Research of AC - 20 asphalt mixture proportioning design on northern end of the capital airport F sliding

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ABSTRACT: Because of the large load and large impact force of airport pavement under, it often appears the phenomenon of serious rut. In order to improve this kind of phenomenon, combined with the capital F slide northern area reconstruction project, we analyze the lower layer type of AC-20 modified asphalt mixture ratio design. We analysis from raw material selection, mixture gradation design and admixture added, and finally choose the excellent performance of asphalt mixture.
KEYWORD: airport pavement; asphalt mixtures; Marshall Mix; road performance; rut

1 INTRODUCTION

In a survey of the airport, we find that most of the airport is the emergence of the phenomenon of rutting, it serious impacts on the pavement service, and brings great trouble to the normal operation of the aircraft ; combined with the capital F slide northern area reconstruction project , we analyze the lower layer type of AC-20 modified asphalt mixture ratio design , so we can find he excellent performance of asphalt mixture to improve the performance of high temperature and water temperature of airport pavement.

2 RAW MATERIALS

2.1 *Aggregate*

There are limestone aggregates, we teste the aggregate indexes in accordance with the relevant regulations, the test results are shown in table 1.

Table 1. The Basalt Coarse aggregate technical indicators

Test items		Test results	Technical requirements	Test method
Bulk specific gravity	15~25mm	2.789	—	T 0304
	10~20mm	2.786		
	5~10mm	2.799		
	3~5mm	2.715		
Apparent specific gravity	15~25mm	2.835	≥2.50	T 0304
	10~20mm	2.830		
	5~10mm	2.831		
	3~5mm	2.805		

From table 1, we can see all the technical indicators of the limestone coarse aggregate meet the specification requirements, and they can be used in the design and engineering.

Table 2. The Basalt Coarse aggregate Particle gradation

mesh size (mm)	P (%)							
	15~25mm		10~20mm		5~10mm		3~5mm	
	Technical requirements	Test results	Technical requirements	Test results	Technical requirements	Test results	Technical requirements	Test results
31.5	100		—		—		—	
26.5	95~100	100	100	100	—		—	
19	—	72.9	95~100	100	—		—	
16	—	39.2	—	88.2	—	100	—	
13.2	0~15	7.3	—	53.2	100	100	—	
9.5	—	1.5	0~15	16.2	95~100	98.7	100	100
4.75	0~5	0.6	0~5	1.8	0~10	45.6	85~100	99.8
2.36	—	0.6	—	1.3	0~5	17.1	0~25	32.4
1.18	—	0	—	0	—	11.3		6.5
0.6	—	0	—	0	—	8.3	0~5	3.2
0.3	—	0	—	0	—	7		2.8
0.15	—	0	—	0	—	0		2.6
0.075	—	0	—	0	—	0		2.5

From table 2, we can see some passing rate of limestone coarse aggregate can not meet the requirements of specification. We should strictly control the quality of the aggregate in the construction in order to make the passing rate and meet the specification requirements.

Table 3. The Basalt FINE aggregate technical indicators

Test items	Technical requirements	Test results
		0~3mm
Apparent specific gravity(g/cm^3)	≥2.50	2.794
Sand equivalent (%)	≥60	78
Sturdiness (%)	≤12	3.6

Table 4. The Basalt FINE aggregate Particle gradation

mesh size (mm)	P(%)	
	0~3mm	
	Technical requirements	Test results
9.5		100
4.75	100	100
2.36	85~100	82.0
1.18		53.6
0.6	20~50	36.9
0.3		27.1
0.15		22.8
0.075	0~15	18.7

From table 3 and table 5, we can see some passing rate of limestone fine aggregate can not meet the requirements of specification. We should strictly control the quality of the aggregate in the construction in order to make the passing rate and meet the specification requirements.

2.2 *Filler*

The filler is milled limestone powder, they all meet the technical requirements, the test results are shown in the table 5.

Table 5. The Mineral filler technical indicators

Test items		Technical requirements	Test results
Apparent specific gravity(g/cm^3)		≥2.50	2.774
Water content(%)		≤1	0.14
Particle gradation	<0.6mm	100	99.6
	<0.15mm	90~100	96.5
	<0.075mm	75~100	83.9
Hydrophilic coefficient		≤1	0.7

From the chart, we can see filler technical indexes meets the specification requirements, it can be used in the design and engineering.

2.3 *Asphalt*

There are Cnooc modified asphalt, we test the asphalt indexes in accordance with the relevant regulations, they all meet the technical requirements as shown in table 6.

Table 6. Cnooc modified asphalt performance test results

Test items		Technical requirements	Test results
Penetration(25℃, 100g, 5s)(0.1mm)		40~80	52.9
Softening point(℃)		>75	87.7
Ductility(5cm/min, 10℃)(cm)		>40	69.8
Equivalent softening point T_{800}(℃)		>50	57.6
Equivalent brittle point$T_{1.2}$(℃)		<-13	-16.3
Flash point(COC)(℃)		>250	271
Density (25℃)(g/cm^3)		actual measurement	1.002
Elastic recovery(15℃)		>75	97
Filmy heating operational test163℃/5h	Mass loss (%)	<1	0.022
	Penetration ratio (%)	>70	67.5
	Ductility(10℃)(cm)	>30	66.6

Test results show that the modified asphalt technology indexes meet the requirements.

2.4 *Anti-rutting agent*

Add 0.5% of the asphalt mixture quality anti-rutting agent can gain higher dynamic stability of mixture. Anti rutting agent basic indexes are tested in table 7.

Table 7. Anti rutting agent basic indexes test results

Test items	Technical requirements	Test results
Density (g/cm^3)	0.9~1.1	0.92
Melt flow rate(190℃, 2.16kg)(g/10min)	≥3	7~10
Water content (%)	≤2	0.2
Softening point(℃)	110~150℃	147

From the chart, we can see anti-rutting agent of all the indicators meet the technical requirements and it can be used in the design and engineering.

3 MIX DESIGN OF AC-20 ASPHALT MIXTURE

3.1 *Aggregate gradation design*

The mix design is adopted for the mineral aggregate gradation of skeleton dense structure. The matching is shown in table 8.

Table 8. Ac-20 ratio of mineral aggregate gradation

specifications	15~25mm	10~20mm	5~10mm	3~5mm	0~3mm	Powder
The percentage (%)	15	20	24	10	26	5

Synthetic mineral aggregate gradation is shown in table 9 and figure 1.

Table 9. AC-20 mineral synthesis aggregate gradation

Mesh size (mm)		31.5	26.5	19	16	13.2	9.5	4.75	2.36	1.18	0.6	0.3	0.15	0.075
p (%)	upper	100	100	100	90	80	72	58	46	34	27	20	14	8
	lower	100	100	95	75	62	52	38	28	20	15	10	6	4
	middle	100	100	97.5	82.5	71	62	48	37	27	21	15	10	6
	synthetic	100	100.0	95.9	88.5	76.7	68.2	52.4	34.1	22.3	16.9	14.0	11.0	9.3

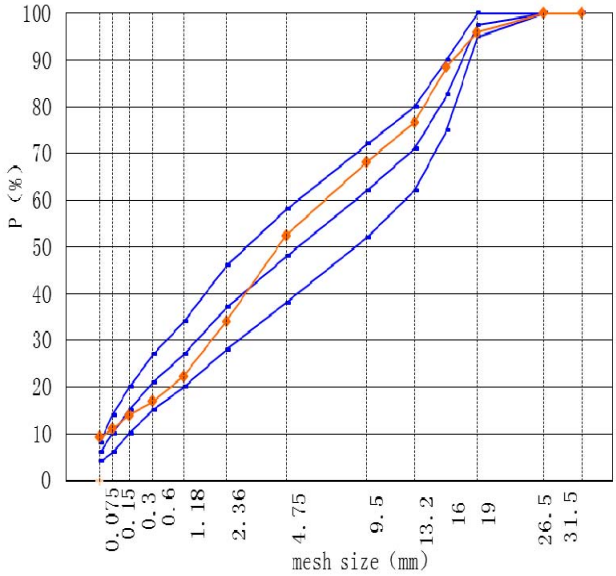


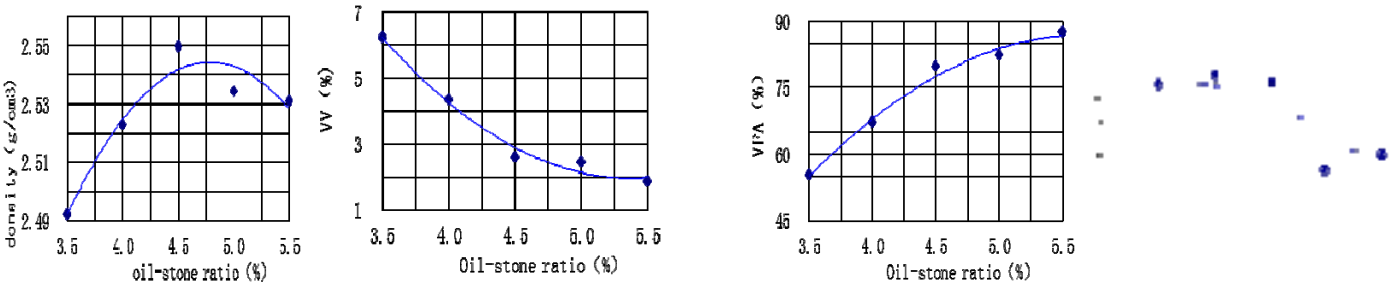
Figure 1. AC-20 grading curve

3.2 *The determination of the optimum proportion*

We select 5 asphalt aggregate ratio of Marshall test and calculate their physical indicators in order to determine the optimum proportion, the test results are shown in table 10 and figure 2.

Table 10. The Marshall test results of different asphalt aggregate ratio

Asphalt-aggregate ratio (%)	Theoretical density(g/cm^3)	Bulk density(g/cm^3)	VV (%)	VMA (%)	VFA (%)	MS(KN)	Flow value (0.1mm)
3.5	2.657	2.492	6.2	13.8	55.1	14.0	26.5
4.0	2.637	2.523	4.3	13.2	67.0	14.3	26.2
4.5	2.617	2.550	2.6	12.6	79.6	14.1	31.3
5.0	2.598	2.534	2.5	13.6	82.0	11.4	29.1
5.5	2.580	2.531	1.9	14.0	87.3	11.8	29.2
Technical requirements	—	—	3~5	≥13	65~75	>8	15~40



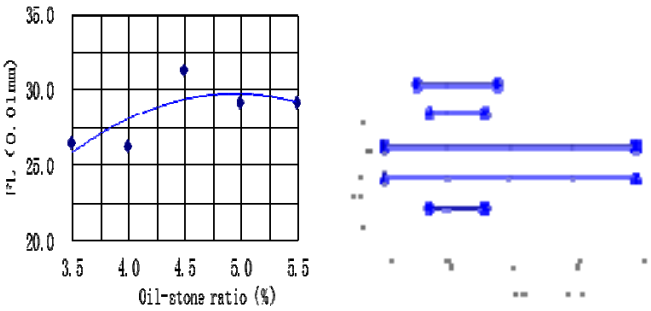


Figure 2. The determination of AC-20 optimum proportion

According to the requirements of the relevant specification, calculated the optimum proportion of 4.1%.

3.3 *Road performance verification*

We make road performance of verification AC-20 asphalt mixture in the optimum asphalt aggregate ratio of 4.1%, the test results are shown in table 11.

Table 11. The Road performance verification test results

Test items	Test results	Technical requirements
MS(KN)	13.0	>8
FL(0.1mm)	24.5	15~40
MSo(%)	87.7	≥80
TSR(%)	83.6	≥80
DS(time/mm)	11705	≥10000
Cw(mL/min)	No seepage	—

From the above test results, all the indexes can meet the requirements of related technologies in the optimum proportion 4.1%.

Adding anti-rutting agent quality of 0.5% asphalt mixture, dynamic stability of asphalt mixture arrives at 11705 times/mm, it meets the design requirements. We can see that the mixture has formed the skeleton dense structure from the profile of the specimen, it meets with the skeleton dense type AC asphalt mixture design intent.

4 CONCLUSION

For the analysis of AC - 20 mix proportion design of asphalt mixture, in order to improve the high temperature performance of asphalt mixture, we can adopt the following measures.

1) We should strictly control each index of the aggregate, all indicators are within the specification limits.

2) We should be reasonable to add additives, such as anti-rutting agent.

3) It is better to choose skeleton dense type of grading.

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