SD96-11-F

SD Department of Transportation
Office of Research

Evaluation of High Density Polyethylene (HDPE) Pipe

SD96-11
Final Report

Prepared by
Office of Research
South Dakota Department of Transportation
Pierre, South Dakota 57501

April, 1998

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. SD96-11-F	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Evaluation of High Density Polyethylene (HDPE) Pipe		5. Report Date April 9, 1998
		6. Performing Organization Code
7. Author(s) Anselem H. Rumpca		8. Performing Organization Report No.
9. Performing Organization Name and Address South Dakota Department of Transportation Office of Research Pierre, South Dakota 57501-2586		10. Work Unit No.
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address South Dakota Department of Transportation Office of Research 700 East Broadway Avenue Pierre, SD 57501-2586		13. Type of Report and Period Covered Final; February 1996 to April 1998
		14. Sponsoring Agency Code

15. Supplementary Notes
An executive summary of this report is published as SD96-11-X.

16. Abstract

This report presents the findings and recommendations on the evaluation of High Density Polyethylene (HDPE) Pipe resulting from a 1996 Transportation Enhancement/Hazard Elimination Project in Martin, South Dakota. This was the first project where HDPE pipe was allowed to be installed under a state highway in South Dakota.

Department researchers installed instrumentation and conducted deflection testing on a 760 mm (30 in) HDPE pipe installed under US Highway 18 in Martin, South Dakota. A horizontal inclinometer probe was used to determine vertical heave or settlement. Surface profiles were monitored with a Dipstick® Floor Profiler. Thirteen separate sets of measurements were taken between August 1996 and June 1997.

Costs were determined for installation and delivery of both HDPE pipes and reinforced concrete pipes (RCP). Neighboring states were surveyed to determine their costs for storm sewer pipes as well as specifications for installing HDPE pipes.

Recommendations were made to allow the installation of HDPE pipe based on information received from the state survey, literature reviews, and the results of the Martin, South Dakota Project.

17. Keyword	18. Distribution Statement No restrictions. This document is available to the public from the sponsoring agency.		
19. Security Classification (of this report) Unclassified	Security Classification (of this page) Unclassified	21. No. of Pages 62	22. Price

sewer. At other times, ice and sand covered the bottom pipe and could not be effectively removed to take measurements.

All of the inclinometer recordings were compared to the base recordings that were taken on August 14, 1996, prior to the asphalt overlay, which was completed on August 16, 1996. No significant differences were noted in the inclinometer readings between August 14, 1996 and August 16, 1996; therefore it was decided to utilize the earlier recordings as the base data.

Based on eight separate recordings between August 14, 1996 and May 20, 1997 the bottom inclinometer pipe had a maximum point deflection of 0.77 mm (.0308 in) or .10%. The average pipe deflection was 0.035 mm (.0014 in) or .005%.

Based on the thirteen recordings which were taken between August 14, 1996 and June 26, 1997, the top inclinometer pipe had a maximum point deflection of 2.28 mm (.0911 in) or .30%. The average top pipe deflection was 0.105 mm (.0042 in) or .01%.

All of the deflection measurements were well within the established five percent deflection threshold established by the technical panel. In fact, throughout the entire recording period there was little if any pipe movement noted.

Task 9: Determine the costs of the installation

Determine the costs of the installation of the HDPE pipe and compare them to the cost of installing round reinforced concrete pipe. Include the backfill and other associated costs. A considerable amount of data exists comparing the costs of reinforced concrete pipe and HDPE pipe. While manufacturers of both products can provide extensive literature expounding the benefits and savings of their individual products, it must be noted that various circumstances and site conditions can favor either product.

Manufacturers' material prices are generally quoted as a delivered product. Cost of the product itself as well as handling charges will be incorporated to cover the loading at the factory and

unloading at the job site. The more difficult the handling of the material, the greater the handling cost. Heavy pipe, such as reinforced concrete products, are more difficult to handle than most other materials, especially lightweight plastics. Additionally, damage resulting from the handling of coated products (e.g., polymer-coated steel) may need to be repaired before installation can proceed.

Hauling charges are also included in the material costs. This figure is affected by the distance between the manufacturing plant and the job site, and the quantity of material that can be hauled at one time. Lightweight corrugated pipes can easily be nested allowing the number of trips to the job site to be markedly reduced.

Equipment and manpower necessary for trenching are the same for nearly all products. However, the equipment and manpower required to handle the pipe is closely linked to its weight. Even small diameter concrete pipe requires equipment to help lower it into the trench. Several laborers are needed to guide it into place to form the joints. With the equipment necessarily come operators which add to the cost of installation.

Rough terrain, vegetation, or a requirement to preserve the environment may make it impossible for equipment to be brought adjacent to the trench. It then becomes a necessity for the pipe to be handled solely by workers (16).

A recent survey of State Departments of Transportation revealed that reductions in installed cost for HDPE pipe were 12 to 38 percent of concrete, and 5 to 28 percent of corrugated steel (17). Information provided from New York, South Carolina and Colorado indicate that the price of corrugated metal pipe and reinforced concrete pipe prices generally dropped when polyethylene pipe was specified as an alternative. Ohio studies indicate that "...when projects are bid as reinforced concrete only, installed costs are an average of 29.2 percent higher on 305 mm to 915 mm (12 to 36 in) drain pipe than when polyethylene is allowed as an alternative". (18)

A 1994 Tennessee “Report on the Use of High Density Polyethylene Pipe in Roadway Drainage Applications” prepared by Fiscal Review Committee Staff indicated that 42 states allow the use of polyethylene pipe 305 mm (12 in) in diameter and greater in highway drainage applications. The report goes on to say that available cost data suggest that when the use of polyethylene pipe is allowed, the cost of concrete pipe goes down, and the cost of polyethylene pipe is generally less than the cost of either metal or concrete pipe. In comparing the experience of other states and some local governments, cost savings were realized not only because polyethylene pipe was a less expensive product, but also because the equipment and labor costs were less. Polyethylene pipe installation also reportedly results in fewer injuries to employees (19).

A review of information supplied by neighboring DOTs indicated varying degrees of use and cost information. The Montana DOT will allow the use of HDPE pipe as an option to RCP, Corrugated Steel Pipe (CSP), and Corrugated Aluminum Pipe (CAP). The contractor is then allowed to select which material he intends to use (for farm field or local approach roads only). To date, Montana has not used HDPE pipe, and excludes the use of HDPE on major and minor collectors and arterial approach roads.

The Wyoming DOT has not completed any installations of HDPE pipe on State projects. The use of HDPE is only specified for “off system” roadways when requested by a municipality or county.

The North Dakota DOT currently does not design any highway projects using plastic pipe larger than 305 mm (12 in) for highway drainage.

The Iowa DOT has used large diameter (305 mm or larger) plastic materials for highway drainage for approximately ten years under driveways, field entrances and unclassified roads. The engineer who responded to the survey was not aware of any cost savings using HDPE pipe. However, other information reviewed during the course of this research indicated that Iowa cost information does show that HDPE pipe is less expensive than RCP.

The Nebraska Department of Roads Materials and Tests Engineer indicated that Nebraska has not had the experience necessary with plastic pipe to provide answers to the survey, which was sent in April, 1997. It should be noted that the Nebraska DOR has co-sponsored studies with the University of Nebraska-Lincoln which resulted in the Nebraska DOR approving a new Policy DES97-01. That policy states that the designers will select the allowable pipe materials for each installation, and the contractor will chose the final pipe material from the list of options provided (which include HDPE).

The Minnesota DOT has used dual-wall corrugated polyethylene pipe since 1989. For storm sewer they allow use of 305 mm to 915 mm (12 to 36 in) diameter pipe with a minimum cover of 610 mm (24 in) and a maximum cover of 6.1 m (20 ft). The pipe must be installed according to their specifications. The pipe must be deflection tested with a maximum allowable deflection of 5% nominal diameter. Polyethylene pipe is included in the construction plans as an alternate to reinforced concrete pipe.

For culvert use, the Minnesota DOT will allow the use of 305 mm to 610 mm (12 to 24 in) diameter dual wall corrugated polyethylene pipe under side roads with a minimum cover of 305 mm (12 in) for private driveways, 610 mm (24 in) for public roads and a maximum cover of 6.1 m (20 ft). They include polyethylene pipe as an alternate to corrugated steel pipe and reinforced concrete pipe for culverts under side roads.

The Minnesota DOT survey response indicated that they have had no significant construction problems or any pipe reported to be damaged by fire. No formal studies have been done to document cost or construction time savings, but their review of the year-end construction costs indicates that providing pipe alternates in the plan leads to lower installed pipe costs.

Prior to the HDPE storm sewer installation in Martin, South Dakota, there had been limited use of HDPE in South Dakota. The City of Sioux Falls had installed HDPE pipe on a project located at 18th Street and Elmwood Avenue. Discussions with city representatives indicated that a

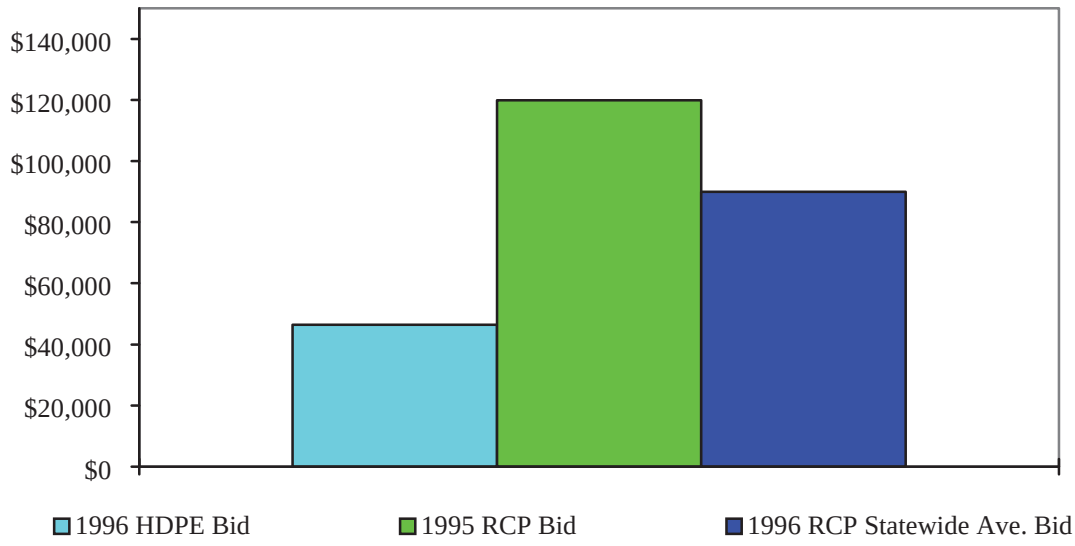
failure had occurred on that project due to bad backfill and improper construction installation. The HDPE storm sewer pipe was replaced with the same product and installed with a granular backfill rather than the clay fill utilized on the first installation. The supplier provided inspection support during the replacement installation. City staff emphasized the need for adequate supervision during the installation of HDPE pipe to make sure that the manufacturers' guidelines are followed. The replaced HDPE storm sewer section continues to be monitored by city personnel and has not had any additional problems to date.

An evaluation of the HDPE pipe bids and the corresponding RCP pipe bids for the Martin project showed that the 1996 HDPE pipe bid price was 39% of the cost of the 1995 Martin RCP bid price. Both the installation cost and the HDPE unit bid price averaged 39% of the cost of the 1995 RCP bid. These costs were for the pipe and installation only, and did not include tees, wyes, bends or other connectors.

The installation and unit costs of over 550 M (1,800 ft) of assorted sizes of HDPE pipes bid in the 1996 Martin project were compared with the 1997 average costs of the same amount of RCP round pipe and installation costs. The results showed the 1996 Martin project HDPE unit and installation costs were 52% of the 1996 statewide average cost of RCP furnished round pipe and installation. The actual Martin HDPE installation bid costs were 71% of the average statewide cost of RCP installation, while the furnished unit HDPE pipe bid costs were 43% of the average statewide cost of furnished RCP pipe. It should be noted that the RCP unit and installation costs were a statewide average for all projects, while the HDPE costs were for the Martin project only. The SDDOT did not have any other HDPE cost comparisons since no other project using HDPE pipe had been let.

When a comparison was done with the HDPE pipe list price supplied by a major HDPE distributor, it was noted that the Martin HDPE unit bid prices were lower than the actual 1995-96 HDPE unit list prices. This may be due to the fact that distributors will often discount unit list prices if sufficient quantities are ordered. In the case of the Martin project, over 550 m (1,800 ft) of HDPE pipe was installed. Since this was the first HDPE project in South Dakota, it may also

be due to the increased competition generated by allowing HDPE pipe distributors to directly compete with RCP pipe distributors.



Martin Project Bid Comparisons

Figure 12 Martin Project HDPE, RCP, And Statewide RCP Average Cost Comparisons For Over 550 M (1,800 Ft) Of Pipe Installed. Costs Include Furnished Pipe And Installation Costs For All Sizes Of Pipe Used In The Project

Finally, when reviewing the overall cost of the use of HDPE pipe, the cost estimator must consider the cost of the granular fill, which provides the protective envelope around the installed HDPE pipe. This is important since some areas of the state do not have good quality granular fill readily available for use in storm sewer projects. The Sioux Falls experience highlights the need for quality granular fill as well as proper installation procedures. On the same note, the Martin project and other literature/research projects demonstrate that HDPE pipe is an acceptable alternative to RCP pipe and CMP pipe when proper installation procedures and materials are utilized.