Test of AC - 20 asphalt mixture ratio on the runway of Da Lian Airport

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Abstract. After years of use, there's oil loss on the asphalt pavement . the bond strength of aggregate decreases . Loose threshing is serious. In order to improve the pavement performance, Extend the service life of pavement , Improve the safety of aircraft operation .we test the AC-20 modified asphalt mixture on the runway of Da Lian Airport from many factors , including raw materials, admixtures, gradation design, optimum ratio of oil to stone, then we find the best ways to resolve it .

1 Introduction

After years of use, there's oil loss on the asphalt pavement . the bond strength of aggregate decreases . Loose threshing is serious. In order to improve the pavement performance, Extend the service life of pavement , Improve the safety of aircraft operation .we test the AC-20 modified asphalt mixture on the runway of Da Lian Airport from many factors , including raw materials, admixtures, gradation design, optimum ratio of oil to stone, then we find the best ways to resolve it.

2 Raw materials

2.1 Aggregate

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

Table1. The Basalt Coarse aggregate technical indicators[1].

Test items		Test results	Technical requirements	Test method
Bulk specific gravity	15~25mm	2.715	≥2.50	T 0304
	10~20mm	2.676		
	5~10mm	2.643		
	3~5mm	2.693		
Apparent specific gravity	15~25mm	2.771	≥2.50	T 0304
	10~20mm	2.753		
	5~10mm	2.775		
	3~5mm	2.693		

From the chart, 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.

Table2. The Basalt Coarse aggregate Particle gradation[2].

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	—	52.9	95～100	100	—		—	
16	—	11.9	—	98.5	—	100	—	
13.2	0～15	0.8	—	80.2	100	100	—	
9.5	—	0.4	0～15	11.9	95～100	98.8	100	100

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4.75	0～5	0.4	0～5	0.3	0～10	17.1	85～100	97.8
2.36	—	0.4	—	0.3	0～5	1.0	0～25	29.3
1.18	—	0.4	—	0.3	—	1.0		11.1
0.6	—	0.4	—	0.3	—	1.0	0～5	5.3
0.3	—	0.4	—	0.3	—	1.0		2.9
0.15	—	0.4	—	0.3	—	1.0		2.1
0.075	—	0.4	—	0.3	—	1.0		0.6

From the chart, 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.

Table3. The Basalt FINE aggregate technical indicators[3].

Test items	Technical requirements	Test results
		0~3mm
Apparent specific gravity（g/cm^3）	≥2.50	2.671
Sand equivalent（%）	≥60	80
Sturdiness（%）	≤12	4.5

Table4. 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	92.3
1.18		56.1
0.6	20~50	37.8
0.3		19.2
0.15		12.1
0.075	0~15	2.9

From the chart, 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, and the test results are shown in the table below.

Table5. The Mineral filler technical indicators

Test items		Technical requirements	Test results
Apparent specific gravity（g/cm^3）		≥2.50	2.669
Water content（%）		≤1	0.6
Particle gradation	＜0.6mm	100	100
	＜0.15mm	90～100	99.5
	＜0.075mm	75～100	85.2
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.

Table6. Cnooc modified asphalt performance test results[4].

Test items		Technical requirements	Test results
Penetration（25℃，100g，5s）（0.1mm）		≤50	36.3
Softening point（℃）		＞80	88.3
Ductility（5cm/min，10℃）（cm）		＞40	48.3
Equivalent softening point T_{800}（℃）		＞50	61.0
Equivalent brittle point$T_{1.2}$（℃）		＜-13	-18.4
Flash point（COC）（℃）		＞250	277
Density （25℃）（g/cm^3）		Actual measurement	1.018
Elastic recovery（15℃）		＞80	92.3
Filmy heating operational test163℃/5h	Mass loss（%）	＜1	-0.04
	Penetration ratio（%）	＞70	75.6
	Ductility（10℃）（cm）	＞30	40.8

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 below.

Table7. Anti rutting agent basic indexes test results

Test items	Technical requirements	Test results
Density (g/cm^3)	0.92~1.1	0.96
Melt flow rate (190℃，2.16kg) (g/10min)	≥3	7~9
Water content（%）	＜2	0.5
Softening point（℃）	140~170℃	145

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.

2.5 Fiber

Fiber can get oil Absorption and reinforcement. Add 0.4% of the asphalt mixture quality fiber can gain higher dynamic stability and water damage resistance of mixture. Fiber agent basic indexes are tested in table below.

Table8. Fiber basic indexes test results

Test items	Technical requirements	Test results
Diameter （μm）	10~25	12.85
Length（mm）	6±1.5	6
Tensile strength（MPa）	≥500	546
Elongation at break（%）	≥15	20
Heat resistance（℃）	≥210℃, no change in volume	no change in volume

From the chart, we can see fiber 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 in table.

Table9. Ac-20 ratio of mineral aggregate gradation[5].

specifications	15~25 mm	10~20 mm	5~10 mm	3~5 mm	0~3 mm	Filler
The percentage（%）	15	30	20	4	30	6

Synthetic mineral aggregate gradation is shown in table and figure.

Table10. AC-20 mineral synthesis aggregate gradation

Mesh size (mm)	19	16	13.2	9.5	4.75	2.36	1.18	0.6	0.3	0.15	0.075
upper	100	90	80	72	58	46	34	27	20	14	8
lower	95	75	62	52	38	28	20	15	10	6	4
middle	97.5	82.5	71	62	48	37	27	21	15	10	6
synthetic	95.3	90.7	84.1	63.4	43.5	35.2	23.6	17.4	10.5	7.7	4.3

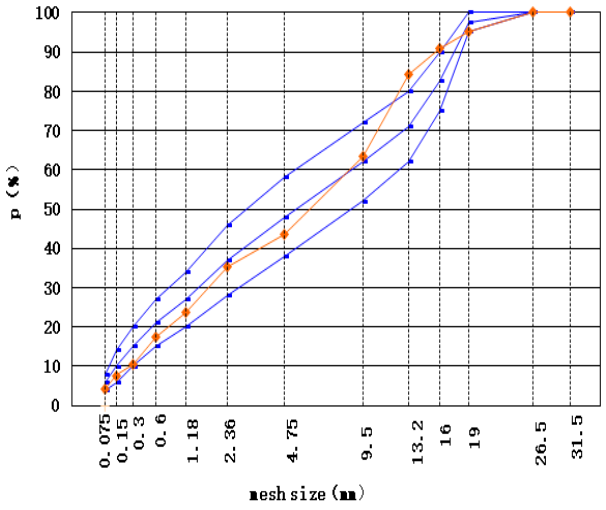

Figure 1. AC-20 grading curve

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 the table and figure below.

Table11. The Marshall test results of different asphalt aggregate ratio

Asphalt-aggregate ratio（%）	Theoretical density（g/cm³）	Bulk density（g/cm³）	VV（%）	VMA（%）	VFA（%）	MS（KN）	FL（0.1mm）
3.2	2.580	2.414	6.5	13.8	53.2	17.9	29.8
3.7	2.562	2.438	4.8	13.3	63.7	19.5	38.4
4.2	2.543	2.444	3.9	13.5	71.3	17.0	32.1
4.7	2.525	2.467	2.3	13.1	82.5	15.7	45.0
5.2	2.508	2.470	1.5	13.4	88.7	15.0	46.6
Technical requirements	—	—	3～5	≥13	65～75	＞9	20～40

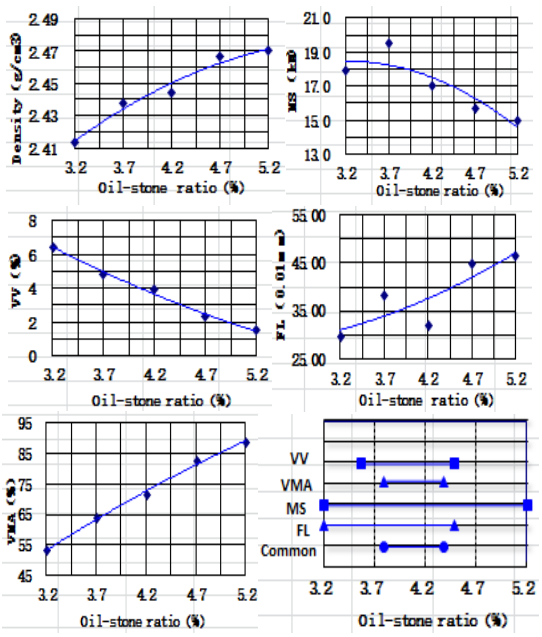

Figure 2. The determination of AC-20 optimum proportion

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 the table below.

Table12. The Road performance verification test results

Test items	Test results	Technical requirements
MS（KN）	17.5	＞8
FL（0.1mm）	33.4	20～40
MSo（%）	91.1	≥80
TSR（%）	92.8	≥80
DS（time/mm）	17077	≥10000
Cw（mL/min）	No seepage	—

MS is strength index, MSo and TSR are water damage resistance index, DS is high temperature performance index, Cw is water permeability index.

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 17077 times/mm, MS arrives at 17.5（KN）, FL arrives at 33.4（0.1mm）, MSo arrives at 91.1%, TSR arrives at 92.8%, Cw arrives at no seepage. They all meet 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, including aggregate, filler and asphalt. The important indicators of aggregate are bulk specific gravity, apparent specific gravity, sand equivalent, sturdiness and p%; The important indicators of filler are apparent specific gravity, water content, Particle gradation and hydrophilic coefficient; The important indicators of asphalt are penetration, softening point, ductility, equivalent softening point, equivalent brittle pointT1.2, flash point, density, elastic recovery and filmy heating operational test163℃/5h.

2) We should be reasonable to add additives, such as anti-rutting agent and fiber. The important indicators of anti-rutting agent are density, melt flow rate（190℃, 2.16kg）, water content and softening point; The important indicators of fiber are diameter, length, tensile strength, elongation at break and heat resistance.

3)it is better to choose skeleton dense type of grading, such as 15～25mm: 10～20mm: 5～10mm: 3～5mm: 0～3mm:fiber=15:30:20:4:30:6.

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