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Evaluation Of Emulsion Based Warm Mixes For Paving Applications

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Abstract

Warm Mix Asphalt (WMA) technology is recently developed in Europe and is gaining strong interest worldwide. By lowering the viscosity of bitumen binder, WMA technology allows mixing, transporting and gives better workability at lower temperature. Using WMA technology, asphalt mix can be produced which is 30°C to 40°C lower than hot mix asphalt (HMA). Less emission, savings in energy cost, less odor are there because of lower mixing and compaction temperature. Despite the benefits, researches are there to analyze its long-term performance.

This project was carried out to evaluate the suitability of bitumen emulsion as an additive when applied to WMA samples of Stone Matrix Asphalt (SMA) and Dense Bituminous Macadam (DBM) mix as per MORTH specification. The binder content has been varied from 4 % to 7 % by weight of aggregates for both mixes. Cement and stone dust have been used as filler for DBM and SMA mixes respectively. VG 30 grade bitumen has been used as binder for both mixes. The optimum binder content for SMA and DBM mixes were found to be 5.93% and 5.33%.

Introduction

Warm Mix Asphalt (WMA) is a fast emerging new technology with potential of revolutionizing the production of asphalt mixtures. WMA technology allows the mixing, and compaction of asphalt at 30°C to 40°C lower temperatures compared to Hot Mix Asphalt (HMA). The technology can reduce production temperatures by as much as 30 percent. Hot asphalt mixes are generally produced at 150º C where WMA mixes are produced at temperatures of about 120ºC or lower.

Gradation for DBM (MORTH)

BIS Sieve	% passing (range)	%passing (adopted)
26.5	100	100
19	90-100	95
13.2	56-88	72
4.75	16-36	26
2.36	4-19	11.5
0.3	2-10	6
0.075	0-8	4
Bitumen content (%)	4-7	4-7

Gradation for SMA (MORTH)

BIS Sieve	% passing (range)	%passing (adopted)
26.5	-	-
19	100	100
13.2	90-100	95
9.5	50-75	62.5
4.75	20-28	24
2.36	16-24	20
1.18	13-21	17
0.6	12-18	15
0.3	10-20	15
0.075	8-12	10
Binder Content (%)	5-7	5-7

Test Procedure

Immerse the specimens in a water bath at 60°C for 30. Thoroughly clean and lubricate the guide rods so that the upper test head slides freely over them. Remove the specimen from the water bath and place in the breaking head. The elapsed time between removal of the sample from the water bath and maximum load determination shall not exceed 30 sec. Place the complete breaking head assembly in position on the testing machine. Place the flow meters, and adjust it to zero.

Apply the load to the specimen by a constant rate of movement of the testing machine head of 50 mm per minute until a maximum load is reached and the load decreases as indicated by the proving ring dial. Record the proving ring micrometer dial reading. The total maximum in kN (that causes failure of the specimen) is taken as Marshall Stability. The stability value obtained is corrected for volume by using correlation ratio table. The total amount of deformation in units of 0.25 mm that occurs at maximum load is recorded as Flow Value.

Discussions

- From the relationships made above, it was found that optimum binder content for SMA and DBM samples were 5.93% and 5.33% respectively.
- Results and graphs obtained from Marshall test indicate that stability is gradually increasing with increase in bitumen and emulsion content and after certain percentage it was decreasing. Maximum stability value for SMA 11.65 kN and 13.28 kN for DBM mixes.
- Flow value of SMA and DBM samples gradually increases with increase in bitumen content. Initially flow value increases slowly, but after that with increase in bitumen content the of flow value increases rapidly.
- Theoretically VMA should remain constant for a given aggregate gradation with respect to binder content. But practically, it is observed that at low bitumen content, VMA slowly decreases with increase in bitumen content then increases after a pause.
- VA of Marshall test samples decreases with increase in bitumen content and VFB increases with increase in bitumen content.

Conclusions

In this observation, two types of mixes i.e. SMA and DBM specimens were prepared using VG 30 as binder tested on Marshall Test

Apparatus. By Marshall Method of mix design, the optimum binder contents for both the mixes were found 5.93% and 5.33% for SMA and DBM respectively. When using Cationic Medium Setting type emulsion with binder, the properties of Mix was improved. Maximum stability value was observed for SMA 11.65 kN and 13.28 kN for DBM mixes. Flow value of SMA and DBM samples gradually increases with increase in bitumen content. VA of Marshall test samples decreases with increase in bitumen content and VFB increases with increase in bitumen content.

Future Scope

In future performance of bitumen emulsion as additive with other grades of bitumen can also be tested and seen whether it can be used successfully or not. Indirect tensile test of bituminous mixes can give us an idea about tensile strength of bituminous mixes. In future, samples also can be prepared at different temperatures. Wheel tracking test can give us idea about the rut resistance of the specimen. Use of other fillers or additives may result in better performance. So it may also be evaluated in future.

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