

Research on mechanism and performance of Lucobit modifier

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Abstract. To research the performance of asphalt mixture with lucobit. Firstly, research the rutting resistance mechanism of Lucobit, through the results of influence rule of aggregate and asphalt for modifier and the modification mechanism of modifier show that Lucobit modifier improves the pavement performance of asphalt mixture by the double effect on asphalt and aggregate. And the gradation of AC-13C is selected to research pavement performance in this text to research the gradation applicability of Lucobit modifier and make it adapt to China's basic national conditions well. Lucobit modifier can greatly improve the high temperature performance of AC-13C asphalt mixture according to the test results. Also Lucobit is proved to have good anti-rutting performance by tracking observation of the domestic first test road with Lucobit more than three years.

Introduction

The Lucobit modified agent is developed and applied for patent by German Basifu chemical industry group in 1966[1, 2]. The company of Lucobit has exclusive rights to produce a kind of polymer which is made up of the mixture of high quality polyethylene copolymer and a special kind of asphalt (ECB) [3]. A lot of research shows that Lucobit has excellent anti-rutting performance which is long-term and efficiency[4]. In the text AC-13C is chosen to research the pavement performance. Also Lucobit has good resistance to rutting by the tracking observation of the test road used Lucobit called Lidai road line which was used more than three years without significant rutting.

Modified mechanism of Lucobit

A grade 70# asphalt was tested on the high temperature performance. Test results of DSR are shown in Table1.

Temperature(°C)		64	70
Asphalt of A grade 70#	G^*/KPa	1.742	0.985
	$\delta (^\circ)$	87.01	87.27
	$G^*/\sin \delta$	1.744	0.986

Table 1 DSR Test results of A grade 70# asphalt

Lucobit modified asphalt was tested on the high temperature performance. Test results of DSR

are shown in Table2.

Temperature(°C)		76	82
Asphalt of Lucobit modified	G^* (KPa)	1.122	0.864
	δ (°)	86.27	86.97
	$G^*/\sin \delta$	1.124	0.865

Table 2 DSR test results of Lucobit modified asphalt

Table1 and Table2 show that $G^*/\sin \delta$ improves two levels when asphalt of A grade 70# is added to Lucobit. It indicates that Lucobit modification plays a positive role in improving the high temperature rutting resistance of asphalt mixture.

The modification of asphalt is a physical blending process[5, 6]. The sufficient mixing of modifier and asphalt is a basic prerequisite to improve the performance of asphalt. On this basis, the light component of asphalt is adsorbed by modifier and swells. The swelling of the modifier and the rest components of asphalt interact and form a new structure system. So the performance of the asphalt obtains improvement. In the process of grinding and the stabilizer or the action of catalyst, Chain scission and crosslinking reaction happens. Then some mesh structure forms. So the viscosity and storage stability of modified asphalt is improved [7].

80% components of Lucobit are 2 - butyl acrylate and vinyl polymer. Lucobit sets the advantages of both. Not only has excellent chemical stability, but also mechanical properties, tensile strength, weathering-resistant property, creep resistance and impact resistance has greatly improved.

Analysis of pavement performance of AC-13C asphalt mixture with Lucobit

To research the grading applicability of Lucobit modifier and make it adapt to the basic national conditions well, the gradation of AC-13C was chosen to research mix design and pavement performance in this text.

Tests were carried out over using the materials from the scene. The mix design results of AC-13C asphalt mixture are shown in Table 3.

Mixture type	Asphalt-aggregate ratio (%)	Bulk volume relative density	VV (%)	Theoretical relative density of testing	Effective thickness of asphalt film(μm)
AC-13C	5.1	2.537	4.5	2.657	6.7

Table 3 Optimal asphalt-aggregate ratio, density and VV

Results show that the asphalt-aggregate ratio of AC-13C asphalt mixture is 5.1% and the VV is 4.5%.The VV can meet the requirement of dense gradation asphalt mixture.

Test results of AC-13C asphalt mixture with Lucobit(7%) and without lucobit are shown in Table 4 to Table 7.

Mixture type	Stability(kN)	Immersion Marshall stability(kN)	Residual stability S_0 (%)	Requirement (%)
AC-13C	9.56	7.76	81.2	≥ 80
AC-13C with Lucobit	11.40	9.92	87.0	≥ 85

Table 4 Test results of Marshall Immersion

Mixture type	Unconditional splitting strength(MPa)	Condition of splitting strength (MPa)	TSR (%)	Requirement (%)
AC-13C	0.716	0.556	77.7	≥ 75
AC-13C with Lucobit	0.950	0.794	83.6	≥ 80

Table 5 Test results of freeze-thaw splitting

Mixture type	Equivalent asphalt content (%)	Dynamic stability(times/mm)				Requirement	Coefficient of variation(%)
		1	2	3	Average		
AC-13C	5.1	1886	1914	1774	1858	≥ 1000	4.0
AC-13C with Lucobit	5.1	7546	7125	7598	7423	≥ 2800	3.5

Table 6 Test results of dynamic stability

Mixture type	Largest load /kN	Middle span deflection /mm	Bending tensile strength/MPa	Stiffness modulus/MPa	Failure strain/ $\mu\epsilon$	Requirement / $\mu\epsilon$
AC-13C	0.87	0.41	7.10	3299	2152	≥ 2000
AC-13C with Lucobit	0.98	0.52	8.00	2937	2724	≥ 2500

Table 7 Test results of -10°C trabecular bending

The results show that water stability, high temperature and low temperature performance of AC-13C asphalt mixture with Lucobit are meet the requirements. Also the results show that Lucobit can greatly improve the high temperature performance of AC-13C asphalt mixture and slightly improve other performances.

Performance verification of asphalt pavement test road with Lucobit

Lidai road line is a main road of liyang in Jiang Su province. Because of the overload vehicles passed this road frequently. Lidai road line was damaged badly before 2010. And Lidai road line was used the test road to verify the performance of Lucobit.

In November 2010 May 2011 and August 2011 respectively used the lucobit scheme to solve the problem of rutting in Lidai road line. The situation of the test road was shown in Table 8.

Name	The first paragraph	The second paragraph	The third paragraph
Paving time	In November 2010,	In May 2011	In August 2011
length (m)	200	300	2000
Pavement structure	The above layer: 4cmSMA-10 (70#+9% Lucobit)	The above layer: 4cmSMA-13 (70#+9% Lucobit)	The above layer: 4cmSMA-13 (70#+9% Lucobit)
	The following layer: 6cmAC-13 (70#+8% Lucobit)	The following layer: 6cmAC-13C (70#+9% Lucobit)	The following layer: 6cmAC-13C (70#+8% Lucobit)

Table 8 The situation of the test road used Lucobit in Lidai road line.

The observation was carried on the test road in Lidai road line in 2012 and 2013. The results show that the test road with Lucobit was used in good condition. Also Lucobit was proved to have good anti-rutting performance by tracking the test road with Lucobit more than three years.

Conclusions

(1) Lucobit modifier improves the pavement performance of asphalt mixture by the double effect on asphalt and aggregate.

(2) Lucobit modifier can greatly improve the high temperature performance of AC-13C asphalt mixture and slightly improve other performances.

(3) Lucobit was proved to have good anti-rutting performance by tracking the test road with Lucobit more than three years.

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