

Ohio DOT 2019 PG Binder Round Robin Results

PG 64-28	ODOT A	ODOT B	LAB #1	LAB #2	LAB #3	LAB #4	LAB #5	LAB #6	LAB #7	LAB #8	LAB #9	LAB #10	LAB #10B	LAB #11	LAB #12	LAB #13	LAB #14	LAB #15
ROTATIONAL VISCOSITY	0.438	0.432	0.407	0.398	0.375	0.427	0.402	0.419	0.431					0.425	0.400	0.413	0.395	0.455
PENETRATION	78	77	83	81	78	75	81	77	71			74		82	85	79	77	84
COMPLEX MODULUS	1.33	1.35	1.31	1.29	1.28	1.34	1.34	1.35	1.32	1.28	1.23	1.31		1.37	1.33	1.33	1.28	1.29
PHASE ANGLE	82.4	82.1	82.6	82.4	82.2	82.3	82.4	82.5	82.5	83.4	82.8	82.5		82.2	82.4	82.5	82.3	82.5
ORIGINAL DSR	1.35	1.37	1.32	1.30	1.29	1.35	1.35	1.36	1.33	1.29	1.24	1.32		1.39	1.35	1.34	1.29	1.30
COMPLEX MODULUS	3.56	3.62	3.60	3.01	3.33		3.64	3.58	3.58					3.47	3.16	3.37	3.32	3.32
PHASE ANGLE	74.7	74.3	74.8	75.9	75.4		74.5	74.7	74.7					75.0	75.2	75.0	74.8	75.2
RTFO DSR	3.69	3.76	3.73	3.10	3.44		3.77	3.71	3.71					3.59	3.27	3.49	3.44	3.43
MASS CHANGE %	-0.268	-0.357	-0.261	-0.256	-0.210		-0.293	-0.789	-0.193					-0.186	-0.216	-0.208	0.198	-0.304
PAV WITH VDO																		
PHASE ANGLE	39.2	40.5	41.3	40.9	41.0		42.8	46.2	42.9					38.4	40.2		40.7	39.8
PAV DSR	3500	2920	3210	3056	2508		2810	3234	2790					3279	3210		3060	3500
ESTIMATED STIFF 1	209	208	203	195	204		197	183	191					164	205		199	224
ESTIMATED STIFF 2	219	203	206	194	206		197	174	189					213	205		202	221
AVERAGE EST STIFF	214.0	205.5	204.5	194.5	205.0		197.0	178.5	190.0					188.5	205.0		200.5	222.5
RANGE	-10	5	-3	1	-2		0	9	2					-49	0		-3	3
M-VALUE 1	0.307	0.312	0.317	0.304	0.300		0.321	0.314	0.317					0.304	0.321		0.312	0.309
M-VALUE 2	0.306	0.314	0.310	0.310	0.302		0.324	0.313	0.322					0.303	0.318		0.310	0.310
AVERAGE M-VALUE	0.307	0.313	0.314	0.307	0.301		0.323	0.314	0.320					0.304	0.320		0.311	0.310
RANGE	0.001	-0.002	0.007	-0.006	-0.002		-0.003	0.001	-0.005					0.001	0.003		0.002	-0.001

PG 70-22M																		
ROTATIONAL VISCOSITY	0.900	0.862	0.850	0.846	0.825	0.868	0.868	0.859	0.909					1.013	0.800	0.833	0.850	0.963
COMPLEX MODULUS	1.64	1.60	1.60	1.56	1.58	1.67	1.63	1.60	1.52	1.58	1.64	1.59		1.59	1.65	1.60	1.55	1.67
PHASE ANGLE	75.0	74.8	75.1	75.1	74.8	74.7	74.9	75.1	75.1	75.8	75.4	74.0		75.0	74.9	75.1	74.8	74.9
ORIGINAL DSR	1.69	1.66	1.65	1.61	1.63	1.73	1.69	1.66	1.57	1.63	1.70	1.65		1.64	1.71	1.66	1.60	1.73
COMPLEX MODULUS	4.25	4.21	4.17	3.89	3.90		4.60	4.39	4.08					4.12	4.03	3.91	3.92	3.89
PHASE ANGLE	66.5	66.4	66.2	66.6	66.6		65.5	65.9	66.3					66.3	66.2	67.0	66.2	66.9
RTFO DSR	4.63	4.60	4.55	4.24	4.25		5.05	4.81	4.45					4.50	4.41	4.25	4.28	4.22
ELASTIC RECOVERY	70.1	69.9	69.0	70.0	68.0		68.1	68.0	68.5					70.0		70.0	69.2	73.0
PAV WITH VDO																		
PHASE ANGLE	44.9	43.5	45.4	44.6	44.9		45.0	44.6	45.7					43.7	44.3		44.2	44.3
PAV DSR	2170	2610	2520	2559	2223		2500	2453	2400					2310	2160		2500	2950
ESTIMATED STIFF 1	150	140	150	152	153		151	100	145					146	120		156	157
ESTIMATED STIFF 2	155	148	148	152	156		148	147	150					142	134		153	161
AVERAGE EST STIFF	152.5	144.0	149.0	152.0	154.5		149.5	123.5	147.5					144.0	127.0		154.5	159.0
RANGE	-5	-8	2	0	-3		3	-47	-5					4	-14		3	-4
M-VALUE 1	0.330	0.329	0.324	0.316	0.316		0.329	0.329	0.325					0.321	0.324		0.318	0.329
M-VALUE 2	0.327	0.332	0.334	0.316	0.317		0.331	0.331	0.330					0.316	0.322		0.317	0.321
AVERAGE M-VALUE	0.329	0.320	0.329	0.316	0.317		0.330	0.330	0.328					0.319	0.323		0.318	0.325
RANGE	0.003	-0.003	-0.010	0.000	-0.001		-0.002	-0.002	-0.005					0.005	0.002		0.001	0.008
MSCR at 58 °C on RTFO																		
Avg % Recovery @ 3.2 kPa	14.48	13.32	14.06	9.33	10.60		4.32	14.47	13.45					15.00	12.78	12.66	11.63	11.66
Jnr @ 3.2 kPa	0.85	0.87	0.84	1.14	1.08		2.30	0.89	0.87					0.85	0.98	0.95	1.00	0.99
% Diff. between Jnr	37.53	33.81	37.10	36.31	40.60		45.35	32.41	33.59					36.18	36.27	35.00	35.40	35.29
MSCR at 64 °C on RTFO																		
Avg % Recovery @ 3.2 kPa	56.59	57.36	55.17	50.66	53.50		57.10	26.26	51.11					60.43	52.96	49.76	50.99	49.87
Jnr @ 3.2 kPa	0.30	0.27	0.33	0.40	0.35		0.29	0.39	0.38					0.23	0.36	0.41	0.39	0.41
% Diff. between Jnr	38.51	36.63	41.03	43.64	51.60		22.23	76.26	38.51					35.20	40.88	28.79	38.77	43.85
O DSR ELASTIC RECOVERY	43.90	47.39							42.00								39.90	44.60
R DSR ELASTIC RECOVERY	51.20	44.27	42.30						55.80								41.60	57.80

Between 1 & 2 Std. Dev
Greater than 2 Std Dev

Ohio DOT 2019 PG Binder

PG 64-28	LAB #16	LAB #17	LAB #18A	LAB #18B	LAB #19	LAB #20	LAB #21	LAB #22	LAB #23	LAB #24	LAB #25	LAB #26	LAB #27	LAB #28	LAB #29	LAB #30	LAB #31	LAB #32
ROTATIONAL VISCOSITY		0.420		0.425	0.368	0.410		0.413	0.420	0.418	0.415	0.400	0.415	0.408	0.357	0.415		
PENETRATION		81			78	79		79	82	78	76	83	81	83	75	83		
COMPLEX MODULUS	1.37	1.33		1.39	1.29	1.30		1.29	1.29	1.34	1.36	1.37	1.29	1.31	1.33	1.34		1.48
PHASE ANGLE	82.3	82.4		82.2	82.6	82.4		82.5	82.3	82.4	82.2	82.3	82.5	82.5	82.4	82.3		81.9
ORIGINAL DSR	1.38	1.34		1.40	1.30	1.31		1.30	1.30	1.35	1.37	1.38	1.30	1.33	1.34	1.34		1.49
COMPLEX MODULUS		3.38			3.31	3.36		3.28	3.13	3.70	3.22	3.29	3.43	3.01	3.67	3.68		
PHASE ANGLE		75.3			74.9	75.0		75.1	75.7	74.0	75.3	75.5	74.9	75.3	74.6	74.3		
RTFO DSR		3.49			3.43	3.48		3.39	3.23	3.85	3.33	3.40	3.55	3.11	3.54	3.82		
MASS CHANGE %		-0.237			-0.213	-0.216		-0.226	-0.223	-0.222	-0.185	-0.198	-0.205	-0.241	-0.262	-0.249		
PAV WITH VDO																		
PHASE ANGLE		41.6			40.7	41.8		41.6	42.7	42.7	41.3	43.8	39.7	41.9	41.9	41.1		
PAV DSR		2800			3170	2465		2783	2932	2560	2890	2720	3156	2787	2882	3170		
ESTIMATED STIFF 1		194			203	185		205	198	193	193	187	205	182	203	217		
ESTIMATED STIFF 2		183			206	188		208	196	193	188	187	208	177	206	217		
AVERAGE EST STIFF		188.5			204.5	186.5		206.5	197.0	193.0	190.5	187.0	206.5	179.5	204.5	217.0		
RANGE		11			-3	-3		-3	2	0	5	0	-3	5	-3	0		
M-VALUE 1		0.317			0.305	0.314		0.309	0.313	0.315	0.319	0.319	0.303	0.315	0.318	0.290		
M-VALUE 2		0.317			0.302	0.312		0.309	0.314	0.316	0.322	0.323	0.311	0.317	0.314	0.292		
AVERAGE M-VALUE		0.317			0.304	0.313		0.309	0.314	0.316	0.321	0.321	0.307	0.316	0.316	0.291		
RANGE		0.000			0.003	0.002		0.000	-0.001	-0.001	-0.003	-0.004	-0.008	-0.002	0.004	-0.002		

PG 70-22M																		
ROTATIONAL VISCOSITY		0.840		0.872	0.748	0.868		0.865	0.885	0.876	0.840	0.850	0.887	0.863	0.855	0.847		
COMPLEX MODULUS	1.69	1.63		1.68	1.56	1.58		1.59	1.55	1.61	1.63	1.63	1.61	1.64	1.66	1.64		1.82
PHASE ANGLE	74.7	74.8		74.8	75.1	75.0		74.9	75.0	75.0	74.8	74.9	75.0	75.0	74.7	74.7		74.4
ORIGINAL DSR	1.76	1.69		1.73	1.62	1.64		1.65	1.60	1.67	1.69	1.69	1.67	1.70	1.73	1.71		1.89
COMPLEX MODULUS		4.12			3.67	3.77		3.71	3.81	4.54	3.67	4.01	4.10	3.78	3.75	3.91		
PHASE ANGLE		66.5			67.1	67.0		66.9	66.7	65.5	67.3	66.4	66.3	67.0	66.5	66.8		
RTFO DSR		4.49			3.98	4.10		4.03	4.15	4.99	3.97	4.37	4.48	4.10	4.09	4.25		
ELASTIC RECOVERY		68.0						67.5	66.5	65.0		69.4	68.0		85.0	70.0		
PAV WITH VDO																		
PHASE ANGLE		44.4			45.5	44.5		45.9	45.5	46.3	45.4	46.9	43.4	47.3	45.4	46.2		
PAV DSR		2490			2590	1789		2255	2489	1940	2560	2330	2425	2291	2449	2210		
ESTIMATED STIFF 1		139			148	146		143	149	149	148	150	141	128	143	145		
ESTIMATED STIFF 2		147			144	143		143	150	143	143	141	143	133	151	149		
AVERAGE EST STIFF		143.0			146.0	144.5		143.0	149.5	146.0	145.5	145.5	142.0	130.5	147.0	147.0		
RANGE		-8			0	3		0	-1	6	5	9	-2	-5	-8	-4		
M-VALUE 1		0.329			0.325	0.315		0.334	0.326	0.330	0.322	0.342	0.324	0.343	0.330	0.329		
M-VALUE 2		0.324			0.326	0.317		0.340	0.324	0.321	0.325	0.336	0.323	0.340	0.333	0.328		
AVERAGE M-VALUE		0.327			0.326	0.316		0.337	0.325	0.326	0.324	0.339	0.324	0.342	0.332	0.329		
RANGE		0.005			-0.001	-0.002		-0.006	0.002	0.009	-0.003	0.006	0.001	0.003	-0.003	0.001		
MSCR at 58 °C on RTFO																		
Avg % Recovery @ 3.2 kPa		11.59			4.65	11.53		12.76	12.26	15.31	65.89	3.19	12.69	11.03	13.69	15.40		
Jnr @ 3.2 kPa		0.98			2.41	0.99		0.99	0.99	0.82	0.14	2.63	0.94	1.00	0.92	0.84		
% Diff. between Jnr		37.02			36.90	34.43		37.73	35.53	38.94	29.27	41.31	34.38	44.18	35.28	39.87		
MSCR at 64 °C on RTFO																		
Avg % Recovery @ 3.2 kPa		49.33			51.84	47.89		50.98	51.60	57.90	49.85	51.77	52.81	49.68	53.28	47.98		
Jnr @ 3.2 kPa		0.40			0.39	0.44		0.42	0.39	0.28	0.43	0.37	0.36	0.42	0.38	0.45		
% Diff. between Jnr		38.90			19.62	40.27		45.77	38.78	38.14	42.38	41.16	39.98	64.90	42.50	47.86		
O DSR ELASTIC RECOVERY		41.20				40.10				37.20		36.70			55.80	43.20		
R DSR ELASTIC RECOVERY		44.80				40.90				39.80		39.80			68.80	47.90		

Between 1 & 2 Std. Dev

Greater than 2 Std Dev

Ohio DOT 2019 PG Binder

PG 64-28	LAB #33	LAB #34	LAB #35	LAB #36	LAB #37	LAB #38	LAB #39	AVG	2 STD DEV	1 STD DEV	STD DEV	1 STD DEV	2 STD DEV
ROTATIONAL VISCOSITY	0.418	0.435	0.460	0.402	0.420	0.398	0.427	0.4136	0.3720	0.3928	0.0208	0.4344	0.4552
PENETRATION	78	73	81	83	80	73	82	79.147	72.284	75.715	3.432	82.579	86.010
COMPLEX MODULUS	1.32	2.86	1.31	1.33	1.33	1.35	1.33	1.365	0.874	1.119	0.246	1.611	1.857
PHASE ANGLE	82.2	78.4	82.4	82.3	82.5	82.3	82.5	82.30	80.96	81.63	0.67	82.97	83.65
ORIGINAL DSR	1.33	2.92	1.32	1.33	1.34	1.35	1.34	1.377	0.870	1.123	0.254	1.630	1.884
COMPLEX MODULUS	3.46	3.31	3.41	3.20	3.37	3.28	3.38	3.388	3.023	3.206	0.183	3.571	3.754
PHASE ANGLE	74.8	75.1	74.9	75.5	75.1	75.3	75.2	75.00	74.19	74.59	0.41	75.41	75.81
RTFO DSR	3.59	3.42	3.53	3.31	3.49	3.39	3.49	3.499	3.124	3.312	0.188	3.687	3.874
MASS CHANGE %	-0.267	-0.269	-0.191	-0.243	-0.241	-0.176	-0.258	-0.240	-0.499	-0.369	0.130	-0.110	0.020
PAV WITH VDO													
PHASE ANGLE	42.1	41.8	44.4	43.1	40.8	42.7	42.4	41.677	38.600	40.139	1.538	43.216	44.754
PAV DSR	2710	2870	2460	2977	3360	2585	2751	2938.871	2370.821	2654.846	284.025	3222.896	3506.921
ESTIMATED STIFF 1	178	195	192	197	208	202	195	197.2	174.2	185.7	11.5	208.8	220.3
ESTIMATED STIFF 2	182	188	198	201	212	203	190	198.7	174.8	186.8	11.9	210.7	222.6
AVERAGE EST STIFF	180.0	191.5	195.0	199.0	210.0	202.5	192.5	198.0	176.6	187.3	10.7	208.6	219.3
RANGE	-4	7	-6	-4	-4	-1	5	-1.5	-21.0	-11.2	9.8	8.3	18.0
M-VALUE 1	0.317	0.306	0.323	0.320	0.314	0.321	0.320	0.313	0.298	0.305	0.007	0.320	0.328
M-VALUE 2	0.319	0.310	0.319	0.316	0.311	0.321	0.316	0.313	0.299	0.306	0.007	0.320	0.327
AVERAGE M-VALUE	0.318	0.308	0.321	0.318	0.313	0.321	0.318	0.3129	0.2989	0.3059	0.0070	0.3199	0.3269
RANGE	-0.002	-0.004	0.004	0.004	0.003	0.000	0.004	-0.0002	-0.0069	-0.0036	0.0033	0.0031	0.0065
PG 70-22M								AVG	2 STD DEV	1 STD DEV	STD DEV	1 STD DEV	2 STD DEV
ROTATIONAL VISCOSITY	0.860	0.941	0.980	0.860	0.865	0.838	0.833	0.8682	0.7715	0.8199	0.0484	0.9166	0.9649
COMPLEX MODULUS	1.66	1.65	1.64	1.62	1.58	1.63	1.64	1.621	1.520	1.570	0.050	1.671	1.722
PHASE ANGLE	74.7	74.9	74.7	75.2	75.1	74.9	75.0	74.92	74.38	74.65	0.27	75.19	75.46
ORIGINAL DSR	1.72	1.71	1.70	1.68	1.64	1.69	1.70	1.679	1.571	1.625	0.054	1.733	1.787
COMPLEX MODULUS	4.19	4.27	4.24	3.87	4.10	3.90	4.03	4.025	3.560	3.793	0.232	4.257	4.490
PHASE ANGLE	66.2	66.2	65.9	67.0	66.3	66.7	66.5	66.48	65.63	66.05	0.43	66.91	67.34
RTFO DSR	4.59	4.67	4.64	4.10	4.47	4.25	4.40	4.386	3.846	4.116	0.270	4.656	4.927
ELASTIC RECOVERY	70.0	67.5	67.5	67.3		67.5	68.0	69.3	62.3	65.8	3.5	72.8	76.3
PAV WITH VDO													
PHASE ANGLE	45.1	45.3	46.4	46.6	45.2	45.7	47.0	45.3	43.3	44.3	1.0	46.3	47.2
PAV DSR	2370	2510	2371	2262	2580	2310	2245	2381.3	1958.6	2169.9	211.4	2592.7	2804.1
ESTIMATED STIFF 1	130	143	147	149	147	147	147	143.8	121.7	132.8	11.0	154.9	165.9
ESTIMATED STIFF 2	132	147	147	144	144	153	145	146.3	133.7	140.0	6.3	152.6	158.9
AVERAGE EST STIFF	131.0	145.0	147.0	146.5	145.5	150.0	146.0	145.1	129.8	137.5	7.6	152.7	160.3
RANGE	-2	-4	0	5	3	-6	2	-2.6	-21.6	-12.1	9.5	6.9	16.4
M-VALUE 1	0.327	0.327	0.335	0.334	0.336	0.332	0.334	0.328	0.314	0.321	0.007	0.335	0.341
M-VALUE 2	0.331	0.321	0.334	0.334	0.338	0.333	0.333	0.328	0.313	0.320	0.007	0.335	0.342
AVERAGE M-VALUE	0.329	0.324	0.335	0.334	0.337	0.333	0.334	0.3274	0.3139	0.3207	0.0067	0.3341	0.3408
RANGE	-0.004	0.006	0.001	0.000	-0.002	-0.001	0.001	0.0003	-0.0081	-0.0039	0.0042	0.0045	0.0087
MSCR at 58 °C on RTFO													
Avg % Recovery @ 3.2 kPa	13.76	12.05	13.63	12.37	13.08	11.34	4.40	13.387	-6.507	3.440	9.947	23.334	33.280
Jnr @ 3.2 kPa	0.90	0.98	0.86	1.02	0.93	1.00	2.45	1.106	0.042	0.574	0.532	1.639	2.171
% Diff. between Jnr	34.99	43.40	38.36	35.42	33.80	34.70	45.50	37.058	29.683	33.371	3.687	40.745	44.432
MSCR at 64 °C on RTFO													
Avg % Recovery @ 3.2 kPa	54.26	54.62	53.71	51.31	53.28	50.26	53.00	51.785	40.922	46.353	5.431	57.216	62.647
Jnr @ 3.2 kPa	0.33	0.34	0.33	0.40	0.35	0.40	0.37	0.367	0.265	0.316	0.051	0.419	0.470
% Diff. between Jnr	39.59	54.41	41.19	24.46	24.80	42.43	40.90	40.748	19.007	29.877	10.871	51.619	62.490
O DSR ELASTIC RECOVERY		46.60						43.22	33.308	38.262	4.954	48.170	53.124
R DSR ELASTIC RECOVERY		55.50						48.50	31.534	40.016	8.482	56.980	65.462

Between 1 & 2 Std. Dev
Greater than 2 Std Dev