

## RECYCLED AGGREGATE CONCRETE USING POZZOLANIC MATERIALS

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### ABSTRACT

Construction is a process of developing new ventures and is a never-ending activity. The aggregates are the raw materials, which constitute 70-80% in the concrete mixture. Every year, it is estimated that the construction industry in India generates about 10-12 million tonnes of waste annually. Concrete is the most versatile material which is used extensively in the construction field. There is a need to think of alternate materials because of the scarcity of natural aggregates.

The use of this recycled coarse aggregate is mainly for two reasons: To decrease CO<sub>2</sub> emission which is harmful to environment and to reduce the cost of construction material / cost cutting/ reduce the budget of the construction. C&D waste can be reduced, re-used and recovered, dramatically reducing the dumping of demolished waste. The main purpose of recycling is to minimize the amount of waste to be deposited and to preserve natural resources.

The present investigation is carried out for evaluation of properties of natural and recycled aggregate concrete. Pozzolanic materials like Fly Ash and Silica Fume are used as mineral admixtures for good workability and for better strength. Cement is replaced with 10% SF and 20% FA in design mix. RAC20 made with different grades of recycled aggregates of GA20, GA25, GA30, GA35 and GA40 with different replacements 50%, 75% and 100%. During mix proportion pre-soaking of aggregates is done before the mixing of concrete. Three stage mixing approach is adopted for the production of concrete. The density of concrete, compressive strength and water absorption of PC & RAC were determined at ages of 7 and 28 days. The results of compressive strength are found to be lower than target strength. With GA20 at 50% replacement, 95% of the target strength is achieved (27.55MPa). Strength could have achieved with increase in curing period.

It is also concluded that the water absorption and density of RAC is lower than NAC.

**Key words:** Recycled aggregate concrete (RAC), Granite aggregate (GA), Parent concrete (PC), Natural aggregate concrete (NAC), Fly ash (FA), Silica fume (SF) Compressive strength, Water absorption and density.

### 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 materials in 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 be used as total and utilized in concrete [8-12]. Construction waste is bulky and heavy and is mostly unsuitable for disposal by composting. 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 to 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 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 mortar in recycled aggregate concrete

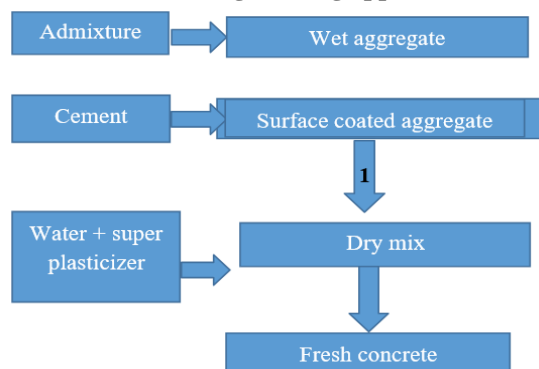
In reused totals, the followed mortar and glue are consistently present. That roughly 20% of concrete mortar was connected to 20 to 30mm size total [12]. The amount of followed mortar in the first total is relative to the strength of the first concrete. The reused totals which started from the low strength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

### 1.4. Influence of Pozzolanic materials and 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 see the 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



## 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) conforming 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

**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.

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  $12000 \pm 400$  vibration per minute.
- Then placed the cube moulds in temperature of  $27 \pm 2^\circ\text{C}$  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 self-adjusting, and the load shall be steadily and uniformly applied, starting from zero at a rate of  $35\text{N/mm}^2/\text{min}$ .

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	23.4	23.4	23.4	23.4	23.4	23.4
Area, Cm <sup>2</sup>	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 <sup>2</sup>	16.05	14.04	17.05	23.07	19.05	24.07
Average strength, N/mm <sup>2</sup>	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 pass 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**

**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 <sup>2</sup> /kg	15000-30000 m <sup>2</sup> /kg

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

Description	Fly ash	Silica Fume
SiO <sub>2</sub>	59.83 %	85%-87%
Al <sub>2</sub> O <sub>3</sub>	30.48 %	-
Fe <sub>2</sub> O <sub>3</sub>	5.87%	-
CaO	1.02%	<1%
MgO	5.0%	-
K <sub>2</sub> O	0.01%	-
Na <sub>2</sub> O	1.28%	-
SO <sub>3</sub>	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  $f_t$  from the specified characteristic compressive strength at 28-day  $f_{ck}$  and the level of quality control.

$$f_t = f_{ck} + 1.65 S$$

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**

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

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

**6. Mix Calculations**

a) Volume of the concrete = 1 m<sup>3</sup>

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.3.1 7: Mix proportions of natural aggregate concrete**

S.NO	Grade of Concrete	Cement Kg/m <sup>3</sup>	F.A Kg/m <sup>3</sup>	C.A Kg/m <sup>3</sup>	Water Kg/m <sup>3</sup>
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	% replacement	Quantity of Pozzolanic Kg/m <sup>3</sup>			Cement and materials, Kg/m <sup>3</sup>			F.A Kg/m <sup>3</sup>	C.A, Kg/m <sup>3</sup>		Water Kg/m <sup>3</sup>
		C	FA	SF	C	FA	N.A		R.A		
NA	0	300	0	0	756	1192	0	1192	0	4.09	
GA20	50	210	60	30		596	596				
GA25	75					298	894				
GA30						0	1192				
GA35											
GA40	100										

- 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	% Replacement of Pozzolanic materials	Total number of Cubes to be casted
RAC 20	GA 20	50, 75, 100	10% Silica Fume 20% Fly ash	18
	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
	TOTAL			

**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

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

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.



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 apace 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  $w_f$  is most extreme applied burden (KN)  $A_p$  is plane space of block shape (mm<sup>2</sup>).



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

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,

5	GA40	2416	2402	2364
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##### 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

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

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 <sup>3</sup>		
		50%	75%	100%
1	GA20	2471	2465	2443
2	GA25	2464	2456	2425
3	GA30	2458	2440	2405
4	GA35	2439	2435	2382

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 PozzolanicMaterials

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 PozzolanicMaterials

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**

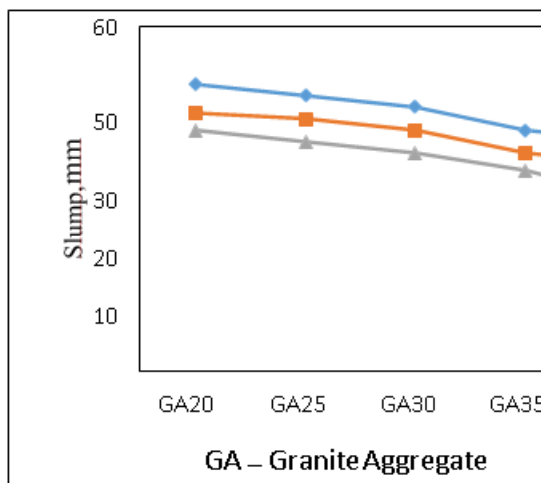


Fig.4.1. Slump of RAC 20

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.4.1 and 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/m<sup>3</sup>, 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)**

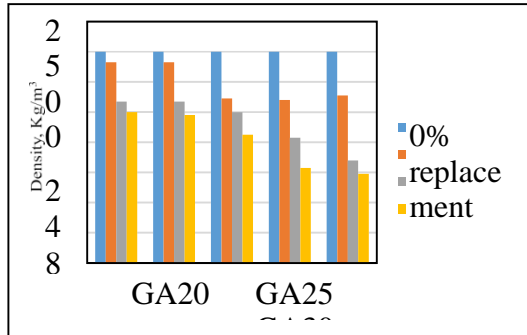
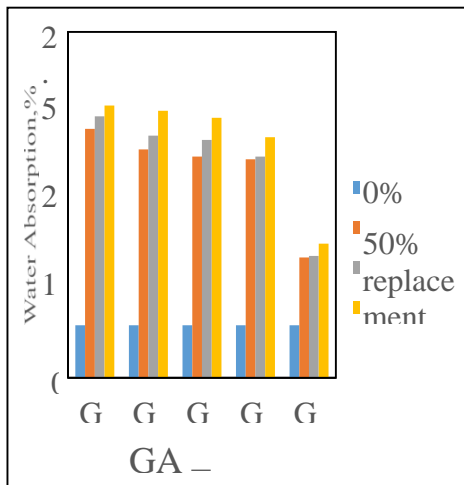


Fig.4.2: Density of Recycled Aggregate Concrete



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.

(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.

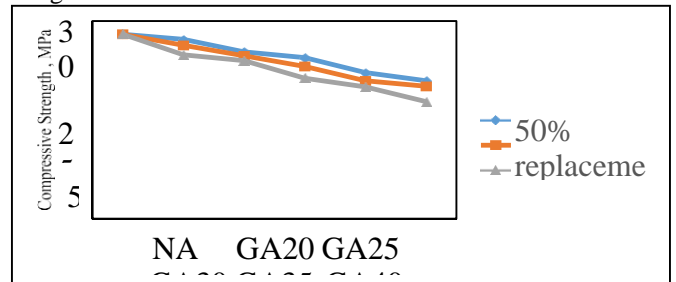


Fig.4.5.: Compressive strength of the recycled aggregate (RAC20) Pozzolanic materials for 28 days

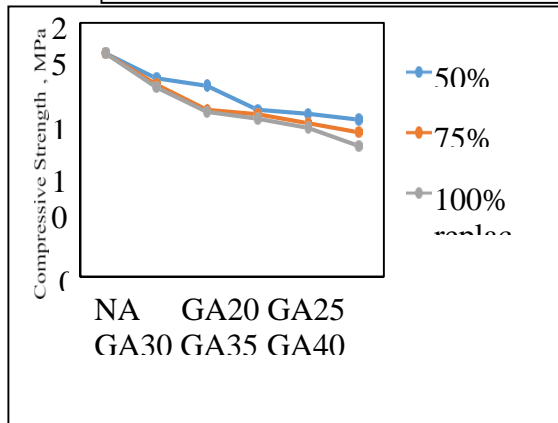


Fig.4.4:Compressive strength of the recycled aggregate (RAC20) Pozzolanic materials for 7 days

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 be obtained for age of curing longer than the 28 days, in case when Pozzolanic materials are added to the recycled aggregate concrete.

## CONCLUSIONS

From the study following conclusions are made

- The opposition of reused total to physical and mechanical activities is lower than new squashed rock total, the qualities are by and large inside adequate cutoff points.
- As the GA grade builds, the usefulness diminishes. Be that as it may, with the expansion of 20% FA and 10% SF to the substitution of concrete showed a superior functionality.
- The reused total cement has less thickness than traditional substantial this might be because of the permeable design of reused total.
- The water assimilation of RAC increment with expansion in

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- At 50% replacement with recycled aggregate (GA20) the strength is nearly equal to target strength

substitution and expansion in grade of total. This might be a result of clung engine appended to thereused total.

- The strength of substantial abatements with expansion in the level of reused total, this might be a direct result of the free mortar around the reuse total which don't permit the appropriate holding between the concrete glue and total.
- For the most part, fly debris and silica seethe based cement can foster strength throughout delayed timeframes. So at a significant stretch of run the compressive strength of RAC with fly debris and silica rage accomplishes comparable strength of regular total cement by adding Pozzolanic materials.

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