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Effect of Reclaimed Asphalt Pavement Aggregates on Permeability of Granular Layers – An Overview

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Abstract—*Reclaimed asphalt pavement (RAP) is a term given to removed and/or milled pavement materials containing asphalt and aggregates. This material is obtained from recycling the existing flexible pavements which have reached the end of their design life. Now a days the use of RAP has grown extensively reducing the use of virgin aggregates which leads to conservation of resources. RAP can be used in construction of base/sub-base of new pavement which results in huge savings. This paper deals with an overview of the Permeability characteristics of granular layers with varying proportions of Reclaimed Asphalt Pavement (RAP) aggregates from various sources like Bituminous concrete(BC) or Dense Bituminous Macadam(DBM) in the Granular mix design with the percentage of 0%, 10%, 20%, 30% and 50%. It is found that about 30% usage of RAP in the mix is optimum where mix design exhibits enhanced drainage properties.*

Keywords*: Permeability, Reclaimed Asphalt Pavement (RAP) aggregates, Natural Coarse Aggregate (NCA), Recycling.*

1. INTRODUCTION

The use of supplementary aggregate material is essential in developing low-cost construction materials and ecological benefits for use in developing countries. It is estimated that the construction industry in India generates about 12-14 million tons of wastes annually. Use of recycled aggregate is not very common in India and other developing countries. There is huge requirement of the aggregate because of fast development in the infrastructure area. In order to reduce the usage of fresh aggregate, recycled aggregate can be used as a replacement materials. The overall development of a country depends upon on a good and well-connected road network.

In the U.S., more than 50 million tons of asphalt paving mixtures are milled annually and the majority is recycled into new asphalt mixtures (Collins and Ciesielski 1994). However, large quantities of reclaimed asphalt pavement (RAP) aggregate remain unutilized and further uses should be explored.

There are two methods of sorting or cleaning of recycled aggregate; first one is dry separation method, which involves removal of lighter matter from heavier stony materials by means of blowing air or constantly causes a lot of dust and second one is wet separation method, which separates a low density impurity are separate by water jets or float-sink tank and fabricate very clean aggregate. Recycled aggregate has inferior relative density and less water absorption capacity whereas fresh aggregate has high. The twelve five-year plans faces a dearth of aggregates in infrastructure trade and due to large boom in manufacturing trade currently and in future, there is a huge predicament of mining and this crisis might be boost exponentially.

Advantages of Reclaimed Asphalt Pavement (RAP) aggregates:

- ✓ Conservation of Virgin aggregates
- ✓ Less emission of Carbon due to less requirement of crushing
- ✓ Reduce the cost of construction
- ✓ Preservation of the Environment

Disadvantages of Reclaimed Asphalt Pavement (RAP) aggregates:

- ✓ Less quality
- ✓ High absorption of water
- ✓ Durability of life cycle of project may affect
- ✓ Lack of specification and guidelines

2. OVERVIEW ON PAST STUDIES

SAGOE-CRENTSIL AND BROWN (1998) stated that the quality of natural aggregates is based in physical and chemical properties of sources sites, where as recycled aggregates depends on contamination of debris sources. It is also stated that natural resources are suitable for multiple product and higher product have larger marketing area but recycled

aggregates have limited product mixes and lower product mixes may restrain the marketing.

LIMBACHIYA et al. (2000) found that Reclaimed asphalt pavement aggregate had lower relative density and less water absorption capacity compared to fresh aggregates. According to their test results, there was no effect with the replacement of 30% coarse recycled aggregates used on the strength of fresh aggregate.

RAMZI TAHA et al. (2002) studied about use of reclaimed asphalt pavement aggregate in road bases and sub-bases stabilized with cement and conducted tests of modified proctor test (MPT) and unconfined compression strength with the mixes of varying proportions of RAP aggregates and cement content of percentage of 0, 3, 5, and 7% and observed that with addition of cement content and virgin aggregate to the mix OMC & MDD & UCC strength are increased and longer curing period also increases the strength.

MANDAL et al. (2002) found that compressive strength was somewhat increased when the amount of replacement of reclaimed asphalt pavement aggregate increased. They concluded that the properties and characteristics of recycled aggregates have sufficient deficiency when compared to fresh aggregate.

ANDERSON (2006) stated the permeability of the blended material decreases as RAP is increased. A typical base course aggregate has a permeability of 0.5 ft/day, but this value is reduced in half when RAP is added to the virgin aggregate. And this may be depend upon many possible reasons like level of compaction, quality of virgin aggregate (hard, angular/rounded), higher percent fines of virgin aggregate (10 to 11%).

KHUSBHU M VYAS AND SHRUTI B KHARA (2013) conducted conducted gradation test, Water absorption, Specific gravity test, Aggregate impact value(AIV) test and flakiness and elongation test for RAP aggregates as per MoRTH.(WMM) and concluded that specific gravity ranges from 2.8 to 3, water absorption ranges from 0.3% to 2%, aggregate impact value is 15.28% (Max. 30%) and combined flakiness and elongated index value is 27.64% (Max.30%) and gradation requirement also satisfied.

VERESH PRATAP SINGH et al. (2014) found that the use of recycled aggregate in road construction in GSB and WMM not only used to achieve economy in the road projects, but also minimizes mining pollution. And maximum values of maximum dry density (MDD) and California bearing ratio (CBR) are obtained with addition of 30% of reclaimed asphalt pavement aggregate and which is less than 0.01g/cc and 0.5% respectively with no addition of RAP aggregates to virgin aggregates.

SIREESH SARIDE et al. (2014) studies that optimum moisture content (OMC) is increased and maximum dry density (MDD) is decreased as the percent of fly ash increases. Modulus of resilience and unconfined compressive strength are increased up to 40% addition flyash. The permissible value of resilient modulus (450 MPa) of the fly ash treated RAP mixes meet the specification laid down by IRC-37,2012. However, the mix has not met the UC strength requirement of 4.5 MPa.

PRAVEEN BERWAL AND PRAVEEN AGGARWAL (2014) conducted water absorption test, specific gravity test, aggregate impact value test and modified proctor test for compaction and CBR test and finally concluded that Values of Maximum dry density and Optimum moisture content of RAP mixes are nearly equal to values for virgin aggregates. And Aggregate impact value and water absorption values are within the permissible limits. Permeability results show that the permeability of recycled aggregates is more than the fresh aggregates. Finally they reported that we can use RAP aggregates of 50% in GSB.

MAULIK RAO AND N C SHAH, (2014) studied about use of reclaimed asphalt pavement aggregate in Granular sub base (GSB), Wet mix macadam (WMM), Dense bituminous macadam (DBM) and concluded that RAP can be used successfully in GSB, WMM and DBM upto 25%,35% and 30% respectively and to meet the requirements of MoRTH 2013. California bearing ration value was increased from 0.85% to 6.8% with addition of RAP of 60%. (Most of the soil in Surat is Black cotton soil)

ARPAN HERBERT et al. (2015) studied about use of reclaimed asphalt pavement aggregate in Granular sub base (GSB), Wet mix macadam (WMM) and concluded that maximum values of maximum dry density and CBR values are obtained with addition of 45% of RAP which is less than 0.01g/cc for GSB, 0.09g/cc more for WMM and 0.5% less respectively with no addition of RAP.

EHSAN ALI AND YOGENDRA KUSHWAHA (2015) carried modified proctor test and California bearing ratio test on granular sub-base (GSB) and wet mix macadam (WMM) with RAP-Virgin aggregate mixes and found that maximum values of maximum dry density and CBR values are obtained with addition of 40% of RAP which is less than 0.01g/cc and 0.5-0.6% respectively with no addition of RAP to the natural aggregates.

3. CONCLUSION

From the discussion on past studies on the topic, it is found that the use of reclaimed asphalt pavement (RAP) aggregate in road bases and sub-bases reduce the use of virgin aggregates and by this we can achieve conservation of environment and reduce the mining pollution. If RAP aggregates are stabilized with cement we can use 100% RAP aggregates in road bases without virgin aggregates. As the percentage of RAP goes on increasing the strength parameters are going to reduce. Many of the researchers concluded that to obtain maximum values of California bearing ratio value and maximum dry density value

limit the percentage of RAP aggregate value to 30% to 40%. Proper guidelines and specification for the use of recycled aggregates also need to be formulated on the basis of the results obtained from the various research studies undertaken in the country itself.

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