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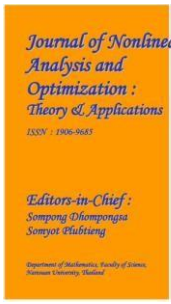

RECYCLED AGGREGATE CONCRETE USING POZZOLANIC MATERIALS

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ABSTRACT
Building new projects is the process of construction, which is a never-ending endeavour. The primary elements that make up 70–80% of the mixture of concrete are the aggregates. The building sector in India is estimated to produce between 10 and 12 million tonnes of garbage a year. The most adaptable material that is often utilised in the building industry is concrete. The lack of natural aggregates means that other materials must be considered.
The primary purposes of using this recycled coarse aggregate are to lower greenhouse gas emissions and to lower building material costs, hence lowering the overall construction budget. Demolished trash may be drastically decreased by recycling, recovering, and minimising construction and demolition waste. Recycling is primarily done to reduce the quantity of garbage that has to be disposed of and to protect the environment.
The goal of the current study is to evaluate the characteristics of concrete using both recycled and natural aggregate. For improved strength and workability, pozzolanic minerals such as fly ash and silica fume are utilised as mineral admixtures. 10% SF and 20% FA are used in lieu of cement in the design mix. RAC20 is composed of several recycled aggregate grades (GA20, GA25, GA30, GA35, and GA40) with varying replacement percentages (50, 75, and 100%). Presoaking the aggregates is done before to mixing the concrete during mix proportion. The method of mixing concrete in three stages is used in its manufacture. At seven and twenty-eight days of age, the density, compressive strength, and water absorption of PC & RAC were measured. Compressive strength findings are discovered to be less than desired strength. At 50% replacement with GA20, 95% of the desired strength (27.55MPa) is reached. Strength may have been attained by extending the curing time.
Additionally, it is shown that RAC has a lower density and water absorption than NAC.
Key words: Compressive strength, fly ash (FA), silica fume (SF), parent concrete (PC), natural aggregate concrete (NAC), recycled aggregate concrete (RAC), granite aggregate (GA), Density and water absorption.

I.INTRODUCTION
Development turns into the fundamental contribution for Financial improvement of any country. Any development action requires a few materials like cement, steel, block, wood and so on Notwithstanding, the concrete substantial remaining parts the primary development material utilized in development businesses. Concrete is the used construction material and has established itself as the most versatile material in all the disciplines of civil owing to its high compressive strength. Moreover, natural resources are depleting remarkably due to extensive demand for new constructions. It is estimated that the construction industry in India generates about 10-12 million tonnes of waste annually. The recycled aggregate in concrete is gaining popularity in all over the world due to the preservation of the environment and suitable development [1]. Hence, a number of studies have been by using recycled aggregate in concrete, but they always resulted in lower level of concrete strengths. This due to the residual impurities on the surface of the aggregates, which blocked the strong bond between cement past and aggregates [2]. A number of previous publications studied the mechanical

behavior of concretes containing recycled aggregates. The results showed the strength loss caused by RAC aggregates at equal water-cement ratio could be reduced if better used as coarse recycled aggregate and if a lower portion of fine recycled aggregates was added [3].
Mineral admixtures such as fly ash, silica fume, metakaolin and granulated blast slag have been utilized for many years either as supplementary cementations materialsin Portland cement concretes or as a component in blended cement [4, 5]. Generally, due to their high Pozzolanic activity, the inclusion of fly ash improvise properties of concrete [6]. Preliminary studies have been conducted on the properties of recycled concrete made with mineral admixtures [7]. The huge amounts of wrecked cement are accessible at different building locales, which are currently representing a major issue of removal in metropolitan regions. This can without much of a stretch reused as total and utilized in concrete [8-12]. Construction waste is bulky and heavy and is mostly unsuitable for disposal by compositing. The growing population in the country and requirement of land for other uses has reduced the availability of land for waste disposal. The trend of the utilization of aggregates is the solution of an excess of waste materials.

1.1 Recycled aggregates in concrete

Recycled aggregates (RA) is a poor quality its higher porosity resulted from cement attaching to the RA surface that hampers the potential of recycle concrete waste. Many previous research works recorded reduction in strength for concrete made with RA, thus the use of RA is mainly confirmed to low grade applications. Recycled concrete is simply old concrete that has been crushed top produce aggregate Recycled aggregates will have higher drying shrinkage than the conventional aggregates.
Concrete made with reused coarse totals and regular fine totals can get a satisfactory compressive strength. The utilization of reused fine total can bring about minor compressive strength decreases. Be that as it may, drying shrinkage and creep of cement made with reused totals is up to 100% higher than concrete with relating regular total. In this way, significantly lower benefits of drying shrinkage can be accomplished utilizing reused coarse total with normal sand. Similarly as with any new total source, reused substantial total ought to be tried for sturdiness, degree, and different properties.

1.2. Recycled aggregate (RA) types

RA is according to the grain size. Typically coarse RA (> 4 mm) is much easier to use in concrete production than fine RA (< 4 mm). This is because after normal concrete crushing and sieving operations the proportion of good natural is much higher in the coarse portion than in the fine portion. After advanced RA production methods, coarse RA can basically consist of natural aggregate.
The use of RA together with other recycled materials in cement based on the use of RA with Pozzolanic such as fly ash (FA)/classified FA/micronized FA, silica fume (SF), slag (SLG), other (recycled) powder/micronized materials, brick powder, glass powder, rock powders and even e.g. lime production waste is a way to widen the use of demolished concrete. RA can also be used to produce low strength materials, as filling materials, including ecological materials also totally without or with a minimum amount of cement.

1.2.1. Advantages in recycling of construction materials

- It leads to conservation of natural resources, especially in regions where aggregates are scarce.
- Use of any recycled material helps to keep that material out of landfills.
- Cost saving: - There are no detrimental effects on concrete & it is expected that the cost of cement could be offset by the lower cost of Recycled Concrete Aggregate (RCA).
- Save environment: is no excavation of resources & less transportation. Also less land is required.
- Save time: - There is no waiting for material availability.

1.2.2. Disadvantages in recycling of construction materials

- Less quality (e.g. compressive strength reduces by 10-30%).
- Duration of procurement of materials may affect life cycle of project.

- Land, special equipment's machineries are required (more cost).
- Very high water absorption (up to 6%).
- It has higher drying shrinkage & creep.

1.3. Influence of adhered motor in recycled aggregate concrete

In reused totals, the followed mortar and glue are consistently present. That roughly 20% of concrete mortar was connected to 20 to 30mm size total [12]. The amount of followed mortar in the first total is relative to the strength of the first concrete. The reused totals which started from the low strength concrete had less followed mortar and concrete had more followed mortar [14-15].

1.4. Influence of Pozzolanic materials an ITZ of recycled aggregate

In customary cement the one of a kind interfacial progress zone is introduced between the mortar glue. Concrete made with reused total have an extra (ITZ) between the old clung mortar to the first total and the new mortar. In the event of a high water- folio proportion concrete, where the old ITZ is more grounded than the new ITZ, the strength of reused total cement was equivalent to that of typical total cement [16]. Then again, in the event of a lower water-folio proportion, where the old ITZ is more vulnerable than the new ITZ, the strength of the reused total cement is lower than that of typical total cement. The silica smolder treatment brought about an expansion of 23 to 33% and 15% in the compressive strength at ages 7 and 28 days, individually [17-19]. Apparently silica seethe impregnation further develops both the interfacial change zone between the reused totals and the new concrete framework, and the mechanical properties of the reused total.

1.5. Three stage mixing approach

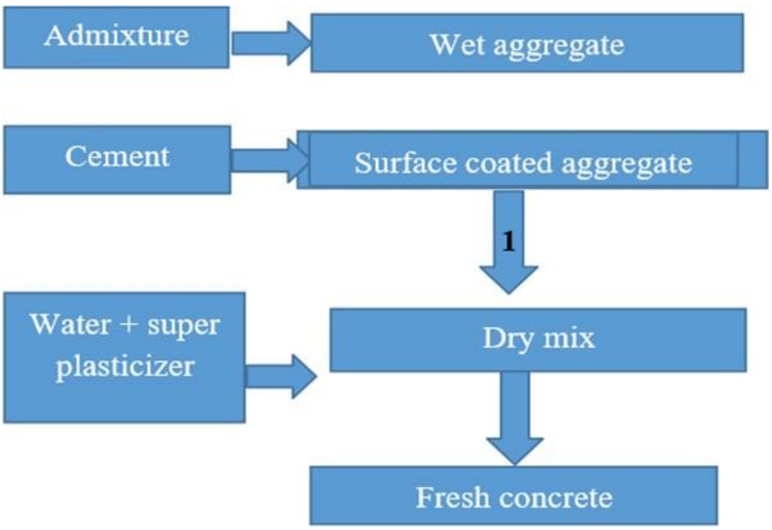

Fig.1.1: Three stage mixing approaches

1.6. Scope and Objective of Work

- To study the parent aggregate on recycled aggregate concrete by using Pozzolanic materials (silica fume and fly ash).
- To the RAC20 using replacement of recycled aggregate (i.e. 50%, 75% and 100%) with natural aggregate.

II. PRELIMINARY EXPERIMENTAL INVESTIGATION

2.1. Introduction

The details of the mix proportions, casting and testing procedures of various tests carried out to investigate the properties of ingredients are presented in this chapter.

2.2. CEMENT

The cement used throughout my thesis was ordinary Portland cement (OPC53grade) confirming to IS: 12269-1989.It was obtained from a single source MAHA Gold LTD, Visakhapatnam. The chemical and physical properties of the cement were tested as per the IS: 4031-1985 & IS: 40311988 respectively.

2.2.1. Compression strength of cement As per IS 403:1988-Part VI

- Taken sample and sand such that quantity of cement and sand ratio is 1:3.
- Then add water of quantity [(P/4) + 3.0] of total mass of cement and sand, whether P is the percentage of standard consistency.
- Mix the cement and sand with a trowel for 1 min and then with water mixture is of uniform the time of mixing shall be not less than 3min.
- Apply petroleum jelly on all sides of mould and its base plate.
- Place the assembled mould on the table of the vibration machine and hold it firmly in position by means of a suitable clamp.
- Attach a hopper of suitable size and shape securely at the top of the mould to facilitate filling and this hopper shall not be removed until the completion of the vibration period.
- Immediately after mixing the mortar, fill the entire quantity of mortar in the hopper of the cube and compact by vibrating. The period of vibration shall be 2 minutes at the specified speed of 12000±400 vibration per minute.
- Then placed the cube moulds in temperature of 27±2oC for 24 hours. removed the cubes from the mould and immediately submerged in clean water after completion of vibration.
- The cubes shall be tested on their sides without any packing between the cube and the steel plates of the testing machine.
- One of plates shall be carried on a base and shall be selfadjusting, and the load shall be steadily and uniformly applied, starting from zero at a rate of 35N/mm2/min.

Table. 2.1: Compressive strength of cement

Description	**Specimen**					
	3 days			**7 days**		
	I	**II**	**III**	**I**	**II**	**III**
Weight of cement, g	200	200	200	200	200	200
Weight standard sand, g	600	600	600	600	600	600
Weight in g of water g	23.4	23.4	23.4	23.4	23.4	23.4
Area, Cm^2	7.06	7.06	7.06	7.06	7.06	7.06
Load at fracture (P), KN	80	70	85	115	95	120
Compressive stress,N/mm^2	16.05	14.04	17.05	23.07	19.05	24.07
Average strength, N/mm^2	15.7			22.0		

2.3. FINE AGGREGATES

Fine aggregate is natural sand sieved to remove particles larger than 4.75 mm. Sand (>0.075mm) is used as a fine aggregate. It is a granular form of silica. The local river sand conforming to zone-II of IS 383-1970 has been used as fine aggregate. The fine aggregate which is clean, inert and free, silt and clay. Sand used in construction purpose should passes at least 85 percent of the strength of standards and mortars of like proportions and consistency. The tests conducted on fine aggregate is as below,

2.4. COARSE AGGREGATE

Coarse aggregate which has been crushed, washed and sieved so that the particles vary from 5 up to 50 mm in size. The coarse aggregate used for this investigation was crushed Quartzite rock without any flaky and elongated particles and confirmed to IS: 383-1970. The size of coarse aggregate was used in the ratio of 64:36 graded aggregates i.e. 64% of 10mm to 20mm and 36% of 6mm to 10mm. The coarse aggregate tested for its physical properties like specific gravity, bulk density, flakiness index, elongation index water absorption

2.5. Fly Ash

Fly Ash is a by-product of coal-fired furnaces at power generation and it is a reactive spherical particle, typically finer than cement, which provides workability to concrete because of its shape, and typically allows for strength and durability enhancing water contents. Strength and durability results may vary based on ash chemistry. Low oxide/high calcium Class C fly ash may provide higher early concrete strengths

than a high oxide/low calcium Class F fly ash. Class F fly ash is typically superior to a Class C fly ash in mitigating damage from both sulfate and alkali–silica damage to concrete.

- Reduces bleeding
- Increase time setting
- Reduces segregation

Fly ash used in experimental work was obtained from Simhadri Thermal Power plant, NTPC and Visakhapatnam. The specific gravity of fly ash is found to be 2.1.

Fig.2.1 Fly ash

2.6. Silica Fume

Silica Fume is a highly reactive Pozzolanic material and is by-product from the manufacture of silicon or Ferro-silicon metal. collected from the gases from electric arc furnaces. Silica fume is an extremely fine powder, with particles about 100 times an average cement grain. Silica fume is available as a dandified powder or in a water-slurry form.

- Reduced permeability
- Improves bonding with in the concrete
- Improve resistance to corrosion
- Increased durability
- Increased compressive and flexural strength

Silica Fume used in experimental work from local industries near Auto Nagar, and Visakhapatnam. The specific gravity of fly ash is found to be 2.2. SF particles are very fine with particle sizes about hundred times smaller than those of average size of OPC particles.

Fig.2.2: Silica fume

2.7. Properties of Pozzolanic materials

2.7.1. Physical Properties of Fly Ash and Silica Fume

Table.2.2. : Physical properties of fly ash and silica fume

2.7.2. Chemical properties of fly ash and silica fume

Description	Fly ash	Silica Fume
Specific Gravity	1.92	2.2
Particle size	<45μm	150 nμ
Surface Area	300-500 m^2/kg	15000-30000 m^2/kg

Table.2.3.: Chemical properties of fly ash and silica fume

Description	Fly ash	Silica Fume
SiO_2	59.83 %	85%-87%
Al_2O_3	30.48 %	-
Fe_2O_3	5.87%	-
CaO	1.02%	<1%
MgO	5.0%	-
K_2O	0.01%	-
Na_2O	1.28%	-
SO_3	3.0%	1.5%
Loss of Ignition	6.0%	4.0%

2.8. Mix design procedure

1. Target Strength for Mix Proportioning

Determine the mean target strength ft from the specified characteristic compressive strength at 28-day fck and the level of quality control.

ft = fck + 1.65 S

Where S is from the Table of approximate contents given after the design mix.

2. Selection of water-cement ratio

From the Table -5 of IS 456-2000.

3. Selection of Water Content

From the Table-2 of IS 10262-2009.

4. Calculation of Cement Content

From the steps 2 & 3, cement content is calculated.

5. Proportion of Volume of CA and CA Content From Table-3 of IS 10262-2009,the volume of coarse aggregate

corresponding to size of aggregate and fine aggregate for water cement ratio.

6. Mix Calculations

a) Volume of the concrete = 1 m3

b) Volume of cement = (mass of the cement/specific gravity of the cement) x (1/1000).

c) Volume of water = (mass of water/specific gravity of water) x (1/1000).

d) Volume of all in aggregate = [a - (b + c)]

f) Mass of coarse aggregate = e x volume of coarse aggregate x specific gravity of coarse aggregate x 1000.

g) Mass of fine aggregate = e x volume of fine aggregate x specific gravity of fine aggregate x 1000.

7. Mix Proportions

Water: Cement: Fine Aggregate: Coarse Aggregate.

8. Trail Mix proportions for grade Conventional Concrete: Table.3.17: Mix proportions of natural aggregate concrete

S.NO	**Grade of Concrete**	**Cement Kg/m^3**	**F.A Kg/m^3**	**C.A Kg/m^3**	**Water Kg/m^3**
1	M20	300	756	1192	165
2	M25	300	752	1236	150
3	M30	330	725	1242	148.5
4	M35	360	702	1200	162
5	M40	400	668	1196	160

- Above Table different mix proportions are casted after curing 28 days and using jaw crusher cubes are crushed required size of aggregates (size of aggregates are 20mm , 10mm) collected recycled aggregate.
- After mix design don for recycled aggregate concrete with replacement of 50%, 75% and 100% of the natural aggregates and partially cement replacement of 20% fly ash, 10% silica fume.

Table.2.4.: Mix design for RAC20

Grade of GA	**% replac ement**	**Quantity of Cement and Pozzolanic materials, Kg/m^3**			**F.A Kg/m^3**	**C.A, Kg/m^3**		**Water Kg/m^3**
		C	FA	SF		N.A	R.A	
NA	0	300	0	0	756	1192	0	4.09
GA20	50	210	60	30		596	596	
GA25								
GA30	75					298	894	
GA35								
GA40	100					0	1192	

- For obtaining RAC 20 the table-6 mixes are used and 18 cubes are casted for each grade with the 50, 75 and 100% replacements of GA20, GA-25, GA-30, GA-35 and GA-40 with addition of pozzolanic materials (i.e 10% of Silica Fume and 20% of Fly Ash).

- Number cubes are casted in recycled aggregate concrete are given table,

Table.2.5.: Recycled Aggregate Concrete Cubes Calculation

Grade of Recycled Aggregate Concrete	**Recycled aggregate obtained from different grades**	**% Replacement of Recycled aggregate concrete of different grades**	**% Replacementof Pozzolanic materials**	**Total number of Cubes to be casted**
	GA 20	50, 75, 100	10% Silica Fume 20% Fly ash	18

RAC 20	GA 25	50, 75, 100	10% Silica Fume 20% Fly ash	18
	GA 30	50, 75, 100	10% Silica Fume 20% Fly ash	18
	GA 35	50, 75, 100	10% Silica Fume 20% Fly ash	18
	GA 40	50, 75, 100	10% Silica Fume 20% Fly ash	18
	TOTA L			90

2.9. Preparation of testing specimen

2.9.1. Mixing

Blending of fixings is done in dish blender of limit 50L. The cementations materials are altogether the total is added and blended followed by progressive option of water and blending. Wet blending is done until a combination of uniform tone and consistency are accomplished which is then prepared for projecting. Prior to projecting the examples, functionality of the blends was found by droop cone test.

Fig.2.3: Mixing of Recycled aggregate concrete

2.9.2. Casting

The cast iron moulds of size 150X 150X150 mm are cleaned and applied with mineral oil on all sides before concrete is poured. The moulds are placed on a level platform. The well mixed concrete is filled in to the moulds and kept on vibration table. Excess concrete was removed with trowel and top surface smooth as per IS 516-1969.

Fig.2.4: Mixing and casting of fresh concrete

2.9.3. Curing

The specimens are cured in water tank.

Fig.2.5: Cubes in curing tank from

2.10. Compression strength test on concrete as is 516:1959

- Representative samples of concrete shall be taken and used for casting cubes 15 cm x 15 cm x 15 cm.
- The substantial will be filled into the shape in layers roughly 5 cm profound. It would be dispersed equally and compacted either by hand packing. After the top layer has been compacted, the outside of cement will be done even out with the highest point of the form utilizing a scoop; and plate to forestall dissipation.
- The example will be put away at site for 24+ ½ h under sodden matting or sack. From that point forward, the examples will be put away in clean water at 27+20C; until the hour of test. The closures of all barrel shaped examples that are not plane inside 0.02 mm will be covered.
- The surface of the testing example will be cleaned off and any free material eliminated from the surface. On account of 3D shapes, the example will be put in the machine in such a way that the heap 3D square as cast, that is, not to the top and base.
- Align the specimen with the steel platen, do not use any packing.
- The load will be applied gradually without shock and expanded ceaselessly at a pace of around 140 kg/sq.cm/min until the obstruction of the example to the expanded burden separates and no more prominent burden can be supported. The greatest burden applied to the example will then, at that point be recorded and any strange highlights noted at the hour of disappointment brought out. The pressure strength of the substantial is,where wf is most extreme applied burden (KN) Ap is plane space of block shape (mm2).

Fig.2.6: Compressive strength testing machine

III. PRESENTATION OF RESULTS

3.1. Introduction

The Normal aggregate (NA) and granulated aggregate (GA) are tested for its physical and mechanical properties. The fresh concrete properties are slump tested. And herded concrete properties are density, water absorption.

3.2. Workability

The property of fresh concrete which is indicated by the amount of useful internal work required to fully compact the concrete without bleeding or segregation in the finished product.

Workability with Pozzolanic and without Pozzolanic is gradually decreased in percentage of recycled aggregates. The set with 20% fly ash and 10% silica fume has more workability than without Pozzolanic material. Workability with % of RCA (in slump value) is shown in table 4.7.

Table.3.1: Flakiness Index of NA & GA

Aggregate	20mm	10mm
NA	12.8	21.3
GA20	13.2	22.3
GA25	14.8	24.6
GA30	16.4	25.3
GA35	17.2	29.4
GA40	18.7	32.4

Table.3.2: Slump of recycled Aggregate concrete with Pozzolanic materials

S.NO	Grade of aggregate	Slump of RAC20,mm		
		% of replacement		
		50%	75%	100%
1	GA20	50	45	42
2	GA25	48	44	40
3	GA30	46	42	38
4	GA35	42	38	35
5	GA40	40	36	30

3.3. Hardened concrete properties of recycled aggregate concrete

3.3.1. Density of Recycled Aggregate Concrete

The density of concrete is a measure of its unit weight. Concrete is cement, fine and coarse aggregates, water, and sometimes some supplementary materials like fly ash, slag, and various admixtures. A normal weight concrete weighs 2400 kg per cubic meter. That the natural air content of recycled aggregate concrete may be slightly higher than that of control concretes made with conventional concrete.

Table.3.2.: Density of RAC20

S.NO	Grade of concrete	Days density of RAC20,Kg/m^3		
		50%	75%	100%
1	GA20	2471	2465	2443
2	GA25	2464	2456	2425
3	GA30	2458	2440	2405

4	GA35	2439	2435	2382

3.3.2. Water absorption of RAC

This is because of the increment extent of concrete glue in RCA, as the amount of joined concrete glue in the substantial with 100% coarse RCA expanded by multiple times than that of cement with 30% coarse RCA. And furthermore inferred that up to 30% coarse RCA had no impeding impact on air porousness, paying little mind to substantial strength. Nonetheless, inborn air porousness found to increment with RCA content past this level. A potential utilization of admixtures, for example, fly debris or silica smoke could diminish essentially porosity and porousness of reused total (both coarse and fine totals) concrete.

Table.3.3: Days Water absorption of RAC20

S.NO	**Grade of concrete**	**Days water absorption of RAC20, %**		
		50%	**75%**	**100%**
1	GA20	1.8	1.89	1.97
2	GA25	1.65	1.75	1.93
3	GA30	1.6	1.72	1.88
4	GA35	1.58	1.6	1.74
5	GA40	0.87	0.88	0.97

3.3.3. Compressive Strength of Recycled Aggregate Concrete

The results obtained after 7 days and 28 days of the compressive strength with and without Pozzolanic materials is tabulated given,

Fig..3.1 Compressive Strength Test of Cubes

Table.3.4:7days Compressive Strength of RAC20 with Pozzolanic Materials

S.NO	**Grade of concrete**	**Compressive strength of 7 days, Mpa**		
		50%	**75%**	**100%**
1	GA20	19.55	18.95	18.66
2	GA25	18.81	16.43	16.23
3	GA30	16.44	16.00	15.55

4	GA35	16.04	15.11	14.66
5	GA40	15.47	14.22	12.88

Table.3.5:28 days Compressive Strength of RAC20 with Pozzolanic Materials

S.NO	Grade of concrete	Compressive strength of 28 days, Mpa		
		50%	75%	100%
1	GA20	27.55	26.22	24.88
2	GA25	25.33	24.44	24
3	GA30	24.44	23.11	21.33
4	GA35	22.07	20.74	20
5	GA40	20.95	20.29	17.77

IV. RESULTS AND DISCUSSION

4.1. Introduction

The Normal aggregate and Recycled aggregate are tested for its physical and mechanical properties at the different replacement levels of 50%, 75% and 100% recycled aggregate concrete. The silica fume (10%) and fly ash (20%) were used as a Pozzolanic materials.

4.2. Workability

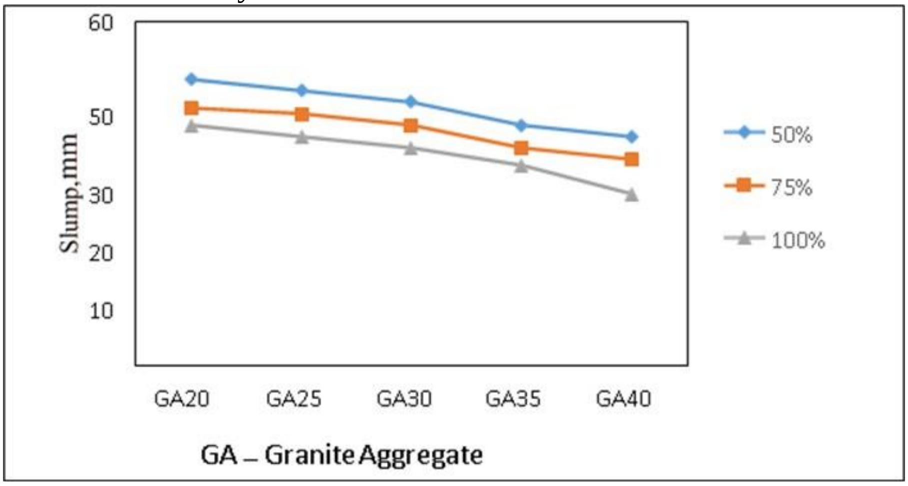

Fig.4.1. Slump of RAC 20

The slump been perform for determining the consistency of all the concrete batches, thus the influence of the combined of FA, SF and RA on the workability of fresh concrete. The slump results are shown fig.4.1

Results from slump tests are shown in fig.4.1and following observation can be drawn

The slump has been obtained for control mix(55mm)

Due to rougher surfaces and to the more irregular shapes of recycled aggregates concrete with represent normal concrete, the replacement natural aggregate with recycled aggregate has significantly reduced in workability.

fly ash and silica fume used in the mixtures has produced clear increasing the workability.

4.3. Hardened Properties of Recycled Aggregate Concrete

4.3.1.Density of Recycled Aggregate (RAC20)

A normal concrete weighs about 2480kg/m3, but the unit mass of concrete density varies amount and density of the aggregate, the amount of air voids entered into the cement and water contents.
Table. 6 shows the theoretical values of the recycled aggregate concrete density calculated for each mix. In particular, the higher the percentage of substitution of natural aggregates with recycled ones, the lower the mean value of the concrete density, such a reduction of with only 30% recycled aggregate concretes.

4.3.2. Water Absorption of Recycled Aggregate Concrete (RAC 20)

Due to high porosity, the void are filled by the Pozzolanic materials water absorption is decreased as the grade of GA is increased. But when compared with NAC, the RAC water absorption is more.

Fig.4.2: Density of Recycled Aggregate (RAC20)

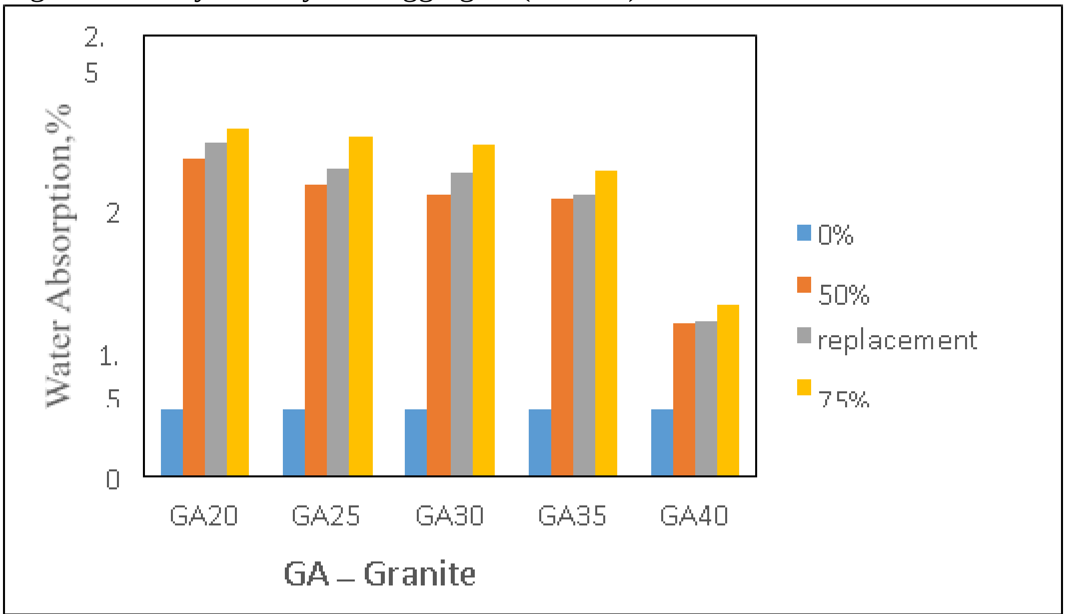

Fig.4.3: Water Absorption of Recycled Aggregate Concrete (RAC20)

4.3.3. Compressive Strength of Recycled Aggregate Concrete (RAC20)

Table .4.2 and 4.3 reports the mean values of the compressive strength evaluated by the testing of several cube samples made of different combinations (GA20, GA25, GA30, GA35 and GA40) and different percentage replacement(50%, 75% and 100%) of recycled aggregates. The tests performed at 7 and 28 days curing.

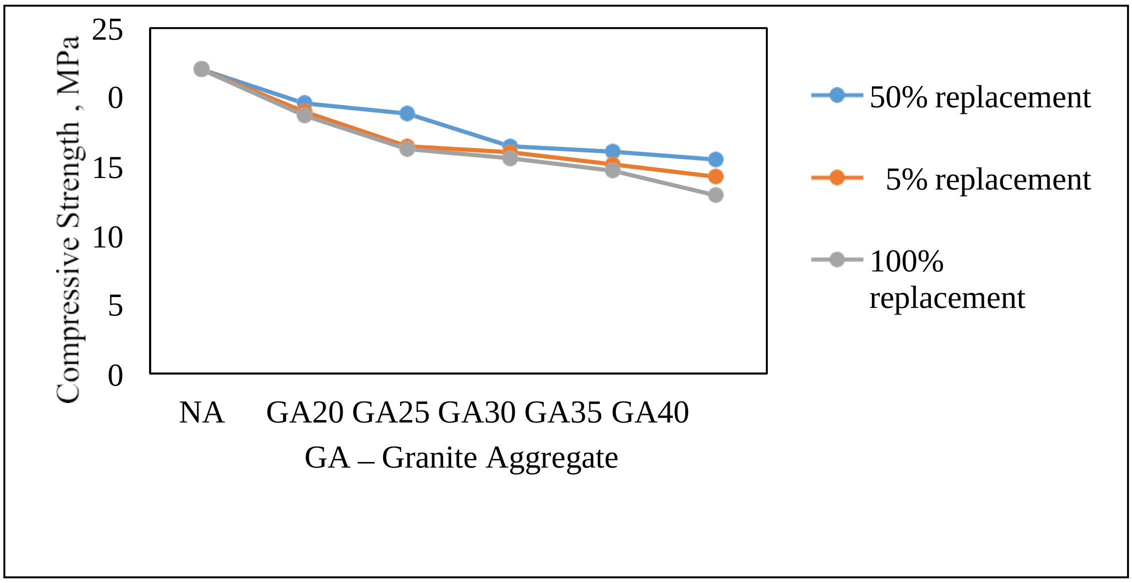

Fig.4.4: Compressive strength of the recycled aggregate (RAC20) Pozzolanic materials for 7 days

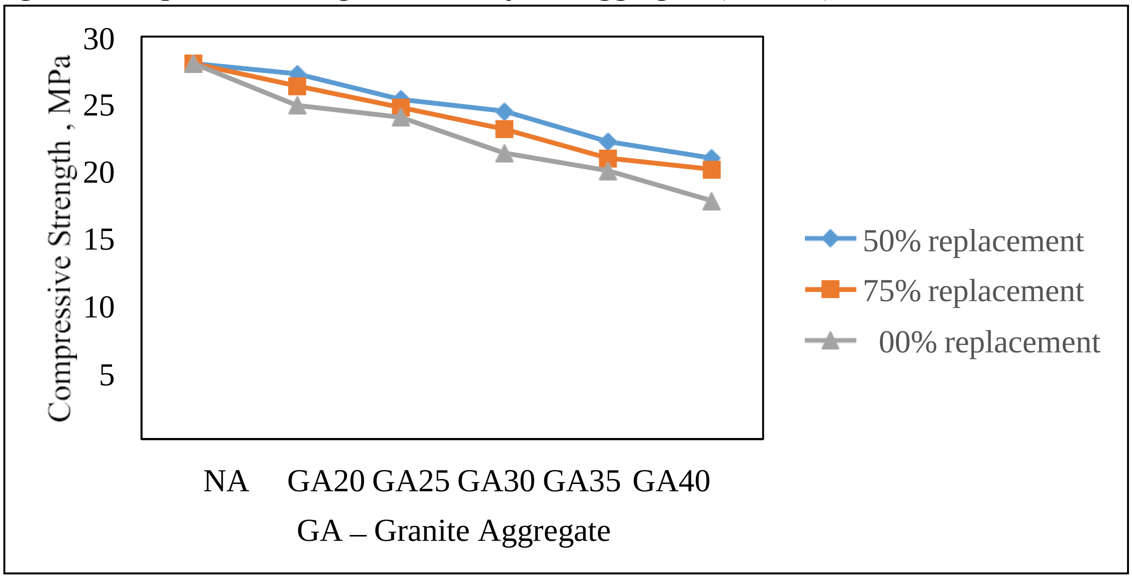

Fig.4.5.: Compressive strength of the recycled aggregate (RAC20) Pozzolanic materials for 28 days

Fig.4.4 and fig.4.5 shows the compressive strength at different grades of aggregates with respect to percentage replacement of recycled aggregate. It is more than recycled aggregate concrete. The Pozzolanic materials (fly ash and silica fume) added to the control mix produces the some effects respect to the replacement of Ordinary Portland cement. In particularly, at short age of curing 7 days the strength is slightly lower than the control concrete, while age of curing is longer than 28 days is even higher. The late achieved of the target strength shown by concrete samples made of the mix due to delayed binding action of fly ash and silica fume. The experimental results also show that the replacement of with recycled aggregate ones produces strength of the recycled aggregate concrete. Recycled aggregate concrete specimens following observation on drawn

- A progressive compressive strength reduced the increasing percentage of recycled aggregates.
- The compressive strength can obtained for age of curing longer than the 28 days, in case when Pozzolanic materials are added to the recycled aggregate concrete.
- At 50% replacement with recycled aggregate (GA20) the strength is nearly equal to target strength

CONCLUSIONS

The study's conclusions are as follows:

- Reused aggregate's resistance to mechanical and physical stress is less than that of freshly crushed rock; overall, the characteristics are within acceptable thresholds.
- The usefulness decreases as the GA grade rises. Nevertheless, the addition of 10% SF and 20% FA in place of concrete demonstrated better functioning.
- The repurposed complete cement's porous construction may be the reason why it is thinner than regular considerable.
- The RAC's water assimilation increases together with substitution and overall grade growth. The clung engine adding to the reused total may be the cause of this.
- The degree of significant reductions in reused total may be directly related to the free mortar around the reused total, preventing the proper adhesion between the concrete adhesive and total.
- Fly ash and cement with a silica seethe foundation may often promote strength over longer periods of time. Therefore, by adding Pozzolanic ingredients, the compressive strength of RAC with fly ash and silica rage achieves equivalent strength of standard complete cement over a considerable stretch of time.

REFERENCES

- Cakar.o., Experimental analysis of properties of recycled coarse aggregate (RCA) concrete with mineral additives, Construction and building materials,Vol-68,2014,pp 17-25.
- Ann.k.y,Moon H.Y,Kim and Y.B,Ryou.J., durability of recycled aggregate concrete using pozzonanic materials, Waste management,Vol-28,2008,pp 993-999.
- Shi-cong kou,Chi-sun poon and Franciso agrela., compresons of natural and recycled aggregate concrete prepared with the addition of different mineral adimixtures, Cement and concrete composites,Vol-33,2011,pp 788-795.
- Carmine lima,Antonio caggiano,ciro faella, Enzo martinelli and Marco pepe., physical properties and mechanical behavior of concrete made with recycled aggregate and fly ash, Construction and building materials,Vol47,2013,pp.547-559.
- Ahmed.S.F.U., properties of concrete containing construction and demolition wastes and fly ash, Journal of materials in civil engineering,2013, pp 1864-1870.
- Valeria Corinaldesi and Giacomo Moriconi., Influence of mineral additions on the performance of 100% recycled aggregate concrete, Construction and building materials , vol-23,2009,pp 2869-2876.
- Ali Abd Elhakam, Abd Elmoaty Mohamed and Eslam Awad., Influence of self- healing, mixing method and adding silica fume on mechanical properties of recycled aggregates concrete, Construction and building materials, Vol35,2012,pp. 421-427.
- Rattapon Somna , Chai Jaturapitakkul and Amde M. Made, Effect of ground fly ash and ground bagasse ash on the durability of recycled aggregate concrete, Cementand concrete composites,Vol-34,2012, pp.848-854.
- Bibhuti Bhusan Mukharjee and Sudhirkumar V. Barai., Influence of incorporation of nano-silica and recycled aggregates on compressive strength and microstructure of concrete, Construction and building materials, Vol 71, 2014,pp. 570-578.
- Saravana Kumar.P, Dhinakaran .G Ph.D ., Effect of Admixed Recycled
- Aggregate Concrete on Properties of Fresh and Hardened Concrete”,journal of materials in civil engineering ,2012, pp 494-498.
- Jun Phil Hwang, Hyun Bo Shim, Sooyoung Lim, and Ki Yong Ann., Enhancing the Durability Properties of Concrete Containing Recycled
- Aggregate by the Use of Pozzolanic Materials, Structural engineering, Vol17,2013,pp.155-163.
- Cui H. Z., Ph.D., Xian Shi,Shazim Ali Memon, Ph.D.,Feng Xing and Waiching Tang, Ph.D., Experimental Study on the Influence of Water Absorption of Recycled Coarse Aggregates on Properties of the ResultingConcretes, J.mater civil engineering,2014,pp.1381-1389.

- Larbi Belagraa and Miloud Beddar., Study of the Mechanical Performance of a Recycled Aggregate Concrete with Admixture Addition, Vol-3, 2013, pp 99-103.
- Shi Cong Kou,Chi Sun Poon and Dixon Chan., Influence of fly ash as a cement addition on the hardened properties of recycled aggregate concrete, Materials and structures , Vol-41,2008,pp.1191-1201.
- Suraya Hani Adnan, Ismail Abdul Rahman, Lee Yee Loon , Performance of Recycled Aggregate Concrete Containing Micronised Biomass Silica, Construction engineering and technology, Vol-1,2010,pp.1-9.
- S.c.Kou and C.S.Poon., Enhancing the durability properties of concrete prepared with coarse recycled aggregate. Construction and building materials.Vol-35, 2012, pp.69- 76.
- Bibhuti Bhusan Mukharjee and Sudhirkumar V. Barai., Influence of Nano-Silica on the properties of recycled aggregate concrete. Construction and Building Materials, Vol-55 (2014), pp.29–37.
- Vivian W. Y. Tam and C. M. Tam, Assessment of durability of recycled aggregate concrete produced by two-stage mixing approach, J Mater Sci, Vol42 (2007) pp.3592–3602.
- Parthasai Reddy., Determination of mechanical properties of recycled aggregate concrete with fly ash, International Journal of Advancements in Research & Technology, Vol-3 (2004) pp.37-39.
- A.K. Padmini, K. Ramamurthy and M.S. Mathews, Influence of parent concrete on the properties of recycled aggregate concrete, Construction and Building Materials, Vol-23, (2009),pp.829–836.
- Vivian W.Y. Tama, X.F. Gao and C.M. Tam, Microstructural analysis of recycled aggregate concrete produced from two-stage mixing approach, Cement and Concrete Research, Vol-35, (2005) pp.1195–1203.
- Concrete technology author by M.S Setty
- Science direct, asce library, springer link journals.