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Comparative Study on Effect of Silica Fume and Animal Bone on Concrete by Partial Replacement of Coarse Aggregate with Animal Bones and Cement with Flyash

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***Abstract* - The demand of natural coarse aggregates in the construction industry has been increased. It is very essential to protect the natural coarse aggregates for further generation. . To fulfil the demand of such naturally occurring materials, various substitutes are used. In the present study, an attempt has made by partial replacing the natural coarse aggregates with animal bones (sheep or goat bones) and cement with fly by comparing with and without silica fume (which is a pozzolonic material, used as an admixture).The present investigation is about the effect of animal bones and an optimum fly ash content and silica fume on properties of concrete, when the partial replacement of coarse aggregate with animal crushed bones by different proportions. An auxiliary test like compression, split tensile, flexural strength test was made on cubes, cylinders, beams for M30 grade concrete and curing for 7days, 28 days, 90days and durability tests were made on cubes by using HCL solution and sea water. The replacement levels of normal coarse aggregate with animal bones by weight and a comparative study has been done between normal conventional concrete and animal bone concrete with and without using of silica fume. From this research the use of silica fume is sustainably increase the mechanical properties of concrete.**

Key words: Animal Bones, Conventional Concrete, Durability properties, Fly Ash, HCL solution, Mechanical properties.

1. INTRODUCTION

In this world, there is great demand of aggregates mainly from civil engineering industry for road and concrete constructions. But now days it is very difficult problem for available of coarse and fine aggregates. So researchers developed waste management strategies to apply for replacement of these aggregates for specific need. Natural resources are depleting worldwide while at the same time the generated wastes from different areas are increasing substantially. The sustainable development for construction involves the use of nonconventional and innovative materials, and recycling of waste materials in order to compensate the lack of natural resources and to find alternative ways conserving the environment. Animal bones (goat or sheep) are one of the materials that are considered as a waste material which could have a some partial usage in construction industry as partial substitute of either fine or coarse or aggregates. In the present era there are lot of animals which are used as meat food like goats, sheep and. Some of these waste bones are just thrown in garbage bins and pits causing uncleanness to the environment .Therefore is a need to look into how can the bones can be utilized beneficially in making concrete that can offer good quality constructions. In this study, bones were collected from disposals, cleaned then dried they were made in to coarse aggregates size. Animal bones are the wastes from meat industry. There are lot wastes from these industries cause environmental pollution .In this world wide they are thousand tons of animal waste bones are produced every year. So there is small scope we can use these animal bones are used in construction industry. Therefore, an effort has been made to utilize these bones (crushed) to study the effect of animal bones on concrete. Some references made aggregate crushing value tests on bones and them given good results for making better quality concrete. A lot of work has been carried out to improve the properties of concrete by using various materials. No work has been done on animal bone as substitute material. As far as bone is concerned, it is a very light and hard material composed of a cellular component and an extracellular matrix. Besides being light and hard, bone does not deteriorate easily. The remains of animal (bones) are dug out even after hundreds of years [Archaeological Survey of India (ASI)] providing a vital clue that the decaying period of bones is good enough to be used in concrete works.

Fly Ash is a mineral portion of coal consumed in a coal fuel power plant. The particles of Fly Ash are spherical shaped, glassy and finer than cement particles. In recent special attention has been devoted to industrial sectors. The industry produces large volume of solid wastes and therefore a huge problem of pollution is generated. The potential use of this waste as a cementing material for concrete is essential. Some researchers are done on fly ash and observed that 10% fly ash showed the highest compressive strength at all ages, use of 15% to 30% fly ash significantly increased the compressive strength at 90 days and 180 days.

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Recent research aimed at energy conservation in the cement and concrete industry has, in part, focused on the use of less energy intensive materials such as fly ash, slags and natural pozzolans. Lately some attention has been given to the use of condensed silica fume as a possible partial replacement for cement. Silica fume, a by- product in the manufacture of ferrosilicon and also of silicon metal, is a very efficient pozzolonic material, there are some problems associated with its use in concrete. The chief problems in using this material are associated with its extreme fineness and high water requirement when mixed with Portland cement. In this research silica fume is used as an admixture by 5% which increase the compressive strength.

2. SELECTIONS OF MATERIALS

2.1 Cement:

Ordinary Portland Cement (OPC) locally available in Vijayawada (the KCP CEMENT Brand Name) in 50kg bags was used for the experiment.

Table 1: properties of cement

S.No	Properties	Value
1	Specific Gravity	3.15
2	Initial setting time	42min
3	Final setting time	256 min
4	Fineness test	5% retained

2.2 Fine Aggregate:

The aggregate size is lesser than 4.75 mm is considered as fine aggregate. The sand particles should be free from any clay or inorganic materials and found to be hard and durable. It was stored in open space free from dust and water. In our region fine aggregate can be found from bed of Krishna River. It conforms to IS 383-1970 comes under zone II.

Table 2: Properties of Fine Aggregate

S.No	Properties	Value
1	Specific Gravity	2.67
2	Density kg/m^3	1580
3	Water absorption	
4	Zone	II

2.3 Coarse Aggregate:

The aggregate size bigger than 4.75 mm, is considered as coarse aggregate. It can be found from original bed rocks. Coarse aggregate are available in different shape like rounded, Irregular or partly rounded, Angular, Flaky. It should be free from any organic impurities and the dirt content was negligible.

Table 3: Properties of Coarse Aggregate

S.No	Properties	Value
1	Specific Gravity	2.70
2	Crushing value	14.21%
3	Impact value	2.5%
4	Density kg/m^3	1560
5	Water absorption	0.6%

2.4 Water:

Potable water from the Civil Engineering Laboratory of the of Gudlavalleru college of engineering and technology was used to prepare the test specimens

2.5 Animal bones:

The bones are collected from the locally available mutton merchants and these are made in to pieces to the size of 16-20mm size of coarse aggregates

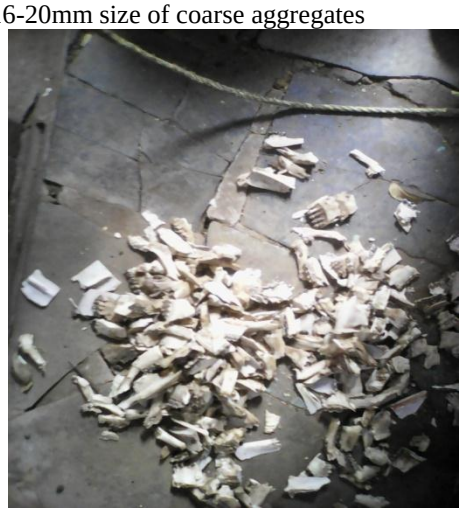

Fig1: Animal Bones

Table 4: Properties of Animal Bones (AB)

S.No	Properties	AB Aggregate
1	Maximum aggregate size mm	20.0
2	Bulk density, Kg/m^3	1510
3	Specific gravity	2.18
4	24-hour water absorption (%)	4.00

2.6 Flyash:

The fly ash collected from (VTPS CONFORMING TO CLASS-F) is used for the study.

Table 5: Properties of Fly ash

S.No	Properties	Fly ash
1	Fineness m^2/kg	351
2	Bulk density, Kg/m^3	1.12gm/cc
3	Specific gravity	2.52
4	Colour	Grey

2.7 SILCAFUME:

Silica fume was procured from ASTRA CHEMICALS in Chennai. The Silica fume is used as an admixture to the cement.

Table 6: Properties of SILICA FUME

S.No	Properties	Silica fume
1	Fineness (m^2/kg)	15,000 to35,000
2	Bulk density(kg/m^3)	1350-1510
3	Specific gravity	2.63

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3. METHOD

The Animal bones (goat or sheep bones) are dried in the open air to clean out the dirt and to reduce the smell and moisture content. The AB was first of all broken down to our coarse aggregate sizes carefully. The size of these bones should be as coarse aggregate sizes. These AB aggregates were used as partial replacement of conventional coarse aggregates in concrete cube, cylinder, and beam specimens up to 40% .The specimens are made for M30 grade concrete. Concrete mix ratio of with a water/cement ratio of 0.45 respectively has been used in the study

In addition to that cement is partial replaced with fly ash by an optimum content i.e., 20% the optimum content of fly ash is taken because the usage of fly ash content is restricted to 30% above this content the strength of the concrete is decreases.

Besides to that an admixture is used to improve the strength to the concrete. An ad mixture silica fume is used in the present study because as far as project concerned use of animal bones gives less strength. To increase the strength an ad mixture silica fume is used. Percentage level of silica fume is 5%because it is a pozzolanic material which gives high strength.

The present study is about the effect of partial replacement of animal bones up to 40% and optimum fly ash content 20% on properties of concrete, and individual trial mixes are made for these proportions without addition silica fume in the first set. And another set is made by using silica fume to the above cement and coarse aggregate proportions and these test results are compared.

3.1 Sieve Analysis:

The experimental work starts with the sieve analysis. IS specified sieves of varying sizes are used. The details of sieve analysis are shown in Table.

Table 7: Sieve Analysis of fine and Coarse Aggregate and Animal bones

IS SIEVE	Coarse aggregate cumulative percentage retained	Fine aggregate cumulative percentage retained	Animal Bones cumulative percentage retained
20mm	0.7	0	0.9
16mm	4.15	0	5.26
12.5mm	15.85	0	16.29
10mm	48.75	0	49.28
4.75mm	98.25	1.17	99.26
2.36mm	100	5.68	100
1.18µm	100	28.14	100
.600µm	100	57.07	100
.300µm	100	98.39	100
.180µm	100	98.68	100
Fineness	5.38	2.87	5.67

4. TESTS AND RESULTS:

The different tests conducted in laboratories are shown in this paper. It consist mixing of concrete in the laboratory by replacing Animal bones as Coarse aggregate with proportions (by volume) of Animal bones(goat or sheep bones) added to concrete mixtures were as follows: 0% (for the control mix), 10%, 20%, 30%, 40% and cement with optimum fly ash content without using silica fume. Concrete samples were prepared and cured in the laboratory, and are tested, to evaluate compressive, split tensile and flexural strength. Another concrete mixture was made as done above by using silica fume.

Compression tests were performed on samples made during 7, 28, 90 days and these specimens are also tested for durability conditions i.e.using hydrochloric acid (HCL 35%concentrated) and sea water curing were for these two sets. compression strength tests performed by cube samples of size 150 x 150 x 150 mm, and cylinders of sizes 300mm x 150mm ,and beams of sizes 500mm x 100mm x 100 mm were prepared and tested at 7, 28 ,90days of curing in water under controlled laboratory conditions. Samples were tested at each curing age.

4.1 Mix Ratio and Mix Description

Mix ratio for this experimental work was noted as
1(Cement):1.67(F.A):2.72(C.A)

4.2 Mix Description

C=Conventional Concrete
C1=10% Animal Bones (A.B) +20% Fly Ash
C2=20% Animal Bones (A.B) +20% Fly Ash
C3=30% Animal Bones (A.B) +20% Fly Ash
C4=40% Animal Bones (A.B) +20% Fly Ash
C5=C1+5% Silica Fume.
C6=C2+5% Silica Fume.
C7=C3+5%Silica Fume.
C8=C4+5% Silica Fume.

ABC= Animal Bones Concrete.
N.W.C=Normal Water Curing.
S.W.C= Sea Water Curing.
A.C=Acid Curing.

Table 9: Compressive strength of cubes in (Mpa): Without Silica Fume in ABC:-

MIX	7 Days	28 Days		
		N.W.C	S.W.C	A.C
C	29.30	38.97	37.45	37.21
C1	30.69	39.90	36.26	36.34
C2	28.56	38.37	35.35	35.82
C3	26.28	36.54	34.68	34.57
C4	25.65	34.29	33.65	33.27

Fig 2: Graphical Representation for Compressive strength of cubes in (Mpa): Without Silica Fume in ABC

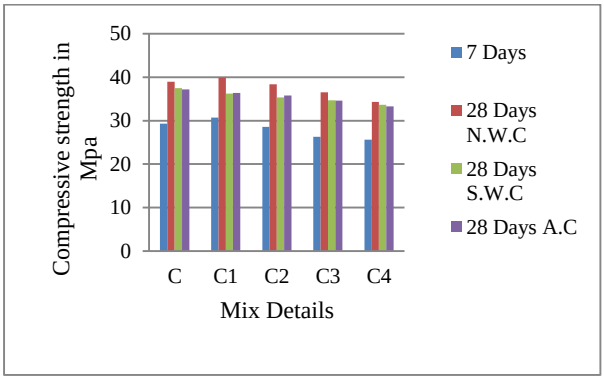

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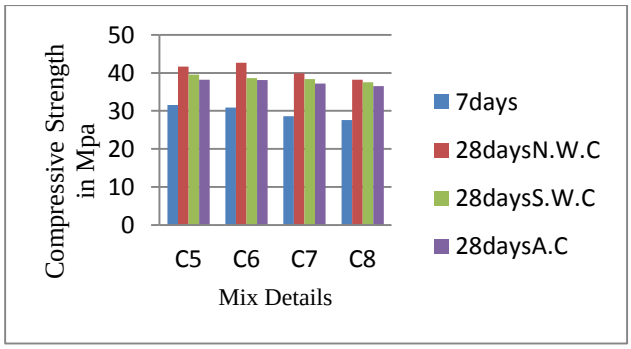
Table 10: Compressive strength of cubes in (Mpa): With Silica Fume in ABC:-

MIX	Compressive strength in Mpa			
	7 Days	28 Days		
		N.W.C	S.W.C	A.C
C5	31.54	41.65	39.56	38.23
C6	30.87	42.69	38.67	38.10
C7	28.64	39.92	38.39	37.21
C8	27.56	38.24	37.54	36.52

Fig 3: Graphical Representation Compressive strength of cubes in (Mpa): With Silica Fume in ABC:-



From the test results, it can be seen that the compressive strength of Animal bone concrete mixes with 10%, 20%, 30%, 40%, by coarse aggregate replacement with animal bones, and cement with optimum fly ash content there is slightly increase in compressive strength at 10%, 20% and after the strength was decrease. It is evident that durability results are also from Table 8 and Fig 2 that compressive strength of at 10%, 20% mixes increases and decrease with age.

However, from above table the highest compressive strength was achieved by20% replacement of animal bones and at remaining percentages are decreases. To increase in strength an ad mixture silica fume is used. From the above table it can be seen that compressive are increases at all percentages, when compared to that without silica fume. So it can be evident that 40% replacement of animal bones with silica fume and optimum fly ash content is achieving the target mean strength of concrete. Durability results are also gives good results compared to all other control mixes.

Table 11: Tensile strength and Flexural Strength for 28 days (Mpa) Without SILICA FUME IN ABC:

Mix	Strength in Mpa	
	Split Tensile strength in Mpa	Flexural Strength in Mpa
C	4.48	6.36
C1	4.35	6.23
C2	4.13	6.06
C3	4.09	5.96
C4	4.02	5.87

Fig 4: Graphical representation for Split Tensile and Flexural Strength of ABC for 28 Days without Silica fume

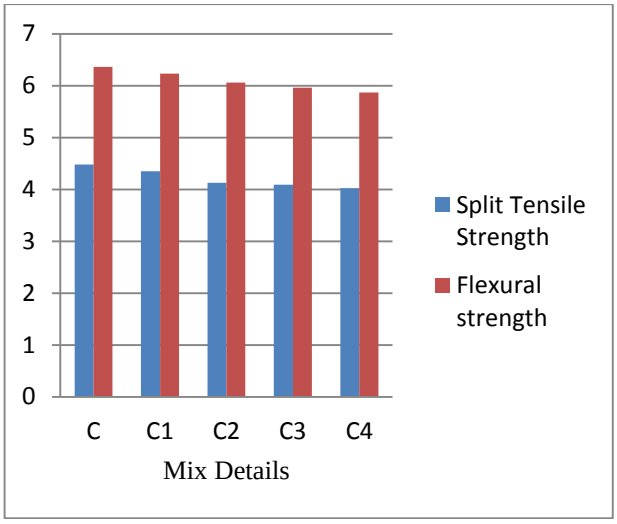
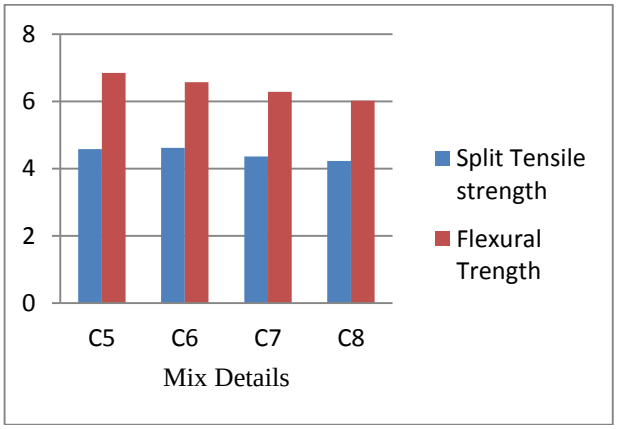


Table 12: Tensile strength and Flexural Strength for 28 days (Mpa) With SILICA FUME IN ABC:

Mix	Strength in Mpa	
	Split Tensile strength in Mpa	Flexural Strength in Mpa
C5	4.58	6.85
C6	4.62	6.57
C7	4.36	6.29
C8	4.23	6.02

Fig 5: Graphical representation for Split Tensile and Flexural Strength of ABC for 28 Days with Silica fume



Here samples of size 500mm x 100mm x 100mm, were prepared and tested for flexural strength at 28-days of curing, and samples of 300mm x 150 mm were prepared and tested for split tensile test at 28 days. At least 3 samples were tested at each curing age. The average flexural strengths and split tensile of the concrete composites measured during this phase of the project are presented in Table and graphically.

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5. CONCLUSIONS

From the above test results in this research following conclusions has been drawn from the study:

- At 20% replacement of Animal Bones and 20% optimum fly ash content increases the compressive strength, and strength decreases gradually with increase in percentages levels.
- Tensile and Flexure strength also decreases with increase in percentage levels of Animal Bones.
- The compressive strength of concrete is increased by adding silica fume.
- Target mean strength of concrete is achieved by adding 5% replacement of silica fume at 40% replacement of Animal Bones.
- Tensile and flexure strength are also increases by adding silica fume in AB concrete.
- By adding Animal Bones in concrete reduces the workability because it has high water absorption to rectify this problem fly ash is added to increase the workability of concrete. Since Fly Ash improves the workability.

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