Test Procedure for

IDEAL CRACKING TEST

TxDOT Designation: Tex-250-F

Effective Date: OCTOBER 2024

1. SCOPE

1.1 This test method determines the cracking tolerance index (CT_{Index}) of compacted bituminous mixtures.

1.2 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

2. APPARATUS

2.1 *Apparatus used in Tex-241-F.*

2.2 *Apparatus used in Tex-207-F.*

2.3 *Apparatus used in Tex-227-F.*

2.4 *Temperature Chamber or Heating Oven,* capable of maintaining 77 ± 2°F (25 ± 1°C).

2.5 *Loading Press,* capable of applying a compressive load at a controlled deformation rate of 2 in. per minute.

2.6 *Load Cell,* with a resolution of 2 lb. and a minimum capacity of 6,000 lb.

2.7 *Loading Strips,* consisting of 0.75 × 0.75 in. square steel bars. Place the surface in contact with the specimen to match the curvature of the test specimen.

2.8 *Displacement Measuring Device,* capable of measuring the displacement with a resolution of ± 0.4 mils (±0.01 mm). The displacement data measured during the test may need some correction for compensating system compliance.

2.9 *Data Acquisition System,* time, load, and displacement data are collected at a minimum of 40 sampling data points per second to obtain a smooth load-displacement curve.

3. TEST SPECIMENS

3.1 *Laboratory-Molded Specimens*—Prepare four specimens in accordance with Tex-241-F. Specimen diameter must be 5.9 in. (150 mm) and height must be 2.4 ± 0.1 in. (62 ± 2 mm)

3.1.1 Density of test specimens must be 93 ± 0.5%, except for Permeable Friction Course (PFC) mixtures and Crack Attenuating Mix (CAM).

Note 1—Mixture weights for laboratory-molded specimens that achieve the density requirement typically vary between 2,400 and 2,600 g.

3.1.2 For PFC mixtures, mold test specimens to 50 gyrations (Ndesign).

3.1.3 Density of the test specimen must be 95 ± 0.5% for CAM mixtures.

3.2 *Core Specimens*—Obtain and prepare cores in accordance with Tex-251-F. Specimen diameter must be 6 in. and height must be a minimum of 1.5 in. There is not a specific density requirement for core specimens.

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4. PROCEDURE

4.1 *Laboratory-Molded Mixtures:*

4.1.1 Mold four specimens in accordance with Section 3.1.

4.1.2 Calculate the density of the specimens in accordance with Tex-207-F and Tex-227-F.

4.1.3 Allow the specimens to stand at room temperature (75 ± 5°F) for a minimum of 24 hr. before testing.

4.1.4 Test laboratory-molded specimens within three days of molding.

4.2 *Roadway Cores:*

4.2.1 Obtain and trim roadway cores in accordance with Tex-251-F.

4.3 Record the density, height, and diameter of each molded specimen or roadway core.

4.4 Place the specimens or cores in the temperature chamber or oven long enough to ensure a consistent temperature of 77 ± 2°F (25 ± 1°C) throughout the specimen before testing. Do not leave the specimens or cores in the temperature chamber or oven for more than 24 hr.

Note 2—For room temperature specimens, 2 hr. conditioning in a temperature chamber of 77°F is enough.

4.5 Calibrate the loading press to use a deformation rate of 2 in. per minute.

4.6 Carefully place one specimen on the lower loading strip with uniform contact and ensure the specimen is centered.

4.7 Slowly lower top loading strip into light and uniform contact with the specimen.

4.8 Ensure the two loading strips remain parallel to each other during testing.

4.9 Apply the load at a controlled deformation rate of 2 in. per minute until the specimen completely fractures and the minimum load reaches 22 lb. During the testing, record the time, load, and displacement at a minimum sampling rate: 40 data points per second.

Note 3—Testing a specimen must be completed in 4 min. or less after removal from the environmental chamber to maintain a uniform specimen temperature.

4.10 Repeat Sections 4.6–4.9 for each specimen.

5. CALCULATIONS

5.1 Calculate the work of failure (W_f) as the area under the load vs. displacement curve (see Figure 1) through the quadrangle rule provided in Equation 1:

$$W_f = \sum_{i=1}^{n-1}\left((l_{i+1} - l_i) \times P_i + \frac{1}{2} \times (l_{i+1} - l_i) \times (P_{i+1} - P_i)\right) \quad (1)$$

where:

W_f = Work of failure, in-pound.

P_i = Applied load at the *i* load step application, lb.

P_{i+1} = Applied load at the *i+1* load step application, lb.

l_i = Displacement at the *i* load step application, in.

l_{i+1} = Displacement at the *i+1* load step application, in.

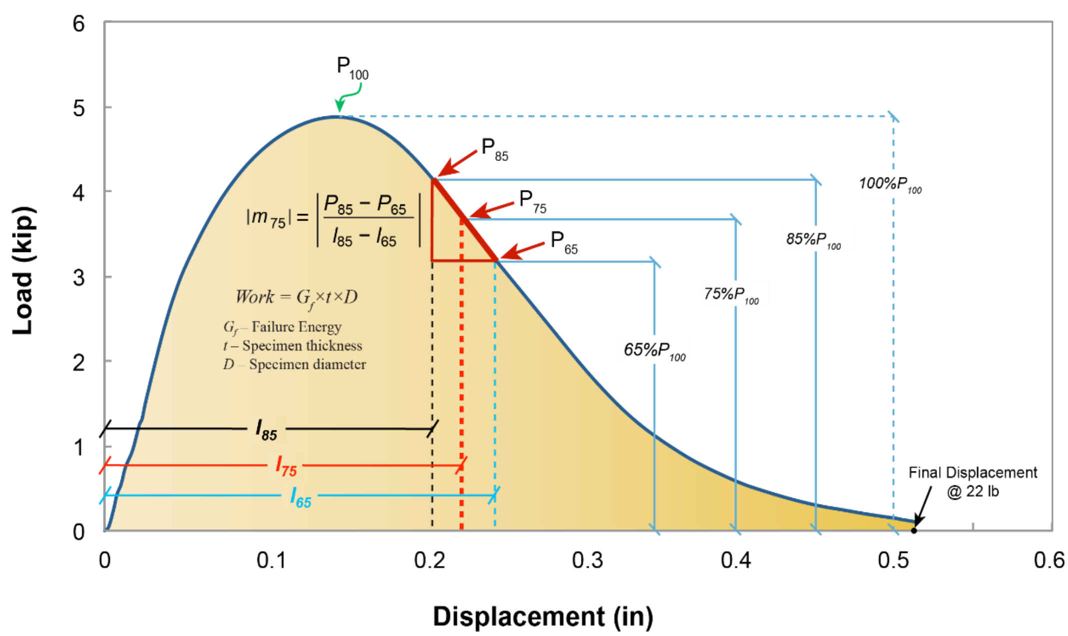

Figure 1.
Recorded load (*P*) versus displacement (*l*) curve

5.2 Calculate the failure energy (G_f) by dividing the work of failure by the cross-sectional area of the specimen (the product of the diameter and thickness of the specimen):

$$G_f = \frac{W_f}{D \times t} \quad (2)$$

where:

G_f = Failure energy, lb./in.

W_f = Work of failure, in.-lb.

D = Specimen diameter, in.

t = Specimen thickness, in.

5.3 Calculate the post-peak slope (m_{75}), see Figure 1.

5.4 Calculate the deformation tolerance (l_{75}), see Figure 1.

5.5 Calculate the cracking tolerance index (CT_{Index}) using Equation 3 and the parameters obtained using the load-displacement curve.

$$CT_{Index} = \frac{t}{2.4} \times \frac{l_{75}}{D} \times \frac{G_f}{|m_{75}|} \times 10^6 \quad (3)$$

where:

CT_{Index} = Cracking tolerance index normalized to 2.4 in. thick specimen

G_f = Failure energy, lb./in.

$|m_{75}|$ = Absolute value of the post-peak slope m_{75}, lb./in.

l_{75} = Displacement at 75 % the peak load after the peak, in.

t = Thickness of specimen, in.

D = Diameter of specimen, in.

5.6 Calculate the tensile strength of the compacted bituminous mixture:

$$S_T = \frac{2P_{100}}{3.14tD} \quad (4)$$

where:

S_T = Indirect tensile strength, psi

P_{100} = Maximum applied vertical load (see Figure 1), lb.

t = Specimen thickness, in. and

D = Specimen diameter, in.

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6. REPORT

6.1 Report the following for each specimen:

- density,
- thickness,
- diameter,
- deformation tolerance (l_{75}),
- post-peak slope (m_{75}),
- work of failure (W_f)
- failure energy (G_f),
- Cracking tolerance index, and
- Indirect tensile strength.

6.2 Report the average cracking tolerance index and the average indirect tensile strength of the tested specimens or cores to the nearest whole number.

7. ARCHIVED VERSIONS

7.1 Archived versions are available.

Special Provision to Item 300
Asphalts, Oils, and Emulsions

Item 300, "Asphalts, Oils, and Emulsions," is amended with respect to the clause cited below. No other clause or requirements of this Item are waived or changed.

Section 300.2.2., Table 3 Polymer-Modified Asphalt Cement has been voided and replaced by the following:

Table 3
Polymer-Modified Asphalt Cement

Property	Test Procedure	Polymer-Modified Viscosity Grade											
		AC-12-5TR		NT-HA[1]		AC-15P		AC-20XP		AC-10-2TR		AC-20-5TR	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Polymer		TR		–		SBS		SBS		TR		TR	
Polymer content, % (solids basis)	Tex-533-C or Tex-553-C	5.0	–	–	–	3.0	–	–	–	2.0	–	5.0	–
Dynamic shear, G*/sin δ, 82°C, 10 rad/s, kPa	T 315	–	–	1.0	–	–	–	–	–	–	–	–	–
Dynamic shear, G*/sin δ, 64°C, 10 rad/s, kPa	T 315	–	–	–	–	–	–	1.0	–	–	–	1.0	–
Dynamic shear, G*/sin δ, 58°C, 10 rad/s, kPa	T 315	1.0	–	–	–	–	–	–	–	1.0	–	–	–
Viscosity													
140°F, poise	T 202	1,200	–	–	–	1,500	–	2,000	–	1,000	–	2,000	–
275°F, poise	T 202	–	–	–	–	–	8.0	–	–	–	8.0	–	10.0
275°F, Pa-s	T 316	–	–	–	4.0	–	–	–	–	–	–	–	–
Penetration, 77°F, 100 g, 5 sec.	T 49	110	150	–	25	100	150	75	115	95	130	75	115
Elastic recovery, 50°F, %	Tex-539-C	55	–	–	–	55	–	55	–	30	–	55	–
Polymer separation, D, %	Tex-540-C	-10	+10	–	–	-10	+10	-10	+10	-10	+10	-10	+10
Flash point, C.O.C., °F	T 48	425		425		425	–	425	–	425	–	425	–
Dynamic shear (@ 0.2 rad/sec.)													
G*, -18°C MPa	Tex-554-C[2]	–	220	–	–	–	220	–	220	–	220	–	220
δ, -18°C, deg.		22	–	–	–	22	–	22	–	22	–	22	–
Tests on residue from RTFOT aging and pressure aging:	T 240 and R 28												
Creep stiffness	T 313												
S, -18°C, MPa		–	300	–	–	–	300	–	300	–	300	–	300
m-value, -18°C		0.300	–	–	–	0.300	–	0.300	–	0.300	–	0.300	–

1. This is a hot-applied TRAIL product.
2. Bending beam rheometer, BBR (T313) is not required unless the low. temp. DSR (Tex-554-C) do not meet the afore specified requirements. BBR will be used for the acceptance criteria in this instance.

Section 300.2.4., Table 8 Cationic Emulsified Asphalt has been voided and replaced by the following:

Table 8
Cationic Emulsified Asphalt

Property	Test Procedure	Type–Grade							
		Rapid-Setting		Medium-Setting		Slow-Setting			
		CRS-2		CMS-2		CSS-1		CSS-1H	
		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	100	350	–	–	–	–
Sieve test, %	T 59	–	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		–		–	
Wet aggregate/after spray		–		Fair/Fair		–		–	
Demulsibility, 35 mL of 0.8% Sodium dioctyl sulfosuccinate, %	T 59	70	–	–	–	–	–	–	–
Storage stability, 1 day, %	T 59	–	1	–	1	–	1	–	1
Particle charge	T 59	Positive		Positive		Positive		Positive	
Distillation test:									
Residue by distillation, % by wt.	T 59	65	–	65	–	60	–	60	–
Oil distillate, % by volume of emulsion		–	0.5	–	7	–	0.5	–	0.5
Tests on residue from distillation:									
Penetration, 77°F, 100 g, 5 sec.	T 49	90	160	90	200	90	160	40	110
Solubility, %	T 44	97.5	–	97.5	–	97.5	–	97.5	–
Ductility, 77°F, 5 cm/min., cm	T 51	100	–	100	–	100	–	80	–

Section 300.2.11. This section has been voided and replaced by the following.

2.11 Performance-Graded Binders. Provide PG binders that are smooth and homogeneous, show no separation when tested in accordance with Tex-540-C (i.e., D<10%), and meet the requirements shown in Table 18.

Separation testing is not required if:

- a modifier is introduced separately at the mix plant by injection in either the asphalt line or mixer,
- the binder is blended onsite in continuously agitated tanks, or
- 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 18
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*/sin(δ), Min, 1.00 kPa, Max, 2.00 kPa[5], Test temperature @ 10 rad/sec., °C	58			64				70				76				82		
Elastic recovery, D6084, 50°F, % Min[6]	–	–	30	–	–	30	50	–	30	50	60	30	50	60	70	50	60	70
Rolling Thin-Film Oven (RTFO) (T 240)																		
Mass change, T 240, Max, %	1.0																	
Dynamic shear, T 315: G*/sin(δ), Min, 2.20 kPa, Max, 5.00 kPa[5], Test temperature @ 10 rad/sec., °C	58			64				70				76				82		
MSCR, T350, Recovery, 0.1 kPa, High Temperature, % Min[6]	–	–	20	–	–	20	30	–	20	30	40	20	30	40	50	30	40	50
Pressure Aging Vessel (PAV) Residue (R 28)																		
PAV aging temperature, °C	100																	
Dynamic shear, T 315 G*.sin(δ), Max, 5,000 kPa (Max, 6,000 kPa for δ ≥42°) Test temperature @ 10 rad/sec., °C	25	22	19	28	25	22	19	28	25	22	19	28	25	22	19	28	25	22
Dynamic shear, Tex-554-C[7]: G*, Max, 220 MPa δ, min. 22° (Test temperature @ 0.2 rad/sec., °C)	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18
Creep stiffness, T 313[8,9]: *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[9] 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 and using an algorithm contained in a Department-supplied computer program, may be provided by the Department, or may be obtained following the procedures outlined in AASHTO MP 323 and R 25.
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 G*/sin(δ) 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. Max values for unaged and RTFO-aged dynamic shear apply only to materials used as substitute binders, as described in Item 341, "Dense-Graded Hot-Mix Asphalt," and Item 344, "Superpave Mixtures."
6. Elastic recovery (D6084) is not required unless MSCR (T 350) is less than the Min % recovery. Elastic recovery will be used for the acceptance criteria in this instance.
7. Bending beam rheometer, BBR (T313) is not required unless the low. temp. DSR (Tex-554-C) do not meet the afore specified requirements. BBR will be used for the acceptance criteria in this instance.
8. Silicone beam molds, as described in AASHTO TP 1-93, are acceptable for use.
9. 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.