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"Feasibility Study on Recycled Aggregate Pavement (RAP) And Waste Plastic In Flexible Pavement" is Case Study

[1]VAISHNAV RAVI D.,[2] DR. JAYESH JUREMALANI,[3] DR. LALIT THAKUR

[1] M.TECH STUDENT,[2] ASSOCIATE PROFESSOR,[3] ASSOCIATE PROFESSOR

[1] DEPARTMENT OF CIVIL ENGINEERING,

[1] PIET, PARUL UNIVERSITY, VADODARA.

Abstract: The project title "Feasibility study on Recycled Aggregate Pavement with waste plastic– A case study" focuses on the issues that occurs in pavement construction. With rapid Urbanization and development in the field of construction demand of natural aggregates increases day by day with corresponding increase in concreate production. Extraction of natural aggregates from Earth leads to destruction of environment as road needs maintenance after certain interval of time, new road layer on existing flexible pavement is done. Thus there is increase in level of road due to which the plinth level of house and shops gets lower. Also rigid pavement passing between two flexible pavement the level of rigid pavement goes down, as new layer is applied on flexible pavement. Thus there is problem of drainage like water logging. So, the use of Recycled Aggregate Pavement (RAP) is feasible solution. RAP is type of pavement in which existing asphalt material is removed by Milling, then it is reused and recycled after process. An appropriate proportion of virgin material and RAP material will give a minimum cost for construction. Thus economy is also achieved. With progress in the field of construction demand of natural aggregate has increased extraction of natural aggregate from earth and disposal of waste plastic is major threat to environment and result in pollution and global warming. In view of utilization of Recycled Aggregate Pavement (RAP) and waste plastic has got significance now. With above serious concern, the optimum percentage mix of RAP, virgin aggregate, bitumen (VG-30) and waste plastic is taken for mix design of Dense Bituminous Macadam (DBM) grade – II as per MORTH 5th revision. It has been combination of Virgin aggregate of 20mm, 10mm, 6mm, stone dust, RAP material of 10%, 20%, 30% and 40%, Bitumen VG-30 and 15% waste plastic of bitumen. Thus, it will enhance its properties. Thus, durability of pavement is increase and sustainability is achieved.

Index Terms - Waste Plastic, Bitumen, Virgin Aggregate, Recycled Aggregate.

I. INTRODUCTION

In order to reduce the usage of aggregate and for dispose of waste plastic, RAP and waste plastic can be used as new material for the flexible pavement. RAP is collected from existing pavement by milling and waste plastic is collected from dump site. Test on RAP material with bituminous extraction test, find out the percentage of bitumen and blending of RAP material with virgin material.

II. Issues

As we know after 3 to 5 years flexible pavement needs maintenance so general practice for maintenance is new road layer is applied on existing flexible pavement. If there is a condition that rigid pavement is passing between two flexible pavement (i.e. BRTS Road) then after some time when flexible pavement needs maintenance that time new road layer is applied on existing flexible pavement. So that level of rigid pavement goes down and drainage problem or water logging occur. And also the plinth level of houses and shops gets lower.

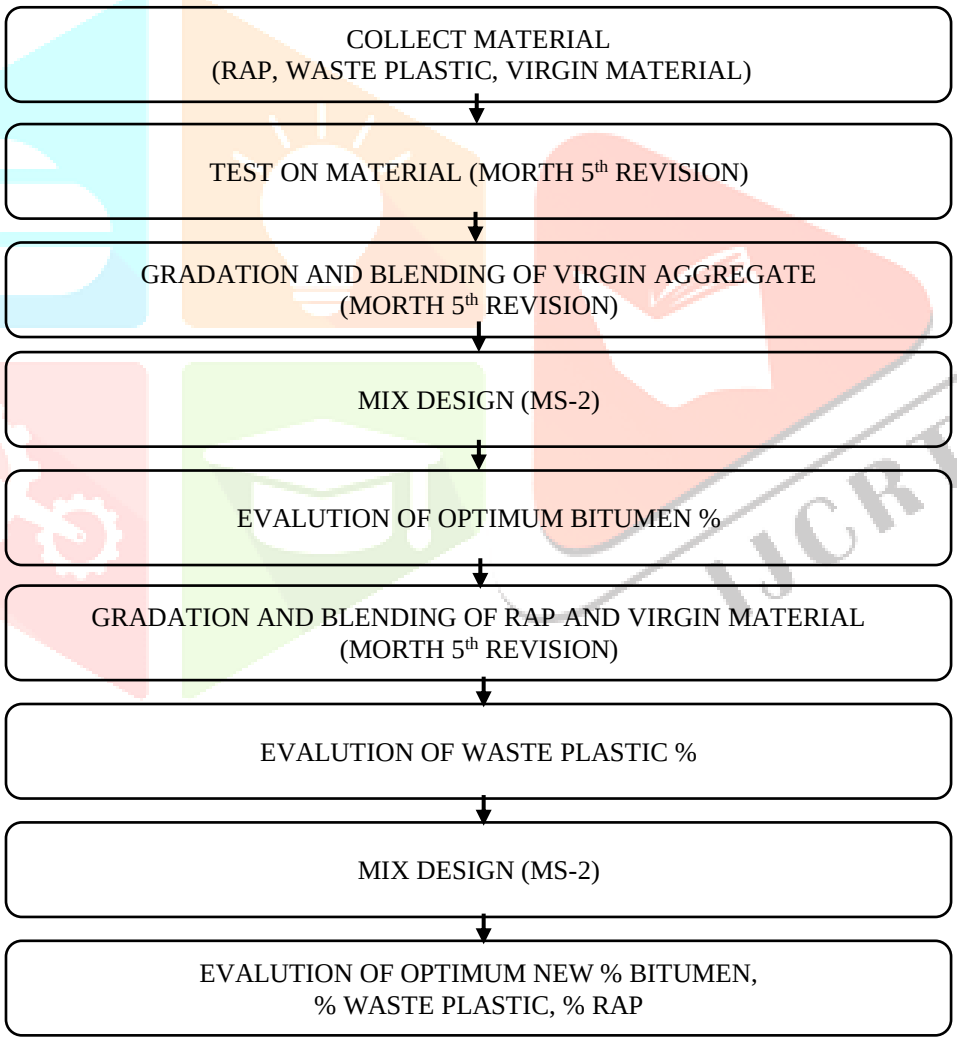
III. Objective

- To find out the optimum percentage use of RAP, Waste Plastic and Virgin Material for flexible pavement.
- To carry out different tests on RAP and Virgin Material and compare their result as per MORTH 5th revision.
- To examine the engineering characteristics of RAP materials including grading, residual binder content etc.
- By Using the Marshall method , Preparations of other several marshall specimens with or without RAP Materials mixes and to achieve optimum binder using such methods
- Using recycle aggregate instead of fresh aggregate to find out effects of recycled aggregate on properties of bituminous concrete mix.
- To ascertain the viability In terms of suitability, economically and environmentally

IV. Scope

- To determine the optimum percentage replace of virgin material by the RAP and bituminous with waste plastic in DBM grade - II.
- To conduct a complete literature review of performance of bituminous mixes containing recycled aggregate pavement.
- To ascertain the Characterization of the materials used in the study.
- To Mix design for conventional mix with different percentage of RAP.
- This study is conducted to explore the use of recycled aggregate pavement materials and laboratory performance of control mix in pavement construction using suitable viscous grade and detailed laboratory investigations

V. Methodology



VI. Laboratory Investigation

Sr. No.	Test Name	Properties	Aggregate Size				Criteria as per IRC/MORTH	Remark
			20mm	10mm	6mm	Dust		
1	**Shape**	Shape	30.51%	32.34%	-	-	**Max 35%**	OK
2	**Impact value**	Toughness	-	8.59%	-	-	**Max 27%**	OK
3	**Crushing value**	Strength	-	24.94%	-	-	**Max 45%**	OK
4	**Los Angeles Abrasion**	Hardness	9.2%	13.28%	-	-	**Max 35%**	OK
5	**Specific Gravity**	Quality	2.67	2.80	2.73	2.68	**2.6 to 2.9**	OK

Table 1 - Test on Aggregate

Sr. No.	Test	Measure	Observed Data	Criteria as per IRC/MORTH	Remark
1	**Penetration**	Hardness $1/10^{th}$ of penetration	62 mm	**45mm**	OK
2	**Softening Point**	Temp. at which bitumen soften	60.6^0 C	**Min 47^0 C**	OK
3	**Absolute Viscosity**	Resistant to flow	3008.57 Poise	**2400-3600**	OK
4	**Kinematic Viscosity**	Resistant to flow	389.22 cSt	**Min. 350 cSt**	OK
5	**Specific Gravity**	Quality	1.01	**0.97-1.02**	OK
6	**Ductility**	Brittleness	85.83 cm	**Min. 40**	OK
7	**Flash & Fire Point**	Hazardous Temp.	231.5^0 C 238.5^0 C	**Min. 220^0 C**	OK

Table 2 - Test on Bitumen

Sieve Size	20mm	10mm	6mm	Stone Dust	Blended Value	Range	Mid Value
	Proportion 39%	Proportion 10%	Proportion 14%	Proportion 37%	100%		
37.5	100	100	100	100	100	100	100
26.5	98.3	100	100	100	99.33	90-100	95
19	63.58	100	100	100	85.79	71-95	83
13.2	19.58	99.46	100	100	68.58	56-80	68
4.75	-	1.87	42.17	99.8	43.01	38-54	46
2.36	-	0.35	11.53	98.2	37.98	28-42	35
0.3	-	-	-	24.4	9.02	7-21	14
0.075	-	-	-	8.4	3.10	2-8	5

Table 3 - Gradation and Blending of Virgin Aggregate

Fig.1 - Value chart

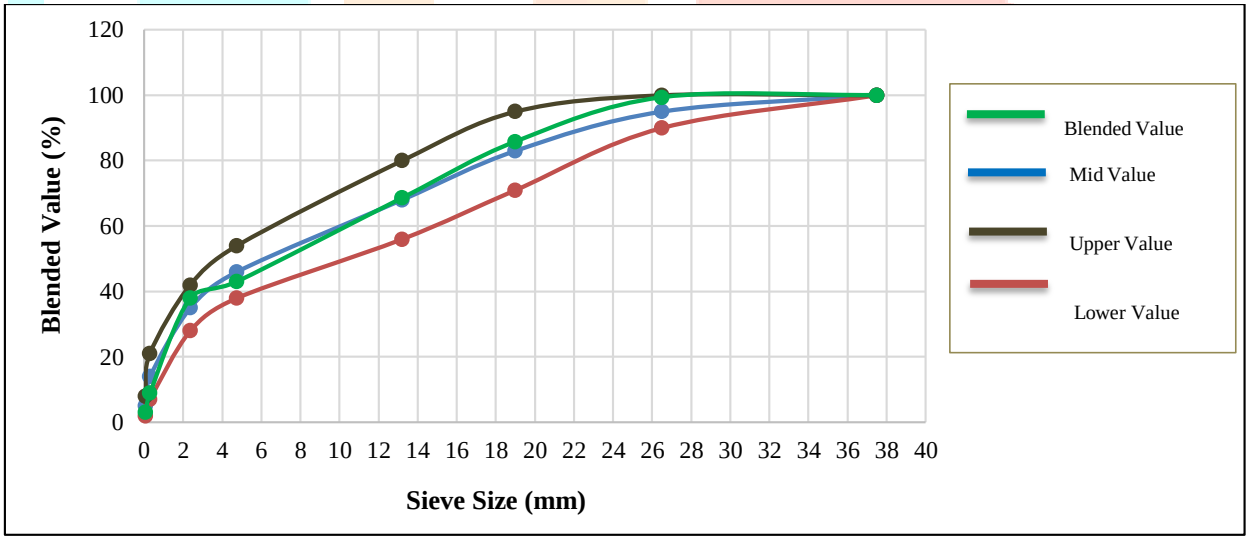
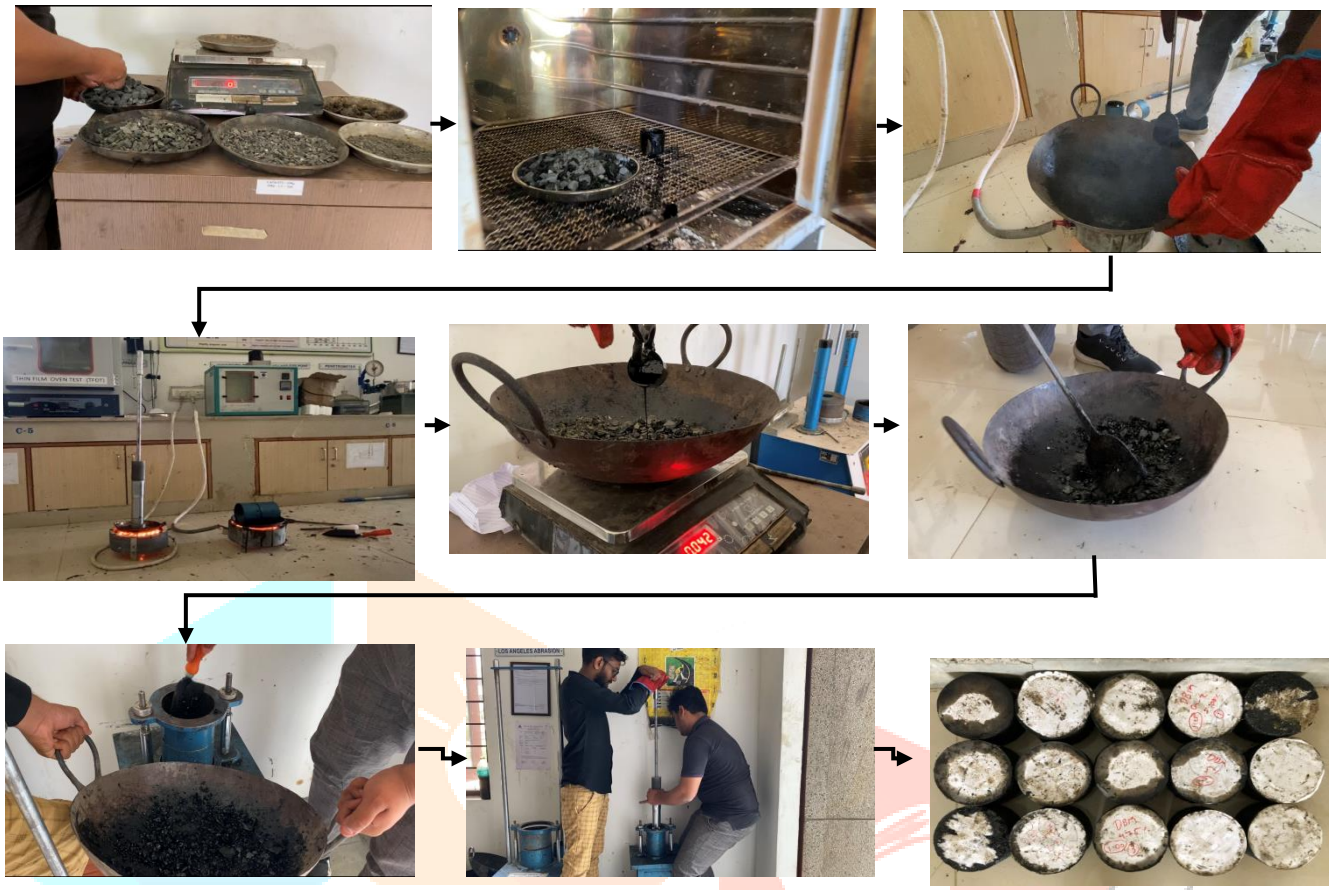


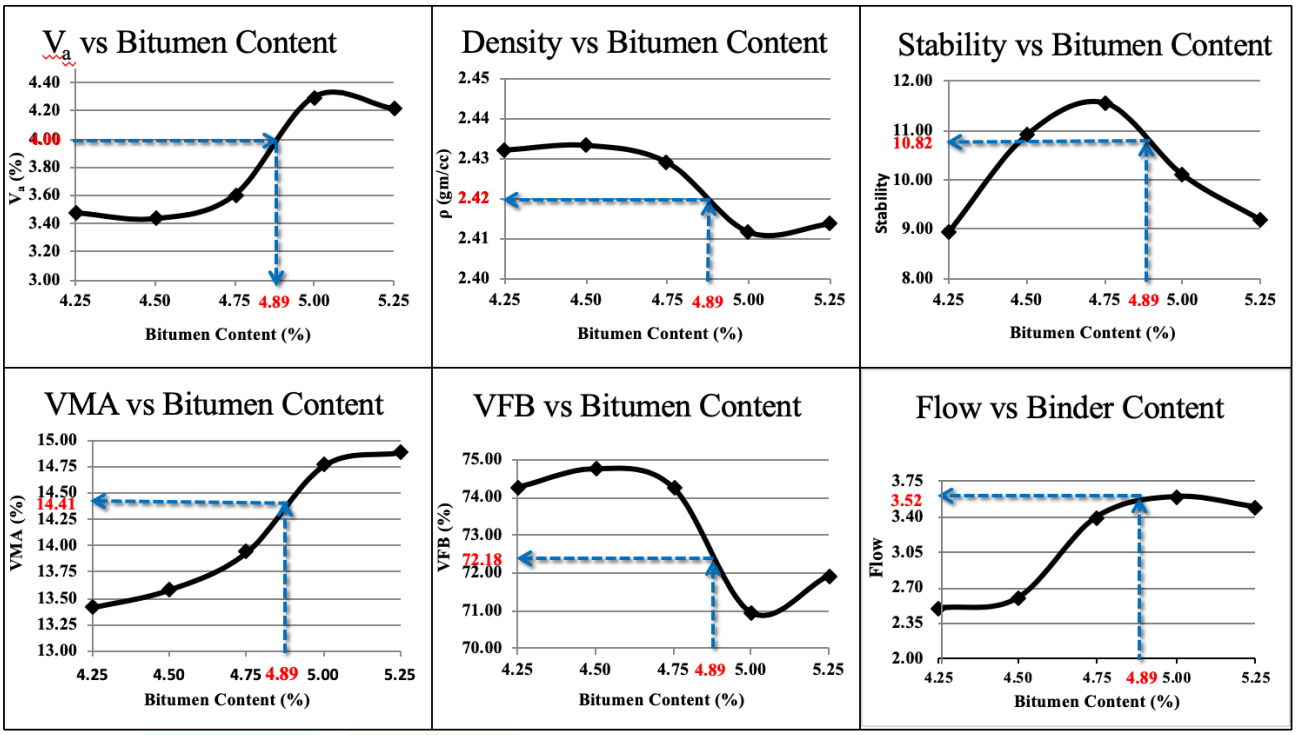
Fig 2 - Marshal Mix Design for DBM grade – II (for virgin material)



Bitumen Content (%)	Density (gm/cc)	V_a (%)	VMA (%)	VFB (%)	Stability (KN)	Flow (mm)	Marshall Quotient (Stability/Flow)
4.25	2.43	2.71	13.41	80.03	8.96	6.20	1.44
4.50	2.43	2.66	13.58	80.44	13.33	4.71	2.83
4.75	2.43	2.83	13.93	79.80	11.54	5.35	2.15
5.00	2.41	3.53	14.76	76.15	10.11	7.70	1.13
5.25	2.41	3.45	14.89	77.09	9.20	7.35	1.25

Table 4 – Volumetric Properties of specimen

Fig 3 - Find the Bitumen Percentage at 4% air void by the graph



- We got **4.89% of bitumen content** at **4% air voids** which is feasible as criteria of IRC/MORTH 5th revision that is **minimum 4.5%.**

Properties	Observed Data From Table 18	Criteria as per IRC/MORTH 5th Revision	Remark
Compaction level	75 blows on each face of the specimen		
Stability (KN at 60^0 C)	10.82	**Min. 9**	OK
Marshall Flow (mm)	3.52	**2-4**	OK
Marshal Quotient (Stability/Flow)	3.07	**2-5**	OK
% Air Voids	4	**3-5**	OK
% Air Void filled with Bitumen (VFB)	72.18	**65-75**	OK
% Void in Mineral Aggregate	14.41	**Min. 12**	OK

Table 5 - Test Result of Virgin Mix Design

Sr. No.	Test Name	Properties	Observed Data	Criteria as per IRC/MORTH	Remark
1	Impact value	Toughness	5.17 %	Max 27%	OK
2	Specific Gravity	Quality	2.6	2.6 to 2.9	OK
3	Water Absorption	Quality	0.35	Max 2%	OK
4	Bitumen Extraction	-	2.5	-	OK

Table 6 - Test on RAP

RAP (%)	Virgin Material (%)	Bitumen Content (%)	Density (gm/cc)	V_a (%)	VMA (%)	VFB (%)	Stability (KN)	Flow (mm)	Marshall Quotient (Stability/Flow)
10	90	4.64	2.49	3.64	11.50	68.91	11.66	3.60	3.24
20	80	4.39	2.44	3.92	12.62	68.91	12.91	3.20	4.03
30	70	4.14	2.45	3.00	11.57	74.11	12.32	4.20	2.93
40	60	3.89	2.50	3.18	9.87		14.66	4.20	3.49

Table 7 - Marshal Mix Design for DBM grade – II (for RAP material)

Properties	10%	20%	30%	40%	Criteria as per IRC/MORTH 5th Revision
Compaction level	75 blows on each face of the specimen				
Stability (KN at 60^0 C)	11.66	12.91	12.32	14.66	Min. 9
Marshall Flow (mm)	3.60	3.20	4.20	4.20	2-4
Marshal Quotient (Stability/Flow)	3.24	4.03	2.93	3.49	2-5
% Air Voids	3.64	3.92	3	3.18	3-5
% Air Void filled with Bitumen (VFB)	68.38	68.91	74.11	67.81	65-75
% Void in Mineral Aggregate	11.50	12.62	11.57	9.87	12

Table 8 - Test Result of RAP Mix Design

- We add the 15% waste plastic of bitumen.

Properties	10%	20%	30%	40%	Criteria as per IRC/MORTH 5th Revision
Compaction level	75 blows on each face of the specimen				
Stability (KN at 60^0 C)	**12.24**	**13.80**	**18.91**	**19.74**	**Min. 9**
Marshall Flow (mm)	3.60	3.9	4.2	4.3	**2-4**
Marshal Quotient (Stability/Flow)	3.40	353	4.5	4.59	**2-5**
% Air Voids	7.95	5.84	5.32	7.68	**3-5**
% Air Void filled with Bitumen (VFB)	48.60	60.73	63.90	47.26	**65-75**
% Void in Mineral Aggregate	15.46	14.86	14.73	14.56	**12**

Table 9 - Test Result of RAP with Plastic Mix Design

VII. Conclusion

- Based on above laboratory experiment material used in this study it was found that proportion of 40% Rap and 60% virgin material is optimum and obtain stability of **14.66** which satisfies MORTH criteria.
- Further on adding 15% waste plastic of bitumen with RAP and virgin material stability has increase to **19.74**.
- Thus durability of road can be increase and material can be saved. Thus, sustainability is achieved.

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