International Journal of Scientific Research in Science, Engineering and Technology
Print ISSN: 2395-1990 | Online ISSN : 2394-4099 (www.ijsrset.com)
doi : https://doi.org/10.32628/IJSRSET

Utilization of Sugarcane Bagasse Ash as Cement and Robo Sand as Fine Aggregates in M30 Grade Concrete

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Article Info
Volume 9, Issue 6
Page Number : 96-109

Publication Issue :
November-December-2022

Article History
Accepted : 07 Nov 2022
Published: 22 Nov 2022

ABSTRACT

There are lots of environmental impacts of cement on our ecology. Cement industry creating environmental problem by emission of CO2 during manufacturing of cement. Today researchers are more focusing towards the environment issue globally. On the other side Sugar cane bagasse ash generated in sugar mill creating environment issue as most of the part is used as a land fill. Fine aggregate is essential component of concrete and cement mortar. So, need for clean sand in the construction from the point of view of durability of structures. As the demand for Natural River sand is surpassing the availability, has resulted in fast depletion of natural sand sources. Robo sand is the answer for this problem especially when some states have already banned the use of river sand for construction. As per reports, Robo sand is widely used all around the world and technicians of major projects around the world insist on the compulsory use of Robo sand because of its consistent gradation and zero impurity. In the present study an experimental investigation of M30 grade concrete is considered to study the behavior of concrete. The workability, strength of the concrete values are studied by using slump cone test and compaction factor test as workability. The strength values are determined by using compressive strength test, split tensile strength test and flexural strength test. The percentage of SCBA and Robo sand used as 0%+0%, 2.5%+5%, 5%+10%, 7.5%+15%, 10%+20%, 12.5%+25%, and 15%+30%, in M30 grade concrete. Along with strength characteristics the acid resistance values are determined with different percentages of sugarcane ash and robo sand.

Keywords: emission of CO2, sugarcane ash, robo sand, workability, strength

I. INTRODUCTION

Concrete plays a major role in the construction industry. It is made up of different types of Materials like cement, fine aggregate and coarse aggregate all together forms concrete and gives the strength to the material. Increasing the population and changing the life style and development of the city are in large scale, so requirements of the building have Increasing day by day so therefore civil engineers are focusing on the agricultural materials and construction materials. Sugarcane bagasse ash is one of the crops growing in India.

Generally sugarcane bagasse ash (SCBA) bagasse is formed after the extraction of the juice the bagasse is remained the farmer won't waste the Bagasse again they use the bagasse for fire purpose, Atlast ash is formed they used for plants and also they refill in the land. So to reduce the land filling and pollution to the Atmosphere here we are using the ash in place of cement which works as Pozzolanic cement and with various strengths. SCBA doesn't require any super plasticizers and also it gives excellent workability results for fresh concrete as well as hardened concrete. Robo sand is formed by crushing of gravel and stone. It is manufactured in stone quarries. Generally it is replaced with river sand and also to reduce the river sand consumption and also it has same properties. Generally using robo sand gives the high compressive strength values.

Ordinary Portland cement is recognized as a major construction material throughout the world. Portland cement is the conventional building material that actually is responsible for about 5% - 8% of global CO2 emissions. This environmental problem will most likely be increased due to exponential demand of Portland cement. Researchers all over the world today are focusing on ways of utilizing either industrial or agricultural waste, as a source of raw materials for industry. This waste, utilization would not only be economical, but may also result in foreign exchange earnings and environmental pollution control. Several researchers and even the Portland cement industry are investigating alternatives to produce green building materials. Industrial wastes, such as blast furnace slag, fly ash and silica fumes are being used as supplementary cement replacement materials. Currently, there has been an attempt to utilize the large amount of bagasse ash, the residue from an in-line sugar industry and the bagasse-biomass fuel in electric generation industry. When this waste is burned under controlled conditions, it also gives ash having amorphous silica, which has pozzolanic properties.

II. LITERATRE REVIEWS

Ashish mathur et al (2014) this study shows minimum void content in m-sand as compared to natural sand which further gives lesser drying shrinkage & less cavitations in structure, provides high durability in all types of concrete work

Dr. Shaik Yajdani et al (2016) It is observed that 60% replacement of natural sand by robo sand is giving better compressive strength, for M20 and M30 grade concrete compared to other proportions of mixes. The slump values of concrete with robo sand were observed to be relatively less when compared to conventional concrete.

Lavanya M.R et al(2017) they concluded that bagasse ash is a pozzolanic material and it can used as a partial replacement for cement. It can increase the overall strength of the concrete up to a 15%

K. Lakshmi et al(2019) found that Partial replacement of cement by SCBA boosts workability of fresh concrete so super plasticizer is not essential concrete with 10%SCBA replacement after 28 days of curing, gives maximum strength compared to concrete of other percentage replacement mixes.

Priyanka A. Jadhav et al (2020) The compressive strength of cement mortar with 50% replacement of natural sand by manufactured sand reveals higher strength as compared to reference mix

As perSravika.V and G.Kalyan (2017), The compressive strength of the CS10%+QD30% and CS20%+QD30% was 24.35N/mm2 and 24.98 N/mm2, Split tensile strength is 3.454N/mm2 and 3.499N/mm2 .The strength of the concrete increases with increase in percentage of coconut shell up to 20% .and there is gradual decrease at 30% replacement. The strength of the Coconut shell and Quarry dust CS10%+QD30%

and CS20%+QD30% concrete is increasing comparatively with normal concrete. So we conclude that the coarse aggregate and fine aggregate replaced with coconut shell aggregate. Moreover it reduces 16.6% cost construction by reducing the cost of coarse and fine aggregate and it also reduces the environmental pollution due to fly ash and coconut shell.

III. EXPERIMENTAL INVESTIGATION MATERIALS AND METHODOLOGY

Scheme of experimental program:

The details of number of blocks to be tested while the experimentation process is given in the below table:

Table 3. 1 No Blocks Required for the Experiment

Sl. No	%SCBA+%RS	Mix ID	Compressive strength of concrete			Split tensile strength of concrete			Flexural strength of concrete			Durability of concrete
			7 days	14 days	28 days	7 days	14 days	28 days	7 days	14 days	28 days	90 days
1	0%+0%	Mix 1	3	3	3	3	3	3	3	3	3	3
2	2.5%+5%	Mix 2	3	3	3	3	3	3	3	3	3	3
3	5%+10%	Mix 3	3	3	3	3	3	3	3	3	3	3
4	7.5%+15%	Mix 4	3	3	3	3	3	3	3	3	3	3
5	10%+20%	Mix 5	3	3	3	3	3	3	3	3	3	3
6	12.5%+25%	Mix 6	3	3	3	3	3	3	3	3	3	3
7	15%+30%	Mix 7	3	3	3	3	3	3	3	3	3	3
Total			63 cubes			63 cylinders			63 Prisms			21 cubes

In each batch 3cubes, 3 cylinders and 3 prisms were casted. Totally 84cubes, 63 cylinders and 63 prisms were casted during entire experimentation.

IV. RESULTS AND DISCUSSIONS

Concrete is, undoubtedly the extremely extensively exploited facetious building components. Adaptability of concrete is responsible to the intention that it is precise in the frequently procurable components, cement, aggregate and water. Inflated exercise of concrete may detritus inpaucity of the matter. Consequently suitable constituents are to be liable to reinstate in ample measures to encounter the equitable of concrete surviving in the field.

Sugarcane baggage ash and robo sand concrete does not found its feasibility in the usage of normal conventional buildings due the bonding action between aggregates and cement. But it finds ease in filling the corners of the moulds and congested areas of the reinforcement without any difficulty.

Mix design of concrete

Final trial mix for M30 grade concrete is 1:1.05:2.46 at w/c of **0.40**

Conventional Concrete Mix Design

M30 grade of conventional concrete mix was done by using IS456-2000 and IS 10262:2009 codes.

Mix Proportions

Mix types with percentage relative proportions and blend proportions of constituent materials are appeared in Table below which are helps to make 1 cubic meter concrete.

Table 4. 1 Mix Proportions used

Percentage of SCBA and Robo Sand	Mix Type	Cement	Fine aggregates	Coarse aggregates	SCBA	Robo sand
0%+0%	Mix 1	394	732	1139	0	0
2.5%+5%	Mix 2	384.15	695.4	1139	9.85	36.6
5%+10%	Mix 3	374.3	658.8	1139	19.7	73.2
7.5%+15%	Mix 4	364.45	622.2	1139	29.55	109.8
10%+20%	Mix 5	354.6	585.6	1139	39.4	146.4
12.5%+25%	Mix 6	344.75	549	1139	49.25	183
15%+30%	Mix 7	334.9	512.4	1139	59.1	219.6

Manufacturing of E Waste concrete

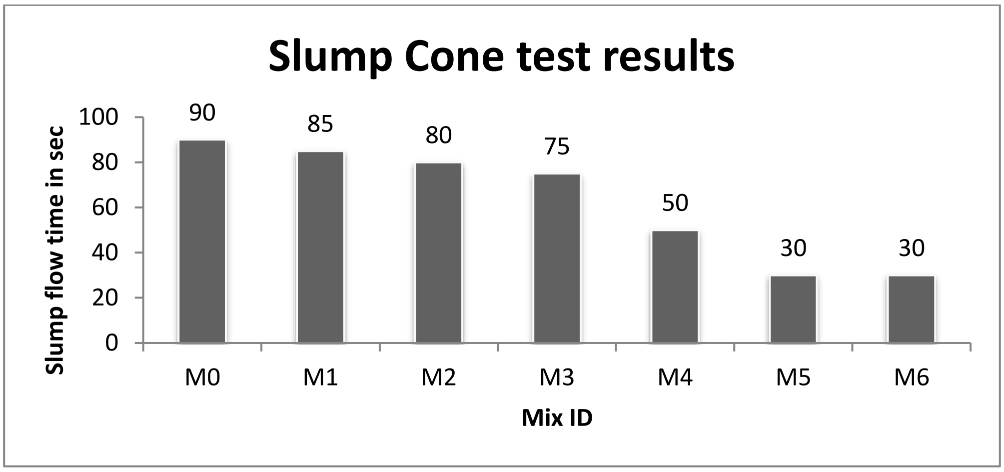
Test results

Fresh concrete tests

Slump Cone test

Table Slump Cone test results

S. No	Percentage of SCBA and Robo Sand	Mix ID	Slump Cone test Values
1	0%+0%	M0	90
2	2.5%+5%	M1	85
3	5%+10%	M2	80
4	7.5%+15%	M3	75
5	10%+20%	M4	50
6	12.5%+25%	M5	30
7	15%+30%	M6	30



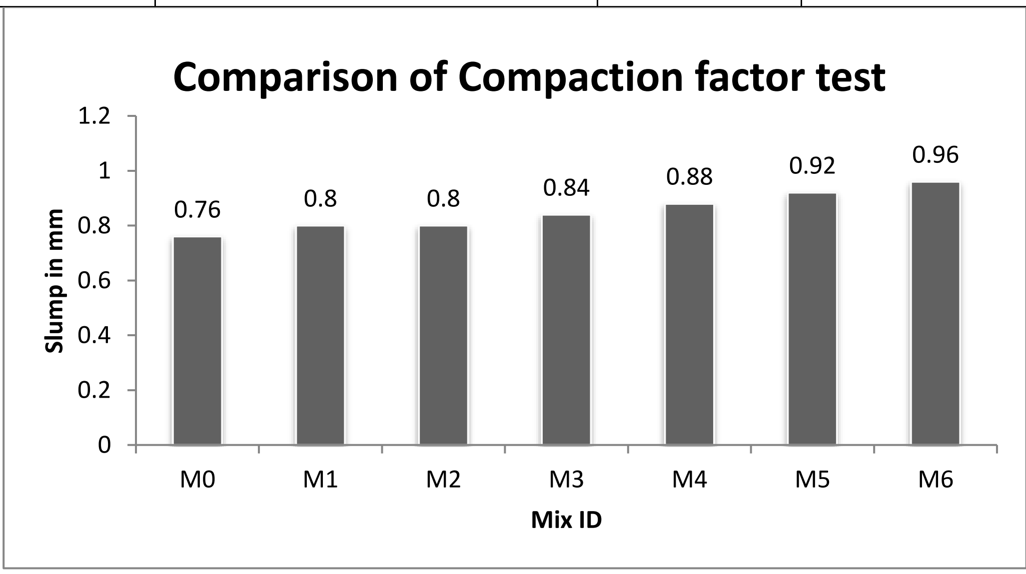
Graph Comparison of Slump in mm

The percentage of baggage ash and robo sand will results in decrease in the value of slump. As we compare the water absorption for the sugarcane baggage ash and robo sand are more than the cement and fine aggregates the concrete mix has become hard behavior Due to this reason the value of slump deceases with increasing the percentage of sugarcane baggage ash and robo sand.

Compaction factor test

Table Compaction factor test results

S. No	Percentage of SCBA and Robo Sand	Mix ID	Compaction factor
1	0%+0%	M0	0.76
2	2.5%+5%	M1	0.8
3	5%+10%	M2	0.8
4	7.5%+15%	M3	0.84
5	10%+20%	M4	0.88
6	12.5%+25%	M5	0.92
7	15%+30%	M6	0.96



Graph 4. 1 Comparison of Compaction Factor results

From the above table and Graph it was observed that increasing the percentage of baggage ash and robo sand will results in decrease the value of Compaction factor value for M30 grade concrete. As we increasing the percentage of of baggage ash and robo sand in the concrete mix the value of weight of the partial compacted concrete will increasing due to the high density of of baggage ash and robo sand materials combinationthe value of compaction factor increases with increasing the percentage of of baggage ash and robo sand.

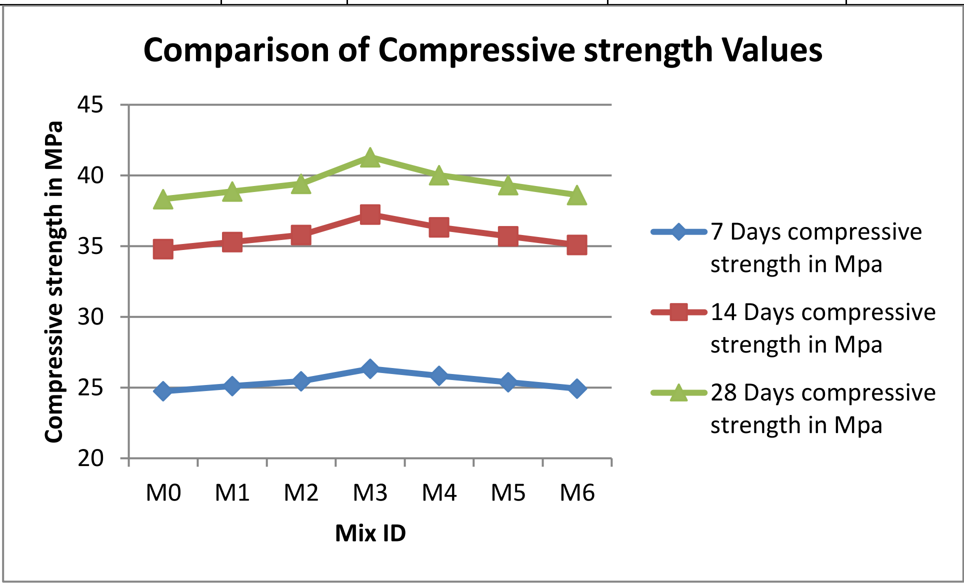
Compressive strength of concrete

Compressive strength testing procedure from IS516-1959:

Comparison of Compressive strength Values

Table 4. 2 Comparison of Compressive strength Values

S. No	Percentage of SCBA and Robo Sand	Mix ID	7 Days compressive strength in Mpa	14 Days compressive strength in Mpa	28 Days compressive strength in Mpa
1	0%+0%	M0	24.74	34.8	38.33
2	2.5%+5%	M1	25.1	35.3	38.88
3	5%+10%	M2	25.45	35.8	39.42
4	7.5%+15%	M3	26.33	37.24	41.3
5	10%+20%	M4	25.84	36.34	40.02
6	12.5%+25%	M5	25.38	35.7	39.32
7	15%+30%	M6	24.93	35.08	38.62



Graph 4. 2 Comparison of Compressive strength Values

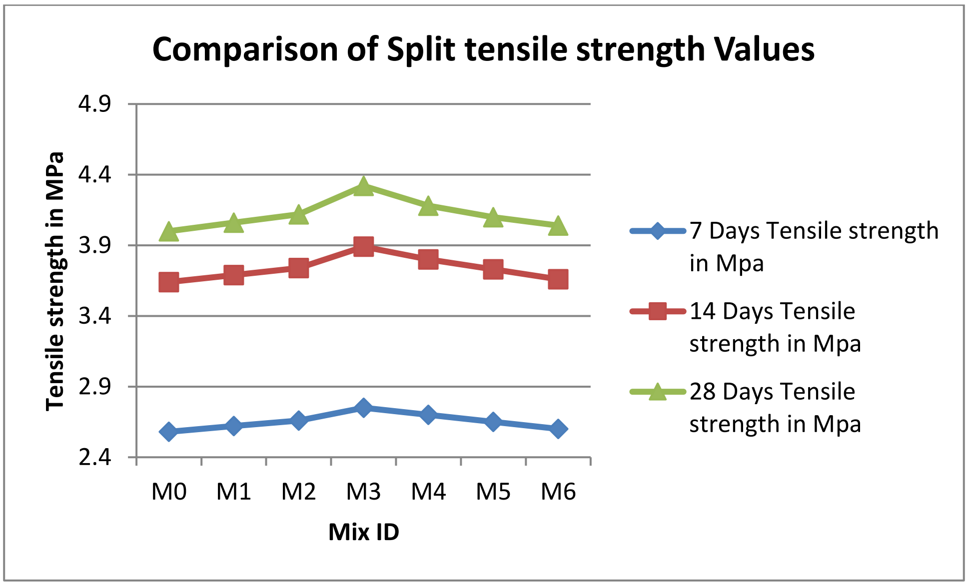
From the above table and Graph it was observed that the optimal value of compressive strength was observed at 7.5%SCBA+15%RS for M30 grade concrete for 7days, 14 days and 28 days curing. At 7.5%SCBA+15%RS mix the bonding action between percentage of baggage ash and robo sand, cement and aggregates will give better strength for 7days, 14 days and 28 days curing at 7.5%SCBA+15%RS mix.

Split tensile strength of concrete

Comparison of split tensile strength of concrete

Table 4. 3 Comparison of split tensile strength of concrete

S. No	Percentage of SCBA and Robo Sand	Mix ID	7 Days Tensile strength in Mpa	14 Days Tensile strength in Mpa	28 Days Tensile strength in Mpa
1	0%+0%	M0	2.58	3.64	4
2	2.5%+5%	M1	2.62	3.69	4.06
3	5%+10%	M2	2.66	3.74	4.12
4	7.5%+15%	M3	2.75	3.89	4.32
5	10%+20%	M4	2.7	3.8	4.18
6	12.5%+25%	M5	2.65	3.73	4.1
7	15%+30%	M6	2.6	3.66	4.04



Graph 4. 3 Comparison of split tensile strength of concrete

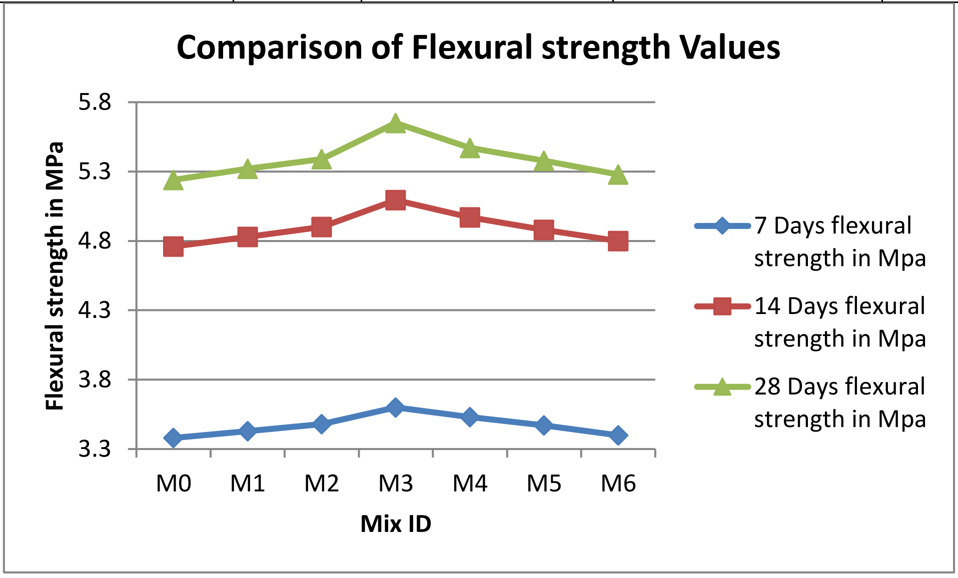
From the above table Graphs it was observed that With the addition of baggage ash and robo sand, will give better Split tensile strength than normal concrete case for 7days, 14days and 28 days curing due to addition of cementious material of baggage ash and robo sand, the mix will result in decreasing the water content due to this reason the optimal value of split tensile strength was observed at 7.5%SCBA+15%RS.

Flexural strength of concrete

Table Comparison of flexural strength of concrete

S. No	Percentage of SCBA and Robo Sand	Mix ID	7 Days flexural strength in Mpa	14 Days flexural strength in Mpa	28 Days flexural strength in Mpa
1	0%+0%	M0	3.38	4.76	5.24
2	2.5%+5%	M1	3.43	4.83	5.32
3	5%+10%	M2	3.48	4.9	5.39

4	7.5%+15%	M3	3.6	5.094	5.65
5	10%+20%	M4	3.53	4.97	5.47
6	12.5%+25%	M5	3.47	4.88	5.378
7	15%+30%	M6	3.4	4.8	5.28



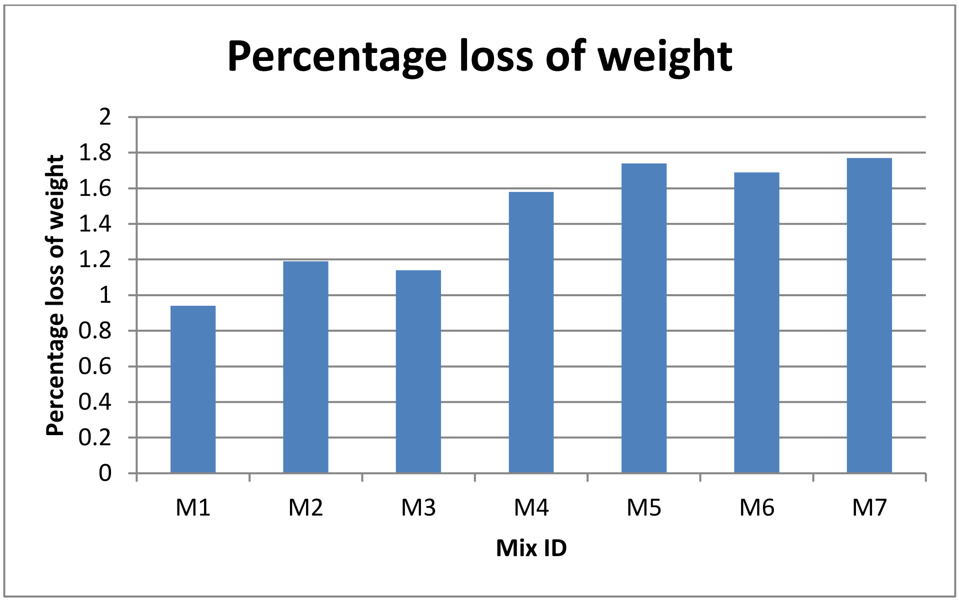
Graph Comparison of flexural strength of concrete

From the above table Graphs it was observed that With the addition of baggage ash and robo sand will give better flexural strength than normal concrete case for 7days, 14days and 28 days curing due to addition of cementious material and fine aggregates baggage ash and robo sand concrete mix will result in decreasing the water content due to this reason the optimal value of flexural strength was observed at 7.5%SCBA+15%RS.

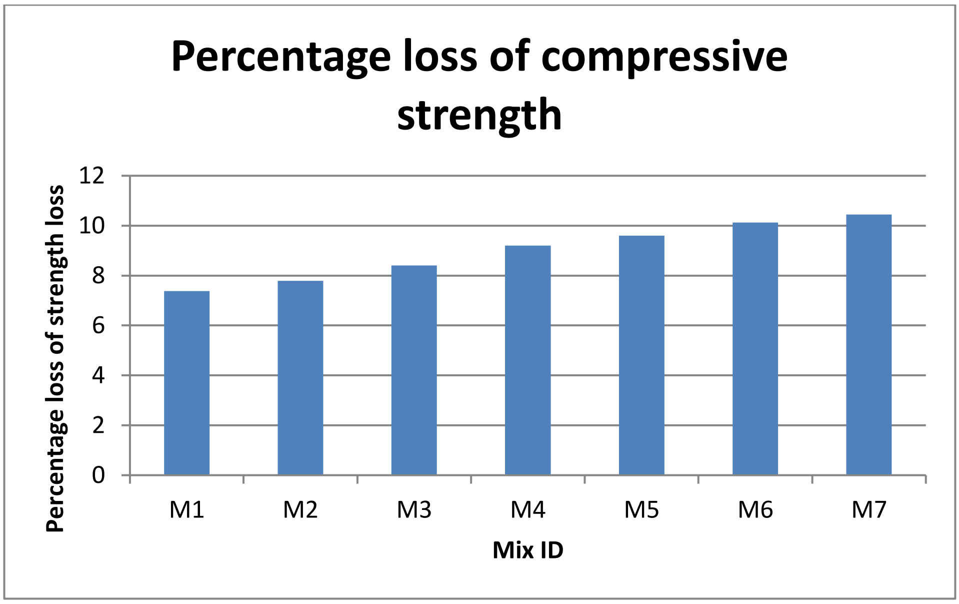
Durability of concrete

Table Acid attack test results

S. No	Percentage of SCBA and Robo Sand	Mix ID	Percentage loss of weight	Percentage loss of compressive strength
1	0%+0%	M0	0.94	7.38
2	2.5%+5%	M1	1.19	7.79
3	5%+10%	M2	1.14	8.4
4	7.5%+15%	M3	1.58	9.2
5	10%+20%	M4	1.74	9.6
6	12.5%+25%	M5	1.69	10.12
7	15%+30%	M6	1.77	10.45



Graph Percentage loss of weight due to acid attack



Graph Percentage loss of strength due to acid attack

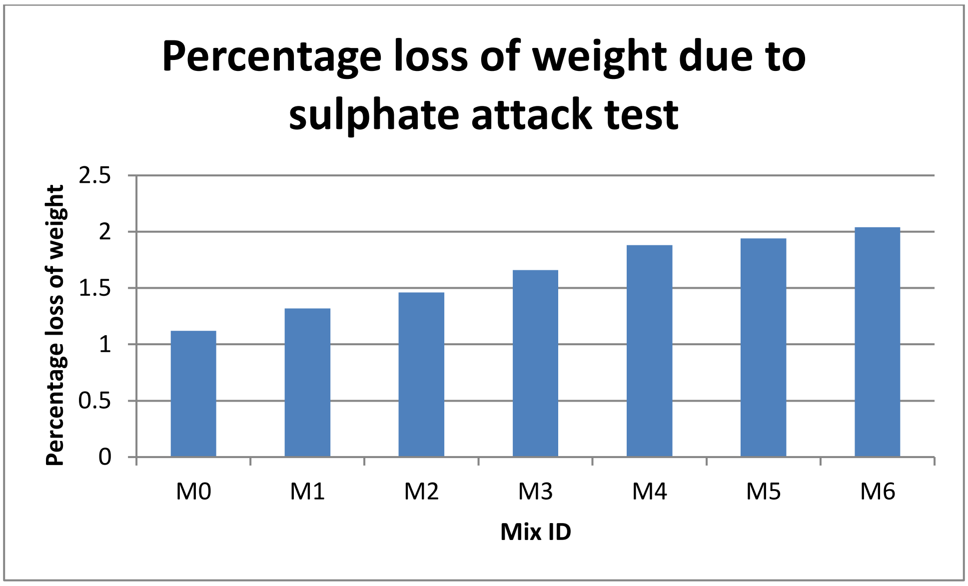
From the above plots and tables it was observed that by increase in the percentage of baggage ash and robo sand the percentage loss of weight loss and strength loss increases this will obtained from the acid attack test results

Sulphate attack test

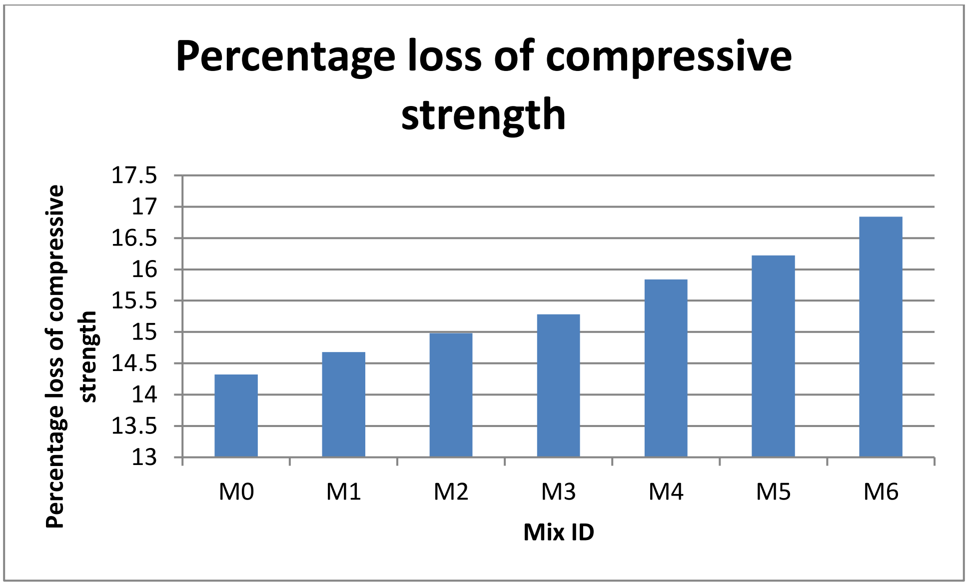
Table Sulphate attack test results

S. No	Percentage of SCBA and Robo Sand	Mix ID	Percentage loss of weight	Percentage loss of compressive strength
1	0%+0%	M0	0.94	14.32
2	2.5%+5%	M1	1.19	14.68
3	5%+10%	M2	1.14	14.98
4	7.5%+15%	M3	1.58	15.28
5	10%+20%	M4	1.74	15.84

6	12.5%+25%	M5	1.69	16.22
7	15%+30%	M6	1.77	16.84



Graph Percentage loss of weight due to sulphate attack test



Graph Percentage loss of strength due to sulphate attack test

Rapid Chloride Permeability Test

The ASTM C-1202-97 quick chloride permeability test was performed on several concrete mixes. The purpose of this test technique is to determine the electrical conductivity of concrete in order to provide a quick estimate of its resistance to chloride ion penetration. This test employed standard cylindrical disc specimens with a diameter of 100mm and a thickness of 50mm after 28 and 60 days of water cure. When using specimens with various dimensions for testing, the test result value of the total charge passed through must be modified, according to ASTMC 1202-97.

The system comprises of a variable D.C. power source that provides the cells with a constant, stabilised voltage. Polymethyl methacrylate is used to make the cells. Between the compartments, concrete specimens are maintained. For voltage feeding, the cells are linked to the main instrument through a three-pin connection and socket. An accurate digital current metre is used to quantify the charge of current flowing through the specimen. On one face, the cells feature grooved recesses, whereas on the other, they are closed. The specimen can be inserted into the cells' open sides. The sodium chloride (NaCl) solution (2.4M concentration) is in one cell, while the sodium hydroxide (NaOH - 0.3M) solution is in the other.
The curved faces of the cylindrical disc specimens are covered with rapid setting epoxy and placed in the open spaces of the two cells, as indicated in the figure. A 60V potential difference is supplied between the electrodes once the leak proofness is checked. Chloride ions migrate from sodium chloride solution to sodium hydroxide solution via the pores of the concrete specimen as a result of the electro chemical cell in the assembly. Over the course of 6 hours, the current flow was measured every 30 minutes, and the total electric charge travelled through the specimen was computed using the formula.

$$Q=900[I_0+I_{360}+2(I_{30}+I_{60}+I_{90}+I_{120}+I_{150}+I_{180}+I_{210}+I_{240}+I_{270}+I_{300}+I_{330})]$$

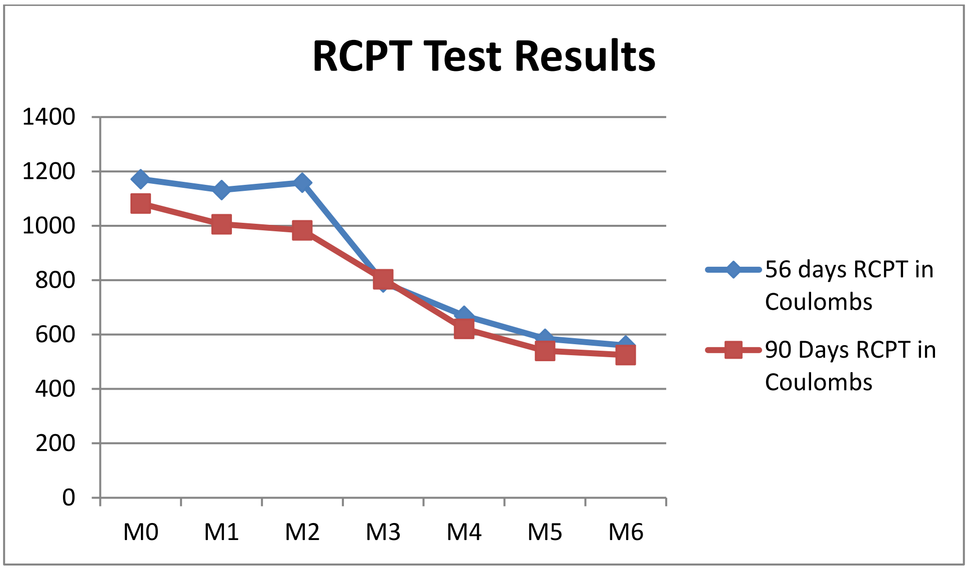
As per ASTMC-1202(5), the concrete resistance to chloride permeability is classified as follows.

Table 5. 1 Permeability Classifications

Charge (coulombs)	Chloride Permeability
> 4000	High
2000-4000	Moderate
1000-2000	Low
100-1000	Very Low
< 100	Negligible

Table Rapid Chloride Permeability Test results

S. No	Mix ID	56 days Chloride permeability		84days Chloride permeability	
		Coulombs	Remark	Coulombs	Remark
1	M0	1406.16	low	1298.4	low
2	M1	1358.04	low	1207.2	low
3	M2	1389.96	low	1180.8	Very low
4	M3	950.4	Very low	964.8	Very low
5	M4	802.98	Very low	746.4	Very low
6	M5	702	Very low	648	Very low
7	M6	672	Very low	630	Very low

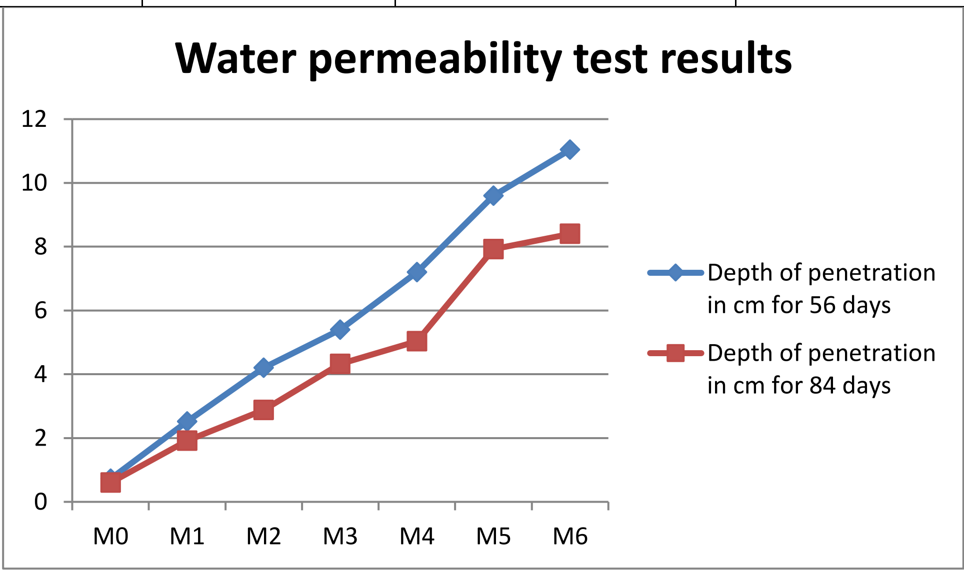


Graph Rapid chloride permeability test results

Water permeability test

Table Water permeability test results

S. No	Mix ID	Depth of penetration in cm for 56 days	Depth of penetration in cm for 84 days
1	M0	0.72	0.6
2	M1	2.52	1.92
3	M2	4.2	2.88
4	M3	5.4	4.32
5	M4	7.2	5.04
6	M5	9.6	7.92
7	M6	11.04	8.4



Graph Water permeability test results

V. CONCLUSION

From the above experimental study the following conclusions are made for the concrete using sugarcane baggage ash as well as robo sand as the partial replacement for the cement and fine aggregates.

1. The sugarcane baggage ash is used to reduce the land filling and pollution to the Atmosphere here we are using the ash in place of cement which works as Pozzolanic cement.
2. Robo sand is formed by crushing of gravel and stone using robo sand gives the high compressive strength values.
3. The intensity of slump cone value decreases with increase in the percentage of sugarcane baggage ash as well as robo sand in M30 grade concrete.
4. The intensity of compaction factor value increases with increase in the percentage of sugarcane baggage ash as well as robo sand in M30 grade concrete.
5. The optimal value of all the strength values related to the compressive strength, split tensile strength and flexural strength and obtained at M3 mix which is of 7.5 percentage of sugarcane baggage ash and 15% of robo sand at 7days, 14days ad 28days curing period.
6. The percentage of weight loss and strength loss values are increasing with increase in the percentages of sugarcane baggage ash as well as robo sand in M30 grade concrete.
7. The quick chloride porousness test is performed with fluctuating groupings of sugarcane ahs and robo sand ash from M0 to M6. As the extent of rice husk ash is expanded, the RCPT esteem brings down.
8. As the measure of sugarcane ahs and robo sand ash in the water penetrability rises, the profundity of entrance for the M30 grade increments.

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Cite this article as :

Asha Srinivas, Ms. G. Sandhya Rani, "Utilization of Sugarcane Bagasse Ash as Cement and Robo Sand as Fine Aggregates in M30 Grade Concrete", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 9 Issue 6, pp. 96-109, November-December 2022.
Journal URL : https://ijsrset.com/IJSRSET229619