Behavior of Recycled Coarse Aggregate in Ternary Blended Concrete with Micro Silica and Fly Ash

Bhatt Rushabh[1], Prof. Y.V.Akbari[2]
Student, Assistant Professor
Civil Engineering Department
Darshan Institute Of Engineering And Technology, Hadala, Rajkot,India.

***Abstract*—The needs of the use of construction and demolition wastes have increased due to the rapid evolution. The demolition wastes are very harmful for the environment if not properly disposed. Nowadays the use of demolition wastes is in landfill, but this paper represents the innovative use of these aggregates in the concrete industry after recycling. The use of Recycled aggregates gives a good support to depleting natural aggregates stock.**

In this study, the behavior of aggregate in concrete is examined by the replacement of percentage variation of Recycled Coarse Aggregate (RCA) with the Natural Coarse Aggregate (NCA) for the determination of structural property and also the cement replaced by the byproducts of the solid waste materials like micro silica and fly ash.

The replacement of Recycled Coarse Aggregate (RCA) with Natural Coarse Aggregate (NCA) is upto 60% with the interval of 20%. The byproduct fly ash is used up to 30% and micro silica content is fixed as 10%.

All replacement had done with the different water cement ratios. In this paper the water cement ratio of 0.45, 0.50 and 0.55 were used.

***IndexTerms*—conserve natural aggregate, minimized waste, protect environment, cost economy, slump test, compacting factor test, compressive strength, split tensile strength test, flexural strength test**

I. INTRODUCTION (HEADING 1)

The rise in population creates the demand of new construction. The concrete is the mixture of cement, coarse aggregate, fine aggregate and water. This all are primary need for making concrete. The proportioning of all the ingredients for making concrete are based on the water cement ratio or grade of concrete. Cement is the prime material for making concrete and also it is costlier than other. The production of cement was about 3 billion tons in 2009 globally and it will estimated of about 6 billion tons in 2020. The production of cement emits a very huge amount of harmful gases such as carbon dioxide (co2). About 7% of co2 emitted from the cement industry. Also in the production of cement the natural resources like lime stone are used in more quantity.

By using the supplementary cementitious material in concrete which are the byproducts of other industrial process. They may useful as a partial replacement of cement as per the properties of the materials in the concrete. Supplementary cementitious material can also improves a concrete property such as resistance to alkali aggregate reaction. The maximum amount is used without affect the concrete properties.

Fly ash is the byproduct of thermal power plant and micro silica is also the non useful byproduct. Annually the production of fly ash is estimated over 100 million tons from around 83 coal based thermal power stations. Micro silica have more sio2 content so it also useful for the concrete.

The use of Recycled Coarse Aggregate (RCA) which are obtained by the processing of construction and demolition waste. This aggregates are useful in the new construction becomes more important to conserve the non renewable natural resources of natural aggregates. By increasing the proportion recycled aggregate with the natural aggregate the strength will be decreased but for the economical and environmental aspect the use of Recycled Aggregates is growing globally.

The use of recycled coarse aggregates and the byproducts such as fly ash and micro silica in the concrete is considered more beneficial from different prospects with similar performance characteristics to the conventional concrete. In recycled coarse aggregates the impurities like cement paste believed that it can affect the strength but a proper gradation makes an improvement in permeability and also in strength. So in normal cases it is useful for all type of construction in the proper manner.

The partial replacement of Recycled Coarse Aggregate (RCA) with Natural Coarse Aggregate (NCA) has done in this study but the full replacement is not give the sufficient strength.

II. SIGNIFICANCE OF THE WORK

The present work is aimed at studying the behavior of Recycled Coarse Aggregate (RCA) in the Ternary Blended Concrete (TBC) by using cementitous materials with different water cement ratio of 0.45, 0.50 and 0.55. by the use of fly ash and micro silica the environmental problem of disposal of waste materials can be satisfied in some manner and also have apart from improving the performance of the concrete. An optimum percentage replacement of Recycled Coarse Aggregate (RCA), fly ash and micro silica as with respect to strength.

III. MATERIALS

Cement

Ordinary Portland Cement (OPC) of Ultra Tech 53 grade conforming IS: 12269, 1987 was used.

Natural Fine Aggregate

Natural Fine Aggregate used for the whole study was obtained from river sand conforming to zone I of IS: 383, 1987. The size of aggregate is less than 4.75mm.

Table 1 Physical Properties of Fine Aggregates

Properties of Natural Fine Aggregate	
Description	***Natural Fine Aggregates***
Specific gravity	2.77
Water absorption	1.0%
Moisture content	Nil

Natural Coarse Aggregate

Machine crushed granite chips conforming to IS: 383, 1970 of maximum size 20mm size of aggregate obtained from the local quarry was used and the specific gravity of 2.77.

Table 2 Physical Properties of Coarse Aggregates

Properties of Natural Coarse Aggregate	
Description	***Natural Coarse Aggregates***
Specific gravity	2.77
Water absorption	1.45%
Moisture content	Nil

Water

Potable water available locally in the college was used for casting and curing.

Micro Silica

The micro silica was procured from the 20 microns Pvt. Ltd, Vikhroli (W), Mumbai. With the specific gravity of 2.6.

Table 3 Properties of Micro Silica

Properties of Micro Silica			
Sr. no.	***Test***	***Micro Silica***	***Unit***
1.	Sio2	98.8	% by weight
2.	Al2O3	Absent	% by weight

Fly Ash

The material was procured from Thermal Power Plant at Gandhinagar, Gujarat. The fly ash of class F was used of light grey colour. The specific gravity of 2.2.

Table 3 Properties of Fly Ash

Properties of Fly Ash			
Sr. no.	***Test***	***Sample: fly ash***	***Unit***
1.	Sio2	29.33	% by weight
2.	Al2O3	12.56	% by weight
3.	CaO	6.65	% by weight
4.	Fe2O3	23.67	% by weight

Recycled Coarse Aggregate

The building demolition waste was collected from a residential building for the commercial aspect and the age of building is about 40 years. The concrete debris was broken into pieces of maximum size of 20mm and 4.75 mm avoiding cement paste in the aggregate crushing plant. The Recycled Coarse Aggregate were washed and dried and then collected for use in concrete mix.

Table 4 Properties of Recycled Coarse Aggregate

Properties of Recycled Coarse Aggregate	
Description	***Recycled Coarse Aggregates***
Specific gravity	2.56
Water absorption	4.46%
Moisture content	1.5%

IV. MIX PROPORTIONING

Design of concrete mix as per the water cement ratio of 0.55 conventional batch was casted and then compared with the percentage replacement of the byproducts and recycled coarse aggregates.

Conventional mix design from the concrete design as per code IS: 10262,2009 is given below.

Table 5 Calculated Mix Design

Concrete Mix Design				
w/c ratio	***Cement (kg)***	***Water (lit)***	***NCA (kg)***	***NFA (kg)***
0.55	358.18	213	1137.67	783.63
0.50	394	213	1110.5	751.22

Partial Replacement of Different Batches					
Batch No.	*W/c Ratio*	*Description*	*No. of Specimens*		
			Cube	*Beam*	*Cylinder*
A1	0.55	100%C NCA NFA	9	3	3
A2	0.55	80%C 10%FA 10%MS 80%NCA 20%RCA NFA	9	3	3
A3	0.55	70%C 20%FA 10%MS 80%NCA 20%RCA NFA	9	3	3
A4	0.55	60%C 30%FA 10%MS 80%NCA 20%RCA NFA	9	3	3
A5	0.55	80%C 10%FA 10%MS 60%NCA 40%RCA NFA	9	3	3
A6	0.55	70%C 20%FA 10%MS 60%NCA 40%RCA NFA	9	3	3
A7	0.55	60%C 30%FA 10%MS 60%NCA 40%RCA NFA	9	3	3
A8	0.55	80%C 10%FA 10%MS 40%NCA 60%RCA NFA	9	3	3
A9	0.55	70%C 20%FA 10%MS 40%NCA 60%RCA NFA	9	3	3
A10	0.55	60%C 30%FA 10%MS 40%NCA 60%RCA NFA	9	3	3
B1	0.5	100%C NCA NFA	9	3	3
B2	0.5	80%C 10%FA 10%MS 80%NCA 20%RCA NFA	9	3	3
B3	0.5	70%C 20%FA 10%MS 80%NCA 20%RCA NFA	9	3	3
B4	0.5	60%C 30%FA 10%MS 80%NCA 20%RCA NFA	9	3	3
B5	0.5	80%C 10%FA 10%MS 60%NCA 40%RCA NFA	9	3	3
B6	0.5	70%C 20%FA 10%MS 60%NCA 40%RCA NFA	9	3	3
B7	0.5	60%C 30%FA 10%MS 60%NCA 40%RCA NFA	9	3	3
B8	0.5	80%C 10%FA 10%MS 40%NCA 60%RCA NFA	9	3	3
B9	0.5	70%C 20%FA 10%MS 40%NCA 60%RCA NFA	9	3	3
B10	0.5	60%C 30%FA 10%MS 40%NCA 60%RCA NFA	9	3	3

V. EXPERIMENTAL WORK

Casting and Curing of Specimens

Casting of specimens was done by proper batching of materials, preparation of moulds and placing of concrete in the moulds. After every 1/3 filling of material into the moulds. The vibrator was used and then the top surface was properly leveled at the end. Then all moulds are allowed to dry for 24 hours and proper batch for identification were written and kept into curing tank for 7, 14 and 28 days.

Slump Test for the Fresh Concrete

The slump test was done for the comparison of degree of workability between natural concrete and recycled aggregate concrete. By increasing the percentage of recycled aggregate the slump value were low but flyash gives more workability so that the values were very near as per mix design. So without any admixtures the workability criteria was satisfied by using byproduct.

Strength Tests

The compressive strength tests were done with the size of specimen 15cmx15cmx15cm. The cubes were tested after curing of 7 days, 14 days and 28 days from the date of casting. Three cubes were tested for each day strength. The work of casting, curing and testing was done in the proper manner. Cylinders were 15cm diameter and 30cm height of size used for split tensile strength. Beams of size 10cmx10cmx50cm were used for flexural strength test. Beams and cylinders were tested after 28 days curing.

Obtained results of each tests are given below in tabular form for water cement ratio 0.55.

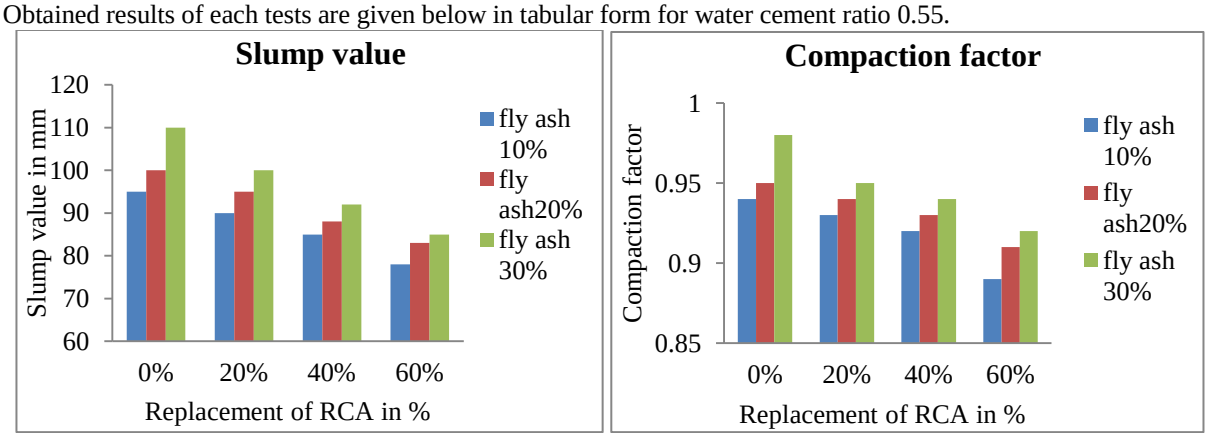


Figure. 1 Results of the Fresh Properties

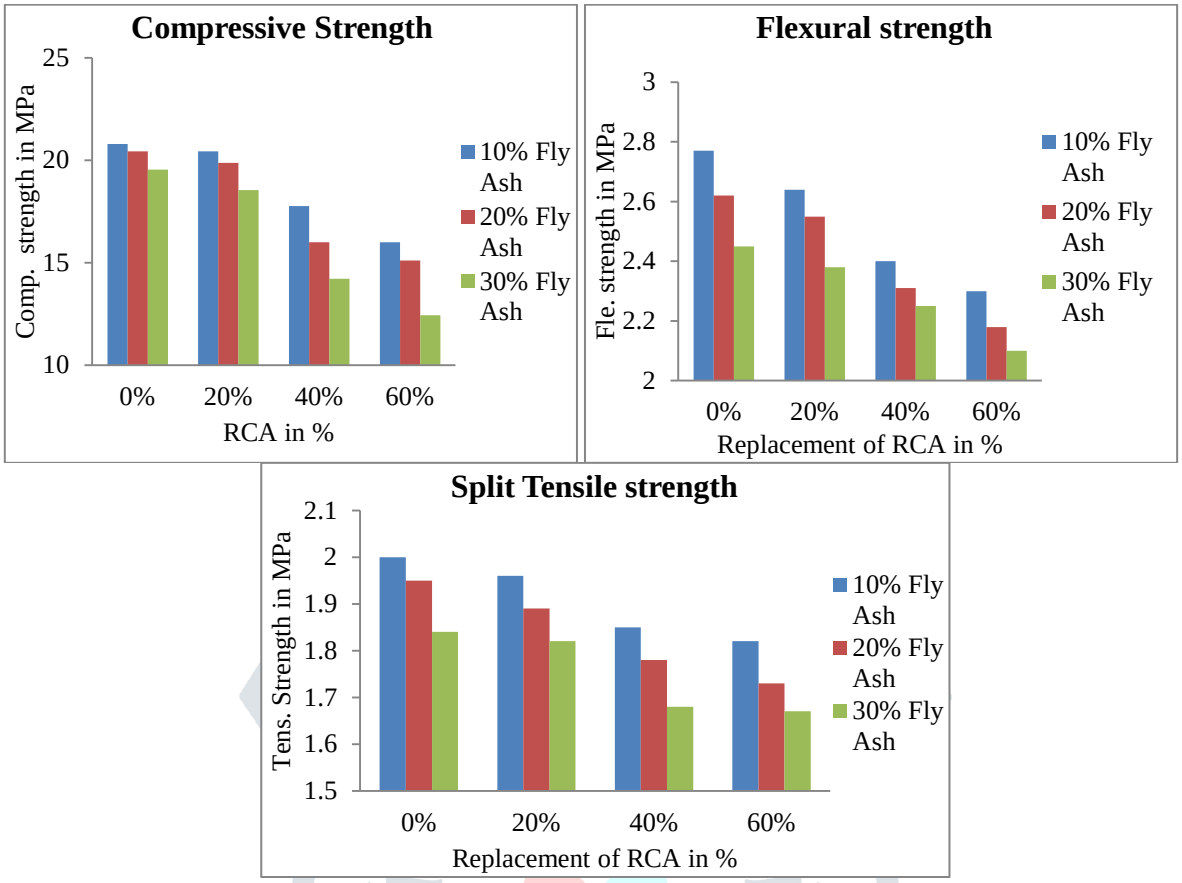


Figure. 2 Results of the Hardened Properties

Obtained results of each tests are given below in tabular form for water cement ratio 0.50.

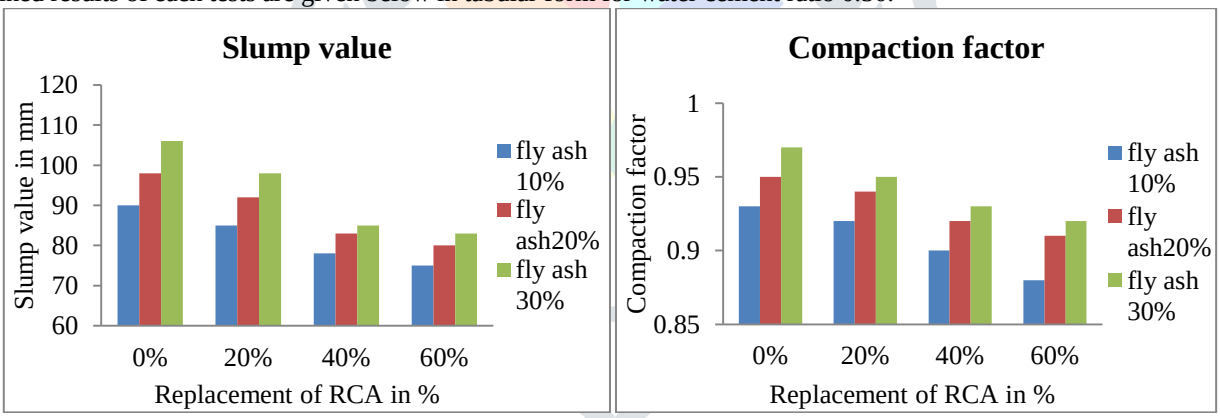
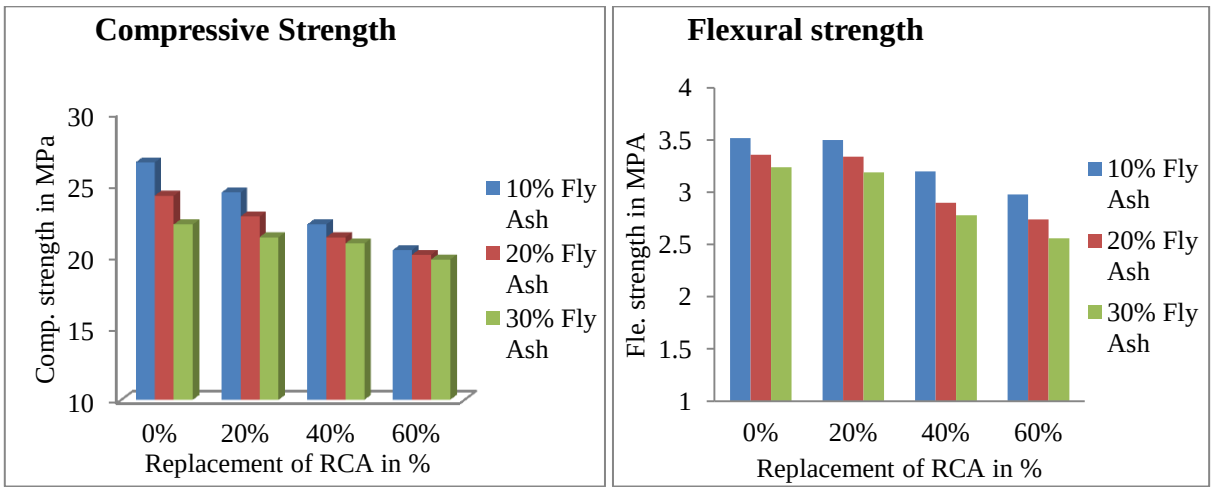


Figure. 3 Results of the Fresh Properties



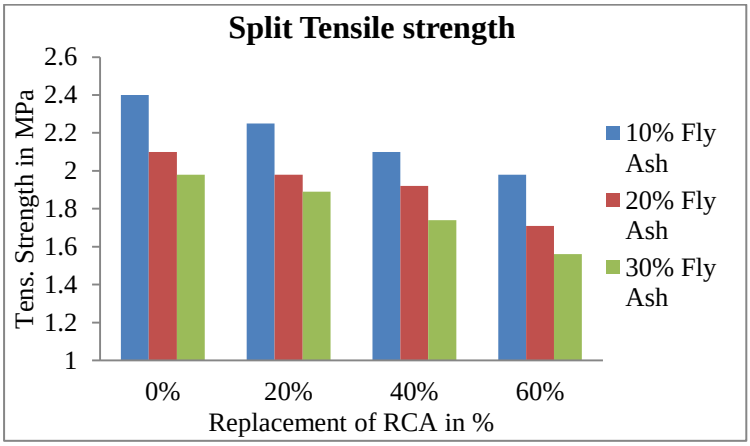


Figure. 4 Results of the Hardened Properties

VI. CONCLUSION

The various experiments have been performed with the comparative study of Recycled Coarse Aggregate (RCA) with Natural Coarse Aggregate (NCA). In this study tried to use maximum proportion of byproducts without decrease in strength. The RCA were used in the replacement of 20%, 40% and 60% with NCA. The byproduct Fly ash used with the replacement of 10%, 20% and 30% with cement and micro silica was constant of 10% replacement with cement. Fly ash and micro silica both were used with every replacement of RCA.

Whole experiment was done for water cement ratio of 0.55 & 0.50. From various experiments and results the following conclusion were made:

1. When increasing the percentage of recycled coarse aggregate the strength will decreases.
2. The reuse of demolition waste and use of byproducts can protects natural resources and decrease the pollution in some manner.
3. The workability criteria is also satisfied by using fly ash and also the requirement of cement can also minimized.
4. By the use of such additive materials the overall cost can also decrease.
5. The results are also very near to conventional concrete.
6. By the use of recycled aggregate reduces the need of quarrying and damage to our landscape.
7. Use of byproducts can also fulfill the requirement of super plasticizers.
8. This type of concrete is useful for small and medium type of construction.

While increasing the percentage RCA with NCA the values of compressive strength, tensile strength and flexural strength are decreases.

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