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Recycled Course Aggregate Concrete Application for Sustainable Construction

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Abstract: ***Concrete is the second-highest material use for construction after water, the construction industry moving toward sustainability with the help of recycling various materials to reduce solid waste accumulation in society and saving natural aggregate sources for the future. Recycling of aggregate leads the sustainable construction due to its large ratio in concrete, new process, and researches improving it in ascending chronologically so it becomes paramount. This Experimental investigation reconnoiter application of recycled coarse aggregate in sustainable construction. In this study quantitative approach analysis is used with the help of interview of penal of experts, those who Engineers, Architect/ designer, Builders, and research engage person with their experience.***

I. INTRODUCTION

A. Terminology

TABLE 1

RA	Recycle Aggregate
RCA	Recycle Coarse Aggregate
NA	Natural Aggregate
C&D	Construction and Demolition waste

Sustainable infrastructure development is present development of infrastructure without compromising the future but the development of infrastructure is growing in Ascending chronological order because it is a symbol of the development of any country.[02] Concrete plays a vital role in this development, concrete is the second largest material after water on the earth. Concrete is made by Three basic materials cement(binder), Aggregate(filler material), and water, the aggregate is used in two basic types one is fine aggregate and the other is coarse aggregate. The coarse aggregate is a major part of concrete which found naturally in the form of rocks but every source has a limit and there are also natural sources are depleted day by day which influences the future sustainability[09]. Construction and demolition waste(Major solid waste) are also heaping, so recycling is a great alternative for future construction. Concrete made with up to 40% replacement of natural aggregate to recycle aggregate gives up to 5% reduction in flexural strength and up to 20% reduction in compressive strength, that is compromise able figure. [10] The unawareness of recycled aggregate is also cause of major ignorance of RCA and RA in construction industry. There are very few standards for recycled aggregate(coarse aggregate and fine aggregate), unavailability of standards makes uncertainty regards to the quality parameter of the aggregate. [08]In India there natural sources are depleted day by day but technology of recycling in construction field is very slow with compared to the developed countries. [03] [09]

II. LITERATURE

Three elemental of the investigation-

A. Global C&D Solid Waste Production

EIA Annual energy outlook(2005) & United Nation World Urbanization Prospects(2007) Indicate the solid waste accumulation problem according to income class and urbanization of population, and its hazardous impact over the period of time due to significant increment in urban population and solid waste accumulation.

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TABLE 2
(Solid waste accumulation in 2005 and 2025(source EIA Annual energy outlook(2005) & United Nation World Urbanization Prospects(2007))

Class	Current available data			Data projection of 2025			
	Urban population (million)	Urban waste		Population Projected (million)		Projected urban waste	
		Kg/cap/Day	Tons/Day	total	urban	Kg/cap/Day	Tons/Day
Lower class	343	0.6	204802	1637	676	0.86	584272
Lower middle class	1293	0.78	1012321	4010	2080	1.3	2618804
Upper middle class	572	1.16	665586	888	619	1.6	987039
Upper class	774	2.13	1649547	1112	912	2.1	1879590
Total	2982	1.19	3532256	7647	4287	1.4	6069705

B. Current Stage of Recycle coarse Aggregate

construction and demolition waste bulking is increasing but there are few initiatives are there to utilizes the construction and demolition waste as recycled aggregate from Sustainable development union website of UN(2020) and Source-website of Europian Demolition Association and Website of EPA, USA(2020) industries setup in following countries for RCA

Table 3
(Major countries using recycled aggregate and number of recycled aggregate industries(]Sustainable development union website of UN(2020) and Source-website of European Demolition Association and Website of EPA, USA(2020))

S.NO.	Countries	Number of plants
1	Belgium	60
2	France	50
3	U.k.	120
4	Netherland	70
5	Germany	220
6	Denmark	20
7	Italy	43

Singapore using 100% of its recycling C&D waste in new construction and repair works.

Sunil Kumar(2017) focus on recycling challenges of solid waste in india on the bases of categorization of cities producing solid waste and population and present the chronological waste production in india and land requirement of accumulation of solid waste[03].

India is also developing some recycle aggregate plants Guideline of environmental Management of Construction & demolition waste march 2017 shows working plants as

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Table 4
(Indian recycled aggregate industries 2017 (source Guideline of environmental Management of Construction & demolition waste march 2017)

Name / Place	Establishment /Formation	Production
Burari (New Delhi)	2009 first registered plant	500ton/day -2009 1200ton/day-2014 2000 ton/ day – permission
Sastri Park (New Delhi)	LT & FS	500 ton/day
Ahmadabad	2014 Ahmadabad environs project ltd.(AEPL)	100 ton/day
Vikroli Mumbai	CIDCO- YUVA Building center	1500ton production in 2002-06
East Kiwai Nagar (New Delhi)	2014 NBCC	

where waste production is very large scale due to new projects and old repairs.

C. Research and Developing Technology

Adhesive impurity makes a difference in strength and durability between natural coarse aggregate (conventional aggregate) and recycled coarse aggregate. In the present time, these impurities like mortar, Bitumen, Organic matter, Chloride, and sulfates, Soil, and filler materials can be removed by different processes that reduce the risk of failure and increase durability and strength. Purushothaman (2019) treat RCA with 10% HCl solution for 24hours for reducing the layer of impurities(mortar) from recycled coarse aggregate up to 70% by this research shows significant results in water absorption, specific gravity, Bulk density, Abrasion resistance, impact value and crushing value. [07]

G.murali(2012) Uses water wash, Nitric acid, sulphuric acid, and hydrochloric acid to treat the RCA and gives the comparison between them based on compressive strength, flexural strength and split tensile strength test this research shows most significant results of nitric acid compressive, split tensile, flexural strength increased by 11.8%,5.6%, and 8.77% respectively concerning untreated so there are possibilities to make RCA is an alternative of natural aggregate. [05]

Prof. A.Tiwari and P. Dwivedi(2014) Replace the recycle coarse aggregate from natural coarse aggregate by 0%, 30%, 40% and 50% gives significant results in 28 day compressive strength as 33MPa, 28Mpa, 26MPa and 27MPa respectively. [10]

III. METHODOLOGY

For consideration of improvement in RCA uses and practice, Generally, there are Qualitative, Quantitative, and mix approaches.

The qualitative approach does not consist of numerical analysis in the other words qualitative approach of research is the non-numerical method of research which based on people's perspectives and opinion to investigate the aspect of their social word. In this research qualitative approach is adopted and collects the opinion of particular groups of Engineers, Architects/Designers, Builders, Professors, and other professionals related to recycling of building material concerning resistance, benefit, possibilities, and hazards. And analysis of the opinions for the maximum possibility to use of RAC in the development. Opinions are collected based on Questionnaires prepared which consist of following points-1. Cost(Initial cost and overall life cycle cost) 2.Green ratting 3.Structural use and possibilities 4. Risk of failure and 5. Personal opinion. The analysis of Opinions based on their experience and practical resistance where high.

A. Introduction of Survey

The survey conducted with the help of interview analysis approach the interview conducted by pre prepared questionnaire and personal opinion with respect to RCA, interviews based on questionnaire prepared are digital (by Google forms) . Base ideology of the interview and questionnaire adopt from Chung,Shan-Shan; and Lo, Carlos W.H[01] and Senaratne,Sepani[08]

Engineer	40
Architect/designer	20
Builder	14
Research person	42

Table 4 Interviewed personality(Experts) and size of their groups

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B. Questionnaire Details

The questionnaire consist of 10 questions, in these question further categories as

Question 1-3	General introduction and experience of recycled aggregate.
Question 4-9	Multiple choice question regards cost, green ratting, structural and non structural possibilities, improvement possibility, standards of recycled aggregate , future opportunity, dependence, sustainability correlation, merits, and demerits.
Question 10	Personal opinion(descriptive)

Table 5 Questionnaire details

IV. RESEARCH FINDINGS

Interview finding of Builder, designer, engineer and researcher group based on the benefit of use, the difficulty of use, and alternative reuse of reducing construct and demolition waste-

Builder's view is mostly cost & unavailable standards oriented they are not using it due to its high initial cost of RCA concerning natural aggregate. There are no proper standards for recycling coarse aggregate where proper quality and standards are there for natural aggregate. Designers or Architects view on the positive side of this they are in the favor of the use of RCA due to its higher green ratting and possibility of explore and enhance the properties, this material is first ever substituted of natural aggregate or conventional aggregate, they also need proper standards and life cycle cost of RCA. Engineers favor it on those sites environment exposed conditions as marine construction occur but they also cannot ignore its structural risk of failure.

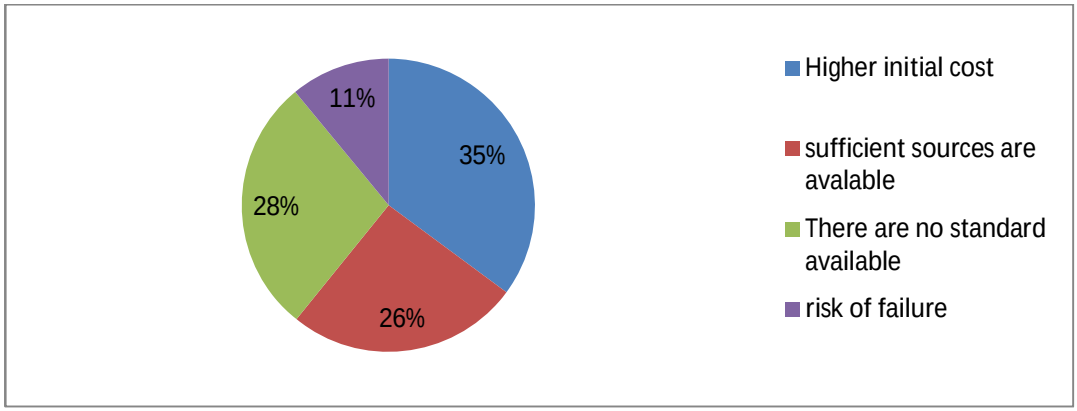

Figure 1(Present scenario of utilization of recycle waste problems in india from 23 interview)

There are some utilization of C&D waste by Builders as following-

C&D waste is used on another site in foundation construction if transportation cost is very high then prefer land filling. C&D waste is used in road sub grade material on another site, this is used by mainly building and road project contract builders. Land filling is the last opinion of builders it increases extra expenses of the project.

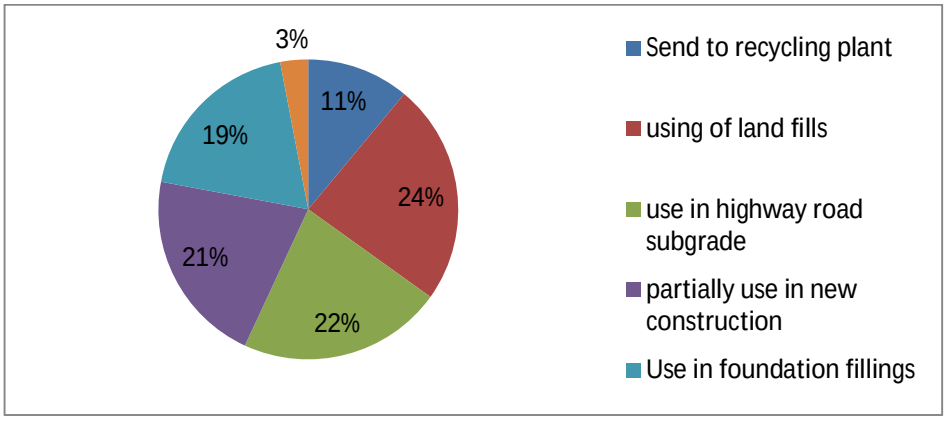

Figure 2 (Interview Vote regard Present use of construction of demolition waste)

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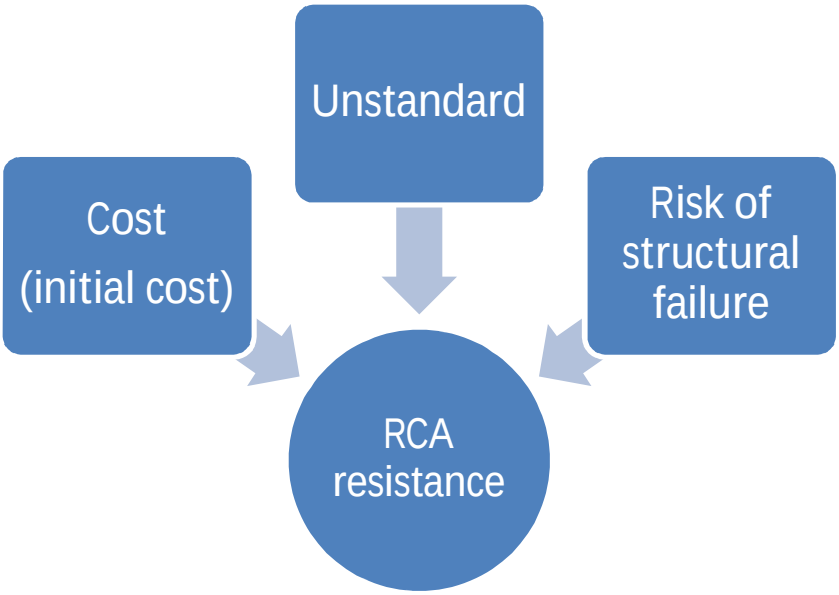

Figure 3 Major RCA resistance from experts views and its analysis

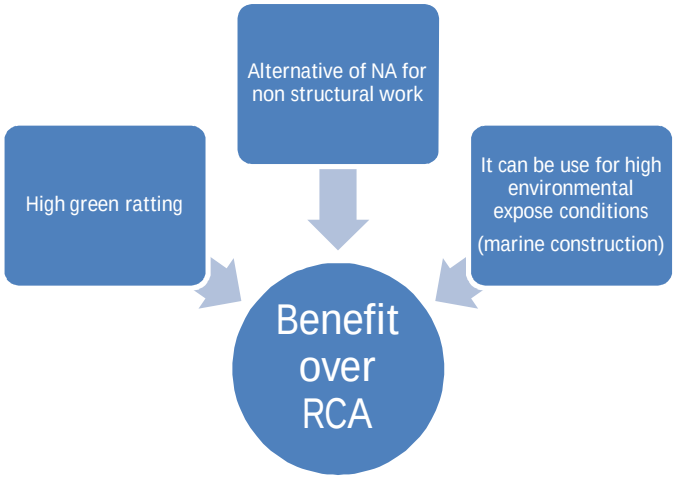

Figure 4 Major benefits introducing RCA in construction industry from experts views and its analysis

V. ANALYSISE

The major hurdles found in this study are less awareness, limitation of standards, Risk of failure and initial cost

26 percentage people in the favor of sufficient sources are available which indicate awareness of recycled construction material is very few in india, 28 percentage of people consider limitation of standards as main hurdle of recycled coarse aggregate, 11 percentage only consider risk of structural failure of recycled coarse aggregate and 35 percentage consider initial cost as main hurdle of the recycled coarse aggregate.

VI. CONCLUSION AND RECOMMENDATION

In the present time, there is much pressure on the construction industry for sustainable construction, recycling of construction material and other recycled material use in construction is the only hope for a sustainable future for the construction industry. The concrete is the second-largest material after water on the earth, the production of sustainable concrete is possible only with recycle aggregate coarse as well as fine, the coarse aggregate having a high ratio in concrete so the alternative of coarse aggregate can make it sustainable up to 80%. The recycled coarse aggregate is the only alternative for natural aggregate to work on both sides of sustainability to save the natural source as well as reduce solid waste produced by construction and demolition waste.

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1) There some resistance over the practice of recycle aggregate as

a) *Cost:* It is primary resistance over the practice of RCA in the place of natural aggregate, there is uncertainty over the cost of RCA but it can be optimized by life cycle cost analysis. Life cycle cost analysis can be used in cost optimization.

b) *Unavailability of Standards:* Very huge deviation in RCA quality parameters so there is no proper standards for recycled coarse aggregate with make it risky for structural units, so proper standards are required for risk analysis and risk optimization.

2) Recycle coarse aggregate can be used in the Government project with proper guidelines for its positive fame.

3) Recycle coarse aggregate can be used in non-structural units and repairs to negotiate its risk of structural failure.

4) Recycle coarse aggregate can be used in marine construction.

Overall there cost and risk of failure are a major concern but it can be optimized by life cycle cost analysis and proper standards.

VII. ACKNOWLEDGMENT

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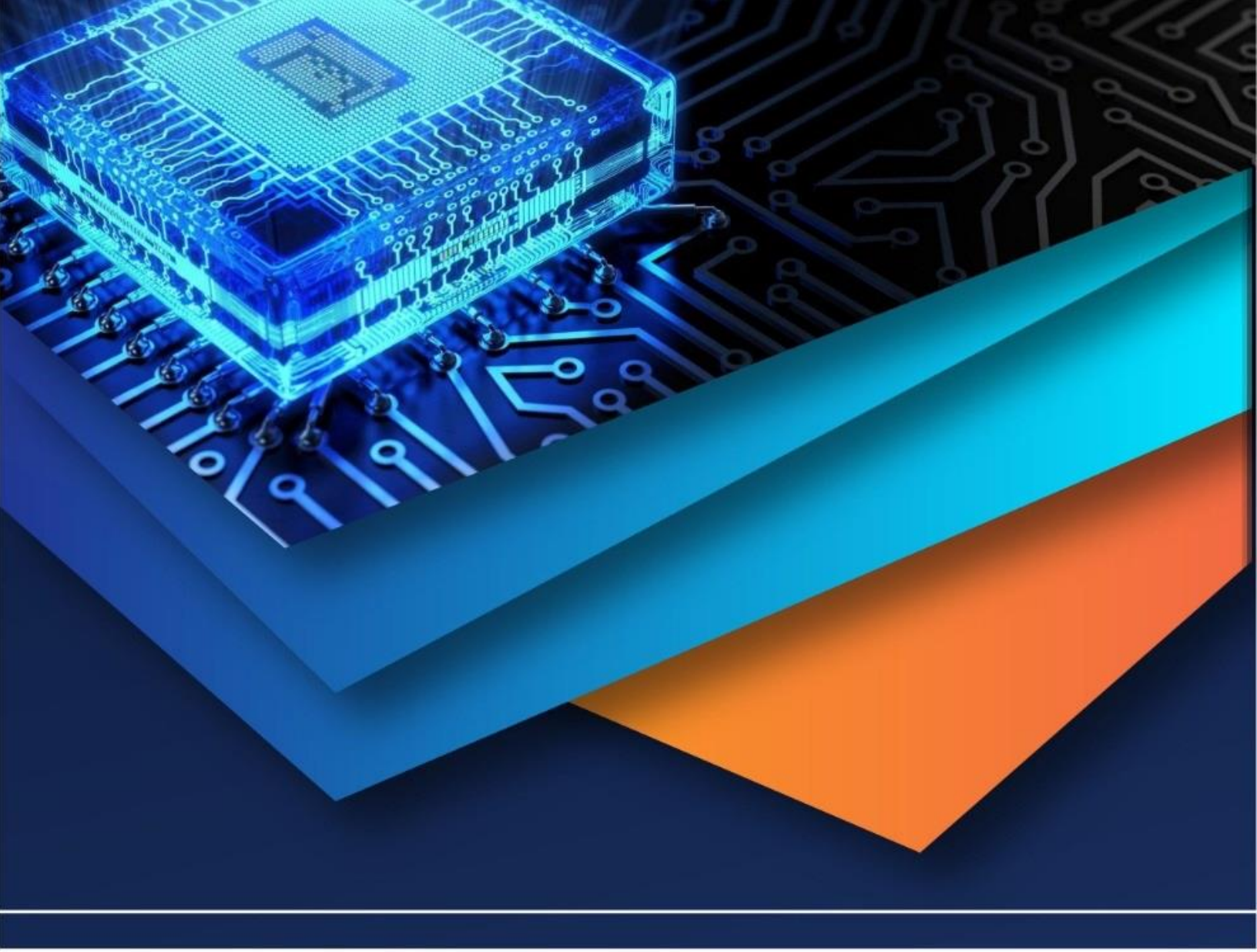

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