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Performance of Recycled Aggregate Concrete for M40 Grade

V.Surya Kiran[1], V.Bala Krishna[2], P.Sowjanya[3]

[1]PG Student, Department of Civil Engineering, SVKR college of Engineering, Andhra Pradesh, India
[2]Assistant Professor, Department of Civil Engineering, SVKR college of Engineering, Andhra Pradesh, India
[3]Assistant Professor, Department of Civil Engineering, SVKR college of Engineering, Andhra Pradesh, India

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Abstract - *Recycled aggregate are comprised of crushed, graded inorganic particles processed from the materials that have been used in the construction and demolition debris. One of the major challenges of our present society is the protection of environment. The use of aggregates from construction and demolition debris (wastes) is showing prospective application in construction as alternative to primary (natural) aggregates. It conserves natural resources and reduces the space required for the landfill disposal. Although there is a critical shortage of natural aggregate, the availability of demolished concrete for use as RECYCLED CONCRETE AGGREGATE (RCA) is increasing. Using the waste concrete as RCA can provide cost savings. Recycled aggregates are the materials for the future. This work is to determine and compare the workability, compression strength, indirect tensile strength, flexural strength and modulus of elasticity properties of recycled aggregate concrete with that of natural aggregate concrete. To attain the planned objectives of the present investigation, M25 grade concrete is taken and the replacement values viz, 0%, 25%, 50%, 75%, 100% were considered. A total of 60 cubes, 40 cylinders, 10 beams were casted to determine the properties mentioned as above The development of compressive and tensile strengths of recycled aggregate concrete at the age of 7and 28 days; the development of flexural strength and static modulus of elasticity at the age of 28 days are investigated. The parameters which were investigated for recycled aggregate concrete and compared with natural aggregate concrete as per BIS specifications found to be decreasing gradually as the percentage of recycled aggregate are increased.*

Key Words: Recycled aggregate, workability, compression strength, indirect tensile strength, flexural strength, modulus of elasticity.

1.INTRODUCTION

Concrete is a composite construction material composed primarily of aggregate, cement and water. It has been proved to be a leading construction material for more than a century. It is estimated that the global production of concrete is at an annual rate of $1m^3$ (approximately 2.5 tones) per capita (**Neville 2003**). The global consumption of natural aggregate (NA) will be in the range of 8-12 billion tones after 2020. Over 1 billion tones of construction and demolition wastes(C&DW) is generated every year worldwide (Anon 2004). The large scale depletion of NA and the increased amounts of C&DW going to landfill sites are causing significant damage to the environment and developing serious problems denting the public and the environmentalist's aspirations for a waste-free society.


Recycled Aggregate

Almost all materials which are used in the construction industry were entirely natural and all waste from demolished buildings was disposed of in landfills and partially in unauthorized places. The utilization of the recycled aggregates created from processing C&DW in new construction has become more important over the last two decades.

The quality of the recycled aggregates has been improved significantly during the last decade as a result of good deconstruction practice and advances in stationary or transportable crushing machinery, as well as the recycling process itself *i.e* .screening and separation.

As a result, improved quality aggregates are available now-a-days, at prices competitive to NA. However, despite the enhanced quality of the recycled aggregates, the uptake of this alternative is still in fact too low(Dhir 2001; Wrap 2007).this limited use is largely due to the past experience formed when low strength cements and low quality recycled aggregates were used as well as the restrictions imposed by standards.

Therefore, this study will focus on the utilization of RA created mainly from crushing old concrete masses, the type of RA that contains little or no impurities and produced in recycling plant.

1.1 Applications of Recycled Aggregate

There are a lot of potential applications of recycled aggregates

(a) Concrete production - The Standing Committee of Concrete Technology (SCCT) recommends that recycled aggregates can be used for concrete production up to Grade 35 until further tests have demonstrated that concrete with higher strength can be consistently produced with satisfactory performance in long-term durability.
(b) Granular materials for fill, filters, drainage layer, etc.
(c) Road sub-base materials.
(d) Concrete paving blocks or similar block works.
(e) Rock fills replacement for sea wall, infill to gabion walls, etc.

Most probably recycled aggregate is used as landfill. Depending upon the needs and priorities of a country usage of recycled aggregate changes.

1.2 Advantages

There are many advantages through using the recycled aggregate. The advantages that occur through usage of recycled aggregate are listed below:

1. Environmental gain
2. Save energy
3. Cost
4. Job opportunities
5. Sustainability
6. Market is wide

1.3 Disadvantages

Although there are many advantages by using recycled aggregate. But there are still some disadvantages in recycled aggregate.

1. Hard to have permit
2. Lack of specification and guidelines
3. Water pollution

2.1. Materials

2.1.1. Cement: cement is a binding material invented by Joseph Aspdin in 1824. It is manufacturedfrom calcareous materials, such as limestone or chalk, and argillaceous material such as shale and clay.

2.1.2. Coarse Aggregate: If the size of aggregate is bigger than 4.75 mm, then the aggregate isconsidered as coarse aggregate.

Eg: Stone, ballast, gravel, brick ballast.

2.1.3. Fine Aggregate: According to IS 383, most of the aggregate which will pass through 4.75mm IS sieve and entirely retained on 75 μ sieve is considered as fine aggregate. Eg: Sand crushed stone, ash or cinder and surkhi.

2.1.4. Water: water is the main ingredient used to mix all the contents. Potable water is used asusage of any other water may contain salts and cause decrease in strength of concrete.

3. Test report on Cement:

Tests on cement	Values
Standard consistency	32%
Initial setting time	34 min
Final setting time	8 hours
Finess modulus	7%
Compression strength	53.5Mpa
Soundness	2mm
Specific gravity	3.13

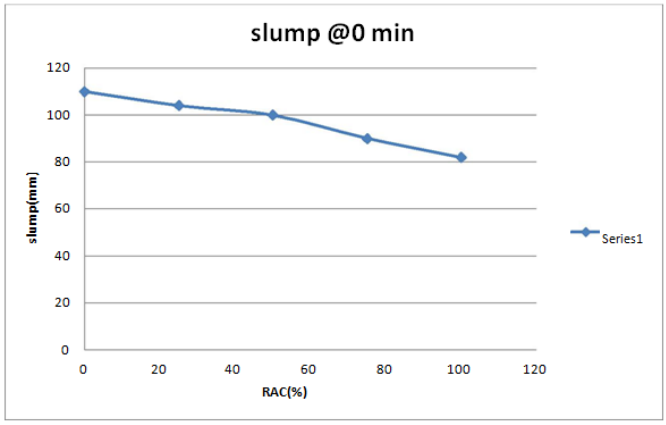
4. RESULTS AND DISCUISSIONS

4.1 Slump test

The slump test indicates a decreasing trend of workability when the percentage of Recycled aggregate increased. Table shows the average slump recorded during the test. According to the result, the highest slump obtained was 110mm and the lowest slump was 82mm. the average slum for each batch of mix was 96mm.

	RAC 0%	RAC 25%	RAC 50%	RAC 75%	RAC100%
Slump @ 0Min	110mm	104mm	100mm	90mm	82mm
Slump @ 30Min	98mm	98mm	94mm	88mm	75mm

Graph

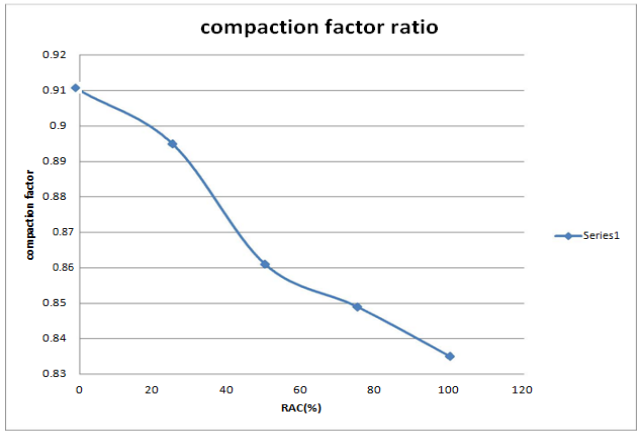


4.2 Compacting Factor

The compacting factor indicates a moderate decreasing trend of workability when the Percentage of recycled aggregate increased.

RAC	0%	25%	50%	75%	100%
Compaction factor	0.91	0.895	0.861	0.849	0.835

Graph

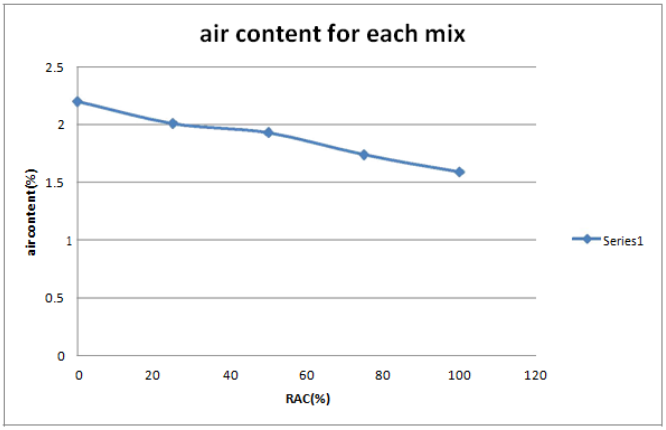


4.3 Air content

The air content indicates a moderate decreasing trend of void ratio when the percentage of recycled aggregate increased.

RAC	0%	25%	50%	75%	100%
Air Content (%)	2.2	2.31	2.63	2.74	3.09

Graph

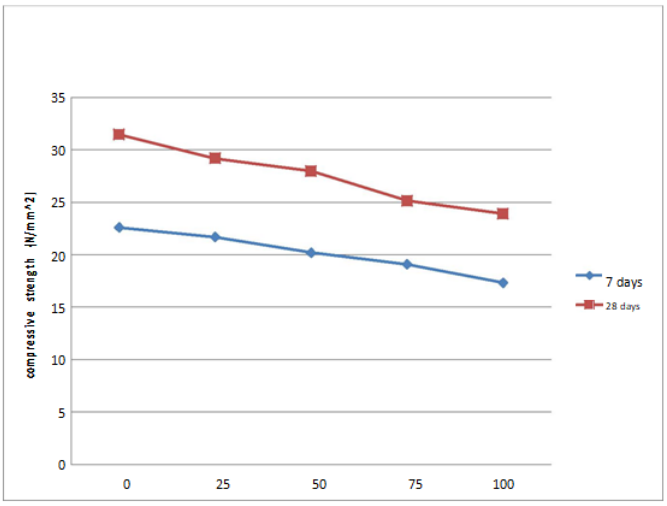


4.4 Compression test

The compression test indicates that an increasing trend of compressive strength in the early age of the concrete specimens.

RAC	Density(kg/m 3)	Compressive strength(N/mm2)	
		7 Days	28 Days
0%	2374	22.6	31.46
25%	2352	21.7	29.2
50%	2345	20.2	27.98
75%	2338	19.09	25.15
100%	2315	17.34	23.9

Graph

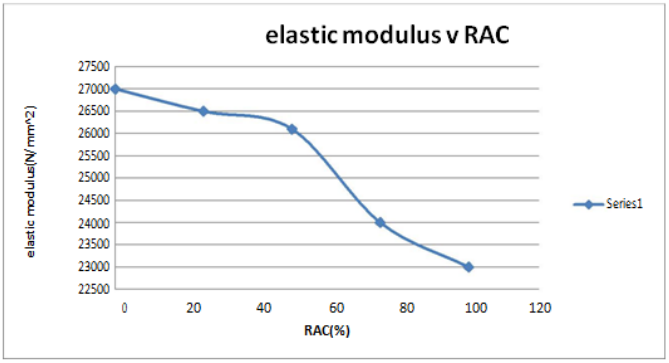


4.5 Elastic modulus

The modulus of elasticity test indicates a decreasing trend of modulus of elasticity value with the percentage of recycled aggregate.

RAC	Compressive strength at28days	Elastic modulus (5000 x√ fck)
0%	31.46	0.27 x 10^5
25%	29.2	0.265 x 10^5
50%	27.98	0.261 x 10^5
75%	25.15	0.24 x 10^5
100%	23.9	0.23 x 10^5

Graph

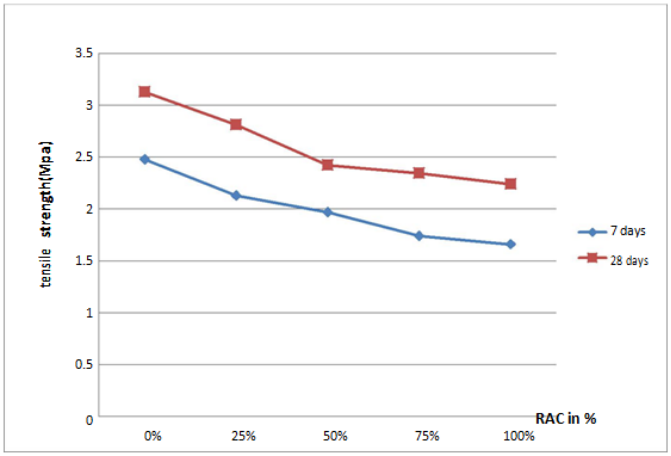


4.6 Split tensile test

The split tensile strength test indicates a decreasing trend of tensile strength value with the percentage of recycled aggregate.

RAC	Density (28days)Kg/m^3	Tensile strength (2P/πDL)	
		7 Days	28Days
0%	2254	2.48	3.13
25%	2240	2.13	2.815
50%	2223	1.969	2.425
75%	2210	1.74	2.345
100%	2200	1.66	2.24

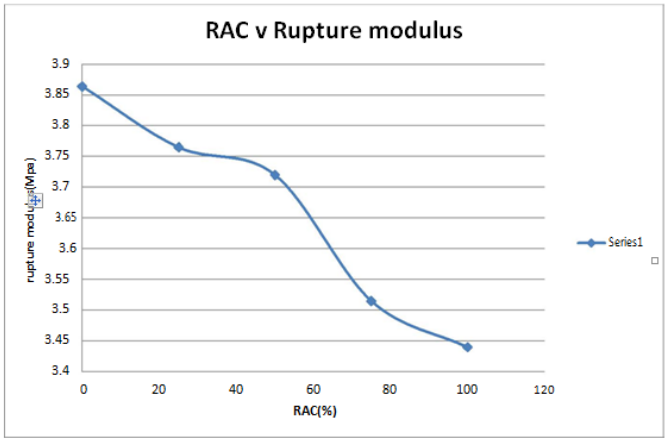
Graph



4.7 Rupture modulus

RAC	Density (28Days)Kg/m^3	Compressive Strength (Mpa)	Rupture modulus (Mpa)
0%	2254	30.5	3.864
25%	2240	29	3.765
50%	2223	28.3	3.72
75%	2210	25.3	3.515
100%	2200	24.2	3.44

Graph



5. CONCLUSIONS

Research on the usage of waste construction materials is very important due to the materials waste is gradually increasing with the increased of population and increasing of urban development. The reasons that many investigations and analysis had been made on recycled aggregate are because recycled aggregate is easy to obtain and the cost is cheaper than virgin aggregate.

Virgin aggregate need to mine but recycled aggregate can ignore this process. This on-going research project is to determine the strength characteristics of recycled aggregate for potential application in the high concrete structural concrete. This type of concrete can only be used under the condition that does not involve a lot of handling works.

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