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A STUDY ON STRENGTH AND DURABILITY PROPERTIES OF CONCRETE WITH REPLACEMENT OF FINE AGGREGATE BY RECYCLED FINE AGGREGATE

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ABSTRACT

The increasing demand for sustainable construction materials has led to the exploration of recycled fine aggregates (RFA) as a partial or full replacement for natural fine aggregates in concrete. This study investigates the strength and durability properties of concrete with varying proportions of RFA at 0%, 20%, 50%, 80%, and 100%. Experimental tests were conducted to evaluate compressive strength, split tensile strength, and flexural strength at different curing ages. Additionally, durability aspects such as water absorption, chloride penetration, and resistance to sulfate attack were assessed.

Results indicate that replacing fine aggregate with RFA affects the mechanical and durability properties of concrete. While lower replacement levels (20% and 50%) exhibited comparable strength to conventional concrete, higher replacement levels (80% and 100%) showed a noticeable reduction due to increased porosity and weaker interfacial bonding. However, proper mix design adjustments, such as the use of supplementary cementitious materials and admixtures, can mitigate these effects and enhance performance.

The study concludes that RFA can be effectively utilized in concrete production, particularly at moderate replacement levels, contributing to sustainable construction practices by reducing dependency on natural aggregates and minimizing construction waste. Further research is recommended to optimize mix proportions and improve the long-term performance of RFA-based concrete.

Keywords: Recycled fine aggregate, strength, durability, sustainable concrete, aggregate replacement, waste utilization.

I. INTRODUCTION

1.1 General

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 Asia, the construction activities are extremely emerging. Parallel to that, one of the main problems in urban areas is the vast amount of construction and demolition waste produced every day. In many population growth and developing countries, construction and demolition waste often had been disposed incorrectly. Since an obligation of searching the solutions, recycling of the waste is the profitable and appropriate alternative that will improve the construction method. The utilization waste materials will help to avoid several environmental or health damages, reduce the exploration of natural resources, and increase the lifetime of the landfill. The abandoned concrete waste products are generated in a significant amount during the production process or the demolition of the buildings. It has causes a large land required storing it and consequence in land pollution.

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These problems will spend a lot of money. In order to make sure the continuously of crushed aggregates supply, the recycling or reuse the concrete waste as an alternate source as an aggregate replacement. Hence, the sustainable development concept will be achieve due to the concern over the depletion of natural resources and deterioration of the global environment while preserving the environment for the benefit of future generation. Some works of the possibility of using crushed recycled concrete as an aggregate replacement in concrete has been carried out. However, there are several researches of concrete waste as a substitute of the raw material and the knowledge of the effect of concrete waste properties in concrete is inadequate, only few works have been used recycled concrete in the construction.

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 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.

1.2 Objective

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.

1.3 Scope of Study

The concrete waste was crushed to fine aggregate with the maximum aggregate size of 4.75mm. Then, the concrete design mix proportion was prepared where the batching of the concrete material was done by weight. Mix proportioning was based on the water cement ratio (water/cement) and the density of the concrete is 2400kg/m3. The scope of this study is the replacement of natural fine aggregate (sand) with recycled fine aggregate. The ratio of sand replaced to recycled fine aggregate are 100:0% as control, 80:20%, 50:50%, 20:80% and 0:100%.

Sieve analysis, specific gravity and water absorption test had been examine to check on recycled fine aggregates characteristic. In order to achieve the objectives, test for concrete samples were conducted in two categories which are Hardened Concrete properties and Transportation properties are tested. There are several Hardened Tests in which we have conducted such as compressive strength and split tensile strength in this investigation. The samples were tested at the age of 1, 7 and 28 days after casting which is during the curing works. No admixture was used in this experiment. So, the workability of the concrete cannot be improved. The results were analyzed and the graphs were plotted form the data. All the parameters from the test can be determined. So that, the results of the optimum proportion of fine crushed recycled concrete aggregate will be determined.

II. LITERATURE REVIEW

2.1 Materials

Cement concrete is environmentally clean construction material, produced from the local raw materials: aggregates (sand and gravel), cement and water. This is universal construction material used for the construction of various buildings and constructions, as well as for the production of construction parts. The choice of construction materials is always determined by quality and price. Both, concrete's quality, as well as price, largely depends on the raw materials used in the production. In concrete's production process it is important to reduce costs in any technological stage as much as possible. However, the quality parameters of the final product have to fulfil the defined limits. One of the ways to reduce the production costs is to replace the natural aggregates with the ones, produced from buildings' demolition waste. Moreover, from ecological point of view, concrete is an ideal material, where it is possible to integrate construction and demolition waste during then manufacturing process.

Demolition and construction waste consists of the following waste materials: reinforced concrete, concrete, bricks, tiles, glass, wood and other materials, obtained during the demolition of the buildings. Larger amount of buildings' demolition waste consists of concrete and ceramics. Main composition of this waste is shown in Fig. 1.

There are several reasons why the amount of construction and demolition waste is increasing worldwide:

- There are a lot of buildings that are not suitable for exploitation, therefore they have to be rehabilitated or demolished;
- Buildings, even if they are suitable for the exploitation (for instance old factories, farm buildings etc.), lose their functionality, their purpose changes and finally they are demolished (Fig. 2)

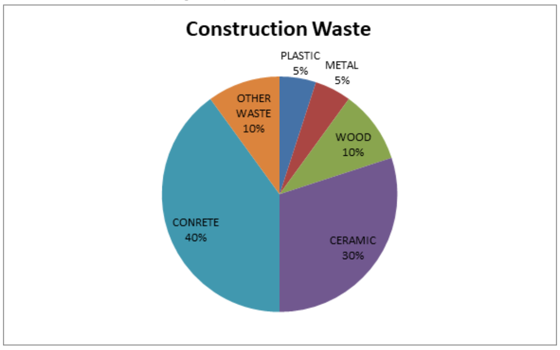

Figure2.1: Composition of materials in building waste

Figure2.2: Demolition waste

2.2 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.

Despite the type of a building being demolished and reprocessing method, main reprocessing stages of the demolition waste are the same: initial preparation of construction and demolition waste, crushing, sorting, metal separation, initial sieving, milling, metal separation, sieving. During demolition of the buildings, excavators, hydraulic alligator shears, metal separation aggregates are used most often. After the demolition works waste is reprocessed by employing special equipment used for the milling and sorting.

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Shredders (Fig.2. 3), milling machines, magnetic separators, sieving machines as well as air separators, That separate thermal insulation materials, wallpaper and other impurities from concrete pieces, are used in reprocessing processes. In Fig. 2.4, the structural technological scheme of the production of the breakstone from concrete waste is shown. After thorough implementation of all breakstone production stages, coarse and fine aggregates of various fractions are obtained. These aggregates, depending on their fraction, are used for the construction.

Figure2.3: Shredder used to prepare concrete breakstone on site.

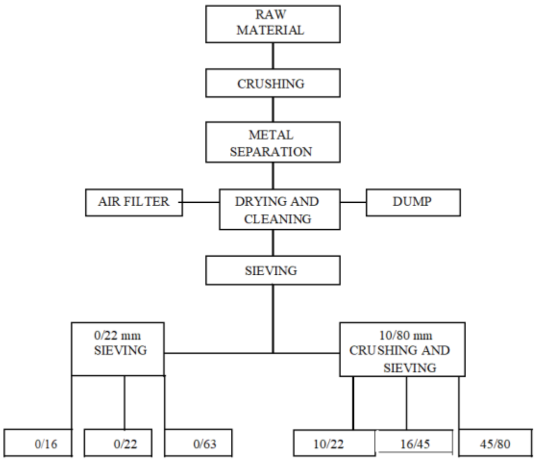

Figure 2.4 Structural technological scheme of the production of the breakstone of various fractions from the construction and demolition waste.

2.3 Problem Statement

For economic, technological and ecological points of view, the aggregate replacement materials have an undoubted role to play in the future of the construction industry. There are lots of benefits in term of economy, preserving the environment, raw materials or natural resources conservation, and energy saving are all substantial. Therefore, the extensive consideration should be applied to the sources and types of aggregates since they can give various effects to the concrete.

Lots of concrete waste is abandoned during the construction and demolition works. For years, the recycled concrete aggregates is been used and still one of the important construction materials instead of other materials. However, the usage of this waste is not too extensive in the construction world today. The reasons of recycled concrete will be used in some of construction works are because of the limited knowledge and research of its performance in the concrete, behavior in the mixing, effects on properties and characteristics to the concrete, and lack of information about the specific standard and capability to the concrete structure.

Since some of the crushed concrete waste properties characteristic are similar to the normal course aggregates, so that the crushed concrete waste can be recycled and substitute as the fine aggregate to the structure. Consequently, the scrupulous understanding of the crushed recycled concrete properties and effect on concrete structure as the coarse aggregate replacement is essential on order to reduce the waste generated and enhance the knowledge of new concrete mix proportion.

2.4 Need for Utilization of Concrete and Masonry Waste Materials

Civil Engineering construction activity is always associated with new development and projects. This can be a housing project, industrial infrastructure power plants, docks and harbour works etc., large quantities of traditional construction materials like earth, sand, stones, bricks, cement concrete, steel, aluminum, wood are used. The demand for these materials is increasing in geometric

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progression. Sustainable development means a commitment to finding and using resources that are renewable. With this philosophy in view, there is an urgent need for optimum reuse of building waste materials available after demolition and renewal of old structures. Also other industrial and agro-waste materials can be appropriately utilized in civil construction works. Therefore, the economic viability of such applications along with the durability of these materials needs further examination. An important obvious advantage is that with recycling of stone, aggregate, bricks etc. quarrying and mining for stones, and will be reduced. Thus the earth surface can be further saved and ecological disturbances on account of this activity will be reduced. For example, raw material for bricks manufacturing is totally earth based. Reuse of bricks means lesser possibilities of removing fertile earth, soil grass cover and forestation. This will minimize environmental destruction in over all terms. With large volume of building works, and to meet its demand, it is observed that there can be large uncontrolled growth of brick kilns, contributing to environmental decay.

Economics and Best Practicable Options for RFA

The main alternative to using recycled aggregates is, of course, natural aggregate and these are still relatively low cost materials. However, in a purely economic balance, the cost of processing to recycled aggregates in the UK is becoming less than that of disposing of the demolition waste and purchasing new aggregates, due to increases in landfill tax and the newly introduced aggregates levy.

If recycled aggregates have to be transported a significant distance from the place of production to the place of use, then both the cost and environmental benefits may become more questionable. In India, the cost of construction materials is increasing incrementally. As a result, in India, the informal sector and secondary industries recycle 15–20% of solid wastes in various building components.

Advantages

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

• Environmental Gain

The major advantage is based on the environmental gain. According to (CSIRO) construction and demolition waste makes up to around 40% of the total waste each year (estimate around 14 million tonnes) going to land fill. Through recycled these material, it can keep diminishing the resources of urban aggregated. Therefore, natural aggregate can be used in higher –grade applications.

• Save Energy

The recycling process can be done on site. According to Kajima Technical Research Institute (2002), Kajima is developing a method of recycling crushed concrete that used in the construction, known as the Within-Site Recycling System. Everything can be done on the construction site through this system, from the process of recycled aggregate, manufacture and use them. This can save energy to transport the recycled materials to the recycling plants.

• Cost

Secondly is based on the cost. The cost of recycled aggregate is cheaper than virgin aggregate. According to PATH Technology Inventory (n.d.), the costs of recycled concrete aggregate are sold around \$3.50 to \$7.00 per cubic yard. It depends on the aggregate size limitation and local availability. This is just around one and half of the cost for natural aggregate that used in the construction works. The transportation cost for the recycled aggregate is reduced due to the weight of recycled aggregate is lighter than virgin aggregate. Concrete Network stated that recycling concrete from the demolition

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projects can saves the costs of transporting the concrete to the land fill (around $0.25 per ton/ mile), and the cost of disposal (around $100 per ton). Besides that, Aggregate Advisory Service also state that the recycling site may accept the segregates materials at lower cost than landfill without tax levy and recycled aggregate can be used at a lower prices than primary aggregate in the construction works.

• Job Opportunities

There will be many people involved in this new technology, such as specialized and skilled persons, general workers, drivers and etc. According to Scottish Executive (2004), a Scottish Market Development Program is developed. The purpose of this program is to recycle the materials that arising in Scotland. This program will provide 150 new jobs in the Scottish industry.

• Sustainability

The amount of waste materials used for land fill will be reducing through usage of recycled aggregate. This will reduce the amount of quarrying. Therefore this will extend the lives of natural resources and also extend the lives of sites that using for landfill.

• Market is wide

The markets for recycled concrete aggregate are wide. According to Environmental Council of Concrete Organization (n.d), recycled concrete aggregate can be used for Side walk, curbs, bridge substructures and superstructures, concrete shoulders, residential driveways, general and structural fills. It also mentioned that recycled concrete aggregate can be used in sub bases and support layers such as unstabilized base and permeable bases.

III. MATERIALS AND MIX PROPORTIONING

3.0 Materials

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

3.1 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. Various properties of the cement has been tested according to IS 12269-1987 and IS 4031 -1988 are given below

3.1.1 Properties of Cement

Physical properties

S.no	Particulars	Results
1	Specific gravity	3.05
2	Initial setting time	170 min
3	Final setting time	230 min
4	Consistency	25%
5	Fineness	3.9

Table 3.1

Chemical Properties

S.no	Particulars	Test results	Specification as per IS:12269:1987
1	LSF(Lime Saturation factor)	0.89	0.8-1.02
2	Alumina Modulus	0.83	Min 0.66
3	Insoluble residue (%)	1.48	Max 3.0
4	Magnesia (%)	1.46	Max 6.0
5	Sulphuric Anhydride (%)	2.06	Max 3.0
6	Loss on Ignition (%)	1.58	Max 4.0
7	Chloride Content (%)	0.009	Max 0.1

Table 3.2

3.2 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.

3.2.1 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 nearby was used. The maximum size of aggregate was varying between 26 -12.5 mm.

Properties of coarse aggregates

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S.no	Particulars	Results
1	Type	Crushed stone
2	Specific Gravity	2.6
3	Water absorption	0.8%
4	Fineness modulus	7.98
5	Size	20 mm (max)
6	Density	1.48

Table 3.3

3.2.2 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

Table 3.4

3.3 Recycled Fine aggregates

The building and demolition 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 separated by sieving. 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	

Table 3.5

3.7 Curing procedure

After casting the cubes and cylinders the specimens were left for 24 hours then they demoulded and kept in normal water curing. The specimens were kept for normal water curing until testing age.

Fig. 3.1 Cement

. 3.2 Fine Aggregate

Fig. 3.3 Recycled fine aggregate

Fig. 3.4 Coarse Aggregate

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Fig. 3.5 Cube moulds

Fig: 3.6 Cylindrical specimen

Fig. 3.7 Cube Specimen

IV. STRENGTH PROPERTIES

Introduction

This chapter explains about the strength properties like compressive strength and split tensile strength.

4.1 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/cm2/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

Fig 4.1Compression strength testing

4.1.1 Compressive strength load details

Compressive Load details of specimen of various mixes in KN							
Mix	cubes	3 days		7 days		28 days	
		Load	Avg	Load	avg	load	avg
M1	1	305	273.33	610	546.67	813.33	728.89
	2	285		570		760	
	3	230		460		613.33	
M2	1	240	303.33	480	606.67	640	808.89
	2	345		690		920	
	3	325		650		866.67	
M3	1	285	294.67	570	590	760	786.67
	2	322		645		860	
	3	277		555		740	
M4	1	305	270	610	540	813.33	720
	2	250		500		666.67	
	3	255		510		680	
M5	1	200	195	400	390	533.33	520
	2	170		340		453.33	
	3	215		430		573.33	

Table 4.1

4.1.2Compressive strength details

Compressive Strength Details of Specimens in N/mm^2							
Mix	cubes	3 days		7 days		28 days	
		Load	avg	Load	avg	load	avg
M1	1	13.56	12.15	27.11	24.30	36.15	32.40
	2	12.67		25.33		33.78	
	3	10.22		20.44		27.26	
M2	1	10.67	13.48	21.33	26.96	28.44	35.95
	2	15.33		30.67		40.89	
	3	14.44		28.89		38.52	
M3	1	12.67	13.10	25.33	26.22	33.78	34.96
	2	14.31		28.67		38.22	
	3	12.31		24.67		32.89	
M4	1	13.56	12.00	27.11	24.00	36.15	32.00
	2	11.11		22.22		29.63	
	3	11.33		22.67		30.22	
M5	1	8.89	8.67	17.78	17.33	23.70	23.11
	2	7.56		15.11		20.15	
	3	9.56		19.11		25.48	

Table 4.2

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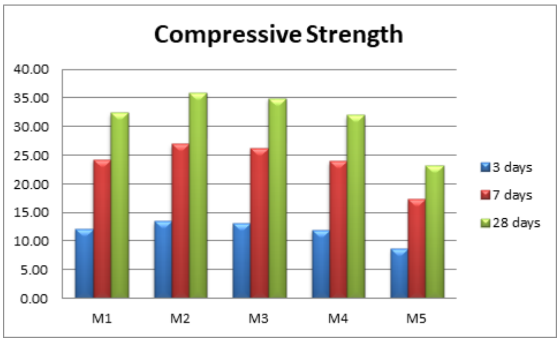
4.1.3 Compressive Strength of different mixes

Compressive strength N/mm^2			
Mix	3days	7 days	28 days
M1	12.15	24.30	32.40
M2	13.48	26.96	35.95
M3	13.10	26.22	34.96
M4	12.00	24.00	32.00
M5	8.67	17.33	23.11

Table 4.3



Graph 4.1 Age vs compressive strength

V. TRANSPORT PROPERTIES

Various permeous properties of recycled fine aggregate concrete has tested for the different mixes. The properties that tested for the recycled fine aggregate concrete are mentioned below.

1. Evaporation test.
2. Absorption test.
3. Moisture migration test.

5.1 Evaporation test

Evaporation test 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 950C 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 are given below in the table 5.2

Evaporation in different mixes

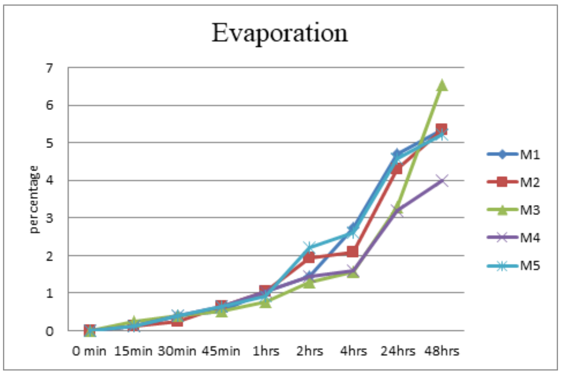
Evaporation in weight									
MIX	0 min	15min	30min	45min	1hrs	2hrs	4hrs	24hrs	48hrs
M1	8.08	8.07	8.05	8.04	8	7.97	7.87	7.72	7.67
M2	8.09	8.08	8.07	8.04	8.01	7.94	7.93	7.76	7.68
M3	8.14	8.12	8.11	8.1	8.08	8.04	8.02	7.89	7.64
M4	7.8	7.79	7.77	7.75	7.72	7.69	7.68	7.56	7.5
M5	8.07	8.06	8.04	8.02	8	7.9	7.87	7.72	7.67

Table 5.1

Evaporation percentage in different mixes

Evaporation in %									
MIX	0 min	15min	30min	45min	1hrs	2hrs	4hrs	24hrs	48hrs
M1	0	0.13	0.39	0.52	1.04	1.43	2.73	4.69	5.34
M2	0	0.13	0.26	0.65	1.04	1.95	2.08	4.29	5.33
M3	0	0.26	0.39	0.52	0.78	1.3	1.57	3.27	6.54
M4	0	0.13	0.4	0.66	1.06	1.46	1.6	3.2	4
M5	0	0.13	0.39	0.65	0.92	2.21	2.6	4.56	5.21

Table 5.2



Graph 5.1 Evaporation **percentages for different mixes**

The values of percentages of evaporation at the ages of 15mins, 30mins, 1hour, 2hours, 3hours, 4hours, 24hours, 48hours, and 72hours are given below in the table 5.2 and this are obtained from the observations that are made from the investigation by taking the changes in the weights of the specimens in periodical ages as mentioned above and they are shown in the table 5.1.As we had conducted some physical tests on the materials and found that the water absorption of RFA as 4% for the different mix proportions of the fine aggregate replacement there will be change in the water/cement ratio.

Graph 5.1 represents the variations of the percentage evaporation occurred in different ages for the different mixes. The evaporation in the early stages is very high and later it

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decreases. At the age of 24 hours the evaporation has been continuously decreased from the mix M1 to M4 as 4.69 to 3.2 and in M5 mix it has increased to 4.56percent. The evaporation is majorly depended on the properties of the ingredients that are used in the concrete as the fines present in the aggregates are more than the absorption is more and that will affect the evaporation property.

5.2 Water Absorption test

Water Absorption 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, 1 hour, 2hours, 3hours, 4hours, 24hours, 48hours and 72hours are given in table 5.4

Water Absorption in different mixes

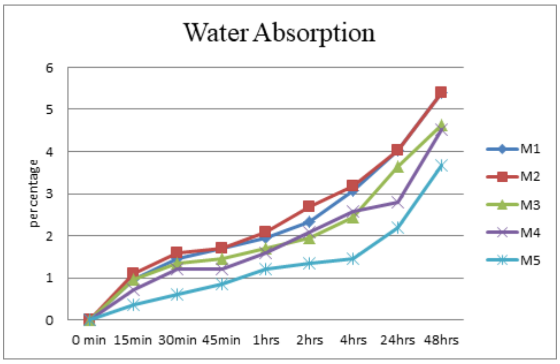
Water Absorption in weight									
MIX	0 min	15min	30min	45min	1hrs	2hrs	4hrs	24hrs	48hrs
M1	7.71	7.79	7.83	7.85	7.87	7.9	7.96	8.04	8.15
M2	7.72	7.81	7.85	7.86	7.89	7.94	7.98	8.05	8.16
M3	7.82	7.9	7.93	7.94	7.96	7.98	8.02	8.12	8.2
M4	7.79	7.85	7.89	7.89	7.92	7.96	8	8.02	8.16
M5	7.86	7.89	7.91	7.93	7.96	7.97	7.98	8.04	8.16

Table 5.3

Water Absorption percentage in different mixes

Water Absorption in %									
MIX	0 min	15min	30min	45min	1hrs	2hrs	4hrs	24hrs	48hrs
M1	0	0.98	1.47	1.71	1.96	2.33	3.06	4.04	5.39
M2	0	1.1	1.59	1.71	2.08	2.69	3.18	4.04	5.39
M3	0	0.97	1.34	1.46	1.7	1.95	2.43	3.65	4.63
M4	0	0.73	1.22	1.22	1.59	2.08	2.57	2.81	4.53
M5	0	0.36	0.61	0.85	1.22	1.34	1.47	2.2	3.67

Table 5.4



Graph 5.2 Water Absorption percentages for different mixes

Graph shows the variations in the percentages of water absorption for the different mixes M1, M2, M3, M4 and M5. M1 mix absorption value is 5.39 for 48 hours as the recycled fine aggregate is replaced with 50% then the value is 4.63%. From the results we can notice that the percentages of the water absorption are reduced with the increase in the replacement of the fine aggregates.

We can observe the values at the age of 45min which made the absorption percentages as 1.71, 1.71, 1.46, 1.22 and 0.85 for the mixes replacing the aggregate by 0%, 20%, 50%, 80% and 100% respectively.

So it is stated that an increase in the replacement of the fine aggregates with the construction and demolition waste will affect the properties of concrete as it has lees percentages of the water absorption property.

5.3 Moisture migration test

Moisture migration 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 noted and the percentages of moisture migration at the ages of 15mins, 30mins, 1 hour, 2hours, 3hours, 4hours, 24hours,

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48hours and 72hours are calculated. The values are given below in the table

Moisture Migration in different mixes

Moisture Migration in weight									
MIX	0 min	15min	30min	45min	1hrs	2hrs	4hrs	24hrs	48hrs
M1	8.02	8.06	8.07	8.08	8.04	8.06	8.07	8.15	8.18
M2	7.76	7.78	7.79	7.8	7.8	7.81	7.83	7.89	8.08
M3	7.73	7.75	7.78	7.79	7.8	7.83	7.85	7.96	8.06
M4	7.4	7.43	7.43	7.45	7.46	7.48	7.52	7.64	7.72
M5	7.86	7.89	7.91	7.93	7.96	7.97	7.98	8.08	8.16

Table 5.5

Moisture Migration recorded in mm for different mixes

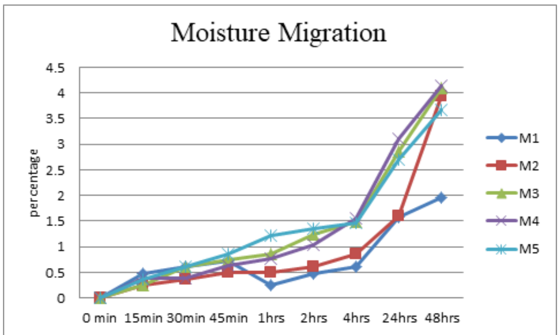
Moisture Migration in mm									
MIX	0min	15min	30min	45min	1hrs	2hrs	4hrs	24hrs	48hrs
M1	0	15	22	28	29	31	35	40	48
M2	0	20	23	32	34	36	38	42	51
M3	0	23	25	28	35	37	38	41	49
M4	0	21	24	29	32	36	33	37	42
M5	0	21	25	33	36	38	39	41	49

Table 5.6

Moisture Migration percentage in different mixes

Moisture Migration in %									
MIX	0 min	15min	30min	45min	1hrs	2hrs	4hrs	24hrs	48hrs
M1	0	0.48	0.61	0.73	0.24	0.48	0.61	1.58	1.95
M2	0	0.24	0.36	0.49	0.49	0.61	0.85	1.59	3.93
M3	0	0.24	0.62	0.74	0.86	1.24	1.48	2.85	4.09
M4	0	0.38	0.38	0.64	0.77	1.03	1.55	3.1	4.14
M5	0	0.36	0.61	0.85	1.22	1.34	1.47	2.69	3.67

Table 5.7



Graph 5.3 Moisture Migration percentages for different mixes

Graph shows moisture migration percentages of cube specimens for different mixes of recycled fine aggregate concrete for the mix M3 moisture migration is more than the other mixes it is 3.1% at the age of 24 hours. As the recycled aggregate content increasing moisture migration % are increased up to 50%. Recycled aggregate content increased above 50% the moisture migration % is decreased.

The results that are observed in the moisture migration test are constant and we can make a statement that replacement of the fine aggregates with the construction and demolition waste does make any changes in the durability properties.

VI. 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 aggregate 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 than the water absorption also increases. The absorption of RFA is 4%.
- The RFA does affect the fresh properties of the concrete.
- The compressive strength is increased up to some percentage of the replacement.
- The properties of the recycled fine aggregate are very similar to the natural aggregates.
- The recycled fine aggregate gives a dense concrete as the fines help in making.
- Tensile strength of the concrete also increases in the replacement of the

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fine aggregate only up to 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 demolition waste.

FUTURE SCOPE

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

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