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RESEARCH PAPER ON USE OF RECYCLED CONCRETE AGGREGATE IN BITUMINOUS CONCRETE

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ABSTRACT

The use of recycled concrete aggregates (RCA) in bituminous concrete was chosen for this project to define the use of recycled material in road construction. This would undoubtedly assist in improving cost-effective road development. This study will aid in the reduction of environmental damage. Mining will be minimized as a result of recovered concrete, resulting in less pollution. Millions of tons of aggregate are used in the construction and maintenance of roads and highways. In light of the scarcity of fresh aggregate, this study proposes that a portion of the fresh aggregate be replaced with recycled material. The road's construction is highly expensive. Only the materials account for more than 60% of the total building cost, with aggregates accounting for around 30% of the total. This recycled concrete is used instead of fresh aggregate in road building to keep the project costs down. It is necessary to investigate the compatibility of recycled concrete in various pavement portions in order to make the greatest use of recycled aggregates. Recycled aggregate was employed in the Granular Sub Base (GSB) and Wet Mix Macadam in this study (WMM).

Keywords:- recycled concrete aggregate (RCA), wet mix macadam, granular sub base, environmental damage, recycled aggregate

1. INTRODUCTION

Concrete is a composite material used in building. Aggregates, cement, and water are used to make it. Because aggregates account for 60 to 75 percent of total concrete volume, aggregate selection is critical, and aggregates also determine the characteristics of concrete. In the application, aggregate provides bulk, strength, and wear resistance. As a result, careful consideration should be paid to the selection and portioning of these aggregates. Fine aggregates such as sand or stone dust, were used in the concrete. Aggregates have formed the bulk of the pavement construction. Aggregates sustain all of the stresses that come from tyre loads on the pavement during the load transfer process, as well as resisting wear from the severe traffic. The qualities of these are extremely essential to engineers for this reason. The size, shape, texture, and gradation of these aggregates are used to classify them. These aggregates act as reinforcement, adding to the overall strength. They are also utilized as a foundation matter for highways, rail tracks.

RAP has been prepared by processing again asphalt & aggregate material. This RAP has grown really popular. Everyone uses it in new construction. However, there has been little research to determine the strength of RAP in cement concrete. Experiments with cement concrete's physical and mechanical properties containing RAP in various concentrations are carried out in this work. The debris from removed asphalt roads was used to create the recycled asphalt pavements employed in this study.

Importance of Research Topic

The current study will investigate under the theme "Utilization of recycled concrete aggregates in bituminous concrete."

This will provide a better comprehension of the concrete's properties when RAP is used as an alternative to fresh coarse aggregate. This will assist in achieving cost -effective road construction. The use of RAP will aid in the conservation of resources, landfill space, and profit for recyclers.

Scope of the Study

In this investigation, virgin coarse aggregate is employed in an M30 cement concrete mix design with a water cement ratio of 0.45 (CA). There are five batches in total, with the following percentages of RAP and fresh coarse aggregate:

a. 0% RAP and 100% CA
b. 25% RAP and 75% CA
c. 50% RAP and 50% CA

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d. 75% RAP and 25% CA

e. 100% RAP and 0% CA

Objective of the Study

The aim of the research is evolving and find such concrete which can be environment friendly as well as goes with the transportation construction. The objectives of the research:-

a. Gathering of research materials

b. Investigate the various assets of the chosen matter.

c. A comparison studyofthe following:

RAP aggregate and fresh coarse aggregate

2. LITERATURE REVIEW

Since the 1970s, the United States has been employing recycled asphalt, which provides a significant benefit to the paving business. Only 20% of a 100 million tons worn out asphalt pavement recovery is currently disposed of in landfills, according to Kelly, while the remaining 80% is currently recycled. Two-thirds of recycled material is utilized as road base aggregate, and the remaining one-third is used as aggregate in fresh asphalt hot mixes.

HISTORICAL BACKGROUND

According to the research, recycled asphalt pavement is widely used around the world. A large portion of RAP is used as a key surface material base in highways. This recycled material was previously utilized in Portland cement concrete. It has been increasingly popular in recent years.

Murshid Delwar et al. (1997) evaluated the compressive strength of these two (coarse and fine) RAPS aggregates amalgamated in standard concrete mixes to that of traditional mix. The findings concluded that compressive strength values are inversely related to RAP content. It indicates that when the RAP content rises, so will the Compressive Strength levels.

According to Baoshan Huang et al. (2005), this RAP could be employed in PCC without requiring any changes to usual equipment or processes.

Salim Al-oraimi and colleagues (2007) investigated the usage of RAP as a coarse aggregate. He employed this RAP in two separate concrete mixes after 28 days. It is employed to replace coarse aggregate by 25, 50, 75, and 100 percent. According to the findings, Slump and RAP are likewise inversely proportional. Compressive and flexural strength both declined as RAP concentration increased. The addition of RAP had no discernible effect on surface absorption. The findings suggested that RAP might be used as an aggregate in non-structural concrete.

Depending on the application, the percentage of RAP should be regulated. When using RAP in your mixes, keep in mind that it has a low droop.

Rap was utilised in place of virgin coarse aggregates in different portions of the study, namely 0, 25, 50, 75, and 100. The aggregate segments were changed to meet the gradation requirements, and their related compressive and flexural strengths were investigated. In all batches of coarse aggregates, the water-to-cement ratio was the same.

Obtaining Recycled Asphalt Pavement

Milling or full depth removal are commonly used to remove asphalt pavement. Milling is the process of removing the pavement surface with a machine known as a milling machine. This milling machine can rip out a thickness of at least 2 inches (50 mm) in a single pass. The full-depth removal technique involves ripping and breaking the pavement with a rhino horn mounted on a bulldozer and pneumatic pavement breakers. Following these steps, front-end loaders collect all of the shattered debris and load it. Many processes, including as crushing, screening, conveying, and stacking, have been performed at this central location. Existing asphalt pavements must be recycled using one of two procedures.

1. Cold milling of existing road
2. Hot mix asphalt plant.

MATERIALS USED AND METHODOLOGY OF THE STUDY

General

The study methodology for the current research effort describes how to get materials and conduct various tests in accordance with IS standards and ASTM 2172.

Material that has been used-

a. pozzolanic cement from Portland (ultra- tech cement).

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b. Coarse natural aggregate
c. Asphalt pavement aggregate recycled
d. Water and sand.

a. Cement: In the test programmed, 3.15 specific gravity Portland pozzolanic cement complying to IS 1489(Part 2):1991 is used (ultra -tech cement).
b. Natural Aggregate: In this investigation, two grades of coarse aggregate were used: 20mm and 10mm. Yamuna Nagar quarry provided the aggregates.
c. Recycled Asphalt Pavement (RAP): RAP is reclaimed and treated asphalt and aggregate pavement material. It is a waste product that is less expensive to get than fresh aggregate. The recycled asphalt pavement employed in the testing procedure ranges in size from 20mm to 4.75mm in thickness. RAP was sourced from an Ambala-based recycling asphalt facility.
d. Fine aggregate (Sand) and Water: a. The study's Yamuna River bed sand was taken from a local UP river. In the test protocol, tap water that is drinkable and devoid of salts or chemicals is used.

TESTING LIST

A number oftests on fresh aggregate and RAP were carried out.

Tests

a. Gradation
b. Specific gravity
c. Water absorption
d. Aggregate crushing rate
e. Aggregate impact rate

Test on RAP

a. Gradation
b. Specific gravity
c. Water absorption
d. Aggregate crushing rate
e. Aggregate effect rate
f. Bitumen content

Test on Fine Aggregate

a. Progression
b. Specific gravity
c. Water absorption

DETAILTESTING PROGRAM

Specific Grav

Because aggregates typically contain voids, multiple forms of specific gravity exist. The following are the details:

Absolute specific gravity is the mass density of solid material that is free of voids divided by the mass density of water.

Apparent specific gravity is defined as the mass density of the solid substance containing the gaps in comparison to the mass density of water

Water Absorption

The pressure of water immersed by a specimen after three days in water is compared to the load of an oven dry specimen. An aggregate's ability to absorb water is a critical aspect in the design mix grade of concrete. It has an impact on the mix design's workability and ultimate volume of concrete. The following is the formula for calculating water absorption.

$Wa=(Wsw\_Ws)/W,x100$ Where: Wa - an aggregate's water absorption

Wsw- the pressure of the compile material after three days of immersion in water. Ws- the weight of the aggregate after drying in an oven at 1055°C for 2 hours.

Coarse Aggregate Test Procedure

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Calculation

Total weight of the sample: - P kg Sample weight in water: - Q kg

The load of the specimen after it has been removed from the water in which it has been drowned for three days and then clean it: - R kg

The load of the specimen after it has been rinse in an oven for 2 hours at a temperature of 100 to 110°C S kg. S/ = Specific gravity (R-Q)

Specific gravity apparent =S/ (S-Q) (R-S)/S x 100 = water absorption (percentage of dry weight)

(A) Oven dry. (B) Balance

Figure.1

Water Absorption Test Machine

4 Spec Grav and Water Absorp Test Procedure for Fine Agg - Seriesof steps for determining specific gravityand water absorption is given below-

Required tools - The following tools will be needed-

a. Balance - The balance should be accurate to within 0.1 percent of the sample weight. It should also have appropriate capability and sensibility.
b. Oven - This must maintain a temperature of at least 100°C to 110°C. It should also be controlled by a thermostat.
c. Vessel –Any vessel that can carry 0.5 to 1 kilograms of material with a diameter of up to 10mm can be used. The vessel must be able to hold a consistent volume of water of 0.5 ml.
d. A one-liter capacity pycnometer with a metal screw and a 6-nun dia hole at the apex is used, as shown in Fig 3.3.
e. A tray with a surface area of at least 325 cm2.

Test steps-

1. A specimen of around 0.5 kg is in the pycnometer as the first step of the test. We use a balance to evaluate the weight of the pycnometer containing the dry sample. The pycnometer should be half-filled to three-quarters full of water.
2. Soak the sample for 10 minutes to release any trapped air. More water is added to the sample after the soak until the pycnometer is flush.
3. The pycnometer is then dried with towel, the weight is checked. After that, the pycnometer must be cleaned.
4. The specimen is kept inoven dry for 2 hours at 105±5°c, after this check the weight.

Computation

P kg = sample load

Q kg = weight of pycnometer containing water drowned specimen Load of a pycnometer filled only with water = R kg.

S kg = load of dry sapmle S/P-(Q-R) = Specific gravity

S/ S-(Q-R) = apparent specific gravity

(P-S)/S x100 = water absorption (percentage of dry weight).

Aggregate Crushing Value Theory

The aggregate used in the top layer is subjected to the stresses listed below.

a. Compressive stress due to moving traffic load
b. Other Stresses action due to traffic load

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Because the aggregate in the pavement gets crushed as a result of the above forces, the pavement deteriorates. To extend the life of pavements, we must focus on employing high-strength aggregates against these loads. As a result, aggregates must be tested against these stresses before being used in the building of pavements. 'Crushing strength test' is the name of the test. The aggregate crushing value is the resistance of an aggregate to crushing under a gradually applied compressive load.

Test Procedure of Crushing Strength of Coarse Aggregate

The crushing strength of coarse aggregate is determined using the procedure outlined on page 4 of IS: 2386(part 4)-1963. The following is the process for determining aggregate crushing strength.

Apparatus required –Following apparatus will be needed-

a. A steel cylinder with an open end. With the plunger and base plate, the cylinder should have a diameter of 15 cm.
b. A metaltamping rod with a circular cross section of 16 mm in diameter and a length of 45 to 65 cm.
c. We must strike a balance. The balance should have a 3 kg capacity
d. 12.5 mm, 10 mm, and 2.36 mm.
e. The compression testing machine depicted in Figure 3.4.

Test procedure

1. A cylindrical measure of 11.5 mm diameter and 18 cm height is filled in three layers with dry aggregates that have passed through 12.5 mm sieves and been retained by 10 mm sieves. Each of the three layers is tampered with the tamping rod at least 25 times. The test specimen is checked and put in three layers in the test cylinder, each layer being tampered with again.
2. A compression testing machine applies a compressive force of 30 tonnes to the sample at a rate of 30 tonnes per minute.
3. Crushed material are sieved through a 2.36 mm sieve, Calculation of crushing strength

Calculation

P kg is the load of specimen Weight =Q kg

2.36 mm (R) load of sample passing appropriate IS sieve = P-Q R/P x 100 = aggregate crushing value (percentage of dry weight).

Figure.2 Compression Testing Machine

Aggregate Effect rate Explanation

The aggregates that has been placed in pavement construction are too responsible for effect caused bytraffic. When cars with steel tyres move from one location to another, they have a varied impact on the aggregates at each level. The pavement's life is also affected by this impact. The 'Impact strength test' is a test that is performed on aggregates against this impact load (toughness). The aggregate's strength in terms of aggregate impact value is determined by the test result. The 'aggregate impact value' refers to an aggregate's resistance to sudden shock or impact, often known as toughness.

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3. TEST RESULTS AND DISCUSSION

General

In order to check the various qualities of materials connected to this study, numerous experiments were undertaken in the lab. All tests has been done with the help of IS standards and ASTM 2172 recommendations. The outcomes of the tests are tabulated.

Specific Gravity and Water Absorption Test of Coarse Aggregate

The specific gravity of a material can be used to determine its strength. Aggregate's strength is mostly determined through ones specific gravity. Aggregates with low specific gravity are considered less strongon comparison to those who have higher specific gravity values. The specific gravity of aggregate in concrete aggregates determines its volume. The specific gravity of coarse aggregate and RAP is checked using IS codes 2386 (part iii)-1983. The outcome has discussed in Table 4.1.

The water probability contained in specimen of aggregates, either insideor on the upper layer, is referred to as water absorption.Porous aggregate has a greater water absorption value. It becomes feeble as a result of increased water absorption. The aforesaid procedure (IS codes: 2386 (part iii)-1983) can be used to determine the water absorption of RAP and coarse aggregate. Table 4.1 shows the outcome. The following approach is used to calculate specific gravity and This given steps has been utilized to calculate specific gravity for aggregates ,these steps has been followed to calculate specific gravity nd water absorption for RAP of20mm size.

Computation

The following total load of CA (10mm) is (A): - 1 kg

(B) coarse aggregate load under water: 0.641 kg

The weight of coarse aggregate after it has been immersed in water for 1 dayand then dried (C): Water absorption = (C-D)/D x 100 = ((1.004-0.998)/0.998) x100 = 0.60 percent

Table.1 Outcome of Spec Grav and Water Absorp Experiment (CA & RAP)

Specimen	10mm	20mm	RAP
Aggregate's Load	1 kg	1 kg	1 kg
Under water load of Aggregate	0.640 kg	0.641 kg	0.600 kg
In air Aggregate's weight, later kept under water for 1 day and then dried	1.003 kg	1.004 kg	1.002 kg
Aggregate's load after drying in oven for two hrs	0.998 kg	0.997 kg	0.990 kg
SG	2.68	2.69	2.456
Evident sg	2.712	2.724	2.554
Water absorption	0.5%	0.60%	1.3 %

4. CONCLUSIONS

Flexural Tensile Testing Machine

The research effort was chosen to check properties of RCA used as CA in CC. "A study on the utilisation of recycled concrete aggregates (RCA) in bituminous concrete." Various experiments on aggregates has been done in this study to assess their qualities. CS and flexural tensile strength tests are carried out on concrete mixtures made up of virgin and RAP aggregates in various proportions (mix A to E). The following conclusions can be derived from the test results:

According to qualities of Aggregate

RAP is currently using as useless material, which is cheaper in comparison to fresh, so concrete made from RAP will naturally be less expensive.

1. Fresh aggregate has a specific gravity of 2.69 to 2.68, while RAP has a specific gravity of 2.49, which is less than 8.5 percent of fresh aggregate.
2. RAP has a water absorption of 1.3 and fresh aggregate has a water absorption of 0.5. This means that at The workability of concrete mix and RAP aggregate in cement concrete are inversely proportional to the Water cement ratio, which means that as the probability of RAP in CC increases, the workability of concrete mix decreases.

3. The gradation of recycled asphalt pavement aggregate met the IS code 383-1970 intended gradation requirement as. This specifies that recycled asphalt pavement aggregate can be utilized in the construction ofpavement as a material(partially/fully) in place of new coarse aggregate ofsizes 20mm and 10mm.

1. There is no discernible difference between RAP and fresh aggregates, as seen in table 4.6. RAP and fresh aggregates have crushing values of 17.36 percent and 17.09 percent, respectively.

Based on compressive strength of concrete

1. CS of all RAP concrete mixes is 10.46 percent, 36.8 percent, 38.4 percent, and 39.5 percent lower after 7 days than that of new concrete Mix M30 (mix This demonstrates that as the percentage of RAP increases, the CS of concrete mix (M30).
2. After 28 days, the compressive strength of RAPC mixes, is estimated to be 6.9%, 18.1 percent, 23.9 percent, and 32.8 percent lower than that of fresh concrete mix M30 (Mix A).
3. It is believed that mixing RAP with fresh aggregate reduces the rate of compressive strength gain.

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