An Experimental Study on Concrete with Partial Replacement of Cement By Rice Husk Ash and Bagasse Ash

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ABSTRACT: Utilization of waste materials in concrete manufacture provides a satisfactory solution to some of environmental concerns and problems associated with waste management. Agro waste such as rice husk ash and bagasse ash were used as pozzolanic material for development of blended cement. The properties of concrete with partial replacement of cement by rice husk ash and bagasse ash for about 30% were investigated which includes its compressive strength, split tensile, flexural strength, durability property such as acid attack and sulphate attack. Among the various percentage replacement of cement by rice husk ash and bagasse ash, the strength test result shows that the optimum percentage replacement was about 70 : 20 : 10 (Cement : RHA : BA) which gives the optimum proportion of 30% replacement of cement with rice husk ash and bagasse ash to produce high performance concrete and contribute to sustainable construction. The cement in the concrete replaced by Bagasse Ash and Rice Husk Ash by the percentage of 5%, 10%, 15%, 20%, 25% and 30%. This optimum proportion result obtained is beneficial in improving the mechanical strength and durability property of the concrete. In this project work Conplast 340 Superplasticizer was used to improve the workability of concrete with replacement materials.

Keywords: Rice Husk Ash, Bagasse Ash, Mechanical Strength, Acid Attack.

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1. Introduction

Concrete is the most common building material made by man. It is obtained by mixing cement, water, aggregate and additives in the required proportions[1]. The mixer, placed in molds and left to harden, becomes hard as stone. The strength, durability and other properties of concrete depend on the properties of concrete components, mixing ratio, compaction method and other controls during setting and hardening[2-4]. Concrete is used extensively in most construction activities. The consumption of steel is much lower than that of concrete. Concrete has the advantage of being easy to handle and transport. It can withstand very high temperatures caused by fire for long periods of time without loss of structural integrity and performs well during man-made natural disasters and also when exposed to flying debris[5,6]. With the remarkable development of the concrete industry, the recycling of waste materials in concrete production, which are used as ingredient substitutes, is becoming widespread worldwide. Some composite materials are used to replace concrete, such as fly ash, rice hull ash, sugar cane ash, slag, fiber, gravel, mud, etc.,[7-10]. Research into the use of waste as a partial replacement for cement has begun in many areas. Rice hulls and sugar cane ash can be potential substitutes for other natural wastes such as rice hull ash and sugarcane ash have more amorphous silica, so the strength of the concrete will not be affected when replaced[11]. Rice husk ash and sugarcane ash improve concrete properties such as workability, durability with low creep, low shrinkage and low heat of hydration, low carbon content, low bleed and low segregation. Reduce CO_2 emissions by partially replacing cement with agricultural waste[12]. Rice husk ash is used as an absorbent for oils and chemicals, as an insulating material for houses, and as a coolant. RHA has the potential to be used as a partial concrete replacement (PCR), has good compressive strength and durability and therefore has the potential tobe used as a PCR material that can contribute to sustainable construction[13]. Sugarcane ash is used to clean up oil spills and also as fertilizer. Therefore, the productive and innovative use of waste prevents pollution[14,15]. In the article, the strength and durability properties of concrete were determined with different percentages of replacing the cement with a mixture of rice husk ash and sugarcane ash in different proportions from 5% to 30% and the optimal rate of substitution of rice husk ash and rice husk ash was determined. Sugar cane ash as a partial cement replacement.

2. Methodology

2.1 Materials Used

The following materials were used for making concrete as follows,

3. Cement
4. Rice Husk Ash
5. Bagasse Ash
6. Fine Aggregate
7. Coarse Aggregate
8. Water
9. Superplasticizer (Conplast 340)

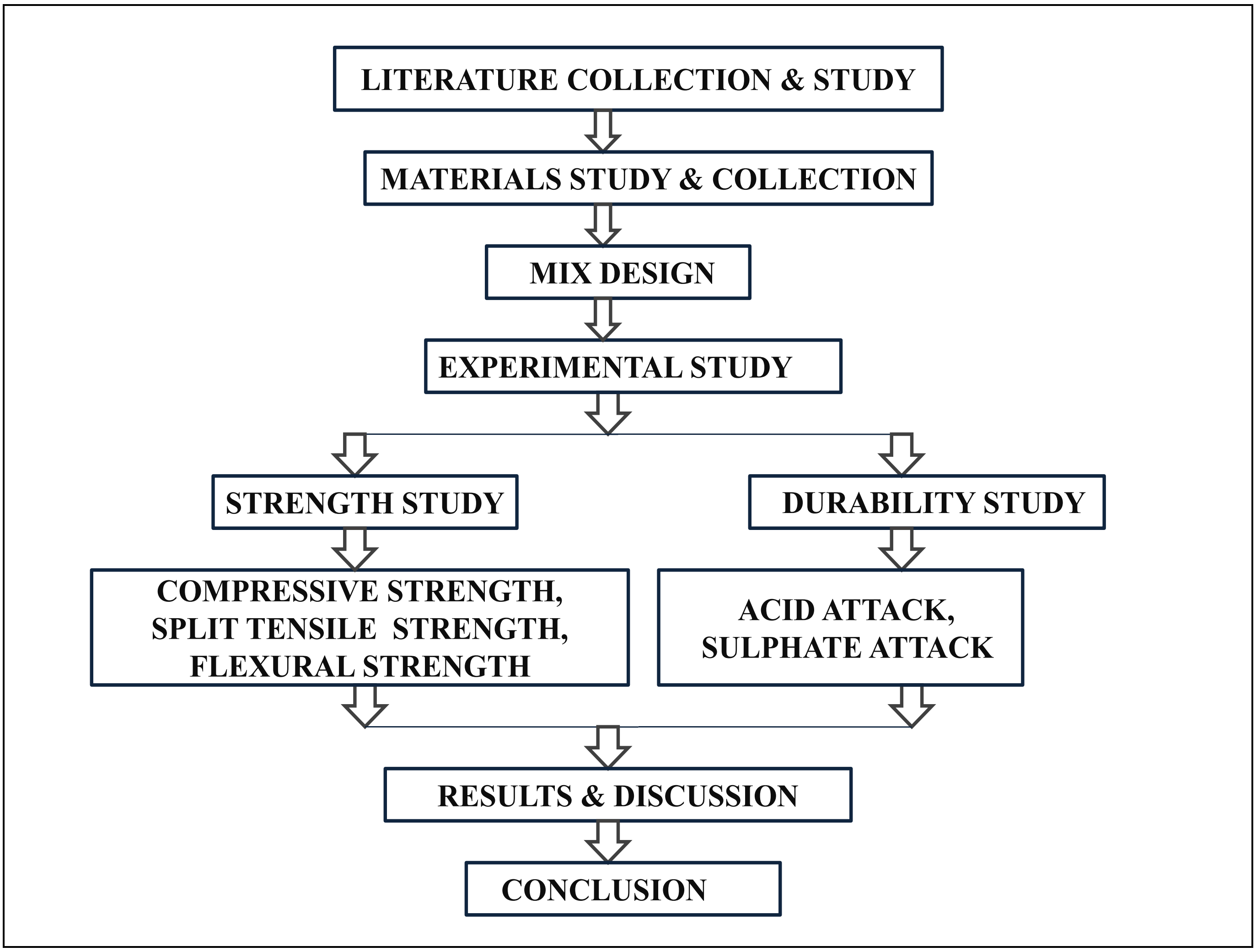

Figure 1. Methodology

2.2 Mix Proportion

The various percentage of M0 grade of concrete mix proportion were given in table 1.

Table 1. Mix proportion

Mix	Cement	RHA	BA
M1	100	0	0
M2	70	30	0
M3	70	25	5
M4	70	20	10
M5	70	15	15
M6	70	10	20
M7	70	5	25
M8	70	0	30

2.3 Mix Quantity

The quantity of the cement, rice husk ash, bagasse ash, fine aggregate, coarse aggregate, superplasticizer and water were given for one cubic meter in Table 2.

Table 2: Mix Quantity

Mix	Cement (kg/m³)	RHA (kg/m³)	BA (kg/m³)	FA (kg/m³)	CA (kg/m³)	Water (kg/m³)	SP
M1	348.32	0	0	790	1038.41	191.57	5.23
M2	243.82	104.49	0	790	1038.41	191.57	5.23
M3	243.82	87.08	17.41	790	1038.41	191.57	5.23
M4	243.82	69.66	34.8	790	1038.41	191.57	5.23
M5	243.82	52.24	52.24	790	1038.41	191.57	5.23
M6	243.82	34.8	69.66	790	1038.41	191.57	5.23
M7	243.82	17.41	87.08	790	1038.41	191.57	5.23
M8	243.82	0	104.49	790	1038.41	191.57	5.23

3. Experimental Investigation

In this research, results based on the experimental investigation carried out to determine the compressive strength of concrete cubes, tensile strength of cylinders and flexural strength of concrete prismwere determined.Cube moulds of size 100mm x 100mm x 100mm and cylinder moulds of diameter 75mm and height 150mm were used. The size of the prism is 500mmx10mmx10mm. The behavior of concrete with various types ofproportion is studied through an experimentalprogramme. The different mix proportion have been prepared and tested through M30grade of concrete with w/c ratio 0.55. The strength properties were evaluated with the help of compressive strength, split tensile strength and flexural strength. The durability test of acid attack and sulphate attack also determined.The percentage of partial replacement of cement with rice husk ash and bagasse ash is increased in the order of 5%.Concrete cubes, prism and cylinders were cast with different % of rice husk ash and bagasse ash. The casted specimens were tested at the age of 7, 14 and 28 Days of curing.

3.1 Compressive Strength of Concrete Specimens

Totally 72 cubes were casted and the test was conducted on cubical specimen of size 100mm x 100mm x 100mm at the age of 7 days, 14 days and 28 days of curing.

Table 3. Test Results on Compressive Strength

Mix	Compressive Strength (MPa)		
	7 Days	14 Days	28 Days
M1	32.1	38	42
M2	26.2	28.5	32.3
M3	32.6	33.8	36.2
M4	35.5	38.6	44.2
M5	34.8	35.3	36.8
M6	28.6	29.3	33.3
M7	26.3	28.6	31.0
M8	25.5	28.2	30.8

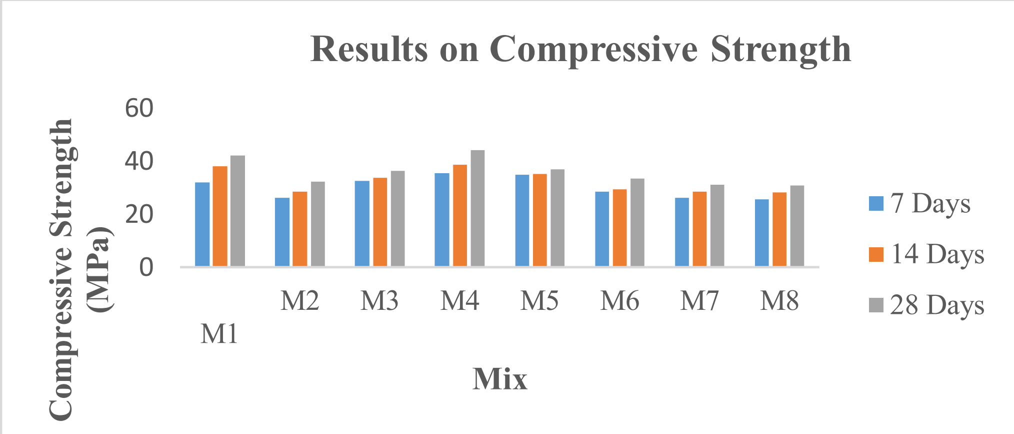

Figure 2. Test Results on Compressive Strength

The percentage of partial replacement of cement with rice husk ash and bagasse ash is increased in the order of 5%. Concrete cubes were cast with different % of rice husk ash and bagasse ash. Fig.3, shows M4 gives the higher compressive strength which contains 70% of cement, 20% of Rice Husk Ash and 10% of Bagasse ash.

3.2 Split Tensile Strength of Cylinder

Totally 72 cylinder were casted and the test was conducted on cylindrical specimen of size dia of 150mm and height of 75mm at the age of 7 days, 14 days and 28 days of curing.

Table 4. Test Results on Split Tensile Strength

Mix	Split Tensile Strength (MPa)		
	7 Days	14 Days	28 Days
M1	2.51	3.1	3.8
M2	2.83	2.94	3.0
M3	3.21	3.3	3.5
M4	5.65	5.8	6.1
M5	4.3	4.9	5.4
M6	3.6	4.1	4.8
M7	2.83	3.2	3.5
M8	2.46	3.1	3.7

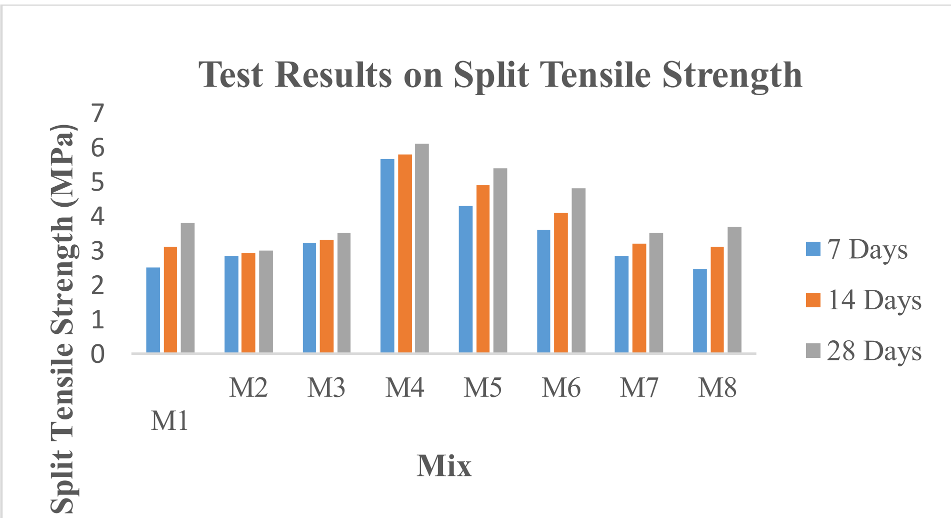

Figure 3. Test Results on Split Tensile Strength

The results shows that, the Compressive Strength is optimum at 70% of cement and 30% (20%RHA+5%BA) replacement of cement with mixture of Rice Husk Ash and Bagasse Ash and strength increase is mainly due to the occurrence of more amount of Silica presence in Rice Husk Ash and Sugarcane Bagasse ash. Hence, it is a cost effective and environment friendly construction used for the sustainable use.

3.3 Flexural Strength of Prism

Totally 72 prism were casted and the test was conducted on prism specimen of size dlength of 750mm breadth of 10mm and width of 10mm at the age of 7 days, 14 days and 28 days of curing.

Table 5. Test Results on Flexural Strength

Mix	Flexural Strength (MPa)		
	7 Days	14 Days	28 Days
M1	3.96	4.24	4.31
M2	1.71	2.04	2.45
M3	2.5	3.34	4.08
M4	4.21	4.35	4.52
M5	1.78	2.1	3.27
M6	2.68	302	3.72
M7	2.25	2.76	3.28
M8	1.64	1.98	2.41

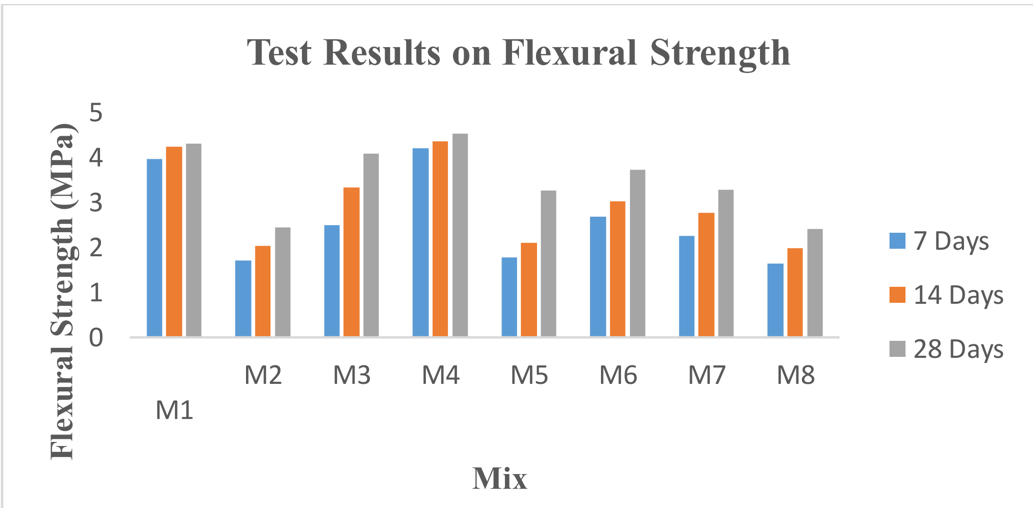

Figure 4. Test Results on Flexural Strength

Fig.4, shows M4 gives the higher flexural strength which contains 70% of cement, 20% of Rice Husk Ash and 10% of Bagasse ash. The result observed that the combination of rice husk ash and bagasse ash significantly increases the strength of concrete.

3.4 Acid Attack Test Results

Table 6. Test Results on Acid Attack

Mix	Weight of concrete before acid Attack(kg)	Weight of concrete after acidattack(kg)	Reduction in weight of concrete(kg)	Reduction in compressive strength after acid attack (%)
M1	2.63	2.55	0.08	3.04
M2	2.47	2.33	0.14	5.6
M3	2.34	2.21	0.13	5.5
M4	2.6	2.55	0.05	1.9
M5	2.58	2.49	0.09	3.4
M6	2.55	2.4	0.15	5.8
M7	2.55	2.37	0.18	7.0
M8	2.6	2.38	0.22	8.4

3.5 Sulphate Attack Test Results

Table 7. Test Results on Sulphate Attack

Mix	Weight of concrete before acid attack (kg)	Weight of concrete after acid attack (kg)	Reduction in weight of concrete (kg)	Reduction in compressive strength after Sulphateattack (%)
M1	2.6	2.55	0.05	2.1
M2	2.5	2.4	0.1	4.0
M3	2.6	2.53	0.07	2.8
M4	2.55	2.5	0.05	1.9
M5	2.7	2.63	0.07	2.5
M6	2.49	2.4	0.09	3.61
M7	2.62	2.55	0.07	2.67
M8	2.65	2.56	0.09	3.3

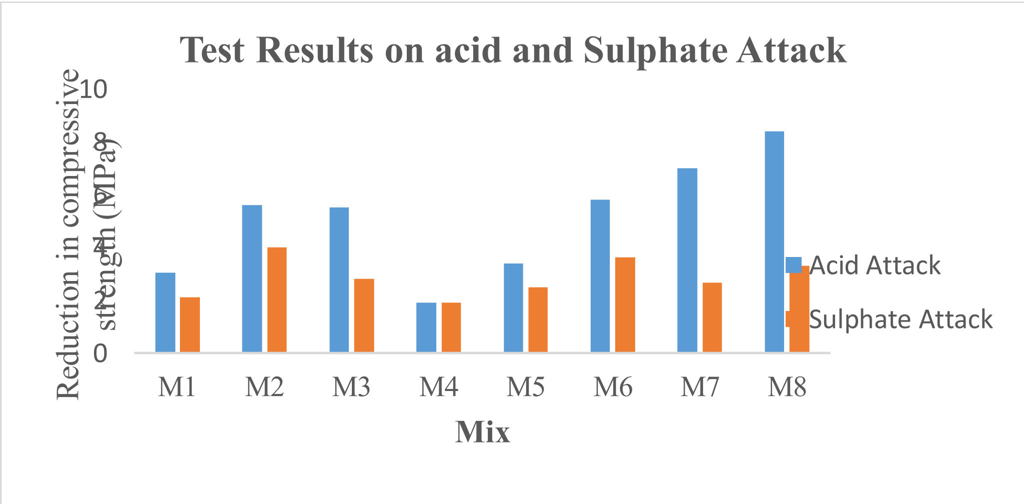

Figure 5. Test results on Acid and Sulphate Attack

Figure 5.illustrates the compressive strength of the test specimens incorporating a different proportion of RHA and BA. Concretes compressive strength increased as the proportion of RHA climbed up to 20% RHA and 10% of BA and after that it dropped with the increment of RHA. Among all concrete mixtures, the M4 mix obtained the lower reduction in the compressive strength for both the acid attack and sulphate attack of the concrete.

3.6 Ultra Sonic Pulse Velocity Test results on Cubes

The ultrasonic pulse velocity test were conducted on the cube specimen and tested for both before and after acid attack of the specimen.

Table 8. Test Results on Ultrasonic Pulse Velocity

Mix	Before Acid Attack		After Acid Attack	
	Average Velocity	Quality of Concrete	Average Velocity	Quality of Concrete
M1	4.14	Good	4.075	Good
M2	3.34	Medium	3.295	Medium
M3	3.94	Good	3.92	Good
M4	4.42	Good	4.36	Good
M5	3.76	Good	3.73	Good
M6	3.94	Good	3.57	Good
M7	3.38	Medium	3.12	Medium
M8	3.16	Medium	2.84	Doubtful

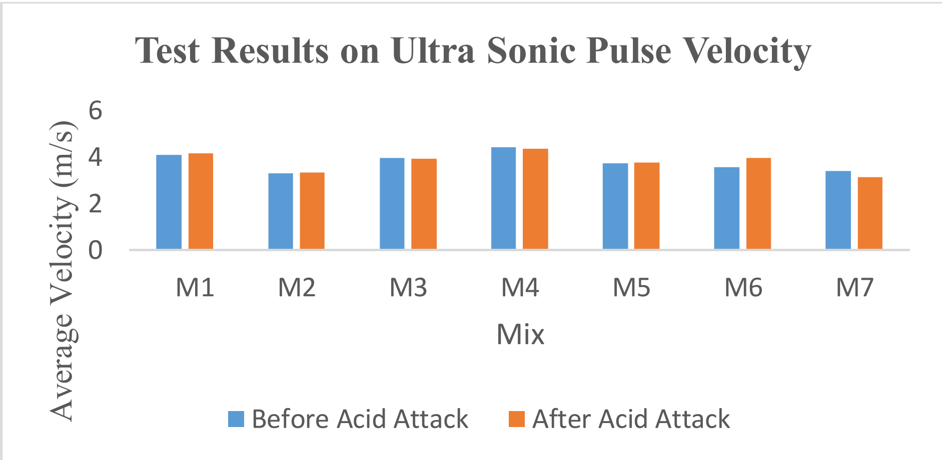

Figure 6. Test Results on Ultrasonic Pulse Velocity

3.7 Rebound Hammer Test Results on Cubes

The rebound hammer test were conducted on the cube specimen and tested for both before and after the acid attack of the concrete.

Table 9. Test Results on Rebound Hammer Test

Mix	Before Acid Attack		After Acid Attack	
	Rebound Hammer No	Compressive Strength (MPa)	Rebound Hammer No	Compressive Strength (MPa)
M1	35.3	32	34.67	31
M2	21.67	12	20.3	11
M3	37.67	36	36.67	35
M4	38.6	38	38.4	37
M5	33.34	29	32.33	27
M6	32.67	28	31.3	26
M7	29.67	23	28.3	21
M8	21.33	12	20.85	11.25

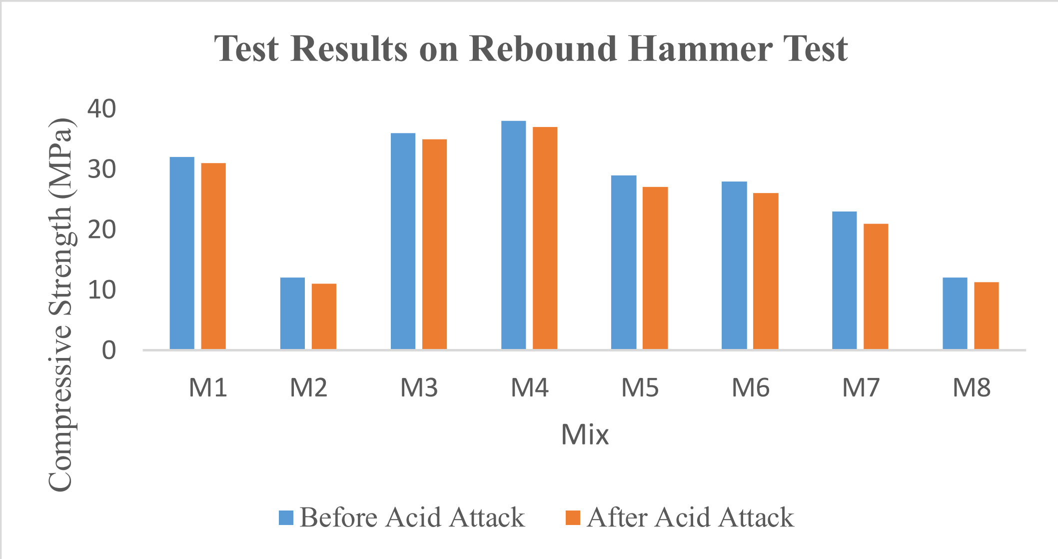

Figure 7. Test Results on Rebound Hammer Test

From the results of Ultrasonic pulse velocity and Rebound hammer 30% OPCreplacement with 20% of RHA and 10% of BA, a higher compressive strength of 37 MPa was seen after the attack and 38MPa was seen before the attack at the age of 28 days as compared to that of the OPC control of 32MPa and 31MPa respectively.

4. CONCLUSION

From the results obtained, the conclusions can be drawn as follows:

- The RHA and BA can be used as a cement replacement material and it gives opportunity to the construction industries to reduce their cost and thereby preserving the environment quality.
- The concrete with replaced material of rice husk ash and bagasse ash for cement shows comparable strength to that of conventional cement concrete.
- From the experimental work and test results it was found that the combination of 20% of RHA and 10% of BA can be used as a replacement of 30% of cement in order to obtain high performance concrete with good strength and durability properties.
- The test results of compressive strength, split tensile strength, flexural strength and acid, sulpahte attacks were indicated that the strength of concrete increases with respect to the percentage of ashes present.

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