

# The KLMY90 # Asphalt and Its Mixture Performance Research for Gannan Area

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**Abstract.** Asphalt pavement is widely used at home and abroad because of its advantages of comfortable driving, convenient maintenance, short construction period, etc. Asphalt becomes brittle and is cracked in winter. Gannan is located in the plateau, belonging to plateau climate, low year-round temperature, often wind and rain, day and night temperature difference, strong sunlight. Therefore, the asphalt was selected with high temperature stability and low temperature ductility. The KLMY90# asphalt and its mixture were studied for the technical properties. The results showed: the content of saturates and aromatic components reduced at aging temperature; the saturated and aromatic content decreased at aging time; the saturated content decreased slowly than the content of aromatic content as the aging time decreasing; the dynamic stability increased with the asphalt-aggregate ratio; the asphalt mixture had superior performance, strong water resistance. The KLMY90# asphalt and its mixture were more suitable for paving roads for Gannan.

## 1 Introduction

Asphalt is a dark brown complex mixture composed of hydrocarbons of different molecular weights and their non-metal derivatives; it is soluble in carbon disulfide [1]. Asphalt pavement has many advantages such as comfortable driving, convenient maintenance, short construction period, easy maintenance, and no reflective driving at night [2-6]. There are many factors that affect the road performance of asphalt and asphalt mixtures, such as the nature of raw materials, climatic conditions, and composition of grading [2,3]. Gannan is located at the edge of the Qinghai-Tibet Plateau; the landforms are complex and diverse; the differences in elevation are obvious [7,8]. There is a great difference in the climate everywhere, and the asphalt is easy to crack. Therefore, the high-index asphalt is selected such as 90#, 110#; their softening point is lower, and the low-temperature ductility is good. The Shell Company makes a research on asphalt mixture with 100# asphalt. The penetration rate of bitumen is reduced to 70mm after experience mixing; the porosity is 3% to 12% after being laid on the road for 5 years [3]. The KLMY90# matrix asphalt and its mixture were studied to be suitable for the climate in Gannan region, and the reference basis put forward for the construction of asphalt pavement in this area.

## 2 Raw material test method and its technical performance indexes

### 2.1 KLMY90# asphalt technical indexes

The KLMY90 # asphalt's main technical indicators were tested according to the reference [9]. The results were shown in Table 1.

### 2.2 Aggregate and mineral powder

Coarse aggregates were available in 9.5 to 19mm, and 4.75 to 9.5mm; the technical specifications were shown in Table 2. Fine aggregates with an apparent density of 2.667g/cm<sup>3</sup> were selected. The technical specifications for ore powder and hydrated lime powder were shown in Table 3.

## 3 The Four-component

The chemical composition of KLMY90# asphalt was studied by changing rule of the four components of aged asphalt, which was tested by the method [9]. The design was as follows: (1) The asphalt four-component content was tested at the aging time for 5 hours under 153°C, 163°C, and 173°C respectively; the results were shown in Table 4; (2) the asphalt four-component content was tested at the aging time for 163°C at 5h, 10h and 15h respectively; the results were shown in Table 5.

**Table 1.** Technical Indexes Values of KLMY 90# Asphalt.

Items		The original asphalt	Test standard	Test basis
Penetration (0.1mm)	30	150.2	—	T0604-2000
	25	99.5	80~100	
	15	44.6	—	
Ductility (5cm/min,10°C,cm)		35.5	≤20	T0605-1993
Ductility (5cm/min,15°C,cm)		>100	≤100	-
Softening point (°C)		47.1	≤42	T0606-2000
Penetration index PI		0.753	-1.8~+1.0	T0604-2000
Density(15°C)		0.990	Actual measurement	T0603-1993
RTFOT (163°C,85min)	Quality loss (%)	0.4	-0.8~0.8	T0610-1993
	Penetration ratio (%)	69.02	≤54	
	Ductility (10°C),cm	8.13	≤6	

**Table 2.** Coarse aggregate technical indicators.

Items		Unit	Results	standard	Test basis
Aggregate abrasion value		%	17.5	≥35	T0317—2005
Aggregate crushing value		%	23.6	≥30	T0316—2005
Specific absorption of aggregate	9.5~16mm	%	0.686	≥3.0	T0304—2005
	4.75~9.5mm		1.172	≥3.0	
Needle flake particle concentration	Mixture	%	13.4	≥20	T0312—2005
And asphalt adhesion(boiled method)	The original asphalt	Level	2	—	T0616—1993
Aggregate volume relative density	9.5~16mm	—	2.620	—	T0304-2005
	4.75~9.5mm		2.590	—	
All kinds of aggregate apparent relative density	9.5~16mm	—	2.668	≤2.45	T0304-2005
	4.75~9.5mm		2.671	≤2.45	

**Table 3.** The results of mineral powder and hydrated lime powder.

Items		Results	standard	Test basis
Apparent relative density	Mineral powder	2.685	≤2.45	T0352-2000
	Hydrated lime powder	2.305	—	
Slag hydrophilicity coefficient		0.60	<1	T0353-2000

**Table 4.** The percentage of four components after bitumen changes with aging temperature.

Items	Standard (%)	Un-aged (%)	Aging time 5h, aging temperature 153°C,163°C,173°C (%)		
			153°C	163°C	173°C
Asphaltene	-	2.79	3.40	3.63	4.69
Saturates	12~27	26.92	26.91	26.90	26.84
Aromatics	21~47	38.61	36.13	33.17	30.77
Colloids	31~55	31.39	32.45	34.56	36.05

**Table 5.** The percentage of four components after bitumen changes with aging time.

Items	Standard (%)	Un-aged (%)	Aging temperature 163°C,aging time 5h,10h,15h(%)		
			5h	10h	15h
Asphaltene	-	2.79	3.63	3.88	4.00
Saturates	12~27	26.92	26.90	25.15	23.58
Aromatics	21~47	38.61	33.17	32.89	31.36
Colloids	31~55	31.39	34.56	36.47	39.11

From Table 4: the content of asphaltenes and colloids increased with the increase of aging temperature at the aging time of 5h; the asphaltene content change is not obviously, but the colloids content changed greatly with the aging temperature. The content of saturates and aromatic components gradually reduced with the increase of aging temperature. The decrease of aromatic content was faster than that of saturated content.

From Table 5: the bitumen did not change at the aging temperature (163°C) ; the asphaltene content and the gum content increased with the aging time changing; and the increase degree for the colloid content was greater than that of the asphaltene content. The saturated content and aromatic content decreased with the increase of aging time; the content of saturated content decreased more slowly than the content of aromatic content as the aging time decreasing; the saturated components of asphalt and the content of aromatic components were oxidized in the aging process of asphalt; and the effects

of ultraviolet rays were converted into asphaltenes and colloids, thereby reducing the performance of asphalt.

## 4 Mixture ratio design method

### 4.1 Mineral mix design

The design of the mineral composition was made according to the reference [10] for the AC-16. The composition of the gradation of the mineral materials was determined after adjustment (seen in Table 6).

### 4.2 Mixture composition design

The asphalt mixture Marshall test was carried out to determine the optimum oil consumption [9]. The results were shown in Table 7.

**Table 6.** Composition Calculation of the AC-16 Mineral Mixture

Screen size (mm)	The original grading (%)						Synthetic grading (%)	Specification recommended range (%)
	9.5~16mm Gravel	4.75~9.5mm Gravel	0~5mm Aggregate chips	0~5mm Sand	Mineral powder	Slaked lime	-	-
	34	25	16	19	4	2	100	
19.0	100	100.00	100.00	100.00	100.00	100.00	100.00	100
16.0	77.73	100.00	100.00	100.00	100.00	100.00	92.43	90—100
13.2	45.60	100.00	100.00	100.00	100.00	100.00	81.50	76—92
9.5	5.71	96.80	100.00	100.00	100.00	100.00	67.14	60—80
4.75	0.17	17.61	96.64	99.86	100.00	100.00	44.90	34—62
2.36	0.00	1.50	76.97	92.26	100.00	100.00	36.22	20—48
1.18	0.00	0.00	57.65	60.50	100.00	100.00	26.72	13—36
0.6	0.00	0.00	44.78	32.98	100.00	100.00	19.43	9—26
0.3	0.00	0.00	30.04	10.51	99.65	100.00	12.79	7—18
0.15	0.00	0.00	17.75	3.88	98.95	97.80	9.49	5—14
0.075	0.00	0.00	6.20	1.46	80.90	82.00	6.14	4—8

**Table 7.** Marshall Mix Test Results.

Asphalt-aggregate ratio	4.0	4.5	5.0	5.5	6.0
Gross volume relative density	2.284	2.316	2.331	2.370	2.381
Maximum theoretical relative density	2.488	2.470	2.452	2.435	2.418
Porosity (%)	8.19	6.25	4.94	2.68	1.52
Mineral material gap rate (%)	16.5	15.8	15.6	14.6	14.6
Saturation (%)	50.5	60.5	68.4	81.7	89.6
Stability (kN)	6.06	6.32	6.34	6.21	6.09
flow value (0.1mm)	26.5	30.5	32.6	34.8	37.6

Table 7 showed: the relative density of the volume increased with the asphalt-aggregate ratio, but become smaller at 5.5. The ratio of voids and the change of voidage decreased; the gap rate of minerals decreased with the asphalt-aggregate ratio and unchanged at 5.5; the stability increased with the asphalt-aggregate ratio, but started to decrease at 5.0; the saturation and flow values increased with the asphalt-aggregate ratio. The optimum amount of asphalt was determined:  $OAC_1=5.029\%$ ;  $OAC_2=(4.997\% + 5.226\%)/2=5.112\%$ ;  $OAC=(OAC_1 + OAC_2)/2=5.070\%$ . The best asphalt-aggregate ratio was set at 5.1%, and the optimum amount of bitumen was converted to 4.85%. The final grading composition of minerals was that: 9.5~16mm gravel 34%, 4.75~9.5mm gravel 25%, 0~5mm gravel 16%, 0~5mm sand 19%, mineral powder 4.0%, slaked lime 2.0% The optimum asphalt-aggregate ratio is 5.1%.

## 5 The road Performance

(1)High temperature stability: the experimental results were shown in Table 8. Table 8 showed: the rut depth increased. The material surface had good performance, flexibility, and durability. The dynamic stability increased with the asphalt-aggregate ratio. In addition, the experimental data also showed that the temperature had the greatest impact on the asphalt mixture, and the frequency and speed were both greater. (2) Water stability: the sability was 6.29kN at 30min of soaking; the sability was 6.12kN at 48h of soaking. The residual stability was 97.38%, which showed that the impact of water was relatively small, and the water resistance was relatively strong.

**Table 8.** Rutting experimental results.

No.	Test temperature	Rut depth (mm) /(min)		Dynamic stability (time/mm)	Average value(time/mm)
		45	60		
①	60°C	1.984	2.264	2250.0	1974.9
②		2.473	2.822	1805.2	
③		2.419	2.756	1869.4	

## 6 Conclusions

The content of saturates and aromatic components gradually reduced, the saturated and aromatic content decreased, and the saturated content decreased more slowly than the content of aromatic content as the aging time decreasing. The dynamic stability increased with the asphalt-aggregate ratio; the asphalt mixture was superior in performance and its ability to resist water intrusion was better; the water resistance was relatively strong. The KLMY90# asphalt and its mixture were more suitable for paving roads in cold regions of Gannan.

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