CONSTRUCTION AND DEMOLISION WASTE AS A REPLACEMENT OF FINE AGGREGATE IN CONCRETE

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***Abstract*— Concrete is the most widely used as construction materials in the world. In fact, concrete is used in virtually everything and there is still no substitutes are available for many of its application. Without concrete, the community and society today could not exist. Therefore, lots of researchers and engineers are doing the research of the aggregate sources. All these research as alternative sources for the replacement of the natural aggregates in producing concrete in the various future construction works. In that concept we had made the research on the fine aggregate replacement in M20 grade concrete with the construction and demolition waste on Different samples like **M1,M2,M3,M4 and M5**. The ratio of sand replaced to recycled fine aggregate are 100:0% as control, 80:20%, 50:50%, 20:80% and 0:100%. The project explains about the properties of materials used in concrete, mechanical and transport properties of the concrete..**

***Index Terms*—Construction waste, Demolition waste, Fine Aggregate, Recycled Fine Aggregate.**

I. INTRODUCTION

Concrete is the most widely used as construction materials in the world. In fact, concrete is used in virtually everything and there is still no substitutes are available for many of its application. Without concrete, the community and society today could not exist. Therefore, lots of researchers and engineers are doing the research of the aggregate sources. All these research as alternative sources for the replacement of the natural aggregates in producing concrete in the various future construction works.

Replacing the natural coarse aggregate with the recycled aggregate in the production of new concrete is conducted in most of work or studies. Hence to conduct more study of the waste materials.

The main objectives of this project are described as follows:

a) To determine the characteristics of the recycled fine aggregate.

b) To determine hardened concrete properties containing in recycled fine aggregate concrete.

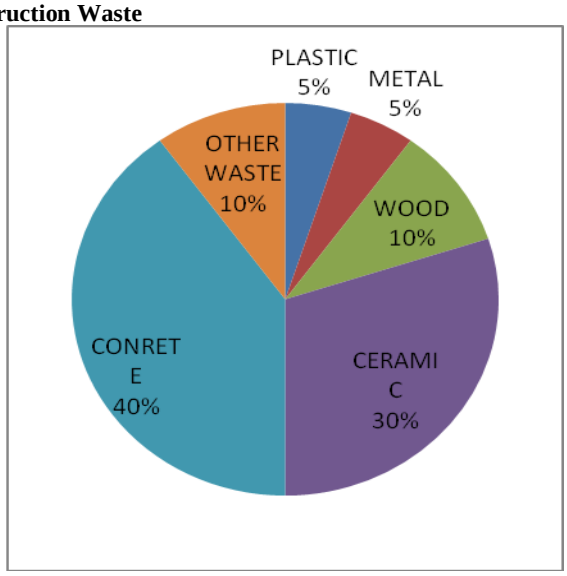
c) To determine transportation properties of recycled fine aggregate concrete.

d) To identify the optimum proportion for replacement the natural fine aggregate with recycled fine aggregate in the concrete.

like crushed recycled concrete properties and their effects on characteristic of the concrete this research is done.

Consequently, this paper discusses and reports on the concrete properties for hardened and fresh concrete by replacing the normal aggregate (sand) with the fine crushed concrete waste.

Construction Waste



Demolition waste

Processing of Demolition Waste

The composition of construction and demolition waste may be different, depending on a building being demolished. When constructions of unfinished buildings are demolished, demolition waste consists of concrete, metal, ceramics. In case the old buildings, that are not rehabilitated and cannot be exploited, are demolished, demolition waste of these buildings demolished consists of concrete, ceramic bricks, tiling or slating, wood, thermal insulation materials, metal and various finishing materials.

Two main reprocessing methods are employed during the reprocessing of buildings' demolition waste:

(1) Waste reprocessing in concrete breakstone production line or in a special site;

(2) Waste reprocessing at a location where waste is created, i.e., at a construction site or at location where building is being demolished. Structural technological scheme of the production of the break stone of various fractions from the construction and demolition waste.

2. MATERIALS AND MIX PROPORTIONING

Materials

This chapter explains the properties of the materials. It also includes mix proportions and mixing.

Cement

Cement is the most important material in the concrete and it act as the binding material. Ordinary Portland cement of 53 grade manufactured by dalmia cements is used in this investigation.

Aggregate

The basic objective in proportioning any concrete is to incorporate the maximum amount of aggregate and minimum amount of water into the mix, and thereby reducing the cementitious material quantity, and to reduce the consequent volume change of the concrete.

Coarse aggregate

Selection of the maximum size of aggregate mainly depends on the project application, workability, segregation, strength and availability. In this research aggregates that are available in the crusher near by was used. The maximum size of aggregate was varying between 26 -12.5 mm.

Recycled Fine aggregates

The building and demolishion waste are taken and crushed to separate fine and coarse materials. Then the aggregates are sent to the batching plant and washed to remove the fines, and then they are seperated by seiving. In our project we had been using the recycled fine aggregate. The aggregates passing through 4.75mm sieve and retained on 90 micron are taken.

Properties of Recycled Fine aggregates

S.no	Particulars	Results
1	Type	Building Waste
2	Specific Gravity	2.72
3	Water absorption	4%
4	Fineness modulus	3.06
5	Grading	Zone II
6	Density	

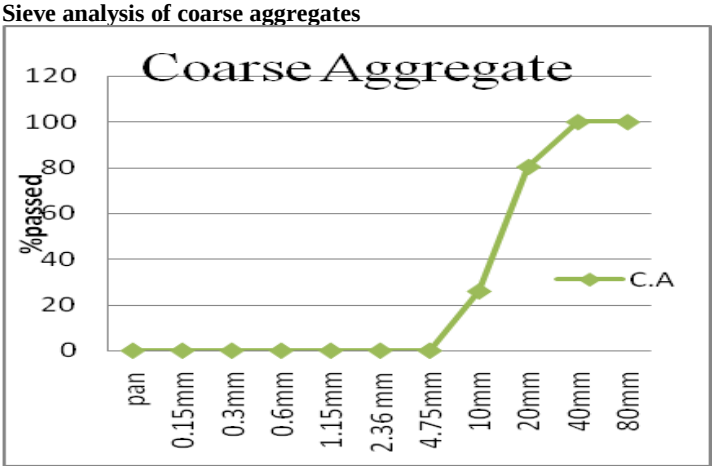
Fine aggregate

The amount of fine aggregate usage is very important in concrete. This will help in filling the voids present between coarse aggregate and they mix with cementaneous materials and form a paste to coat aggregate particles and that affect the compactability of the mix. The aggregates used in this research are without impurities like clay, shell and organic matters. It is passing through 4.75mm sieve.

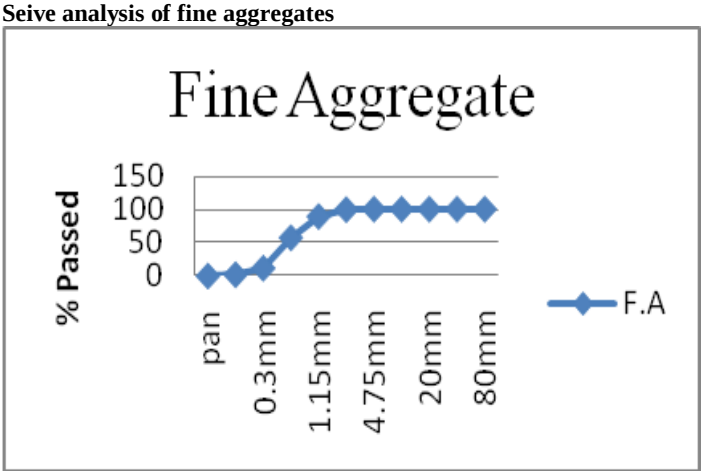
Properties of fine aggregates

S.no	Particulars	Results
1	Type	River sand
2	Specific Gravity	2.4
3	Water absorption	1%
4	Fineness modulus	3.40
5	Grading	Zone-III
6	Density	1.57

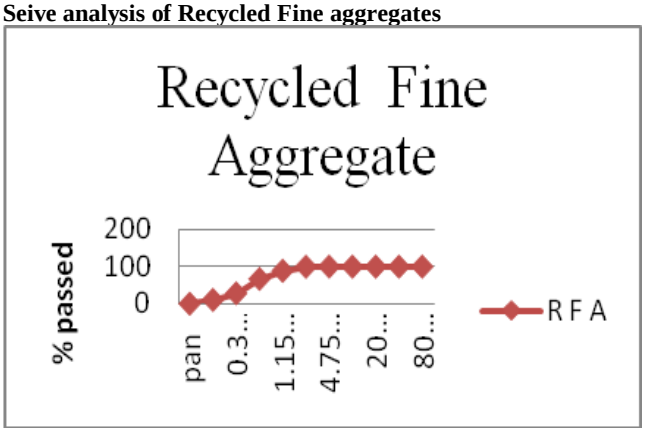
Sieve analysis of coarse aggregates



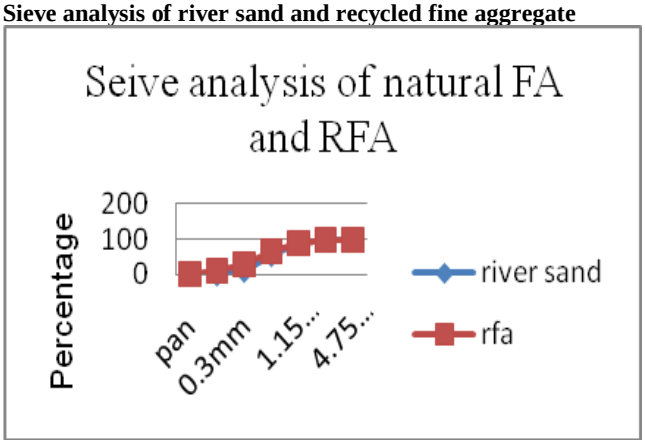
Seive analysis of fine aggregates



Seive analysis of Recycled Fine aggregates



Sieve analysis of river sand and recycled fine aggregate



Mix proportioning

- Mix proportioning was based on the water cement ratio (water/cement) and the density of the concrete is 2400kg/m^3.
- slump of concrete 0.5 for economical purpose.
- The quantity of cement i.e; 350 kg/m^3 used.
- Quantity of water should be 175kg/m^3. For fine and coarse aggregate absorption of water in additional 1 % and 0.8% of water was used.
- The quantity of aggregates is taken based on the aggregate grading curve is selected.
- The quantity of fine aggregates used is 646kg/m^3, coarse aggregates is 1229kg/m^3, the quantity of 20mm and 12mm are 502kg/m^3 and 727kg/m^3.
- For the investigation purpose the fine aggregates replaced with recycled fine aggregates in percentage relatively 0, 20, 50, 80 and 100 percent for the mixes M_1, M2, M3, M4 and M_5 respectively.

Specimen Details

- The specimens like cubes, cylinders and beams that are used to conduct the strength tests are taken according *to IS10086-1982*.
- Compression strength = cube moulds of 150mmX150mmX150mm are used.
- Split tensile strength = cylindrical moulds of 100dia@200mm

Fine Aggregate

Recycled fine aggregrate

3.STRENGTH PROPERTIES

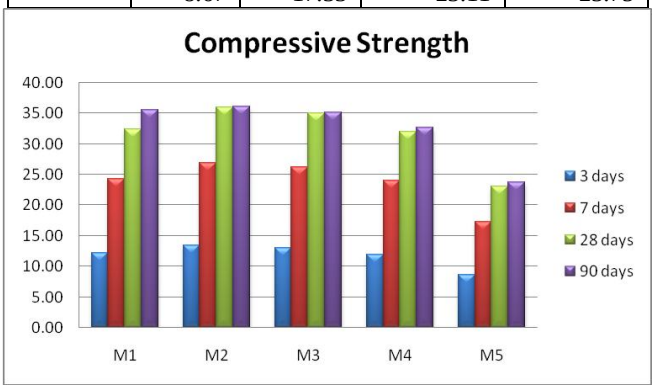
Testing of Compressive Strength:

Compression test is done confirming to *IS: 516-1953*. All the concrete specimens that are tested in a 2000KN capacity Compressive-testing machine. Concrete cubes of size 150mm x 150mm x150mm and cylinders of size 100mm dia& 200mm height were tested for crushing strength, crushing strength of concrete was determined by applying load at the rate of 1400 N/cm^2/min till the specimens fail. The maximum load applied to the specimens was recorded and divided the failure load with cross-sectional area of the specimens for compressive strength has been calculated.

Compressive strength test was conducted on cubes of 150mmX150mmX150mm cubes for the various mixes M1,M2,M3,M4 and M5 of the Recycled fine aggregate concrete are given in the below table

Compressive Strength of different mixes

Mix	Compressive strength N/mm^2			
	3 days	7 days	28 days	90 days
M1	1.49	2.33	2.52	2.62
M2	1.53	2.34	2.60	2.68
M3	1.59	2.36	2.65	2.72
M4	1.19	2.22	2.41	2.54
M5	0.88	2.22	2.33	2.48
	12.00	24.00	32.00	32.64
	8.67	17.33	23.11	23.75



Split Tensile Strength

This test is conducted in a 2000 KN capacity Compression-testing machine by placing the cylindrical specimen, so that its axis is horizontal to the plates of the testing machine. Narrow strips of packing material i.e., plywood is placed between the plates and the cylinder to receive compressive stress. The load was applied uniformly at a constant rate until failure by splitting along the vertical axis takes place. Load at which the specimens failed is recorded and the split tensile stress is obtained using the formula based on *IS: 5816-1970.*

$$F_t = 2P/\pi DL$$

Where P = Compressive load on the cylinder

L = Length of the cylinder D = Diameter of the cylinder

Split tensile strength has done for the mixes M1, M2, M3, M4 and M5 of therecycled fine aggregate concrete the test has conducted on the cylinder of 100mmX200mm. The values of the split tensile strength test at the age of 1 day, 7 days, 28 days has shown in the table below

Split Tensile Strength for different mixes

Mix	3days	7 days	28 days	90 days
M1	1.53	2.34	2.60	2.68
M2	1.59	2.36	2.65	2.72
M3	13.48	26.96	35.95	36.12
M4	1.19	2.22	2.41	2.54
M5	13.10	26.22	34.96	35.19
	0.88	2.22	2.33	2.48
	12.00	24.00	32.00	32.64
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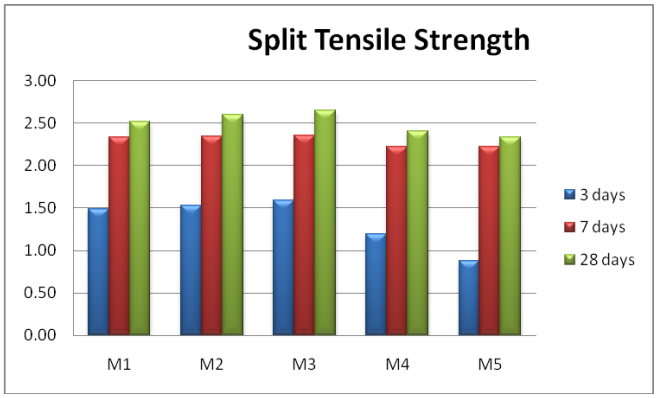
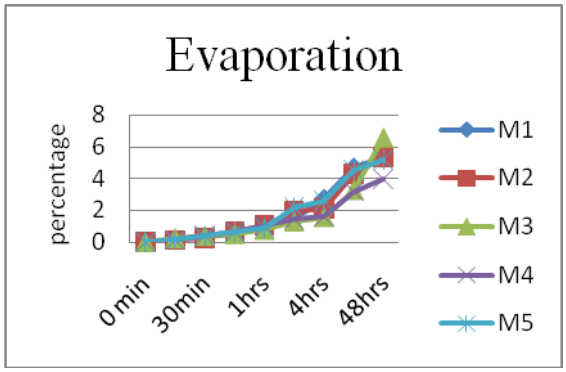
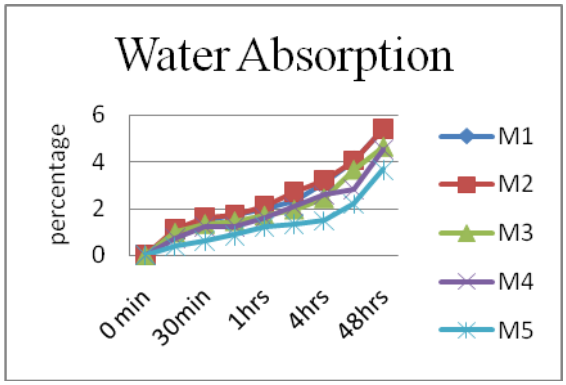


4. TRANSPORT PROPERTIES

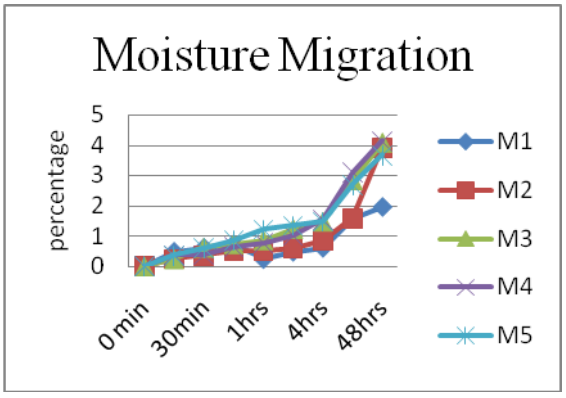
- **Evaporation test**
  - It has done on the cubes of 150mmx150mmx150mm for the mixes of recycled fine aggregate concrete.
  - It has done after curing of 28 days. After curing of 28 days cube specimens were allowed to normal temperature to normal dry, after normal drying cube specimens were kept in oven at the temperature of 95^{0}C
  - cube specimens were taken from the oven at ages of 15mins, 30mins, 1hour, 2hours, 3hours, 4hours, 24hours, 48hours, 72hours.
  - The values of percentages of evaporation at the ages of 15mins, 30mins, 1hour, 2hours, 3hours, 4hours, 24hours, 48hours, and 72hours



- **Water Absorption test**
  - This test has done on the cubes of 150mmx150mmx150mm for the mixes of recycled fine aggregate concrete.
  - It has done after 72 hours evaporation cube specimen.
  - After 72hours evaporation cube specimens were allowed to normal temperature,
  - cube specimens were kept in curing tank and the weight of the specimen are taken at the ages of 15mins ,30mins, 1hour, 2hours, 3hours, 4hours, 24hours, 48hours, 72hours and percentage absorption is calculated.
  - The values of percentages of absorption at the ages of 15mins, 30mins, 1hour, 2hours, 3hours, 4hours, 24hours, 48hours and 72hours.



- **Moisture migration**
  - This test has done on the cubes of 150mmx150mmx150mm for the mixes of recycled fine aggregate concrete.
  - It has done after 72 hours evaporation, cube specimens were allowed dry to normal temperature.
  - Cube specimens were kept on the layer of water for the absorption of moisture,
  - cube specimens were taken from the moisture migration test at the ages of 15mins, 30mins, 1hour, 2hours, 3hours, 4hours, 24hours, 48hours and 72hours.
  - The values of moisture migration in mm are notedand the percentages of moisture migration at the ages of 15mins, 30mins, 1 hour, 2hours, 3hours, 4hours, 24hours, 48hours and 72hours



ANNEXURE-A

Material

Grade of concrete : M20

Type of cement : Dalmia cement, OPC 53

Max. Nominal size of coarse aggregate : 20 mm

Fine aggregate : Recycled fine aggregate from building waste

Type of aggregate : Crushed angular aggregate.

Chemical admixture : Not used

Test data for materials

i. Specific gravity of cement : 3.168

ii. Specific gravity of

a. Coarse aggregate : 2.62

b. Fine aggregate : 2.4

c. Recycled Fine aggregate : 2.72

iii. Sieve analysis

a. Coarse aggregate : Conforming to Table 2 of IS 383

b. Fine aggregate : Conforming to Zone III of IS 383

c. Recycled Fine aggregate : Conforming to Zone II of IS 383

iv. Compressive Strength of cement

S.no	Description	3 days	7 days	28 days
1	0% RFA	35	46	58
2	20% RFA	35	45	55
3	50% RFA	33	44	54
4	80% RFA	32	42	52
5	100% RFA	28	39	48

v. Workability

Slump Cone Test for 0.5 water factor

a. 0% RFA : 60mm

b. 20% RFA : 56mm

c. 50% RFA : 54mm

d. 80%RFA :50mm

e. 100% RFA :45mm

5.CONCLUSION

Results of experiments on compressive strength, split tensile strength, water absorption and evaporation for different recycled fine aggregate concrete have been presented with those of control concrete. For the mixes of the replaced aggregat with the construction waste the investigation had been made on different strength and transport properties and the following conclusions are made

- In the recycled aggregate the percentage of fines present is more than that of the natural sand.
- As the fines are more then the water absorption also incraeses. The absorption of RFA is 4%.
- The RFA does affect the fresh properties of the concrete.
- The compressive strength is incrasedupto some percentage of the replacement.
- The proprties of the recycled fine aggregate are very similar to the natural aggregates.
- The recycled fine aggregates give a dense concrete as the fines help in making.

- Tensle strength of the concrete also incrases in the replacement of the fine aggregte only upto some percentage.
- This recycling has lots of advantages to the environment and human kind.
- So the replacement of the fine aggregate in the concrete can be done by the construction and demolisition waste.

FUTURE SCOPE

- The chemical tests to be performed whether the particles of mortar react with cement.
- The brick bats shouled be noticed in the demolition waste and take measures on preventing it.
- The finer particles to be removed from the waste
- The x-ray dffraction and analysis of particles should be observed
- Bonding nature and mortar properties to be observed.

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- IS: 456-2000 “Code Of Practice For Plain And Reinforced Concrete”
- IS: 516-1959 “Methods Of Testing For Strength Of Concrete”
- Splitting tensile stress is obtained using the formula based on *IS: 5816-1970.*
- Compression test is done confirming to *IS: 516-1953.*
- The specimens like are used to conduct the strength tests are taken according *to IS10086-1982*.
- Physical properties of cement has been tested according to *IS 12269-1987*
- Chemical properties of cement has been tested according to *IS 4031 -1988.*

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