A STUDY ON BITUMINOUS MIX WITH RECLAIMED ASPHALT PAVEMENT AS REPLACEMENT TO AGGREGATES, CRUMB RUBBER, WASTE ENGINE OIL AS REJUVENATOR

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Abstract:
Reclaimed Asphalt Pavement, which is scarified flexible pavement, can be thought of as a practical replacement for natural aggregate and binder, offering a cost- and energy-effective solution to improve the qualities of an asphalt mixture. Understanding the potential of RAP as As part of the effort being made on a worldwide scale to address the growing problem of climate change and promote a sustainable environment, several governments are attempting to recycle RAP as a practical recycling method. The purpose of this task was to create a technique for calculating The quantity of recycled materials asphalt pavement that should be utilized in a bituminous concrete wearing course with a nominal aggregate size of no greater than 14 mm. Crumb Rubber was added as and Waste Engine Oil (WEO) as a rejuvenator and binder modifier, respectively. to the RAP. Five samples will be sent upon occupancy.

Keywords: Reclaimed Asphalt Pavement, Crumb Rubber(CR), Waste Engine Oil(WEO)

1. INTRODUCTION

Since recovered bituminous pavement is a viable replacement for natural aggregate and binder, its application is considered to as recycling old asphalt pavement. Utilising RAP might save expenses, mineral utilisation, relevant pollutants, and energy and energy-related expenditures. In fact, using RAP might result in reductions of up to 35 percent and 70 percent in manufacturing costs and petrol emissions, respectively. However, due to a lack of knowledge and unusual recycling standards, the use of recycled asphalt pavement is still very uncommon in many nations. A framework must be developed in order to gauge recovered asphalt pavement, particularly when various reclaimed asphalt pavement proportions are put in the. Reclaimed asphalt pavement is still only exploited in a very just a small portion of countries due to ignorance and odd recycling legislation. As a consequence, it was shown that incorporating 30% recycled asphalt pavement into hot enough asphalt had little to no unfavourable impacts.

1.1 RECLAIMEDOASPHALTOPAVEMENT (RAP)

The phrase "Reclaimed Asphalt Pavement" (RAP) refers to materials that have been removed and/or treated and yet include asphalt and aggregate. When asphalt pavements are removed from resurfacing of road or to get access to underground services, these materials are produced.

1.2 CRUMB RUBBER (CR)

Crumb Rubber (CR) is a hydrocarbon binder created when crumb rubber, which is made by recycling old tires, interacts physically and chemically with bitumen and a few other additives.

1.4 REJUVENATOR

Rejuvenators are substances created to return the aged (oxidized) asphalt binders' original qualities by reestablishing the original asphaltenes-to-maltene ratio. Since many rejuvenators are proprietary, it is challenging to provide a useful general explanation.

1.5 BINDER

The binder functions as an inexpensive, waterproof, thermoplastic adhesive as the material is bitumen. In other words, it serves as the binding agent that keeps the road together. In its most common form, asphalt binder is simply the residue from petroleum refining.

1.6 FILLER

The addition of filler materials to resin or binders (plastics, composites, or concrete) can improve certain qualities, lower the cost of the final product, or a combination of the two.

Elastomers and plastics are the two industries that employ filler materials the most.

1.7 CRUSHED GRANITE

Crushed granite made from decomposed granite is used to construct pavement. It is applied to heavy-use trails in urban, regional, and national parks as well as driveways, garden walkways, bocce courts.

Objectives:

1. To reuse the waste material (RAP) in bituminous pavement construction.
2. To save to virgin aggregates up to maximum extent.
3. To check the Marshall Stability readings upon replacement of natural aggregates by RAP materials.
4. To check the flow value by using used engine oil as rejuvenator in Reclaimed Asphalt Pavement.

2. LITERATURE REVIEW

Mamun, A.A. et al.[1] focuses to examine the feasibility for reusing existing asphalt pavement Utilizing used cooking oil to create new asphalt pavement (WCO). WCO is being included into the pavement components in an effort to lessen the stiffness impact of the recovered asphalt pavement (RAP). We want to determine how these variations in RAP and WCO proportions impact the properties of the regenerated asphalt mixture. Due to various combinations of RAP and WCO percentages. ANOVA may be used to detect significant differences or variations in the asphalt mixture's characteristics. Rubber from recycled tyres is one an instance of recycled material that perhaps utilized again and again, which lowers production costs and promotes environmental sustainability. Taherkhani, H et. al.(2) using recycled aggregates derived from steel slag, a study shows the effects of adding recycled tyre rubber to asphalt concrete. Aggregates made of steel slag have Increased stiffness (up to 30%) at high temperatures from the inclusion of crumb rubber is advantageous for preventing rutting. Crumb rubber was also added to the asphalt concrete mixes a decrease in rutting, or persistent deformation, in asphalt concrete compositions. Road building is now more enduring and sustainable because to these adjusted combinations' improved resilience to fatigue cracking and rutting.

3. MATERIALS AND METHODOLOGY

3.1 MATERIALS PROPERTIES

The five primary components taken in this experiment were Reclaimed asphalt pavement, original aggregates, bitumen binder, modifier and rejuvenator (Fig. 1). The Reclaimed Asphalt Pavement was gathered at Davangere, in the Indian state of Karnataka. The prime filler was crushed granite, and the non-active filler was 10% standard Portland cement. The Natural aggregate properties were required in order to meet government agency which undertakes road works. Additionally, using a mixer with a propeller at 200 rpm for two hours at 160°C, the virgin binder was changed with 15% CRM of 80 mesh size. 60/70 penetration grade bitumen was used as the virgin binder. The rheological qualities of the binder which has became old were softened by the rejuvenator, which contained 15% WEO (by% of binder became old in mass), while the virgin binder's rheological qualities were enhanced by the binder modifier, which contained 15% CRM (by% of virgin binder mass). Amount of specific gravity used WEO was 0.87.

a) Natural Aggregate

b) Reclaimed Asphalt Aggregate

c) Crumb Rubber

d) Bitumen

e) Waste Engine Oil

Fig. 1: Bituminous Mix Materials (a, b, c, d and e)

3.2 METHODOLOGY

3.2.1 Marshall Test

The five primary components taken in this experiment were Reclaimed asphalt pavement, original aggregates, bitumen binder, modifier and rejuvenator (Fig. 1). The Reclaimed Asphalt Pavement was gathered at Davangere, in the Indian state of Karnataka. The prime filler was crushed granite, and the non-active filler was 10% standard Portland cement. The Natural aggregate properties were required in order to meet government agency which undertakes road works. Additionally using a mixer with a propeller at 200 rpm for two hours at 160°C, the virgin binder was changed with 15% CRM of 80 mesh size. 60/70 penetration grade bitumen was used as the virgin binder. The rheological qualities of the binder which has became old were softened by the rejuvenator, which contained 15% WEO (by% of binder became old in mass), while the virgin binder's rheological qualities were enhanced by the binder modifier, which contained 15% CRM (by% of virgin binder mass). The specific used WEO was 0.87. The Reclaimed asphalt pavement was first squashed and air-dried. In the interim, the matured folio was extricated. The dissolvable used to extricate the matured folio was methylene chloride arrangement. The extricated matured fastener was then described. The RAP totals containing 4.1% matured folio (by% of RAP total mass) were then utilised to decide the joined total degree. At last, the matured folio was restored with 15% Waste Engine Oil (by % of matured cover mass).

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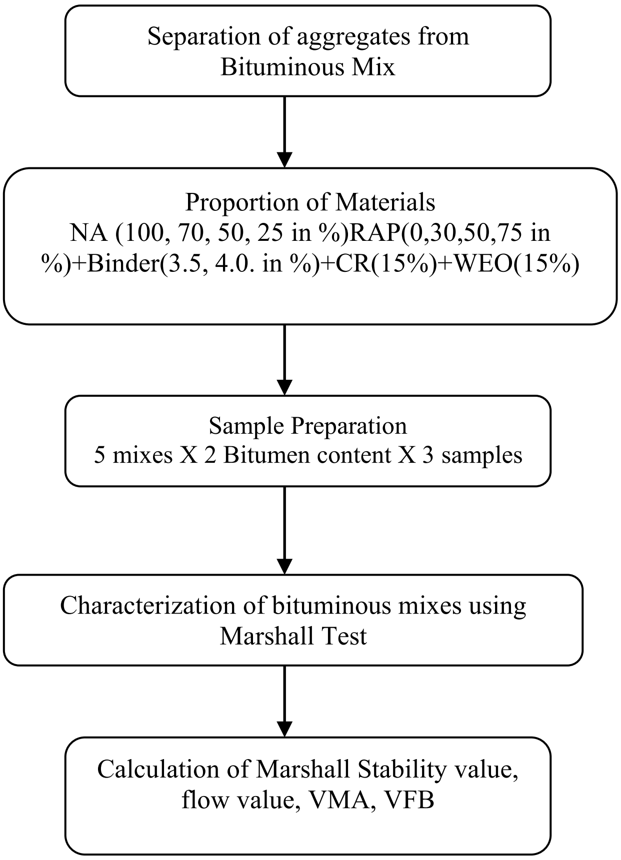

Fig. 2: Flow Chart in this analysis

Fig. 3: Marshall Stability machine setup

Fig. 4: Marshall compacted test specimen

4. ANALYSIS AND RESULTS

4.1 Aggregate Test Results

Table 1: Aggregate Test Results

Sl. No.	Description	Result	Ranges as per IS CODE	Code Reference
1	Specific gravity test on natural aggregates	2.8	3	IS: 2386 (Part 3)
2	Specific gravity test on aged aggregates	2.6	3	IS: 2386 (Part 3)
3	Impact test on natural aggregates	22.65 %	20-30%	IS: 2386 (Part 4)
4	Impact test on aged aggregates	28.28 %	20-30%	IS: 2386 (Part 4)
5	Crushing value test on natural aggregates	11.35 %	<16%	IS: 2386 (Part 4)
6	Crushing value test on aged aggregates	15.04 %	<16%	IS: 2386 (Part 4)

4.2 Bitumen Test Results

Table 2: Bitumen Test Results

Sl. No.	Description	Result	*Ranges as per IS CODE*	Code Reference
1	Specific gravity test	0.866	0.97-1.02	IS:1202-1978
2	Penetration test	69 cm	60-70	IS:1203-1978
3	Ductility test	52 cm	50-100	IS:208-1978
4	Viscosity test	314 sec	300 sec	IS:1206-1978
5	Bitumen softening point test	68°	35°-70°	IS:1205-1978

4.3 THE MAKE UP OF EACH MIX

Table 3: Specimen Ingredients

Mix Type	RAP (%)	NA (%)	CRM (%)	WEO (%)
R0	0	100	0%	0%
R30	30	70	15%	15%
R40	40	60		
R50	50	50		
R75	75	25		

4.4. MARSHALL TEST RESULTS

4.4.1 MARSHALL STABILITY TEST FOR 3.5% OF BITUMEN CONTENT

Table 4: Marshall Test Results For 3.5% Binder

Mix Type	Marshall Parameters				
	Stability (KG)	Flow (mm)	Air Void (%)	VMA (%)	VFA (%)
R0	643.37	3.0	8.48	53.76	18.42
R30	1178.45	3.1	7.49	67.29	21.55
R40	1082.9	3.4	7.66	69.65	21.90
R50	987.35	3.4	7.22	70.53	21.97
R75	796.25	4.0	7.91	63.63	22.95

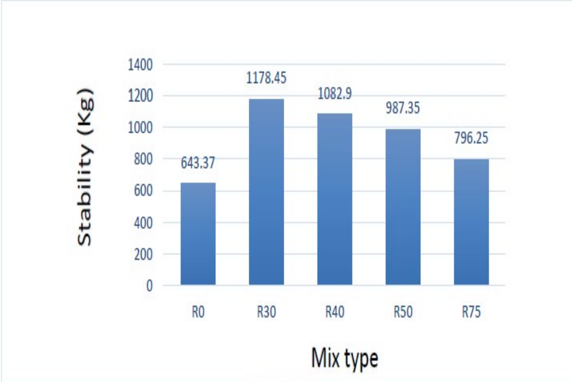

Fig. 5: Stability graph for 3.5% bitumen content.

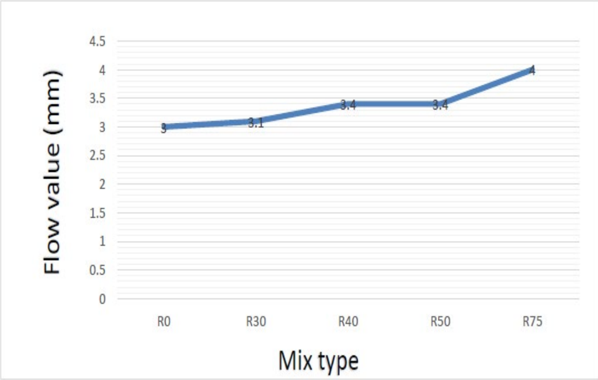

Fig. 6: Flow graph for 3.5% bitumen content.

4.4.2 MARSHALL STABILITY TEST - 4.0% BITUMEN

Table 5: Marshall Test Results For 4.0% Binder

Mix Type	Marshall Parameters				
	Stability (KG)	Flow (mm)	Air Void (%)	VMA (%)	VFA (%)
R0	905.00	4.0	7.33	18.69	74.76
R30	1178.2	4.1	5.23	21.72	75.91
R40	1080.9	4.3	6.23	22.35	76.24
R50	987.50	4.5	5.97	22.06	76.99
R75	760.35	5.0	5.65	21.91	76.30

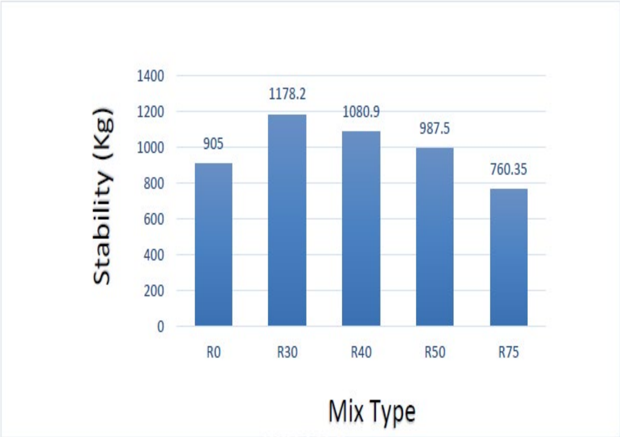

Fig. 7: Stability graph for 4.0% bitumen content.

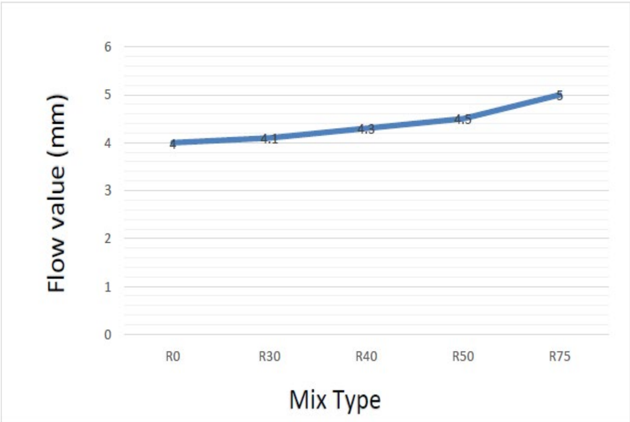

Fig. 8: Flow graph for 4.0% bitumen content

5. DISCUSSION AND CONCLUSION

5.1 DISCUSSION

1. These results support the usage of all RAP mixtures in the road construction sector, where up to 100% RAP may be used into the HMA design without significantly affecting the asphalt mix's performance.

2. The stability of RAP mixes increased by more than 30%, demonstrating the effectiveness of WEO as a rejuvenator to improve the characteristics of the deteriorating binder.

3. Rejuvenators are now gaining popularity in asphalt technologies owing to their capacity to restore the aged binder's original qualities, which may help avoid thermal fractures and brittleness.

4. The stability was thought to be enhanced by the addition of CR to the mixture.

5. Because WEO is used in RAP mixes, which allows aggregates to float in the mixture, the flow of the mixes improved as RAP concentration rose.

6. The outcome also showed that the rejuvenator softened the deteriorated binder and improved the asphalt mix's workability.

7. The flow standard for all combinations was 2-4 mm. Due to the inclusion of WEO in RAP mixes, which allowed aggregates to float in the mixture, the flow of the mixes improved when RAP concentration was increased. Additionally, when the quantity of RAP content grew, so did the amount of WEO.

8. The outcome also showed that the rejuvenator softened the deteriorated binder and improved the asphalt mix's workability. Additionally, adding CRM to the mix increased its flow value.

5.2 CONCLUSIONS

1. The stability of all RAP mixes was higher than the R0 as well as the standard limits (8.0 kN). It was discovered that adding RAP material increased the flow. The results also demonstrated that all RAP mixtures met the Marshall stability and flow requirements.

2. Research on the effectiveness of RAP mixtures in preventing moisture damage revealed that a 30% RAP mix outperformed a 50% RAP mix, however both blends outperformed the control.

3. The pavement becomes more sustainable, long-lasting, and cost-effective when RAP is used as an alternative material in conjunction with rejuvenator.

4. A large increase in income is projected in the linked pavement construction industry as a result of using greater RAP percentages in asphalt mixes.

5. It was discovered that the flow increased with the addition of RAP material. The results also demonstrated that all RAP mixtures met the Marshall stability and flow value

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