

**COMPARATIVE STUDY OF APPLICABILITY OF EVOTHERM
TECHNOLOGY AS A SUBSTITUTE TO CONVENTIONAL HOT MIX IN
THE KASHMIR VALLEY (J&K)**

Wajahat ahmad mir¹, Prof. Lalit deshwal²

¹M.tech student, department of civil engineering, SRCEM, Palwal,
²Assistant professor, department of civil engineering, SRCEM, Palwal,

Abstract— The laying of bituminous mixes in the Kashmir valley stops in the month of October and then again starts towards the end of April. Thus appreciable time of the year is lost owing to low temperature in these months which hinders the developmental process. This problem associated with construction of bituminous pavements in cold season in the Kashmir valley can be effectively encountered by the evotherm technology which maintains the viscosity of bituminous mixes during laying and compaction even at low temperatures

Keywords— Evotherm, Warm mix asphalt, Bitumen, Marshal Stability, Flow value, Kashmir

I. INTRODUCTION

Evotherm is a water-free warm mix asphalt technology designed to allow the production and compaction of high quality asphalt pavements at temperatures 50 to 90°F lower than conventional hot mix asphalt (HMA). Evotherm WMA enables asphalt to coat aggregate at reduced temperatures while also lubricating the mix to improve workability and compaction. Evotherm improves adhesion at the asphalt-aggregate interface thereby addressing water sensitivity issues. Evotherm 3G is formulated to be compatible with all types of asphalt binders including neat, polymer modified, rubberized asphalt, and PPA modified. Any asphalt using PPA or any type of phosphate cross linking agent will utilize either Evotherm R1 or S1. All other asphalts will utilize J1 or M1. MWV works very closely with the asphalt terminals to provide the correct chemistry for every application. As of 2013, Evotherm WMA has been used to pave over 50,000 miles around the world with all types of asphalt pavements, including heavily travelled interstates, urban streets, and rural roads. The U.S. National Centre for Asphalt Technology evaluated Evotherm pavement from 2005-2012, demonstrating that it can withstand over 20 million ESALs of traffic with less than 3 mm of rutting. Evotherm promotes adhesion at lower temperatures by acting as both a liquid antistriper and a warm mix additive. It is an easy to handle, pump-able liquid that may be added at the asphalt terminal or at the mix plant. Evotherm is a new generation warm mix asphalt chemical additive which was invented by MeadWestvaco in 2003. Evotherm allows traditional hot mix asphalt to work at a comparable warm mix temperature which is 50 to 75 °C (100 to 130°F) lower than HMA.

II. TESTING METHODOLOGY FOR DESIGN OF DBM (WITH AND WITHOUT ADDITIVES)

An important issue regarding WMA is mixture design. One of the main issues is to determine if mixture design for WMA can be performed exactly like HMA. Based on findings published in current literature and discussions with WMA researchers, standard mix design procedures for HMA must be modified to accommodate WMA. Based on the findings, the authors currently believe that WMA should provide the same structural values as HMA. Some researchers have pointed out that, since certain WMA technologies require a mixing process that is different from conventional HMA, new guidelines need to be developed for proper QC/QA of the mix. The suitability of WMA for the high production rates of asphalt plants needs to be examined. There is concern by some engineers that those WMA products which utilize moisture may induce some clogging in bag houses; however, no such problems were reported. Except for the temperature of the mat, there are generally no differences in construction activities whether using HMA or WMA, after the product leaves the plant.

III. EXPERIMENTAL INVESTIGATIONS AND LABORATORY TESTING

- **Results on Physical Properties of PURE BITUMEN**

Test Conducted	Test Results	Requirements as per MORTH
Penetration Test	137	60-70
Softening Point	43.9C	45-55
Specific Gravity	1.019	Min 0.99
Flash Point Fire Point	305C 325C	Min 175

• **Results on physical properties of BITUMEN WITH EVOTHERM**

Test Conducted	Test Results
Penetration Test	109mm
Softening Point	43.2C
Specific Gravity	1.0771
Flash Point Fire Point	300C 325C

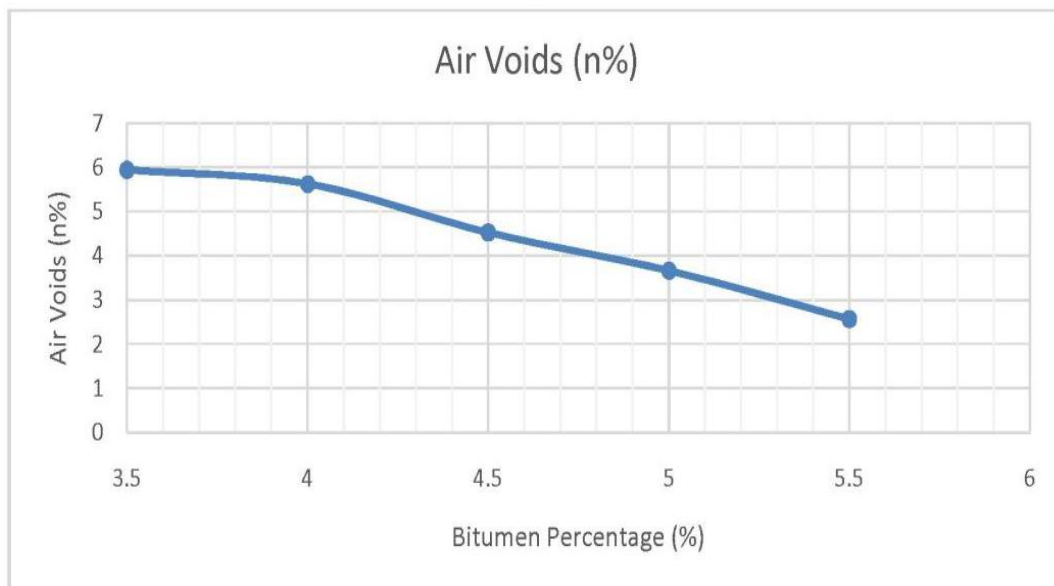
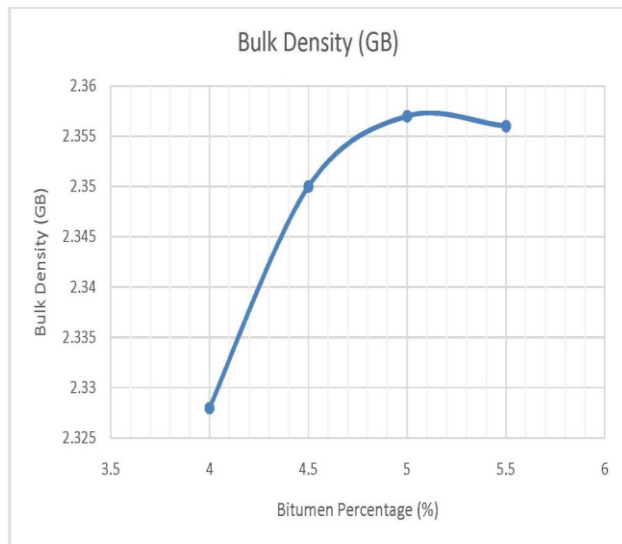
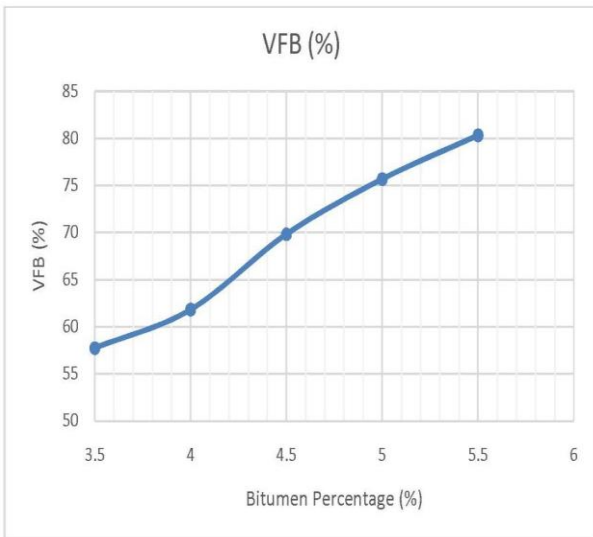
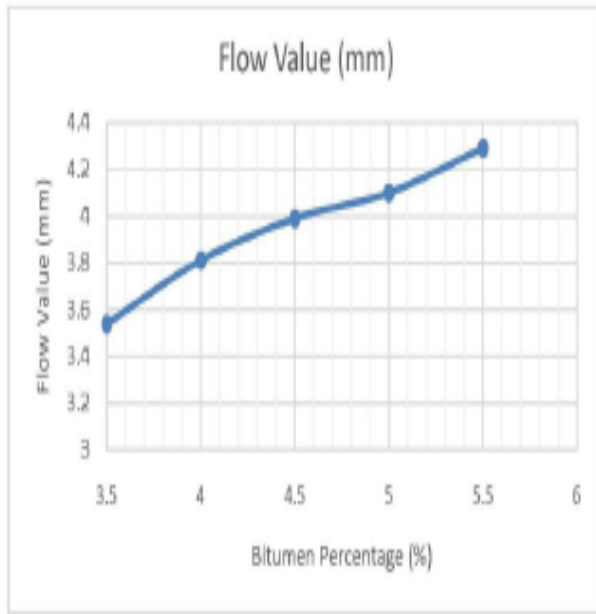
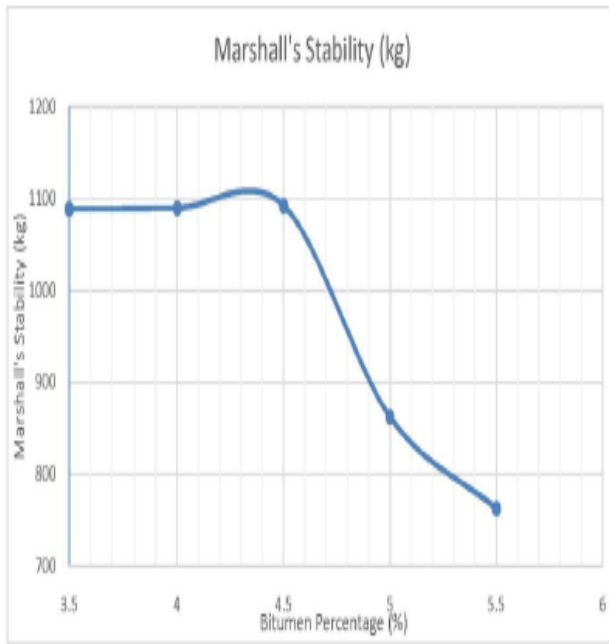
• **Marshall's Stability Value and Flow values for Samples with pure Bitumen**

S. No	Bitumen % percentage	Marshalls Stability(kg)	Flow value	Bulk density GB	Air voids V _v %	Volume of Bitumen V _B %	VMA%	VFB%
1	3.5	1088.72	3.54	2.36	5.94	8.107	14.04	57.74
2	4.0	1090.0	3.81	2.328	5.63	9.139	14.81	61.83
3	4.5	1092.62	3.99	2.35	4.523	10.33	7.2	69.845
4	5.0	862.4	4.10	2.357	3.66	11.102	14.71	75.68
5	5.5	762.4	4.29	2.356	2.57	12.56	15.80	80.33

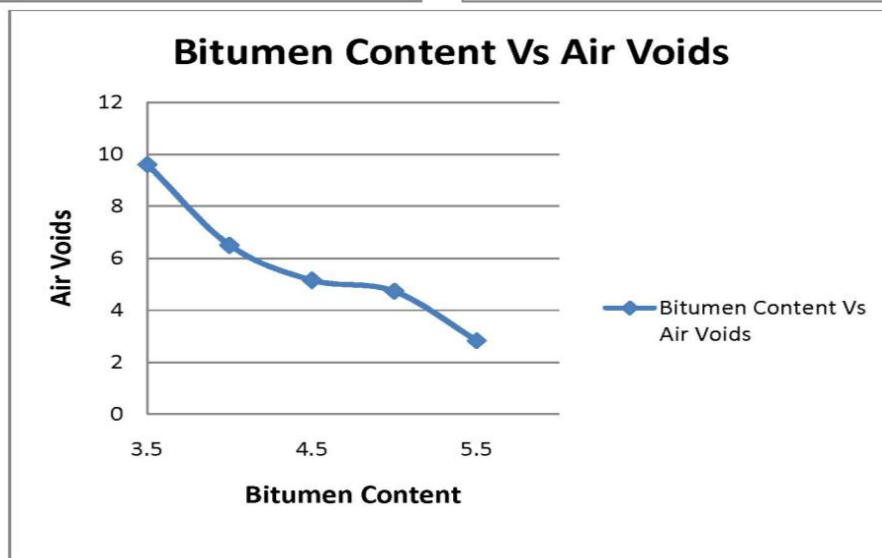
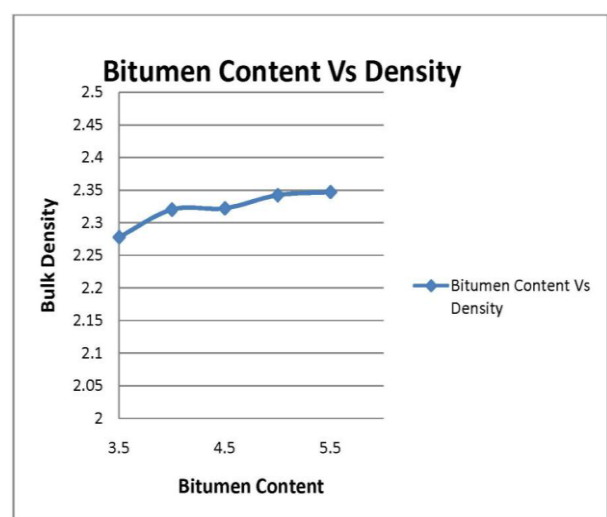
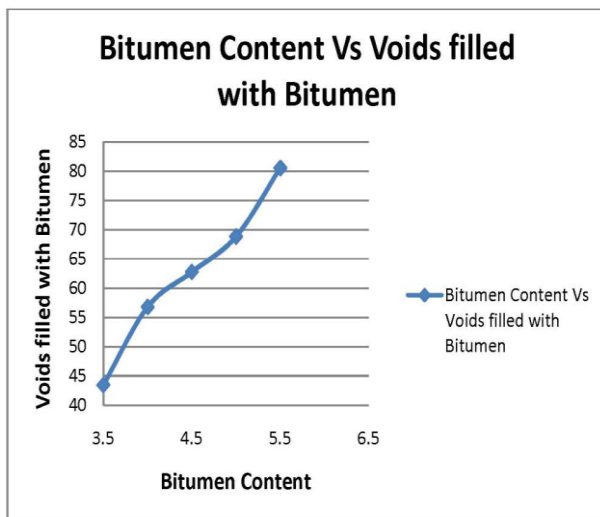
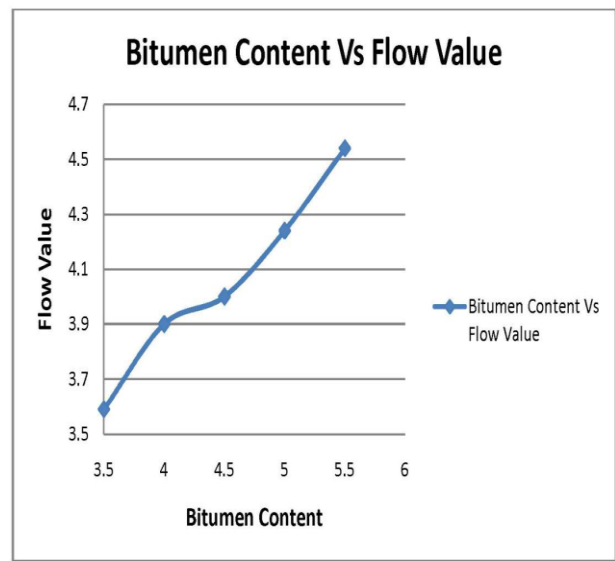
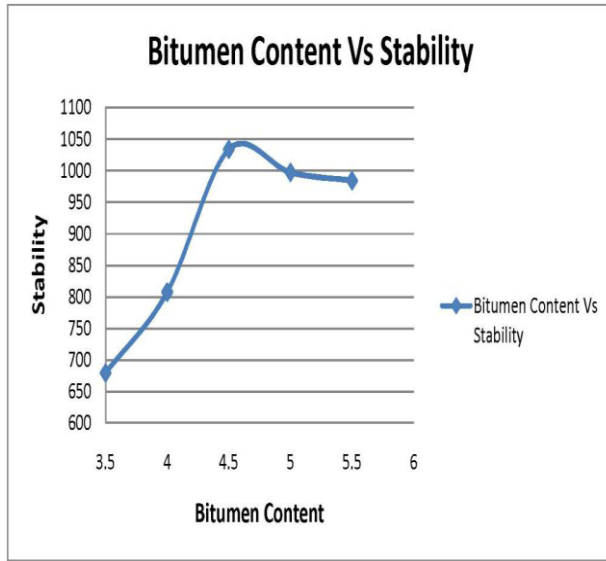
• **Marshall's Stability Value and Flow values for Samples with Bitumen mix with Evotherm**

S.No	Bitumen % percentage	Marshalls Stability(kg)	Flow value	Bulk density GB	Air voids V _v %	Volume of Bitumen V _B %	Voids in mineral agg VMA%	Voids filled with Bitumen VFB%
1.	3.5	679.5	3.59	2.278	9.6	7.39	17.03	43.437
2.	4.0	807.34	3.9	2.32	6.5	8.643	15.26	56.77
3.	4.5	1033.6	4.00	2.322	5.15	9.70	15.46	62.74
4.	5.0	996.87	4.24	2.342	4.73	10.437	15.19	68.80
5.	5.5	984.2	4.54	2.347	2.83	12.25	15.25	80.49

- Variation of Bitumen Content Vs various parameters in case of pure Bitumen



- Variation of Bitumen Content Vs various parameters in case of Bitumen mixed with evotherm



III. RESULTS AND DISCUSSIONS

The test specimens were prepared both with and without evotherm and Marshalls tests were carried out on the prepared specimens. After plotting the Marshalls stability values against bitumen content, the optimum binder content was

obtained, likewise the flow value and voids content were plotted. From the graphs obtained, all the test results were seen satisfying the MORTH recommendations.

Also from the observations of the test results of specimens with evotherm, it was seen that the test samples were compacted at a much lower temperature and also the mixing temperature was lower than the conventional DBM samples.

Even though the specimens were mixed and compacted at lesser temperatures, no significant negative impact on the properties was felt.

• **The structural properties of the Marshalls test samples with pure bitumen are as**

Optimum Bitumen percentage (%)	4.7
Marshalls stability(Kg)	1000
Flow value (mm)	4.1
Bulk density	2.355
Air voids (%)	4.00
Voids filled with bitumen	73

• **The structural properties of the Marshalls test samples with bitumen mixed with evotherm**

Optimum Bitumen percentage (%)	4.7
Marshalls stability (Kg)	999.5
Flow value (mm)	4.2
Bulk density	2.325
Air voids(%)	4.5
Voids filled with bitumen	68

IV. CONCLUSIONS

Evotherm technology studied by us showed decrease in the viscosity of the binder at lower mixing temperatures, which leads to fully coated aggregates at the same temperature. It reduces the mixing temperature by about 30°C than HMC. Based on Marshall Tests, for warm mixes are compacted at 110°C, for DBM warm mixes optimum binder content is observed to be 4.7%.

Based on the results from the lab testing on HMA and WMA using Evotherm, the following conclusions were made:

- Satisfactory Marshall Characteristics are observed for mixes prepared at lower temperatures at their optimum binder contents and binder compositions.
- The specific mix i.e. mix prepared at 4.7% binder content and 80/100 bitumen composition considered to be the most suitable warm mix which is normally comparable with normal HMA.
- It is found that the addition of Evotherm lowers the measured air voids in the sample for a given asphalt content than HMA increasing the density and the required quantity of bitumen.

Due to lower temperatures required during mixing the emission of harmful gases like CO₂, NO_x, SO₂ etc. are considerably reduced, hence the warm mix will be more feasible for the environment. Also, the hauling capacity of the mixed asphalt will be augmented as high temperature for the usage of asphalt is not required.

V. APPLICABILITY IN THE KASHMIR VALLEY (J&K)

- The WMA with Evotherm can be used under lower temperatures as shown in our studies, as a result, pavement construction works can be continued in months having lower temperatures in states like J&K using WMA technology, hence increasing the paving season.
- The technology will extend working season in road construction by about two months and R&B department will be able to lay asphalt on maximum roads even in cold weather conditions.

REFERENCES

1. *Bureau of Indian Standards*, Indian Standard methods of Test for Aggregate for Concrete, IS : 2386 part 4 — 1963 (Reaffirmed 1997),
2. *Bureau of Indian Standards*, Indian Standard Method of Test for Determining Aggregate Impact Value of Soft Coarse Aggregates, IS : 5640 — 1970 (Reaffirmed 1998)
3. *Bureau of Indian Standards*, Indian Standard Specification of Coarse and Fine Aggregate from Natural Sources for Concrete, IS : 383 — 1970 (Reaffirmed 1997)
4. *Ministry of Road Transport and Highways*, Specifications for Road and Bridge Works, Fourth Revision, Indian Roads Congress, New Delhi
5. *Road Research Laboratory*, Bituminous Materials in Road Construction, DSIR, HMSO Publication, London
6. *Knight B.H, and Knight, RG*, Road Aggregates, Their Uses and Testing, Edward Arnold Co. London
7. *E. C.A.F.E*, Report of the Seminar on Low Cost Roads and Soil Stabilization , New Delhi, 1958.
8. *Ministry of Road Transport and Highways*, Specifications for Road and Bridge Works, Fourth Revision, Indian Roads Congress, New Delhi, 2001
9. *Roberts F.L. Kandhal P.S, Brown E.R, Lee DY and Kennedy T W*, Hot Mix Asphalt Materials, Mixture Design and Construction, (Second Edition), NAPA Education Foundation, Lanham, Maryland
10. *Asphalt Institute*, Mix design, Methods for Asphalt Concrete and Other Hot Mix Types (Sixth Edition — 1993), Asphalt Institute, Lexington, U.S.A
11. *Road Research Laboratory*, Bituminous Materials in Road Construction, H.M.S.O, London