sites, must take special precautions against heat stress.

### Adapt to the Heat

Get gradually accustomed to the heat over a one-week period. On your first day in a hot environment, you may only be able to do half the work that a fully adapted worker could do. You can increase the workload each day until by the end of the week you can operate at "full steam."

### Drink Water Frequently

Drink at least a glass of water every 20 to 30 minutes. This will allow your body to replace the water loss due to sweating. Since sweating is one way your body cools itself, help your body cool itself.

### Wear Personal Protective Equipment

Wear personal protective equipment for hot environments. Personal protective equipment can range from ordinary work clothes made from breathable fabrics to specially designed suits cooled by air or ice.

### Use Engineering Controls

Use fans, ventilators, exhaust systems and air conditioning systems. Install heat shields and insulation on heat-producing machinery.

### Keep Cool

Be familiar with first-aid techniques for heat stress. Seek medical attention when a co-worker shows any signs of heat stress. Keep your cool. Heat stress is dangerous but is also preventable.

## Study of recycled concrete

*Continued from page 14*

The California Department of Transportation's current specifications allow use of RCA in pavement supporting layers. Caltrans is working with the concrete and aggregate industries to develop further applications of RCA.

Caltrans has found that even though the initial production cost of recycled concrete aggregate may be higher than that of new aggregate, the location of RCA plants near project areas lowers the final cost of using the material, primarily due to reduced hauling and overhead costs. This also saves time and reduces the damage to highways from loaded trucks.

Summaries of the Texas, Michigan, Virginia, Minnesota and California RCA reviews can be found online at [www.fhwa.dot.gov/pavement/recycle.htm](http://www.fhwa.dot.gov/pavement/recycle.htm). An overall summary report is due to be released later this year. FHWA also is working with the American Association of State Highway and Transportation Officials, U.S. Environmental Protection Agency and the American Concrete Institute to develop guidance information on how states can use recycled concrete in highway applications.



**University of Nevada, Reno**  
Nevada T<sup>2</sup> Center/257  
Reno, NV 89557-0179

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