Research on The Experiment of the Time Rule of the Demulsification about the Cold Recycling Emulsified Asphalt Mixture in view of the Gradation Demulsification

Baoyang Yu¹, Minjiang Zhang¹, Liping Zhang¹

¹Institute of Transportation Engineering, Shenyang Jianzhu University, Shenyang, China

ABSTRACT: The paper in order to solve the problems and technical difficulties of emulsified asphalt cold recycling mixing plant, which can promote the application and promotion of the technology in Liaoning Province. It developed an emulsified asphalt cold recycling mixture that can achieve levels of breaking, and analyzed the time rule of the demulsification about the cold recycling emulsified asphalt mixture in view of the gradation breaking under different factors. And the paper also makes an analysis of its road performance. Based the premise of the substantially unchanged performance, the additives, the pH of emulsion and the temperature of mixing that can be used to change the time rule of the demulsification about the cold recycling emulsified asphalt mixture. In addition, the road performance of cold recycling emulsified asphalt mixture in view of the gradation is better than the normal cold recycling emulsified asphalt mixture. The technology of the emulsified asphalt cold recycling mixing plant in view of the gradation can effectively solve the current technical problems and defects of asphalt emulsion cold recycling.

INTRODUCTION

The asphalt pavement as the main part of the pavement structure, after using a period of time, the road performance has been unable to meet the requirements of the pavement, but as the material itself still has considerable value in use thanks to its performance which could reached the pavement performance requirements by means of recycling. Plant emulsified asphalt cold recycling technology is the cleanest, environmentally friendly in a variety of recycling technology, which is more in line with the construction conditions in the northern region. However, there exist some technical problems and defects in plant mix cold recycling emulsified asphalt technology at present as the breaking time and the rule of the emulsion are hard to be controlled and measured and its pavement performance is poor.

Which analyzes the demulsification rule of emulsified asphalt cold recycled mixture based on gradation demulsification through a large number of experimental research on indoor.

In order to solve the problems and technical difficulties of plant-mixed emulsified asphalt cold recycling, promote the application of emulsified asphalt plant cold recycling technology in view of gradation demulsification in Liaoning Province, a lot of researches and experiments are carried out in this paper. A high performance of emulsified asphalt cold recycling mixture based on gradation demulsification is developed through the relevant experimental researches, and then its breaking time rule and road performance are analyzed under different factors.
THE CONCEPT OF GRADATION DEMULSIFICATION AND THE MANUFACTURING OF EMULSIFIED ASPHALT PLANT COLD RECYCLING TECHNOLOGY IN VIEW OF GRADATION DEMULSIFICATION

The Concept of Gradation Demulsification

Emulsified asphalt cold recycled mixture break one time generally with the varying lengths of demulsification time generally. According to the use and the construction of different distance, the demulsification time can be adjusted through the mixture formulation. Because of emulsified asphalt cold recycled mixture has a lot of demulsification when paving in the conventional cold recycling construction, the performance of the mixture can't reach the best. Therefore, the emulsified asphalt cold recycled mixture in view of gradation demulsification came into being.

The gradation demulsification, which is able to break two or three times and the curve of breaking time law presents step shape. The demulsification amount is small, accounting for about 10%~20% at the first demulsification time of the emulsified asphalt cold recycled mixture in view of gradation demulsification when paving. After rolling, it can achieve a large amount of 90%~100% emulsion so that the mixture can form the strength rapidly.

The Manufacturing of Emulsified Asphalt Plant Cold Recycling Technology in view of Gradation Demulsification.

The emulsified asphalt plant cold recycling technology in view of gradation demulsification was created in this paper, and the core is the mixture of emulsifier. Novel emulsifier was manufacturing by adding the amine (2~3), the phenol (1) and the alcohol (1) during the certain temperature, pressure and time. And it can realize demulsification 2~3 times in order to achieve the level of demulsification.

MIXTURE RATIO DESIGN OF COLD RECYCLING EMULSIFIED ASPHALT MIXTURE IN VIEW ON LEVEL OF DEMULSIFICATION

In this paper, using emulsified asphalt cracked slowly by the cationic, RAP from milling material of Shen Fu Da Dao Sanbaotun section, new minerals from the quarry of Fushun hada and ordinary portland cement with strength grade 32.5. Raw materials are tested to satisfy the requirements of specification and application. Based on level of demulsification of emulsified asphalt cold recycled mixture is applied to the bottom layer of surface in this case, and according to design of gradation composition in 《the highway asphalt pavement regeneration technology standard》JTG f41-2008 and classified results between RAP and new aggregate, designing the synthetic gradation of this paper, synthetic grading curve as shown in Figure 1.
Figure 1. Compositive grading curve for cold recycling emulsified asphalt mixture in gradation demulsification.

Through the experiment, obtaining ratio of the optimum amount on emulsified asphalt, mixing water used and cement used is 4%, 2.68% and 1.5%, respectively. Meanwhile, various performance indexes of cold recycling emulsified asphalt mixture in gradation demulsification satisfy requirements of specification, and verify the rationality of design for mixture composition.

STUDY ON DEMULSIFICATION TIME REGULARITY TEST OF COLD RECYCLING EMULSIFIED ASPHALT MIXTURE IN LAYER OF DEMULSIFICATION UNDER DIFFERENT INFLUENCE FACTORS

Effect factors of the demulsification time rule of cold recycling emulsified asphalt mixture mainly are as follows: ① additive; ② the PH value of emulsion; ③ the amount of mixing water used; ④ the amount of emulsified asphalt used; ⑤ mixing temperature. But, the amount of mixing water used and emulsified asphalt used in the composition design of the mixture has been determined, therefore the significance is not obviously which is transforming the two factors in order to change the demulsification rule of cold recycled mixture. This paper carried out only study about demulsification time regularity on cold recycling emulsified asphalt mixture in view of demulsification under three factors of additive and the PH value of emulsion and mixing temperature.

According to the above three factors, this paper through the relationship between different compaction time and the Marshall stability, determine demulsification time rules on the level of demulsification of cold recycled emulsified asphalt mixture. Specific test methods are as follows:

(1)Procedure for manufacture and curing of test pieces:

According to the production requirement for Marshall test piece of emulsified asphalt cold recycled mixture in 《The technical standard for highway recycled asphalt pavement》 JTG F41-2008, mixing material in accordance with the specified order of added material (RAP material, new crushed stone, stone chips, cement, water, additives, emulsified asphalt), delaying the compaction time of the mixture, and
specimens are hit the two-sided for 50 times, then carried out maintenance in curing box of 60°C for 48 hours, after which hit the two-sided for 25 times, and finally conserved 12 hours at room temperature.

(2) Marshall stability of test specimens:
Specimens after conserve are soaked in water bath box of 40°C and curing 0.5 hours in water bath, then testing its corresponding stability, and drawing P-T curve.

Study on Additive to the Demulsification Time Rule of Cold Recycled Emulsified Asphalt Mixture based on Levels Demulsification
In the construction of cold recycled emulsified asphalt, additives are widely used such as calcium chloride, ammonium chloride and aluminum sulfate and other. This paper will study the influence on the three kinds of additives to the demulsification time rule of cold recycled emulsified asphalt mixture based on levels demulsification. In addition, in order to analyze and compare the effect of additives to the demulsification time rules of cold recycling mixture better, this paper adds an analysis about the level rule of breaking time of cold recycled emulsified asphalt mixture without any additives.

According to different compaction time of Marshall stability, time rule curve of demulsification (P-T) can be obtained by based on levels of demulsification of emulsified asphalt mixture with the different doses of three additives, as shown in Figure 2~4.

Figure 2. Effect of aluminum sulfate on the breaking time rule of cold recycling emulsified asphalt mixture.

Figure 3. Effect of ammonium chloride on the breaking time rule of cold recycling emulsified asphalt mixture.
(1) From figure 2~4 shows, cold recycled emulsified asphalt mixture with various additives achieves levels of demulsification, and P-T curve is ladder.

(2) From the analysis of comparison between figure 2~4 and figure 5 shows, the breaking time is delayed, which is from 2 hours prolonged to 6 hours, after cold recycled emulsified asphalt mixture on the level of demulsification added a dose of additives. This is because that the cations from additives ionized in water delay losing balance of electric double layers in the cationic emulsified asphalt, then which is delaying breaking time of emulsified asphalt cold recycled mixture. In addition, adding an appropriate amount of additives, can improve performance of the mixture, for example, compared with a dose of 0.1%, the 5 hours stability of aluminum sulfate mixture with a dose of 0.3% is increase by 1.07kN.

Research on The Time Rule of The Breaking at Emulsified Asphalt under Various pH Values to Cold Recycling Emulsified Asphalt Mixture in Gradation of Demulsification

This paper analyzes cold recycling emulsified asphalt mixture with pH values of 1, 1.3 and 1.6 respectively above the level of rule breaking time, and study the change of its performance.

According to the test results, the P-T curves of different emulsified asphalt pH values are drawn, as shown in Figure 6.
Figure 6. The time rule of the breaking at emulsified asphalt under various pH values to cold recycling emulsified asphalt mixture of the gradation demulsification.

Figure 6 shows, breaking time of the emulsified asphalt cold recycling mixture can be changed effectively by altering emulsified pH value: to reduce the pH of the emulsion, can delay the breaking time of cold recycling emulsified asphalt mixture gradation based on demulsification. When the pH value on the emulsion drop to 1, time rule of cold recycled mixture demulsification is almost equal to pH value at 1.3, achieve final demulsification after about 6 hours, and stability of cold recycled mixture is up to 11.68kN. In this paper, according to range of application on pH value of emulsified asphalt in the actual road engineering application and test data in the case, the emulsified pH value is recommended not less than 1.3.

Study on The Regularity of The Breaking Time at Mixing Temperature to Cold Recycling Emulsified Asphalt Mixture of The Gradation Demulsification

Under normal circumstances, the temperature of road surface is often higher than the atmospheric temperature, which is due to the effect of light reflection and heat absorption of road material and so on. It is necessary various mixing temperature will have an effect on the time rule of the breaking of cold recycling mixture, this paper makes an analysis and a research on the regularity of the breaking time of cold recycling emulsified asphalt mixture under various temperatures (25℃, 45℃ and 60℃). The specific P-T line is shown in Figure 7.
As shown in Figure 7:
(1) The higher mixing temperature, the sooner demulsification cold recycling emulsified asphalt mixture of the gradation demulsification, and the hierarchical demulsification is unable to be realized at a temperature of 60°C.
(2) With the increase of the mixing temperature, pH curve decline accelerated, which is due to the speed of demulsification of emulsified asphalt accelerated when mixing temperature rise, then emulsified asphalt has been demulsification, weaken for the cementation, the mixture has been not conducive to compact, the void ratio of the specimen became larger, and the stability was decreased after compaction.

INVESTIGATIONS ON THE EXPERIMENT OF THE ROAD PERFORMANCE TEST OF COLD RECYCLING EMULSIFIED ASPHALT MIXTURE IN VIEW OF THE GRADATION

The asphalt mixture pavement performance mainly refers to the rutting resistance in high temperature, low temperature crack resistance, water stability and fatigue resistance etc. This paper verified the performance improvement of the rutting resistance in high temperature, water stability based on cold recycling emulsified asphalt mixture plant, by choosing and comparing with the road performance of normal cold recycling emulsified asphalt mixture. The performance comparison results are shown in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Stability degree (Mpa)</th>
<th>Void fraction (%)</th>
<th>Dry ITS (MPa)</th>
<th>Wet ITS (MPa)</th>
<th>Splitting strength ratio(%)</th>
<th>Dynamic stability(times/mm)</th>
<th>Coating rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>gradational</td>
<td>11.67</td>
<td>9.71</td>
<td>0.52</td>
<td>0.49</td>
<td>94.20</td>
<td>2200</td>
<td>91.8</td>
</tr>
<tr>
<td>normal</td>
<td>10.54</td>
<td>10.92</td>
<td>0.51</td>
<td>0.47</td>
<td>92.16</td>
<td>1750</td>
<td>70.3</td>
</tr>
</tbody>
</table>

Table 1 shows, the comparison of mixture performance: cold recycling emulsified asphalt mixture of the gradation > normal cold recycling emulsified asphalt mixture plant. This is because the oil film thickness of emulsified asphalt uniform, which is used by emulsified asphalt mixture gradation based on demulsification, and the coating rate of the cold recycling emulsified asphalt mixture in view of the gradation demulsification is increased by 21.5% than ordinary emulsified asphalt plant mix cold recycling mixture under the electron microscope, and air gap rate is obviously reduced. In addition, based on levels of demulsification of emulsified asphalt cold regeneration mixture achieves the levels of demulsification, it make the mixture in an optimum performance compacted. So the road performance of cold recycling emulsified asphalt mixture in view of the gradation demulsification is more superior than ordinary cold recycling emulsified asphalt mixture plant.
CONCLUSIONS

(1) Based the premise of the substantially unchanged performance, this study drew the additives, the pH of emulsion and the temperature of mixing that could be used to change the time rule of the demulsification about the cold recycling emulsified asphalt mixture.

(2) The road performance of cold recycling emulsified asphalt mixture in view of the gradation was better than the normal cold recycling emulsified asphalt mixture.

REFERENCES


