

# To Investigate The Performance Characteristics of Bitumen Mixture Using RAP & RCA

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**Abstract-** this research investigated to reuse the existing pavement materials [RAP, RCA]. For several reasons mainly to preserve natural resources such as aggregate & to satisfy economic requirement by reducing the cost of highway construction and rehabilitation. Now a day's usage of road is more, so the volume of vehicle is high. Since it leads to high traffic and causes damage on pavement surface so the maintenance process on road surface is done regularly so the usage of natural aggregate is higher on road construction the road construction industry are consuming more amount of natural aggregate on road construction since to reduce the usage of natural aggregate in road construction we are introducing RAP and RCA

**Keywords-** Reclaimed Asphalt Pavement (RAP), Recycled Concrete Aggregate (RCA)

## I. INTRODUCTION

The aim is to reuse the existing pavement materials [RAP, RCA]. For several reasons mainly to preserve natural resources such as aggregate & to satisfy economic requirement by reducing the cost of highway construction and rehabilitation. This type of method ultimately convert old asphalt concrete pavement into sustainable pavement. The phase of construction, maintenance, and with the introduction of new technique of perpetual pavement RAP&RCA it is necessary to consider recycling as one of the promising solutions for rehabilitation of old asphalt concrete pavement and ultimately to convert them into perpetual Pavements The aim is to reuse the existing pavement materials for several reasons, mainly to preserve natural resources such as aggregates, and to satisfy economic requirements by reducing the cost of highway construction and rehabilitation. Now a day's usage of road is more, so the volume of vehicle is high. Since it leads to high traffic and causes damage on pavement surface so the maintenance process on road surface is done regularly so the usage of natural aggregate is higher on road construction the road construction industry are consuming more amount of natural aggregate on road construction since to reduce the usage of natural aggregate in road construction we are introducing RAP and RCA. General RAP & RAC

Composition consists of 70–80% coarse aggregate, 8–12% filler, 6.0–7.0% binder, and 0.3 per cent fiber. RAP & RAC can be mixed by a wet process or dry process. During the wet process, asphalt cement binder is modified with 5-25% weight of Reclaimed Asphalt Pavement (RAP) at an elevated temperature. In the dry process, the particles are mixed with aggregates before addition to asphalt. In this project study, the main purpose of this research is to determine the effects of incorporating RAP + RCA waste on the pavement surface.

## SIGNIFICANCE

The current project is able

- To provide a mixture that offered maximum resistance to studded tire wear.
- To prevent pavement distresses, a new mix design of asphalt additives is developed.
- To minimize the damage of pavement such as resistance to rutting and fatigue cracking
- To reduce the cost of rehabilitation.
- To protect pavement material for future generation

## APPLICATIONS:

Some of the industrial application of Reclaimed Asphalt Pavement and Recycled Concrete Aggregate are

- Highways
- Bridges
- Bus lanes
- Car parks
- Harbors and
- Area With high lorry frequency

## OBJECTIVES

1. To study the performance of RAP&RCA pavement with normal pavement, and find out the ways of cost saving in repair and maintenance of pavement

- To determine the tensile strength ratio of natural pavement aggregate with 16% & 20% (Combined Combination with 30% RAC and 70 % RAP) by weight of the bitumen).
- To determine the percentage use of feasible for pavement

## II. METHODOLOGY

The project aims to improve the mechanical properties of RAP and RCA with additives. Aggregate is the major component in pavement mix and they provide strength to pavement mixtures. We have adopted 19 mm aggregate which is used as Binder Course. The total weight of aggregate taken was 1200g. Particle size distribution is determined by aggregate gradation. Various tests were performed to determine the properties of RAP & RCA ingredients. Mix design is computed for RAP & RCA, consisting modifier in two varying percentage such as 16% and 20% by weight of bitumen. Bitumen were added in two different percentage such as 6% and 6.5% by weight of aggregate. As per the dry process method, the additives were mixed with the aggregate before adding bitumen. The selected bitumen was heated to 160 °C for about 1 h before blending with the aggregate. The Marshall compactor was used for the compaction stage of the process with 50 blows applied to both the faces of the sample at 150 °C. The Optimum bitumen Content (OBC) was estimated at which the air voids ( $V_a$ ), and the minimum voids in mineral aggregates (VMA) are 4 and 17 percent respectively. Volumetric properties are determined and plotted in graphs. Indirect tensile strength of the SMA Mix is determined and the OBC is estimated by comparison of volumetric properties of various mix.

### Steps in Methodology

- Allocation of raw materials like Aggregates, RAP, RCA and Bitumen.
- Properties of materials is determined as per IS Code respectively.
- Specimen is prepared with Marshall Compactor as per mix design.
- Volumetric properties are determined and plotted in graph.
- Indirect tensile strength determination.
- OBC is identified from the comparison of volumetric properties.

## III. MATERIALS

Pavement Mix consists of coarse and fine aggregate, bitumen, Reclaimed Asphalt Pavement (RAP), Recycled

Concrete Aggregate (RCA). Well graded 19 mm coarse aggregate is used to add strength to the mix. Penetration grade bitumen such as 60/70 grade is utilized as a binding agent are the modifiers added to the mix.

## IV. MIX DESIGN

The Marshall Mix design is done by following the procedure specified in ASTM D1559. The bitumen contents used in the mixture is varied at the rate of 6% and 6.5% by weight of aggregate. RAP and RCA contents were replaced instead pavement material and bitumen (16% and 20% by weight of bitumen), in RAP and RCA (70+30) in dry process. As per the dry process method, the additives were mixed with the aggregate before adding bitumen. The weight of aggregate for each sample was 1200g.

### A. Mix Design

#### Sample 1:

#### 16% Modifier – 6% Bitumen

Weight of aggregate = 1200 g

Weight of bitumen:

Considering 16% modifier

Weight of bitumen = 60.48 g

Weight of RAP = 3.306 g

Weight of RCA = 8.214 g

TABLE I MIX DESIGN

S.no	Description	Sample 1 (g)	Sample 2 (g)	Sample 3 (g)	Sample 4(g)
1	Weight of aggregate	1200	1200	1200	1200
2	Weight of bitumen	60.48	65.52	57.6	62.4
3	Weight of RAP	3.306	3.74	4.32	4.68
4	Weight of RCA	8.214	8.74	10.08	10.92

## V. TESTS & RESULTS

For testing of the pavement Mix the test usually is of three types 1. Material Test 2. Marshall test 3. Indirect tensile test

### A. MATERIAL TESTING

First the materials must be tested for its property, there are various test available for testing the materials. They are

1. *Gradation of coarse aggregate*: Gradation of the aggregate required for the mix is done according to IRC: SP: 79-2008.

We have adopted 19 mm SMA which is used as Binder Course. The total weight of aggregate taken was 1200g.

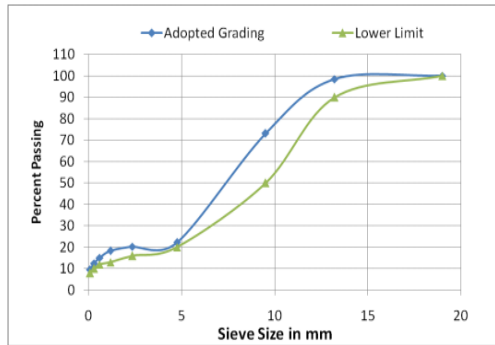


Fig. 1 Aggregate Gradation Curves

2. *Specific gravity of coarse aggregate:* The specific gravity of coarse aggregate is determined by using pycnometer and the result was found to be 2.85.

3. *Water absorption of coarse aggregate:* Water absorption of coarse aggregates is determined by following IS: 2386 (Part III) 1963, and found to be 1.7%

4. *Specific gravity of Bitumen:* The specific gravity of bitumen was found to be 1.018.

5. *Penetration test of Bitumen:* Penetration of a bituminous material at 25°C is 64.35.

6. *Softening Point of Bitumen:* Softening point of bituminous material is 55°C.

**B. MARSHALL TEST**

The Marshall Mix design procedure as specified in ASTM D1559 was used in this study. The weight of aggregate for each sample was 1200g. The results are plotted below

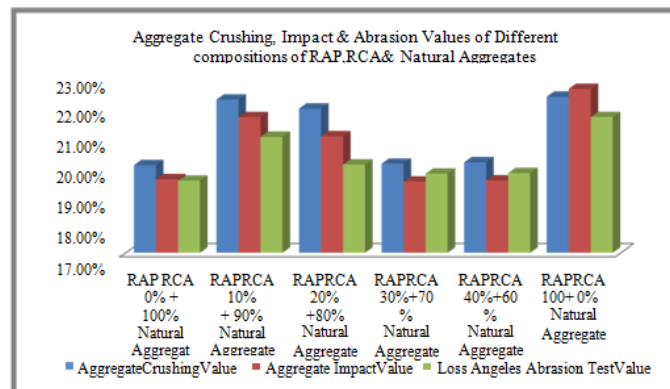
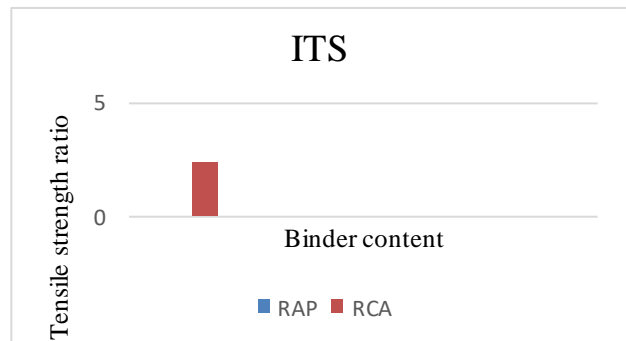


Fig 1 Values of Different parameters at various compositions of RAP & Natural Aggregates

**C. INDIRECT TENSILE STRENGTH**

The variation of Indirect Tensile Strength Ratio for Mix with different dosage of the RAP and RCA is determined by:

$$TSR (\%) = (ITS_{wet} / ITS_{dry}) \times 100$$



**D. PROPERTIES OF OPTIMUM BINDER CONTENT**

Optimum Binder Content (OBC) for SMA Mix has been estimated considering the Air Voids (Va), Minimum Voids in Mineral Aggregates (VMA) and Tensile Strength Ratio (TSR) respectively.

TABLE II Volumetric Properties of P<sub>AVENEMENT</sub> Mixtures at OBC

Properties	Value obtained
Optimum Binder Content by Weight of Aggregate, %	6.5
Bulk Specific Gravity of Compacted Mixture, Gmb	2.35
Air Voids, %	2.89
VMA, %	18.82
VB, %	79.27
Stability, kN	15.18
Flow, mm	3.04
TSR, %	94

From the above tests, the optimum bitumen content is 6.5% mix of aggregate (20% (RAP+RCA)).

**VI. CONCLUSION**

From the experimental investigations the following conclusions are drawn.

- The indirect tensile Strength Ratio lies in the range of 85 - 94%. This satisfies the condition of optimum bitumen content.
- The pavement mixes have shown good stone on stone contact (VCA DRC < VCA MIX).

- The 17% Voids in Mineral aggregate and 3 - 5% air voids in the mix were fulfilled as pavement Mix design criteria.
- Based on the above results, the combined combination of RAP and RCA improves the properties of the mix and they can be used as a stabilizing additive.
- Based on the above results, the combined combination of RAP and RCA improves the properties of the mix and they can be used as a stabilizing additive.
- The optimum dosage of the Additive was found to be 20 % (Combined Combination with 30% RCA and 70 %RAP) by weight of the bitumen.
- Long term performance of the combination on RAP & RCA Mix has to be studied for further applications.

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