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An Investigation on Durability and Mechanical Properties of Basalt-Recycled Aggregate

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Abstract - *The cubes are tested for two kinds of test to clarify the modulation of compressive strength, flexural strength of concrete by using basalt as aggregate as per the mix design. The tests were carried out with 60%, 30% basalt as aggregate. The study has gone through performance of durability studies and mechanical properties how they both performance in concrete. Based on results, the compare between concrete with normal aggregate and concrete with basalt aggregate was performed for durability parts. Curing conditions are improved by adding recycled aggregate, use of fly ash. Basalt aggregate (BA) with a 3% water absorption, raw recycled aggregate and basalt (RRA), and improved recycled aggregate and basalt (PRA) were the main experimental variables. The drying shrinkage of PRA was similar to that of BA with an average difference of <7% as the age increased. The efficient use of recycled aggregate higher performance than that of concrete comprising BA and improved durability.*

Key Words: Basalt, Recycled Aggregate, Curing, Fly ash Compressive Strength, Flexural Strength.

1. INTRODUCTION

Industrial growth has resulted in the rapid rise of concrete-based buildings attended by environmental degradation due to the use of numerous natural resources, such as aggregate. The group of natural resources led to the destruction of rivers and mountains, resulting in a lack of resources. The durability of a structure is said to be its ability to serve its intended purpose for a necessarily oflong period oftime or at least its service time and a durable concrete in one which satisfactorily performs in its exposed environ- mental conditions during its service life span. Aggregates are used for very specific purposes including significant economic benefit in the final costof concrete. They make about 65-75 % of the volume of the concrete mixture and they are the least expensive component of the concrete mixture. Therefore, we have decided to replace the normal aggregates with basaltaggregates. The physical properties of concrete are not expressively affected if recycled aggregate replaces less than 30% of coarse aggregate during concrete production. Although new studies with various novelty have been conducted, they have not been applied to research or practical applications.

2. METHODOLOGY OF TESTING AND MATERIALS

The experimental variables include the aggregate type, FA substitution rate, and curing condition. For the three variables with three factors, nine mixtures were set using the Taguchi investigationaldesign method.

The aggregate used in the experiment was pre- wetted in water for 24 h, considering the high absorption rate of the aggregate, and then the experiment was conducted by correcting moisture. It has a fine-grained material texture due to molten rock cooling too quickly for large material crystals to grow.

Apart from basalt, the type of Portland cement used in the current experimentation as a component of con- crete is ordinary Portland Cement of Grade 43 and high quality. For the experimentation the nominal sizes of thecoarse aggregate used were 20 mm and 10 mm and the sand conforming to Zone II was used as the fine aggregate.

In the experiment, we used Type I ordinary Portland cement from "S" company and FA from "Y" thermal power plant. The physical properties of the materials are listed in Tables 1 and 2 while their chemical properties are listed in Table 3.

Table -1: Physical properties of cement

Density (g/cm3)	Finenes s (m2/kg)	Setting Time in (mints)		Compressive Strength (MPa)		
		Initia l	Final	3 Day s	7 Day s	28 Day s
3.14	383	46	376	24	30.1	43.6

Table -2 Physical properties of fly-ash

			Activity Index (%)	
Density g/cm³	Fineness m²/kg	Flow Value Ratio (%)	28 Days	91 Days
2.15	356	108	90	96

Table -3 Chemical composition of cement

Type	CaO (%)	SiO2 (%)	Al2O3 (%)	Fe2O3 (%)	MgO (%)	Ig. Loss (%)	Other (%)	Total (%)
Cement	2.4	21.1	4.4	3.2	3.1	3.4	2.4	100
Fly-ash	5.8	52.7	21.7	7.8	2	2.4	7.6	100

2.1 TESTING METHODOLOGY

Preparing the Moulds:

Three types of moulds were usedfor current experimentation cubes, cylinder and prisms. The cubic moulds were of the dimensions 150 x 150 x 150 mm, the cylindrical moulds having diameter as 150 mm and height as 300 mm and the prisms with cross sectional area of 150 x 150 mm and length 7oo mm.Tamping, with usually 25 blows is done after every layerof concrete is added.

Mixing of Concrete:

The materials comprising ofthe concrete mix were weighed on the balance and then inserted inside the mechanical mixer.

Compaction of Concrete:

During the production of concrete a considerable amount of air is entrapped. Also during its transportation, there is a possibility of par- tial segregation of aggregates. If the entrapped air is not removed and the segregation of coarse aggregate not cor- rected, the concrete may be porous, non-homogenous andof poor strength.

Curing of Specimens:

In the current experimentation, curing of cube and cylindrical specimens to gain 28day strength was done using the steam curing machine available at the Material testing Laboratory, Department of Civil Engineering.

The curing of prisms for 7, 14 and 28 days strength; cylinders for 7 and 14 day strength and cubes for 7 and 14 day strengths was done by ponding with water in a curing tank located just outside the laboratory.

Table -3 Chemical composition of cement

Aggregate Type	Replacement Ratio of Fly Ash (wt%)	Curing Condition
Basalt aggregate	**0**	**Water curing**
Raw recycled aggregate and Basalt	30	Air-dry curing
Improved recycled aggregate and Basalt	60	Steam and air-dry curing

Table -4 Mix proportion of concrete

S.No of ID	Air (%)	w/b (%)	s/a (%)	Unit Weight (kg/m³)							
				Water	Binder		Coarse Aggregate			Fine Aggregate	Total
					Cement	FA	Basalt	RRA	PRA		
BA FA0	6	44	41	164	382	-	1042	-	-	660	2242
BA FA30				164	286	96	1016	-	-	644	2203
BA FA60				164	192	191	992	-	-	628	2162
RRA FA0				164	381	-	522	442	-	660	2163
RRA FA30				164	286	96	510	431	-	644	2124
RRA FA60				164	192	191	497	420	-	628	2085
PRA FA0				164	381	-	522	-	486	660	2208
PRA FA30				164	286	96	510	-	475	644	2168
PRA FA60				164	191	191	497	-	463	628	2129

Fig -1: Coarse aggregates of BA

Fig -2: Coarse aggregates of RRA

Fig -3: Coarse aggregates of PRA

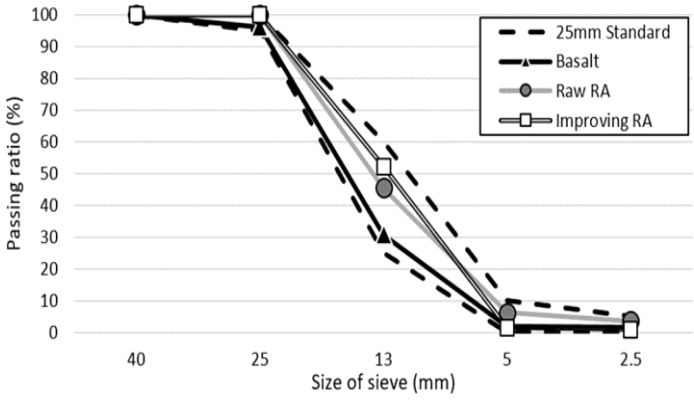

Chart -1: Grading of coarse aggregate

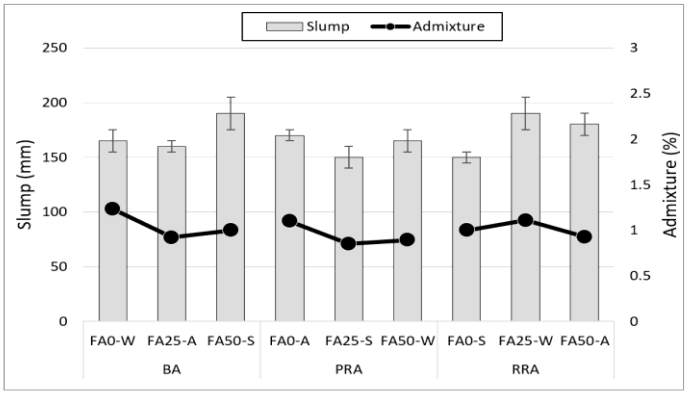

Chart -2: Slump of fresh concrete

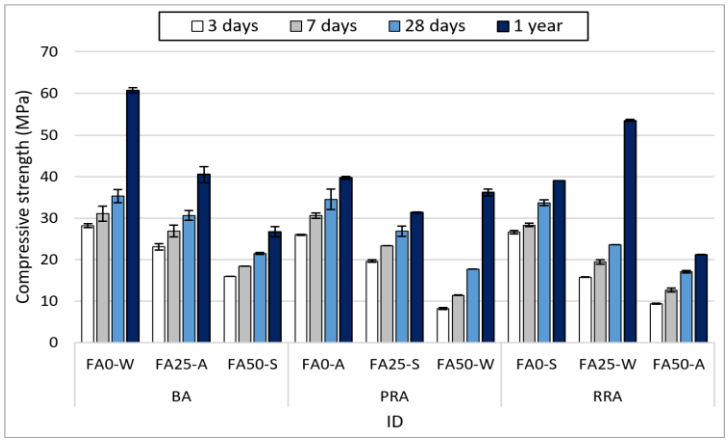

Chart -3: Compressive strength of concrete

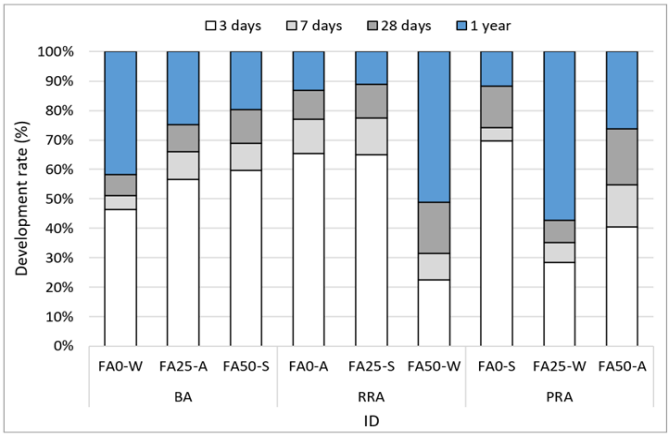

Chart -4: Development rate on compressive strength of concrete

For the fire resistance value, the results show thatconcrete with 50% and 30% basalt as aggregate shows much better fire-resistant value than nor- mal concrete, thus making it better fire-resistantmaterial. For water permeability value, The results show that concrete with 50% and 30% basalt as aggregate shows much less water permeability value than normal concrete.

3. CONCLUSIONS

- The compressive strength, a significant increase of 30.1%, 43.6% was seen in the mix containing basalt aggregate 50%, 30% respectively. Therefore, this result is favorable.
- The flexural strength, there was a marginal increase of 4.69%, 3.4% in the flexural strength in the basalt mix 50%, 30% respectively. Hencefavorable.
- The durability of concrete, steam curing tended to decrease drying shrinkage, which this is because blended water was consumed and a dense matrix was constructed due to high temperature heat and humidity in early curing. When the improved recycledaggregate was used, the drying shrinkage decreased over time at a level similar to that ofbasalt.
- The fire resistance, the basalt aggregate of 50%,30% replaced concrete is found to be 16.49%, 9.8% more fire resistant.
- The water permeability, there was an increase of 49.26%, 32.98% in the permeability penetrationin the basalt mix of 50%, 30% respectively.
- The properties of fresh concrete, there was no decrease in the slump due to theinfluence of the recycled aggregate, but some air content increased due to the porous old paste of the recycled aggregate.

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