# An Experimental Study on Zeolite as an Additive in Warm Mix Asphalt with Polymer Modified Asphalt

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***Abstract*: Warm mix asphalt (WMA) is a recent technology used to reduce the mixing and compaction temperatures without affecting the quality of pavement. Warm mix asphalt is a bituminous mixture where all its constituents are mixed, placed, compacted at medium temperature. A number of WMA processes have been developed in recent days. One of the processes includes the use of synthetic zeolite as an additive. An attempt has been made in the laboratory to develop warm mix asphalt mixes using synthetic zeolite as an additive at a specified mixing and compaction temperature which were obtained after a number of trials. The stone matrix asphalt (SMA) and dense bituminous macadam (DBM)mixes with aggregate gradation as per MORTH specifications were made with varying binder contents (4.5%, 5%, 5.5% 6%,6.5%). The zeolite content was 0.3% by weight of aggregate.***

## I. INTRODUCTION

A number of processes have been developed to reduce the mixing and compaction temperature of hot mix asphalt (HMA). The mixing and compaction temperature of HMA usually range from 275-325 F. Its use in pavement of roads leads to large consumption of energy and emission of greenhouse gases and other pollutants to atmosphere. Warm mix asphalt is a recent technology used for pavement of roads which utilises relatively low mixing and compaction temperature than HMA. Its use in pavement of roads reduces energy consumption, greenhouse gas emission and asphalt oxidation. It also increases paving season and hauling distance for a better work environment. Asphalt Concrete mixture of polymer modification is used to reduce the damage early and increasing the durability of pavement to various damage such as permanent deformation, fatigue during this process the polymer asphalt mixing using Hot Mix Asphalt / HMA. In accordance with the name and nature of hot mix asphalt, require high enough heating temperature on the Asphalt Mixing Plant (AMP), and also requires a high temperature compaction. As a result, it takes quite a lot of fuel so produced a large exhaust emission. Emissions generated during the mixing process and compaction of HMA is a challenge for the environment.

## II. LITERATURE REVIEW

Goh et al., evaluated the properties of WMA with the addition of Aspha-min (synthetic zeolite) based on the Mechanistic-Empirical Pavement Design Guide (MEPDG). They found that the addition of Aspha-min did not have any effect on the dynamic modulus values for any of asphalt mixtures examined. The rut depths predicted from the MEPDG simulations showed that WMA could decrease rutting and the greatest difference of rutting between WMA and its control could be up to 44%.

Lee et al., prepared three types of CIR-foam specimens: (a) CIR-foam with 1.5% of Sasobit® (wax), (b) CIR-foam with 0.3% Aspha-min (synthetic zeolite), and (c) CIR-foam without any additive. They reported that WMA additives have improved the CIR-foam mixtures compatibility resulting in reduction of air void. The indirect tensile strength of CIR-foam mixtures with Sasobit®(wax) was the highest. Flow number of CIR-foam mixtures with Sasobit® was the highest followed by ones with Aspha-min® (synthetic zeolite), and the specimens without any additive.

Wielinski et al.,2009 (22) conducted a study based on laboratory tests and field evaluations of foamed WMA. They found that the Hveem and Marshall properties of HMA and WMA were almost similar, and all met the Hveem design requirements and the mixture property requirements. The in-situ densities were also almost similar.

## III. EXPERIMENTAL INVESTIGATION

To analyse the properties of bitumen with and without adding the zeolite to the mixes and also to determine the properties aggregates the following laboratory test were conducted as per the IS codal provisions.

Tests on Aggregates:

1) Aggregate Impact Test 2) Aggregate Crushing Test 3) Shape Test a) Flakiness Index b) Elongation Index 4) Los Angeles Abrasion Test

Tests on Mixes

Bitumen is used as a binder in SMA and DBM mix. The various characteristics of bitumen that affects the bituminous mix behavior are susceptibility to temperature, visco-elasticity and aging. For preparation of SMA and DBM mix samples VG30 grade bitumen used.

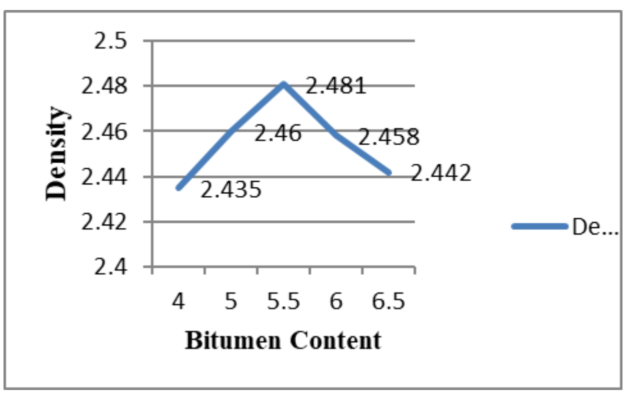
1.Specific Gravity Test 2. Penetration Test with and without adding zeolite 3. Softing Point Test 4. Viscosity Test and 5. Ductility Test

## IV. RESULTS

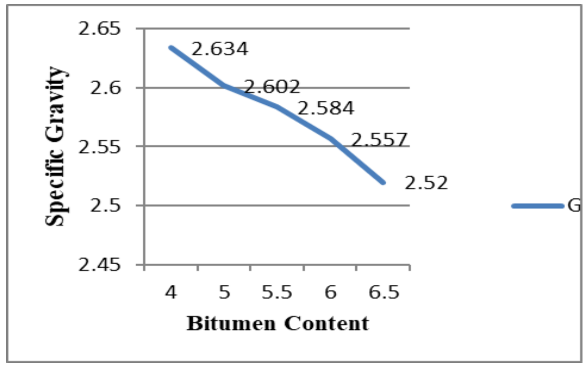
By conducting the detailed laboratory investigations on the materials the following results were obtained.

TABLE: 1 Physical properties of SMA samples

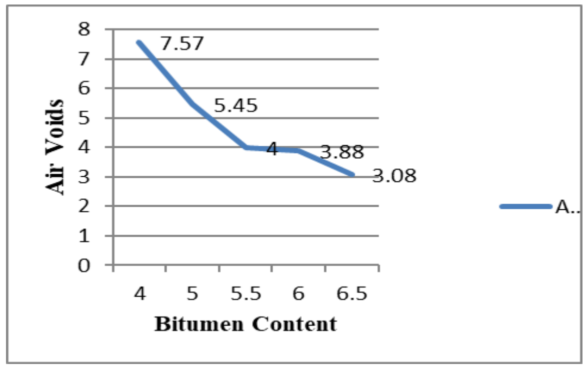
| % of Bitumen by wt. Of mix | Density =g / d (Gmb) | Gmm | Air Voids (I - h) / i)*100 | V M A (100 - (H*B)/Gsb) | VFB (K - J) K *100 | Load (m*6.27) | Corr. Load (o*n) | Flow (mm) |
|---|---|---|---|---|---|---|---|---|
| 4.5 | 2.435 | 2.634 | 7.57 | 13.27 | 43.00 | 1030 | 1057 | 2.1 |
| 5 | 2.460 | 2.602 | 5.45 | 12.82 | 57.52 | 1163 | 1193 | 2.7 |
| 5.5 | 2.481 | 2.584 | 4.00 | 12.57 | 68.13 | 1356 | 1410 | 3.1 |
| 6 | 2.458 | 2.557 | 3.88 | 13.82 | 71.96 | 1463 | 1463 | 3.7 |
| 6.5 | 2.442 | 2.520 | 3.08 | 14.82 | 79.22 | 1525 | 1525 | 4.2 |



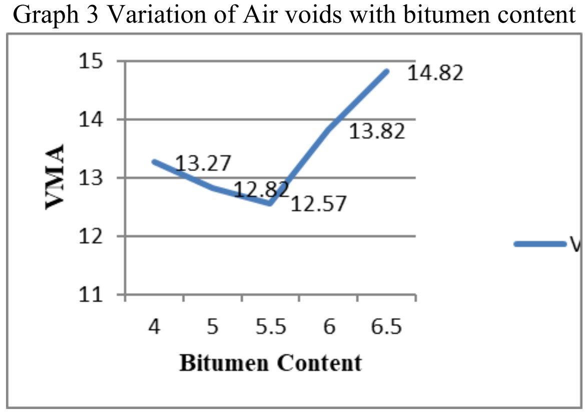

Graph 1 Variation of density with bitumen content



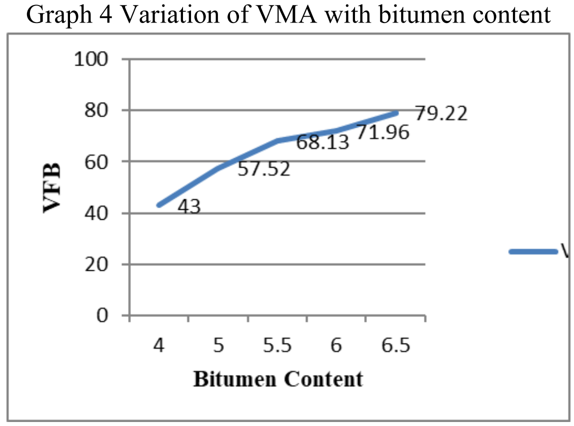

Graph 2 Variation of specific gravity with bitumen content




Graph 3 Variation of Air voids with bitumen content



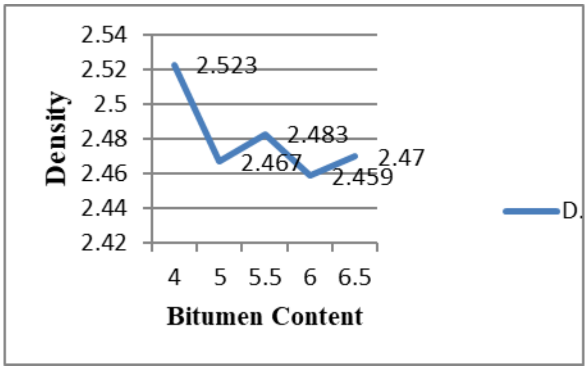

Graph 4 Variation of VMA with bitumen content



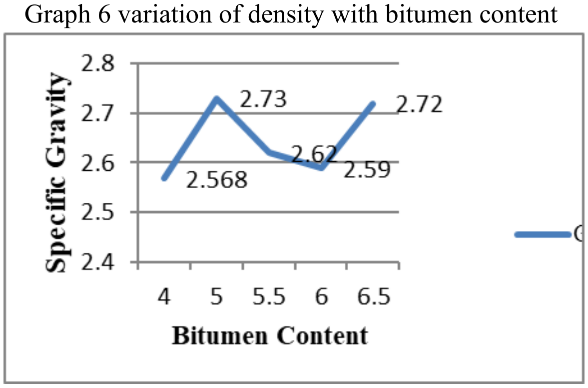

Graph 5 Variation of VFB with bitumen content

TABLE: 2 Properties of DBM sample

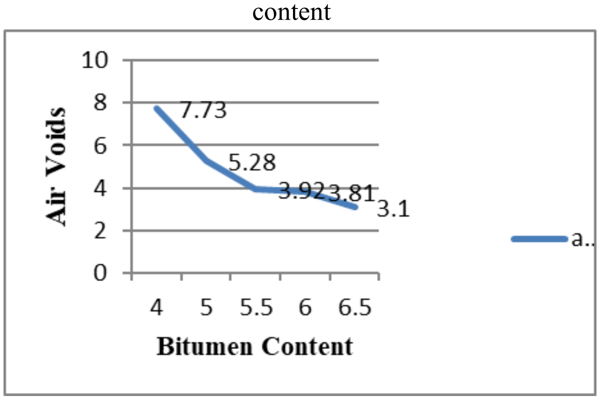
| % of Bitumen by wt. Of mix | Density =g / d (Gmb) | Gmm | Air Voids (I - h) / i)*100 | V M A (100 - (H*B)/Gsb) | VFB (K - J) K *100 | Load (m*6.27) | Corr. Load (o*n) | Flow (mm) |
|---|---|---|---|---|---|---|---|---|
| 4.5 | 2.523 | 2.568 | 7.73 | 10.68 | 83.72 | 1050 | 1076 | 2.26 |
| 5 | 2.467 | 2.73 | 5.28 | 13.12 | 60.56 | 1188 | 1236.6 | 2.8 |
| 5.5 | 2.483 | 2.62 | 3.92 | 13.04 | 69.93 | 1356 | 1410 | 3.2 |
| 6 | 2.459 | 2.59 | 3.81 | 14.31 | 73.35 | 1463 | 1463 | 3.75 |
| 6.5 | 2.47 | 2.72 | 3.10 | 15.37 | 79.85 | 1525 | 1525 | 4.3 |



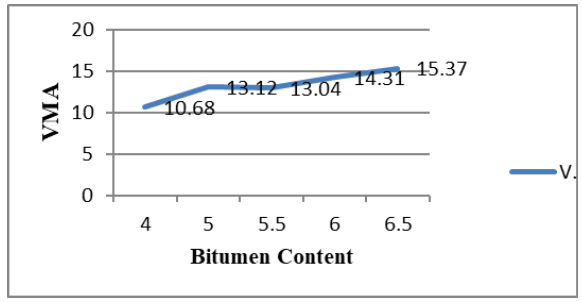

Graph 6 variation of density with bitumen content



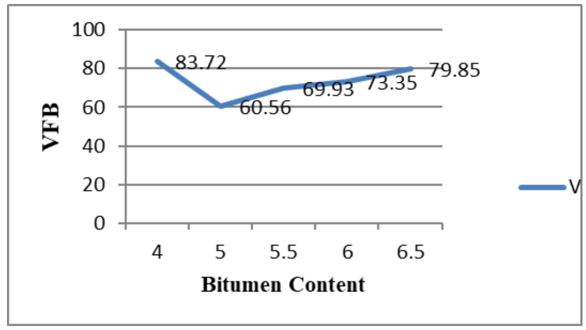

Graph 7 Variation of Specific gravity with bitumen content




Graph 8 Variation of air voids with bitumen content




Graph 9 Variation of VMA with bitumen content




Graph 10 Variation of VFB with bitumen content

## V. CONCLUSIONS

1. The SMA samples were prepared using varying bitumen content of 4%, 5%, 5.5%, 6% and 6.5% and DBM samples were prepared using bitumen content of 4%,5%,6% and 6.5% at a temperature of 110. The stability value increases initially with increase in bitumen content but then decreases gradually.
2. The flow value increases with the increase in the bitumen content for both the mixes. The increase is slow initially for SMA samples, but later the rate increases with the increase in the bitumen content.
3. For DBM samples, the flow value gradually increases with increase in bitumen content. As the bitumen content increases the homogeneity is lost, due to which lumps are formed, which makes the sample loose its homogeneity, reducing stability and increasing deformation under load.

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