Repairing Utility Trenches
Acknowledgment

This project was funded by the Minnesota Local Road Research Board (LRRB). Legislation creating the Board was passed in 1959. The board appointments are made by the Commissioner of the Minnesota Department of Transportation (Mn/DOT). It includes four county and two city engineers whose terms are set at a maximum of two 3-year positions. Persons serving from Mn/DOT include the Director of the Research Administration Office, the State Aid Engineer, and the Research Administration Engineer, who also serves as secretary. A representative from the University of Minnesota serves as the tenth member.

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- Constructing research elements and reconstructing or replacing research elements that fail.

- Conducting a program for the monitoring and implementation of research results.

The program is approved on a calendar year basis by the LRRB Board.
Each year miles of utility trenches are cut, backfilled, and surfaced by utility companies, government agencies, and contractors. Improper repair of these trenches leads to bumps, settlements and pavement failure. Unfortunately, city and county governments are not always responsible for the repair and have little control over the construction methods used.

To provide information regarding the methods of repairing utility trenches that are commonly used in Minnesota, the Local Road Research Board (LRRB) requested that this report be written. The report outlines the results of a survey of Minnesota cities who were asked to detail their specifications and construction methods for backfill and surface repair.
Repairing Utility Trenches

By

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Executive Summary

The construction requirements for utility trench repair vary between agencies. Many cities and counties have developed their own specifications and standard details for repairs. Others use the Minnesota Department of Transportation (Mn/DOT) Standard Specifications or the City Engineers Association Standards. To provide information regarding the best methods for repairing utility trenches, the Local Road Research Board (LRRB) requested that this report be written.

This report will summarize the results of a survey conducted in the Fall of 1991, along with standard specifications for utility trench repair.

The report includes information obtained from the following sources:

- literature searches
- interviews
- survey results

The report will focus on the following areas:

- specifications
- material requirements
- construction methods used in Minnesota
- use of flowable flyash or unshrinkable fill

Introduction

Each year miles of utility trenches are cut, backfilled, and surfaced by utility companies, government agencies, and contractors. Improper repair of these trenches leads to bumps, settlements, and pavement failure. Unfortunately, city and county governments are not always responsible for the repair and have little control over the construction methods used.

According to a 1990 survey of public works directors, the biggest complaints regarding utility trench repair are as follows [1]:

- improper backfill and inadequate compaction
- use of incompatible material as fill or surfacing
- utilities slow in completing the work
- undercutting of pavements and gutters
- trenches too narrow
- inadequate supervision of utility crews
- no accountability for repair by utility
- poor communication between governing agencies and utilities

Undercutting is a major problem, as it results in voids beneath the pavement, causing it to eventually settle and break. Inadequate compaction, due to narrow trenches not yielding room for proper compacting equipment, lack of supervision, or thick lifts, also cause settlement and pavement failure. Estimates show that patches reduce the average pavement life by eight to ten years. Additional maintenance requirements, long-term settlement, pavement roughness, and public dissatisfaction also result from trench repairs [2].
According to the University of Kansas Transportation Center Newsletter (February 1988), the success of utility trench repairs is dependent on close monitoring of the work by governing agencies. They offer the following guidelines for developing functional utility-cut ordinances [3]:

1. All work should require a permit that includes plans and specifications for each step of the project. It should include the hours of work, extent and method of work, signing and barricade plan, vehicular and pedestrian safety measures, backfill requirements, pavement restoration, and clean-up and patch maintenance requirements.

   The permits ensure that the city or county will be notified in advance of any work, enabling them to coordinate the work with any planned resurfacing or construction projects. The agency will also be better prepared to provide full or part-time inspection of the work.

2. Bonds should be issued based on the amount of potential damage that might occur, and should remain in effect for two years after construction to ensure good work.

3. Clear and explicit specifications should be developed explaining the regulations, backfill materials, and compaction requirements. Inspection of the pavement restoration should be required immediately upon completion and then again 6 to 24 months later.

4. Utility repairs should be coordinated with resurfacing projects to prevent the patching of a newly paved street.

Survey Results

To determine how cities and counties throughout Minnesota deal with trench repair issues, Braun Intertec Pavement, Inc. recently conducted a survey of government agencies for the Local Road Research Board. A total of 89 responses were received, 40 from cities and 49 from counties. Overall, the survey showed a variety of problems and solutions related to utility trenching. Several agencies reported minimal problems and trench settlement, resulting from good communication between the utility, contractor, and agency. Those agencies also had detailed plans and specifications included with required permits, and a city or county inspector on-site to monitor construction.

The first step in performing the utility repair is removal of the surface layer. A clean straight sawcut of the pavement will provide for better bond between the patch and existing surface. Several agencies reported that they specify sawing the pavement several feet back from the trench to prevent undermilling and pavement breakage. This is also recommended to provide enough area for good compaction of the base and granular layers.

Since a narrow trench hinders adequate compaction, it is recommended that a minimum trench width of 18 inches be specified. This will accommodate a hand tamper or a small vibratory roller. The City of Roseville specifies a minimum trench width of 18 inches for pipes less than ten inches in diameter, and a width of 2 feet more than the pipe diameter for pipes larger than 10 inches. St. Paul requires a trench width equal to the pipe diameter plus 1.5 times the distance from ground surface to the bottom of the pipe, with a maximum trench width of 15 feet. All OSHA standards for trenching should also be specified. OSHA requires that the ground be sloped, or shoring be used to support the walls and faces of all trenches five feet or more deep. Also, trenches four feet or deeper must have exit ladders or steps, and no material may be stored within two feet of the excavation edge.
Most of the agencies responding to the survey required that the utility company or its private contractor complete the backfilling. It is therefore important that backfill methods be clearly specified. Backfill materials specified in Minnesota are shown in Figure 1, and the compaction specifications used shown in Figure 2.

According to the survey, excavated material is often used for backfill, compacted at lift depths of 6 or 12 inches for cohesive soils, and 12 inches for granular soils (See Figures 3 and 4). St. Paul only allows excavated material to be used as backfill if it is a stable mixture of sand and clay, sand, gravel, or a mixture thereof, with a maximum particle size of three inches. They require that unacceptable material be replaced with granular backfill.
Mn/DOT specifies that the upper 3 feet of backfill be placed in 8-inch lifts, and lifts below 3 feet be less than 12 inches thick. The upper 3 feet of the embankment must be compacted to at least 100 percent of Maximum Density, and that below the upper 3 feet must be compacted to at least 95 percent of Maximum Density. Compaction is to be obtained with a tamping roller or an approved type of vibratory compactor, except in plastic soils. For plastic soils, pneumatic, steel-wheeled, or grid rollers may be used for compacting layers of 8 inches or less.

Compaction of the backfill materials is critical for avoiding excessive trench settlement. The majority of cities require the use of a non-vibratory compactor for cohesive soils, and a vibratory compactor for granular soils. The number of passes required over each lift was usually not specified, with cities relying on visual inspection to tell them when the material was adequately compacted.

The City Engineers Association of Minnesota has prepared Standard Utility Specifications for Water Main and Service Line Installation and Sanitary Sewer and Storm Sewer Installation, which many cities reported that they use in conjunction with Mn/DOT Specifications.
According to these specifications, excavated material can be reused as long as it meets the following requirements:

<table>
<thead>
<tr>
<th>Percent Passing</th>
<th>Material Use Designation</th>
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<tbody>
<tr>
<td>Sieve Size</td>
<td>Foundation</td>
</tr>
<tr>
<td>3 inch</td>
<td></td>
</tr>
<tr>
<td>2 inch</td>
<td></td>
</tr>
<tr>
<td>1 inch</td>
<td>100</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>85 - 100</td>
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<tr>
<td>3/8 inch</td>
<td>30 - 60</td>
</tr>
<tr>
<td>No. 4</td>
<td>0 - 10</td>
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<tr>
<td>No. 10</td>
<td>20 - 65</td>
</tr>
<tr>
<td>No. 40</td>
<td>0 - 35</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 - 10</td>
</tr>
</tbody>
</table>

**NOTE:** Granular foundation, bedding and encasement material provided for plastic pipe and fittings shall meet the requirements of ASTM 2321, Class I, II or III materials or the requirements provided above if the Engineer authorizes such substitution.

Materials are classified in the following way:

<table>
<thead>
<tr>
<th>Material Use Designation</th>
<th>Zone Designation</th>
</tr>
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<tbody>
<tr>
<td>Granular Foundation</td>
<td>Placed below the bottom of pipe grade as replacement for unsuitable soils, to achieve better foundation support.</td>
</tr>
<tr>
<td>Granular Bedding</td>
<td>Placed below the pipe mid-point, prior to pipe installation, to facilitate proper shaping and to achieve uniform pipe support.</td>
</tr>
<tr>
<td>Granular Encasement</td>
<td>Placed below an elevation one foot above the top of pipe, after pipe installation, for protection of the pipe and to assure proper filling of voids or thorough consolidation of backfill.</td>
</tr>
<tr>
<td>Granular Backfill</td>
<td>Placed below the surface base course, if any, as the second stage of backfill, to minimize trench settlement and provide support for surface improvements.</td>
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Excavated mineral soil that is reasonably free of foreign material, frozen clumps, oversized stone, rock, concrete, or bituminous chunks that may damage the pipe may be used as backfill. Within one foot of the top of the pipe, all material must be less than 1-1/2 inches for 12 inch pipes and smaller, and less than 2 inches for pipes greater than 12 inches in diameter.

According to the City Engineers Association specifications, trench widths must be sufficient to permit the pipe to be laid and joined properly, and the backfill to be placed and compacted as specified. Additional space must be provided to permit the placement of sheeting and shoring, and to accommodate all appurtenances. They specify a maximum trench width of two feet greater than the pipe diameter.

Backfill is to be placed in 8-inch lifts up to an elevation one foot above the top of pipe. Above that, lifts can be 12 inches thick. Each layer is to be compacted mechanically or by hand, until there is no further visual evidence of increased consolidation. Pavement is to be restored to meet existing materials and thicknesses, and according to Mn/DOT specifications [4].

A study by the Minnesota Highway Department (now Mn/DOT) conducted in the 1960s found that even with compaction to very high densities, a 1/2 to 1-inch settlement of fill material can be expected, and recommended that a permanent patch not be placed until after one spring season. They also recommended that the patch be placed about 1/2-inches higher than the surrounding pavement to account for additional settlement, and that particular attention be given to the upper two feet of the trench. This was found to be the depth in which the major portion of consolidation will most likely occur [5].

The same study also found that settlement amount is dependent on the backfill and surrounding soil type, backfill depth, type of compactor used, depth and width of trench, and month and year of construction. Most agencies responding to the survey do not place a permanent patch until after one spring season. A cold mix temporary patch is used first (see Figure 5). Leaving the patch higher than adjacent pavement is not standard practice by the Minnesota agencies responding to the survey, as illustrated by Figure 6.
Surface material used in Minnesota to patch the trenches is usually the same as the surrounding surface, and most agencies specify a full-depth patch over the backfill material. Prior to patching, 70 percent of the cities saw a straight cut on the adjacent edge and cover it with tack. The use of geotextiles beneath the surface is not common, with only 17 percent of the cities stating that they have used it. Among those cities with concrete pavements, 41 percent require full slab replacement when repairing utilities, and 44 percent require that dowels be used when replacing the slab. Hennepin county requires that if the trench opening is within three feet of a joint, the pavement must be removed to the joint. All patches must also be tied with No. 8 rebars.

**Alternative Methods**

Many of the problems associated with utility trenching, including undermining, insufficient compaction, narrow trench widths, and inadequate supervision of work crews, can be alleviated with the use of an engineered fill, also referred to as unshrinkable fill or flowable fly ash. Flowable fly ash is a slurry mixture of Class F fly ash with the addition of 4 to 5 percent Portland Cement to the dry weight of the fly ash, along with enough water to provide for the desired consistency for the specific application (usually a 9 ± 2 inch slump). The material is poured in place, filling all voids with no compaction required [6].

Unshrinkable fill offers several advantages when compared to granular material. It can be expected to fulfill the same performance expectations more consistently than granular fill that has been compacted to specifications. Unshrinkable fill is easier to use and no compaction is needed since it is self-consolidation. Less testing and inspection are required, and as it becomes more available, the cost of unshrinkable fill is decreasing [7]. Eight of the Minnesota agencies responding to the survey stated that they had experience with unshrinkable fill. Products used include Rochester Ready Mix low strength mortar, Kost Brothers Controlled Density Fill, and K-Crete by Cemstone. Prices ranged from $40 to $60 per cubic yard.

The use of flowable fly ash is now mandatory on all street cuts in several Michigan cities, and is exclusively used for trench cuts in Toronto [8]. The Toronto mix consists of 2,600 pounds of -3/8 inch aggregate, 800 pounds of mortar sand, 94 pounds (one bag) of Portland Cement, and water to achieve the required slump. The cured mix achieves the required stability, and can be removed with a pick and shovel. They have not experienced any repair failures to date, and have adopted the use of unshrinkable fill as the only backfilling material to be used in paved sections of right-of-way.

Because of the mix’s inherent stability, it can be paved over immediately. The surface should be consolidated first, which can be done simply by walking on it. However, there are some limitations associated with the use of this material. Since it ravel quickly when exposed to traffic, the fill must be covered with aggregate or paved before it is opened to traffic. Also, the cement in the slurry will accelerate deterioration of underground metal facilities in the area must be covered or treated before the slurry is placed [9].

Another way to eliminate the problems associated with utility trenching is by prohibiting it. Four counties responding to the survey stated that, except in the case of an emergency, open cuts on paved roads are prohibited. All pipes must be jacked or bored under existing pavement. Due to disturbance of the ground during the process, some settlement or bumps in the road surface may still occur.

Complete survey results and sample specifications from agencies responding to the survey are available upon request from Braun Intertec Pavement, Inc.
References

1 "How to Get Utilities to Repair Streets Right," Better Roads, April 1990, p.35.


3 University of Kansas Transportation Center Newsletter, February 1988.

4 Standard Utilities Specifications for Water Main and Service Line Installation and Sanitary Sewer and Storm Sewer Installation, City Engineers Association of Minnesota, 1988 Edition.


7 Johnson, p.13.


9 Brinkley, p.35.