Pavement Cuts for Utilities - A Field Guide to Their Accomplishment and Maintenance

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FOR UTILITIES

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TO
THEIR ACCOMPLISHMENT
AND MAINTENANCE

J. M. Iddins
and
C. F. Scholer

October 1984
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PREFACE

The HIGHWAY EXTENSION AND RESEARCH PROJECT FOR INDIANA COUNTIES AND CITIES provides advice, counsel and training on matters pertaining to local roads, streets and transit. This activity is funded by the Indiana Department of Highways and by the Federal Highway Administration. HERPICC is a Federal Highway Administration Technology Transfer Center serving local governments primarily in the state of Indiana.

County, city and town officials may communicate with HERPICC by calling our toll free number 800-428-7639 (in Indiana only) or by writing to:

HERPICC
Civil Engineering Building
Purdue University
West Lafayette, IN 47907
INTRODUCTION

The conditions of our city and county streets are of increasing interest to the motoring public. The public is paying more fuel tax, but receiving less in terms of smooth-riding quality roads. In fact, rough-riding surfaces cause the motoring and bicycling public to spend thousands of dollars each year for front-end alignments and other repair work on their automobiles, trucks and bikes. The public is turning to local city and county engineers and asking questions about the poor road conditions.

This manual was written to show the methods which work well for several states, counties and cities. The purpose of this manual is not to have every city and county rewrite and reorganize their entire street cut programs. Cities and counties may use it to improve or round out incomplete programs. The contents of this manual should not be used as specifications, but as a guide to develop a set of specifications and procedures. The research for this manual was conducted through personal interviews, telephone calls and letters to state, county, city and utility engineers. States were contacted because cities and counties usually develop their material from state specifications. The State Highway Departments or Departments of Transportation of Indiana, Kentucky, Tennessee, Michigan, Illinois and Ohio were contacted. The Indiana city engineers of Indianapolis, Valparaiso, Kendallville, West Lafayette, Lafayette, Bedford, and Alexandria were contacted. Only one county engineer was contacted because most street cuts are made in cities.
TRAFFIC CONTROL
AND SAFETY

Safety begins with basic protection. The workers must wear safety clothing or clothes which can be easily seen.

Safety clothing checklist:
- Orange safety vest
- Hardhat
- Good boots
- Gloves

This does not include the special equipment needed by the various utilities and welders. Any person working on or near the road should wear safety clothing. Also, workers should face the traffic whenever possible in order to see the oncoming traffic. Equipment being used should be highly visible by drivers. The equipment and work area should be located away from traffic, if possible. If not, the equipment should be placed between workers and the oncoming traffic. Figure 1 shows how the work vehicles or equipment should be placed.

Traffic Control Devices and How to Use Them

Every situation is different and must be analyzed that way. There are four variables that must be considered in the selection and implementation of traffic control devices. These will be used as guidelines for the discussion.
- Type of Work
  1. Location
  2. Time involved
- Type of roadway
  1. Speed
  2. Traffic volume

**Figure 1**: Example of protecting a worksite with vehicles

Location and type of work involved are important variables. More control devices will be needed when the work area is close to traffic. The work will generally be stationary in the case of street cut repairs. Stationary means the work-time will be relatively long term (longer than fifteen minutes). If the repair is located on the roadway, maximum protection should be used for the safety of the worker and the motorist.
The protection should start with a warning to the drivers well in advance of the work area. The warnings should give specific directions to the drivers, like the signs in Figure 2. Also, channelizing devices should be used to direct the motorist safely around the work area. Channelization varies with the speed of the traffic and lane width.

Figure 2: For the dimensions of the warning and advance warning signs, reference the Indiana Manual on Uniform Traffic Control Devices (pages D23-D38). All signs must be reflectorized or illuminated.

The duration of the repair will determine the type of channelizing devices used. Cones should be used for repairs that last less than one day. For repairs that last overnight, barricades or barrels with steady burning lights should be used. Flashing lights are only to be used with obstructions. On heavily traveled roads, repair work should not be allowed between 7-9 a.m. and 4-6 p.m., if at all possible. One way to avoid heavy volume times is to reschedule the work for night. The main traffic problem with night work is reduced visibility for the motorist. Therefore, increased warning and protection devices would be needed. For exact sizes of signs, cones and barricades refer to the Indiana
Manual on Uniform Traffic Control Devices for Streets and Highways (Section D). This manual also gives details for sign placements.

As mentioned earlier the type of roadway establishes the speed and volume of traffic. Divided and undivided roads must be handled differently. For example, warnings must be given on both sides of the road for in-lane repairs on a one-way road, refer to Figure 3. For two-way traffic, both directions should be warned. For work along curves the taper must be placed so it ends at the tangent point of the curve, reference Figure 4.

Higher traffic volumes require greater visibility of devices. Elevated signs should be seven feet high. For lower-volume rural roads, five feet high signs are sufficient. Figure 5 gives the specific dimensions of these signs.

Figure 3: Advance warning for utility construction on a two-lane, one-way road
Speed plays a major role in determining the devices used and their spacing. For high speeds (over 45 mph), large signs should be used. For lower speeds, smaller signs may be used. Sign size dimensions are given in the above manual.
Sign spacing is important. The spacing should be far enough from the repair for the motorist to react, but close enough to be a constant reminder (refer to Figure 3). For high speed roads (over 45 mph), advance warning should be given at approximately 1500 feet in front of the work area. When a series of advance warnings are given, they should be placed at approximately 1500, 1000 and 500 feet in front of the work area (Figure 3).

Where traffic will be traveling at speeds less than 45 mph but over 30 mph, the advance warning may not be necessary if a flashing light warning sign is visible from 1000 feet in advance of the work site. For speeds lower than 30 mph, the flashing light warning sign should be visible from 500 feet in advance of the work site. For lower-speed rural roads, the flashing light signs may be placed just in the immediate area of the work site. Work sites with warnings in the immediate area should still have a proper taper of cones or barricades. [4]
Procedures for the Use of Traffic Control Devices

The actual procedures for traffic control can be characterized by five phases:

1. Planning
2. Installation
3. Inspection
4. Maintaining
5. Removing

The planning phase consists of estimating the signs that will be needed and the placement of work vehicles at the job site. One must calculate the taper for channelization devices. For the installation phase, traffic control devices should be placed in the order that traffic will see them. After installation, the inspector should test the devices by driving through the site as the average motorist would. This will help to determine if the signing and tapers are clear and easily understood. Once the devices are in place and inspected, they must be maintained for the duration of the utility repair. This is essential for the safety of the repairmen and the motorist. For longer term operations, sandbags can be used as additional weight for barriers and/or barrels to prevent them from being blown over. The signs being used should be removed when they no longer apply. The devices should be removed in the reverse order in which they were placed. [15]
REPAIRS

Below are the recommended minimum material specifications. They were taken from the Indiana State Highway Commission Standard Specifications 1978 and the Indianapolis Department of Transportation's Right-of-Way Manual 1981. All numbered or coded material below refers to state specified material.

Examples of Material Specifications
(Note: All numbers refer to Indiana State Highway Standard Specifications-1978)

Hot Asphalt Emulsion (AE) Pavement (Section 402)

The materials shall conform to the requirements set out in the following referenced subsections.

402.02 Aggregates.
402.03 Bituminous material
402.04 Preparation of mixtures
Composition Limits for:
Base  No. 4, No. 5
Binder No. 8, No. 9
Surface No. 11-III,
Type IV

The base, binder, and surface mixtures specified before, shall be made using coarse aggregate in combination with fine aggregate and a percent of bitumen, as specified in the “Job-Mix Formula” of the Indiana State Highway Standard Specifications-1978 (Subsection 402.04-b).
Hot Asphalt Concrete Pavement  
(Section 403)

The materials shall conform to the requirements of the subsections referenced below.

403.02 Aggregates  
403.03 Bituminous material  
403.04 Preparation of mixtures

Composition Limits for:
  Base    No. 4, No. 5  
  Binder  No. 8, No. 9  
  Surface No. 11-B

The base, binder, and surface mixtures specified before, shall be made using coarse aggregate in combination with fine aggregate and a percent of bitumen, as specified in the “Job-Mix Formula” of the Indiana State Highway Standard Specifications-1978 (Subsection 403.04-b).

Cold Mixed Bituminous Pavement  
(Section 406)

Materials shall conform with the subsections listed below.

406.02 Aggregates and Bituminous Material  
Coarse Aggregates:  
  For Base Mixtures (open graded):  
    Subsection 903.02  
  For Base Mixtures (dense graded):  
    Subsection 903.02  
  For Binder Mixtures:  
    Subsection 903.02  
  For Surface Mixtures:  
    Subsection 903.02
Natural Sand Surface:
   Subsection 903.01
Bituminous Material for Mixture
   For Stockpiling, Asphalt
      Emulsion AE-150:
         Subsection 902.04

**Prime Coat**
*(Section 408)*

Materials should conform to the requirements of the subsections listed below.

408.02 Bituminous Material
   Cut-Back Asphalt, MC-70:
      Subsection 902.03
   Asphalt Emulsion, AE-P:
      Subsection 902.04
408.03 Cover Aggregate.
   Coarse Aggregate
      Subsection 903.02
   Fine Aggregate
      Subsection 903.01

**Tack Coat**
*(Section 409)*

The type and grade of bituminous material shall be as set out and referenced below, or as specified.

409.02 Bituminous Material
   Asphalt Emulsion, AE-T:
      Subsection 902.04
   Cut-Back Asphalt, RC-70:
      Subsection 902.03

**Backfill ("B" Borrow)**
*(Section 211)*

Structure backfill material shall conform to the requirements set out in Subsection 211.02 of the Indiana State Highway Standard Specifications-1978.
Compactors

These compactors can be used for fine aggregate (sand), coarse aggregate, soil and asphalt.

- Stomper VR-15 (135 lbs) - smaller excavations
- Bomag soil tamper T50 (118 lbs) - smaller excavations
- Vibratory plate compactor - large open cuts
- Bomag T70 (175 lbs) - large areas
- Wacker 6VR-220Y (250 lbs) - large areas

Note: Any type of compactor similar to these could be used.

When crews are not in the area, cover the cut with a steel plate. A minimum thickness of three-fourths of an inch is required. Secure the plates so they will not cause a hazard when traffic passes over them.

Care must be taken by construction crews to protect the existing pavement around the street cut repair. Damage is generally caused by tracked excavators. Plywood or heavy mats can be placed beneath tracked vehicles to prevent them from marring the pavement.

Special care should be taken to prevent undermining of existing pavements. The reason for this is it is impossible to compact the material under the undermined surface. Once traffic loads are applied, immediate settlement generally takes place in flexible asphalt pavements. [4]
LONG TERM REPAIRS

Many types of streets need street cut repairs. The long term repair will be explained in three stages, which cities and counties must control. The three stages are:

1. Cutting the street
2. Backfilling
3. Surface restoration
CUTTING OF STREETS

The cutting depends largely on the type of surface to be cut. For asphalt, concrete and asphalt over concrete streets there are two basic methods used.

1. All cuts shall be sawed to 1/3 depth of the pavement and then completed with a mechanical hammer that has a cutting edge of at least 4 inches. A minimum saw cut of 2 inches is required.

2. All cuts shall be made with a mechanical hammer that has a cutting edge of at least 4 inches. Before final repairs are made, the cuts shall be “squared.” The edges of all cuts are to be straight. [4]

For the chip seal and gravel streets the procedures vary. For chip seal pavements the cuts shall be made by a mechanical hammer with a cutting edge of at least 4 inches. As above, the edges are to be straight and parallel. For gravel roads, cuts can be made by mechanical or manual means.
BACKFILLING

The inspector or foreman at the job site should decide if the excavated material is suitable for backfill. If not, the foreman should decide to either replace or treat (with cement, lime or bituminous) to produce an adequate fill.

The existing soil will help determine what type of backfill to use.

Clay and Silty Clay Soils

Do not use a granular backfill. This will make the utility trench become a drainage channel. Instead, excavated material should be used. Protect the excavated material from moisture loss. This can be done by covering the material with a tarpaulin, and on hot days the material should be sprinkled every hour.

Sands and Silt Soils

Granular material should be used if possible. The excavated material can be used for backfill if large stones (larger than three inch diameter) are removed and it is recompacted to its original density. Alternates to replacing excavated material are:

Lime. Mix - highly plastic fine-grained soils with two to eight percent weight of the soil. Swelling is reduced as workability and strength of the soil is increased.

Cement. Mix sands, silts and silty clays with two to eight percent by weight of the soil. The soil's permeability is reduced while the soil's strength and durability are increased.
Bitumen. Mix granular soils, silts, and silty clays with less than ten percent by weight of the soil. The bitumen strengthens and waterproofs the soil.

Reusing Existing Material

If the excavated material is reused the material should be compacted in six inch loose lifts. Sprinkling the backfill before each compaction should help to achieve a higher density than if compacted dry. The compactors previously mentioned should be used. The final backfill density should be equal to or greater than before excavation. The check can most easily be obtained by using the Clegg Impact Tester.

Granular Backfill

For granular backfill there are several means of compaction. Fine aggregates (sand) can be compacted or stabilized by mechanical compactors, saturation and chemical means. The size of cut may determine which mechanical compactor is selected. The sand should be placed in less than twelve inch loose lifts. Each layer should be compacted by mechanical means or saturation to at least 95 percent of its maximum dry density. Ready-mix concrete suppliers can supply a sand slurry, composed of saturated sand, which will flow around utilities. The sand needs no compaction after placement ($12.50/ton, August 1983). Care should be taken to check the surrounding subbase material. If the material is composed of mainly clay, then saturation is not recommended. Portland cement is the chemical means of stabilizing a fine aggregate backfill. Due to the expense of portland cement
and the need for thorough mixing, mechanical and saturation are the most common means used to reach the specified compaction. Flyash and flyash-cement mixture may provide excellent stabilized aggregate mixtures. (See following section on Alternatives to Backfilling.)

For coarse aggregates, the most widely used method of compaction is mechanical compaction. Some moisture is added to lubricate the particles. Gravel should be placed in 6-inch loose lifts and compacted. The Indiana Department of Highways aggregate specification 53-B describes the most widely used backfill material.
Alternatives to Backfilling

Another method similar to the chemical stabilization methods is a controlled density fill. (This is essentially the same as a low strength concrete.) A controlled density fill can be made to densities of 90 to 135 pounds per cubic foot and compressive strengths from low to 1600 psi. There are several advantages to using controlled density fill (CDF).

- CDF needs no compaction equipment or labor.
- CDF can be made to any consistency.
- CDF flow readily in and around pipes.
- CDF can easily be made to meet density and/or strength specifications.
- CDF can be applied without forms or support.
- CDF can be worked on within 4 hours under normal conditions.
- CDF can be cut or trenched without caving in or running. [3]
SURFACE RESTORATION

Surface restoration depends on the existing surface. All pavement should be replaced with similar paving materials. For asphalt pavements, all edges or joints of the existing pavement shall be cleaned and tack-coated prior to the placement of the new asphalt. The new asphalt shall be placed in three-inch compacted lifts. The lifts shall be compacted by a mechanical tamp or vibrator. Figure 6 shows a cross section of an asphalt repaired utility cut. [12]

Figure 6: Utility repair cross section of an asphalt road. The depths of the asphalt courses vary and should match the existing pavement.
For concrete streets, the reinforcement should be similar to the existing material. Drill and grout new reinforcing bars into the existing pavement. Protect the freshly placed concrete against drying. The protection can be of several types. A membrane-type curing compound (two applications) or wet coverings, such as burlap covered with plastic are the most popular. The repaired cut should be protected from traffic for at least 36 hours.*

![Diagram of concrete and compacted granular backfill subbase or controlled density fill.]

**Figure 7: Utility repair cross section of a concrete road. The depth of the concrete should match the existing pavement (4).**

The repair can be opened to traffic if steel plates, mentioned earlier, are used. Figure 7 shows the cross section of a concrete repaired utility cut. [4]

*Shorter time periods may be achieved with high strength concrete mixes, accelerating admixtures and/or special placement methods. Contact your ready mixed concrete supplier or call HER-PICC for recommended mixes.*
For streets that are asphalt over concrete, the above procedures still apply. The only difference is that a tack coat is needed between the concrete and asphalt. Figure 8 shows an asphalt over concrete repaired utility cut. It must be stressed that streets must be repaired with paving materials similar to existing materials. With the increase in popularity of recycling asphalt, more and more milling machines are being used. The milling machines mill off the old asphalt surface so new or recycled mixes can be placed. Concrete patches in asphalt streets may dull or break the teeth from the milling machines. This is the main reason for replacing repairs with existing patch materials.

![Figure 8: Utility repair cross section of an asphalt over concrete road. The depths of asphalt and concrete should match the existing pavement (4).](image-url)
For gravel streets, the compaction needs to be the same as coarse aggregates for backfill. Figure 9 gives a cross section of how the street cut repair should look.

Figure 9: Utility repair cross section of a gravel road (4).
TEMPORARY REPAIRS

The street-cutting procedures are the same as long term repairs. The only difference is with backfilling and surface treatment. The backfill should be a coarse aggregate like the IDOH #53 stone. The stone should be compacted as well as possible. Then a cold bituminous mixture can be placed. Several utility contractors use concrete as a temporary surface material. Concrete is even used temporarily on asphalt streets. Then in early spring, before June 15, the temporary patches should be torn out and repaired as stated in the Long Term Repair section. For a cross section of a temporary repair reference see Figure 10. [12,17]

Figure 10: Temporary utility repair cross section of asphalt, concrete or asphalt over concrete road. The depth of the surface course may vary depending on existing pavement depths (4).
TESTING

Most cities and counties do not have the funds available for modern nuclear testing so several methods are presented. The inexpensive methods recommended are the Sand Cone and the Clegg Impact Tester. These two tests can be used with state standard base materials to develop standard compaction methods. The Clegg Impact tester can then be used to field check the compaction.

Sand Cone

Initially the mass of the sand container with the attached cone is determined. Then the test hole is prepared. Care must be taken not to overexcavate. The device must be able to span the top of the test hole. The apparatus is then placed over the hole. The valve on the sand cone container is opened to allow the sand to flow into the hole and cone. Once the flow of sand stops, the valve is closed and the mass of the container and sand are measured. The difference from the initial mass is the mass required to fill the hole and cone. Since the volume in the cone is constant, the amount in the test hole can be calculated. The volume of the hole can be calculated because the loose density of the sand is known. The dry mass of the soil removed is measured by drying it out. The dry density equals the dry mass divided by the volume of the test hole.

For the standard reference to the test see ASTM (American Society for Testing Materials) D1556. This reference should be obtained to perform the test.
The Clegg Impact Tester will be a valuable tool in utility construction [6, 17]. The Clegg Tester does not give a moisture content or a density value. It simply compares the impact value of the tested material to a standard. The best standard for a street cut repair, using the excavated material, is the area of the repair before excavation. The standard can be set by stopping every three to six inches during excavation, then several impact readings can be taken with the Clegg Tester.
Once the standard has been established, the compaction of the backfill can be easily checked against the standard to ensure adequate compaction. The backfill should be checked every three to six inches. Figure 12 is a picture of the Clegg Impact Tester. The Clegg Impact Tester can be used by inspectors or utility crews.

The material replaced in the excavation should not be dry if the Clegg Tester is to be used. Moist material is essential.
ALTERNATIVES TO UTILITY CUTS

Utility contractors have found other means to replace damaged pipes, hence avoiding some street cuts. Presently three methods of untrenched construction are used in Indiana. Old leaky pipes can be replaced by jacking, coring or boring. All three are being used and provide utility contractors with valuable alternatives to street cuts. For county and city streets, the pits for the untrenched construction should be located a minimum of 10 feet from the edge of the street. Pits should be excavated no more than 48 hours in advance of untrenched construction and backfilled within 48 hours after construction is completed. While the pits are open, they should be marked and protected by barricades. Shoring is required for any excavation over five feet. The shoring is designed, erected, supported, braced, and maintained so that it will safely support all vertical and lateral loads during construction. [9]

Jacking is one of the most popular untrenched methods in the state for pipes less than six inches in diameter. A casing or corrosion-resistant carrier must be used. Driving works most effectively in compressible soils. A steady thrust, hammering or vibrating is needed to drive the pipe with a pilot shoe. The city of Alexandria, Indiana used a backhoe to provide the steady thrust. Driving should not be used for long distances. Long drives may wander far from the desired line and grade. [9,16]
Figure 13: Boring, Jacking, Coring
Boring is another popular alternative to street cuts. Large pipes can be jacked through oversize bores and carved progressively ahead of the pipe. The auger should not exceed the outside diameter of the following pipe by more than 1 inch. The spoil is mucked back through the pipe. Line and grade are easy to control. A grout backfill is used for pipes more than twelve inches in diameter and for overbreaks, unused holes, or abandoned pipes. [16]

Coring is the third alternative to utility cuts. This method is mainly used when driving becomes too difficult in hard soils. Line and grade are fairly easy to control with coring. A small casing (six inches or less) without a pilot shoe is drilled into the difficult soil. The soil enters the pipe as it advances. Then the core is removed by sluicing, during or after the drilling. [9]

More cities and counties are turning to these methods to prevent traffic disruption and eliminate street cut settlements. City and county engineers should stay in touch with local contractors and utilities on their abilities to dountrenched construction. As stated earlier, untrenched construction is a specialty item that demands special skills.
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