A Review on Warm Mix Asphalt

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Abstract— The aim of this study is to compare various properties of warm mix asphalt with hot mix asphalt and also finding benefits of using warm mix asphalt over conventional hot mix with the help of various papers published in national and international journals. From our research we have come to the inference that warm mix asphalt is a better alternative to conventional hot mix asphalt in various manner such as environmental, economical and on the basis of various properties. The bitumen can be mixed with aggregates properly even after reducing the temperature of mixing upto 30°C. Also it has better potential as compared to hot mix asphalt. Warm mix asphalt has remarkable effects on various properties such as Marshall Stability, retained stability, resistance to deformation, moisture resistant, tensile strength and also low carbon footprints. This paper narrates different techniques used for production of warm mix asphalt different types of additives that are available.

Key words: Warm Mix Asphalt (WMA), Hot Mix Asphalt (HMA), Binder Aging, Moisture Resistance

I. INTRODUCTION

Road transportation sector is considered as the major source for economic growth and development of country. Currently majority of Indian roads are flexible pavements which are surfaced with bituminous roads (Also called Hot Mix Asphalt).High mixing and compaction temperatures are required for HMA in order to achieve adequate asphalt coating over aggregates and desired in-place density. The main concern with the production of HMA is that it requires large amount of energy along with release of gases into the environment. Bituminous mixes are classified on the basis of their mixing temperature range i.e.

a) Cold Mixes

It is formed with unheated aggregates and bitumen emulsion. Its temperature range is about 0 to 30ºC

b) Half Warm Mix Asphalt

Its temperature range is 65ºC to 100ºC.

c) Warm Mix Asphalt

Its temperature range lies between 100ºC to 140ºC.

d) Hot mix asphalt

Manufacturing temperature of hot mix asphalt depends on type of binder. The mixing temperature is above 140ºC.

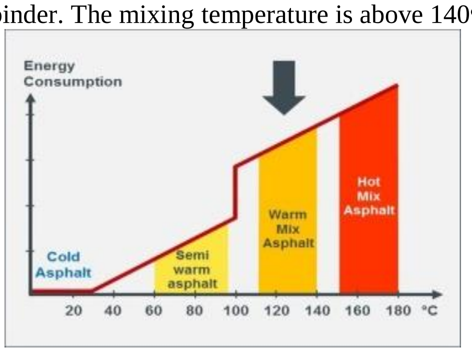

Fig. 1: Graphical Presentation of Temperature Range of Bituminous Mix

Rigid environmental regulations and present need to reduce emissions, creates a need in asphalt sector to opt for an alternative that reduce amount of energy consumption and results in environmental benefits. Warm mix asphalt is an emerging technology for constructing the asphalt pavement WMA is a technology that allows producing the asphalt material at 30 to 40ºC lower temperatures than conventional HMA. Warm mixes are classified on the basis of technology and additives used for reducing production temperatures:

a) Foaming technology

Water is injected into the bitumen by various means which increases the volume of binder resulting in better coating of aggregates and workability at even lower mixing temperature.

b) Organic Additives

This contains hydrocarbons with high molecular weight which when added to the binder causes reduction in viscosity beyond melting point.

c) Chemical additives

It includes combination of emulsifying agent, surfactants and polymers to improve coating, workability and ease of compaction

d) Hybrid technology

It is a combination of two or more WMA technologies.

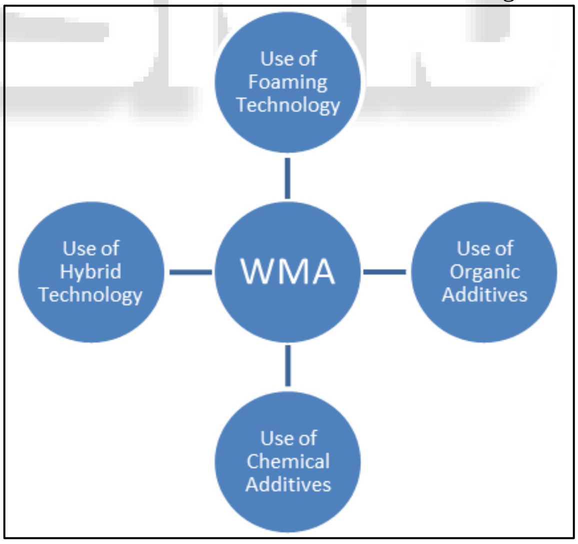

Fig. 2: Types of WMA

II. WARM MIX ADDITIVES

A. *Aspha-Min®*

Aspha-min® is a manufactured synthetic sodium aluminum silicate, or better known as zeolite. This zeolite has been hydro-thermally crystallized and in /white powdered form. By use of Aspha-min the asphalt temperature can be reduced to 30ºC.

B. Evotherm

Evotherm is a water-free warm mix asphalt technology designed to allow the production and compaction of high quality asphalt pavements at temperature lower than conventional hot mix asphalt (HMA). It is produced by using chemical additive technology. Evotherm improves adhesion at the asphalt-aggregate interface.

C. Zeolites

Zeolites are type of silicates and have large vacant space in structure. The well-known use of zeolites is as a water softener. It is described by its ability to lose or absorb water without damaging its cystal structure.

D. Sasobit

It is a product of Sasol wax manufactured from natural gas by the process of polymerization. It is fine crystalline long chain hydrocarbon available in form of flakes, crystals and fibres. Its melting point is nearly 99ºC (approx) and gets dissolved completely in asphalt binder at a temperature greater than 115ºC. It lowers the viscosity of mix and acts as flow modifier. The recommended dosage is 1.5% Sasobit by weight of the binder.

E. Advera

Advera is an aluminosilicate or hydrated zeolite powder and does not affect the performance of binder. It can reduce the temperature by 10-20ºC. It reduces the emission up to 60% at plant and site.

F. Cecabase RT

It is an organic additive which in form of liquid at 25ºC and used as an additive in production of WMA. Adding a liquid surfactant into the bitumen allows a temperature drop of the asphalt mix production and paving processes up to 40°C. It can be added either in bitumen storage tank or directly in drum.

G. Rediset

Rediset WMA is an additive that not only allows the processing of asphalt mixes at lower temperatures, but also allows the compaction of asphalt mixes containing high contents of reclaimed asphalt pavement (RAP). It also allows resistance to aging and water.

H. Asphaltan B

It is available in granular form and available in granular form in 25 kg bags created specifically for "rolled asphalt". It is a mixture of substances based on Montan wax constituents and higher molecular weight hydrocarbons.

I. Wam-Foam®

WAM foam is a product that is formed using two separate binder components in the mixing stage. Binder is divided into two different forms i.e. Soft binder and hard binder in form of foam.

J. Revix

Revix is a chemical additive. It allows reduction of 15-27ºC temperature as compared to HMA mixture.

III. Benefits of WMA over HMA

1) Longer Haul Distance

Viscosity of stiff binder decreases but temperature drop with time is less thus allowing higher haulage distance and better workability and reducing risk of compaction troubles.

2) Environment Friendly

It reduces the emission by 20-30% and also reduces emission of volatile organic compounds.

3) Operational Economy

It reduces the fuel consumption of burner and the plant wear is also less.

4) Better working Conditions

Improve working conditions by reducing exposure to fuel emissions, fumes and heat thus allowing workers to inhale far less smoke, odor and dust at construction site.WMA gives better paving conditions inside tunnels where ventilation is less

5) Increasing Durability

Due to low production temperatures it eliminates premature binder aging which increases the life of pavement and reduces need of maintenance.

6) Extended Paving Season

As the difference between the production and ambient temperature is smaller the paving season can be extended upto colder months of the year.

7) Ease of Placing and compaction

WMA additives and processes act as a compaction aid especially at night work.

Research has been carried throughout the world at various levels on warm mix technology and following results have been obtained through it:

1) Addition of Aspha-min increases the compactibility of mixes. With decrease in mixing and compacting temperatures the rutting potential can increase which might be able to reduce binder ageing.
2) The addition of Sasobit® does not affect the resilient modulus of an asphalt mix but the indirect tensile strengths for mixes containing Sasobit® were lower, in some cases, as compared to the control mixes.
3) WMA has significant advantages such as energy saving, decreased binder aging, lower emission of CO_2 and paving in colder regions etc. It is also found that with certain modifiers performance of WMA is further increased.
4) With WMA technology we can achieve desired bitumen viscosity at 20-30°C less temperature as compared to HMA.
5) WMA mixtures prepared with optimum RAP content perform better than HMA mixtures containing 20% RAP in terms of rutting characteristics.
6) All these additives are used in range of 3-4% by weight of bitumen.
7) Higher strength is achieved by using Rediset at a temperature of 135°C.
8) Reduction in fuel consumption by adding organic, chemical additives and foaming technology is 35%, 50% and 20% respectively.
9) Tensile strength ratio test and moisture induced sensitivity test (MIST) showed that the mixes containing

warm mix asphalt additives performed better in comparison to hot mix asphalt.

10) A better elastic performance was observed by adding 3% of both SBS and Sasobit, also mixture of these chemicals have high resistance against deformation.
11) Retained stability of warm mixes produced below 125°C was observed to be lower than that of control mixes.
12) Warm mixes produced at 120°C shows better resistance towards rutting than control mixes.
13) Mechanical properties of the mix with addition of Zeolites can be improved after reduction of upto 20°C.
14) WMA additives led to decrease the mixture resistance to permanent deformation, although the mixture resistance to cracking can remain similar or even improve as compared to that of the control-HMA.
15) With addition of Aspha-min the air voids were increased before and after aging and stability decreases slightly.

IV. Conclusion

Warm mix asphalt is an emerging technology for constructing the asphalt pavement. WMA is a technology that allows producing the asphalt material at 30 to 40^{o}C lower temperatures than conventional HMA. Warm mixes are classified on the basis of technology and additives used for reducing production temperatures. It has a remarkable effect on various properties of bituminous mix such as stability, density, flow value, retained stability, fatigue failure, resistance to deformation.

V. Gaps Identified

1) The technology is new and most of the investigation is done abroad. Thus need to be practiced more in India.
2) Studies are not specific to the nature of binder.
3) No specific considerations have been given to grades of bitumen.
4) No specific study is carried out at secondary level for determining the retained stability of mixes.
5) All the chemicals used in warm mixes are not locally available thus are not cost effective in our country.

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