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Experimental Study on Strength and Durability of Concrete By Partial Replacement of Cement, Fine And Coarse Aggregate using Corn Cob Ash, C&D Waste Recycled Sand and Bethamcherla Stone with Addition of Steel Fibers

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***Abstract*- Main objective of this project is to reduce the usage of cement, fine aggregate and coarse aggregate and improve the strength of concrete by using steel fibers. In this study we will investigate on the strength characteristics and durability properties of concrete with CORN COB ASH (CCA), CONSTRUCTION & DEMOLISION (C&D) WASTE RECYCLED SAND and BHETAMCHERLA STONE (BS) and addition of STEEL FIBERS. Replacement of CCA, C&D Sand and BS are about 0%, 5%, 10%, 15% and 20% respectively by weight of Cement, Fine Aggregate and Coarse Aggregate. The obtained optimum % of CCA, C&D Sand and BS are investigated. Then with that optimum % of CCA, C&D Sand and BS obtained are used to produce concrete.. Then the steel fibers will be added to the optimum % of CCA, C&D Sand and BS concrete and to conventional concrete in the % of 0%, 1%, 1.5%, and 2% by the weight of cement. Mechanical properties at 7,14,28 days will be investigated. Then investigations will be carried out for Percentage loss in compressive, split tensile and flexural strengths, Percentage loss of weights by considering the Durability tests such as acid attack test and alkaline attack test at the age of 28 and 90 days. The grade of concrete is M25.**

***Keywords:-* Corn Cob Ash (CCA), Construction &Demolision (C&D) Waste Recycled Sand , Bhetamcherla Stone (BS), Steel Fibers, Hydro Chloric Acid (Hcl), Sulphuric Acid (H2so4).**

I.INTRODUCTION

Concrete is a widely used man-made construction material. Concrete is manufactured by cementitious materials to bind themselves together, as well as with other materials to form a strong and solid mass. Cement industries releases huge amount of carbon dioxide during processes that effecting the environment and causing global warming And by large mining of river sand[fine aggregate], leads to decrease of water level present in the earth. For this reason, partially replacement of cement and fine aggregate with corn cob ash and c&d waste recycled sand.

In addition to this materials coarse aggregate is also been partially replaced with waste produced from bethamcherala floor slab cutting industry.Which can be used as a substitute for regular coarse aggregate. Using these materials will be bits of help in the reduction of the concrete cost.

So then the cement replaced with corn cob ash , river sand replaced with c&d waste recycled sand and coarse aggregate replaced with bethamcherala stone in concrete.

II. MECHANICAL PROPERTIES

Mechanical properties can be referred as calculation of strength obtained by the concrete at an interval of 7,14 and 28 days of curing. Investigations will be carried out for Percentage loss in compressive, split tensile and flexural strengths.

III. DURABILITY PROPERTIES

Durability properties of concrete can be referred as to with stand of chemical and weathering actions. Investigations will be carried out for Percentage loss in compressive strength after immersed in acid for 28 and 90 days.

IV. HISTORY OF REPACEMENT MATERIALS

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In India, Corn is the third most important food crops after rice and wheat. According to estimate, it is cultivated more than 10 m ha during Kharif season which covers nearly 75% area. The use of corn cob ash in concrete will reform the construction industry through cost savings. Pozzolona materials are being used to improve mechanical properties of cement mortar and concrete. The chemical composition of pozzolonas varies depending up on the source and preparation technique. Use corn cob ash (CCA) as a pozzolona, without considering its chemical properties in this study.

There is no written quantification of construction and demolition (C&D) waste being generated in India. Municipal Corporation of Vijayawada says that is collecting huge amount of C&D waste daily from the city which amounts to almost large tonnes of waste annually in the city of Vijayawada alone. C&D waste if recycled can significantly substitute the demand of natural sand by Vijayawada.

Bethamcherla waste stone aggregate which is used in this study is waste product from Bethamcherla floor slab cutting industry bought from Kurnool district . Bethamcherla is famous for the polish stones. The mine around Bethamcherla have stones in various colors like marble white, buff, joy, green etc. These stones are of 1 feet in size and will be used for enormous designs at home

V. PROPERTIES OF MATERIALS

Table 1. Physical Properties of cement.

S.no.	Property	Value Obtained
1	Specific Gravity	2.929
2	Fineness	6%
3	Normal Consistency	33%
4	Initial setting time	80 minutes
5	Final setting time	180minutes

Table 2. Physical Properties of Fine Aggregate.

S.no.	Property	Value Obtained
1	Specific Gravity	2.68
2	Fineness modulus	2.6
3	Grading zone	II

Table 3. Physical Properties of Coarse Aggregate.

S.no.	Property	Value Obtained
1	Specific Gravity	2.88
2	Fineness modulus	7.65

Table 4. Physical Properties of Corn Cob Ash.

S.no.	Property	Value Obtained
1	Specific Gravity	3.02
2	Fineness modulus	4%
3	Colour	Black

CORN COB FIREING CORN COB ASH
Fig 1.

Table 5. Physical Properties of C&D SAND.

S.no	Property	Value Obtained
1	Specific Gravity	3.4
2	Fineness	4.76%

C&D WASTE COLLECTION C&D SAND
Fig 2.

Table 6. Physical Properties of Bethamcerala Stone.

S.no.	Property	Value Obtained
1	Specific Gravity	3
2	Fineness modulus	8

BETHAMCERALA STONE
Fig 3.

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Table 7. Physical Properties of Steel Fiber.

S.no.	Property	Value
1	Aspect Ratio	80
2	Length	60mm
3	Diameter	0.75mm
4	Density	7900 Kg/mm^2

Table 8. Physical Properties of Water.

S.no.	Property	Value Obtained
1	pH	7

VI. MECHANICAL PROPERTY RESULTS

Cement is replaced with corn cob ash of about 5%, 10%, 15%, and 20% respectively and compared with nominal (M25) concrete mix(S).S1, S2, S3, S4 means replacement of CCA in 5%,10%,15% and 20% respectively.

Table 9. Compressive Strength of different mixes of Corn Cob Ash.

S.No.	Mix	Compressive Strength (N/mm2)		
		7 days	14 days	28 days
1	S	13.5	20	26.6
2	S1	23	26.4	28.6
3	S2	23.2	26.8	29.1
4	S3	21.2	24.2	26.2
5	S4	20.2	21.2	24.5

Fig 4. Steel Fibers

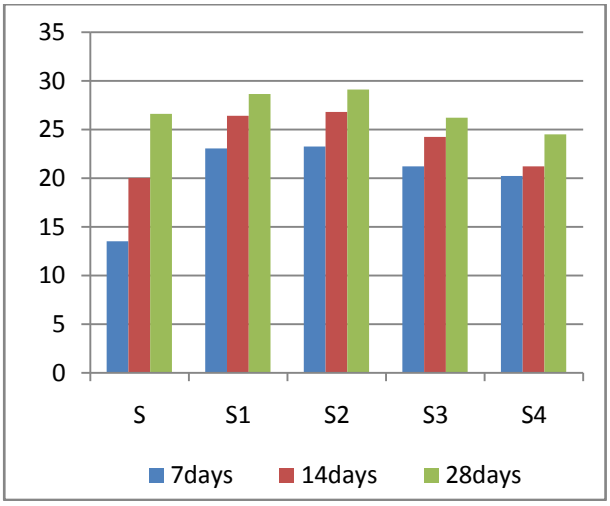

Fig 5. Graph Showing The Compressive Strength Of Table 7. Physical Properties of Steel Fiber.

Concrete With Partial Replacement Of Cement By CCA.

Table 10. Split Tensile Strength of different mixes of Corn Cob Ash.

S.No.	Mix	Split Tensile strength (N/mm2)		
		7 days	14 days	28 days
1	S	0.778	1.44	1.83
2	S1	1.4	2.2	3
3	S2	1.5	2.3	3.2
4	S3	1.2	1.8	2.9
5	S4	0.9	1.2	2.6

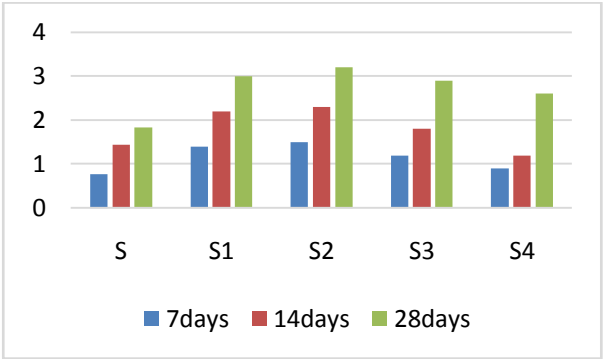

Fig 6. Graph Showing The Split Tensile Strength Of Concrete With Partial Replacement Of Cement By CCA.

Table 11. Flexural Strength of different mixes of Corn Cob Ash.

S.No.	Mix	Flexural Strength (N/mm2)		
		7 days	14 days	28 days
1	S	3	3.5	4
2	S1	2.1	2.8	3.5
3	S2	2.2	3.0	3.8
4	S3	1.8	2.5	3.2
5	S4	1.2	2.4	3.0

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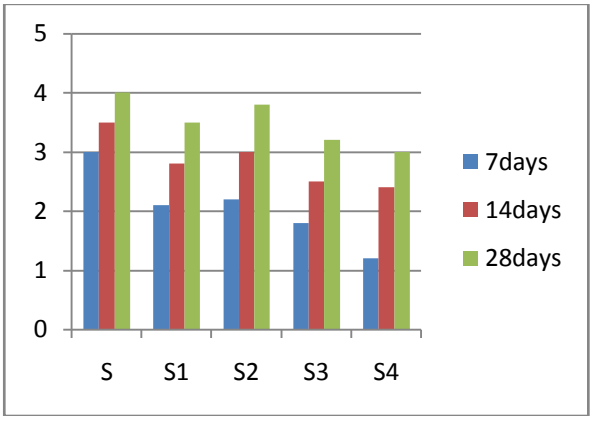

Fig 7. Graph Showing The Flexural Strength Of Concrete With Partial Replacement Of Cement With Corn Cob Ash.

Fine aggregate is replaced with C&D waste recycled sand of about 5%, 10%, 15%, and 20% respectively and compared with nominal (M25) concrete mix(S).
S5, S6, S7, S8 means replacement of C&D waste recycled sand in 5%,10%,15% and 20% respectively.

Table 12. Compressive Strength of different mixes of C&D Sand in F.A.

S.No.	Mix	Compressive Strength, (N/mm^2)		
		7 days	14 days	28 days
1	S	13.5	20	26.6
2	S5	22.6	25.2	27.2
3	S6	24.2	26.2	28.2
4	S7	23.2	25.3	27.2
5	S8	21.2	23.2	25.6

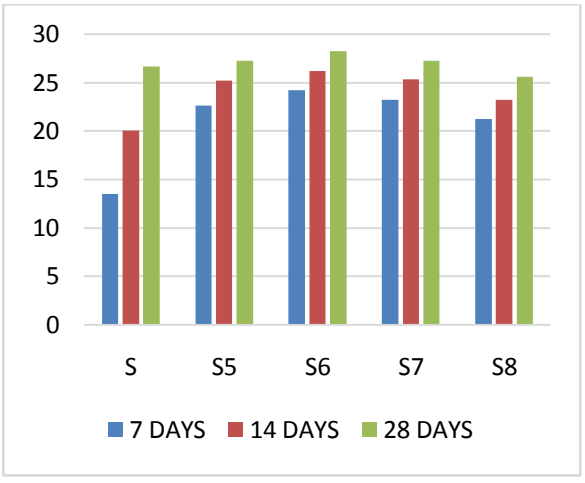

Fig 8. Graph Showing The Compressive Strength Of Concrete With Partial Replacement Of F.A By C&D Sand.

Table 13. Split Tensile Strength of different mixes of C&D Sand in F.A.

S.No.	Mix	Split Tensile strength, (N/mm^2)		
		7 days	14 days	28 days
1	S	0.778	1.44	1.83
2	S5	1.6	2.3	2.1
3	S6	1.8	2.5	3.2
4	S7	1.3	2.2	2.8
5	S8	0.9	2.0	2.3

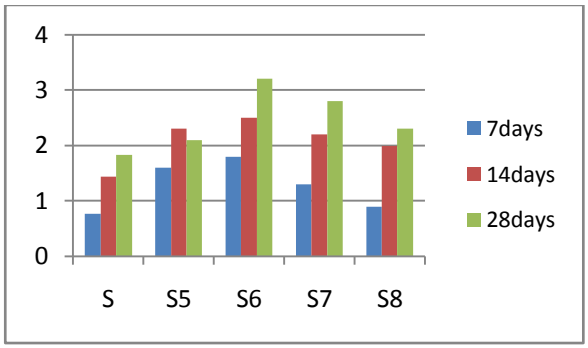

Fig 9. Graph Showing The Split Tensile Strength Of Concrete With Partial Replacement Of F.A By C&D Sand.

Table 14. Flexural Strength Of Different Mixes Of C&D Sand In F.A

S.No.	Mix	Flexural Strength, (N/mm^2)		
		7 days	14 days	28 days
1	S	3	3.5	4
2	S5	2.2	3.1	3.8
3	S6	2.3	3.3	3.9
4	S7	2.1	3.0	3.4
5	S8	1.8	2.4	2.9

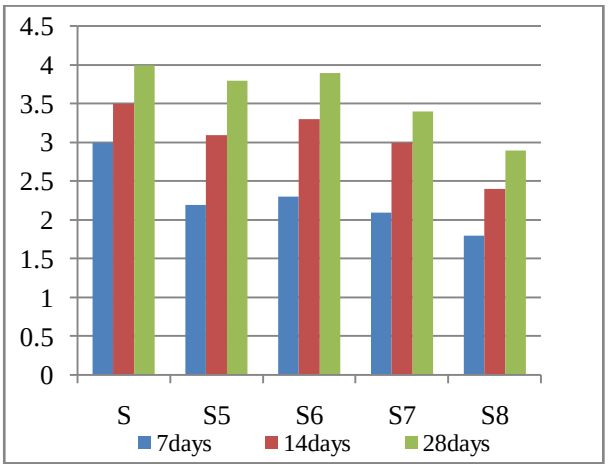

Fig 10. Graph Showing The flexural Strength Of Concrete With Partial Replacement Of F.A By C&D Sand.

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Coarse aggregate is replaced with Bethamcherala stone of about 5%, 10%, 15%, and 20% respectively and compared with nominal (M25) concrete mix(S).

S9, S10, S11, S12 means replacement of Bethamcherala stone in 5%,10%,15% and 20% respectively.

Table 15. Compressive Strength Of Different Mixes Of Bethamcherla Stone In C.A

S. No.	Mix	Compressive Strength, (N/mm2)		
		7 days	14 days	28 days
1	S	13.5	20	26.6
2	S9	23.2	26.2	27.2
3	S10	23.4	27.2	28.2
4	S11	24.2	28.2	29.3
5	S12	23.2	27.2	28.2

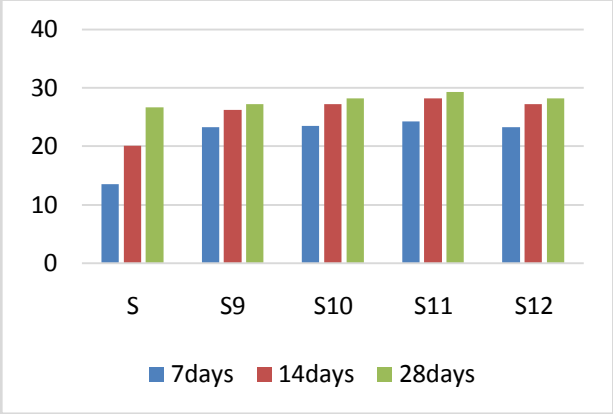

Fig 11. Graph Showing The Compressive Strength Of Concrete With Partial Replacement Of C.A By BS.

Table 16. Split Tensile Strength of different mixes of Bethamcherla Stone in C.A

S. No.	Mix	Split Tensile strength (N/mm2)		
		7 days	14 days	28 days
1	S	0.778	1.44	1.83
2	S9	1.2	2.2	2.8
3	S10	1.6	2.4	2.9
4	S11	1.8	2.6	3
5	S12	1.6	2.4	2.6

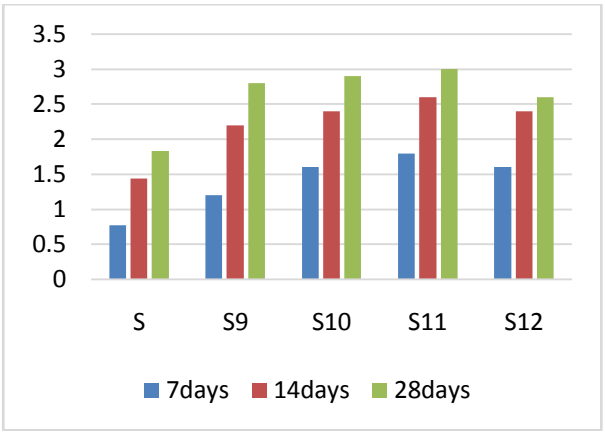

Fig 12. Graph Showing The Split Tensile Strength Of Concrete With Partial Replacement Of C.A By BS.

Table-17: Flexural Strength of different mixes of Bethamcherla Stone in C.A

S. No.	Mix	Flexural Strength, (N/mm2)		
		7 days	14 days	28 days
1	S	3	3.5	4
2	S9	2.62	2.8	3.2
3	S10	2.7	2.9	3.1
4	S11	2.72	3.0	3.3
5	S12	2.2	2.6	3.1

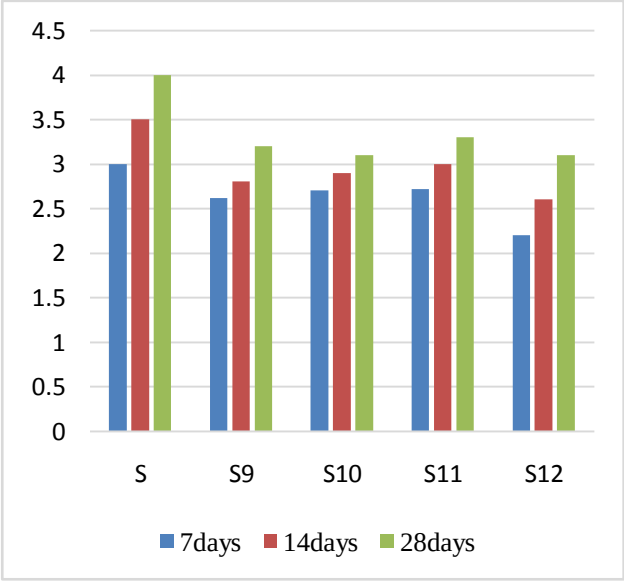

Fig 13. Graph Showing The flexural Strength Of Concrete With Partial Replacement Of C.A By B.S.

After getting the optimum values of every replacement materials another set of concrete is casted and tested with conventional mix(S).S13 means % replacement of CCA,C&D sand and BS in 10,10&15 by weight.

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Table 18. Compressive Strength of optimum % of replacement materials.

S. No.	Mix	Compressive Strength, (N/mm^2)		
		7 days	14 days	28 days
1	S	13.5	20	26.6
2	S13	24.2	27.2	30.1

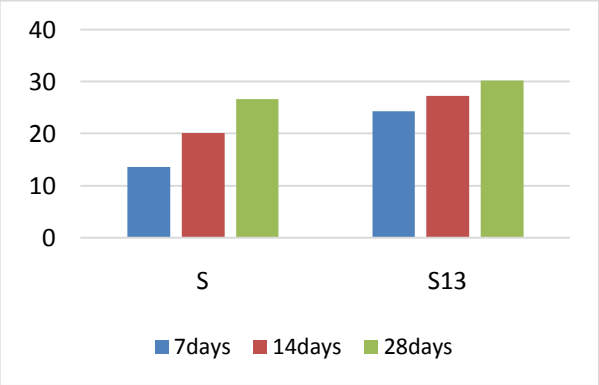

Fig 14. Graph Showing The Compressive Strength Of Optimum % Of Replacement Materials.

Table 19. Split Tensile Strength of optimum % of replacement materials.

S. No.	Mix	Split Tensile strength, (N/mm^2)		
		7 days	14 days	28 days
1	S	0.778	1.44	1.83
2	S13	1.8	2.4	3.4

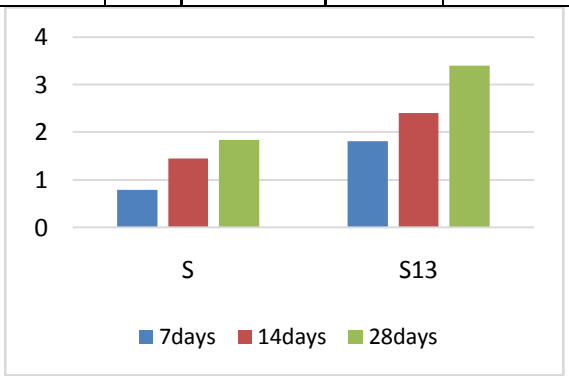

Fig 15. Graph Showing The Split Tensile Strength Of Concrete With Optimum % Of Replacement Materials.

Table 20. Flexural Strength of optimum % of replacement materials.

S. No.	Mix	Flexural Strength, (N/mm^2)		
		7 days	14 days	28 days
1	S	1.8	3.2	3.6
2	S13	3	3.5	4

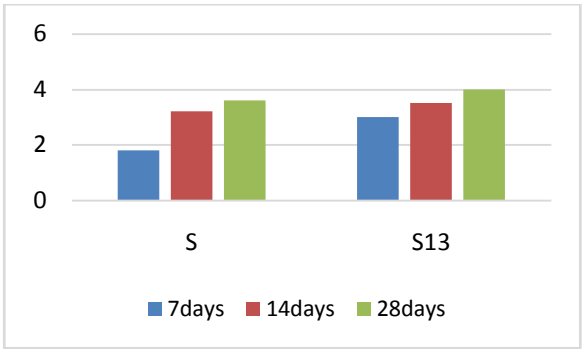

Fig 16. Graph Showing The flexural Strength Of Concrete With Optimum % Of Replacement Materials.

VII. ADDITION OF STEEL FIBERS

Steel fibers are added in 1, 1.5 and 2% to S13 noted as S14, S15 and S16. Test results are compared with S, S13 and optimum value is noted.

Table 21. Compressive Strength of % Addition Of Steel Fibers.

S. No.	Mix	Compressive Strength(N/mm^2)		
		7 days	14 days	28 days
1	S	13.5	20	26.6
2	S13	24.2	27.2	30.1
3	S14	25	28	30
4	S15	24	27.5	29.5
5	S16	26	29	31

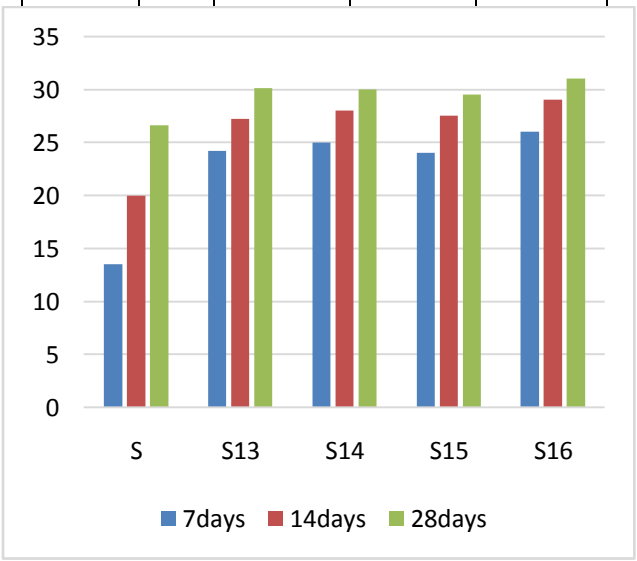

Fig 17. Graph Showing The Compressive Strength Of % Addition Of Steel Fibers.

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Table 22. Split Tensile Strength of optimum Of % Addition Of Steel Fibers.

S. No.	Mix	Split Tensile strength, (N/mm2)		
		7 days	14 days	28 days
1	S	0.778	1.44	1.83
2	S13	1.8	2.4	3.4
3	S14	2	2.6	3.6
4	S15	2.2	2.4	3.7
5	S16	2.4	2.8	3.8

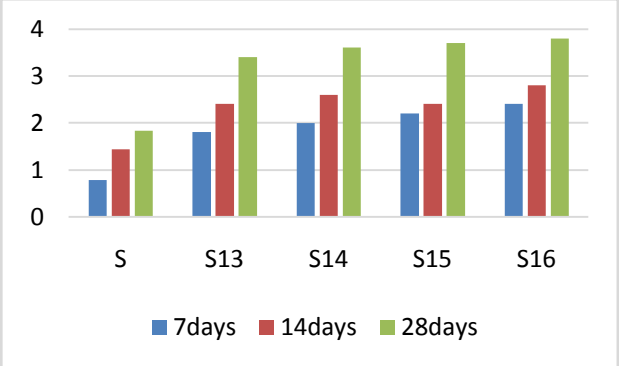

Fig 18. Graph Showing The Split Tensile Strength Of Concrete With % Addition Of Steel Fibers.

Table 23. Flexural Strength Of Optimum Of % Addition Of Steel Fibers.

S. No.	Mix	Flexural Strength, (N/mm2)		
		7 days	14 days	28 days
1	S	1.8	3.2	3.6
2	S13	3	3.5	4
3	S14	3.1	3.6	4.1
4	S15	3.3	3.8	4.3
5	S16	3.5	4	4.5

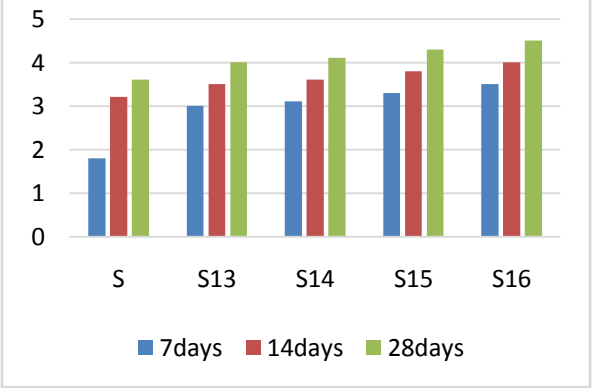

Fig 19. Graph Showing Theflexural Strength Of Concrete With % Addition Of Steel Fibers.

VIII. DURABILITY PROPERTY RESULTS

To check the Acid resistance of concrete Hydro Chloric acid (HCL), Sulphuric Acid (H2SO4) is selected. The concentrations of acids in water are taken as 2% & 4% to water and tested after 28 & 90 days of immersion.

HCL H2SO4

Fig 20.

Table 24. Compression Strength Results When Cubes Cured In 2% In HCL.

S. No	Mix	Compressive Strength, (N/mm2)	
		28 days	90 days
1	S	20	18.3
2	S13	22	20.2
3	S16	21.3	19.1

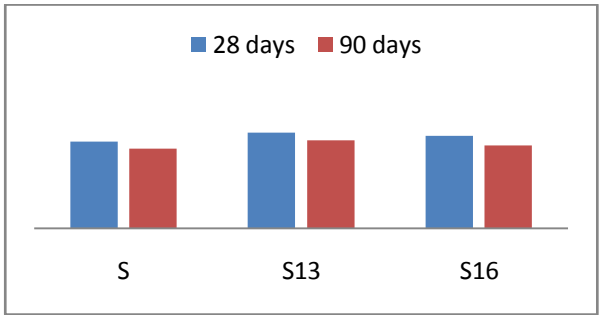

Fig 21. Graph Showing Compression Strength Results When Cubes Cured In 2% In Hcl.

Table 25. Compression strength results when cubes cured in 4% in HCL.

S. No	Mix	Compressive Strength, (N/mm2)	
		28 days	90 days
1	S	19	16
2	S13	21	19.4
3	S16	20	18

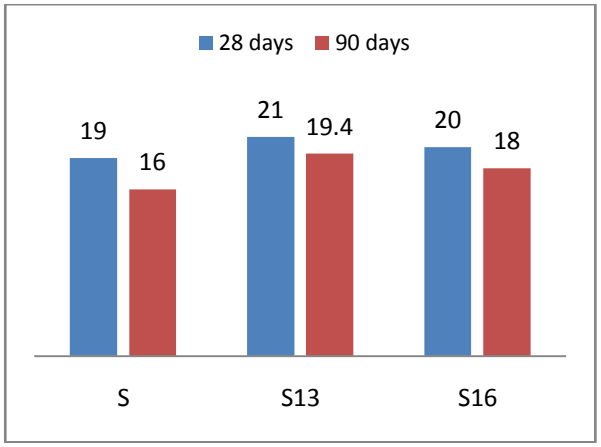

Fig 22. Graph Showing Compression Strength Results When Cubes Cured In 4% In Hcl.

Table 26. Compression Strength Results When Cubes Cured In 2% In H2SO4.

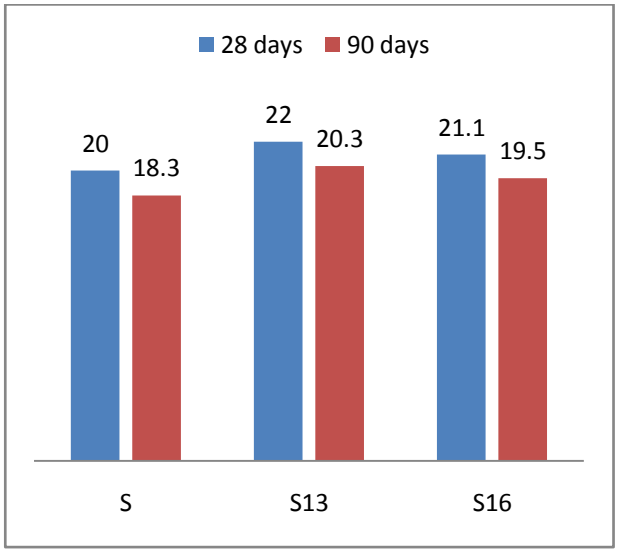

Fig 23. Graph Showing Compression Strength Results When Cubes Cured In 2% In H2SO4.

Table 27. Compression Strength Results When Cubes Cured In 4% In H2SO4.

S. No	Mix	Compressive Strength, (N/mm2)	
		28 days	90 days
1	S	19	16
2	S13	21	19
3	S16	20	18.5

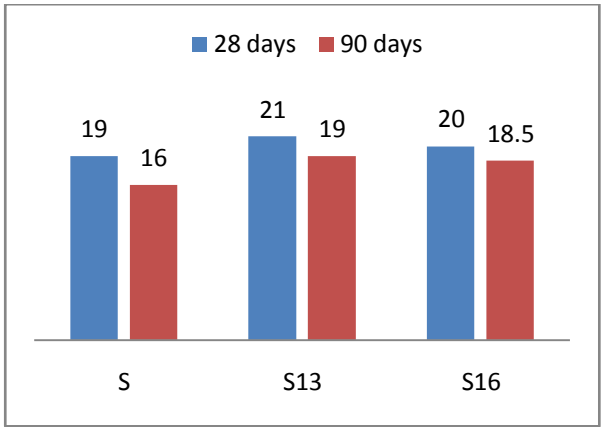

Fig 24. Graph Showing Compression Strength Results When Cubes Cured In 4% In H2SO4

IX. CONCLUSION

S. No	Mix	Compressive Strength, (N/mm2)	
		28 days	90 days
1	S	20	18.3
2	S13	22	20.3
3	S16	21.1	19.5

It is found that there is increase in compressive, split tensile and flexural strength at 10% partial replacement of cement by CCA when compared to normal concrete.It is found that there is increase in compressive, split tensile and flexural strength at 10% partial replacement of F.A by C&D sand when compared to normal concrete.It is found that there is increase in compressive, split tensile and flexural strength at 15% partial replacement of C.A by B.S when compared to normal concrete.It is found that there is increase in compressive, split tensile and flexural strength when all replacement materials are replaced at a time and compared to normal concrete.It is observed that maximum values for tests where found when 2% of steel fibers are added compared to normal mix and replacement mix.

The durability study shows that strength of concrete will be decreased while the steel fibers % is increasedIn durability study at 2% and 4% HCL for 90 days curing the strength will be decreased up to 6 to 8 %.In durability study at 2% and 4% H2SO4 for 90 days curing the strength will be decreased up to 5 to 7 %.Finally the replacement materials we have taken in this study can be used for construction practice because there is no major difference in strength and durability properties compared to normal concrete.

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