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An Experimental Study on Partial Replacement of Cement in Concrete with Sugarcane Bagasse Ash

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ABSTRACT:- Green concrete is a revolutionary topic in the history of concrete industry. This was first invented in Denmark in the year 1998. Green concrete has nothing to do with colour. It is a concept of thinking environment into concrete considering every aspect from raw materials manufacture over mixture design to structural design, construction, and service life.

Green concrete is very often also cheap to produce, because, for example, waste products are used as a partial substitute for cement, charges for the disposal of waste are avoided, energy consumption in production is lower, and durability is greater. Green concrete is a type of concrete which resembles the conventional concrete but the production or usage of such concrete requires minimum amount of energy and causes least harm to the environment. The CO_2 emission related to concrete production, inclusive of cement production, is between 0.1 and 0.2 t per tonne of produced concrete.

However, since the total amount of concrete produced is so vast the absolute figures for the environmental impact are quite significant, due to the large amounts of cement and concrete produced. Since concrete is the second most consumed entity after water it accounts for around 5% of the world‘s total CO_2 emission (Ernst Worrell, 2001). The solution to this environmental problem is not to substitute concrete for other materials but to reduce the environmental impact of concrete and cement. Pravin Kumar et al, 2003, used quarry rock dust along with fly ash and micro silica and reported satisfactory properties.

The potential environmental benefit to society of being able to build with green concrete is huge. It is realistic to assume that technology canbe developed, which can halve the CO_2 emission related to concrete production. With the large consumption of concrete this will potentially reduce the world‘s total CO_2 emission by 1.5-2%. Concrete can also be the solution to environmental problems other than those related to CO_2 emission. It may be possible to use residual products from other industries in the concrete production while still maintaining a high concrete quality.

And as it is known that several residual products have properties suited for concrete production, there is a large potential in investigating the possible use of these for concrete production. Well-known residual products such as silica fume and fly ash may be mentioned. The concrete industry realised at an early stage that it is a good idea to be in front with regard to documenting the actual environmental aspects and working on improving the environment, rather than being forced to deal with environmental aspects due to demands from authorities, customers and economic effects such as imposed taxes. Furthermore, some companies in concrete industry have recognised that reductions in production costs often go hand in hand with reductions in environmental impacts. Thus, environmental aspects are not only interesting from an ideological point of view, but also from an economic aspect.

Key words:- Green concrete, fly ash, micro silica, CO_2 emission, concrete production

I. INTRODUCTION

In a modern world every country deserves to have development and infrastructure that play vital role in the enhancement. The major used material in the infrastructure development is

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concrete. It is basically amalgam of aggregate, fine aggregate and ordinary Portland cement as the conventional binding material. As we know that in the production of cement affect environment very badly. The production of Ordinary Portland cement has been found to be responsible for about 6%–9% of global carbon (IV) oxide (CO2) emissions and cement industry has also been found to be the second largest CO2 emitting industry after the power generation. It was further found that each tone of cement production produces approximately one tone of CO2 emission. So researchers think about alternatives of cement and used industrial wasteas the replacement of cement which waste has adhesive property likecement.

Many industrial wastes like blast furnace slag, fly ash and silica fumeare used as a substituent cement material. But nowadays agriculture waste is also a very big issue in our country so researcher looks into this matter and utilizing the sugar cane baggage ash as a cement material toreduce the load on cement and also minimize the pollution.The partial replacement of ordinary Portland cement however by agricultural waste or agro-waste has been seen as an alternative solution for decreasing CO2 emission due to less cement consumption for construction industry.

Sugarcane is cultivated in India since ancient times. It is supposed to be originated from South and South-East Asia. India is that the second largest producer of cane sugar next to Brazil.

Bagasse contain the fibrous non-biodegradable material that left over as juice is extracted from sugarcanes and sugar manufacturing industry eliminates out this residue in large quantity during sugar manufacturing process. Bagasse is often used as a fuel by the sugar industry and when leads to burned at high temperatures leads to the generation of sugarcane baggage ash. Many countries generate a big amount of sugarcane bagasse ash as a waste**.**

An Overview of Sugarcane Bagasse Ash

The silica (SiO2) present in sugarcane bagasse ash reacts with the free lime (Ca (OH)2) released during the hydration of cement. The chemical equation for the hydration of Tricalcium silicate – major component of cement, is:

$$2Ca_3SiO_5 + 7H_2O \rightarrow 3CaO.2SiO_2.H_2O + 3Ca(OH)_2 + Heat$$

Tricalcium Silicate + Water → Calcium Silicate Hydrate + Calcium hydroxide + Heat

Worldwide production of sugarcane

Among the major producing countries, Brazil occupies the first place with about 28% of world's sugar production followed by India with 18%, China 10% and Thailand 8% as per the newest estimates available. The largest canesugar consumer is India with about 34% followed by EU with 21%, China with 18%, Brazil with 13% and UnitedStates with 12% as per the estimates for 2020-21.

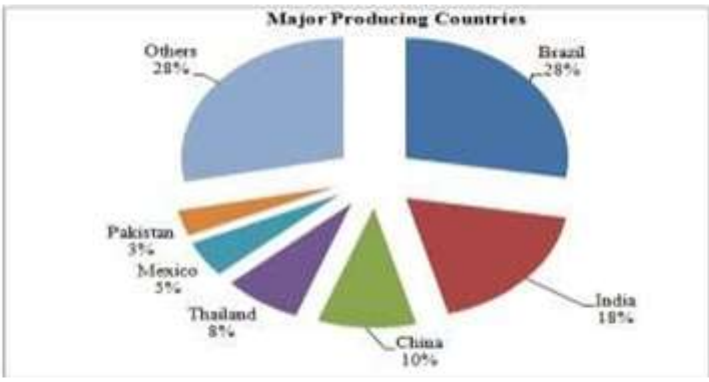


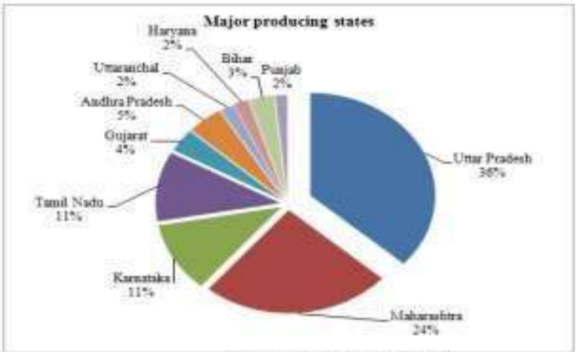
Fig- 1.2 Worldwide production of sugarcane

Sugarcane Production in India

Sugarcane production in India features a cycle of 2-3 years because the crop once planted usually stays for two years onthe field giving two harvests. The cane area and thereby production is primarily driven by the costs. Nevertheless, the assembly has witnessed a uniform upward movement and reached over 28 million tons in 2018-19 though moderated in the subsequent two years. Production for the year 2020-21is estimated at 25.5million tones.

State-wise production

State wise production indicates that more than 80% of sugar comes from only four states viz., Uttar Pradesh, Maharashtra, Karnataka and Tamil Nadu. Uttar Pradesh has traditionally been cultivating and contributing for 36-40% of total sugarcane produced in the country. Maharashtra has been the third largest producer but itsproduction was doubled since 20018-19 onwards and consequently its share has goneup to nearly 25% in therecent years. The steep jump in the overall sugarcane production in 2020-21 onwards could primarily beattributed to increase in production levels of Maharashtra.



Source: Ministry of Agriculture, GoI

Fig- 1.3 State-wise production

Fig.1.4 sugar mil

Fig.1.5 unloading sugarcane in mill

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Fig-1.6 Sugarcane Baggage Ash

SCOPE OF THE WORK

In this thesis present work is to carry out of detailed analysis of concrete using sugarcane baggage ash in following ways.

1. Design M35 grade of concrete mix.
2. Casting of concrete cubes of M35 grade of concrete with different percentages of Sugarcane Baggage Ash (0%, 5%, 10%, 15%, and 20%).
3. Curing of cubes in normal and HCL.

II. LITERATURE REVIEW GENERAL

Many researchers have carried out various studies on such substitute materials in making cement composites like concrete and sandcrete. It has therefore become an attractive practice by researchers to utilize locally available material to produce concrete. The reviews below shows the various studies performed on the partial replacement of cement and fine aggregate with sugarcane bagasse ash and laterite soilrespectively.

III. REVIEW OF LITERATURE

1. M. VijayaSekhar Reddy, I.V Ramana Reddy,

Studied the behavior of High Performance Concrete (HPC) which is being the most used type of concrete in the construction industry. They replaced cement with supplementary cementing materials like fly ash,silica fume, and metakaolin.

They concluded that there was a considerable increase in service life of the concrete structure and reduction in heat of hydration by using supplementary cementing materials in concrete. They observed the maximum and minimum percentage of reduction in strength of concrete when concrete was replaced with fly ash were 12.64% and 1.92%.

2. Dr. P. SrinivasRao .

Studied the durability characteristics of metakaolin blended concrete byadopting M20 Grade of concrete. An attempt was made with H_2so_4 and HCL. Steel fibres with 60 as aspect ratio at 0%,0.5%,1.0% and 1.5% of volume of concrete are used.

They concluded that the percentage weight loss was reduced and compressive strength was increased in the case of fibre reinforced concrete and concrete containing 10% metakaolin replaced by weight of cement when compared to concrete and the percentage weight loss was less when immersed in HCL and H_2so_4.

3. P. Murthi and V.siva Kumar

Studied the resistance of acid attack of ternary blended concrete by immersing the cubes for 32
Weeks in sulphuric acid and hydrochloric acid solutions. Binary blended concrete was developed using 20% class F fly ash and ternary blended concrete was developed using 20% fly ash and 8% silica fumeby weight of cement.

They concluded that the ternary blended concrete was performing betterthat the ordinary plain concrete. They observed that the mass loss for 28and 90 days of M20 PCC specimens were 19.6% and 16.1% respectively. They also observed that the time taken for reduction of 10% mass loss when immersed in 5% H_2SO_4 and 5% HCL solutions was 32 weeks.

4. A.K Al- Tamimi and M.sonebi

Studied the properties of self- compacting concrete when immersed in acidic solutions. Workability was obtained using slump cone test, L-box and orimet for SCC mix. Cylindrical specimen of diameter 45mmand length 90mm were casted and cured for 28 days in water after theywere immersed in 1% HCL and 1% H_2so_4 solutions by maintaining a phof 5 regurarly.

They concluded that self- compacting concrete was performing better than control concrete when exposed to 1% sulphuric acid and

hydrochloric acid.
They observed that the time taken for 10% mass loss for SCC was 18 weeks and for CC was 6 weeks.

5. Madhusudhan Reddy

Studied the effect of HCL on blended cement and silica fume blended cement and their concretes. Concrete cubes were casted using deionised water with a series pf dosages implanted into water and using only deionized water for comparison. These cubes were tested for determining chloride ion permeability and compressive strength.
They concluded that compressive strength reduction of sugarcane ash blended concrete and silica fume blended concrete was 2 to 19% at 28 days and 90 days.

6. UroojMasood

Studied the behavior of mixed fibre reinforced concrete exposed to acids. A mixture 75% glass and 25% steel fibres were used in mixed fibre reinforced concrete and cubes were casted and cured for 30, 60, 90, 120 and 180 days in acids and sodium sulphate. Test specimen were tested for weight loss and denseness of concrete of exposed and unexposed specimen at all the ages and compressive strength at 180 days.

They concluded that resistance towards the sulphuric acid attack was maximum when 100% steel fibreswas used when compared to other fibres and without any fibres. Mixed fibre reinforced specimen and 100% steel fibre reinforced specimens exhibited more resistance towards the attack of sulphuric acid.

7. Mr. G. Siva Kumar

Studied on preparation of Bio-cement using sugarcane baggasse ash and its Hydration behavior.In this study they had used as partial replacement in ordinary Portland cement (OPC) by 10% weight. Compressive strength of the sample was carried out and reported that the cementious material in sugar cane bagasse ash is responsible for early hydration. The pozzolonic activity of bagasse ash results in formation of more amount of C-S-H gel which result in enhances the strength, and hence bagasse ash is a potential replacement material forcement.

8. Mr. H.S. Otuoze

Studied had investigated on "Characterization of Sugarcane Bagasse ash and ordinary Portland cement blends in Concrete". The SCBA is obtained by burning sugar cane bagasse at between 600-700 degrees celcius, since the sum of sio2, Al2o3 and Fe2o3 is 74.44% For strength test, mix ratio of 1:2:4 was used and OPC was partially replaced with 0%, 5%, 10%, 15%, 20%,25%,30%,35%,40% by weight in concrete. Compressive strength values of hardended concrete were obtained at the of 7,14,21,28 days. Based on the test conducted, it can be concluded that SCBA is a good pozzolona for concrete cementation and partial blends of it with OPC could give good strength development and other engineering properties in concrete.

9. Mr. Lavanya

A experimental study on compressive strength of concrete by partial replacement of cement with sugarcane bagasse ash. The feasibility of using sugar cane bagasse ash, a finely grounded waste product from thesugarcane industry, as partial replacement for cement in conventional concrete is examined. The test were conducted as per BIS codes as evaluate the stability of SCBA for partial replacement up to 30% of cement with varying water cement ratio. They showed that addition of SCBA results in improvement of strength in all cases and according tothe results obtained, it can be concluded that bagasse ash can increase the overall strength of concrete when used up to a 15% cement replacement level with W/C ratio of 0.35, bagasse ash is valuable pozzolonic material and it can potentially be used as a replacement forcement.

10. Mr.R. Srinivasan

Experimental study on Bagasse Ash in concrete. They had observed that sugar cane bagasse is fibrous waste-product of sugar refining industry, and causing serious environmental problem which mainly contain aluminium ion and silica. Hear bagasse ash has been chemically and physically characterized, and partially replaced in the ratio of 0%,5%,15%,25% by weight of cement in concrete. Fresh concrete tests like compaction factor test and slump cone test were undertaken, as well as hardened concrete test like compressive strength. Spilt tensile strength, flexural strength and modulus of elasticity at the age of seven and 28 days were done. The results show that the SCBA in blended concrete had significantly higher compressive strength, tensile strength and flexural strength compare to that of the concrete without SCBA. It is found that cement could be advantangeously replaced with SCBA up to maximum limit of 10%. Partial replacement of cement by SCBA increases workability of fresh concrete.

GENERAL

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The material selected for the analysis of partial replacement of cement with sugarcane baggasse ash includes cement, fine aggregate, coarse aggregate and sugarcane baggasse ash and water. In this chapter we look about the properties of following material.In this chapter discussed about the experimental studies and performed test on cubes on various ways. Also discussed the procedure of experiment done on the cubes for knowing the effect of SCBA on mixing of aggregate.

CEMENT

Ordinary Portland cement of 53 grades from a single batch was used for the entire work and care has been taken that it has to been stored in airtight containers to stop it from being suffering from the atmospheric and monsoon moisture and humidity. The cement procured was tested for physical requirements in accordance with IS: 12269-1987 and for chemical requirements in accordance with IS: 4032-1977.

Table No.-3.1 Properties of cement

S.NO	Property	Value
1	Normal consistency	34mm
2	Fineness of cement	8%
3	Setting time	
	Initial (Minutes)	88
	Final (Minutes)	245
4	Compressive Strength	
	3 Days	28.78 Mpa
	7 Days	40.54 Mpa
	28 Days	54.72 Mpa

Fig- 3.1 OPC-53

SUGARCANE BAGASSE ASH

Sugarcane bagasse consists of approximately 52% of cellulose, 26% of hemicelluloses of ligin. Each ton of sugarcane generates approximately 28% of bagasse (at a moisture content of 52%) and 0.64% of residual ash. The residue after combustion presents a chemical composition dominates by silicon dioxide (sio2). In spite of being a material of hard degradation and that presents few nutrients, the ash is used on the farms as a fertilizer in the sugarcane harvests. Inthis sugarcane bagasse ash was collected during the cleaning operation of a boiler in the sugar factory, located in the town of Meerut, Uttar Pradesh.

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Fig-3.2 Sugarcane bagasse ash

Table No.-3.2 Physical Properties of SCBA:

S.NO.	Property	Value
1.	Density	$578kg/m^3$
2.	Specific Gravity	2.2
3.	Mean particle size	0.1-0.2μm
4.	Min specific surface area	$2500m^2/kg$
5.	Particle shape	Spherical

Table No.-3.3 Chemical properties of SCBA:

S. NO.	Component	Symbol	Percentage
1.	Silica	SiO_2	63
2.	Alumina	Al_2O_3	31.5

3.	Ferric Oxide	Fe_2O_3	1.79
4.	Manganese Oxide	MnO	0.004
5.	Calcium Oxide	CaO	0.48
6.	Magnesium Oxide	Mgo	0.39
7.	Loss on Ignition	LOI	0.71

FINE AGGREGATE

The river sand, passing through 4.75 mm sieve and retained on 600 µm sieve, conforming to Zone II as per Is 383-1970 was used as fine aggregate in the present study. The sand is free from clay, silt and organic impurities. The aggregate was tested for its physical requirements such as gradation, fineness modulus, and specific gravity and bulk modulus in accordance with IS: 2386-1963.

Fig-3.3 Fine aggregate

Table No.-3.4 Properties of aggregate:

S. NO.	Property	Value
1.	Specific Gravity	2.60
2.	Bulk density gm/cc	1.542
3.	Fineness Modulus	2.74
4.	Zone	II

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COARSE AGGREGATE

Throughout the investigations, crushed coarse aggregates of20mm procured from the local crushing plants were used. The aggregate wastested for its physical requirements such as gradation, fineness modulus, specific gravity and bulk density etc.in accordance with IS: 2386-1963 and IS: 383-1970.

Fig-3.4 coarse aggregate

Table No.-3.5 Properties of coarse aggregate:

S. NO.	Property	Value
1.	Bulking Density (ϒ)gm/cc	1.610
2.	Specific Gravity (G)(20mm)	2.74
3.	Fineness Modulus	7.17
4.	Aggregate impact value (%)	25.21
5.	Aggregate crushing Value (%)	25.22

WATER

Fresh portable water free from organic matter and oil is used in mixing the concrete. Water in required quantities were measured by graduated jar and added to the concrete. The rest of the material for preparation of the concrete mix was taken by weigh batching. The pH value should notbe less than 7.

DESIGN OF MIX CONCRETE

(M35) Aggregate size 20mm
Minimum cement content:320 kg/m^3 (from table 5 456)
W/c ratio:0.4
Workability:75mm (slump)
Exposure:Severe

1) Target Mean Strength of concrete

From IS: 10262-2009, the target mean strength for the specified characteristic cube strength is

$$f_{ck}^{1} = f_{ck} + 1.65 \times s$$

$$f_{ck}^{1} = 35 + (5 \times 1.65) = 43.25\ N/mm^2$$

(‘s’ is standard deviation N/mm^2 s = 5, from table 1 IS 10262:2009)

2) Selection of Water-cement Ratio

The free Water cement ratio required for the target mean strength of43.25N/mm^2 is W/c =0.40

3) Selection of water content:

For 20mm aggregate = 186 liters (25 to 50mm slump)

For 75mm slump = 186 + 3/100* 186 (for every 25mm increase in slump 3% water should be increased)

191.58 ltrs (from table 2 IS 10262:2009)

4) Determination of cement content:

w/c = 0.40

192/c = 0.40

C = 480kg/m^3 hence ok

5) Proportion of volume of coarse aggregate and fine aggregatecontent:

Fine aggregate = zone 2

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Volume of coarse aggregate per unit volume of total aggregate for different zones of fine aggregate = 0.62 for every +/- 0.05 change in w/c ratio we have to change -/+ 0.01 change in volume of coarse aggregate per unit volume of total aggregate therefore 0.40 = 0.64 Fine aggregate
= 0.36

6) Mix calculations:

a) Volume of concrete = $1m^3$ Take cement content = $330kg/m^3$
b) Volume of cement = (mass of cement/specific gravity)*(1/100)

= (330/3.15)*(1/1000) = $0.104m^3$

c) Volume of water = (mass of water/specific gravity)*(1/1000)

= (192/1)*(1/1000) = $0.192m^3$

d) Volume of aggregate = (a-(b+c))

= 1- (0.104+0.192) = $0.703m^3$

e) Mass of coarse aggregate = d* volume of coarse aggregate*specific gravity of coarse aggregate = (0.703*0.64*2.74*1000) = 1232.78 kg
f) Mass of fine aggregate = d* volume of fine aggregate*specific gravity of fine aggregate = (0.703*0.36*2.74*1000) = 693.43 kg

The mix proportion then becomes:
Mix proportion for M35 by weight

Water : Cement : Fine Aggregate :Coarse Aggregate
192: 330.00 : 693.43 : 1232.78

EXPERIMENTAL INVESTIGAITON

In the present experimental investigation sugar cane bagasse ash has been used as partial replacement of cement in concrete mixes. On replacing cement with different weight percentage of SCBA the compressive strength is studied at different ages of concrete cured in different environments like normal water and HCL diluted solution. The details of experimental investigations are as follows

PREPARATION OF TESTING SPECIMEN MIXING

Mixing of ingredients is done in pan mixer of capacity 40 liters. The cementations materials are thoroughly blended and then the aggregate is added and mixed followed by gradual addition of water and mixing. Wet mixing is done until a mixture of uniform color and consistency are achieved which is then ready for casting. Before casting the specimens, workability of the mixes was found by compaction factor test.

Fig- 3.6 Cement ingredients

PREPARATION OF SPECIMENS

The cast iron moulds are cleaned of dust particles with mineral oil on allsides before concrete is poured in to the moulds. The moulds are and applied placed on a level platform. The well mixed concrete is filled in to the mould sand kept on vibration table. Excess concrete was removed with trowel and top surfaces finished level and smooth as per IS 516-1969.

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Fig-3.7 Preparation of specimen

CURING OF THE SPECIMENS

The specimens are left in the moulds undisturbed at room temperature forabout 24 hours after casting. The specimens are then removed from the mould sand immediately transferred to the different curing environment tubs i.e. cubes arecured in fresh water and 5% HCL diluted solution.

Fig- 3.8 Curing of the specimens

TESTING OF SPECIMENS

A time Schedule for testing of specimens is maintained to ensure theirproper testing on the due date and time. The cast specimens are tested as perstandard procedures, immediately after they are removed from curing tubs andwiped off the surface water, as per IS 516-1959.

Fig- 3.9 sample of cubes

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Fig- 3.10Hydraulic Compressive Testing Machine

DESCRIPTION OF COMPRESSION TESTINGMACHINE

The compression testing machine used for testing the cube specimens is of standard make. The capacity of the testing machine is 2000 KN. The machine as a facility to control the rate of loading with a control valve

.The plates are cleaned and oil level is checked, and kept ready in all respects for testing After the required period of curing, the cube specimens are removed from the curing tubs and cleaned to wipe off the surface water. It is placed on the machine such that the load is applied centrally. The smooth surfaces of the specimen are placed on the bearing surfaces. The top plate is bought in contact with the specimen by rotating the handle. The oil pressure valve is closed and the machines switched on. A uniform rate of loading 140 kg/sq.cm/min is maintained.

TESTS CONDUCTED
WORKABILITY

The workability was measured using slump cone and compaction factor apparatus for different percentage replacement of cement with sugarcane bagasseash in concrete. Workability of concrete depends upon W/C (water cement) ratio. If water is increases in the concrete workability is also increases but strength is decreases.

Fig- 3.13 Slump cone and compaction factorapparatus

COMPRESSIVE STRENGTH OF CONCRETESPECIMENS

Concrete specimens are casted to determine the compressive strengthof different weight percentages of sugarcane bagasse ash concrete as perIS 516-1969.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 12 Dec 2021, pp: 1099-1115 www.ijaem.net ISSN: 2395-5252

Fig- 3.14 Testing of cube CTM

DURABILITY

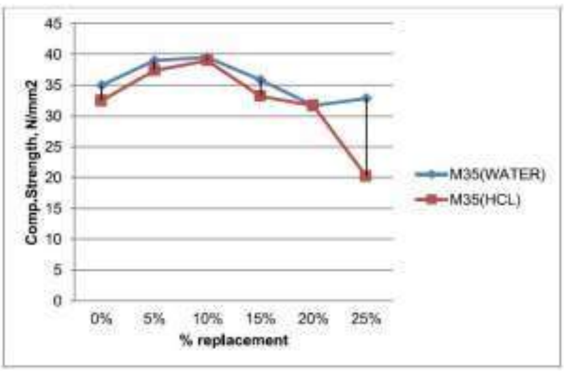
The durability of sugarcane bagasse ash concrete was tested for resistance1Oml HCL diluted solution. The response of chemical attack on different percentage replacement of cement with sugarcane bagasse ash in concrete was studied by reduction in compressive strength. For conducting these tests, concrete cubes of 100mm x 100mm x 100mm size with ordinary and different percentage replacement of cement with sugarcane bagasse ash were cast. These cubes were immersed in a HCL solution by maintaining 4 to 4.5 ph. values for different periods of 7, 28and 60days.

Durability studies on Cement Conventional Concrete & Sugar Cane Bagasse Ash Concrete. Concrete is the most versatile material of construction the world over. It is achieved that the distinction of being the "largest man-made material with the average per capita consumption exceeding 2 kg. Concrete is the material of choice for a variety of applications such as housing. Bridges, highway pavements, industrial structures, water carrying and retaining structures etc.

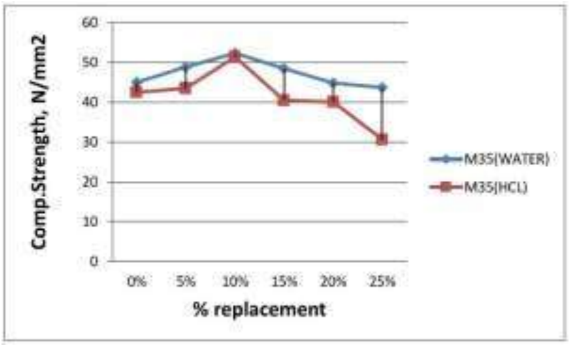
The credit for this achievement goes to well-known advantages of concrete such as easy availability of ingredients, adequate engineering properties for a variety of structural applications, adaptability, versatility, relative low-cost etc. Moreover, concrete has an excellent ecological profile compared with other materials of construction. With the continuing expansion of infrastructure and housing construction, especially in the developing countries of Asia, Africa, and South America, the rate of consumption of cement and concrete 1s rising and is bound to go further. In India, concrete construction scenario has been witnessing considerable growth indecent years.

4.1 RESULTS AND DISCUSSIONS

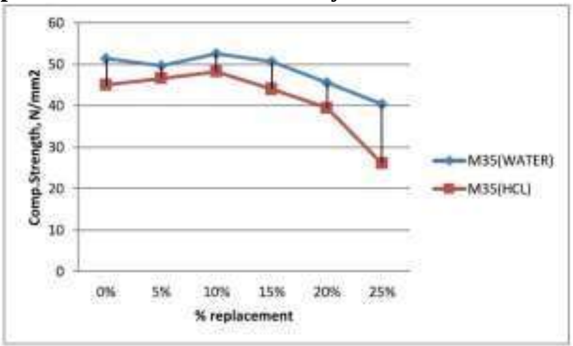
The result of experimental practices and analysis are presented in this chapter section 5.2 provides the result of compressive strength of M35 grade of concrete after partial replacement of cement with SCRB at various percentage and about effect of HCL on compressive strength.



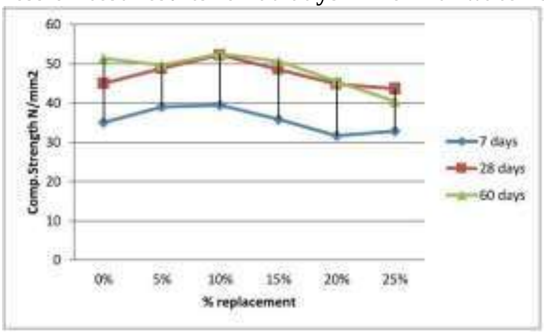
Graph-1 Compression test results for 7 days in normal water &HCL Solution



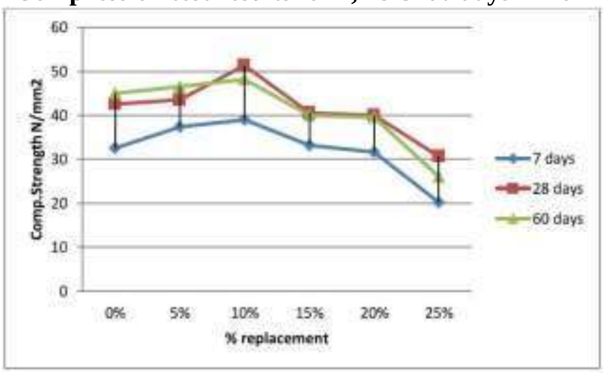
Graph-2 Compression test results for 28 days in normal water &HCL Solution



Graph-3 Compression test results for 60 days in normal water &HCL Solution



Graph-4 Compression test results for 7, 28 & 60 days in normalwater



Graph-5 Compression test results for 7, 28 & 60 days in HCLSolution

IV. CONCLUSION AND DISCUSSION

The result of experimental practices and analysis are presented in thischapter section 5.2 provides the result of compressive strength of M35 grade of concrete after partial replacement of cement with SCRB at various percentage and about effect of HCL on compressive strength.

CONCLUDING REMARKS

The experimental test conducted on the cube (150×150×150 mm), results are obtained as following.

1. Compressive strength of concrete cube with 0% SCBA for 7days has been obtained as 35 MPa.
2. Compressive strength of concrete cube with 0% SCBA for 14days has been obtained as 44MPa.
3. Compressive strength of concrete cube with 0% SCBA for 28 days has been obtained as 52.39MPa.
4. Compressive strength of concrete cube with 5% SCBA for 7days has been obtained as 38MPa.
5. Compressive strength of concrete cube with 5% SCBA for 14 days has been obtained as 47.6MPa.
6. Compressive strength of concrete cube with 5% SCBA for 28 days has been obtained as 48.6MPa.
7. Compressive strength of concrete cube with 10% SCBA for 7 days has been obtained as 38.5MPa.
8. Compressive strength of concrete cube with 10% SCBA for 14 days has been obtained as 52.4MPa.
9. Compressive strength of concrete cube with 10% SCBA for 28 days has been obtained as 54.5MPa.
10. Compressive strength of concrete cube with 15% SCBA for 7 days has been obtained as 36.5MPa.
11. Compressive strength of concrete cube with 15% SCBA for 14 days has been obtained as 47.6MPa.
12. Compressive strength of concrete cube with 15% SCBA for 28 days has been obtained as 51.65MPa.
13. Compressive strength of concrete cube with20% SCBA for 7days has been obtained as 32.64MPa.
14. Compressive strength of concrete cube with 20% SCBA for 14 days has been obtained as 43.82MPa.
15. Compressive strength of concrete cube with 20% SCBA for 28 days has been obtained as 46.5MPa.
16. Compressive strength of concrete cube with 25% SCBA for 7 days has been obtained as 33.85MPa.
17. Compressive strength of concrete cube with 25% SCBA for 14 days has been obtained as 44.65MPa.
18. Compressive strength of concrete cube with 25% SCBA for 28 days has been obtained as 41.3MPa.

CONCLUSION

The experimental study seen that the compressive strength of concrete increases with help of SCBA, if use in partially replacement of cement in concrete, after that the compressive strength gets decreases it's also seen that use of HCL for curing of cube in place of normal water is also helpful in the enhancement of compressive strength.

Following conclusion is summarized as per experimental study.

19. By increasing the percentage of SCBA in mix design there is gradual decreases of compressive strength for 7 days.
20. After 14 days compressive strength of cube is increases for acertain percentage.
21. Maximum compressive get by the experiment is at 28 days after the replacement of 10% cement with SCBA.
22. Compressive strength is reduced very low acid attack aftercured of 28 days.

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