

Research on Polyphosphoric Acid Modified Asphalt Aging Test

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Abstract. With the development of China's science and technology and large-scale construction of infrastructure, put forward higher requirements to the highway pavement performance, modified asphalt is necessary. Aging is a problem of modified asphalt in use process cannot be ignored, which directly affects the life of the road, is the main factor affecting the durability of asphalt pavement. This paper use PPA additive preparation of PPA modified asphalt, studies the effects of asphalt in different PPA contents modification. Using the modified asphalt rotating thin film oven, simulation of asphalt mixing and paving in the aging effects of high temperature and oxidation process of asphalt, by measuring the three performance of asphalt, studies the hot oxygen aging effects on modified asphalt performance. Analysis the improvement of different modifiers and modifiers added amount of asphalt aging properties.

1. Introduction

Asphalt is a kind of temperature sensitive material, as the temperature changes its status and performance will be changed [10]. Ordinary road asphalt due to its composition and structure determines its thermal performance is poor, elasticity and anti-aging performance is poor, high temperature easy flow, low temperature brittle crack, must be modified to improve performance [1]. The main purpose of modification is to improve the way of asphalt mixture at high temperature performance, enhance its anti-rutting, fatigue, anti-aging and anti-low temperature cracking resistance performance, etc. [7]. Modified asphalt means "mixed with rubber, resins, polymers, ground rubber powder or other fillers extrinsic doping agents (modifier), or take lightly oxidized asphalt processing and other measures to improved performance of asphalt and asphalt binder ". The study found that the polymer modified asphalt can greatly improve the performance of asphalt pavement [8]. Polyphosphoric acid (PPA) as an asphalt chemical modifier has been did a lot of research in foreign countries [6], it is a viscous liquid with high temperature stability, high storage stability, and simple preparation process.

In use process of asphalt pavement is a combination of various natural factors, produce a series of physical and chemical change, make its using performance decay gradually, gradually elasticity that aging [4]. The aging rate is directly related to the asphalt pavement life [5], Oxygen is the main cause of asphalt aging metamorphism, heat is the main external promote asphalt aging conditions [10]. Using the modified asphalt rotating thin film oven, simulation of asphalt mixing and paving in the aging effects of high temperature and oxidation process of asphalt, Study the changes of performance after short-term thermal oxygen aging.

2. Discussed problems

2.1 Materials preparation.

In this paper, a level of 90 asphalt is primary materials, Test instrument for SYD-2806G type softening point tester, SYD-2801E penetration instrument, SYD-4508G type asphalt ductility, SYD-0610 type rotating thin film oven, heating type magnetic stirrer, 88-1 digital display

temperature high power magnetic mixer, vacuum drying oven, flat scraper, multi-purpose furnace, etc. In addition, the main reagent used in the test is poly-phosphoric acid and the release agent.

2.2 The matrix asphalt aging test.

A level of 90 asphalt softening point, ductility and penetration testing after aging, Results are shown in figure 1.

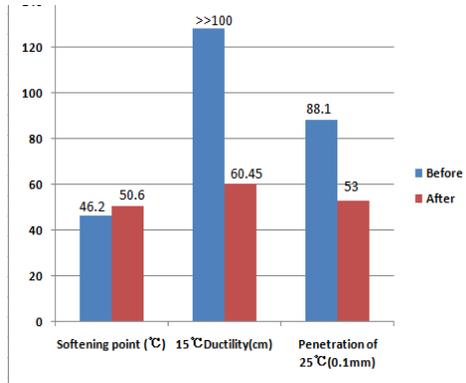


Fig.1 matrix asphalt performance

After aging test, The softening point of matrix asphalt has a little change, but has a great impact on the ductility, in vacuum condition and oven ageing, penetration is decreased at the same temperature. With the increase of consistence, asphalt becomes harder and the construction become more difficult.

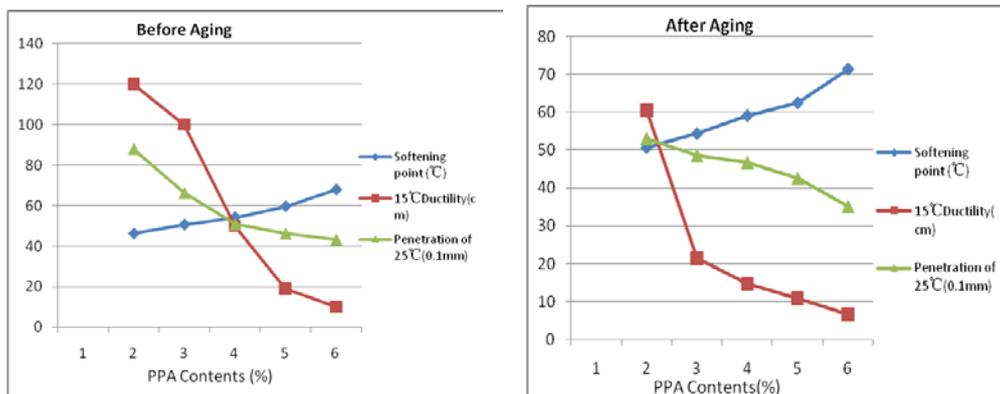
2.3 PPA modified asphalt aging test.

PPA modified asphalt after aging for three big performance test, results are shown in table1, to map the performance of modified asphalt test pattern is shown in figure 2.

Table1. PPA modified asphalt performance before and after aging

Content (%)	Softening point (°C)			15°C Ductility (cm)		Penetration of 25°C (0.1mm)		
	Before (T ₁)	After (T ₂)	ΔT	before	After	Before (P ₁)	After (P ₂)	K _P
0.0	46.2	50.6	4.4	120.00	60.45	88.1	53.0	60.2
0.5	50.6	54.3	3.7	100.00	21.45	66.3	48.5	73.2
1.0	54.2	59.1	4.9	49.93	14.70	51.0	46.7	91.6
1.5	59.6	62.5	2.9	19.07	10.80	46.3	42.5	91.8
2.0	67.8	71.4	3.6	10.07	6.70	43.3	35.1	81.1

Note: $\Delta T = T_2 - T_1$, $K_P = P_2/P_1 \times 100$



(a). Before aging

(b). after aging

Fig.2 PPA modified asphalt performance before and after aging

2.4 PPA modified asphalt aging analysis.

High-temperature performance. Softening point is an important index of asphalt high temperature stability [9], directly associated with the degree of deformation of the road surface directly associated. From the Fig.2, softening point is increased after aging, the high temperature stability of asphalt has a certain degree of improvement. With the increase of dosage of PPA, asphalt softening point curve towards the gap tends to be stable. Shown that modifier dosage have effect on high-temperature performance after aging.

The changes of softening point can reflect the degree of asphalt cement is sensitive to aging. Softening point incremental data according to the difference between the before and after aging asphalt. The higher the degree of softening point increases, the greater the asphalt aging. It has the largest date when the modifier dosage is 1.0%, at the same time, the highest degree in asphalt cement is sensitive to aging.

Low-temperature performance. Ductility is the ability to stretch at a certain temperature before break, it is the nature of the rheology, reflect the deformation and crack performance to a certain extent to a certain extent [3]. After aging test, compared with the matrix asphalt, ductility reduced a lot, Poor low temperature performance. It has a big influence on the asphalt ductility when content before 1.5%. With the increase of PPA, the ductility gap before and after aging gradually reduced. It is only 3.37 cm when the modifier dosage is 2.0%, and has a trend of continue.

Observed in the tests, matrix asphalt is ductile failure during stretching, shown in figure 3 (c). Modified asphalt specimen appeared necking immediately after the start stretching, stretch segment thickness essentially the same after continue stretching, suddenly broken when pulled to a certain extent. Wide fracture surface, both ends were bullet shape, as shown in 3 (b) as shown. After aging, some specimen were different, port widest part of the specimen brittle failure, shape as shown in figure 3 (c). This may be reacted between asphalt and modifier, then the composition of the asphalt had changed, macro perspective, at low temperatures, changes in cohesion and stress makes specimen fracture in the initial deformation.



(a)matrix asphalt (b)modified asphalt



(c) modified asphalt aging

Fig.3 Asphalt specimen fracture morphology

Penetration analysis. Penetration reflect the consistency of asphalt [11]. Typically, the lower penetration, it indicates that the higher consistency, the harder asphalt, and construction have become more and more difficult. After oven aging, both of penetrations at the same temperature are decreased, indicating that the components in the asphalt have changed after high temperature aging test, also shows increased consistency of asphalt and asphalt to become harden. With the increase of polyphosphoric acid content, penetration slope of the curve are decreasing before and after aging, and penetration gap decreases. In addition, residual penetration ratio gradually increases, anti-aging properties of asphalt become well. From Fig.2, it has better anti-aging performance when the modifier dosage is 1.0% and 1.5%. Consider other properties, in this test. It has the best performance of modified asphalt when the PPA content is 1.0%.

3. Conclusions

In this paper, through the analysis of the aging test different PPA modifier content before and after aging effect on the performance of asphalt, the main conclusions are as follows:

(1) Softening point is an important index of asphalt high temperature stability. Softening point is increased after aging, the high temperature stability of asphalt has a certain degree of improvement.

(2) Ductility is the ability to stretch at a certain temperature before breaking. After aging test, compared with the matrix asphalt, ductility greatly reduce, Poor low temperature performance.

(3) Penetration reflect the consistency of asphalt. Penetration appeared reduced varying degrees after aging. Asphalt consistence increase, the solid particles increase, asphalt becomes more rigid and lead to the construction more difficult.

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