Consideration of Strength Parameters of Reclaimed Asphalt Pavement (RAP) Concrete over Conventional Concrete

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Abstract: The Reclaimed Asphalt Pavement (RAP) has become a typical practice in the transportation business. RAP from reusing exercises address the issues of diminishing use of declining virgin total sources, material stockpiling and removal of recovered black-top material. The rule factors behind reusing endeavours incorporate decrease of development squander, safeguarding of non inexhaustible normal assets, and lower vitality costs. In light of numerous researches facility test results suggested for utilization of RAP in street base and sub base layers is in fact practical. Various transportation organizations have been reusing RAP in unbound base and sub base layers. In this examination, the ideal rate for supplanting recovered totals with Virgin Aggregates is found and the ideal rate is tried for the quality attributes of the totals. Despite the fact that having a huge amount of RAP, because of its inadequate quality necessities it can't be utilized until it is dealt with. The treated RAP material can be mixed with material like lime, fly debris, concrete oven cleans or Portland concrete in unsterilized street asphalts. The reason for this examination work is to show up at the ideal level of reused black-top asphalt and cementitious material dependent on quality boundaries in street development to make the base course impermeable. It expands the quality and firmness of the sub base layer just as it decreases the protection from rutting and weariness breaking.

Key words: Reclaimed Asphalt Pavement, base course, recycling, virgin aggregate

1. Introduction
Recovered Asphalt Pavement is the term given to empty just as reprocessed black-top materials containing black-top and totals. These materials are created when black-top asphalts are expelled for recreation, remerging, or to acquire access to covered utilities. When appropriately squashed and screened, RAP comprises of top notch, very much reviewed totals covered by black-top concrete. RAP is generally removed either by milling or full-depth removal [1]. The utilization of RAP material is expanding as nearby, state, and government transportation offices utilize their assets. Generally, old asphalt material was expelled and discarded in landfills. As land filling these materials has become not so much down to earth but rather more costly and the accessibility of value virgin materials decays, the expansion of RAP to asphalt blends has become increasingly predominant [2]. Utilizing the RAP overall substitution of virgin Aggregates won't be possible as it has insignificant quality as it is utilized. But replacing the RAP with Virgin Aggregates in an optimum percentage is feasible.
Therefore, the optimum percentage for replacement should be found to use the waste resources without compromising the safety [3]. The utilization of RAP may develop by expanding the quantity of thruway development and restoration extends that utilization RAP, just as by expanding the measure of RAP utilized in explicit undertakings. In order for it to be successful, recycled asphalt pavement must be cost-effective, perform well, and be environmentally sound. Reclaimed Asphalt Pavement from the road shown in Figure (a) and (b).

![Figure 1 RAP images of (a) RAP collected from the road (b) crushed RAP](image)

1.1. Scope of this research:
The purpose of this research work is to arrive the optimum percentage of recycled asphalt pavement and additives material based on strength parameters in road construction to make the base course impermeable [4]. Utilization of RAP material in street development has been demonstrated to decrease both the pace of exhaustion of regular assets and the measure of development flotsam and jetsam arriving at the urban landfills.

1.2. Objectives:
To arrive an optimum RAP mix with and without interactions between the virgin aggregate (VA), recycled materials and the chemical stabilizer. To study the properties like Optimum moisture content, Maximum dry density, California bearing ratio of RAP mixes to investigate the properties like strength, compressibility, and resilient modulus of the mixes to evaluate the durability properties of RAP mixes [5].

2. Experimental Observation:

2.1. Compressive Strength:
To find the optimum percentage of replacing the Reclaimed aggregates with Virgin aggregates by various mix ratios of [6] reclaimed aggregates and virgin aggregates.
Procedure

1. Remove the specimen from water after specified curing time and wipe out excess water from the surface.
2. Take the dimension of the specimen to the nearest 0.2m as shown in Figure 2 (a)
3. Clean the bearing surface of the testing machine
4. Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.
5. Align the specimen centrally on the base plate of the machine.
6. Rotate the movable portion gently by hand so that it touches the top surface of the specimen.
7. Apply the load gradually without shock and continuously at the rate of 140 kg/cm²/minute till the specimen fails and the specimen is taken out, the appearance of the specimen shown in Figure 2 (b)
8. Record the maximum load and note any unusual features in the type of failure.

![Figure 2 Specimen images of (a) cubes cast with RAP, (b) failed specimens](image-url)
2.2. Los Angeles Abrasion test:
To find whether the optimum percentage of replacing also satisfies the abrasion value. Take 2.5kg of sample and 8 steel balls into the machine shown in Figure 3. The machine is turned at a speed of 30 to 33 cycles for each moment. The machine is turned for 500 upheavals. After the ideal number of upheavals, the machine is halted and the material is released from the machine taking consideration to take out the whole stone residue. Utilizing a strainer of size bigger than 1.70 mm I.S sifter, the material is first isolated into two sections and the better position is taken out and sieved further on a 1.7 mm I.S sieve. Let the original weight of aggregate be W1 gm, weight of aggregate retained on 1.70mm.

![Figure 3 Los Angeles Abrasion Test Machine](image)

2.3. Impact value test:
The ideal level of supplanting the recovered totals exposed to affect is tried. The test comprises of totals passing strainer and held least sifter and dried in a stove. Test totals are topped off to around 33% full in the tube shaped measure and packed multiple times with adjusted finishes of the packing bar as appeared in Figure 4. Further amounts of totals are then added to up to 33% full in the round and hollow third full in the chamber and 25 strokes of the bar are given. The measure is presently loaded up with the total to flood packing multiple times. The net edge of the totals in the measure is resolved the closest developed and this weight of the total is utilized for winning act copy cost on a similar material. The test is exposed to a metal of 15 such blows, each being conveyed at a timespan short of what one second. The part passing the strainer is gauged exact to 0.1gm.

![Figure 4 Impact value test apparatus](image)
2.4. Crushing strength test:
Squashing quality of the ideal blend is checked for as far as possible. The tube shaped measure is filled by the test of total in three layers of around equivalent profundity, each layer being packed multiple times by the adjusted finish of the packing pole. After the third layer is packed, the totals at the head of the round and hollow mark are levelled off by utilizing the packing pole as a straight edge. About 6.5 kg of total is required for getting ready two test tests. The test in this manner taken is then weighted. A similar load of the example is taken in the recurrent test. The chamber of the test contraption is put in position on the base; 33% of the test is put in this chamber and packed multiple times by the packing bar. Essentially, two pieces of the test example is included, each layer being exposed to 25 blows. The all out profundity of the material in the chamber in the wake of packing will anyway be 10 cm the outside of the totals is levelled and the unclogged embedded with the goal that it lays on this surface in level position. The chamber with the test and unclogged in position is set on a pressure machine as appeared in Figure 5. Burden is then applied however the unclogged at a uniform pace of 4 ton for every moment until the absolute burdens is 40 tone. Aggregates including the squashed part are expelled from the chamber and sieved on a 2.36 mm IS sifter. The material which passes this sifter is gathered. The above smashing test is rehashed on a second example of a similar load as per the above test method. Along these lines two tests are made for a similar example for taking a normal worth..

The reclaimed aggregates were taken from the excavated roads and tested compressive strength when used in concrete by a compressive testing machine. The aggregates used for the concrete is of different mix ratios to find the optimum amount of replacing the reclaimed aggregates. Then the optimum percentage is tested for various aggregates test (Los Angeles abrasion test, Impact value test, crushing strength test) for testing the safety of using the optimum percentage in the construction. The resulted value gives assurance for whether the optimum percentage found subjected to the test is safe or not.

![Crushing strength test](image)

**Figure 5** Crushing strength test
3. Result and discussion:

3.1. Compressive Strength
The compression test results obtained as per the amount of reclaimed asphalt pavement.

| RAP % with VA | SAMPLE I     | SAMPLE II    | SAMPLE III   | AVERAGE     |
|---------------|--------------|--------------|--------------|-------------|
| 20            | 20.70 kN/m²  | 20.10 kN/m²  | 20.25 kN/m²  | 20.35 kN/m² |
| 30            | 22.15 kN/m²  | 22.05 kN/m²  | 22.00 kN/m²  | 22.06 kN/m² |
| 40            | 25.15 kN/m²  | 25.3 kN/m²   | 25.25 kN/m²  | 25.24 kN/m² |

*Figure 6* Bar graph representation of the observed compressive strength in the samples

The compressive strength of samples increases when the percentage of virgin aggregate increases and it reaches its minimum strength.
3.2. Los Angeles Abrasion Tests
The loss angle abrasion test value for both sample 1 & 2 are shown in the below table.
Sample 1: 100% Virgin aggregates
Sample 2: 80% Virgin aggregates + 40% RAP

Table 2

| S.NO | DESCRIPTION                                      | SAMPLE I | SAMPLE II |
|------|--------------------------------------------------|----------|-----------|
| 1    | Original weight of aggregates, W1, gm            | 2.5kg    | 2.5kg     |
| 2    | Weight of materials retain on 1.7mm IS sieve after test, W2 | 2.1kg    | 2kg       |
| 3    | Weight of passing (W1-W2)gms                     | 0.4kg    | 0.5kg     |
| 4    | Abrasion value in % = (W1-W/W2) X 100            | 19.04%   | 25%       |

Figure 7 Bar graph representations of abrasion values of samples

The percentage of wear should not exceed 16, the aggregate abrasion value of samples are obtained beyond the limit. As per the typical properties of some of the Indian aggregates, the impact value obtained for the sample taken from Sulur (Coimbatore) is 33%, so our sample is acceptable.
3.3. Aggregate Impact Value Test:
The impact value test for aggregate has been noted and the results for both the samples are shown in the following table.
Sample 1: 100% Virgin Aggregates
Sample 2: 80% Virgin aggregates + 40% RAP

| S.NO | WEIGHT OF AGGREGATES (A) | THE FRACTION PASSING THROUGH THE 2.36MM (B) | THE FRACTION RETAINED THE 2.36MM (C) | AGGREGATE IMPACT VALUE =B/A X 100 % |
|------|--------------------------|-------------------------------------------|-----------------------------------|----------------------------------|
| 1.   | 359                      | 49                                        | 310                               | 13.64%                           |
| 2.   | 350                      | 47                                        | 303                               | 13.4%                            |

Calculation of sample 1:

\[(49/359)\times 100 = 13.64\%\]

Calculation of sample 2:

\[(47/350)\times 100 = 13.4\%\]

**Figure 8** Bar graph representation of impact values of samples

Virgin aggregate can be used because the aggregate impact value should not exceed 30%, the impact value obtained here is lies within the limit.
3.4. Crushing Value Test:
In the below table the crushing value of the aggregate shown for both the samples.
Sample 1: 100% Virgin aggregates
Sample 2: 80% Virgin aggregates + 40% RAP

Table 4
CRUSHING TEST VALUE

| S.NO | DESCRIPTION                              | SAMPLE I | SAMPLE II |
|------|------------------------------------------|----------|-----------|
| 1    | Weight of sample passes 2.36mm IS sieve after test W2 | 0.46     | 0.60      |
| 2    | Weight of sample retain on 2.36mm IS sieve after test W3 | 2.3      | 2.32      |
| 3    | W1=W2+W3                                  | 2.76     | 2.92      |
| 4    | Average aggregate crushing value          | 20%      | 25.86%    |

Calculation for sample 1:
Total weight of dry sample taken, W1= 2.3 kg
Weight of crushed material passing 2.36mm IS sieve, W2= 0.46 kg
Aggregate crushing value =W2/w1 x 100= 20%

Calculation for sample 2:
Total weight of dry sample taken, W1= 2.32 kg
Weight of crushed material passing 2.36mm IS sieve, W2= 0.60 kg
Aggregate crushing value =W2/W1 x 100= 25.86%

Figure 9 Bar graph representation of crushing value of samples
The crushing value of aggregate which is used for roads or runways should not exceed 30%, the crushing value obtained here is within the limit, so it is same as normal aggregate.
4. Conclusion:

Reclaimed asphalt pavement (RAP) when used under optimum percentage has no major impact in the strength properties. Therefore, using the RAP with Virgin Aggregates in the concrete is advisable under the optimum percentage of replacement [7]. The laboratory tests on the aggregates clearly indicate the reduction in the strength properties of aggregates when RAP is introduced. But the difference is minimal [8]. Studies show that the use of chemical stabilization agents may require environmental assessment on a case by basis. Using the wastes should be the future. Therefore, replacing the RAP in the construction should be encouraged. Reportedly there is a large amount of RAP available in various plants, using the RAP will save the Virgin Aggregates and be useful in construction waste management [9] [10]. Construction wastes are increasing day by day and there should be norms to be followed by the people which will regulate the usage of wastes in the construction thereby reducing the construction wastes.

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