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Study On Concrete Using Various Recycled Material From Construction Industry

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ABSTRACT

The transformation from a conventional consumption based society to a sustainable society is urgently required due to the pollution of the natural environment, the exhaustion of the natural resources and the decreasing capacity of the final waste disposal facilities. Currently, the construction industry produces 40% of the total volume of industrial waste, which signals a need for reuse to protect the environment and it also requires a study to analyze the possibility using these re-cycled materials at various conditions. And conservation of natural resources and preservation of environment is the essence of development. Rapid growth in population and urbanization are pushing the growth in the construction, especially in the developing countries, and old buildings are being demolished to be replaced with new ones. One of the problem arising from continues technological and industrial development is the disposal of waste material it may be pointed out that Asia alone produces about 760 million tones of construction waste every year. Following this process indiscriminately leads to two basic problems. On the one hand there is an urgent need to fruitfully use the construction debris, which is often simply thrown away or used as a filling material, without considering the ensuing environmental problems. On the other hand the industry is faced with non-availability of good quality aggregate within reasonable distance, and deforestation for thoughtless mining for aggregates from quarries. In fact the problem with natural sand is more serious, and there is an urgent need to consider available options.

Presently the demand for housing is very high in India. The emphasis on infrastructural development has led to mega golden quadrilateral project which has resulted in construction of highway pavements bridges, flyovers, expressways, etc. connecting the length and breadth of the country the enormous increase in construction activities has resulted in consumption of basic materials of concrete making. This has led to shortage of conventional building materials. The construction boom in India coupled with limited supply of natural aggregates and the emphasis on infrastructure development has brought the recycling option to the forefront. Recycling of construction wastes is considered as the need of the hour. There is an urgent need to consider various options.

Key Words: *Demolished, Construction Debris, Recycling Of Construction Waste And Deforestation etc..*

1.INTRODUCTION

1.1 RECYCLING OF CONSTRUCTION AND DEMOLITION WASTE- WORLD SCENARIO

Recycling of construction and demolition (C&D) waste was first carried out after Second World War in Germany to tackle the problem of disposing large amount of demolition waste caused by the war and simultaneously to generate the raw material for reconstruction. Considerable research has been carried out in U.S.A, Japan, U.K, France, Germany, Denmark etc. for recycling concrete stone and brick masonry bituminous and other constituents of waste from construction industry. These studies have demonstrated possibility of using construction waste to substitute new materials of recycling.

In most countries C&D waste goes towards land filling of low lying areas. Reclaimed asphalt pavement are removed from the construction site or road bed, crushed in to aggregate and fines, and use in road way and shoulder base, shoulder surfacing and widening drive way and parking lot maintenance, ditch linings and pavement repairs . concrete construction debris comes from the demolition of buildings, bridge supports, airport runway, and concrete road beds and is broken up and crushed in to fill, coarse and fine aggregate and base material for roads. Recycled aggregate from RAP and reclaimed Portland cement concrete (RPCC) competes in the construction market with natural aggregate. In certain cases federal and state highway contracts for new highway construction require the use of recycled materials.

Hong cong generates about 14 million tones of C&D waste each year and faces almost a crisis on how to accommodate these surplus materials. Apart from putting more efforts in minimizing the generation and setting up of temporary fill banks recycling is one of the most effective means to alleviate the growing problem. For higher grade applications (up to M_{35} concrete), the current specifications allows a maximum of 20 percent replacement of normal coarse aggregates by recycled aggregates.

In Japan, the target for the recycling ratio of demolished concrete in the year 2000 was set at 90 percent, and the actual results for 1990, 1993 and 1995 were 48 percent, 67 percent, 65 percent respectively. In 2000 it reached 96 percent but almost entirely as a sub base material for road pavement. Several trials are now under way to enhance the use of demolished concrete for fresh concrete, including a trial to establish Japan industrial standard for recycled aggregate and /or recycled concrete.

In the European union the C&D waste generation is estimated to be at about 180-370 million tones which is approximately equivalent to 1 tone per capita per year. Most of the European countries have targets for recycling ranging from 50 percent to 95 percent of the C&D waste production by the 2015. As studies have indicated recycled materials are generally less expensive than natural materials.

1.2 . RECYCLING OF CONSTRUCTION AND DEMOLITION WASTE INDIAN SCENARIO

The Indian construction industry is highly employment intensive and accounts for approximately 50percent of the capital outlay in successive 5-year plans of the country. The project investment in this sector continues to show a growing trend. Rapid construction activity and growing demand for houses has led to short fall of traditional building materials. Rapid industrialization has led to the generation of large quantities of wastes, which posses major problem of disposal. Disposal and utilization of industrial wastes is one of the major problems in India. Factors such as environment, economy, shortage of land for disposal and the shortage of good quality of raw material for construction make it imperative that wastes should be suitably recycled.

1.3 WASTE GENERATION

The central pollution control board (CPCB) estimates current quantum of solid waste generation in India to be to the tune of 48 million tons per annum, out of which the waste from construction industry accounts for about12 to 14.7 million tons as given in table 1.1. management of such high quantum of waste puts enormous pressure on the solid waste management system. At present, the management of waste from construction industry in India comprises of the following elements. Re-use of only the selected material salvaged in good condition during demolition. Sending metallic items for recycling through scrap dealers. Dumping of the remaining items to low laying sites and dumping areas. Estimated waste generation during construction and renovation / repair work is 40 to 60 and 40 to 50 kg/m^2 respectively. The highest contribution to waste generation is from demolition of buildings, respectively. The typical application of various recycled materials is given in table 1.2.

Table 1.1 waste constituents in India (million tons per annum)

Constituent	**Quality generation in million tons per annum (range)**
Soil, sand and gravel	4.20 to 5.14
Bricks and masonry	3.60 to 4.40
Concrete	2.40 to 3.67
Metals	0.60 to 0.73
Bitumen	0.25 to 0.30
Wood	0.25 to 0.30
Others	0.10 to 0.15

Table 1.2 typical applications of various recycled materials

Material	**Wearing course**	**Base**	**Sub base**	**Back fill**	**General fill**	**Drainage**	**Land scaping**
Reclaimed asphalt pavement(RAP)	√						
RCC		√	√	√	√	√	
Bricks /tiles		√	√			√	√
Masonry products		√					
Sands		√					
Green waste							√

1.4 RECYCLING AS AN OPTION

In India very few attempts have been made to use recycled aggregate on a large scale. The Technology Information Forecasting and Assessment Council (TIFAC) had commissioned a techno market survey on utilization of waste from construction industry.

The focus of their study was to assess the present knowledge of the Indian construction industry on the possibility of the recycling of C&D wastes. The survey was targeted towards the housing / building sector and road construction segment. According to findings of

the survey, the most dominant reason for not adopting recycling of waste from construction industry is "Not aware of the recycling techniques" while 70 percent of the respondents have indicated that they are not even aware of recycling possibilities. The response of industries, which can use the recycled product, indicates that presently, the specifications do not provide for use of recycled product in the construction activity. Sixty seven percent of the respondents from user industry have indicated non availability of recycled product as one of the reasons for not using it.

1.5 WHAT ARE RECYCLED CONCRETE AGGREGATES?

Recycled concrete aggregate (RCA) is obtained mainly by crushing and processing concrete elements that have been previously used in construction, where the masonry content limited to not more than 5 percent. Recycled aggregates are there for not the same as recovered aggregates which are obtained by washing the cement paste out of fresh concrete and returning the aggregate to the aggregate stockpile.

There are two main aspects, which require close attention before considering use of recycled aggregate in structural concrete.

Inferior physical properties for example, lower density and higher water absorption compared with natural aggregate these are attributable to the adhesion of cement – sand paste from the present concrete. Which cannot be removed completely even with the advanced processes in practice.

Likelihood of problems inherited from the present concrete, caused by internal chemical reactions (high-alumina cement, alkali –aggregate reaction, etc) and/or by the actions of deterioration mechanisms on the parent concrete (chloride, carbonation, etc)

Further there is a need to carefully plan the use of concrete with recycled aggregates as past work has also indicated a tendency for higher rates of carbonation and permeability. Thus it appears that the use of recycled concrete as aggregate should pose no special problems at least in lower level application, such as plain concretes, concrete having compressive strength up to about 20-30 Mpa, or in pavement sub base concrete etc. however replacement levels of up to 20 percent can be recommended for concrete grades more than 35 Mpa. However caution needs to be exercised to use aggregate made with demolition waste in other applications in view of the performance of such concretes in creep, shrinkage, etc. in higher end applications.

1.6 PARADIGM OF FUTURE GENERATION CONCRETE

The current policy of development emphasizes on self sustained technology and green global environment which puts constraints over higher production rates of materials. The production of cement liberates $^-$ co_2 in the atmosphere and polluting the environment. Globally efforts are taken to specify the minimum cement content for concrete subjected to different exposure condition without affecting its performance during its service life. More recently there have been a grooving awareness of the importance of sustainability in concrete construction and in particular the more effective and efficient use of materials. i.e. to recycle or re use materials. The 3'R's is to reduce, reuse and recycle the waste products judiciously.

It is now progressively recognized that the use of recycled aggregates in concrete construction represent a potential value added outlet for the materials. And is often economically viable and environmentally beneficial. There are also benefits of waste reduction. When used appropriately it has been shown that these materials may

- Create high performance aggregates to conserve natural mineral resources.
- General sustainable construction.
- Reduce waste disposal cost.
- Minimize dependency on landfill.

The need for durable concrete construction and responsible use of materials can be met through minor changes to existing concrete technology and construction practices.

1.7 BORN AGAIN CONCRETE FROM CONCRETE DEBRIS

Recycling of the construction waste is considered as the need of the hour. Research in different countries has suggested the possibility of reusing the hard insert materials in the construction wastes. Broken concrete and bricks mostly from building can be used to give recycled aggregate concrete (RAC) and similarly broken pavement can be used to build reclaimed asphalt pavement (RAP).

Recycled concrete aggregate is obtained mainly by crushing and processing concrete elements that have been previously used in construction, where the masonry content is limited to be not more than 5 percent. The use of recycled concrete as aggregate should not pose any special problems at least in lower level applications such as plain concrete.

1.8 CONCLUDING REMARK

In this chapter the essential features of the development of the third generation concrete are brought out in this chapter. Factors such as environment, economy, shortage of land for disposal and the shortage of good quality of raw materials for construction to make it imperative that wastes should be suitably recycled is emphasized. The detailed literature survey is covered in the next chapter

2.EXPERIMENTAL INVESTIGATIONS

2.1 GENERAL

The main aim of this experimental work is to study the physical properties of the materials, and also to study the properties of recycled aggregate concrete at various temperature.

2.2 SOURCE OF WASTE CONCRETE

The concrete debris were collected from the demolition works doing in vel tech university Avadi and also from the casting yard of Soma constructions and coarse aggregates were segregated from the debris manually and sieved to obtain the specified size.

Fig 2.1segregating coarse aggregates from waste concrete.

Fig 2.2 source of debris

2.3 MATERIALS USED IN THE PRESENT WORK

The materials used in the present experimental investigation are

- Cement
- Natural fine aggregate (NFA)- sand (IS383-1970)
- Natural coarse aggregate (NCA)- crushed 20mm max size (IS383-1970)
- Recycled coarse aggregate 20mm max size (RCA)
- Potable water available in Vel tech university

2.4 EXPERIMENTAL INVESTIGATION ON PHYSICAL CHARACTERISTICS OF MATERIALS

The detailed experimental investigation is carried out to establish the physical characteristics of the materials going to use such as cement, course aggregate, fine aggregate.

2.4.1 SPECIFIC GRAVITY OF AGGREGATES

The test procedure for determining the specific gravity of coarse aggregate is outlined below following the guidelines as per IS 2386(part III) – 1963 reaffirmed 1997

Using the pycnometer – a sample of about 1 kg of the specified size placed in the tray and washed with water at a temperature of 22to 32^{o}c. soon after immersion the air entrapped in or bubbled on the surface of the aggregate shall be removed by gentle agitation with a rod. The sample shall be immersed for 24 ± ½ hours. The water shall be then carefully drained from the sample by decantation through the filter paper, any material retained being return to the sample. The aggregate including any solid matter retained on the filter paper, shall be exposed to gentle current of warm air to evaporate surface moisture and shall be stirred at frequent intervals to ensure uniform drying until no free surface moisture can be seen and the material just attains a free running condition. Care shall be taken to ensure that this stage is not passed. The saturated and surface dry sample shall be weighed (weight W2). The aggregate then shall be placed in the pycnometer which shall be filled with distilled water. Any trapped air shall be eliminated by rotating the pycnometer on it's side, the hole in the apex of the cone being covered with a finger. The pycnometer shall be toped up with distilled water to remove any froth from the surface of the water in the hole is flat. The pycnometer shall be dried on the outside and weighed (weight W3). The contents of the pycnometer shall be emptied into the tray, care being taken to ensure that all the aggregate is transferred. The pycnometer shall be refilled with distilled water to the same level as before, dried on outside and weighed (weight W4).

Specific gravity shall be calculated as given in equation

Specific gravity of aggregate = $\frac{w2-w1}{(w2-w1)-(w3-w4)}$

Table 2.1 specific gravity of F.A

Name	Description	Observation (g)
W_1	Wt. of empty bottle	463
W_2	Wt. of empty bottle & sample	1010
W_3	Wt. of empty bottle, sample and H_2O	1605
W_4	Wt. of empty bottle and H_2O	1267
= 2.61	$\frac{W_2 - W_1}{(W_2 - W_1)-(W_3 - W_4)}$	

Table 2.2 specific gravity of C.A

Name	Description	Observation (g)
W_1	Wt. of empty bottle	463
W_2	Wt. of empty bottle & sample	918
W_3	Wt. of empty bottle, sample and H_2O	1557
W_4	Wt. of empty bottle and H_2O	1267
= 2.75	$\frac{W_2 - W_1}{(W_2 - W_1)-(W_3 - W_4)}$	

Table 2.3 specific gravity of R.C.A

Name	Description	Observation (g)
W_1	Wt. of empty bottle	463
W_2	Wt. of empty bottle & sample	900
W_3	Wt. of empty bottle, sample and H_2O	1525
W_4	Wt. of empty bottle and H_2O	1267
= 2.56	$\frac{W_2 - W_1}{(W_2 - W_1)-(W_3 - W_4)}$	

2.4.2 STANDARD CONSISTENCY TEST

The standard consistency test of a cement paste is defined as that consistency which will permit a vicat plunger having 10mm diameter and 50mm length to penetrate to a depth of 33-35 from the top of the mould, the apparatus is called vicat apparatus. This apparatus is used to find out the percentage of water required to produce a cement paste of standard consistency. The standard consistency is sometimes called as normal consistency.

Table 2.4standard consistency

Trail	Water content %	Penetration (mm)	Consistency p
1	24	16	
2	28	40	0.1358
3	29	44	

2.4.3 INITIAL SETTING TIME

The apparatus used for this initial setting time is vicat apparatus. Lower the needle gently and bring it in contact with the surface of the test block and quickly release. Allow it to penetrate in to the test block in the beginning the needle will completely pierce through the test block. But after some time when the paste starts losing it's plasticity. The needle may penetrate only to a depth of 33-35 mm from the top. The period elapsing between the time when water is added to the cement and the time at which the needle penetrates the test block to depth equal to 33-35 mm from the top is taken as initial setting time.

Table 2.5 initial setting time

Trail	Time (min)	Penetration (mm)	Initial setting time (min)
1	5	50	
2	10	48	
3	15	45	30.27
4	20	40	
5	25	36	
6	30	32	

2.4.4 SIEVE ANALYSIS

This is the name given to the operation of dividing a sample of aggregate into various fractions each consisting of the particle of the same size. The sieve analysis is conducted to determine the particle size distribution in a sample of aggregate which is called gradation.

The aggregate used for making concrete are normally of the maximum size 80mm, 40mm, 20mm, 10mm, 4.75mm, 2.36mm, 600micron, 300micron, and 150 micron. The aggregate fraction from 80mm to 4.75mm are termed as coarse aggregate and those fraction from 4.75mm to 150micron are termed as fine aggregate. The size 4.75mm is common fraction appearing both in coarse aggregate and fine aggregate.

Table 2.6 sieve analysis test for C.A

S.NO.	Sieve designation	Aperture size (mm)	Wt. of residue(gms)	% of Wt. of residue	Cumulative % of retained Wt.	% of passing
1	80	80	0	0	0	0
2	63	63	0	0	0	0
3	50	50	0	0	0	0
4	40	40	0	0	0	0
5	25	25	80	4	4	96
6	20	20	319	15.95	19.95	80.05
7	12.5	12.5	1035	51.75	71.70	28.30
8	10	10	425	21.25	92.95	7.08
9	4.75	4.75	141	7.05	100	0

Table 2.7 sieve analysis test for F.A

S.NO.	Sieve designation	Aperture size (mm)	Wt. of residue(gms)	% of Wt. of residue	Cumulative % of retained Wt.	% of passing
1	4.75	4.75	12	1.2	1.2	98.8
2	2.36	2.36	16	1.6	2.8	96.0
3	1.70	1.70	45	4.5	7.3	88.7
4	1.18	1.18	108	10.8	18.1	70.6
5	600µ	0.60	388	38.8	56.9	43.1
6	300µ	0.30	309	30.9	87.8	12.2
7	150µ	0.15	96	9.6	97.4	2.6
8	90µ	0.09	23	2.3	99.7	0.3
9	PAN	0	3	0.3	100	0

Table 2.8 sieve analysis for R.C.A

S.NO.	Sieve designation	Aperture size (mm)	Wt. of residue(gms)	% of Wt. of residue	Cumulative % of retained Wt.	% of passing
1	80	80	0	0	0	0
2	63	63	0	0	0	0
3	50	50	0	0	0	0
4	40	40	0	0	0	0
5	25	25	75	3.75	3.75	96.25
6	20	20	299	14.95	18.70	81.30
7	12.5	12.5	1055	52.75	71.45	28.55

8	10	10	418	20.90	92.35	7.65
9	4.75	4.75	153	7.65	100	0

2.4.5 TESTS FOR WATER ABSORPTION

A sample of aggregate not less than 2kg is washed and immersed in water for 24 hours and it's immersed weight in water is found (A). It is taken out of the water and the saturated surface dry sample is weighed in air (B). It is then over dried and weighed(C)

Specific gravity =C/(B-A)x100

Water absorption for normal aggregate is found that 4%, and for recycled aggregate concrete it is 6%.

2.5 MIX DESIGN DETAILS OF M_{20} CONCRETE

The m_{20} grade of concrete is designed as per IS method (IS 10262-1982). The mix design details are given below for the concrete manufactured.

- Characteristic Strength = 20 N/mm^2
- Degree of quality control = good
- Degree of workability = 0.85
- Max. Size of aggregate = 20mm
- Sp. Gravity of C.A = 2.6
- Sp. Gravity of F.A = 2.6
- Sp. Gravity of CEMENT = 3.15
- Type of exposure = Moderate
- Type of usage = RCC Structure
- Target mean strength @ end of 28 day (f_{ck}) = 27.59 N/mm^2
- Selection of water cement ratio (W/C) = 0.48%
- Approximate air content Estimation = 2%
- Mix proportion by bulk volume

0.48 : 1 : 1.29 : 2.67

2.6 TESTS ON FRESH CONCRETE

2.6.1 SLUMP TEST

The standard apparatus for this test is the slump cone. It is used to measure the workability of concrete. Workability is used to define the ease or difficulty with which the concrete can be handled.

From the test conducted it is observed that both conventional and recycled aggregate concrete are getting the true slump. But workability was little bit less when compared to conventional concrete.

2.7 COMPRESSIVE STRENGTH OF CONCRETE

As per the recommendations of IS: 516:1959. Standard dimensions of cubes 150 X 150 X150mm (9 no's) in each of the concrete cast with natural aggregates, recycled aggregates. The samples are cured and tested at the end of 7 days, 14 days and 28 days. The samples are taken out at the end of 7 days, 14 days and 28 days kept outside and wiped of surface moisture. Three numbers of samples in each of the concrete were subjected to rebound hammer test and followed by compression test using the compression testing machine of 300T capacity. The results of the average strength of the cubes are reported below.

2.7.1ULTRASONIC PULSE VELOCITY TEST

Ultra sonic pulse velocity method which involves the measurement of the time of travel of electronically generated mechanical pulses through the concrete, the pulse generator circuit generates the pulses (15 to 50 KHz) and transducer transmits these to mechanical pulses and the reception of the pulses is measured electronically and this is used for the estimation of the quality of the specimen.

Fig 2.3 compression test for concrete cube

2.7.2 TEST RESULTS ON CUBES

Table 2.9 Rebound hammer, UPV and compression test results of NAC at 100^{o}c

Temperature At (^{o}c)	Type of test	Curing done in days		
		7days	14days	28days
100	Normal compression test result (N/mm^2)	21.817	23.74	27.82
100	Rebound hammer Test result (N/mm^2)	21.33	22.667	27.33
100	U P V test	Excellent	Excellent	Excellent

Table 2.10 Rebound hammer, UPV and compression test results of NAC at 200^{o}c

Temperature At (^{o}c)	Type of test	Curing done in days		
		7days	14days	28days
200	Normal compression test result (N/mm^2)	20.92	23.03	26.95
200	Rebound hammer Test result (N/mm^2)	20.33	22.67	26.333
200	U P V test	Excellent	Excellent	Excellent

Table 2.11 Rebound hammer, UPV and compression test results of NAC at 300°c

Temperature At (°c)	Type of test	Curing done in days		
		7days	14days	28days
300	Normal compression test result (N/mm^2)	18.99	21.36	25.30
300	Rebound hammer Test result (N/mm^2)	18.33	20.667	24.667
300	U P V test	Excellent	Excellent	Excellent

Table 2.12 Rebound hammer, UPV and compression test results of RAC at 100°c

Temperature At (°c)	Type of test	Curing done in days		
		7days	14days	28days
100	Normal compression test result (N/mm^2)	20.26	22.99	24.01
100	Rebound hammer Test result (N/mm^2)	20	22.33	23.667
100	U P V test	Excellent	Excellent	Excellent

Table 2.13 Rebound hammer, UPV and compression test results of RAC at 200°c

Temperature At (°c)	Type of test	Curing done in days		
		7days	14days	28days
200	Normal compression test result (N/mm^2)	19.667	21.767	23.27
200	Rebound hammer Test result (N/mm^2)	19.33	21.667	23.667
200	U P V test	Excellent	Excellent	Excellent

Table 2.14 Rebound hammer, UPV and compression test results of RAC at 300°c

Temperature At (°c)	Type of test	Curing done in days		
		7days	14days	28days
300	Normal compression test result (N/mm^2)	17.846	21.463	22.29

300	Rebound hammer Test result (N/mm^2)	17.33	21.667	21.667
300	U P V test	Excellent	Excellent	Excellent

2.8 SPLIT TENSILE STRENGTH OF CONCRETE

As per the recommendations of IS 516-1959. Standard dimension of cylinders of 150mm diameter 300mm height (9 nos) in each of the concrete cast with natural aggregates, recycled aggregates. The samples are cured and tested at the end of 7 days, 14 days and 28 days. The samples are taken out at the end of 7 days, 14 days and 28 days kept outside and wiped of surface moisture. Three numbers of samples in each of the concrete were subjected to split tensile test using the compression testing machine of 300T capacity. The results of the average strength of the cylinders are reported below.

2.8.1 TEST RESULTS

Table 2.15 Split tensile strength of NAC

Temperature At (^{o}c)	Type of test	Curing done in days		
		7days	14days	28days
100	Split tensile test results (N/mm^2)	1.416	2.001	2.654
200		1.582	2.098	2.735
300		1.529	1.959	2.649

Table 2.16 Split tensile strength of RAC

Temperature At (^{o}c)	Type of test	Curing done in days		
		7days	14days	28days
100	Split tensile test results (N/mm^2)	1.147	1.685	2.064
200		1.025	1.472	1.906
300		0.958	1.416	1.825

3.RESULT ANALYSIS AND CONCLUSION

3.1 RESULT COMPARISON

The cubes of NAC and RAC were tested under high temperature of various levels (100°c, 200°c, 300°c) and the performance of the same at 7th day, 14th day and 28th day in terms of compressive strength and Tensile strength has been done. From the results obtained, the analysis of the values were done.

Comparison of 7th day compressive strength

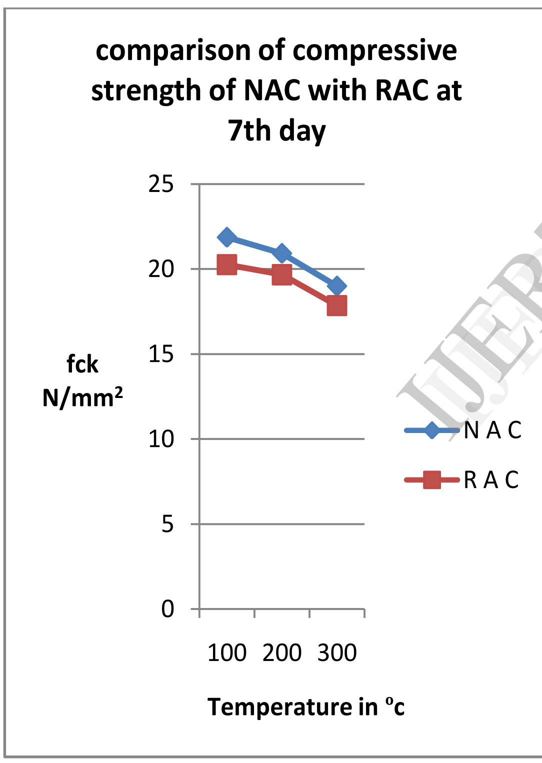

Figure3.1 Comparison of 7th day compressive strength

At high temperature the RAC performance show a lesser trend than that of NAC. At 100°c, RAC achieves compressive strength up to 92.9% than NAC. At 200°c, the RAC achieves compressive strength up to 94.1% than NAC. At 300°c, the RAC achieves compressive strength up to 93.9% than NAC.

This shows that, even though the RAC shows a low strength. The difference in strength is very less and the performance of RAC under 200°c was much better than other temperature.

Comparison of 14th day compressive strength

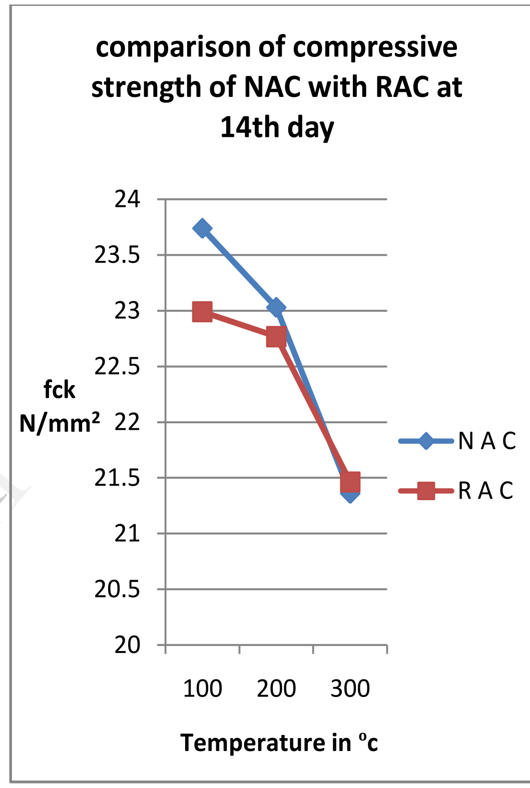

Figure3.2 Comparison of 14th day compressive strength

At 14th day 100°c and 200°c the RAC achieves a strength of 96.85% and 94.6% respectively when compared to NAC. But at 300°c RAC shows a Marginal increase of 0.48% than that of NAC. This shows that the percentage increase of compressive strength from 7th day to 14th day is higher for RAC than NAC.

Comparison of 28th day compressive strength

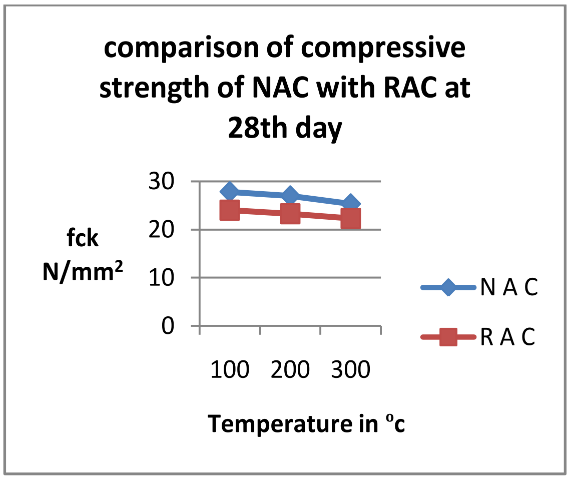

Figure3.3 Comparison of 28th day compressive strength

At 28th day, RAC achieves almost 86.3%, 86.35%, 88.11% of compressive strength of NAC at 100°c, 200°c, 300°c respectively .This shows that the percentage increase in strength from 14th day to 28th day is lesser for RAC than NAC

Comparison of 7th day split tensile strength

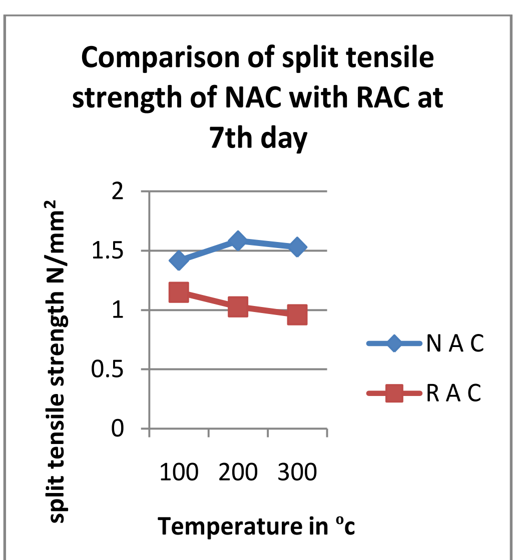

Figure3.4 Comparison of 7th day split tensile strength

At high temperature the RAC performance show a lesser trend than that of NAC.

While comparing with NAC, RAC has achieved strength 81.01% At 100°c.

While comparing with NAC, RAC has achieved strength 64.8% At 200°c.

While comparing with NAC, RAC has achieved strength 62.7% At 300°cThis shows RAC has achieved almost satisfactory tensile strength when compared NAC.

Comparison of 14th day split tensile strength

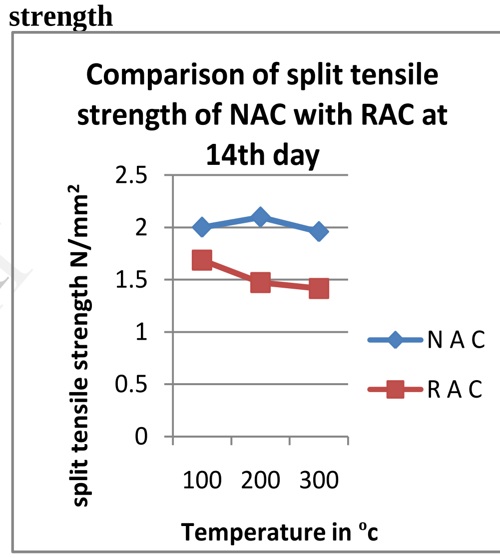

Figure3.5 Comparison of 14th day split tensile strength

At 14th day, RAC achieves tensile strength of 84.2%, 70.2% and 72.3% at 100°c, 200°c & 300°c respectively when compared to NAC

Comparison of 28th day split tensile strength

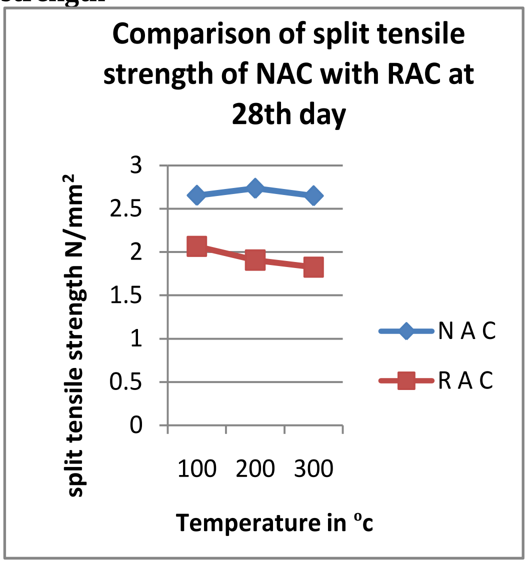

Figure 3.6 Comparison of 28th day split tensile strength

At 28th day , RAC performance was fairly low. At 100°c, 200°c, 300°c RAC achieves 78.84%, 69.7%, 68.9% respectively when compared to NAC.

This shows the percentage of increase in tensile strength is almost same for both NAC and RAC

3.2 CONCLUSION

From inferences of the test results and the graphs comparing compressive strength and split tensile strength of NAC and RAC the following conclusions can be drawn

While considering the strength characteristics, RAC exhibited almost the same properties as those exhibited by the NAC.

The compressive strength test results show that the RAC achieves a value of 86% to 95% of the NAC at temperature ranges from 100°c to 300°c

The added benefit of using RAC is that it paves the way to a new alternative of disposing waste concrete instead of simply dumping it pointlessly at places.

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