

Experimental Investigation on Warm Mix using Zycotherm as a Chemical Additive with PMB 40 in Mix Design

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Abstract— With the rise of human activity, since the beginning of the 20th century due to rapid rise in heavy loaded vehicles in limited road space to withstand high stresses with minimum maintenance on Indian roads has put pressure on it. Warm Mix Asphalt (WMA) is one of newest technologies that allow mixing, production, placing and compaction of asphalt mixes at significantly lower temperatures due to chemical modification of the bitumen as compared to the traditional Hot Mix Asphalt (HMA) practice. Lower temperatures result in reduced fuel usage, fume exhausts, greenhouse gas emissions, reduces wear and tear, while enhancing worker health and safety conditions during pavement construction. In this paper an attempt is made to use polymer modified bitumen (PMB) 40 paving mix having benefits of reducing temperature and cost of maintenance without sacrificing its quality. polymer modified bitumen (PMB) 40 paving mix with innovative warm mix additive (Zycotherm) in suitable doses is prepared and tested to determine key properties of Marshall Mix design as per the provisions of codal practice.

Key words: Warm mix, Zycotherm, PMB 40, Material properties, Material tests

I. INTRODUCTION

Due to increasing demand in highway construction, scientists and researchers are constantly trying to improve the performance of bitumen pavement. Asphalt concretes are widely used in pavements. Bitumen is the naturally occurring byproduct of crude oil. Due to increase in vehicles in recent years the road surfaces have been exposed to high traffic resulting in deformation of pavements due to excessive stress. Permanent deformation happens when pavement does not have sufficient stability, improper compaction and insufficient pavement strength.

From practical experiences it is proved that the modification of asphalt binder with polymer additives, offers several benefits. To enhance various engineering properties of asphalt many modifiers such as styrene based polymers, polyethylene based polymers, polychloroprene, various oils have been used in asphalt. Polymer modified bitumen suitable proportions changes the properties thereby increasing higher life of pavement. But temperature of PMB of mixing, laying and compacting is more. These techniques are much practiced in many other countries. Zycotherm material as an additive allows the mixing lay down, and compaction of asphalt mixes at significantly lower temperatures compared to hot mix asphalt. Initially overview of pavement types, layers and their functions are discussed followed by brief introduction on warm mix design.

II. MATERIALS & METHODOLOGY

A. Polymer Modified Binder (PMB 40):

The PMB shall be prepared by blending suitable penetration grade bitumen compatible with additives at refinery or any other plant having adequate mixing and blending facilities. The material shall be homogenous and shall not foam when heated at 170°C. No mineral matter other than naturally present in the ingredient materials shall be used. Modifier shall not de-mix on heating at 170°C or later during cooling.

B. Zycotherm:

The Warm Mix Asphalts (WMA) is modified Hot Mix Asphalt (HMA) which is produced, laid and compacted in temperature which is lower than conventional HMA. This technology is classified in category like use of water or organic additives or Chemical additives. In this study use of Zycotherm WMA which is chemical additives in the liquid form. Zycotherm is WMA additive developed by Zydex Industries, Gujarat, India. This is an odor free, chemical warm mix additive that has been engineered to provide significantly improved benefits over current WMA technologies by offering lower production and compaction temperatures, while simultaneously enhancing the moisture resistance of pavements by serving as an antistrip. Mixes that have been modified with Zycotherm can be produced at 120°C - 135°C for and compacted at 90°C - 120°C. Overall, Zycotherm offers temperature reductions depending on the properties of the mix.

III. OBJECTIVE

This study aimed at determining the mixing and compaction temperature reduce due to addition of Zycotherm as a chemical additive with PMB-40. Marshall tests is conducted on the mixes by varying dose of Zycotherm from 0.125%, 0.130%, 0.135%, 0.140% and 0.145% by the weight of bitumen mix and find out fuel saving due to adding Zycotherm. And then cost analysis has been done.

IV. PROPERTIES OF MATERIAL

A. Aggregate Test Result:

Sr. No.	Physical Property	Result	Limits as per Morth Specification
1	Specific Gravity	2.65	-
2	Bulk Density, gm/cc	1.5486	-
3	Water Absorption, %	0.68	2% Max.
4	Impact Value, %	11.47	27% Max

5	Flakiness Index, %	10.20	Combined 30% Max
6	Elongation, %	12.58	
7	Stripping value, %	97.25%	Min. Retained coating 95%

Table 1: Aggregate Test Result

B. PMB-40 Test Results:

Sr. No	Tests	Results	Recommendation as per IS 15462-2004
		PMB 40	
1	Penetration at 25°C, 0.1 mm,	44	30-50
2	Softening Point, °C, min	65	60
3	Specific Gravity	1.02	---
4	Viscosity, 150°C, Poise	8.46	9-Mar
5	Elastic recovery, 15°C, % (min)	70	70

Table 2: PMB-40 Test Results

V. LITERATURE REVIEW

- Rohith N. and J.Ranjitha (2007) studied on Marshall Stability properties on warm mix asphalt using Zycotherm a chemical additive. They find out optimum binder content and temperature after adding suitable dose of Zycotherm.
- Bhargav N. Gautama (2013) studied on warm mix design of bituminous concrete using Rediset WMX. In this study they find out reduction in mixing and compaction temperature using suitable dosage rate of Rediset at optimum temperature by Marshall Stability.
- Brain D. Prowell (2007) studied on The International Technology Scanning program summary report. They find out % reduction in emissions and fuel usage due to use of Warm mix technology.
- Devendra K. patel (2013) studied on Experimental Investigation of warm mix using Rediset as additive with PMB-40 in warm mix design. They find out optimum binder content of HMA and WMA and find out optimum dosage rate of Rediset at optimum temperature by Marshall Stability.

VI. MARSHALL METHOD OF MIX DESIGN

- The Marshall Stability and flow test provides the performance prediction measure for the Marshall Mix design method.
- Preparation of specimen
- The specimens are casted in triplicate and the average of the three specimens for each mix is considered during the analysis of data. The preparation of the specimen is as follows:-
- The materials for the sample i.e. 1200grams of aggregates of five different sizes, PMB-40 and

Zycotherm is weighed according to the proportioned values for the different mixes.

- The aggregates of the required gradation were mixed in a pan. The entire mixture was heated to a temperature of 150°C.
- The weighed PMB-40 for a sample was heated to 150°C and was added to the heated aggregate. Zycotherm and PMB-40 was mixed well with the aggregates to get a homogenous mixture at different temperature.
- The homogenous bituminous mix was poured into the mould for compaction at suitable temperature to ensure compaction was done.
- The specimen was compacted with 75 blows to each side of the cylindrical sample mounted on a standard mould assembly with a standard Marshall hammer that has a circular tamping face and a weight of 4.536 kg with a free fall of 45.7 cm to get the Marshall Compaction Specimen. The compacted specimen was allowed to cool down to room temperature before extraction of the sample.
- A steel disc with a diameter not less than 100 mm and a minimum thickness of 13 mm was used for extracting the compacted specimen from the mould by applying a slow gradual force using a hydraulic jack to the face of the specimen.

VII. CONCLUSION

After trying to different combination of different percentage of Warm mix additive Zycotherm with PMB-40 and then find out optimum binder content at optimum temperature and suitable dosage rate of Zycotherm. And then find out how much % fuel reduce due to addition of Zycotherm and cost Analysis has been done.

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