Performance Evaluation of Reclaimed Asphalt Pavement (RAP) Aggregates in Rigid Pavement: A Review

Vivek Kumar[1], M. U. Rizvi[2*], Anil Kumar Yadav[3]
[1,2,3]Dept. of Civil Engineering, Integral University,
Lucknow, India

ABSTRACT

The objective of this study is to understand the importance 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 virgin mixes. If calculated and implemented appropriately RAP mixes have a constructive effect on various parameters like Marshall Stability, moisture resistance and density. This paper presents the importance of using RAP mixes.

INTRODUCTION

Reclaimed asphalt pavement (RAP) is the term given to removed and/or reprocessed pavement materials containing asphalt and aggregates. These materials are generated when asphalt pavements are removed for reconstruction, resurfacing, or to obtain access to buried utilities. When properly crushed and screened, RAP consists of high-quality, well-graded aggregates coated by asphalt cement. Asphalt pavement is generally removed either by milling or full-depth removal. Milling entails removal of the pavement surface using a milling machine, which can remove up to 50 mm (2 in) thickness in a single pass. Full-depth removal involves ripping and breaking the pavement using a rhino horn on a bulldozer and/or pneumatic pavement breakers. In most instances, the broken material is picked up and loaded into haul trucks by a front-end loader and transported to a central facility for processing. At this facility, the RAP is processed using a series of operations, including crushing, screening, conveying, and stacking. Although the majority of old asphalt pavements are recycled at central processing plants, asphalt pavements may be pulverized in place and incorporated into granular or stabilized base courses using a self-propelled pulverizing machine. Hot in-place and cold in-place recycling processes have evolved into continuous train operations that include partial depth removal of the pavement surface, mixing the reclaimed material with beneficiating additives (such as virgin aggregate, binder, and/or softening or rejuvenating agents to improve binder properties), and placing and compacting the resultant mix in a single pass.

HISTORY OF RECLAIMED ASPHALT PAVEMENT (RAP) CONCRETE

Recycling asphalt pavement creates a cycle of reusing materials that optimizes the use of natural resources. Reclaimed asphalt pavement (RAP) is a useful alternative to virgin materials because it reduces the need to

use virgin aggregate, which is a scarce commodity in some areas of the United States. It also reduces the amount of costly new asphalt binder required in the production of asphalt paving mixtures. This report informs practitioners about the state of the practice for RAP use in the United States as well as best practices for increasing the use of RAP in asphalt pavement mixtures while maintaining high-quality pavement infrastructures. High percentage RAP mixtures are achieved with processing and production practices, resulting in cost and energy savings. Based on an evaluation of pavements containing 30 percent RAP through the Long-Term Pavement Performance (LTPP) program, it has been determined that the performance of pavements containing up to 30 percent RAP is similar to that of pavements constructed from virgin materials with no RAP. This report is of interest to engineers, contractors, and others involved in the specification and design of asphalt mixtures for flexible pavements, as well as those involved in promoting the optimal use of RAP. RAP was successfully used by State transportation departments for many years before the implementation of the Superior Performing Asphalt Pavements (Superpave) mixture design method in the late 1990s.

ADVANTAGES OF USING RAP MIXES

The underlying principle of economical construction is the base of usage of RAP. Following are some other important factors which shall further justify the need for using RAP.

a) Sustainable development b) Optimizing the use of natural recourses c) Reducing environmental impact d) Increase in restrictions on the dumping of reusable materials e) Reduction in material cost, energy cost and total job cost

MATERIALS AND MIX PROPORTIONS

RAP primarily consists of cement, fine aggregate, coarse aggregate, reclaimed asphalt pavement and water.

a) Coarse Aggregate

Different types of naturally available aggregates i.e. quartzite gravel, flint gravel, limestone, river gravel, crushed granite etc. were used in past in making RAP and are well documented. The size of the coarse aggregate used is kept fairly uniform to minimize surface roughness and for a better aesthetic.

b) Fine Aggregate

Sand taken from river beds and pits is normally used as fine aggregate, after it is cleaned and rendered free from silt, clay and other impurities. Fine aggregate can be natural or crushed depending upon the local availability of it.

c) Binder Material

Ordinary Portland cement is used in the mixture as primary cementing material. Apart from OPC, PPC can also be used as binder material. In addition different blends of Portland cement and supplementary cementing materials may be used. SCMs have a large influence on the properties of concrete and are key to

achieving high performance and sustainable mixes. Each blend contained two types of SCM adding up to 35% of the cementing materials. Supplementary Cementitious Materials (SCMs) include fly ash, pozzolonas, silica fume and blast-furnace slag. These added materials will affect the performance, setting time and strength of the final product.

d) Reclaimed Asphalt Pavement (RAP)

The use of RAP has evolved into routine practice in many areas around the world. In the United States, the Federal Highway Administration (FHWA) reported that 73 of the 91 million metric tons of asphalt pavement removed each year during resurfacing and widening projects are reused as part of new roads, roadbeds, shoulders and embankments. The recycling of existing asphalt pavement materials produces new pavements with considerable savings in material, money, and energy. Aggregate and binder from old asphalt pavements are still valuable even though these pavements have reached the end of their service lives. They have been used, for many years, with virgin aggregates and binders to produce new asphalt pavements, proving to be both economical and effective in protecting the environment. Furthermore, mixtures containing RAP have been found, for the most part, to perform as well as the virgin mixtures. A sample of RAP shown in fig 1.1.

Fig. 1.1 Reclaimed Asphalt Pavement

e) Water

Water that is potable is generally good for use in the mix. Coarse aggregate should be kept damp before batching, especially if the weather is very hot with low humidity in order to ensure consistency and uniformity from batch to batch of plastic pervious concrete. If the aggregate is too dry before being mixed, the mixture will not place or compact well. But excess free water on aggregates contributes to the overall mixing water and will create a wet, soupy mix in which the paste flows off, and the voids are filled.

SUMMARY & CONCLUSIONS

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. Though 20%- 50% are mostly adopted. It is easy to remove flexible pavement and use its material for placing of concrete pavement. Thus reducing transportation cost and cost of natural aggregates. Use of RAP aggregate also reduces the burden on natural course aggregate for increasing aggregate demand for construction of roads. It helps to reduce environmental imbalances and pollution while removing natural aggregate in quarry. Increasing the RAP binder percentages increases the stiffness, viscosity and critical temperature of the blend. On increasing the amount of RAP binder in blend increases the stiffness of the binder. But decrease with the increase in temperature.

ACKNOWLEDGEMENT

The authors are thankful to Integral University, Lucknow for acknowledging this paper with MCN IU/R&D/2018-MCN000485.

REFERENCES

1. Singh Jaspreet, Singh Jashanjot, Duggal A,K. A Review Paper on Reclaimed Asphalt Pavement (Rap). Inte. J. Modern trends in engg. and researsh .2015; *02(08):454-456*

2. Pradyumna T.Anil, Mittal Abhishek, Jain, P.K. Characterization of Reclaimed Asphalt Pavement (RAP) for Use in Bituminous Road Construction. Procedia - Social and Behavioral Sciences. 2013;104: 1149 – 1157

3. Hussain Arshad, Yanjun Qiu, Effect of Reclaimed Asphalt Pavement on the Properties of Asphalt Binders, Procedia Engineering . 2013; 54: 840 – 850.

4. Verma Abhishek, Sharma Rachit, Shrivastava Monil and Prashant. Evaluation of Reclaimed Asphalt Pavement (Rap) In Flexible Pavement Layers. World Journal of Engineering Research and Technology. 2017, Vol. 3, Issue 2, 91 -104.

5. Mohamady Ahmed, Elshahat Ashraf, Mahmoud Fathy Abdi. Abdallah , Mohamed Hoseny. Effect of Using Reclaimed Asphalt Pavement on Asphalt Mix Performance. IOSR Journal of Computer Engineering (IOSR-JCE). 2014; 16(6): 55-67.

6. Manjunatha K A, Narasimha murty M R, Murali Mohan M V, Antony Sebastian,. Feasibility Study of Rap As Aggregates In Cement concrete. IJRET: International Journal of Research in Engineering and Technology. 2015;4(6): 529-532.

7. Bock Luc De and Gonçalves Arlindo. Recycled Asphalt Pavement. RILEM TC 198-URM. 2005.

8. Singh Jashanjot, Duggal A.K. An Experimental Study on Reclaimed Asphalt Pavement In Bituminous Concrete. International Journal of Modern Trends in Engineering and Research (IJMTER). 2015; 02(8):

9. Memon N. A., D. Hassan, A. Pathan. Rigid Pavement Design Using Recycled Asphaltic Materials. Sindh Univ. Res. Jour. (Sci. Ser.). 2016; 48 (2): 399-406.

10. Ahmad M. Abu Abdo. Utilizing Reclaimed Asphalt Pavement (RAP) Materials In New Pavements-A Review. Int. J. Of Thermal & Environmental Engineering 2016: 12(1).