MEPDG Software Digest

Introduction

This digest is a summary of the major issues in regard to implementing the MEPDG software with the SISSI data during the Phase II of the SISSI project. As such, it describes both software/data issues identified in version 0.9 (released in November 2006) and version 1.0 (released in May 2007). Users of the new version 1.0 should recognize two important facts. First, the climatic database used in the latest calibration and available for design is now substantially larger and enhanced. Old databases downloaded with previous releases should be scrapped. Second, design solutions and associated files generated with versions 0.9 require some additional inputs and experience some difficulty if simply reloaded and run. Therefore, it is recommended that the user regenerate each input file prior to re-running an old analysis. The research team recommends that problems of interest be run again with the new version (i.e., 1.0) for comparison with solutions from earlier versions (i.e., 0.9) due to the new calibration of the empirical performance models.

One unique feature of the MEPDG is that pavement designers have a great deal of flexibility in obtaining the design input for a design project based on the critical nature of the project and the available resources through the Hierarchical Input Level (HIL). The HIL can be applied to various aspects: traffic, materials, and environmental input. For the SISSI project, all input were obtained by using a mix of three HILs. For the asphalt concrete (AC) material properties, most parameters were input as Level 1 except for Poisson's ratio, unit weight, and thermal properties (see Appendix). Details of compiling the inputs and running the MEPDG software are presented in a separate document.

The major issues reported in this digest are all related to the construction of master curves using Level 1 inputs, namely the binder dynamic modulus master curve, the mixture dynamic modulus master curve, and the mixture creep compliance master curve.

Asphalt Binder Data

In the MEPDG, two material properties are required to characterize the asphalt binder, binder dynamic modulus (G*) and phase angle (δ) collected from the Dynamic Shear Rheometer (DSR) test in accordance with the AASHTO T315 protocol. The binder testing should be performed after Rolling Thin Film Oven (RTFO) test aging in accordance with AASHTO T240. Tests results are needed over a range of temperatures for a loading rate of 1.59 Hz (10 rad/sec). Some of the binder data collected for the SISSI project is shown in Table 1.

The MEPDG requires the dynamic modulus and phase angle data at 40, 55, 70, 85, 100, 115, and 130 ^{o}F, such that a reasonable master curve can be constructed. Although it is desirable to measure the binder properties over the same temperature range as the mixture tests, the DSR measurements using the normal parallel plate geometry are subject to significant compliance errors below about 40 °F. In this study, G* master curve (Figure 1) and δ master curve (Figure 2) were first constructed with the SISSI binder data and then extrapolated to the temperatures (e.g., 40 ^{o}F) which were not included in the testing plan (Figures 3 and 4).

Table 1. Summary of binder data from the DSR test (at 10 rad/sec only)

Asphalt Binder	Temperature		G*, kPa	δ, deg
	^{o}C	^{o}F		
PG 76-22	58	136	19.58	62.05
	64	147	10.47	64.13
	70	158	5.63	66.85
	75	167	3.18	69.90
	81	178	1.75	74.08
PG 64-22	52	126	14.39	79.46
	58	136	6.32	82.14
	64	147	2.84	84.54
	70	158	1.34	86.65
	75	167	0.68	88.26

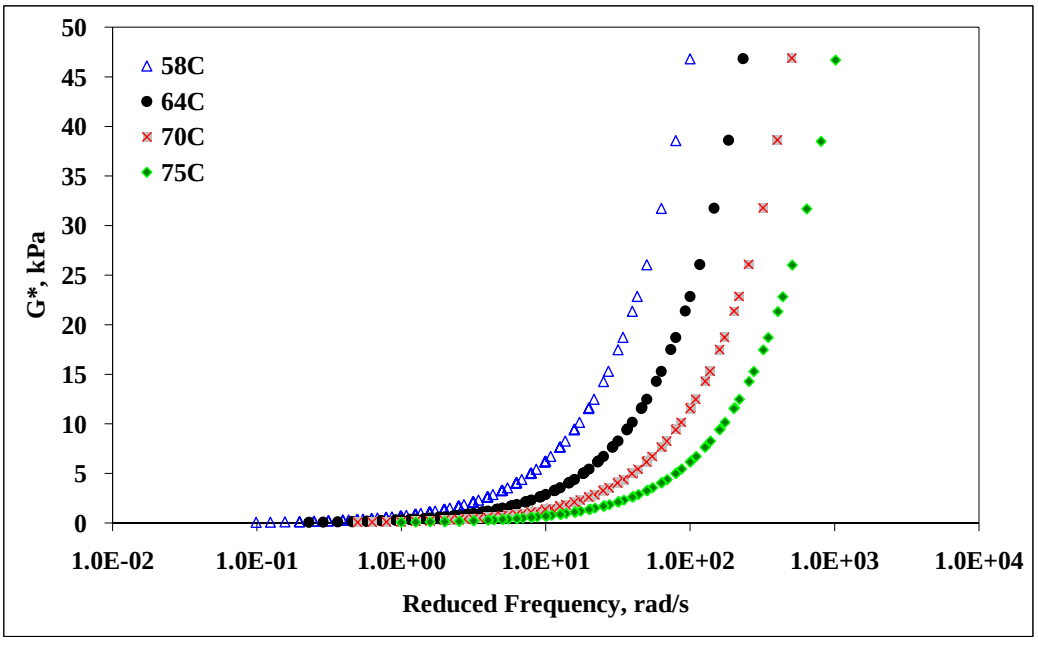

Figure 1. G* master curves at various temperatures for PG 64-22

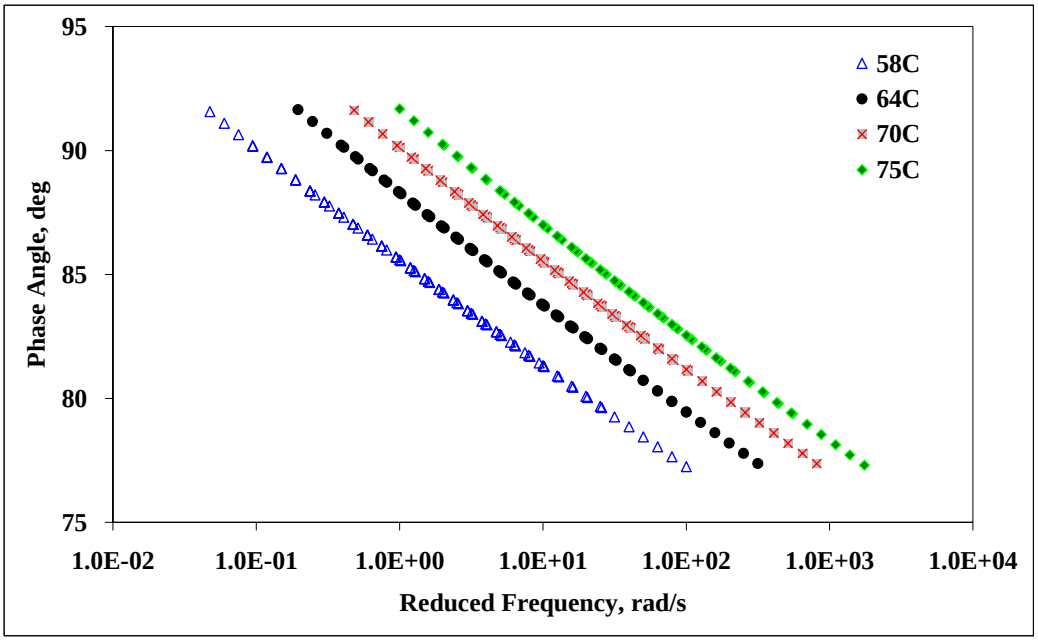

Figure 2. δ master curves at various temperatures for PG 64-22

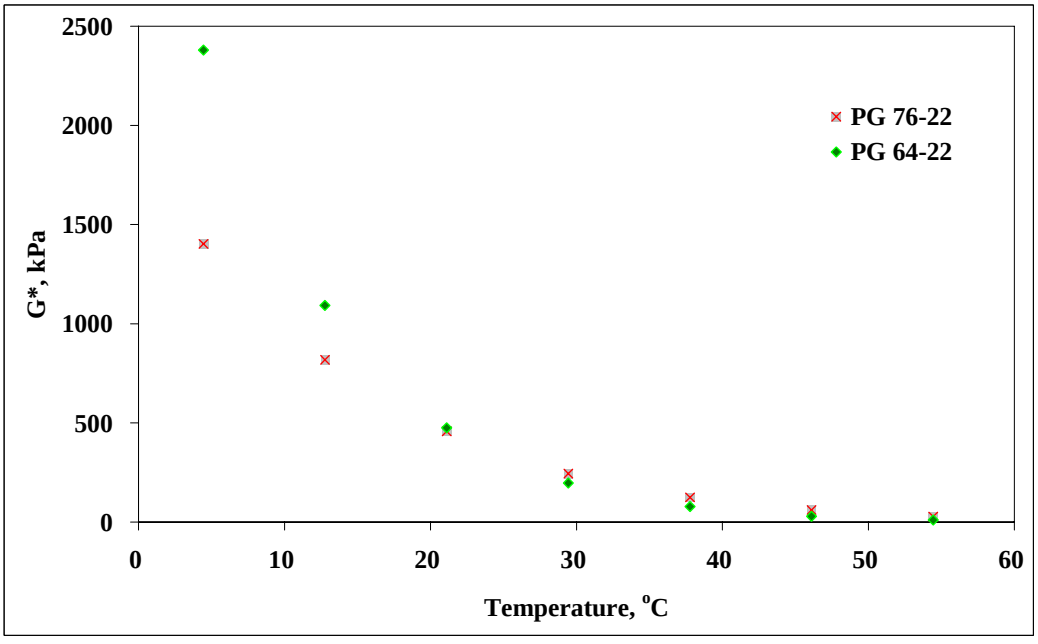

Figure 3. G* master curves

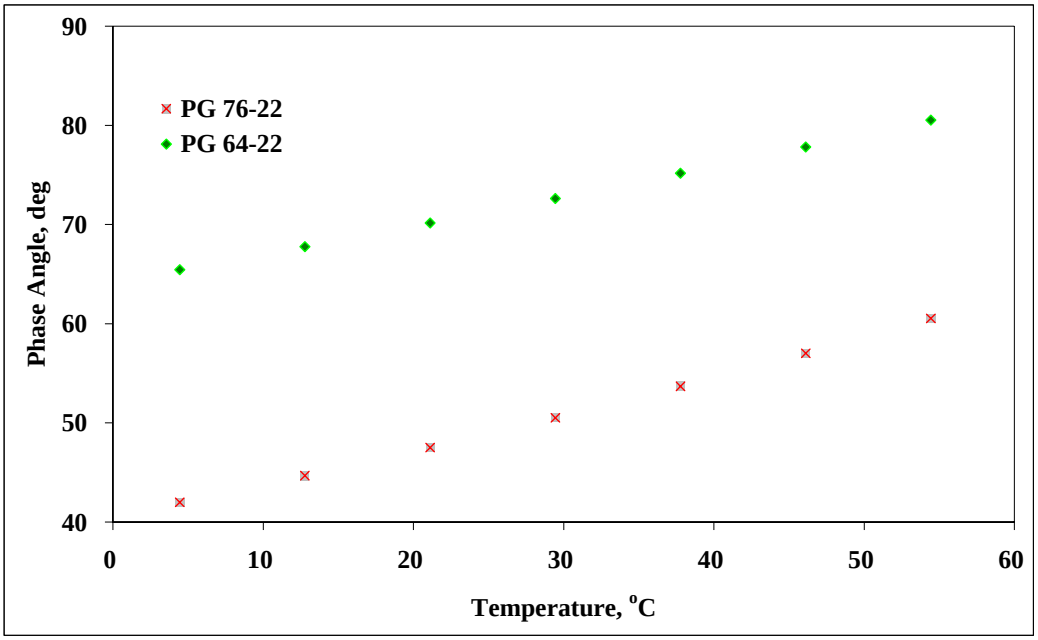

Figure 4. δ master curves

Major issues related to the asphalt binder data in version 1.0

It was found that the MEPDG software could not construct G* and δ master curves using the SISSI binder data. One possible explanation is that the G* and δ values extrapolated at low temperatures may be out of the internal limits of the MEPDG software (personal communications with Mr. Gregg Larson from ARA). However, this assumption is still subject to verification.

Dynamic modulus of AC mixture

The modulus properties of AC are known to be a function of temperature, rate of loading, age, and mixture characteristics such as binder stiffness, aggregate gradation, binder content, and air voids. To account for temperature and rate of loading effects, the modulus of the AC are determined from a dynamic modulus (|E*|) master curve constructed at a reference temperature of 70 °F. In the MEPDG, the dynamic modulus master curve is defined as a function of loading frequency and temperature.

At Level 1, actual laboratory data from the complex modulus test are required to develop the master curve and shift factors. To account for short-term aging that occurs during mixing and compaction, the mixture testing should be performed after short-term oven aging in accordance with AASHTO R30. The mixture data consist of dynamic modulus frequency sweep tests on replicate specimens for five temperatures (10, 40, 70, 100, and 130 ^{o}F) and four rates of loading (0.1, 1, 10, and 25 Hz). The test should be conducted in accordance with AASHTO TP62 using the temperatures and loading rates. The specimens should have a diameter of 100mm and a

height-to-diameter ratio of 1.5. They should be tested using lubricated ends, and axial deformations should be measured over the middle 100 mm of the specimen at three locations around the circumference. Specimens meeting these size requirements can be cored from the middle of gyratory compacted specimens. Based on these inputs a master curve of E* versus reduced time is then derived to define behavior of this layer under loading and at various climatic conditions.

Similar to the DSR test, for the SISSI project, the complex modulus test was only conducted at intermediate and high temperatures. Therefore, |E*| master curves was first constructed with the actual laboratory data and then extrapolated to the temperatures (e.g., 10 ^{o}F) which were not included in the testing plan.

Major issue of E* data in version 1.0

It was found that the MEPDG software could not construct |E*| master curves using the SISSI |E*| data. One possible explanation is that the |E*| values extrapolated at low temperatures may be out of the reasonable limits (personal communications with Mr. Gregg Larson from ARA). However, this assumption is subject to verification. As shown in Figures 5 through 11, a significant difference is observed between the master curves constructed using the SISSI Level 1 (|E*|) data from laboratory testing and Level 3 data from the Witczak |E*| prediction model.

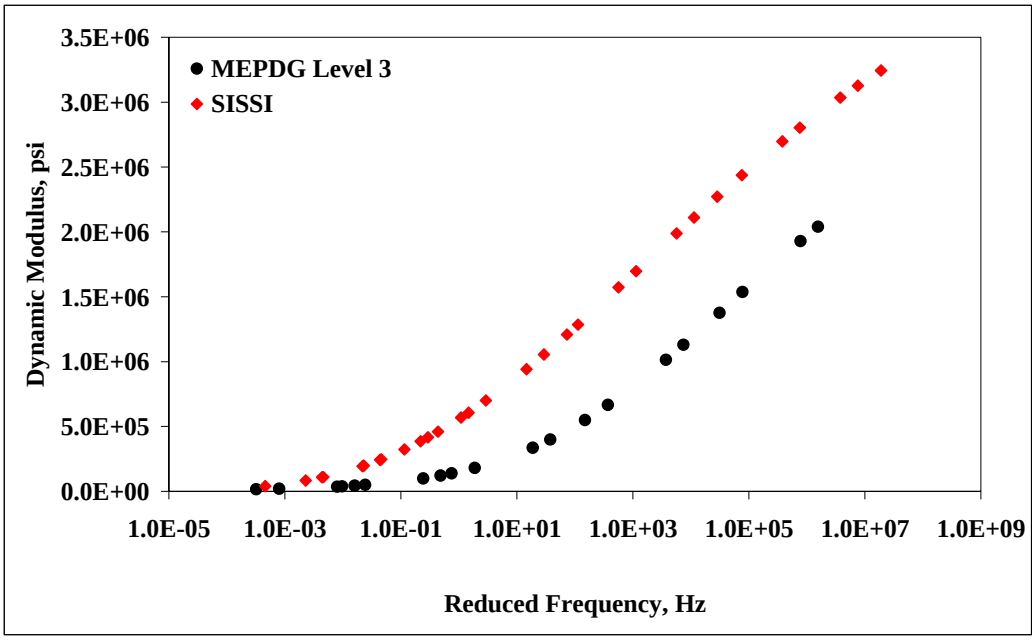

Figure 5. |E*| master curves, Tioga wearing layer

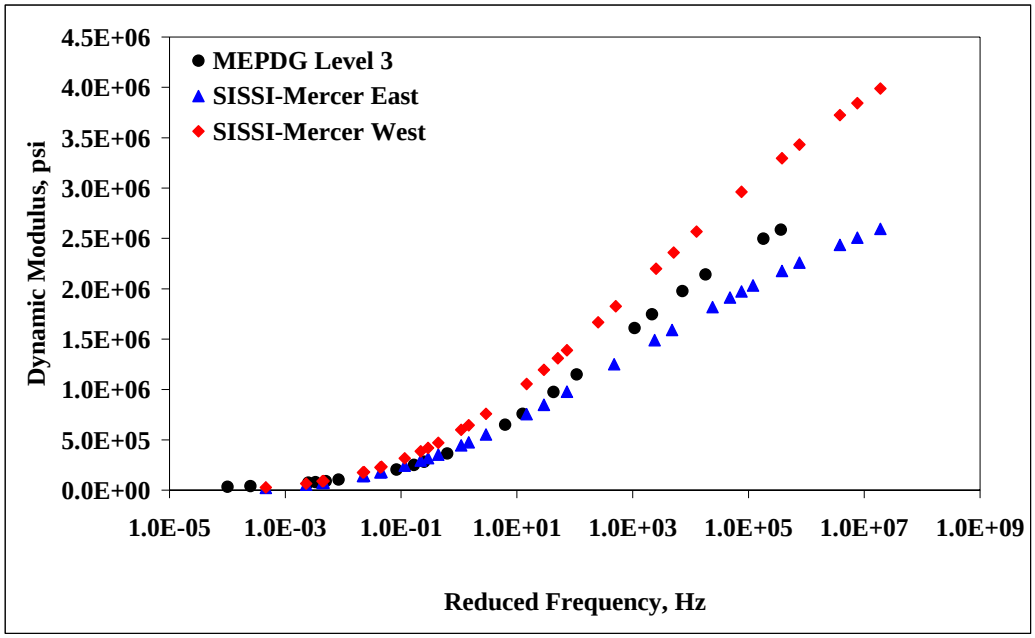

Figure 6. |E*| master curves, Mercer wearing layer

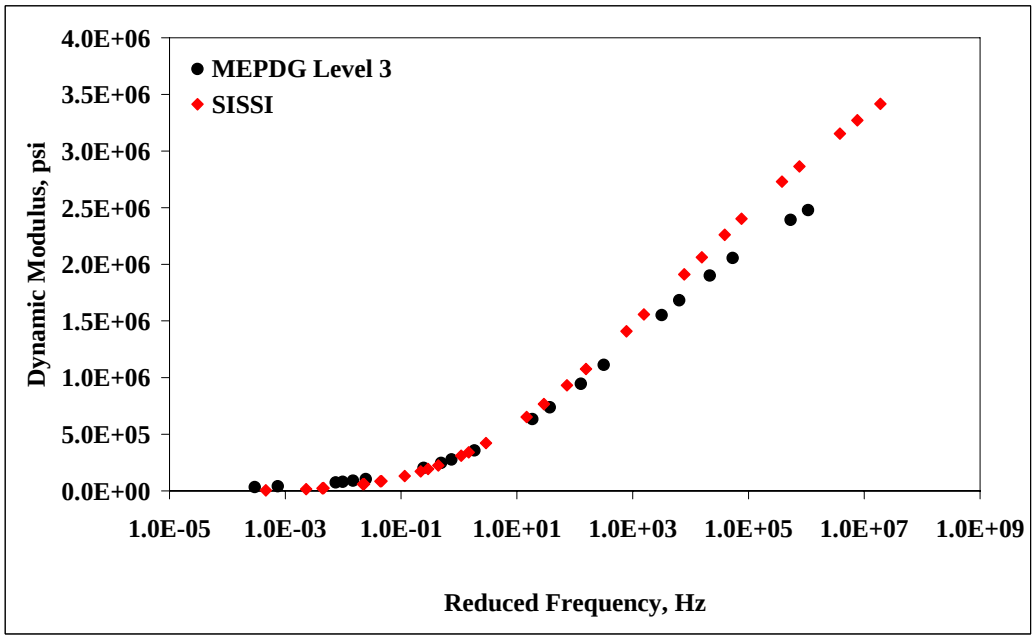

Figure 7. |E*| master curves, Warren wearing layer

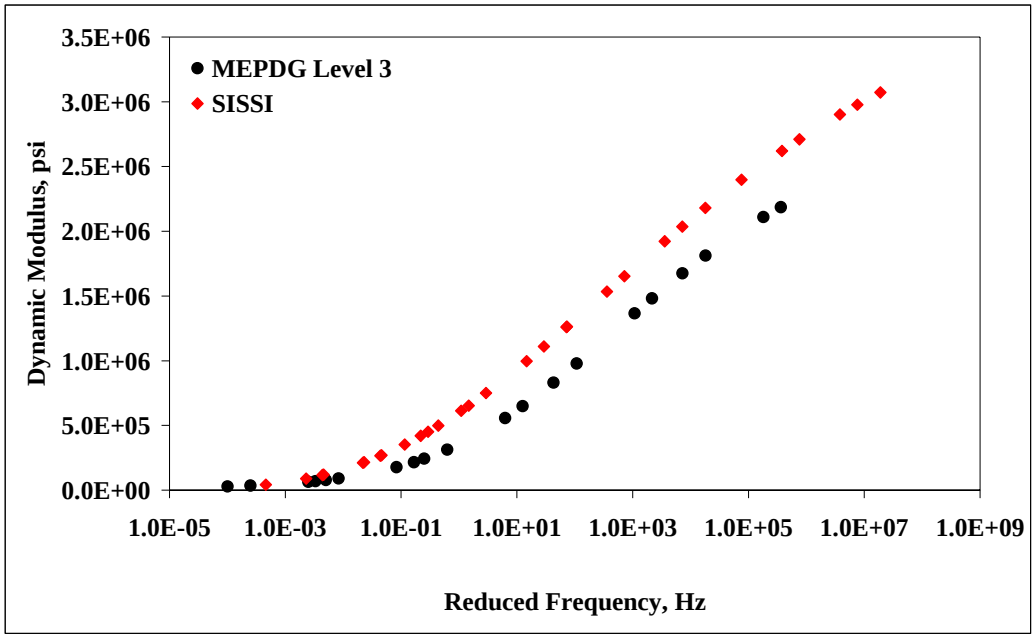

Figure 8. |E*| master curves, Perry wearing layer

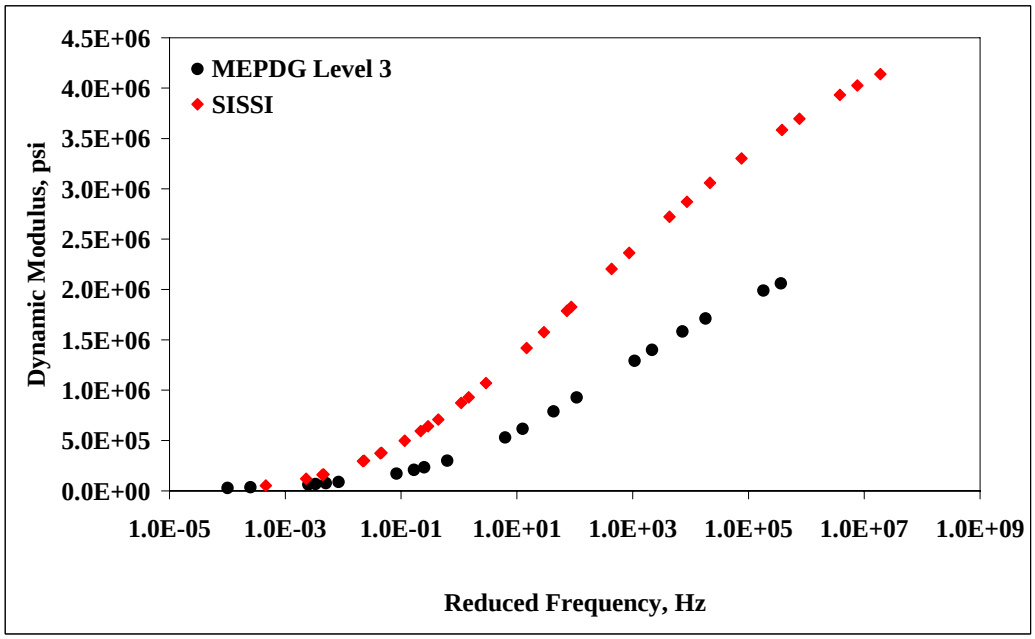

Figure 9. |E*| master curves, Delaware wearing layer

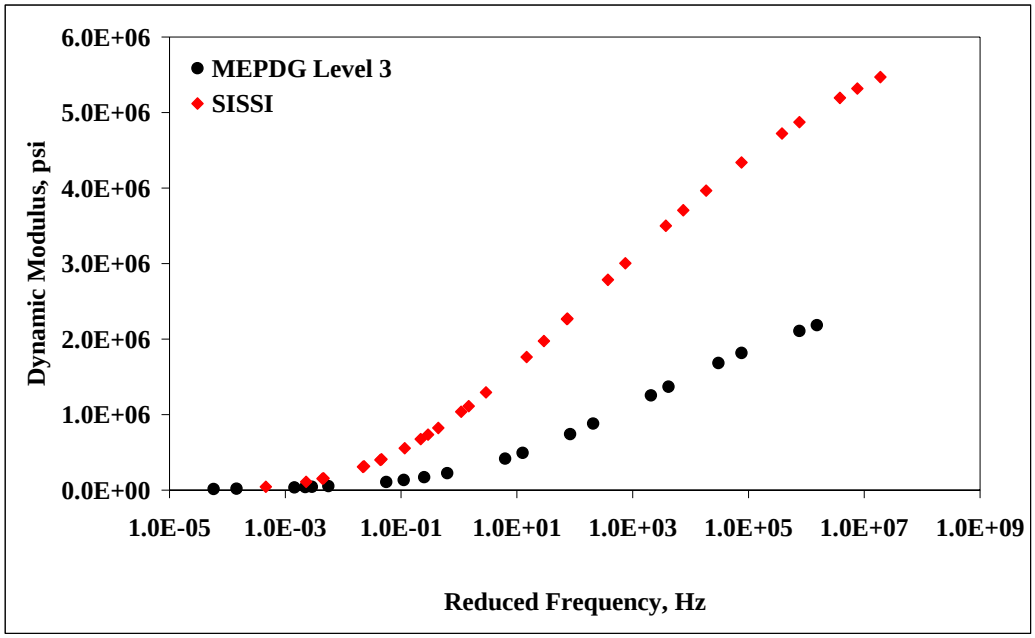

Figure 10. |E*| master curves, Somerset wearing layer

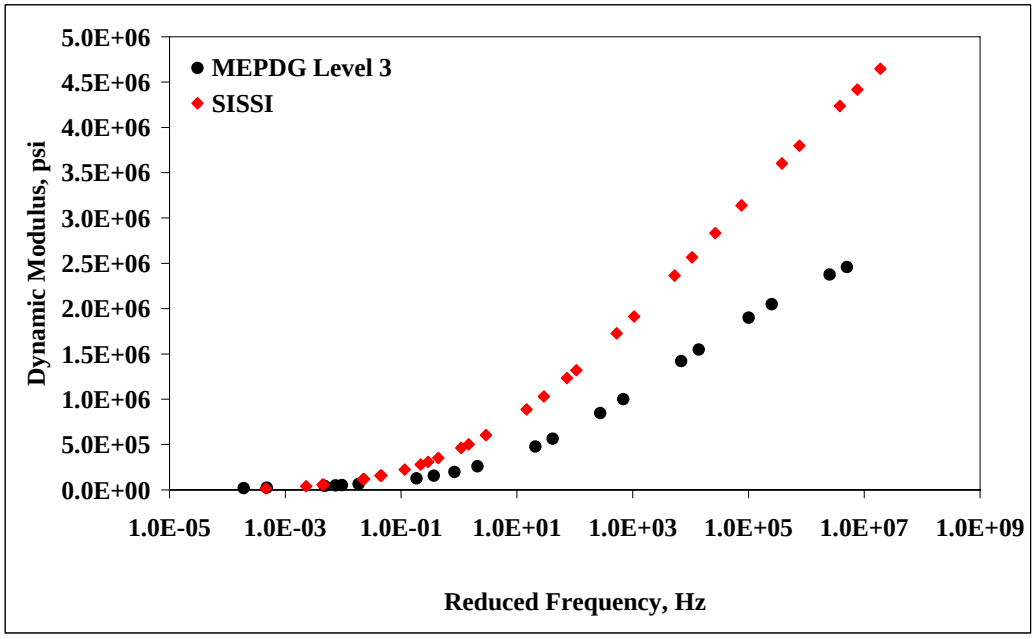

Figure 11. |E*| master curves, Blair wearing layer

Creep compliance of AC mixture

The MEPDG predicts the progression of thermal cracking over the life of the design pavement based on the material properties and the climatic condition of the local area.

Note that this distress type is not load related and is only influenced by the asphalt concrete (AC) material properties with respect to the climatic conditions. The AC properties that are used to predict thermal cracking are:

- Tensile strength
- Creep compliance
- Coefficient of thermal contraction

Tensile strength is the strength parameter that is indicative of the tensile strength of the material when subjected to an indirect tensile strength test at a temperature of 14 ^{o}F. For Level 1, actual laboratory test data is input for AC tensile strength in accordance with AASHTO T322, Determining the Creep Compliance and Strength of Hot Mix Asphalt (HMA) Using the Indirect Tensile Test Device.

Creep compliance, D(t), is material parameter that is indicative of the tensile compliance of the material when subjected to an indirect tensile strength test under strain levels that keep the material in its viscoelastic range and at a temperature of -4, 14 and 32 ^{o}F. The creep compliance values are entered at specified time periods from the start of the test till the test duration (100 seconds). For Level 1, actual laboratory creep data is input from tests conducted in accordance with AASHTO T322.

The coefficient of thermal contraction of the AC mixture is an important input to determining the thermal cracking potential of the AC layer. This input is a measure of the extent of contraction the material undergoes with decreasing levels of temperature. The user can either input this value directly or can use the value computed by the MEPDG software. The MEPDG software computes CTC internally using the AC volumetric properties: VMA, CTC of asphalt binder, percent volume of aggregates, CTC of aggregates. Mixture VMA is the percent volume of voids in the mineral aggregate and equals the sum of percent volume of air voids and the percent volume of effective asphalt binder. Aggregate coefficient of thermal contraction is the coefficient of thermal contraction of the aggregate used in the mix design, and is expressed as the change in volume per unit volume for unit decrease in temperature.

Major issues related to creep compliance data in version 0.9

It was found that the MEPDG software could not construct D(t) master curves using the SISSI creep compliance data. There are two possible reasons for this issue. First, for the SISSI project, the creep compliance master curves were constructed using Sigmoidal function instead of Power Law adopted by the MEPDG software. Second, laboratory data were not collected at the exact times required by the MEPDG. Consequently, D(t) values at short times, such as 2 seconds, were extrapolated from the Sigmoidal-based creep compliance master curves.

Appendix – AC material inputs summary

AC input summary for Tioga

Mixture E*						
Wearing	0.1	0.5	1	5	10	25
14	2437744	2697427	2803452	3034870	3127944	3244787
40	1285486	1572325	1697719	1988096	2111333	2271284
70	415505	606258	700147	941689	1054273	1209250
100	107811	194061	242813	385218	459311	568739
130	39293	82717	109875	197194	246455	323145
Binder	0.1	0.5	1	5	10	25
14	1937882	2052233	2094824	2179988	2211334	2248405
40	1409006	1602771	1678507	1835814	1895695	1967898
70	402787	606489	702353	933841	1034237	1164876
100	72609	160227	212861	369591	450471	567308
130	16151	49771	74562	163568	216837	301197
BCBC	0.1	0.5	1	5	10	25
14	3484555	3728343	3821095	4010264	4081297	4166425
40	1697099	2110685	2284824	2670378	2826087	3020843
70	658694	998115	1160968	1563053	1741524	1977679
100	123193	264555	349398	604181	737375	932144
130	29839	85956	126362	269934	355819	492511

Gradation		
Wearing	Retained on 3/4	0.0
	Retained on 3/8	11.0
	Retained on #4	37.9
	Passing #200	5.5
Binder	Retained on 3/4	1.1
	Retained on 3/8	32.1
	Retained on #4	46.2
	Passing #200	5.4
BCBC	Retained on 3/4	11.1
	Retained on 3/8	42.6
	Retained on #4	60.6
	Passing #200	5.1

General Properties		
Wearing	Pbe	7.8
	AV	10.8
Binder	Pbe	7.4
	AV	9.5
BCBC	Pbe	7.3
	AV	9.3

Binder G* and Delta			
PG 64-28	40		
	70		
	100		
	130		

Mixture D(t) and Strength				
Time	D(t), 1/psi			Strength, psi
	-20	-10	0	
1	3.4E-07	3.9E-07	5.2E-07	608
2	3.5E-07	4.1E-07	5.6E-07	
5	3.6E-07	4.3E-07	6.3E-07	
10	3.8E-07	4.6E-07	7.0E-07	
20	3.9E-07	4.9E-07	7.9E-07	
50	4.1E-07	5.4E-07	9.4E-07	
100	4.3E-07	5.8E-07	1.1E-06	

AC input summary for Mercer East

Mixture E*						
Wearing	0.1	0.5	1	5	10	25
14	1983091	2189569	2273071	2453573	2525446	2615047
40	1247075	1486934	1589151	1820222	1916041	2038502
70	317518	474651	552582	753828	847737	976903
100	73365	139591	178054	292801	353405	443593
130	23962	54781	74911	142045	180950	242440
Binder	0.1	0.5	1	5	10	25
14	3291136	3664653	3816880	4148243	4281065	4447357
40	1515844	1915855	2093535	2510079	2688615	2921563
70	463342	710399	835260	1163450	1319063	1535348
100	98411	194040	250994	425155	519141	661037
130	30331	72346	100598	197647	255315	348037
BCBC	0.1	0.5	1	5	10	25
14	3571414	3826388	3924814	4128477	4206116	4300138
40	2039368	2436573	2601656	2964635	3110745	3293505
70	767475	1108510	1269368	1662913	1836892	2067166
100	183211	349146	442879	711573	847488	1042947
130	56833	135733	187147	355185	449857	595573

Gradation		
Wearing	Retained on 3/4	0.0
	Retained on 3/8	12.0
	Retained on #4	51.0
	Passing #200	4.2
Binder	Retained on 3/4	11.0
	Retained on 3/8	48.0
	Retained on #4	67.0
	Passing #200	3.2
BCBC	Retained on 3/4	22.0
	Retained on 3/8	59.0
	Retained on #4	80.0
	Passing #200	3.4

General Properties		
Wearing	Pbe	6.8
	AV	10.4
Binder	Pbe	6.8
	AV	9.1
BCBC	Pbe	8.3
	AV	8.1

Binder G* and Delta			
PG76-22	40		63
	70		68
	100		74
	130		79

Mixture D(t) and Strength				
Time	D(t), 1/psi			Strength, psi
	-20	-10	0	
1	3.7E-07	4.1E-07	5.7E-07	715
2	3.8E-07	4.3E-07	6.2E-07	
5	4.0E-07	4.6E-07	7.0E-07	
10	4.2E-07	4.8E-07	7.8E-07	
20	4.4E-07	5.2E-07	8.8E-07	
50	4.7E-07	5.7E-07	1.1E-06	
100	5.0E-07	6.2E-07	1.2E-06	

AC input summary for Mercer West

Mixture E*						
Wearing	0.1	0.5	1	5	10	25
14	2956165	3285302	3419009	3709151	3825088	3969930
40	1313189	1669231	1827681	2199560	2359049	2567165
70	420044	644496	757759	1054827	1195343	1390273
100	88305	175117	226903	385318	470772	599685
130	26848	64712	90287	178397	230833	315174
Binder	0.1*	0.5	1	5	10	25
14	2387835	2712280	2844777	3133001	3248253	3392147
40	1079301	1410079	1558552	1908613	2059047	2255303
70	192420	340305	421367	649493	763785	927843
100	22955	58858	83786	171389	224126	309318
130	4359	14917	23670	60369	85765	130766
BCBC	0.1	0.5	1	5	10	25
14	2583706	2818702	2911231	3106116	3181695	3274236
40	1217769	1528319	1662754	1969244	2096840	2259886
70	411335	631568	740576	1019483	1147919	1322473
100	79950	166237	218200	376805	461573	588036
130	21530	57016	81893	169523	222146	306751

Gradation		
Wearing	Retained on 3/4	0.0
	Retained on 3/8	12.0
	Retained on #4	51.0
	Passing #200	4.2
Binder	Retained on 3/4	11.0
	Retained on 3/8	48.0
	Retained on #4	67.0
	Passing #200	3.2
BCBC	Retained on 3/4	22.0
	Retained on 3/8	59.0
	Retained on #4	72.0
	Passing #200	3.4

General Properties		
Wearing	Pbe	6.8
	AV	10.3
Binder	Pbe	6.2
	AV	9.0
BCBC	Pbe	7.3
	AV	9.2

Binder G* and Delta			
PG 76-22	40	1437122	
	70	377066	
	100	91847	
	130	20988	

Mixture D(t) and Strength				
Time	D(t), 1/psi			Strength, psi
	-20	-10	0	
1	3.4E-07	3.9E-07	5.6E-07	745
2	3.5E-07	4.2E-07	6.1E-07	
5	3.7E-07	4.5E-07	7.0E-07	
10	3.9E-07	4.8E-07	7.9E-07	
20	4.0E-07	5.2E-07	9.0E-07	
50	4.4E-07	5.8E-07	1.1E-06	
100	4.7E-07	6.5E-07	1.3E-06	

AC input summary for Warren

Mixture E*						
Wearing	0.1*	0.5	1	5	10	25
14	2402070	2729628	2863458	3154707	3271216	3416719
40	1076078	1408479	1557892	1910617	2062373	2260501
70	192503	340768	422102	651176	766028	930973
100	22906	58791	83726	171433	224276	309688
130	4344	14880	23621	60302	85706	130749
Binder	0.1	0.5	1	5	10	25
14	2564514	2795351	2886120	3077059	3151015	3241494
40	1222534	1530676	1663755	1966482	2092244	2252723
70	411677	631531	740201	1017820	1145465	1318756
100	80035	166483	218514	377167	461866	588107
130	21501	57052	81981	169774	222464	307121
BCBC	0.1	0.5	1	5	10	25
14	2769179	2998610	3087106	3269811	3339233	3423064
40	1383936	1725337	1870145	2193240	2324773	2490216
70	422178	669471	792431	1106183	1249659	1443189
100	67557	155067	210184	383759	478310	620408
130	14674	45777	69441	158513	214418	306379

Gradation		
Wearing	Retained on 3/4	0.0
	Retained on 3/8	3.8
	Retained on #4	29.9
	Passing #200	5.3
Binder	Retained on 3/4	1.0
	Retained on 3/8	29.2
	Retained on #4	58.2
	Passing #200	5.5
BCBC	Retained on 3/4	24.1
	Retained on 3/8	68.7
	Retained on #4	76.3
	Passing #200	5.3

General Properties		
Wearing	Pbe	12.7
	AV	6.4
Binder	Pbe	9.3
	AV	5.7
BCBC	Pbe	8.1
	AV	6.7

Binder G* and Delta			
PG 64-22	40	1874725	66
	70	390401	70
	100	67029	75
	130	9607	80

Mixture D(t) and Strength				
Time	D(t), 1/psi			Strength, psi
	-20	-10	0	
1	4.4E-07	5.6E-07	8.1E-07	631
2	4.6E-07	6.0E-07	9.0E-07	
5	4.8E-07	6.6E-07	1.1E-06	
10	5.1E-07	7.2E-07	1.2E-06	
20	5.4E-07	7.9E-07	1.4E-06	
50	5.8E-07	9.2E-07	1.7E-06	
100	6.3E-07	1.0E-06	2.1E-06	

AC input summary for Perry

Mixture E*						
Wearing	0.1	0.5	1	5	10	25
14	2404403	2629925	2720455	2914888	2991843	3087415
40	1261942	1537004	1655806	1927424	2041188	2187462
70	452551	653766	751218	997511	1110265	1263474
100	118003	213051	266351	420183	499158	614537
130	42145	90211	120287	216486	270321	353467
Binder	0.1	0.5	1	5	10	25
14	3018626	3327300	3451898	3720779	3827665	3960770
40	1495354	1852702	2008885	2369668	2522191	2719437
70	494174	735841	855298	1162773	1305818	1502165
100	115519	218774	278516	456045	549473	688164
130	37989	86423	117936	222590	283008	378243

Gradation		
Wearing	Retained on 3/4	0.0
	Retained on 3/8	16.0
	Retained on #4	46.0
	Passing #200	4.0
Binder	Retained on 3/4	5.0
	Retained on 3/8	22.0
	Retained on #4	49.0
	Passing #200	4.5

General Properties		
Wearing	Pbe	6.4
	AV	7.9
Binder	Pbe	7.7
	AV	10.2

Binder G* and Delta			
PG 76-22	40	1402496	42
	70	456848	48
	100	124035	54
	130	27810	61

Mixture D(t) and Strength				
Time	D(t), 1/psi			Strength, psi
	-20	-10	0	
1	2.3E-07	2.5E-07	3.7E-07	769
2	2.4E-07	2.7E-07	4.1E-07	
5	2.5E-07	2.9E-07	4.8E-07	
10	2.7E-07	3.1E-07	5.6E-07	
20	2.8E-07	3.4E-07	6.5E-07	
50	3.1E-07	3.9E-07	8.1E-07	
100	3.4E-07	4.4E-07	9.7E-07	

AC input summary for Delaware

Mixture E*						
Wearing	0.1	0.5	1	5	10	25
14	3295158	3578380	3690497	3928085	4020855	4135018
40	1834932	2210109	2369462	2727776	2875374	3062995
70	640432	928895	1067650	1415042	1572403	1784456
100	159435	295344	372071	593832	707451	872851
130	53591	120189	162675	300283	377792	497679
Binder	0.1	0.5	1	5	10	25
14	3783712	4174499	4331841	4670442	4804641	4971395
40	1826890	2281172	2480121	2940088	3134570	3385985
70	584075	884908	1034820	1422996	1604368	1853842
100	126615	248371	320179	537019	652550	825268
130	38932	93141	129418	252934	325607	441474

Gradation		
Wearing	Retained on 3/4	0.0
	Retained on 3/8	11.0
	Retained on #4	51.0
	Passing #200	5.1
Binder	Retained on 3/4	3.0
	Retained on 3/8	32.0
	Retained on #4	59.0
	Passing #200	3.8

General Properties		
Wearing	Pbe	8.0
	AV	9.6
Binder	Pbe	7.0
	AV	10.7

Binder G* and Delta			
PG 76-22	40		
	70		
	100		
	130		

Mixture D(t) and Strength				
Time	D(t), 1/psi			Strength, psi
	-20	-10	0	
1	2.5E-07	2.8E-07	2.9E-07	827
2	2.5E-07	2.9E-07	3.1E-07	
5	2.6E-07	3.1E-07	3.4E-07	
10	2.6E-07	3.3E-07	3.8E-07	
20	2.7E-07	3.6E-07	4.3E-07	
50	2.9E-07	4.1E-07	5.4E-07	
100	3.0E-07	4.8E-07	6.5E-07	

AC input summary for Somerset

Mixture E*						
Wearing	0.1	0.5	1	5	10	25
14	4318676	4699347	4849126	5164467	5286735	5436445
40	2279219	2791672	3010138	3501945	3704446	3961524
70	735480	1110153	1293734	1759487	1972467	2260739
100	153186	308624	400474	676138	821488	1036536
130	43735	110878	156744	314463	407410	555084
Binder	0.1	0.5	1	5	10	25
14	3885636	4204256	4327682	4583640	4681361	4799762
40	2057875	2525165	2722244	3160503	3338577	3562467
70	643543	993451	1165288	1599993	1797608	2063479
100	117003	252596	335217	588435	723628	924555
130	28752	81718	120015	257807	341505	476547
BCBC	0.1	0.5	1	5	10	25
14	4004720	4490076	4688773	5122932	5297554	5516629
40	1565086	2046347	2265010	2787833	3015888	3316698
70	495785	781956	929277	1322979	1512350	1777940
100	94981	195953	257850	452336	559693	724165
130	27058	68403	97234	199841	262587	365399

Gradation		
Wearing	Retained on 3/4	1.0
	Retained on 3/8	29.0
	Retained on #4	55.0
	Passing #200	4.2
Binder	Retained on 3/4	11.0
	Retained on 3/8	53.0
	Retained on #4	67.0
	Passing #200	4.0
BCBC	Retained on 3/4	22.0
	Retained on 3/8	62.0
	Retained on #4	73.0
	Passing #200	3.9

General Properties		
Wearing	Pbe	
	AV	
Binder	Pbe	
	AV	
BCBC	Pbe	
	AV	

Binder G* and Delta			
PG 64-22	40	2380010	65
	70	475503	70
	100	77217	75
	130	10314	81

Mixture D(t) and Strength				
Time	D(t), 1/psi			Strength, psi
	-20	-10	0	
1	3.0E-07	3.5E-07	5.2E-07	693
2	3.1E-07	3.6E-07	5.7E-07	
5	3.2E-07	3.9E-07	6.6E-07	
10	3.4E-07	4.2E-07	7.5E-07	
20	3.5E-07	4.5E-07	8.6E-07	
50	3.8E-07	5.0E-07	1.1E-06	
100	4.0E-07	5.5E-07	1.3E-06	

AC input summary for Blair

Mixture E*						
Wearing	0.1	0.5	1	5	10	25
14	3146697	3612369	3808383	4248108	4429592	4661233
40	1320290	1727132	1914272	2368188	2569241	2837465
70	308451	501756	604590	889217	1030845	1234331
100	55632	116850	155311	279923	350827	462007
130	15741	39885	56975	119247	158281	223567
Binder	0.1	0.5	1	5	10	25
14	3427089	3930669	4142154	4615472	4810354	5058678
40	1381844	1819975	2022085	2513321	2731227	3022132
70	332106	543073	655490	966891	1121872	1344487
100	58379	124143	165711	301037	378295	499646
130	16120	41602	59814	126729	168925	239744
BCBC	0.1*	0.5	1	5	10	25
14	3653943	4332332	4623501	5287491	5565542	5923554
40	1264376	1763677	2002849	2603888	2878486	3251912
70	198241	366835	464152	754507	908478	1138854
100	22446	57796	82997	175304	233339	330514
130	4468	14676	23140	59308	85019	131820

Gradation		
Wearing	Retained on 3/4	0.0
	Retained on 3/8	11.0
	Retained on #4	37.9
	Passing #200	5.5
Binder	Retained on 3/4	1.1
	Retained on 3/8	22.1
	Retained on #4	46.2
	Passing #200	5.4
BCBC	Retained on 3/4	11.1
	Retained on 3/8	42.6
	Retained on #4	60.6
	Passing #200	5.1

General Properties		
Wearing	Pbe	7.7
	AV	10.3
Binder	Pbe	6.4
	AV	9.5
BCBC	Pbe	8.3
	AV	9.5

Binder G* and Delta			
PG 64-22	40		
	70		
	100		
	130		

Mixture D(t) and Strength				
Time	D(t), 1/psi			Strength, psi
	-20	-10	0	
1	1.9E-07	2.3E-07	2.9E-07	795
2	2.0E-07	2.4E-07	3.2E-07	
5	2.0E-07	2.7E-07	3.8E-07	
10	2.1E-07	2.9E-07	4.4E-07	
20	2.2E-07	3.2E-07	5.1E-07	
50	2.4E-07	3.7E-07	6.6E-07	
100	2.6E-07	4.3E-07	8.3E-07	