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Development of high stability hot mix asphalt concrete with hybrid binder

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Abstract: Cost reduction of public works projects has been desired due to severe financial circumstances. Therefore, asphalt pavement has been requested to extend its life. Semi-flexible pavement or epoxy asphalt pavement, which has high rutting resistance and oil resistance, may be applied to the place where these performances are demanded. However, special technique is required in manufacturing and construction. In addition, these materials have also raised a problem that they cannot be recycled. Meanwhile, conventional asphalt pavement has several drawbacks. It is vulnerable to rutting caused by traffic load and damage caused by petroleum oils such as gasoline or motor oil. The materials used in asphalt mixtures were studied for improving the durability of asphalt mixture. A high stability asphalt concrete was developed which has equal or superior performance to semi-flexible pavement and epoxy asphalt pavement. In this paper, the process of selecting the substance and the characteristics evaluation of the developed mixtures are described. Furthermore, an inspection result as well as follow-up survey of the performance of the developed mixtures obtained from trial and actual construction is shown.

Key words: hot mix asphalt; rutting resistance; oil resistance; semi-flexible pavement; epoxy asphalt pavement

1 Introduction

Asphalt concrete mixture is widely used for paving roads and highway surfaces because it is easy to construct and repair. Long-life asphalt pavement is in high demand as a part of reducing expenses for public works and maintenance costs. Conventional asphalt concrete pavement has several drawbacks. It was vulnerable to rutting caused by traffic load and damage caused by petroleum oils such as gasoline, light oil and motor oil (Minegishi 2003; Technical Investigation Center 2004). Semi-flexible pavement or epoxy asphalt pavement was used in some sections where high durability was especially important, but this type

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of asphalt was complicated to produce and construct, and the waste from pavement repair was difficult to recycle (Okude 1995; Sundhl and Hede 2002; Ichioka et al. 2003; Van de Ven and Moleneaar 2004; Widyatmoko et al. 2006).

The materials of asphalt concrete pavement were investigated aiming to improve the drawbacks and a high stability hot asphalt concrete mixture (high stability asphalt concrete) was developed, which used a hybrid binder consisting of polymer modified asphalt and a special additive. The hybrid binder is thermoplastic and thus ordinary production and application methods can be used for the high stability asphalt concrete. It has high oil and flow resistance as well as water and abrasion resistance comparable to semi-flexible pavement and epoxy asphalt pavement.

This paper gives an overview of the high stability asphalt concrete and its development, and describes the results of an on-road follow-up survey and investigation on further improvement of stability.

2 Determining binder materials and blending ratio

2.1 Selecting materials for binder

In order to improve the oil resistance of the asphalt concrete mixture, it was tested with the addition of various resins expected to improve the rutting resistance. Polymer modified asphalt having improved compatibility with the special additive was used as the base of the binder. It was decided that the mixture would be stone mastic asphalt (SMA) (13), which produces a rough surface with few voids to achieve high oil resistance. The amount of binder was the optimum value calculated by mix design. The mixture was mixed and compacted at (175 ±5)℃ and (160 ±5)℃, respectively.

Figure 1 shows the flow of selecting resins. First, the resins were investigated for appropriate melt viscosity (less than 1000 mPa · s at 180 ℃) and softening point (above 60 ℃ and below 140 ℃) in consideration of the manufacture and construction. Then, specimens were prepared in the laboratory to check the workability and test for oil resistance. Finally, wheel tracking and other performance tests were conducted to select the resin to be used as the special additive for the binder.

The amount of additive to be added to the binder was investigated by conducting wheel tracking tests on specimens containing different amounts of the additive. The resultant dynamic stability was found to correspond to the amount of admixture, as predicted. It was decided that a mix ratio of 20% with the measurement limit of 63000 wheel passes/mm would be used. Use of straight asphalt 60/80 instead of the modified asphalt was also tested, but the resultant dynamic stability was only about 2000 wheel passes/mm, suggesting that the additive and the polymer modified asphalt show synergistic effects.

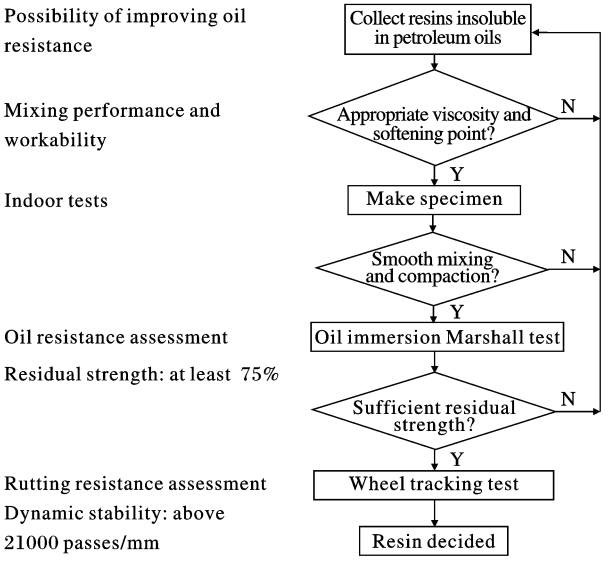

Fig. 1 Flow of selecting oil-resistant resins

2.2 Material composition and characteristics of hybrid binder

The modified asphalt used in the hybrid binder is polymer modified asphalt having improved compatibility with the selected additive. The characteristics of the additive are described below and the properties are shown in Tab. 1. Fig. 2 is a microscopic photograph of the hybrid binder. The additive does not dissolve in bitumen and is thus observed as small spheres dispersed in the binder.

Thermo plasticity: it melts at around the mixing and compaction temperature and thus does not impede workability.

Oil resistance: it makes the mixture high oil resist-