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# Strength Characterisation In Fly Ash With Recycled Concrete Aggregate

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**Abstract** --- In this experimental work, an approach has been made to determine the feasibility of recycled aggregate in the concrete. For that purpose two water cement ratios are chosen for making concrete mix of same characteristic strength. Again, to determine the effect of recycled aggregate on the strength, the percentage of the recycled is adjusted with 10%, 20%, 30%, 50% and 100%. It was found that with addition of recycled aggregate the concrete strength and workability decrease, to improve the strength and the workability, the flyash is added at the rate of 10% and 20% as replacement of PPC. The compressive strength of concrete is determined, after curing periods of 7, 28 and 90 days. To establish an empirical relationship between the strength of concrete and four variable parameters (i.e. percentage of RCA, percentage of flyash, curing age and water-cement ratio), two modeling methods were used namely to develop the mathematical model by Multi-linear Regression Method and to develop the Neural Network model by Artificial Neural Networking Method.

The test results show that 90 days strength of mix RAC20+F10 is almost nearly greater or equal to strength of NAC based concrete. The compressive strength of 90 days, of the above mix was found to be 3.92% more than the natural aggregate based concrete on average. On the other hand, when water cement ratio is decreased, the 90 days compressive strength was found to be 2.97% for 7% decrement in water-cement ratio.

**Keywords**: - Natural aggregate, Recycled Coarse Aggregate, Flyash, Compressive strength, MLR

## I. INTRODUCTION

The Indian economy is still expanding significantly, and substantial investment in infrastructure continues to be required in order to sustain India's economic progress. The country's capacity to absorb the benefits from new technology and industries depends on the availability, quality and efficiency of more basic forms of infrastructure including energy, water and land transportation. In some areas, roads, rail lines, ports and airports are already operating at capacity, so expansion is a necessary prerequisite to further economic growth. The Indian Government recognizes this imperative. As per the Eleventh Five Year Plan, more than US$500 billion worth of investment is planned to flow into India's infrastructure by 2012. Construction projects account for a substantial portion of the proposed investments, making the Energy and Construction sector one of the biggest beneficiaries of the infrastructure boom in India. Indian Construction Industry is highly employment intensive and accounts for approximately 50% of the capital outlay in successive 5-Year Plans of our country. The Projected investment in this industrial sector continues to show a growing trend [Ellzabeth Montgomery, 2008].

Construction activity leads to the generation of solid wastes, which include sand, gravel, concrete, stone, bricks, wood, metal, glass, plastic, paper etc. The management of construction and demolition waste is a major concern for town planners due to the increasing quantum of demolitions' rubble, continuing shortage of dumping sites, increase in transportation and disposal cost and above all growing concern about pollution and environmental deterioration [TMS- 150 2001].

Recently, aggregates derived from demolished concrete structures were of relatively low strength, and applications were of secondary importance. The necessity of demolition of structures with strong concrete, created the source of recycled aggregate. Recycling is the act of processing the used material for creating a new product. The usage of natural aggregate is getting more and more

 

intense with the advanced development in the infrastructure area. In order to reduce the usage of natural aggregate, recycled aggregate can be used as the replacement materials. Recycled aggregate is comprised of crushed, graded inorganic particles processed from the materials that have been used in the constructions and demolition debris. These materials are generally from buildings, roads, bridges, and sometimes even from catastrophes, such as wars and earthquakes. The aim of the present work is to determine the way and style of utilization of recycled coarse aggregates for application in high strength concrete, which will give a better understanding on the uses of concrete with recycled coarse aggregates, as an alternative material to natural coarse aggregate in concrete.

## II. EXPERIMENTAL PROGRAMME

### 2.1 Materials Used:-

**Portland Pozzolana Cement** conforming to **IS: 1489 (Part-I)** is used.
**Sand** available from the local source is used which conforms to **zone-II** as per **IS: 383-1970**.
**Flyash** is obtained from the **Korari Thermal Power Plant**, Nagpur **Coarse Aggregate** from the local available source is used; they were classified as basalt,
**Recycle Coarse Aggregate** is obtained from three different sources i.e. S1-crushed specimen from laboratory, S2- demolished building waste at 28years old and S3-demolished building waste at 62 years old .

### 2.2 Test result of coarse aggregate.

Table.2.1: Properties of coarse aggregate

| Test | Natural coarse aggregate | Recycled aggregate concrete | | |
|---|---|---|---|---|
| | | S1 | S2 | S3 |
| Fineness modulus | 6.478 | 6.70 | 6.06 | 6.65 |
| Specific Gravity | 2.77 | 2.63 | 2.66 | 2.64 |
| Water absorption % | 1.42 | 3.19 | 3.56 | 3.80 |
| Bulk Density Kg/m$^3$ | 1735 | 1570 | 1610 | 1580 |
| Moisture content | 1.42 | 1.87 | 1.77 | 1.80 |
| Crushing value % | 20.20 | 24.60 | 22.40 | 24.60 |
| Impact value % | 15.64 | 22.30 | 20.60 | 22.50 |

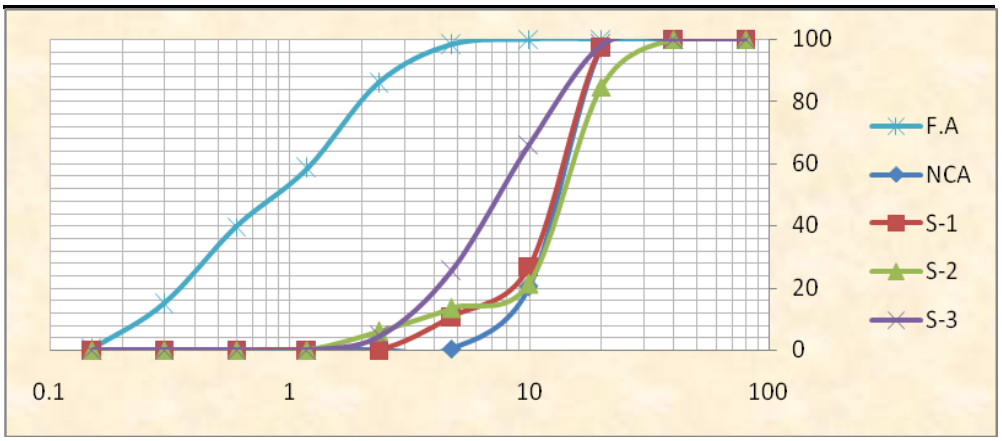


Fig. 2.1: Grading of curves

 

### 2.3 Methodology

Mix design according to IS: 10262:2003 was done for water cement ratio 0.45 and 0.38 for concrete of grade M30. For the casting of concrete containing 0%, 20%, 30%, 40%, 50% and 100% replacement of recycle aggregate are used. Mould sizing 150mm by 150mm by 150mm were used. After casting, the cubes are cured to test the compressive strength the concrete at 7 days, 28 days and 90 days respectively. The test procedure is according to the method mentioned in IS: 516:1989. The obtained experimental values are than used to do regression analysis by using SPSS software. After the analysis the contribution of selected parameters of concrete are determined and an empirical formula was developed. Again, flyash is used as an admixture in replacement of cement to improve the workability and the strength. The percentage of flyash used is 10% and 20%. The method of proportion, mixing, casting, and curing is same as above.

## III. EXPERIMENTAL RESULTS

The experimental results obtained after the curing of 28 days and 90 days are shown below in the graph

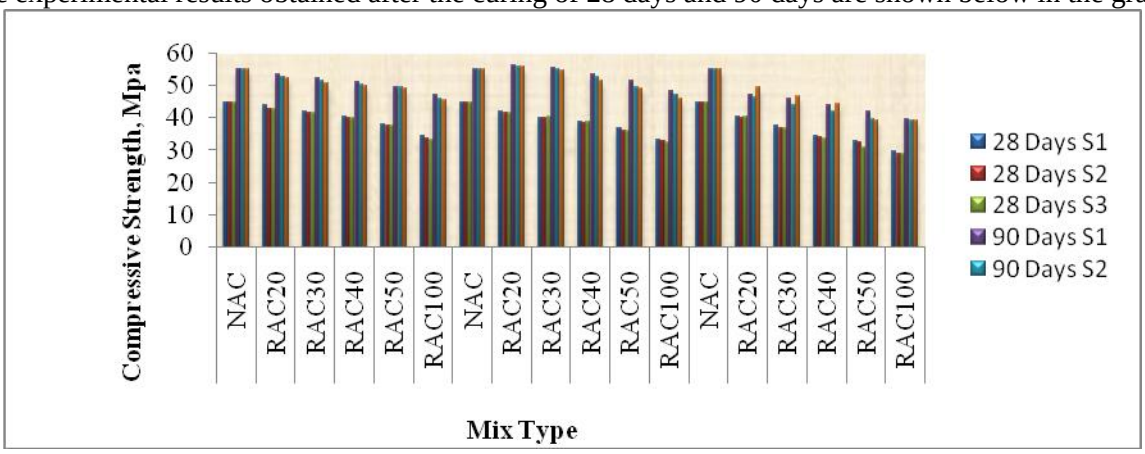


Fig. 3.1: Relationship between compressive strength and Flyash percentage

The strength of NAC concrete is more than the strength of recycled aggregate concrete for all the mixes, except for the strength of RAC20 + F10 mix at 90 days. The 28 days strength decreases with percentage of flyash in all mixes. The 90 days strength of recycled aggregate with 10 % flyash is found to be greater than 0% and 20% flyash with recycled aggregate.

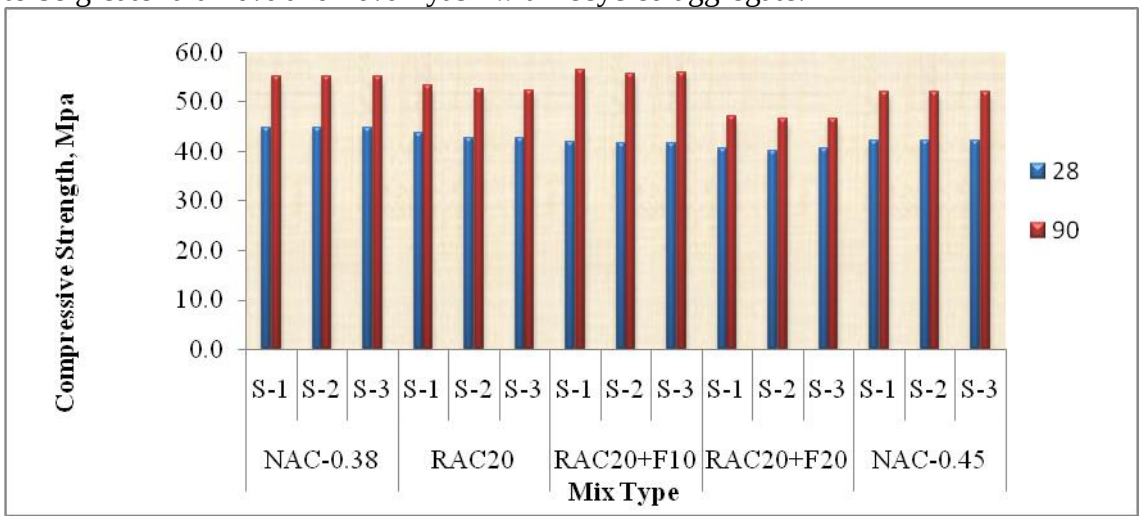


Fig. 3.2: Relationship between compressive strength of RAC20 and NCA

 

The strength of RAC20 for 0.38 water cement ratio is almost same as that of the strength of NCA for 0.45 water cement ratio. Strength of RAC20 + F10 for 0.38 water cement ratio is highest amongst all the mixes at 90 days.

## IV. DATA ANALYSIS

Results obtained are further used for the regression analysis by using SPSS sofware to form a emprical formula by considering four parameter of Recycle concrete i.e water cement ratio, flyash percentage, recycle aggregate percentage, age of curing.They are kept as independent variable and the experimental compressive strength is kept as dependent variable.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4$$

$$Y = 53.768 - 0.109*X_1 - 0.221*X_2 + 0.252*X_3 - 51.45*X_4$$

Where Y indicates the predicted compressive strength of concrete, in $N/mm^2$
$X_1$ indicates the percentage of recycled Coarse aggregate,
$X_2$ indicates the percentage of flyash,
$X_3$ indicates the Age of curing in days,
$X_4$ indicates the water cement ratio

## V. RESULT OF ANALYSIS

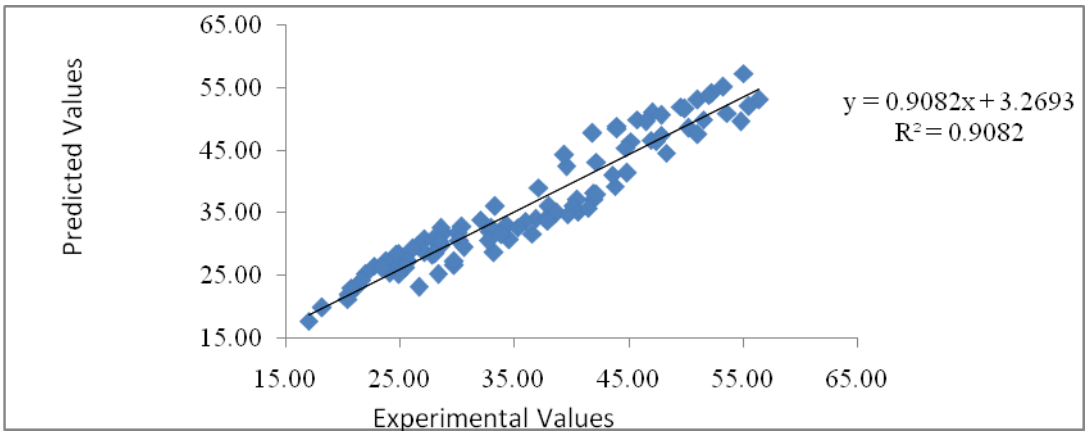


Fig.5.1: Predicted value V/S Experimental value

## VI. CONCLUSION

From the study following conclusion are made:

[1] The strength of concrete decrease with increase in the percentage of recycle aggregate, this may be due to the loose mortar around the recycle aggregate which do not allow the proper bonding between the cement paste and aggregate.
[2] The results also indicate that for RCA samples obtained from three different sources, there was no significant variation in strength of concrete at given RCA samples.
[3] RAC based concrete with 10% fly ash replacement gives higher compressive strength than normal RAC based concrete in 90 days.
[4] The test results shows that the Natural aggregate can be replaced by recycle aggregate up-to 40% with 10% flyash.

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