

**SUBSECTION 4.18
ASPHALTS, OILS, AND EMULSIONS**

- I. **Description:** Provide asphalt cements, cutback and emulsified asphalts, performance-graded asphalt binders, and other miscellaneous asphalt materials as specified on the plans.

- II. **Materials:** Provide asphalt materials that meet the stated requirements when tested in accordance with the referenced Department, AASHTO, and ASTM test methods. Refer to the Material Inspection Guide (maintained by the TxDOT’s Construction Division), Section 11. “Asphalt Inspection, Quality Control and Quality Assurance,” for sampling and testing requirements.
 - A. **ACRONYMS** used in this Item are defined in Table 1.

**Table 1
Acronyms**

Acronym	Definition
Test Procedure Designations	
Tex	Texas Department
T or R	AASHTO
D	ASTM
Polymer Modifier Designations	
P	polymer-modified
SBR or L	styrene-butadiene rubber (latex)
SBS	styrene-butadiene-styrene block co-polymer
TR	tire rubber (from ambient temperature grinding of truck and passenger tires)
AC	asphalt cement
AE	asphalt emulsion
AE-P	asphalt emulsion prime
A-R	asphalt-rubber
C	cationic
EAP&T	emulsified asphalt prime and tack
H-suffix	harder residue (lower penetration)
HF	high float
MC	medium-curing
MS	medium-setting
PCE	prime, cure, and erosion control
PG	performance grade
RC	rapid-curing
RS	rapid-setting
S-suffix	stockpile usage
SCM	special cutback material
SS	slow-setting

- B. **Asphalt Cement:** Asphalt cement must be homogeneous, water-free, and nonfoaming when heated to 347°F, and must meet Table 2 requirements.

**Table 2
Asphalt Cement**

Property	Test Procedure	AC-1.5		AC-3		AC-5		AC-10		AC-20	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity 140°F, poise 275°F, poise	T 202	100	200	250	350	400	600	800	1200	1600	2400
Penetration, 77°F, 100g, 5 sec.	T 49	250	-	210	-	135	-	85	-	55	-
Flash point, C.O.C., °F	T 48	425	-	425	-	425	-	450	-	450	-
Solubility in trichloroethylen , %	T 44	99.0	-	99.0	-	99.0	-	99.0	-	99.0	-
Spot test	Tex-509-C	Negative									
Tests on residue from Thin-Film Oven Test:	T 179	-	-	-	-	-	-	-	-	-	-
Viscosity, 140°F, poise	T 202	-	450	-	900	-	1500	-	3000	-	6000
5 cm/min., cm	T-51	100	-	100	-	100	-	100	-	70	-

1. If AC-0.6 or AC-1.5 ductility at 77° F is less than 100 cm, material is acceptable if ductility at 60°F is more than 100cm.

- C. **Polymer-Modified Asphalt Cement:** Polymer-modified asphalt cement must be smooth and homogeneous, and comply with the requirements of Table 3. If requested, supply samples of the base asphalt cement and polymer additives.

**Table 3
Polymer-Modified Asphalt Cement**

Property	Test Procedure	Polymer-Modified Viscosity Grade							
		AC-5 w/2% SBR		AC-10 w/2% SBR		AC-15P		AC-20-5TR	
		Min	Max	Min	Max	Min	Max	Min	Max
Polymer		SBR		SBR		SBS		TR	
Polymer content, % (solids basis)	Tex-533-C	2.0	-	2.0	-	3.0	-	5.0	-
Dynamic shear, G*/sin δ, 64°C, 10 rad/s, kPa	T 315	-	-	-	-	-	-	1.0	-
Viscosity 140°F, poise 275°F, poise	T 202 T 202	700	-	1,300	-	1,500	-	2,000	-
Penetration, 77°F, 100 g, 5 sec.	T 49	120	-	80	-	100	150	75	115
Ductility, 5cm/min., 39.2°F, cm	T 51	70	-	60	-	-	-	-	-
Elastic recovery, 50°F, %	Tex-539-C	-	-	-	-	55	-	55	-
Softening point, °F	T 53	-	-	-	-	-	-	120	-
Polymer separation, 48 hr.	Tex-540-C	None		None		None		None	
Flash point, C.O.C., °F	T 48	425	-	425	-	425	-	425	-
Tests on residue from Thin-Film Oven Test: Retained penetration ratio, 77°F	T 179 T 49	-	-	-	-	0.60	1.00	0.60	1.00
Tests on residue from RTFOT aging and pressure aging: Creep stiffness S, -18°C, MPa m-value, -18°C	Tex-541-C and R 28 T 313	-	-	-	-	-	-	-	300
		-	-	-	-	-	-	0.300	-

- D. **Cutback Asphalt:** Cutback asphalt must meet the requirements of Tables 4, 5, and 6 for the specified type and grade. If requested, supply samples of the base asphalt cement and polymer additives.

Table 4
Rapid-Curing Cutback Asphalt

Property	Test Procedure	Type-Grade					
		RC-250		RC-800		RC-3000	
		Min	Max	Min	Max	Min	Max
Kinematic viscosity, 140°F, cSt	T 201	250	400	800	1,600	3,000	6,000
Water, %	T 55	—	0.2	—	0.2	—	0.2
Flash point, T.O.C., °F	T 79	80	—	80	—	80	—
Distillation test:	T 78						
Distillate, percentage by volume of total distillate to 680°F							
to 437°F		40	75	35	70	20	55
to 500°F		65	90	55	85	45	75
to 600°F		85	—	80	—	70	—
Residue from distillation, volume %		70	—	75	—	82	—
Tests on distillation residue:							
Penetration, 100 g, 5 sec., 77°F	T 49	80	120	80	120	80	120
Ductility, 5 cm/min., 77°F, cm	T 51	100	—	100	—	100	—
Solubility in trichloroethylene, %	T 44	99.0	—	99.0	—	99.0	—
Spot test	Tex-509-C	Neg.		Neg.		Neg.	

Table 5
Medium-Curing Cutback Asphalt

Property	Test Procedure	Type-Grade							
		MC-30		MC-250		MC-800		MC-3000	
		Min	Max	Min	Max	Min	Max	Min	Max
Kinematic viscosity, 140°F, cSt	T 201	30	60	250	500	800	1,600	3,000	6,000
Water, %	T 55	—	0.2	—	0.2	—	0.2	—	0.2
Flash point, T.O.C., °F	T 79	100	—	150	—	150	—	150	—
Distillation test:	T 78								
Distillate, percentage by volume of total distillate to 680°F									
to 437°F		—	25	—	10	—	—	—	—
to 500°F		40	70	15	55	—	35	—	15
to 600°F		75	93	60	87	45	80	15	75
Residue from distillation, volume %		50	—	67	—	75	—	80	—
Tests on distillation residue:									
Penetration, 100 g, 5 sec., 77°F	T 49	120	250	120	250	120	250	120	250
Ductility, 5 cm/min., 77°F, cm ¹	T 51	100	—	100	—	100	—	100	—
Solubility in trichloroethylene, %	T 44	99.0	—	99.0	—	99.0	—	99.0	—
Spot test	Tex-509-C	Neg.		Neg.		Neg.		Neg.	

1. If the penetration of residue is more than 200 and the ductility at 77°F is less than 100 cm, the material is acceptable if its ductility at 60°F is more than 100 cm.

**Table 6
Special-Use Cutback Asphalt**

Property	Test Procedure	Type-Grade					
		MC-2400L		SCM I		SCM II	
		Min	Max	Min	Max	Min	Max
Kinematic viscosity, 140°F, cSt	T 201	2,400	4,800	500	1,000	1,000	2,000
Water, %	T 55	—	0.2	—	0.2	—	0.2
Flash point, T.O.C., °F	T 79	150	—	175	—	175	—
Distillation test: Distillate, percentage by volume of total distillate to 680°F to 437°F to 500°F to 600°F	T 78	—	—	—	—	—	—
Residue from distillation, volume %		35	80	20	60	15	50
Tests on distillation residue: Polymer		SBR	—	—	—	—	—
Polymer content, % (solids basis)	Tex-533-C	2.0	—	—	—	—	—
Penetration, 100 g, 5 sec., 77°F	T 49	150	300	180	—	180	—
Ductility, 5 cm/min., 39.2°F, cm	T 51	50	—	—	—	—	—
Solubility in trichloroethylene, %	T 44	99.0	—	99.0	—	99.0	—

E. **Emulsified Asphalt:** Emulsified asphalt must be homogeneous, not separate after thorough mixing, and meet the requirements for the specified type and grade in Tables 7, 8, 9, and 10.

Table 7 Emulsified Asphalt

Property	Test Procedure	Type-Grade									
		Rapid-Setting		Medium-Setting			Slow-Setting				
		HFRS-2		MS-2		AES-300	SS-1		SS-1H		
		Min	Max	Min	Max	Min	Max	Min	Max		
Viscosity, Saybolt Furol 77°F, sec. 122°F, sec.	T 72	—	—	—	—	75	400	20	100	20	100
Sieve test, %	T 59	—	0.1	—	0.1	—	0.1	—	0.1	—	0.1
Miscibility	T 59	—	—	—	—	—	—	Pass	—	Pass	—
Cement mixing, %	T 59	—	—	—	—	—	—	—	2.0	—	2.0
Coating ability and water resistance: dry aggregate/after spray wet aggregate/after spray	T 59	—	—	—	—	Good/Fair Fair/Fair	—	—	—	—	—
Demulsibility, 35 ml of 0.02 N CaCl ₂ , %	T 59	50	—	—	30	—	—	—	—	—	—
Storage stability, 1 day, %	T 59	—	1	—	1	—	1	—	1	—	1
Freezing test, 3 cycles ¹	T 59	—	—	Pass	—	—	—	Pass	—	Pass	—
Distillation test: Residue by distillation, % by wt. Oil distillate, % by volume of emulsion	T 59	65	—	65	—	65	—	60	—	60	—
Tests on residue from distillation: Penetration, 77°F, 100 g, 5 sec.	T 49	100	140	120	160	300	—	120	160	70	100
Solubility in trichloroethylene, %	T 44	97.5	—	97.5	—	97.5	—	97.5	—	97.5	—
Ductility, 77°F, 5 cm/min., cm	T 51	100	—	100	—	—	—	100	—	80	—
Float test, 140°F, sec.	T 50	1,200	—	—	—	1,200	—	—	—	—	—

1. Applies only when the ODR designates material for winter use.

Table 8
Cationic Emulsified Asphalt

Table 8
Cationic Emulsified Asphalt

Property	Test Procedure	Type-Grade											
		Rapid-Setting		Medium-Setting		Slow-Setting							
		CRS-2	CRS-2H	CMS-2	CMS-2S	CSS-1	CSS-1H						
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
Viscosity, Saybolt Furol 77°F, sec.	T 72	-	-	-	-	-	-	-	-	20	100	20	100
122°F, sec.		150	400	150	400	100	300	100	300	-	-	-	-
Sieve test, %	T 59	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1
Cement mixing, %	T 59	-	-	-	-	-	-	-	-	-	2.0	-	2.0
Coating ability and water resistance: dry aggregate/after spray	T 59	-	-	-	-	Good/Fair	Good/Fair	-	-	-	-	-	-
wet aggregate/after spray		-	-	-	-	Fair/Fair	Fair/Fair	-	-	-	-	-	-
Demulsibility, 35 ml of 0.8% sodium dioctyl sulfosuccinate, %	T 59	70	-	70	-	-	-	-	-	-	-	-	-
Storage stability, 1 day, %	T 59	-	1	-	1	-	1	-	1	-	1	-	1
Particle charge	T 59	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive
Distillation test:	T 59												
Residue by distillation, % by wt.		65	-	65	-	65	-	65	-	60	-	60	-
Oil distillate, % by volume of emulsion		-	0.5	-	0.5	-	0.5	-	0.5	-	0.5	-	0.5
Tests on residue from distillation:													
Penetration, 77°F, 100 g, 5 sec.	T 49	120	160	70	110	120	200	300	-	120	160	70	110
Solubility in trichloroethylene, %	T 44	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-
Ductility, 77°F, 5 cm/min., cm	T 51	100	-	80	-	100	-	100	-	100	-	80	-

Table 9
Polymer-Modified Emulsified Asphalt

Property	Test Procedure	Type-Grade											
		Rapid-Setting		HFRS-2P		Medium-Setting		AES-300P		Slow-Setting		SS-1P	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77°F, sec.	T 72	-	-	-	-	75	400	75	400	75	400	30	100
122°F, sec.	T 59	50	200	150	400	-	-	-	-	-	-	-	-
Sieve test, %	T 59	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1
Miscibility	T 59	-	-	-	-	-	-	-	-	-	-	-	Pass
Coating ability and water resistance: dry aggregate/after spray	T 59	-	-	-	-	Good/Fair	Good/Fair	Good/Fair	Good/Fair	Good/Fair	Good/Fair	-	-
wet aggregate/after spray	T 59	60	-	50	-	-	-	-	-	-	-	-	-
Demulsibility, 35 ml of 0.02 N CaCl ₂ , %	T 59	-	1	-	1	-	1	-	1	-	1	-	1
Storage stability, 1 day, %	T 59	-	80	-	-	-	-	-	-	-	-	-	-
Breaking index, g	Tex-542-C	-	-	-	-	-	-	-	-	-	-	-	-
Distillation test: ¹	T 59	65	-	65	-	65	-	65	-	65	-	60	-
Residue by distillation, % by wt.		-	3	-	0.5	-	3	-	5	-	7	-	0.5
Oil distillate, % by volume of emulsion		-	-	-	-	-	-	-	-	-	-	-	-
Tests on residue from distillation:		-	-	-	-	-	-	-	-	-	-	-	-
Polymer content, wt. % (solids basis)	Tex-333-C	-	-	3.0	-	-	-	-	-	-	-	3.0	-
Penetration, 77°F, 100 g, 5 sec.	T 49	225	300	90	140	150	300	300	300	300	300	100	140
Solubility in trichloroethylene, %	T 44	97.0	-	97.0	-	97.0	-	97.0	-	97.0	-	97.0	-
Viscosity, 140°F, poise	T 202	-	-	1,500	-	-	-	-	-	-	-	1,300	-
Float test, 140°F, sec.	T 50	-	-	1,200	-	1,200	-	1,200	-	1,200	-	50	-
Ductility ² , 39.2°F, 5 cm/min., cm	T 51	-	-	50	-	-	-	-	-	-	-	50	-
Elastic recovery ² , 50°F, %	Tex-339-C	55	-	55	-	-	-	-	-	-	-	-	-
Tests on RTFO curing of distillation residue	Tex-541-C	-	-	-	-	-	-	-	-	-	-	-	-
Elastic recovery, 50°F, %	Tex-539-C	-	-	-	-	50	-	50	-	50	-	30	-

1. Exception to T 59: Bring the temperature on the lower thermometer slowly to 350°F ± 10°F. Maintain at this temperature for 20 min. Complete total distillation in 60 ± 5 min. from the first application of heat.

2. HFRS-2P must meet one of either the ductility or elastic recovery requirements.

Table 10
Polymer-Modified Cationic Emulsified Asphalt

Property	Test Procedure	Type-Grade					
		Rapid-Setting				Slow-Setting	
		CRS-1P		CRS-2P		CSS-1P	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77°F, sec. 122°F, sec.	T 72	—	—	—	—	20	100
Sieve test, %	T 59	—	0.1	—	0.1	—	0.1
Demulsibility, 35 ml of 0.8% sodium dioctyl sulfosuccinate, %	T 59	60	—	70	—	—	—
Storage stability, 1 day, %	T 59	—	1	—	1	—	1
Breaking index, g	Tex-542-C	—	80	—	—	—	—
Particle charge	T 59	Positive		Positive		Positive	
Distillation test: ¹	T 59						
Residue by distillation, % by weight		65	—	65	—	62	—
Oil distillate, % by volume of emulsion		—	3	—	0.5	—	0.5
Tests on residue from distillation:							
Polymer content, wt. % (solids basis)	Tex-533-C	—	—	3.0	—	3.0	—
Penetration, 77°F, 100 g, 5 sec.	T 49	225	300	90	150	55	90
Viscosity, 140°F, poise	T 202	—	—	1,300	—	—	—
Solubility in trichloroethylene, %	T 44	97.0	—	97.0	—	97.0	—
Softening point, °F	T 53	—	—	—	—	135	—
Ductility, 77°F, 5 cm/min., cm	T 51	—	—	—	—	70	—
Ductility ² , 39.2°F, 5 cm/min., cm	T 51	—	—	50	—	—	—
Elastic recovery ² , 50°F, %	Tex-539-C	45	—	55	—	—	—

1. Exception to T 59: Bring the temperature on the lower thermometer slowly to 350°F ±0°F. Maintain at this temperature for 20 min. Complete total distillation in 60 ±5 min. from the first application of heat.

2. CRS-2P must meet one of either the ductility or elastic recovery requirements.

- F. **Specialty Emulsions:** Specialty emulsions may be either asphalt-based or resin-based and must meet the requirements of Table 11.

**Table 11
Specialty Emulsions**

Property	Test Procedure	Type-Grade					
		Medium-Setting				Slow-Setting	
		AE-P		EAP&T		PCE ¹	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77°F, sec. 122°F, sec.	T 72	–	–	–	–	10	100
Sieve test, %	T 59	–	0.1	–	0.1	–	0.1
Miscibility ²	T 59	–	–	Pass	–	Pass	–
Demulsibility, 35 ml of 0.10 N CaCl ₂ , %	T 59	–	70	–	–	–	–
Storage stability, 1 day, %	T 59	–	1	–	1	–	–
Particle size ⁵ , % by volume < 2.5 μ m	Tex-238-F ³	–	–	90	–	90	–
Asphalt emulsion distillation to 500°F followed by Cutback asphalt distillation of residue to 680°F: Residue after both distillations, % by wt. Total oil distillate from both distillations, % by volume of emulsion	T 59 & T 78	40	–	–	–	–	–
Residue by distillation, % by wt.	T 59	–	–	60	–	–	–
Residue by evaporation ⁴ , % by wt.	T 59	–	–	–	–	60	–
Tests on residue after all distillation(s):							
Viscosity, 140°F, poise	T 202	–	–	800	–	–	–
Kinematic viscosity ⁵ , 140°F, cSt	T 201	–	–	–	–	100	350
Flash point C.O.C., °F	T 48	–	–	–	–	400	–
Solubility in trichloroethylene, %	T 44	97.5	–	–	–	–	–
Float test, 122°F, sec.	T 50	50	200	–	–	–	–

1. Supply with each shipment of PCE:

- a copy of a lab report from an approved analytical lab, signed by a lab official, indicating the PCE formulation does not meet any characteristics of a Resource Conservation Recovery Act (RCRA) hazardous waste;
- a certification from the producer that the formulation supplied does not differ from the one tested and that no listed RCRA hazardous wastes or PCBs have been mixed with the product; and
- a Material Safety Data Sheet.

2. Exception to T 59: In dilution, use 350 ml of distilled or deionized water and a 1,000-ml beaker.

3. Use Tex-238-F, beginning at "Particle Size Analysis by Laser Diffraction," with distilled or deionized water as a medium and no dispersant, or use another approved method.

4. Exception to T 59: Leave sample in the oven until foaming ceases, then cool and weigh.

5. PCE must meet either the kinematic viscosity requirement or the particle size requirement.

- G. **Recycling Agent:** Recycling agent and emulsified recycling agent must meet the requirements in Table 12. Additionally, recycling agent and residue from emulsified recycling agent, when added in the specified proportions to the recycled asphalt, must meet the properties specified on the plans.

**Table 12
Recycling Agent and Emulsified Recycling Agent**

Property	Test Procedure	Recycling Agent		Emulsified Recycling Agent	
		Min	Max	Min	Max
Viscosity, Saybolt Furol, 77°F, sec.	T 72	–	–	15	100
Sieve test, %	T 59	–	–	–	0.1
Miscibility ¹	T 59	–	–	No coagulation	
Residue by evaporation ² , % by wt.	T 59	–	–	60	–
Tests on recycling agent or residue from evaporation:					
Flash point, C.O.C., °F	T 48	400	–	400	–
Kinematic viscosity,	T 201				
140°F, cSt		75	200	75	200
275°F, cSt		–	10.0	–	10.0

1. Exception to T 59: Use 0.02 N CaCl₂ solution in place of water.

2. Exception to T 59: Maintain sample at 300°F until foaming ceases, then cool and weigh.

- H. **Crumb Rubber Modifier:** Crumb rubber modifier (CRM) consists of automobile and truck tires processed by ambient temperature grinding. CRM must be:

1. free from contaminants including fabric, metal, and mineral and other nonrubber substances;
2. free-flowing; and
3. nonfoaming when added to hot asphalt binder.
4. When tested in accordance with Tex-200-F, Part I, using a 50-g sample, the rubber gradation must meet the requirements of the grades in Table 13.

Table 13
CRM Gradations

Sieve Size (% Passing)	Grade A		Grade B		Grade C		Grade D	Grade E
	Min	Max	Min	Max	Min	Max		
#8	100	–	–	–	–	–	As shown on the plans	As approved
#10	95	100	100	–	–	–		
#16	–	–	70	100	100	–		
#30	–	–	25	60	90	100		
#40	–	–	–	–	45	100		
#50	0	10	–	–	–	–		
#200	–	–	0	5	–	–		

I. Crack Sealer: Polymer modified asphalt-emulsion crack sealer must meet the requirements of Table 14. Rubber-asphalt crack sealer must meet the requirements of Table 15.

Table 14
Polymer-Modified Asphalt Emulsion Crack Sealer

Property	Test Procedure	Min	Max
Rotational viscosity, 77°F, cP	D 2196, Method A	10,000	25,000
Sieve test, %	T 59	–	0.1
Storage stability, 1 day, %	T 59	–	1
Evaporation Residue by evaporation, % by wt.	Tex-543-C	65	–
Tests on residue from evaporation: Penetration, 77°F, 100 g, 5 sec.	T 49	35	75
Softening point, °F	T 53	140	–
Ductility, 39.2°F, 5 cm/min., cm	T 51	100	–

Table 15
Rubber-Asphalt Crack Sealer

Property	Test Procedure	Class A		Class B	
		Min	Max	Min	Max
CRM content, Grade A or B, % by wt.	Tex-544-C	22	26	–	–
CRM content, Grade B, % by wt.	Tex-544-C	–	–	13	17
Virgin rubber content ¹ , % by wt.		–	–	2	–
Flash point ² , COC, °F	T 48	400	–	400	–
Penetration ³ , 77°F, 150 g, 5 sec.	T 49	30	50	30	50
Penetration ³ , 32°F, 200 g, 60 sec.	T 49	12	–	12	–
Softening point, °F	T 53	–	–	170	–
Bond ⁴	D5329	–	–	–	Pass

1. Provide certification that the min. % virgin rubber was added.
2. Before passing the test flame over the cup, agitate the sealing compound with a 3/8- to 1/2-in. (9.5- to 12.7-mm) wide, square-end metal spatula in a manner so as to bring the material on the bottom of the cup to the surface, i.e., turn the material over. Start at one side of the thermometer, move around to the other, and then return to the starting point using 8 to 10 rapid circular strokes. Accomplish agitation in 3 to 4 sec. Pass the test flame over the cup immediately after stirring is completed.
3. Exception to T 49: Substitute the cone specified in ASTM D 217 for the penetration needle.
4. No crack in the crack sealing materials or break in the bond between the sealer and the mortar blocks over 1/4 in. deep for any specimen after completion of the test.

J. Asphalt-Rubber Binders: Asphalt-rubber (A-R) binders are mixtures of asphalt binder and CRM, which have been reacted at elevated temperatures. The A-R binders meet D 6114 and contain a minimum of 15% CRM by weight. Types I or II, containing CRM Grade C, are used for hot mixed aggregate mixtures. Types II or III, containing CRM Grade B, are used for surface treatment binder. Table 16 describes required binder properties.

Table 16
A-R Binders

Property	Test Procedure	Binder Type					
		Type I		Type II		Type III	
		Min	Max	Min	Max	Min	Max
Apparent viscosity, 347°F, cP	D 2196, Method A	1,500	5,000	1,500	5,000	1,500	5,000
Penetration, 77°F, 100 g, 5 sec.	T 49	25	75	25	75	50	100
Penetration, 39.2°F, 200 g, 60 sec.	T 49	10	—	15	—	25	—
Softening point, °F	T 53	135	—	130	—	125	—
Resilience, 77°F, %	D 5329	25	—	20	—	10	—
Flash point, C.O.C., °F	T 48	450	—	450	—	450	—
Tests on residue from Thin-Film Oven Test:	T 179						
Retained penetration ratio, 39.2°F, 200 g, 60 sec., % of original	T 49	75	—	75	—	75	—

K. Performance-Graded Binders: PG binders must be smooth and homogeneous, show no separation when tested in accordance with Tex-540-C, and meet Table 17 requirements. Separation testing is not required if:

1. a modifier is introduced separately at the mix plant either by injection in the asphalt line or mixer,
2. the binder is blended on site in continuously agitated tanks, or
3. binder acceptance is based on field samples taken from an in-line sampling port at the hot mix plant after the addition of modifiers.

**Table 17
Performance-Graded Binders**

Property and Test Method	Performance Grade																	
	PG 58			PG 64			PG 70			PG 76			PG 82					
	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28
Average 7-day max pavement design temperature, °C ¹	< 58			< 64			< 70			< 76			< 82					
Min pavement design temperature, °C ¹	>-22	>-28	>-34	>-16	>-22	>-28	>-34	>-16	>-22	>-28	>-34	>-16	>-22	>-28	>-34	>-16	>-22	>-28
ORIGINAL BINDER																		
Flash point, T 48, Min, °C	230																	
Viscosity, T 316: ^{2,3} Max, 3.0 Pa.s, test temperature, °C	135																	
Dynamic shear, T 315: ⁴ G ² /sin(□), Min, 1.00 kPa Test temperature @ 10 rad/sec., °C	58			64			70			76			82					
Elastic recovery, D 6084, 50°F, % Min	-	-	30	-	-	30	50	-	30	50	60	30	50	60	70	50	60	70
ROLLING THIN-FILM OVEN (Tex-541-C)																		
Mass loss, Tex-541-C, Max, %	1.0																	
Dynamic shear, T 315: G ² /sin(□), Min, 2.20 kPa Test temperature @ 10 rad/sec., °C	58			64			70			76			82					
PRESSURE AGING VESSEL (PAV) RESIDUE (R 28)																		
PAV aging temperature, °C	100																	
Dynamic shear, T 315: G ² /sin(□), Max, 5000 kPa Test temperature @ 10 rad/sec., °C	25	22	19	28	25	22	19	28	25	22	19	28	25	22	19	28	25	22

**Table 17
Continued
Performance-Graded Binders**

Property and Test Method	Performance Grade																	
	PG 58			PG 64			PG 70			PG 76			PG 82					
	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28
Average 7-day max pavement design temperature, °C ¹	< 58			< 64			< 70			< 76			< 82					
Min pavement design temperature, °C ¹	>-22	>-28	>-34	>-16	>-22	>-28	>-34	>-16	>-22	>-28	>-34	>-16	>-22	>-28	>-34	>-16	>-22	>-28
Creep stiffness, T 313:5, 6 S, max, 300 MPa, m-value, min, 0.300 Test temperature @ 60 sec., °C	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18
Direct tension, T 314:6 Failure strain, min, 1.0% Test temperature @ 1.0 mm/min., °C	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18

1. Pavement temperatures are estimated from air temperatures using an algorithm contained in a Department-supplied computer program, may be provided by the Department, or by following the procedures outlined in AASHTO MP 2 and PP 28.
 2. This requirement may be waived at the Department's discretion if the supplier warrants that the asphalt binder can be adequately pumped, mixed, and compacted at temperatures that meet all applicable safety, environmental, and constructability requirements. At test temperatures where the binder is a Newtonian fluid, any suitable standard means of viscosity measurement may be used, including capillary (T 201 or T 202) or rotational viscometry (T 316).
 3. Viscosity at 135°C is an indicator of mixing and compaction temperatures that can be expected in the lab and field. High values may indicate high mixing and compaction temperatures. Additionally, significant variation can occur from batch to batch. Contractors should be aware that variation could significantly impact their mixing and compaction operations. Contractors are therefore responsible for addressing any constructability issues that may arise.
 4. For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be substituted for dynamic shear measurements of G²/sin(□) at test temperatures where the asphalt is a Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary (T 201 or T 202) or rotational viscometry (T 316).
 5. Silicone beam molds, as described in AASHTO TP 1-93, are acceptable for use.
 6. If creep stiffness is below 300 MPa, direct tension test is not required. If creep stiffness is between 300 and 600 MPa, the direct tension failure strain requirement can be used instead of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.

L. **EQUIPMENT:** The contractor will provide the required or necessary equipment in accordance with Item 4.20, "Equipment for Asphalt Concrete Pavement" and Item 4.21 Weighing and Measuring Equipment."

III. CONSTRUCTION:

A. **Seasonal Restrictions:** The "open" season for applying asphaltic materials and mixtures for the listed items shall be as follows, unless authorized otherwise in writing by the ODR.

Items
4.11, 4.12,

Open season
From April 15th through September 30th

4.06, 4.13, 4.17, 4.24

From April 15th through October 31st

- B. **Typical Material Use:** Table 18 shows typical materials used for specific applications. These are typical uses only. Circumstances may require use of other material.

Table 18
Typical Material Use

Material Application	Typically Used Materials
Hot-mixed, hot-laid asphalt mixtures	PG binders, A-R binders Types I and II
Surface treatment	AC-5, AC-10, AC-5 w/2% SBR, AC-10 w/2% SBR, AC-15P, AC-20-5TR, HFRS-2, MS-2, CRS-2, CRS-2H, HFRS-2P, CRS-2P, A-R binders Types II and III
Surface treatment (cool weather)	RS-1P, CRS-1P, RC-250, RC-800, RC-3000, MC-250, MC-800, MC-3000, MC-2400L
Precoating	AC-5, AC-10, PG 64-22, SS-1, SS-1H, CSS-1, CSS-1H
Tack coat	PG Binders, SS-1H, CSS-1H, EAP&T
Fog seal	SS-1, SS-1H, CSS-1, CSS-1H
Hot-mixed, cold-laid asphalt mixtures	AC-0.6, AC-1.5, AC-3, AES-300, AES-300P, CMS-2, CMS-2S
Patching mix	MC-800, SCM I, SCM II, AES-300S
Recycling	AC-0.6, AC-1.5, AC-3, AES-150P, AES-300P, recycling agent, emulsified recycling agent
Crack sealing	SS-1P, polymer mod AE crack sealant, rubber asphalt crack sealers (Class A, Class B)
Microsurfacing	CSS-1P
Prime	MC-30, AE-P, EAP&T, PCE
Curing membrane	SS-1, SS-1H, CSS-1, CSS-1H, PCE
Erosion control	SS-1, SS-1H, CSS-1, CSS-1H, PCE

- C. **Storage and Application Temperatures:** Use storage and application temperatures in accordance with Table 19. Store and apply materials at the lowest temperature yielding satisfactory results. Follow the manufacturer's instructions for any agitation requirements in storage. Manufacturer's instructions regarding recommended application and storage temperatures supercede those of Table 19.

Table 19
Storage and Application Temperatures

Type-Grade	Application		Storage Maximum (°F)
	Recommended Range, °F	Maximum Allowable (°F)	
AC-0.6, AC-1.5, AC-3	200–300	350	350
AC-5, AC-10	275–350	350	350
AC-5 w/2% SBR, AC-10 w/2% SBR, AC-15P, AC-20-5TR	300–375	375	360
RC-250	125–180	200	200
RC-800	170–230	260	260
RC-3000	215–275	285	285
MC-30, AE-P	70–150	175	175
MC-250	125–210	240	240
MC-800, SCM I, SCM II	175–260	275	275
MC-3000, MC-2400L	225–275	290	290
HFRS-2, MS-2, CRS-2, CRS-2H, HFRS-2P, CRS-2P, CMS-2, CMS-2S, AES-300, AES-300S, AES-150P, AES-300P	120–160	180	180
SS-1, SS-1H, CSS-1, CSS-1H, PCE, EAP&T, SS-1P, RS-1P, CRS-1P, CSS-1P, recycling agent, emulsified recycling agent, polymer mod AE crack sealant	50–130	140	140
PG binders	275–350	350	350
Rubber asphalt crack sealers (Class A, Class B)	350–375	400	–
A-R binders Types I, II, and III	325–425	425	425

IV. **MEASUREMENT AND PAYMENT:** The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but is subsidiary or is included in payment for other bid Items.