The Preparation Process and Properties of Crumb Rubber Modified Asphalt*

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Abstract: A new technology was used to produce Crumb Rubber Modified Asphalt (CRMA) that has good properties, and the pilot plant and scaled-up production were also taken successfully. The physical properties of CRMA produced with different processes were tested. It shows that the properties of CRMA produced with the new preblending—masterbatch process are superior to the traditional process apparently, and the CRMA produced the new process can be regarded as having good storage stability.

Key words: crumb rubber; modified asphalt; process; physical properties

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Crumb Rubber Modified Asphalt (CRMA) is one of the most attractive ways in polymer-modified asphalts. Because it does not only improve the integrated properties of asphalt material at both low and high temperature, but also minimize the more and more serious waste-disposal problems in environments[1—3]. In the present work, a new process was used to produce CRMA that has good properties, and a series of experiments were done on the physical properties of CRMA with different processes. It shows that the properties of CRMA produced with the new process are superior to the traditional process apparently. Moreover, the pilot plant and scaled-up production were also taken successfully.

1 Experiments

1.1 Materials

AH-90 paving asphalt was supplied by LiaoheHuanxiling Asphalt Factory of Panjin, Liaoning, China. The physical properties of this grade of asphalt are as follows: penetration: 90 dmm (25 ℃, 100 g, 5 s); softening point: 49.5 ℃ (ring and ball test); ductility: > 120 cm (15 ℃, 5 cm/min).

DH-CRM (40 mesh) was used as modifying agents. It was produced by ambient wet ground processing.

SBS 1031 was produced by Yanshan Petrochemical Co, China.

SBR was provided by Shenyang Sanxin Co, China.

Sulfur was a commercial product (industrial grade).

1.2 Preparation

1.2.1 Preblending—masterbatch process

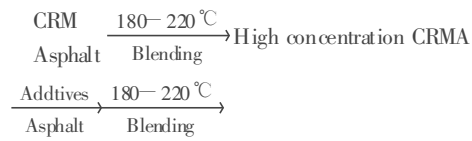

Fig 1 Preblending—masterbatch process

1.2.2 Traditional process[4]

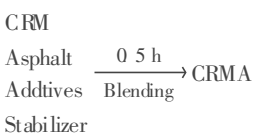

Fig 2 Traditional process

1.3 Devulcanized ratio of CRM test method

The devulcanized ratio of CRM was investigated according to GB 3516-83.

1.4 The physical properties of CRMA test method

The physical properties of CRMA were determined according to JTJ036-2000.

2 Results and discussion

2.1 Preblending—masterbatch process

The new process is divided into two main parts: preblending process and master batch process.

2.1.1 Preblending process

A preblending material of high concentration of CRM is produced by adding a given part of CRM (based on 100 parts asphalt) and asphalt, which has been heated to 160 ~200 ℃ until it flows fully, into a single screw extruder. During this process, the processing temperature is an important influential factor, and it shows that the appropriate

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temperature (140 ~ 160 ℃) can prevent the asphalt not only from solidifying on the screw at low temperature, but also from flowing too fast to be combined with CRM well in the extruder at high temperature.

The process can not only solve the problem of floating CRM on asphalt during the production of master batch, but also shorten the preparation time half apparently. This result indicates that the poor compatibility between CRM and asphalt is improved through preblending process.

2.1.2 Master batch process

A homogenous master batch of CRMA is obtained by adding CRM or the preblending material to asphalt and, then, mixing the components at 180 ~ 220 ℃ under a high shear rate for 30-100min. In addition, the sample of CRMA is produced when various additives and appropriate asphalt are added into the master batch, and the high shearing continues at 180 ~ 220 ℃ for 30-60 min. It is found that the high temperature and high shear mixing are essential to produce the homogenous master batch, and when they are decreased, the preparation time increases correspondingly.

Fig. 3 shows the comparison of devulcanized ratio of CRM with different processes. It exhibits that the devulcanized ratio of CRM with master batch process is higher than that with traditional process. It can be explained that high mechanical energy and heat supplied by master batch process can promote the break of the cross bond of S in CRM effectively and improved the dispersion of crumb rubber into asphalt.

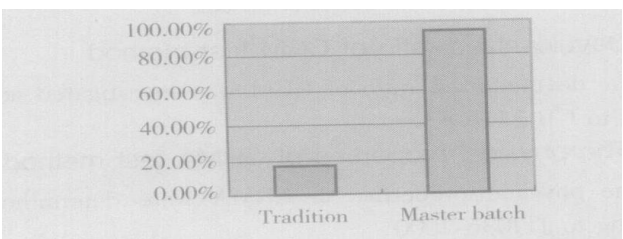

Fig 3 Comparison of devulcanized ratio of CRM produced with different processes

2.2 The physical properties of CRMA

Among the physical properties of CRMA, Ductility, Softening point and Penetration reveal crack resistance of low temperature, stability of high temperature and flow performance in the construction respectively. In the present work, the physical properties of CRMA are improved obviously in contrast with the traditional process as Table 1 shows. It is found that crack resistance of low temperature, stability of high temperature and the flow performance in the construction of CRMA with Preblending—masterbatch process are better than the traditional process. Moreover, due to the difference in the solubility parameter and density between CRM and asphalt, phase separation would take place in CRMA during storage at elevated temperatures. In the segregation tests, however, it is found that the difference in softening points between the top and the bottom is 2 ℃. So the sample produced with premix and master batch can be regarded as having good storage stability.

Tab. 1 Comparison of the physical properties of CRMA produced with different processes

Blending process	5℃ Ductility /cm	Softening point /℃	Penetration (0.1 mm)
New process	35.6	66.6	81
Traditional process	18.2	56	72

2.3 The pilot plant and scaled-up production

The pilot plant and scaled-up production were taken successfully, and the physical properties of CRMA of scaled-up production were similar to that of laboratory as Tab. 2 shows. The CRMA of scaled-up production has also been used for building a 2 km road in the section of Anyang, Anshan, Liaoning, China.

Tab. 2 Comparison of the physical properties of CRMA produced between the laboratory and scaled-up production

Blending process	5℃ Ductility /cm	Softening point /℃	Penetration (0.1mm)
Laboratory	35.6	66.6	81
Scaled-up production	35.2	64.8	80

3 Conclusions

(1) A new preblending-masterbatch process was used to produce Crumb Rubber Modified Asphalt (CRMA) that has good properties.

(2) The new process can not only improved the poor compatibility between CRM and asphalt, but also promote the break of the cross bond of S in CRM effectively.

(3) The physical properties of CRMA produced with preblending-masterbatch process is better than that with the traditional process.

(4) The CRMA produced with the new process can be regarded as having good storage stability.

(5) The pilot plant and scaled-up production were taken successfully.

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新型胶粉改性沥青制备工艺和性能的研究

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摘　要：采用新型预混－母料工艺制备出了性能优良的胶粉改性沥青，并成功地进行了中试和放大生产。分别考察了新工艺和传统工艺所制备的胶粉改性沥青的常规性能。结果表明，与传统工艺相比，预混－母料工艺能够显著提高胶粉改性沥青的各项常规性能。

关键词：废胶粉；沥青；制备工艺；常规性能

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