Use of Recycled Materials in Highway Construction

Appendix G

February 1992

WA-RD 252.2

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

APPENDIX G.

SPECIFICATIONS FOR RECYCLED MATERIALS

When old asphalt concrete is proposed for inclusion in the mix (either from materials obtained from this project or an existing stockpile), the Contractor shall submit his design for approval, including representative samples taken in the presence of the Engineer, and the approximate proportions of the various materials (old asphalt concrete, new aggregate, recycling agent, new paving asphalt) to be used. Upon tentative approval of approximate proportions proposed by the Contractor, the materials will be proportioned together for a job mix design. Approval of the mix design shall be based upon meeting the specification requirements of section 9-03.8(2) of the standard specifications for the specified Class ACP or as shown in these special provisions. In addition, for mix design approval, the blend of recovered paving asphalt plus recycling agent and additional paving asphalt shall meet the requirements for AR-4000W in accordance with section 9-02.1(4) of the standard specifications. The Contractor shall allow 15 working days for this approval and design once the material has been received at the Materials Laboratory. Additional time may be required if the proportions will not make an adequate design, as determined by the Engineer, or if the Contractor requests more than one rejuvenator or paving asphalt source approval. The Contractor is also advised that production of the asphalt concrete shall not commence until the job mix design has been established.

Asphalt concrete pavement Class *** B *** will be measured by the ton with no deduction being made for the weight of the paving asphalt or any other component of the mixture.

For the purpose of asphalt cement adjustment computations and paving asphalt revision quantities, if any, the new paving asphalt and recycling agent, if any, will be measured by the ton with the quantity determined from production data. The State reserves the right to make random checks of the gross and tare weights of the transport equipment at the time of delivery, as well as measuring the paving asphalt volume in the storage tank prior to and after the deposit from the transport vehicle.

The unit contract price(s) per ton for *** "Asphalt Conc. For Preleveling Cl. B Incl. Paving Asphalt" and "Asphalt Concrete Pavement Class B Incl. Paving Asphalt" *** shall be full compensation for furnishing all labor, equipment, tools and materials, including the cost involved with the furnishing of recycling agent, if any, and the furnishing of paving asphalt, necessary to produce and place the asphalt concrete pavement as specified.

RUBBER MODIFIED ASPHALT CONCRETE PAVEMENT

This work shall consist of placing Plusride Asphalt on those portions of the roadway shown in the plans.

SR 530
SKAGIT COUNTY LINE TO
DAHLGREN ROAD
85W025

Plusride Asphalt is a patented process licensed by:

All Seasons Surfacing Corporation
1017 NE 4th Street, Suite No. 1
Bellevue, WA 98004
(206) 454-3830

The Contractor shall arrange to have a technical representative of All Seasons Surfacing Corporation on the project while Plusride is being mixed or placed.

The rubber modified asphalt concrete shall consist of granulated rubber added to the aggregate phase of an asphalt concrete mixture.

The standard specifications for asphalt concrete shall be applicable except for the following:

Materials

The materials used in this rubber modified asphalt concrete shall have the following properties:

Asphalt

The asphalt shall be AR-4000W conforming to section 9-02.1(4) of the standard specifications. The percent of asphalt required in this mixture shall be between 7.5 and 9.5 percent.

Granulated Rubber

The granulated rubber and cord fibers shall be ground from rubber tires and shall meet the following gradation:

Sieve	Percent Passing by Weight
1/4	100
No. 4	76-100
No. 10	28-42
No. 20	16-24

Aggregate

The aggregate shall meet the general requirements of section 9-03.8(1) of the standard specifications and in addition shall meet the following specifications:

Sieve	Percent Passing by Weight
5/8	100
3/8	60-80
1/4	30-44
No. 10	20-32
No. 30	13-25
No. 200	8-12

Fracture 75% minimum
Sand Equivalent 45 minimum

Mineral filler is usually required to meet the minimum 200 material requirements.

Blending and Mixing

A representative sample of the total paving mixture, which meets the mix requirements, shall be produced prior to producing the mix for the project paving.

The construction requirements set forth in section 5-04.3(1)B of the standard specifications shall be supplemented by the following:

The amount of granulated rubber shall be determined by a method which uniformly feeds the mixer within ± 0.15 percent.

The components of the rubber modified asphalt concrete shall be combined in the following order and proportions:

1. Add mineral aggregate
2. Add rubber granules at 3.0 percent by weight of the total mix (60 lb/ton)
3. Mix for 15 seconds
4. Add the design asphalt content
5. Mix normal time

The construction requirements set forth in section 5-04.3(1)D of the standard specifications shall be supplemented by the following:

Granulated rubber introduced into the mixer shall be drawn from storage bins by a continuous mechanical feeder which will uniformly feed the mixer within ± 0.15 percent.

The plant shall be equipped with a heat shield or other means to prevent the open flame from coming in contact with the granulated rubber.

The first sentence of the third paragraph of section 5-04.3(8) of the standard specifications is deleted and the following substituted:

> The temperature of the mix at discharge shall be between 325% F. and 360% F. for batch plants or between 300% F. and 325% F. for drum mixer plants.

Mix Design

The Contractor shall submit to the Engineer a rubber modified asphalt concrete mix design that has been agreed to by the patent holder.

Job Mix Tolerances

All mix furnished for the project shall conform to the approved job-mix formula within the following ranges of tolerances:

Sieve Size	Percent Passing
3.8" or 1/4"	± 6
No. 10 or No. 30	± 4
No. 200	± 2
Gap Grading Percent	± 4
Asphalt Percent	± 0.4
Rubber Percent	± 0.15*

*Not determinable by extraction testing.

The plant shall be equipped to feed mineral filler into the mix within an accuracy of 0.5 percent.

Spreading and Finishing

Section 5-04.3(9) of the standard specifications is deleted and replaced with the following:

> The mixture shall be laid upon an approved surface, spread and struck off to the grade and elevation established. Special care must be taken to obtain a good joint as it may be difficult to hand rake this material. Asphalt pavers complying with section 5-04.3(3) shall be used to distribute the mixture.
>
> A CSS-1 tack coat shall be applied and shall consist of 0.06-0.08 gallon/square yard of retained asphalt. The spraying temperature shall be from 70% to 140% F.
>
> On areas where irregularities or unavoidable obstacles make the use of mechanical spreading equipment impractical, the paving may be done with other equipment or by hand.

Compaction

Asphalt rollers and compaction procedures shall conform with the standard requirements and supplemented with the following:

Breakdown compaction should begin immediately behind the paving machine. However, some delay may be required to prevent roller pickup. The roller drums must be kept well watered and a wetting agent may be necessary to decrease the occurrence of roller pickup.

Breakdown compaction shall be accomplished using a 10-12 ton vibratory or static steel roller. The roller must apply a minimum force of 250 pounds per linear inch of drum width to the pavement surface.

An 8-10 ton tandem steel roller shall be used for finish rolling. Finish rolling of the mat shall continue until the temperature of the mat has dropped below 140%F or until elastic movement under the roller is no longer observed.

The proper rolling procedure shall be established with a control strip to determine equipment and number of coverages necessary to obtain the target density. The target density, as a percentage of maximum theoretical density, shall be 95% to 98% (2% to 5% air voids).

Measurement

Section 5-04.4 of the standard specifications is supplemented with the following:

Measurement of the rubber modified asphalt concrete will be by the ton and will include the granulated rubber, the asphalt cement and any other component of the mix.

Payment

Section 5-04.5 of the standard specifications is supplemented with the following:

The unit contract price per ton for "Rubber Modified Asphalt Concrete Pavement" shall be full compensation for furnishing all labor, equipment, materials, supplies, and royalties (if any) required in the construction of this material as specified.

POLYESTER MODIFIED ASPHALT CONCRETE PAVEMENT

This work shall consist of mixing, placing and compacting asphalt concrete that has had polyester fibers introduced at the time of mixing.

SR 530
SKAGIT COUNTY LINE TO
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85W025

SUGGESTED GUIDE MATERIAL SPECIFICATION FOR CRUMB RUBBER ADDITIVE

1.0 SCOPE

This specification covers scrap tire crumb rubber for use as an additive in asphalt paving applications.

2.0 APPLICABLE DOCUMENTS

AASHTO Standards

T 2 Sampling Aggregates
T 27 Sieve Analysis of Fine and Coarse Aggregate
T 255 Total Moisture Content of Aggregate by Drying

ASTM Standards

C 136 Sieve Analysis
D 297 Methods for Rubber Products - Chemical Analysis (natural rubber content)

3.0 GENERAL CHARACTERISTICS

Crumb rubber additive (CRA) is scrap tire rubber which has been processed by ambient grinding or granulating methods, reducing the rubber to particles which generally pass the No. 4 Sieve. The CRA may be obtained from any combination of passenger and truck tires which meet this specification. It shall be free of injurious amounts of steel, fabric or other deleterious substances.

4.0 PHYSICAL REQUIREMENTS

4.1 *Grading* -- The gradation of the CRA shall conform to one of the following gradations.

Sieve Size	CRA-I	CRA-II	CRA-III	CRA-IV	CRA-V
	(percent of weight passing)				
No. 4	100	--	--	--	--
No. 8	80-100	100	--	--	--
No. 16	40-60	80-100	100	--	--
No. 30	0-20	40-60	70-100	100	--
No. 50	--	0-20	20-40	40-60	100
No. 100	--	--	--	--	50-80

A mineral powder (such as calcium carbonate) may be added, up to a maximum of 4% by weight, to reduce sticking and caking of the crumb rubber particles.

4.2 *Deleterious Substances* -- The fiber content shall be less than 0.1% by weight for spray applications and less than 0.5% by weight for all other applications. The CRA shall contain no metal particles. The moisture content shall be less than 0.75% by weight. Mineral contaminants (prior to the addition of mineral powder) shall not be greater than 0.25% by weight.

5.0 SUPPLEMENTARY REQUIREMENTS

5.1 *Specific Gravity* -- The specific gravity of the CRA shall be

1.15 ± 0.05.

5.2 *Chemical Analysis* -- The CRA shall meet the following limits:

natural rubber	15% - 30%
carbon black	30% - 35%
ash	8% maximum
acetone extract	11% - 18%
rubber hydrocarbon	40% - 50%

5.3 *Packaging* -- When the proposed production method specifies adding whole units of CRA into a batch facility mixing chamber (pug mill), the containers shall be a low density polyethylene material having a melting point of less than 240°F.

6.0 METHODS OF SAMPLING AND TESTING

The gradation shall be tested in accordance with ASTM C-136 using a 50 gram sample.

Fiber content shall be determined by weighing fiber balls which are formed during the gradation test procedure. Rubber particles shall be removed from the fiber balls before weighing.

The metal content shall be determined by thoroughly passing a magnet through a 50 gram sample.

The moisture content shall be determined in accordance with AASHTO T-255, using a controlled temperature oven at 140°F and 50 gram sample.

The mineral contaminant content shall be determined by water float separation. Stir a 50 gram sample into a 1 liter glass beaker filled with water and allow the sample to stand for 30 minutes. The mineral contaminant is that material which does not float to the top of the beaker.

SUGGESTED GUIDE MATERIAL SPECIFICATION FOR ASPHALT RUBBER BINDER

Asphalt rubber may be covered by patents 4,609,182; 4,085,078; 4,068,023; 3,891,585. Any use of this technology should include a determination of the validity of the patent rights and risk of infringement.

1.0 SCOPE

This specification covers asphalt rubber binder graded by climate zones for use in asphalt paving construction.

2.0 APPLICABLE DOCUMENTS

Crumb Rubber Additive Material Specification

AASHTO Standards

M 226	Viscosity Graded Asphalt Cement
M 20	Penetration Graded Asphalt Cement
T 49	Penetration of Bituminous Materials
T 51	Ductility of Bituminous Materials
T 179	Effect of Heat and Air on Asphalt Materials (Thin-Film Oven Test)

ASTM Standards

D 2994	Standard Test Methods for Rubberized Tar
D 36	Standard Test Methods for Softening Point of Bitumen (Ring and Ball)
D 3407	Standard Test Methods for Joint Sealants, Hot-Poured, for Concrete and Asphalt Pavements
D 88	Standard Test Method for Saybolt Viscosity
D 92	Standard Test Method for Flash and Fire Points by Cleveland Open Cup
D 2007	Test Method for Characteristic Groups in Rubber Extender and Processing Oils by the Clay-Gel Absorption Chromatographic Method

3.0 GENERAL CHARACTERISTICS

Asphalt rubber binder is an asphalt cement binder modified with crumb rubber additive (CRA). An extender oil may be added to supplement the composition of the binder. The blend of asphalt and CRA is allowed to fully react prior to incorporation into the construction.

4.0 BINDER REQUIREMENTS

4.1 *Asphalt Cement.* The asphalt cement shall meet the requirements of AASHTO M 226 or M 20. The selected source and grade shall be compatible with the CRA to provide a uniform blend meeting the specified asphalt rubber binder properties.

4.2 *Crumb Rubber Additive.* The CRA shall meet the requirements

of the CRA Material Specification. The selection of the CRA properties, particularly the gradation, shall be established by the project design parameters.

4.3 *Asphalt Extender Oil.* The extender oil shall be a resinous, high flash point, aromatic hydrocarbon meeting the following test requirements:

viscosity, SSU, 100°F ASTM D 88	2500 min.
flash point, COC, °F ASTM D 92	390 min.
asphaltenes, % by weight, ASTM D 2007	0.1 max.
aromatics, % by weight, ASTM D 2007	55.0 min.

4.4 *Asphalt Rubber Binder.* The asphalt rubber binder shall conform to the requirements given in Table 1.

5.0 MANUFACTURING REQUIREMENTS

Asphalt rubber binder shall be prepared by blending and reacting the materials in accordance with the conditions and the proportions established by the designed job mix formula. The equipment shall be capable of preheating the asphalt cement to the reaction temperature, accurately proportioning the materials, blending the materials into a uniform mixture and maintaining circulation and even heat distribution at the reaction temperature during the reaction phase.

6.0 METHODS OF SAMPLING AND TESTING

Measuring the apparent viscosity of the asphalt rubber binder may be determined using a portable rotational shear viscometer in lieu of a Brookfield (ASTM 2994). The portable viscometer shall be correlated against the Brookfield for each modified binder developed. A standard test procedure shall be established for the particular portable viscometer.

TABLE 1 - REQUIREMENTS FOR ASPHALT RUBBER BINDER GRADES

GRADE		AR-1	AR-2	AR-3
TEST METHOD		CLIMATE ZONE HOT	MODERATE	COLD
Highest Mean Monthly Temp. (°F)		>100	80 - 100	<80
Lowest Mean Monthly Temp. (°F)		>30	10 - 30	<10
Apparent Viscosity (cps) 347°F (175°C) ASTM D 2994 spindle 3, 12 rpm	min.	1000	1000	1000
	max.	4000	4000	4000
Penetration (1/10 mm) 77°F (25°C) AASHTO T 49 100 gram, 5 sec	min.	25	50	75
	max.	75	100	150
Penetration (1/10 mm) 39.2°F (4°C) AASHTO T 49 200 gram, 60 sec	min.	15	25	40
Softening Point (°F) ASTM D 36	min.	130	120	110
Resilience (percent) 77°F (25°C) ASTM D 3407	min.	20	10	0
Ductility (cm) 39.2°F (4°C) AASHTO T 51 1 cm/min	min.	5	10	20
Tests on Thin Film Oven Residue, AASHTO T 179				
Penetration (percent of original retained) 39.2°F (4°C) AASHTO T 49 200 gram, 60 sec	min.	75	75	75
Ductility (percent of original retained) 39.2°F (4°C) AASHTO T 51 1 cm/min	min.	50	50	50

NOTE: The binder measured for compliance shall include the extender oil and any other additive proposed in the job mix formula.

**SUGGESTED GUIDE SPECIFICATION
FOR THE CONSTRUCTION OF
SURFACE TREATMENTS USING ASPHALT RUBBER BINDER**

1.0 DESCRIPTION

This work shall consist of the application of asphalt rubber binder followed by an application of cover aggregate.

2.0 MATERIALS

The materials for this work shall meet the following requirements:

2.1 *Asphalt Rubber Binder* -- The asphalt rubber binder shall meet the requirements of the Asphalt Rubber Binder Material Specification. The selection of the grade of asphalt rubber binder shall be determined as a part of the job mix formula design.

2.2 *Cover Aggregate* -- Aggregates shall be crushed stone, crushed slag, crushed gravel or natural gravel. Only one type of aggregate shall be used. Aggregates shall meet the requirements of AASHTO M 283. If specified by the job mix formula, the aggregate shall be precoated with asphalt.

The aggregate shall have a retained asphalt film above 95 percent when tested in accordance with AASHTO T 182. Aggregates that do not meet this requirement may be considered if a satisfactory antistripping additive is used.

2.3 *Binder Diluent* -- The binder diluent shall be a kerosene-type diluent compatible with all other materials as determined by the job mix formula design. The kerosene shall meet the following additional requirements:

Flash Point (ASTM D 92)	80°F minimum
Initial Boiling Point (ASTM D 850)	350°F minimum
Dry Point (ASTM D 850)	450°F maximum

NOTE: All kerosene may not meet these requirements.

2.4 *Job Mix Formula* -- The job mix formula (JMF) shall specify the source, composition and proportion of the aggregate, asphalt rubber binder and additives for each surface treatment to be supplied for the contract. Only the materials approved by the JMF may be used. All surface treatment materials incorporated into the project shall conform to the individual tests' tolerance ranges established in the JMF.

The JMF shall be established by the Contractor and approved by the Engineer in accordance with the mix design specifications. At least 10 days prior to

production, the Contractor shall submit to the Engineer a JMF for each mixture, the supporting test data, and samples of materials from each source. The JMF for each surface treatment shall be in effect until a modification is approved by the Engineer.

3.0 CONSTRUCTION REQUIREMENTS

3.1 *Weather Limitations* -- The application of an asphalt rubber surface treatment shall only be permitted under the following conditions:

ambient air temperature	60°F and rising
surface temperature	60°F minimum
surface condition	dry

3.2 *Delays* -- When a delay in surface treatment application occurs, the asphalt rubber binder shall be allowed to cool. Just prior to use, the asphalt rubber shall be slowly reheated to the specified JMF mixing temperature, thoroughly mixed and the viscosity checked. If the viscosity is outside the JMF specification, the asphalt rubber binder in question shall not be accepted for further use.

3.3 *Equipment* -- DISTRIBUTOR: The distributor shall be capable of uniformly applying the asphalt rubber binder at the temperature and application rate specified in the JMF. The distributor shall be equipped to maintain the specified temperature and provide continuous circulation of the binder in the tank and distributor bar. The distributor shall be equipped with appropriate gauges and meters for monitoring the operation.

AGGREGATE SPREADER: The aggregate spreader shall be self-propelled and of sufficient capacity to apply the aggregate within the specified time. The spreader shall have positive controls to deposit the quantity of material required by the JMF uniformly over the full width of the binder application.

ROLLERS: The rollers shall be self-propelled, pneumatic tire and capable of reversing without backlash. Each tire shall be inflated to a minimum of 100 psi and carry a minimum 3000 pounds. The number of rollers and speed of operation shall be approved by the Engineer.

3.4 *Surface Preparation* -- The entire surface shall be cleaned using approved methods until the surface is acceptable to the Engineer. After cleaning, the surface shall receive a tack coat as directed by the JMF.

3.5 *Preparation of Asphalt Rubber Binder* -- Production of

the binder shall conform to the Asphalt Rubber Binder Material Specification. The binder shall be maintained at the specified mixing temperature without local overheating and shall be circulated to maintain uniformity until it is applied to the pavement surface.

3.6 *Application of the Binder* -- The rate of application shall be specified by the JMF. The amount of binder applied shall not exceed the capability of the aggregate spreader to immediately cover the application.

The binder viscosity may be adjusted to improve the spray application by adding a kerosene diluent. The type and amount of diluent shall be established by the JMF. The addition of the diluent should occur in the distributor immediately prior to the spray application. The blending process should achieve a uniform viscosity in the minimum possible time.

Building paper shall be used at the beginning and end of each application of the binder. Proper construction techniques shall be used for longitudinal and construction joints.

3.7 *Application of the Cover Aggregate* -- The application of the cover aggregate shall immediately follow the application of the binder. Spreading shall be accomplished so the tires of the trucks and aggregate spreader do not contact the uncovered binder. The rate of aggregate spread shall comply with the JMF.

The entire application of cover aggregate shall be rolled as soon as possible after the aggregate is placed. The rolling pattern shall properly embed the cover aggregate into the binder. A minimum of three passes of the pneumatic roller shall be obtained.

After the rolling is completed, the entire surface shall be lightly swept to remove any loose cover aggregate. Traffic will not be permitted on the surface until the asphalt rubber binder has cured sufficiently to minimize any dislodging of cover aggregate.

4.0 METHOD OF MEASUREMENT

5.0 BASIS OF PAYMENT

SUGGESTED GUIDE SPECIFICATION
FOR THE CONSTRUCTION OF
HOT MIX ASPHALT CONCRETE USING ASPHALT RUBBER BINDER

1.0 DESCRIPTION

This specification provides general requirements that are applicable to all types of hot mix asphalt concrete using asphalt rubber binder (HMAR) irrespective of aggregate type and gradation, type and amount of binder, or pavement use.

This work shall consist of one or more courses of HMAR constructed on a prepared foundation.

2.0 MATERIALS

The materials for this work shall meet the following requirements:

2.1 *Asphalt Rubber Binder* -- The asphalt rubber binder shall meet the requirements of the Asphalt Rubber Binder Material Specification. The selection of the grade of asphalt rubber binder shall be determined as a part of the JMF design.

2.2 *Coarse Aggregate* -- Coarse aggregate (retained on the No. 8 sieve) shall be crushed stone, crushed slag, or crushed gravel meeting the requirements of AASHTO M 283.

2.3 *Fine Aggregate* -- Fine aggregate (passing the No. 8 sieve) shall consist of stone screenings, slag screenings, manufactured sand, natural sand, or a combination thereof, meeting the requirements of AASHTO M 29.

2.4 *Mineral Filler* -- Mineral filler shall meet the requirements of AASHTO M 17.

2.5 *Additives* -- Anti-stripping and/or other additives (in addition to crumb rubber) shall be approved by the job mix formula. Additives shall be added at the specified rate using appropriate in-line blending or other approved method.

2.6 *Job Mix Formula* -- The job mix formula (JMF) shall specify the source, composition and proportion of the aggregates, mineral filler, asphalt rubber binder and additives for each mixture to be supplied for the contract. Only the materials approved by the JMF may be used. All mixtures incorporated into the project shall conform to the individual tests' tolerance ranges established in the JMF.

The JMF shall be established by the Contractor and

approved by the Engineer in accordance with the mix design specifications. At least 30 days prior to production, the Contractor shall submit to the Engineer a JMF for each mixture, the supporting test data, and samples of materials from each source. The JMF for each mixture shall be in effect until a modification is approved by the Engineer.

3.0 CONSTRUCTION REQUIREMENTS

3.1 *Weather Limitations* -- The HMAR shall only be placed under the following conditions:

For compacted thickness less than 1½ inches	
ambient air temperature	60°F and rising
surface temperature	60°F minimum
surface condition	dry

For compacted thickness 1½ inches and greater	
ambient air temperature	50°F and rising
surface temperature	50°F minimum
surface condition	dry

3.2 *Delays* -- When a delay in HMAR production occurs, the asphalt rubber binder shall be allowed to cool. Just prior to use, the asphalt rubber shall be slowly reheated to the specified JMF mixing temperature, thoroughly mixed and the viscosity checked. If the viscosity is outside the JMF specification, the asphalt rubber binder in question shall not be accepted for further use.

3.3 *Equipment* -- Equipment used for the production, placement and compaction of HMAR shall conform to the AASHTO Guide Specifications for Highway Construction with the following modifications:

The hot mix asphalt mixing facility shall have automatic controls that coordinate the proportioning, timing and discharge of the mixture.

The hauling equipment and compaction rollers may be thinly coated with a light application of a non-petroleum based wetting agent to reduce sticking of the mixture to the equipment. Oiling the surfaces with kerosene or diesel fuel will not be permitted.

Pneumatic-tired rollers will not be used.

3.4 *Surface Preparation* -- Surface preparation shall conform to the AASHTO Guide Specifications for Highway Construction.

3.5 *Preparation of Asphalt Rubber Binder* -- Production of the binder shall conform to the Asphalt Rubber Binder Material Specification. The binder shall be maintained at the specified mixing temperature without local overheating and shall be circulated to maintain uniformity until it is metered into the hot mix facility mixing chamber.

3.6 *Mixing, Placing and Compacting* -- Mixing, placing and compaction shall conform to the JMF and the AASHTO Guide Specifications for Highway Construction.

4.0 METHOD OF MEASUREMENT

5.0 BASIS OF PAYMENT

**SUGGESTED GUIDE SPECIFICATION
FOR THE CONSTRUCTION OF
RUBBER MODIFIED HOT MIX ASPHALT CONCRETE**

Rubber modified hot mix asphalt concrete may be covered by patents. Any use of this technology should include a determination of the validity of the patent rights and risk of infringement.

1.0 DESCRIPTION

This specification provides general requirements that are applicable to all types of rubber modified hot mix asphalt concrete (RUMAC) irrespective of aggregate type and gradation, crumb rubber type and gradation, type and amount of asphalt binder, or pavement use.

This work shall consist of one or more courses of RUMAC constructed on a prepared foundation.

2.0 MATERIALS

The materials for this work shall meet the following requirements:

2.1 *Asphalt Binder* -- The asphalt binder shall meet the requirements of the AASHTO M 266 or M 20. The selection of the grade of asphalt binder shall be determined as a part of the JMF design.

2.2 *Coarse Aggregate* -- Coarse aggregate (retained on the No. 8 sieve) shall be crushed stone, crushed slag, or crushed gravel meeting the requirements of AASHTO M 283.

2.3 *Fine Aggregate* -- Fine aggregate (passing the No. 8 sieve) shall consist of stone screenings, slag screenings, manufactured sand, natural sand, or a combination thereof, meeting the requirements of AASHTO M 29.

2.4 *Mineral Filler* -- Mineral filler shall meet the requirements of AASHTO M 17.

2.5 *Crumb Rubber* -- Crumb rubber shall meet the requirements of the Crumb Rubber Additive Material Specification. The selection of the CRA properties, particularly process method and gradation, shall be determined as a part of the JMF design.

2.6 *Additives* -- Anti-stripping and/or other additives shall be approved by the job mix formula. Additives shall be added at the specified rate using appropriate in-line blending or other approved method.

2.7 *Job Mix Formula* -- The job mix formula (JMF) shall specify the source, composition and proportion of the aggregates, mineral filler, crumb rubber, asphalt binder and additives for each mixture to be supplied for the contract. Only the materials approved by the JMF may be used. All mixtures incorporated into the project shall conform to the individual tests' tolerance ranges established in the JMF.

The JMF shall be established by the Contractor and approved by the Engineer in accordance with the mix design specifications. At least 30 days prior to production, the Contractor shall submit to the Engineer a JMF for each mixture, the supporting test data, samples of materials from each source, and a production work plan. The work plan shall detail the equipment and sequence for adding the crumb rubber into the mixing process. The JMF for each mixture shall be in effect until a modification is approved by the Engineer.

3.0 CONSTRUCTION REQUIREMENTS

3.1 *Weather Limitations* -- The RUMAC shall only be placed under the following conditions:

For compacted thickness less than 1¼ inches	
ambient air temperature	60°F and rising
surface temperature	60°F minimum
surface condition	dry

For compacted thickness 1¼ inches and greater	
ambient air temperature	50°F and rising
surface temperature	50°F minimum
surface condition	dry

3.2 *Equipment* -- Equipment used for the production, placement and compaction of RUMAC shall conform to the AASHTO Guide Specifications for Highway Construction with the following modifications:

The hot mix asphalt mixing facility shall have automatic controls that coordinate the proportioning, timing and discharge of the mixture. The facility shall be capable of uniformly feeding and measuring the amount of crumb rubber placed into the mixing chamber.

Transporting RUMAC on rubber belts is prohibited.

Drum mixing facilities shall not add the crumb rubber to the aggregate cold feed system. The

crumb rubber must be added beyond the aggregate drying and heating section of the mixing chamber.

The hauling equipment and compaction rollers may be thinly coated with a light application of a non-petroleum based wetting agent to reduce sticking of the mixture to the equipment. Oiling the surfaces with kerosene or diesel fuel will not be permitted.

Pneumatic-tired rollers will not be used.

3.3 *Surface Preparation* -- Surface preparation shall conform to the AASHTO Guide Specifications for Highway Construction.

3.4 *Mixing, Placing and Compacting* -- Mixing, placing and compaction shall conform to the JMF and AASHTO Guide Specifications for Highway Construction with the following modifications:

Finish rolling shall continue until the temperature of the mat drops below 140°F.

4.0 METHOD OF MEASUREMENT

5.0 BASIS OF PAYMENT

Bituminous Material:

Bituminous material shall be asphalt-rubber (vulcanized) conforming to the requirements of Section 1009 of the Standard Specifications, except for the following:

The rubber shall conform to the following gradation:

Sieve Size	Percent Passing
No. 10	100
No. 16	75 - 100
No. 30	25 - 100
No. 50	0 - 45
No. 100	0 - 10
No. 200	0 - 5

The asphalt-rubber shall conform to the following:

Parameter	Requirement
Viscosity, Haake, 350 F.	1500 - 4000 centipoise
Cone Penetration, 77 F. (ASTM D-1191)	20 Minimum
Softening Point, F. (ASTM D-36)	125 F. Minimum
Resilience, 77 F. (ASTM D-3407)	15% Minimum

The asphalt type shall be AC-10

The asphalt cement shall be modified by the addition of a minimum of 20 percent of granulated rubber, by weight of the asphalt, unless otherwise approved by the Department's Central Laboratory.

During the production of asphalt-rubber, the contractor shall maintain at the plant site equipment necessary to measure the viscosity. The asphalt-rubber shall be maintained between 1500 and 4000 centipoise at 350 F. The viscosity shall be checked at the direction of the Engineer.

In no case shall the asphalt-rubber be diluted with extender oil, kerosene, or other solvents. Any asphalt-rubber so contaminated shall be rejected.

Any kerosene or other solvents used in the cleaning of equipment shall be purged from the system prior to any subsequent use of that equipment.

The asphalt cement and rubber shall be blended for a period of at least one hour prior to mixing with the mineral aggregate and mineral admixture; however, the mixture of asphalt cement and rubber shall not be held at temperatures over 350 degrees F. for a period over 10 hours. The temperature of the asphalt cement shall be between 350 and 400 degrees F. at the addition of the granulated rubber. Temperature of the asphalt-rubber shall be maintained between 325 and 375 degrees F. during the one hour reaction period.

At the end of each shift, the contractor shall provide the Engineer with documentation on the production of asphalt-rubber, which includes the following:

1. The amount and temperature of the asphalt cement prior to the addition of rubber.

2. The amount (bags) of rubber added.

3. The viscosity of the asphalt-rubber just prior to the mixing with the aggregate and mineral admixture.

4. The time of the rubber additions and viscosity tests.

Mix Design:

Approximately 200 pounds of produced mineral aggregate, in proportion to the anticipated percent usage, shall be obtained by the contractor and witnessed by the Engineer so that both parties are satisfied that samples are representative of the mineral aggregate to be utilized in the asphaltic concrete production.

The contractor shall also furnish one full bag (as packaged by the supplier) of the granulated rubber proposed for use, one gallon of asphalt cement from the intended supplier, two gallons of the proposed mixture of asphalt and rubber, and, if mineral admixture is required, a one gallon can of the mineral admixture to be used in the asphaltic concrete.

Along with the samples furnished for mix design testing, the contractor shall submit a letter explaining in detail his methods of producing mineral aggregate including wasting, washing, blending, proportioning, etc., and any special or limiting conditions he may propose. His letter shall also state the source(s) of mineral aggregate, the source of asphalt cement and granulated rubber, the asphalt-rubber supplier, and, if required, the source and type of mineral admixture.

Within 10 working days of receipt of all samples and the contractor's letter in the Central Laboratory, the Department will provide the contractor with the percentage of asphalt-rubber to be used in the mix, the percentage to be used from each of the stockpiles of mineral aggregate, the composite mineral aggregate gradation, and any special or limiting conditions for the use of the mix.

ARIZONA DOT STANDARD SPECIFICATIONS - 1990.

SECTION 1006

The grading shall meet the following requirements when tested in accordance with the requirements of Arizona Test Method 201.

Sieve Size	Percent Passing
3/8 inch	100
No. 4	95-100
No. 16	45 -80
No. 50	0 -30
No. 100	0 -10
No. 200	0 - 4

Fine aggregate shall have an average sand equivalent value of not less than 75 when tested in accordance with the requirements of AASHTO T 176.

Fine aggregate shall be of such quality that, when made into mortar and subjected to the test for mortar-making properties in accordance with the requirements of AASHTO T 71, the mortar shall develop a compressive strength at seven and 28 days of not less than 90 percent of that developed by a mortar prepared in the same manner with the same Type II cement and graded Ottawa sand having a fineness modulus of 2.40 plus or minus 0.10.

(C) Coarse Aggregate:

Coarse aggregate shall consist of crushed stone, gravel, or other approved inert material of similar characteristics, including cinders when specified, having hard, strong and durable pieces free of clay and other deleterious substances. The aggregate shall be washed.

The coarse aggregate gradation shall conform to the appropriate size designation of AASHTO M 43 when tested in accordance with the requirements of Arizona Test Method 201, Section 12 (3), except the amount of material passing the No. 200 sieve shall not exceed 1.0 percent.

The percent of wear of coarse aggregate at 500 revolutions, when tested in accordance with the requirements of AASHTO T 96, shall not exceed 40.

1006-2.04 Admixtures:

(A) General Requirements:

The contractor shall furnish Certificates of Compliance conforming to the requirements of Subsection 106.05 for each type of admixture furnished. Admixtures containing chlorides will not be acceptable for concrete containing uncoated reinforcing steel or embedded metal items.

All concrete admixtures shall be stored in suitable containers in accordance with the manufacturer's recommendations. All liquid admixtures shall be protected from freezing. Liquid admixtures that have frozen shall not be used.

(B) Air-Entraining Admixtures:

Air-entraining admixtures shall conform to the requirements of AASHTO M 154.

(C) Chemical Admixtures:

Chemical admixtures shall conform to the requirements of AASHTO M 194.

(D) Fly Ash:

Fly ash shall conform to the requirements of ASTM C 618 for Class C or F mineral admixture, except that the loss on ignition shall not exceed 3.0 percent.

Fly ash, when used as a replacement for portland cement, shall have an R factor less than 2.5. The R factor is defined as (C-5%)/F, where C is the calcium oxide content expressed as a percentage and F is the ferric oxide content expressed as a percentage. The R factor requirement may be waived if the contractor furnishes documented test results that the soil in contact with the portland cement concrete contains less than 0.10 percent water soluble sulfate (as SO4) and/or the water in contact with the portland cement concrete contains less than 150 milligrams per liter sulfate (as SO4). The tests for sulfates shall be performed in accordance with the requirements of California Department of Transportation Test Method No. 417. Calcium and ferric oxide content shall be determined in accordance with the requirements of ASTM C 311.

1006-2.05 Concrete Curing Materials:

Liquid membrane forming compound shall conform to the requirements of AASHTO M 148. Type 2 compound with either a Class A or Class B vehicle shall be used for concrete pavement, bridge decks, and approach slabs. Type 1 compound with either a Class A or Class B vehicle shall be used for other concrete items.

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

1006-3 Design of Mixtures:

1006-3.01 Design Criteria:

Portland cement concrete shall conform to the requirements specified in Table 1006-A for each of the Classes listed therein.

Unless otherwise shown in Table 1006-A, the proposed slump shall be chosen by the contractor. Concrete at the proposed slumps shall be sufficiently workable to allow proper placement without harmful segregation, bleeding, or incomplete consolidation.

Air-entraining admixtures will be required for all classes of concrete placed above an elevation of 3,000 feet, except for precast, prestressed structural members. The amount of entrained air in the concrete mixture shall not be less than four percent nor more than seven percent by volume.

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

SPECIAL PROVISION

JOB R20082

ASPHALT RUBBER STRESS ABSORBING MEMBRANE INTERLAYER

DESCRIPTION. This item shall consist of the application of a hot asphalt rubber material covered with aggregate for the scaling of existing concrete pavement and performing as a stress absorbing membrane interlayer (SAMI). This item shall include all materials, equipment, and construction methods necessary to produce a high quality SAMI in conformity with the lines and grades shown on the plans or as designated by the Engineer.

The SAMI shall be in accordance with Section 402 of the Standard Specifications for Highway Construction, edition of 1988 except as modified herein.

MATERIALS.

(a) Asphalt. The grade of asphalt cement for the asphalt rubber mixture shall be an AC-5 which shall comply with Section 403 of the Standard Specifications.

(b) Granulated Reclaimed Rubber. The granulated reclaimed rubber used shall be produced primarily from the processing of automobile and truck tires. The rubber shall be produced by ambient temperature grinding processes only.

The gradation of the granulated reclaimed rubber when tested in accordance with ASTM C-136 and using a 50 gram ± 1 gram sample, shall meet the following requirements:

Sieve Sizes	Percent Passing
#8	100
#10	95-100
#30	0-10
#50	0-5

The use of rubber from multiple sources is acceptable provided that the overall blend of rubber meets the gradation requirements.

The individual granulated rubber particles, irrespective of diameter, shall not be greater in length than 3/16 inch (5mm).

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

SPECIAL PROVISION

JOB R20082

ASPHALT RUBBER STRESS ABSORBING MEMBRANE INTERLAYER

The granulated rubber shall have a specific gravity of 1.15 ± 0.05 and shall be free of loose fabric, wire and other contaminants except that up to 4 percent (by weight of rubber) calcium carbonate or talc may be added to prevent rubber particles from sticking together. The rubber shall be sufficiently dry so as to be free flowing and not produce a foaming problem when blended with the hot asphalt cement.

The granulated reclaimed rubber shall be accepted by certification from the rubber supplier.

(c) Asphalt Rubber. At least 10 days before the beginning of membrane placement the asphalt-rubber supplier shall furnish to the engineer the asphalt-rubber mix formulation which shall contain the following information:

Asphalt Cement
- Source of Asphalt Cement
- Grade of Asphalt Cement
- Percentage of Asphalt Cement by total weight of the asphalt-rubber mixture.

Granulated Reclaimed Rubber
- Source of Granulated Rubber
- Grade of Granulated Rubber
- Percentage of Granulated Rubber by total weight of the asphalt-rubber mixture.

If granulated rubber from more than one source is utilized the above information will be required for each granulated rubber used.

(d) Aggregate. The aggregate shall be composed of clean and durable crushed rock, crushed gravel or slag conforming to the requirements of Section 403 of the Standard Specifications.

The aggregate shall meet the following gradation:

Sieve Sizes	Percent Passing
3/8	100
1/4	70-100
#8	0-5
#200	0-1

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

SPECIAL PROVISION

JOB R20082

ASPHALT RUBBER STRESS ABSORBING MEMBRANE INTERLAYER

Proposed aggregate samples shall be submitted to the following address for review and testing a minimum of 21 days prior to application:

International Surfacing, Inc.
Attention: Gene Morris
6751 W. Galveston
Chandler, AZ 85226

International Surfacing Incorporated shall test the aggregate for stripping characteristics. The results shall be submitted to the Engineer for approval.

APPLICATION RATE. The application rate of the aggregate and asphalt rubber shall be determined by the asphalt rubber supplier and submitted to the Engineer. The design aggregate application rate shall be applied at a rate of 23 to 33 pounds per square yard (based on 2.63 specific gravity). The design application rate of the asphalt rubber shall range from 0.55 to 0.65 gallon/square yard.

EQUIPMENT. All equipment necessary for the production and application of the Stress Absorbing Membrane Interlayer is detailed in this section.

(a) **Asphalt Rubber Equipment.** An asphalt heating tank with a hot oil heat transfer system or retort heating system capable of heating asphalt cement to the necessary temperature for blending shall be used. This unit shall be capable of heating a minimum of 3,000 gallons of asphalt cement. A mechanical blender with a two stage continuous mixing process shall be used to blend the asphalt and rubber. This blender shall be capable of producing a homogeneous mixture of asphalt cement and granulated rubber at the specified ratios as directed by the Engineer. This unit shall be equipped with a granulated rubber feed system capable of supplying the asphalt cement feed system, as not to interrupt the continuity of the blending process. A separate asphalt cement feed pump and finished product pump are required. This unit shall have both an asphalt cement totalizing meter in gallons and a low rate meter in gallons per minute.

(b) **Distributor.** The distributor shall be self propelled pressure type equipped with a separate power unit, distributing pump capable of pumping the specified material at the specified rate through the distributor tips, and equipment for heating the bituminous materials. The distribution bar on the distributor shall be fully circulating with nipples and valves so constructed that they are bathed in the circulated

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

SPECIAL PROVISION

JOB R20082

ASPHALT RUBBER STRESS ABSORBING MEMBRANE INTERLAYER

asphalt rubber materials to the extent that the nipples will not become partially plugged with congealing material upon standing thereby causing preliminary streaked or irregular distribution of asphalt. The distributor pumping system shall be capable of applying asphalt rubber material within ± 0.5 gallons per square yard tolerance of the specified application rate. The distributor shall have a boot board on the rear of the vehicle and a bootman shall accompany the distributor. The bootman shall ride in a position so that all spray bar tips are in full view and readily accessible for unplugging if a plugged tip should occur. The distributor shall also include a tachometer, pressure gauge, volume measuring device and a thermometer.

(c) Rollers. A minimum of three operational self propelled pneumatic tired rollers shall be used for the required rolling of the cover materials. The pneumatic-tired rollers shall carry a minimum loading of 3,000 pounds on each wheel and a minimum air pressure of 100 pounds per square inch in each tire.

CONSTRUCTION. For optimum performance it is recommended that holes and depressions in the old pavement surfacing should be repaired by patching and transverse and longitudinal cracks 3/8 inch wide and above be repaired by cleaning and filling with an asphalt-rubber crack sealant.

Immediately prior to the application of the asphalt-rubber membrane, the surface shall be thoroughly cleaned of foreign matter in order to insure adequate adhesion of the asphalt-rubber to the pavement.

Due to the handling characteristics of asphalt-rubber, when irregular areas are to be sealed it is recommended that this be done with an RS or CRS chip seal emulsion or paving grade asphalt cement as per Section 403 of the Standard Specification.

(a) Asphalt-Rubber Mixing and Reaction. The percentage of granulated rubber shall be 22 percent plus or minus 3 percent by weight of total asphalt-rubber mixture, the exact granulated rubber content shall be as determined by the mix design submitted by the asphalt-rubber supplier. During membrane interlayer placement the granulated rubber percentage shall not fluctuate by more than 1 percent by weight of total asphalt-rubber mixtures.

The temperature of the asphalt cement shall be between 350 and 425°F at the addition of the granulated rubber. The asphalt and rubber shall be combined and mixed together in the asphalt-rubber blending unit and

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

SPECIAL PROVISION

JOB R20082

ASPHALT RUBBER STRESS ABSORBING MEMBRANE INTERLAYER

reacted in the distributor for a period of time as required by the Engineer which shall be based on laboratory testing by the asphalt-rubber supplier. The temperature of the asphalt-rubber shall be above 325°F during the reaction period.

When a job delay occurs after full reaction, the asphalt rubber may be allowed to cool. The asphalt rubber shall be reheated slowly just prior to application but not to a temperature exceeding 350°F.

(b) Application of Stress Abosorbing Membrane Interlayer. Placement of the asphalt-rubber membrane shall be made only under the following conditions:

1. The pavement surface temperature shall be 45°F and rising.
2. The pavement surface is clean and absolutely dry.
3. The wind conditions are not excessive.
4. All construction equipment such as asphalt-rubber distributor, cover material spreader, haul trucks with cover material, and rollers are in position and ready to commence membrane placement operations.
5. Rain is not imminent.

The asphalt rubber mixture shall be applied at a temperature of 290°F to 340°F at a rate of 0.55 to 0.65 or ± 0.5 gal.yd^2 of the design applciation rate. Transverse joints shall be constructed by placing building paper across and over the end ofthe previous asphalt rubber application. Once the spraying has progressed beyond the paper it shall be removed immediately and disposed of as directed by the Engineer. All longitudinal joints shall not exceed a four inch overlap.

Cover materials shall be applied immediately to the asphalt rubber after spreading at a rate of 23 to 33 pounds per square yard or ± 5 lbs. per square yard of the design application rate (at 2.63 specific gravity).

At the time of application to the asphalt rubber, the aggregate shall be surface dry so as to gain proper adhesion to the asphalt-rubber.

(c) Rolling. At least three operationsl pneumatic-tired rollers shall be provided to accomplish the required embedment of the cover material. At some project locations or where production rates dictate, fewer rollers may be utilized as directed by the Engineer. At no time shall there be less than two operational pneumatic tired rollers on a project.

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

SPECIAL PROVISION

JOB R20082

ASPHALT RUBBER STRESS ABSORBING MEMBRANE INTERLAYER

Sufficient rollers shall be used for the initial rolling to cover the width of the aggregate spread with one pass. The first pass shall be made immediately behind the cover material spreader, and if the spreading is stopped for an extended period, the cover material spreader shall be moved ahead or off the side so that all cover material may be immediately rolled. Four complete passes with rollers shall be made with all rolling completed within one hour after the application of the cover material.

(d) Brooming. Brooming or sweeping may begin a minimum of one hour after membrane placement.

TRAFFIC CONTROL. Except when it is necessary that hauling equipment must travel on the newly applied membrane, traffic of all types shall be kept off the membrane until it has had time to set properly. The speed of all hauling equipment shall not exceed 15 miles per hour hwen traveling over a membrane which is not adequately set. The minimum traffic free period shall not be less than one hour.

METHOD OF MEASUREMENT.

(a) Mineral aggregate will be measured by the ton

(b) Antistrip additive will be measured by the pound

(c) Asphalt rubber will be measured by the gallon

Quantities of asphalt rubber may be determined by calibrated meter and checked by weight of material or tank volume measurements. The quantity of anti-strip additive will be determined by a percentage of the weight of asphalt rubber based on the manufacturer's recommendation.

BASIS OF PAYMENT. Work completed and accepted and measured as provided above will be paid for as follows:

(a) Mineral aggregate for Stress Absorbing Membrane Interlayer will be paid for at the contract unit price bid per ton for mineral aggregate in Stress Absorbing Membrane Interlayer.

(b) Asphalt Rubber for Stress Absorbing Membrane Interlayer will be paid for at the contract unit price bid per gallon for asphalt rubber in Stress Absorbing Membrane Interlayer.

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

SPECIAL PROVISION

JOB R20082

RUBBER MODIFIED ASPHALT CONCRETE HOT MIX SURFACE AND BINDER COURSE

DESCRIPTION: This item shall consist of the materials, equipment, and construction procedures necessary for producing and placing rubber modified dense graded asphalt concrete hot mix surface course and binder course in conformity with the lines and grades shown on the plans or as designated by the Engineer.

Rubber modified asphalt concrete hot mix surface and binder courses shall meet all the requirements for Type 1 binder course or Type 1 surface course outlined in Sections 405 and 406 of the Standard Specifications for Highway Construction, edition of 1988, except as modified herein.

MATERIALS:

(a) GRANULATED RECLAIMED VULCANIZED RUBBER: The rubber used shall be produced primarily from the processing of automobile and truck tires. The rubber shall be produced by ambient temperature grinding process only. The gradation of the rubber when tested in accordance with ASTM C136 and using a 50 gram ± 1 gram sample shall meet the following requirements:

Sieve Size	Percent Passing
#10	100
#16	98-100
#30	70-100
#50	10-40
#200	0-5

The use of rubber of multiple types from multiple sources is acceptable provided that the overall blend of rubber meets the gradation requirements.

The graulated rubber shall have a specific gravity of 1.15 ± 0.05 and shall be free of loose fabric, wire and other contaminants. Calcium carbonate or talc of up to 4 percent (by weight of rubber) may be used to prevent rubber particles from sticking together. The rubber shall be sufficiently dry so as to be free flowing and not produce a foaming problem when blended with the hot asphalt cement.

The length of the individual rubber particles shall not exceed 3/16 inch.

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

SPECIAL PROVISION

JOB R20082

RUBBER MODIFIED ASPHALT CONCRETE HOT MIX SURFACE AND BINDER COURSE

(b) ASPHALT CEMENT: The amount of asphalt cement in the mix shall be between 5.0 and 10.0 percent of the total mix. The exact amount of asphalt cement in the mix will be determined by the mix design. The grade selected shall be determined by laboratory testing performed by the asphalt rubber supplier to insure appropriate stability. These laboratory results shall be submitted to the Engineer.

(c) RUBBER MODIFIED ASPHALT CEMENT: The rubber modified asphalt cement shall be a uniform reacted mixture of compatible paving grade asphalt cement, granulated reclaimed vulcanized rubber, and liquid antistrip agent if required. The proportion of granulated rubber shall be between 16 and 20 percent by weight of rubber modified asphalt cement.

The rubber modified asphalt binder shall meet the following physical properties when reacted at 350°F ± 10°F for 60 minutes:

Property	Test Method	Requirements: Min	Max
Viscosity, Haake 350°F (cp)	ISI	1500	4000
Cone Penetration, 77°F	AASHTO T187	40	-
Softening Point (°F)	AASHTO T53	125	-
Resilience, 77°F (%)	ASTM D3407	15	-

MIX DESIGN: The Contractor shall submit a mix design to the Engineer not less than 14 days before production of the mix begins. The mix design shall be performed by the asphalt rubber supplier or his duly appointed representative. The mix design shall consist of the following information:

1. Physical properties of rubber modified asphalt cement
2. Source and grade of asphalt
3. Percentage of rubber and asphalt cement in rubber modified asphalt cement
4. Source and gradation of granulated rubber
5. Source and quantity of antistrip agent

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

SPECIAL PROVISION

JOB R20082

RUBBER MODIFIED ASPHALT CONCRETE HOT MIX SURFACE AND BINDER COURSE

The mix design shall also include the design mix properties shown in Table 4-1 in Section 405 of the Standard Specifications for the binder course and Table 4-2 in Section 406 for the surface course. All properties and tolerances for Type 1 binder and surface courses shown in Section 405 and 406 of the Standard Specifications shall be met except as modified below:

Property	Surface	Binder
Design Air Voids	2.5 to 4.5	2.5 to 5.0
Flow	20 max	20 max
Asphalt Rubber Binder Content Tolerance	±0.5%	±0.5%

The mix design shall also recommend the following:

1. % rubber modified asphalt binder (total, and aggregate weight basis)
2. mix production temperature
3. mix compaction temperature
4. density range for high performance, however, the minimum density shall be 92% of theoretical

EQUIPMENT: All equipment for mixing, spreading and compacting rubber modified asphalt concrete hot mix surface course and binder course shall meet the requirements of Section 409 of the Standard Specifications except as modified herein.

(a) EQUIPMENT FOR RUBBER MODIFIED ASPHALT CEMENT: All equipment utilized in production and proportioning of the asphalt-rubber binder shall be described as follows:

1. An asphalt heating tank with a hot oil heat transfer system or retort heating system capable of heating asphalt cement to the necessary temperature for blending with the granulated rubber. This unit shall be capable of heating a minimum of 3,000 gallons of asphalt cement.

2. An asphalt-rubber mechanical blender with a two stage continuous mixing process capable of producing a homogenous mixture of asphalt cement and granulated rubber, at the mix design specified ratios, as directed by the engineer. This unit shall be equipped with a granulated rubber feed system capable of supplying the asphalt cement feed system, as not to interrupt the continuity of the blending process. A separate asphalt cement feed pump and finished product pump are required. This unit shall have both an asphalt cement totalizing meter in gallons and flow rate meter in gallons per minute.

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

SPECIAL PROVISION

JOB R20082

RUBBER MODIFIED ASPHALT CONCRETE HOT MIX SURFACE AND BINDER COURSE

3. An asphalt-rubber storage tank equipped with a heating system to maintain the proper temperature for pumping and adding of the binder to the aggregate and an internal mixing unit within the storage vessel capable of maintaining a proper mixture of asphalt cement and granulated rubber.

4. An asphalt-rubber supply system equipped with a pump and metering device capable of adding the binder by volume to the aggregate at the percentage required by the job-mix formula.

(b) MIXING EQUIPMENT: The rubber modified asphalt concrete mixing equipment shall be capable of producing a paving mixture meeting all the requirements contained in this specification. The plant shall provide proper aggregate gradation, rubber asphalt content and mixing temperature.

(c) MIXTURE SPREADING EQUIPMENT: Paving shall be accomplished with self-propelled, mechanical spreading and finishing equipment, pneumatic tired or tracked type, having a tamping bar or vibratory screed or strike-off assembly capable of distributing the material to not less than the full width of a traffic lane and to the depth needed to achieve the minimum compacted thickness or finished grade as required. The screed or strike-off assembly shall be equipped with a heating unit that maintains the temperature needed to prevent tearing of the paving mixture during spreading. Pavers that leave ridges, indentations or other marks in the surface that cannot be eliminated by rolling or prevented by adjustment in operation of the equipment shall not be used.

(d) HAULING EQUIPMENT: Trucks for hauling the paving mixture shall be tailgate discharge, dump or moving bottom (horizontal discharge) type, and compatible with the spreading equipment. If a dump unit is utilized, the bed will not push down on the paver receiving hopper when fully raised or have too short a bed which results in mixture spillage in front of the paver.

(e) COMPACTION EQUIPMENT: Rollers shall be self-propelled, 2-axle (tandem) steel-wheel type and shall have a minimum weight of 8 tons. The maximum roller weight shall be 12 tons. All rollers shall be equipped with pads and a watering system to prevent sticking of the paving mixture to the steel-tired wheel (drums). Vibratory rollers may be used for dense grade mixes only. Unless otherwise permitted by the engineer, the contractor shall furnish a minimum of two of the rollers as described above. Pneumatic tire rollers will not be used, due to the increased adhesiveness of the asphalt-rubber binder.

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

SPECIAL PROVISION

JOB R20082

RUBBER MODIFIED ASPHALT CONCRETE HOT MIX SURFACE AND BINDER COURSE

(d) HAULING OF RUBBER ASPHALT MIX: Truck beds shall be clean of materials such as dirt, mud and aggregates. Just prior to loading of the mixture, the truck bed shall be sprayed with a light application of a soapy solution of a silicone emulsion (oiling with kerosene or diesel fuel will not be permitted due to the increased stickiness of the asphalt-rubber binder) to reduce sticking of the mixture to the truck bed.

(e) SPREADING OF RUBBER ASPHALT MIX: The mixture whall be placed and finished by means of the paving equipment specified under subheading "Equipment" of this specification except under certain conditions or at certain locations where the engineer determines use of self-propelled pavers impractical. Mixture spread temperature shall be 275°F to 300°F.

The paving equipment shall place the mixture without segregation or tearing within the specified tolerances and true to the line, grade and crown indicated on the plans. In order to achieve a continuous spreading operation, the speed of the paver shall be coordinated with the production of the mixing plant and the hauling trucks.

The mixture shall not be placed on any wet surface or when weather conditions will otherwise prevent its proper handling or finishing. The mixture shall be placed only when the atmospheric temperature is at least 50°F.

(f) COMPACTION: The mixture shall be rolled by means ofthe compaction equipment specified under subheading "Equipment" of this specification. A minimum of two rollers shall be used for mixture compaction unless otherwise directed by the engineer. The steel-tired wheel (drums) shall be wetted with plain water or, if necessary, with soapy water to prevent mixture pick-up during rolling. No pneumatic rolling will be permitted.

Initial or breakdown compaction shall commence immediately after mixture spreading and shall consist of at least 3 full coverages unless otherwise directed by the engineer to prevent damage to the course being compacted. A coverage shall be as many passes as are necessary to cover the entire width being paved with a pass being one movement of a roller in either direction. Each coverage shall be complete before subsequent coverages are started. Final rolling consisting of not less than one complete coverage, shall be used to smooth the surface of the mat. All rolling shall be accomplished without excessive aggregate fracturing or mixture shoving.

(g) APPLICATION OF BLOTTER MATERIALS: The application of blotter material (usually 4 to 6 pounds per square yard) meeting the requirements of Section 401 of the Standard Specifications may be required on a warm mat before opening to traffic. The use, rate and locations for blotter material shall be designated by the engineer.

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

SPECIAL PROVISION

JOB R20082

RUBBER MODIFIED ASPHALT CONCRETE HOT MIX SURFACE AND BINDER COURSE

METHOD OF MEASUREMENT:

(a) Mineral aggregate will be measured by the ton. Mineral filler will not be measured separately but will be considered as mineral aggregate.

(b) Asphalt cement will be measured by the ton and reduced by the amount of anti-strip required.

(c) Anti-strip additive will be measured by the pound.

(d) Granulated rubber will be measured by the ton.

(e) MIX DESIGN: The work involved in furnishing a mix design, including all required revisions, will not be paid for directly, but will be considered included in the price bid for rubber modified asphalt concrete hot mix surface course and rubber modified asphalt concrete hot mix binder course.

Quantities of aggregate and asphalt cement will be determined by weighing the composite mixture on truck scales, determining the weights of the asphalt cement and granulated rubber by the job mix formula and deducting these weights from the total weight of the composite mixture to obtain the weight of the aggregate. The quantity of anti-strip additive will be determined by a percentage of the weight of asphalt cement based on the job mix formula.

When an automatic printer system is used in conjunction with an automatic batching and mixing control system, the printed batch weights will be used in lieu of truck scales in making this determination.

BASIS OF PAYMENT: Work completed and accepted and measured as provided above will be paid for as follows:

(a) Mineral aggregate for the Binder Course will be paid for at the contract unit price bid per ton for Mineral Aggregate in Rubber Modified ACHM Binder Course.

(b) Mineral aggregate for the Surface Course will be paid for at the contract unit price bid per ton for Mineral Aggregate in Rubber Modified ACHM Surface Course.

In cases where the combined specific gravity of the mineral aggregate exceeds 2.80, the tonnage of mineral aggregate will be adjusted for payment by multiplying the tonnage of mineral aggregate used by a specific gravity of 2.80 and dividing by the higher specific gravity.

ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT

SPECIAL PROVISION

JOB R20082

RUBBER MODIFIED ASPHALT CONCRETE HOT MIX SURFACE AND BINDER COURSE

(c) Asphalt cement will be paid for at the contract unit price bid per ton for Asphalt Cement in Rubber Modified ACHM.

(d) Anti-strip additive will be paid for at the contract unit price bid per pound for Anti-strip Additive in Rubber Modified ACHM.

(e) Granulated rubber will be paid for at the contract unit price bid per ton for Granulated Rubber in Rubber Modified ACHM.

The contract unit prices mentioned above shall be full compensation for furnishing materials; for heating, mixing, hauling, placing, rolling and finishing; and for all labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
Mineral Aggregate in Rubber Modified ACHM Binder Course	Ton
Mineral Aggregate in ~~Rubber~~ Modified ACHM Surface Course	Ton
Asphalt Cement in Rubber Modified ACHM	Ton
Anti-Strip Additive in Rubber Modified ACHM	Pound
Granulated Rubber in Rubber Modified ACHM	Ton

Connecticut

GENERAL SPECIFICATIONS FOR THERMOPLASTIC SIGN BLANKS
APRIL 1990

SCOPE

Thermoplastic panels are designed to serve as a substrate for reflective sheeting in the fabrication of traffic signs. The following specifications define general characteristics, mechanical properties and physical properties. ASTM test procedures are noted for each of the general specifications outlined below. ASTM test procedures and specific attributes for each material are noted on their properties sheet.

GENERAL CHARACTERISTICS

Whenever possible thermoplastic panels will be manufactured from reclaimed materials that satisfy the following general and specific material specifications. The panels shall be stabilized so as not to release migrating constituents (i.e., solvents, monomers, etc.) and shall contain no residual release agents on the surface. Panels shall not contain visual cracks, pinholes, foreign inclusions, or surface wrinkles that would impair the designed purpose, alter specific dimensions, or effect serviceability.

MECHANICAL PROPERTIES

Mechanical properties shall be measured according to the ASTM test method indicated for each attribute described on the individual material specifications sheets.

PHYSICAL PROPERTIES

1. Weatherability - The panels will be tested under ASTM D-4329, standard for light/water exposure of plastics and DIN 53 384 testing of plastics and exposure to artificial light but shall have a functional life of no less than seven years.

2. Fire Resistance - See individual material properties sheet. (Test #ASTM D635-UL94) but shall be rated V-2 or better.

3. Impact resistance - Test method ASTM D-3763 or by impacting at 72 degrees F using a Gardner impact tester with a 1" dart at 60 ft#.

4. Coefficient of Linear Thermal Expansion - see individual material properties sheet. (per ASTM D696) but shall not exceed 3.75x10 in/in/ F.

5. Panel Flatness - With a 30 inch by 30 inch panel freely suspended at one corner, the maximum deflection measured diagonally, parallel and perpendicular to the panel by lines drawn through the center of the panel shall not

exceed 0.5 inches. The panel shall then be freely suspended at one corner in an oven for 48 hours at 180 degrees F. The maximum deflection shall again be measured as previously noted and shall not exceed 0.5 inches. All measurements shall be made when panels are at ambient temperature.

6. Flexibility - Panels shall be capable of flexing at least 4" in both directions from an at rest position at a sustained rate of 9,000 cycles per hour for at least 125,000 cycles.

7. Thermal Stability - Panel materials must be sufficiently designed to remain functional in a temperature range of -65 degrees F to 212 degrees F. The sign material must also be capable of accepting of 250 degrees F for three minutes in a fully supported condition to allow the application of heat-activated sheeting material. A sample 3" x 12" must be capable of bending 90 degrees in a center loaded beam with simple supports immediately after preparation at -50 degrees F for 24 hours.

8. Panel Smoothness - Panels shall be manufactured with smooth surfaces on both sides of the panel. Small deviations will be acceptable if they do not adversely affect the adhesion of the reflective sheeting or the sign legibility.

9. Color - Panels shall be pigmented to a visually uniform color within the following range using a colorimeter with a Hunter L a b scale:

Criteria	Value	Tolerance
L	77	+/- 6
a	0.0	+/- 0.5
b	0.0	+/- 0.5

10. Specific gravity as measured by ASTM D 792 will range from 1.0 to 1.3 depending upon the material specified.

PHYSICAL DIMENSIONS

1. Panel Thickness - Panel thickness shall have a tolerance of +0.010 inches.

2. Dimensional tolerances: Equilateral panels must be no more than 1/64"/ft when measured across the corners and-0" + 1/64/ft from side to side. Rectangular panels must measure 0" + 1/64"/ft both ways up to a maximum of -0 + 3/4".

SIGNAGE SUBSTITUE EVALUATION

OVERVIEW

The need for an alternative substitute to aluminum has been strongly expressed by the industry due to the continuing losses caused by theft and unpredictable pricing. Substitutes such as fiberglass have not proven functionally satisfactory, are made of virgin material and are not recyclable. Disposition of discarded signs is difficult because of refusal by many landfills to accept this material. International Plastics has developed a 100% salvaged thermoplastic substitute for this application and can offer production quantities now.

DISCUSSION

The development of a new alternative substitute for the traffic sign industry involves four basic areas: U.V. resistance that will assure at least a 7-10 year life; ability to withstand high winds and impact; legibility and adhesion of the finishing surfaces that is comparable to aluminum and a substrate that is not attractive to thieves. A number of samples of the alternative substrate have been exposed to local ambient conditions since December 1989 for overall evaluation. Samples are on test in a tropical ambient. The proposed plastic resin has excellent U.V. stability and has a long history of exterior applications. Further U.V. evaluation is not required for this signage application.

TESTING

In order to evaluate the mechanical capability of this system it was necessary to determine the ability of this substrate to tolerate flexing and the ability of the applied sheeting (3M material) to maintain its integrity under high wind conditions. In order to approximate these conditions a testing device has been developed to simulate sustained hurricane force winds against a typical 30" square single post traffic control sign. This device generates total deformation of 10" at the periphery of the sign at a sustained rate of 300 cycles per minute. No failures of the substrate, adhesion of the sheet to the substrate or the sheet itself has occurred after 125,000 cycles. Adhesion of the finishing sheeting at 150 F for 85 hours did not effect the substrate or sheeting. A complete compilation of the properties and test criteria is attached.

ADVANTAGE

The elimination of substrate theft created by the high salvage value of aluminium is accomplished. The use of recycled plastics for signs that are themselves recyclable at the end of their useful life provides a valuable service that has important political implications for the user. The ability to flex on impact reduces replacement costs. Much more important benefits result by its ability to yield and absorb energy, an important factor in the reduction of impact damage and possiblo injury. Last but not least, this approach is highly competitive to aluminum and other substrates now being offered and has potential for further cost reduction as applications multiply across the country.

SPECIFICATIONS FOR ASPHALT-RUBBER CONCRETE MIX

1.0 MATERIALS

1.1 Asphalt-Rubber Binder

The asphalt-rubber binders shall be a uniform and reacted mixture of compatible paving grade AC-20 asphalt cement and ground reclaimed rubber.

1.1.1. Asphalt Cement

The asphalt cement shall be an appropriate grade as determined by the asphalt-rubber supplier and shall meet requirements of AASHTO M226 for the specific grade used.

1.2 Ground Reclaimed Rubber

The rubber used shall be produced primarily from the processing of scrap rubber (automobile and truck tires) from the District of Columbia Department of Public Works. If the supplier uses ground rubber from sources outside the District, he shall obtain and remove from the District of Columbia an amount of discarded tires equivalent to the amount of ground rubber used. The rubber shall be produced at ambient temperature.

1.2.1 Gradation

The gradation of the rubber when tested in accordance with ASTM C136 and using a 50 grams $\pm$ 1 gram sample shall meet

the following requirments:

Sieve Size	%Passing
#10	100%
#16	95 - 100%
#30	70 - 100%
#80	0 - 20%
#200	0 - 5%

The use of rubber of multiple types from multiple sources is acceptable provided that the overall blend of rubber meets the gradation requirements.

1.2.2. Additional Rubber Requirements

The length of the individual rubber particles shall not exceed 3/16 of an inch (5mm).

The ground rubber shall have a specific gravity of 1.15 ± 0.05 and shall not contain more than 0.5 % loose fabric, wire, and other contaminants. Calcium carbonate or talc up to 4% by weight of rubber may be added to prevent rubber particles from sticking together. The rubber shall be sufficiently dry (no free water) so as to be free flowing and not producing a foaming problem when blended with the hot asphalt cement.

1.2.3 Acceptance

The ground rubber shall be accepted by certification from the rubber supplier.

1.3 Extender Oil

The extender oil shall be resinous high flash point aromatic hydrocarbon conforming to the following requirements:

Viscosity, SSU, at 100 F (ASTM D-88)	2,500 Min.
Flash point, COC, F (ASTM D-92)	390 Min.
Molecular Analysis (ASTM D-2007)	
Asphaltenes, weight %	0.1 Max.
Aromataics, weight %	55.0 Min.

2.0 HOT MIX ASPHALT DESIGN

2.1 Materials

2.1.1 Asphalt-Rubber Binder

The asphalt-rubber binder shall be a uniform blend of the asphalt, rubber and extender oil.

The asphalt-rubber blend shall contain 20 $\pm$ 4 percent rubber by weight of binder. The blended asphalt-rubber binder when reacted for one hour at 350°F $\pm$ 10°F shall possess the

following physical properties:

Property	Type II
Viscosity, 350°F	1500 cp min.
Cone Penetration, 77°F (ASTM D1191)	20 min.
Softening Point, F (ASTM D30)	125 min.
Resilience, 77 F (ASTM D3407)	15% min.

2.1.2 Aggregates

Aggregates shall meet the requirements of D.C. Specification Sec. 401.02 B and D for binder (leveling course) gradation and quality.

2.1.3 Anti-stripping Agent

An anti-stripping agent that is heat stable and approved for use by D.C. Dept. of Public Works Standard Specifications (Sec. 831) shall be incorporated into the asphalt-rubber material at the dosage required by the job mix formula.

2.2 Hot Mix Asphalt Rubber Design

The contractor shall send a representative sample of the asphalt cement and aggregate proposed to the asphalt rubber supplier for mix design 30 days prior to paving. The asphalt-rubber supplier shall supply to the engineer

a mix formula at least 10 days before pavement construction is scheduled to begin. The mix formula provided to the engineer shall contain the following information:

* asphalt cement grade and source

* antistrip percentage to be used and source

* ground rubber source and gradation

* rubber percentage to be used

* extender oil percentage to be used and source

* physical properties of the binder in accordance with Section 2.1.1

* all other requirements as per Interim Revisions of D.C. Standard Specifications, paragraph 805.01 with exceptions that maximum flow shall be 18 and the temperature shall be as stated in Section 4.0.

3.0 EQUIPMENT

3.1 Asphalt Heating Tank

An asphalt heating tank shall be equipped with a minimum of 2,800 gallon tank capable of raising the temperature of the product at a rate of 60°F per hour.

3.2 Mechanical Blender

A mechanical blender for proper proportioning and thorough mixing of the asphalt cement and ground rubber will be required. The blender shall be capable of producing a homogenous mixture at the specified ratio. This unit shall have an asphalt totaling meter (gallons or liters), a flow rate meter (gallons per minute or liters per minute), a positive placement auger to feed the rubber properly into the mixing chamber at the specified rate, and a screw auger in both the mixing chamber and heat tank running through a static motionless mixer. The blender will have a separate asphalt cement feed pump and a finished product pump to maximize production.

3.3 Asphalt-Rubber Storage Tank

An asphalt-rubber storage tank equipped with a heating system to maintain the proper temperature for pumping and adding the binder to the aggregate and an internal mixing unit within the storage tank capable of maintaining a proper blend of asphalt cement and rubber will be required.

3.4 Asphalt-Rubber Supply System

An asphalt-rubber supply system equipped with a pump and metering device capable of adding the binder by volume to the aggregate at the percentage required by the job-mix formula will be required.

4.0 MIXING AND REACTION PROCEDURE

4.1 Asphalt Temperature

The temperature of the asphalt shall be between 350°F and 415°F at the time the rubber is blended with the asphalt.

4.2 Blending and Reacting

The asphalt and rubber shall be combined and mixed together in a blender unit, pumped into the agitated storage tank, and reacted for a minimum of 45 minutes from the time the rubber is added to the asphalt.

4.3 Reaction Temperature

The temperature of the asphalt-rubber binder shall be maintained between 325°F and 385°F during the reaction period.

4.4 Transfer

After the material has reacted for at least 45 minutes, the asphalt-rubber binder shall be maintained at a temperature of 325°F to 385°F before being metered into the mixing chamber of the asphalt concrete production plant at the percentage required by the job mix formula.

4.5 Delays

When a delay occurs in binder use after its full reaction the asphalt-rubber shall be allowed to cool. The asphalt-rubber binder shall be reheated at a rate not to exceed

100° F just prior to use to a temperature not to exceed 375°F and shall be thoroughly mixed before pumping and metering into the hot mix plant for combination with the aggregate. The viscosity of the asphalt-rubber binder shall be checked by the producer.

5.0 ASPHALT-RUBBER CONCRETE MIX TEMPERATURE

The acceptable range of mix temperatures is:

310°F to 350°F at the plant
290°F to 335°F at the road site.

RECYCLED PLASTIC FENCE POST

1-0 DESCRIPTION

The work covered in this section consists of furnishing recycled plastic line fence posts in accordance with these specifications. The fencing shall comply with the applicable articles of Sections 550 and 954 of the 1991 "Standard Specifications for Road and Bridge Construction" for Type A (Farm Fence).

2-0 MATERIALS

The materials used for this fencing material shall consist of a minimum of 75% recycled plastic and shall be uniform in composition throughout the length of the post. The posts shall contain no more than 20% voids over the length of the post. The posts shall be brown in color approximating tree bark to blend with the surroundings, shall have no cracking, chipping, flaking, peeling or splintering in the final product. No chemical additives shall be part of the post composition. Approved chemicals, including fillers and colorants, designed to inhibit photo degradation or biological/biochemical decomposition will be permitted to enhance durability.

3-0 PHYSICAL REQUIREMENTS

3.1 Minimum dimensions for line posts:

Length - 8 feet

Cross-section - Round post 3.25 inch diameter.

Square post 3.5 inch by 3.5 inch

3.2 Straightness

The straightness of the post shall comply with Section 954-5 for timber fence posts

3.3 Flexural Strength

The posts shall meet the requirements of the latest edition of the Southern Pine Inspection Bureau's Standard Grading Rules for Southern Pine Lumber, for No. 2SR Stress Rated Grade timber.

4-0 DURABILITY REQUIREMENTS

Recycled plastic posts shall be durable and useful for a minimum of 35 years. The posts shall be resistant to soil organisms and resistant to all insects, especially attacks by fire ants and termites. As defined here, resistance refers to maximum post weight loss of no more than one percent (1.0%) over the life of the post.

The recycled plastic posts, when located in wet conditions (fresh or marine waters) shall demonstrate a water uptake not to exceed ten percent (10%) by weight over the lifetime of the post.

The recycled plastic posts shall be self-extinguishing after exposure to a grass fire.

5-0 SAMPLING AND DELIVERY

Recycled plastic posts shall be delivered to the Department in wrapped bundles of no more than 50 posts. One additional post per thousand and a minimum of one per order shall be included in the order for Department testing.

6-0 CERTIFICATION

For recycled plastic posts, the manufacturer shall certify that such posts have been tested in accordance with this specification and found to meet the requirements. A certification shall be provided for each lot of a shipment. The manufacturers shall also certify the following:

a. The source of the recycled plastic waste, including the state and type of waste (consumer or industrial).

b. The total percent of recycled plastic in the final product.

Iowa Department of Transportation

SPECIAL PROVISIONS
for
ASPHALT RUBBER CEMENT (ARC) CONCRETE

FN-21-6(6)—21-07, Black Hawk County

August 27, 1991

THE STANDARD SPECIFICATIONS, SERIES OF 1984, ARE AMENDED BY THE FOLLOWING MODIFICATIONS. THESE ARE SPECIAL PROVISIONS, WHICH SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

1028.01 DESCRIPTION.

The asphalt rubber cement (ARC) concrete mix composition will include the incorporation of ARC in the mixture, using the aggregates selected by the Contractor.

The Contractor shall have a representative of the rubber supplier available on the project site during production of the asphalt rubber cement concrete mixture.

1028.02 GENERAL REQUIREMENTS.

The ARC concrete mixes shall conform to the requirements of the standard specifications for the standard asphalt cement concrete mixes as specified in the plans. The Standard Specifications are modified as follows:

A. Mineral Aggregate for the ARC Concrete Mixes.

Mineral aggregate requirements shall be in accordance with the plans and the standard specifications except the gradations for the concrete mixtures shall meet the following:

Sieve size	Percent passing 1/2" Type A ARC Concrete Mixture	Percent passing 3/4" Type B ARC Concrete Mixture
1"		100
3/4"	100	90-100
1/2"	90-100	70-90
3/8"	75-95	60-80
#4	50-70	40-60
#8	35-50	30-45
#30	15-25	12-22
#50	6-16	5-14
#200	2-8	2-6

B. Asphalt Rubber Cement.

The asphalt rubber cement shall be a uniform reacted blend of compatible paving grade asphalt cement, ground reclaimed vulcanized rubber, extender oil if required, and liquid anti-stripping agent when indicated by standard moisture susceptibility tests. The asphalt rubber cement shall meet the physical parameters listed below.

Apparent Viscosity, 347°F., Spindle 3, 12 RPM cps (ASTM D2669 Brookfield)	Min Max	1,000 4,000
Penetration, 77°F., 100 g, 5 sec.: 1/10 mm. (ASTM D5)	Min Max	50 100
Penetration, 39.2°F., 200 g, 60 sec.: 1/10 mm. (ASTM D5)	Min	25
Softening Point: °F., (ASTM D36)	Min	120
Resilience, 77° F.,: % (ASTM D3407)	Min	10
Ductility, 39.2° F., 1 cpm: cm. (ASTM D113)	Min	10
TFOT Residue, (ASTM D1754) Penetration Retention, 39.2° F.: %	Min	75
Ductility Retention, 39.2° F.: %	Min	50

C. Asphalt Extender Oil.

An asphalt extender oil may be added, if necessary, to meet the requirements of asphalt rubber cement. Extender oil shall be a resinous, high flash point, aromatic hydrocarbon meeting the following test requirements.

Viscosity, SSU, at 100 degrees F (ASTM D88)	2500 min.
Flash Point, COC, degrees F (ASTM D92)	390 min.
Molecular Analysis (ASTM D 2007):	
Asphaltenes, Wt. %	0.1 min.
Aromatics, Wt. %	55.0 min.

D. Equipment.

All equipment shall conform to the standard specifications unless noted otherwise in this Special Provision.

1028.03 GROUND RECLAIMED VULCANIZED RUBBER.

A. General.

The ground rubber shall be produced from the processing automobile and/or truck tires by ambient grinding methods. The rubber shall be substantially free from contaminants including fabric, metal, mineral, and the non-rubber substances. The rubber shall be sufficiently dry to be free flowing and not produce a foaming problem when added to hot asphalt cement. Up to 4% by weight of talc or other appropriate blocking agent can be added to reduce agglomeration of the rubber particles.

A.1 Physical Requirements.

Gradation and Particle Length: When tested in accordance with ASTM C-136 using a 50 gram sample, the resulting rubber gradation shall meet the following gradation limits.

Sieve Size	Percent Passing Type II
#10	100
#16	75-100
#30	26-60
#50	0-20
#200	0-5
Max. Particle Length	3/16"

A.2 Fiber Content.

The ground rubber shall be designated Grade A or Grade B. For Grade A rubber, the fiber content shall be less than 0.1% by weight. For Grade B rubber the fiber content shall be less than 0.5% by weight. The fiber content shall be determined by weighing fiber agglomerations which are formed during the gradation test procedure. Rubber particles shall be removed from the fiber agglomerations before weighing.

A.3 Moisture Content.

The moisture content of the ground rubber shall be less than 0.75% by weight.

A.4 Mineral Contaminants

The mineral contaminant amount of the ground rubber shall not be greater than 0.25% by weight as determined after water separating a 50 gram rubber sample in a 1 liter glass beaker filled with water.

A.5 Metal Contaminants

The rubber shall contain no visible metal particles as indicated by thorough stirring of a 50 gm. sample with a magnet.

B. Packaging

The ground rubber shall be supplied in moisture resistant packaging such as either disposable bags or other appropriate containers. Bags shall be palletized into units for shipment and glue shall be placed between layers of bags to increase the unit stability during shipment. Palletized units containing bags shall be wrapped with ultra-violet resistant stretch wrap. The maximum allowable tolerance per bag will be $\pm$ 2 lbs. for bags weighing 100 lbs or less.

C. Labeling

Each container or bag of ground rubber shall be labeled with the manufacturer designation for the rubber and the specific type in accordance with this specification, the nominal rubber weight designation with tolerance, and the manufacturer lot designation. Palletized units shall contain a label which indicates

the manufacturer and production lot number designations, rubber type, and net pallet weight.

D. Certification

The supplier shall ship with the rubber, certificates of compliance which certify that all requirements of these specifications are complied with for each production lot number of shipment.

E. Anti-Stripping Agent

If required by the job mix formula to produce appropriate water resistance, an anti-stripping agent that is heat stable and approved for use by the specifying agency shall be incorporated into the asphalt rubber cement at the percentage required by the job mix formula. It shall be added to the asphalt cement prior to blending with the ground rubber.

1024.06 ASPHALT RUBBER CEMENT BLEND DESIGN

The asphalt cement shall be grade AC-5 unless otherwise recommended by the asphalt rubber supplier and approved by the Engineer. The asphalt rubber cement design shall be performed by the asphalt rubber supplier. The proportion of ground rubber shall be between 15 and 20 percent by weight of the total mixture of the asphalt rubber cement.

The Contractor shall supply to the Engineer a mix formulation at least 10 days before pavement construction is scheduled to begin. The mix formula shall consist of the following information.

A. Design Mix.

The design mix shall meet the requirements of the Standard Specifications, Series of 1984, and as amended herein.

B. Asphalt Cement.

The Source of Asphalt Cement.
The Grade of Asphalt Cement.
The Source and Grade of Extender Oil.
The Percentage of Asphalt Cement and Extender Oil by total weight of the Asphalt Rubber Cement.

C. Ground Reclaimed Rubber.

The Source of Reclaimed Rubber.
The Grade of Reclaimed Rubber.
The Percentage of Ground Rubber by total weight of the Asphalt Rubber Cement.

If ground rubber from more than one source is utilized, the above information will be required for each source of ground rubber used.

D. Anti-Strip Agent.

The Source of Anti-Strip.
The Percentage of Anti-Strip by weight of asphalt.

E. **Physical Properties.**

The physical properties of the blend in accordance with Section 1028.02B. The weight per gallon of the blend at 350°.

F. **Asphalt Rubber Cement Content.**

The design asphalt rubber cement content based on the dry weight of the aggregate.

G. **Mix Temperature Range.**

The mix temperature range for the aggregate and asphalt rubber cement.

H. **Density Requirements.**

The mixture design will be based on the 50 blow Marshall test.

1028.05 ASPHALT RUBBER CEMENT AND PRODUCTION EQUIPMENT

All equipment utilized in production and proportioning of the asphalt rubber cement shall be described as follows:

A. **Asphalt Heating Tank.**

An asphalt heating tank with a hot oil heat transfer system or retort heating system capable of heating asphalt cement to the necessary temperature for blending with the ground rubber. This unit shall be capable of heating a minimum of 3,000 gallons of asphalt cement.

B. **Blender.**

An asphalt rubber mechanical blender with a two stage continuous mixing process capable of producing a homogeneous mixture of asphalt cement and ground rubber, at the mix design specified ratios, as directed by the engineer. This unit shall be equipped with a ground rubber feed system capable of supplying the asphalt cement feed system, as not to interrupt the continuity of the blending process. A separate asphalt cement feed pump and finished product pump are required. This unit shall have both an asphalt cement totalizing meter in gallons and a flow rate meter in gallons per minute.

C. **Storage Tank.**

An asphalt rubber storage tank equipped with a heating system to maintain the proper temperature for pumping and adding of the asphalt rubber to the aggregate and an internal mixing unit within the storage vessel capable of maintaining a proper mixture of asphalt cement and ground rubber.

D. **Supply System.**

An asphalt rubber supply system equipped with a pump and metering device capable of adding the asphalt rubber by volume to the aggregate at the percentage required by the job-mix formula.

E. Temperature Gauge.

An armored thermometer of adequate range in temperature reading shall be fixed in the asphalt rubber feed line at a suitable location near the mixing unit.

1028.06 ASPHALT RUBBER CEMENT MIXING, REACTION AND TRANSFER PROCEDURE.

A. Asphalt Cement Temperature.

The temperature of the asphalt cement shall be between 375° and 425° F. at the addition of the ground rubber.

B. Blending and Reacting.

The asphalt cement and ground rubber shall be combined and mixed together in a blender unit, pumped into the agitated storage tank, and then reacted for a minimum of 45 minutes from the time the ground rubber is added to the asphalt cement. Temperature of the asphalt rubber cement shall be maintained between 325° and 375° F. during the reaction period.

C. Transfer.

After the material has reacted for at least 45 minutes, the asphalt rubber cement shall be metered into the mixing chamber of the hot mix plant at the percentage required by the job mix formula.

D. Delays.

When a delay occurs in asphalt rubber cement use after its full reaction, the asphalt rubber shall be allowed to cool. The asphalt rubber cement shall be reheated slowly just prior to use to a temperature between 325° and 375° F., and shall also be thoroughly mixed before pumping and metering into the hot mix plant for combination with the aggregate. The viscosity of the asphalt rubber cement shall be checked by the asphalt rubber supplier. If the viscosity is out of the range specified in Section 1028.02B of this specification, the asphalt rubber cement shall be adjusted by the addition of either the asphalt cement or ground rubber as required to produce a material with the appropriate viscosity.

1028.07 COMPACTION REQUIREMENT.

The Asphalt Rubber Cement concrete shall be compacted to 95% of laboratory density.

1028.08 COMPACTION EQUIPMENT.

A minimum of two rollers meeting Article 2001.05 Paragraph B shall be furnished. Pneumatic tired rollers will not be allowed.

1028.09 METHOD OF MEASUREMENT AND BASIS OF PAYMENT OF ASPHALT RUBBER CEMENT (ARC) CONCRETE.

The Asphalt Rubber Cement Concrete Mix will be measured as per the standard specification, and be paid for in tons. Asphalt Rubber Cement for use in the Asphalt Rubber Cement Concrete Mix will be measured as per the standard specifications and be paid for in tons.

#082704

Iowa Department of Transportation
Highway Division
Ames, Iowa

Date of Letting: August 27, 1991
Date of Addendum: July 30, 1991

Black Hawk County
FN-21-6(6)--21-07

A. C. C. Resurfacing
Bid Order 41

In the proposal form on page 1 of the "Special Provisions Text" delete SP-1024, Special Provisions for Asphalt Rubber Cement (ARC) Concrete and replace it with SP-1028, Special Provisions for Asphalt Rubber Cement (ARC) Concrete (attached).

NOTICE: Only the prime contractor receives this addendum and responsibility for notifying any potential subcontractors or suppliers remains with the prime contractor.

winter will be retested if stored in a heated warehouse. Carryover lots of white-pigmented compound of less than five barrels shall not be used.

Carryover lots of all curing compounds, unprotected from freezing, shall not be used.

Section 4106. Paper and Plastic Film for Curing Concrete

4106.01 CURING PAPER. Paper to be used for curing concrete shall meet requirements of ASTM C 171, except that, in lieu of the moisture loss limitation prescribed, the following shall apply: The moisture loss shall not be greater than 5.0 percent of the original mixing water used when the paper is tested in accordance with Laboratory Test Method 901, with the paper remaining in place for 24 hours.

The paper shall be prepared in sheets of sufficient width to cover the full width of concrete surface being placed without stretching and with normal allowance for shrinkage.

4106.02 PLASTIC FILM. Plastic film used for curing concrete shall be tough, pliable, moisture-proof, and sufficiently durable to retain its moisture-proof properties during the time it is in place on the surface of the concrete. It shall meet requirements of 4106.01 for retention of moisture in concrete and for size of sheets. The plastic film shall be white-pigmented material. The film shall be not less than 0.00085 inch thick, shall have not less than 70 percent daylight reflectance relative to the magnesium oxide when tested in accord with ASTM E 97, and shall be opaque. If the thickness of plastic film is less than 0.0034 inch, it shall not be used more than once for curing concrete.

Section 4107. Plastic Film for Subgrade Treatment

4107.01 GENERAL. Plastic film to be used for treating subgrade of concrete pavement shall be polyethylene film not less than 0.00085 inch thick, either clear or white-pigmented type. The width of strips used shall provide a lap not less than 12 inches between adjacent strips. Plastic film which has been used no more than once for curing concrete pavement and has been salvaged in usable condition may be used for treatment of subgrade.

Section 4108. Fly Ash

4108.01 GENERAL Fly ash to be substituted for portland cement in concrete shall meet the chemical and physical requirements of ASTM C 618, either Class C or Class F; the loss on ignition shall not exceed 5.0 percent. For Class C fly ash, the pozzolanic activity test with lime will not be required.

Approval of the source of fly ash will be required. This is to be based on fly ash produced when the power plant is using specific materials, equipment and processes. Any change in materials, equipment, and processes shall void the source approval, and a new approval of the source will be required.

Inspection and acceptance of fly ash will be in accord with IM 491.17. The source may be certified or uncertified, as detailed therein.

Section 4109. Aggregate Gradations

4109.01 GENERAL. Gradations for various aggregates are shown in the gradation table on the following pages, and each gradation is identified by number. When the aggregate is tested by means of laboratory sieves, the sieve analysis shall show a gradation within the range permitted for the gradation number specified for that aggregate.

Section 4110. Fine Aggregate for Concrete

4110.01 DESCRIPTION. Fine aggregate for concrete shall consist of clean, hard, durable, mineral aggregate particles free from injurious amount of silt, shale, coal, organic matter, or other deleterious material and shall comply with the following requirements. Fine aggregate for concrete floors, overlays, and pavements shall be natural sands. Natural sand is defined as fine aggregate resulting from disintegration of rock through erosional processes. Manufactured sand produced from igneous or metamorphic rock may be used with approval of the Engineer.

4110.02 SHALE. Fine aggregate from an approved source shall have a historical record of not more than 2.0 percent shale and coal particles retained on a No. 16 sieve.

4110.03 GRADATION. Fine aggregate for concrete shall meet requirements of Section 4109 for gradation number 1. In

Iowa

ments of Section 4115; the gradation shall meet requirements of 4115.06, and the aggregate shall be of the durability class specified for the aggregate in the pavement.

E. Class M Concrete. The proportions used for Class M concrete shall conform to the following. These mixes are intended where high-early-strength concrete is required by the plans or the Engineer. These mixes may also be used at locations designated by the Contractor, subject to approval of the Engineer.

Basic Absolute Volumes of Materials Per Unit Volume of Concrete*

Mix No.	Cement Minimum	Water	Entr. Air	Fine Agg.	Coarse Agg.
M-3	0.148764	0.153134	0.06	0.287146	0.350956
M-4	.155569	.160255	.06	.312088	.312088
				Class V Agg.	Fine Limestone
CIV-M	.159916	.191816	.06	.558855	.029413

Approximate Quantity of Dry Materials Per Cubic Yard of Concrete*

Mix No.	Cement Pounds	Fine Agg. Tons	Coarse Agg. Tons
M-3	787	0.641	0.784
M-4	823	.698	.698
		Class V Agg.	Fine Limestone
CIV-M	846	1.234	0.066

* These quantities are based on the following assumptions: Specific gravity of cement, 3.14; Specific gravity of Class V agg., 2.62; Specific gravity of other agg., 2.65; Water-cement ratio with M mixes, 0.328; Water-cement ratio with CIV-M, 0.390; Air voids with all mixes, 6.0 percent.
These mixes are designed for low-slump concrete, suitable for many of the applications for which they are specified. The water-cement ratio is intended to be controlled by the slump specified elsewhere for concrete where these mixtures are used. These proportions may not provide a yield of 100 percent.

F. Combined Fine and Coarse Aggregate. If use of combined fine and coarse aggregate is approved, the proportions will be fixed on the basis of the relative amounts of fine and coarse aggregate contained, so as to be equivalent to one of the appropriate mixes specified above for screened aggregates. Attention is directed to conditions under which combined fine and coarse aggregate may be used, as specified in 4115.07.

G. Specific Gravity. The foregoing proportions are based on a specific gravity of 2.62 for Class V aggregate and 2.65 for other aggregates. If the material furnished shows an average specific gravity other than these values, the proportions by weight will be adjusted by the ratio which the actual average specific gravity bears to the foregoing values.

H. Water and Consistency. The amount of mixing water used shall be that which will produce workable concrete of uniform consistency. Except as specifically modified by the Engineer, the slump, measured in accordance with AASHTO T 119, shall not be less than 1/2 inch or more than 3 inches for machine-finished, fixed-form pavement, 2 inches for machine-finished, slip-form pavement, or 4 inches for hand-finished pavement.

If it is found impossible to produce concrete having the required consistency without exceeding the maximum allowable water-cement ratio specified, the cement content shall be increased as directed by the Engineer so that the maximum water-cement ratio will not be exceeded. Any additional cement will be considered incidental, and no additional payment will be allowed.

The basic absolute volume of water per unit volume of concrete is based on average conditions. If characteristics of the material are such that the total quantity of water used to secure the required consistency is such that the batch yield, computed on the basis of absolute volumes of the batch quantities used, is deficient by more than 2.0 percent, the proportions may be adjusted by the Engineer to correct the yield. Adjustment described in this paragraph will not be a basis for adjustment of the contract unit price.

I. Entrained Air Content. Air entrainment shall be accomplished by addition of an approved air-entraining agent. The intended air entrainment of the finished concrete is 6 percent. To allow for loss during consolidation, the air content of fresh, unvibrated concrete when delivered or placed on the subbase or subgrade, as determined by AASHTO T 152 for gravel or stone coarse aggregate, shall be 6.5 percent as a target, with a maximum variation of plus or minus 1.5 percent. When Class V aggregate is used, the quantity of air-entraining agent added shall be the quantity normally used with other aggregate, but shall be adjusted so as to secure the specified air content.

J. Admixtures. When authorized by the Engineer, approved admixtures may be used for the purpose of improving workability or for retarding hardening and shall be used in accordance with instructions issued by the Engineer.

K. Use of Fly Ash. Fly ash may be used as a substitute for a portion of the portland cement for A, B, or C mixes, excluding C-3WR, C-4WR, C-5WR, C-6WR, CIV-A, 47-B and 47-BB mixes. This substitution is an option of the Contractor, including use of either class of fly ash. With reasonable notice to the Engineer, the Contractor may change to or

from the mixture with fly ash. If fly ash is used in the mixture, coarse aggregate meeting requirements of Section 4115 for Class 3 durability shall be used. Fly ash shall meet requirements of Section 4108.

Fly ash may not be substituted for portland cement after October 15.

Fly ash shall be transported, stored, handled, and batched in such a manner as to keep it dry.

When a fly ash mixture is used, the maximum substitution shall be as follows:

Class C fly ash: 15 percent of the cement, by weight, may be removed and shall be replaced with an equal amount of Class C fly ash, on a pound-per-pound basis.

Class F fly ash: 15 percent of the cement, by weight, may be removed and shall be replaced with Class F fly ash at a 1¼-to-1 basis, 1¼ pounds of fly ash for each pound of cement removed.

The change in absolute volumes, due to the fly ash substitution, shall be applied to each aggregate using the same ratio as the ratio of aggregates for that particular mix number.

For estimating quantities, the specific gravity of Class C fly ash is assumed to be 2.68, and for Class F fly ash, 2.40 is assumed.

For each mix, the design and maximum water-cement ratio shall be reduced by 0.004 for each 1 percent of cement substituted with Class C fly ash and by 0.01 for each 1 percent of cement substituted with Class F fly ash. Fly ash is included in the water-cement ratio calculation as portland cement.

2301.05 EQUIPMENT GENERAL. The Contractor shall provide sufficient equipment to perform all operations necessary to complete the work. Equipment shall meet requirements of 2001.01 and the following provisions.

2301.06 PROPORTIONING AND MIXING EQUIPMENT. Equipment used for proportioning and mixing concrete materials shall comply with the following:

A. Weighing and Proportioning Equipment. Article 2001.20 shall apply.

B. Mixing Equipment. Article 2001.21 shall apply.

C. Bins. Article 2001.06 shall apply.

D. Portland Cement Concrete Batch Trucks. Trucks used for transporting proportioned dry batches to the mixer may be used with written approval of the Engineer. For larger projects, separate cement compartments may be required.

2301.07 CONSTRUCTION EQUIPMENT FOR PORTLAND CEMENT CONCRETE PAVEMENT. Equipment necessary for construction of concrete pavement shall comply with the following requirements:

A. Equipment for Standard Concrete Pavement.

1. ***Side Forms*** shall have a height, without horizontal joint, at least equal to the designed thickness of the pavement at its edge, except the additional height represented by integral curb may be secured by bolting extra forms upon the top of the main form.

   The top face of a form shall not vary from a true plane by more than 1/8 inch in 10 feet, and the upstanding face shall not vary from a true plane by more than 1/4 inch in 10 feet.

   Flexible or curved forms shall be used for curves having radii of 100 feet or less.

   a. Forms Required to Support Heavy Equipment shall be made of steel not thinner than U.S. standard 5 gage (approximately 7/32 inch). They shall be equipped with a device for holding abutting sections firmly in alignment, which device shall permit adjustment for horizontal and vertical curves. Forms having a height of 8 inches or more shall have a base not less than 8 inches wide. Forms having a height less than 8 inches shall have a base width not less than their height. They shall be equipped with not less than three staking points per each 10 feet of length with means for securely locking the form to each stake. Flange braces and staking pockets shall extend outward on the base not less than 2/3 the height of the form.

   All forms in a single line in any day's run shall be of the same height, and there shall be not more than one change in the base width.

   b. Forms Not Required to Support Heavy Equipment may be made of wood or steel. They shall have sufficient stiffness and shall be so staked as to remain vertical and substantially true to line and grade during placing and finishing of concrete. Straight wood forms shall be of nominal 2-inch stock. All wood forms shall be dressed on the side supporting the concrete and on their upper edge.

2. ***Curb Forms*** used to form the back of all curbs shall be metal except where returns of small radius or other special sections make use of metal forms impractical. Back forms for curb shall be rigidly attached to the side forms for the pavement slab, using all fastenings pro-

KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION
TO THE
STANDARD SPECIFICATIONS
EDITION OF 1973

NOTE: WHENEVER THIS SPECIAL PROVISION CONFLICTS WITH THE PLANS, SUPPLEMENTAL SPECIFICATIONS OR STANDARD SPECIFICATIONS, THIS SPECIAL PROVISION SHALL GOVERN.

HOT RUBBER-ASPHALT SEAL TREATMENT

1.0 DESCRIPTION: THIS SPECIAL PROVISION COVERS THE REQUIREMENTS FOR MATERIALS, APPLICATION RATES, EQUIPMENT AND CONSTRUCTION METHODS FOR USE ON THE HOT RUBBER-ASPHALT SEAL TREATMENT.

BID ITEMS:
RUBBER-ASPHALT
KEROSENE
COVER MATERIAL - SPECIAL
BLOTTER SAND
EMULSIFIED ASPHALT (SS-1H)
WATER FOR EMULSIFIED ASPHALT
MANIPULATION

2.0 MATERIALS:

A. REQUIREMENTS.

(1) BITUMINOUS MATERIALS

1.1 ASPHALT CEMENT.....SECTION 1002.01 (STD. SPECS.)
AS SHOWN ON THE PLANS
1.2 EMULSIFIED ASPHALT (SS-1H) .....SECTION 1002.01 (STD. SPECS.)

(2) KEROSENE - THE KEROSENE SHALL HAVE A BOILING POINT OF NOT LESS THAN 350°F OR 177°C.

(3) WATER .....SECTION 1014.02 (STD. SPECS.)

(4) GROUND VULCANIZED TIRE RUBBER - THE GROUND TIRE RUBBER SHALL BE FULLY VULCANIZED AND SHALL MEET THE FOLLOWING REQUIREMENTS:

4.1 GRADATION

SIEVE SIZE	% RETAINED
No. 8	0
No. 10	0 - 2
No. 40	90 - 100

4.2 THE GROUND TIRE RUBBER, IRRESPECTIVE OF DIAMETER SHALL BE LESS THAN 7 MM IN LENGTH.

4.3 THE SPECIFIC GRAVITY OF THIS MATERIAL SHALL BE 1.15± 0.03.

4.4 THIS MATERIAL SHALL CONTAIN NO MORE THAN A TRACE OF FABRIC AND SHALL BE FREE FROM WIRE OR OTHER CONTAMINATING MATERIALS, EXCEPT THAT UP TO 4% OF CALCIUM CARBONATE MAY BE INCLUDED TO PREVENT THE PARTICLES FROM STICKING TOGETHER.

(5) AGGREGATE FOR BLOTTER SAND - SHALL COMPLY WITH THE REQUIREMENTS OF FA-A IN SECTION 1001.02 (c).

(6) AGGREGATE FOR COVER MATERIAL - THE AGGREGATE FOR COVER MATERIAL SHALL COMPLY WITH THE REQUIREMENTS OF SECTION 1001.08 OF THE STANDARD SPECIFICATIONS WITH THE FOLLOWING ADDITIONS AND EXCEPTIONS:

6.1 QUALITY REQUIREMENTS

SOUNDNESS, MINIMUM	0.90
WEAR, MAXIMUM.....	40%
ABSORPTION, MAXIMUM.....	4.0%

KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION
TO THE
STANDARD SPECIFICATIONS
EDITION OF 1990

NOTE: Whenever this Special Provision conflicts with the plans or standard specifications, this Special Provision shall govern.

ASPHALT RUBBER (REACTED)

1.0 DESCRIPTION:

The reacted asphalt rubber binder - bituminous mixture will include the incorporation of reacted asphalt rubber into the bituminous mixture, using the bituminous mixture shown in the contract. The percent of asphalt rubber in the mixture shall be in accordance with the recommendation of the supplier of the asphalt rubber.

The Contractor shall have a representative of the asphalt rubber supplier available on the project during production of the asphalt rubber bituminous mixture.

2.0 GENERAL REQUIREMENTS:

A. The aggregate for bituminous mixture for BM-1T shall conform to Section 603 and 1103 of the 1990 Standard Specifications.

B. Asphalt Rubber. The asphalt-rubber binder shall be a uniform reacted blend of compatible paving grade asphalt cement, granulated reclaimed vulcanized rubber, extender oil, if required, and liquid anti-striping

agent when indicated by standard moisture susceptibility tests. The asphalt-rubber binder shall meet the physical parameters listed below.

Apparent Viscosity, 347° F., Spindle 3, 12 RPM, cps (ASTM 2669)	Min Max	1,000 4,000
Penetration, 77° F., 100 g, 5 sec.: 1/10 mm. (ASTM D5)	Min Max	50 100
Penetration, 39.2° F., 200 g, 60 sec.: 1/10 mm. (ASTM D5)	Min	25
Softening Point: ° F., (ASTM D36)	Min	120
Resilience, 77° F.,: % (ASTM D3407)	Min	10
Ductility, 39.2° F., 1 cpm: cm. (ASTM D113)	Min	10
TFOT Residue, (ASTM D1754) Penetration Retention, 39.2° F.: %	Min	75
Ductility Retention, 39.2° F.: %	Min	50

Asphalt Extender Oil: An asphalt-extender oil may be added, if necessary, to meet the requirements of asphalt rubber binder. Extender oil shall be a resinous, high flash point, aromatic hydrocarbon meeting the following test requirements:

Viscosity, SSU, at 100° F. (ASTM D88)	2500 min.
Flash Point, COC, degrees F. (ASTM D92)	390 min.
Molecular Analysis (ASTM D 2007):	
Asphaltenes, Wt. %	0.1 max.
Aromatics, Wt. %	55.0 min.

C. All equipment shall conform to the standard specifications unless noted otherwise in this Special Provision.

3.0 GRANULATED RECLAIMED VULCANIZED RUBBER

3.1 General. The ground rubber shall be produced from processing automobile and/or truck tires by ambient grinding methods. The rubber shall be substantially free from contaminants including fabric, metal, mineral, and other non-rubber substances. The rubber shall be sufficiently dry to be free flowing and not produce a foaming problem when added to hot asphalt cement. Up to

4% by weight of talc or other appropriate blocking agent can be added to reduce agglomeration of the rubber particles.

3.1.1 Physical Requirements.

Gradation and Particle Length: When tested in accordance with ASTM C-136 using a 50 gram sample, the resulting rubber gradation shall meet the following gradation limits.

Percent Passing

Sieve Size	Type II
No. 10	100
No. 16	75-100
No. 30	25-60
No. 50	0-20
No. 200	0-5
Max. Particle Length	3/16"

3.1.2 Fiber Content: The ground rubber shall be designated Grade A or Grade B. For Grade A rubber, the fiber content shall be less than 0.1% by weight. For Grade B rubber, the fiber content shall be less than 0.5% by weight. Fiber content shall be determined by weighing fiber agglomerations which are formed during the gradation test procedure. Rubber particles shall be removed from the fiber agglomerations before weighing.

3.1.3 Moisture Content: The moisture content of the ground rubber shall be less than 0.75% by weight.

3.1.4 Mineral Contaminants: The mineral contaminant amount of the ground rubber shall not be greater than 0.25% by weight as determined after water separating a 50 gm. rubber sample in a 1 liter glass beaker filled with water.

3.1.5 Metal Contaminants: The rubber shall contain no visible metal particles as indicated by thorough stirring of a 50 gm. sample with a magnet.

3.2 Packaging: The ground rubber shall be supplied in moisture resistant packaging such as either disposable bags or other appropriate containers. Bags shall be palletized into units for shipment and glue shall be placed between layers of bags to increase unit stability during shipment. Palletized units containing bags shall be wrapped with ultra-violet resistant stretch wrap. The maximum allowable tolerance per bag will be ± 2 lbs. for bags weighing 100 lbs. or less.

3.3 Labeling: Each container or bag of ground rubber shall be labeled with the manufacturer designation for the rubber and the specific type in accordance with this specification, the nominal rubber weight designation with tolerance, and the manufacturer lot designation. Palletized units shall contain a lable which indicates the manufacturer and production lot number designations, rubber type, and net pallet weight.

3.4 Certification: The manufacturer shall ship along with the ground rubber, a Type "A" certification as listed in Section 2600 of the Standard Specifications.

3.5 Anti-Stripping Agent: If required by the Job-Mix Formula to produce appropriate water resistance, an anti-stripping agent that is heat stable and approved for use by the specifying agency shall be incorporated into the asphalt-rubber material at the percentage required by the job mix formula. It shall be added to the asphalt cement prior to blending with granulated rubber.

4.0 ASPHALT RUBBER BLEND DESIGN

The asphalt cement shall be grade AC-5 unless otherwise recommended by the asphalt rubber supplier and approved by the Engineer. The mixture design shall be performed by the asphalt-rubber supplier. The proportion of ground rubber shall be between 15 and 20 percent by weight of the total mixture of the asphalt rubber binder.

The Contractor shall supply to the Engineer a mix formulation at least 10 days before pavement construction is scheduled to begin. The mix formula shall consist of the following information.

A. Design Job Mix
Shall meet the requirements of Section 1103.

B. Asphalt Cement
Source of Asphalt Cement
Grade of Asphalt Cement
Source and Grade of Extender Oil
Percentage of Asphalt Cement and Extender Oil by Total Weight of the Asphalt-Rubber Binder

C. Granulated Reclaimed Rubber
Source of Granulated Rubber
Grade of Granulated Rubber
Percentage of Granulated Rubber by Total Weight of the Asphalt-Rubber Mixture

If granulated rubber from more than one source is utilized, the above information will be required for each granulated rubber used.

D. Anti-Strip Agent
Source of Anti-Strip
Percentage of Anti-Strip by Weight of Asphalt

E. Physical properties of the blend in accordance with 2.0 (B). Also the weight per gallon of the blend at 350° F.

F. Design Asphalt Rubber Content based on the dry weight of the aggregate.

G. Mix Temperature range for the aggregate and asphalt rubber binder.

H. Density Requirement - The mixture design will be based on 50 blow Marshall.

5.0 ASPHALT-RUBBER MIXING AND PRODUCTION EQUIPMENT

All equipment utilized in production and proportioning of the asphalt-rubber binder shall be described as follows:

5.1 Asphalt Heating Tank: An asphalt heating tank with a hot oil heat transfer system or retort heating system capable of heating asphalt cement to the necessary temperature for blending with the granulated rubber. This unit shall be capable of heating a minimum of 3,000 gallons of asphalt cement.

5.2 Blender: The asphalt-rubber mechanical blender with a two stage continuous mixing process capable of producing a homogeneous mixture of asphalt cement and granulated rubber, at the mix design specified ratios, as directed by the engineer. This unit shall be equipped with a granulated rubber feed system capable of supplying the asphalt cement feed system, as not to interrupt the continuity of the blending process. A separate asphalt cement feed pump and finished product pump are required. This unit shall have both an asphalt cement totalizing meter in gallons and a flow rate meter in gallons per minute.

5.3 Storage Tank: An asphalt-rubber storage tank equipped with a heating system to maintain the proper temperature for pumping and adding the binder to the aggregate and an internal mixing unit within the storage vessel capable of maintaining a proper mixture of asphalt cement and granulated rubber.

5.4 Supply System: An asphalt-rubber supply system equipped with a pump and metering device capable of adding the binder by volume to the aggregate at the percentage required by the job-mix formula.

5.5 Temperature Gage: An armored thermometer of adequate range in temperature reading shall be fixed in the asphalt-rubber feed line at a suitable location near the mixing unit.

6.0 ASPHALT-RUBBER MIXING, REACTION AND TRANSFER PROCEDURE:

6.1 Asphalt Cement Temperature: The temperature of the asphalt cement shall be between 375 and 425 degrees F. at the addition of the granulated rubber.

6.2 Blending and Reacting: The asphalt and granulated rubber shall be combined and mixed together in a blender unit, pumped into the agitated storage tank, and then reacted for a minimum of 45 minutes from the time the granulated rubber is added to the asphalt cement.

Temperature of the asphalt-rubber mixture shall be maintained between 325 degrees F. and 375 degrees F. during the reaction period.

6.3 Transfer: After the material has reacted for at least 45 minutes, the asphalt-rubber shall be metered into the mixing chamber of the hot mix plant at the percentage required by the job-mix formula.

6.4 Delays: When a delay occurs in binder use after its full reaction, the asphalt-rubber shall be allowed to cool. The asphalt-rubber shall be reheated slowly just prior to use to a temperature between 325 degrees and 375 degrees F., and shall also be thoroughly mixed before pumping and metering into the hot mix plant for combination with the aggregate. The viscosity of the asphalt-rubber shall be checked by the asphalt-rubber supplier. If the viscosity is out of the range specified in Section 2.0 (B) of this specification, the asphalt-rubber shall be adjusted by the addition of either the asphalt cement or granulated rubber as required to produce a material with the appropriate viscosity.

7.0 COMPACTION REQUIREMENT:

The Reacted Asphalt Rubber Binder - Bituminous Mixture shall be compacted in accordance with Subsection 603.

8.0 COMPACTION EQUIPMENT:

A minimum of two rollers meeting the requirements of Subsection 151.03 shall be furnished. At least one of the rollers will be a vibratory roller. Pneumatic tired rollers will not be allowed.

9.0 METHOD OF MEASUREMENT AND BASIS OF PAYMENT.

The Reacted Asphalt Rubber Binder - Bituminous Mixture will be measured as per the Standard Specifications, and be paid for in tons. Asphalt rubber for use in the Reacted Asphalt Rubber Binder - Bituminous Mixture will be measured as per the Standard Specifications and be paid for in tons.

1-9-91

SECTION 310

FLY ASH MODIFIED SUBGRADE

310.01 DESCRIPTION.

This work shall consist of constructing one or more courses of a mixture of soil, fly ash, and water, in accordance with these specifications, as shown on the Plans or established by the Engineer.

BID ITEMS
Water.
Fly Ash.
Manipulation for Fly Ash Treated Subgrade.

310.02 MATERIALS.

Materials shall conform to the requirements specified in the Materials Division.

Fly Ash	Section 2000
Water	Section 2400

310.03 EQUIPMENT.

(a) The machinery, tools, and equipment necessary for proper execution of the work shall be on the project and approved by the Engineer prior to beginning of construction operations. Pulverization of existing subgrade and blending of the mixture shall be accomplished with equipment with a recycling or mixing drum and an automatic water proportioning system. Initial compaction shall be achieved using a vibratory roller having a minimum operating weight of twelve tons with a minimum centrifugal force of 24 tons. Rubber-tired or smooth-wheeled rollers shall be used for final compaction of the stabilized section. All machinery, tools and equipment used shall be maintained in satisfactory and workmanlike manner.

(b) Fly ash shall be stored and handled in closed weatherproof containers until immediately before distribution. Fly ash exposed to moisture prior to mixing with recycled material shall be discarded.

(c) If fly ash is furnished in trucks, each truck shall have the weight of fly ash certified on public scales or the Con-

tractor shall place a set of standard platform truck scales or hopper scales at a location approved by the Engineer.

310.04 CONSTRUCTION REQUIREMENTS.

(a) General.

The purpose of this specification is to secure a completed section of treated material which contains a uniform mixture of fly ash and pulverized material with no loose or segregated areas, has a uniform density and moisture content, and is well bound for its full depth. It shall be the responsibility of the Contractor to regulate the sequence of his work, to process a sufficient quantity of material to provide full depth as shown on the Plans, to use the proper amounts of fly ash, to maintain the work, and to rework areas as necessary to meet the above requirements.

(b) Weather Limitations.

Fly ash mixing operations shall not be performed when the subgrade is frozen or when the ambient air temperature is less than 50 degrees F. The Contractor shall be responsible for the protection and quality of the fly ash modified subgrade mixture under any weather conditions.

(c) Preparation of Roadbed.

The subgrade shall be brought within reasonably close conformity to the line and grade shown on the Plans. On projects containing more than 20,000 square yards of manipulation, the subgrade shall be trimmed by means of automatically controlled equipment with regard to grade. The Engineer may waive the use of automatically controlled equipment in areas of irregular dimension where operations of automatic equipment is impractical.

(d) Treatment of Subgrade.

The subgrade material shall be pulverized through use of the specified equipment. Depth of pulverization shall be as designated. The pulverized subgrade material and fly ash shall be mixed thoroughly until a uniform mixture is obtained. All clods shall be reduced in size by mixing until the pulverized subgrade material-fly ash mixture meets the following size requirement when tested.

Sieve Size	Percent Retained
1½ inch	0
½ inch	50 maximum

(e) Moisture Control.

Prior to application of fly ash, the moisture content of the pulverized subgrade material shall be adjusted so that following the application of fly ash, the moisture content of the mixture is within the range specified. If the moisture content of the pulverized material is below the required limit, water shall be added and blended thoroughly with the material by continued mixing. The addition of water in the mixing drum of the stabilizing unit during incorporation of fly ash is acceptable providing it can be demonstrated that adequate control of moisture content can be maintained.

The required moisture content will be established by the Engineer based on laboratory tests on the site materials and specific fly ash content to be used for the treatment. Final moisture content of the mix, immediately prior to compaction shall be uniform and not exceed plus or minus three percentage points of the optimum moisture content of the mix. If the moisture content exceeds the specified limits, additional fly ash may be added to lower the moisture content to the required limits. Lowering the moisture content by aeration following addition of fly ash will not be allowed. If the moisture contents are below the specified limits, additional water shall be added and uniformly blended with the mixture. Additional fly ash added to lower the moisture content shall be at the expense of the Contractor.

(f) Application.

If necessary, immediately prior to application of fly ash, the roadway shall be bladed to allow uniform distribution of fly ash.

The fly ash shall be spread in an approved manner at the rate specified. Care shall be taken to prevent the fly ash from flowing off the area to be treated.

The fly ash shall be distributed at a uniform rate in such a manner as to minimize the scattering of fly ash by wind. Fly ash shall not be applied when wind conditions, in the opinion of the Engineer, are such that blowing fly ash becomes objectionable to adjacent property owners or significantly reduces the amount of fly ash incorporated into the work.

When required by the Plans, retarder shall be applied immediately following distribution of fly ash by an approved distributor capable of providing the specified rate of application. The retarder can be diluted with mix water to ensure more uniform application provided initial soil moisture con-

tents are at a suitable level to accommodate the additional water. Retarder shall be subsidiary.

(g) Mixing.

The pulverized subgrade material and fly ash shall be thoroughly mixed and the mixing continued until a homogeneous, friable mixture of pulverized subgrade material and fly ash meeting the specified size requirements is obtained.

(h) Compaction.

Compaction of the mixture shall begin immediately after mixing and confirmation that the moisture content is within the specified range. Mixing shall be completed within ½ hour following incorporation of fly ash. The material shall be sprinkled as necessary to maintain the specified moisture content. Compaction of the mixture shall begin at the bottom and shall continue until the entire depth of mixture is uniformly compacted to the specified density.

All non-uniform (too wet, too dry or insufficiently treated) areas which appear shall be corrected immediately by scarifying the areas affected, adding or removing material as required and reshaping and recompacting.

The stabilized section shall be compacted to a minimum of 95 percent of the combined materials maximum dry density as determined in accordance with Section 2500.

In addition to the requirements specified for density, the section shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, tests will be made by the Engineer. If the material fails to meet the density requirements, the Engineer may require it be reworked as necessary to meet those requirements and/or require the Contractor to change his construction methods to obtain required density on the next section. Additional fly ash will be added to the areas that are reworked at no additional cost to the owner, and the amount required will be established by the Engineer. Should the section, due to any reason or cause, lose the required stability, density and finish before the surface is placed or the work is accepted, it shall be reprocessed, recompacted and refinished at the sole expense of the Contractor. Reprocessing shall follow the same patterns as the initial stabilization including the addition of fly ash.

(i) Time Limitation.

Compaction on the surface of each section shall be com-

pleted within two hours after incorporation of the fly ash. Any areas failing to meet this requirement will be rejected and shall be reprocessed.

(j) **Finishing and Curing.**

Following the compaction of the stabilized section, on projects containing more than 20,000 square yards of manipulation, the treated section will be trimmed to the required lines and grade by means of equipment which is automatically controlled with regard to grade. The surface shall then be compacted with a smooth wheel or pneumatic tired roller.

The Engineer may waive the use of automatically controlled equipment on projects containing less than 20,000 square yards of manipulation and on narrow or irregular dimensions where operation of the automated equipment is impractical. Finishing of these areas may be as set forth above or the surface will be lightly scarified during finishing operations and bladed to a uniform grade and cross section to eliminate any imprints left by the equipment.

After the fly ash treated section has been finished as specified herein, the surface shall be protected against rapid drying by either of the following curing methods for a period of not less than seven days or until the surface course has been placed:

(1) Maintain in a thorough and continuously moist condition by sprinkling.

(2) Apply an asphaltic prime coat.

310.05 METHOD OF MEASUREMENT.

(a) Fly Ash will be measured by the ton. Delivery tickets showing weight of the fly ash delivered to the project will be furnished to the Engineer.

(b) Manipulation for Fly Ash Treated Subgrade will be measured by the unit shown on the Plans, complete in place.

(c) Water will be measured by the 1,000 gallons by means of calibrated tanks or distributors for the amount used in the mixing operation. Curing water will not be paid for.

310.05 BASIS OF PAYMENT.

The amount of completed and accepted work, measured as provided above, shall be paid for at the Contract unit price per ton for "Fly Ash", per unit as shown on the Plans for "Manipulation for Fly Ash Treated Subgrade" and per 1,000 gallons of "Water" which shall be full compensation for all

material, pulverizing, mixing, spreading, drying, application of fly ash, shaping and maintaining, for all curing including all curing water and/or other curing materials, for all manipulations required, for all hauling and freight involved, for all tools, equipment, labor, and incidentals necessary to complete the work.

(b) Portland Cement.

Unless otherwise specified on the Plans or in the Contract, either Type IP Portland-Pozzolan cement, Type I(PM) Pozzolan-Modified Portland cement or Type II Portland cement shall be used for the construction of bridge decks (wearing course) and concrete pavement. Either Type IP Portland-Pozzolan cement, Type I (PM) Pozzolan-Modified Portland cement, Type I or Type II Portland cement may be furnished for all other types of construction unless specified otherwise on the Plans or in the Contract.

(c) Fly Ash Modified Concrete.

Fly ash modified concrete shall be any concrete containing fly ash or blended cement. At the option of the Contractor, fly ash from an approved source may be used as a partial replacement for Portland cement. The source and type of fly ash and cement shall not be changed for a project. The consistency of fly ash modified concrete shall be the same as for mixed aggregate or coarse and fine aggregate concrete as shown in (a) above.

The amount of cement that may be replaced with fly ash shall not exceed 15 percent of the minimum pounds of cement per cubic yard listed in Section 402.04.

Fly ash may be substituted for the displaced cement at a rate of one to 1½ pounds of fly ash for each pound of cement removed.

When fly ash modified concrete is furnished, the pounds of water per pound of cement plus fly ash or pounds of water per pound of blended cement shall not exceed the values specified for pounds of water per pound of cement listed as maximums in Section 402.04.

Fly ash will not be permitted as a partial replacement for cement if Type IP, I(PM) or Type III cement is furnished.

At least 15 days before placement of fly ash modified concrete on the project, the Contractor shall furnish to the Engineer complete mix design data including proportions and sources of all mix ingredients and the results of strength tests representing the mix(es) he proposes to use. This strength data shall come from project records for previous KDOT projects or from tests in an independent laboratory, and shall be equal to or exceed the strength requirements listed in Table 1. Test specimens shall be prepared in accordance with Section 2500. Flexural tests shall be performed in accordance with Section 2500. Compressive strength tests shall be in accordance with ASTM C-39. Laboratories performing these tests must be reg-

ularly inspected by the Cement and Concrete Reference Laboratory (CCRL) (N.B.S.).

If the Contractor plans to replace a part of the cement in the mix with fly ash, he shall furnish to the Engineer the results of mortar expansion tests using the same fly ash and the same cement he proposes to use on the project. The tests shall be as described in ASTM C441 and results shall not exceed the maximum of 0.020% expansion specified in ASTM C618, Table 2A. Tests shall be conducted by a laboratory regularly inspected by the CCRL and results shall be furnished to the Engineer at least 15 days before placement of concrete on the project.

NOTE: After sufficient data has been collected, the strength test requirements may be waived but only with the approval of the Chief, Bureau of Materials and Research.

TABLE 1
DESIGN STRENGTH REQUIREMENTS

Concrete Class	Specimen Age	Unit Strength (p.s.i.)
AAA	28 days	5490 Compressive
AAA (AE)	28 days	5280 Compressive
A	28 days	4275 Compressive
A (AE)	28 days	4110 Compressive
Pavement	7 days	450 *Flexural
B or B (AE)	--	Not Required

* Third Point Loading

402.04 CLASSIFICATION.

The limiting values for each respective type of concrete are as follows:

(a) General.

The cement, water and air content specified herein will be verified. Maximum limits shown for pounds of water per pound of cement shall include free water in aggregates but excludes water of absorption of the aggregates.

(b) Concrete for Pavement-Air Entrained.

TABLE 2

	Minimum Pounds of Cement per Cubic Yard of Concrete	Maximum Pounds of Water Per Pound of Cement	Percent of Air by Volume
Pavement (Surface Course):			
Coarse and Fine	602	0.49	6 ± 2
Mixed or Total Aggregate.....	620	0.49	6 ± 2

SUBSECTION 2004

FLY ASH FOR USE IN CONCRETE

2004.01 DESCRIPTION.

This specification covers fly ash which may be used as a partial replacement for Portland cement in concrete.

2004.02 REQUIREMENTS.

(a) Fly ash shall be furnished from a prequalified source.
(b) Fly ash shall meet the chemical and physical requirements of ASTM C618, Class C or Class F, with the following exceptions or additions:
(1) The loss on ignition shall not exceed 3.0%.
(2) The supplementary optional physical requirements of Table 4 shall apply.

2004.03 PREQUALIFICATION.

(a) Becoming Prequalified.

Suppliers desiring to prequalify fly ash from a power plant shall submit to the Engineer of Tests the following:
(1) A one gallon sample of fly ash representative of material intended for use on Department projects.
(2) Certified test results of fly ash produced by the power plant. These tests results shall represent a period of six months immediately prior to the prequalification request. The test results shall show the high, low and average values determined for each month.
(3) Written information as to the sources of coal utilized in the production of fly ash for the preceding six month period.
(4) Written evidence of the latest Cement and Concrete Reference Laboratory (CCRL) inspection of the laboratory performing the fly ash testing.
(5) The name of the person in charge of quality control for fly ash at the power plant.

The Engineer of Tests will test the submitted sample and review the information submitted by the source, for compliance with the specifications. The Chief of Materials and Research will notify the source in writing of the results. Power plants complying with all requirements will be placed on a list of prequalified fly ash sources maintained by the Bureau of Materials and Research.

Prequalification of the source of fly ash will be based on fly ash produced when the power plant is using specific materials, equipment and processes. Any change in materials, equipment or processes shall void the source prequalification, and a new prequalification will be required.

(b) Maintaining Prequalified Status.

After a fly ash source has gained prequalified status the source will be permitted to furnish fly ash for use on Department projects provided the following conditions are met.

(1) The quality monitoring program meets the minimum sampling and testing frequencies established in ASTM C311, except frequency of sampling shall be at least one sample for each 200 tons. This frequency may be reduced with the approval of the Chief of Materials and Research. The tonnage units expressed in ASTM C311 are interpreted to refer to as-marketed material. At least one sample for each 30 days, for the months of *March through October* shall be tested for complete analysis by the producer for conformance to Department specifications. The test reports for all monitoring samples shall be submitted to the Bureau of Materials and Research within 40 days of the sampling date.

The tests shall be conducted by an approved laboratory. The quality control laboratory will be considered approved it if is properly equipped, has the capabilities to perform the tests required by these specifications and is regularly inspected by the Cement and Concrete Reference Laboratory (CCRL) program. Continued approval of the control laboratory will depend on the satisfactory comparison of its test results with the results obtained by the Materials and Research Center.

(2) In addition to the test frequencies listed in 2004.03 (b)(1) above, daily control tests shall be conducted to establish the uniformity of the fly ash being produced. Specific tests shall be determined by the Engineer. As a minimum, loss on ignition, percent retained on the No. 325 mesh sieve, and specific gravity shall be determined. Test records and shipment reports shall be maintained by the supplier and shall be available for review by Department personnel for at least three years after the fly ash has been tested. The laboratory conducting these daily tests shall have the appropriate facilities and testing equipment to conduct the tests but will not require inspection by the CCRL.

(3) The fly ash source has not changed materials, equipment or processes since the prequalification of the source. Any such

changes will void the prequalified status of the fly ash source and a new prequalification will be required.

2004.04 METHODS OF TEST.

Fly ash shall be sampled and tested in accordance with ASTM C311. Field Sampling of fly ash will be in accordance with KT29.

2004.05 BASIS OF ACCEPTANCE.

The basis of acceptance of fly ash furnished under this specification shall be the following:

(a) Prequalification of the power plant that produced the fly ash.

(b) A proper certification for each shipment of fly ash. The supplier shall furnish to the Field Engineer two copies of the bill of lading which shall include the following certification statement and the signature of a responsible company representative.

Certification Statement

The material herein has been sampled and tested as prescribed by the Kansas Department of Transportation and complies with the applicable specification requirements for Class _____ fly ash.

Date _____ Signed _____.

The bills of lading shall be identified with a project number, and shall denote the fly ash source, the type and the quantity in the shipment. These copies shall accompany each load, and shall be retained at the project or ready mix plant for the Field Engineer's records.

In the case of more than one project being supplied by a ready mix plant, the plant shall furnish the Field Engineer, for each project, either a copy of the bill of lading, or a listing of the bills of lading representing the fly ash incorporated in the project. The listing shall bear the signature of a responsible representative of the supplier.

Note: Verification samples will be obtained by Department personnel at the project site. Tests results which do not comply with the specifications may be considered sufficient cause to rescind approval to furnish fly ash on a certification basis.

SECTION 2005

FLY ASH FOR STABILIZATION

2005.01 DESCRIPTION.

This specification covers fly ash which is suitable for treatment of soil, soil-aggregate and aggregate mixtures for purposes of stabilization. Fly ash is a finely divided residue that results from the combustion of ground or powdered coal.

2005.02 REQUIREMENTS.

(a) General.

Fly ash furnished under this specification shall be prequalified and comply with the requirements of ASTM C618, Class C, except the supplementary optional physical requirements in Table 4 will not apply and the minimum calcium oxide (CaO) content of the fly ash shall be 25%.

(b) Storage and Handling.

Fly ash shall be stored and handled in closed waterproof containers prior to distribution on the roadway or fill. Other methods of storage and handling are subject to the approval of the Engineer. Fly ash that has been partially caked or set shall not be used.

2005.03 PREQUALIFICATION.

Suppliers wishing to prequalify fly ash shall submit, for each power plant, certified analyses of the fly ash tests completed during the 90 day period immediately prior to the prequalification request. The certified analyses shall be representative of the material proposed for use under this specification and shall be based on tests conducted in a laboratory regularly inspected by the Cement and Concrete Reference Laboratory. The analyses shall be forwarded to the Chief of Materials and Research. The Chief of Materials and Research shall review the submitted information and if satisfactory, place the source on a prequalified list that will be maintained by the Bureau of Materials and Research.

Prequalified sources of fly ash will retain their prequalified status as long as test results of verification samples obtained by the Department and test results of quality control samples obtained by the producer indicate that the producer is exer-

cising acceptable quality control. Results of the tests representing each power plant shall be sent to the Chief of Materials and Research on a monthly basis. When results of these tests indicate inadequate producer quality control, the source will lose its prequalified status.

2005.04 METHODS OF TEST.

Fly ash shall be sampled and tested in accordance with ASTM C311. Field Sampling of fly ash will be in accordance with KT29.

2005.05 BASIS OF ACCEPTANCE.

The basis of acceptance of fly ash furnished from prequalified individual plants shall be receipt of a certification prepared by the producer to cover the quality of each shipment. The certification shall be signed by the producer or his assigned representative. The certification shall show compliance with specifications and shall be attached to or be a part of the scale ticket, weigh bill or other shipping document that accompanies each shipment.

Fly ash received from a prequalified plant will be accepted for immediate use upon receipt by the Field Engineer of a copy of a producer's certification showing compliance with this specification.

Maine

April 11, 1990

SPECIAL PROVISIONS
SECTION 617
SOIL CONDITIONERS

Description. This work shall consist of furnishing and placing soil conditioners on designated slopes in reasonably close conformity with the thicknesses called for on the plans or as authorized.

MATERIALS

Erosion Control Mix. Erosion control mix shall consist of a composted bark mix of recycled composted bark flume grit and fragmented wood generated from water-flume log handling systems in paper mills. The mix shall conform to the following:

(a) Ph-Range 5.0 - 6.0
(b) Passing through a screen size not larger than 6 inches
(c) Containing no less than 25 percent organic base material
(d) No stones larger than 2 inches in diameter shall be allowed

Superhumus Topsoil. Superhumus topsoil shall consist of the same material as erosion control mix, except that it shall not contain any bark or wood fibers greater than 3/4 inch in size and shall meet the following:

(a) Ph-5.0 - 6.0
(b) Screen Size - 3/4 inch minus
(c) Containing no less than 25% organic base
(d) No stones, clods, roots over 1 inch in size shall be allowed

Seed. Seed shall meet the requirements of Subsection 717.03, Method Number 2, Roadside Mixture.

Fertilizer. Fertilizer shall meet the requirements of Subsection 717.01(b) Inert Filler Granular Fertilizer.

Limestone. Limestone shall meet the requirements of Subsection 717.02.

CONSTRUCTION REQUIREMENTS

Application of Erosion Control Mix. Erosion control mix shall be spread evenly and uniformly, three inches deep, on prepared areas as designated on the plans.

All Stones larger than 2 inches in diameter shall be removed.

Application of Superhumus Topsoil. Before spreading superhumus topsoil, fertilizer and limestone shall be added and thoroughly mixed at the following rates:

Fertilizer	15 pounds per 1000 square foot
Limestone	25 pounds per 1000 square foot

Superhumus topsoil shall then be spread uniformly in two layers on prepared Erosion Control Mix.

The first layer shall be three inches thick. All stones, roots, clods and all other foreign matter greater than 1 inch shall be removed. Superhumus topsoil shall be raked to a smooth surface, meeting the required grades.

A second layer, 1/4 to 1/2 inch thick, of superhumus topsoil containing Method Number 2 seed mix at a rate of 4 lbs. per 1000 square foot shall be applied over the surface of the first layer to ensure an even cover of grass over the prepared area.

Method of Measurement. Soil conditioners will be measured by the cubic yard complete in place after finishing to the required depths as shown on the plans or directed. Lateral measurements will be parallel with the slope of the ground.

Basis of Payment. The accepted quantities of soil conditioners will be paid for at the contract unit price per cubic yard complete in place.

Payment shall be full compensation for furnishing and placing the composted bark mix and for furnishing and mixing seed, fertilizer and limestone when required for superhumus topsoil.

Payment will be made under:

Pay Item		Pay Unit
617.30	Composted Bark Mix	Cubic Yard

North Country Products™

COMMERCIAL BLEND COMPOST

UTILIZATION AGREEMENT

North Country Products™ Commercial Blend Compost is a blend of municipal sludge, woodash, sawdust and paper mill sludge from a recycled fiber operation. The formulation has been designed to optimize the compostability of the mixture and create a stable, nutrient balanced finished end product. The approximate dry weight of inputs in descending order is as follows:

Sawdust
Municipal Wastewater Sludge
Paper Mill Sludge
Woodash

This compost is approved by the Maine Department of Environmental Protection for the following five uses:

1. Industrial & commercial landscaping
2. Roadside reclamation & landscaping projects including those performed by/for the Maine Department of Transportation.
3. Forest land application
4. Landfill closure final cover material
5. Reclamation/closure of gravel pits which do not overrule significant groundwater aquifers or primary sand and gravel recharge areas.

It is recommended you consult with Resource Conservation Services, Inc. to determine application rates of the material for your particular project(s) and application(s). However, in no case should this product be used in excess of 65 dry tons/acre (approximately equivalent to 130 wet tons/acre, or 300 CYS/acre @ 50% moisture and 850 lbs./CY, or approximately a 2" layer.)

By signing this agreement, you hereby agree to these conditions of usage.

Signature: _____

Company Name: _____

Intended Use/Location: _____

Volume: _____

Date: _____

Bangor-Veazie-Orono
95-8(146) Maine

December 24, 1990

SPECIAL PROVISION
SECTION 403
HOT BITUMINOUS PAVEMENT
(Asphalt Rubber Mixtures)

DESCRIPTION: This work shall consist of furnishing and placing two courses of dense graded hot bituminous mixture with an asphalt-rubber binder material on an approved base in accordance with these Special Provisions and in reasonably close conformity with the lines, grades, compacted thickness and typical cross section shown on the plans.

All relevant provisions of Sections 401 -- Plant Mix Pavements - General, Section 702 - Bituminous Material, and Section 703 - Aggregates, shall apply except as modified by this Special Provision.

MATERIALS

AGGREGATES: Aggregates shall meet the quality requirements of Subsection 703.07. The two mixtures shall meet the gradation requirements of the following mixtures:

SHIM COURSE (GRADING E)		WEARING COURSE (GRADING C)
Sieve Designation		Percent Passing (by weight)
3/4 inches		100
1/2 inches	100	80-100
3/8 inches	90-100	65-100
No. 4	70-100	40-70
No. 8	50-90	26-52
No. 16	36-78	17-40
No. 30	24-66	10-30
No. 50	15-50	7-22
No. 100	8-30	4-14
No. 200	3-8	2-7
% Asphalt-Rubber	8.5-10.0	7.0-8.5

GRANULATED RUBBER: Granulated rubber particles shall be reclaimed vulcanized rubber produced primarily from the processing of scrap rubber, automobile or truck tires and shall be produced at ambient temperature by cryogenic grinding processes only. The use of rubber of multiple types from referenced sources is acceptable provided the blend of rubber meets the following gradation:

Sieve Size	% Passing	Sieve Size	% Passing
#10	100	#80	5-30
#30	30-50	#200	0-5

The length of the individual rubber particles shall not exceed 3/16 inches (5mm). The granulated rubber shall have a specific gravity of 1.15 ± 0.05 and shall be free of loose fabric, wire and other contaminants except that up to 4% (by weight of rubber) calcium carbonate or talc may be added to prevent rubber particles from sticking together. The rubber shall be sufficiently dry so as to be free flowing and not produce a foaming problem when blended with the hot asphalt cement. The granulated rubber will be accepted by certification from the rubber supplier.

EXTENDER OIL: Extender Oil, if required, shall be a resinous high flash point aromatic hydrocarbon conforming to the following requirements:

Viscosity, SSU, at 100°F (ASTM D-88)	2,500 Min.
Flash Point, COC, °F (ASTM D-92)	390 Min.
Molecular Analysis (ASTM D-2007)	
asphaltenes, weight %	0.1 Max.
Aromatics, weight %	55.0 Min.

ASPHALT CEMENT: The grade of asphalt cement shall be as selected by the asphalt-rubber supplier and shall meet the requirements of subsection 702.01.

ASPHALT-RUBBER BLEND: The asphalt-rubber supplier shall submit an asphalt-rubber blend formulation to the Engineer at least 10 days before pavement construction is scheduled to begin. A sample of each of the components of the blend including asphalt cement, rubber and extender oil (if used) shall be furnished with the formulation. The asphalt-rubber blend shall contain 20± 4.0 percent rubber by weight of the total blend.

The asphalt-rubber blend, when reacted for one hour at 350°F (± 10°F), shall possess the following physical properties:

Viscosity, 350°F	1500 cp Min.
Cone Penetration, 77°F (ASTM D1191)	20 Min.
Softening Point, °F (ASTM D30)	125° Min.
Resilience, 77°F (ASTM D3407 modified with 60 second recovery period)	15 Percent Min.

CONSTRUCTION REQUIREMENTS

MIXING AND PRODUCTION EQUIPMENT: All equipment used in the production and proportioning of the asphalt-rubber binder shall be as follows:

(a) An asphalt heating tank to heat the asphalt cement to the necessary temperature for blending with the granulated rubber. This unit shall be equipped with a minimum 2800 gallon tank capable of raising the heat of the product at a rate of 60°F per hour.

(b) A mechanical blender for proper proportioning and thorough mixing of the asphalt cement and granulated rubber. The blender shall be capable of producing a homogenous mixture at the designed specified ratio. This unit shall have an asphalt totaling meter (gallons or liters), a flow rate meter (gallons per minute or liters per minute), a positive placement auger to feed the rubber properly to the mixing chamber at the specified rate and an auger in the mixing chamber running through a static motionless mixer.

(c) An asphalt-rubber storage tank equipped with a heating system to maintain the proper temperature for pumping and adding of the binder to the aggregate and a 12 inch auger internal mixing unit capable of maintaining a proper mixture of asphalt cement and rubber.

(d) An asphalt-rubber supply system equipped with a pump and metering device capable of adding the binder by volume to the aggregate at the percentage stipulated by the job-mix formula.

MIXING AND REACTION PROCEDURE: The temperature of the asphalt cement shall be between 350°F and 425°F at the time the rubber is blended with the asphalt.

The asphalt cement and rubber shall be mixed together in the blender unit, pumped into the agitated storage tank and then reacted for a minimum of 30 minutes from the time the rubber is added to the asphalt.

The temperature of the asphalt-rubber blend shall be maintained between 325°F and 385°F during the reaction period.

After the blend has reacted for a minimum of 30 minutes, it shall be metered into the bituminous mix plant at the percentage required by the job-mix formula.

When a delay occurs in the use of the blend after its full reaction, the blend shall be allowed to cool. The asphalt-rubber shall be reheated slowly just prior to use, but not to a temperature exceeding 375°F and shall be thoroughly mixed before pumping and metering into the bituminous mix plant.

MIXING: At least two weeks prior to placement of the mix, the Contractor shall submit, for the approval of the Engineer, a job-mix formula for the mix.

MIXING AND PLACING: The asphalt rubber mixtures shall be manufactured in a batch or drum mix plant and paced on the roadway in accordance with Section 401-Plant Mix Pavement-General with the following additions or exceptions:

(a) The asphalt-rubber blend shall be introduced into the mixtures at a temperature of 325°F to 385°F.

(b) The temperature of the asphalt-rubber mixtures when discharged from the mix plant shall be between 310°F and 350°F.

(c) Truck bodies shall be coated with an approved soap solution or silicone emulsion. (Petroleum based solutions will not be allowed).

METHOD OF MEASUREMENT: Asphalt-Rubber Mixtures will be measured as specified in Subsection 401.21.

BASIS OF PAYMENT: The accepted quantities of asphalt-rubber mixtures will be paid for at the contract unit price per ton for the bituminous mixtures, including asphalt-rubber binder complete in place.

Payment will be made under:

Pay Item		Pay Unit
403.304	Hot Bituminous Pavement Asphalt-Rubber Grading E	Ton
403.305	Hot Bituminous Pavement Asphalt-Rubber Grading C	Ton

12-16-88

MARYLAND STATE HIGHWAY ADMIN.

SPECIFICATIONS FOR BITUMINOUS CONCRETE

ASPHALT-RUBBER BINDER

917.05 BITUMINOUS CONCRETE WITH ASPHALT-RUBBER BINDER. The mixture shall be plant mixed materials manufactured in a plant meeting the requirements of Section 915.

917.05.01 AGGREGATES. Aggregates shall meet the requirements of Section 903.07.

917.05.02 BITUMINOUS MATERIAL. Bituminous material shall meet the requirements of Section 902.01.

917.05.03 GRANULATED RECLAIMED VULCANIZED RUBBER. The rubber shall be produced from processing of automobile and truck tires. The rubber shall be produced by ambient temperature grinding methods. Multiple types and sources of rubber are acceptable provided the overall blend meets the following requirements:

Chemical Analysis (ASTM D297) - Natural rubber content percent by weight 25 ± 5 percent.

Gradation (AASHTO T 27) -

Sieve Size	Percent Passing
No. 8	100
No. 16	75 - 100
No. 30	20 - 90
No. 100	0 - 20
No. 200	0 - 5

The length of individual particles shall not exceed 3/16 inch. Granulated rubber shall have a specific gravity of 1.15 ± 0.05 and be free of loose fabric, wire, and other contaminants except that a maximum of 4 percent (by weight) of calcium carbonate or talc may be added to prevent the particles from sticking together. The rubber shall be sufficiently dry to be free flowing and not foam when blended with hot asphalt.

917.05.04 ASPHALT-RUBBER BINDER. The asphalt rubber binder shall contain 18 ± 3 percent rubber by total weight of the asphalt, and be a uniform reacted mixture of asphalt cement,

granulated reclaimed vulcanized rubber, and if required, an antistripping additive. The binder shall meet the following physical requirements when heated at 350 ± 10 F for 60 ± 5 minutes:

Test	Requirement
Viscosity, 350 F, Haake	1,500 - 4,000 CP
Viscosity, 140 F (AASHTO T202)	600 - 2,000 P
Softening Point (AASHTO T 53)	125 - 160 F
Cone Penetration, 77F (AASHTO T 49)	40 min.
Resilience, 77 F (ASTM D 3407 modified with 60 seconds recovery period)	20 % min.

If an extender oil is necessary in order for the asphalt-rubber binder to meet these requirements, it shall be a resinous, high flush point aromatic hydrocarbon meeting the following:

Test	Requirement
Viscosity, SUS, 100F (ASTM D88)	2500 min.
Flash Point, CUC, F (ASTM D92)	390 min.

The use of an extender oil shall not exceed 7 percent by weight. The asphalt cement and the extender oil shall be combined to form a material that is chemically compatible with the rubber.

917.05.05 DESIGN MIX. The bituminous pavement mixture shall be a surface course meeting the following gradation requirements:

Sieve Size	Percent Passing
3/4 in.	100
1/2 in.	86 - 99
3/8 in.	70 - 94
No. 4	35 - 68
No. 8	24 - 52
No. 16	16 - 36
No. 30	10 - 26
No. 50	7 - 18
No.200	2 - 9

A laboratory study shall be conducted by the Contractor in accordance with AASHTO T245 and as modified by MSMT 405. The following criteria shall be used in the selection of an appropriate asphalt-rubber binder content:

Marshall Test Requirements

Mix Designation SC-R	
Stability, min, lb.	1,500
Flow, 0.01 in.	8 - 20
Voids, Mineral Agg. % min.	16
Voids, Total Mix, %	3 - 5
Compaction Blows Used	75

917.05.06 **MIX DESIGN APPROVAL. The requirements shall be the same as Section 917.01.04 and the following:**

1. **Source and proportion of rubber.**
2. **Source and proportion of extender oil, if required.**
3. **Certification, showing actual test results, of specification compliance for all materials to be used in the work.**

917.05.07 **HEAT STABLE ANTISTRIPPING ADDITIVE. The requirements shall be the same as Section 917.01.05.**

917.05.08 **PLANT CONTROL. The requirements shall be the same as Section 917.02.06 and the following:**

1. **The temperature of the asphalt cement and, if required, extender oil shall be between 350-400 F at the time the rubber is blended.**
2. **The asphalt cement and rubber shall be properly proportioned and thoroughly blended in a suitable mechanical mixing tank. The method and equipment for blending shall be accessible so that the Engineer can readily determine the percentages by weight for each material being incorporated into the mixture.**
3. **After the asphalt cement and rubber have been introduced into the mixing tank, the materials shall be mixed continiously for a minimum of 45 minutes at a temperature between 325-400 F.**

4. The contractor may use an agitated storage tank to store the asphalt-rubber blend provided that the material is kept between 325-375 F during the reaction period.

5. The asphalt-rubber mixture after reaching the desired consistency shall not be held at temperatures over 325 F for more that 4 hours.

6. The asphalt-rubber mixture shall not be applied or used as a binder after it has been retained at or above the mix temperature for more than 48 hours.

7. When a delay occurs in binder use after its full reaction, the asphalt-rubber shall be allowed to cool. The asphalt-rubber shall be reheated slowly just prior to use to a temperature between 325 and 375 F, and shall also be thoroughly mixed before pumping and metering into the hot plant for combination with the aggregate. The viscosity of the asphalt-rubber shall be checked by the Contractor. If the viscosity is out of the range specified, the asphalt-rubber shall be adjusted by the addition of additional asphalt cement or granulated rubber to produce a material with the appropriate viscosity.

917.05.09 HAULING UNIT. Hauling units shall meet the requirements of subsection 915.02.14 and the following:
Truck beds should not be oiled or treated with diesel oil. If necessary, a spray application of a soapy solution or a silicone emulsion should be used.

917.05.10 COMPACTION. Steel wheel rollers shall be used for the breakdown and finish rolling. They shall be equiped with a watering or soapy watering system that prevents the picking up of the hot mixed materials by the roller faces.
The mixture shall be between 265-300 F during initial breakdown compaction. Normal rolling patterns shall be applied.

917.05.11 DENSITY REQUIREMENTS. Density Requirements shall be the same as Section 401.03.09.

917.05.12 METHOD OF MEASUREMENT. This item will be measured on the basis of the weight of the combined mixture furnished, completed and accepted.
The quantity of bituminous material for tack coat will not be measured.

917.05.13 BASIS OF PAYMENT. Basis of payment shall be the same as Section 401.05.

Grade 3 - Non-sagging consistency.

c. Class A - For use below 40 degrees Fahrenheit; the lowest allowable temperature to be defined by the manufacturer of the product.

Class B - For use between 40 and 60 degrees Fahrenheit.

Class C - For use above 60 degrees Fahrenheit; the highest allowable temperature to be defined by the manufacturer of the product.

3. All bonding surfaces shall be clean and free of all oil, dirt, grease or any other materials which would prevent bond. Mixing and application shall be in strict accordance with the manufacturer's instructions.

Nebraska

ASPHALTIC CONCRETE, TYPE "HMR"

Description

The Asphaltic Concrete, Type "HMR", composition will include the incorporation of reacted asphalt-rubber binder in the mixture. The volumes of ingredients in the mixture shall be in accordance with the recommendation of the supplier of the reacted asphalt-rubber binder.

The department will conduct a pre-bid conference in the Department's Central Headquarters auditorium on June 7, 1990, beginning at 10:00 a.m. to allow contractors to obtain specific information relative to the use of reacted asphalt-rubber binder. Representatives of suppliers will be available to advise the contractors of specialized equipment that will be required and to provide any technical manuals. The representative will also relate any personal knowledge that has been obtained from experience on previous work of this nature.

A representative of the supplier will be available on the project site during the erection of the asphalt plant, during the initial production of the materials, and on call if the contractor desires technical assistance during production operations.

Requirements

Asphaltic Concrete, Type "HMR", shall conform to the requirements of Section 1007 in the Standard Specifications, as amended herein.

Mineral Aggregate For Asphaltic Concrete

a. The combined mineral aggregate for Asphaltic Concrete, Type "HMR", shall be composed of crushed sand gravel and crushed rock aggregates and mineral filler, if needed. The combined aggregate shall contain not less than 70 percent crushed rock.

b. The gradation of the crushed rock shall be such that, in combination with Mineral Aggregate No. 3-A (Crushed Sand Gravel), and mineral filler, if needed, a job mix formula meeting the target value requirements shown below can be established.

RANGE FOR TARGET VALUES

Sieve Size	Percent Retained
3/8 inch	40 ± 10
No. 50	92 ± 4
No. 200	96 ± 2

* This requirement is based on a specific gravity range of 2.55 to 2.75 for the material passing the No. 200 sieve. For specific gravities outside these limits, the range may be adjusted by the Materials and Tests Engineer to maintain an equivalent volume of material passing the No. 200 sieve.

c. In addition to the above requirements, the gradation of the combined mineral aggregate proposed for use shall have zero retention on the 1-inch sieve, not more than 15 percent on the 3/4-inch sieve, 63± 7 on the No. 4 sieve and 80 ± 6 on the No. 10 sieve.

Asphalt-Rubber Binder

For bidding purposes the asphalt-rubber binder content is established at 8.1% by weight of total aggregate for densed-graded mixtures.

The asphalt-rubber binder shall be a uniform mixture of compatible paving grade asphalt cement, granulated reclaimed vulcanized rubber, and if required by the mixture design, liquid anti-strip agent. The asphalt-rubber binder shall meet the following physical parameters when reacted at 350 degrees fahrenheit ± 10 degrees fahrenheit for 60 minutes.

Test	Requirements
Viscosity Haake, 350 degrees F.	1500-4000 CP
Cone Penetration 77 degrees F. ASTM D1191	Per job mix
Softening Point 135-200 degrees F. ASTM D36	Per job mix
Resilience 77 degrees F. ASTM D3407	15% Min.

Granulated Reclaimed Vulcanized Rubber

The rubber used shall be produced primarily from the processing of automobile and truck tires. Final grinding of the rubber shall be accomplished with ambient temperature processes only. The use of ground rubber from multiple sources is acceptable provided the overall blend of rubber meets the gradation requirements. The gradation of the rubber when tested in accordance with ASTM C136 using approximately 50 grams shall be in accordance with the following table:

Sieve Size	Percent Retained	
	Min.	Max.
No. 10	0	5
No. 16	0	2
No. 30	90	100
No. 50	98	100
No. 200	100	--

Gradation of rubber shall be determined by compatibility and reaction characteristics required in the job mix formula.

Specific gravity of the rubber shall be 1.15 ± 0.05 and shall be free from faric, wire, or other contaminating materials. However, up to four percent calcium carbonate may be included to prevent the particles of rubber from sticking together.

The rubber shall be dry so as to be free flowing and not produce foaming when blended with hot asphalt cement. Particle maximum length shall not exceed six times its minimum dimension.

Packaging

The ground rubber shall be supplied in moisture resistant disposable bags which weigh 50 ± 2 lbs. The bags shall be palletized into units each containing 50 bags to provide net pallet weights of 2500 ± 100 lbs. Glue shall be placed between layers of bags to increase the unit stability during shipment. Palletized units shall be double wrapped with U.V. resistant stretch wrap.

Certification

The manufacturer shall ship with the rubber, certificates of compliance which certify that all requirements of these specifications are complied with for each production lot number of shipment.

Asphalt-Rubber Blend Design

The mixture design shall be performed by the asphalt-rubber supplier. The proportion of granulated rubber shall be between 17 and 25 percent by weight of the total mixture.

The asphalt-rubber supplier shall supply to the engineer a mix formulation at least 10 days before pavement construction is scheduled to begin. The mix formula shall consist of the following information:

1. Aggregate
   - Source
   - Gradation
   - Blend percentages
   - Mixture gradation

2. Asphalt-Rubber
   - Source and grade of asphalt cement
   - Source and grade of crumb rubber
   - Crumb rubber percentage for the Asphalt Rubber Binder
   - Temperature when added to aggregate

3. Asphalt-Rubber binder content

4. Mix temperature

5. Placement temperature

6. Density requirement

Asphalt-Rubber Mixing and Production Equipment

All equipment utilized in production and proportioning of the asphalt-rubber binder shall be described as follows:

1. An asphalt heating tank with a hot oil heat transfer system or retort heating system, capable of heating asphalt cement to the necessary temperature for blending with the granulated rubber. This unit shall be capable of heating a minimum of 3,000 gallons of asphalt cement.

2. An asphalt-rubber mechanical blender with a two stage continuous mixing process capable of producing a homogeneous mixture of asphalt cement and granulated rubber, at the mix design specified ratios, as directed by the engineer. This unit shall be equipped with a granulated rubber feed system capable of supplying the asphalt cement feed system as not to interrupt the continuity of the blending process. A separate asphalt cement feed pump and finished product pump are required. This unit shall have both an asphalt cement totalizing meter in gallons and a flow rate meter in gallons per minute.

3. An asphalt-rubber storage tank equipped with a heating system to maintain the proper temperature for pumping and adding of the binder to the aggregate and an internal mixing unit within the storage vessel capable of maintaining a proper mixture of asphalt cement and granulated rubber.

4. An asphalt-rubber supply system equipped with a pump and metering device capable of adding the binder by volume to the aggregate at the percentage required by the job-mix formula.

Asphalt-Rubber Mixing and Reacting Procedure

1. Asphalt Cement Temperature

Paragraphs 3.a. and 3.b. of Subsection 1007.08 in the Standard Specifications are void.

The temperature of the asphalt cement shall be between 350 and 400 degrees F. at the addition of the granulated rubber.

2. Blending and Reacting

The asphalt and granulated rubber shall be combined and mixed together in a blender unit, pumped into the agitated storage tank, and then reacted for a minimum of 45 minutes from the time the granulated rubber is added to the asphalt cement. Temperature of the asphalt-rubber mixture shall be maintained between 325 and 375 degrees F. during the reaction period.

3. Transfer

After the material has reacted, the asphalt-rubber shall be metered into the mixing chamber of the asphalt concrete production plant at the percentage required by the job-mix formula.

4. Delays

When a delay occurs in binder use after its full reaction, the asphalt-rubber shall be allowed to cool. The asphalt-rubber shall be reheated slowly just prior to use to a temperature between 325 and 375 degrees F., and shall also be thoroughly mixed before pumping and metering into the hot plant for combination with the aggregate. The viscosity of the asphalt-rubber shall be checked by the asphalt-rubber supplier. If the viscosity is out of the range specified in Section 3 of this specification, the asphalt-rubber shall be adjusted by the addition of additional asphalt cement or granulated rubber to produce a material with the appropriate viscosity.

Compaction Equipment

Paragraph 2. of Subsection 507.08 in the Standard Specifications is voided and superseded by the following:

A minimum of two self-propelled two-axle steel-wheel rollers shall be furnished for each spreader and finisher. Rollers shall have a maximum weight of 12 tons.

Asphalt Content in Asphaltic Concrete

Testing of asphalt content in Subsection 1007.04 and Subsection 1007.05 in the Standard Specifications is void.

Method of Measurement

Asphaltic Concrete, Type "HMR", shall be measured in accordance with the Standard Specifications.

Asphalt-Rubber Binder for use in the Asphaltic Concrete shall be measured by "tank-stabs" at the end of each day of operation, or as directed by the engineer. The "tank-stabs" will then be converted to tons based on specific gravity of the material.

Basis of Payment

Asphaltic Concrete Type, "HMR" will be paid for in accordance with the Standard Specifications.

Asphalt-Rubber Binder which is measured herein shall be paid for at the contract unit price per ton for the item "Asphalt-Rubber Binder For Asphaltic Concrete". This shall be full compensation for furnishing the asphalt cement, granulated reclaimed vulcanized rubber, anti-strip agent, delivering, hauling, storing, heating and for all labor, equipment, tools and incidentals necessary to complete the work.

ASPHALT-RUBBER STRESS ABSORBING MEMBRANE INTERLAYER

1. Scope

This specification covers the material, equipment and construction procedures for a Stress Absorbing Membrane.

2. Prequalification of a New Asphalt-Rubber Material

Prequalification of a new asphalt-rubber material or applicator may be requested at any time. Prequalification will be based on three controlled field applications evaluated after three years performance under traffic. New asphalt-rubber material that has been evaluated and prequalified by an agency recognized nationally may be prequalified by that agency upon disclosure of suitable evidence of successful performance. Notwithstanding other agency prequalification, the state reserves the right to withhold prequalification pending the performance evaluation of local controlled field applications.

3. Materials

3a. Asphalt

The grade of asphalt cement for the asphalt-rubber mixture shall be AC-5 or AC-10 which will comply with the requirements of AASHTO-M226. The grade selected shall be based on laboratory testing by the asphalt-rubber supplier, to insure compatibility with the granulated reclaimed rubber.

If indicated necessary by laboratory testing, an approved anti-stripping additive may be added to the asphalt cement up to 1.0 percent by weight of asphalt.

3b. Granulated Reclaimed rubber

The granulated reclaimed rubber used shall be produced primarily from the processing of automobile and truck tires. The rubber shall be produced by ambient temperature grinding processes only.

The gradation of the granulated reclaimed rubber when tested in accordance with ASTM C-136 and using a 50 gram ± 1 gram sample, shall meet the following requirements:

Sieve Size	Percent Retained	
	Min	Max
No. 8	0	0
No. 10	0	5
No. 30	90	100
No. 50	95	100

The use of rubber from multiple sources is acceptable provided that the overall blend of rubber meets the gradation requirements.

The individual granulated rubber particles, irrespective of diameter, shall not be greater in length than 3/16 inch (5mm).

The granulated rubber shall have a specific gravity of 1.15 +/- 0.05 and shall be free of loose fabric, wire and other contaminants except that up to 4 percent (by weight of rubber) calcium carbonate or talc may be added to prevent rubber particles from sticking together. The rubber shall be sufficiently dry so as to be free flowing and not produce a foaming problem when blended with the hot asphalt cement.

The granulated reclaimed rubber shall be accepted by certification from the rubber supplier.

3c. Diluent

The diluent shall have the following properties:

Flash Point	130 degrees F. Min.
Initial Boiling Point (ASTM D-86)	340 degrees F. Min.
Dry Pint (ASTM D-86)	390 to 415 degrees F.
Total Saturates	85% Min.

3d. Asphalt-Rubber

The asphalt-rubber supplier shall furnish to the Engineer, a minimum of 10 days before the beginning of membrane placement, the asphalt-rubber mix formulation which shall contain the following information:

Asphalt Cement
- Source of Asphalt Cement
- Grade of Asphalt Cement
- Percentage of Asphalt Cement by total weight of the asphalt-rubber mixture

Granulated Reclaimed Rubber
- Source of Granulated Rubber
- Grade of Granulated Rubber
- Percentage of Granulated Rubber by total weight of the asphalt-rubber mixture

If granulated rubber from more than one source is utilized, the above information will be required for each granulated rubber used.

Diluent
- Source of diluent
- Grade of Diluent
- Percentage of Diluent allowable by volume of the asphalt-rubber mixture

3e. Cover Aggregate

The mineral aggregate will be tested in accordance with the Standard Specifications.

Aggregate shall be composed of a clean and durable crushed rock or crushed gravel produced from a uniform deposit of raw material.

The gradation of the cover aggregate shall meet the following size requirements:

Sieve Size	Percent Retained	
	MIN	MAX
1/2 inch	0	0
3/8 inch	0	30
1/4 inch	90	100
No. 8	95	100
No. 200	98	100

Note: LA Wear 40% (MAX)

Proposed aggregate samples shall be submitted to the asphalt-rubber supplier a minimum of 21 days prior to application, to test for aggregate stripping characteristics. The results shall be submitted to the Engineer.

Note: Crushed Aggregate - 75% of all material retained on the No. 8 sieve shall have at least one fractured face.

4. Equipment

4a. General

The equipment used by the contractor shall include a selfpropelled rotary power broom or mobile pickup broom for pavement cleaning and excess cover material removal.

4b. Asphalt-Rubber Equipment

All equipment utilized in the production and application of the asphalt-rubber shall be as described as follows:

4b.1. An asphalt heating tank with a hot oil heat transfer system or retort heating system capable of heating asphalt cement to the necessary temperature for blending with the granulated rubber. This unit shall be capable of heating a minimum of 3,000 gallons of asphalt cement.

4b.2. An asphalt-rubber mechanical blender with a two stage continuous mixing process capable of producing a homogenous mixture of asphalt cement and granulated rubber, at the mix design specified ratios, as directed by the engineer. This unit shall be equipped with a granulated rubber feed system capable of supplying the asphalt cement feed system as not to interrupt the continuity of the blending process. A separate asphalt cement feed pump and finished product pump are required. This unit shall have both an asphalt cement totalizing meter in gallons and a flow rate meter in gallons per minute.

4b.3. A truck or trailer mounted self-powered distributor truck equipped with a retort heating unit, and an internal mixing device capable of maintaining a uniform mixture of asphalt cement and granulated rubber. It shall be equipped with a full circulating spreader bar and a pumping system capable of applying asphalt-rubber material within +/- .05 gallons per square yard tolerance of the specified application rate and must give a uniform covering of the surface to be treated. The distributor shall have a boot board on the rear of the vehicle and a bootman shall accompany the distributor. The bootman shall ride in a position so

that all spray bar tips are in full view and readily accessible for unplugging if a plugged tip should occur. The distributor shall also include a tachometer, pressure gauge, volume measuring device and a thermometer.

4c. Cover Material Spreader

The cover material (chip) spreader shall be a self-propelled machine with an aggregate receiving hopper in the rear, belt conveyors to carry the aggregate to the front, and a spreading hopper equipped with a full-width distribution auger and spread roll. The spreader shall be in good mechanical condition and be capable of applying the cover material uniformly across the spread at the specified rate.

4d. Rolling Equipment

A minimum of three operational self-propelled pneumatic-tired rollers shall be used for the required rolling of the cover material. The pneumatic-tired rollers shall carry a minimum loading of 3,000 pounds on each wheel and a minimum air pressure of 100 pounds per square inch in each tire.

4e. Hauling Equipment

Trucks for hauling cover material shall be tailgate discharge and shall be equipped with a device to lock onto the hitch at the rear of the cover material spreader. Haul trucks shall also be compatible with the cover aggregate spreader so that the dump bed will not push down on the spreader when fully raised or have to short a bed which results in aggregate spillage while dumping into the receiving hopper.

5. Construction

5a. General

Immediately prior to the application of the asphalt-rubber membrane, the surface shall be thoroughly cleaned in order to insure adequate adhesion of the asphalt-rubber to the pavement.

5b. Asphalt-Rubber Mixing and Reaction

The percentage of granulated rubber shall be 23 percent plus or minus 3 percent by weight of total asphalt-rubber mixture, the exact granulated rubber content shall be as determined by the mix design submitted by the asphalt-rubber supplier. During membrane placement the granulated rubber percentage shall not fluctuate by more than 1 percent by weight of total asphalt-rubber mixture.

The temperature of the asphalt cement shall be between 350 and 425 degrees F. at the addition of the granulated rubber. The asphalt and rubber shall be combined and mixed together in the asphalt-rubber blending unit and reacted in the distributor for a period of time as required by the Engineer which shall be based on laboratory testing by the asphalt-rubber supplier. The temperature of the asphalt-rubber mixture shall be above 325 degrees F. during the reaction period.

After the reaction between asphalt cement and granulated rubber has occurred, the viscosity of the hot asphalt-rubber mixture may be adjusted for spraying and/or better "wetting" of the cover material by the addition of a diluent. The

diluent shall comply with the requirements noted earlier and shall not exceed 7.5 percent by volume of the hot asphalt-rubber mixture.

When a job delay occurs after full reaction, the asphalt-rubber may be allowed to cool. The asphalt-rubber shall be reheated slowly just prior to application but not to a temperature exceeding 350 degrees F. An additional quantity of diluent not exceeding 3 percent by volume of the hot asphalt-rubber mixture may be added after reheating.

5c. Application of Asphalt-Rubber Material

Placement of the asphalt-rubber membrane shall be made only under the following conditions.

1. The pavement surface temperature shall be 45 degrees F. and rising.
2. The pavement surface is clean and absolutely dry.
3. The wind conditions are not excessive.
4. All construction equipment such as asphalt-rubber distributor, cover material spreader, haul trucks with cover material, and rollers are in position and ready to commence membrane placement operations.
5. Rain is not imminent.

The asphalt-rubber mixture shall be applied to a temperature of 290 degrees to 340 degrees F. at a rate of 0.65 +/-.05 GAL/SY. Transverse joints shall be constructed by placing building paper across and over the end of the previous asphalt-rubber application. Once the spraying has progressed beyond the paper, the paper shall be removed immediately and disposed of as directed by the Engineer. All longitudinal joints shall not exceed a four-inch overlap.

5d. Application of Cover Material

The cover material shall be surface dry at the time of application to the asphalt-rubber to optimize adhesion characteristics.

Cover material shall be applied immediately to the asphalt-rubber after spreading. Crushed aggregate shall be applied at the rate of 30 to 36 lb/S.Y.

Selection of the actual application rate shall be performed by the Engineer at the time of placement, based on visual inspection of the trial rates.

5e. Rolling

At least three operational pneumatic-tired rollers complying with the requirements as mentioned shall be provided to accomplish the required embedment of the cover material. As some project locations or where production rates dictate, fewer rollers may be utilized as directed by the Engineer. At no time shall there be less than two operational pneumatic-tired rollers on a project.

Sufficient rollers shall be used for the initial rolling to cover the width of the aggregate spread with one pass. The first pass shall be made immediately behind the cover material spreader, and if the spreading is stopped for an extended period, the cover material spreader shall be moved ahead or off the side so that all cover material may be immediately rolled. Four complete passes with rollers shall be made with all rolling completed within one hour after the application of the cover material.

5f. Traffic Control

Except when it is necessary that hauling equipment must travel on the newly applied membrane, traffic of all types shall be kept off the membrane until it has had time to set properly. The speed of all hauling equipment shall not exceed 15 miles per hour when traveling over a membrane which is not adequately set. The minimum traffic-free period shall not be less than one hour. All traffic control shall be the responsibility of the contractor.

5g. Removing Loose Cover Material

Sweeping can begin a minimum of one hour after membrane placement.

Method of Measurement

Asphalt-Rubber Binder shall be measured in gallons.

All mineral aggregate for stress absorbing membrane will be measured by the cubic yard, at the point of delivery at which point the contractor will be required to strike off the materials to uniform heights even with the tops of the boxes of the vehicles. Final acceptance shall be based on approved material, in place and accepted by the engineer.

Basis of Payment

Asphalt-Rubber binder which is applied shall be paid for at the contract unit price per gallon for the item "Asphalt-Rubber Binder, Applied". This price shall be full compensation for furnishing, heating, delivering, hauling, and storing all asphalt-rubber binder; for applying the asphalt-rubber binder to the road; and for all labor, equipment, tools and incidentals necessary to complete the work.

Mineral aggregate which have been accepted by the engineer and applied for the stress absorbing membrane, measured as herein provided, shall be paid for at the contract unit price per cubic yard for the item, "Mineral Aggregate for Asphalt-Rubber Membrane". This price shall be full compensation for furnishing, measuring and hauling, sweeping, distributing, rolling the cover material, and maintaining the cover coat as herein provided, and for all equipment, labor, tools and incidentals necessary to complete the work.

PROPOSAL GUARANTY
(A-23-1085)

As an evidence of good faith in submitting a proposal for this work or for any portion thereof as provided in the proposal form, the bidder must file with his proposal a bid bond, which must be executed on the Department of Roads' Bid Bond form, in the amount of 5 percent of the amount bid for any group of items or collection of groups for which the bid is submitted.

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STATE OF NEBRASKA
DEPARTMENT OF ROADS

ADDENDUM NO. 1
TO THE SPECIAL PROVISIONS
FOR
STATE
PROJECT NO. F-4-5(1001)

The Special Provisons are amended as follows:

SPECIAL PROSECUTION AND PROGRESS

The provision under the heading of "Special Prosecution and Progress," included on Page No. 6 of the special provisions, is amended to include the following:

The contractor for the Group 9 work included this proposal may perform work under the item "Concrete Pavement, Class 'PR' Pavement Repair" prior to the tentative beginning date included in this proposal without the assessment of working days against the contract time allowance.

* * * * *

The gradation chart for the reclaimed vulcanized rubber on the bottom of Page No. 49, in the special provisions is void and superseded by the following:

Seive Size	Percent Min.	Retained Max.
No. 10	-	0
No. 30	0	30
No. 50	60	90
No. 200	95	100

* * * * *

The special provision under the subheading "Compaction Equipment" on Project No. 52 is void and superseded by the following:

Paragraph 2 of Subsection 507.08 in the Standard Specifications is void and superseded by the following:

A minimum of four self-propelled, two-axle, steel wheel rollers shall be furnished and used for each finishing machine. Two of the four shall be vibratory types having separate controls for energy and propulsion.
Rollers shall have a maximum weight of 12 tons.

* * * * *

The special provision under the subheading "Method of Measurement" on page No. 58 is void and superseded by the following:

Method of Measurement

Asphalt-Rubber Binder shall be measured in gallons.

All Mineral aggregate for stress absorbing membrane will be measured by the cubic yard, at the point of delivery at which point the contractor will be required to strike off the material to a uniform level in the vehicle. Final acceptance shall be based on approved material, in place and accepted by the engineer.

DEPARTMENT OF ROADS

G. C. Strobel
Director-State Engineer

Issued: June 11, 1990

GCS:V5/DOC/A

NOTICE: Only the contractors issued bidding proposals receive this addendum and responsibility for notifying any potential subcontractors or suppliers remains with the contractor.

August 26, 1985
Revised September 26, 1985
Revised November 19, 1985
Revised July 25, 1986
Revised November 13, 1986

NEW MEXICO STATE HIGHWAY AND TRANSPORTATION DEPARTMENT
SPECIAL PROVISIONS
FOR
IN-SITU COLD RECYCLING OF BITUMINOUS MATERIAL
SECTION 405-A

All applicable provisions of the New Mexico State Highway and Transportation Department's Standard Specifications for Road and Bridge Construction shall apply in addition to the following:

1. **DESCRIPTION.**

1.1 This work shall consist of pulverizing the existing bituminous surfacing, to the depth shown on the plans, to provide the nominal thickness lift shown on the plans, of recycled bituminous base course throughout the width shown on the plans, mixing an emulsified binder agent and water (if required) with the pulverized bituminous surfacing, then spreading and compacting said mixture as shown on the plans and as provided herein unless otherwise directed by the Project Manager.

The Contractor shall furnish all equipment, tools, labor, all materials (except the pulverized bituminous material), and any other appurtenances necessary to complete the work.

2. **MATERIALS.**

2.1 The emulsified binder agent shall be High Float Emulsion of the type shown on the plans with the option, by the Department, to change one grade, at no increase in price. Any change in grade of binder agent shall be made only with the concurrence of the Central Laboratory. The High Float Emulsion shall meet the requirements of Section 402 - BITUMINOUS MATERIALS of the Standard Specifications.

2.2 The Cold Recycled Material shall meet the following gradation requirements:

Sieve Size	% Passing
1 1/4"	100
1"	90-100

2.3 The Sealing Emulsion shall be High Float Emulsion (diluted) CSS-1 h or other approved equal.

3. **CONSTRUCTION REQUIREMENTS.**

3.1 The existing bituminous surfacing shall be cold recycled in a manner that does not disturb the underlying material in the existing roadway.

3.2 Prior to initiating any recycling operations or other inherent work, the Contractor shall clear, grub and remove all vegetation and debris within the width of pavement to be recycled. Disposal of said vegetation and debris shall be as directed by the Project Manager.

3.3 Recycled operations shall not be performed when the atmospheric temperature is below 50 degrees F. and/or when the chill factor is below 35 degrees F., (chill factor shall be determined as per Subsection 401.31 General., part (a) Weather Limitations of the Standard Specifications, or when the weather is foggy or rainy or when weather conditions are such that in the judgment of the Project Manager, proper mixing, spreading and compacting of the recycled material cannot be accomplished.

3.4 When commencing recycling operations, the emulsified binder agent shall be applied to the pulverized bituminous material at the initial design rate determined by the Materials Laboratory Bureau based on samples submitted at the time of construction. The exact application rate of the emulsified binder agent will be determined and varied by the Project Manager as required by existing pavement conditions. An allowable tolerance of plus or minus 0.2 percent of the initial design rate or Project Manager directed rate of application shall be maintained at all times.

The Contractor may add water to the pulverized material to facilitate uniform mixing with the emulsified binder agent. Water may be added prior to or concurrently with the emulsified binder agent.

In the event segregation occurs behind the paver, the Project Manager may require that the forward speed of the milling operation be reduced and/or that the amount of material going through the crusher be increased and the crusher adjusted to produce more fines. The Contractor may be required to make other changes in his equipment and/or operations, as necessary to obtain a satisfactory end-product.

3.5 The Contractor shall demonstrate his ability to obtain a minimum density of 96 percent of a laboratory specimen prepared in accordance with AASHTO T-245 (50 blows). The Project Manager may require a redemonstration of rolling capabilities when a change in the recycled materials is observed, whenever a change in rolling equipment is made or if densities are not being obtained with the rolling pattern being used.

After the recycled material has been spread and compacted, NO

TRAFFIC (this includes Contractor's equipment) shall be permitted on the completed recycled bituminous base for at least two hours. The area may then be opened to all traffic and shall be allowed to cure such that the moisture content is reduced to 1% or less, by total weight of mix, before placing hot bituminous concrete surfacing.

After the moisture content of the recycled material is 1% or less, the Contractor may, with the concurrence of the Project Manager elect to seal the surface with emulsion at an approximate rate of 0.05 to 0.10 gallon per square yard. Said emulsion, if used, will be paid for under the item sealing emulsion.

Any damage to the completed recycled bituminous base shall be repaired by the Contractor, as directed by the Project Manager prior to placing any hot bituminous surfacing. Said repair(s) shall be made at no additional cost to the New Mexico State Highway and Transportation Department.

Any fillet of fine, pulverized material which forms adjacent to a vertical face shall be removed prior to spreading the recycled mix, except that such fillet adjacent to existing pavement which will be removed by overlapping during a subsequent milling operation need not be removed.

4. **EQUIPMENT.**

4.1 The Contractor shall furnish a self-propelled machine capable of pulverizing in-situ bituminous materials to the depth shown on the plans, in one pass. Said machine shall have a minimum rotor cutting width of twelve feet, standard automatic depth controls and maintain a constant cutting depth. Said machine shall also incorporate screening and crushing capabilities to reduce or remove oversize particles prior to mixing with emulsion. Oversize particles shall be reduced to size by crushing, however, the Contractor may, with concurrence of the Project Manager, waste oversize particles prior to adding emulsion.

The emulsified agent shall be applied through a separate mixing machine capable of mixing the pulverized bituminous material and the emulsified binder agent to a homogeneous mixture and placing the mixture in a windrow. The method of depositing the mixed material in a windrow shall be such that segregation does not occur.

A positive displacement pump, capable of accurately metering the required quantity of emulsified binder agent, down to a rate of 4 gal./min., into the pulverized bituminous material, shall be used. Said pump shall be equipped with a positive interlock system which will permit addition of the emulsified binder agent only when the pulverized bituminous material is present in the mixing chamber and will automatically shut off when the material is not in the mixing chamber.

Each mixing machine shall be equipped with a meter capable of registering the rate of flow and total delivery of the emulsified binder agent introduced into the mixture.

4.2 Placing of the recycled bituminous base course shall be accomplished with a self-propelled bituminous paver meeting the requirements of Subsection 401.32 Equipment Part 3. Bituminous Pavers., except that heating of the screed will not be permitted. The bituminous recycled material shall be spread in one continuous pass, without segregation, to the lines and grades established by the Project Manager.

When a pick-up machine is used to feed the windrow into the paver hopper, the pick-up machine shall be capable of picking up the entire windrow to the underlying materials.

4.3 Rollers shall meet the requirements of Subsection 401.32 EQUIPMENT., Part 4. Rollers. The number, weight, and type of rollers shall be sufficient to obtain the required compaction while the mixture is in a workable condition except that the pneumatic roller(s) shall be 30 ton minimum weight.

Initial rolling shall be performed with the pneumatic roller(s) and continued until no displacement is discerned or until the pneumatic rollers have walked out. Final rolling to eliminate pneumatic tire marks and achieve density shall be done by steel wheel roller(s), either in static or vibratory mode, as required, to achieve required density.

Rolling shall be performed in accordance with paragraph 3, Section 401.35 Compaction, of the 1984 Standard Specifications.

Rollers shall not be started or stopped on uncompacted recycled material. Rolling shall be established so that starting and stopping will be on previously compacted recycled material or on existing PMBP.

Any type of rolling that results in cracking, movement or other types of pavement distress shall be discontinued until such time as the problem can be resolved. Discontinuation and commencement of rolling operations shall be at the sole discretion of the Project Manager.

5. METHOD OF MEASUREMENT.

5.1 In-Situ Cold Recycling of Bituminous Material shall be measured by the Square Yard.

Water will not be measured and paid for separately but shall be included in the In-Situ Cold Recycling of Bituminous Material work.

The High Float Emulsion of the type shown on the plans will be measured by the Ton.

The Sealing Emulsion will be measured by the Ton.

6. BASIS OF PAYMENT.

The accepted quantity of In-Situ Cold Recycling of Bituminous Material will be paid for at the contract unit price per Square Yard

complete and in place.

The accepted quantity of High Float Emulsion of the type shown on the plans will be paid for at the contract unit price per Ton complete and in place.

The accepted quantity of Sealing Emulsion will be paid for at the contract unit price per Ton complete and in place.

Payment will be made under:

PAY ITEM	PAY UNIT
In-Situ Cold Recycling of Bituminous Material.	.Square Yard
High Float Emulsion	.Ton
Sealing Emulsion	.Ton

Project No. 618

ITEM 448 - ASPHALT CONCRETE WITH GRV RUBBER

The requirements of 448 shall apply; deviations from these are as follows:

The bituminous material shall be a reacted mixture of asphalt cement and granulated reclaimed vulcanized tire rubber (GRV Rubber). No reclaimed pavement shall be used.

The maximum flow (0.01) inch for the JMF shall not exceed 22.

Pneumatic tire rollers shall not be used.

MATERIALS

Asphalt Cement. The asphalt cement used shall meet the requirements of 702.01.

Extender Oil. An extender oil may be added, if necessary, to meet the physical requirements of the asphalt cement - GRV Rubber binder. Extender oil shall be a resinous, high flash point, aromatic hydrocarbon meeting the following test requirements:

Property	Limits	ASTM Test Method
Viscosity, SSU, at 100F	2500 Min.	D88
Flash Point, COC, F	390 Min.	D92
Molecular Analysis:		
Asphaltenes, percent by weight	0.1 Max.	D2007
Aromatics, percent by weight	55.0 Min.	D2007

A letter of certification stating the extender oil complies with the specification requirements shall be furnished with each shipment.

GRV Rubber. The gradation of the GRV Rubber when tested in accordance with ASTM C136 shall be within the following limits:

Sieve Size	Percent Passing
No. 10	100
No. 16	98 - 100
No. 30	70 - 100
No. 50	10 - 40
No. 200	0 - 5

The GRV Rubber shall have the following properties:

Property	Tolerance
Specific gravity	1.10 - 1.20
Fiber content (1), percent by weight	0.1 min.
Moisture content, percent by weight	0.75 min.
Mineral contaminants(2), percent by weight	0.25 max.
Metal contaminants (3)	non visible

(1) Fiber content shall be determined by weighing the fiber agglomerations which are formed during the gradation test procedure. Rubber particles shall be removed from the fiber agglomerations by weighing.
(2) The mineral contaminant amount shall be determined after water separating a 50 gram rubber sample in an one-liter beaker filled with water.
(3) The rubber shall contain no visible metal particles as indicted by thoroughly stirring of a 50 gram sample with a magnet.

The manufacturer of the GRV Rubber shall furnish certified test data to the Laboratory that their GRV Rubber meets the above specification requirements.

The GRV Rubber shall be supplied in moisture resistant disposable bags and the bags shall be double wrapped with ultraviolet resistant stretch wrap during shipment. A letter of certification stating that the material complies with specification requirements shall be furnished with each shipment.

BINDER

The design of the asphalt cement - GRV Rubber binder (Binder) shall be performed by the Binder supplier. The proportion of GRV Rubber shall be 16 to 20 percent by total weight of the Binder. The Binder shall meet the following properties when reacted at 340 - 360F for 60 minutes:

Property	Limits	ASTM Test Method
Apparent Viscosity, 347F, Spindle 3, 12 RPM; cps	1000-4000	D2669
Penetration, 77F, 100g, 5 sec. 0.10 mm.	50 - 100	D5
Penetration, 39.2F, 200 g, 60 sec. 0.10 mm.	25 Min.	D5
Softening Point, 0F	120 Min.	D36
Resilience, 77F, percent	10 Min.	D3407
Ductility, 39.2F, 1 cpm, cm.	10 Min.	D113
TFOT Residue, 39.2F, percent:		
Penetration Retention	74 Min.	D1754
Ductility Retention	50 Min.	D1754

The proposed Binder mix formulation shall be submitted to the Laboratory along with the proposed JMF for the asphalt concrete. The proposed Binder mix formulation shall show the source, type or grade and percent by total weight of the Binder for the asphalt cement, extender oil (if needed) and GRV Rubber.

BINDER BLENDING EQUIPMENT

The blender for Binder shall be mechanical and shall have a two stage continuous mixing process capable of producing a homogenous mixture of asphalt cement and GRV Rubber, at the designed ratios, as directed by the Laboratory. This unit shall be equipped with a GRV Rubber feed system capable of supplying the asphalt cement feed system as not to interrupt the continuity of the blending process. A separate asphalt cement feed pump and finished product pump are required. This unit shall have an asphalt cement totalizing meter in gallons and a flow rate meter in gallons per minute.

The Binder storage tank shall meet the requirements of 750.01 and shall have an internal mixing unit within the tank capable of maintaining a proper mixture of asphalt cement and GRV Rubber.

The Binder supply system shall be equipped with a pump and metering device capable of adding the binder by volume to the aggregate at the percentage required by the JMF.

BINDER MIXING PROCEDURE

The temperature of the asphalt cement shall be between 350 and 400F at the time of the addition of the GRV Rubber. The asphalt cement and GRV Rubber shall be combined and mixed together in the blender and pumped into the Binder storage tank. It then shall be agitated for a minumum of 45 minutes from the time the GRV Rubber is added to the asphalt cement to allow for proper reaction. Temperature of the Binder shall be maintained between 325 and 375F during the reaction period.

After the Binder has reacted, it shall be allowed to cool. The Binder shall then be reheated slowly and mixed to a temperature between 325 and 375F before pumping and metering into the mixing plant for asphalt concrete production. The viscosity of the Binder shall be checked by the Binder supplier. If the viscosity is out of th range specified above, the Binder shall be adjusted by adding asphalt cement or GRV Rubber to produce a material with the appropriate viscosity.

Project No. 618

Item	Unit	Description
448	Cubic Yard	Asphalt concrete with GRV Rubber surface Course, Type 1
448	Cubic Yard	Asphalt concrete with GRV Rubber, intermediate course, Type_____

OKLAHOMA

(a) **General.** Epoxy-resin adhesives for general use with concrete shall comply with AASHTO M 235.

If the type, grade and class of epoxy-resin is not specified on the Plans or in the Proposal, the Contractor shall furnish an epoxy-resin system that is appropriate for its intended use in accordance with AASHTO M 235.

Epoxy-resin adhesives for bonding pavement markers to pavement surfaces shall meet the requirements of Subsection 736.04 of these Specifications.

(b) **Acceptance.** The Contractor shall furnish a type A certification for each batch or lot of each component.

SECTION 702
FLY ASH

702.01. DESCRIPTION. This Section covers fly ash to be used as an admixture for concrete and to modify or stabilize soils. Fly ash shall meet the requirements of ASTM C 618, Class C or Class F.

The product of only one plant shall be used on the project, unless otherwise approved by the Engineer. The Contractor shall provide suitable means of storing and protecting the fly ash against contamination and dampness. Fly ash which has become partially set, contains lumps of caked fly ash or has been contaminated will be rejected.

All methods of sampling and testing shall be in accordance with the requirements of ASTM C 311 except as modified by the Department's acceptance policy published as: "Procedure for Sampling, Testing and Acceptance of Fly Ash." Copies of the procedure are available at the office of the Materials Engineer.

SECTION 703
MINERAL AGGREGATE, MISCELLANEOUS USES

Description. This Specification covers the requirements for mineral aggregate intended for various uses not specifically covered in other sections of these Specifications.

703.01. AGGREGATE FOR AGGREGATE BASE.

(a) **Materials Covered.** These Specifications cover the aggregate for use in the construction of aggregate base courses Section 303.

(b) **General Requirements.** The aggregate base course material shall consist of an intimate mixture of graded aggregate, coarse and fine, and shall be practically free from vegetable or other deleterious substances. Coarse aggregate (material retained on a No. 10 sieve) shall consist of sound, tough, durable particles or fragments of gravel, stone, mine chats, disintegrated granite, crushed concrete, or a combination thereof. Fine aggregate shall be sand, stone dust or other inert finely divided mineral matter.

At least 40 percent of that portion of the completed mixture retained on the No. 4 sieve shall be composed of uniformly graded crushed particles (pieces of aggregate with one or more fractured faces resulting from the artificial crushing).

(c) **Physical Properties.** The coarse aggregate retained on the 3/8 inch sieve of the finished mixture shall have a percent of wear, Los Angeles Abrasion

Test, of not more than 50. No source of material used in the blend shall have a percent of wear of more than 50.

(d) **Gradation.** The graded aggregate when uniformly blended and sampled from trucks or windrows shall conform to the following requirements depending on the type being used. Materials for base courses which contain oversize particles of rock, gravel, lumps of clay or conglomerated material shall not be loaded into vehicles for delivery to the road. Such oversize particles of aggregate must be screened, crushed or otherwise processed to meet the Specifications before delivery to the road. The samples taken from trucks or windrows after the graded aggregate has been uniformly blended, shall conform to the gradation limits for the type being constructed, as follows:

SIEVE SIZE	PERCENT PASSING	
SQUARE	TYPE A	TYPE B
3 in		100
1 1/2 in	100	40-100
3/4 in.	40-100	30-75
3/8 in.	30-75	25-60
No. 4	25-60	20-50
No. 10	20-43	15-35
No. 40	8-26	7-22
No. 200 a/	4-12	3-10

a/ Note: The material passing the no. 200 sieve shall not be greater than 2/3 of the amount of material passing the no. 40 sieve.

(e) **Characteristics of material passing the no. 40 sieve.**

For all types, the material passing the no. 40 sieve shall conform to the following:

The plasticity index shall not exceed	6
The liquid limit shall not exceed	25

The blending of separate aggregates will be permitted to produce an aggregate mixture meeting the above requirements providing no individual aggregate has a plasticity index in excess of 8.

(f) **Sampling and Testing.** Tests shall be conducted in accordance with the latest revision of the following AASHTO Methods except as noted:

Los Angeles Abrasion	T 96
Sieve Analysis	T 27
Sampling	T 2
Determining Plastic Limit & Plasticity Index	T 90
Fractured Faces	OHD L-18
Method of Preparation of Samples	T 87
Determining Liquid Limit	T 89
Standard Density	T 180 Method D

association with a lesser amount of magnesium oxide capable of slaking with water.

(b) **Chemical Composition.** When tested under the appropriate sections of ASTM C 25, the lime shall conform to the following requirements:

Available calcium hydroxide expressed as calcium oxide.
Available lime index (as is basis) expressed as CaO - not less than 90 percent.

(c) **Fineness.** When tested under the appropriate sections of ASTM C 110, the lime shall conform to the following requirements:

Percent passing the no. 200 sieve	90 or more
Slaking Temperature Rise	40° C or more
Total active Slaking Time	20 minutes or less

When tested in accordance with method OHD L-28 the lime shall conform to the following requirements:

Percent passing 5/8 in. sieve	95 or more
Percent passing the no. 200 sieve	15 or less

706.03. BY-PRODUCT LIME. By-product lime will be tested under the appropriate sections of ASTM C 25 to determine the available lime index (by rapid sugar method) expressed as available calcium hydroxide $Ca(OH)_2$.

Calculations will be based on the dry weight of the material. Sufficient tonnage of the by-product lime shall be required to provide an equivalent amount of available lime based on 90 percent availability per ton (dry weight) of hydrated lime.

706.04. AGRICULTURAL LIMESTONE. Agricultural limestone shall be a high calcic or dolomitic limestone having a neutralization value of at least 80 percent of calcium carbonate. It shall be of such fineness that 100 percent passes the no. 4 sieve, at least 90 percent passes the no. 8 sieve, and at least 30 percent passes the no. 60 sieve. The neutralization value and sieve analysis shall be in accordance with ASTM C 602. The material shall be free from harmful quantities of toxic salts and other objectionable matter.

SECTION 707
SLURRY SEAL COAT

707.01. DESCRIPTION. These Specifications cover the materials for use in the construction of a slurry seal coat for pavements.

707.02. MATERIALS.

(a) **Approval of Materials.** Prior to use, samples of all materials proposed to be used under these Specifications shall be submitted to the Materials Division for tests. Preparation of trial mixtures to determine the initial job-mix formula shall be the responsibility of the Contractor. The final job-mix shall be established in accordance with Subsection 409.04.

If a change in sources of materials is made, a new job-mix shall be established before the new material is used. When unsatisfactory results or other conditions make it necessary, the Engineer may establish a new job-mix.

The aggregate will be conditionally approved in the stockpile at the plant. The asphalt will be conditionally approved at the source. The mixture will

be conditionally approved after blending and mixing at the slurry seal machine, pending the results of all applicable final acceptance tests.

(b) **Mineral Aggregate.** The aggregate shall be mine chat, crushed stone, crushed slag or crushed gravel, composed of hard durable pebbles or fragments which may be combined with not more than 50 percent natural or manufactured sand. The aggregate shall be free of lumps or balls of clay, loosely bonded aggregations, adherent films of clay, organic material or other foreign material. Slag shall be air-cooled, blast furnace slag uniform in density.

The mineral aggregate shall meet the requirements of asphalt concrete in Subsection 708.02.

(c) **Asphalt.** The asphalt shall be a mixing grade emulsified asphalt conforming to the provisions of Subsection 708.03 Table 2C or 2D.

(b) **Mineral Filler.** If mineral filler is required, it shall be portland cement or hydrated lime conforming to Subsection 701.02 or 706.01. The mineral filler shall not exceed 2 percent of the dry weight of the aggregate.

707.03. COMPOSITION OF MIXTURES. The mixture shall consist of a uniform mixture of aggregate and emulsified asphalt within the following limits:

Sieve Size	Percent Passing
3/8 in.	100
No. 4	90-100
No. 10	60-85
No. 40	25-45
No. 80	12-30
No. 200	5-15
Residual Asphalt, dry weight of aggregate	7-12%
Mineral Filler, dry weight of aggregate	0-2%

707.04. TOLERANCES. The residual asphalt content of the mixture shall not vary more than ± 0.5 percent from the job-mix when measured by the tank-strap method.

707.05. SAMPLING AND TESTING. Sampling and testing shall be done in accordance with Subsection 708.06.

SECTION 708
PLANT MIX BITUMINOUS BASES AND SURFACES

Description. This Section covers the materials requirements, mix designs, proportioning, mix tolerances, and sampling and testing methods for plant mixed bituminous bases and surfaces.

708.01. APPROVAL OF MATERIALS. Prior to use, aggregate sources and percentage of blends must be approved on a project basis by the Materials Engineer.

The aggregate shall be stockpiled in accordance with Subsection 106.07 and may be accepted in stockpile at the plant site. The plant mixed materials may be accepted after blending and mixing at the plant. Asphalt must be obtained

301.0201

PAVEMENT "REHABILITATION/RECYCLING"

DESCRIPTION: This item of work consists of the Rehabilitation of an existing pavement structure into a processed asphalt stabilized base (recycled base course). The existing pavement is to be mixed with a specified depth of the existing gravel base. This mixture of pavement and gravel is to be processed, reshaped, rolled, compacted and fine graded to the specified cross section and/or grades.

The remaining gravel base and/or subgrade may be modified to properly accommodate the processed asphalt stabilized base course. Any modifications of this nature, if required, such as but not limited to the excavation and replacement of unsuitable materials and trimming and fine grading will be accomplished under separate bid items. Any movement of the existing recyclable materials to allow for these modifications is included in the bid item of Pavement "Rehabilitation/Recycling".

EQUIPMENT: The Contractor has the option to utilize whatever equipment can effectively pulverize, crush, mix and blend the recyclable materials to specification. Furthermore, the Contractor can either choose to process in-place or load and haul the recyclable materials to an off-site location, process them into the proper recycled material and return it to the job site.

CONSTRUCTION METHOD: Prior to the start of Pavement "Rehabilitation/Recycling" all water and gas gates are to be lowered to a minimum depth of one foot from proposed finish grade. All manholes and catch basin frames, grates and covers are to be removed. The structures are to be covered with a temporary cover which shall overhang the pavement opening by a minimum of one foot on all sides of adequate strength to accommodate truck and construction equipment loadings. The voids remaining after utility gates or drainage structures are lowered are to be filled with gravel borrow material conforming to the standard specification, M.01.09. The existing pavement is to be scarified and mixed with gravel from the roadway structure.

The minimum depth of existing gravel to be incorporated in the rehabilitation process will be shown on the plans. This quantity will be taken from the uppermost portion of the base layer unless otherwise specified.

Water and calcium shall be added to ensure optimum moisture content at the time of compaction. They shall be applied at the rate of 0.25 lbs. of calcium chloride per gallon of water per square yard of recycled pavement area. The mixing formula may be modified by the Engineer to compensate for temperature, humidity, weather and/or density determinations.

Any required modifications to the remaining gravel base and/or subgrade such as but not limited to cuts, fills, grade realignment and the removal of unsuitable materials will be made before spreading the asphalt stabilized base material. Existing utility gates, manholes and catch basins are to be adjusted to finish grade.

The thickness of the processed asphalt stabilized (recycled) base course will be shown on the plans, graded to the specified cross section, plan grades or as directed by the Engineer and compacted to a uniform density of not less than 95 percent. Density measurements will be based upon AASHTO T-180 Method D.

The restored cross section shall be thoroughly compacted to a dense consolidated mass by rolling with an approved roller capable of producing the specified density. The required density will be measured by a Nuclear Density Gauge.

The processed asphalt stabilized base shall be tested for smoothness and accuracy of grade and if any portions are found to lack required smoothness or accuracy such portions shall be rescarified, reshaped, recompacted, and otherwise manipulated as the Engineer may direct until the required smoothness and accuracy are obtained. The finished surface shall have a tolerance of 1/2-inch plus or minus to the grades shown on the plans or as directed.

It is the responsibility of the Contractor to insure that the equipment/construction methods he intends to use are capable of complying with project specifications.

MATERIALS: The processed asphalt stabilized base material (recycled base material) is to meet the gradation requirements as specified below under GRADATION "_____".

SIEVE DESIGNATION	GRADATION "A" % PASSING BY WEIGHT	GRADATION "B" % PASSING BY WEIGHT
3"	100	100
2-1/2"	80-100	100
1-1/2"	70-100	70-100
3/4"	50-85	50-95
NO. 4	30-55	30-75
NO. 50	8-24	8-30
NO. 200	2-12	3-12

If additional aggregate is needed, the Contractor may be directed to add material from an outside source. However, scarified pavement and gravel fines must be crushed together and thoroughly worked and/or reworked as described herein.

Additional gravel shall conform to R. I. Standard Specification for Gravel Borrow M.01.09.

METHOD OF MEASUREMENT: Pavement "Rehabilitation/Recycling" will be measured for payment by the square yard of new recycled pavement area and accepted by the Engineer.

BASIS OF PAYMENT: The accepted quantities of Pavement "Rehabilitation/Recycling" as measured above will be paid for at the contract unit bid price per square yard of new recycled pavement area. This unit price shall include all compensation for scarifying, mixing, pulverizing, any loading and hauling or other handling of recyclable materials as well as all other incurred costs resulting from the Contractor's choice to process off site, spreading, reshaping, regrading, rolling, compacting and fine grading as required to meet the specifications herein. Additionally, the unit bid price will include all compensation for moving the processed material to allow for modifications to the remaining gravel base and/or subgrade and/or the removal of unsuitable materials and the movement of any surplus asphalt stabilized base material from one location to another within the project limits or its disposal if necessary. The unit bid price shall also include compensation for material, placement and removal of required temporary covers over structures. This unit bid price also includes all compensation for all labor, equipment, tools and other incidentals necessary to complete this item of work.

The following work operations and materials may be necessary to properly complete the work specified above. When required, these items will be measured and compensated for complete, in-place and accepted under their appropriate bid items.

Cut and Match Asphalt Pavement.

Excavation (To modify the gravel base and/or subgrade or remove unsuitable materials.)

Reconstruct CB "D" to CB "F"

Adjust Water Gates

Adjust Gas Gates

Gravel Borrow Subbase (To adjust the gravel base and/or subgrade or to replace unsuitable materials.)

Coarse or Fine Aggregate from outside sources.

Water for Compaction Control.

Calcium Chloride for pavement Rehabilitation.

Adjust catch basins or manholes to grade.

Trimming and find grading (To adjust the gravel base or subgrade.)

402.9926

BITUMINOUS PAVEMENTS (RECYCLE OPTION)

The provisions of Section 400 - Bituminous Pavements shall apply except that the Contractor has the option of recycling reclaimed asphalt pavement (RAP). RAP may be recycled in any of the following mixes or applications:

Bituminous Concrete - Plant Mix Base
Bituminous Concrete - Modified Base
Bituminous Concrete - Modified Binder

If the Contractor chooses the recycling option, the following modifications to the specification requirements shall apply:

MATERIALS: RAP shall consist of asphalt pavement recovered in conformance with RIDOT specifications for "Remove and Dispose Flexible Pavement and/or Remove and Dispose Flexible Pavements from Concrete", as specified. RAP shall meet the requirements stated below in MATERIALS REQUIREMENTS.

COMPOSITION OF MIXTURES: The blend percentage of RAP shall be selected within the limits shown in Table 1:

Table 1

Plant Type	% Reclaimed Material	
	MAX.	MIN.
Drum Mixer	70	10
Batch	50	10

The recycled mixture of RAP, new aggregate and added asphalt cement shall meet the requirements specified in Section M.03.01 as amended, Plant Mix Bituminous Concrete Pavements, for aggregate gradation, and asphalt cement content. The added asphalt cement grade shall be selected as described herein.

For any bituminous mixture containing RAP, the Contractor shall formulate and submit to the Engineer, a Job Mix Formula (JMF) which shall include:

1. Gradation and asphalt content of the RAP.
2. Gradation of recycled mixture.
3. Percentage of RAP added.
4. New aggregate source(s).
5. Total asphalt cement content (based on total mixture weight).
6. Added asphalt cement content (based on total mixture weight).
7. Grade of added asphalt cement.
8. Recycling Agent Additive (Type and Amount, optional, if needed)

MATERIALS REQUIREMENTS

1. Bituminous Materials. The added asphalt cement may be AC 20, AC 15, AC 10, AC 5, AC 2.5 or other asphalt cement grades approved by the Engineer.

2. Recycled Asphalt Pavement (RAP). The aggregate component of the RAP shall meet the requirements of Section M, Materials. The bitumen component of the RAP shall be asphalt cement and shall be free of significant contents of solvents, tars or other contaminating substances that will make the RAP unacceptable for recycling as determined by the Engineer. The RAP shall be separated according to specific pavement source by the Contractor unless otherwise permitted by the Engineer.

   The Engineer will use one of the following procedures to approve the RAP quality:

   A. RAP obtained from a pavement which was constructed with asphalt cement, and aggregates that meet the current requirements of Section M, Aggregates, will be approved by the Engineer.

   B. If the source of the RAP or its quality is not known, the Contractor shall submit to the Department at least 15 calendar days prior to the start of paving the following:

      a) Designated use of the RAP and approximate proportions.

      b) A five (5) pound (minimum) sample representing the RAP to be incorporated into the recycled mixture.

      c) The penetration test result (77F, 100g, 5s) of the bituminous material recovered from the RAP.

   The Engineer will determine the acceptability of the RAP for the designated use. Details for sampling and testing the RAP are available from the Materials Section.

Acceptance Requirements: The following are the acceptance requirements:

A. Certification from the Contractor stating source of RAP.

B. Analysis of RAP and its components by the Engineer.

Stockpile Requirements: RAP from similar pavement types and sources shall be stockpiled on a free draining base separated from other aggregates and RAP sources and shall be free of foreign materials. The stockpile must contain at a minimum the amount projected to be used in five (5) days or necessary to complete the project.

Prior to entry into the mixer, the RAP shall have a reasonably uniform gradation from coarse to fine with 100 percent passing 1-1/2" sieve.

3) Recycling Agent Additives. The recycling agent additive shall be a material that is chemically and physically compatible with asphalt cement. Recycling Agent Additive material shall be composed of selected maltene and asphaltene fractions derived from petroleum crude. The additive when mixed with aged asphalt shall restore the properties of the aged asphalt to a level that is reasonably consistent with the requirements of current specifications for the new asphalt.

BITUMINOUS MIXING PLANT

1) Batch Plant. The plant shall meet all the requirements of Section 401 of the Standard Specifications with exceptions and additions as noted herein. It shall be modified as required to permit recycling in conformance with all local, state and federal air pollution standards. The recycling modification shall be such that it provides a separate, independent, controlled cold feed system to introduce the salvaged bituminous pavement material into the weight box for automatic proportioning, with new (virgin) aggregates, liquid asphalt and additives as required. This cold feed system shall also be equipped with a 1-1/2" scalping screen to insure that all bituminous pavement material being recycled will be 100% passing a 1-1/2" sieve. The recording equipment shall be capable of automatically recording the batch weight of the salvaged bituminous pavement material along with other batch components, on the required delivery tickets.

The new (virgin) aggregates shall be dried and heated to a sufficiently high temperature to produce a recycled mixture with a discharge temperature of at least 280°F or as approved by the Engineer. The salvaged bituminous pavement material to be recycled shall be added to the heated aggregates in the weight box at a rate that will minimize heat loss and provide for efficient plant operations. The salvaged bituminous pavement material to be recycled shall not be preheated prior to being added to the weight bin. The combined aggregate and pavement material shall be mixed in the pugmill for approximately 20 seconds, after which the mixture shall be sprayed with the asphalt cement and additives, as required, and mixed for approximately 25 seconds more. These components shall be proportioned and mixed so as to fall with the limits of the approved job-mix formula.

2) Dryer-drum Plant. The turbulent mass dry-drum type plant shall consist of a dryer with a dual entry system capable of drying, heating and mixing new aggregate and salvaged bituminous pavement material to the temperature and gradation requirements established in the Job-Mix Formula. It shall be capable of recycling in conformance with all local, state and federal air pollution standards. This type plant shall also conform to the following specifications:

A. Aggregate Storage

1) Sufficient storage space shall be provided for uniform stockpiles of various sized or blended aggregate and salvaged bituminous pavement which shall be kept separated until they have been introduced into the cold bins that feed the drier. A minimum of four cold feed bins shall be required.

2) The storage yard shall be maintained in a neat and orderly manner and the separate stockpiles shall be readily accessible for sampling.

B. Bitumen Storage

1) Tanks shall be provided for the storage of bituminous material. They shall be equipped to heat and hold the material at the required temperature.

2) The heating shall be accomplished by steam coils, electricity, or other approved means so that no flame shall be in contact with the tank.

3) The circulating system for the bituminous material shall be designed to assure proper and continuous circulation during the operating period.

4) Provisions shall be made for measuring and sampling these storage tanks.

C. Cold Feed System

1) The plant shall have a device at each cold bin to feed the aggregate accurately and uniformly. No gravity type feeders will be permitted. Each adjustment opening shall be provided with indicators graduated to allow proportioning. Each aggregate feeder shall be interlocked in such a manner that production is interrupted if one or more cold bin becomes empty or the flow is obstructed.

2) A mineral filler bin, when required, shall be added to the standard plant cold feed bins, and shall feed the mineral filler at adjustable rates accurately and uniformly. The feeder shall be interlocked so that production is interrupted if the bin becomes empty or the flow is obstructed.

3) The aggregate weighing equipment for all aggregates including mineral filler shall consist of a continuous weighing device either as it is proportioned by the individual feeders or after all materials have been depositioned on a common belt. Belt scales shall meet the requirements of N.B.S. Handbook 44 and shall be installed according to the scale manufacturer's recommendations.

4) The plant shall have an adjustable feed rate control for each aggregate cold bin feeder, mineral filler feeder and salvaged bituminous pavement feeder. The plant shall proportion the total aggregate quantity to the drum mixer with such accuracy and uniformity that the variation of material per interval of time shall not exceed an amount equal to 1.5% of the total weight of bituminous mixture per interval of time.

5) An automatic aggregate sampling device shall be provided which will divert a representative combined aggregate sample, including mineral filler, into a hopper or container for the purpose of gradation testing. The container shall cut the full width and depth of the aggregate flow. The sampling point shall be after the aggregate is proportioned and prior to its mixing with bitumen.

D. Bituminous Control Unit

1) The bitumen shall be proportioned by a meter accurate to 0.1 percent. A flow switch designed to interrupt production if the bitumen flow is discontinued shall be installed in the delivery line between the meter and the mixer.

2) The asphalt delivery system shall be coupled with the aggregate delivery system to automatically maintain the required proportions as the aggregate flow varies. The delivery tolerance for bitumen shall be ± 0.4 percent of the total mixture weight.

3) The bitumen feed line shall be equipped with a thermometer.

4) An approved bitumen sampling valve will be provided.

E. Mixer Unit

1) The Plant shall include a continuous mixer unit having an automatic burner control and capable of producing a uniform mixture within the Job-Mix Formula Tolerances. The mixture shall be discharged into a hot bituminous mixture holding bin meeting the requirements of paragraph (g) Hot Bituminous Mixture Holding Bins.

2) The Drum Mix Plant shall utilize a center entry system for recycling purposes.

3) The moisture content of the mixture upon discharge from the mixer shall not exceed 1.5% by weight and the mixture shall have a minimum temperature of 260°F.

F. Safety Requirements

1) Guarded ladders shall be provided to all points where accessibility to plant operations is required.

2) Accessibility to top of truck bodies shall be provided by a platform or other suitable device, placed in an acceptable location near the testing laboratory, to enable the Engineer to obtain samples and mix temperature data.

3) All gears, chains, pulleys, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected.

4) A clear and unobstructed passage shall be maintained at all times in and around the truck loading area.

G. Hot Bituminous Mixture Holding Bin

1) Hot bituminous mixtures may be stored in holding bins especially designed for that purpose. Each holding bin shall be inspected by the Department to determine acceptance at specific holding times.

2) Acceptance shall be based upon the ability of the holding bin to hold land discharge mixtures within the quality criteria specified by the Job-Mix Formula and the R.I. Standard Specifications.

H. Automated Blending System

1) The "Plant" shall have an automated blending system for proportioning virgin aggregate, liquid bitumen, additives as needed, and recyclable material.

2) The blending system shall include a hardcopy strip printer; capable of totalizing and printing at intervals quantities of virgin aggregate, liquid bitumen, additives as needed, and recyclable materials.

I. Weigh Batcher and/or Truck Scale

1) The "Drum Plant" shall have a computerized scale system with a digital printer consisting of a weigh batcher and/or truck scale.

2) The digital recorder will automatically print the following data on delivery tickets:

1) Date mixed.
2) Net weight of mixture in the truck.
When a truck scale is used the net weight of mixture shall be automatically calculated by tare weighing the truck when empty and full.
3) Time of each load.

3) The following information shall also be included on the delivery slips:

a) Name of customer.
b) Name of project and contract numbers.
c) Truck identification.
d) Type of mixtures.
e) Additives.

RHODE ISLAND DEPARTMENT OF TRANSPORTATION
DIVISION OF PUBLIC WORKS
MATERIALS SECTION

Specifications for PlusRide Asphalt

1. GENERAL

This work shall consist of furnishing and placing PlusRide™ asphalt, a rubber modified asphalt concrete which is a mixture of granulated rubber, asphalt cement and mineral aggregate, in accordance with Section 400 of the Rhode Island Standard Specifications with the exceptions as herein noted. Attention is directed to sections 2.2, 2.3, and 2.4 of these specifications. The aggregate gradations are coarse and gap graded, which generally requires addition of a mineral filler to meet the gradation requirements. PlusRide asphalt is produced and placed with standard equipment, however, a system must be provided for introduction of the granulated rubber and any required mineral filler.

PlusRide asphalt is a patented process licensed by:

All Seasons Surfacing Corporation
2281 116th Avenue N.E. Suite 2
Bellevue, Washington 98004-3015
(206) 454-3830
New England contact, Ed Hamlin 401-738-2045

The Contractor is hereby advised that the following specifications are based on a patented process. Upon award of the contract, the contractor shall execute a License Agreement with the Licensor, which grants use of the process in return for payment of a royalty fee. Upon award, such license agreement shall be bound as part of the agreement for this contract and shall become a part thereof.

2. MATERIALS

2.1 Asphalt - The grade of asphalt used for the PlusRide shall be paving grade AC-20 which shall comply with the provisions of Rhode Island Standard Specifications M.03.02.1.

2.2 Aggregate - Coarse and fine aggregate shall meet the requirements of subsection M.03.02.3 of the Rhode Island Standard Specifications. The gradation of this aggregate shall also conform to the following master range:

Sieve Size	% Passing By Weight
5/8	100
1/2	---
3/8	60-80
1/4	30-44
#10	20-32
#30	13-25
#200	8-12

The PlusRide asphalt mixture must be gap graded to allow space for the rubber granules. To achieve this, the amount of aggregate passing the 1/4" sieve and retained on the No. 10 sieve may be no more than 12%.

2.3 Mineral Filler - The use of a mineral filler will probably be necessary to meet the minus #200 sieve requirements. The Contractor shall submit a representative sample of the mineral filler material to the Engineer for his approval and use in establishing the final job-mix formula.

2.4 Granulated Rubber - the granulated rubber shall be ground only from whole passenger or truck tires. (Heavy equipment tires shall not be used.) It shall be cubical or thread-shaped and individual rubber particles, irrespective of diameter, shall not be greater in length than 5/16 inch. The granulated rubber shall conform to the following specifications:

Sieve Size	Percent Passing By Weight
1/4"	100
No. 4	76-100
No. 10	28-42
No. 20	16-24

The rubber granulator shall furnish written certification of compliance with the foregoing specifications. In addition, each delivery shall be sampled (not less than one sample for each 20 tons) and a dry sieve analysis performed to ensure that the rubber granules meet gradation requirements. The sampling and test must be completed and the rubber granules approved for use before any of the delivery is incorporated into the PlusRide asphalt mixture.

3. COMPOSITION OF THE MIXTURE

After a representative quantity of aggregate has been produced and not less than fifteen (15) calendar days before production of the rubber modified bituminous mix begins, the Contractor shall submit to the Engineer his proposed job-mix formula. Representative samples shall then be taken of this stockpiled material and the final job mix formula established by the Engineer, based upon laboratory Marshall method design procedures. The mixture shall have a percent of air voids within the range of three percent plus or minus one-half percent ($3 \pm \frac{1}{2}\%$).

The job-mix formula shall include definite single values for:

1. The percentage of aggregate passing each specified sieve, based on the dry weight of the aggregate.

2. The percentage of bituminous material to be added, based on the total weight of the mixture.

3. The granulated rubber percentage shall be 3.5%, based upon the weight of total mixture.

In addition to the aggregate sample furnished above, the Contractor shall furnish the Engineer with one (1) gallon of the proposed asphalt cement and ten (10) pounds of granulated rubber meeting the requirements of this section.

Should a change in source of material be found necessary, a new job-mix formula will be established in the same manner as described above. All mix furnished for the project shall conform to the approved job-mix formula within the following ranges of tolerances:

Sieve Size	Tolerance Percent Passing
3/8" or 1/4"	± 6
No. 10 or No. 30	± 4
No. 200	± 2
Gap Grading Percent	± 4
Asphalt Percent	± 0.4
Rubber Percent	± 0.15*

*Not determinable by extraction testing.

The asphalt content shall be between 7.5 and 9.0 percent by weight of the total mixture. The actual asphalt content within the specified range shall be determined by the Marshall Method of Mix Design.

4. BITUMINOUS MIXING PLANT

PlusRide shall be produced in a batch type bituminous mixing plant which meets all the applicable requirements of subsection 401.03.2 of the Rhode Island Standard Specifications with the following additions:

1) The amount of granulated rubber to be added to each batch shall be measured by one of the following methods:

   a) The amount of granulated rubber shall be determined by weighing on springless dial scales, or by a method which uniformly feeds the mixer within ± 0.15 percent of the required amount.

   b) Bags of granulated rubber may be used for proportioning provided the batch size is adjusted to use whole bags of rubber. No partial bags will be allowed.

2) If mineral filler is used, the plant shall be equipped to feed this material into the mixer within an accuracy of 0.5%.

5. PREPARATION OF MIXTURE

The Contractor shall prepare a work plan describing his planned procedures for mixing and placing the material. The plan shall include such details as the method of introducing rubber granules into the mixture, mixing times, temperatures and equipment. Mixing

of the material will not be allowed to begin until the work plan has been approved in writing by the engineer.

Trial batches of the job-mix will be required prior to approval of the job-mix formula.

Standard mixing procedures as detailed in the Rhode Island Standard Specifications shall apply except as follows:

1) The aggregates and granulated rubber shall be combined and mixed thoroughly for 15 seconds minimum, prior to introducing the asphalt. The asphalt, aggregate and rubber granulate shall be mixed a minimum of 40 seconds so as to achieve a uniform distribution of all materials and coating of the aggregate and granulated rubber by asphalt. The mixing temperature shall be between 340°F and 360°F.

2) The completed mixture shall conform to the job-mix formula within the allowable gradation tolerances specified in Section 3. If the aggregate gradation is within the tolerance limits, but out of the specification limits shown in Section 2.2, on two (2) consecutive mixture samples, a plant and/or aggregate adjustment must be made to bring the gradation within the specification limits before resuming production.

6. EQUIPMENT

The equipment requirements of the Rhode Island Standard Specifications shall apply, except that at least two steel wheel rollers shall be used for compaction. A 10-12 ton static or vibratory steel wheel roller shall be used for breakdown and an 8-10 ton tandem static steel wheel roller shall be used for finish rolling. Pneumatic rollers shall not be used to compact PlusRide asphalt.

7. CONSTRUCTION METHODS

The construction procedure shall conform to the requirements of the Rhode Island Standard Specifications for constructing a bituminous concrete pavement with the following exceptions:

1) A tack coat of asphalt emulsion type SS-1 (diluted to 50% with water) shall be applied to the surface on which the PlusRide is to be placed. The application rate shall be between 0.10 and 0.12 gallons per square yard.

2) The mixture must be covered while being transported. The temperature of the mixture at the time of placement shall be no less than 300°F. It must be placed on an approved clean, dry surface which has a temperature of at least 45°F.

3) The maximum compacted lift thickness shall be 2 inches. Because of the stiffness of the mix, special care should be taken to get a good joint immediately with the paver. Where hand placement or raking is required, it should be done immediately.

4) Breakdown compaction should begin immediately behind the paving machine. However, some delay may be required to prevent roller pickup. The roller drums must be kept well watered. It may be necessary to add detergent to the water as a wetting agent to decrease the occurrence of roller pickup. The compaction must be done carefully and it is important that the finish rolling continue until the pavement has cooled off and any elastic movement can no longer be observed in the pavement (approximately 140°F). The target density, as a percentage of maximum theoretical density, shall be 95 to 98% (2% to 5% air voids). The proper rolling procedure shall be established with a control strip to determine equipment and number of coverages necessary to obtain the target density.

5) Cold longitudinal joints should be avoided if possible. If a cold joint does occur, the edge of the existing lift should be coated with a tack coat before the adjacent lift is placed.

6) All joints shall be sealed with asphalt emulsion or asphalt cement.

8. METHOD OF MEASUREMENT

PlusRide asphalt pavement shall be measured in accordance with sub-section 401.04 of the Rhode Island Standard Specifications.

9. BASIS OF PAYMENT

The accepted quantities of PlusRide asphalt pavement shall be paid for at the contract price per ton for the bituminous paving mixture. This price includes the bituminous material complete in place as well as sweeping and cleaning.

601.2000

PORTLAND CEMENT CONCRETE WITH FLY ASH

DESCRIPTION: This specification covers the requirements for the optional partial replacement of portland cement with fly ash for all field concrete except for high-early strength mixes.

Concrete containing fly ash shall conform to the Rhode Island Standard Specifications for Road and Bridge Construction and subsequent revisions with the exceptions as herein noted.

GENERAL REQUIREMENTS:

Materials - Fly Ash, for replacement in portland cement Type I or II, shall conform to ASTM C 618, Class C or F, except for the loss on ignition which is a maximum of 4.0 %. It may be substituted up to 15 % by weight on a 1:1 ratio as partial replacement.

Fly ash shall only be accepted from a Department approved source. Prequalification of a source may be based upon test results by the Department's lab or upon a certified report of test results by a CCRL approved or nationally recognized independent laboratory showing the material to be in full compliance with the specification. The frequency and method of testing of ASTM C 311 will be followed thereafter.

Handling - Separate storage bins will be made available for fly ash if used and it shall be protected from rain and moisture. Unless otherwise noted, fly ash shall be handled in the same manner as portland cement.

Mix Design Submittal - The Contractor will submit for approval by the Engineer a job-mix formula at least 40 days in advance when using this option. The job-mix formula shall include the supplier and the amounts by weight of coarse and fine aggregate; cement; water; and fly ash. It shall also include the maximum aggregate size; specific gravity, unit weight and percent absorption of the aggregates; the percentage of air; slump and the yield. The contractor will also perform a trial mix based on the design mix and submit to the State the test results which shall include the slump, air content, yield and 7 and 28 day compressive strengths on the concrete. The test results shall be submitted to the State with the mix design. Some adjustment in yield will have to be made in the mix design to adjust for the different specific gravity of the fly ash.

Batching - Fly ash shall be weighed to within +/- 1% of the design weight, cumulatively with the cement, and last in the weighing sequence to avoid the possibility of the finer substituted material leaking through the weigh hopper gate. The batch weight for the cement will be changed to read cement and fly ash.

Recording Equipment - Slips shall also include "Weight of Fly Ash" when used.

Limitations of Mixing - Concrete manufactured with fly ash as constituents may have a reduced strength gain rate and/or an increased setting time. Because of this, care must be taken in curing when placing concrete of this type in colder weather.

METHOD OF MEASUREMENT: Portland cement concrete with fly ash will be measured as provided for in the specifications for the particular item or items under which it is paid.

BASIS OF PAYMENT: Portland cement concrete with fly ash will be paid for as provided in the specification covering the particular use. Any portland cement concrete not otherwise provided for will be paid for under the item of concrete masonry of the class indicated and required.

These payments shall constitute full compensation for furnishing all labor, materials, equipment, tools, and incidentals necessary to produce, place and protect the concrete as herein specified, in addition to any requirements in the specification for the particular use.

As you can tell, there were basically supplier furnished specs. The process has worked well for us and the process

STATE OF SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
ASPHALT RUBBER SURFACE TREATMENT
OF BRIDGE DECKS

[redacted]

I. DESCRIPTION

This work consists of an application of a hot rubberized asphalt cement mixture immediately covered by a uniform spread of cover aggregate.

II. MATERIALS

A. Asphalt: Asphalt cement shall be 85-100 Pen. AC or AC-10 conforming to the requirements of Sec. 890.

B. Extender Oil: Extender oil shall be a resinous, high flash point, aromatic hydrocarbon conforming to the following requirements:

T-78 Viscosity, SUS @ 100 deg.F. ---------- 2,500 min. (ASTM D88)
T-48 Flash Point, C.O.C. deg.F. ---------- 392 min. (ASTM D92)
Molecular Analysis: (ASTM D2007)

Asphaltenes, % W ---------- 0.1 max.
Aromatics, % W ---------- 55 min.

C. Ground Rubber: Rubber shall be a dry, free flowing blend of 50% G-380 and 50% G-381 designation, of the U.S. Rubber Reclaiming Company, Inc.

1. Designation G-380 shall be a blended mixture of vulcanized and devulcanized rubbers conforming to the following:

a. Chemical Analysis

Acetone Extract	18-21%
Ash	17-23%
Carbon Black	20-26%
Rubber Hydrocarbon	35-42%

b. Gradation Analysis

Passing No. 7 mesh sieve	100%
Passing No. 8 mesh sieve	99-100%
Passing No. 20 mesh sieve	35- 68%
Passing No. 30 mesh sieve	31- 51%
Passing No. 100 mesh sieve	4- 20%

2. Designation G-381 shall be composed of No. 1 truck and bus tire peels and shall conform to the following:

a. Chemical Analysis

Acetone Extract	15- 20%
Ash	7% Max.
Carbon Black	28- 33%
Rubber Hydrocarbon	45% Min.
Natural Rubber	20- 30%

b. Gradation Analysis

Retained on No. 20 mesh sieve	0-Trace%
Retained on No. 30 mesh sieve	0-10%
Retained on No. 40 mesh sieve	20-50%
Retained on No. 60 mesh sieve	15-55%
Retained on No. 80 mesh sieve	0-20%
Retained on No. 100 mesh sieve	0-15%
Pan	0-20%

3. Rubber shall be free from fabric, wire and other contaminants. Not more than four (4) percent calcium carbonate may be included to prevent particles from caking.

D. Cover Aggregate: Cover Aggregate shall be from quarried ledge rock deposits in Eastern South Dakota known as Sioux Falls Quartzite.

1. Gradation requirements (By dry weight)

Passing 1/2 inch sieve	100%
Passing 3/8 inch sieve	70-100%
Passing No. 4 sieve	0- 10%
Passing No. 8 sieve	0- 5%
Passing No. 200 sieve	0- 2%

2. Material retained on a No. 4 sieve shall have two or more fractured faces produced by crushing.

3. L. A. Abrasion Loss shall not exceed thirty-five (35) percent.

4. Sodium Sulfate Soundness Loss shall not exceed ten percent.

III. CONSTRUCTION REQUIREMENTS

A. Weather and Seasonal Requirements: Application of Asphalt Rubber Surface Treatment will be permitted only:

1. During daylight hours.

2. When weather conditions and the surface to be treated are dry.

3. When wind does not adversely affect spraying operations.

4. When the air and surface temperature in the shade are at least 70 deg.F. and rising.

5. Between June 15 and September 1, inclusive.

B. Preparation: The surface shall be swept with a rotary power broom and cleaned of foreign material with an air compressor and blow gun. Cleaning shall extend 15 feet beyond area to be treated at each end of bridge. The Contractor shall provide protection for expansion devices and deck drains.

C. Equipment: The following equipment shall be furnished by the Contractor:

1. A self-propelled rotary power broom.

2. Two self-propelled, smooth pneumatic tired rollers which have a surface width of at least 60 inches and furnish a minimum rolling pressure of 250 pounds per inch of rolling width.

3. A self-propelled aggregate spreader with positive controls, capable of spreading the aggregate uniformly over the full width at the specified rate.

4. A self-powered pressure distributor equipped with a separate power unit, distributing pump and equipment for heating and mixing the asphalt rubber material.

The distributor spray bar shall be full circulating with nipples and valves constructed so they are bathed in circulating asphalt. The distributor shall be equipped with an adjustable length spray bar, so arranged that application width will be available in 2 foot intervals from 4 feet to a least 12 feet.

Distributor equipment shall include a pump tachometer and a feet per minute tachometer, pressure gages, volume measuring devices, mixing equipment and a thermometer.

Prior to application of the asphalt-rubber mixture, the Contractor shall furnish evidence that the distributor has been tested for transverse and longitudinal spread rates. Rates shall not vary by more than ten percent or 0.05 gallons per square yard from the specified rate.

The method and equipment for combining the rubber, asphalt cement and extender oil shall be such that the percentages by weight and volume of the materials can be readily determined.

D. Mixing of Asphalt Rubber: The asphalt cement shall be heated to 400 to 425 deg.F. prior to adding the rubber. The rubber shall be combined with the asphalt cement and a homogenous mixture attained. The rubber shall be combined with the asphalt cement and mixed at a temperature of 400 to 410 deg. F. for 30 minutes prior to application.

The proportions of the materials shall be as follows:

Asphalt Cement	76.5% (by weight)	±2%
Rubber	23.5% (by weight)	±2%

After mixing the asphalt cement-rubber mixture, Extender oil shall be added, in the amount of approximately 2%, by volume, of the asphalt cement, to give the proper viscosity.

After satisfactory consistency has been obtained application shall proceed immediately.

E. Application of Asphalt Rubber: Asphalt-rubber mixture shall be applied at 390 to 410 deg.F. in a uniform, continuous manner. Unauthorized increases in application rates will not be eligible for payment.

Application of asphalt rubber to wheel guards and median curbs shall be made prior to deck application. With the distributor end nozzle adjusted to the proper angle (approximately 45 deg.) a shot shall be made, using only this end nozzle to the face of the wheel guard, curbs and to ±6 inches onto the deck. The application shall extend at least 6 inches onto the curb or wheel guard.

A strip of building paper at least three feet wide and a length equal to the spray bar plus one foot shall be used at the beginning and end of each spread. Skipped areas and deficiences shall be corrected immediately after cover aggregate has been applied and rolled. Areas inaccessible to the distributor shall be covered by hand spray methods. The distributor, when not in operation, shall be parked off the deck or roadway or drip pans shall be placed under the spray bar.

The adjacent spread shall be overlapped 6 to 8 inches. Under no circumstance shall spraying operations proceed when it is evident the asphalt rubber spread will not be covered with aggregate and rolled immediately.

F. Application of Cover Aggregate: Cover Aggregate shall be spread immediately following application of the asphalt-rubber mixture.

The Contractor shall protect the treated surface from traffic damage. A complete aggregate coverage shall be maintained.

Immediately prior to application of asphalt rubber, the joint edge and area to be treated shall be swept clean of loose cover aggregate. The joint edge shall be swept back 12 inches onto the adjacent spread to accomodate the overlap.

Cover aggregate shall be applied at a temperature of not less than 215 deg. F. As an alternate to this requirement, the aggregate may be preheated in a central mixing plant to a temperature between 290 and 350 deg. F. and precoated with 0.50% (±0.25%) asphalt cement. This asphalt cement shall conform to AASHTO M 20 or M 226.

Loading into hauling units shall be done in a manner that minimizes segregation. Unauthorized increases in rates will not be eligible for payment.

G. Rolling: Rolling shall begin immediately behind the spreader and

shall consist o six complete coverages with pneumatic tired rollers. Rollers shall be operated in unison, in a close interval, and if the width of spread allows, in a staggered formation at a speed not to exceed three miles per hour.

Roller sequences shall be varied to obtain the most satisfactory embedment of the cover aggregate. Turning or stopping rollers on freshly treated surfaces is prohibited.

H. Maintenance and Repair:

1. Areas of the surface treatment which are unsatisfactory due to insufficient asphalt-rubber or cover aggregate application shall be repaired with additional asphalt, cover aggregate and rolled so that the finished surface is acceptable.

   Additional compensation for repair will be limited to the first two items mentioned.

2. Loose material shall be very lightly broomed off the surface within one hour after rolling is completed to minimize windshield and headlight breakage. Within 24 hours of application, the surface shall be broomed more vigorously to remove any remaining loose material. If there is excessive displacement of embedded cover aggregate, sweeping shall be discontinued until cover aggregate is retained.

   Loose material shall be picked up immediately after brooming and disposed of.

IV. METHOD OF MEASUREMENT

A. Asphalt-Rubber: Asphalt Rubber will be measured to the nearest tenth of a ton.

B. Cover-Aggregate, Modified: Cover Aggregate, Modified will be measured to the nearest tenth of a ton.

V. BASIS OF PAYMENT

A. Asphalt Rubber: Asphalt Rubber will be paid for at the contract price per ton. The weight of extender oil will not be included in the quantity for payment. The cost shall be absorbed in the contract unit price bid for Asphalt Rubber.

B. Cover Aggregate, Modified: Cover Aggregate, Modified will be paid for at the contract price per ton.

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cell compression type. All materials shall conform to the requirements of AASHTO M 220.

Type II—Hot-Poured Elastic Type Concrete Joint Sealer

This sealer shall conform to the requirements of ~~AASHTO M 173~~ ASTM D 3405 with the following exceptions: The joint sealer shall be a mixture of virgin synthetic rubber or reclaimed rubber or a combination of the two with asphalt and plasticizers and tacifiers. Ground cured rubber scrap shall not be used. The sealer shall be free of foreign material, and when melted shall be free of lumps. The contractor shall furnish the Engineer a certified statement from the manufacturer showing compliance with the above composition.

The flow at 140° F shall not exceed 1.0 centimeter in 5 hours. Ductility at 77° F shall be not less than 40 centimeters, when tested in accordance with AASHTO T-51.

The Contractor shall furnish the Engineer a certified copy of the test results, showing the batch number, indicating that the material supplied conforms to the requirements of the specifications.

SECTION 906—DAMPPROOFING AND WATERPROOFING MATERIALS

APPROVED
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4-11-88
OF FHWA

SPECIAL PROVISION

REGARDING

AGGREGATE-LIME-FLY ASH STABILIZED BASE COURSE

Description. This work shall consist of constructing a base composed of mineral aggregate, hydrated lime and fly ash in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness and typical cross-section shown on the plans or as directed by the Engineer.

MATERIALS

Materials. Materials used in this construction shall meet the following requirements:

Material	Subsection
Crushed Aggregate Class B, Grading C	903.05
Lime	918.04
Bituminous Material for Curing	
Emulsified Asphalt, Type SS-1, RS-2	904.03
Cut-Back Asphalt, Grade RC-250	904.02
Water	918.01

Fly ash shall meet the requirements of ASTM C 593 except that loss on ignition shall not exceed 10% when tested according to ASTM C 311, Section 11 and 12, and the combined silicon dioxide (Si02), aluminum oxide (Al203) and iron oxide (Fe203) shall be more than 60% when tested according to ASTM C 311, Section 13 and 14.

Proportioning. The lime, fly ash and aggregate design shall be proportioned within the following limits based on dry weight:

Material	Range of percent by weight of total dry mix
Lime	2 to 5
Fly Ash	6 to 20
Aggregate	75 to 92

The mixture will be within +/- 2 percent of the optimum moisture of the mixture, as determined from the AASHTO T 99, Method C (with replacement) procedure.

The design of the mixture shall be such that when compacted into cylinders, cured for 28 days at 100 degrees F, and tested in accordance with ASTM C 593, Part 8 and 9, the cylinders will have minimum average compressive strength of 950 psi and no individual test lower than 800 psi.

At least 45 days prior to the production of the stabilized mixture, the contractor shall submit for the Engineer's approval, a mix design, a statement naming the source and percentage of each component, and a report showing the results of the applicable tests meeting the above requirements of the Specifications. The contractor shall submit the following quantities of components for material testing and verification of the mix design:

Hydrated Lime	25 lb.
Fly Ash	50 lb.
Aggregate	200 lb.

At the Engineer's option, verification of the mix design may be done on an annual basis provided the properties and proportions of the material do not change appreciably. Mix designs complying with the above requirements will be approved. The approved proportions of material will govern during the progress of the work and no change in source or character of any material shall be made without approval. Approval will be based on verification of the new mix design.

EQUIPMENT

Equipment. All equipment necessary for the satisfactory performance of this construction shall be on the project or at the mixing site, and approved by the Engineer before work will be permitted to begin. Such equipment shall include an approved mixing plant. The mixing plant shall be a stationary or portable batch or continuous mix type. The mixing plant shall be equipped so as to permit the Engineer to verify the component percentages at any time. Stationary or portable batch type plants shall be equipped with batching devices and scales for proportioning the individual components by weight and shall be of such accuracy that the material percentages based on the total dry weight will be maintained within the following tolerances:

Hydrated Lime +/- 0.25 percent
Fly Ash +/- 0.75 percent
Water +/- 2.0 percent

Stationary or portable batch type plants shall have scales meeting the requirements of Subsection 501.04 (a) 3 of the specifications. Separate scales and hoppers shall be used for weighing the aggregate and the lime and the fly ash. The fly ash, however, may be weighed cumulatively in the weigh hopper with the lime, provided the lime is added first.

Continuous type mixing plants shall be equipped with metering devices and scales for proportioning each component by weight so as to maintain the above stated tolerances. Satisfactory means shall be provided to afford a positive interlocking control between the aggregate feed, the lime feed, and the fly ash feed. The control settings for the lime flow, the fly ash flow and the aggregate flow will be based on the total dry weight of the mixture. There must be an acceptable method provided for proportioning the lime flow and fly ash flow as variations in aggregate flow take place. An approved method of checking and calibrating the weighing system shall be located within easy access on the plant. An automatic interlock system will be provided that will shut off the lime flow and fly ash flow when the aggregate flow ceases. The aggregate feed system shall employ computer controlled adjustments to automatically produce mix of the correct proportions over the entire range of production rates of the plant. The flow of water into the continuous type plant shall be controlled by a meter or other approved regulating device to positively maintain a uniform moisture content in the mixture. A separate, quick, automatically operating on-and-off device shall be required to shut the water off instantly when the mixer stops.

Rollers shall be either pneumatic tire or vibratory type and meet the requirements of Subsection 407.07

The spreader shall be self-propelled or tractor drawn and be capable of maintaining a uniform rate of travel while spreading. The spreader shall be capable of laying a lift of uniform consistency and thickness with proper grade control. The mixture shall be transported from the central plant in clean, tight trucks having a cover of canvas, securely fasted on all sides of the truck bed, or other suitable material of such size as to maintain the moisture content and prevent the loss of fines.

CONSTRUCTION REQUIREMENTS

Limitations. Stabilization will not be permitted when the aggregate or the surface on which the base course is to be laid is wet or frozen or when it is raining or snowing or is at a temperature of 40°F or less. Processing operations for this material shall not be started unless the air temperature in the shade is at least 40°F and rising. The construction of the aggregate-lime-fly ash stabilized base course shall be covered with the succeeding stage of base or pavement construction prior to December 15.

Subgrade Preparation. The subgrade shall be prepared in accordance with Section 205, 207, 301 or 302 whichever is applicable.

Mixing. The aggregate shall be mixed with the proper amount of lime, fly ash and water in an approved mixer, and mixing shall continue until a thorough and uniform mixture is obtained. The aggregate shall be handled in a manner which will prevent contamination and segregation. The plant will be capable of discharging the mixture without undue segregation.

Spreading. After mixing, the material shall be transported to the job site while it contains the proper moisture content, and shall be spread to the required thickness and cross-section by an approved spreader. If the required compacted depth of the base exceeds eight inches, the base shall be constructed in two or more approximately equal layers. The maximum compacted thickness of any one layer shall not exceed eight inches.

Compacting. Compaction shall be accomplished in accordance with Subsection 309.07, of the specifications except as modified by the following:

Delete the third and fourth sentences in the second paragraph of this Subsection and substitute the following in lieu thereof:

The average dry density of each lot shall be not less than 100% of the maximum density as determined by AASHTO Designation T 99, Method C (with replacement) procedure. Further, no individual test shall be less than 97% of the maximum density.

The Engineer may employ a control strip and random sampling to evaluate and adjust the contractor's rolling procedure.

The number of compaction and finishing units shall be sufficient to insure the initial compaction of the processed section of the stabilized base course within 4 hours from the time the water is added at the mixer. The final finishing and compaction shall be within 8 hours from the time of mixing. This time may be extended by the Engineer, if the material has not reached an initial set. If for any reason construction operations are delayed or suspended and the Engineer orders any loose or uncompacted material removed and disposed of, the contractor shall perform this work at his own expense. No aggregate-lime-fly ash base course may be salvaged.

Finishing. As per Subsection 304.09 of the specifications.

Construction Joints. As per Subsection 309.09 of the Specifications.

Thickness and Surface Requirements. As per Subsection 309.10 of the Specifications.

Curing. After the aggregate-lime-fly ash base has been finished, the surface shall be sealed with one of the bituminous materials specified above, applied by a pressure distributor at the rate of 0.10 to 0.25 gallons per square yard or as directed by the Engineer. The bituminous material shall be heated or otherwise prepared to insure uniform distribution and shall be applied no later than 24 hours after completion of finishing operations unless in the judgement of the Engineer it should be delayed. The finished base shall be kept continuously moist until the bituminous curing seal has been applied. The curing material shall be maintained by the Contractor during a seven day protection period so that all of the aggregate-lime-fly-ash base course will be covered effectively during this period. Only pneumatic tired equipment required for applying the curing seal will be permitted on the base except where necessary to maintain local traffic until the mixture has cured for seven days.

Opening to Traffic and Maintenance. As per Subsection 309.12 of the specifications.

COMPENSATION

Method of Measurement. Bituminous material for curing seal, fly ash and lime shall be measured by the ton in accordance with Section 109.

The weight of the mineral aggregate shall be determined by weighing the aggregate-lime-fly ash mixture on truck scales meeting the requirements of Section 109 and deducting the weight of the lime and fly ash. The weight of moisture in the aggregate at the time of weighing in excess of eight percent will be deducted. No direct payment for mixing water will be made; however, water added on the road at the direction of the Engineer will be measured by the M.G. in accordance with Section 109.

Basis of Payment. The accepted quantities of mineral aggregate, bituminous material, lime, and fly ash will be paid for by the ton and the water will be paid for by the M.G. complete in place.

Payment will be made under:

Item No.	Pay Item	Pay Unit
312-01	Mineral Aggregate (ALFSB)	Ton
312-02	Lime	Ton
312-03	Fly Ash	Ton
312-04	Bituminous Material (ALFSB)	Ton
203-06	Water	M.G.

(Rev. 03-31-86)
(Rev. 09-11-87)ASE
(Rev. 5-14-90)ASE

December 16, 1985

SPECIAL PROVISION

REGARDING

CEMENT REPLACEMENT WITH FLY ASH IN PORTLAND CEMENT CONCRETE

Description. This specification grants the contractor the option to replace a portion of the cement in Portland cement concrete, up to a maximum specified herein, with fly ash. It is the contractor's responsibility, if he chooses to use fly ash as a cement replacement, to provide Portland cement concrete of the design strengths specified in all applicable special provisions, on the plans, or in the Standard Specifications. Fly ash will not be used in concrete when high early strength is specified. When Type IP cement is used, the applicable requirements of this Special Provision shall apply.

Materials. Except as modified herein and exclusive of the supplementary optional physical requirements, the fly ash used in this construction shall meet the requirements of AASHTO M295, Class F or Class C, for the class specified. Fly ash of different classes or sources, used as a partial cement replacement in Portland cement concrete, will not be permitted on the same project nor will fly ash substitution be allowed in blended cements (usually Type IP).

A. Chemical Requirements

	Fly Ash Class F	Fly Ash Class C
1. Uniformity requirements: The loss on ignition of individual samples shall not vary from the average established by the ten preceding tests, or by all preceding tests if the number is less than ten, by more than: Loss on ignition, max variation, percentage points from average	1.0	1.0

B. Physical Requirements

	F	C
1. Pozzolanic activity index:		
With Portland cement, at 7 days, min, percent of control	60	60
With Portland cement, at 28 days, min, percent of control	75	75

Source Approval. Fly ash used in the work shall be obtained from a source approved by the Department in accordance with its established procedures.

Design. The following table indicates the maximum cement replacement rates (by weight) and minimum fly ash cement substitution ratios (by weight) for the class of fly ash specified:

Class of Fly Ash	Cement Replacement Rate Max, % (by weight)	Minimum Fly Ash Cement Substitution Ratios (by weight)
F	15.0	1.25:1
C	25.0	1:1

The contractor shall submit a mix design with fly ash as a partial cement replacement in Portland cement concrete for the Department's review and approval together with the following information, as a minimum, furnished by an approved independent testing laboratory:

1. Certified results of compressive strength tests at ages of 7, 14 and 28 days conducted in accordance with ASTM C192.

2. Tests for slump, entrained air content, unit weight and yield conducted in accordance with ASTM C192.

Any request for a change in source of materials or admixtures from the original mix design must be made in writing to the Regional Materials and Tests Engineer explaining the necessity for the change and must be accompanied by a new mix design in accordance with the above provisions. No concrete will be allowed to be placed until the new design is approved.

The water/cement ratio shall be based on the total cementitious material; thus in computing the water/cement ratio in fly ash cement concrete, one pound of fly ash will be equivalent to one pound of cement. The maximum water/cement ratio shall not be in excess of that shown on the design or in Special Provision 604C.

Construction Requirements.

A. Acceptance: Portland cement concrete with fly ash as a partial cement replacement shall not be produced until the concrete supplier furnishes the following information to the Engineer:

1. Copies of the results of all tests performed by the fly ash producer within the previous 30 days on shipments to the concrete supplier showing:

   Fineness (percent retained on No. 325 sieve)
   LOI (Loss of ignition)
   Specific Gravity
   Soundness (Autoclave Expansion)
   Moisture Content
   Pozzolanic Activity, 7 day cement

2. A notarized certification from the fly ash producer stating that the fly ash meets the Department's specifications.

B. Plant: The following requirements must be verified prior to producing any Portland cement concrete with fly ash as a partial cement replacement.

1. Fly ash must be stored in a separate silo from the cement.

2. The fly ash is to be added to the concrete by methods and equipment approved by the Engineer capable of uniformly distributing the material throughout the mix.

3. The fly ash may be weighed cumulatively in the weigh hopper with the cement provided the cement is added first.

4. The temperature of the fly ash is not to exceed 160 F at time of introduction to the mix.

5. The mix shall be closely monitored to maintain a consistent air content between 5% and 8%.

C. Roadway: Additional testing may be required to verify desired properties. Additional compensation for the expense and/or lost production due to the additional testing will not be allowed the contractor. The following are examples of additional testing th may be required:

1. Additional air tests as felt necessary by the Engineer t the entrained air due to fluctuations in LOI and finen fly ash material.

604B

2. Additional compressive test specimens may be needed to determine strengths for form removal due to the slowed strength development inherent with fly ash concrete.

Measurement and Payment. Use of fly ash as a partial cement replacement will not be measured and paid for separately. All costs associated with the manufacture and placement of Portland cement concrete with fly ash as a partial replacement shall be included in the unit bid prices of the other items. In addition, no extensions of working time will be considered due to delays for additional testing and/or slowed strength development.

Texas

Project IR 40-1(147)079

SPECIAL PROVISION

TO

ITEM 300

ASPHALTS, OILS AND EMULSIONS

For this project, Item 300, "Asphalts, Oils and Emulsions", of the Standard Specifications, is hereby amended with respect to the clauses cited below and no other clauses or requirements of this Item are waived or changed hereby.

Article 300.2. Materials is supplemented by the following:

(10) Granulated Reclaimed Rubber Additive. When specified on the plans or in other specifications in the contract, granulated reclaimed vulcanized rubber, produced primarily from the processing of automobile and truck tires, shall be added to the asphalt at a rate of 16-20 percent by weight of the original asphalt to produce a rubber-modified asphalt cement for use in asphaltic concrete.

Ground tire rubber shall be produced from scrap tires ground in a facility in Texas, if such material is available in Texas.

(a) Granulated Reclaimed Vulcanized Rubber

The rubber shall be produced by ambient-temperature grinding processes only. The granulated rubber shall comply with the following gradation when tested by test method Tex-200F, Part I:

Sieve Size	Percent Retained
No. 10	0
No. 16	0-25
No. 30	40-75
No. 80	80-100
No. 200	95-100

The use of multiple types of rubber from multiple sources is acceptable provided that the overall blend of rubber meets the gradation requirements. In addition, the individual rubber particles shall not exceed 3/16 inch.

The granulated rubber shall have a specific gravity of 1.15, plus or minus 0.05, and shall be free of loose fabric, wire, cord or other contaminating materials, except that up to four percent (by weight of rubber) calcium carbonate or talc may be added to prevent rubber particles from sticking together. The rubber shall be sufficiently dry and shall not have a moisture content in excess of two percent by weight so as to be free-flowing and not produce a foaming problem when blended with the hot asphalt cement.

(b) Rubber-Modified Asphalt Cement

The finished asphalt-rubber blend shall be a uniform reacted mixture of asphalt cement and granulated reclaimed vulcanized rubber and shall conform with the following requirements when reacted at 350 degrees Fahrenheit, plus or minus 10 degrees Fahrenheit, for 60 minutes:

Property	Rubber-Modified *AC
Viscosity, Haake, 350 Degrees F	1500-4000 cp.
Cone Penetration, 77 Degrees F (ASTM D1191)	20 Minimum
Softening Point, F (ASTM D36)	125 Degrees F Minimum
Resilience, 77 Degrees F (ASTM D3407)	15 % Minimum

* The grade of asphalt cement to be used will be selected by the Engineer.

(c) Asphalt-Rubber Mixing Equipment

All equipment used in producing and proportioning the asphalt-rubber blend shall be as follows:

An asphalt-rubber mechanical blender with a two-stage continuous mixing process capable of producing a homogeneous mixture of asphalt cement and granulated rubber, at the ratios determined by the Engineer shall be used. This unit shall be equipped with a granulated rubber feed system capable of supplying the asphalt cement feed system, as not to interrupt the continuity of the blending process. A separate asphalt cement feed pump and finished product pump are required. This unit shall have both an asphalt cement totalizing meter in gallons and a flow rate meter in gallons per minute.

An asphalt-rubber storage tank equipped with a heating system to maintain the proper temperature for pumping and adding of the asphalt-rubber blend to the aggregate and an internal mixing unit within the storage vessel capable of maintaining a proper mixture of asphalt cement and granulated rubber shall be used.

An asphalt-rubber supply system equipped with a pump and metering device capable of adding the asphalt-rubber blend by volume to the aggregate at the percentage determined by the Engineer shall be used.

(d) Asphalt-Rubber Mixing Procedure

The temperature of the asphalt cement shall be between 350 and 400 degrees Fahrenheit at the addition of the granulated rubber.

The asphalt and granulated rubber shall be combined and mixed together in a blender unit, pumped into the agitated storage tank, and then reacted for a minimum of 45 minutes from the time the granulated rubber is added to the asphalt cement. Temperature of the asphalt-rubber mixture shall be maintained between 325 degrees Fahrenheit and 375 degrees Fahrenheit during the reaction period.

After the material has reacted for at least 45 minutes, the asphalt-rubber shall be metered into the mixing chamber of the asphaltic concrete plant at the percentage determined by the Engineer.

If a delay occurs in the use of the asphalt-rubber blend after its full reaction, the asphalt-rubber mixture may be allowed to cool, but shall be slowly reheated just prior to use to a temperature of 325 to 375 F and shall also be thoroughly mixed before pumping and metering into the asphaltic-concrete plant for combination with the aggregate. The viscosity of the asphalt-rubber should be checked to insure compliance with the range previously specified. If the viscosity is out of the specified range, it may, with the permission of the Engineer, be adjusted by addition of a small amount of asphalt cement or granulated rubber, or by blending with a new batch of asphalt-rubber. If, in the opinion of the Engineer, the asphalt-rubber mixture has been damaged by excessive or prolonged heating, it shall not be used.

Texas

SPECIAL SPECIFICATION

ITEM 3664

HOT ASPHALT-RUBBER SEAL COAT

1. DESCRIPTION. This item shall consist of a surface treatment composed of one or two applications as shown on the plans, of a hot asphalt-rubber material covered with aggregate for sealing of new bases or existing pavement in accordance with these specifications.

This process may be proprietary and bidders are given general notification that the Department makes no representations as to rights or ownership of processes or methods required in any specification, and that the bidder is solely responsible for making appropriate inquiries, securing permission, paying royalties, etc., for their use.

2. MATERIALS.

a. Asphaltic Materials. The asphaltic materials used shall be one or more of the materials prescribed in the Item, "Asphalts, Oils and Emulsions", whichever are called for on the plans.

b. Rubber. The rubber shall be one of the following types:

Type I - Ground tire rubber, to be used in a mixture of asphalt, rubber and diluent.

Type II - Mixture of ground tire rubber and high natural reclaimed scrap rubber, to be used in a mixture of asphalt, extender oil and rubber. The natural rubber content, determined by ASTM D 297, shall be a minimum of 25 percent.

The ground rubber shall comply with the following gradation requirements when tested by Test Method Tex-200 F, Part I:

U.S. Std Sieve Size	Percent Retained Type I	Type II
No. 8	0	0
No. 10	0-5	-
No. 30	90-100	50-70
No. 50	95-100	70-95
No. 100	-	95-100

The ground rubber shall be free from fabric, wire, cord or other contaminating materials, except that up to four percent of a dusting material such as calcium carbonate may be included to prevent the particles from sticking together. The

rubber, irrespective of diameter, shall not be greater than 1/4 inch in length and shall not have a moisture content in excess of two percent by weight.

Ground tire rubber shall be produced from scrap tires ground in a facility in Texas, if such material is available in Texas.

c. Diluent. The diluent shall be a hydrocarbon distillate complying with the following requirements when tested in accordance with ASTM Test Method D 86:

Initial Boiling Point, F, Minimum	340
End Point, F, Maximum	600

d. Extender Oil. The extender oil shall be a high-flash, resinous aromatic type which when blended with the asphaltic material will result in a mixture with an absolute viscosity of 600-2000 poises at 140 F.

e. Aggregate. The aggregate used shall be of the type and grade or types and grades as noted on the plans and selected from those prescribed in the Items, "Aggregate for Surface Treatments", "Aggregate for Surface Treatments (Precoated)" or in the Item, "Aggregate for Surface Treatments (Lightweight)".

3. EQUIPMENT.

a. Distributor. The distributor shall be self-propelled pressure type equipped with a separate power unit, distributing pump capable of pumping the specified material at the specified rate through the distributor tips, and equipment for heating the bituminous material. The distribution bar on the distributor shall be fully circulating with nipples and valves so constructed that they are bathed in the circulating asphalt to the extent that the nipples will not become partially plugged with congealing asphalt upon standing, thereby causing preliminary streaked or irregular distribution of asphalt. Distributor equipment shall include a tachometer, pressure gauges, volume measuring devices, and a thermometer for reading temperature of tank contents. The spray bars on the distributor shall be controlled by a bootman riding at the rear of the distributor in such a position that operation of all sprays is in full view and accessible to him for controlling spray widths. The distributor shall be capable of adequately mixing the asphalt, rubber and diluent or oil and keeping the rubber in uniform suspension. The distributor may be equipped with an on board scale system capable of weighing its load within an accuracy of 0.4% of the load being weighed.

The method and equipment for combining the rubber and asphalt shall be so designed and accessible that the Engineer can readily determine the percentages, by weight, of each of the two materials being incorporated into the mixture.

b. Aggregate Spreader. A self-propelled [illegible] spreader will be used which will uniformly spread aggregate at the rate specified by the Engineer.

c. Rollers. Rolling equipment shall meet the governing specifications for the Item, "Rolling".

d. Broom. Broom shall be a rotary, self-propelled power broom for cleaning existing pavement surfaces.

e. Aggregate Heating System. The system for heating the cover aggregate shall be of the type that continually agitates the aggregate during heating and in which the temperature can be so controlled that the aggregate will not be injured in the necessary heating operations required to obtain the specified temperature. The burner, or combination of burners, and type of fuel used shall be such that in the process of heating the aggregate to the desired specified temperature, no residue from the fuel shall adhere to the heated aggregate. A continuous recording thermometer shall be provided which will indicate the temperature of the aggregate when it leaves the heating system.

f. Truck Scales. A set of standard platform truck scales, conforming to the Item, "Weighing and Measuring Equipment" shall be placed at the location approved by the Engineer. The Engineer may waive this requirement if the distributor has adequate on board, calibrated scale system.

4. CONSTRUCTION METHODS.

Seal coats shall not be applied when the air temperature is below 70 F and is falling, but may be applied when the air temperature is above 65 F and is rising the air temperature being taken in the shade and away from artificial heat. Seal coats shall not be applied when the temperature of the surface on which the seal coat is to be applied is below 50 F.

Hot asphalt-rubber material shall not be placed when general weather conditions, in the opinion of the Engineer, are not suitable.

The Contractor may use a mixture of asphalt, diluent and Type I rubber or of asphalt, extender oil and Type II rubber.

a. Mixture of Asphalt, Type I Rubber and Diluent (Optional).

(1) Mixing. The proportions of the asphalt and rubber by weight shall be 75 plus or minus 2 percent and 25 plus or minus 2 percent, respectively.

The temperature of the asphalt shall be between 350 F and 425 F during the addition of the rubber. The asphalt and rubber shall be carefully combined and mixed and reacted together. The reaction period shall be at least 30 minutes after all rubber has been added. At the direction of the Engineer, the reaction period shall be extended to obtain the desired properties in the asphalt-rubber mixture. The temperature of the resulting asphalt-rubber mixture shall not be less than 325 F during the reaction period.

If a job delay results after the full reaction has occurred, the asphalt-rubber mixture may be allowed to cool, but shall be slowly reheated to an acceptable spraying temperature just prior to application. If, in the opinion of the Engineer, the asphalt-rubber mixture has been damaged by excessive or prolonged heating, it shall not be used.

Just prior to application, diluent up to a maximum amount of 7-1/2 percent by volume of the hot asphalt-rubber mixture may be added as required to obtain optimum viscosity for spray application and better "wetting" of the cover aggregate.

The Contractor shall show proof that his equipment is capable of mixing the asphalt and rubber to achieve the required consistency, or demonstrate the ability to achieve this consistency by placing a test section at a location acceptable to the Engineer.

(2) Prime Coat. Prior to applying the hot asphalt-rubber treatment on a base course, the surface to be sealed shall receive a prime coat, unless otherwise directed by the Engineer, applied and paid for as a separate item conforming to the requirements of the Item, "Prime Coat".

(3) Tack Coat. When directed by the Engineer, prior to applying the hot asphalt-rubber treatment on an existing wearing surface, a tack coat shall be applied. The tack coat, if used, shall not be paid for separately but shall be considered subsidiary to the various bid items.

(4) Application. The temperature of the asphalt-rubber mixture plus diluent, shall be adjusted to obtain the proper application characteristics, but shall not exceed 350 F. The mixture shall be applied on the approved, prepared surface with specified self-propelled pressure distributor so operated as to distribute the material in the quantity specified, evenly and smoothly, under a pressure necessary for proper distribution.

Hot asphalt-rubber material may be applied in a width not to exceed 13 feet, or as shown on the plans, but may be reduced if uniformity of distribution is not achieved. No traffic or hauling will be permitted over freshly applied hot asphalt-rubber material. Hot asphalt-rubber material shall not be applied until immediate covering with aggregate at the proper temperature is assured. Paper or other suitable material shall be used to prevent overlapping of transverse joints.

Where specified on the plans, the cover aggregate shall be preheated to a temperature between 250 and 350 F. Canvas or similar covers that completely cover each load shall be used to minimize temperature drop of the exposed cover aggregate, if directed by the Engineer.

Aggregate shall be immediately and uniformly applied and spread by the specified self-propelled continuous feed aggregate spreader, unless otherwise shown on the plans or authorized by the Engineer in writing. The aggregate shall be applied at the approximate rates indicated on the plans and as directed by the Engineer.

The Contractor shall be responsible for the maintenance of the surface until the work is accepted by the Engineer.

The entire surface shall be broomed, bladed or raked as required by the Engineer and shall be thoroughly rolled with the type or types of rollers specified on the plans.

All storage tanks, piping, retorts, booster tanks and distributors used in storing or handling asphaltic material shall be kept clean and in good operating condition at all times, and they shall be operated in such manner that there will be no contamination of the asphaltic materials with foreign materials. It shall be the responsibility of the Contractor to provide and maintain in good working order, a recording thermometer at the storage heating unit at all times.

b. Mixture of Asphalt, Extender Oil and Type II Rubber.

(1) Mixing. The proportions of the asphalt and rubber by weight, shall be 78 percent, plus or minus 2 percent, asphalt (including extender oil) and 22 percent, plus or minus 2 percent, rubber. The asphalt and extender oil shall be combined and heated to a temperature of not less than 400 F. The proportions of the asphalt and extender oil shall be that which will result in a blend of materials with an absolute viscosity of 600-2000 Poises at 140 F, when sampled and tested in accordance with Test Method Tex-528-C.

After the asphalt and extender oil have reached the [illegible] consistency, the Type II rubber shall be added and the [illegible] mixed and reacted together. The reaction period shall be at least 30 minutes after all rubber has been added. Temperature of the material during the reaction period shall be 375 to 425 F.

If a job delay results after the full reaction has occurred, the asphalt-rubber mixture may be allowed to cool, but shall be slowly reheated to an acceptable spraying temperature just prior to application. If, in the opinion of the Engineer, the asphalt-rubber mixture has been damaged by excessive or prolonged heating, it shall not be used.

The Contractor shall show proof that his equipment is capable of mixing the asphalt and rubber to achieve the required consistency, or demonstrate the ability to achieve this consistency by placing a test section at a location acceptable to the Engineer.

(2) Prime Coat. Prior to applying the hot asphalt-rubber treatment on a base course, the surface to be sealed shall receive a prime coat, unless otherwise directed by the Engineer, applied and paid for as a separate item conforming to the Item, "Prime Coat".

(3) Tack Coat. When directed by the Engineer, prior to applying the hot asphalt-rubber treatment on an existing wearing surface, a tack coat shall be applied. The tack coat, if used, shall not be paid for directly, but shall be considered subsidiary to the various bid items.

(4) Application. The temperature of the asphalt-rubber mixture shall be adjusted to obtain the proper application characteristics, but shall not exceed 425 F. The mixture shall be applied on the approved, prepared surface with specified self-propelled pressure distributor so operated as to distribute the material in the quantity specified, evenly and smoothly, under a pressure necessary for proper distribution.

Hot asphalt-rubber material may be applied in a width not to exceed 13 feet, or as shown on the plans, but may be reduced if uniformity of distribution is not achieved. No traffic or hauling will be permitted over freshly applied hot asphalt-rubber material. Hot asphalt-rubber material shall not be applied until immediate covering with aggregate at the proper temperature is assured.

Paper or other suitable material shall be used to prevent overlapping of transverse joints.

where specified on the plans, the cover aggregate shall be preheated to a temperature between 250 and 350 F. Canvas or similar covers that completely cover each load shall be used to minimize temperature drop of the exposed cover aggregate, if directed by the Engineer.

Aggregate shall be immediately and uniformly applied and spread by the specified self-propelled continuous feed aggregate spreader, unless otherwise shown on the plans or authorized by the Engineer in writing. The aggregate shall be applied at the approximate rates indicated on the plans and as directed by the Engineer.

The Contractor shall be responsible for the maintenance of the surface until the work is accepted by the Engineer.

The entire surface shall be broomed, bladed or raked as required by the Engineer and shall be thoroughly and slowly rolled with type or types of rollers specified on the plans.

All storage tanks, piping, retorts, booster tanks and distributors used in storing or handling asphaltic materials shall be kept clean and in good operating condition at all times, and they shall be operated in such manner that there will be no contamination of the asphaltic materials with foreign materials. It shall be the responsibility of the Contractor to provide and maintain in good working order a recording thermometer at the storage heating unit at all times.

5. MEASUREMENT. Hot asphalt-rubber mixture will be measured by the ton of 2,000 pounds, including asphalt, rubber and diluent (or extender oil); weighed upon completion of the mixing and just prior to delivery to the point of application and tared immediately after application. If the distributor is equipped with on board scales the weighing will be immediately before and after each application.

Aggregate will be measured by the cubic yard in vehicles, as applied on the road.

6. PAYMENT. The work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" will be paid for at the unit prices bid for "Hot Asphalt-Rubber" and "Aggregate" of the type and grade specified, which prices shall be full compensation for cleaning the existing surface; for furnishing all materials and freight involved; for all heating,

mixing, hauling and placing all materials including labor, [illegible] materials and for all manipulations, labor, tools, equipment and incidentals, including test sections, necessary to complete the work except rolling and prime coat.

Unless otherwise shown in the plans, all rolling performed as required will be measured and paid for in accordance with the provisions governing the item or items, "Rolling".

The prime coat will be measured and paid for in accordance with the provisions governing the Item, "Prime Coat".

Texas

STATE DEPARTMENT OF HIGHWAYS
AND
PUBLIC TRANSPORTATION

Departmental Materials Specification: D-9-8900
Fly Ash

I. Description: This specification shall govern for the composition, quality, sampling and testing of two types of fly ash. Fly ash is hereby defined as the finely divided residue or ash that remains after burning finely pulverized coal at high temperatures.

II. Bidder's and/or Supplier's Requirements:

A. Procurement by the State: All prospective bidders are hereby notified that, before any bid is considered, the material proposed for submission shall be a material on the list of approved sources of material covered by this specification maintained by the Department.

B. Contracts: All contractors and/or suppliers on contracts are hereby notified that all fly ash, utilized in production of products for the Department shall be a fly ash from a source shown on the list of approved sources of fly ash maintained by the Department.

III. Payment:

A. Procurement By the State: Payment for all materials under this specification shall be in accordance with the conditions prescribed in the contract awarded by the State.

B. Contracts: All materials under this specification utilized in the production of products for the Department will be paid for in accordance with the governing specifications for the items of construction in which fly ash is used.

IV. Prequalification and Performance History:

A. Establishment of Prequalification as an Approved Source: Prospective Bidders and/or Suppliers who desire to establish prequalification for materials governed by this specification, should contact the Materials and Tests Engineer, State Department of Highways and Public Transportation, Austin, Texas 78703.

D-9-8900
4-89

The following information must accompany the request for approval:

1. The name of the supplier or company

2. Location of the power plant

3. Coal origin

4. Storage facilities and capacity

5. Production procedures. Production procedures shall be one of the following:

   a. Use coal from only one origin

   b. Use coal from two or more origins blended uniformly at a constant ratio prior to burning.

   c. Use coal from two or more origins with the fly ash from each stored in separate, identifiable units.

   d. Use coal from two or more origins stored and burned separately, and the fly ash kept separately until blended uniformly at a constant ratio prior to placing in storage.

6. Copies of test reports showing results obtained in their quality control program. (At least one test report per month for the previous six months shall be submitted.) The test reports shall include the coal origin, sampling and test date and all chemical requirements specified elsewhere in this specification.

7. Details of Quality Control Program shall be submitted along with request for prequalification. Details shall include measures taken to ensure that fly ash not meeting the requirements of this specification produced during shut-down or start-up and other operations is kept separated from material meeting the requirements of this specification.

B. Sampling for Prequalification: Sampling for establishment of prequalification as an approved source shall be in accordance with Test Method Tex-733-I Prospective Bidders and/or Suppliers will be notified, after their material has been evaluated, as to conformance with requirements of this specification.

C. Quality Control of Approved Sources: Sources on the approved list must furnish the following items to the Materials and Tests Division on a monthly basis:

1. A copy of a test report showing results obtained in their routine quality control program. The test report shall include the coal origin, test date and results of all chemical requirements specified except available alkalies, as Na_2O.

2. A sample from the same material represented by the test report in 1, above, shall be submitted along with test report. Minimum sample size shall be 1 pint.

D. Sampling for Quality Control of Approved Sources: Sampling for quality control of sources on the approved source list shall be in accordance with Test Method Tex-733-I.

E. Performance History: Some of the tests required by this specification extend over a prolonged period of time and some tests cannot be made after the material is used. Therefore, testing for acceptance of materials supplied on any contract or State purchase order will only be considered on those materials which are identifiable by the Materials and Tests Engineer as being a material having an established performance history of compliance with the criteria established by this specification and shown on the list of approved sources.

F. Re-evaluation: When, it is determined that changes have been made in the composition, burning process, or quality of a prequalified material that may affect its performance, a re-evaluation of the performance may be required. The Department reserves the right to conduct whatever tests are deemed necessary to identify a prequalified material and to determine if a change has been made in composition, burning process, or quality that may affect its performance. Changes that are detected in composition, burning process, or quality that may affect performance and have not been reported by the source, may be cause for removal of that source from the list of approved sources of fly ash.

G. Withdrawal, Approved Source: A source may be removed from the approved list for the following reasons:

1. Any change in the production procedures, including the use of precipitator performance additives, from those shown in the original request for approval.

2. Failure of any project or source sample to comply with specification requirements.

3. A source becomes inactive and/or does not furnish fly ash to Department projects for a period of one year.

H. Re-establishment as an Approved Source: Any source that has been removed from the list of approved sources for any reason and desires to be re-established as an approved source shall document, in writing, to the Materials & Tests Engineer that the cause for removal has been corrected and request prequalification in accordance with Article IV. Prequalification and Performance History of this specification. In addition, the supplier seeking re-establishment as an approved source shall stipulate that all costs associated with re-establishment will be borne by the supplier and shall be paid to the Department prior to replacement on the list of approved sources.

V. Sampling and Testing: Sampling and testing shall be in accordance with the Department of Highways and Public Transportation, Materials and Tests Division Manual of Testing Procedures, Test Method Tex-733-I. Easy access shall be provided for sampling.

VI. Packaging: When packaged in bags for shipment and/or delivery to a project, each bag shall contain approximately one cubic foot of fly ash, volume shall be based on bulk density. Each bag shall be labeled with the following:

A. Supplier

B. Power Plant Location

C. Net Weight *

D. Type of Fly Ash

* Weight from bag to bag shall not vary more than plus or minus 5% of the weight shown on bag.

VII. Material Requirements: This specification covers the general and specific requirements for two types of fly ash. Both types of fly ash shall meet all requirements of this specification except when specific requirements are shown for a particular type of fly ash.

A. Chemical Requirements: Fly ash shall conform to the chemical requirement for each type as shown in the following table.

	Type A	Type B
Silicon dioxide (SiO_2) plus aluminum oxide (Al_2O_3) plus iron oxide (Fe_2O_3), min, %	70.0	50.0
Sulfur trioxide (SO_3), max, %	5.0	5.0
Calcium Oxide (CaO), Variation in percentage points of CaO from the average of the last 10 samples (or less provided 10 have not been tested) shall not exceed plus or minus	4.0	4.0
Magnesium Oxide (MgO), max, %	5.0 *	5.0 *
Available alkalies, as Na_2O, max, % (when used in conjunction with reactive or potentially reactive aggregates)	1.5	1.5
Moisture content, max, %	2.0	2.0
Loss on ignition, max, %	3.0	3.0

* When the autoclave expansion or contraction limit is not exceeded, an MgO content above 5.0% may be acceptable.

B. Physical Requirements: Fly ash shall conform to the physical requirements for each type as shown in the following table.

	Type A	Type B
Fineness ------ retained on 325 sieve (45 cm), max. %	30.0	30.0
Variation in percentage points retained on the 325 sieve from the average of the last 10 samples (or less provided 10 have not been tested) shall not exceed plus or minus	5.0	5.0

D-9-8900
4-89

Pozzolanic activity index with portland cement as a minimum percentage of the control at 28 days	75	75
Water requirement, maximum percentage of control	100	100
Soundness autoclave expansion or contraction, maximum %	0.8	0.8
Increase of drying shrinkage of mortar bars at 28 days, maximum percent	0.03	0.03
Reactivity with cement alkalis mortar expansion at 14 days, maximum percent	0.020	0.020
Specific gravity, maximum variation from average %	5.0	5.0

Drying shrinkage shall be tested in accordance with ASTM C 157.

Alkali reactivity shall be tested in accordance with ASTM C 441.

Specific gravity shall be tested in accordance with ASTM C 188.

All other physical requirements shall be tested in accordance with ASTM C 311.

** The Contractor shall exercise care in adjusting the monument cases and covers so as not to damage them. Any of the parts or materials which are damaged due to the Contractor's operations shall be replaced by him at his own expense.

The monument cases and covers shall be reset in accordance with details on standard plans and section 8-13 of the standard specifications.

The Contractor has the option of adjusting the monuments to grade by the use of riser rings as detailed on the plans.

The unit contract price per each for "Adjusting Monument Case and Cover" shall be full compensation for all labor, tools, materials and equipment necessary or incidental to the completion of the work as specified herein.

STRESS ABSORBING MEMBRANES*

** This work shall consist of application of a hot rubber-asphalt mixture covered with an appropriate crushed aggregate in the form of a Stress Absorbing Membrane (SAM) used as a wearing surface or a Stress Absorbing Membrane Interface (SAMI) used as an interface between old and new pavement.

Materials

Asphalt

Asphalt shall be AR-2000W or AR-4000W conforming to section 9-02.1(4) of the standard specifications.

Granulated Rubber

Granulated Rubber shall be free from fabric, wire, or other contaminating materials except that up to 4% of calcium carbonate may be included to prevent particles from sticking together. The gradation of the rubber shall meet one of the following and shall be at the option of the Contractor:

1. When only ground vulcanized rubber is used, it shall be at least 95% passing the No. 16 sieve and not more than 10% shall pass the No. 25 sieve.

2. If powdered, reclaimed "devulcanized" rubber is used, approximately 40% shall be added to 60% ground vulcanized rubber scrap and the total blend shall meet the following grading:

Sieve	% Passing
No. 10	100
No. 30	60 - 80
No. 50	35 - 70
No. 100	10 - 25

Cover Aggregate

** Cover aggregate shall meet the specifications established in section 9-03.4 of the standard specifications and shall be (size) and 1/4" - 0. The coarse cover aggregate shall also be required to meet one of the following conditions during construction. The aggregate condition shall be as directed by the Engineer:

1. Surface dry at the time of application, as defined by AASHTO T-85, Sec. 4.2.

2. Dry and heated to a minimum of 250°F.

** 3. The dried and heated aggregate (Item #2) precoated with 1-2% AR-2000W or AR-4000W prior to application.

Because of the amount of dust and water in the aggregate is not known prior to construction, the Contractor shall submit bids for all three conditions and at the Engineer's option one or more of these items will be utilized.

SR 12
Jackson Highway to Silvercreek -
ACP Overlay
77 W 207
**Revised December 27, 1977

Construction Requirements

Weather Limitations

1. Minimum ambient air temperature of 50°F.

2. The pavement shall be absolutely dry.

3. The wind conditions will be such that a satisfactory membrane can be achieved.

Equipment

Equipment shall be as designated in section 5-02.3(1) of the standard specifications except as follows:

1. Self propelled power brooms for cleaning the existing pavement will be required.

2. Only self propelled pneumatic tired rolling equipment will be used on this project.

Mixing Asphalt and Rubber

The asphalt and rubber shall be combined as rapidly as possible in the proportions of a minimum of two pounds of rubber to one gallon of asphalt then held for such a time and temperature that the consistency of the mix approaches that of a semi-fluid material. The temperature of the asphalt shall be between 350°F and 450°F. The use of up to 9 percent diluent to assist in the mixing of the rubber and the spray application of the mixture will be permitted. If a diluent is used, it shall have a boiling point of at least 350°F. After reaching the proper consistency, application shall proceed immediately, and in no case shall the material be held at temperatures in excess of 350°F for more than one hour after reaching that point.

The method and equipment for combining the rubber and asphalt shall be so designed and accessible that the Engineer can readily determine the percentages, by weight, of each of the two materials being incorporated into the mixture.

Application

Prior to the hot asphalt rubber treatment, the surface shall be cleaned and patched as specified in section 5-04.3(5)A of the standard specifications. The application rate of the hot asphalt rubber mixture shall be between 0.50 and 0.60 gallons per square yard depending upon the nominal size of the aggregates to be used and as ordered by the Engineer.

** Spreading of aggregate shall be as soon as possible but not more than 15 seconds following the application of the hot asphalt rubber mixture and shall be between 25 - 40 pounds per square yard for the SAM. The amount of aggregate required for the SAMI should be only the amount necessary to protect the membrane from construction equipment required for placement of the asphalt concrete. This quantity is estimated to be 25 pounds per square yard.

The rolling of cover aggregate shall proceed immediately after application and shall be a minimum of four complete coverages to ensure maximum embedment of the aggregate. The number of rollers furnished will be to the satisfaction of the Engineer.

An application of 5 - 10 pounds per square yard of 1/4" - 0 aggregate shall be applied after rolling and before opening a lane to traffic where traffic is of such volume or speed that it may displace the cover aggregate.

All joint edges shall be swept clean of overlapping cover material prior to the adjacent application of asphalt-rubber material. All reasonable precautions shall be taken to avoid "skips" and "overlaps" at joints and to protect the surfaces of adjacent structures from being spattered or marred. All transverse joints shall be made by placing building paper over the ends of the previous applications, and the joining application shall start on the building paper. The paper shall be removed and disposed of to the satisfaction of the Engineer.

** SAMI construction will require a tack coat of CSS-1 applied to the SAMI prior to overlay in accordance with section 5-04.3(5)A of the standard specifications. Prior to application of the tack coat all surplus cover aggregate shall be removed by brooming. Surplus aggregate shall become the property of the Contractor and shall be removed from the project. Within rural areas, surplus aggregate may be disposed of within the project limits as directed by the Engineer.

SR 12
Jackson Highway to Silvercreek -
ACP Overlay
77 W 207
**Revised December 27, 1977

Measurement

Section 5-02.4 of the standard specifications is hereby supplemented by the following:

Rubberized Asphalt will be measured by the ton in accordance with section 1-09 and shall include the rubber and diluent.

Surface drying, heating, and/or precoating aggregate will be measured by the cubic yard in trucks at the point of delivery on the roadway.

Payment

The list of bid items under the first paragraph of section 5-02.5 of the standard specifications is hereby supplemented by the following:

7. "Surface Drying Aggregate (size)", per cubic yard.

8. "Heating Aggregate (size)", per cubic yard.

** 9. "Precoating Aggregate (size) Incl. Asphalt", per cubic yard.

10. "Rubberized Asphalt", per ton.

Section 5-02.5 of the standard specifications is hereby supplemented by the following:

The unit contract price per cubic yard for "Surface Drying Aggregate (size)" shall be full compensation for furnishing necessary equipment, hauling, drying and storing the aggregates in accordance with the specifications.

The unit contract price per cubic yard for "Heating Aggregate (size)" shall be full compensation for furnishing necessary equipment, hauling, heating and storing aggregates in accordance with the specifications.

** The unit contract price per cubic yard for "Precoating Aggregate (size) Incl.
** Asphalt" shall be full compensation for furnishing necessary materials, equipment, hauling, precoating and storing aggregates in accordance with the specifications.
** Heating of the aggregate will be paid for under the unit contract price per cubic yard for "Heating Aggregate (size)".

The unit contract price per ton for "Rubberized Asphalt" shall be full compensation for furnishing the asphalt, rubber and diluent, mixing, heating, hauling and spreading on the roadway.

Any incidental work required to complete the stress absorbing membrane, (SAM), or the stress absorbing membrane interface (SAMI), specified herein, but not specifically mentioned in the foregoing specifications, shall be performed by the Contractor and shall be considered as incidental to the construction, and all costs therefor shall be included in the unit contract prices of the bid items.

MEMBRANE WATERPROOFING (DECK SEAL)
December 26, 1989

Description
This work consists of furnishing and placing an approved waterproofing membrane over a properly prepared concrete bridge deck prior to placing the asphalt concrete overlay, in accordance with these specifications, and in reasonably close conformity with the Plans or as directed by the Engineer.

The waterproofing membrane for this project shall be selected by the Contractor from one of the following systems:

System A
A factory laminated sheet composed of either suitably plasticized coal tar or rubberized asphalt reinforced with a polypropylene fabric and primed in accordance with the manufacturer's recommendations.

System B
A hot-applied, rubberized elastomeric membrane with primer if required by the manufacturer.

System C
A hot-applied reclaimed rubber/asphalt membrane.

Preparation of Concrete Deck
The entire deck and the sides of the curb to the height of the asphalt overlay shall be essentially free of all foreign material such as dirt, grease, etc. Prior to applying the primer or liquid membrane, all dust and loose material shall be removed from the deck with compressed air. Any surface defects such as spalled areas, cracks, protrusions, etc., that will decrease the effectiveness of the membrane by puncturing, stretching, etc., shall be corrected prior to application of the membrane.

Weather and Moisture Limitations
Work shall not be done during wet weather conditions, nor when the deck and ambient air temperatures are below 50 degrees F. The deck shall be surface-dry at the time of the application of the primer or liquid membrane.

The Engineer may order work to be suspended in accordance with Section 1-08.6 because of the above weather and moisture limitations.

New Concrete Areas
All areas of the deck that have less than 28 day old concrete shall be allowed to cure for a period of time recommended by the membrane manufacturer or as ordered by the Engineer before application of the membrane.

Concrete Protection
The Contractor shall use care to protect all concrete surfaces from damage. Any damage to exposed surfaces shall be repaired at the Contractor's expense.

Membrane Application
The primer and membrane waterproofing shall extend from the roadway deck up onto the curb face the thickness of the asphalt overlay. Special care shall be used at the curb face to see that the membrane adheres to the concrete.

The Contractor shall not begin application of membrane waterproofing deck seal to the bridge until he has demonstrated, to the satisfaction of the Engineer, that all labor, equipment, and materials necessary to apply the membrane and asphalt concrete overlay are either on hand or readily available to complete the work in a timely manner.

Membrane Protection

The membrane material shall be protected from damage due to the paving operations. The method of membrane protection for Membrane Systems A and B shall be as recommended by the manufacturer of the membrane system and approved by the Engineer. The method of membrane protection for Membrane System C shall be as specified under Membrane System C.

No traffic or equipment except that required for the actual waterproofing and paving operations will be permitted to travel or rest on the membrane waterproofing until it is covered by the asphalt overlay.

Asphalt Concrete Overlay

The membrane manufacturer's recommendations shall be thoroughly considered in the application of the asphalt concrete overlay particularly as to the type of paving machine, laydown temperature of the asphalt concrete, protection of membrane while paving, rolling temperature and technique, and other items unique to each membrane. Differences in application procedure shall be resolved by the Engineer and his decision shall be final. Vibratory rollers shall not be used on bridge decks.

Evaluating Waterproofing Effectiveness

When, in the Engineer's judgment, it is indicated that the completed sections of the waterproofing membrane should be evaluated for waterproofing effectiveness prior to application of membrane protection, evaluation of the waterproofing membranes effectiveness will be performed in the following manner:

a) For decks with epoxy-coated reinforcing bars, the waterproofing membrane will be visually inspected for uniformity of application, tears, punctures, and bonding. All such deficiencies shall be repaired as approved by the Engineer prior to placement of the membrane protection.

b) For decks with uncoated reinforcing bars, testing by WSDOT Test Method No. 413A will be performed. Any portion of the membrane found to have a resistance reading below 100,000 ohms shall be repaired. Those membranes which provide less than 70 percent readings above 250,000 ohms shall be replaced or, at the option of the Contractor, repairs may be made to bring the membrane to the acceptance level. After completion of the asphalt overlay, a final evaluation of the waterproofing effectiveness of the membrane/pavement system will be made in accordance with WSDOT Test Method No. 413A. The acceptance standards for the pavement membrane system shall be 70 percent readings above 250,000 ohms and no single reading below 100,000 ohms. Those areas requiring repair or replacement to meet acceptance standards shall be repaired or replaced as approved by the Engineer.

The testing will be conducted by state forces.

The Engineer will not require testing of the waterproofing membrane to evaluate the waterproofing effectiveness for precast prestressed member bridges. (i.e. precast prestressed concrete bridges without cast-in-place concrete roadway decks).

Membrane System A

Materials

Primer

The primer used to bond membrane to deck and to seal seams and patches shall be a water resistant adhesive compatible with the membrane. The primer shall be of suitable consistency for application by brush, roller, or spray without further dilution.

Membrane

The membrane shall be factory-laminated sheet composed of either suitably plasticized coal tar or rubberized asphalt reinforced with polypropylene fabric. It shall be manufactured free from blemishes, discontinuities, and other defects. The membrane shall be supplied in rolls, having a minimum width of 36 inches, and shall conform to the following requirements:

Thickness:	65 mils minimum
Pliability (1):	No cracks

(1) Place a 4 inch by 1 inch membrane specimen in a -10 degree F cold chamber for two hours. While still in the cold chamber, bend the specimen 180 degrees over a 1 inch radius mandrel. Remove specimen from cold chamber and inspect for cracks.

Application

The primer shall be applied to the cleaned concrete surfaces at the rate and according to the procedure recommended by the membrane manufacturer. All surfaces to be covered by the membrane shall be thoroughly and uniformly coated with primer. Precautionary measures shall be taken to ensure that pools and thick layers of primer are not left on the deck surface to scum over. Drying time prior to applying the membrane shall normally be as recommended by the manufacturer, however, the membrane shall not be applied until substantially all volatile material has dissipated from the primer.

The prefabricated membrane shall be applied to the primed curb and bridge deck surfaces by either hand methods or mechanical applicators. The membrane shall be placed in such manner that a shingling effect will be achieved and that any water which accumulates will drain toward the curb and the drain pipes. Each strip shall be overlapped a minimum of 4 inches or as recommended by the manufacturer. An adhesive or a wide tipped torch to cause tackiness shall be used, if necessary, to assure a good seal of the joints. Hand rollers or other satisfactory pressure apparatus shall be used on the applied membrane to assure firm and uniform contact with the primed concrete surfaces.

Any torn or cut areas, or narrow overlaps, shall be patched using a satisfactory adhesive and by placing sections of the membrane over the defective area in such a manner that the patch extends at least 6 inches beyond the defect. The patch shall be rolled or firmly pressed onto the surface.

The fabric shall be neatly cut and contoured at all joints as directed by the Engineer.

After the membrane waterproofing has been completed, the membrane shall be cut with two right angle cuts at all deck drain pipes. The cuts shall be made to the inside diameter of the drain pipes, after which the corners of the membrane waterproofing shall be turned down into the drains and laid in a coating of asphalt binder.

Membrane System B

Materials

Primer

The primer, if required, shall meet the manufacturer's recommendations.

Membrane

The membrane shall meet the following requirements:

Viscosity, SSF at 350 degrees F	ASTM E 102	950-1350
Softening Point, degrees F	ASTM D 2398	165 Min.
Adhesion, psi	ASTM D 429(1)	15 Min.
Cold Bend Test, Minus 10 degrees F		(2) No cracks
Compatibility with Asphalt		Complete

(1) Adhesion ASTM D 429, Method A(Modified). This is a tension test of vulcanized rubber to steel. Coat the surfaces of the 2 metal plates described in the procedure with an epoxy resin of at least 2000 psi tensile strength. Stand the coated ends on Ottawa sand (ASTM C 109). Apply a pressure of 10 lbs. for a minimum of eight hours to ensure adequate bedding of the sand in the resin. Brush all loose particles from the treated metal surface and coat each with 0.3 gram of primer.

Cover the bottom of a cylindrical thin film oven test pan (ASTM D 1754) with a release paper such as Technipeel No. 985 made by the Brown Paper Company of Kalamazoo, Michigan. Any release paper that retains its release properties after use is satisfactory.

Pour 50 grams of membrane (350 - 375 degrees F) into the release-treated pan. Allow the membrane to cool to ambient temperature. Remove it from the pan and cut circular sections to fit the metal plates or discs coated as above.

Fit the circular section of membrane on one metal disc and place the other metal disc over it. Put this sandwich in a 140

degree F oven. Place a one kg weight on it and leave in the oven for two hours.

Test in accordance with ASTM D 429, Method A, and calculate adhesion as total load at failure divided by area of adhered surface, whether failure occurred at bonded surface or within the membrane material.

(2) Cold Bend Test. Pour 50 grams of membrane into a container, as described for the adhesion test. Allow it to cool to ambient temperature and remove from the pan.

Dust both sides lightly with talc to prevent stickiness.

Place the specimen in a -10 degree F cold chamber for two hours. While still in the cold chamber, bend the specimen 180 degrees over a radius not to exceed 1 inch.

Remove the membrane from the cold chamber and check for cracks. Only material which shows no cracks will be considered satisfactory.

Application

Primer

The primer, if required, shall be applied to the pavement as specified by membrane manufacturer.

Membrane Application

If the primer has become contaminated, the pavement shall be cleaned and a new primer applied and allowed to cure before the membrane is applied.

The membrane material shall be heated in accordance with the manufacturer's recommendations. To ensure against overheating; a double-boiler type heater shall be used and the membrane material shall be circulated or agitated during the heating process.

The membrane shall be applied to the clean, dry (primed) surface at a nominal rate of 0.5 gallon per square yard and in accordance with the manufacturer's recommendations as to application temperatures.

Placement of the asphalt concrete wearing surface shall be done in accordance with the recommendations of the coating manufacturer.

Membrane System C

Membrane System C shall consist of an asphalt/rubber membrane together with a membrane protective fabric. The asphalt/rubber membrane shall be produced by one of the two known proprietary processes combining granulated tire rubber with asphalt cement. Method 1 uses a ground, vulcanized rubber and an extender oil where as Method 2 uses ground vulcanized rubber and a kerosene diluent. Either method is acceptable based on proper compliance with the specification and certification of materials.

Materials

Asphalt Cement

The asphalt shall be paving grade asphalt meeting the requirements for AR-1000 as specified in the uniform Pacific Coast Asphalt Specifications or it shall be AR-2000W or AR4000W conforming to Section 9-02.1(4).

Rubber Extender Oil (Method 1)

The extender oil shall be a resinous, aromatic hydrocarbon meeting the following requirements when tested as indicated:

Test	ASTM Test Method	Requirement
Viscosity, SSU at 100°F	D 88	2,500 min.
Flash Point, COC Open Cup	D 92	392 min.
Molecular Analysis:	D 2007	
Asphaltenes, percent by Weight		0.1 max.
Aromatics, percent by Weight		55.0 min.

Kerosene Type Diluent (Method 2)

The kerosene type diluent used shall be compatible with all materials used and shall have a flash point (ASTM D 92) of not less than 80°F. The initial boiling point shall be not less than 300°F with a total distillation (dry point) before 450°F (ASTM D 850). The Contractor is cautioned that a normal kerosene or range oil cut may not be suitable.

Ground Rubber Components

Method 1

The rubber shall meet the following physical and chemical requirements:

The granulated crumb rubber shall contain 22 ± 5 percent by weight natural rubber and shall meet the following requirements:

Sieve Size	Percent Passing
U.S. No. 8	100
U.S. No. 30	40-75
U.S. No. 50	10-35
U.S. No. 100	0-15

The sieves shall comply with AASHTO M 92 (ASTM E 11). All percentages are by weight.

The specific gravity of the rubber shall be 1.15 ±0.05 and shall be free of fabric, wire, or other contaminating materials, except that up to four percent of calcium carbonate may be included in the rubber to prevent particles from sticking together.

Method 2

The combined granulated rubber shall consist of a minimum of 80 percent by weight of vulcanized rubber produced by the

processing of tires. The rubber shall consist of one type or a blend of types as indicated below. The type or blend selected shall be based on laboratory testing by the asphalt/rubber supplier.

The granulated rubber types shall meet the following gradation:

Sieve Sizes		Percent Passing		
		Type 1	Type 2	Type 3
U.S. No. 8	(2.36mm)	100	---	---
U.S. No. 10	(2.00mm)	95-100	---	---
U.S. No. 16	(1.18mm)	---	100	100
U.S. No. 30	(0.600mm)	0-10	60-90	95-100
U.S. No. 50	(0.300mm)	0-5	0-20	30-60
U.S. No. 80	(0.180mm)	---	0-5	15-35
U.S. No. 200	(0.075mm)	---	---	0-10

The sieves shall comply with the requirements of AASHTO M 92 (ASTM E 11). All percentages are by weight.

The individual granulated rubber particles, regardless of diameter, shall not be greater in length than 0.250 inch for Type 1 or 0.125 inch for Type 2 and Type 3.

The combined granulated rubber shall have a specific gravity of 1.15 ±0.05 and shall be free of loose fabric, wire and other contaminants except that up to four percent (by weight of rubber) calcium carbonate or talc may be added to prevent rubber particles from sticking together. The rubber shall be sufficiently dry to be free flowing and not produce foaming when blended with the hot asphalt cement.

Fabric For Membrane Protection

The fabric shall be a polypropylene material having the following properties:

Tensile strength, either direction, min. 47 lbs. (WSDOT Test Method 916)

Weight, oz./sq. yd.	3-6
Width, inches	36 min.

Certification of Quality Assurance

The asphalt/rubber supplier shall furnish the Engineer the asphalt/rubber mix formulation which shall contain the following information, a minimum of seven days prior to starting placement of the membrane:

Asphalt Cement	Granulated Rubber
Grade of asphalt	Total rubber content, weight
Source of asphalt	Percent of asphalt/rubber mixture

Rubber type(s) and content of each type (if blend), weight, and percent of combined rubber:

Asphalt Modifier

Type of Modifier
Quantity of modifier, weight
Percent of asphalt cement

The Contractor shall submit certifications that the asphalt cement is compatible with the rubber. New certifications will be required if the asphalt cement is changed. The supplier shall furnish a certificate of compliance with these specifications for each shipment.

The granulated rubber shall be accepted by certification from the rubber supplier.

Preparation of Asphalt/Rubber

Both Methods

The method and equipment for combining the rubber and asphalt shall be so designed and accessible that the Engineer can readily determine the percentages, by weight, of each of the two materials being incorporated into the mixture.

Method 1

The rubber and modified asphalt shall be combined in a ratio of 20 ± 2 percent rubber to 80 ± 2 percent asphalt by weight and reacted for a sufficient time at 400° F ±25° F to produce a product with the following properties:

Viscosity at 400	1700 cps max.
Softening Point (R & B)	120° F min.
Flex Temperature (90° Bend Test)	20° F max.

In the event a delay occurs when the product is ready to be applied, the heat will be turned off until the job resumes.

Method 2

The percent of combined rubber shall be as indicated by the mixture design for specific project requirements by weight of total mixture, that is, by total weight of asphalt cement plus asphalt modified (if used) plus granulated rubber.

The temperature of the asphalt shall be between 350° and 425° F (177° to 218° C) at the addition of the vulcanized rubber. The asphalt and rubber shall be combined and mixed together in a blender unit then reacted in the distributor for a period of time as required by the Engineer and, based on laboratory testing, by the asphalt/rubber supplier. The temperature of the asphalt/rubber mixture shall be above 325° F (163° C) during the reaction period.

After the reaction between asphalt and rubber has occurred, the viscosity of the hot asphalt/rubber mixture may be adjusted for spraying or better wetting of the cover material by the addition of a diluent. The diluent shall comply with the requirements for kerosene type diluent (Method 2) and shall

not exceed 7 5 percent by volume of the hot asphalt rubber mixture

When a job delay occurs after full reaction, the asphalt rubber may be allowed to cool. The asphalt/rubber shall be reheated slowly just prior to application but not to a temperature exceeding 325° F (163° C). An additional quantity of diluent not exceeding three percent by volume of the hot asphalt rubber mixture may be added after reheating.

Construction of Membrane

Equipment

The equipment used for mixing and spreading the asphalt and rubber shall be a self-powered pressure distributor equipped with a separate power unit, a distributing pump capable of pumping the specified material at the specified rate through the distributor tips, and equipment for heating the bituminous material. The distribution bar on the distributor shall be fully circulating with nipples and valves so constructed that they are bathed in the circulating asphalt to the extent that the nipples will not become partially plugged with congealing asphalt. Distributor equipment shall include a tachometer, pressure gauges, volume measuring devices, and a thermometer for reading temperatures of tank contents. The spray bars on the distributor shall be controlled by a bootman riding at the rear of the distributor in such a position that operation of all sprays is in full view and accessible to him for controlling spread widths.

Application

The application rate of the hot asphalt/rubber mixture shall be 0.55 ± 0.10 gallon per square yard uniformly applied.

All transverse joints shall be made by placing building paper over the ends of the previous applications, and the joining application shall start on the building paper used. Once the application process has progressed beyond the paper used, the paper shall be removed and disposed of to the satisfaction of the Engineer. If the Contractor can demonstrate the ability to produce satisfactory transverse joints without paper, no paper will be required as long as the joints remain satisfactory. Any unsatisfactory joint shall be repaired at the Contractor's expense.

Membrane Protection

Prior to overlaying with asphalt concrete, the asphalt rubber mixture shall be covered with membrane protection fabric. The fabric shall be aligned and carefully rolled or broomed into the asphalt rubber mixture. Rolling or brooming the fabric into the asphalt should be accomplished in such a way that any air bubbles which form under the fabric will be removed. This can best be accomplished by brooming from the center of the fabric toward the outer edges. Initial alignment is very important since the fabric direction cannot be changed appreciably without causing wrinkles. If the alignment of the

fabric must be changed, the fabric shall be cut and realigned overlapping the previous material and proceeding as before. All joints shall be overlapped a minimum of 1 inch.

After the membrane waterproofing has been completed, the fabric shall be cut around the top inside of the frame of inlets and laid in a coating of asphalt binder.

Payment

The unit contract price per square yard for "Membrane Waterproofing (Deck Seal)" shall be full pay for performing the work as specified. The price paid shall include repairing any damaged or defective waterproofing membrane and damaged asphalt overlay.

Measurement

Membrane waterproofing will be measured by the square yard. The area to be measured will be the area of the bridge deck and curb which is satisfactorily sealed and accepted.

Payment

The unit contract price per square yard for "Membrane Waterproofing (Deck Seal)" shall be full pay for performing the work as specified. The price paid shall include repairing any damaged or defective waterproofing membrane and damaged asphalt overlay.

When old asphalt concrete is proposed for inclusion in the mix (either from materials obtained from this project or an existing stockpile), the Contractor shall submit his design for approval, including representative samples taken in the presence of the Engineer, and the approximate proportions of the various materials (old asphalt concrete, new aggregate, recycling agent, new paving asphalt) to be used. Upon tentative approval of approximate proportions proposed by the Contractor, the materials will be proportioned together for a job mix design. Approval of the mix design shall be based upon meeting the specification requirements of section 9-03.8(2) of the standard specifications for the specified Class ACP or as shown in these special provisions. In addition, for mix design approval, the blend of recovered paving asphalt plus recycling agent and additional paving asphalt shall meet the requirements for AR-4000W in accordance with section 9-02.1(4) of the standard specifications. The Contractor shall allow 15 working days for this approval and design once the material has been received at the Materials Laboratory. Additional time may be required if the proportions will not make an adequate design, as determined by the Engineer, or if the Contractor requests more than one rejuvenator or paving asphalt source approval. The Contractor is also advised that production of the asphalt concrete shall not commence until the job mix design has been established.

Asphalt concrete pavement Class *** B *** will be measured by the ton with no deduction being made for the weight of the paving asphalt or any other component of the mixture.

For the purpose of asphalt cement adjustment computations and paving asphalt revision quantities, if any, the new paving asphalt and recycling agent, if any, will be measured by the ton with the quantity determined from production data. The State reserves the right to make random checks of the gross and tare weights of the transport equipment at the time of delivery, as well as measuring the paving asphalt volume in the storage tank prior to and after the deposit from the transport vehicle.

The unit contract price(s) per ton for *** "Asphalt Conc. For Preleveling Cl. B Incl. Paving Asphalt" and "Asphalt Concrete Pavement Class B Incl. Paving Asphalt" *** shall be full compensation for furnishing all labor, equipment, tools and materials, including the cost involved with the furnishing of recycling agent, if any, and the furnishing of paving asphalt, necessary to produce and place the asphalt concrete pavement as specified.

RUBBER MODIFIED ASPHALT CONCRETE PAVEMENT

This work shall consist of placing Plusride Asphalt on those portions of the roadway shown in the plans.

SR 530
SKAGIT COUNTY LINE TO
DAHLGREN ROAD
85W025

Plusride Asphalt is a patented process licensed by:

All Seasons Surfacing Corporation
1017 NE 4th Street, Suite No. 1
Bellevue, WA 98004
(206) 454-3830

The Contractor shall arrange to have a technical representative of All Seasons Surfacing Corporation on the project while Plusride is being mixed or placed.

The rubber modified asphalt concrete shall consist of granulated rubber added to the aggregate phase of an asphalt concrete mixture.

The standard specifications for asphalt concrete shall be applicable except for the following:

Materials
The materials used in this rubber modified asphalt concrete shall have the following properties:

Asphalt
The asphalt shall be AR-4000W conforming to section 9-02.1(4) of the standard specifications. The percent of asphalt required in this mixture shall be between 7.5 and 9.5 percent.

Granulated Rubber
The granulated rubber and cord fibers shall be ground from rubber tires and shall meet the following gradation:

Sieve	Percent Passing by Weight
1/4	100
No. 4	76-100
No. 10	28-42
No. 20	16-24

Aggregate
The aggregate shall meet the general requirements of section 9-03.8(1) of the standard specifications and in addition shall meet the following specifications:

Sieve	Percent Passing by Weight
5/8	100
3/8	60-80
1/4	30-44
No. 10	20-32
No. 30	13-25
No. 200	8-12

Fracture 75% minimum
Sand Equivalent 45 minimum

Mineral filler is usually required to meet the minimum 200 material requirements.

Blending and Mixing

A representative sample of the total paving mixture, which meets the mix requirements, shall be produced prior to producing the mix for the project paving.

The construction requirements set forth in section 5-04.3(1)B of the standard specifications shall be supplemented by the following:

The amount of granulated rubber shall be determined by a method which uniformly feeds the mixer within ± 0.15 percent.

The components of the rubber modified asphalt concrete shall be combined in the following order and proportions:

1. Add mineral aggregate
2. Add rubber granules at 3.0 percent by weight of the total mix (60 lb/ton)
3. Mix for 15 seconds
4. Add the design asphalt content
5. Mix normal time

The construction requirements set forth in section 5-04.3(1)D of the standard specifications shall be supplemented by the following:

Granulated rubber introduced into the mixer shall be drawn from storage bins by a continuous mechanical feeder which will uniformly feed the mixer within ± 0.15 percent.

The plant shall be equipped with a heat shield or other means to prevent the open flame from coming in contact with the granulated rubber.

SR 530
SKAGIT COUNTY LINE TO
DAHLGREN ROAD
85W025

The first sentence of the third paragraph of section 5-04.3(8) of the standard specifications is deleted and the following substituted:

> The temperature of the mix at discharge shall be between 325% F. and 360% F. for batch plants or between 300% F. and 325% F. for drum mixer plants.

Mix Design

The Contractor shall submit to the Engineer a rubber modified asphalt concrete mix design that has been agreed to by the patent holder.

Job Mix Tolerances

All mix furnished for the project shall conform to the approved job-mix formula within the following ranges of tolerances:

Sieve Size	Percent Passing
3.8" or 1/4"	± 6
No. 10 or No. 30	± 4
No. 200	± 2
Gap Grading Percent	± 4
Asphalt Percent	± 0.4
Rubber Percent	± 0.15*

*Not determinable by extraction testing.

The plant shall be equipped to feed mineral filler into the mix within an accuracy of 0.5 percent.

Spreading and Finishing

Section 5-04.3(9) of the standard specifications is deleted and replaced with the following:

> The mixture shall be laid upon an approved surface, spread and struck off to the grade and elevation established. Special care must be taken to obtain a good joint as it may be difficult to hand rake this material. Asphalt pavers complying with section 5-04.3(3) shall be used to distribute the mixture.
>
> A CSS-1 tack coat shall be applied and shall consist of 0.06-0.08 gallon/square yard of retained asphalt. The spraying temperature shall be from 70% to 140% F.
>
> On areas where irregularities or unavoidable obstacles make the use of mechanical spreading equipment impractical, the paving may be done with other equipment or by hand.

Compaction

Asphalt rollers and compaction procedures shall conform with the standard requirements and supplemented with the following:

Breakdown compaction should begin immediately behind the paving machine. However, some delay may be required to prevent roller pickup. The roller drums must be kept well watered and a wetting agent may be necessary to decrease the occurrence of roller pickup.

Breakdown compaction shall be accomplished using a 10-12 ton vibratory or static steel roller. The roller must apply a minimum force of 250 pounds per linear inch of drum width to the pavement surface.

An 8-10 ton tandem steel roller shall be used for finish rolling. Finish rolling of the mat shall continue until the temperature of the mat has dropped below 140%F or until elastic movement under the roller is no longer observed.

The proper rolling procedure shall be established with a control strip to determine equipment and number of coverages necessary to obtain the target density. The target density, as a percentage of maximum theoretical density, shall be 95% to 98% (2% to 5% air voids).

Measurement

Section 5-04.4 of the standard specifications is supplemented with the following:

Measurement of the rubber modified asphalt concrete will be by the ton and will include the granulated rubber, the asphalt cement and any other component of the mix.

Payment

Section 5-04.5 of the standard specifications is supplemented with the following:

The unit contract price per ton for "Rubber Modified Asphalt Concrete Pavement" shall be full compensation for furnishing all labor, equipment, materials, supplies, and royalties (if any) required in the construction of this material as specified.

POLYESTER MODIFIED ASPHALT CONCRETE PAVEMENT

This work shall consist of mixing, placing and compacting asphalt concrete that has had polyester fibers introduced at the time of mixing.

SR 530
SKAGIT COUNTY LINE TO
DAHLGREN ROAD
85W025

RUBBERIZED ASPHALT CONCRETE PAVEMENT CLASS D

Description

As shown in the Plans, or as designated by the Engineer, the Contractor shall construct rubberized asphalt concrete pavement Class D.

Materials

Section 9-02 shall apply except for the following changes:

Asphalt-Rubber Binder

The asphalt-rubber binder shall be a uniform reacted mixture of compatible paving grade asphalt cement, granulated reclaimed vulcanized rubber, and if required by the mixture design, liquid anti-stripping agent. The asphalt-rubber binder shall meet the following physical parameters when reacted at 350°F +.- 10°F for 60 minutes:

Parameter	Test Method	Requirement
Viscosity, at 350°F cp.	Haake	1500 - 4000
Cone Penetration. 77°F min.	ASTM D1191	20
Softening Point, F min.	ASTM D36	125
Resilience, 77°F min.	ASTM D3407	15%

Asphalt Cement

The asphalt cement for the asphalt-rubber binder shall be AR2000W and shall comply with the requirements of Section 9-02.1(4).

Granulated Reclaimed Vulcanized Rubber

The rubber used shall be produced primarily from the processing of automobile and truck tires. The rubber shall be produced by ambient temperature grinding processes only. The gradation of rubber when tested in accordance with ASTM C136, using approximately 50 grams, shall meet the following requirements:

Sieve Sizes	Percent Passing Open Graded
#10	100
#16	75 - 100
#30	25 - 60
#80	0 - 20
#200	0 - 5

The use of rubber of multiple sources is acceptable provided that the overall blend of rubber meets the gradation requirements.

The granulated rubber shall have a specific gravity of 1.15 ± 0.05 and shall be free of loose fabric wire and other contaminants except that up to 4% (by weight of rubber) calcium carbonate or talc may be added to prevent rubber particles from sticking together. The rubber shall be sufficiently dry so as to be free flowing and not produce a foaming problem when blended with the hot asphalt cement.

The length of the individual rubber particles shall not exceed 3 16 inch (5 mm).

The granulated rubber shall be accepted by certification from the rubber supplier.

Anti-Stripping Agent

If required by the job mix formula to produce appropriate water resistance, an anti-stripping agent meeting the requirements of Section 9-02.4 shall be incorporated into the asphalt-rubber material at the percentage required by the job mix formula. It shall be added to the asphalt cement prior to blending with the granulated rubber.

Asphalt-Rubber Binder Mixture Design

The mixture design shall be performed by the asphalt-rubber supplier. The proportion of granulated rubber shall be between 16% - 20% by weight of the total mixture.

The asphalt-rubber supplier shall supply to the engineer a mix formulation at least 10 days before pavement construction is scheduled to begin. The mix formulation shall consist of the following information:

Asphalt Cement

Source of Asphalt Cement
Grade of Asphalt Cement
Percentage of Asphalt Cement by total weight of the asphalt-rubber mixture.

Granulated Reclaimed Rubber

Source of Granulated Rubber
Grade of Granulated Rubber
Percentage of Granulated Rubber by total weight of the asphalt-rubber mixture.

If granulated rubber from more than one source is utilized the above information will be required for each granulated rubber used.

Anti-Strip Agent

Source of Anti-Strip
Grade of Anti-Strip
Percentage of Anti-Strip by weight of the asphalt.

Asphalt-Rubber Mixing and Production Equipment

All equipment utilized in production and proportioning of the asphalt-rubber binder shall be described as follows:

An asphalt heating tank with a hot oil heat transfer system or retort heating system capable of heating asphalt cement to the necessary temperature for blending with the granulated rubber. This unit shall be capable of heating a minimum of 3,000 gallons of asphalt cement.

An asphalt-rubber mechanical blender with a two stage continuous mixing process capable of producing a homogenous mixture of asphalt cement and granulated rubber, at the mix design specified ratios, as designated by the Engineer. This unit shall be equipped with a