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Experimental Investigation on Fully Recycled Coarse Aggregate Concrete At Various Atmospheric Conditions

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ABSTRACT

In developing country like India construction and demolition waste is generating in many folds. The conventional way for this waste is to dump in landfills, which is adversely affecting the environment there is an urgent need for utilization of such waste in an effective and efficient manner. The amount of construction waste has been dramatically increased in the last decade and social and environment concerns on the recycling of the waste have consequently increased. The recycled aggregates are the material for the future construction. Some million ton's of concrete wastages are demolished from the old buildings in every country for developing their countries .In this paper recycled coarse aggregate used 100%.

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 properties 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 due to effect of various temperature changes such as sulphate attack, acid attack, sea water and normal water.

KEY WORDS: Natural aggregates, Recycled Coarse Aggregates(RCA), Surface treatment method, Hydrochloric acid, Sulfuric acid, compressive strength, flexural strength.

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INTRODUCTION

Concrete is a composite material composed mainly of water, aggregate, and cement. When these ingredients are mixed together, they form a fluid mass that is easily moulded into shape. Over time, the cement forms a hard matrix which binds the ingredients together into a durable stone-like material with many uses. Additives and reinforcements are included in concrete to achieve the desired physical properties of the finished material.

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.

Waste arising from construction and demolition (C & D) constitutes one of the largest waste streams developed in many countries, of this a large proportion of potentially useful material disposed as landfill. The environmental and economic implications of this are no longer considered sustainable and as a result, the construction industry is experiencing more pressure than ever before to overcome this practice. The applications of recycled aggregate in construction have started since end of World War II by using demolished concrete pavement as recycled aggregate in stabilizing the base course for road construction (Ashraf M. Waigh[3] 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.

Advantages of recycling construction materials

Reduces the amount of virgin aggregates to be created, hence Less evacuation of natural resources. While being crushed into smaller particles a large amount of carbon dioxide is absorbed. This reduces the amount of CO2 is the atmosphere. Cost saving – few research studies have shown a significant reduction in construction costs if RAC is used. Conserves landfill space, reduces the need for new landfills and hence saving more costs. Creates more employment opportunities is recycling industry. The Recycled construction materials is used for construction of precast and cast in situ gutters & kerb"s. There are no detrimental effects on concrete and it is expected that the increase in the cost of cement could be offset by the lower coast of recycled concrete aggregate (RCA). There is no excavation of natural resources and less transportation and also less land is required. Less emission of carbon due to less crushing. Up to 30% replacement of natural aggregates with RCA or recycled mixed aggregates**.**

Limitations or disadvantages of recycling of construction material

Duration of procurement of materials may affect life cycle of project. High water absorption up to 60%, it has

higher drying shrinkage and creep. Land, special equipments, machineries are required(more cost). Less quality , compressive strength reduces by 10-30%.

- Downgrading of quality of concrete.
- Increase in water absorption capacity ranging from 3% to 9%
- Decrease in compressive strength of concrete (10-30%)
- Reduces workability of concrete.
- Lack of specifications and guidelines.
- Less durability of RAC, however few papers have shown an improvement in the durability by mixing it with special materials like fly ash.

EXPERIMENTAL WORK

Material gathering :

Cement OPC 53 grade.

Fine aggregate .

Recycled coarse aggregate .

Fig 1: Collection Of RCA

Fig 2: Separation Of RCA From Cubes

Fig 3: Sieving of RCA

TESTS ON MATERIALS:

Specific gravity :

Specific gravity is the ratio of the density of solids to the density of liquids.

Fig 4: Specific Gravity Test

Table 1: Specific Gravity Results

CEMENT	F.A	C.A	R.C.A
2.96	2.57	2.81	2.93

Consistency:

The standard consistency of cement paste is defined as that consistency which will permit a vi-cat plunger having 10mm diameter and 50mm length to penetrate to a depth of 33-35 from the top of the mould.

Cement = 30%

Fig 5: Consistency

Initial setting time:

This time interval for which the cement product remains in plastic condition is known as "Initial setting time".

Initial setting time =30 min.

Aggregate impact and abrasion test: The recycled aggregate is relatively weaker than the natural aggregate against mechanical actions. As per IS 2386,the crushing and impact values for concrete wearing surfaces should not exceed 45% and 50% respectively. The crushing & impact values of recycled aggregate satisfy the BIS specifications except recycled aggregate for impact value as originally it is low grade rubbles.

Aggregate Impact value = 11.3%

Aggregate abrasion test:

abrasion value = 23%.

RESULTS & DISCUSSIONS

The chapter presents the results of strength tests (compressive and flexural strengths) conducted on Recycled coarse aggregate concrete of M30 grade for Normal water curing. The results of studies conducted on concrete specimens subjected to sea water curing also presented. The chapter also presents the effect of sea water curing on mechanical properties (compressive strength and flexural strength) of Recycled coarse aggregate of M30 grade.

Fig 6: Compression Testing Machine

Table 2: Comparison between compressive strengths in different conditions

Description	Compressive strength in Mpa at age of concrete			
	7 days	14 days	28 days	60 days
Normal condition (0% replacement)	20.8	28.8	32.11	30.2
Normal water (100% replacement)	15.8	21.2	24.3	23.5
Sea water (100% replacement)	14.04	19.39	23.53	22.95
H_2SO_4 solution (100% replacement)	14.72	19.98	22.98	21.48
HCL solution (100% replacement)	15.81	21.89	25.33	24.21

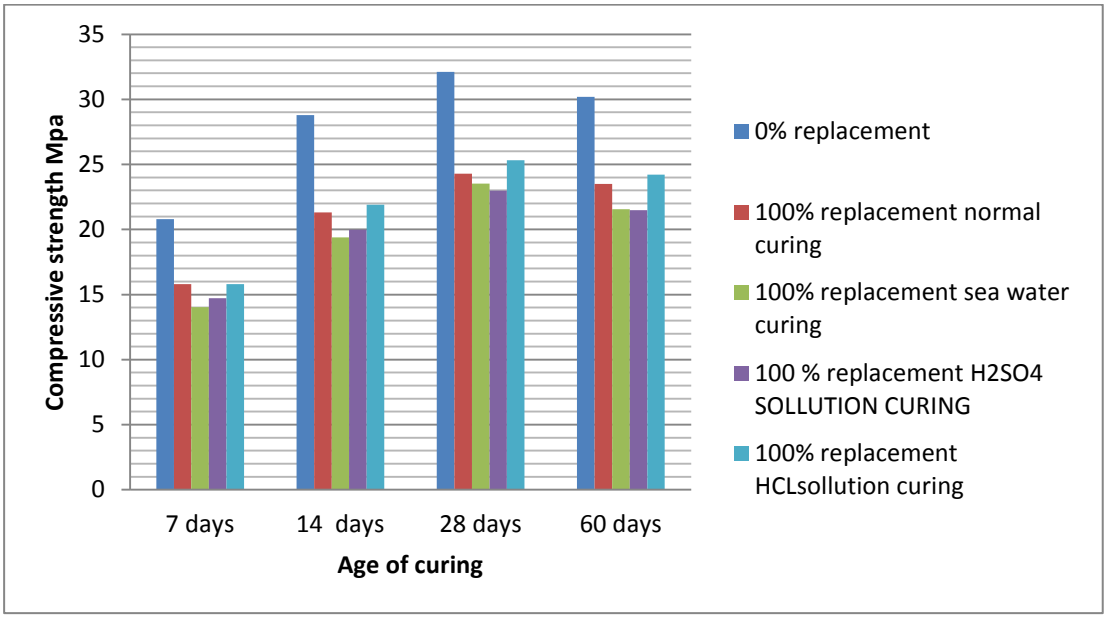

Fig 6: Graph comparison between compressive strengths in different conditions

FLEXURAL STRENGTH:

Description	Flexural strength (MPa) at age of concrete			
	7 days	14 days	28 days	60 days
Normal condition (0% replacement)	2.47	3.42	3.8	3.78
Normal water (100% replacement)	2.3	3.12	3.5	3.41
Sea water (100% replacement)	2.09	2.24	2.40	2.35
H_2SO_4 solution (100% replacement)	2.3	2.6	2.75	2.73
HCL solution (100% replacement)	2.32	2.62	2.85	2.82

Table 3: comparison of flexural strengths in different condition

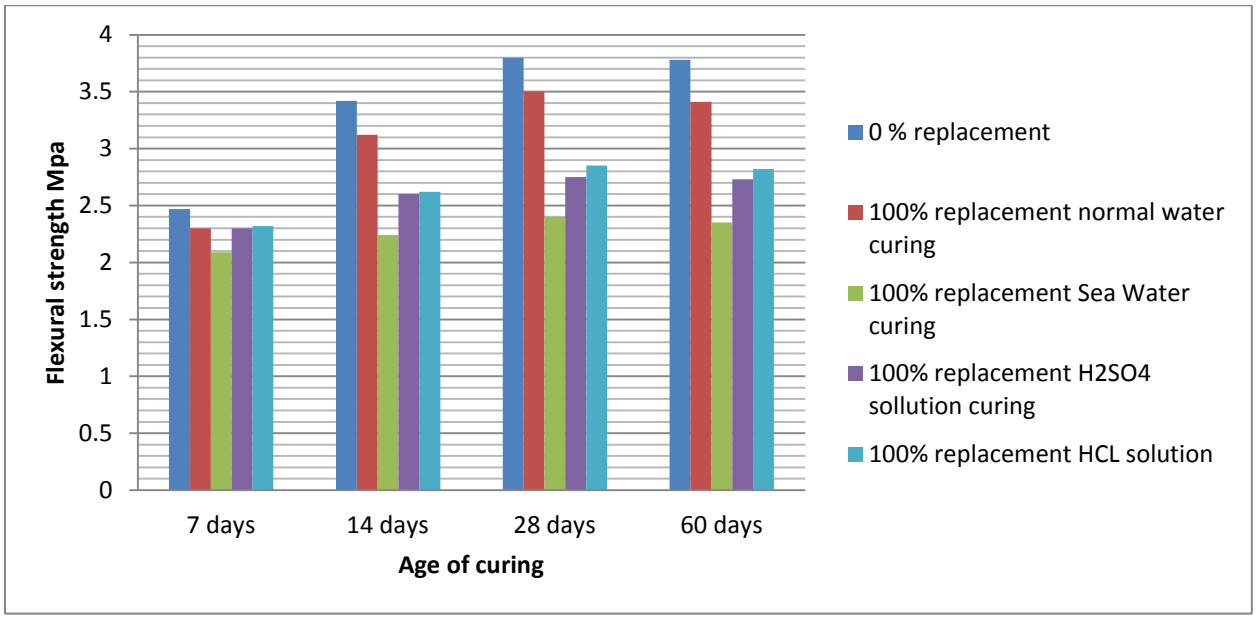

Fig 7: Graph comparison of flexural strengths in different conditions

Applications of Recycled Aggregate

1. It Can be used for construction gutters, pavements etc.
2. It can be used at construction of temporary structures at construction sites.
3. Large pieces of crushed aggregate can be used for building revetments which in turn is very useful in controlling soil erosion.
4. Recycled concrete rubbles can be used as coarse aggregate in concrete.
5. Production of RAC also results in generation of many by-products having many uses such as a ground Improvement material, a concrete addition, an asphalt filler etc.
6. From these studies it can be used at village bathrooms, small garages, goo downs etc.

CONCLUSIONS

- Based on the results of the experimental studies on M30 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 concrete structures low strength pavements(pedestrians) and village bathrooms.

Conclusions on compressive strength

- 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 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.

LIMITATIONS OF STUDY

The results of study are based on strength of concrete measured up to 60 days of age.

The results of study are applicable to Recycled coarse aggregate having same properties of Recycled aggregates as used in this project.

The results of study are applicable for concretes with OPC Cement of 53 Grade.

SCOPE FOR FURTHER STUDY

- Studies may be carried out on assessing suitability of Recycled aggregate as alternate to conventional coarse aggregate in M30 and above Grade of Concrete
- The studies could continue out up to 180 days, it may give better results for marine environment, Acid and sulphate
- Similar study may be made by using Portland Pozzalana Cement of 53 grade instead of Ordinary Portland Cement.
- Similar study may be made by using other replacement materials instead of fine aggregate.
- Replacement of 100% coarse aggregate curing in sea water, acid attack, sulphate attack, the member developed by shear.

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