Experimental Investigation on Higher Proportion of Recycled Asphalt Pavement Mixture for Road Construction

Anu Thakur, Sandeep Singh

Abstract: The tremendous usage of virgin asphalt and aggregates is leading to their exploitation as a resource. There is a great importance to use the ruined pavement materials which causes various environment hazards and creates disposal problems. The main purpose of this study is to use the higher proportion of recycled asphalt pavement mixtures for road construction in a national highway project. The percentage of Recycled Asphalt Pavement (RAP) is taken at a range of 10% to 50% and then doing various tests related to strength and check the best one percentage of Recycled Asphalt to be used in road construction. The main scope of this study is to reduction in material cost, energy cost and also total job cost. This is done as RAP involves reuse of materials so the above all cost reduces. Through this the amount of bitumen content present in the RAP is calculated. Today the reduction on the dumping of reusable materials is increasing. So in future there is very high possibility of ban on their disposal into landfills. So that is the reusing of bituminous material show to sustainable development. An effort is done to achieve the stabilization of asphalt by performing different tests on bitumen and aggregates as per MORTH specification. Furthermore an attempt was carried out through Marshall Stability Test to examine the all Marshall values mainly the load and flow rate of asphalt specimen by using manual compaction and conditioned in a water bath at a specified temperature. This paper presents a research to study the behavior of mixture of asphalt with RAP. Finally a guideline that is selected from the reference sample to be in service of access the higher proportion of RAP and the optimum value of modified sample.

Keywords: - RAP, Asphalt, Marshall Test, Flow, Stability.

I. INTRODUCTION

RAP(Recycledasphaltpavement)isdefinedasdetached pavement material containing asphalt and aggregates. These materials are caused when asphalt pavements are removed for resurfacing, reconstruction or to obtain access to buried utilities. The use of recycled asphalt pavement has become the most common resource to produce new asphalt. It also reduces the cost of construction and environmental impacts by reusing the Existing pavement. Now RAP is being used with various methods as the technology with RAP has increased. Hot mix asphalt without RAP materials has been shows the same qualities as hot mix asphalt with RAP material in terms of rutting, ravelling and weathering and also fatigue and cracking. These materials are also used for granular sub base andgranularbaseofflexiblepavement. ThopropertiesofRAP materials can be improved by blending of aggregates and by addition of chemicalstabilizers.

In recent years there was a gradual increase in construction and demolition wastes. It has resulted in waste disposal problem due to shortage of available landfills. Reuse of these materials after proper recycling cab be the right solution for thesame. Therewillbereductionincostabout25%to30%by reusing the recycled material generated at same site. Before using such materials the mechanical properties must be tested and suitable blending is done ifrequired.

The percentage of Recycled Asphalt is chosen at different levels by various researchers. But in this work we take a range ofRecycledAsphaltfrom10%to50%andcheckthebestone percentage of Recycled Asphalt to be used in road construction.

II. OBJECTIVES

- To check the feasibility of using up to 50% Recycled Asphalt. Used in road construction (by doing proportionofRecycledAsphalttofrange10%to50% and then preparing the sample and doing various test related to strengthetc.)
- To compare the test results for different proportion of Recycled Asphalt and find the Optimum Percentage Value.
  - To do costanalysis.
  - Using VG40grade.

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III. METHODOLOGY

It is one of the most important and difficult step for any work because the whole results are dependent upon the series of tasks that are following the methodology. Now, following are the steps adopted in this work:

- To conduct the standard test for the performance of bitumen.
- To conduct the standard test on aggregates.
- To determine the Optimum binder content (OBC) by Marshall Stability Test.
- Mixing the different range of Recycled Asphalt from 10% to 50% and check the best one percentage of Recycled Asphalt to be used in road construction.
- Add the chemical admixture named as Zycosoil to further enhance the percentage of Recycled Asphalt in road construction.
- Find the stability and flow by performing the Marshall test on sample.

IV. EXPERIMENT WORK

4.1 MATERIALS

4.1.1 VG40 Grade is used to prepare the samples. The related test of this bitumen is shown in below Table 1.

<table>
<thead>
<tr>
<th>S.NO</th>
<th>BITUMEN TEST</th>
<th>OBTAINED VALUE</th>
<th>ACCEPTANCE LIMITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Penetration Test (ASTM D5)</td>
<td>38mm</td>
<td>35-50</td>
</tr>
<tr>
<td>2</td>
<td>Softening Point Test (ASTM D36)</td>
<td>50.67°C</td>
<td>50-58</td>
</tr>
<tr>
<td>3</td>
<td>Ductility Test (ASTM D113)</td>
<td>52.4cm</td>
<td>≥60</td>
</tr>
<tr>
<td>4</td>
<td>Specific Gravity Test(ASTM D70)</td>
<td>1.030</td>
<td>1.0 – 1.1</td>
</tr>
</tbody>
</table>

Table 1 Test on Bitumen VG-40

4.1.3 Recycled Asphalt:

The RAP sample is collected from NH 95, near Village - Khamano, District- Ludhiana (Punjab). Through the Milling machine a required depth of the pavement is removed and smooth the surface by removing the paved area and RAP is loaded into haul trucks. Afterwards the percentage of recycled asphalt is calculated by performing Bitumen Extractor Test with the use of Benzene. In 500g of RAP the 3% (15g) Recycled Asphalt is extracted.

![Figure 1: RAP loaded into truck](image-url)

Table 2 Test on Aggregate

<table>
<thead>
<tr>
<th>S.NO</th>
<th>AGGREGATE TEST</th>
<th>OBTAINED VALUE</th>
<th>ACCEPTANCE LIMITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aggregate Crushing Test (IS 2386 Part 4)</td>
<td>21.80%</td>
<td>30% max</td>
</tr>
<tr>
<td>2</td>
<td>Aggregate Impact Test (IS 2386 Part 4)</td>
<td>15.60%</td>
<td>24% max</td>
</tr>
<tr>
<td>3</td>
<td>Aggregate Abrasion Test (IS 2386 Part 4)</td>
<td>22.9%</td>
<td>30% max</td>
</tr>
<tr>
<td>4</td>
<td>Flakiness And Elongation Test (IS 2386 Part 1)</td>
<td>26.22%</td>
<td>40%</td>
</tr>
<tr>
<td>5</td>
<td>Specific Gravity Test</td>
<td>2.4</td>
<td>2.1 – 3.2</td>
</tr>
</tbody>
</table>

Table 2 Test on Aggregate

4.1.2 Aggregates: The test conducted for aggregates will be as per IS383:2016 Specifications are underas:
4.1.4 **Benzene:** It is an organic compound having a chemical formula C\textsubscript{6}H\textsubscript{6}. As in liquid appearance benzene is colourless, clear and it is very easily evaporates at room temperature. Here, benzene is used to separate the Recycled Asphalt from RAP.

![Figure 2: Recycled Asphalt](image)

**Figure 2: Recycled Asphalt**

4.1.5 **Admixture:** Zycosoil (ZYDEX Industry) is very rich in to control the Anti-stripping of the aggregates and asphalt by giving them proper stability. It helps to reduce the oxidation of the bituminous binder and also it is very much stable. Here, this admixture is used to enhance the best percentage to Recycled Asphalt with different dosage of Zycosoil chemical.

![Figure 3: Benzene](image)

**Figure 3: Benzene**

4.2 **MIX PREPARATION**

The construction of common asphalt mix is done by traditional method. The RAP mix includes the following steps:

- Take 500g sample of recycled asphalt pavement and determine the quantity of recycled asphalt.
- Replacement is performed at different proportion from 10% to 50% of recycled asphalt with virgin asphalt.

![Table 3: At Optimum itumen at Content 5%](image)

<table>
<thead>
<tr>
<th>Recycled Asphalt + Natural Material</th>
<th>V A (%)</th>
<th>VMA (%)</th>
<th>VFB (%)</th>
<th>FLOW (MM)</th>
<th>STABILITY (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10% + 90%</td>
<td>4.3</td>
<td>15.7</td>
<td>72.92</td>
<td>2.86</td>
<td>2161.76</td>
</tr>
<tr>
<td>20% + 80%</td>
<td>3.7</td>
<td>15.15</td>
<td>76.06</td>
<td>3.19</td>
<td>2243.34</td>
</tr>
<tr>
<td>30% + 70%</td>
<td>3.4</td>
<td>15.26</td>
<td>77.16</td>
<td>3.48</td>
<td>1855.85</td>
</tr>
<tr>
<td>40% + 60%</td>
<td>3.1</td>
<td>14.19</td>
<td>79.25</td>
<td>3.97</td>
<td>1815.66</td>
</tr>
<tr>
<td>50% + 50%</td>
<td>0.7</td>
<td>12.86</td>
<td>94.59</td>
<td>4.50</td>
<td>1325.61</td>
</tr>
</tbody>
</table>

4.2.1 **Marshall Test:**

- To prepare a sample of bituminous mix the required quantities of a course and fine aggregates are collected in pan and further kept in oven at a temperature of 175°C.
- Heat the bitumen to its melting point and kept it in the oven at preheating between 100 to 150°C.
- Now mix the heated Recycled Asphalt at required percentage in the virgin bitumen.
- When the whole mixture is mixed completely, transfer the mix to the pre-heated mould and compacted the mix with 75 numbers of blows by using hammer from both the sides.
- After this, the sample is left to cool at room temperature for 24 hours.
- Before the testing is to be done, the weight in air and submerged weight of the sample is calculated and then the sample is kept in water bath at temperature of 60°C for 30 minutes.

4.2.2 **Marshall Test Result:** After finding the Optimum Bitumen Content at 5%, the following percentages of Recycled Asphalt is mixed with the virgin materials and find that with increase the percentage up to 30% gives better results but after that there is a decline in the stability value. So the use of 30% of Recycled Asphalt gives the best percentage from 10% to 50%.

![Table 3: At Optimum itumen at Content 5%](image)
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So, we can say that 30% Recycled Asphalt is the best to be with the virgin or natural materials for road construction in National Highway Project.

Figure 4: Marshall Stability v/s Recycled Asphalt content.

Figure 5: Flow value v/s Recycled Asphalt content

Figure 6: Volume of Mineral Aggregates (VMA) v/s Recycled Asphalt content.

V. CONCLUSIONS

- It was conclude that 15g Recycled Asphalt is extracted from the 500g of Recycled Asphalt Pavement.
- It was noticed that the Recycled Asphalt can surely be used in any National Highway after making it compatible to the required specifications of MORTH.
- From the above results, it is very clear that from 10% to 50% the 30% of Recycled Bitumen percentage is the best to be used in mixtures for road construction because it gives the quite better stability and flow value.
- So by this the problem of dumping of RAP is totally solved as the waste material is used in the pavement.
- The effective use of waste material make it environment friendly as well as deduction in the cost.
REFERENCES

2. Xinjun Li, Timothy R. Clyne, Mihai O. Marasteanu (2005) “RAP effect on binder and mixture quality”.
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