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جامعة الملك فهد للبترول والمعادن

CE 442

CONSTRUCTION AND MAINTENANCE OF
HIGHWAYS AND AIRPORTS

HW No. 4

Marshall mix design were carried out to design the wearing course and base course for Dhahran –Dammam expressway following the Ministry of Transport Method MOT. The results of mix design are shown in Figure 1 for Wearing course and Figure 2 for base course including calculations. Determine the optimum asphalt content for wearing course and base course. Explain design philosophy and present your answer using engineering Figures.

Bulk Sp.Gr of Each Aggregate Gradation (Gsb)=	2.58	2.58	2.59	2.78	0.00										
Used Percentage of Each Aggregate Gradation =	24.00	36.00	35.00	5.00	0.00										
Combined Bulk Sp.Gr of Agg.(Gsb)=	2.594														
Percent of AC at Approximate Optimum =	5.000														
Max. Sp.Gr. At Approximate Optimum =	2.430														
Specific Gravity of Asphalt(Gb) =	1.026														
Effective Sp.Gr of Agg (Gse) =	2.619														
Asphalt Absorbtion,% (Pba) =	0.375														
% Bitumin by Wt. of Mix	4.00			4.50			5.00			5.50			6.00		
% Effective Bit. by Wt. of Mix(Pbe).	3.64			4.14			4.64			5.15			5.65		
Trial No.	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
I.Sp.Gr Determenition															

Specimen No.	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0
Dry Wt. in Air,gm.	1229.0	1230.5	1201.1	1236.7	1211.8	1236.8	1248.5	1259.8	1225.6	1206.7	1251.8	1257.2	1259.3	1237.0	1225.1
Sur. dry Wt. in Air,gm.	1232.9	1235.3	1203.7	1238.5	1213.9	1238.6	1250.5	1262.1	1227.4	1208.1	1252.8	1258.7	1261.1	1238.2	1227.1
Wt. in Water,gm.	702.6	704.1	684.2	707.1	692.8	705.9	711.5	719.0	700.2	684.9	710.4	714.5	712.8	700.5	694.7
Volume,cc.	530.300	531.200	519.500	531.400	521.100	532.700	539.000	543.100	527.200	523.200	542.400	544.200	548.300	537.700	532.440
Bulk sp.Gr.	2.318	2.316	2.312	2.327	2.325	2.322	2.316	2.320	2.325	2.306	2.308	2.310	2.297	2.301	2.301
Average Sp.Gr.		2.315			2.325			2.320			2.308				2.299
II.Void Analysis															

Max. Sp.Gr.		2.466			2.448			2.430			2.413				2.395
% Air Voids	6.001	6.046	6.225	4.918	4.991	5.143	4.678	4.541	4.332	4.404	4.341	4.246	4.123	3.964	3.948
Average Air Voids %		6.091			5.017			4.517			4.330			4.012	
% Voids Mineral Agg.(VMA)	14.2236	14.2644156	14.4281	14.313479	14.379142	14.51568	15.1621382	15.0405418	14.8541895	15.9708997	15.9159924	15.83258848	16.765162	16.627304	16.613634
Avg.% Voids Mineral Agg.(VMA)		14.305			14.403			15.019			15.906			16.669	
% Voids Filled	63.523346	63.311441	62.473683	71.312023	70.931974	70.15274	74.4495325	69.80629135	70.8370774	72.4279563	72.7253094	73.18093378	75.4091601	76.160313	76.235477
Average % Voids Filled		63.103			70.799			71.698			72.778			75.935	

Figure 1. Asphalt Concrete Wearing Course Mixtures Design Using Marshall Method

Bulk Sp.Gr of Each Aggregate Gradation (Gsb)=	2.60	2.58	2.58	2.59	2.78											
Used Percentage of Each Aggregate Gradation =	30.00	8.00	24.00	34.00	4.00											
Combined Bulk Sp.Gr of Agg.(Gsb)=	2.597															
Percent of AC at Approximate Optimum =	4.500															
Max. Sp.Gr. At Approximate Optimum =	2.455															
Specific Gravity of Asphalt(Gb) =	1.026															
Effective Sp.Gr of Agg (Gse) =	2.627															
Asphalt Absorbtion,% (Pba) =	0.463															
% Bitumin by Wt. of Mix	3.50				4.00				4.50							5.50
% Effective Bit. by Wt. of Mix(Pbe).	3.05				3.56				4.06							4.56
Trial No.	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
I.Sp.Gr Determenition																
Specimen No.	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0	
Dry Wt. in Air,gm.	1233.8	1232.3	1217.2	1323.4	1289.7	1192.1	1188.1	1194.6	1215.4	1251.3	1290.4	1242.1	1249.0	1265.4	1243.3	
Sur. dry Wt. in Air,gm.	1236.5	1233.9	1219.2	1325.3	1291.6	1194.5	1190.0	1196.2	1216.9	1252.0	1291.6	1243.2	1252.8	1268.3	1244.3	
Wt. in Water,gm.	703.5	700.8	693.6	756.6	736.5	679.0	680.8	682.7	696.6	712.3	736.2	707.7	710.2	722.4	706.6	
Volume,cc.	533.000	533.100	525.600	568.700	555.100	515.500	509.200	513.500	520.300	539.700	555.400	535.500	542.600	545.900	537.700	
Bulk sp.Gr.	2.315	2.312	2.316	2.327	2.323	2.313	2.333	2.326	2.336	2.319	2.323	2.320	2.302	2.318	2.312	
Average Sp.Gr.		2.314			2.321			2.332			2.320			2.311		
II.Void Analysis																
Max. Sp.Gr.		2.491			2.473			2.455			2.437			2.420		
% Air Voids	7.085	7.215	7.045	5.903	6.052	6.491	4.959	5.239	4.849	4.871	4.672	4.830	4.870	4.203	4.441	
Average Air Voids %		7.115			6.148			5.015			4.791			4.505		
% Voids Mineral Agg.(VMA)	13.972848	14.0935541	13.935396	13.966061	14.102727	14.50397	14.1859013	14.43894974	14.086888	15.1751101	14.9972929	15.1383709	16.2267951	15.639875	15.849175	
Avg.% Voids Mineral Agg.(VMA)		14.001			14.191			14.237			15.104			15.905		
% Voids Filled	56.513641	55.9510092	56.690194	64.960088	64.228387	62.1598	72.1394487	63.71760427	65.5787787	67.9014127	68.8505224	68.09568281	69.9902537	73.12555	71.98084	
Average % Voids Filled		56.385			63.783			67.145			68.283			71.699		
III.Stability Determination																
Dial Reading	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Stability (measured),Kg.	1402	1387	1355	1655	1586	1635	1600	1552	1510	1335	1394	1404	1153	1205	1176	
Height of specimen,mm.	63.1	63.5	63.2	64.5	63.6	62.1	62.3	62.9	63.2	63.8	63.5	64	63.9	64.1	64	
Height of specimen,in.	2.484252	2.5	2.488189	2.5393701	2.503937	2.444882	2.45275591	2.476377953	2.48818898	2.51181102	2.5	2.519685039	2.51574803	2.523622	2.519685	
Correction Factor	1.014739	1.00075863	1.0112223	0.9667903	0.9972992	1.050718	1.04340199	1.021815912	1.0112223	0.99042271	1.00075863	0.983601995	0.98700541	0.9802124	0.983602	
Corrected Stability,Kg.	1422.664	1388.05222	1370.2062	1600.038	1581.7166	1717.924	1669.44318	1585.858295	1526.94567	1322.21431	1395.05753	1380.977201	1138.01724	1181.1559	1156.7159	
Avg. Stability,Kg.		1393.641			1633.226			1594.082			1366.083			1158.630		
Flow,1/100 in.(Failure)	2.5	2.4	2.8	2.9	3.3	2.5	3	4	3.4	4.5	4.5	3.5	5	5.4	5.7	
Avg.Flow		2.567			2.900			3.467			4.167			5.367		

Figure 2. Asphalt Concrete Base Course Mixtures Design Using Marshall Method