Production And Use Of Reclaimed Asphalt Pavement And Its Performance In A Highway Project By Addidng Anti-Stripping Agent

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Abstract: ***During the maintenance or the construction of asphalt pavement the utilization of reclaimed asphalt pavement (RAP) can diminish the cost of the project, time consumption, conservation of natural resources and most importantly no harm to the environment. In this paper we are going to study the performance of pavement containing RAP (20%, 30%, 40% and 50% excluding the RAP aggregates of size 20 mm), anti-stripping agent Zycotherm, 1% of virgin bitumen contain are replaced by bitumen attached on RAP aggregates after the screening process. Tests performed for conventional and modified pavement sample are Marshall Stability and flow. Test for virgin aggregates and RAP aggregates are impact test, crushing test, shape test, specific gravity and bitumen extraction test. Test for virgin bitumen and modified bitumen are softening and penetration test.***

Index Terms: ***Reclaimed asphalt pavement (RAP), virgin bitumen, Zycotherm, RAP aggregates.***

I. INTRODUCTION

As road is the most commonly used mode of transportation and takes major role in development for any area therefore the construction of roads and maintenance becomes very important. Use of RAP is now very common all over the globe because of reuse of existing materials without any disposal issues, asphalt mix properties can be upgraded by changing aggregates and asphalt binder, the standard of pavement can be increased and surface can be improved by increasing the frictional property, cost reduction over the conventional methods and most significantly the utilization of RAP is pollution free. In many states of India, the use of RAP is new and not so common. Studies have proven that the use of RAP can be as good as the new and can be better by increasing its quality by adding other binder materials like plastics wastes, rubber wastes and proper aggregates. The use of RAP was first started in 1915 and the promotion of use of RAP workably was started in 1970's. Hot mix recycling is the common method for recycling asphalt pavements. Here we found better performance of asphalt hot mix containing RAP than the conventional hot mix and cheaper construction cost, as the main aims for a construction is to complete the project cheaper, less time taking and effective quality. Asphalt pavement is removed from the existing pavement by milling, excavating, ripping and crushing, or full depth removal [2]. After that milling process pulverized RAP materials are conducted screening process and stoked and prepared for the mix with virgin aggregates and virgin bitumen adding anti-stripping agent (Zycotherm). After the mixing process the new hot mix is then transferred to the road constructing area for paving.

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II. MATERIALS

2.1 Bitumen

Bitumen of VG 40 is used for the preparation of sample.

2.2 Virgin Aggregates

As per to IRC 90:2010 & MORTH specification the selection of aggregates are made.

2.3 RAP Aggregates

RAP aggregates are the aggregates obtained after the screening of milled pavement. Here RAP aggregates replace virgin aggregates by 20%, 30%, 40% and 50% for the preparation of modified sample. In these aggregates the bitumen content after the screening process is 1%.

2.4 Zycotherm

Anti-stripping agent Zycotherm is used 0.1% to 0.12% of the bitumen content in the mix. It increases the adhesion between bitumen and the aggregate. Zycotherm increases the binding capacity, decreases air voids and stripping.

III. PREPARATION OF SAMPLE

For conventional asphalt mix traditional method is used.
For modified asphalt mix containing RAP the following steps are followed:

- Coarse aggregates, fine aggregates and fillers of RAP and virgin aggregates are batched and mixed.
- Mixer is then heated at required temperature.
- During the process of heating of bitumen Zycotherm is added.
- Then heated mixed aggregates are added to the bitumen and continue the mixing process.

For each percentage of RAP content three samples are prepared for finding the mean value.

IV. TESTS

4.1 Marshall stability test and flow test

Marshall stability and flow test gives the performance prediction measure for the Marshall mix design method. The loading rate is 50.8 mm/minute.

Percentage of RAP (%)	Optimum bitumen content (%)	Percentage of virgin bitumen replaced by bitumen contained on RAP (%)	Zycotherm (%)	Stability (kN)
0	5	0	0.1	22.8
20	5	3.8	0.1	23.8
30	5	5.7	0.1	22.4
40	5	7.6	0.1	18.8
50	5	10	0.1	16.5

Table no. 1: Marshall stability for both conventional and modified design.

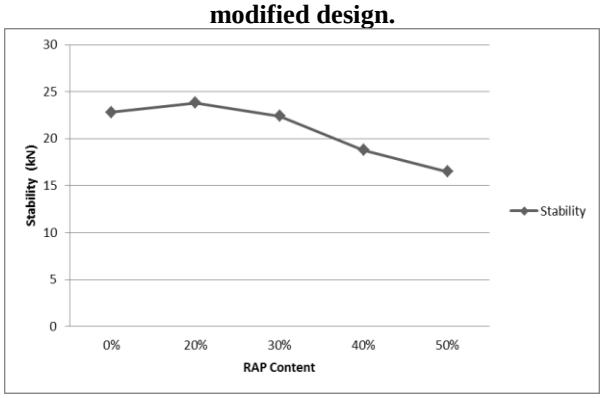

Figure 1: Effect of RAP content on stability.

Percentage of RAP (%)	Optimum bitumen content (%)	Percentage of virgin bitumen replaced by bitumen contained on RAP (%)	Zycotherm (%)	Flow (mm)
0	5	0	0.1	2.10
20	5	3.8	0.1	2.36
30	5	5.7	0.1	2.47
40	5	7.6	0.1	2.58
50	5	10	0.1	2.78

Table no. 2 : Flow value for both conventional and modified design.

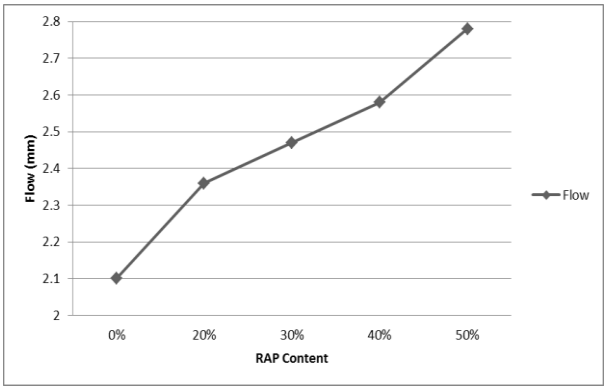

Figure 2: Effect of RAP content on flow value.

Percentage of RAP (%)	Optimum bitumen content (%)	Percentage of virgin bitumen replaced by bitumen contained on RAP (%)	Zycotherm (%)	VA (%)
0	5	0	0.1	5.69
20	5	3.8	0.1	4.99
30	5	5.7	0.1	4.33
40	5	7.6	0.1	4.71
50	5	10	0.1	5.61

Table no. 3: Air voids (VA) for both conventional and modified design.

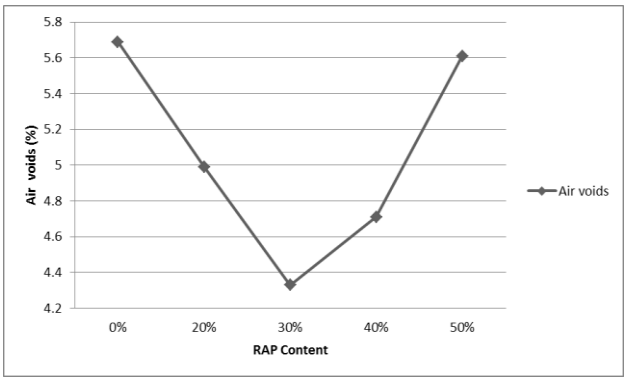

Figure 3: Effect of RAP content on Air voids.

Percentage of RAP (%)	Optimum bitumen content (%)	Percentage of virgin bitumen replaced by bitumen contained on RAP (%)	Zycotherm (%)	VMA (%)
0	5	0	0.1	17.45
20	5	3.8	0.1	16.72
30	5	5.7	0.1	16.20
40	5	7.6	0.1	16.58
50	5	10	0.1	17.43

Table no. 4: Volume of mineral aggregates (VMA) for both conventional and modified design.

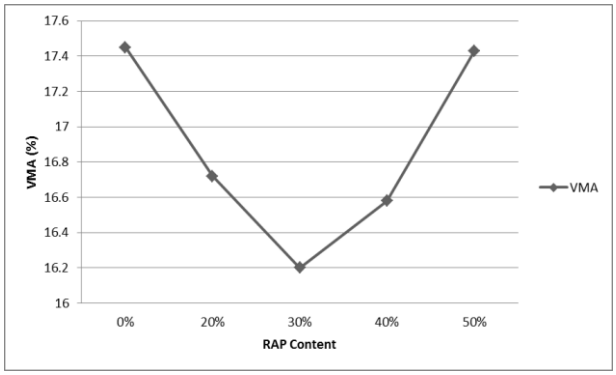

Figure 4: Effect of RAP content on VMA.

Percentage of RAP (%)	Optimum bitumen content (%)	Percentage of virgin bitumen replaced by bitumen contained on RAP (%)	Zycotherm (%)	VFB (%)
0	5	0	0.1	63.39
20	5	3.8	0.1	70.14
30	5	5.7	0.1	73.28
40	5	7.6	0.1	71.59
50	5	10	0.1	67.81

Table no. 5: Void filled with bitumen (VFB) for both conventional and modified design.

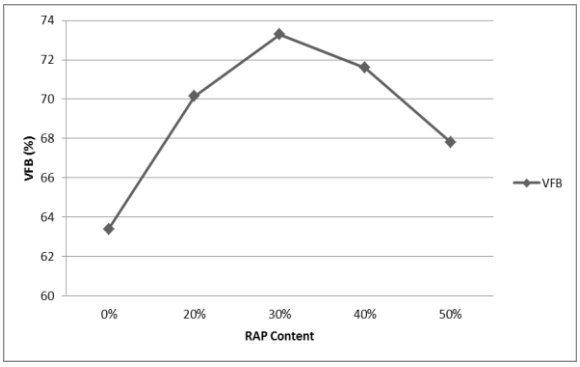

Figure 5: Effect of RAP content on VFB

4.2 Softening point test (IS: 1205-1978)

S. No.	Optimum bitumen content (%)	Virgin Bitumen replaced by recycled bitumen (%)	Zycotherm (%)	Softening point
1	5	0	0	51
2	5	0	0.1	52.8
3	5	3.8	0.1	52
4	5	5.7	0.1	51.15
5	5	7.6	0.1	50
6	5	10	0.1	50

Table no. 6: Softening point test results.

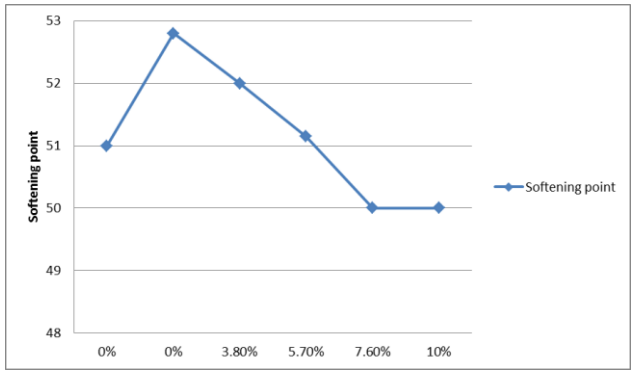

Figure 6: Effect of RAP and Zycotherm content on softening point.

S. No.	Optimum bitumen content (%)	Virgin Bitumen replaced by recycled bitumen (%)	Zycotherm (%)	Penetration (mm)
1	5	0	0	49
2	5	0	0.1	47
3	5	3.8	0.1	48
4	5	5.7	0.1	49
5	5	7.6	0.1	52
6	5	10	0.1	54

Table no. 7: Penetration test results.

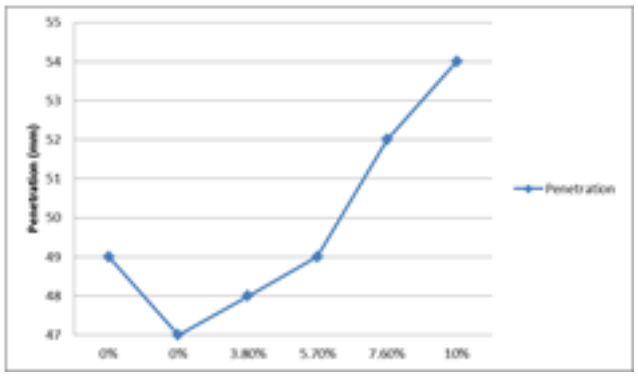

Figure 7: Effect of RAP and Zycotherm content on penetration.

4.4 Test on aggregates (MORTH)

Sample	Impact test	Los Angles abrasion test	Crushing strength	Flakiness and Elongation Index
100% Virgin aggregate	17.40%	20.80%	22.40%	21%
20% RAP + 80% Virgin aggregate	17.20%	20.76%	22.30%	20.72%
30% RAP + 70% Virgin aggregate	16.80%	20.05%	21%	20.50%
40% RAP + 60% Virgin aggregate	16.12%	19.70%	20.68%	20.38%
50% RAP + 50% Virgin aggregate	15.60%	19.42%	20.54%	20.30%

Table no. 8: Tests on aggregates.

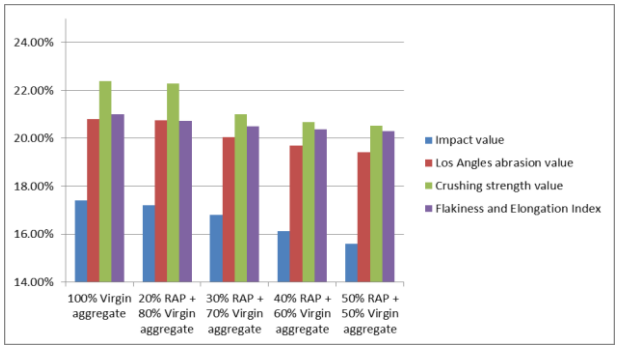

Figure 8: Different test readings of aggregate.

Sample	Specific gravity	Soundness test	Water absorption	Bitumen extraction test (ASTM D2172-1988)
100% Virgin aggregate	2.67	7.20%	1.20%	4.48%
20% RAP + 80% Virgin aggregate	2.692	7.08%	1.18%	4.48%
30% RAP + 70% Virgin aggregate	2.704	6.70%	1.06%	4.50%
40% RAP + 60% Virgin aggregate	2.716	6.58%	0.96%	4.51%
50% RAP + 50% Virgin aggregate	2.728	5.80%	0.98%	4.54%

Table no. 9: Tests on aggregates

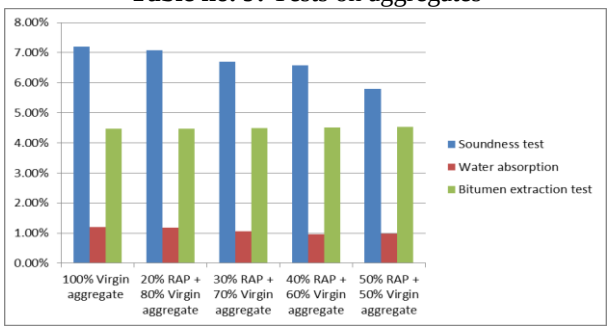

Figure 9: **Different test readings of aggregate.**

V. CONCLUSIONS

1. After performing Marshall stability test on various sample we found that sample containing RAP 20% gives the best performance with stability 23.8kN and flow 2.36mm whereas the reference sample has stability 22.8kN and flow 2.10mm.
2. The softening point of bitumen is increased when zycotherm is added. When the RAP bitumen is added 3.8% is added to the virgin bitumen the best result is obtained as compared to other mix proportion.
3. Penetration value of bitumen decreases when zycotherm is added. When the RAP bitumen is added 3.8% is added to the virgin bitumen the best result is obtained as compared to other mix proportion.

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