Evaluation of Rediset as Warm Mix Adhesion Promoter with CRMB 60 in Mix Design

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Abstract **- In India, environment friendly technology is needed to reduce pollution. For Hot mix asphalt at plant and paving site, emissions from burning fuels, fumes, odours are generated more as mixing temperature is high causing more CO_2. This calls for the demand of lowering mixing temperature to reduce emissions keeping in view green house effect without sacrificing the quality of the resulting pavement. Warm mix asphalt is a fast emerging new technology developed in Europe and US, now it has been recommended to carry field trials by border roads organization of India.**

In this study, an attempt is made in the bituminous mix design using CRMB 60 with Warm mix adhesion promoter to determine the laying temperature in suitable proportion, at which the material is mixed and to be placed on the prepared surface without any compromise with quality. Significant reduction in temperature have documented the obvious benefits of cutting fuel consumption, decreasing the production of green house gases and enhancing engineer benefits include better compaction on the road and the ability to haul paving mix for longer distances.

1. INTRODUCTION

Engineers with open mind have to adopt material for use of bituminous concrete purpose to meet the required quality, keeping in aspect economy, increasing benefits to mankind and to satisfy the recommendation and requirements of MoRTH Section 508. Ever increasing growth of laden vehicles in limited road space has to withstand the toughest conditions and high resistance to strong shearing forces with minimum maintenance.

Rising energy prices, global warming, and more stringent environmental regulations have resulted in an interest in warm mix bitumen technologies as a mean to decrease the energy consumption and emissions associated with conventional hot mix Bitumen production. Typically, the mixing temperatures of warm mix bitumen range from 100 to 130 °C compared to the mixing temperatures of 150 to 160 °C for hot mix Bitumen Thus, warm mix has been gaining increasing popularity in the recent years. When producing Hot Mix a lot of energy is used to heat the aggregate. This is not only costly but also generates a large amount of CO2 emissions. Warm mix additives namely Rediset dose in 1.5%, 2.0% and 2.5% is used with CRMB 60 to reduce the mixing and compaction temperature is a logical, economical approach to meet performance standard for pavement today. Rediset WMX system enables the production of hot mix ≥ 30°C lower temperature vs. control Hot Mix and this will reduce fuel consumption by at least 20% and significantly lower emissions not only at the hot-mix plant but also at the paving site but it prolongs the service life of the road by improving the performance and durability of the bitumen pavement.[15]

2. MATERIALS AND METHODOLOGY:

2.1 Crumb Rubber Modified Binder (CRMB 60)

Crumb Rubber Based Type-D CRMB 60 is a Softening Point Based Bitumen modified with Crumb Rubber powder from discarded truck tyres, used in many applications. When Crumb Rubber Modified Bitumen is combined with mineral aggregates it provides higher cohesion and better adhesion compared to conventional and paving bitumen grades. CRMB also offers great elastic recovery, reduced degree of rutting, improves anti- stripping properties and high ageing resistance. In colder climatic conditions and winter months the CRMB stops cracking that occurs when the road surface contracts. In extreme hot climatic conditions and summer months the CRMB stops the asphalt from softening, when road surface temperatures may exceed 65°C. CRMB is suitable for roadways and motorways with heavy traffic flow. Higher skid resistance, better road grip and smother vehicle break application, which reduces accident.[16]

2.2 Warm Mix – Adhesion Promoter (Rediset)

Warm mix is technology which gives you the space to prepare a mix at lower temperature than hot mix. This technology is classified in category like use of water or Organic additives or Chemical additives. The Rediset which is chemical additives has used in the pellet form and does not contain water. It may be added to 1.5, 2.0% and 2.5% by weight of binder. It is directly added to binder and blending it to proper mixing with binder at 110 °C temperature. Rediset WMX are easy to incorporate with existing equipment, possess adhesion promoting properties, extends life of pavement and is suited to a wide range of mix types and aggregates.[14]

3. METHODOLOGY

In this study first of all study of physical properties of crusher aggregate sizes 20 mm and 6mm obtained from

quarry of Chikhli, Navsari district is carried out. Gradation meeting MoRTH section 508, nominal aggregate size is taken with stone dust and lime as filler material to meet the suitable mixes for bituminous mixes design. The Bitumen used for this study is ready made CRMB 60 obtained from Hincol Company, GIDC Savli, Baroda District. Relevant tests to determine the properties on CRMB 60 with and without rediset material are carried out.

Finally samples are prepared for Mix Design (Marshall Test) to determine the Optimum Bitumen Content of CRMB 60. To it varied proportions of 1.5%, 2.0% and 2.5% of Rediset material is added by weight of CRMB 60 to determine optimum temperature and optimum dosage of rediset to meet the required quality by satisfying the recommendation and requirements of MoRTH Section 508.

1. Laboratory investigations to determine physical properties of aggregates:

Table 1. Physical Properties of Aggregate

Sr. No.	**Property**	**Test**	**Result**		**Recommended Value as per MoRTH 500 section-508**	
1	Cleanliness (dust)	Grain size analysis	2.11%		Max 5% passing 0.75 mm sieve	
2	Toughness	Aggregate Impact value	11.3%		24% Max	
3	Particle shape	Flakiness and elongation Index (combined)	22.44%		30% Max	
4	Water absorption	Water absorption	20 mm Agg.= 0.3% 6 mm Agg. = 1.66%		2% Max	
5	Specific Gravity & Gradation	Specific Gravity	Sp. gr	Wt. of sample	% of Sample	---
		20 mm Agg	2.64	564	47	
		6 mm Agg.	2.49	276	23	
		Stone dust	2.49	324	27	
		Lime	2.26	36	03	
		Total		1200	100	

2. Gradation of aggregates meeting MoRTH section 508

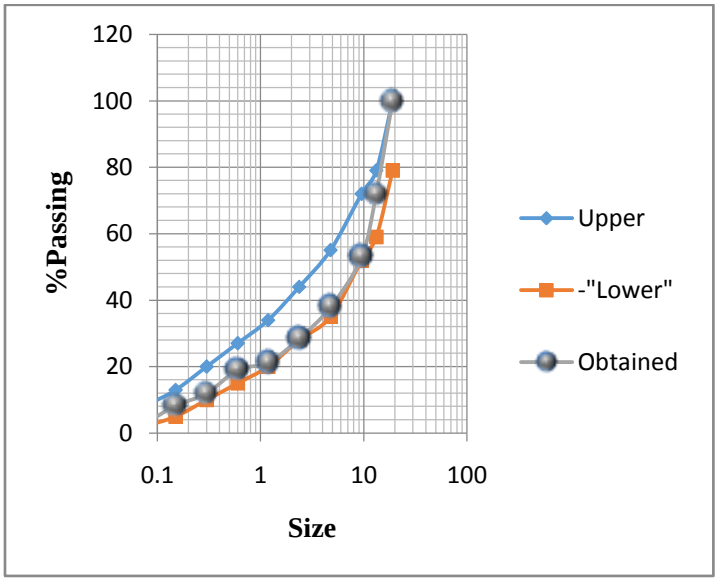

Figure 1. Gradation of aggregate chart

From the plot of aggregate gradation chart as shown in figure 1, the most appropriate line obtained falls above the lower limit line which means that the selected aggregate proportion classified as fine aggregate.

3. Laboratory investigations to determine physical properties of CRMB60 with and without rediset

Table 2. Test Result of CRMB 60

Sr. No.	**Tests**	**Results**		**Recommendation as per IS 15462-2004**
		CRMB 60	**CRMB 60 + Rediset**	
1	Penetration at 25 °C, 0.1 mm, 5 sec	43	35	<50 (IS:1203)
2	Softening Point, °C, min	66	62	60 (IS:1205)
3	Specific Gravity	1.05		---
4	Viscosity, 150 °C , (Poise)	8.4	7.35	3-9 (IS:1206 Part-1)
5	Elastic recovery, 25 °C, cm (min)	60	53	35 (---)

4. Marshall Mix design for optimum binder content using CRMB 60

For determining the Optimum Bitumen Content, 3 samples are prepared of bitumen content at 5, 5.5 and 6% of

gradation mix weight at mixing temperature 160° C as per the procedure and requirements of MoRTH section 508.

Table 3. Marshall results showing properties of mix satisfying MoRTH section 508.

Sr. No	Average Bitumen Content	Average Stability Kg	Average Flow Value mm	Average Bulk Sp. Gravity g/cc	Average Vv %	Average VFB %	VMA %
1	5.0%	1778.67	3.70	2.34	5.14	67.57	15.83
2	5.5%	1962.33	4.07	2.38	4.29	73.69	16.21
3	6.0%	1836.00	4.83	2.33	3.99	76.10	16.64

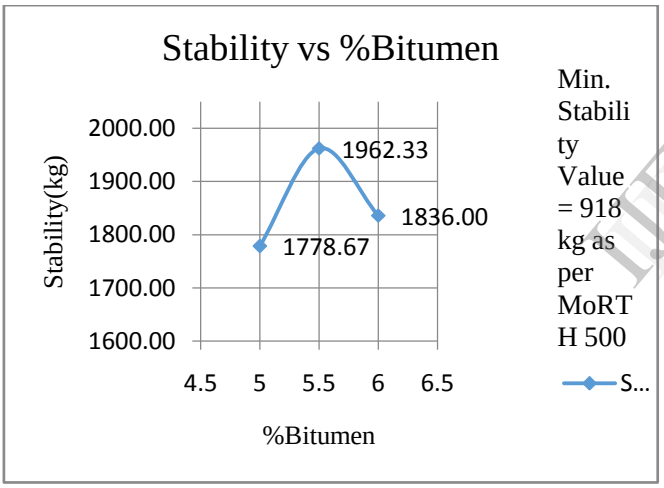

Figure 2. Bitumen Vs Stability

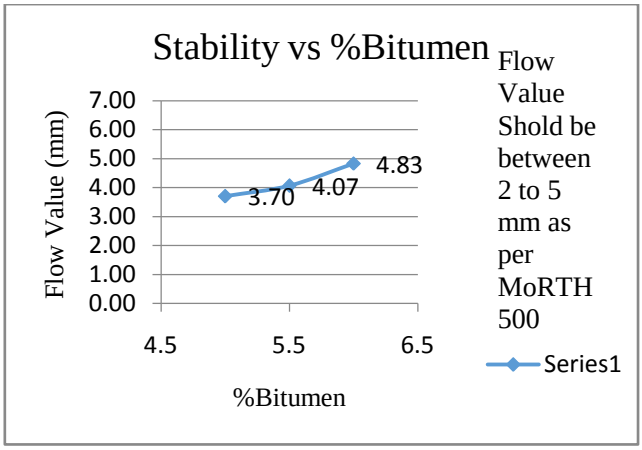

Figure 3. Bitumen Vs Unit Weight

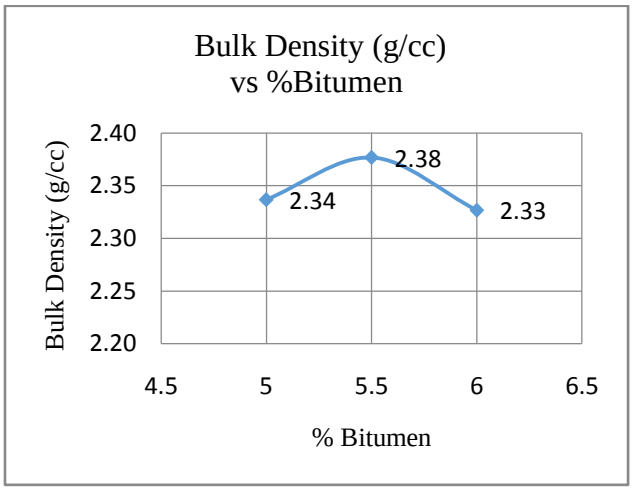

Figure 4. Bitumen Vs Volume of Voids

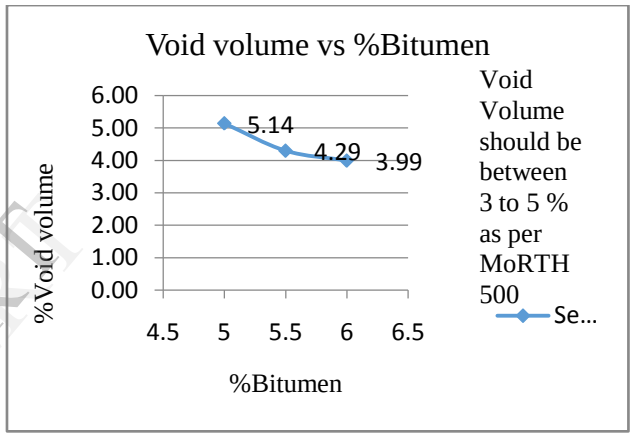

Figure 5. Bitumen Vs Flow Value

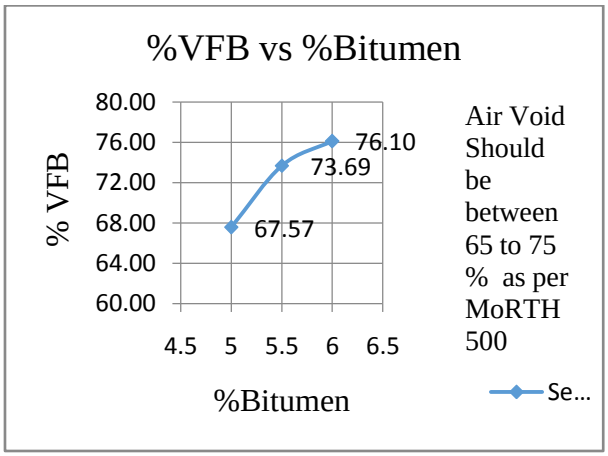

Figure 6. Bitumen Vs VFB

Looking to the figure 2, 3, 4, 5 and 6 the optimum binder content 5.5% satisfies the limit laid down in MoRTH section 508 with respect to maximum stability, Marshall Flow value, bulk specific gravity, percentage air voids in compacted mix and voids filled with bitumen.

5. Marshall Mix design for CRMB 60 (5.5 % optimum binder content) plus Rediset with optimum dosage and optimum temperature.

Test results of Bituminous Concrete mix using CRMB 60 with 5.5% optimum bitumen content is taken into consideration for mix design by addition of 1.5, 2 and 2.5% dosage of Rediset at temperature 110°C, 120°C and 130°C by weight of CRMB 60 to obtain homogeneous mix to evaluate the volumetric properties meeting the required standards for fulfilment of road construction work. Graphs of all properties of each mix are plotted as shown in figure:

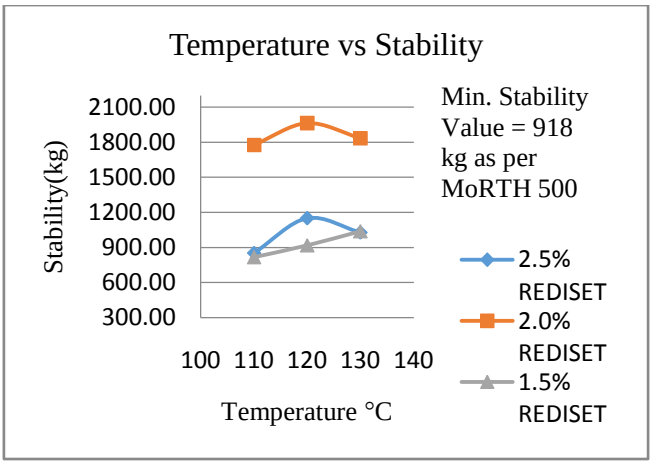

Figure 7. Temperature Vs Stability

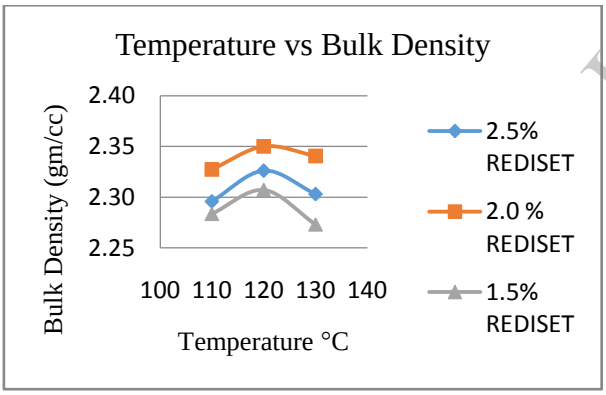

Figure 8. Temperature Vs Bulk Sp. Gravity

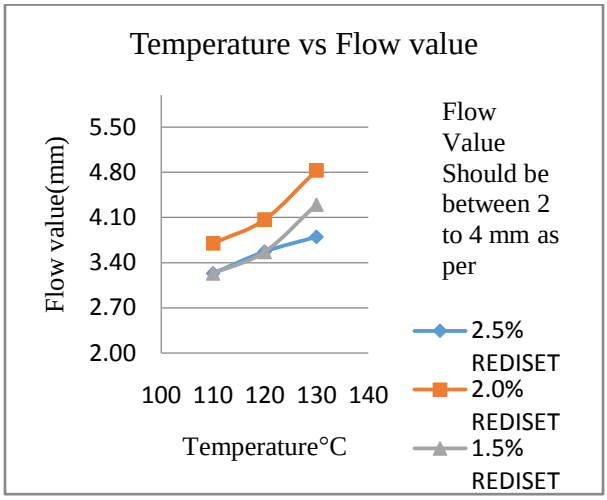

Figure 9. Temperature Vs Flow Value

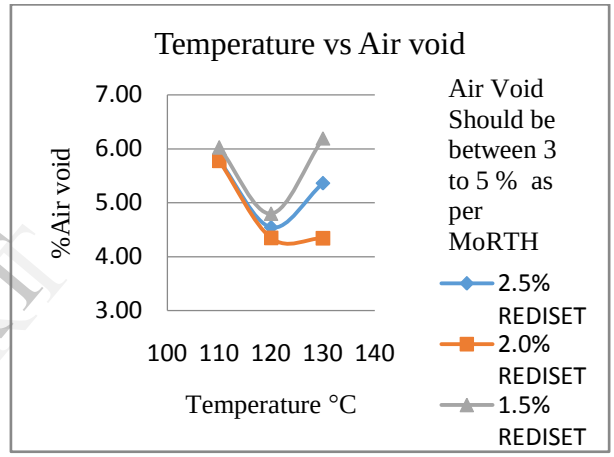

Figure10. Temperature Vs Air void

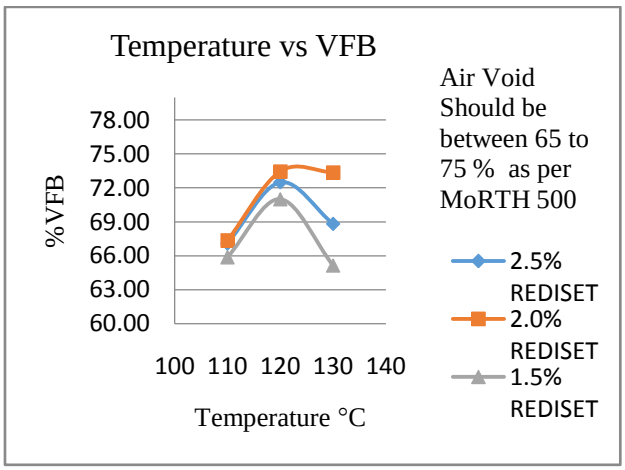

Figure11.Temperature Vs VFB

Looking to the graphs it is clearly seen that optimum temperature is 120°C for warm mix design at 2% addition of Rediset. Also as the air voids decreases stability and bulk specific gravity goes on increasing and this is witnessed too. After 120°C decline in stability, bulk density, volume filled with bitumen is seen when the rise in air voids is seen. The addition of rediset in CRMB 60 is obviously clear that it has

potential to improve mix compatibility efforts with decrease in their air voids.

Dosage of 1.5% Rediset shows reduction in stability which obviously higher than the MoRTH requirement except at 110°C temperature. There has been also increase in air voids which clearly mean that there is not proper compaction of mix at temperature 110°C, 120°C and 130°C.

Similarly, addition of 2.5% Rediset shows reduction in stability which obviously higher than the MORTH requirement except at 110°C temperature. There has been also increase in air voids which clearly mean that there is not proper compaction of mix at temperature 110°C, 120°C and 130°C.

4. CONCLUSION

Bituminous mixes prepared at control temperature (160 ºC) emit lots of fumes which is responsible for Environment degradation and Global warming. Also, at control mix it consumes more fuel. By this study it is possible to prepared CRMB 60 mixes at 120 ºC temperature using Warm mix - Adhesion Promoter which is 30 ºC less than the control mix. Also reduction in mixing temperature emits less fumes, CO2 and other gases responsible for Global warming. Reduction in mixing temperature will save fuel and become it to cost effective.

Hence, it is vividly clear that use of 2% addition of Rediset as Warm mix at 120 ºC temperature in construction of Bituminous Concrete is eco-friendly, cost effective and beneficial under precise supervision.

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