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Comparative Study on Design of Bituminous Mixes Containing Reclaimed Asphalt Pavement

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ABSTRACT: RAP is a deteriorated bituminous mix that contains aged bitumen and aggregate. Hence its performance is comparatively poorer than virgin mix. Performance of RAP can be enhanced by adding virgin bitumen, virgin aggregates & rejuvenators (such as waste plastic) in suitable proportions. Recycling of reclaimed material from a deteriorated pavement to reuse partially or fully to produce new pavement materials results in considerable savings of material, money & energy. In its order Supreme Court of India from the perspective of conserving natural resources & to prevent other ecological impact, ordered to stop some of the quarrying process across India. In order to keep progress in the development of Indian road networks which has got major share in country's economic growth, it is necessary for pavement engineers to think alternatives for use of mineral aggregates which is an important constituent of bituminous pavement. Recycling is one such alternative that reduces use of new materials, conserves natural resources & most importantly reduces carbon foot prints there by earning carbon credits for India. Present work focuses on evaluation and comparison of physical and engineering properties of bituminous mixes containing RAP material in various percentages through extensive laboratory tests for the construction of surface course in flexible pavements.

KEYWORDS: Bitumen, Aggregate, RAP, Rejuvenators, Pavement, Surface course.

I. INTRODUCTION

Effective, timely and speedy continuation is the only way to protect the huge capital investments which are linked to the road system. The proper strengthening and maintenance of the road network is required. Where deteriorating of roads increase with the steady increase in traffic. Overlaying the distressed pavements with virgin courses had been adopted and continues to be the preferred method for return of aged pavements. The continuous application of overlays increases the pavement thickness and approaches the curb line. The careful methods are responsible for 22 percent of the global energy consumption and 25 percent of fossil fuel burning across the world and 30 percent of global air pollution and greenhouse gases. The accessibility and efficient recycling technology favoured the adoption of Reclaimed Asphalt Pavements (RAP) Technology in many countries. Recycling, in place of conventional method of overlaying of asphalt pavements has made a rapid advancement in the developed countries. This method of strengthening and repairing of roads was based on their stability rather than their initial cost. The concept of RAP lies in restoring the physic-chemical properties of the aged bitumen to its original and at the same time it enhances the mechanical properties and strength of the aged binder. With the development of RAP technology, asphalt pavement treatment costs would much decrease. The various ecological and economic advantages which contributed to enhancement of recycling processes throughout the world are conservation of aggregates and binders, decrease in pavement thickness, reduced cost of transportation, conservation energy and labor, preservation of existing pavement

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geometric, preservation of environment. The ability to mill and remove old, distressed pavements allows for more effective analysis techniques which create RAP may have substantial engineering benefits. Severely cracked or rutted layers can be removed so that their damage is not reflected through a new surface layer. The effective use of RAP solves a large societal problem because it does not occupy landfill space.

II. MATERIALS

The use of Reclaimed Asphalt Pavement (RAP) has been enormously increased due to escalating increases in crude oil prices as well as cost of energy are expected to result in increased prices of asphalt binders. Reclaimed Asphalt Pavement is formed by cold milling, heating or softening and removal of existing pavement, full depth removal, or plant waste Hot Mix Asphalt (HMA) materials.

A. Virgin Aggregate

For the present study virgin aggregates are obtained from Hathi Belgal quarry.

B. Bitumen Binder

In the present study VG-30 and CRMB-55 type binders are used to ascertain the characteristic of bituminous mixes containing various percentage of RAP material with normal and modified binders

C. Milled RAP



Fig.1: Milled RAP

Fig. 1 is the Milled material obtained from the site near Bellary circle flyover, Kurnool where the milling process was in progress for overlaying purpose. Reclaimed asphalt pavement (RAP) is obtained by removing or reprocessing pavement materials containing asphalt and aggregates, generally RAP is generated when asphalt pavements are removed for reconstruction or resurfacing. When crushed and screened properly it consists of high-quality, well-graded aggregates coated with asphalt cement.

D. Processed RAP



Fig.2: Sieved Processed RAP

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Fig. 2 shows the bituminous pavement material for reuse, which is obtained by processing reclaimed (full depth) asphalt material in an exclusively developed equipment developed by M/S K K Waste Plastic Management Pvt. Ltd. Bengaluru. Reclaimed material for processing is obtained from Hosakote – Gownipalli via Chintamani road (SH-82) which is presently under reconstruction.

III. TEST PROCEDURE

A. Marshall Method of Mix Design

Marshall Stability test of a mix is defined as maximum load carried by a compacted specimen at a standard test temperature of 60°C. The flow value is the deformation of specimen that under goes during the loading up to the maximum load in 0.25 mm units. The Marshall Stability value of a compacted specimen of bituminous mix indicates its resistance to deformation under applied incremental load and the flow value indicates the extent of deformation it undergoes due to loading or its flexibility. The Marshall Stability test is applicable for hot mix design using bitumen and aggregates with maximum size of 25mm.

B. Preparation of Test Specimens

The coarse aggregates, fine aggregates and the filler material are proportioned and mixed in such a way that final gradation of the mixture is within the range of bituminous course (BC) mix. The aggregates and filler are mixed together in the desired proportion to fulfill the design requirements and the specified gradation. The required quantity of the mineral aggregate mix is weighed and taken so as to produce a compacted bituminous mix specimen of thickness 63.5mm approximately. The compaction level chosen is 75 blows on either side of the Marshall specimens for bituminous mix. Marshall Tests were conducted according to ASTM-D1559-96.

C. Test procedure for Preparing Marshall Specimens

The aggregates were proportioned and mixed. The aggregates were heated to a temperature of 160⁰-180⁰C and a required quantity of bitumen i.e., 4, 4.5, 5.0, 5.5, and 6.0 and percent by weight of aggregate. It is heated to a temperature of 120-145⁰C, the heated bitumen is added to the heated aggregates and thoroughly mixed at a desired mixing temperature of 165-175⁰C. The mix is placed in a preheated mould of 10.16cm diameter and 6.35cm height with base plate and collar. After levelling the top surface, the mix is compacted by means of rammer of 4.54kg weight with 457mm height of free fall with 75 blows. The process is repeated on the other face also. After the compaction the specimen with the mould is allowed to cool down to the room temperature. Three specimens are prepared for bitumen contents of 4, 4.5, 5.0, 5.5 and 6.0 percent by weight of aggregates for designed aggregate gradation. The same test procedure was adopted for Marshall Test on both conventional and recycled bituminous concrete mixes. The compacted specimens are removed after 24 hours curing in air. Later the specimen is extracted using specimen extractor. The mean height, weight in air, weight in water of the specimens was noted and bulk density is calculated. The specimens are kept in a thermostatically controlled water bath and maintained at 60±1 for 30-40 minutes. The specimens are taken out, placed in Marshall Test head and tested to determine Marshall Stability value, which is the maximum load before failure, and the flow value, which is the deformation of the specimen in “mm” up to the maximum load. The equipment used is strain controlled with strain rate of 50mm/minute. The corrected Marshall Stability value of each specimen is determined by applying appropriate correction factor, if the average height of the specimen was not exactly 63.5mm.

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IV. TEST RESULTS

Milled Material				
	Binder	Percentage RAP	Marshall Stability (Kg)	Flow (mm)
1	VG-30	35	1139.05	3.4
2		40	1071.93	3.5
3		50	1306.37	2.97
4		60	1059.69	3.63
5		100	1285.23	4.63
6	CRMB-55	35	1501.06	3.4
7		40	1438.39	4.18
8		50	1422.89	4.1
9		60	1465.09	3.68
10		100	1267.21	4.13

Table 1: Test Result of Milled RAP

Processed RAP				
	Binder	Percentage RAP	Marshall Stability(Kg)	Flow (mm)
1	VG-30	35	1084.24	3.45
2		40	1148.1	4.6
3		50	1228.05	4.41
4		60	1262.32	5.58
5		100	1019.64	6.94
6	CRMB-55	35	1267.21	3.45
7		40	1318.24	3.68
8		50	1495.65	4.34
9		60	1374.23	3.7
10		100	1600.52	6.74

Table 2: Test Result of Processed RAP

Marshall Mix design for control mix with virgin aggregates and both (milled and processed) type of RAP material is summarized in the tables from Table 1 to Table 2 all the mixtures fulfil the minimum stability criteria of 600Kg and also satisfy VMA and VFA requirements. It can be observed from the results that Marshall Stability increases linearly with increase in RAP content. The flow values for all mixes falls within the permissible limits of 2mm to 4mm except for the mixes containing 50% and 100% RAP material. The variability in the properties of mix is due to variability in the RAP material as such size and shape of the aggregates, % fines, % of aged bitumen content etc., which generally increases with increase in RAP percentage.

V. CONCLUSION

It is observed from the extensive laboratory evaluation of different Marshall Mixtures containing RAP materials that, the blending of virgin and RAP material overall improve the mixture properties by HMA technology. The main conclusions drawn from the present work are as follows:

- In laboratory, bituminous mixture blended with RAP is designed using Marshall Method and it is observed that bituminous mixes containing RAP material perform same or even better than the conventional mix.
- Marshall Stability values increases almost linearly with increase in RAP content.
- The maximum Marshall stability of bituminous mix with VG-30 as binder is 1306.37 Kg which is achieved for blend of virgin aggregates and 50% of Milled RAP corresponding to a flow value of 2.97mm.
- The maximum Marshall stability of a bituminous mix with VG-30 binder is achieved for mix containing 60% of Processed RAP that is 1262.32 kg and its flow value is 5.58mm which doesn't fall within the permissible limits of 2mm to 4mm.

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- When the Modified binder CRMB-55 is used, maximum stability of 1501.06 Kg is achieved for mixture containing 35% of Milled RAP with a flow value of 3.67mm satisfying minimum requirement of both stability and flow criteria.
- Maximum stability value of 1495.65 Kg corresponding to a flow value of 4.34mm is yielded for bituminous mix containing 50% of Processed RAP with CRMB-55 binder.
- It is evident from the present study that properties of bituminous mixture improves with the addition of RAP material, hence use of recycling materials will help in conserving non-renewable resources, reduces carbon foot prints, consumption of fossil fuels and also it reduces the HMA price and improves the performance especially in the areas where aggregate and asphalt are in short of supply or where haul distances to remote locations are exclusively long.

REFERENCES

1. Shaopeng Wu, et al, "*Investigation of temperature characteristics of recycled hot mix asphalt mixtures*", Resources, Conservation and Recycling journal 51, pp 610–620, 2007.
2. Chui-Te Chiu, et al, "*Life cycle assessment on using recycled materials for rehabilitating asphalt pavements*", Resources, Conservation and Recycling journal 52, pp 545–556, 2008.
3. Williams Kehinde Kupolati, "*Characterization of Bitumen Extracted from Used Asphalt Pavement*", European Journal of Scientific Research ISSN 1450-216X, Vol.25- No.2 pp.226-233, 2009.
4. Derya Deniz, et al, "*Expansive characteristics of reclaimed asphalt pavement (RAP) used as base materials*", FHWA-ICT-09-055, 2009.
5. Mesut Tigidemir, et al, "*Investigation of fatigue behaviour of asphalt concrete pavements with fuzzy-logic approach*", International Journal of Fatigue 24, pp 903–910, 2009.
6. B. Barra, et al, "*Fatigue behaviour of dense asphalt mixes in dry and environmental-conditioning states*", Construction and Building Materials journal 29, pp 128–134, 2012.
7. Ercan Ozgan, "*Fuzzy logic and statistical-based modelling of the Marshall Stability of asphalt Concrete under varying temperatures and exposure times*", Advances in Engineering Software journal- 40, pp 527–534, 2009.