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AN IN-DEPTH INVESTIGATION OF THE APPLICATION OF RECYCLED AGGREGATES IN PAVEMENT CONSTRUCTION

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Abstract: *The requirement of concrete aggregate in India is large. Corresponding to current annual production of cement of 300 million tonnes, total requirement of coarse and fine aggregate for use in cement concrete, mortar and plasters of about 1500 MT per year is a safe estimate. Only aggregate from natural sources are allowed in Specifications. Of late, there is difficulty in obtaining natural aggregates for constructions within economic distances. This will help in achieving economy in road construction as well as saving on environment degradation in term of reduced mining and less pollution. Construction and maintenance of roads and highways involve millions of tons of aggregate. Considering the scarcity of fresh aggregate, replacement of part of the fresh aggregate with recycled aggregate is considered in the rural roads. The tests are conducted for various proportion mix of Recycled aggregates and Natural aggregates.M30 grade of concrete is being used for the design. The waste concrete as RCA conserves virgin aggregates, reduces the impact on landfills, decreases energy consumption and can provide cost savings. Recycled aggregates are comprised of crushed, graded inorganic particles processed from the materials that have been used in the constructions and demolition debris. The Techniques of processing C&D wastes, effects of RCA on the properties of concrete and international status of standardization are described. Recent R&D work on use of RCA and fine fractions as replacement of coarse and fine aggregate in high strength concrete is described. This includes novel mixing techniques of virgin and recycled aggregate in concrete mixers.*

Index Terms - Demolished waste, Recycled Aggregate Concrete, Life cycle assessment, Mechanical properties, Carbon emission.

I. INTRODUCTION

In recent years, sustainable development and environmental concerns have prompted significant interest in exploring alternative materials for construction, particularly in the field of pavement construction. Traditional road construction materials, such as natural aggregates, have beenassociated with resource depletion and environmental degradation due to extensive quarrying activities. This has led to a growing emphasis on the utilization of recycled aggregates as a viableand eco-friendly alternative in pavement construction.

Recycled aggregates are derived from various sources, including demolished concrete, asphalt, and other construction wastes. The process of recycling these materials not only reduces the burden on landfills but also conserves natural resources and decreases energy consumption. The application of recycled aggregates in pavement construction offers the potential to address both environmental and economic challenges while maintaining the performance and durability of the constructed infrastructure.

This proposed in-depth investigation aims to comprehensively evaluate the application of recycled aggregates in pavement construction. By conducting a rigorous analysis of laboratory experiments, field trials, and real-world case studies, the study seeks to provide valuable insights into the feasibility, advantages, and challenges associated with the utilization of recycled aggregates. Laboratory experiments will be conducted to assess the physical and mechanical characteristics of recycled aggregates, including particle size distribution, density, water absorption, and strength properties. Comparative analyses will be performed between recycled aggregates and traditional natural aggregates to identify any variations and potential areas of concern.

Field trials will play a crucial role in the investigation, as they allow for the assessment of recycled aggregate pavements under real-world conditions. Monitoring and data collection will involve the measurement of pavement distresses, surface roughness, skid resistance, and overall structural performance. These observations will help validate the laboratory findings and provide.

II. LITERATURE REVIEW

Alqarni, A.S., Abbas et al (2022) investigated several parameters in this study. The firstparameter analyzed the effect of replacing varying percentages of coarse aggregate with recycledaggregate. The second parameter examined the influence of two aggregate sizes (10 and 20 mm).The third parameter was intended for investigating the influence of three different RCA treatment methods utilizing sodium silicate immersion, cement slurry, and the Los Angeles (LA) abrasion simulation. The test results generally indicated degradation in the engineering propertiesof concrete produced using untreated RCA compared to the control. The degree of reduction increased as the replacement percentage was increased regardless of the aggregate size. The reduction in compressive strength appeared to have a more pronounced effect in comparison to the splitting tensile strength. The use of treated RCA improved concrete slump by 15–35%.

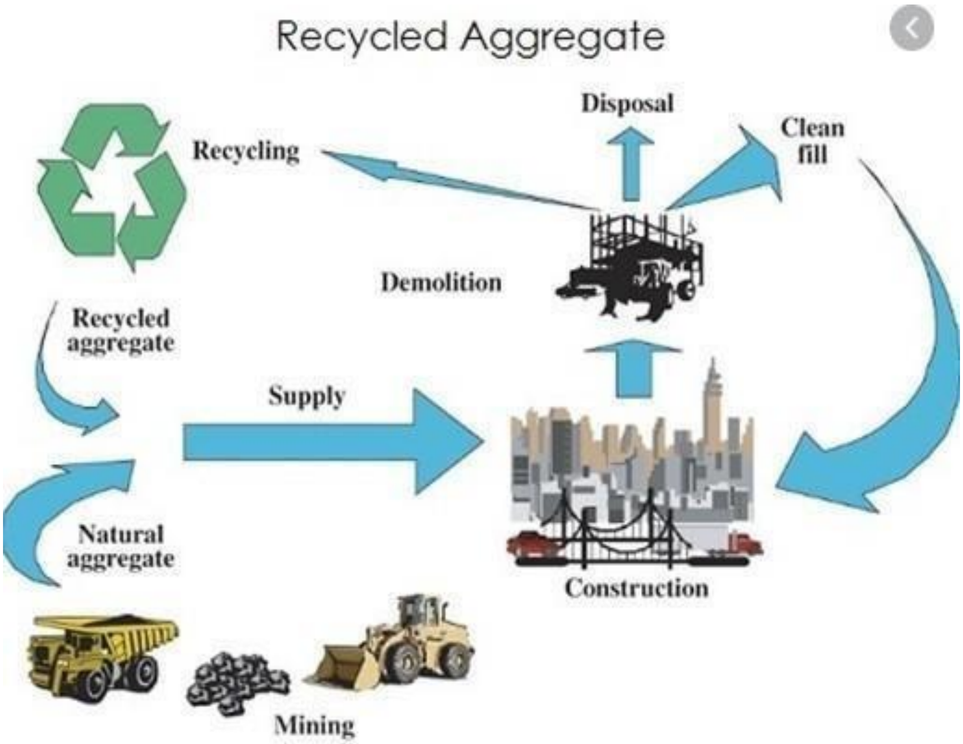
Xiao, J., Zhang, H et al (2022) analyzed a milestone paper by Limbachiya, Leelawat, and Dhir in the field of high-strength recycled aggregate concrete and its far-reaching impact on the research of recycled aggregate concrete. Furthermore, the existing hot-topics as well as research contributors in the field of recycled aggregate concrete were briefly summarized in this paper, and the new development directions of recycled aggregate concrete including fully recycled concrete were prospected and discussed

Rahul Saini and Ujjawal Shekhar (2021) studied the use of recycled concrete aggregate (RCA)into high strength 50 N/mm^2 or greater. The effects of coarse RCA content on the compression strength, bulk density and durability properties of such concretes have been established. The results showed that up to 30% coarse RCA had no effect on concrete strength but there after there was a gradual reduction as the RCA content increased. Concrete mixes with partial replacement of natural aggregate with (0,50,100) recycled aggregate. the effects of silica fume (SF) in the concrete mix design to improve the quality of recycled aggregates in concrete are presented. Cement was replaced with SF at 0%, 5% and 10%.

Ali, A.A.M., Zidan, R.S. and Ahmed (2020) studied to determine the effect of the more readily available well water in Mosul City when combined with recycled aggregate on compressive, splitting, and flexural strengths of high-strength concrete. The mixtures were prepared using fourdifferent percentages of RCA, replacing 0 %, 25 %, 50 %, and 100 % natural coarse aggregate (NCA). In total, eight mixtures were designed, four mixtures cured by potable water (PW), and the other four mixtures cured by well water. The results showed the compressive strength decreases by about 16.0 % when using well water for concrete made with NCA. Also using WW caused drop about 13.2 %, 10.0 % and 8.5 % for concrete containing 25%, 50 % and 100 % RCA, respectively. The flexural and splitting tensile strength also reduced when using well water.

III. METHODOLOGY

3.1 Collection of Materials



3.2 Tests on VCA and RCA

1. **Test on VCA**

Specific Gravity Test

Aggregate Crushing Value Test

Los Angeles Abrasion Test

Impact Value Test

2. **Test on RCA**

Specific Gravity Test

Aggregate Crushing Value Test

Los Angeles Abrasion Test

Impact Value Test

3.3 MIX design

a) STIPULATIONS FOR PROPORTIONING

a) Grade designation: M30

b) Type of cement: OPC 53 Grade conforming IS 12269

c) Maximum nominal size of aggregate: 20mm

d) Maximum water-cement ratio: 0.45 (Table 5 of IS 456:2000)

e) Workability: 100-120mm slump

f) Exposure condition: Moderate (For Reinforced Concrete)

g) Method of concrete placing: Pumping

j) Degree of supervision: Good

k) Type of aggregate: Crushed Angular Aggregates

m) Maximum cement content: 360 kg/m^3

b) TEST DATA FOR MATERIALS

a) Cement used: OPC 53 Grade conforming IS 12269

b) Specific gravity of cement: 3.15

c) Specific gravity of Aggregates:

1) Coarse aggregate 20mm : 2.67

2) Fine aggregate: 2.65

d) Water absorption:

1) Coarse aggregate: 0.5 %

2) Fine aggregate (Msand) : 2.5 %

e) Free (surface) moisture:

1) Coarse aggregate: Nil (Absorbed Moisture also Nil)

2) Fine aggregate: Nil

f) Sieve analysis:

1) Coarse aggregate: Conforming to all in aggregates of Table 2 of IS 383

2) Fine aggregate: Conforming to Grading Zone II of Table 4 of IS 383

c) TARGET STRENGTH FOR MIX PROPORTIONING

f'ck =fck + 1.65 s

Where,

f'ck = target average compressive strength at 28 days,

fck = characteristics compressive strength at 28 days, and

s = standard deviation.

From Table I of IS 10262:2009, Standard Deviation, s = 5 N/mm^2.

Therefore, target strength = 30 + 1.65 x 50 = 38.25 N/mm^2.

d) SELECTION OF WATER-CEMENT RATIO

Adopted maximum water-cement ratio = 0.44. From the Table 5 of IS 456 for Very severe Exposure maximum Water Cement Ratio is 0.45 0.44 < 0.45 Hence ok.

e) SELECTION OF WATER CONTENT

From Table 2 of IS 10262:2009, maximum water content for 20 mm aggregate = 186 litre (for 25 to 50 mm slump range) Estimated water content for 100 mm slump = 186+ (6/186) = 197 litre.

f) CALCULATION OF CEMENT CONTENT

Adopted w/c Ratio = 0.44

Cement Content = 158/0.44 = 359 kg/m^3

g) PROPORTIO0N OF VOLUME OF COARSE AGGREGATE AND FINEAGGREGATE CONTENT

From Table 3 of (IS 10262:2009) Volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone II) for water-cement ratio of 0.44

Mix Proportion By weight = 1:2.21:3.09

w/c	Cement content	Fine aggregate content	Coarse aggregate content
158	360 kg/m^3	796 kg/m^3	1112 kg/m^3
0.44	1	2.21	3.09

IV. RESULTS AND ANALYSIS

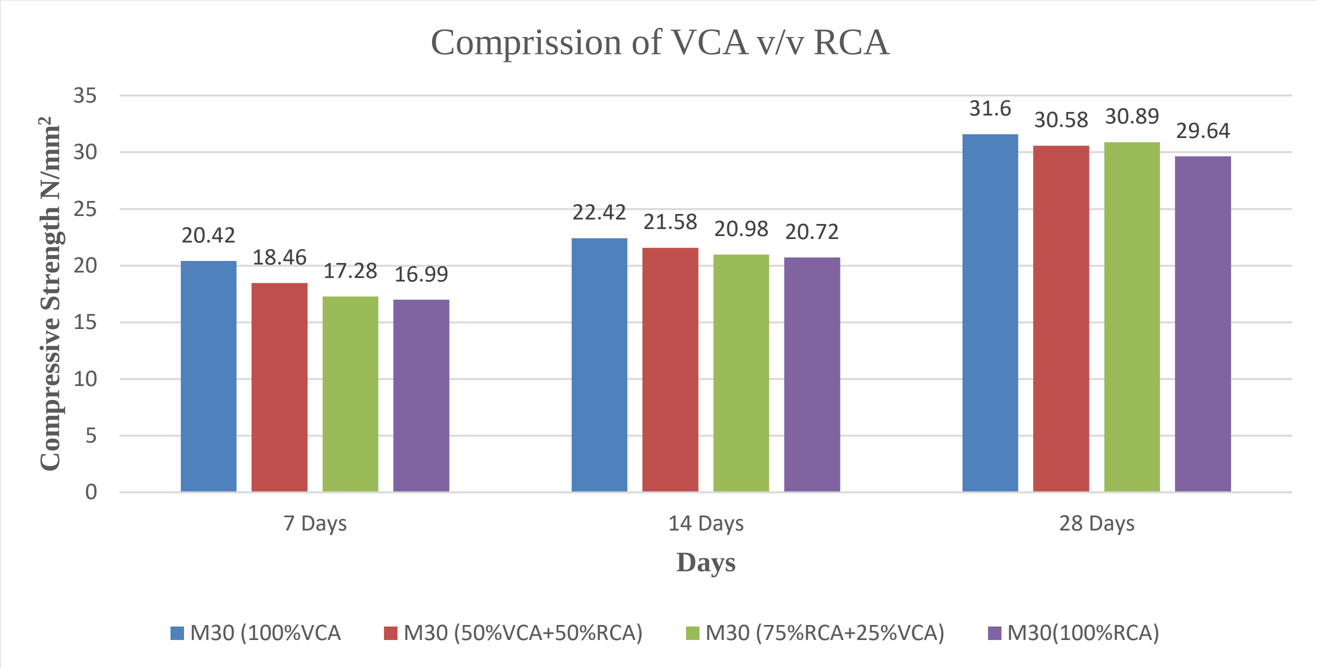
4.1 Results of VCA and RCA

TEST	VCA	RCA
Specific Gravity Test	2.6	2.68
Aggregate Crushing Value Test	15%	22%
Los Angeles Abrasion Test	15%	18%
Impact Value Test	15%	16%

4.2 Cube Casting

Grade of Concrete	7 Days Compressive Strength (N/mm^2)	14 Days Compressive Strength (N/mm^2)	28 Days Compressive Strength (N/mm^2)
M30 (100% VCA)	20.42	22.42	31.6
M30 (50% RCA+50%VCA)	18.46	21.58	30.58
M30 (75%RCA+25%VCA)	17.28	20.98	30.89
M30 (100% RCA)	16.99	20.72	29.64

4.3 Compression Strength comparison of VCA and RCA



V. CONCLUSION

In conclusion, the utilization of recycled aggregates in pavement construction presents a promising avenue for enhancing sustainability and cost-efficiency in infrastructure development. By diverting waste from landfills and reducing the reliance on virgin materials, the incorporation of recycled aggregates not only promotes environmental conservation but also aligns with the principles of a circular economy. While initial processing costs may be a concern, the long-term benefits in terms of resource conservation and reduced environmental impact outweigh these challenges. Moreover, ongoing research and technological advancements are continually improving the quality and performance of recycled aggregates, further bolstering their viability as a reliable alternative in pavement construction. Therefore, embracing the widespread adoption of recycled aggregates represents a crucial step towards achieving more sustainable and resilient infrastructure systems in the future.

VI. REFERENCES

1. Limbachiya, M.C., Leelawat, T. and Dhir, R.K., 2021. Use of recycled concrete aggregate in high-strength concrete. *Materials and structures*, *33*, pp.574-580.
2. Emad, M., Soliman, N.M. and Bashandy, A.A., 2019. Recycled aggregate high-strength concrete. *International Journal of Civil Engineering and Technology" IJCIET"(ISSN0976-6316)*, *10*(9), pp.128-146.
3. Ali, A.A.M., Zidan, R.S. and Ahmed, T.W., 2020. Evaluation of high-strength concrete made with recycled aggregate under effect of well water. *Case studies in construction materials*, *12*, p.e00338.
4. Tayeh, B.A., Al Saffar, D.M. and Alyousef, R., 2020. The utilization of recycled aggregate in high performance concrete: a review. *Journal of Materials Research and Technology*, *9*(4), pp.8469-8481.
5. Alqarni, A.S., Abbas, H., Al-Shwikh, K.M. and Al-Salloum, Y.A., 2022. Influence of treatment methods of recycled concrete aggregate on behavior of high strength concrete. *Buildings*, *12*(4), p.494.
6. Xiao, J., Zhang, H. and de Brito, J., 2022. M&S highlight: Limbachiya, et al.(2000), Useof recycled

aggregate in high-strength concrete. *Materials and Structures*, *55*(2), p.40.

7. Makul, N., 2020. Cost-benefit analysis of the production of ready-mixed high-performance concrete made with recycled concrete aggregate: A case study in Thailand. *Heliyon*, *6*(6).

8. Abed, M., Nemes, R. and Tayeh, B.A., 2020. Properties of self-compacting high-strengthconcrete containing multiple use of recycled aggregate. *Journal of King SaudUniversity-Engineering Sciences*, *32*(2), pp.108-114.

9. Amin, M., Zeyad, A.M., Tayeh, B.A. and Agwa, I.S., 2021. Effects of nano cotton stalk and palm leaf ashes on ultrahigh-performance concrete properties incorporating recycled concrete aggregates. *Construction and Building Materials*, *302*, p.124196.

10. Toghroli, A., Mehrabi, P., Shariati, M., Trung, N.T., Jahandari, S. and Rasekh, H., 2020.Evaluating the use of recycled concrete aggregate and pozzolanic additives in fiber-reinforced pervious concrete with industrial and recycled fibers. *Construction and Building Materials*, *252*, p.118997.

11. properties of recycled aggregate concrete" Construction and BuildingMaterials,V.23, No.2, pp. 829-836.

12. Pirahmadian, Azadeh Ebrahimi (2012) Theoretical Investigation Heat Transfer Mechanisms in Nano fluids and the Effects of Clustering on Thermal ConductivityInternational Journal of Bioscience, Biochemistry and Bioinformatics, Vol. 2, No. 2,