쇄석을 Antistripping Agent로 전처리하는 방법이 아스팔트 도로포장의 성능에 미치는 효과

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Effect of Aggregate Pretreatment with Antistripping Agent on Stripping Resistance of Asphalt Paving Mixture

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INTRODUCTION

In recent years, stripping has been a serious problem in asphalt paving mixture. Stripping is the breaking of the adhesive bond between the aggregate surface and the asphalt cement. When the bond is broken, the asphalt pavement weakens and develops various kinds of failure, such as cracking or surface ravelling [1]. There may be several mechanisms in the stripping phenomenon, most of which are caused by the action of water at the asphalt-aggregate interface.

A number of techniques have been developed to reduce the stripping damage in asphaltic pavements. Of these methods, the addition of chemical antistripping additive (ASA) to asphalt has been widely used in maintaining pavement durability, because of its low cost and ease of implementation [2, 3].

However, many antistripping additives are known to be susceptible to heat, and thus, with storage in hot asphalt cement they can lose their effectiveness severely. In addition, in the high temperature range (> 100 °C), many of the antistripping additives can interact chemically or physically with compounds in the asphalt to form inactive complexes which cannot act as surfactants. To circumvent such problems, a novel approach of aggregate pretreatment with ASA was investigated in this study. The aggregate was pretreated with aqueous emulsions/solutions of different organic surface modifiers.

There are many ways to evaluate the effect of aggregate pretreatment with ASA emulsions on the asphalt-aggregate bond. However, the boiling water test was chosen as the standard evaluation method for its simplicity and rapidity [3, 5]. The test was also used to investigate the dependence of the asphalt-aggregate bond strength on such variables as aggregate pretreatment drying time, pretreatment drying temperature, and pH of boiling water.

EXPERIMENTAL

Material

An AC-20 asphalt was used in this study. This asphalt was provided by the Alabama Highway Department.

Granite was observed by Yoon [4] to be very susceptible to stripping and for this reason was used throughout this work as a test aggregate. This Georgia

Norcross granite, used in Alabama road construction, was supplied by the Georgia Highway Department. This aggregate was crushed and screened to 3/8" - #4 mesh size.

Different kinds of antistripping additives were used in this study. Most of them were commercial type ASA. In some cases, the additives were incorporated into asphalt. However, most antistripping additives were used as emulsions of antistripping surface modifiers in order to precoat the aggregate surface before mixing with asphalt. The list of the types of ASAs used in this study was described in Table 1.

Table1. List of the Type of ASAs Used for Aggregate Pretreatment

Abbreviations	Type of ASAs
Control	Experiment without ASA
N.H.	Normal Hexane (Used as Solvent)
ASA #1	1 wt% Emulsified Iron Naphthenate
ASA #2	1 wt% Iron Naphthenate in N.H.
ASA #3	5 wt% Emulsified Asphalt
ASA #4	0.5 wt% Iron Naphthenate in ASA #3
ASA #5	5 wt % Cationic SBR Latex
ASA #6	5 wt% Anionic Latex
ASA #7	1 wt% Payvon Special

Procedure

The first boiling water test was conducted in 1983 [5]. It was a composite of several procedures, many of which originated from ASTM D-3625. Several changes were made due to variations in testing equipment. However, the changes were minor and do not alter the test's effectiveness [5].

The resulting amount of asphalt coating retained on the aggregate after the test was determined visually and reported in terms of the observed percentage. In order to standardize the visual evaluation as much as possible, a rating board was developed having 10 intervals from 0 to 100 percent of retained coating.

RESULTS AND DISCUSSION

The addition of antistripping additives to asphalt has been a common method of overcoming stripping problem. However, many antistripping additives are known to be susceptible to heat, and thus, the effectiveness of the additives can be severely reduced in hot asphalt.

As can be seen in Figure 1, the percent coverage retained after the boiling water test decreased with the increase in the storage time of asphalt containing antistripping additive. This may have been caused by the acceleration of chemical reaction of ASA with functional groups in the asphalt by heat to form inactive complexes or by thermal degradation.

To overcome those inherent disadvantages of addition of ASA to bulk asphalt, direct application of ASA surface modifiers to aggregate surface was investigated in this study.

Figure 2 shows that the effect of the aggregate pretreatment with ASA on the stripping resistance was excellent for all kinds of ASAs tested compared to the case of control. In Figure 2, control means that aggregate without pretreatment with ASA emulsion was just mixed with asphalt . The excellent stripping resistance could have been caused by the aggregate surface modification by the ASA emulsions. When the aggregate is pretreated with ASA emulsion, the aggregate surface is coated by the surface modifier. Therefore, the adhesive bond between the asphalt and the aggregate surface will be independent of the aggregate.

As shown in Figure 3, the percent retained coverage after the boiling water test increased considerably as drying temperature increased from 100 °C to 250 °C. Drying time was 3 minutes. This improvement can be attributed to some type of coking reaction taking place on the coated aggregate. As pretreatment temperature was increased the adsorbed surface modifiers layer became more strongly chemisorbed and physically interlocked to the aggregate surface. That is, increased pretreatment temperature renders surface modifier to be adsorbed on the aggregate surface to cause more coke formation and thereby to form stronger bonds.

Another important variable in the pretreatment process is the drying time. As can be seen in Figure 4, the percent coverage retained after the boiling water test increased as pretretment drying time increased except for control. Extended pretretment drying time can also increase the aggregate surface temperature. The higher the aggregate temperature become, due to increase in drying time, the more surface reactions, such as coking or polymerization, are able to occur. Therefore, stronger adhesive bond between the asphalt and the surface modifiers layer could be obtained. That is, effective pretreatment drying time as well as pretreatment drying temperature can also play an important role in reducing the stripping propensity of asphalt pavement.

In order to investigate the influence of pH of contacting water on stripping, the boiling water test was carried out according to the variation in the initial pH of boiling water. As shown in Figure 5, stripping became more severe with ASA #7 as the pH of boiling water increased. When pH of contacting water becomes high, the negative surface potential of the asphalt in contact with the aggregate would be higher due to the dissociation of acidic components of the asphalt. Consequently, the increased repulsion force between both the negatively charged aggregate and asphalt will be easily able to disrupt the asphalt-aggregate bond.

REFERENCES

1. Fromm, H.J., Proceedings of the Association of Asphalt Paving Technologists, vol. 43, 1974.
2. Tunnicliff, D.G. and Root, R.E., NCHRP Report 274, 1984.
3. Kennedy, T.W. et al., Transportation Research Record 968, 1984.
4. Yoon, H.H., Dissertation, Chemical Engineering in Auburn University, 1987.
5. Frazier Parker, Jr. and Michael S. wilson., Auburn University, Civil Engineering Press, 1986.

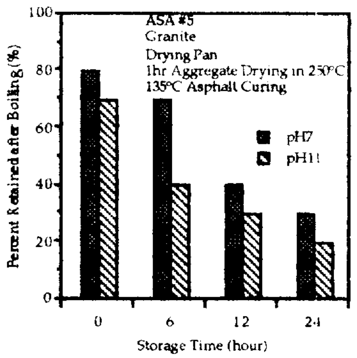

Figure 1. Loss of Effectiveness of ASA in Asphalt with Storage Time

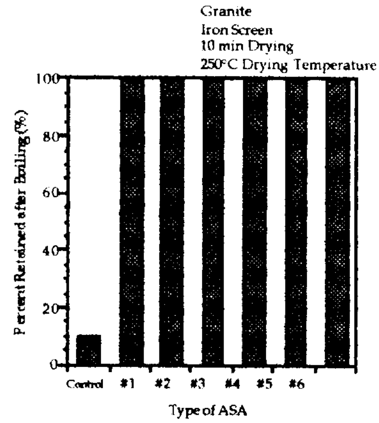

Figure 2. Effect of Aggregate Pretreatment with ASA on Asphalt-Aggregate Bond

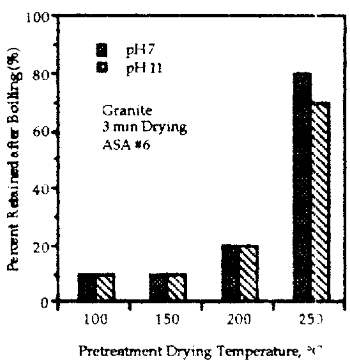

Figure 3. Effect of Pretreatment Temperature on Stripping Propensity

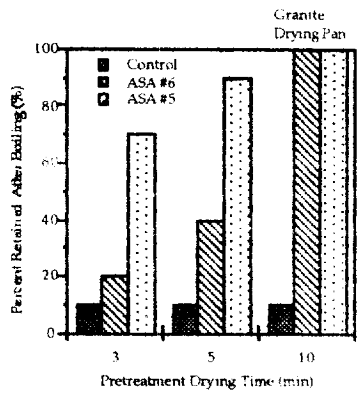

Figure 4. Effect of Pretreatment Drying Time on Stripping Propensity

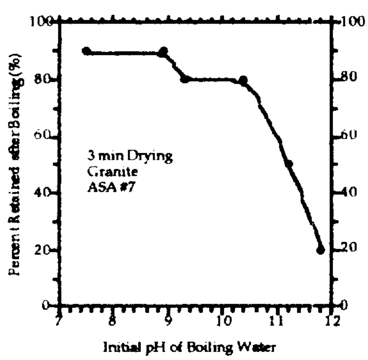

Figure 5. Effect of Initial pH of Boiling Water on Stripping Propensity