# A REVIEW PAPER ON WARM MIX ASPHALT TECHNOLOGIES

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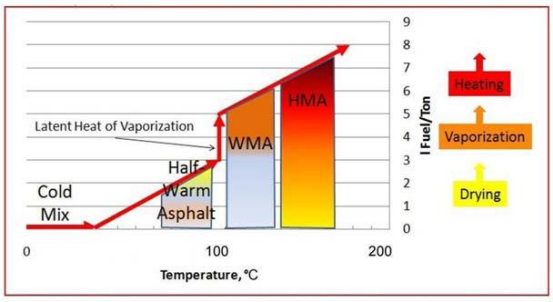
**Abstract:** The objective of the study is to find out the various advantages of Warm Mix Asphalt Technology (WMA) ascompared with the Hot Mix Asphalt Technology (HMA) with the help of different research Papers Published in National and International Journals. From our research we have come to the conclusion that Warm Mix Asphalt Technology can be better option as compared to the HMA Technology in term of its environmental benefits and other properties. With the use of WMA Technology we can achieve desired bitumen viscosity at 20-30˚C less temperature as compared to HMA. WMA has better performance when compared to HMA. WMA has significant advantages such as energy saving, decrease binder ageing, lower emission of fuels, paving in colder regions etc. It is also found out that with certain modifiers the performance of WMA is further increased.WMA has significant effect on different parameters such as Marshall stability, Indirect Tensile Strength (ITS), Tensile Strength Ratio (TSR), rut depth, deformation, toughness, moisture resistance etc. This paper describes different techniques of obtaining WMA and different Warm Mix Chemicals that are available.

**Keywords:** Warm mix Asphalt (WMA), Warm Mix chemical,Indirect Tensile Strength (ITS), Tensile Strength Ratio, Moisture resistance, Binder ageing.

## 1. INTRODUCTION

- From the considerations to protect the Earth humans are on path of searching better technologies which are environmental friendly and economical. In search of such environmental friendly techniques Highway Engineers have developed Warm Mix Asphalt Technology which is an alternative to Hot Mix Asphalt Technology. There are four types of Mixes:
- Hot Mix
- Warm Mix
- Half Warm Mix
- Cold Mix




Warm mix asphalt is produced at temperatures in the range of 20 to 40ºC lower than conventional hot mix asphalt (HMA). Hot mixes are produced by heating the aggregate and bitumen to high temperature in order to achieve the desired viscosity, such that it can adequately coat the aggregate and mix with other ingredients. The objective of WMA is to obtain desired binder viscosity and perform the same objective at lower mixing temperature without compromising on performance. Desired viscosity to fully coat the aggregates is obtained by adding certain chemicals or additives. These chemicals can either be in powder form or in liquid form. With the reduction in production temperature there are

some additional benefits, such as reduced greenhouse gas emissions, fumes, and odours generated at the plant and the paving site.

## 2. Advantages of WMA:

In order to prove that Warm Mix Asphalt Technology is better than HMA Technology we have to find out certain advantages of WMA over HMA. These are listed below:

**i) Emission**: the first and the most palpable benefit is lower emission. As compared to HMA, WMA produces lower emissions because of reduced temperature. According to various studies and surveys it is observed that there is a reduction of 20-35% in the emissions.

**ii) Fumes:** due to temperature reduction WMA yields less fumes as compared to HMA.

**iii) Workability:** by achieving the same viscosity at lower temperature the workability may improve, leading the better compaction.

**iv) Binder aging:** due to high mixing temperature volatile compounds present in bitumen are lost it is called Binder ageing and because of that pavement develops cracks after some time.

**v) Energy:** reduced burner fuel led to energy saving.

**vi) Plant Wear:** due to lower temperature there is less wear and tear in the plant

**vii) Proximity to site**: due to less emissions and fumes WMA plants can be located within or near residential societies.

**viii) Compaction**: compaction is easier in warm mixes than HMA.

**ix) RAP:** the future use of pavement in terms of RAP is increased because of decreased binder ageing.

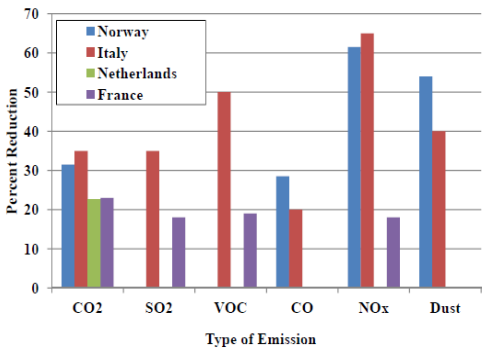



Figure 2 Reported Reduction in Plant Emission with the use of WMA for Selected EU Nations(data by WMA Technical Working Group[3])

## 3. Techniques to produce WMA and Warm Mix Chemical available:

The Most common techniques for producing WMA are organic additives, chemical additives and foaming techniques.

**i) Organic additives:** Those techniques which use certain organic additives such as organic waxes, or fatty amides having melting points slightly higher than those of in service temperatures. Due to these organic additives observed reduction in temperature is 20-30° C.

**ii) Foaming techniques:** Those techniques which uses water for reducing binder viscosity. This is done by converting water into steam which increases the volume of binder thereby reducing its viscosity. The water then evaporates.

**iii) Chemical Additives:** Those techniques which use certain chemical additives which act as surfactants and reduce the frictional forces between aggregate and binder. Due to these chemical additives observed reduction in temperature is 20-30°C

Sasobit, Asphaltan-B, Licomont BS and Aspha-Min chamicals are widely used in Germany. Aspha-Min, EOMAC, Ecoflex, LEA, Warm-Foam, Evotherm are used in France. Advera, Double barrel Green, Evotherm, LEA, Aspha-Min, Asphaltan-B are used in U.S. Sasobit, WMA, Asphamin are used in European countries.

Some other Chemicals are: Asphaltan A and Romonta, Evotherm DAT, Evotherm 3G, Rediset WMX, Revix, Cacabase, LT Asphalt etc.

Various researches carried out in different parts of the world revealed that:

i) After 46 months of service both HMA and WMA have similar International Roughness index.
ii) WMA have better workability than HMA.
iii) Both WMA and HMA have similar cost because cost of fuel saved counter balance the cost of Warm Mix Chemical.
iv) There is no significant effect on moisture susceptibility of Warm Mix additives when compared to control mixes.
v) The energy saving using WMA is equivalent to approximately 1.5-2 liters of fumes/tonnes of material.
vi) WMA reduces the total air pollutants such as CO, $NO_x$, $SO_x$ and volatile organic compounds.
vii) WMA technology is suitable for cold regions because of lower temperature requirements.
viii) By using Rediset a mix of high strength is achieved at a temperature of 115°C and 135°C
ix) At maximum additive content of 4% only Sasobit can change the viscosity of binder with the reduction in mixing temperature of 10° C.
x) Only Cacabase act as surfactant it do not affect the viscosity of bitumen.
xi) After 3 month of service Indirect Tensile Strength (ITS) values of WMA mixture had higher than the HMA mixture. However after 46 months HMA exhibit the higher ITS value.
xii) Normal dosage of Sasobit used is 4-5%.
xiii) It was noticed on allowing reduction of mixing temperature of about 10°CSasobitchanges the viscosity of the binder when the maximum additive of 4% was used.
xiv) WMA has better performance than HMA in general.
xv) Reduction in fuel consumption by adding organic, water based foaming and chemical additives are 35%, 11-20% and 50% respectively.

Overall from this study we have concluded that WMA have good performance than HMA.

## 4) Summary and Conclusions:

WMA technology is a newer technology which enables us to prepare a bituminous mix at significantly lower temperature than HMA technology by adding certain external agents. This technology helps to reduce the emissions of greenhouse gases by 20-30%. It has significant effect on Bituminous mix characteristics for example Stability, density ITS, TSR, resilient modulus, fatigue behaviour etc.

## 5) Gaps identified:

i) The evaluation is newer; most of the studies have been done abroad need to made more in this country.

ii) No specific consideration have been given to different grades of binder.

iii) There are limited studies which are based on SUPERPAVE classification method which is not prevailing in India.

v) Specific studies are needed to evaluate the properties of the surface and base course.

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