City of Tacoma

Fiber Reinforced Asphalt Concrete Pavements

Final Report
WA-RD 133.1

October 1987

Washington State Department of Transportation
Planning, Research and Public Transportation Division

in cooperation with the
United States Department of Transportation
Federal Highway Administration

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO. WA-RD 133.1	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
4. TITLE AND SUBTITLE Fiber Reinforced Asphalt Concrete Pavements - City of Tacoma		5. REPORT DATE October 1987
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) C.A. Toney, Research Administrator		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS City of Tacoma, Construction Division, Department of Public Works, Suite 332, Tacoma Municipal Builidng, Tacoma, WA 98402-3769		10. WORK UNIT NO.
		11. CONTRACT OR GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Washington State Transportation Commission, Department of Transportation, Transportation Building, Olympia, WA 98504		13. TYPE OF REPORT AN PERIOD COVERED Final 11/83 - 10/87
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES: In Cooperation with The U.S. Department of Transportation, Federal Highway Administration, Federal Aid Project No. M-3268 (1) & (2), Federal Aid Program No. 3-1280-19

16. ABSTRACT

The use of BoniFibers™ fiber reinforced Asphalt Concrete Pavement (ACP) at three City of Tacoma intersections is reported. Product selection, fiber reinforced ACP mix design, old pavement removal, construction and evaluations are documented.

BoniFibers™ fabric reinforced ACP appears to provide a durable roadway at intersections that have a high volume of turning and heavy traffic. Continued monitoring of the City of Tacoma fiber reinforced ACP is recommended until major deterioration occurs.

17. KEY WORDS BoniFibres, Fiber Reinforced Pavement, Fiber Reinforced ACP, Polyester Fibers, Polymar Fibers, Reinforced Pavement, Reinforced Asphalt	18. DISTRIBUTION STATEMENT N/A

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
None	None	19	

DOT FORM 310-022 (11 86) -1216-

FIBER REINFORCED ASPHALT CONCRETE PAVEMENTS

CITY OF TACOMA

Final Report

By

Carl A. Toney

Research Administrator

For

Washington State Transportation Commission

Department of Transportation

In

Cooperation

With

US Department of Transportation

Federal Highway Administration

October 1987

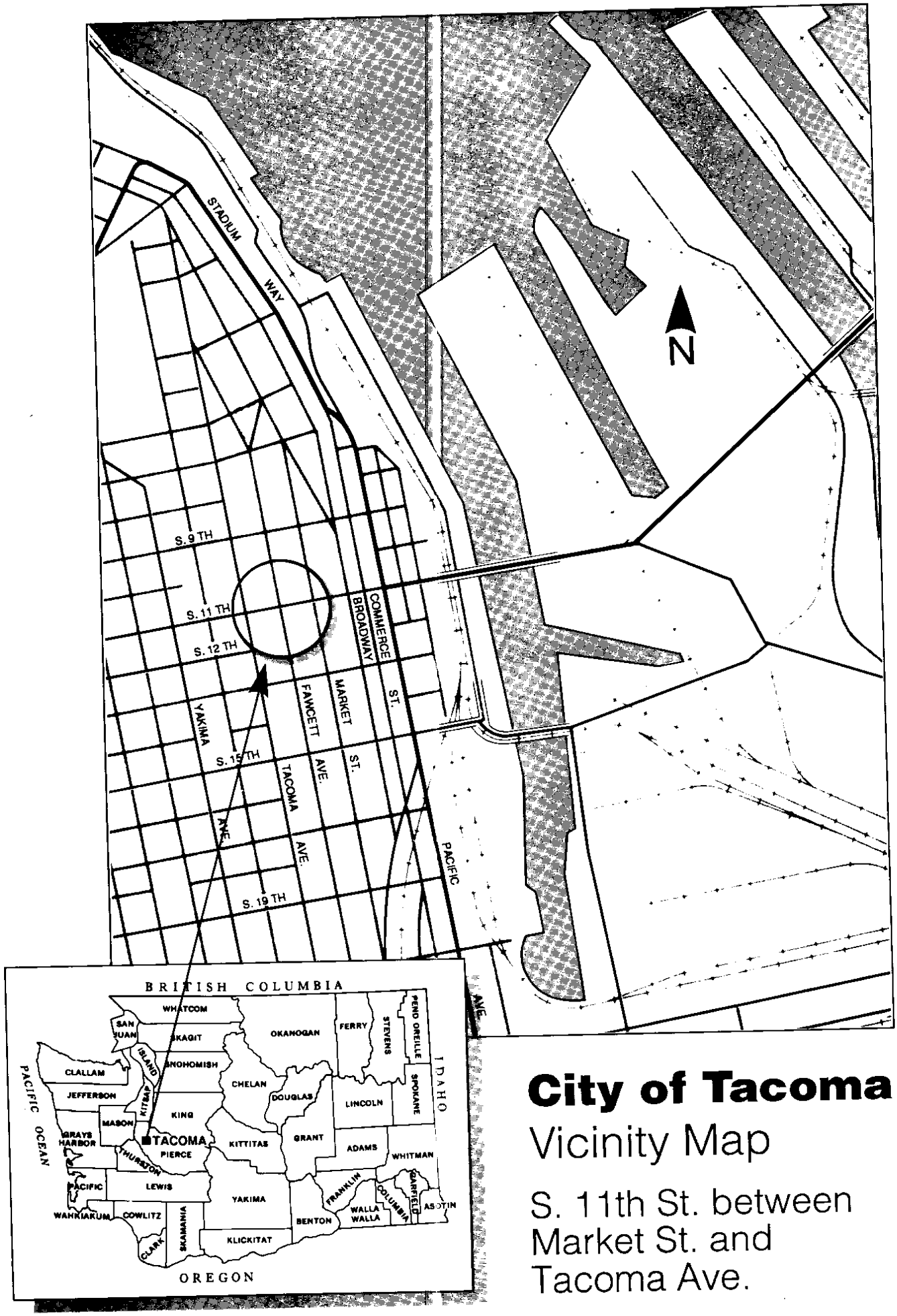
DISCLAIMER

The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Washington State Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

NOTICE

The Washington State Department of Transportation and the United States Government do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

CONTENTS



City of Tacoma

Vicinity Map

S. 11th St. between Market St. and Tacoma Ave.

INTRODUCTION

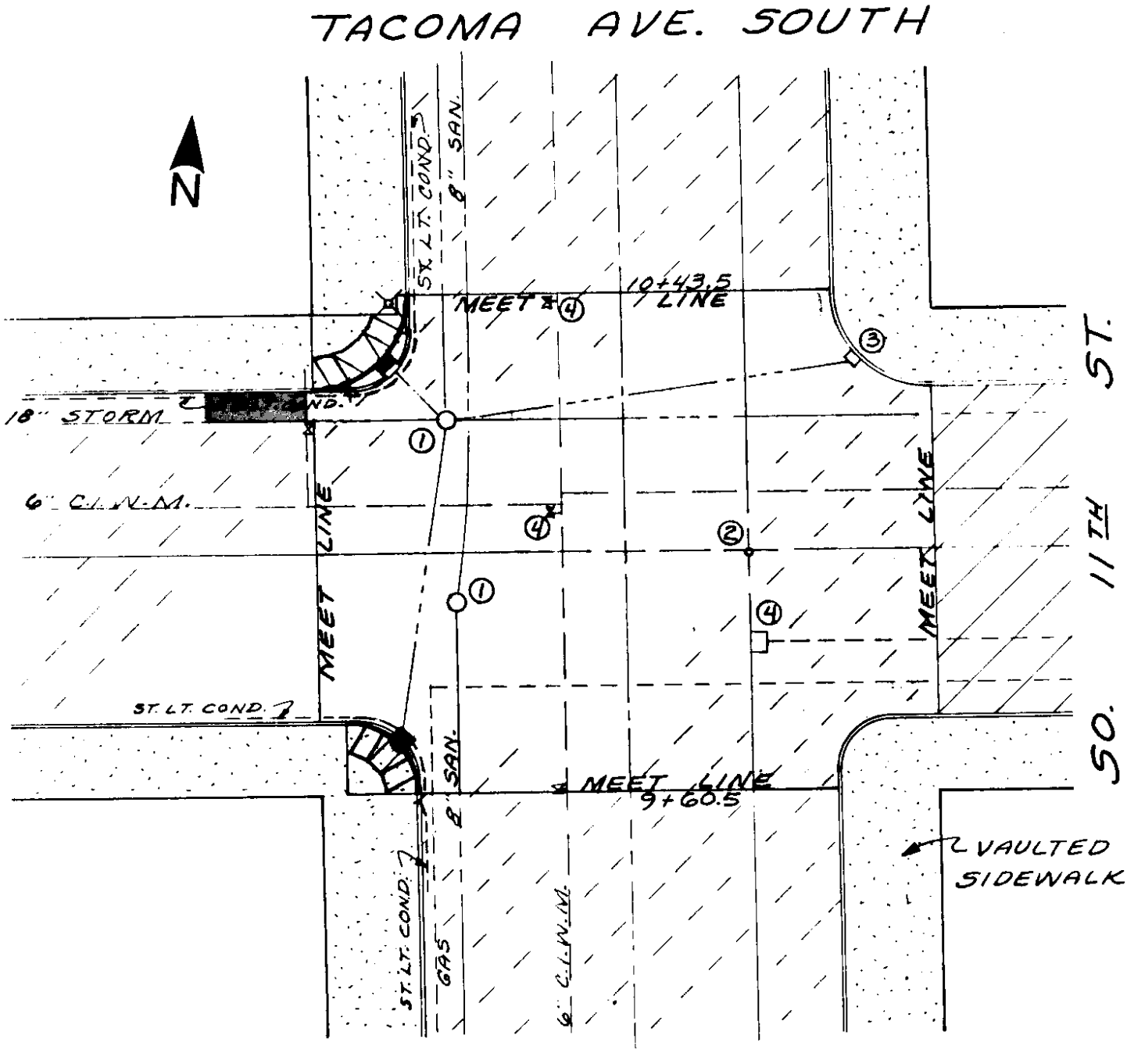
In November 1983, the City of Tacoma replaced the deteriorated asphalt conrete pavement (ACP) of three major arterial intersections with fiber reinforced ACP. BoniFibers™ was chosen for this construction based on its performance at similar intersections in the City of Seattle. The Seattle intersections were located on hill streets, which had frequent bus traffic. The pavements required annual or semi-annual maintenance. At the time the City of Tacoma constructed the paving project being reported herein, the Seattle intersections had performed well for a two year period.

The City of Tacoma intersections repaved with BoniFibers™ on this project had an average grade of 12 percent. The intersections were subject to high traffic volumes of trucks and buses. The intersections also experienced a high volume of turning traffic.

The old ACP at all four intersections, listed below, was in extremely poor condition and required frequent maintenance.

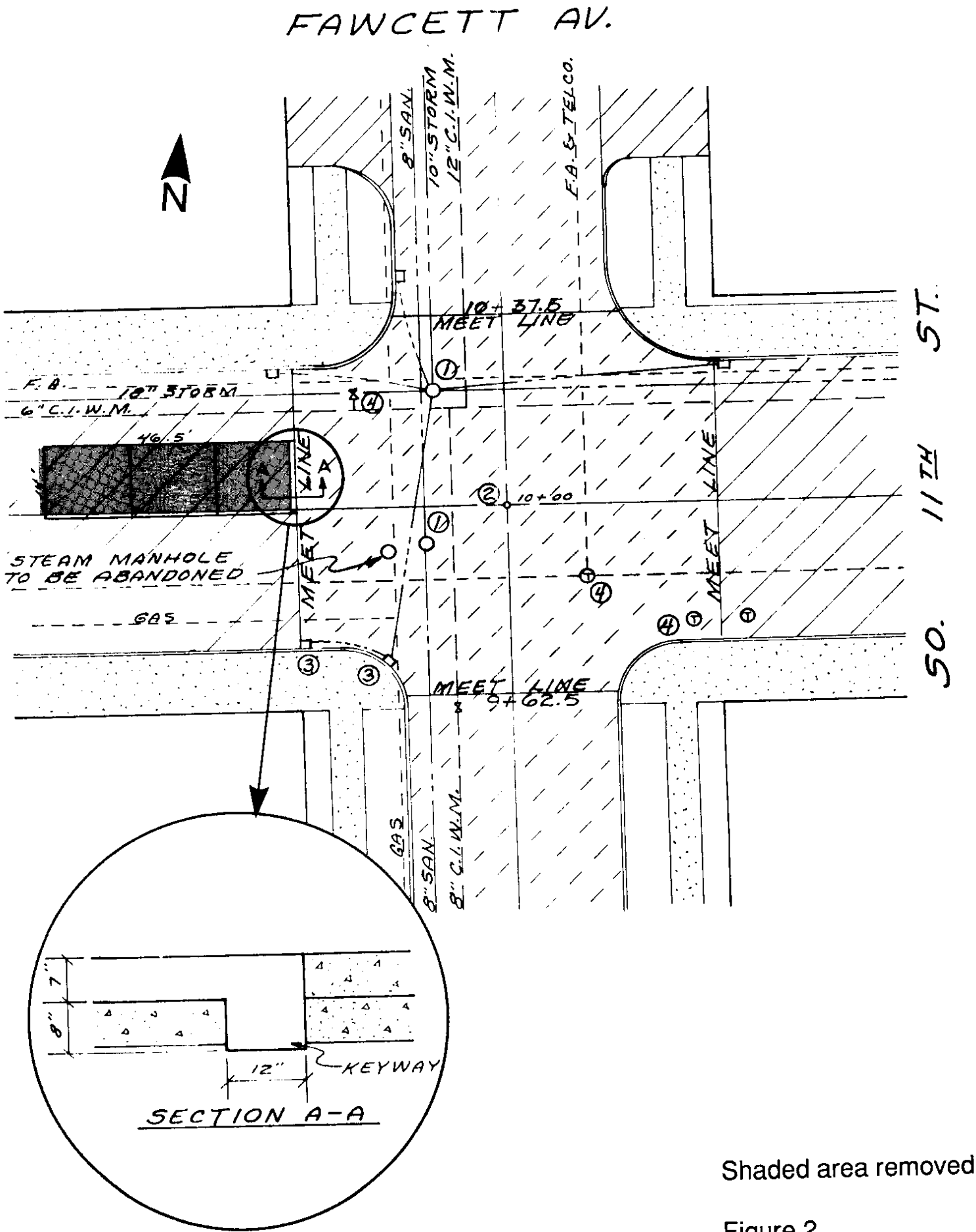
- 11th Street and Tacoma Avenue (Figure 1)
- 11th Street and Fawcett Street (Figure 2)
- 11th Street and Market Street (Figure 3)
- 9th Street and Market Street (Control Figure 4)

The construction plan called for removal of ± 2" of the old ACP, removal of deteriorated base material and repair and repaving with fiber reinforced Class B ACP at three intersections and conventional Class B ACP at one intersection. The intersectons have been monitored for four years to date and are performing well. There are only a few areas where the base was repaired and at old utility cut and utility vault locations where minor distress and cracking have appeared.



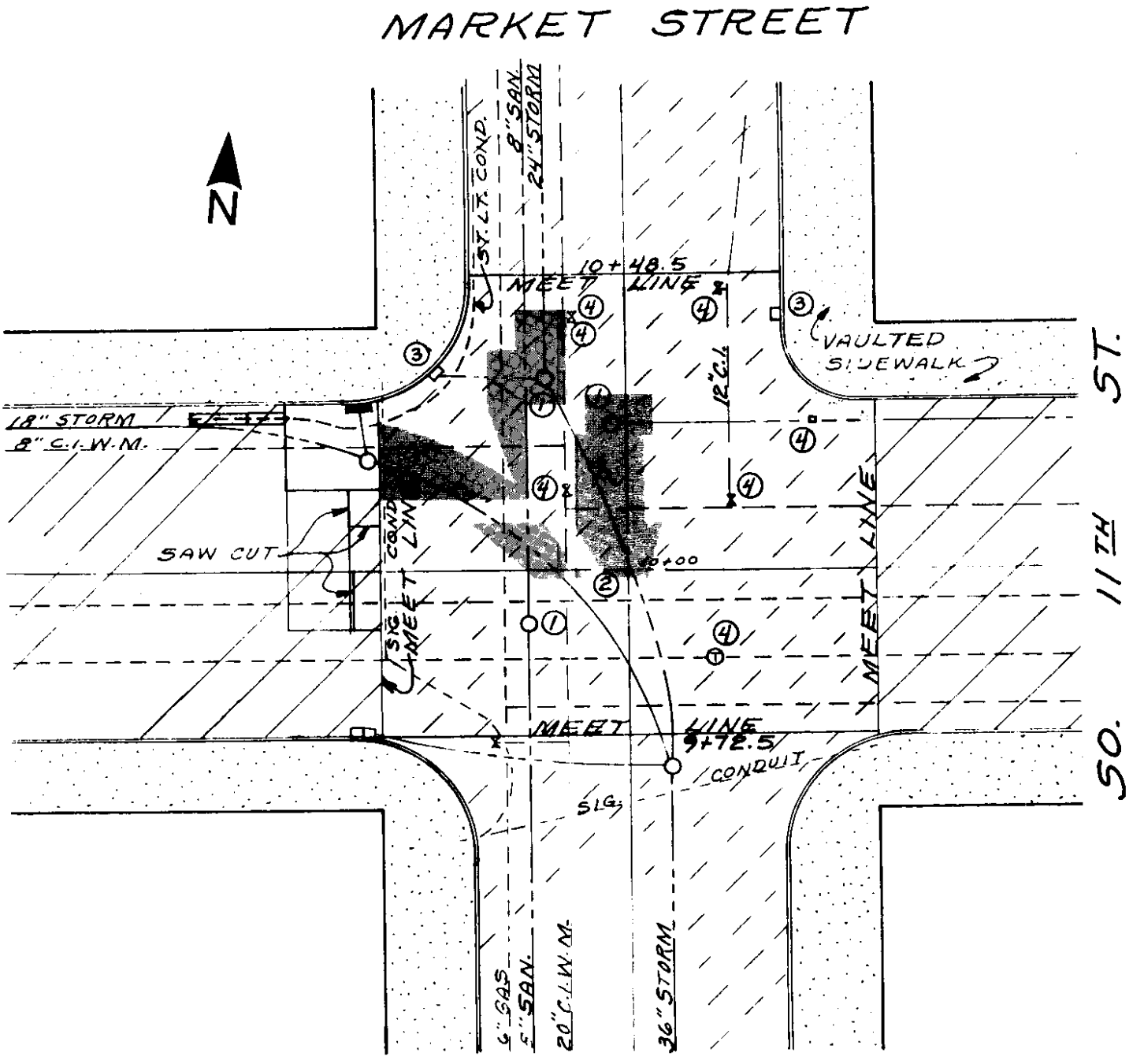
Shaded area removed

Figure 1



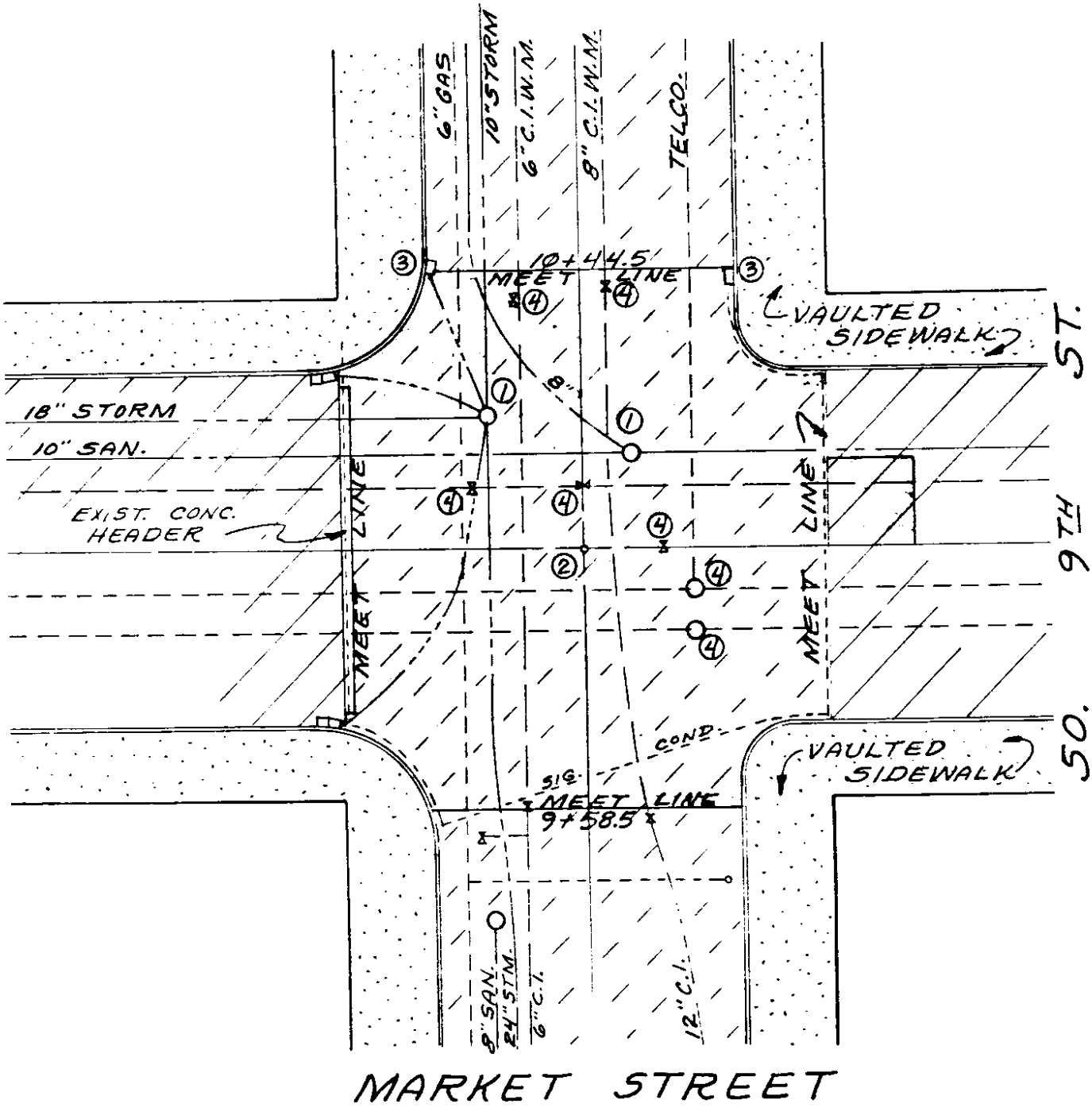
Shaded area removed

Figure 2



Shaded area removed

Figure 3



Control Section
Figure 4

"FIBER REINFORCED ASPHALT CONCRETE PAVEMENTS"

Product

BoniFibers™ is the trade name for polyster fibers manufactured and supplied by Kapejo Inc., Peirce Road, Wilmington, Delaware, 19803.

Polyster is the polymerized product of components from crude oil of which asphalt is also a component.

BoniFibers™ are available as B, C, and D. BoniFibers™ B are cut 1/4" long for coarse mixes of asphalt concrete mixes which have some 3/8" size aggregate but usually no greater than 15 percent of the 3/8". BoniFibers™ C are random cut, with an average length of 1/50", for fine mixes of asphalt concrete - mixes with aggregate usually no larger than #4 size. BoniFibers™ D are cut 1/2" long for base mixes in new installations - mixes which have no more than 70 percent passing the 3/8" sieve.

BoniFibers™ have a specific gravity of 1.38 and will not melt at temperatures less than 480°F. They have an ignition temperature of 1040°F. In properly mixed product, BoniFibers™ are observed to be discrete, not clumped; therefore, their break strength of 78,000 p.s.i. is effective. At 70°F and 65% relative humidity, the water absorbability of BoniFibers™ is only 0.4% (the absorbability of cotton is 10.3%).

In order to assure uniform distribution of BoniFibers™ throughout the asphalt concrete, they must be added to the aggregate at the beginning of the dry-mix cycle which is at least 15 seconds, and perferably 30 seconds, long. If BoniFibers™ are added just before the asphalt is metered in, the very oleophilic BoniFibers™ will seize the asphalt and therefore deny to the aggregate sufficient asphalt to coat each aggregate particle, thereby producing an unsatisfactory product.

The presence of BoniFibers™ does not alter the temperatures required for overlays, original road installations, and either hot or cold mix to fill potholes.

Fiber Reinforced ACP Mix Design

Standard Class B asphalt concrete modified as follows:

- Increase asphalt control by .25 percent by weight.
- Add 1/4" long polyester fibers (BoniFibers™ B) to the dry aggregate during the dry mix cycle (15 lbs fiber per 6,000 lb batch).
- Mix dry aggregate and BoniFibers™ in a pugmill 30 to 60 seconds prior to introducing the liquid asphalt.

Construction

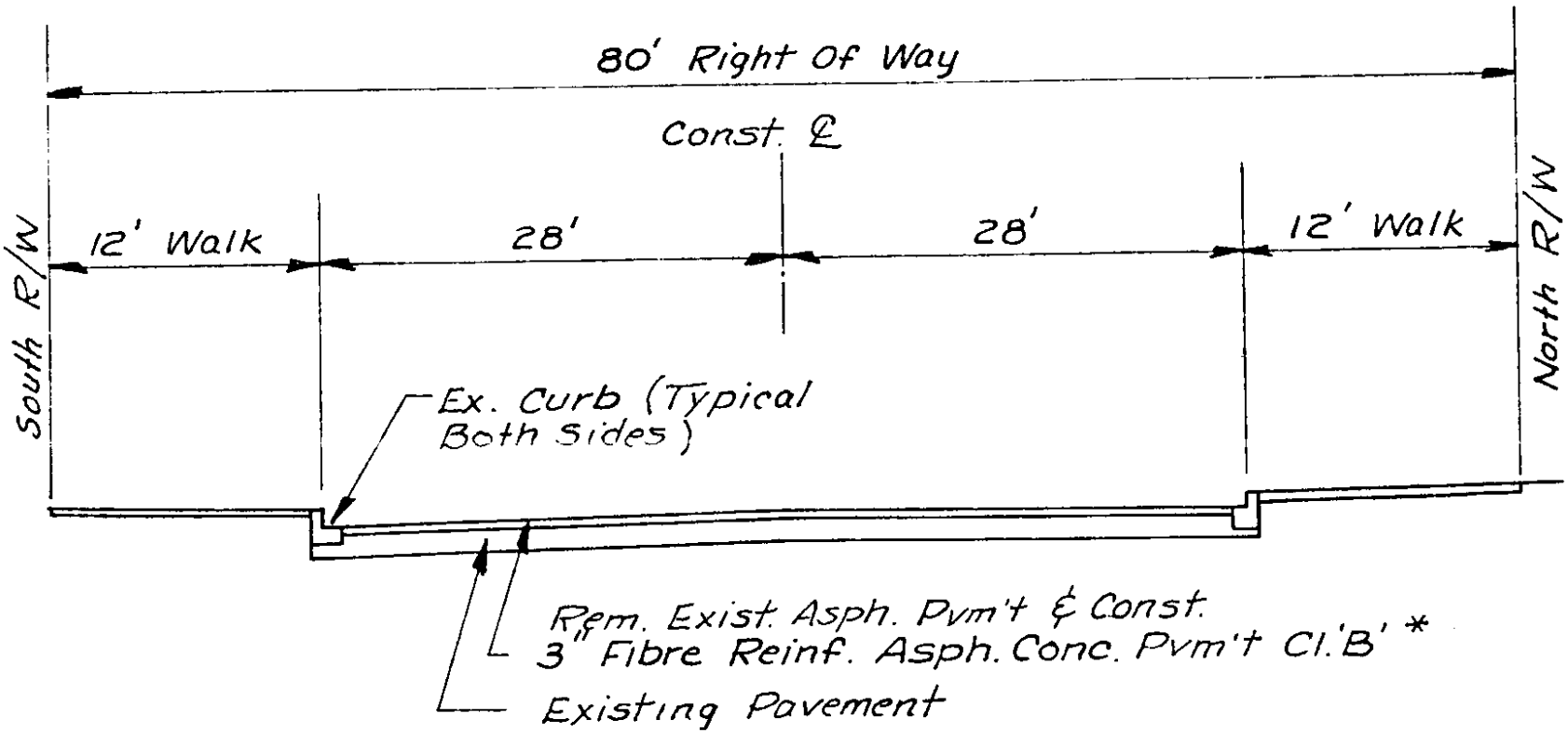
The construction project for the four intersections started on October 10, 1983 and was completed December 2, 1983. The removal of the old ACP and base repairs were completed on October 23. The paving was delayed until November 29, 1983 due to inclement weather. Conditions for paving were far from being ideal but were adequate and the paving was completed free of major problems.

The four intersections were cold planed to remove ±2" of the deteriorated ACP (Figure 5 and 6 - Typical Roadway Section). After cold planing, areas of the old concrete or sandstone base that showed signs of failure were repaired. Prior to paving, a tack coat using CSS-1 cutback 40 percent was applied at the rate of 0.10 gallon per square yard. Both the Standard Class B ACP and the fiber reinforced Class B ACP were placed using standard paving equipment. The mix temperatures ranged from 300°F to 320°F prior to dumping into the paving machine. The pavement mat breakdown was by two steel wheeled rollers. Pneumatic wheeled rollers were not used for breakdown because the fiber reinforced mix stuck to the wheels. The BoniFibers™ asphalt concrete was sticky when placed; sticking to hand tools, rakes, shovels, and the auger of the paving machine. The continuous loading of the paving machine seemed to provide enough force to allow the mix to move through the machine without clogging the paver or slowing the paving speed. There were no other problems during the paving operation. The air temperature at the time of paving was 40°F. The skies were overcast.

Evaluations

The three fiber reinforced ACP sites and the control site were monitored yearly for four years. To date, the BoniFibers™ are functioning the same as the Standard Class B asphalt concrete control intersection which is showing no significant deterioration.

The only distress noted is cracking at locations where the base was repaired and at old utility cuts and around utility vaults. This amounts to less than 1 percent of the total pavement surface area repaired and paved.

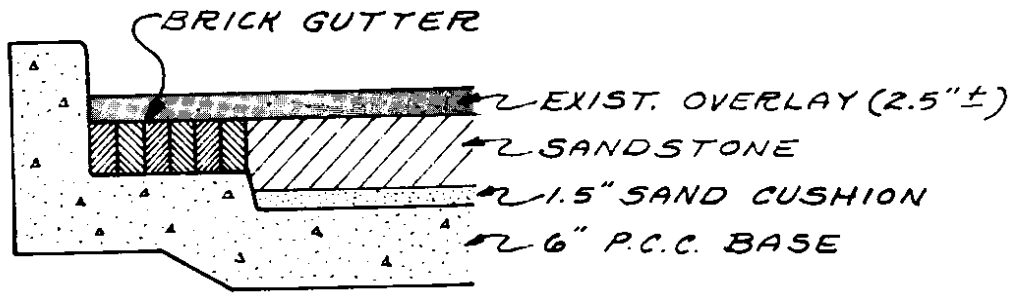


TYPICAL ROADWAY SECTION
INTERSECTION IMP. OF SO. 11th
ST. AT MARKET ST., FAWCETT
AVE & TACOMA AVE.

FIGURE 5

* At The Intersection Of So. 11th St. & Market, Use Cl. 'B' Paving Asphalt Only

Typical Section
Existing asphalt intersection



Typical Section
Slab replacement

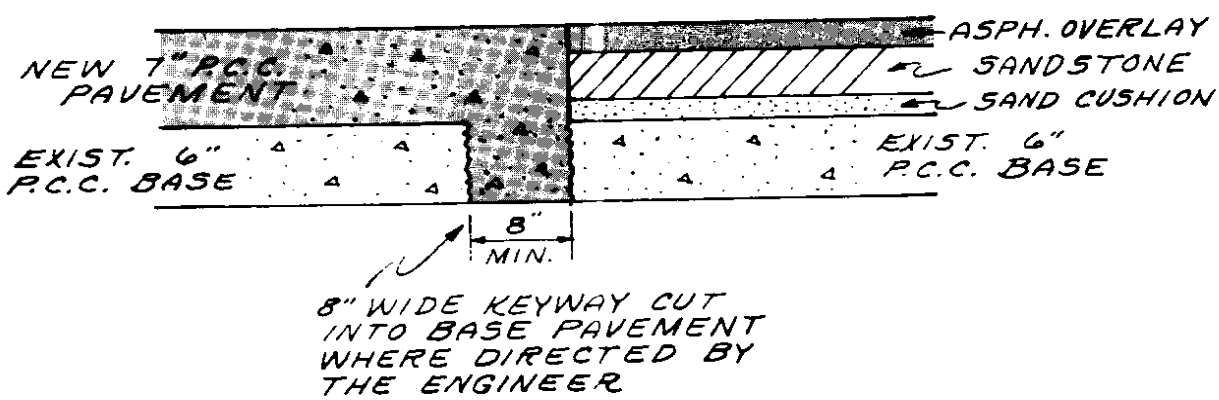


FIGURE 6

Conclusions

1. BoniFibers™ fabric reinforced Class B ACP appears to provide a durable roadway at intersections that have a high volume of turning and heavy traffic.
2. BoniFibers™ fabric reinforced pavement has performed as well as the standard Class B ACP, control section.
3. Conventional paving equipment and tools can be used when paving BoniFibers™, fabric reinforced Class B ACP.
4. Fabric reinforced Class B ACP using BoniFibers™ placed during cool, 40°F weather, tends to stick to paving tools and the paver auger.

Recommendations

- Continue to monitor the City of Tacoma BoniFibers™ fabric reinforced ACP until major deterioration occurs.
- Construct and evaluate new pavement sections using fiber reinforced ACP as experimental features.

APPENDIX A

Specifications for ASPHALT CONCRETE with BoniFibers™

Description

This asphalt concrete is an otherwise conventional asphalt mix containing no more than 0.5% (by weight of total mix) BoniFibers, the safe polyester fibers specially engineered to provide superior asphalt concrete. No spraying, curing, or other special equipment is used for installing this mix.

Uses

1. To resist alligatoring and pot-hole formation.
2. To provide stronger, more durable curbs.
3. For filling pot-holes to keep them filled.
4. As bridge-deck membranes, to prevent corrosion of rebars.

Composition

The presence of the small amount of BoniFibers in asphalt concrete requires only a slight increase in asphalt concentration — 0.2% to 0.3%, enough to coat the BoniFibers. For example, when 6.9% asphalt is required for a fiber-free mix, 7.1% to 7.2% asphalt should be used when BoniFibers are included. The aggregate is as specified by the State Highway Department for the particular service use because the presence of BoniFibers does not change the grading of the aggregate. While 0.25% (by weight of total mix) is the preferred concentration of BoniFibers for any of its uses, for overlays on streets with a traffic density less than 5000 vehicles per day, 0.125% BoniFibers has been found to be satisfactory.

A bridge-deck membrane with BoniFibers is unique technology. In order to attain zero air voids to prevent passage of melted snow (containing de-icing salts) to the rebars, an excess of asphalt is used (8.5% to 12.5%); and to give such a mixture sufficient stability to permit installation with conventional paving equipment, at least 0.25% BoniFibers are used.

Test Results

Depending on the aggregate available, Marshall Stability (ASTM D-1559) tests of asphalt concrete with BoniFibers have been in the range of from 1610 to 2320 pounds, and the respective fiber-free control asphalt concrete test mixes have been in the range of from 1330 to 1920 pounds.

Specifications of BoniFibers

BoniFibers are available as B, C, and D. BoniFibers B are cut ¼" long for coarse mixes of asphalt concrete — mixes which have some ⅜" size aggregate but usually no greater than 15% of the ⅜". BoniFibers C are random cut, with an average length of 1/50", for fine mixes of asphalt concrete — mixes with aggregate usually no larger than #4 size. BoniFibers D are cut ½" long for base mixes in new installations — mixes which have no more than 70% passing the ⅜" sieve.

BoniFibers have a specific gravity of 1.38 and will not melt at temperatures less than 480°F. They have an ignition temperature of 1040°F. In properly mixed product, BoniFibers are observed to be discrete, not clumped; therefore, their break strength of 78,000 p.s.i. is effective. At 70°F. and 65% relative humidity, the water absorbability of BoniFibers is only 0.4% (the absorbability of cotton is 10.3%) — this is why polyester fibers do not cake on storage. BoniFibers, except for their length, are identical to the polyester fibers in apparel and industrial fabrics. After almost 30 years handling of commercial polyester fibers in textile mills, no dermatological or inhalation problems have been experienced. Polyester is the polymerized product of components from crude oil of which asphalt is also a component. All these factors together is why BoniFibers are so well fitted to reinforce asphalt concrete.

Source of BoniFibers

BoniFibers are created by continuous melt spinning, processed, and then cut to appropriate sizes, all in the United States of America. They are supplied by Kapejo Inc., 3 Peirce Road, Wilmington, Delaware 19803.

Preparation of the Asphalt Concrete

In order to assure uniform distribution of BoniFibers throughout the asphalt concrete, they must be added to the aggregate at the beginning of the dry-mix cycle which is at least 15 seconds, and preferably 30 seconds, long. If BoniFibers are added just before the asphalt is metered in, the very oleophilic BoniFibers will seize the asphalt and therefore deny to the aggregate sufficient asphalt to coat each aggregate particle, thereby producing an unsatisfactory product. For producing mix for the bridge-deck membrane, the wet-mix cycle must be 60 seconds. This longer time, coupled with a higher temperature, assures the escape of any air originally present in the mix for the bridge-deck membrane.

Installing Asphalt Concrete with BoniFibers

Conventional paving machines and rollers are used. The need for a tack coat is not obviated because BoniFibers are present. The surface to receive a bridge-deck membrane should be dry prior to, and during, installation of the membrane. For installing curbs, the use of fuel oil or other solvents in the curb machine should be avoided or at least minimized since such use lessens the cementing property of the asphalt. The hopper of the curb machine should be kept full to attain good compaction. If a pot-hole is not cleaned out of all loose materials, if standing water is not removed, if the asphalt concrete is added without rodding to permit escape of entrapped air, and if the filled pot-hole is not tamped sufficiently — the presence of BoniFibers in the asphalt concrete for filling that pot-hole will have no significant effect on the life-expectancy of that filled hole.

Temperatures

The presence of BoniFibers does not alter the temperatures required for overlays, original road installations, and either hot or cold mix to fill pot-holes. The temperature of the curb mix with BoniFibers, in the curb-making machine, should be below 300°F. but not less than 250°F. In order to assure zero air-voids, the temperature of the mix for bridge-deck membranes must be not more than 400°F. at the hot-mix plant and not less than 325°F. at installation.

Hydroplaning and Skid Resistance

Because the concentration of BoniFibers is so low, their presence has no effect, good or bad, either on the elimination of hydroplaning when open-grade mixtures are used, or on skid resistance in any wearing course.

Limitations

BoniFibers longer than ½", and in concentrations greater than 0.5% by weight of total mix, should not be used. Because of the short mixing time which is economically acceptable, lengths and concentrations in excess of these would result in non-uniform distribution of BoniFibers throughout the asphalt concrete. Uniform distribution is the key to the utility of BoniFibers. The concentration of fibers must be a direct function of traffic density and may be influenced by the type of aggregate used. Where both a base and a wearing course are needed as an overlay, it is not sufficient to have fibers only in one course. Oil-based paint should not be used directly on an asphalt curb because the oil, being a solvent for asphalt, will cause the curb to crack and slump. If the curb is first painted with an aluminum-based paint, an oil-based paint may be used as a second coat.

In the laboratory, hand mixing (as well as the use of a conventional laboratory mixer) is necessary in order to simulate the tumbling action of plant equipment. Therefore, about 2 minutes of mixing is needed in the laboratory bowl in order to get uniform distribution of aggregate with BoniFibers. Also, because of heat loss to the laboratory room, the aggregate should be heated about 25°F. higher than would be necessary for a fiber-free mix. The asphalt should not be added to the laboratory bowl until there is good mixture of fibers throughout the aggregate.

****

Asphalt Concrete with BoniFibers is available from: