Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 01, January-2019

Study on Partial Replacement of Cement with Animalbone Powder Along with the Addition of Polyproplyene Fiber in Concrete

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***Abstract*— Demand of cement is increasing day by day but its manufacturing process results in emission of Co_2 on the other hand animal bone is a wasteful material which is dumped on the land and causes pollution In this study cement used is ordinary portland (OPC) of grade 43 was used to produce a concrete of M25 concrete and for partial replacement of cement animal bone powder (ABP) was used. To evaluate properties of concrete different test were conducted. For chemical properties of ABP EDAX test was conducted. Concrete cubes were casted with the partially replacement of cement by the ABP in ratio 0%, 5% , 10% and 15% respectively. Curing was done for 7,14 and 28 days respectively.. Comparison of compressive strength with mean target and normal M25 concrete give the optimum replacement value 5% . After this the polypropylene fiber(PPF) and polyester fiber(PF) were added in normal M25 concrete. 1%,1.5%and 2% for polypropylene fiber and 0.2%, 0.25% and 0.3% respectively. Comparing their compression test results addition of PPF improves strength of concrete much better than PF and the optimum value is 1.5% . Then concrete cubes were casted by replacing cement with ABP in similar ratio along with the addition 1.5% PPF . There was increase in compressive strength of cube the optimum value of replacement of cement was 10%.Concrete Cylinder were casted with Similar replacement of cement and addition of PPF and the optimum result of split tensile strength optimum was at 10% replacement of cement however, durability still increases with further replacement of cement with ABP**

Keywords—Ordinary Portland Cement, Animal Bone Powder, Polypropylene Fiber

I. INTRODUCTION

Concrete is widely used construction material and its demand is increasing day by day . The main ingredient of the concrete is cement. Production of cement contributes a great share in the air pollution. Many attempts had made to find an replacement for the cement. Crushed or died animals are disposed of in the dumping land is becoming a major issue . Many researches had been made to find the uses of animal bone . The chemical ingredients of the animal bone powder are similar but the percentage proportion are different. Many investigation work is carried in which cement is replaced with the animal bone powder . In this work M25 grade of concrete was used . The cement was partially replaced with the animal bone powder along with the addition of polypropylene fiber in concrete. Compressive strength of concrete in which cement is replaced with the animal bone powder is compared with the strength in which cement is replaced with animal bone powder along with the addition of polypropylene fiber. Split tensile strength is both the concretes is compared.

II. LITERATURE REVIEW

M. Kotb et al . (2010) stated that the strength of concrete rises suddenly with the replacement of the cement by animal bone powder to a certain percent . Replacement of the cement was done with different percentages likes 0, 5,10 and 15 % . Equal number of the cubes are casted for the testing on the 7,14,28,90and 180 days . These were tested for compression test. The compression strength of concrete was observed to increase un till 5% but for the 10% and 15% it decreases . Cylinder with replacement of cement by 0%,5%, 10% and 15% . Equal number of cylinders are tested for the 7,14,28,90and 180. The tensile strength increases till 5% and decreases for 10% and 15% so they are no recommended for the use. They used scanning electrons microscope and X-ray diffraction test and the reason for increase in strength for 5% replacement is that bone powder act as the filler material and speeds the hydration process.

Anthony Nkem Ede and AbimbolaOluwabambi Ige(2014) reported that concrete is used throughout the world for the construction purpose . United state of america uses concrete $30 billion. Moreover researches had been carried out to enhance the properties like strength and durability . Authors stated that recently Nigeria found that steel fiber used was of very low quality for example in Lagos Concrete failed in compressive strength test in 2010. Its yield strength was found to be less than $460N/mm^2$ which is the minimum strength referred by BS8110 (1997) . Authors used polypropylene fiber as the reinforcing material they added 0.25, 0.5 , 0.75 and 1%

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of polypropylene fiber and tested after curing of 7,14, 21 and 28 days . The result is enrichment in strength of the concrete and the optimum value of addition was between 0.25-0.5% .

F.N.Okoye and O.I Odumodu(2016) reported that the bone powder contains all the similar components as cement have but are present in different quantities. They replaced ordinary portland cement with the animal bone powder . The replacement of cement with bone powder has percentage- 0, 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100% . The strength of cement decreases after the replacement with bone powder more than 10% . If cement was not replaced the crushing strength of the concrete was 25.95N/mm^2 . They conducted mineralogical analysis on bone powder to find the chemical composition . They find out the structural analysis that bone powder should replace cement up to 10% and 20% replacement should be permitted for using it in the rendering purpose .

S. M. VARMA. et at. (2016) stated that in the environment cattle bones are already a waste matter so its ash can partially be used to replace cement for concrete modification . They casted the concrete cube with partially replacing the cement with animal bone powder ash . In the research the casted cubes for the testing after 7, 28 days . There was not a sudden change in the strength and the durability of the concrete but it helps in reducing the green house gases emission . Replacement of cement with bone powder ash has another benefit in cleaning the environment by removing the waste of bones . One of the other aspect of this research was that there were increase in economical value of concrete by the reduction in its cost.

M. Kiruthika and K. Mahendran (2017) stated that bone powder ash can partially be used in place of cement . In their research they casted concrete cubes with 0, 4 8 and 12% replacement of concrete by bone powder ash . They casted M20 grade of concrete with replacement and tested it on the 7 and 28 days after curing . The result is an increase in the compressive strength of the concrete . The maximum compressive strength was recorded when replacement of cement was at 12%. So they concluded that bone powder ash can be used in place of cement in concrete not only to improve the environmental conditions but also to reduces the cost of concrete . They stated that by the replacement of cement with bone powder ash the green concrete can be formed . There was also a considerable increase in the tensile strength of the concrete for both 7 and 28 days tested specimens .

III. SELECTED MATERIALS

- Cement used is ordinary portland of garde 43 color grey and with no lump present.
- River sand of zone II .
- Aggregate used was of 20mm size.
- Animal bone powder of fineness 75 micron.
- Polypropylene fiber.
- Polyester fiber 20mm.

V. TESTING OF MATERIAL

(A) Test conducted on the Aggregate

1. Water absorption test.
2. Sieve test.
3. Sp. Gravity test.

(B) Test conducted on the Cement

1. Fineness test.
2. Specific gravity test of cement.
3. Soundness test of cement.
4. Initial and Final setting time .

(C) Test conducted on the animal bone powder

1. Sieve test.
2. EDAX test.

VI. RESULT OF MATERIAL TESTED

(A) Fine Aggregate (FA)

1. Modulus of fineness of FA= 2.835
2. Free surface moisture content = 1.5%
3. Percentage of water absorption = 1.5%
4. Sp gravity of FA = 2.64

(B) Coarse Aggregate (CA)

1. Maximum size of aggregate = 20mm
2. Fineness modules of CA = 6.564
3. Water absorption = 1%
4. Sp. gravity of CA = 2.70

(C) Cement

1. Cement initial setting time = 29 minutes
2. Cement final setting time = 595 minutes
3. Cement soundness = 7.64 mm
4. Cement Fineness = 228.5 m^2/kg

VII. RESULTS OF STRENGTH AND DURABILITY TESTS

(A) Compressive strength of concrete after partial replacement of cement with animal bone powder .

Table 1 : compressive strength after 7 days (Replacement of cement by ABP

Replacement of Cement in values by Animal bone powder(in %)	Failure Load (kN)S1	Failure Load (kN)S2	Failure Load (kN)S3	Average Load (kN)	Compressive Strength (N/mm^2)
0	571.03	543.31	548.85	554.4	24.64
5	450.92	473.92	455.52	460.125	20.45
10	412.99	417.21	434.06	421.425	18.73
15	392.81	377.56	373.74	381.37	16.95

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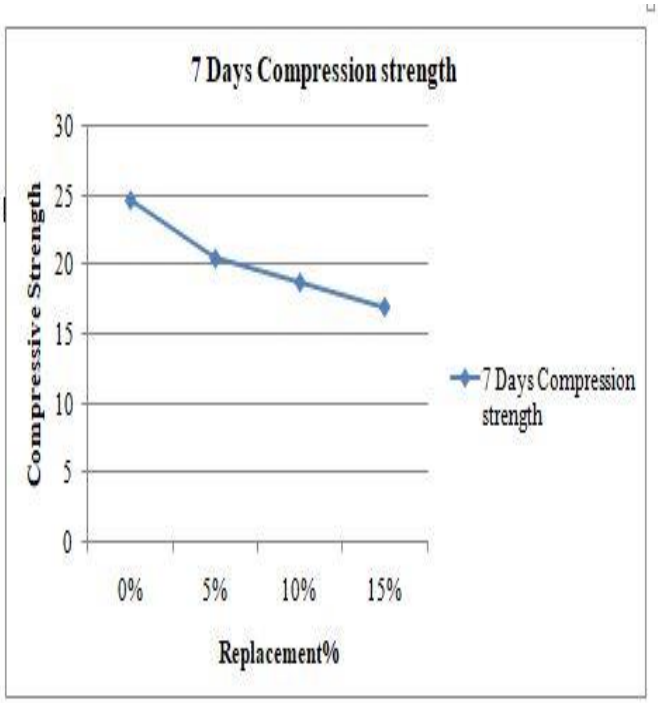

Fig 1. Graph of 7 day compressive strength (Replacement of cement by ABP)

(B) Compressive strength of the cube with replacement of cement by animal bone powder along with addition of polypropylene fiber after 7 days.

Table 2 : Showing compressive strength test (replacement of by animal bone powder along with the addition of PPF) after 7 days .

Replacement of Cement in values by ABP (in %)	Replacement of Cement in values by PPF(in %)	Failure Load (kN)S1	Failure Load (kN)S2	Failure Load (kN)S3	Average Load (kN)	Compressive Strength (MPa)
5	1.5	568.71	541.10	546.62	552.15	24.54
10	1.5	528.85	503.18	508.31	513.45	22.82
15	1.5	462.82	486.44	467.55	472.27	20.99

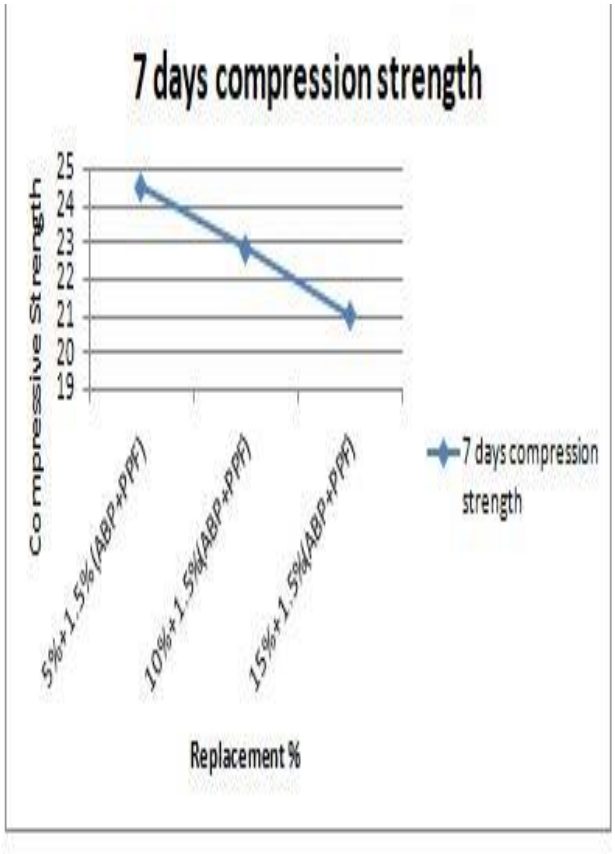

Fig 2. Graph of 7 day compressive strength for replacement by animal bone powder and addition of polypropylene fiber.

(C) Comparison of compressive strength of concrete with partial replacement of cement with animal bone powder and with addition of Polypropylene fiber after 28 days.

Table 3 : Compressive strength test on the cubes with replacement by animal bone powder after 28 days .

Replacement of Cement in values by Animal bone powder(in %)	Failure Load (kN)S1	Failure Load (kN)S2	Failure Load (kN)S3	Average Load (kN)	Compressive Strength (MPa)
0	816.82	808.57	849.82	825.07	36.67
5	737.57	775.20	745.09	752.62	33.45
10	699.88	665.91	672.70	679.50	30.20
15	571.26	543.53	549.07	554.62	24.65

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Table 4 : Compressive strength test results with replacement by animal bone powder along with addition of polypropylene fiber after 28 days

Replacement of Cement in values by ABP (in %)	Replacement of Cement in values by PPF(in %)	Failure Load (kN)S1	Failure Load (kN)S2	Failure Load (kN)S3	Average Load (kN)	Compressive Strength (MPa)
5	1.5	877.63	868.77	913.09	886.50	39.4
10	1.5	765.13	8041.17	772.94	780.75	34.7
15	1.5	680.90	687.85	715.64	694.80	30.88

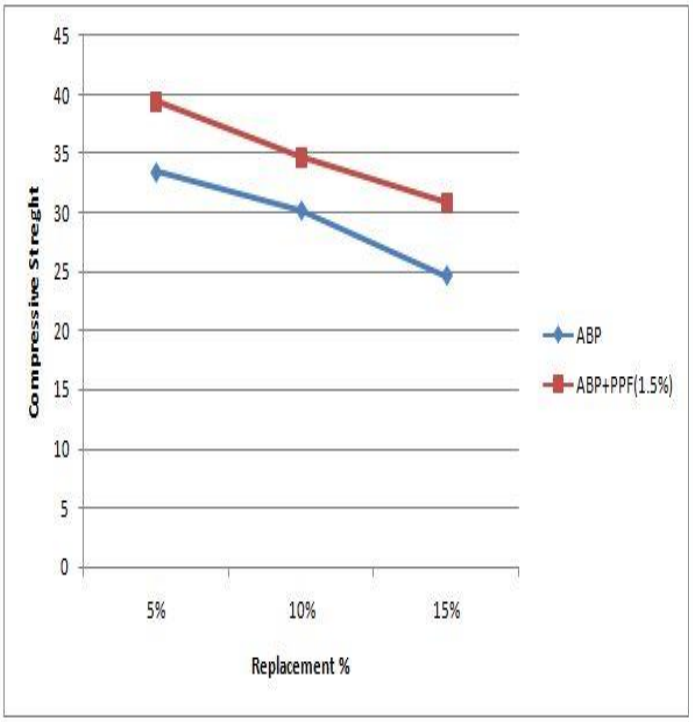

Fig 3. Comparison Graph for 28 day compressive strength for replacement of cement with ABP and replacement of cement with ABP along with addition of PPF.

(D) Split tensile strength of cylindrical concrete with partial replacement by animal bone powder after 7 day.

Table 5 : Split tensile strength test on the *cylinders* with replacement of by animal bone powder after 7 days .

Replacement of Cement in values by Animal bone powder(in %)	Split Tensile Strength (N/mm^2) H1	Split Tensile Strength (N/mm^2) H2	Split Tensile Strength (N/mm^2) H3	Average Split Tensile Strength (N/mm^2)
0	2.35	2.34	2.45	2.38
5	2.15	2.27	2.178	2.20
10	2.02	2.03	2.12	2.06
15	1.92	1.90	1.99	1.94

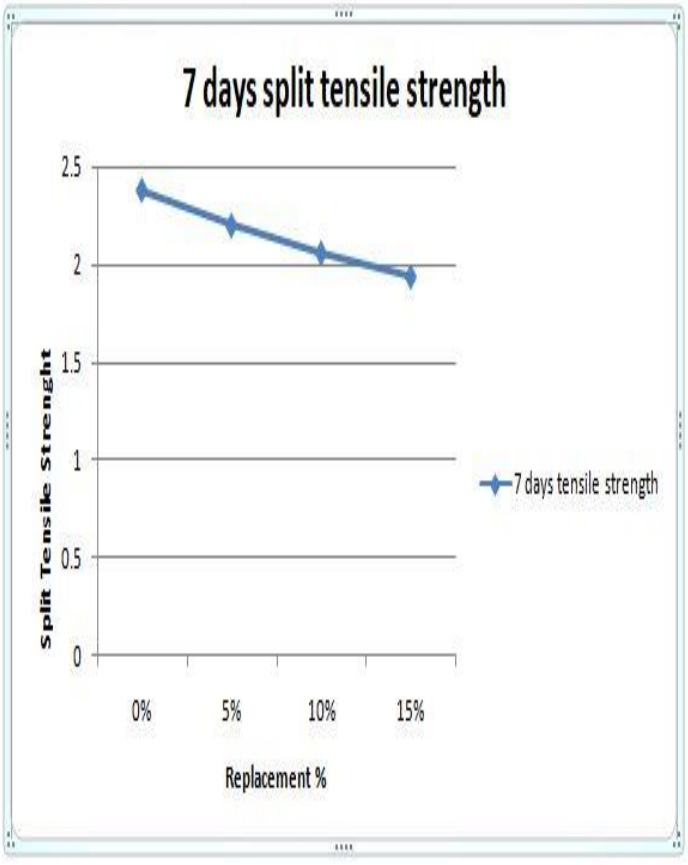

Fig 4. Graph showing split tensile strength for replacement by animal bone powder for 7 days.

(E) Split tensile strength of the cylinders with replacement by animal bone powder with addition of polypropylene fiber.

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Table 6 : Compressive strength test with replacement by animal bone powder along with the addition of Polypropylene after 7 days .

Replacement of Cement in values by ABP (in %)	Addition values by PPF(in %)	Split Tensile Strength (N/mm^2) H1	Split Tensile Strength (N/mm^2)	Split Tensile Strength (N/mm^2) H3	Split Average Tensile Strength (N/mm^2)
5	1.5	2.59	2.72	2.63	2.65
10	1.5	2.34	2.31	2.43	2.36
15	1.5	2.07	2.09	2.19	2.12

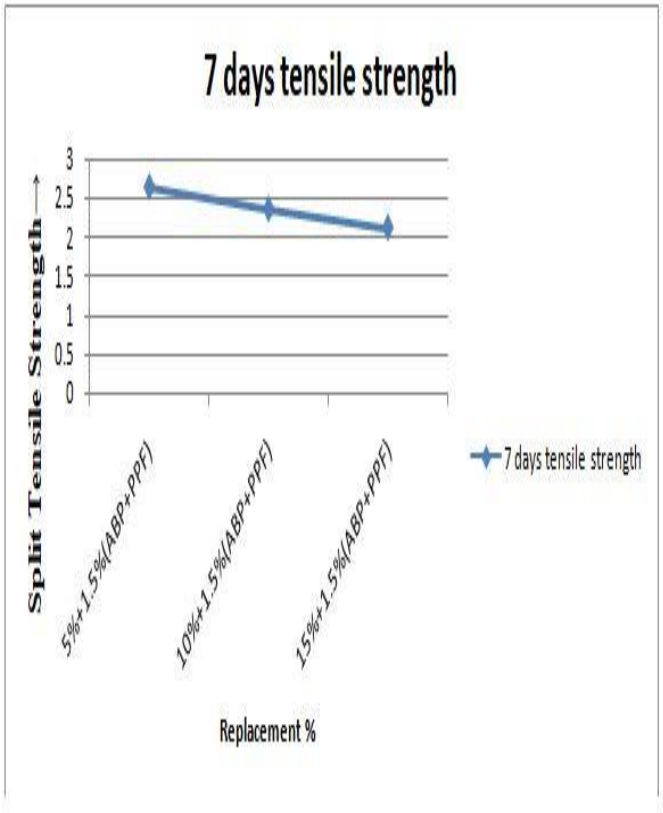

Fig 5. Graph showing split tensile strength for replacement by animal bone powder with addition of polypropylene fiber.

(F) Comparison of split tensile strength of concrete by animal bone powder and along with addition of Polypropylene fiber after 28 days.

Table 7 : Split tensile strength test result with replacement by animal bone powder (ABP) after 28 days .

Replacement of Cement in values by Animal bone powder(in %)	Split Tensile Strength (N/mm^2) H1	Split Tensile Strength (N/mm^2) H2	Split Tensile Strength (N/mm^2) H3	Average Split Tensile Strength (N/mm^2)
0	3.60	3.56	3.75	3.64
5	3.45	3.64	3.49	3.53
10	3.12	3.09	3.26	3.16
15	2.75	2.78	2.89	2.81

Table 8 : Split tensile strength test results with replacement by animal bone powder ABP along with addition of PPF after 28 days

Replacement of Cement in values by ABP (in %)	Replacement of Cement in values by PPF(in %)	Split Tensile Strength (N/mm^2) H1	Split Tensile Strength (N/mm^2)	Split Tensile Strength (N/mm^2) H3	Average Split Tensile Strength (N/mm^2)
5	1.5	4.25	4.48	4.29	4.34
10	1.5	3.56	3.52	3.71	3.60
15	1.5	2.88	2.91	3.03	2.94

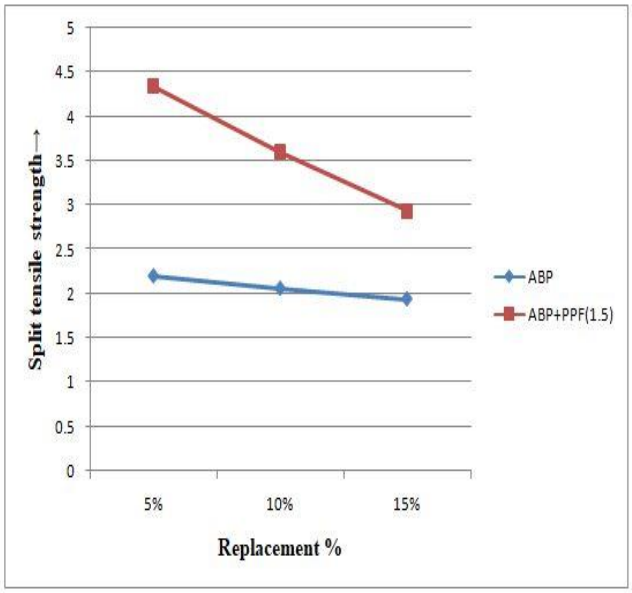

Fig 6. Comparison Graph Split tensile strength test results for replacement by animal bone powder (ABP) and replacement by animal bone powder(ABP) along with addition of PPF.

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VIII. CONCLUSION

- The replacement of cement with animal bone powder till 10% gives the best results for the strength.
- The strength of concrete decreases with the replacement percentage above 10%.
- The optimum percentage of cement replacement with animal bone powder is 10%. and that of polypropylene fiber is 1.5% for the both cylinder and cubes. If the replacement of the cement is above this percentage than the strength decreases with increase in percentage .
- Polypropylene fiber and animal bone powder are used for production of the concrete.
- Replacing cement with animal bone powder decreases the pollution because manufacturing of cement causes the air pollution.
- The maximum compressive and split tensile strength is for replacement of 10% of cement with animal bone powder and addition of 1.5% of polypropylene fiber by weight of cement.

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