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DEMOLISHED CONCRETE WASTE AS AGGREGATE IN STRUCTURAL CONCRETE

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ABSTRACT

In major cities there is a surge in construction and demolition waste (CDW) quantities causing an adverse effect on the environment. The use of such waste as recycled aggregate in concrete can be useful for both environmental and economical aspects in the construction industry. This study discusses the possibility to replace natural coarse aggregate (NA) with recycled concrete aggregate (RCA) in structural concrete.An investigation into the properties of RCA is made using crushing and grading of concrete rubble collected from different demolition sites and landfill locations.Aggregates used in the study were: natural sand, and crushed concretes obtained from different sources.

INTRODUCTION

As everyone know that concrete is the main construction material worldwide. As 2/3rd of the concrete consists of aggregates, the skeleton form of the concrete is formed by the presence of aggregates only. In the concrete the major part consist of coarse aggregate, so there is a huge demand of coarse aggregate, it makes the whole world to see towards the requirement of the coarse aggregate. If we extract the natural coarse aggregate it causes to the environmental imbalance, so the whole world is looking towards the aggregates which are extracted from the solid construction waste of the old building and the roads. To manage the concrete waste the usage of recycled coarse aggregate is a very important step towards the development and preservation of the environment.

The property of the recycled aggregate is the main problem for using it because they will not fulfill the desired requirement so we alternatively replacing it with that of naturally coarse aggregate. This property of recycled coarse aggregate mainly depends on the recycle material quality. This recycled material quality can be get influenced by the collection of it and while delivering it to site. The main motto of this project is to find the strength of cube and flexural strength by replacing the natural coarse aggregate with recycled coarse aggregate either partial or complete replacement. For this, we should know the basic properties of the recycled coarse aggregate like water absorption, specific gravity, shape, and texture, and some physical properties.

So many countries are using this construction and demolition waste (recycled coarse aggregate) as the secondary reuse in the structural works. After the demolition of the old buildings, the material which is removed is considered worthless and deposited as the demolition waste.

Recycled concrete aggregate (RCA) is generally produced by the crushing of concrete rubble, screening then removal of contaminants such as reinforcement, paper, wood, plastics and cement mortar. Concrete made with such recycled concrete aggregate is called recycled aggregate concrete (RAC). The main purpose of this work is to determine the basic properties of RAC made of coarse recycled concrete aggregate then to compare them to the properties of concrete made with natural aggregate concrete (NAC).

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OBJECTIVE OF PROJECT

1. To find the strength of the concrete by mixing the virgin coarse aggregate with reused coarse aggregate with various percentages like 30 percentage, 60 percentage and 100 percentage with two different ages.

2. This experiment can help in study and as well as comparison of various properties of the aggregate through flexural strength and compressive strength

LITERATURE REVIEW

Pavan [1]: In this research work, the RAC has been used with OPC (Ordinary Portland Cement) and PSC (Portland Slag Cement) with 7 and 28 curing days to study the different mechanical properties such as split tensile and compressive strength test. The concrete is used is hardened concrete. The recycled concrete is made by using the demolish concrete and natural concrete in 60:40 ratio. The results were compared with naturally available aggregates. P.C.

Yong [2]: RCA from site- tested concrete samples was employed in the research. These are 14 day concrete cubes from a local building site after compression testing. These cubes are split into required sizes. Around 200 Kg of recycled concrete aggregate was used in this study. The results shows that RCA has good quality concrete. The compressive strength test of RCA is also higher than Natural recycled aggregate. In terms of split tensile strength, wet density, flexural strength test RA is comparable to regular concrete.

M.C Neil [3]: In this research paper, RCA is studied which includes its properties, effects and its production on a major scale. To study the RCA concrete material properties compressive strength test, splitting tensile strength test, crack width and spacing, modulus of rupture and elasticity, structural performance of RCA cubes were discussed. Overall, it is concluded that the RCA properties can vary with different materials admixtures, it can be used to built a structural concrete.

Yehla S [4]: This research paper focuses on the both the properties of RCA that is mechanical and physical of recycled aggregate concrete. The research provided the impact of RCA quality on concrete characteristics. From the time range of around six months sample was collected from an any place, both the aggregate property indicated an acceptable changes in properties. All admixtures except three shows the acceptable values in compressive, tensile, flexural, splitting strength test.

M. Chakradhara [5]: In this paper, the properties of RCA is studied using a various strength test in four grade, M 20, M 25, M 30, M 40 as a NCA concrete and four recycled aggregate RCA 20, RCA 25, RCA 30 AND RCA 40. The study demonstrates that the Mechanical property like compressive strength test of the different M- Grade samples is lower than the RAC grade sample, but the same test conducted with more mixing ratio of M20, M20, M25, with RCA 20, RCA gives acceptable results. RAC absorbs more energy than controlled concrete under flexural test.

METHODOLOGY

The main theme of this project is to utilize recycled coarse aggregate for the production of Concrete. As disposal of demolished Concrete is not possible easily , they can create adverse impact on environment. Reuse of Coarse Aggregate in concrete industry is considered as the most feasible application. It would be great if we can partially or completely replace the Natural Coarse Aggregate with Recycled Coarse Aggregate. Therefore the methodology carried out here in our research according to sequential order is

- It is important to select proper ingredients, evaluate their properties and understand the interaction among different materials for optimum usage.

- The materials used for this investigation is same as that used for normal concrete and partial replacement of recycled coarse aggregate with Natural Coarse Aggregate.

- In this experimental work, the typical size of Cube 150mm x 150mm x 150mm for compressive test and Prsim 100mm x 100mm x 500mm for flexural strength is used.

- The nominal mix design of concrete M20 (1:1.5:3) is done according to the Indian Standard guidelines for M20 grade .

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- Based on the components of the mixes, the Natural Coarse Aggregate was replaced by Recycled Coarse Aggregate 30% , 60% & 100% .
- Concrete is poured into moulds of cubes and prisms and compacted carefully using tamping rod, trimmed the top surface with trowel and levelled the concrete.
- The specimens are demoulded after 24 hours and then curing is done for the period of 28 days
- After 28 days the specimens has been taken out from the curing tank just prior to the test. The Compressive test for Cubes and Flexural test for Prisms has been conducted.

SOURCE OF RECYCLED AGGREGATE

General:

The main source of recycled coarse aggregate is from the concrete structures which have exhausted their limit of serviceability, that may be either from the old houses, roads, industrial building, old hospitals, theatres, government buildings when the structure is collapsed due to heavy fire accident's, earthquakes, land slidings etc., or it may be demolished for renovation or for new constructions . The availability of recycled aggregate is very hard to find in the demolition waste but extracting the required size of aggregate are very difficult, and this extracted aggregate will not have the same properties as same as natural aggregate, Finding the aggregate of different ages is a very typical task, this project mainly focuses on the collection of two unique ages of recycled aggregate, so two ages of aggregates have been collected and named it as Age 1 and Age 2.

Age 1 Aggregate :

This Age 1 aggregate is collected from Murad Nagar, its age is of about 10 years, the size of this aggregate is not unique, so it is first separated to the required size of the project requirement with the help of sieve, the size of the recycled coarse aggregate has been maintained in between 16 mm to 20 mm.

Fig 1 : Demolished site of Murad Nagar

Age 2 Aggregate :

The Age 2 is collected from Meraj Colony which is located in Tolichowki, the age of the building is of 40 years old, the aggregate of this age is also not unique, so sieve has been done to bring the aggregate to the required size for the project.

Fig 2 : Demolished site of Meraj Colony

Seperation of Coarse aggregate from demolished concrete :

The demolished concrete has been brought to the college and the Coarse aggregate isseperated from the demolished concrete. There was mortar attached to the coarse aggregate , then the mortar is separated from the coarse aggregate. It was very difficult but we tried to remove the maximum content of mortar.

Fig 3 : Separation of coarse aggregate from demolished concrete

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EXPERIMENTAL PROGRAM

Materials Used:

Cement:

It is one of the important binding material used for preparing the concrete. It is made by mixing calcareous (lime) and argillaceous (clay) material in 2/3rd and 1/3rd proportion respectively. When water is added with cement a reaction(chemical) takes place, the nature of that reaction is exothermic, a certain amount of heat is produced is known as the heat of hydration. The better Portland cement exists in the following chemical proportions and ingredients like Alumina (6%), Silica (20%), Lime (63%, Iron oxide (3%), Magnesium oxide (2%). From the above chemical ingredient like Iron oxide, Alumina, Silica are called as Acidic materials whereas Magnesium and Lime are called as Alkaline materials a cert PPC 53 grade of cement has been used for this experiments this ordinary Portland cement of 53 grade has been conformed to IS 1226:1987.

Fig 4: Cement

Fineness:

The fineness of the cement is known with dry sieving as per IS: 4031 (Part 1) – 1996. The fineness of cement is measured by sieving. The proportion of cement particle grain sizes of which is larger than the required mesh size is then determined

Apparatus:

1. Balance (10 gm. nearest to 10 mg)
2. Sieve (90µm IS sieve)
3. Nylon Bristol Brush (preferably 25 to 40 mm bristle)

Material:

1. Cement

Procedure:

1. Take the cement accurate weight of about 100 g to the maximum nearest of 0.01gm put it on a sieve of 90 microns Indian standard sieve.
2. Break if any air-set slumps in the samples with fingers.
3. Shake the pan for some time and linear movement for the time of 10 minutes, until maximum cement to pass through the sieve.
4. Collect the residue with brush and weight the sample which is the residue left on the sieve.
5. Express the left residue in the form of percentage nearest to 0.1 percentage
6. Repeat the whole process for the more two times by taking the 100gm sample each time.

Fig 5.: Fineness of Cement

Table No 1: Fineness of sieve analysis

SL.No.	Sample Weight has taken (W) (gm)	Residue Weight (R) (gm.)	Percentage Of Residue	Residue Average Percentage
1	100	9.5	9.5	9.43
2	100	9	9	
3	100	9.8	9.8	

Result:

Residue percentage of cement sample by the dry method of sieving 9.43 %

RESULT AND ANALYSIS

Slump Cone Test:

To check the workability of the fresh Traditional concrete.

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Apparatus:

1. Slump Cone
2. Tamping Rod(16mm diameter and 60cm length)
3. Metallic Sheet
4. Weighing Machine(for measuring the ingredients)
5. Scale.

Material:

1. Cement
2. Fine and coarse Aggregate
3. Water

Table No 6.1: Degree of workability

Degree of workability	Very Low	Low	Medium	High
Slump value (in mm)	0-25	25-50	50-100	100-175

Procedure:

1. And further, fill the complete mould within 3 layers, each layer has to be tamped 25 strokes, after completion of filling the excess mix has to be taken away with the help of a trowel
2. Hold the cone with two hands and lift the cone in vertical direction slowly and remove it
3. The fresh concrete will get subside, now take the height of the slum by taking the slump cone inverted and the tampering rod has reading measured it by placing the flat scale horizontally and taping rod touching the top point of the concert, read the reading on the tampering rod
4. The difference between the cone height and the subsidiary concert will the slump value

Result:

The slump value of fresh concreteis 60 mm.

Conclusions:

The slump value shows that the concrete has Medium degree of workability.

Fig 6 : Filling of concrete

Fig 7: Tampering of concrete

Fig.8: Checking the Slump Value at the Laboratory

RESULT AND DISCUSSION

The results which were obtained by conducting tests on the cubes and prism made with different percentage replacement of natural coarse aggregate with recycled coarse aggregate has shown that

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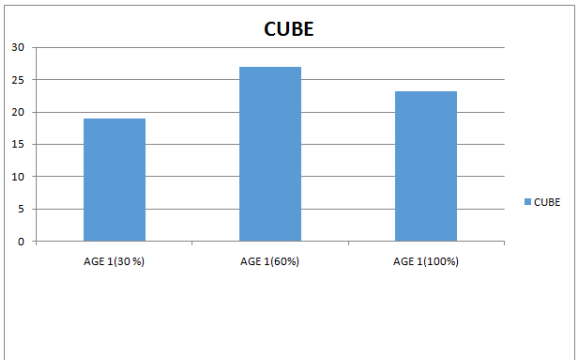
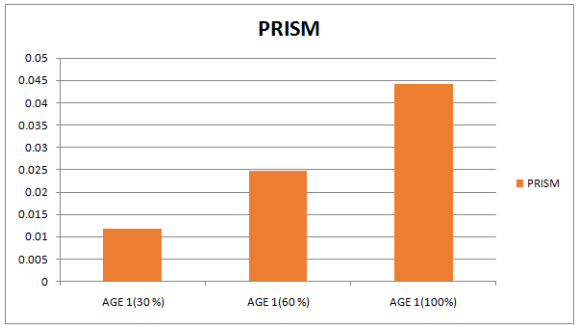
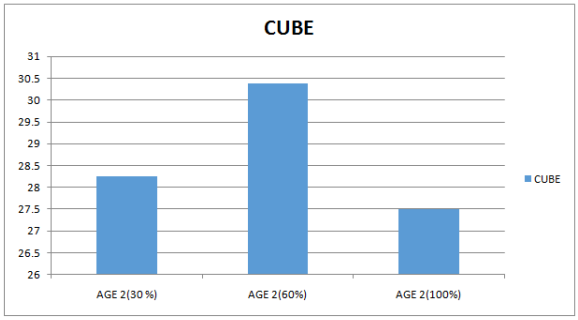
1. The full replacement of recycle aggregate are showing the almost same result as of specimen cast with traditional concrete at 28 days curing.
2. The replacement of natural coarse aggregate by adding 30 % of recycled aggregate is reaching the strength of the mix.
3. While replacing 60% of recycled aggregate with natural coarse aggregate the strength is high in case of cubes and they are some difference in case of a prism.
4. According to the test results recycle aggregate will give sufficient results and meet the standard strength of the specimen which was prepared with traditional aggregates.
5. Mixing the natural coarse aggregate with recycling coarse aggregate with 60 % replacement is the best combination for getting more strength.
6. Prism which was made with 100 % replacement will have more strength than that of 30 % and 60 % replacement in case of a prism.
7. Comparing to 100% strength for age 1, age 2 and traditional concrete, the AGE 2 has given the more strength.
8. For 30% and 60 % replacement the age 2 has shown more strength than the age 1 for 28 days curing in case of cube.



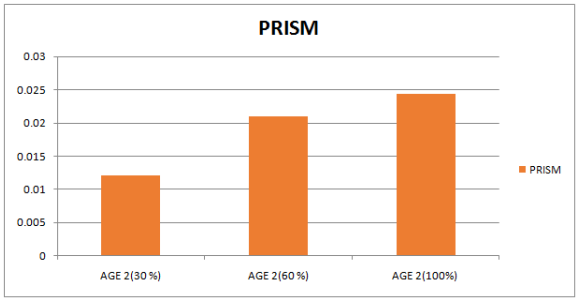
Graph 1: Showing the compressive strength of cube with AGE 1 recycled aggregate by replacing it with 30%, 60% and 100



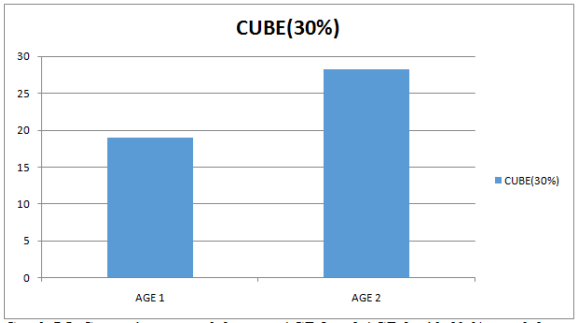
Graph 7.2: Showing the flexural strength of prism with AGE 1 recycled aggregate by replacing it with 30%, 60% and 100 %



Graph 7.3: Showing the compressive strength of cube with AGE 2 recycled aggregate by replacing it with 30%, 60% and 100 %



Graph 7.4: Showing the flexural strength of prism with AGE 2 recycled aggregate by replacing it with 30%, 60% and 100 %



Graph 7.5: Comparison strength between AGE 1 and AGE 2 with 30 % recycled coarse aggregate

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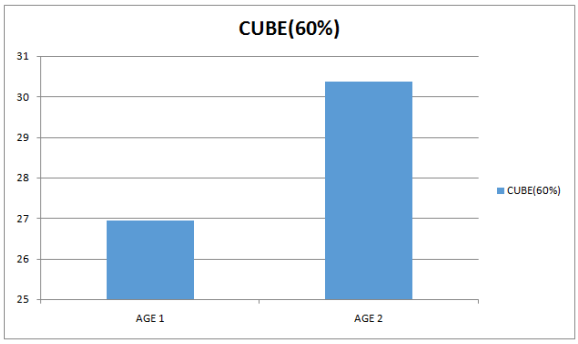
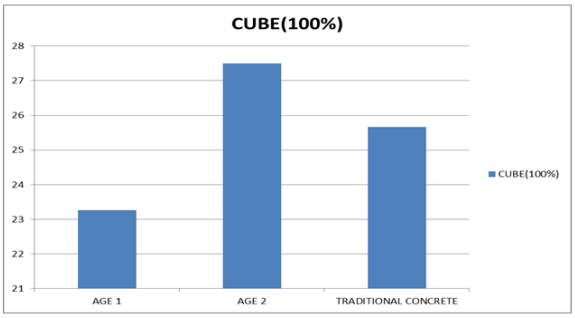
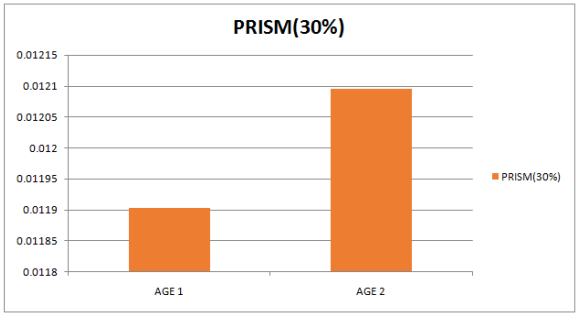


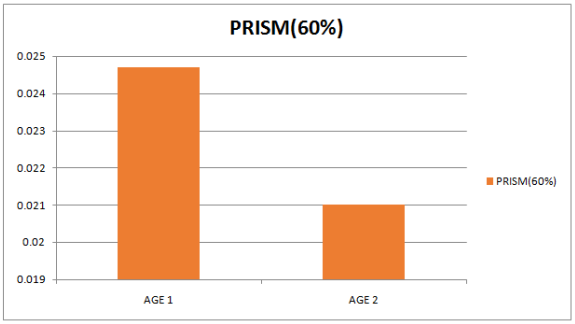
Graph 7.6: Comparison strength between AGE 1 and AGE 2 with 60 % recycled coarse aggregate



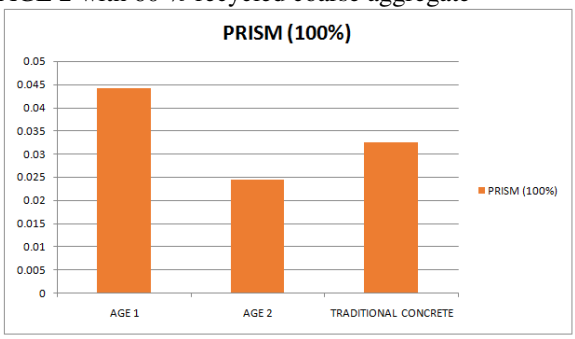
Graph 7.7: Comparison strength between AGE 1, AGE 2 and traditional concrete with 100% recycled coarse aggregate



Graph7.8: Comparison strength between AGE 1 and AGE 2 with 30 % recycled coarse aggregate



Graph7.9: Comparison strength between AGE 1 and AGE 2 with 60 % recycled coarse aggregate



Graph7.10: Comparison strength between AGE 1 and AGE 2 and traditional concrete with 100 % recycled coarse aggregate

CONCLUSION

1. Concrete which has the combination replacing the natural coarse aggregate by recycling coarse aggregate of 30% has a small little variant in the strength.
2. Concrete mixing with the combination of replacement of natural coarse aggregate with recycling coarse aggregate of a higher percentage than 30% are giving the result more than the standard one.
3. As the surface of the recycled aggregate is of high angular, it also has a water absorption much higher than the natural coarse aggregate.
4. The recycled aggregate has the surface which is attached to the cement particles, thus making the bond much higher than the traditional one.

Compressive strength of traditional concrete = 25.67 N/mm^2

Table No 8.1: Test results for the cube

SL.No	Replacement Percentage	Days of Curing	Age 1 (10 Years)	Age 2 (40 Years)
			Cube (N/mm^2)	Cube (N/mm^2)
1	30	28	18.976	28.250
2	60	28	26.944	30.368
3	100	28	23.26	27.56

Flexural strength of traditional concrete = 0.0325 N/mm^2

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Table No 8.2 : Test results for the prism

SL.No	Replacement Percentage	Days of Curing	Age 1(10 Years)	Age 2(40 Years)
			Prism (N/Mm^2)	Prism (N/Mm^2)
1	30	28	0.0119	0.0120
2	60	28	0.0247	0.0210
3	100	28	0.0441	0.0244

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