

# DETERMINATION OF MECHANICAL PROPERTIES OF RECYCLED AGGREGATE CONCRETE WITH FLY ASH

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## ABSTRACT

Minimizing the environmental impact and energy and CO<sub>2</sub> intensity of concrete used for construction is increasingly important as resources decline and the impact of greenhouse emissions becomes more evident. The objective of the present investigation was to assess the properties of concrete that combine both supplementary cementitious material (fly ash) and recycled aggregate. In this investigation an attempt was made to understand how the properties of concrete get affected when fly ash is used as a cement replacement and recycled concrete aggregate as a replacement to conventional coarse aggregate in different proportion. An experimental investigation was carried out to study the properties of F-RA (fly ash based recycled aggregate) concrete. For concrete IS 10262:2009 method of mix design is adopted and considering this as a basis, mix design for replacements has been made. Mix design was made for M-20 grade of concrete. Three different aggregate replacement levels namely 15%, 30% and 45% with recycled aggregate were chosen for the study. The results from various tests are compared and optimum recycle aggregate replacement is chosen. Fly ash replacement with cement in different proportions, i.e 10%, 20%, 30% and 40% is done for the optimum recycled aggregate concrete.

**Keywords**— recycled coarse aggregate; sustainable development; concrete; mechanical properties; fly ash

## 1. INTRODUCTION

Concrete is the most extensively used construction material in the world. It is a material synonymous with strength and longevity. Since concrete is widely used in construction, there is huge demand for production, it leads to hike in the material cost. Utilization of Recycled Aggregate in concrete has been employed due to awareness of society in natural resources protection. The application of Recycled Aggregate (RA) as coarse aggregate in concrete mixes has been initiated as to make use effectively the waste materials. Even though RCA is becoming a good alternative material, there is still a weakness on its performance in concrete. It was found that concrete containing Recycled Aggregate obtained lower in workability compared to concrete using Natural Aggregate. Fly ash is a by-product of coal burning power plants. This ash is fine material & possesses good pozzolanic property. When mixed with lime and water the fly ash forms a cementitious compound with properties very similar to that of Portland cement. By addition of fly ash the concrete becomes denser resulting in a tighter, smoother surface with less bleeding.

### Use of flyash in recycled aggregate concrete

- \*Fly Ash compensates for lower compressive strength of recycled aggregate concrete.
- \*Fly Ash increases long term strength development of recycled aggregate concrete.
- \*Fly Ash offsets increased water demand of recycled aggregates.
- \*Fly Ash increases the workability of recycled aggregate concrete.

\*Fly Ash reduces the higher levels of drying shrinkage of recycled aggregate concrete.

## 2. EXPERIMENTAL STUDY

This experimental study consist of two parts. Firstly, the coarse aggregate in nominal concrete of grade M20 is replaced with recycled aggregates in different proportions i.e; 15%, 30% and 45%. And are tested for compressive strength test and split tensile tests. The optimum percentage replacement is found out.

Now, by using the optimum percentage of coarse aggregate replacement recycled aggregate concrete is designed with replacement of cement with fly ash in various proportions i.e; 10%, 20%, 30% and 40% and are tested for tensile and compressive strengths.

Mix design for M20 grade concrete is done and proportions were found to be 1:1.8:3 of cement, fine and coarse aggregate respectively, with w/c as 0.5.

### Materials

Recycled aggregate: Recycled aggregate is nothing but the Concrete aggregate collected from demolition sites. Recycled aggregate is produced by crushing concrete, and sometimes asphalt, to reclaim the aggregate. Recycled aggregate can be used for many purposes. The primary market is road base. The recycled aggregate used in this experiment was obtained from debris of

broken down of slab and properly cleaned by chipping of any concrete left on the aggregate.

Fly-ash: Fly ash is obtained as a waste in furnaces of coal burning power plants and on a large scale as a volcanic ash. The fly ash used is class F fly ash. In this type the calcium content is less than 6% .therefore it is also called as low calcium ash. It contains more than 2% of unburnt carbon.

### 3. RESULTS AND DISCUSSIONS

#### 3.1 Effect of recycled aggregate on concrete

The coarse aggregate is replaced with recycled aggregate in different proportion (15%, 30%, and 45%). The specimens casted are cured for 7 and 28 days. The compressive strength test are conducted on cubes and there values are tabulated as show in table 1 and figure 1 shows the comparison of compressive strengths of different proportions of recycled aggregates

Percentage of recycled coarse aggregate	Compressive strength for 7 days,Mpa	Compressive strength for 28 days,Mpa
RA0%	18.2	25.4
RA15%	17.3	23.6
RA30%	14.7	20.1
RA45%	13.1	18.3

Table 1

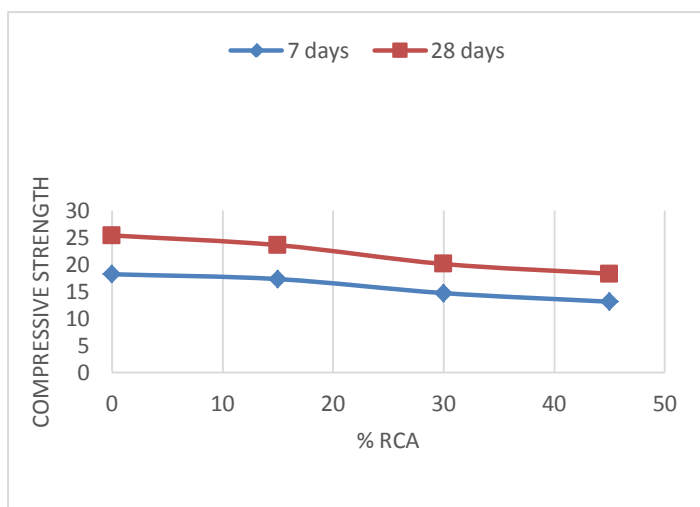


Figure 1

The below table 2 shows the tabulated values of split tensile strength of recycled aggregate concrete cylinders and figure 2 gives the comparison of the strengths for different curing periods.

Percentage of recycled coarse aggregate	Split tensile strength for 7 days,Mpa	Split tensile strength for 28 days,Mpa
RA0%	1.78	2.32
RA15%	1.46	1.93
RA30%	1.23	1.74
RA45%	0.98	1.53

Table 2

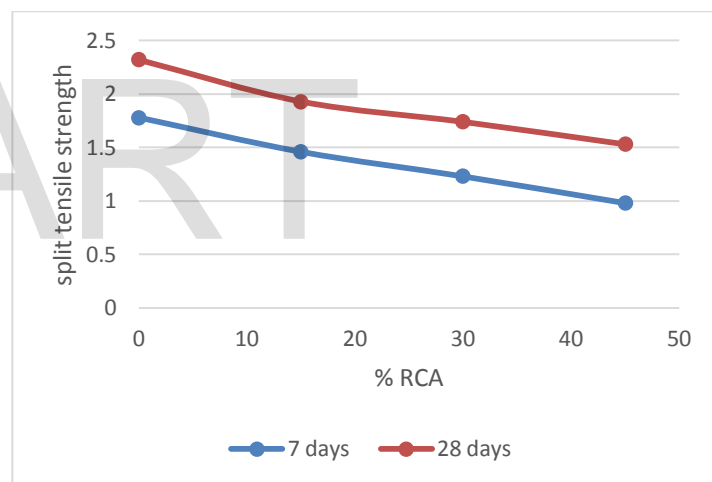


Figure 2

From the above values it can be seen that by increase in percentage of recycled aggregate with natural aggregate in concrete the compressive and split tensile strength of concrete decreases. So it can be considered RA15% as optimum value.

#### 3.2 Effect of fly-ash on recycled aggregate concrete

Certain percentage of cement is replaced with fly-ash (10%, 20%, 30%, and 40%) in mix design for optimum recycled aggregate concrete (15% recycled aggregate replacement; RA15%) the compressive strength and split tensile strength are tabulated in tables 3 and 4 respectively for values for 7 and 28 days.

Percentage of recycled coarse aggregate	Compressive strength for 7 days,Mpa	Compressive strength for 28 days,Mpa
FA0%+ RA15%	17.3	23.6
FA10%+RA15%	15.7	22.8
FA20+RA15%	13.8	21.5
FA30%+RA15%	12.3	19.1
FA40%+RA15%	11.6	17.8

Table 3

Figures 3 and 4 shows the comparisons of compressive and split tensile strengths respectively.

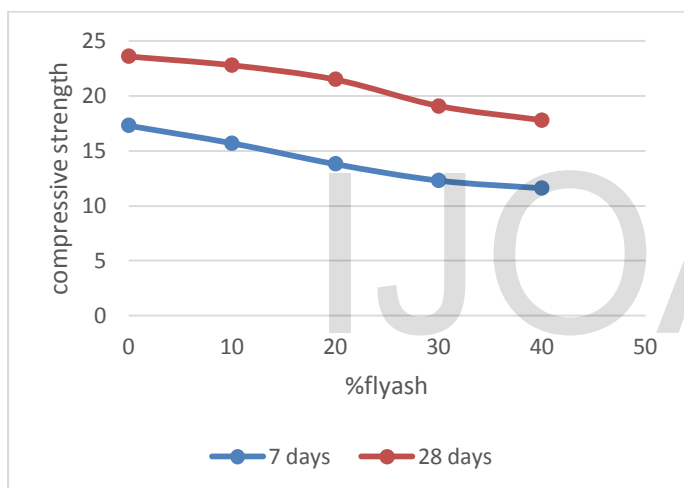


Figure 3

Percentage of recycled coarse aggregate	Split tensile strength for 7 days,Mpa	Split tensile strength for 28 days,Mpa
FA0%+ RA15%	1.46	1.93
FA10%+RA15%	1.37	1.78
FA20+RA15%	1.31	1.64
FA30%+RA15%	1.12	1.36
FA40%+RA15%	0.98	1.22

Table 4

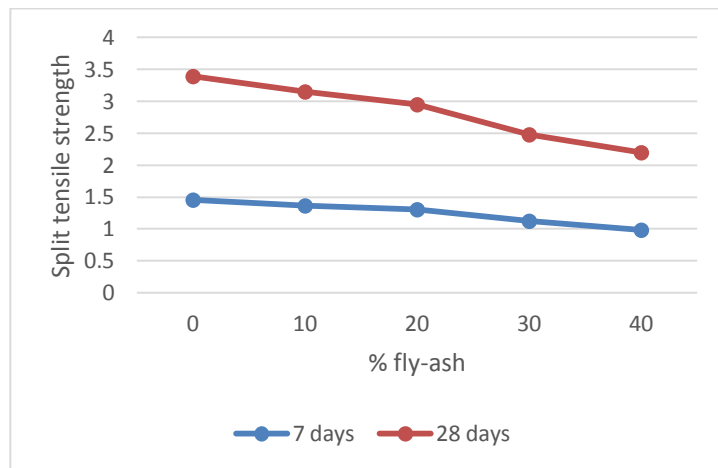


Figure 4

#### 4. CONCLUSIONS

15% of RA and 10% of fly ash is giving approximately same results as that of 100% NA and 0% fly ash. The workability of RAC concrete could be increased by addition of fly ash. It can be found that with increase of recycled aggregate percentage replacement there is a decrease in the strength of concrete.

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