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Study on Strength Characteristics by using Fully Recycled Coarse Aggregate Concrete at Various Atmospheric Conditions

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ABSTRACT

A large amount of construction waste has been dramatically increased in the last decade and environmental concerns on the recycling of waste has been increased. Mostly nowadays developing countries are demolishing some million tons of concrete wastages from the old buildings. So they are using Recycled aggregates for future construction. In this paper recycled coarse aggregate used 100%. In our research work, we have collected the demolition waste from our village cement concrete road was demolished for the purpose of renovation. The demolished road is of M20 grade concrete and age of concrete is 8years.

Nowadays construction of any concrete structure requires huge amount of natural coarse aggregate. So they are using demolition waste, to reduce the cost of purchasing natural coarse aggregate.

Recycled coarse aggregate are separated from the demolished waste by using equipment's. To improve the quality of recycled coarse aggregate by using treatment method's. The recycled coarse aggregates are weak in drying of shrinkage and creep. To control the drying of shrinkage and creep by using fly ash etc .The strength characteristics of natural coarse aggregate and recycled coarse aggregates. Recycled coarse aggregate are successful utilization in many countries such as European, American and Russia. This paper present's the investigation of strength characterstics due to effect of various temperature changes such as sulphate attack, acid attack , sea water and normal water.

KEYWORDS: *Natural aggregates, Recycled coarse aggregates, Surface treatment method, Hydrochloric acid, Sulfuric acid, compressive strength, flexural strength.*

I. INTRODUCTION

Concrete is the most widely used construction material on this earth. In fact, concrete is used in virtually everything and there is still no substitute available for many of its applications. Without concrete, the community and society cannot exist. Therefore, lots of researches are going to find the new varieties of concrete which are economical for the construction. All these researches are focused on the replacements of different ingredients of the concrete which makes the concrete cheaper and even stronger too. In a developing country like India, old and dilapidated structures are

demolished for the purpose of building new and high rise structure to meet the population demand. As a result, considerably large amounts of debris and rubble get accumulated in cities. This waste generated during demolition is mainly in the form of aggregate and dust which are dumped into nearly empty pits or on lands, river beds, pasture lands and agriculture fields leading to wide spread environmental pollution. Development of infrastructure also increases the demand for production of concrete, which in turn increases the demand for supply of aggregates. Lack of availability of good quality aggregates within reasonable distance brings out the need to identify sources of new aggregate. The waste generated in the region has the potential to meet the aggregate demands for construction activities. The twin objectives of conservation of natural resources and pollution free environment may be achieved if demolished concrete is effectively utilized. The new construction using the demolish waste as aggregate both fine and coarse in making new concrete will provide a solution to the present problem.

The use of recycle aggregate concrete in construction industry is advantageous and economical. The waste from construction and demolition work is of large volume and increasing in time. To overcome this issue, sustainable concrete construction is one of the strategies to be considered by the construction industry. One way of achieving these is to introduce recycled aggregates from these wastes of construction and demolition works into the production of concrete. In some countries the government encourage the use of recycled and reuse materials for construction industry. The reuse of recycled aggregate (RA) is not a common practice in construction industry. Nowadays there is depletion of natural aggregates and time will come where the sources of natural aggregate will soon decrease and will encounter a reduction in its supply. There is a severe shortage of infrastructural facilities like houses, hospitals, roads etc. in India and large quantities of construction materials for creating those facilities are needed. The planning Commission allocated approximately 50% of capital outlay for infrastructure development in five year plans. From environmental point of view, for production of natural aggregates of 1 ton, 0.0046 million ton of carbon emitted. Whereas for production of 1 ton recycled aggregate only 0.0024 million ton carbons is produced. Considering the global consumption of 10 billion tons/year of aggregate for concrete production, the carbon footprint can be determined for the natural aggregate as well as for the recycled aggregate(source: Hossam Z. El- Karmonty et al 2013). The use of recycled aggregate generally increases the drying shrinkage creep & porosity to water & decreases the compression strength of concrete compared to that of natural aggregate concrete. The use of recycled aggregate in replacing the normal coarse aggregates in concrete construction has become popular among researchers. They compare the performance and characteristics of the two aggregates used. Most researchers found that the performance of recycled aggregate used in concrete has low workability and less compressive strength. The reasons for these are smooth texture and round shape of RA, higher percentage of fine particles and high water absorption. Researchers claimed that recycled aggregate has more angular shape and rough surface texture compare to natural aggregate. The angular shape and rough texture of RA leads to better bond and higher strength of concrete. To increase the compressive strength, recycled aggregate should be oven dried condition that will create the interfacial bond between cement paste and aggregate particles.

II. LITERATURE REVIEW

Goudappa Biradar et al (2015) an investigated on "An Experimental Study on Recycled Coarse Aggregates" Many researchers state that the recycled aggregates that are obtained from concrete specimen make good quality concrete. For improving the quality of recycled coarse aggregate, various surface treatment methods such as washing the recycled aggregates with water and diluted acid were investigated. Strength properties of the treated and untreated coarse aggregate were compared. The results indicated that the compressive strength of recycle aggregate is found to be less than the natural aggregate. A lot of experiments have been made to

investigate the strength behavior of recycled aggregate concrete using demolition waste. Tests results show that behavior of concrete like workability, variation of strength made with recycled aggregate is more or less similar to conventional concrete. Mix designs can be made using recycled aggregate for structural concrete elements instead of disposing off the recycled concrete to achieve economy.

Ravi patel et al (2013) an investigated on "Experimental investigation or recycled coarse aggregate replaced for natural coarse aggregate in concrete" in general, present status & utilization of recycled coarse aggregate in India with their future need is discussed. This Research Paper reports the basic properties of recycled coarse aggregate. It also compares these properties with natural aggregates. Basic changes in all aggregate properties were determined. Basic concrete properties like compressive strength, workability etc. are explained here for different combinations of recycled course aggregate with natural aggregate. The experimental results show that the early compressive strength of concrete made of natural coarse aggregate and recycled coarse aggregate is approximately same . In compaction factor test at the replacement of 40% of Recycled Aggregate the compaction factor value is maximum, the highest compacting factor ratio is 0.90. So we can say that at the replacement of 40% recycled aggregate concrete is more workable. The compression test result indicates an increasing trend of compressive strength in the early age of the concrete specimens with 60% recycled aggregates. However, it shows that the strength of recycled aggregate specimens were gradually increase up to 40% replacement of recycled aggregate & then it decreases at the 100% replacement of recycled aggregate after 28 days. The target strength for M40 grade is 48.25MPa that are achieved for all the specimens tested in the study. The results also show that the concrete specimens with 40% replacement of recycled aggregate get the highest strength when compared to the concrete specimens with different percentage of recycled aggregate. From the obtained result, it is possible to use 40% recycled aggregate for higher strength of concretes.

Sudhir p.patil et al (2013) an investigated on "Recycled coarse aggregates" The slump of the normal concrete is observed to be less than the recycled one. Split tensile test shows that concrete has good tensile strength when replace up to 25-50% .Due to lack of treatment process for RCA adequate strength is not achieved but by applying more advanced and sophisticated treatment process the strength can be improved.

G. Murali et al (2012) an investigated on "Experimental study on recycled aggregate concrete" However the strength of recycled aggregate concrete can be improved by the water and acid treatments such as hydrochloric and sulfuric acid.

Sagoe et al (2002) stated that the difference between the characteristic of fresh and hardened recycled aggregate concrete and natural aggregate concrete is relatively narrower than reported for laboratory crush recycled aggregate concrete mixes. There was no difference at the 5% significance level in concrete compressive and tensile strength of recycled concrete and control normal concrete made from natural aggregate.

Poon (2002) reported that there were not much effect of the compressive strength of brick specimens with the replacement of 25% and 50% of recycled aggregate. But when the percentage of recycled aggregate replacement increased, the compressive strength of the specimens was reducing.

Mandal et al (2002) also found that there will no effects on the concrete strength with the replacement of 30% of recycled aggregate. But the compressive strength was gradually decreasing when the amount replacement of recycled increased. They concluded that the properties and the strength characteristic of recycled aggregate concrete were deficiency when compared to the specimens that made by the natural aggregate.

Limbachiya et al (2000) found that recycled concrete aggregate had 7 to 9% lower relative density and 2 times higher water absorption than natural aggregate. According to their test results, it shown that there was no effect with the replacement of 30% coarse recycled concrete aggregate used on the ceiling strength of concrete. It also mentioned that recycled concrete aggregate could be used in

high strength concrete mixes with the recycled concrete aggregate content in the concrete.

III. EXPERIMENTAL STUDIES

Cement

53 grade OPC cement is used in the present work. The properties of cement are determined from the laboratory investigations. The results of tests conducted on cement are presented in Table 4.1, along with the permissible limits for ascertaining quality of cement.

Properties	Results	Permissible limit as per IS:8112-1989
Fineness of Cement	6.3%	Not more than 10 %
Normal consistency	33%	-
Specific gravity	3.03	-
Initial Setting Time	98min	Should not be less than 30 min
Final Setting Time	348min	Should not be less than 600 min
Compressive strength		
of cement cubes for		
3 days	29.5 MPa	Should be > 27 MPa
7 days	38.4 MPa	Should be > 37 MPa
28 days	55.1 MPa	Should be > 50 MPa

Physical Properties of Cement

Coarse Aggregate

A natural and recycled aggregate were used in this study. Natural coarse aggregate NCA) used was from an established quarry satisfying the requirements of IS 383:1970. Totally, two different nominal sizes of coarse aggregate were selected as 20 mm and 10 mm. Recycled coarse aggregate (RCA) was obtained from manual breaking of crushed concrete cubes in Anakapalli . The aggregate was sieved through a standard set of sieves to produce an aggregate of 20mm and 10 mm size graded metal.

Physical properties	Natural Coarse	Recycled Coarse
	Aggregate (NAC)	Aggregate(RAC)
Maximum nominal size	20	20
graded(mm)		
Specific gravity	2.88	2.84
Bulk density (loose	1534.75	144.29
)kg/m3		
Bulk density	1778.29	1592.67
(rodded)kg/m3		
Water Absorption	0.60 %	0.80 %
percent (%) IS:2386		
(Part3)-1963		
Impact value %	19.30%	30.85 %

Fine Aggregate

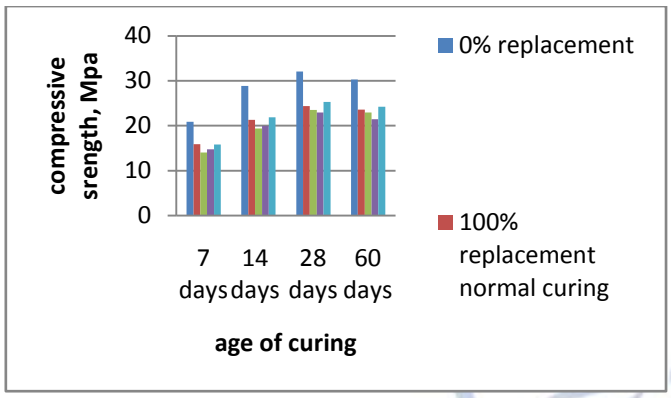
In the present study, river sand conforming to Zone II as per 383: 1970 was used as Conventional fine aggregate. The fine aggregate is clean, inert and free from organic matter, silt and clay. The fine aggregate was completely dried before use. The physical properties of the fine aggregate were given in Table 4.3 below

Physical properties	Natural fine aggregate
Particulars	River Sand
Zone	Zone II
Specific gravity	2.86
Bulk density (kg/m3)	1695
Fineness	2.64
Water absorption	0.60 %

IV. RESULTS & DISCUSSIONS

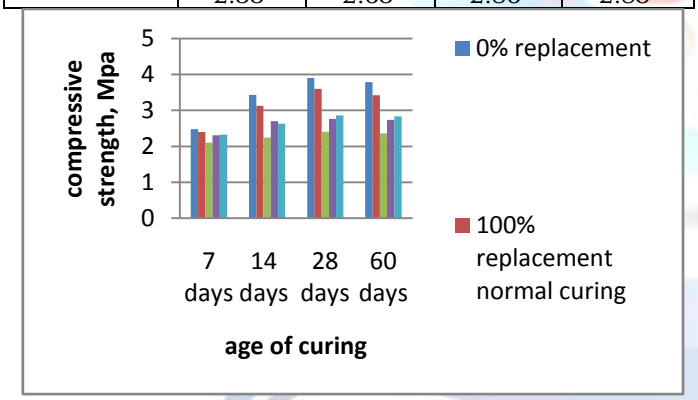
Comparision between compressive strengths in different conditions

Description	Compressive strength (MPa) at age of concrete			
	7 days	14 days	28 days	60 days
Normal condition	20.9	28.9	32.12	30.3
(0% replacement)				
Normal water	15.9	21.3	24.4	23.6
(100%				
replacement)				
Sea water	14.05	19.40	23.54	22.96
(100%				
replacement)				
H2SO4 sollution	14.73	19.99	22.99	21.49
(100%				
replacement)				
HCL solution	15.82	21.90	25.34	24.22



Comparison between flexural strengths in different conditions

Description	Flexural strength (MPa) at age of concrete			
	7 days	14 days	28 days	60 days
Normal condition (0% replacement)	2.48	3.43	3.9	3.79
Normal water (100% replacement)	**2.4**	3.13	3.6	3.42
Sea water (100% replacement)	2.10	2.25	2.41	2.36
H2SO4 sollution (100% replacement)	2.31	2.7	2.76	2.74
HCL solution	2.33	2.63	2.86	2.83



V. CONCLUSION

➢ Based on the results of the experimental studies on M20 grade concretes with recycled and natural coarse aggregates and taking the effect of curing with normal water, sea water, sulfate attack and acid attack the following conclusions are drawn.

➢ The Recycled aggregate satisfied the strength parameters for use as alternative to natural coarse aggregate in concrete making like temporary concretestructures low strength pavements (pedestrians) and village bathrooms.

Conclusions on compressive strength

➢ A maximum reduction of about 26% was noticed in compressive strength when the entire coarse natural aggregate was replaced with RCA. The strength is achieved 74% in compressive strength in normal water curing.

➢ A maximum reduction of about 31% was noticed in compressive strength when the entire coarse natural aggregate was replaced with RCA. The strength is achieved 69% in compressive strength in sea water curing.

➢ A maximum reduction of about 29% was noticed in compressive strength when the entire coarse natural aggregate was replaced with RCA. The strength is achieved 71% in compressive strength in H2SO4 sollution water curing.

➢ A maximum reduction of about 22% was noticed in compressive strength when the entire coarse natural aggregate was replaced with RCA. The strength is achieved 78% in compressive strength in HCL sollution water curing.

➢ A maximum reduction of about 27% was noticed in compressive strength when the entire coarse natural aggregate was replaced with RCA. The strength is achieved 73% in average compressive strength. These results may impact on durability studies.

Conclusions on flexural strength

➢ A maximum reduction of about 11% was noticed in flexural strength when the entire coarse natural aggregate was replaced with RCA. The strength is achieved 89% inflexural strength in normal water curing.

➢ A maximum reduction of about 36% was noticed in flexural strength when the entire coarse natural aggregate was replaced with RCA. The strength is achieved 64% in flexural strength in Sea water curing.

➢ A maximum reduction of about 27% was noticed in flexural strength when the entire coarse natural aggregate was replaced with RCA. The strength is achieved 73% in flexural strength in H2SO4 solution water curing.

➢ A maximum reduction of about 25% was noticed in flexural strength when the entire coarse natural aggregate was replaced with RCA. The strength is achieved 75% in flexural strength in HCL solution water curing.

A maximum reduction of about 24.75% was noticed in flexural strength when the entire coarse natural aggregate was replaced with

RCA. The strength is achieved 75.25% in average flexural strength. These results may impact on durability studies.

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