International Journal of Advance Research in Science and Engineering
Vol. No.5, Special Issue No. (02), March 2016
www.ijarse.com
IJARSE
ISSN 2319 - 8354

USE OF RAP MATERIAL IN BITUMINIOUS PAVEMENT

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ABSTRACT

Reclaimed Asphalt Pavement (RAP) is an innovating technique in India, and the use ofRAP is gradually increasing popularity. Using RAP does not only help in minimizing the budget of project but also ensures proper utilization of material. The objective of this study is to understand the vitality of using RAP for the construction of bituminous pavements. From this study and from previous research papers it can be concluded that using RAP is advantageous as RAP mixes can yield results equal or even higher than fresh mixes. If calculated and introduced appropriately RAP mixes have a constructive effect on various parameters like Marshall Stability, moisture resistance and density. This paper presents the scope of using RAP mixes.

Keywords: Reclaimed Asphalt Pavement, Dense Bituminous Macadam, Milling, Hot Mix Plant, Wet Mix Macadam.

I. INTRODUCTION

The bituminous pavement rehabilitation alternatives are mainly overlaying, recycling and reconstruction. In recycling practice the material from deteriorated pavement, known as reclaimed asphalt pavement (RAP) is partially or fully reused in new construction. It is also reported that recycled mix has higher resistance to scuffing and shearing which in turn increase the rutting resistance. Chances of reflective cracking are found to be less with recycled mix. Bituminous pavement recycling technology is not yet a popular in India. However, in advanced countries bitumen is the most recycled material in the construction industry. A research paper shows that RAP of various different percentages have been used in the construction of bituminous pavement varying from 10 to 70%. In rare cases up to 80% of RAP has been successfully used. The construction of a new pavement or overlays involves a huge consumption of aggregates of different sizes along with binder. This leads to high cost of project. Because of restrictions imposed on mining in various regions and heavy load on natural resources, it becomes necessary to recycle the pavements. RAP is a new technique in which aggregates from a previous pavement are scarified and are reused in the construction of a new pavement. Using RAP reduces the cost of the project marginally. The purpose of using RAP is more justified as from the past few experience it has been observed that strength parameters either of same or better quality are produced by RAP mixes when compared to standard virgin mixes. The reduction in the cost of project is directly proportional to the percentage of RAP used though an ideal percentage should be analysed which gives the optimal strength specification and economics.

1.1 Objective study

1. To use the RAP material as filling material without doing any analysed and test in low lying areas.
2. To use the RAP material as GSB (Granular Sub Base) after analysing and then adding the missing sieve size material.
3. To use the RAP material as WMM after investigating and then adding the missing sieve size material.
4. To investigate the RAP material and after carrying out Marshal tests as per the instruction given in MS-2 of ASPHALT INSTITUTE and reprocess the RAP material to certain percentage of mixing with fresh aggregate and virgin bitumen.
5. To use the RAP material by way of certain few percent of mixing it with low CBR soil to advance the CBR of the existing soil and thereby decreasing the crust thickness and cost both as per IRC 37 method.

II. LITERATURE SURVEY

Robert Locander et al., (Feb.2009)- The Colorado Department of Transportation has used reclaimed asphalt pavement (RAP) as a base on many projects in reconstruction strategy. CDOT specifications allow RAP to be alternative for aggregate base course (ABC). RAP may be produced during cold milling of existing hot mix asphalt (HMA) pavement. A Colorado procedure and a project special condition to determine the macro-texture of cold planned HMA pavement were implemented in the 2007 paving season to ensure satisfactory surface textures for the placement of HMA overlays. RAP produced during cold milling of HMA pavement appears to be constantly well-graded as a result of the new procedure. Stiffness strength and permeability are two areas of concern regarding the use of Reclaimed Asphalt Pavement material one more objective of the study is to compare the stiffness strength and permeability of milled RAP and fresh aggregate base course material. Alternative research objective is to establish reasonable fault design input values to be used by pavement designers when using RAP as a alternate for fresh aggregate base course or sub-base material.

H.ZIARI et al., (2005) Department of Civil Engineering Iran Science & Technology, Tehran -Economic and environmental considerations have prompted the recycling of steel, aluminium, plastic, and many materials. One of these recyclable materials is hot mix asphalt .This paper presents research findings from the Investigation of Recycled Asphalt Pavement mixtures project. The samples contained from 0 to 40 percent RAP from a road of Tehran. RAP material was blended with fresh aggregate such that all samples tested had approximately the same grading. Samples were examined for resilient modulus. The resilient modulus test provide a measure of the elastic properties of the mixture.

Alex K. Apeagyei et al., (2012)– Studied on the production of high-RAP mixes (i.e., mixes with more than 20% for surface and intermediate) to evaluate the stiffness characteristics of asphalt-concrete mixtures containing various RAP amounts to achieve a better understanding of how high RAP affects the mixture performance properties that are important for more hard-wearing and cost-effective asphalt. The use of higher

RAP percentages with locally available binders was adopted as an approach to decrease the demand on specialty more expensive Fresh binder and Fresh aggregates in Virginia. Recent researches have established that RAP replacement at proportions above 50% is feasible to produce new HMA mixtures obtaining acceptable results in the mechanical properties.

Dr. N. C. Shah, Uka Tarsadiya University Maliba Campus Bardoli, Surat- Presently, working as an engineer of road department in local self-government of Surat city author was facing the same in old city area where many roads are having higher elevated level as compared to corresponding properties and have become a serious problem. To overcome the above said problem, milling process was procured in municipal corporation and many roads were milled in different depths as per the requirement and viability and after milling the roads were resurfaced with sufficient wearing coats.

Eddi.N.Johnson et al.,(April 2009) Minnesota Department of Transportation Maplewood Minnesota -This study included a survey of practicing local engineers, field performance inspection of new bituminous and bituminous overlay construction, and laboratory testing. The most common binder performance grades were recognized along with the most common percentage of recycled asphalt in bituminous mixtures. Engineers regarded rutting, cracking, and construction as the most important issues when using recycled asphalt pavement. About one-third of Minnesota agencies eliminate RAP from wear course mixture. Analysis of dynamic modulus inclination from field cores showed that full-depth sample were more useful for relating field and laboratory performance than were the wear or non-wear course sample. Analysis showed stronger relationships existed to low temperature act on grade and to the percentage of fresh asphalt binder in the mixture than to the percentage of RAP in the mixture. Field performance associated well to mixture master curves in the middle part of the test frequency range. Recommendations take in using low-temperature grades of PG-34 take in RAP in the wear course, and using material control to achieve good performance. Other consideration are specifying the source material source, screening and separating by particle size (fractionated RAP), or specifying RAP asphalt content.

III. METHODOLOGY

The use of RAP is gradually gaining popularity with the latest development in technology. Earlier pavements were scarified by excavators which gave huge blocks of RAP materials. Therefore it was difficult to use RAP materials in the construction of new pavements. Now with the latest development in technology, scrappers have been made available in the market which cut the pavement to desired thickness thereby making the use of RAP materials much easier. RAP is obtained not as a choice but mostly as compulsion in one or more of the following reasons:

a) Using successive layers over the years as overlay causes increased level of roads compared to build up areas in surroundings, which results in to drainage problems.

b) Realignment of the road makes the removal of existing pavement a necessity.

c) Infrastructure progress like construction of flyovers etc. require removal of pavements.

The process of making RAP mix starts with the collection of RAP materials from the scarified pavement. The collected materials are then subjected to various tests like sieve analysis, residual binder, grading, Marshall

Stability test etc. All the results of the tests of reclaimed materials along with virgin aggregates that have to be added are then analysed and an optimal percentage of RAP is defined. The process of construction of RAP is carried out as the same conventional method of construction of bituminous pavement. Based on the process adopted in recycling the bituminous mix, it can be classified as central plant recycling and in-situ recycling. If the RAP is customized at a plant away from construction site then the process is known as vital plant recycling. In-situ recycling process the RAP modified in place, where from it is available. Further, the RAP could be heated to condition it. If heat is given then the process is known as hot mix recycling. In case of cold mix recycling old materials are conditioned using the recycling agent (like, low viscosity emulsion) without application of heat. The categorization system is presented schematically in Figure.Another way of classification could be based on depth of the old pavement removed. If the apex layers of pavement fail, then the upper layers are removed and laid again. This process is identified as surface recycling. However, if base failure occurs then the pavement layers up to base layer is separate and constructed again. This process is known as full depth retrieval.

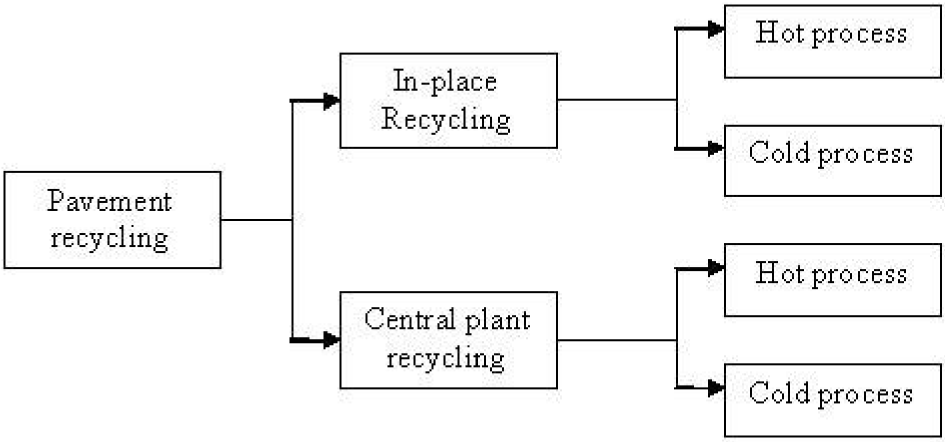


Fig. Classification of recycling methods based on processes

IV. TEST ON RAP

1. Extraction Test.
2. Impact Test.
3. Shape Test
4. Aggregate Stripping Value Test.
5. Aggregate Crushing Test.
6. Soundness or Durability Test.
7. Crushing Test.
8. Water Absorption Test.
9. Specific Gravity Test.

V. MIX DESIGN

1. Combined Aggregates in the Recycled Mixture: Using the gradation of the aggregate from the RAP, the reclaimed aggregate material, if any, and new aggregate, a combined gradation meeting the desired specification is calculated. After the blend of aggregate(Aggregate in the RAP, new aggregate and / or RAM) has been established, the amount of new aggregate is expressed as r, in percentage.
2. Approximate Asphalt Demand of the Combined Aggregates- The approximate asphalt demand of combined aggregates may be foundout by the Centrifuge Kerosene Equivalent (CKE) test or calculated by this empirical formulae:

   $P = 0.35a + 0.045b + Kc + F$

   Where P= approximate total asphalt requirement of recycled mix, percent by weight of mix.

   a= % of mineral aggregate retained on 2.36mm sieve.

   b= % of mineral aggregate passing the 2.36mm sieve and retained on 75micron sieve.

   c= % of mineral aggregate passing 75 micron sieve.

   K= 0.15 for 11-15% passing 75 micron sieve.

   0.18 for 6-10% passing 75 micron sieve.

   0.2 for 5% or less passing 75 micron sieve.

   F= 0-2%. Based on absorption of light or heavy aggregate. In the absence of the other data, a value of 0.7 is suggested.
3. Estimate percentage of new asphalt mix: The quantity of new asphalt to be added to the trial mixes of recycled mixture, expressed as percentage by weight of total mix is calculated by this formula:

   $$P_{nb} = \frac{(100^2 - r\,P_{sb})Pb}{100(100-P_{sb})} - \frac{(100-r)\,P_{sb}}{100-P_{sb}}$$

   Where P_{nb}= percent of new asphalt in recycle mix

   r = new aggregate expressed as percent of total aggregate in recycled mix

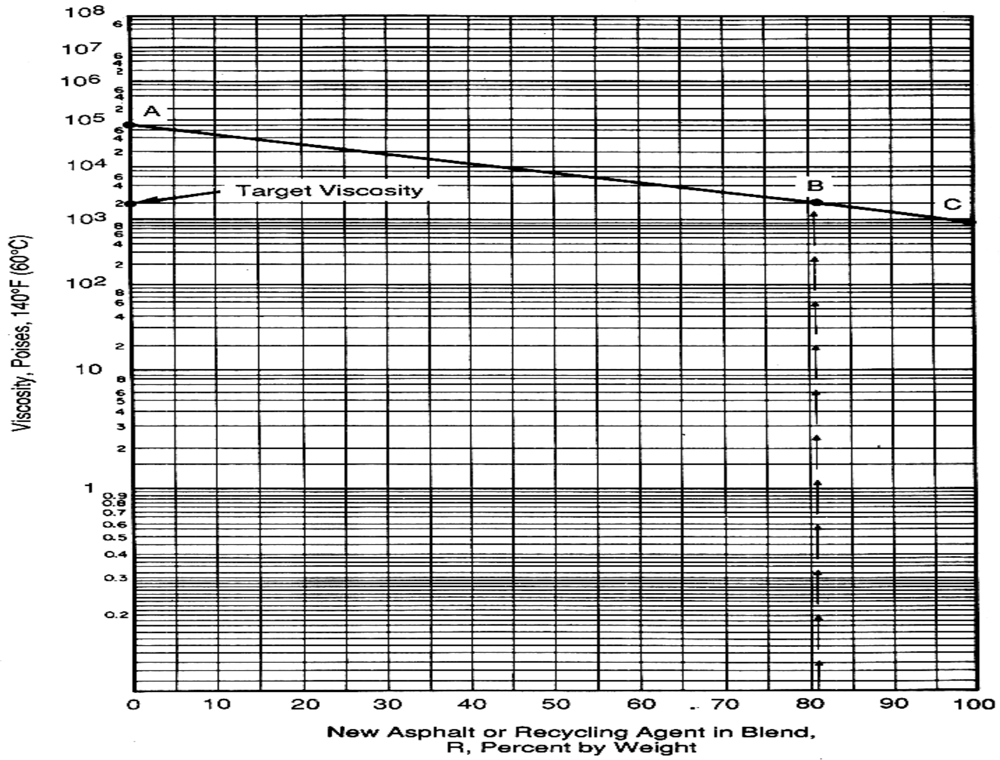
   P_b= asphalt content of total recycled asphalt mix or asphalt requirment, determined by CKE or empirical formula

   P_{sb}= percentage asphalt contain of reclaimed asphalt pavement.
4. Select grade of new asphalt- Using a fig. a target viscosity of asphalt blend is selected. A commonly certain target point is the viscosity at the mid range of an AC–20 asphalt or 2000 poises.

   $$R = 100\, P_{nb}/P_b$$

5. Trial Mix Design- Trial mix design are then made using the Marshal Appratus. The formulas is shown in above are used for proportioning the ingridents.

   Keep in mind that if two different aggregate source is utilized such a new aggregate and RAM, te percentage of each of these sources must be determined and equal to P_{ns}



Asphalt viscosity blending chart

VI. ADVANTAGES

The following points suggest the generalized benefits:

1. Reuse and Conservation of non-renewable energy sources
2. Preservation of the environment and reduction in land filling
3. Energy conservation and improved pavement smoothness
4. Cost saving over traditional rehabilitation methods
5. Improved pavement physical properties by modification of existing aggregate gradation and asphalt binder properties.
6. Avoids further crushing of aggregate particles in RAP, which may allow higher RAP contents in mixes
7. Lowest cost of RAP processing options
8. Millings from large projects are likely to have a steady gradation and asphalt content.
9. Limits crushing of aggregate particles in RAP, which reduces dust generation.
10. Using different sized RAP stockpiles provides greater flexibility in developing mix designs.

VII. LIMITATIONS

Although different percentages of RAP have been used in different projects, there is no optimal percentage of RAP that should be used. The percentage of RAP depends upon many parameters like

1. Age of RAP materials

2. Binder content,

3. Availability of RAP,

4. Viscosity of binder.

Such factors need further investigations and therefore more studies are required. Following are the major limitations,

1. No definite optimal percentage of RAP that can be used, in bituminous mix, has been specified.

2. This implies, that more studies are required, to narrow down the range of RAP for its application in different types of mixes.

3. Corrections also need to be established with respect to age of RAP and other factors example residual binder, percentages etc.

VIII. RESULT

Addition of RAP to a mixture increase the resilient modulus. At 27^0 C , adding 30% RAP to control mixture resulted in a 60% increase in stiffness. The sources of the RAP also affect the resilient modulus results.

IX. CONCLUSION

RAP is a new technology with the help of which bituminous pavements can be constructed at a reduced cost as it involves the usage of old bituminous pavement materials. Also it ensures optimization of resources and supports sustainable development. Optimal percentage of RAP depends upon the composition of reclaimed bituminous material and type of layer in which it is to be used Numerous transportation agencies have been recycling RAP in unbound base and sub-base layers for many years, however, there is a lack of literature on actual field performance. Because of concerns related to lower shear strengths and excessive permanent deformations resulting from large strains as RAP content increases, there is a general trend of using up to 50% RAP content by weight in virgin aggregate base and sub-base layers. There is a general lack of uniformity among the RAP use specifications adopted by various transportation agencies. RAP for use in base and sub-base layers can be characterized by performance-related parameters and properties including those needed for pavement design, such as grading, resilient modulus, shear strength beneath static tri-axial loading and permanent deformation under repeated tri-axial loading, and those identifying material durability, such as frost susceptibility and abrasion resistance as measured by performing test. When the nuclear density gauge is used for wet/dry density measurements, the compaction acceptance criteria need to be modified to account for the RAP content. Current pavement design procedures do not account for RAP material properties.

X. ACKNOWLEDGEMENT

Every orientation work has an imprint of many people and it becomes the responsibility of author to express deep gratitude for the same. During the entire duration of preparing our project report, we received endless help from a number of people and we feel that our report would be incomplete if we do not convey our grateful thanks to them. This acknowledgement is a humble attempt to thank all those who were involved in our project work and were of immense help to us.The first and foremost we take the opportunity to thank our principle Prof. C.K.PATIL, for his throughout support. secondly, we thank Prof. K.U. SARAF, head of civil engineering department, B.V.C.O.E. & R.I. AnjaneriNashik, for giving us this opportunity to select and present this project and also provide facilities for its completion. We also humbly thank to Prof. K.U. SARAFour project guide for his indispensable support, priceless suggestions and for his valuable time. Also a special thanks to Mr. ASHOK KATARIYA, Mr. D.V. MARODE,Miss. MADURA JOSHI,Mr. K.S. NIKAM and entire team of AshokaBuildcon LTD. and for theirco- operation and support throughout. We would be failing in our duty, if we do not thank project coordinator Prof K.U.Saraf and all faculty members of civil department for their experienced advice and evergreen cooperation. Also we would like to thank to all our friends who helped us a lot to complete this report.

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