EXPERIMENTAL STUDY ON THE BEHAVIOUR OF CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITHCERAMIC WASTE IN ADDITION OF 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, and 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 of10%, 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*: Ceramic waste, Sisal fiber**

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CHAPTER-I

INTRODUCTION:

1.1 GENERAL:

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.

Ceramic waste in general is the waste related to tile, ceramic and sanitary waste produced during manufacturing process, polishing and dressing. It is actually available in a powder form. Ceramic waste is replaced in place of ordinary Portland cement used in concrete as it improves the toughness of concrete. Ceramic waste can be replaced by concrete in many different ways. In this work cement is partly replaced by the ceramic waste.

1.2 Raw Materials

1) Cement
2) Aggregates
   a) Fine aggregate
   b) Coarse aggregate
3) Ceramic waste
4) Sisal fiber

1.2.1 CEMENT:

Cement is normallyobtainable in powdered form which is a matter used mostly in construction fields. Cement is a substance which can sets, hardens and binds easily with other materials. Cement can be roughly characterized into hydraulic and non – hydraulic cements. Hydraulic cements are that which set and hardens in the attendance of water. Whereas non-hydraulic cements can be strengthened in absence of water i.e., in dry conditions.

The main raw materials for the manufacture of cement are calcareous and argillaceous materials. The final product of cement will in grey color which is obtained by finely grinding the raw materials, mixing and then burning in a kiln. The chief raw materials are admixture of high calcium limestone which imparts cementing properties. In some cements, blast furnace slag may be used and that cement can be as Ordinary Portland cement (OPC). Due to presence of iron oxide, the color is granted to the cement. In the nonattendance of impurities, the color mightbe white but for the check of quality of cement, color is not a factor. Specific gravity test can be done as the check for quality of cement. The specific gravity of cement must be at least 3.10. Ordinary Portland cement (OPC) of grade 53 was used for the research.

In the present world,the majorityuses cement asbuildingsubstance. Concrete mix consists of cement, aggregates (fine and coarse) and water. For constructional works concrete mix is used extensively than any other man discoveredresources on the earth.The binding gel will be formed by proper reaction of cement with water that unite other elements together and creates hard rock type material. The wholeprocedure is termed as 'hydration' in which concrete will be strengthened in existence of water. In this process a few amount of lime $Ca(OH)_2$ along with binding gel is also released. The coarse and fine aggregate acts as space filler in theconcrete. The strength of concrete can be knowbyquantity of cement adopted and the ratio of water to cement content in the concrete mix. There are numerousfactors which limit the measure of cement and proportion of water-cement content to be used in a concrete.

Great amount of heat is liberated while the process of hydration is carried out. When the cement quantity increases, the heat discharge will be greater which leads in distress to concrete.Whenthe process of hydration is donewith time, lime is releasedgradually. The major portions of this liberated lime remain unemployed surplus and craft concrete absorbent where a small quantity is used toupholdthe pH of concrete. The high grade cement has higher CIS hence liberatesuperior amount of excess lime regularly in advanced porosity in the concrete. Further, with elevated content in heat of hydration, water content and porosity increase the vulnerability of concrete mass when it is out to a variety of exterior and interiorviolentsurroundings.

Fig 1.1 CEMENT

1.2.2 Types of Cements:
The different types of the cements normallypresented in the market are:
Ordinary Portland Cement 33 Grade (as per IS: 269-1989 Reaffirmed 2004)
Ordinary Portland Cement 43 Grade (as per IS 8112-1989 Reaffirmed 2005)
Ordinary Portland Cement 53 Grade (as per IS: 12269-1987 Reaffirmed 2004)
Portland Pozzolana Cement fly ash bused (as per 1: 1489-1991-part-1 Reaffirmed 2005)
Portland Pozzolana Cement calcined clay based (as per IS: 1489-1991-part-2 Reaffirmed 2005)
Portland Slag Cement (as per IS: 455-1989 Reaffirmed 2005)
Ordinary Portland Cement(OPC 33 grade, 43 grade and 53 grade)
Ordinary Portland Cement(OPC 53 grade)
OPC is formed by familiarly by proper mixing of calcareous and argillaceous and other materials containing alumina iron oxide and silica composition. Further cement is burned in a kiln atcertain temperature and crushing the ensuing cement residue with chemical mostly gypsum there by creating cement able tosatisfythe IS specifications. The different grades of Ordinary Portland cement are due to its compressive strength at 28 days.

1.2 SISAL FIBER:
Sisal fiber is a naturally available fiber which is retrieved from the vegetation of sisal plants. It is well adopted natural fiber which can be used as admixture in concrete as it is easy to cultivate. To improve different strength characteristics such as better quality structure and sustainability this material is preferred. Using this fiber in concrete has exposed no corrosion of a concrete mass. To shapethese sisal fiber leaves are dried out, brushed and baled. Concrete mixture contains of cement, fine and coarse aggregate and water in whichwater and cement act as binding materials and the aggregates are useful for repairing holes. This concrete will betough in compression and 8 to 10 percentage weedy in tension which was early discussed by Abdul Rahuman and Sai Kumar Yeshika (2015). As providing reinforcement in concrete improves its possessions and fiber reinforcement havefor all time been adopted which is capable as strengthening of cement .Sisal fibers are used in production ofstring rope and also dartboards. The chiefintend of bring in the fibers is to seize the cracks which may beformed due to application of loads by force on the crack countenance. It will not permit the cracks to extendanymore and thus establishes a little crack circulationcondition. The fiber is regularlyexpressed by suitable numerical limitation called 'Aspect Ratio'. It is the proportion of the length of fiber to the least lateral dimension of the same fiber.

PROPERTIES OF SISAL FIBER
- Thepreservation of this fiber is easy,negligible wear and tear.
- Eco-friendly.
- Does not draw or entrapdirtparticle.
- Do not attractdampness or wet easily.
- Due its fine quality it can be dyed easily.
- To catch up fire the leaves should be pampered with borax.
- It exhibits good resistance qualities.

Fig 1.2 SISAL FIBER

Chemical proportions	percentage
Cellulose	65
Hemicelluloses	12
Lignin	9.9
Waxes	2
Total	100

Table 1.1 CHEMICAL COMPOSITION OF SISAL FIBER

Sisal fiber belongs toAgava group. It is scientifically termed as Agave sisalana. Thissubstance is preferred to develop the strength, durability and also reduces the weight of concrete. It can be employed in automobile engineering and fiber glass in compound materials.

1) Specific Gravity 1.35
2) Tensile strength 348 to 375 N/mm^2
3) Density 1.25 g/cm^3

1.3 Aggregates

The chief materials used for the manufacturing of mortar and concrete, aggregates are the resources used as filler material. They are manufactured from blast furnace sing andare the resultant from igneous, sedimentary and metamorphic rocks. The main structure to the concrete is given by the aggregate which decreases the contraction and resultchange in financial system. 70-80%amount of the concrete is engaged by these aggregates and hasconsiderablecontrol on the characteristics of the concrete. A check on the quality and the type of the aggregate used should be carried out before using in mix. They mustbe supposed to be durable, strong, tough, and clean with suitable grade size to accomplishtremendous economy from the concrete mix. Former aggregates were measured as chemically active and also certain type reveals chemical bond at the interface of the aggregates and cement paste. To boostup the bulk density of concrete, aggregates are mainlydifferentiated in two evident sizes in which the superior one known as coarse aggregate and the minor one known as fine aggregate (sand). The coarse aggregate will shape the majormedium of concrete where as the fine aggregate form the packingmediumamid the coarse aggregate. The utmost size of the coarse aggregate adopted during this project is 20mm while the minimum being 4.75mm.

1.3.1 Fine Aggregate

River Sand

In this development the fine aggregate was used which was a dirt free and hygienic river sand which is fleeting through 4.75 mm sieve and having specific gravity up to 2.60. This fine aggregate belongs to zone II satisfying the Indian Standard specifications. Fine aggregate (sand) is agathering of granules of mineral mass resulting from the breakdown of rock. It is notable from gravel only by the mass of the granules or elements, but is different from clays which include organic resources.

Mainly the Sand is obtained by dividing and getting separated from the organic resources due to the act of wind on the land sources which has relatively homogeneous size of grains.Generallymarketable sand is achieved from river bed or from sand banksformerlyproduced by the motion of winds. A large amount of the earth's exterior contains sand, and these sands are regularly quartz and supplementary siliceous resources. The majorityvaluable commercial sands are silica sands frequently about 98% pure. However, beach sands are even, circular to overlaid elements from the harshstroke of tides and waves and are open to organic material.

The white beach sands contain for the most part silica but mightas well be of zircon, monazite, garnet and additional minerals which are useful for removea variety ofrudiments.Sand size greater than 0.07mm is adopted as a fine aggregate in mortar and concrete. The Sand which is used for mix design is generally the silica sand in granular form and is termed as normal sand as per IS: 650. In India, Ennore sand is normally used sand and in UK it is Leighton buzzard sand. The typical sand is obtained in areas of Ennore, Tamilnadu. The sand should be quartz, slight gray or whitish color in variety and should be openby deposits.

Fig 1.3 FINE AGGREGATE(SAND)

1.3.2 Coarse Aggregate

Coarse aggregate may be obtained from uncompacted, compacted or incompletely compactedstone or gravel the majority of which is hold on 4.75 mm sieve. These are rigid, tough, thick, strong, apparent and open from layer and supportervarnishand also free from harmful amount of crumbleportions, alkali, organic materials and additionaltoxic substances.Crumbling and extended aggregate must be kept away fromthe mix.

Fig 1.4 COARSE AGGREGATE

1.4 CERAMIC WASTE:

The manufacturing of tiles and floor coveringsengenders ceramic waste powder while the finishing and the polishing process are continued. During the polishing process, required quantities of water are used hence the obtained ceramic waste material will be in wet state. The ceramic waste powder which contains asymmetric and angular particles thus obtained will be in similar to cement particles in texture. Every year Indian industries produce about 100 Million tons of ceramic waste.

About 15-30% material generated from the ceramic industries will be neglected as waste during the total production. The generated waste is left beside without recycling to any form at present. The ceramic industries are discardingthese waste materials into any nearby hollow or availablevacant or empty spaces;close to their entityeven thoughwarned areas have been noticeable for dumping. The ceramic waste will be hard, tough and extremely resistant to chemical, biological and physical deprivation. By depositing of waste in vacant lands it leads to huge occupation of useful empty areas, dust pollution and severe environmental problems particularly when the wet waste got dried up. Hence it is important to dispose the ceramic waste properly without damaging the existing peaceful environment.By reusing the ceramic waste powder in the construction industry the above discussed problems can be encountered. As the ceramic waste produced is increasing day by day, there is a stress on ceramic industries to find a solution for its proper disposal.

Fig 1.5 CERAMIC WASTE

1.5 NECESSITY OF THE WORK:

The main spotlight of present researches is recycling of waste material or by product from developed industries, which can be replaced totally or partially in place of cement, sand or as an admixture in concrete, without negotiation on its desired strength. The necessities for introducing concrete along with ceramic waste are the same as that of placing the ordinary concrete. It is essential that all concrete should be completelycompressed to ensure long-standing durability.

Due to its structural stability, steadiness and strength for any type of structureor model concrete is the most adopted construction material than many other existing materials. Hence it exhibits high durability, mechanical properties, workability and less cost concrete is the most accepted building material in the human race. However the manufacturing of cement releases greenhouse gases, chiefly CO_2 which is being accountable for regarding 5% of worldwide anthropogenic CO_2production in the world. Ceramic waste is hard and possessesbrilliant durability characteristics. It reduces the heat of hydration of cement.

Sisal fiber has been proposed as an admixture because it gives additional benefit to concrete. By the use of fibers, there will be extensive increase in strength, the behavior of existing post – cracking and increase in degree of ductility. The occurrences ofcracks, whether simple or multiple cracks depends on the strength properties of the fibers themselves, the ductility of fibers, bond between matrix and fiber interface, volume of the fiber reinforcement and its spacing, the orientation and dispersion of the fibers and aspect ratio and shape.

1.6 OBJECTIVE OF THE WORK:

The main intend of the study is to recognize how the incompletesubstitution of cement with ceramic waste powder and addition of sisal fiber as an admixture influences the concrete. The changeable factors measured in this study are concrete grade of M30 and curative periods for 7 and 28 days of the concrete sample. Ceramic waste powder has been physically and chemically characterized and replaced partially in the ratio of 10%, 20%, 30%and 40% bythe weight of cement for mix and sisal fiber is added in the ratio of 0.5%, 1%, 1.5% and 2%.

The parameter investigated is how the strength characteristics of ceramic waste powder replaced concrete cubes, cylinders and beams changes with respect to time in days. The test results regarding to hardened concrete like compressive strength and Split tensile strengths at the age of 7 and 28 days are carried out and flexural strength for 28 days are obtained.

1.7 SCOPE OF STUDY

The scope to study is to executes a good environment with sustainable structures and non-hazardous structures for the human life and not to release much waste from construction field and to improve the life time of the structure used for industrial purposes and also and to maintain maximum strength for a natural co-ordinate system of work and to help the production of material for which we are constructing in the field and to satisfy the needs of construction works.

We have used the admixtures like sisal fiber and ceramic waste powder in our project so as to maintain the strength in concrete and use of remaining wastes which are produced from the industries not to pollute the environment and using them for construction purposes so as to improve the structural stability. This project analyzes the strengths of ceramic waste which is replaced in content of cement in the concrete and sisal fiber as admixture.

CHAPTER –II

LITERATURE REVIEW

2.1 GENERAL:

In thissection, theinvestigation has been done on using ceramic wastein place of cement and sisal fiber as admixture inthe concrete has been reviewed.

Comparison of strength properties of different concrete mix:

In this particular study which was done by Abdul rahuman and saikumaryeshika 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 M25with varying percentages (0.5%, 1%, 1.5%) of sisal fibers. They observed that there is a 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.

Study on the properties of reinforced concrete due to addition of varying proportions of sisal fiber:

This study was carried out Gollapallepriyankarani 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.

Comparing the workability of concrete with and without the presence of polymer:

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 optimisticcontact on sisal fiber composite in the attendance of normal rubber latex polymer.

Obtaining the properties of sisal fiber reinforced concrete by partially replacing the cement by Ground Granulated Blast Furnace Slag:

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%.

Strength factors of sisal fiber reinforced concrete composite slabs:

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.

Sisal fiber reinforced concrete(Groundnut Shell Ash):

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.

Study on the effect of ceramic fine aggregate on the partial replacement of sand:

A.R.Pradeep, M.I.BasavaLinganaGowda (2016) has conducted a 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.

Experimental study using ceramic waste tiles as partial replacement of sand:

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 a interval of 10 percent. Optimum replacement level of fine aggregate with ceramic waste is 40%.

Mechanical strength properties of M25 grade concrete with the partial replacement of sand by using ceramic waste:

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.

The properties of M30 grade concrete with partial replacement of fine aggregate with waste ceramic tiles:

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.

CHAPTER-III

EXPERIMENTAL INVESTIGATION

3.1 INTRODUCTION

The toughened concrete testing plays avital role in the concrete structures. Main significant properties of concrete include the compressive strength. In this chapter we deal with the mix design with various extents, the process of preparing cubes for different curing periods in UTM to find the compressive strength.

In the currentinvestigationalresearch, ceramic waste has been used forreplacing of cement and sisal fiber assupplementarycomponent in the concrete mixes. The result of totalingdifferent proportions of ceramic waste and sisal fiber assupplementary material to concrete mixto find the results of compressive strength is studied.

Now days the amount of ceramic waste which is producedfrom the ceramic industriescauses asignificanteffect on the mankind and environment. Sisal fiber is the natural fiber from tree which is eco friendly. By adding fibers in concrete tensile strength can be increased to the concrete, as using steel fibers it is not economical so sisal fiber can be preferred as an alternative fibers to steel fibers as sisal fibers are eco friendly too.

3.2MATERIALS

3.2.1 Cement:

In this investigation the locally available Portland cement of grade 53 is used. Today the Portland cement is the majority andusually used sort of cement on the planet. Care should be taken and it should be stored in airtight equipment so the check on the cement can be maintained which is to be free from being affected by the dampness, atmospheric and wetness. As per IS: 12269-1987, the cement mix is experienced to determine the physical and chemical requirements in concurrence with IS: 4032-1977.The particulars are shown in the table2 .The cement belongs to a grade of 53.

3.2.1 Chemical properties of Cement

Material composition	Weight in percentage
CaO	63.49
SiO_2	21.25
Al_2O_3	4.75
Fe_2O_3	4.30
MgO	1.02

Table 3.1 Chemical properties of Cement

3.2.2 TESTS ON CEMENT:

The cement was obtained in solitarybatch and appropriatelypreserved. Ordinary Portland Cement of 53 Grade was adopted.

The following gives the details of the field tests:

a) The cement should look greenish in color. There should not be any presence of plump.
b) The cement should offersoftsensation when rubbedamidst the fingers.
c) It should give a cool feeling when a hand is thrust into a cement bag.
d) If a handful of cement is thrown in water, the cement should float for a few minutes before it sinks.

The laboratory tests conducted are:

a) Fineness
b) Normal consistency

c) Specific Gravity

3.2.3FINENESS OF CEMENT

The important factor for determining the rate of hydration is the fineness of cement itself and further it used to obtain the rate of evolution of heat and also the rate of gain of strength. To offer greater surface area for hydration finer cement is used and hence the quicker and better the development strength raise in fineness of cement ,it is also set up to raise the dying concrete. Either by sieving or by determination of specific surface air-permeability apparatus fineness of cement is tested. The total surface area of all the particles in gram of cement is called specific surface.IS-90 micron sieve conforming to IS 460-1965 is used.

Using fingers air set lumps in the cement sample are to be flattenedand the sieves are to be used to press mortar. By holding the sieve in two hands cautiously the sieving shall be gradually done and with moderate wrist movement. All through the sieving constantturning round of the sieve shall be carried out.

1) Weight of cement taken on the sieve =100gms
2) Weight of residue after sieving =3gms
3) Percentage of fineness = (3/100) *100
= 3%

- Fineness of cement sample = 3%

3.2.4 NORMAL CONSISTENCY OF CEMENT

The standard consistency of a cement paste can be defined as the consistency which will allow the vicat plunger to penetrate to a depth of 5 to 7 mm from the bottom of the vicatmould. Firstly the quantity of water which may be adopted for the concrete mix must be fixed so that it is helpful to determine the values of initial and final setting time along with this compressive strength and soundness of cement can also be determined. Hence by using the vicat apparatus we can discover the measure of required water for a cement paste with usual consistency.

S.NO	Percentage of added Water	Quality of added water (ml)	Vicat's plunger reading in mm
1	28	84	24
2	30	90	31
3	32	96	33

Table 3.2 USING VICAT APPARATURES `CONSISTENCY OF CEMENT

The standard consistency of cement is 32%.

3.2.5 SPECIFIC GRAVITY OF CEMENT

For calculations in correlation with cement concrete design work, specific gravity of cement is required, to resolve the moisture content and for calculation of volume yield of concrete.

Where W1 = weight of empty flask.
W2 = weight of water + bottle.
W3 = weight of bottle + diesel.
W4 = weight of bottle + cement + diesel.
W5= weight of cement

Fig 3.1 SPECIFIC GRAVITY BOTTLES

1.	Weight of empty bottle,	W1 gm	69.8	69.8	69.8
2.	Weight of bottle+ water,	W2 gm	193	190	192
3.	Weight of bottle+ kerosene,	W3 gm	172	171	173
4.	Weight of bottle+ cement+ kerosene,	W4 gm	216.2	215	217.5
5.	Wt of cement,	W5 gm	25	25	25
6.	Gravity of kerosene	(W3W1)/(w2-w1)	0.84	0.84	0.83
7.	Sp. Gravity of cement, S=W5(W3-W1)/((W5+W3-W4)(W2-W1)		3.15	3.14	3.15
	Average specific gravity of cement = 3.15				

Table 3.3 SPECIFIC GRAVIITY OF CEMENT

3.2.6 Initial and Final Setting Time of Cement

In order to place the concrete block in position suitably, it is essential that the initial setting time of cement is not too rapid and after it has been laid, hardening should be quick so that the structure can be made use of as early as possible.

Initial Setting Time:

Firstly place the test block below the vicat's needle andbring down the needle slowly until it will be in contact with the surface of the test block and from there release it rapidly. Now permit the needle so thatit penetrates into the test block.

In the commencement, the needle will entirelypenetrate through the test block. But after some time when the paste initiates to lose its plasticity, the needle will penetrate only to a depth of 33-35mm from summit. Now stop the clock.

Final Setting time:

To determine the final setting time restore the needle of vicat apparatus by the needle with an annular connection. The cement is measured finally set when the needle which penetrated gently to the surface of test block; the needle makes an impression there on, while the attachment can't do so.

Observation and calculation:

Weight of cement = 400gm.

(Size of cement particle passing 75µsize)

Needle area dimension of 50mm=1mm long.

Gauging time =2-3min

P = 32%

Quantity of water = 0.85P x weight of cement = [(0.85 x 32)/100]x 400g=108.8ml.

Trails	1	2	3	4	5	6	7	8	9	10	11
Min Time	0	5	10	15	20	25	30	35	40	45	50
Initial Reading mm	40	40	40	40	40	40	40	40	40	40	40
Final Reading mm	0	0	0	1	2	2	3	3	4	5	6
Difference (might not penetrated) 'mm'	0	0	0	39	38	38	37	37	36	35	34

Table 3.4: Initial and Final Setting time of Cement

Result: Initial setting time of cement = 60min.
Final setting time of cement = 5 Hrs.

S.NO	Properties /Characteristics	Test results	Requirements as per IS 12269-1987
1.	Normal consistency	32%	---
2.	Setting time Initial setting time Final setting time	60minutes 240minutes	Not less than 30 minutes Not more than 60 minutes
3.	Specific gravity	3.15	---
4.	Fineness of cement by sieving through sieve no.9 (90 microns)for a period of 15min.	3.0%	<10%
6.	Compressive strength of cement (28 days)	55Mpa	53 Mpa

Table 3.5- Physical Properties of Portland Cement (53 grade)

3.3 Chemical properties of SISAL FIBERS:
The chemical composition of sisal fiber is explained briefly below

Materials	Sisal fibers (%)
Cellulose	65
Hemicelluloses	12
Lignin	9.9
Waxes	2
Total	100

Table 3.6 Chemical properties of SISAL FIBERS

3.4Aggregate
Aggregates are the imperative ingredient in concrete. They offer body to the concrete by reducing the shrinkage and have a lesser economy. For providing efficient workable concrete, high-quality gradation of aggregates is the main vital factor. High quality grading includes a limited section of aggregates in essential percentage such that the samples hold least amount of voids. So samples of the high quality graded aggregate have least voids and so it involves least amount of paste to seal up the emptiness in the aggregates. Minimum paste implies fewer quantities of cement and water, which are responsible for amplified economy, higher durability, minor shrinkage and greater strength.
The properties of the aggregates are significant lyprejudiced in the concrete; since they dwell in about 80% of the whole volume of the concrete. The aggregate can be categorized as

- Fine aggregate
- Coarse aggregate

3.4.1 (a) Fine aggregate:
The locally available river sand is usually adopted as fine aggregate in the present investigation. The river sand which is passed through 4.75 mm sieve and retained on 600 µm sieve, belonging to Zone II as per IS 383-1970 is adopted as the fine aggregate in the currentrevise. The sand should be open from silt, organic impurities and clay.As per IS 2386-1963, the adopted sand must be tested for determining various characteristics such as bulk density and specific gravity etc.These test values are tabulated in form of a table. Sieve analysis is also carried out and the results are shown in table. The fine aggregate be conventional to standard specifications.

3.4.1 Specific Gravity Test and Water Absorptions
Specific gravity for any type of aggregate can be described as the ratio between the weights of a given volume of sample to the weight of equal volume of water at the same tense temperature. To carry out the all the calculations related to the cement and

concrete designing work, specific gravity of fine aggregate is required in general. And also todeterminethe moisture content and also for calculating the volume yield of concrete the specific gravity test is very essential.

Fig. 3.2 Specific gravity of Fine Aggregate

Specific gravity:	Trail 1	Trail 2	Trail 3
Weight of the empty pycnometer (W1g)	600	600	600
Weight of pycnometer + water (W2g)	1463	1463	1463
Weight of saturated surface dry (W3g)	1127	1124	1126
Weight of pycnometer + water + Fine aggregate(W4)	1788	1786	1788
Bulk specific gravity= (W3-W1) / [(W2-W1)-(W4-W3)]	2.61	2.60	2.61

Table 3.7: Specific Gravity of Fine Aggregates

Water Absorptiorn:	Trail 1	Trail 2	Trail 3
Weight of the tray +saturated surface dry F A (W5)g	1605	1589	1602
Weight of tray + oven dry Fine Aggregate (W6)g	1600	1585	1598
Weight of empty try	1070	1065	1068
Percentage of water absorption	0.94	0.76	0.75

Table 3.8 Water Absorption of fine Aggregates

Bulk specific gravity = W3/(W3-(W4-W2)) = Average value= 2.61
Percentage of water absorption = (W5-W6/W6-W7) X100 = Average value = 0.82%
Result: specific gravity of the fine aggregate is 2.64
Percentage of water absorption is 0.82%.

3.4.2 Fineness modulus of sand:

Fineness modulus is just defined in a numerical value to give a clear idea about the mean size of the material sand used in the total quantity of aggregates adopted. Hence determiningthe fineness modulus may be judged as a useful method for standardization and to know the gradation of the aggregates.

S.NO	I.S.Sieve No.	Weight retained (gm)	Cumulative weight retained (gm)	Cumulative percentage retained	Cumulative Percentage passing
1.	10mm	0	0	0	100
2.	4.75mm	8	8	0.8	99.2
3.	2.36mm	36	44	4.4	95.6
4.	1.18mm	88	132	13.2	86.8
5.	600µ	274	406	40.6	59.4
6.	300µ	500	906	90.6	9.4
7.	150µ	90	996	99.6	0.4
TOTAL					249.2

Fineness modulus, $(\sum F)/100 = 249.2/100 = 2.49$

S.No	Property	Test Result
1.	Specific Gravity	2.61
3.	Fineness Modulus	2.49
4.	Zone	II

Table 3.10 Properties of Fine Aggregate

3.4.3 (b) Coarse aggregate:

Generally the coarse aggregate will be adopted from any accessible sourceusually being 20mm in supposed size to be used from the crushed sharp granite metal from the machineries. It should be open from contaminated mass such as organic matter, dust particles and clay etc. The aggregate will undergo tests required to judge their physical properties such as fineness modulus, gradation, bulk density&specific gravity etc. But as per IS: 383-1970 and IS: 2386-1963 the coarse aggregate will also beexperienced to different teststo know its various properties.

Fineness Modulus of Coarse Aggregate:

Fineness modulus is just defined in a numerical value to give a clear idea about the mean size of the material aggregate used in the total quantity of aggregates adopted. Hence determining the fineness modulus may be judged as a useful method for standardization and to know the gradation of the aggregates.

S .No.	I.S. Sieve No.	Weight Retained (gms)	Percentage weight retained	Cumulative Percentage Retained	Percentage Passing
1.	40mm	0	0	0	100
2.	20mm	850	17.00	17.00	82.46
3.	10mm	4092	81.84	98.84	0.76
4.	4.75mm	58	1.16	100.00	0
5.	2.36mm	0	0	100.00	0
6.	1.18mm	0	0	100.00	0
7.	600µ	0	0	100.00	0
8.	300µ	0	0	100.00	0
9.	150µ	0	0	100.00	0
Total				715.84	

Table 3.11Fineness modulus of coarse aggregate

Fineness modulus= 715.84 / 100 = 7.15

3.4.4 Specific Gravity and Water Absorption

Specific gravity for any type of aggregate can be described as the ratio between the weights of a given volume of sample to the weight of equal volume of water at the same tense temperature. To carry out the all the calculations related to the cement and concrete designing work, specific gravity of coarse aggregate is required in general. And also to determine the moisture content and also for calculating the volume yield of concrete the specific gravity test is very essential.

Coarse Aggregate	Trail 1	Trail 2	Trail 3
Weight of saturated agg..suspended in water wire basket (W1g)	3290	3293	3291
Weight of empty wire basket while keeping in water (W2g)	1882	1880	1881
Weight of saturated surface dry aggregate (W3g)	2080	2082	2082
Weight of oven dry aggregate (W4g)	2040	2040	2040
specific gravity = W4/W3-(W1-W2)	2.67	2.65	2.65
Average specific gravity	2.65		
Percentage of water absorption = (W3-W4/W4) X100	0.19	0.2	0.2

Table 3.12 Specific gravity and Water absorption of coarse aggregate

Result:

Specific gravity = 2.65.

Percentage of water absorption = 0.2%.

S.No	Property	Test Result
1	Specific Gravity(G)	2.85
2	Fineness Modulus	7.17

Table 3.13 Properties of coarse aggregate

3.5 CERAMIC WASTE:

Ceramic waste is usually the wastage related to tile, ceramic & sanitary waste produced during manufacturing process, polishing and dressing. It is actually available in powdered form.

Properties:

The chemical properties and physical properties of ceramic wastewill be obtained by testing the samples as per Indian standards.

3.3 Chemical properties of Ceramic waste

Materials	Ceramic waste powder(%)
SiO_2	63.29
Al_2O_3	18.29
Fe_2O_3	4.32
CaO	4.46
MgO	0.72

Table 3.14 Chemical composition of ceramic waste

MIX DESIGN:

IS METHOD (as per IS 10262: 2009)

Design requirements:

Characteristics compressive strength (Fck)	- 30 N/mm^2
Maximum size of aggregate	- 20mm
Degree of workability	- 0.86 compaction factor
Degree of quality control	- Good
Type of exposure	- very severe
Type of compaction	- Vibration
Type of aggregate	- Crushed angular aggregate

Test data for materials:

Type of cement or Grade of cement	- OPC 53 grade
Specific gravity of Cement	- 3.15
Specific gravity of sand	- 2.60
Specific gravity of coarse aggregate	- 2.65
Bulk density of sand	-1600 kg/m^3
Fineness modulus of sand	- 2.49
Minimum cement content	- 320 kg/m^3
Maximum water cement ratio	- 0.45
Grading zone of sand	- Zone II
Workability	- 50-100 (slump)

Design of concrete mix:

1. Target mean strength (fck1)

Fck1 = fck +1.65S

Where S = 5 N/mm2 from table 1 of IS10262:2009.

Fck1 = 30 + 1.65x5 = 38.25Mpa.

2. Selection of Water cement ratio

Adopting water cement ratio =0.43 < 0.45

Hence ok

3. Estimation of Water content

From table 2, IS 10262:2009

Maximum water content for 20mm aggregate = 186 liters

Estimated water content for 100mm slump = 186+ (6/100) x 186

= 197liters.

As Super plasticizer is being used, the water content can be reduced by 25%.

Therefore **watercontent** = 0.75x197 = **147.75litres**

4 Calculation of cement content

Water cement ratio = 0.43

Cement content = 147.75/0.43 = **343.6 kg/m3**> 320 kg/m^3

Hence ok.

5 Proportion of volume of coarse and fine aggregate content

From table 3, IS 10262:2009, the volume of coarse aggregate corresponding to 20mm size aggregate and fine aggregate (Zone II) for the w/c ratio of 0.5 = 0.62

In the present case w/c ratio = 0.43

Therefore volume of coarse aggregate is required to be increased to decrease the fine aggregate content.

As the w/c ratio is lowered by 0.06, the proportion of volume of coarse aggregate is increased by 0.01(at the rate + or - 0.01 for every + or – 0.05 change in the w/c ratio)

For Pump able concrete this value should be reduced by 10%

Therefore, volume of **coarse aggregate** = 0.62 + (0.06/0.05)x0.01 = **0.633**

So, Volume of **fine aggregate** = 1- 0.633 = **0.367**

MIX CALCULATIONS:

A. Volume of concrete = **1 m^3**

B. Volume of cement = {(mass of cement)/ (specific gravity of cement) } x (1/1000)

= (343.6/3.15)x 0.0001 = 0.109 m^3

C. Volume of water = {(mass of water)/ (specific gravity of water) } x (1/1000)

= (147.75/1) x 0.0001 = 0.147 m^3

D. Volume of all aggregates = {A- (B+C)} = {1 – (0.109+0.147)} = 0.738m^3

Mass of coarse aggregate = D x (volume of coarse aggregate x specific gravity of coarse aggregate) x 1000 = 0.738x0.633x2.65x1000= 1237.9 kg/m^3

Mass of fine aggregate = D x (volume of fine aggregate x specific gravity of fine aggregate) x 1000 = 0.738x0.367x2.6x1000= 704.1 kg/m^3

MIX PROPORTIONS:

Cement	Fine aggregate	Coarse aggregate	W/C ratio
343.6	704.1	1237.9	147.75
1	2.04	3.6	0.43

Table 5.1 Mix proportions by weight

After conducting trail mixes for both methods the resulting proportions are compared and an average trail mix is used for casting

THE AVERAGE MIX PROPORTIONS OF TRAIL MIX:

Cement	Fine aggregate	Coarse aggregate	W/C ratio
343.6	702.2	1239.9	147.75
1	2.04	3.6	0.43

3.6 Water:

In the concrete mix, most vital and less costly ingredient is water. Fresh filtered water does not contain organic matter and oily matter is adoptable in the concrete mix and it helps in distributing the cement and other substances evenly. The pH value should not be less than 6. The w/c ratio will control the quantity of water to be added to the mix which is the widely noticeable factor and it improves the lubricant nature of the mix. When the amount of water is properly mixed with the concrete, the below mentioned possessions are noticed.

There will be increase in workability and the economy which will increase the reliability and the quality of the mix along with this there will be decrease in strength, cohesion, and durability. Here for both the purpose of curing and mixing Potable water is used. The results are the permissible limits for solids.

3.7 PREPARATION OF TESTING SPECIMENS:

3.7.1 Sampling of Material

Sampling process involves preparing a test sample of the materials which shall be used in the proposed construction work so as to check the quality of the materials. There will be different test samples prepared for each different materials used for in case of cement the test samples will be made by taking a little portion from each numbers of bag in the site. Test samples of aggregate will be made by taking a little portion from each numbers of bags in the site. Test samples of aggregate will be made by takingbiggerheaps by quarter weights.

3.7.2 Preparation of Materials

All the materials which will be used in the construction works must be bring to room temperature 270 ± 30C ahead ofinitiation of the tests. After arriving at the laboratory the cement material should be mixed well by hand or through proper mixer so that it gives good mixture with high possibility of attaining uniformity and blending nature to the mixture. Proper care should be taken to avoid formation of lumps in the mix and to eliminate the entry of any foreign substance. The storage of cement must be done carefully in a dry place or in containers which are free from entry of air.Concrete and its aggregatesamples of each batch should be well graded and must be stored in dry condition.

3.7.3 Proportioning

Proportioning step includes employing correct proportions of materials used in the concrete mix. The required quantities of cement, aggregates and water which are used to provide a good mix must be calculated properly. Depending upon the grade of the mix the proportions of the materials can be calculated. No material must be added more than the proportional limit because it may not give the good mix for the proposed work.

3.7.4 Batching

To measure the quantity of material weighing is the appropriate method which can be carried out. Using thisweighing method in batching amenitiessimplicity, flexibility and accuracy. The weigh batches are obtainable in various forms. In small constructions, the weighing is done by using equipment which has two weighing buckets in which each one is connected to a levers system which gives the load applied on the equipment by the spring action of dials presented. The buckets are rotated by a spindle placed in the center of the equipment about their own axis. As a resultwhen one bucket is loaded the another bucket will discharge the material present in it to the concrete mixer. This method is widely used for small works. On the other hand the large constructions, the weighing equipment containing weighing buckets are used. This is feed from a hugeover head storage hopper and it rejects the material by gravity, straight in to mixer.

3.7.5 Measurement of water

The amount of water used in the concrete mix is the most important factor to be considered. Based on the water cement ratio the calculated water must be added to the mix. If water addition is more than the measured quantity these will cause dilution of the paste there by decreasing the strength of the mix and it is responsible for developing shrinkage cracks more effectively. If there is more excess water present in the mix it will be bleed out of the surface causing the failure of the structure. In other hand if water added is low then the water cement ratio the materials will not bind properly causing cracks and ultimate failure of the structure. Thus the measurement of the quantity of the water in the mix must be done properly.

3.7.6Mixing of concrete

The mixing of the Concrete can be done by hand but mostly it is done by a batch mixer so that all materials will be mixed well without any spilling or loss. The quantities of material should be at least 10 percent extra in every batch because there will be in loss of some material while mixing ormaking cubes, as materials get stick to the surface of mixer the extra material should be adopted.The every batch of the concreteshould be mixed in a non-absorbent platform and water resistant area with trowel, shovel or by comparableappropriateequipment by the procedure mentioned below.

1) Firstly cement and fine aggregate should be mixed well without any presence of water until mix is systematicallycombined and uniform color is obtained.

2) The coarse aggregate is now added to the well combined mixture of cement and fine aggregate and now the materials are again mixed well until coarse aggregate is evenlyspreadall through the batch.

3) Now the calculated quantity of water is added and the whole batch will be thoroughly mixed until the concrete mix looks as homogeneous and attains the preferred consistency.

4) If the addition of water quantity becomes more the mix becomes diluted and the mixing procedure must be repeated to adjust the consistency if not the batch must be left aside and a fresh batch must be prepared with appropriate addition and mixing of materials.

3.8 Preparation of concrete Cubes

3.8.1 Moulds

Themoulds used for casting are generally used are metal, steel or cast iron and of material which is hard enough to stopdeformationcan also be adopted. The moulding is done in such a way that the exclusion of this specimen is done without causing any damage or disfiguring to it and the assembly of the specimen should be done in required dimensions and selected. Themould of required height and required distance between the opposite faces should be adopted.The mouldsare supplied with a metal base plate of a plane surface. The dimension of base plate must be selected properly so that it gives support to the mould while filing without causing any leakages of the material and it if fitted to the mould by proper adjustment of the screws. The attachments of the mouldmust be fixed tightly before filling and handling.

Before filling the mouldwith the material and for further use, the screw joints the of the mould and the side walls, corner edges and base plate of the mould is coated with a thin layer of oil so that there will be no leakage of water from the mix during the filling procedure is done. The mould oil is also to be applied for the internal faces of the mould before adding up the concrete into the mould so as to avoiding the sticking of concrete to the internal faces of the mould. With the use of tamping rod made of steel and having dimensions as 16mm in diameter and 0.6m long and bullet pointed at the lower end is used to make the concrete surface leveled. As per IS: 10086-1982, the concrete cubes should be of size 100mm X 100mm X 100mm.

3.8.2Compacting:

After the proper mixing of the all materials in the mix with adding correct quantities of water, the mix is placed in the required dimensions of the mould which is properly fitted by the adjustments of screws and then the mould is coated with a oil in its internal surface, side corners, screw joints and base plate. After the coating is done the mould is filled with the material in layers in which each layer will be up to 5cm depthand each layer should be compacted well to avoid the presence of evaporation. After the bottom layer of mix is filled in the mould it should be compacted by hand or by placing the mould on the table surface which has spring vibrators below it which helps in vibrating the moulds avoiding air lumps in the mix.

If thecompaction is done by hand, we will adopt a tamping rod which is used to give strokes of minimum 25 in number for each layer and the number of strokes should be given will be dependent on the type of concrete mould we used. Hence if we adopt cubical mould the strokes should not be less than thirty five for each layer and if it is a 15cm cube and twenty five strokes must be given for each layer if it is 10cm cubical mould. And in case of cylindrical mould the strokes must not be less than 30 strokes for each layer. The stroked is given by a tamping from the top of the each layer placing at 90^0 angles and tamped well by the required number of strokes so that tamping rod should go throughthe bottom of the mix so that the mix is distributed uniformly throughout the moulds. If there is a presence of air voids in the mix contained in the mould the exterior sides of the mould surface must also be tamped with the rod.

Fig **3.3 Required cubes, cylindrical and beam specimens**

3.8.3 Curing of Specimens:

After proper compaction of moulds the specimens are kept aside in thatmoulds without causing any disturbance to the moulds and are placed at room temperature for 24 hours. And then they are removed from the moulds by losing the screws and by slowing tamping the sides of the moulds and they are transferred into other curing tanks. The casted number of cubes, beams and cylinders are now kept in fresh water for curing.

Fig 3.4- Specimens Cured in Water

3.9 Testing Of Specimens:

When the required curing period is achieved the specimens are taken out of the curing tanks and the surfaces are cleaned up to clear the presence of surface water and specified tests in a standard procedure are carried out as per IS 516-1959. In this work the specimens are tested for flexural, compression and split tensile tests.

3.9.1 Description of compression testing machine:

For conducting tests on the cubical specimens to determine the compressive strength values we generally use compression testing machine which is of standard form. The maximum capacity of the compression machine was about 2000KN. This machine has a control valve which is useful for controlling the pace of the load applied. It consists of a plates where the test blocks are placed in the machine these plates should be cleanand the level of oil applied must also be verified before starting the machine to carry out the tests.

When the cubes are cured properly for a specific period of time they are taken out of the curing tanks andthe surfaces are cleaned up to clear the presence of surface water. Now the cube is placed in the center of the plate of the compression testing machine and the load is permitted on to the cube. The smooth surface of the cube is positioned on the bearing surface. Now the handle presented on the side of the machine is rotated until the top plate is bought in touch to the surface of the cube. The machine is started on after closing the oil pressure valve. The consistentpace of load about 140 kg/sq.cm/min is continued.

Figure 3.5 - Compression Testing Machine

3.9.2 Compressive Strength Test on Concrete Specimens:

Many tests are conducted on the concrete cubes in which the compressive test is considered important as it gives a clear information of every characteristic of the cube. By just conducting this test we can judge that the concreting process is prepared accurately or not. We can design the concrete mixes in such a way that they present a extensive variety of durability and mechanical characteristics so as to reach the requirements of good designed structure. Hence in designing a building or any another structural works the civil engineers commonly check the compression strength value to know about the mix used. The tests are conducted at two different curing periods being 7 and 28 days, when the cubes are broken by placing in a compression testing machine and the loading value at which crack is developed is noted down.

$$\text{Compressive strength} = \frac{\text{Maximum load}}{\text{Cross sectional area}}$$

Fig 3.6 Testing on Compression Testing Machine

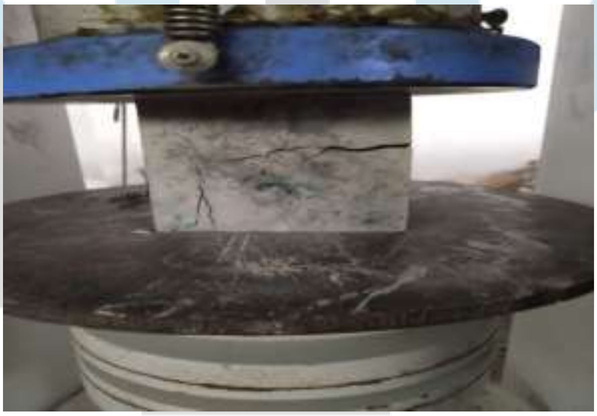


Figure 3.7 - Failure of specimen in compression testing machine

3.3.3 Split tensile strength

Next to the compression test, the tensile strength test is the most useful property of the concrete which is to be calculated. The concrete has less tensile strength and are fragile in nature hence they are not able to with stand when tension is applied directly. But the cylinders are tested for the maximum load value of tensile strength test by placing cubes in the center of the machine on the iron rods used to support and the strength value is noted where a crack is formed on the cylinder. The formation of crack is due to failure of cylinder in tension.

Here, cube split tensile strength formula is calculated as per [From IS**:** 5816: 1999 Revised 2004].

$$\text{Fct} = \frac{2\,p}{\pi\, l\, d}$$

Where,

P = greatest load (Newton)
L = specimenlength (mm)
D = cross-sectional dimensional of specimen

Fig 3.8 - Split Tensile Testing

Fig 3.9Tested Specimens after failure

3.3.4 Flexural strength test:

While conducting flexural strength test the hypotheticalhighest tensile stress which is achieved at the underneath fibers of the test block is actually termed as the modulus of rupture. The tensile and compressive stresses are induced in the top and bottom fibers of the beam when it is applied for bending. The strength which is developed by resisting this bending force by the beam member is recognized as flexural strength. The standard beam has a span of 600mm and dimensions being 100mm X 100mm X 500m.

The testing machine consists of 2 rollers which are in diameter of 38mm which are used to support the beam which will be placed on above these rollers in such a way that the center to center span will be equal to 13.3cm and are fixed at 1/3rd point sustaining length. Now when the load is applied it is distributed uniformly to the both rollersand these rollers are positioned in way so that axial load is induced so that no tensional strain or stress is achieved. The applied load will be subjected with nodistress and it will be increasedconstantlyto an extent so the extreme fiber stresses will be enlargedto approximately 7kg/cm^2/minute. The application of loading will be kept on increasing up to a extent where crack will be appears on the beam and finally the failure of beam occurs and the utmost load which the beam resisted in the test process is noted down.

The flexural strength of the beam can be indicated by using a parameter known as modulus of rupture and it is indicated by ‘F_b’, if ‘a’ is equivalentto the space between the line of fracture and the nearest support measured on a center line of the tensile side of the specimen, in cm, is calculated to the nearest 0.05Mpa as follows.

$$f_b = \frac{PL}{bd^2}$$

When ‘a’ is less than 20cm but greater than 17cm for 15cm specimen or less than13.30cm But greater than 11.00cm for a 10cm specimen.

Where,

P = ultimate load in N
L = span of the beam in mm
b = width of the specimen in mm
d = depth of the specimen in m

The beam members are conducted for tests on 28 days after proper curing. The average of the three specimens is reported as the flexural strength.

Fig 3.10 Flexural strength testing machine

CHAPTER - IV
RESULTS AND DISCUSSION

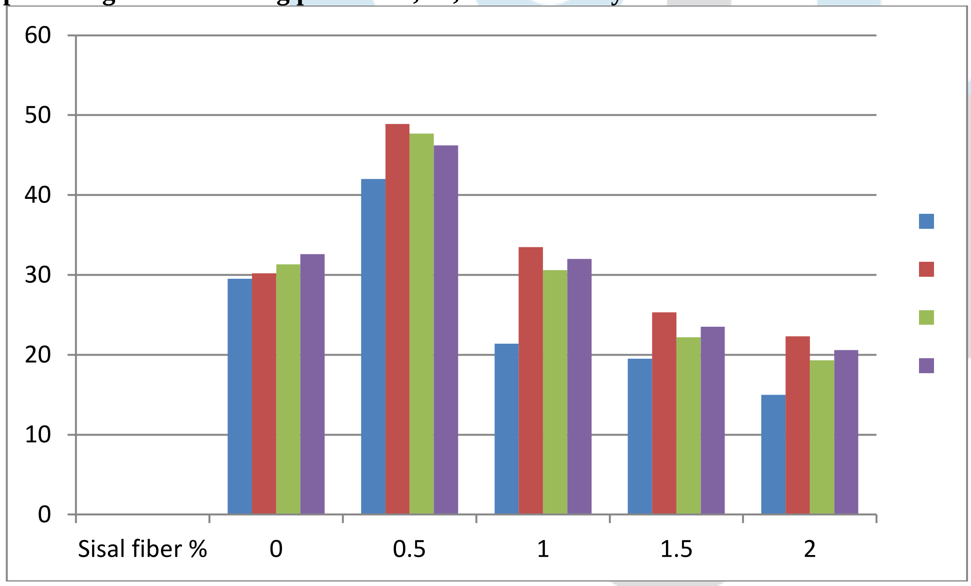
A number of tests are done to the concrete samples so that to know the values of strengths of the concrete members in which replacement of cement is done by using ceramic waste powder and concurrently adding sisal fiber in different proportions. The investigationalanalysis values arementioned in the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

4.1 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.

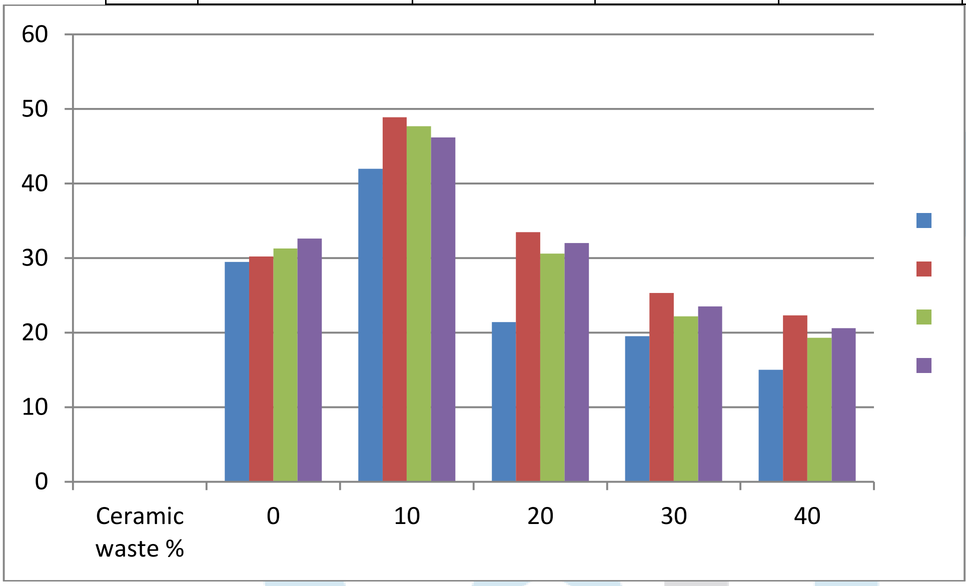
Cube codes	Ceramic waste %	Sisal fiber %	7 Days	28 Days	56 Days	90 Days
A	**0**	**0**	**29.5**	**30.2**	**31.3**	**32.6**
B	10	0.5	42	48.9	47.7	46.2
C	20	1.0	21.4	33.5	30.6	32
D	30	1.5	19.5	25.3	22.2	23.5
E	40	2.0	15	22.3	19.3	20.6

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



Compressive strength graph with varying percentages of sisal fibers for 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

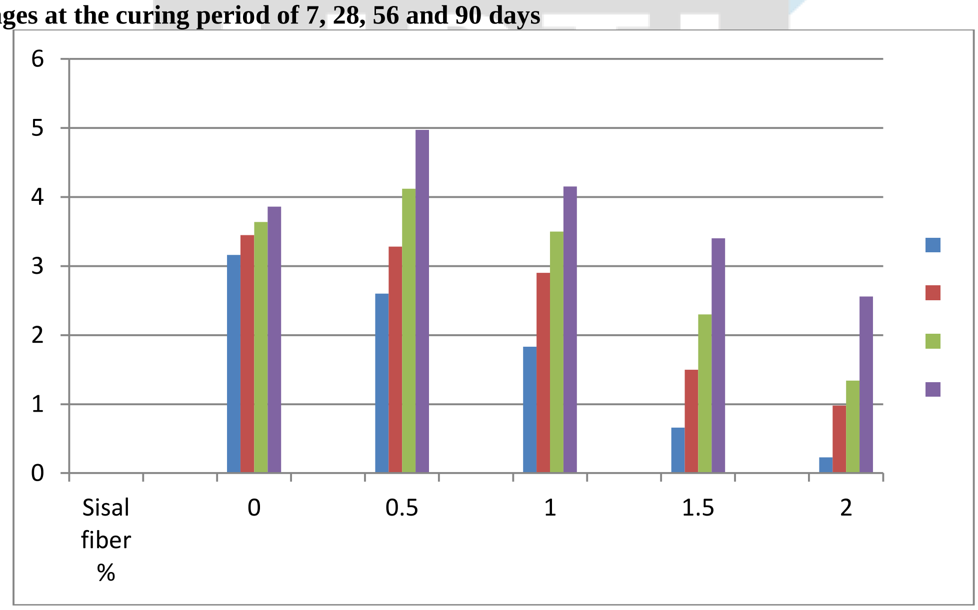


Compression strength graph with varying percentages of ceramic waste for 7, 28, 56 and 90 days

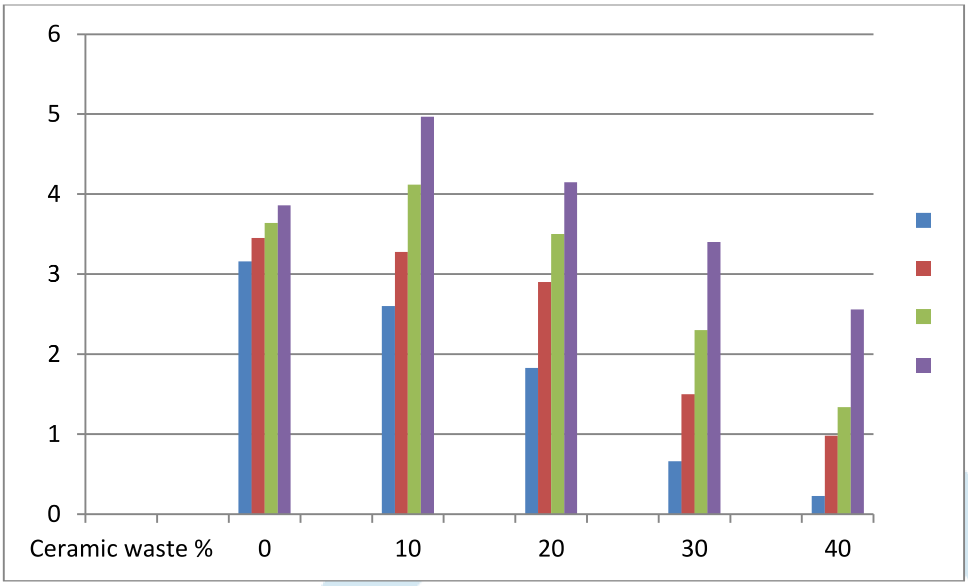
4.2 SPLIT TENSILE STRENGTH:

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



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



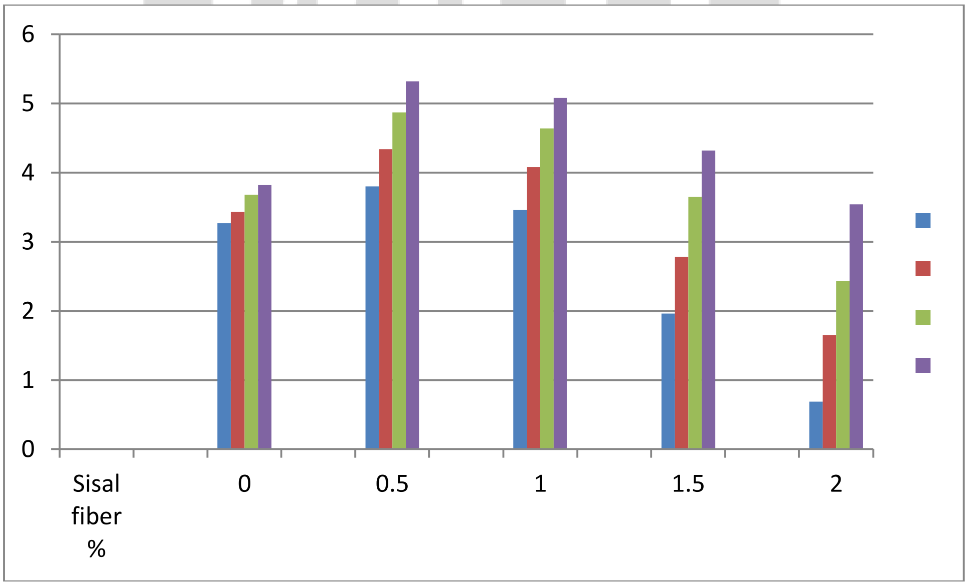
Split tensile strength graph with varying percentages of ceramic waste for 7, 28, 56 and 90 days

4.3 FLEXURAL STRENGTH:

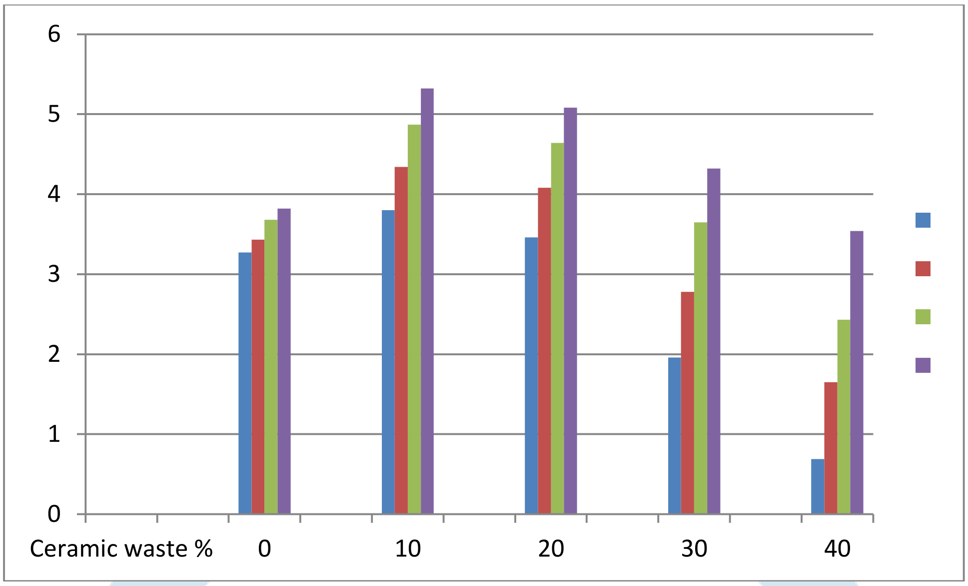
As per IS 516-1959, the flexural strength values are demonstrated by carrying out tests in the compression testing machine in two different curing periods being 7 and 28 days and are tabulated.

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

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



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



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 thereobserved a reduce in strength from Table-4.1.
- The split tensile strength of concrete in which 0% to 40% replacing of cement is done byceramic waste and concurrently0% to 2% addition of sisal fiber at the age of 28 days has achievedobjective 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-4.2.
- The flexural strength of concrete in which0% 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 fiberthere will be reduction in strength as observed in Table-4.3. This proves that with 10% replacingof cement with ceramic waste and 0.5% addition of sisal fiber shows better results.
- The concreteof grade M30 has an increase in strength by replacingcement with ceramic waste powder up to 25% and using sisal fiber as admixture and supplementary replacingcementby constitutes decrease the compressive strength.
- Utilization of sisal fibers and its applications are used for the development of the construction industry, material sciences.

CHAPTER – V

CONCLUSION

- 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.

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