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Recycle Concrete Aggregate with Bituminous Mixture

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ABSTRACT

Nowadays, with the increasing population in the world, construction activities such as houses, bridges, apartments, and other infrastructure are rapidly increasing. As a result, the wastage of concrete aggregates is also increasing. To minimize this waste, recycled concrete aggregates can be effectively utilized in hot mix asphalt mixtures for road pavement construction.

The objective of this study is to understand the importance and feasibility of using Recycled Concrete Aggregates (RCA) in the construction of bituminous pavements. RCA materials are obtained from the milling process. In this study, samples of RCA were collected and analyzed to determine their suitability for use in flexible pavements. Various properties such as gradation, Aggregate Impact Value, Aggregate Crushing Value, Specific Gravity, Flakiness and Elongation Index, Los Angeles Abrasion Value, and Water Absorption were determined and compared with standard specifications.

The study also evaluates Marshall Stability, deformation, and moisture damage resistance of Hot Mix Asphalt (HMA) mixed with different proportions of RCA. The Marshall Mix Design method was adopted to determine the Optimum Binder Content (OBC) for asphalt mixes containing RCA. Five aggregate combinations were tested with RCA contents of 0%, 10%, 20%, and 30%. The optimum binder content was found to be approximately 5%, 5.5%, and 6% respectively for the mixes.

Keywords:* *Bituminous mixture, Marshall Mix design, Recycled Concrete Aggregates (RCA), Flexible pavement, Hot Mix Asphalt.

1. INTRODUCTION

The gradual increase of urbanization in addition the construction and demolition of buildings and renovation of cement concrete asphalt pavements on highway are produced up to 600 million tones of solid wastes in each year. Another study evaluated the feasibility of using aggregate from recycled construction and demolition waste(RCDW) in pavement applications. A laboratory program was conducted by geotechnical characterization, bearing capacity and repeated load triaxial tests. The results show that the composition and the compactive effort influence on the physical characteristics of the RCDW aggregate. The compaction process has promoted a partial crushing and breakage of RCDW particles, changing the grain-size distribution and increasing the percentage of cubic grains. This physical change contributes to a better densification of the RCDW aggregate and consequently an improvement in bearing capacity, resilient modulus and resistance to permanent deformation. The results have shown that the RCDW aggregate may be utilized as coarse base and sub-base layer for low-volume roads Therefore the recycling of solid waste used as replacing natural aggregates and minimizing the shortage which was saves the natural resources. so, we extract the recycled aggregates from the solid waste or recycling plants utilizing as per test results of aggregates and bituminous tests.

We determine the optimum content from the various number of test samples with different state of design mixes as per the IRC Marshall mix design.The recycled aggregates are used up to 30 percentage for conducting the marshal mix design. The properties of aggregates asphalt binder mixture made of RA were investigated in terms of density-void analysis and stability per unit flow and were compared with the control specimens.

1.1Background of the study

Recycling of waste concrete is not a new concept and is effectively carried out in many parts of the world such as the UK, France, Denmark, Germany, the USA, Japan, etc. (McCree 1988; Mullehorn. Mahoney 1990; Baldocchi 1993; Paul 1994; Richardson Jorden 1994; Chini Monteiro 1999; Elias-Ozkan 2001; Thurber Engineering Ltd 2001; Kawano 2002; Chen et al. 2003; Park 2003; Zaharieva et al. 2003; Levy Helene 2004; Robinson et al. 2004; Oikonomou 2005). Recycled aggregates produced from crushed concrete are generally regarded as a higher quality product than aggregate

from mixed CRD waste (Thurber Engineering Ltd 2001).
Extensive research is being carried out internationally to explore various cost-effective applications of RA and to establish basic parameters for these applications. Its usage includes base material for roads, base material for footings and foundations, landscaping material, drainage material placed around underground pipes, aggregate in new asphalt or concrete, etc. The use of these alternative aggregate materials as a substitute for primary materials results in multiple environmental and economic benefits, which include (Nunes 1996) the following activities. 1.
Reduction in primary quarrying activities and utilization of finite natural resources. Reduction in new waste stockpiles.
Clearance and reduction of abandoned land. Economical disposal or recycling of materials..
The engineering properties of aggregates and asphalt have also been investigated by carrying out physical and mechanical tests. The performance characteristics of these were evaluated on the basis of requirements given in the NHA specifications (NHA 1998). The research described in this paper can provide a model for local government/civic authorities in solving the problem of illegal dumping of waste. It may also be an aid in initializing economic recycling activities and creating employment opportunities. The data for design will be available to highway engineers to design the wearing course with RA.
The study may also be helpful in dealing with large quantities of rubble produced as a consequence of a seismic activity. This rubble can be effectively used in building new roads. However, the durability aspects of wearing course made up of RA were not investigated in this study.
Similarly, economic considerations are also beyond the scope of the study.

1.2 Objectives

To determine the physical properties of natural aggregates and recycled concrete aggregates (RCA). To determine the optimum bitumen content for bituminous mix samples.
To evaluate the effects of using RCA in bituminous mixture in terms of stability and flow value by using Marshal Mix design method.
To compare the test results with the performance of the traditional control convention asphalt mixes in laboratory with addition of RCA.

2. INTRODUCTION OF MATERIALS

2.1 Materials

Aggregates are mainly used in building constructions and road pavements. Material used for mixing with cement, bituminous, lime, gypsum or other purposes. in pavements the amount of aggregates in asphalt pavement mixtures is generally 90-95 percent by weight and 75-85 percent by volume. Aggregates are primarily responsible for load supporting capacity of a pavement. These are divided into following categories:
Fines:Silt, clay or dust particles smaller than 0.75mm usually the undesirable impurities in aggregates.

Fig no. 1

Fine Aggregates: Aggregate particles mainly between the 4.75 mm size and the 0.75mm sieve.

Fig no. 2

Coarse Aggregates: Particles mainly divided more than 4.75 mm sieve size.

Fig no. 3

Bituminous:

1. Bitumen, also known as asphalt in the United States, is a substance produced through the distillation of crude oil that is known for its waterproofing and adhesive properties.
2. Bituminous materials are used for road construction, roofing, waterproofing, and other applications as required grade such as VG-10, VG-20 VG-30, VG-40.

Fig no. 4

2.2 Recycled Concrete Aggregates:

Recycled concrete aggregate (RCA) are aggregates obtained by recycling clean concrete waste from processing of demolition renovation of buildings highways, bridges etc. Where content of other concrete waste must be very low. RCA are produced in stationary recycling plants. It can be used in flexible pavements base layers. Processed recycled aggregate Bridges pavements Aggregate in lean concrete Aggregate in bituminous concrete Construction of curbs and gutters

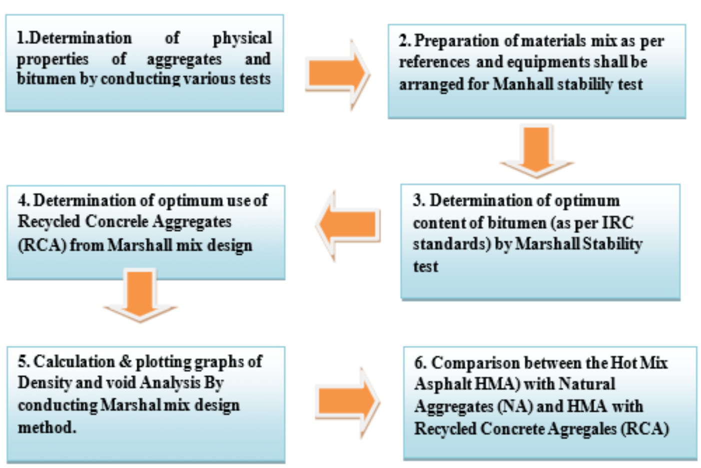
Fig no. 5

Advantages of R.C.A

One of the main reasons to use RCA in structural concrete is to make construction more? green? and environmentally friendly. Reduces the amount of aggregates to be created, hence less evacuation of natural resources. Cost saving. Create more employment opportunities in recycling industry. RCA are used to replace of natural aggregates to control environmental economic advantages**.**

3. METHODOLOGY

3.1 Actual Process



3.2 Properties

STRENGTH: The aggregates used in top layers are subjected tostress action due to traffc wheel load,wear and tear,crushing.

HARDNESS: The aggregates used in the surface course are subjected to constant rupture or abrasion due to moving traffic. *The abrasive action is severe when steel tired vehicles moves over the aggregates exposed at the top surface.

TOUGHNESS: Resistance of the aggregates to impact is termed as toughness.

*Aggregates used in the pavement should be able to resist the effect caused by the jumping of the steel tired wheels from one particle to another at different levels causes' severe impact on the aggregates.

SHAPE OF AGGREGATES: Particular shape range may have rounded cubical, angular, flaky or elongated particles.

*Flaky and elongated particles will have less strength and durability (compared to cubical, angular or rounded particles of the same aggregates.)

*Hence too flaky and too much elongated aggregates should be avoided as far as possible.

Freedom from deleterious particles: Aggregates should be clean, tough and durable. It should be free from at or elongated pieces, dust, clay balls and other objectionable material.

4. TEST AND RESULTS

4.1 Marshall Stability Test

The Marshall stability and flow test provides the performance prediction measure for the Marshall Mix design method. The stability portion of the test measures the maximum load supported by the test specimen at a loading rate of 50.8 mm minute Load is applied to the specimen till failure, and the maximum load is designed as stability. During the loading, an attached dial gauge measures the specimen's plastic flow (deformation) due to the loading. The flow value is recorded in 0.25 mm(0.01 inch) increments at the same time when the maximum load is recorded. The important steps involved in Marshal mix design are summarized next.

APPARATUS:

Marshall stability testmachine, hammer, cylindrical moulds, hanger with weight, compaction pedastal, Set of sieves (19, 13.2, 9.5, 4.5, 2.36, 1.18, 0.6 0.3, 0.15, 0.075)mm, water bath, VG 30 bituminous grade.

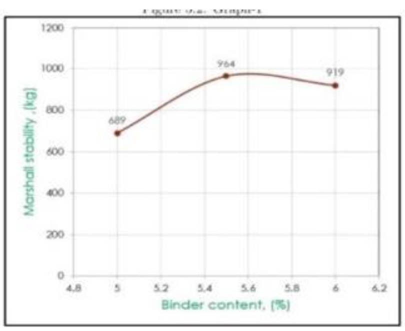
Observation of Natural Aggregates

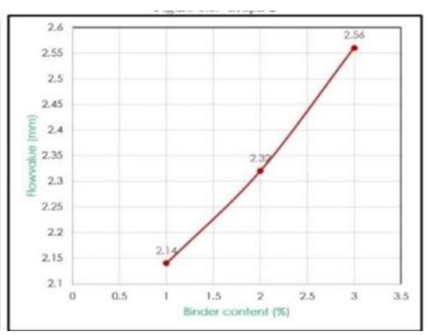
Sample No.	Bitumen Content (%)	Mean Height (cm)	Flow Dial Reading	Flow Value (0.01 mm)	Proving Ring Reading (0.026 mm)	Correction Factor	Corrected Stability (kN)
1	5.0	6.18	214	2.14	255	1.04	6.89
2	5.5	6.23	—	2.32	360	1.03	9.64
3	6.0	6.30	225	2.56	340	1.04	9.19

Density And Void Analysis

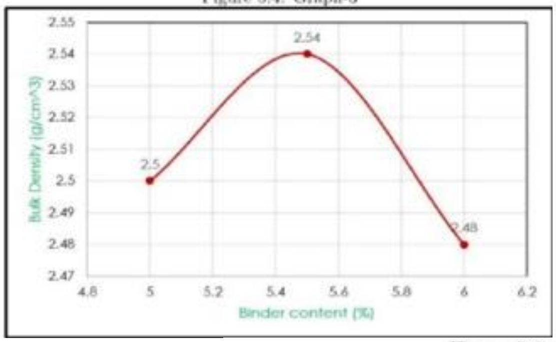
S. No.	Sample	Mix Temp (°C)	Comp	Height of Sample (cm)	Mean Height (cm)	Wt. of Sample (gm) In Air	Wt. of Sample (gm) In Water	Bulk Density (GB)	Theoretical Density	Vv in (%)	Vb in (%)	VMA (%)	VFB (%)
1	VG30	160	150	6.0, 6.3, 6.4	6.23	1225	760	2.50	2.57	2.72	12.37	15.09	81.97
2	VG30	160	150	6.1, 6.3, 6.15	6.18	1250	750	2.54	2.57	1.16	12.57	13.73	91.55
3	VG30	160	150	6.2, 6.3, 6.4	6.18	1270	770	2.40	2.57	0.38	12.67	13.05	97.08

Analysis by Graph





Void Analysis Equations



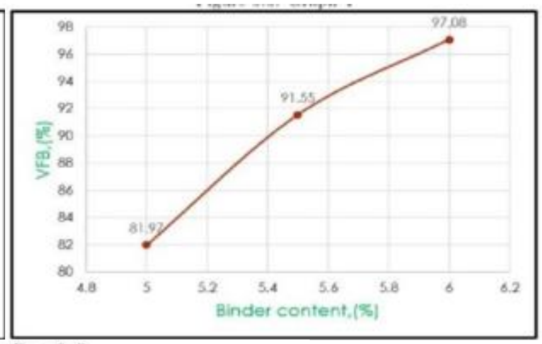
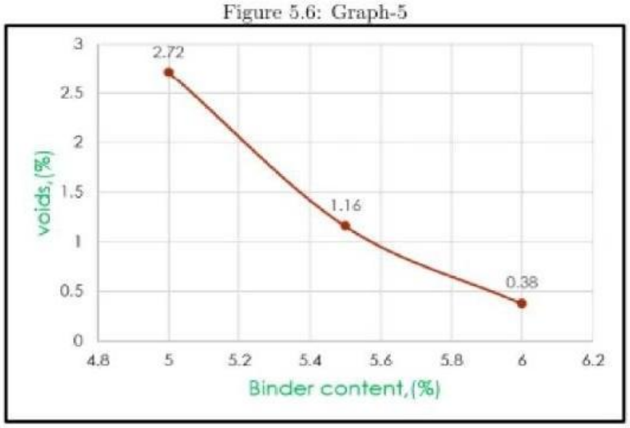


Figure 5.6: Graph-5



Observation for R.C.A

S. No.	Bitumen Content (%)	Percentage of R.C.A Content	Weight of Specimen (gm) In Air	Weight of Specimen (gm) In Water	Mean Height (cm)	Flow Dial Reading (0.01 mm)	Flow Value (mm)	Proving Ring Reading (0.026 mm)	Correction Factor	Corrected Stability
1	5.5%	10%	1300	795	6.5	370	3.70	365	1.00	9.49
2	5.5%	10%	1260	750	6.5	290	2.90	260	1.00	6.76
						Average	3.3		Average	8.12
3	5.5%	20%	1250	755	6.6	420	4.20	575	1.00	14.95
4	5.5%	20%	1260	775	6.4	355	3.55	545	1.04	14.73
						Average	3.87		Average	14.84
5	5.5%	30%	1255	765	6.3	215	2.15	550	1.09	15.58
6	5.5%	30%	1245	755	6.3	355	3.55	—	1.09	18.13
						Average	2.85		Average	16.85

4.2 Comparison of results

Comparison of Marshall parameters obtained at optimum bitumen content with RCA

S. No.	Parameters	N.A.	R.C.A. (30%)
1	OBC%	5.5%	5.5%
2	Stability (kg)	964	1685.5
3	Flow (mm)	2.84	2.85

5. CONCLUSION

- The following conclusions can be drawn from the results and discussion presented in this study.
- The impact, crushing, and Los Angeles values of selected virgin aggregates in this study were found to be within the limit (i.e., less than 30percent,)
- The penetration softening point, viscosity, and ductility values of collected VG30 binder were found to be within the limit as per IS codes, and hence found to be appropriate to use for construction of pavements.
- The optimum bitumen content was found from the above plotted graphs of Bulk density(Gb) VF B, Marshall stability flow values OBC as 5.5percent in R.C.A.

- The graph shows percentage of RCA increases the stability will be increased until 30 percent thereafter it will decreases.so, the more percentage of RCA increases automatically the strength will be decreases.
- The optimum R.C.A content for the satisfactory Marshall mix design was found 30 percent as per above Marshall test results.

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