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WARM MIX ASPHALT: FUTURE OF BITUMINOUS PAVEMENT

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Abstract – *This study has been carried out to find some suitable alternate to the conventional methods of bituminous pavement construction which involves high mixing and placing temperature. Presently, Hot Mix Asphalt is being used widely in bituminous pavements. This leads to high fuel consumption and large emissions which causes severe damage to the environment. Warm Mix technology is a new technology which requires lesser temperature as compared to hot mixes by addition of suitable additives. In this study, various advantages and suitability of Warm Mix Asphalt (WMA) have been studied with the help of various research papers on this topic.*

It is found that by using warm mix additives, the mixing and placing temperature required can be reduced to 30-40°C as compared to hot mixes. Various other parameters like Marshall Stability, density, air voids etc. are also improved by using suitable warm mix additives. We have briefly described various warm mix additives and their uses in this study. Further, use of various bitumen modifiers like anti-stripping agents, polymer modifiers etc. can improve the performance of the mix. Thus it can be concluded that using suitable warm mix technology for pavement construction can be an appropriate alternate to the conventional hot mix technology.

Key Words: Warm Mix Asphalt, Warm Mix additives, Hot Mix Asphalt, foaming technology, Sasobit, Evotherm, Cecabase, zeolites, WAM.

1. INTRODUCTION

Roads are the 'lifeline' of a country's economic growth. There can be no development in a country if there is no inter connectivity between urban and rural areas. Road transportation is the most widely used type of transportation used in any country. So the construction and maintenance of roads is of prime importance for a country's development. But the present conventional method of bituminous pavement construction involves high fuel consumption and large emissions causing environmental degradation. So there is a need to find an alternate which is environmental friendly and economical at the same time. Warm Mix Asphalt technology is one of the solutions which combine energy savings and environmental benefits. On the other hand, in the modernization of the technology, there should be no compromise with the strength and other characteristics of the pavement.

The concept of warm mix was first introduced in Europe in late 1990's with the increase in environmental awareness. The main objective of this technology is to reduce the harmful emissions formed by conventional hot mix. WMA is produced at temperatures 30 to 50°C lower than HMA. Retaining same strength, durability and performance at reduced temperature is achieved by adding certain additives, emulsions or by changing the methodology of production. In future, warm mix technology would effectively replace hot mix technology, due to alarming environmental depletion taking place at present. As the technology is new and developing, continuous research is going on the selection and suitability of the additives used. According to the technology or additive used, WMA can be classified into four categories, as discussed below.

2. TYPES OF WARM MIX ASPHALT

Foaming technology: This method is based on increasing the volume of the bitumen. This is achieved by injecting small amount of water into the bitumen, either directly in hot bitumen or in mixing chamber. When water gets evaporated, it creates foaming action and thus makes the asphalt less viscous at lower temperature. Excess water can cause stripping action, so additional care is required in design. According to the method of addition of water, foaming technology can be of following two types.

i) Water carrying chemical additives: Certain zeolites or mineral additives are added to mix which contains moisture absorbed in them. With rise in mix temperature, water gets released in bitumen in the form of very tiny foam droplets. Hence its volume gets increased and the aim of proper coating of aggregates is achieved.

ii) Wet fine aggregate addition: This is done in two steps. First, the binder is mixed with heated aggregates in the mixer. Fine aggregates containing about 3% moisture content is then added to mix. This water gets evaporated with temperature and causes foaming action.

Organic additives: In this method, an organic compound is added to the mix, which has melting point close to the temperature of mixing. The compound melts and increases the viscosity of bitumen. As the asphalt cools down after placement, the additive solidifies into small dispersed

particles, providing stiffness to the binder. Long chain hydrocarbons having large molecular mass can be used as additives. Melting point of the additive should be more than the temperature prevailing at site, as it may melt again and loosen its strength.

Chemical additives: This method is different from the above two methods. The principle behind this method is to decrease the friction between the aggregates and bitumen. This in turn helps in getting desired workability of mix. A mixture of emulsifying agents, surfactants (surface acting agents) and polymers is used in pre-determined proportions. 28-50^{o}C fall of temperature can be noted by using this method.

Hybrid technologies: As the name suggests, it is a combination of two or more technologies. Low energy asphalt (LEA) is an example which makes use of a chemical additive along with injection of water in the mix.

3. ADDITIVES USED IN WARM MIX ASPHALT

As the warm mix technology is comparatively a new and emerging technology, there is no particular final product which can be used as an additive prescribed by IRC SP:101-2014. Though, a generic idea about the constituents which can be used as additives is given. Continuous research in this field is giving rise to many patented products which can be used in warm mix efficiently. Some of them are described below.

- Sasobit®: It is an organic additive made of sasol wax. It composes of long chain aliphatic hydrocarbons. It gets completely mixed up with bitumen at 150^{o}C and gets crystallized when asphalt gets cooled down.
- Zeolites: It is a water containing chemical additive, which causes foam production in bitumen. It includes about 20% of absorbed moisture in it. It is composed of silicates with high void ratio. Aspha-min® and Advera are two products which are essentially zeolites, produced by different companies.
- Cecabase® RT: It is an organic additive. When added to the mix, it acts as an interface between aggregates and bitumen, resulting in a more workable mix.
- Evotherm®: It is a customized chemical additive. This provides a better coating of aggregates and adhesion. Asphalt emulsion mixed with Evotherm® chemical is to be used instead of traditional binder.
- WAM-Foam: It is a foam producing additive. The binder is divided into two components. At first stage, a soft binder is mixed with heated aggregates and then a hard binder in a foam form is mixed with the coated aggregates.

Many other companies in India have also produced warm mix additives. But a greater knowledge and awareness is needed for use of the technology in India. Some of the major producers and suppliers of additives are mentioned here. Shell Thiopave®, has recently been awarded accreditation for trial purposes by IRC after a successful trial on a 500 m road stretch in Delhi. Tarak Chemicals, a representative of Ceca Chemicals supplies Cecabase® RT in India. AQUABlack is a foam bitumen production technique provided by MARINI Fayat Group. Techno RTM India is a major supplier of Evotherm® in India.

4. ADVANTAGES OF WARM MIX ASPHALT

- Reduction in emissions: The prime objective of adopting warm mix technology is to lower the production of harmful emissions and this is its biggest advantage. About 30% decrease in emissions is observed by using appropriate technology.
- Energy and cost savings: As the temperature requirement is low for WMA, fuel consumption for heating is low. Hence, energy requirement is considerably reduced. This in turn, directly results in cost cutting of fuel, providing an economical product, as compared to HMA.
- Elimination of health hazards to workers: At high temperatures, bitumen releases toxic fumes in traces that are harmful for the workers. They can cause headache, rashes and cough. Even signs of cancer emerging due to these fumes have been observed. A significant reduction in these fumes can be achieved by using warm mix technology.
- Enhanced workability: Use of specialized additives increase the workability in different ways. This helps with placement and compaction of asphalt.
- Less binder aging: With increase in temperatures at time of production of asphalt, the volatile compounds in bitumen gets evaporated. This leads to development of cracks in the pavement and hence repeated maintenance. Keeping the temperature low helps in reduction of binder aging.
- Production in cold weather: Additives used in WMA helps in compaction at low temperatures also, allowing the paving to extend in cold weather also. Further, the temperature difference between the mix and the environment is also less, which helps in all season paving.
- Use of Reclaimed Asphalt Pavement (RAP): Use of recycled asphalt, which is otherwise a waste, can be incorporated in WMA as the additives help in bringing back the freshness of old asphalt. Also, WMA can be used as a better RAP material in some later constructions as binder aging is reduced.

5. CONCLUSION

Warm mix technology can truly be the future of bituminous pavements. By using this technology, not only pavement construction becomes economical, but also helps preserving the environment without compromising the strength and other essential requirements of the mix. As the technology is new, intense research is required in this regard to be used for practical purposes. Study on various warm mix additives and their suitability in the local environment needs to be done. Technology needs to be spread and promoted so that it may replace the conventional methods, paving way to an environment friendly future.

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