Experimental Study on Behaviour of Concrete by Partial Replacement of Cement by Ceramic Waste with Sisal Fiber

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Abstract

Concrete is the generally used construction material which requires large quantities of natural resources of available cement, coarse aggregate, fine aggregate. As the wide usage of concrete may leads to increase in cost of resources an alternate material can be used as limited substitution of fine aggregates, coarse aggregates, cement or as admixtures in concrete. In this project experimental investigations are conducted as to minimize the budget for concrete and environmental degradation. In my work, experiments have been conducted by replacing cement with ceramic waste powder in varying percentages and using sisal fiber as an admixture. Recycling of ceramic waste by incorporating them into building materials is a practical solution for problems too. In this project, cement replacement is done by ceramic waste up to 40% along with adding up of sisal fiber. The cement replacement is done at percentages of 10%, 20%, 30 % and 40% by ceramic waste powder and addition of sisal fiber 0.5%, 1%, 1.5% and 2% respectively. The design Mix used for the project is M30 grade with W/C Ratio being 0.45.The Conventional concrete made by replacing cement with ceramic waste powder and adding sisal fiber as admixture concrete specimens were casted and loaded for values of compressive strength ,flexural strength and split tensile strength for 7, 28, 56 and 90 days.
Keywords: Sisal Fiber, Concrete, Ceramic Waste

I. INTRODUCTION

Concrete is the frequently used construction resource which has quantities of cement, fine aggregate, coarse aggregate mixed with certain amount of water which hardens in time. As concrete can be casted in desired shape and due its high strength and stability it is well used instead of brick and stone masonry. Fiber reinforced concrete includes suitable fiber material along with cement, fine aggregate and coarse aggregate. Fiber can be known by a factor known as “Aspect Ratio”. Aspect Ratio can be defined as the proportion of length to its diameter. By using natural fibers it offers advantage of waste diminution and resource protection.

The benefit of adding fibers is, it will increase the features of concrete such as tensile strength, impact strength, durability and shrinkage properties. They also help in controlling shrinkage cracks and reducing bleeding of water .Many inspections are done to revise the properties of reinforced concrete due to the addition of naturally available fibers. Natural fibers are those which are formed naturally by plants, animals and mineral sources. This idea of using naturally available fibers for increasing the strength, durability is not at all new. Sisal fiber is a natural fiber which is generated from the leaves of sisal plants.

II. LITERATURE REVIEW

In this particular study which was done by Abdul rahuman and saikumar yeshika in the year 2015, they have studied the various strength properties and the workability of sisal fiber reinforced concrete with varying percentages of sisal fiber in different concrete mix. This study includes two different concrete mixes i.e., M20 and M25 with varying percentages (0.5%, 1%, 1.5%) of sisal fibers. They observed that there is an increase in compressive and tensile strengths at 1.5% addition of sisal fibers for both M20 and M25 mixes. The maximum strength values are 50.53% increase in compressive strength and 3.416% increase in tensile strength for 1.5% adding of sisal fiber for M20 mix and 52.51% increase in compressive strength and 3.904 % increase in tensile strength for 1.5% adding of sisal fiber for M25 mix have been recorded.:

This study was carried out Gollapalle priyankarani in the year 2015 in which the properties of reinforced concrete by adding up different proportions of sisal fiber (0.5%, 1%, 1.5%, 2%, 3%) in M20 grade mix. She concluded that the flexural, compressive and tensile strength are kept on increasing and the maximum strength values are attained at 1.5% addition of sisal fiber and further addition of sisal fiber causes decrease in the strength values.

This study was done by K.V.Sabarish et al. in the year 2017 in which investigation of the strength and durability of sisal fiber reinforced concrete was done. He compared workability of different mix of concrete by increasing the addition of sisal fiber and has noted that workability has improved about 29% without polymer. Later he observed raise in compression, tensile and flexural strengths as 13%, 15.5%, 12% respectively which have the optimistic contact on sisal fiber composite in the attendance of normal rubber latex polymer.:

This observation is done by P.Satish et al. in the year 2016 in which partial replacement of cement is done by GGBS in the sisal reinforced concrete. The cement is replaced at percentages of 10%, 20% and 30% by the slag and a constant 1% of sisal fiber is added to the concrete mix of M30 grade. The optimum value of replacing cement with ground granulated blast furnace slag is observed at 20%.

This study was done by M.Aruna in the year 2014. She initially studied the mechanical behavior such as tensile strength and hardness of sisal fiber reinforced cement composite slabs with 1%, 2%, and 3% addition of sisal fiber were evaluated. The sisal fiber concrete specimens shows their compressive strengths as 21.36, 19.76 and 20.62 N/mm2 with 1, 2, 3% fiber content. Hence with increasing the amount of fiber added there is a decrease in compressive strength is observed.

Kanchidurai S et al. (2017) has carried out experimental studies on sisal fiber reinforced concrete with Groundnut Shell Ash. In his work, GSA replacement for cement is 0, 5, 10, 15 and 20% and SFR is added for each set percentage of GSA as 1, 2, and 3% by its weight.Na_2CO_3 treatment was carried out to reduce the potential deterioration of SF. It is recommended upto 10% of replacement of cement by GSA and 2% addition of SF provides optimum values.

A.R.Pradeep, M.I.Basava Lingana Gowda (2016) has conducted an experimental study on the effect of ceramic fine aggregate on the partial replacement of sand in percentages of 10 & 20%. They observed that with increase in percentage of ceramic fine aggregate there is decrease in flexural, compressive & split tensile strength.

Hitesh Kumar Mandavi(2015) has presented the result of an experimental study carried out in which ceramic tiles was used as a partial replacement of sand in range of 10 to 50% at an interval of 10 percent. Optimum replacement level of fine aggregate with ceramic waste is 40%.

G.Siva Prakash et al.(2016)done experimental study on the mechanical strength properties of M25 grade concrete with the partial replacement of sand by using ceramic waste at 10%, 20%, 30%, 40% & 50%.They concluded that replacement of 30% ceramic waste to sand can be considered as optimum percentage for M25 grade concrete.

Utkarsh Singh Chandel et al.(2017) has studied the properties of M30 grade concrete with partial replacement of fine aggregate with waste ceramic tiles at 10%, 20%, 30% & 40%. They observed changes in flexural, split tensile & compressive strengths.

III. RESULTS AND DISCUSSIONS

A number of tests are done to the concrete samples so that to know the values of strengths of the concrete members in which replacement of cement is done by using ceramic waste powder and concurrently adding sisal fiber in different proportions. The investigational analysis values are mentioned in the tables below and are graphically represented so as to illustrate the compressive strength, flexural strength and split tensile strength of concrete

A. *Compressive Strength:*

As per IS 516-1959, the compressive strength values are demonstrated by carrying out tests in the compression testing machine in two different curing periods being 7 and 28 days and are tabulated.

Table - 4.1
Compressive strengths for simultaneous replaced cement with ceramic waste and adding sisal fiber for different percentages at the curing period of 7, 28, 56 and 90 days

Cube codes	*Ceramic waste %*	*Sisal fiber %*	*7 Days*	*28 Days*	*56 Days*	*90 Days*
A	*0*	*0*	*29.5*	*30.2*	*31.3*	*32.6*
B	*10*	*0.5*	*42*	*48.9*	*47.7*	*46.2*
C	*20*	*1.0*	*21.4*	*33.5*	*30.6*	*32*
D	*30*	*1.5*	*19.5*	*25.3*	*22.2*	*23.5*
E	*40*	*2.0*	*15*	*22.3*	*19.3*	*20.6*

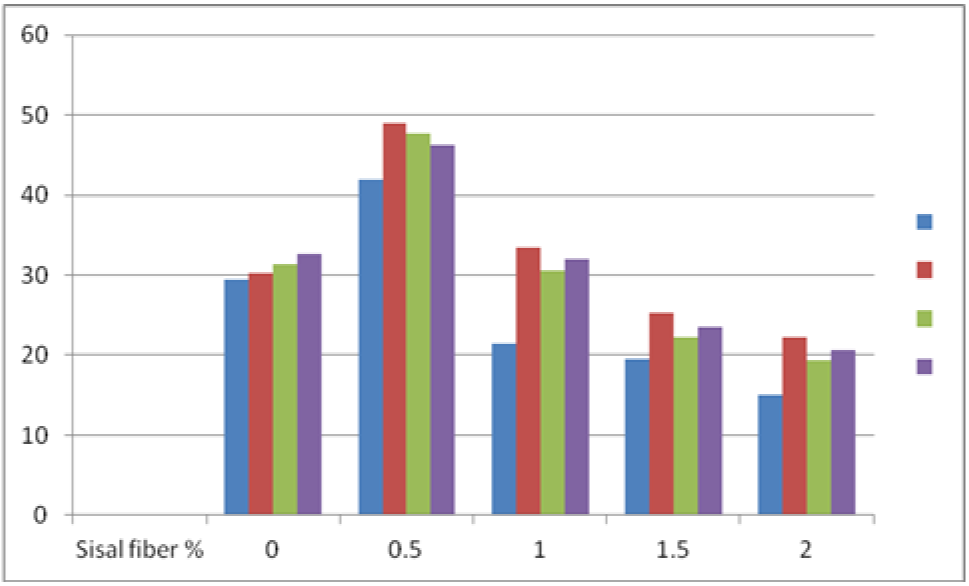

Fig. 1: Compressive strength graph with varying percentages of sisal fibers for 7, 28, 56 and 90 days

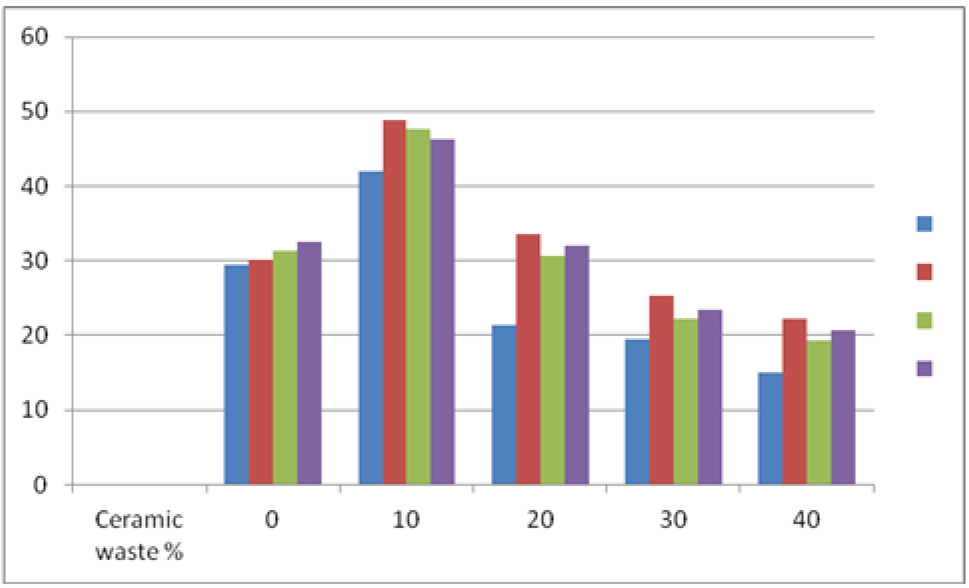

Fig. 2: Compression strength graph with varying percentages of ceramic waste for 7, 28, 56 and 90 days

B. Split Tensile Strength:

As per IS 516-1959, the split tensile strength values are demonstrated by carrying out tests in the compression testing machine in two different curing periods being 7 and 28 days and are tabulated.

Table - 4.2
Split tensile strength values for simultaneous replaced cement with ceramic waste and adding sisal fiber for different percentages at the curing period of 7, 28, 56 and 90 days

Set	Ceramic waste %	Sisal fiber %	7 Days	28 Days	56 Days	90 Days
A	0	0	3.16	3.45	3.64	3.86
B	10	0.5	2.6	3.28	4.12	4.97
C	20	1.0	1.83	2.9	3.5	4.15
D	30	1.5	0.66	1.5	2.3	3.4
E	40	2.0	0.23	0.98	1.34	2.56

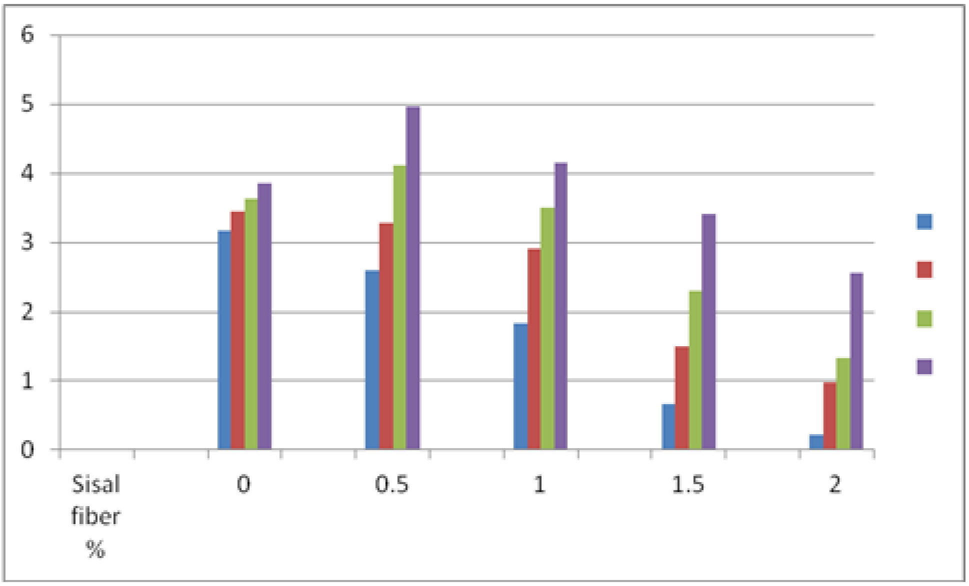

Fig. 3: Split tensile strength graph with varying percentages of sisal fibers for 7, 28, 56 and 90 days

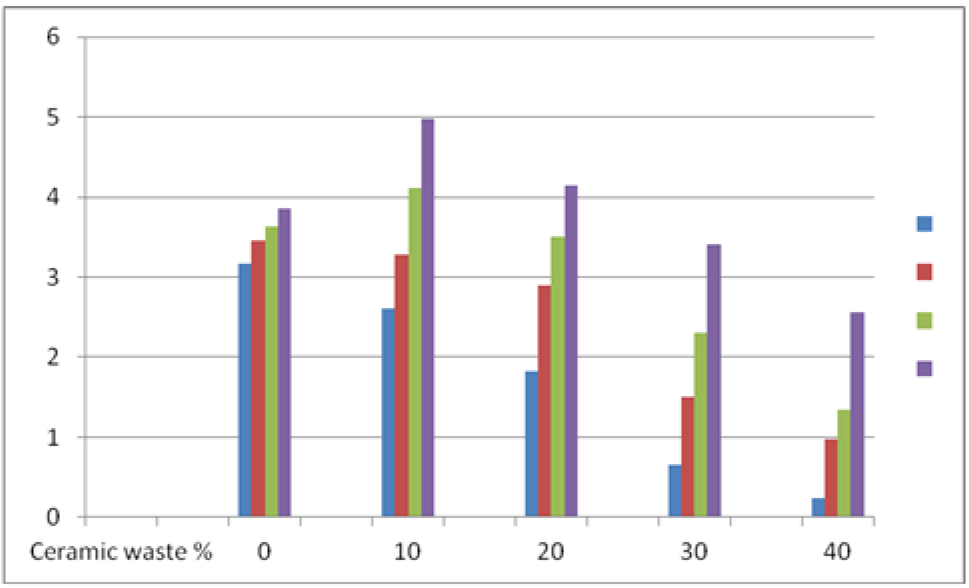

Fig. 4: Split tensile strength graph with varying percentages of ceramic waste for 7, 28, 56 and 90 days

C. *Flexural Strength:*

As per IS 516-1959, the flexural strength values are demonstrated by carrying out tests in the compression testing machine in two different curing periods being 7 and 28 days and are tabulated.

Table - 4.3
Flexural strength for simultaneous replacement of cement with ceramic waste and addition of sisal fiber for different percentages at the age of 7, 28, 56 and 90 days

Set	*Ceramic waste %*	*Sisal fiber %*	*7 Days*	*28 Days*	*56 Days*	*90 Days*
A	*0*	*0*	*3.27*	*3.43*	*3.68*	*3.82*
B	*10*	*0.5*	*3.80*	*4.34*	*4.87*	*5.32*
C	*20*	*1.0*	*3.46*	*4.08*	*4.64*	*5.08*
D	*30*	*1.5*	*1.96*	*2.78*	*3.65*	*4.32*
E	*40*	*2.0*	*0.69*	*1.65*	*2.43*	*3.54*

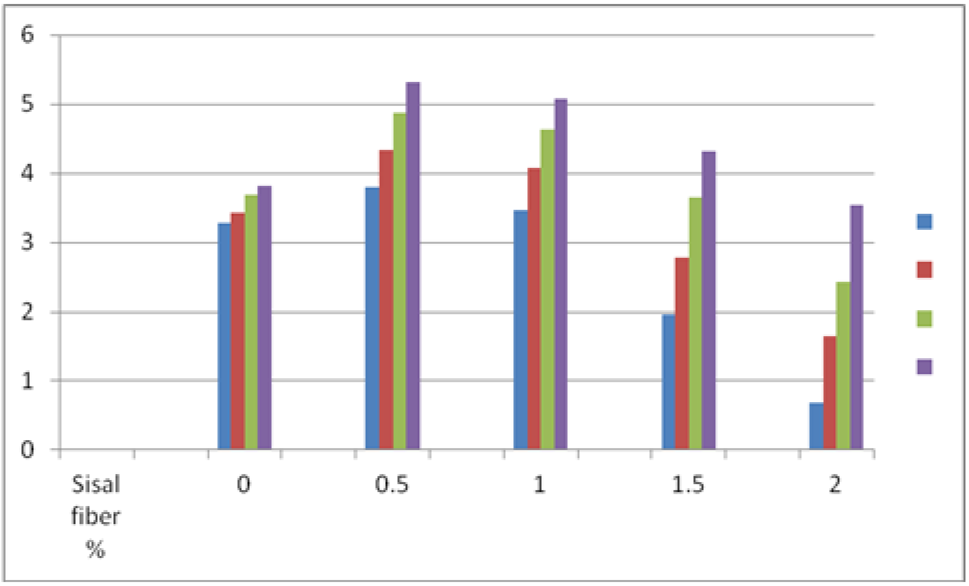

Fig. 5: Flexural strength graph with varying percentages of sisal fiber for 7, 28, 56 and 90 days

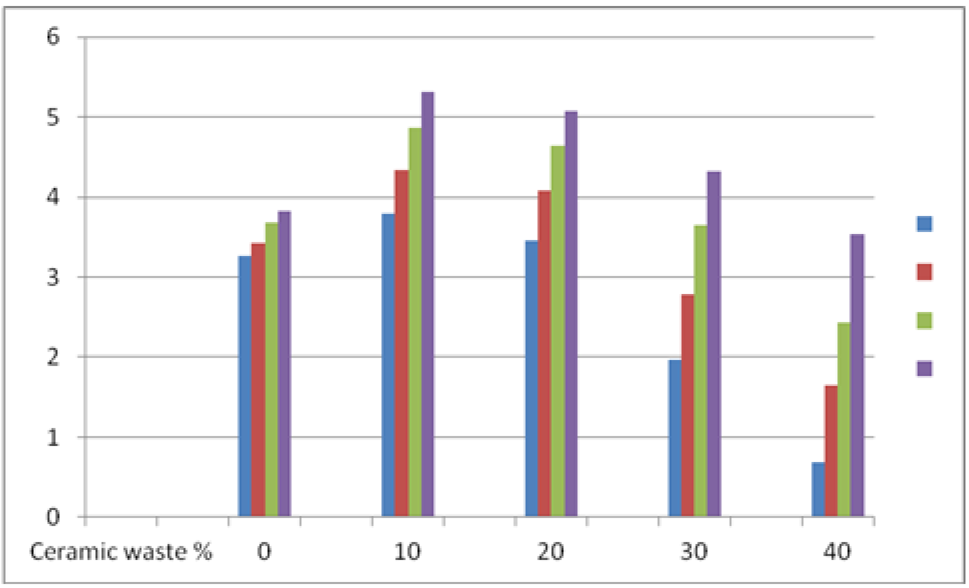

Fig. 6: Flexural strength graph with varying percentages of ceramic waste for 7, 28, 56 and 90 days

- The compressive strength of concrete in which 0% to 40% replacing of cement is done by ceramic waste and concurrently 0% to 2% addition of sisal fiber of 28 days has achieved the objective mean strength at 10% of ceramic waste and with 0.5% addition of sisal fiber and further increase in replacing the cement with that of ceramic waste and adding sisal fiber there observed a reduce in strength from Table-4.2.
- The split tensile strength of concrete in which 0% to 40% replacing of cement is done by ceramic waste and concurrently 0% to 2% addition of sisal fiber at the age of 28 days has achieved objective mean strength at 10% of ceramic waste and 0.5% of sisal fiber. Further increase in replacement of ceramic waste there will be reduction in strength observed in Table-4.4.
- The flexural strength of concrete in which 0% to 40% replacing of cement is done by ceramic waste and concurrently 0% to 2% addition of sisal fiber at the age of 28 days has achieved the objective mean strength at 10% of ceramic waste powder and 0.5% of sisal fiber. Further increase in replacement of ceramic waste and addition of sisal fiber there will be reduction in strength as observed in Table-4.6. This proves that with 10% replacing of cement with ceramic waste and 0.5% addition of sisal fiber shows better results.
- The concrete of grade M30 has an increase in strength by replacing cement with ceramic waste powder up to 25% and using sisal fiber as admixture and supplementary replacing cement by constitutes decrease the compressive strength.
- Utilization of sisal fibers and its applications are used for the development of the construction industry, material sciences.

IV. Conclusions

- The maximum compressive strength is obtained at the curing period of 28 days by 10% replacing cement with ceramic waste and concurrently 0.5% addition of sisal fiber.
- The split tensile strength of concrete in which 10% of cement is replaced with ceramic waste and concurrently 0.5% addition of sisal fiber has maximum mean strength at the age of 28 days.
- The flexural strength of concrete in which 10% of cement is replaced with ceramic waste and concurrently 0.5% addition of sisal fiber has maximum strength at the age of 28 days.

Hence the use of 10% ceramic waste in concrete and using 0.5% sisal fiber as admixture gives the optimum values of strength.