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SPECIAL POLYMER MODIFIED ASPHALT CEMENT

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Interim Report
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U.S. Department of Transportation
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16. Abstract

This report covers the pre-construction, construction and the first evaluation following construction at the following locations:

- I-25, Colorado Blvd.
- I-25, Pueblo
- Hwy 85, Santa Fe Avenue
- I-70, Flagler

An additional project has been added that will be constructed during the 1992 construction season. This project is located on Brighton Blvd. between I-70 and Sand Creek. This project will contain a section with Type I polymer, a section with Type III polymer and also a section with no binder.

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I. Background

This study was initially requested by District 1 to evaluate the Flagler location. Since the initiation of this study, three additional sites were added and at least one more location will be added during the 1992 paving season.

The four locations constructed in 1991 all contained the polymer-modified binder similar to the Type I-C described by the AASHTO Task Force 31 (Appendix A). For comparison purposes a section containing the standard mix without a modified binder was constructed at each location. In addition, the I-25, Pueblo location included a section containing rubberized asphalt, AC-20R (modified Asphalt from AASHTO Task Force 31, Type II-B).

The AASHTO Task Force 31 was formed to develop a set of generic specifications for polymer modified asphalts. The result of this Task Force 31 was a guide specification describing three types of polymer-modified asphalts each based on different types of commonly used polymers.

These field notes cover the pre-construction, construction and the first evaluation following construction on the following four locations:

I-25, Colorado Blvd.
I-25, Pueblo
Hwy. 85, Santa Fe Avenue
I-70, Flagler

Projects constructed during the 1992 paving season will compare two types of polymers and possibly a third. It has been decided a Type I polymer, Type III polymer and a section containing an unmodified binder will be evaluated on one selected project.

II. Pre-Construction -- All Locations

The pre-construction evaluation at all the locations included establishing a 600 foot control and a 600 foot test section. Crack maps were drawn, and the overall roadway condition was noted for the test and control sections. Since the Pueblo location was heater-scarified prior to construction, pre-construction rutting data was not taken. Pre-construction rutting data was taken at the other three locations.

III. Construction -- I-25, Colorado Blvd.

This project (CX 01-0025-58) is located on I-25 in Denver. The project was approximately 4.97 miles in length and included both the northbound and southbound lanes. The project extended from Colorado Blvd. to south of U. S. Highway 6.

Construction at this location consisted of milling the entire width of the mainline. The minimum depth for milling was 1/4" below the wheel ruts. The average milling depth in the test and control section was 3/4". Following milling the roadway was covered with 2" of HBP.

The plant was located approximately 8 miles away from the job. Paving restrictions in the Denver Metro area typically requires construction work to be done at night. Milling began about 9:00 PM on June 18, 1991 in the left lane of northbound I-25. The milling operation continued in the left lane for the entire evening. The next night the miller backed up and began milling the northbound center lane. This is the area and lane to be evaluated as the test section. This lane was selected because it is the lane travelled by the highest percentage of trucks. Truckers tend to stay out of the right lane through this area because of the number of entrance and exit ramps.

The test section containing the non-polymerized SHRP coarse gradation (Appendix B) pavement began at approximately MP 204.1 and extended for 600 feet. A map containing the location of the test and control section is included in this set of notes. Milling in this section left the left wheel path of the existing pavement exposed intermittently from the beginning of the test section to about station 1+10. Severe cracking and ravelling could be seen in a few places, particularly around station 0+25. The unmilled left wheel path also could be seen to a lesser extent at stations 2+00 and

3+00. The control section was located around MP 204.5 just north of the Steel St. structure in the center northbound lane. This section contained a polymerized SHRP coarse gradation pavement, which was used throughout the remainder of the project. In this section the milling process removed all the existing rutting except at one location. This was in the area of station 0+93. Following milling existing cracks could still be seen in both the test and control sections.

The mixing temperature at the plant was approximately 315°F and behind the laydown the mix was around 290°F. The design AC was 3.7± 0.3%.

There were not any problems noted during construction in either the test or control section.

Photos from pre-construction and construction are included in these set of notes.

IV. Post-Construction Evaluation -- I-25, Colorado Blvd.

The first evaluation following construction was scheduled for November 9, 1991. This evaluation included deflection measurements, rut measurements, crack mapping and photographs.

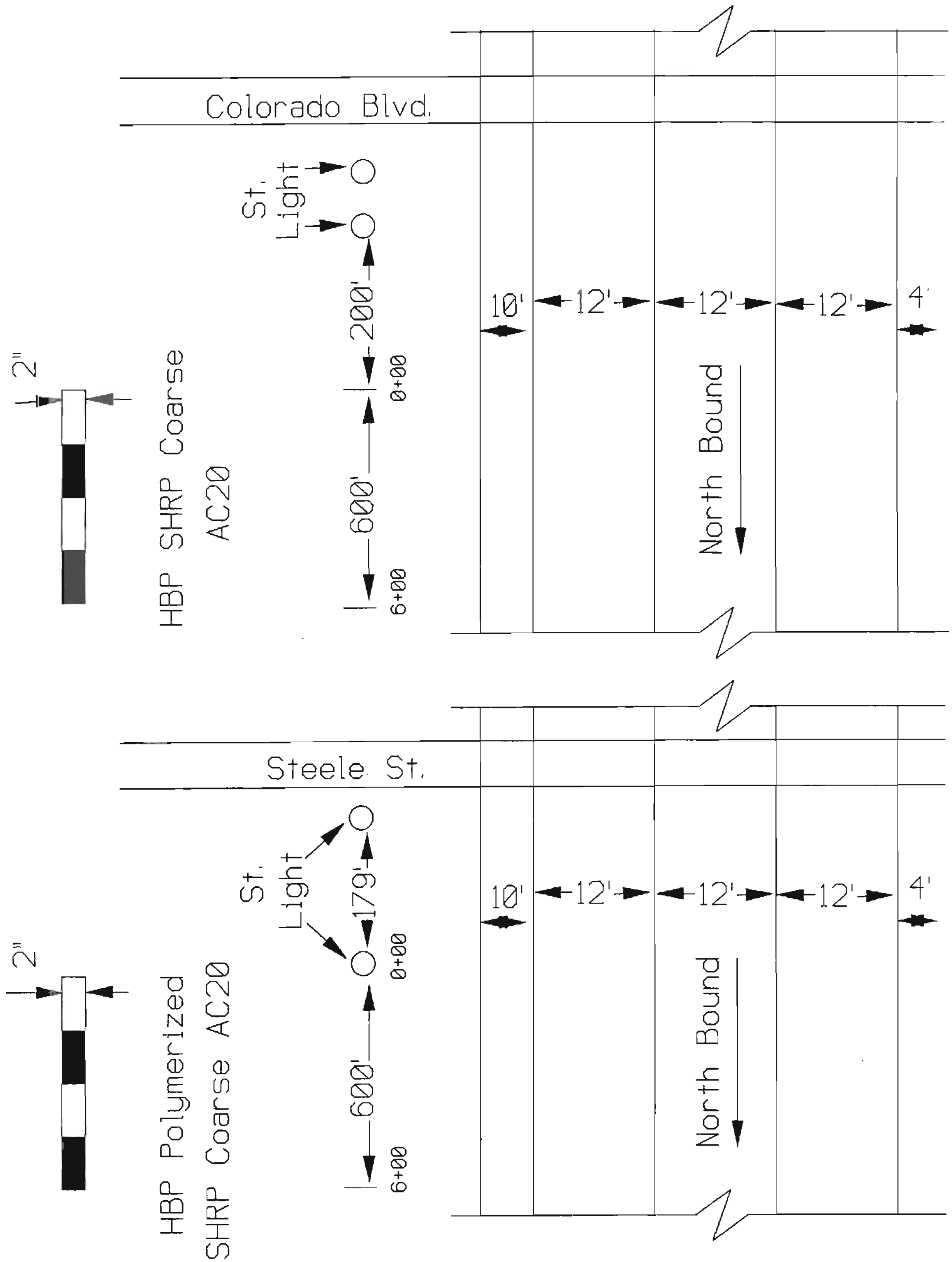
The deflection measurements will be used as a baseline and compared to deflection measurements taken each year during the study. From the measurements taken during this evaluation it appears the load carrying capacity of the section with the polymer is similar to that of the section without the polymer. Rutting measurements taken during this evaluation show minimal rutting. The rutting which was measured (less than a tenth of an inch) is contributed to surface variations resulting from construction and not a rutting mix.

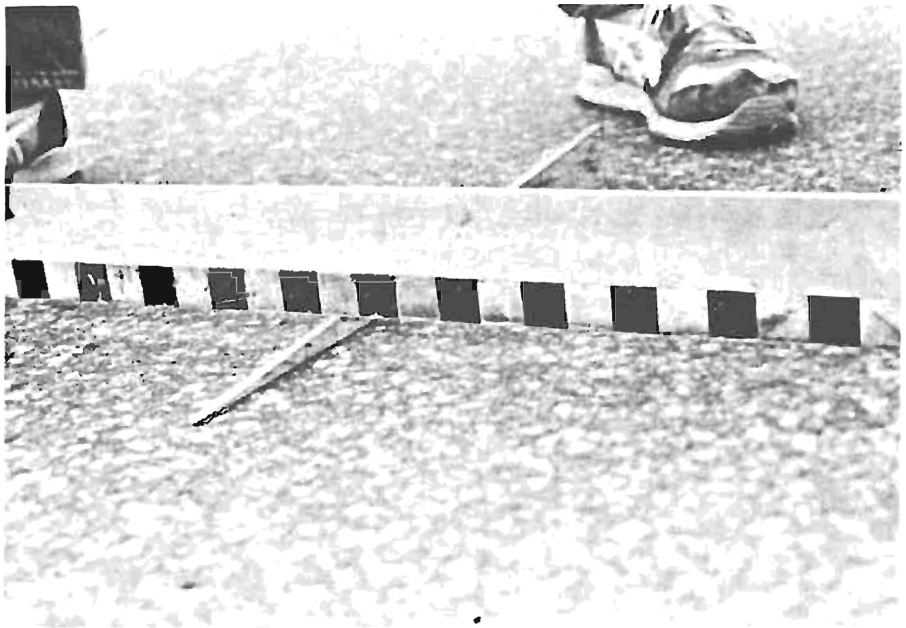
Some longitudinal cracking was noted during this evaluation in the left wheel path of the center lane in the control section. This is in the area of a construction joint, and possibly construction related; it is too early for it to be a reflective crack. Both the test and control sections contained some ravelling in the left wheel path of the center lane. This also is a result of construction techniques; it appears to happen at the end of each truck load.

The next evaluation is planned for May 1992.

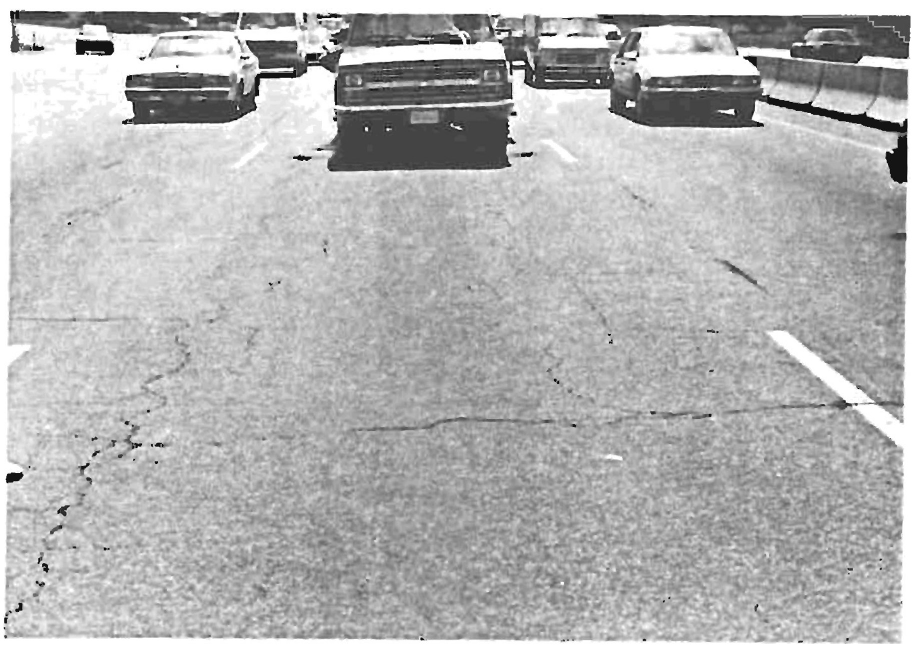
FIGURE 1

I-25, Colorado Blvd.

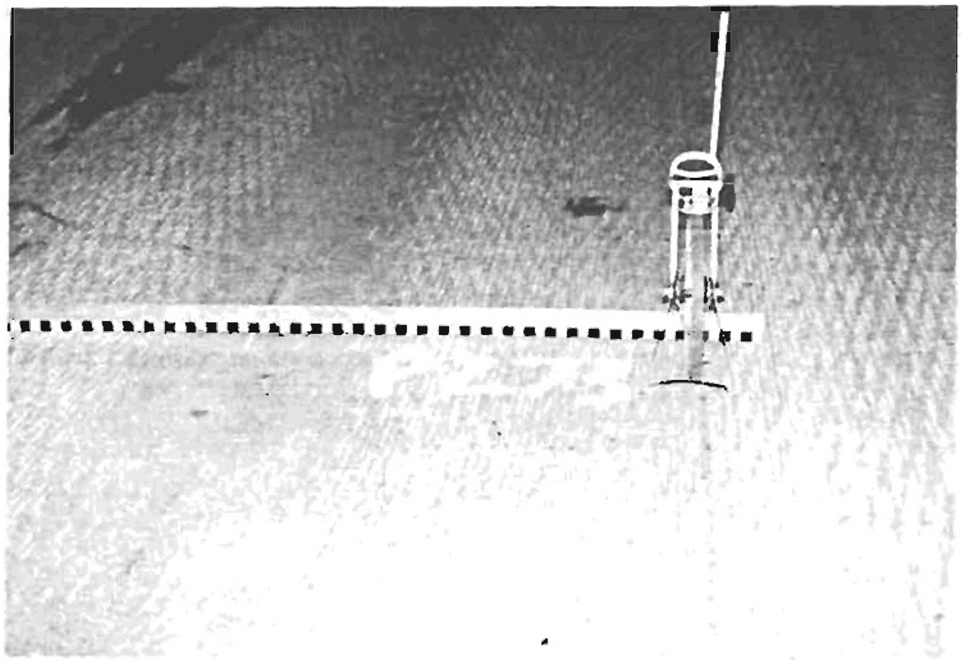




Pre-construction rutting



Typical pre-construction cracking



Rutting could still be seen in wheel path following milling.

V. Construction -- I-25, Pueblo

This job (CXIR 02-0025-30) is located north of Pueblo on I-25 between M.P. 101 and M.P. 109. The project consisted of heater scarifying approximately the top 1" of the existing pavement, placing 2 3/4" HBP (Gr C) with a 1" HBP (Gr C) top mat. The top mat in the southbound lanes contained (AC-20R) [Task Force Table II-B]. The top mat in the northbound direction contained a polymer-modified AC (AC-20) taken from Table I-C. In the southbound driving lanes approximately 1000 feet of the top 1" mat was built using a standard AC-20 binder for comparison purposes and is referred to as the control section. The project called for an AC content of 5.0±0.3%.

The contractor's batch plant was located approximately 14 miles from the south end of the project and the days when the test and control sections were paved, 13 trucks were used. At their plant their aggregate temperature was 320°F to 340°F, asphalt temperature 320°F, mixing temperature 320°, baghouse temperature 210°F and at the job the compaction temperatures were between 280°F and 290°F.

No problems obtaining densities were reported.

The contractor did not report any difficulties working with the rubberized or polymerized mixes over the standard mixes. However, there were some plant problems that caused minor delays in paving but they were not associated with the different mixes.

Pre-construction photos and a site map is included in this set of notes.

VI. Post-Construction Evaluation -- I-25, Pueblo

The first evaluation following construction was performed on August 15, 1991. The evaluation included rutting measurements, deflection measurements, cracking mapping and visual inspection of the roadway.

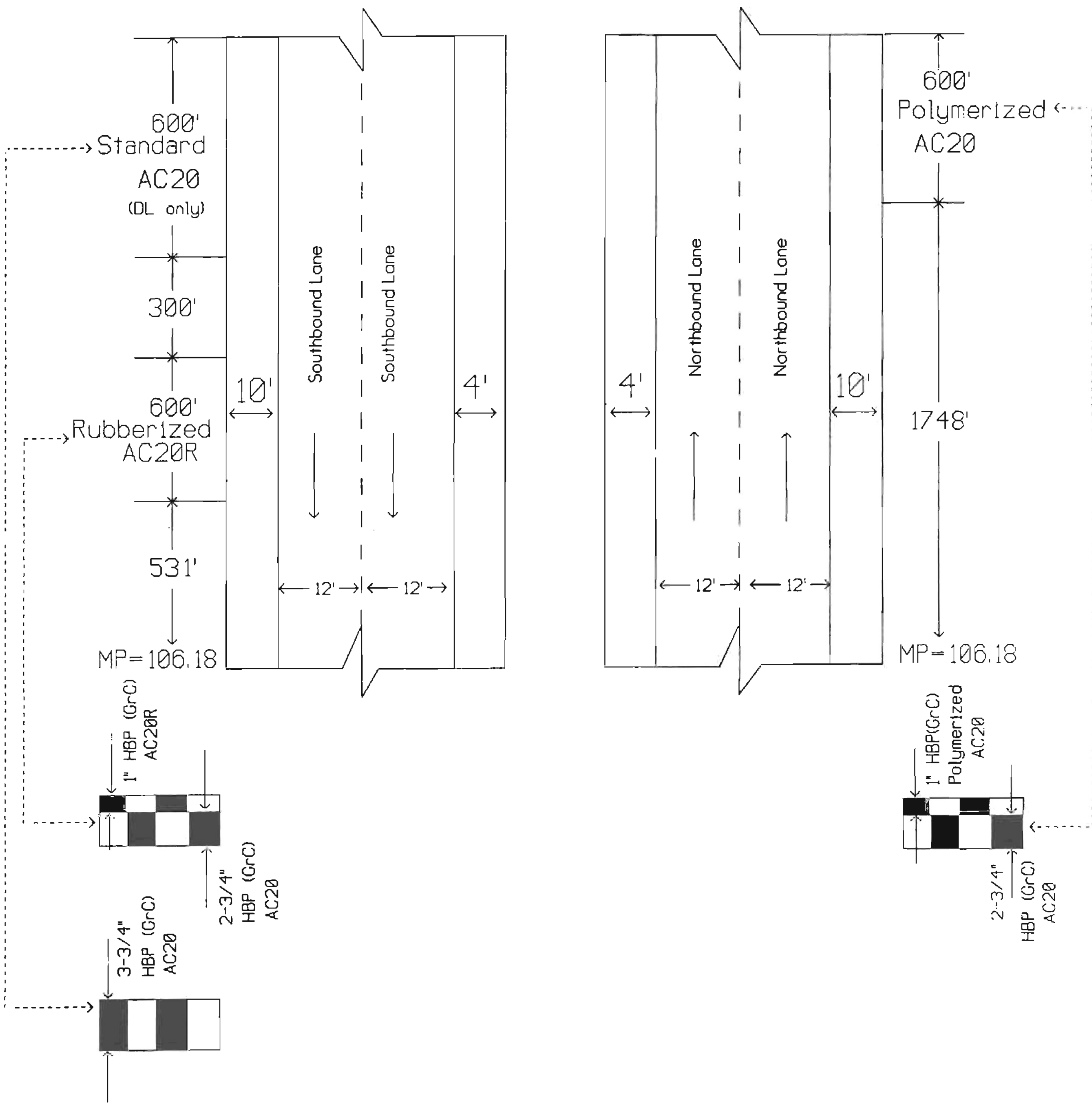
The evaluation did not show any difference in the appearance of the two test sections as compared to the control. The left wheel path in the driving lane of the control section appeared to be a little rough but was not showing any signs of rutting. In the other two sections there was no noticeable rutting. The paving joint in the test section containing the rubberized AC was noticeable but was not showing any signs of deterioration. There was no cracking in any of the sections.

The next evaluation is planned for May 1992.

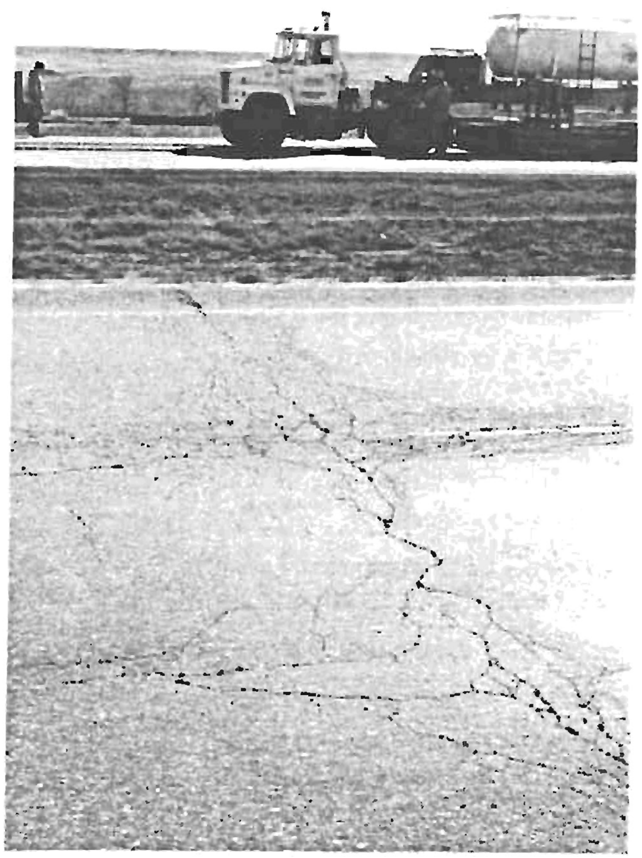
FIGURE 2

I-25, Pueblo

Special Polymer Modified Asphalt Cement



The typical condition of the existing pavement before construction.



Prior to construction the majority of the transverse cracks were badly deteriorated.

VII. Construction -- Highway 85, Santa Fe Ave.

Project CX 10-0085-17 is located between M.P. 200 and M.P. 204.45 on State Highway 85 (Santa Fe Avenue). The project consisted of milling the existing pavement in the driving and passing lane and then placing a 2" lift of Grading SC. The mix required 3.7±0.3% AC content.

The milling began on June 12, 1991. Following the milling, existing cracks could still be seen in both the control and test sections.

The milling did not appear to be getting below the wheel paths in some areas. This could possibly cause slippage or deformation in the new mat. The rough texture of the milled surface made it very difficult to uniformly tack the surface. However, since the surface is rough it is very doubtful that this will cause any bonding problems.

The drum-dryer plant was located approximately 3.5 miles from the project. During the paving of the test and control sections 9 trucks were operating, 5 end dumps and 4 tandems. This plant produced 1500 to 2000 tons per day with an average of 300 tons per hour. The mixing temperature at the plant for the polymerized mix was around 321°F.

Both the control and test sections are located in the northbound driving lane. A map showing the location of the evaluation sections is included in this set of notes.

There were no problems obtaining densities. But to obtain densities it is important that the roller stay close to the lay down machine. A pneumatic roller was not used on this project because it tended to pick up the mat.

An observation that was made during construction is that the lack of fines made the mix very difficult to work with when doing the handwork. This was noticed especially in the tapers and widening sections. The material in these areas is more open than in the remainder of the mat.

Photos from the pre-construction, construction and the first evaluation following construction are included in this set of notes.

VIII. Post-Construction Evaluation - Highway 85, Santa Fe Ave.

The first evaluation following construction at this location was performed on July 29, 1991. This evaluation included crack mapping, measuring ruts, deflection measurement and visual inspection of the pavement surface.

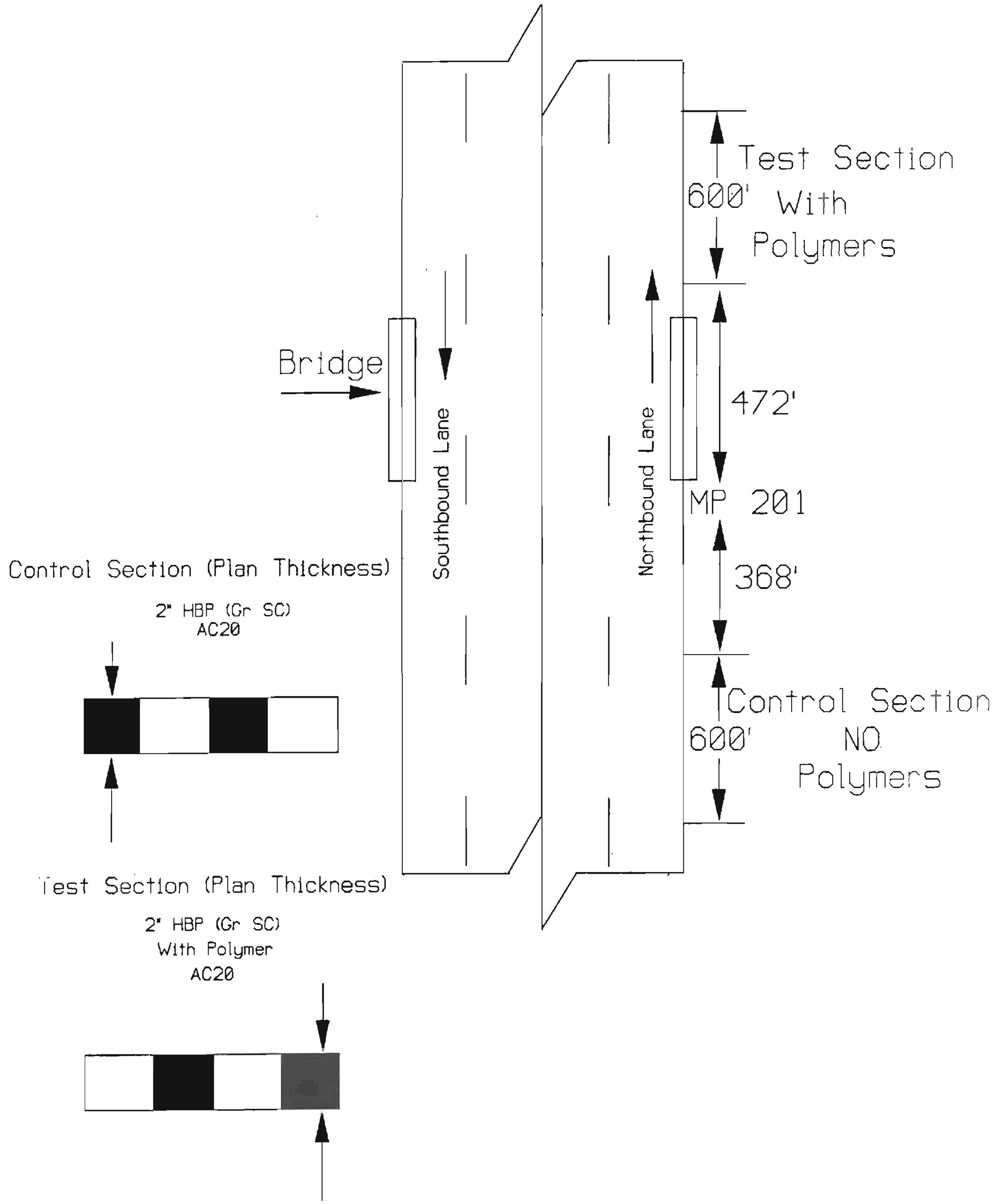
No cracking has appeared in either section. There was no noticeable rutting in either section. Although the deflection data has not been temperature corrected, the raw data does not indicate there is a difference between the two sections.

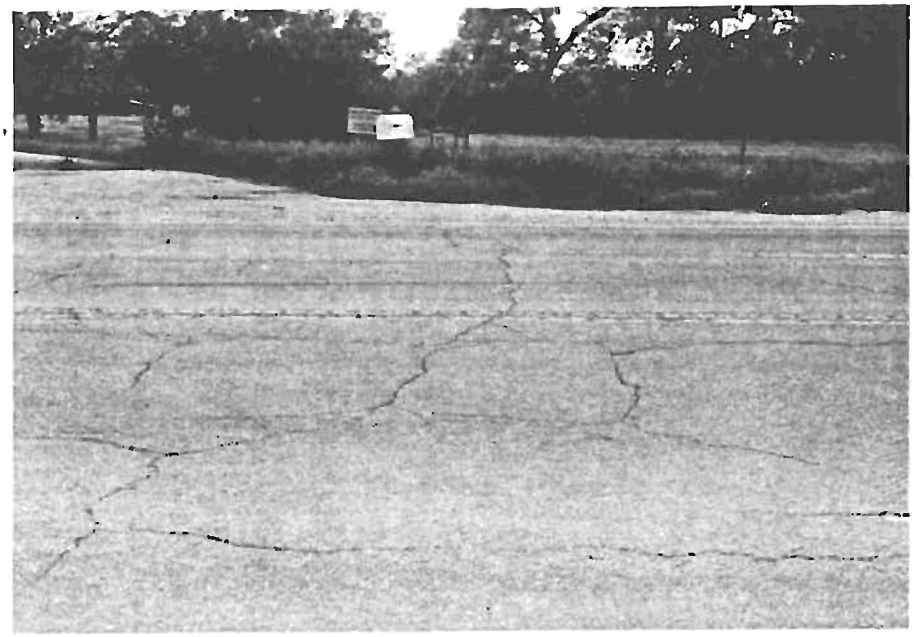
Some random areas of segregation were noticed during this evaluation. These areas are not limited to the polymer or non-polymer sections. These areas will be observed over the evaluation period for further deterioration.

The next evaluation is planned for May 1992.

FIGURE 3

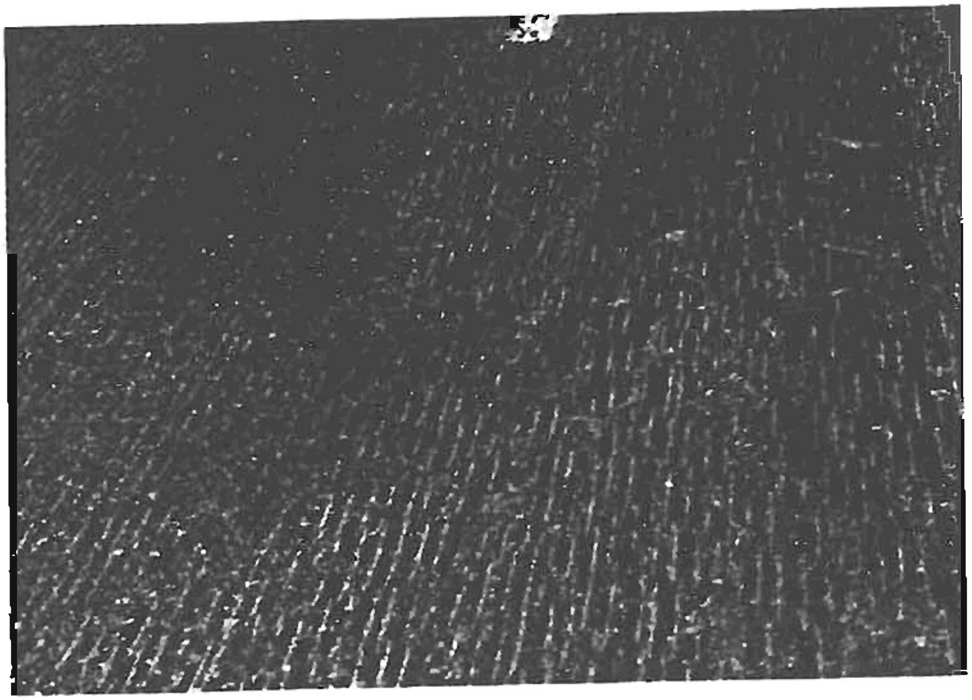
Highway 85, Santa Fe Ave.





Condition of pavement prior to construction.

Pre-paving rutting



Following milling cracks could still be seen in the pavement.

Some rutting could still be seen in wheel path following milling.

Segregated areas could be found throughout the project during the first evaluation following construction.

IX. Construction - I-70, Flagler

Project FRI(CX) 070-5-56 is one of the locations of the SHRP SPS 5 study. The polymer test section will be compared to two of the SHRP test sections. This project is located in the eastbound lanes of I-70 east of Flagler. The project extends from M.P. 386.00 to M.P. 395.1. Under this study three sections will be evaluated.

The first evaluation section, a 600 foot section located on the west end of the project consisted of an HBP Grading CX leveling coarse, 4-1/4" HBP Grading G lift with a 2" HBP Grading C lift (polymerized) on the surface. This section is referred to as the test section. The next evaluation section referred to as control section I is a 600 foot section (SHRP-SPS 080504) containing 5" of HBP grading C. This section was constructed in two lifts, a 3" and a 2" respectively. This section also had an HBP grading CX leveling coarse. The third evaluation section (CDOT-SPS 080510) referred to as a control section II, contained an HBP grading CX leveling coarse, 4-1/4" HBP grading G lift, with a 2" HBP grading C lift on the surface. The evaluation sections were set-up in the driving lane of the eastbound direction. A site map showing the locations of each evaluation section is included in this set of notes.

The drum dryer plant was located 5 miles from the west end of the project. The plant produced 350 tons per hour and used between 8 and 13 flowboy trucks. In the evaluation sections they paved the 10 foot shoulder and 12 foot driving lane in tandem for the top mat. The lift below the top mat was placed with the outside pass 11 foot and the center pass 12 foot.

The polymerized HBP was mixed at approximately 335°F. The temperature immediately behind the paver was approximately 320°F.

There were no difficulties obtaining the required densities in any of the sections. However, a pneumatic roller was not used in the polymerized section because it tended to pick up the mat.

X. Post-Construction Evaluation - I-70, Flagler

The first evaluation following construction was performed on October 10, 1991. This evaluation included deflection measurements, rutting measurements, crack mapping and visual observations.

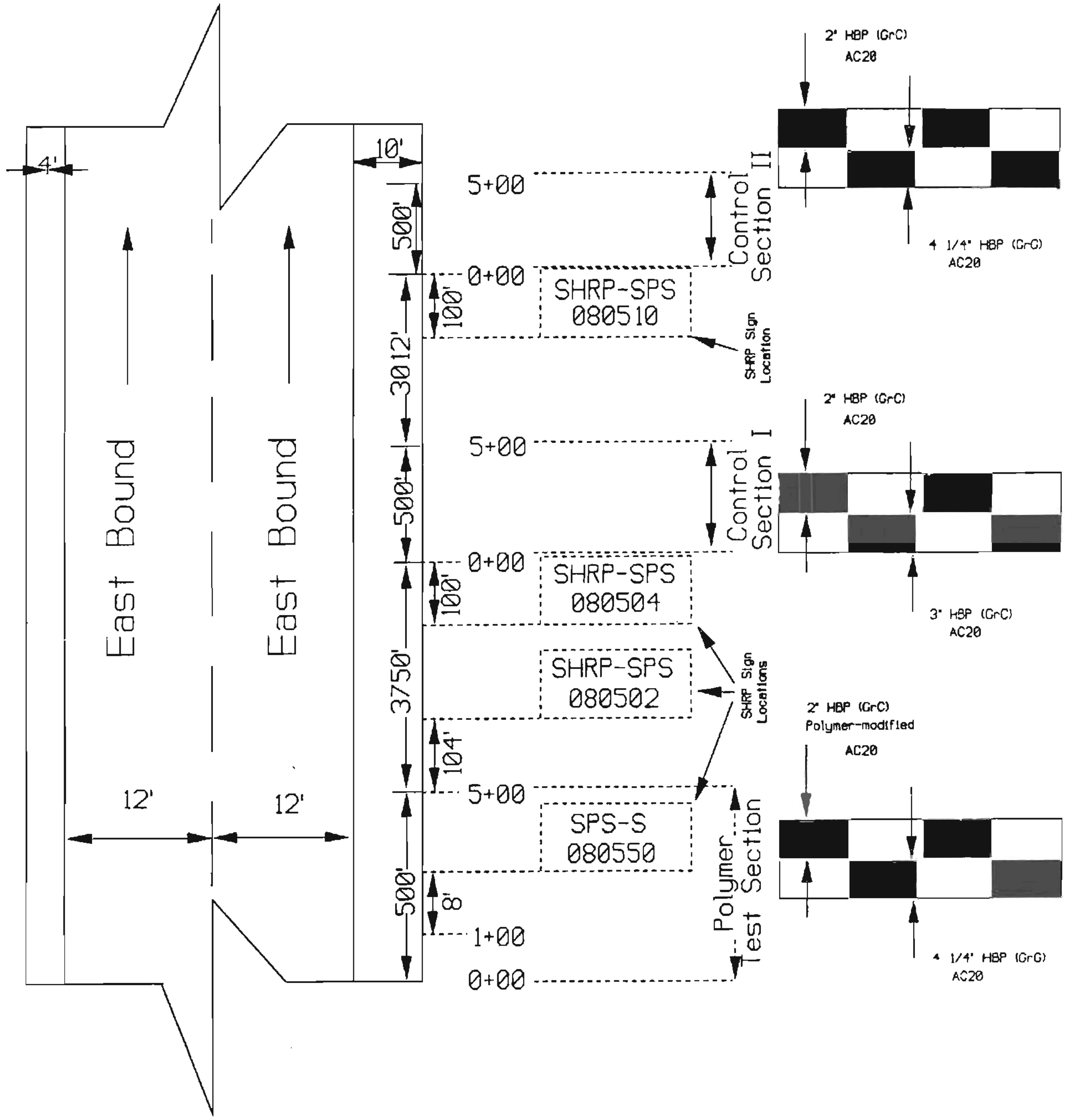
Although the deflection measurements have not been corrected for temperatures the raw data indicates no difference in readings of the three sections. As with the other test locations, there were no irregularities as far as rutting in any of the sections at this location. The straight edge used to measure rutting laid perfectly flat across the roadway. There is no cracking in the pavement. There did not appear to be any rough or segregated spots in any of the evaluation sections. Overall the evaluation sections looked great.

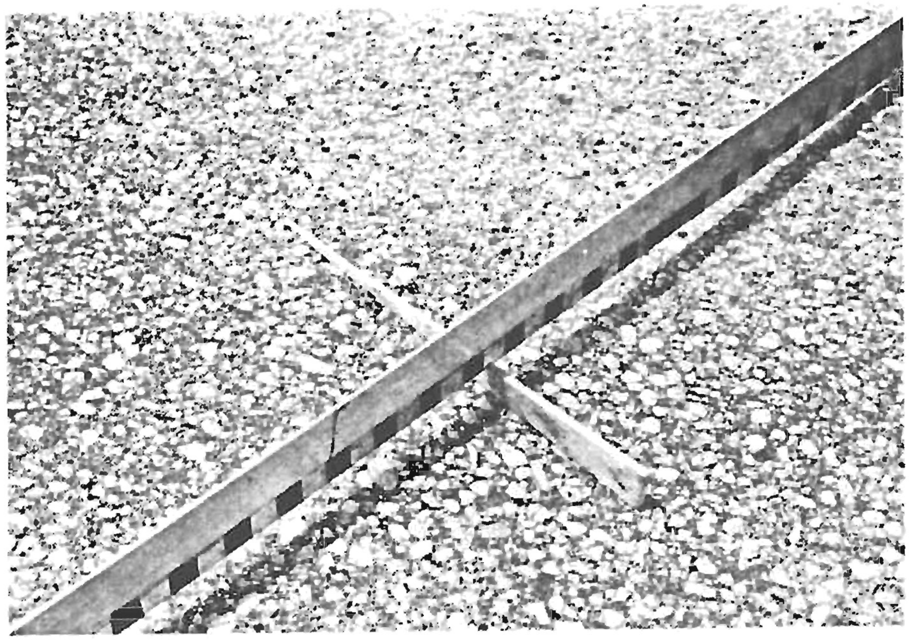
The most severe distress at this location found during the pre-construction evaluation was rutting. The cracking consisted of mostly longitudinal and the cracking was not severe. There were some patched areas and some flushing in both wheel paths. Photos from pre-construction are included in this set of notes.

The next evaluation is planned for May 1992.

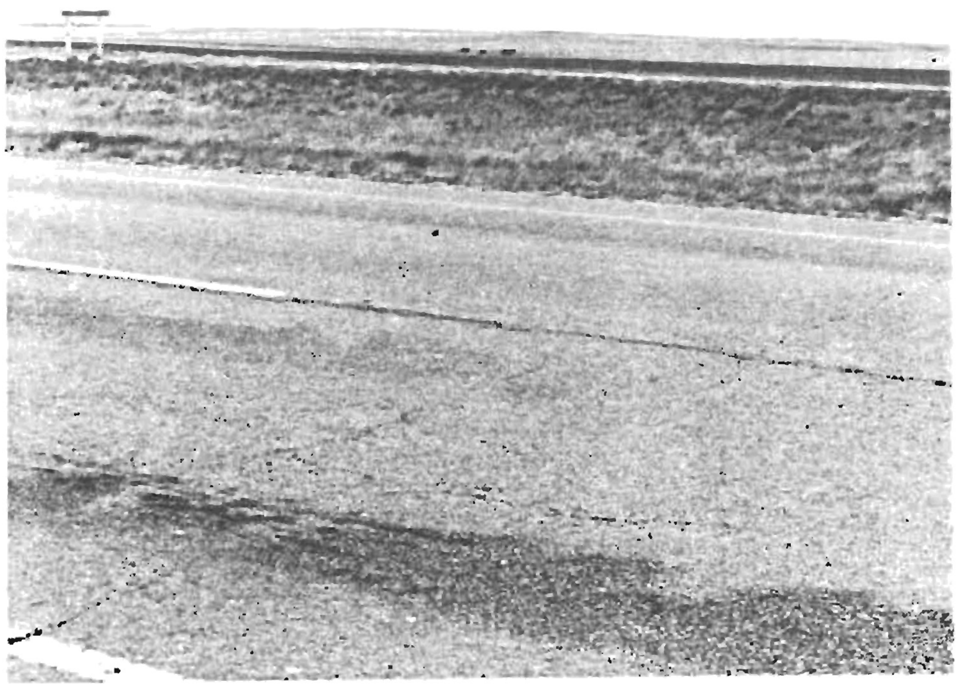
FIGURE 4

I-70, Flagler





Pre-construction rutting



Longitudinal cracking and flushing in the wheel paths could be found in the pavement prior to paving.

XI. Conclusions and Observations

Because of the required higher mixing temperatures for the polymerized AC it was thought that the percent opacity would not be acceptable. However the four project in this study did not produce "blue smoke" during the operation of the plant. In the 1992 paving season a quick study to evaluate the correlation between the higher mixing temperature to the opacity levels will be performed. The specification for the mixing of polymerized asphalt is at least 330°F when discharged from the mixer and the initial compaction shall begin before the mixture cools to 290°F.

Based on viscosity tests provided by the supplier, the mixing temperature for the polymer modified was reduced to 318°F for the I-25, Colorado Blvd. and the Highway 85, Santa Fe projects.

During construction of these projects it was observed that to obtain required densities as soon as possible requires good rolling techniques. The roller must keep up with the paver and get density when the mat is still hot.

There does not appear to be any difference in working with the polymerized mix as compared to the standard mix in fact some think the higher mixing and compacting temperatures improve the workability.

APPENDIX A

Guide Specifications Polymer Modified Asphalt
Task Force 31

AASHTO-AGC-ARTBA Joint Committee

Subcommittee On
New Highway Materials

Task Force 31

GUIDE SPECIFICATIONS
POLYMER MODIFIED ASPHALT

TASK FORCE 31

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AASHTO-AGC-ARTBA JOINT COMMITTEE PROPOSED SPECIFICATIONS FOR POLYMER MODIFIED ASPHALT

INTRODUCTION

The American Association of State Highway and Transportation Officials, the Associated General Contractors, and the American Road and Transportation Builders Association formed a working relationship called the AASHTO-AGC-ARTBA Joint Committee whose functions according to the by-laws are:

A. To promote harmonious relations between state highway and transportation officials and highway contractors that are in the public interest;

B. To discuss jointly those matters which relate to or affect the actual construction of highways. To this end the Joint Committee shall be responsible for considering any matters of general interest and application that affect both contractors and state highway officials; and

C. To promote an increased scope of joint cooperative activities between state highway departments and highway contractors at the state level.

The Subcommittee on New Highway Materials under the auspices of the AASHTO-ARTBA-AGC Joint Committee authorized the formation of a task force to develop generic guide specifications for polymer modified asphalts. Task Force No. 31 - Polymer Modified Asphalts was formed as a result. Members of the Task Force were selected from industry, user-agencies and acedemic interests in an attempt to tap resources of as much technical expertise regarding polymer modified asphalts as possible. In this sense, the resulting guide specification represents a consensus of those involved with pavement construction utilizing these types of modified asphalt products.

Work by the task force to develop a generic, performance-based specification for polymer modified asphalts has resulted in three descriptive specifications for polymer modified asphalts. Although these specifications are not performance oriented in a mechanistic sense, materials which could meet these specifications are being used in the construction of asphalt concrete pavements, and therefore, have an empirical connection with field performance.

Each of the materials described are generic in the sense that requirements for a specific polymer, its quantity and its method of manufacture are not included in the specification. A wide variety of materials, material quantities and methods of manufacture can be used to meet these specifications.

It is the hope of the Task Force that the polymer modified asphalt guide specifications provided will aid user agencies in the development of their specifications for polymer modified asphalts.

SPECIFICATION DEVELOPMENT

There are hundreds of potential polymers which can be used to modify asphalt cement properties. The specification described herein has been developed to describe the characteristics of certain specific types of polymer modified asphalt (PMA) which have been used successfully in practice, to date. The list of potential polymer modified asphalts was limited to include:

- those used in practice with success on at least a semi-routine basis and,
- those for which specifications had been written which describe properties of the resulting modified binder in common terms which could be verified by users.

The result of this work is a guide specification describing three types of polymer modified asphalts each based on different types of commonly used polymers. Therefore, this specification is not a performance-based document in the sense that fundamental material properties are described which might be satisfied by any type or combination of materials. Instead, the specification describes materials for which satisfactory performance has been documented. It is the hope of the task force that this information will be used as a guide for agencies wishing to use polymer modified asphalts. A more desirable, generic specification will only be possible as additional field experience is gained by practitioners or as truly fundamental material properties emerge from ongoing research in asphalt technology, for example the Strategic Highway Research Program (SHRP).

Each of the three types of polymer modified asphalts are specified differently due to the various types of polymers which could be used for modification. Therefore, the guide specifications do not necessarily have common tests or test requirements. At first, these differences make the specification seem less objective, by describing specific types of products. However, one premise of the guide specification that various polymers may provide beneficial asphalt behavior by different mechanisms. Therefore, setting the same tolerances in a given empirical test for each type of polymer modified binder did not seem rational. Until additional data is collected for the various modified systems which can be correlated to field performance, a truly performance oriented specification will not be possible. This information is being collected in the SHRP program, and when the specifications from SHRP are generated they should be incorporated into this guide specification, as well. The guide specification is designed for such modification.

The properties of the binders have been described, in most cases, by conventional ASTM or AASHTO test procedures, or by procedures that are currently being evaluated by these organizations for standardization. It is realized that more sophisticated evaluation procedures could, and in the future should, be used to describe properties of polymer modified binders. However, much of the equipment necessary to conduct more fundamental evaluations is not readily available to user agencies and perhaps, more importantly, have not been developed fully in a theoretical sense so that limiting criteria could be applied in a practical specification.

The specifications include several grades of polymer modified asphalt within each type. This grading is an attempt to describe polymer modified binders which might be usable in different climates. A significant amount of work by the West Coast User-Producer Group has been done to develop a performance-based asphalt specification for differing climatic conditions. The activities of this group have been observed closely with respect to specifying for specific purposes and climates, in fact some of the materials described herein agree closely with certain materials described in the sixth version of the West Coast User-Producer PBA specifications.

There has been an attempt to control or limit several types of pavement behavior in the specification. These parameters and a description of how controls are imposed are as follows:

- Low temperature cracking
- Permanent deformation
- Binder homogeneity
- Safety
- Fatigue cracking
- Aging
- Purity
- Workability

Low Temperature Cracking/Fatigue Cracking

Low temperature properties of the polymer modified binders are controlled by either penetration or ductility at 39.2F (4C) depending on the type of binder specified. For example, Types I and III use penetration and Type II, ductility. Because some evidence suggests that low temperature penetration may also correlate to fatigue properties, this requirement may also help limit fatigue cracking in some asphalt mixtures.

Permanent Deformation

An attempt has been made to provide higher binder stiffness and/or increased elasticity at elevated temperatures. These characteristics are addressed by including ring and ball softening point for materials described in Types I and III, and including an elastic recovery requirement for Type I. Presently, high temperature properties for Type II materials are controlled indirectly by limiting temperature susceptibility through penetration and viscosity tests and by specifying a lower limit on toughness. To date, these empirical methods appear to be suitable for most polymer modified materials.

Aging

All materials have requirements for retention of certain consistency parameters after artificial aging. The rolling thin film (RTFO) and thin film oven (TFO) tests are used to produce aged binders. After conditioning by either of these methods each binder has a required minimum retained consistency or elastic component. It is recognized that RTFO and TFO aging may not be ideal methods for producing realistic aging of asphalt binders. In fact, for some modified binders, where "skinning" of the surface can occur, artificially low indications of aging can occur. Also, some polymer modified binders exhibit Weissenberg properties in which the material has been observed to "flow uphill" in response to the shearing action as the fluid rotates in the RTFO bottles.

Homogeneity

Polymer modified asphalts are generally multiple-phase systems in which the polymers are dispersed in the asphalt liquid phase. Many of these systems require a certain amount of incompatibility between the phases for the polymers to provide any benefit. However, excessive incompatibility is not desirable for proper storage and handling. Therefore, all of the systems have requirements for limiting separation of the asphalt-polymer blend either by separation tests or by ductility after aging in the rolling thin film oven.

Actual limits are reported when sufficient data exist to support such criteria. However, a separation test for one material may not be appropriate for other materials. Therefore, for example, Type I has a suggested procedure and criteria, while Type II does not. This is not an indication that Type II does not have a tendency for incompatibility, just that the state-of-the-art has not been well developed for measuring incompatibility of this material.

Safety

Safety aspects of the polymer modified asphalts are addressed by minimum requirements on Cleveland Open Cup Flash Point. In most cases the lower limit is well below temperatures used in the field.

Purity

Type I and II materials include a minimum requirement for solubility of the original asphalt cement. This requirement is provided to ensure the polymer modified asphalt is not contaminated with mineral fines or fillers. The requirement is not placed on the blended polymer modified asphalt because certain types of polymer modified asphalts do not dissolve readily in conventional solvents presently used in the paving industry. No data is available, to date, which indicates if a single solvent will ever be available for performing solubility on the multitude of possible asphalt polymer blends.

Workability

Ideally, construction of asphalt concrete pavements with polymer modified asphalts should not require unusual procedures in any stage of the construction process. However, because many polymer modified binders can be formulated to produce extremely high stiffnesses, a limit has been placed on the high temperature viscosity for each material. This limit is based on pumpability of the material, and it is believed that the highest limit, 2000 centistokes at 275F (135C) for the I-C material can be handled effectively by conventional pumps used today.

PROPOSED GUIDE SPECIFICATIONS

A description of each of the polymer modified asphalts follows with a brief description of the origin of the specification and suggested purposes for each grade of polymer modified asphalt.

Type I Polymer Modified Asphalt

Description:
Type I Polymer Modified Asphalt is based on properties of conventional asphalt cements after modification with styrene block copolymers. Most styrene block copolymer modified asphalts which meet this specification have butadiene midblocks and could be diblock or triblock, ie SB or SBS, configurations.

		I-A	I-B	I-C
Penetration, 77F, 100g, 5sec	Min	100	75	50
	Max	150	100	75
Penetration, 39.2, 200g, 60sec	Min	40	30	25
Viscosity, 140F, P	Min	1000	2500	n/a
Viscosity, 275F, cSt	Max	2000	2000	2000
Softening Point, R & B, F	Min	110	130	150
Flash Point, F	Min	425	425	450
Solubility in TCE, %*	Min	99.0	99.0	99.0
Separation**, R & B difference, F	Max	4	4	4
RTFOT Residue				
Elastic Recovery***, 77F, %	Min	60	60	70
Penetration, 39.2F, 200g, 60s	Min	20	15	13

* Solubility of original asphalt by ASTM D2042.
** Method described in Appendix A
*** Method described in Appendix B

Uses:
Type I-A
Binder for use in hot mix asphalt concrete in cold service conditions and in hot applied surface treatment applications and crack filling.

Type I-B
All purpose grade intended for dense or open graded asphalt concrete and hot applied sealing applications in hot climates.

Type I-C
Hot climate applications where asphalt concrete is to be used in high volume traffic areas carrying large percentages of trucks.

Type II Polymer Modified Asphalt

Description:
Type II Polymer Modified Asphalt is based on properties of conventional asphalt cements after modification with styrene butadiene rubber latex (SBR) or neoprene latex.

		II-A	II-B	II-C
Penetration, 77F, 100g, 5sec	Min	100	70	80
Viscosity, 140F, P	Min	800	1600	1600
Viscosity, 275F, cSt	Max	2000	2000	2000
Ductility, 39.2, 5 cpm, cm	Min	50	50	25
Flash Point, F	Min	450	450	450
Solubility*, %	Min	99	99	99
Toughness, 77F, 20 ipm, in-lbs	Min	75	110	110
Tenacity, 77F, 20 ipm, in-lbs	Min	50	75	75
RTFOT or TFOT Residue				
Viscosity, 140F, P	Max	4000	8000	8000
Ductility, 39.2, 5 cpm, cm	Min	25	25	8
Toughness, 77F, 20 ipm, in-lbs	Min			110
Tenacity, 77F, 20 ipm, in-lbs	Min			75

* Solubility of original asphalt by ASTM D2042.

Uses:
Type II-A
Binder for use in hot mix asphalt concrete in cold service conditions and in hot applied surface treatment applications and crack filling.

Types II-B and C
All purpose grade intended for dense or open graded asphalt concrete and hot applied sealing applications in hot climates.

Type III Polymer Modified Asphalt

Description:
Type III Polymer Modified Asphalt is based on properties of conventional asphalt cements after modification with ethylene vinyl acetate or polyethylene.

		III-A	III-B	III-C	III-D	III-E
Penetration, 77F, 100g, 5sec	Min	30	30	30	30	30
	Max	130	130	130	130	130
Penetration, 39.2, 200g, 60sec	Min	48	35	26	18	12
Viscosity, 275F, cSt	Min	150	150	150	150	150
	Max	1500	1500	1500	1500	1500
Softening Point, R & B, F	Min	125	130	135	140	145
Flash Point, F	Min	425	425	425	425	425
Separation*		Homog	Homog	Homog	Homog	Homog
RTFOT Residue						
Loss, %	Max	1.0	1.0	1.0	1.0	1.0
Penetration, 39.2, 200g, 60sec	Min	24	18	13	9	6

* Method described in Appendix C

The Type III asphalts are distinguished by differences in consistency at 39.2F (4C) using the penetration test and at high temperatures using the softening point test. As one moves from left to right in the table, as with the other asphalts, the materials become progressively harder, or stiffer. The philosophy of Type III PMA is to require the softening point be 40F higher than the normal daily maximum air temperature during the hottest month of service. Low temperature penetration is set based on normal daily minimum air temperatures during the coldest month.

SEPARATION TEST FOR TYPE I
POLYMER MODIFIED ASPHALT

SEPARATION TEST FOR TYPE I POLYMER MODIFIED ASPHALT

II.0 Scope

1.1 The separation of polymer from asphalt during hot storage is evaluated by comparing the ring and ball softening point of the top and bottom samples taken from a conditioned sealed tube of polymer modified asphalt. The conditioning consists of placing a sealed tube of polymer modified asphalt in a vertical position in a 325F oven for a 48 hour period.

2.0 Referenced Documents

2.1 ASTM D36: Softening Point of Bitumen (Ring and Ball Apparatus).
ASTM E11: Specifications for Wire Cloth Sieves for Testing Purposes

3.0 Apparatus

3.1 Aluminum Tubes[1] - 1 inch diameter by 5-1/2 inch length blind aluminum tubes. Used to hold the test sample during the conditioning.

3.2 Oven - An oven capable of maintaining 325 ± 10F.

3.3 Freezer - A freezer capable of maintaining 20 ± 10F.

3.4 Rack - A rack capable of supporting the aluminum tubes in a vertical position in the oven and freezer.

3.5 Spatula and Hammer - The spatula must be rigid and sharp to allow cutting of the tube containing the sample when at a low temperature.

4.0 Procedure

4.1 Place the empty tube with sealed end down in the rack.

4.2 Carefully heat the sample until sufficiently fluid to pour. Care should be taken to avoid localized overheating. Strain the melted sample through a No. 50 sieve conforming to ASTM E11. After thorough stirring, pour 50.0 grams

[1] Aluminum tubes may be obtained from Sheffield Industries, P. O. Box 351, New London, CT 06320, 203-442-4451. Observations have been reported regarding leakage of asphalt from the bottom of these tubes during the conditioning period. Other tubes may be required if this leakage is significant.

into the vertically held tube. Fold the excess tube over two times and crimp and seal.

4.3 Place the rack containing the sealed tubes in a 325±10F oven. Allow the tubes to stand undisturbed in the oven for a period of 48 ± 1 hour. At the end of the heating period, remove the rack from the oven and immediately place in the freezer at 20 ± 10 F taking care to keep the tubes in a vertical position at all times. Leave the tubes in the freezer for a minimum of 4 hours to completely solidify the sample.

4.4 Upon removing the tube from the freezer, place the tube on a flat surface. With the spatula and hammer, cut the tube into three equal length portions. Place the beakers in a 325 ± 10F oven until sufficiently fluid to remove the pieces of aluminum tube.

4.5 After a thorough stirring, pour the top and bottom samples into appropriately marked rings for the ring and ball softening point test. Prepare the rings and apparatus as described in ASTM D36[2]

4.6 The top and bottom sample from the same tube should be tested at the same time in the softening point test.

5.0 Report

5.1 Record the softening point of the top and bottom portions of the sample. Duplicate separation tests should be run.

[2] Other physical and chemical residue tests may be run at this time, if desired.

ELASTIC RECOVERY TEST FOR TYPE I POLYMER MODIFIED ASPHALT

ELASTIC RECOVERY TEST

1.0 Scope

1.1 The elastic recovery of a polymer modified asphalt cement is evaluated by the percentage of recoverable strain measured after elongation during a conventional ductility test. Unless otherwise specified, the test shall be made at a temperature of 77F ± 0.9F (25 ± 0.5C) and with a speed of 5 cm/min ± 5.0%.

2.0 Referenced Documents

2.1 ASTM D113: Ductility of Bituminous Materials.
ASTM E11: Specification for ASTM Thermometers.

3.0 Apparatus

3.1 Mold - The mold shall be similar in design to that described for use in the ductility test (ASTM D113), Figure 1, except that the sides of the mold assembly, parts a and a' shall have straight sides producing a test specimen with cross-sectional area of 1 cm^2.

3.2 Water Bath - The water bath shall be maintained at the specified test temperature, varying not more than 0.18F (0.1C) from this temperature. The volume of water shall be not less than 10 liters, and the specimen shall be immersed to a depth of not less than 10 cm and shall be supported on a perforated shelf not less than 5 cm from the bottom of the bath.

3.3 Testing Machine - For pulling the briquet of bituminous material apart, any apparatus may be used which is so constructed that the specimen will be continuously immersed in water as specified while the two clips are pulled apart at a uniform speed without undue vibration.

3.4 Thermometer - An ASTM 63C or 63F thermometer shall be used.

3.5 Scissors - Any type of conventional scissors capable cutting polymer modified asphalt at the test temperature.

4.0 Procedure

4.1 Prepare test specimens and condition as prescribed by ASTM D113.

4.2 Elongate the test specimen at the specified rate to a deformation of 10 cm.

4.3 Immediately cut the test specimen into two halves at the midpoint using the scissors. Keep the test specimen in the water bath in an undisturbed condition for 1 hour.

4.4 After the one hour time period, move the elongated half of the test specimen back into position near the fixed half of the test specimen so the two pieces of polymer modified asphalt just touch. Record the length of the test specimen as *X*.

5.0 Report

5.1 Calculate the percent recovery by the following procedure:

$$\text{Recovery, \%} = \frac{10 - X}{10} \times 100$$

SEPARATION TEST FOR TYPE III POLYMER MODIFIED ASPHALT

SEPARATION TEST FOR TYPE III POLYMER MODIFIED ASPHALT

1.0 Scope

1.1 This test is a simple qualitative test for compatibility of low density polymers in asphalt.

2.0 Apparatus

2.1 Containers - Standard 6 oz. metal sample cups (1.875"H x 2.75" I.D.).

2.2 Oven - An oven capable of maintaining 275 ± 10F.

3.0 Procedure

3.1 After a blend of polymer in asphalt has been prepared and is still at elevated temperature, pour enough of the mix into a clean 6 oz. metal test cup to fill it to the formed roll on the cup (appox. 1/4" from top). Place the sample in a controlled temperature oven at 275^{O}F for 15 to 18 hours. Remove carefully from oven without disturbing the surface and observe the sample. After the initial observation, a spatula can be used to gently probe the sample and check consistency of any surface layer and check for sludge on the bottom. These observations and tests should be done while the sample is still hot, within five minutes after removal from the oven.

3.2 Depending on the physical characteristics of the polymer and compatibility of the particular asphalt/polymer system, varying conditions will be noted. These are described and should be reported as follows:

DESCRIPTION	REPORT
Homogeneous, no skinning or sludge	HOMOGENOUS
Slight polymeric skin at edges of cup	SLIGHT EDGE SKINNING
Thin polymeric skin on entire surface	THIN TOTAL SKINNING
Thick polymeric skin (1/32"+) on entire surface	THICK TOTAL SKINNING
No surface skinning but thin sludge at bottom of container	THIN BOTTOM SLUDGE
No surface skinning but thick (1/4"+) sludge at bottom of container	THICK BOTTOM SLUDGE

If these descriptions do not match the particular sample, note the exact phenomena encountered and retain the sample.

APPENDIX B

Specification for Grading SC

REVISION OF SECTION 703
PLANT MIX PAVEMENTS - AGGREGATES

Section 703 of the Standard Specifications and Standard Special Provisions is hereby revised for this project as follows:

In subsection 703.04, add the following to Table 703-1:

TABLE 703-1
MASTER RANGE TABLE AND TOLERANCE
TABLE FOR HOT BITUMINOUS PAVEMENT

Sieve Designation	Percent by Weight Passing Sieve			*Tolerance
	Grading SF	Grading SC	Grading GG	
1 1/2"	100			
1"	96-100			
3/4"	84-96	100	100	**
1/2"	71-90	61-81	62-82	±6
3/8"	63-84	50-70	52-72	±5
#4	47-70	34-49	40-60	±5
#8	35-60	18-34	36-52	±4
#30	19-38	8-16	18-32	±4
#200	3-9	3-9	3-9	±2.0

*These tolerances apply only to gradings SF, SC, and GG in lieu of the tolerances specified in subsection 401.02, Table 401-1, as revised for this project.

** The tolerance for the 3/4" sieve for Grading SF is ±4%. When 100% passing is designated, there shall be no tolerance.

Minimum voids in the mineral aggregate is 13 for Grading SF, 11 for Grading SC and 12 for Grading GG.