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EVALUATING THE PROPERTIES OF AGGREGATES BY ADDING DIFFERENT WASTE PRODUCT FOR PAVEMENT CONSTRUCTION.

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ABSTRACT

The most preferred pavement system for highway and road constructions are Flexible pavement. The goal of achieving and becoming a developed country, urbanization, industrialization and construction activities have taken place and are increasing daily in a developing country like India and other countries also. Today's everyone growing demand and their needs for the supply of non-renewable resources which is very limited is one of the significant challenges of the global pavement industry. The solid waste which is coming from these materials which are open dumped and requires large area through which the degradation is done and minimize the availability of land which kept for other use. Detailed analysis by many researchers has shown that waste materials are used on the ground in the form of coarse aggregate, fine aggregate and concrete in uneven pavements and Subbase and composite materials provides a cost. The use of recycled materials or the use of materials effective, efficient and sustainable process without compromising the strength and durability of the coating. Various studies have shown that secondary materials provide good waste disposal technology, reduce the need for conventional materials and reduce overall construction costs. Asphalt pavements and construction and demolition waste are important recycling sources. Recycled materials are first extracted from their sources, processed, and then made suitable for use in paving use of Recycled Asphalt Pavements (RAP) and construction demolition on unconsolidated construction. In addition, this review should readily address many important issues related to the replacement pavements and encourage researchers and highway agencies worldwide to establish a working framework to achieve high performance.

Keywords: RAP, Flexible pavement, Demolition waste, Asphalt pavement.

- **Introduction: -**

The aim of this study was to develop a cost-effective base/sub base using a combination of waste materials (i.e., RCA, RAP) to replace virgin materials. About 95% of world's roads are made of flexible pavements. It is composed of four layers namely sub grade, sub base, base andsurface course. Sub-grade is natural soil over which other layers are laid. Many times, it's foundthat existing sub grade is weak, or is of expansive nature, i.e., little change in moisture conditionleads to substantial volume change within a short period. In such cases, sub grade is modified using certain additives. This modified sub-grade is called sub base. Above sub-base lies base course which is a load-bearing layer composed majorly of high-quality aggregates of different sizes. Above it lies surface course, which is a mixture of aggregates, fines, filler, and binder. This layer is directly in contact with traffic load, hence using a superior quality material is an absolute necessity. A significant part of flexible pavement is composed of aggregates which are procured from selected quarry sites. Their extraction process includes blasting, drilling, excavating and crushing. These methods are highly unsustainable as a massive quantity of waste produced during the process is either filled back at quarry site or disposed of abruptly, affecting ecological cycle in many hazardous ways. Similarly, bitumen, which is used as binding agent in the surface course, also has an unfavorable impact on environment and health.Using admixtures adds supplementary cost. In recent years, utilizing of industrial by-productsin treatment of problematic soils is in high demand as it promotes more sustainable constructionand decreases the cost.

FLEXIBLE PAVMENT: -

A simple pavement includes a base course and an asphalt surface layer on top of the subbase. The surface layer may consist of one or more layers of asphalt or hot mix asphalt (HMA). These coatings are weak in bending and therefore deform under load. The potential coating replacement process is achieved through the interaction of different coating systems. The load is directly above the layers and distributes (sharply) with depth to the base, subbase and subbase layers, and finally to the surface. Because stress from traffic is highest at the top, the surface layer has the greatest stiffness (measured by elastic modulus) and contributes the most to the strength of the pavement.

General Cross-Section of Flexible Pavement

A cross-section of the transition process consists of the following layers:

Fig1.1-Typical cross section of flexible pavement

1. Surface Course:

- The surface layer is the top layer of the flexible track and is generally the best layer because it must withstand the greatest stress and wear.
- The main design purpose is to protect the equipment, prevent water from entering the system and ensure that it does not fall.
- It is generally made of bitumen bonded with 25mm - 0.75mm quality aggregate (filler).
- Its thickness varies between 25 and 50 mm.
- The surface layer of the road easily protects the base layer from traffic and water while also providing enough tire friction to create less noise in the city and better light for the road during night driving. This surface is provided with a membrane coated with bitumen.

2. Binder Course:

- The connection layer is the layer between the surface layer and the layer and transfers the log loads from the surface to the layer.
- Asphalt is a bonded aggregate (nominal size) layer.
- This layer is also known as overlay.
- Thickness varies from 50 mm to 100 mm.

3. Base Course:

- Hard crushed aggregate materials are generally used in the construction of this system.
- The base layer is the back of the flexible coating.
- Its thickness varies between 100 mm and 300 mm.
- Base A sole or base in a walk is a layer of material used on asphalt pavements, race tracks, rides or parks.
- It is located below the wear layer and sometimes has an additional adhesive layer.
- If there is a layer, the base layer is created directly on top of the layer .

4. Sub-base Course:

- Subbase is a layer beneath the foundation that provides additional support and supports groundwater.
- It is usually an optional layer and will not be created if the base layer has good properties.
- Thickness ranges from 100 mm to 300 mm.
- The base layer is the layer (or layers) beneath the outer layer.
- A sub- base is not always needed.
- A proper sub-base consists of various sizes of crushed stone aggregate, commonly known as crusher run.
- Depending on the sub soils on our site we may need 8-12 inches of various sizes of sub-base.

5. Compacted Sub-grade course:

- Sub-grade is the bottom most layer which is nothing but natural soil layer compacted up to required depth generally about 150 to 300 mm to receive the loads coming from top layers.
- This layer is termed as foundation for the pavement system.
- Subgrade is the lowest layer of a flexible road and usually consists of a layer of compacted soil.
- Its main function is to prevent all stress from the layers.

6. Application of Prime Coat

- Primer is low viscosity diluted bitumen applied over the base layer.
- Most are a mixture of bitumen (80%) and kerosene (20%).
- To make one liter of lining, we need 1.05 kg of bitumen and 0.10 kg of kerosene and burn it to sufficient temperature.
- When the primer is ready, spread it over the base surface and let it dry for three days.
- Use 6-9 kg per 10 m^2.

RECLAIMED ASPHALT PAVEMENT (RAP MATERIALS) (15%-40%)

a) Reclaimed Asphalt Pavement (RAP) is the term given to removed and reprocessed pavement materials containing asphalt and aggregates.
b) These materials are generated when asphalt pavements are removed for reconstruction or resurfacing.
c) When properly crushed and screened, RAP consists of high-quality, well graded aggregates coated by asphalt bitumen.

CURRENT MANAGEMENT OPTIONS:

- RECYLING: The majority of the RAP that is produce is recycled and used, although not always in the same year that it is produced. Recycled RAP is almost always returned back into the roadway structure in some form, usually incorporated into asphalt paving by means of hot or cold recycling. But it is also sometimes used as an aggregate in base or subbase construction.
- DISPOSAL: Excess asphalt concrete is disposed of in landfills or sometimes in the right way. In most situations, this occurs where small quantities are involved, or where the materials is commingled with other materials, or facilities are not readily available for collecting and processing the RAP.

HIGHWAY USES AND PROCESSING REQUIREMENTS

Milled or crushed RAP can be used in a number of highway construction applications. These include its use as an aggregate substitute and asphalt cement supplement in recycled asphalt paving (hot mix or cold mix), as a granular base or subbase, stabilized base aggregate, or as an embankment or fill materials.

S No.	Type of property	RAP property typical range of values	
1.	**Physical Property**	**Unit weight / density of single aggregate**	**1940-2300kg/m^3**
2.	**Moisture content**	**Normal**	**Not more than 5%**
3.	**Mechanical properties**	**Bulk unit weight**	**1600-2000kg/m^3**
4.	**California Bearing ratio(CBR)**	**If 40% RAP and 60%Natural aggregates**	**100%**

Asphalt Concrete Aggregate and Asphalt Cement Supplement - Recycled asphalt pavement can be used as a composite material, but in this application it also provides additional asphalt cement binder. This reduces the need for asphalt cement in new or recycled asphalt mixtures containing RAP. When used in asphalt paving applications (hot or cold mix). RAP can be performed at the head office or at the workplace (workplace).

Processing Requirements:

- **Hot Mix Asphalt (Central Processing Facility):** Recycled hot mix is normally produced at a central RAP processing facility, which usually contains crushers, screening units, conveyors and stackers designed to produce and stockpile a finished granular RAP product processed to the desired gradation.
- **Hot Mix Asphalt (In –Place Recycling):** Hot in-place recycling is a process of repaving that is performed as either a single or multiple pass operation using specialization heating , scarifying and compaction equipment.
- **Cold Mix Asphalt (Central Processing Facility):** The RAP processing requirements for cold mix recycling are similar to those for recycled hot mix, except that the graded RAP product is incorporated into cold mix asphalt paving mixtures as an aggregates substitute.
- **Cold Mix Asphalt (In –Place Recycling):** The cold in-place recycling process involves specialized plants or processing trains, whereby the existing pavement surface is milled to a depth of up to 150mm (6 in) processed, mixed with asphalt emulsion (or foamed asphalt) and placed and compacted in a single pass. There is no processing required prior to the actual recycling operation.

Recycled Concrete Aggregate (RCA):

Concrete is the most common material used for construction around the world. Approximately million tones of concrete is termed as construction waste per year. These demolished materials are often termed on land are not used for any purpose. This affects the environment and fertility of the land. Reusing concrete in the form of

aggregate would lead to the environmental and economic benefits. Apart from these recycled aggregates has several benefits since they are durable like natural aggregate. Versatile can be used for different functions and so on. To use recycled concrete aggregate for concrete contaminants like reinforcing steel, foundation materials, soil etc. are removed from the concrete. It can be done by screening or air separation, demolition, using electromagnets etc. than the debris crushed either manually or mechanically specified size and quality usually around 20mm to 50mm. Based on various research it is generally accepted that around 30% of natural crushed course aggregate can be replaced with coarsely cycled aggregate without significantly affecting any of the properties of the concrete. However, it is advised to perform the various concrete test by replacing some part of natural aggregate determine the perfect proportion of concrete.

Material and Method

Material used in this method are as follows: -

I. Reclaimed Asphalt Pavement

II. Construction Demolition Material

Summary of prominent reviewed research for the use of locally generated waste in base course of flexible pavement.

Waste	Used as	Test Parameters	Conclusion
Marble quarry waste	Aggregate in base course	Physical properties, Strength and stability	Recycled marble aggregates had sufficient strength and stability
Marble waste	Aggregate in base course	Physical parameters, Strength, Stability, long term performance	60% RMA can be used efficiently as a partial replacement to virgin aggregates in low volume roads
Marble dust	Filler	Strength, stability and durability	Marble dust performed similar to limestone dust and can be used as filler
Marble dust	Fines	Strength, durability and stability	Improved stability value, can be used as 100% replacement of conventional fines
Ballast quarry waste	Coarse and fine aggregates in HMA in individual and combined form	Strength, Stability, Durability, moisture susceptibility, long-term performance	Best performance was obtained from mix containing 100% basalt coarse aggregates and conventional fine aggregates
Ballast quarry waste	Aggregate in stone matrix asphalt	Strength and Stability	Mix containing recycled waste gave better stability values
RCA	Coarse aggregates	Physical properties, Strength, stability, long-term study	RCA can be used as coarse aggregates
RAP	Surface course of airport pavement	Strength, stability and durability, followed by field study	40% replacement of RAP deemed suitable for low volume roads and 40% replacement of RAP can be used as surface course in airport pavement

Table 3.1 – List of waste material used in base course in prominent reviewed research

Figure 3.1 - Reused Asphalt Pavement

LOS ANGELES ABRASION VALUE OF AGGREGATE

Firstly we will take 5000g-10000g aggregate as a sample in a try according to the specification or according to the grade of aggregate required. Then we have to wash the aggregate properly and we have to dry the sample to remove the moisture in an oven at 105°C to 110°C to substantially constant weight and shall confirm to one of the grading shown in Table1. The grading or gradings used shall be those most nearly representing the aggregate furnished for the work. Place the aggregates and steel balls or abrasion charge into the LOS Angeles apparatus . Place 11 steel balls and pack the steel door of the abrasion testing machine tightly and start the machine for rotation and the power of motor of that machine is 1 Horse Power(HP). When the rotation of machine starts there is screen in the machine in which we can see the number of rotations taken by the machine. The speed of machine will be 20- 25 per minute and rotations depends upon the grade of aggregates. For gradings A, B, C and D, the machine shall be rotated for 500 revolutions; for gradings E, F and G, it shall be rotated for 1000 revolutions. The machine shall be so driven and so counter-balanced as to maintain a substantially uniform peripheral speed. If an angle is used as the shelf, the machine shall be rotated in such a direction that the charge is caught on outside surface of the angle. After that when the rotations are completed we will open the lid and place the tray below the machine and take out all the sample from the machine and preliminary separation of the sample should be done. Take sample or dust material and pass it through 1.70mm IS Sieve. While passing the dust material will be passed and the remaining aggregate will be sorted and again washed in water and wash till the water gets clear which means all the particles and dust should get settle down. After washing dry the sample into thermostatically controlled oven at 105°C to 110°C to a substantially constant weight, and accurately weighed to the nearest gram (B). Then we will weigh the sample after oven drying. We will check the retained sample or remaining sample and compare it from the sample which was taken in starting for this procedure.

Calculation: -

1. The difference between the original weight and the final weight of the test sample is expressed as a percentage of the original weight of the test sample. This value is reported as the percentage of wear.

Aggregate Abrasion Value = ((A-B)/A) X 100

Where, A = weight in gm of oven-dried sample.

B = weight in gm of fraction retained on 1.70 mm IS Sieves

which is again oven dried.

Fig. 3.2.1 :- Los Angles Abrasion Test Machine

IS Sieve Designation	Percent by Weight Passing the IS Sieve					
	Grading I	Grading II	Grading III	Grading IV	Grading V	Grading VI
75.0 mm	100	-	-	-	100	-
53.0 mm	80-100	100	100	100	80-100	100
26.5 mm	55 –90	70-100	55-75	50-80	55-90	75-100
9.50 mm	35-65	50-80	–	–	35-65	55-75
4.75 mm	25 – 55	40-65	10-30	15-35	25-50	30-55
2.36 mm	20- 40	30-50	–	–	10-20	10-25
0.85 mm	–	–	–	–	2-10	–
0.425 mm	10-15	10- 15	–	–	0-5	0-8
0.075 mm	<5	< 5	< 5	< 5	–	0-3

IMPACT VALUE OF AGGREGATE

First we will take some aggregates and wash them nicely and the aggregate comprising the test sample shall be dried in an oven for a period of four hours at a temperature of 100 to 110°C and cooled. After that we will take some aggregates passing from 12.5mm sieve and retaining on 10mm sieve by keeping the tray below the sieve. Now we will take that 10mm retained aggregate and fill the cylindrical cup with aggregates. Before filing the aggregate first we will weigh the empty cylindrical cup then we will fill the aggregate in it. Now while filling the aggregate in the cylindrical cup we have to keep in mind that the aggregate should be filled in 3 layers and each layer will be tamped by 25 times with tamping rod and the upper most layer is also rolled by tamping rod so that the extra aggregate which is filled in the cylinder will fall down for accurate result. Now we will take weight of that filled cylindrical cup.The whole aggregate is shifted to bigger mould so that the value of impact value can be find. The container should be fixed firmly to the machine base and all test samples should be placed inside and compressed by squeezing the tamping rod 25 times at a time. To ensure that the impact machine is tight and the hammer can be directed sideways, it should be placed on a horizontal plate, block or ground without being compressed or compressed. The hammer should be lifted until its bottom is 380 mm above the surface of the aggregate in the container and allowed to fall on the aggregate. The test sample shall be subjected to a total of 15 such machines, each separated by not less than one second. Then remove the crushed aggregate from the container and sieve the entire thing through a 2.36 mm IS sieve within one minute until no material passes.

Calculation-

The ratio of the weight of fines formed to the total sample weight in each test shall beexpressed as a percentage, the result being recorded to the first decimal place:

- Empty cylindrical cup weight (W1)
- Weight of cup + aggregate (W2)
- Weight of aggregate (W3) = W2-W1
- Weight of aggregate passing through 2.36mm sieve (W4)

Aggregate Impact Value (%) = (W4/W3) X 100

Fig.3.3.2: - Impact Testing machine

WATER ABSORPTION TEST

Take approximately 2 kg of the entire sample, wash it to remove fine dust, and place it in a metal basket. The wire basket is placed in water at 220°C to 320°C.Immediately after immersion, the air trap was removed from the sample by lifting the basket to 25 mm above the tank bottom and allowing it to fall 25 times, approximately one in two drops. Fill the basket with aggregates in water for 24 ± 0.5 hours. Measure or weighed the basket and collect it in water at 22°C to 32°C. Remove the basket, collect it from the water and dry it with a dry, damp cloth. The surface dried aggregates are also weighed. Place the mixture in a shallow dish and heat in the oven to 100 to 1100 °C for 24 ± 0.5 hours. It was then cooled in a closed box and weighed. Immediately after immersion, the instrument is removed from the sample by lifting the basket to 25 mm above the bottom of the tank and lowering it 25 times at a rate of approximately one drop per second. The fine basket and aggregate are suspended in water at 22°C to 32°C. Remove the basket, collect the water and place a dry cloth on it. The surface dried aggregates are also weighed .Place the mixture in a shallow dish and heat in the oven to 100 to 1100 °C for 24 ± 0.5 hours. Then cool in a closed container and weigh. .

Calculation -

i. Weight of saturated aggregates in air: W1 g =

ii. Weight of oven dry aggregates in air: W2 g =

Water Absorption (%) = [(W1-W2) *100]/W2

Results and Discussion-

Table 4.1: - Result of test performed on different materials

Property	VA	VA+RAP	VA+RCA	VA+RAP+RCA	MORTH Specification
Los Angel's Test (%)	19.6	22.55	27.4	29.76	40
Impact Value Test (%)	20.7	18.40	25.3	22.5	30
Water Absorption Test (%)	0.4	-	1.8	-	2

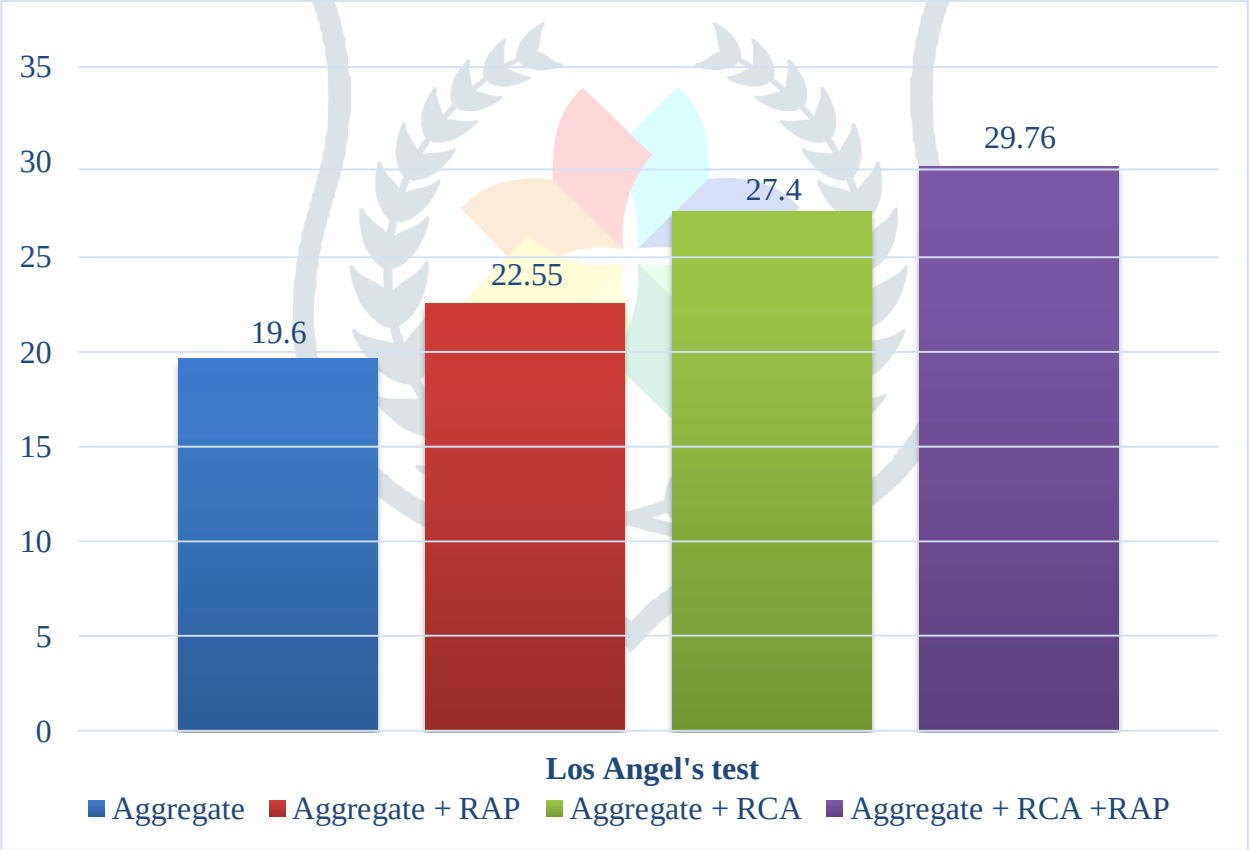

Fig. 4.1: - Los Angel's Test

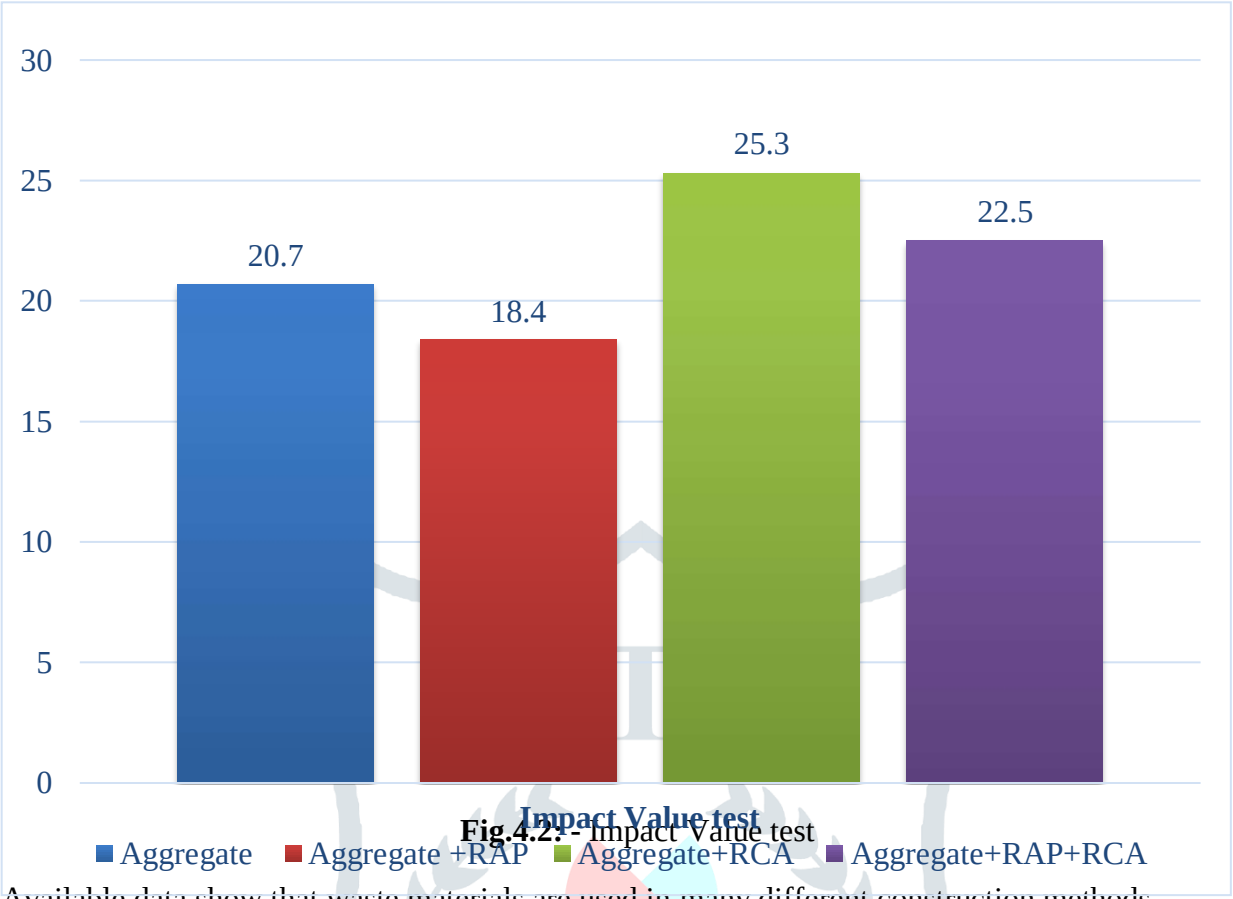

Fig.4.2:- Impact Value test

1. Available data show that waste materials are used in many different construction methods.
2. Therefore, all test values are in the best range and can be used in all layers except for wear of the coating surface layer.
3. This study shows that 30% can be added when using RAP because it is less difficult and there is no need to add asphalt binder. Therefore, this will be an incentive to improve environmental safety.
4. The design and production of quality RAP and CDW mixtures are more difficult and should be done by experienced coating engineers.
5. The RAP and CDW mixture design is dependent on the standards, scope of application and the impact of RAP and CDW technologies on the environment and economy.
6. RAP and CDW hybrid design depends on the nature, application, and environmental and economic impact of RAP and CDW technologies.
7. Savings and recycling costs and environmental impact as RAP and CDW methods use recycled materials and ultimately reduce waste from previous research history.
8. Alignment of the installation is very important in a good inspection of RAP materials and should be carried out from the beginning of the old road to the final paving stage.
9. More research is needed before identified waste can be considered as an alternative to construction.

Conclusion-

1. In this we concluded that there are many studies on waste or different types of waste which can be used in road construction especially in flexible pavement.

2. In this study we have also analyzed that the waste is not useable that can also be use in construction and make the required land free which create problem to the globe.

3. While using these waste like demolition waste and recycled aggregate in flexible pavement it also helps in conserving energy and also save the aggregates which are virgin or new for construction and reduces the cost of construction.

4. While doing these type of projects we should keep in mind that the waste which we are using should be in huge condition and should have homogeneity in composition and free from dangerous component which can harm people or environment.

5. The waste which we are using in our construction should be properly checked and after that analysis should be done that where it can be used and for what type of structures it can be used.

6. There are many recycled materials like RAP, RAC etc. which reveals there changes in shape and size .

7. While using these types of waste the physical properties of these waste depend on both the material and the manufacturing process but the researchers found that these waste change there physical properties when it is tested or performed.

8. These waste are properly used in construction and proper mixing should be done with the help proper equipment which is needed and what are the technical restrictions and quality control should be followed.

9. When these type of materials are used the research should precisely handle its behaviour and check any conflicting statement is there or not.

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10. MORTH Specification

ABSORPTION TEST

Take approximately 2 kg of the entire sample, wash it to remove fine dust, and place it in a metal basket. The wire basket is placed in water at 220°C to 320°C.Immediately after immersion, the air trap was removed from the sample by lifting the basket to 25 mm above the tank bottom and allowing it to fall 25 times, approximately one in two drops. Fill the basket with aggregates in water for 24 ± 0.5 hours. Measure or weighed the basket and collect it in water at 22°C to 32°C. Remove the basket, collect it from the water and dry it with a dry, damp cloth. The surface dried aggregates are also weighed. Place the mixture in a shallow dish and heat in the oven to 100 to 1100 °C for 24 ± 0.5 hours. It was then cooled in a closed box and weighed. Immediately after immersion, the instrument is removed from the sample by lifting the basket to 25 mm above the bottom of the tank and lowering it 25 times at a rate of approximately one drop per second. The fine basket and aggregate are suspended in water at 22°C to 32°C. Remove the basket, collect the water and place a dry cloth on it. The surface dried aggregates are also weighed .Place the mixture in a shallow dish and heat in the oven to 100 to 1100 °C for 24 ± 0.5 hours. Then cool in a closed container and weigh. .

Calculation -

iii. Weight of saturated aggregates in air: W1 g =

iv. Weight of oven dry aggregates in air: W2 g =

Water Absorption (%) = [(W1-W2) *100]/W2 =