STUDY OF STRENGTH CHARACTERSTICS OF CONCRETE BY ADDING COIR FIBRE AND REPLACEMENT OF STEEL SLAG

Submitted in partial fulfillment of the requirements

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MASTER OF TECHNOLOGY

in

CIVIL ENGINEERING

by

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School of Civil Engineering

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DECLARATION

I, Ankit Sharma (Regd. No. 11502407), hereby declare that this thesis report entitled **"Study of strength characteristics of concrete by adding coir fibre and replacement of steel slag"** submitted in the partial fulfilment of the requirements for the award of degree of Master of Civil Engineering, in the School of Civil Engineering, Lovely Professional University, Phagwara, is my own work. This matter embodied in this report has not been submitted in part or full to any other university or institute for the award of any degree.

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Place: Jalandher **Reg.no. 11502407**

CERTIFICATE

Certified that this project report entitled **"The study of strength characteristics of concrete by adding coir fibre and replacement of steel slag"** submitted individually by student of School of Civil Engineering, Lovely Professional University, Phagwara , carried out the work under my supervision for the Award of Degree. This report has not been submitted to any other university or institution for the award of any degree.

Signature of Supervisor

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ABSTRACT

Concrete is very basic material of all the structural members. It is basically the mixture of coarse aggregates, fine aggregates and cement. When these materials are mixed up and water is added the resulting material made is called concrete.

Concrete is required to bear the compressive loads without failure. But sometimes it may weak or cracks may develop on its surface, which when become wider or which when expand reduces the strength of concrete significantly.

So, sometimes we added some materials to concrete as the replacement of cement up to some extent. These materials are called self-cementing materials such as fly ash, silica fume, rise husk ash and etc.

The previous studies has shown that when these materials added to concrete as a replacement of cement, there is significantly improve in the properties of concrete.

In my research work I am replacing fine aggregates and adding coir fibre to concrete. From the precious research papers it was found the coconut fibres gives good strength to the concrete and increase its properties value. So here I am interesting to find out the compressive and tensile strength of concrete by adding coir fibre in concrete and replacing fine aggregates in concrete by steel slag. Coconut fibre is the waste material which is obtains from the outer most part of the coconut.

So, the aim of this study will be to figure out that what will be the influence on the various strength of concrete by the addition of coconut fibres and replacing fine aggregates in concrete by steel slag.

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LIST OF ABBRIVATION

%	Percentage
Kg	Kilo Gram
Gms	Grams
Mpa	Mega Pascal
w/c ratio	Water cement ratio
Max.	Maximum
Min.	Minimum
Cm	Centimetre
Dia	Diameter
Fig	Figure
N	Newton
CF	Coir Fibre

CHAPTER 1
INTRODUCTION

1.1 General

These days the concrete is commonly used as a material for construction in the globe with the new discoveries in technology and science in the field of construction, the use of concrete as structural member by the different basis .It has been found that the concrete is weak in flexural and tension ,the concrete is most commonly found that reinforced using reinforced bars of steel Most time it is found that the use of steel reinforcement is very expensive to make the concrete durable ,economical and strong world–wide. Considerable efforts have been made to make the concrete strong and durable. Fibre concrete can withstand more stress following a portion of its resistance sustain cracking. Various types of fibres reinforced concrete are added in the concrete like steel fibre, glass fibre and some natural fibres are coconut, sisal, jute, eucalyptus grands pulp, malva fibre, pineapple leaf, kenafbast, sansevieria leaf, abaca leaf, date, bamboo, palm, flax, hemp, cotton, sugarcane fibres. Natural fibres are the cheap fibres and easily available in the market of many countries so we can easily purchase we can easily use or handle of natural fibre because of their high flexibility etc. Conventional concrete loses its tensile strength by the formation of multiple cracks. Fibre reinforced concrete (FRC) may be defined as a composite materials made with Portland cement, aggregate, and incorporating discrete discontinuous fibres.

1.2 Coirfibre

Extracted part from the outer shell of a coconut is Coconut fibre. Coir, Cocoas nucifera and Arecaceae (Palm), respectively are the family name of the coconut fibre.

There are basically two types of coconut fibre.

a) Brown fibres: - This type of fibre is strong, thick and has high abrasion resistance.
b) White fibres: -This type of fibre is finer and smoother, but they are very weak in strength.

Coconut fibres are commercial obtainable in three forms, namely bristle (long fibres), mattress (relatively short) and decorticated (mixed fibres). All these three type of fibres has different uses which depend upon the requirement. Brown fibres are mostly used for engineering work.

Applications of coconut fibres are used in many branches of engineering but mainly this fibre is used in civil engineering for construction purpose. This fibre is one of the best fibres among all natural fibresand is mainly found in tropical region and the forests where rainfall is high. It is a low cost fibre and has good flexibility, durability and that is why we can have used this fibre as a reinforcement material in the concrete. Coconut fibre is obtained from the outer part shell of coconut and it's a scientific name and plant family name of the coconut natural fibre is "coir". Only two types of coconut fibres are produced one is the brown fibre take out from the matured coconut fibre and another is the white fibre are take out from the immature of coconut. Both coconut fibres have different properties in the brown fibres are the thick, strong and high abrasion resistance but in case of white fibres it is smoother finer and also a weaker but in these two only brown fibres are mostly used. They can also be used effectively in the reinforced concrete material development. The coconut fibre is easily available in large quantity and it is cheap also.

Fig.1 coconut tree, coconut and coconut fiber(E.M.Collins etal.2000)

1.2.2Chemical Composition

Coconut coir composed of cellulose, hemi-cellulose and lignin as major part. These compositions affect the various properties of coconut fibres. The pre-treatment of fibres changes its properties as well as properties of its composites. Sometimes it improves the properties of fibres but sometimes its effects are not positive.

Cellulose

Cellulose is an organic material with formula $C_6 H_{10} O_5$. Cellulose is an important Structural member of cell wall in plants. Cellulose is one of the plentiful organic Polymers in this planet. Cellulose appeared like white powder and has a density of 1.5g/cm^3.Cellulose is tasteless, have no odour and hydrophilic with contact angle of 20-30 degree.

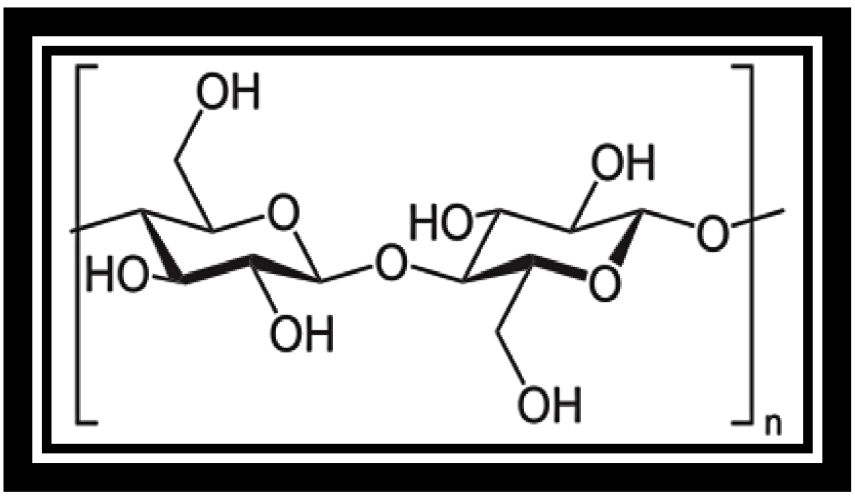

Fig.2 Diagrammatically representation of cellulose

Hemi cellulose

Hemi cellulose is also known as polyose. Like cellulose it is also present in cell wall of all plants. While cellulose is rigid and free from break down due to water addition (hydrolysis) but hemi cellulose is amorphous structure with some strength and dilute acid or base is used for hydrolysed hemi cellulose.Hemicellulose found in hardwood trees. Hemi cellulose is also known as polyose. Like cellulose it is also present in cell wall of all plants. While cellulose is rigid and free from break down due to water addition (hydrolysis) but hemi cellulose is amorphous structure with some strength and dilute acid or base is used for hydrolysed hemi cellulose.

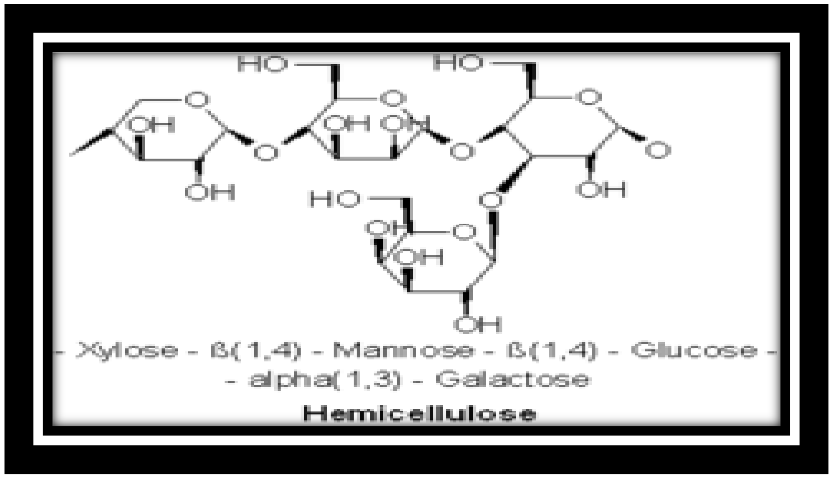

Fig.3 diagrammatically representation of hemi cellulose

Lignin

Lignin is a type of complex organic polymer that forms structural material in support Tissue of vascular plants and algae specially in wood and bark lignin is very important For forming cell wall it help them in avoid rot problem and provide rigidity.

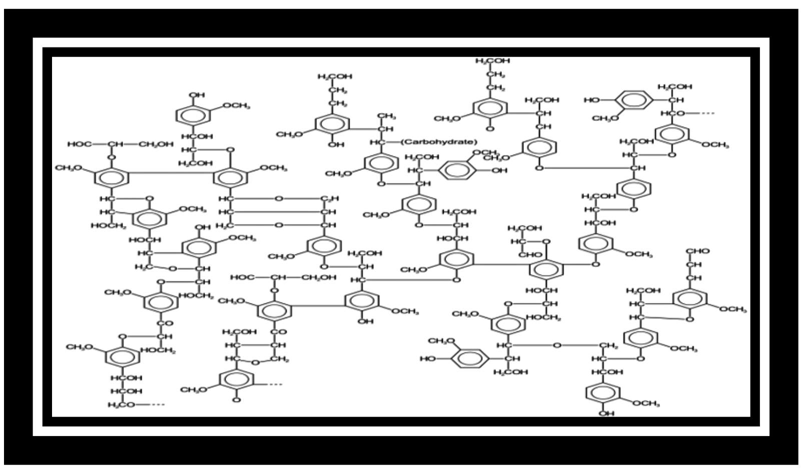

Fig.4 An example of lignin structure

1.2.3 Applications of coir fibre

1. Sometimes fibre is used in plaster work to improve the properties of mortar.
2. Coir fibre breaks the propagation of crakes to move further in the concrete.
3. Fibre is used in roof as a roofing material.
4. Fibre can be used to make bags, mats, mattresses and etc.

1.3Steel slag

The by-product of melting of steel waste from the impurities and fluxing agents is known as steel slag. This is liquid slag floating over the liquid steel in arc or induction furnaces, or other melting units. Historically substantial amount of solid wastes are generated from ferroalloys industry. Industries generate great amount of waste materials which cause tremendous harm to both the environment and ecology. 10-15% of the waste removed from the furnace separately to the total steel produced. So it has become very important to reuse the waste material because of the reinforcement of regulations of environmental that need minimizing waste disposal. The main goal of the government and the agencies which protect environment is to find ways and to minimize the problems of disposal and health hazards of by-products or waste which is produced from these types of industries. This problem is main in steel making industries because these industries generate a huge quantity of by-products. However, due to developing science and technology it is possible to use. Steel slag in many fields such as to use steel slag in concrete to improve its properties.

Chemically steel slag consists of mainly SiO_2, Al_2O_3, CaO, MnO, MgO, TiO_2, and P_2O_5andFe_2O_3. The steel slag is a by-product, which can be utilized in the construction field. As we all know due to the durability of concrete it is a widely used construction material for various types of structures. From the time when concrete was discovered it was considered that it is a durable material which requires a little or no maintenance but later it was found that, when reinforced concrete structures are subjected to harsh environments, due to chloride and sulphate attack, acid attack, corrosion failure and etc. deterioration of concrete will occur. Utilization of industrial soil waste or secondary materials has been encouraged in the construction field now days for the production of cement and concretes. There is very little number of researchers on the use of Steel slag in cement concrete.

1.3.1 Applications of steel slag

1. It can be used as a building material and can be used as the fine aggregates in concrete to improve the properties of concrete.
2. It can be used as fill and embankment in the road construction.
3. It can be used as sub grade in the road construction.

1.4 Scope of the study

The steel slag and coconut fibre are the industrial and agricultural waste products. Industry as a product of Agricultural waste to reduce environmental impact, The concrete grade M 20 is used for research work i.e. fine aggregates is to be changed (by weight) by steel slag and addition of coconut fibre to concrete by 7%, 14%, 21%, 28% and 35% and 1% and 2% and 3% respectively, To get optimal results. The various concrete properties like compressive strength, split tensile strength and flexural strength for various mixes is to be examined at a changed proportion of steel slag and coconut fibre . And the standard concrete specimens i.e., concrete specimens with no replacement and no addition in cement also would cast out. The results carried out after replacement and addition of cement compared with the standard concrete mix and then best result is taken into considered for practical applications.

1.5 Objective of the study

In my investigation work is study the characteristics strength of concrete M20 grade for different percentage replacement of sand with steel slag and with addition of coconut fibre.

The main objective for project is: -

1. To investigate the effect on compressive strength of concrete by changing of sand with steel slag and addition of coconut fibre for different percentages and to find the optimal quantity.

2. To investigate the effect on tensile strength of concrete by changing of sand with steel slag and addition of coconut fibre for different percentages and to find the optimal quantity.

3. The objective of the study was determined and compares the difference in strength of concrete

Contain steel slag and coir fibre and normal concrete. This investigation was carried out using several tests, compressive test and Split Tensile test.

CHAPTER2

REVIEW OF LITERATURE

Shreeshail.B.H et al (2015) [1] has studied the behaviour of concrete by adding coir fibre. As per his research he has found that there is increase in the compressive strength of concrete by adding coir fibre in it. His results are shown below

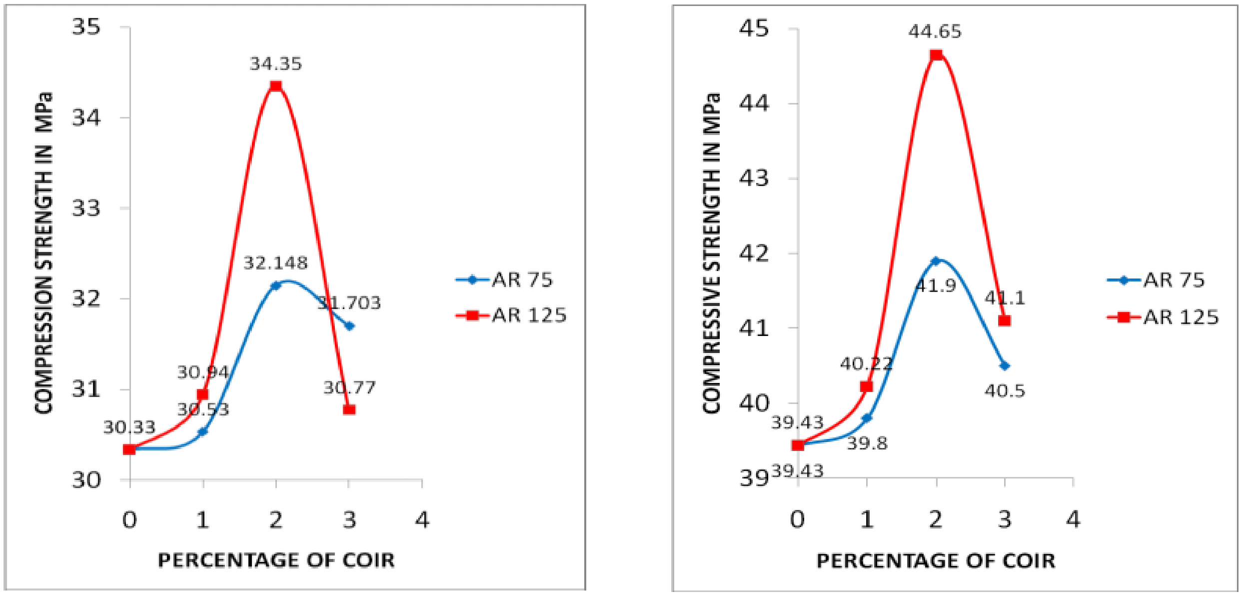

Fig.5 Compressive strength at 7 days and 28 days by adding coir fibre (Shreeshail.B.Het al.2015)

Above graphs are showing the effect of addition of coir fibre on the compressive strength of M30 grade of concrete at different aspect ratios. For 7 days testing maximum value of compressive strength at aspect ratio 75 is obtained at 2% of coir fibre which was 32.148 MPa and after that it starts decreasing. At AR 125 max. Value of compressive strength was obtained at 2% of coir fibre which was 34.35MPa. For 28 days testing max. Value of compressive strength was at 2% of coir fibre which was 41.9MPa and 44.65Mpa at AR 75 and 125 respectively.

Jayaprada et al.(2015)[2]has found there is an increase in compressive strength of concrete of grade M20 up to an addition of 1.25% of coir fibre in addition of sisal fibre. The increase in compressive strength is shown in table below.

Here in table below CS-1 stands for 0.5 percent of coir fibre and 0.5percent of sisal fibre. CS-2 means that 0.75 percent of sisal fibre CS-3 means that0.25 percent of sisal fibre and 1 percent of coir fibre. CS-4 means 1 percent of sisal fibre and 0.25 percent of coir fibre and CS-5 stands for 0.25 percent of sisal fibre and 0.75 percent of coir fibre.

Results are shown for all the mixes which contain different proportion of fibres as discussed above. Compressive, tensile and flexural strength of specimens were tested by adding different proportion of fibres and a conclusion has been made.

Table: 1Mechanical properties of concrete mixes with fibre(Jayapradaet al.2015)

S.NO.	Compressive strength In N/mm^2	Flexural strength In N/mm^2	Split tensile strength In N/mm^2
Control mix	23.734	6.0	2.673
Sisal fibre-0.5 Coir fibre-0.5 (CS-1)	35.84	6.22	2.921
Sisal fibre-0.75 Coir fibre-0.25 (CS-2)	33.72	6.41	2.981
Sisal fibre-0.25 Coir fibre-1 (CS-3)	26.152	5.82	2.562
Sisal fibre-1 Coir fibre-0.25 (CS-4)	25.091	5.62	2.374
Sisal fibre-0.25 Coir fibre-0.75 (CS-5)	35.31	6.723	2.861

From above table we can see that for CS-1 when the proportion of sisal and coir fibre were 0.5 percent compressive strength was found to be $35.84/mm^2$ tensile strength was $6.22N/mm^2$and split tensile strength was 2.921 percent. At CS-2 compressive, tensile and flexural strength were $33.72N/mm^2$,$6.41N/mm^2$, and $2.981N/mm^2$ respectively. At CS-3, CS-4 and CS-5 the Compressive strength was found to be decreasing. So from here we can conclude that the maximum value of compressive strength was $35.84N/mm^2$ which was corresponding to CS-1 when proportion of sisalfibre was 0.5 percent and coir fibre was 0.5 percent.

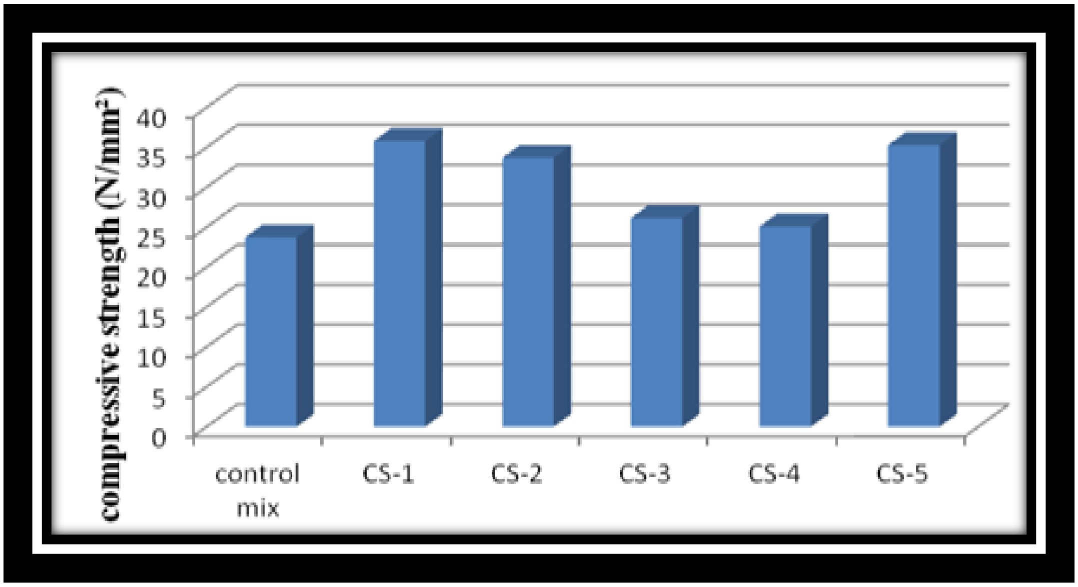

Fig.6 Compressive strength of concrete at 28 days curing (Jayapradaet al.2015)

Above figure is showing the value of compressive strength of concrete added with different proportion of sisal fibre and coir fibre. The maximum value of compressive strength was found to be at CS-1.

Dr.M.A. Ismail et al. (2009) [3] has studied the properties of ordinary Portland cement by adding different type natural fibres. The types of fibres he has used and their properties as shown below

From table shown below we can see that density is maximum in case of rosella fibre whereas coconut fibre gives highest value of modulus of elasticity. Water absorption is maximum in case of coconut fibre and tensile strength is maximum in rosella fibre. In case of date palm density is 463 kg/m^3 which is lowest among all given above and tensile strength is minimum in case of reed which is in the order of 70 to 140MPa. He has done testing by using cement of grade 53. He has found that coir fibre give maximum value of compressive when it is added 0.5% and after that the value of compressive strength starts decreasing.

Table: 2. Properties of OPC by adding different fibres (Dr.M.A. Ismail et al.2009)

Fibre type	Density in kg/m^3	Water absorption In percentage	Modulus of elasticity in GPa	Tensile strength In MPa
Rosella	800-750	40-50	10-17	170-350
Date palm	463	60-65	70	125-200
Coconut	145-380	130-180	19-26	120-200
Reed	490	100	37	70-140
Sisal	800-700	56	15	268

In above mentioned fibres in table shown above rosella, coir and sisal fibre is found to be best for utilization in concrete whereas reed and date palm was found to be weak fibres.

Table: 3 Properties of mortar by adding Coir fibre (Dr.M.A. Ismail et al.2009)

Fibre cement ratio in percentage		Bulk density In gm/mm^3	Compressive strength in MPa	Tensile strength In MPa
By weight	By volume			
0	0	1.895	57.51	6.41
0.25	0.3	1.903	59.73	5.64
0.5	0.66	1.893	58.92	7.153
0.75	1.0	1.891	57.94	7.54
1.0	1.33	1.885	57.71	8.62
1.5	2.0	1.879	53.32	9.23
2.0	2.67	1.853	49.23	9.641
3.0	4.0	1.826	42.94	9.82

Above table is showing the effect of coir fibre on cement mortar at different percentages by weight and by volume. The maximum value of compressive strength was found to be at 0.25 percent of coir by weight.

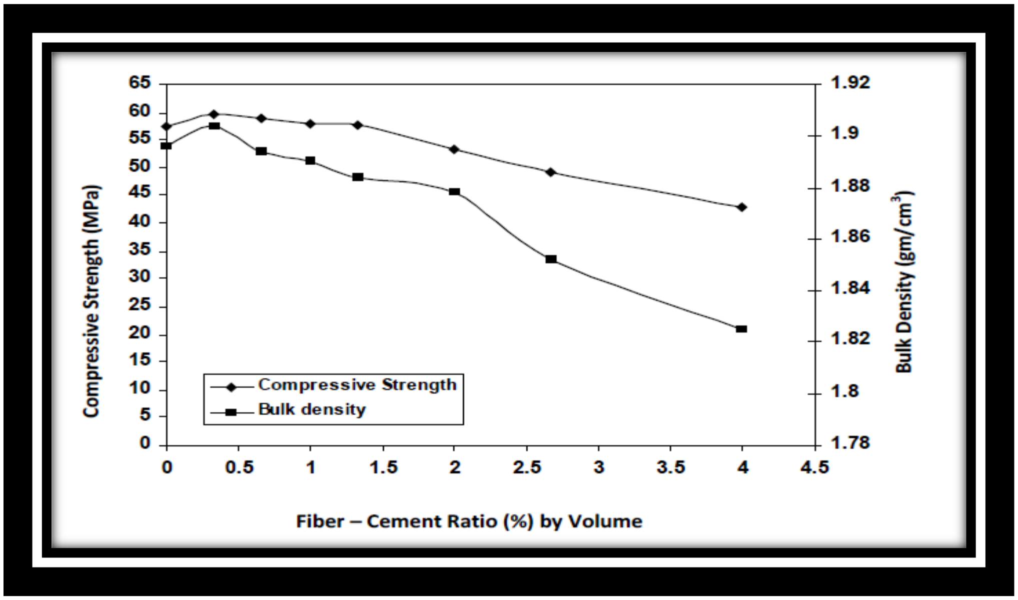

Fig.7 Influence of fiber on compressive strength and bulk density (Dr.M.A. Ismail et al.2009)

Abovegraph is showing that the compressive strength and bulk density is first start increasing upto fibre content of 0.5% and then it starts decreasing. So it has been concluded that 0.5% is the optimum percentage of coir fibre upto which compressive strength ans bulk density is maximum.

Baruah and Talukdar et al. (2008) [4] has studied the properties of coconut fibre reinforced concrete of grade M20. Their research is shown in table below

Table: 4 Properties of concrete and coir fibre reinforced concrete (Baruah, Talukdaret al.2008)

Fibre volume fraction in %	Compressive strength in MPa.	Split tensile Strength in MPa.	Modulus of Rupture MPa.	Shear strength In MPa.
_	21.421	2.881	3.252	6.182
0.5	21.702	3.023	3.381	6.472
1.0	22.742	3.182	3.684	6.813
1.5	25.103	3.372	4.071	8.184
2.0	24.351	3.343	4.162	8.212

From above table it can be seen that the strength of control mix was 21.421MPa.After the addition of coir fibre at 0.5%, 1% and 1.5% it starts increasing and maximum at the percentage of 1.5% and then at 2% of coir fibre it decreases. Same as in the case of tensile strength. The tensile strength first starts increasing by adding coir fibre up to the percentage of 1.5% of coir fibre and then at 2% of coir fibre it decreases. So from above table it has been found that the optimum percentage of coir fibre up to which compressive as well as tensile strength are increasing is 1.5%.

Anthony Nkem Ede and Joshua OlaoluwaAgbedeetal (2007) [5] Use Coconut Husk Fibre for Improvement Compressive and Flexural Strength of Concrete.

Table:5 Compressive strength of cubes of various samples(Anthony Nkem Ede, et al.2007)

% of Fibers	7 days (N/mm^2)	14 days (N/mm^2)	21 days (N/mm^2)	28 days (N/mm^2)
Control	11.40	14.94	16.92	19.14
0.25	12.17	14.755	17.1	20.015
0.5	20.06	22.765	23.26	26.435
0.75	15.3	17.715	20.155	20.775
1	11.115	14.88	15.705	18.675

Above table is showing the compressive strength of concrete of grade M15 added with coir fibre is maximum at 0.5% of coir fibre for all ages as shown above. Compressive strength of 7 days, 14 days, 21days and 28 days ages of curing of concrete with 0.5% of coir fibre is found to be 20.06N/mm^2, 22.765N/mm^2, 23.26N/mm^2 and 26.435N/mm^2 respectively. So it has been concluded that 0.5% of coir fibre is the optimum oercentage of coir fibre upto which compressive strength of concrete is increasing and after that it starts decreasing.

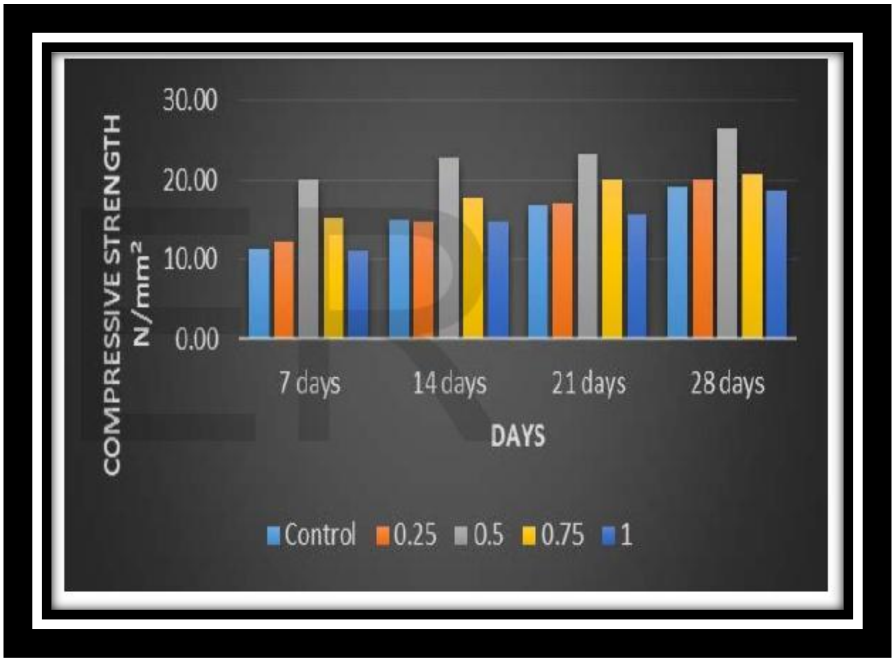

Fig.8 Compressive strength of CF added concrete (Anthony NkemEdeet al.2007)

From above study it can be literally seen that concrete offers highest compressive strength at fibre content 0.5% and after that compressive strength starts decreasing beyond when fibre content exceed 0.5%.

Krishna Prasanna P et al (2014) [6] investigate the properties of high strength concrete added with steel slag. The results are shown in table below

Table: 6 Compressive strength of cubes at different %age of steel slag **(**Krishna Prasanna P et al.2014)

Percentage of steel slag	7 days compressive strength In N/mm^2	28 days compressive strength In N/mm^2
0	53.01	83.02
5	55.03	84.01
10	54.01	85.04
15	55.04	87.03
20	56.00	88.01
25	58.06	90.02
30	57.01	87.05
35	58.02	88.04

From above results it has been found that the maximum value of compressive strength occurs at 25 percent of steel slag which was found to be 58.09N/mm^2 at 7 days of curing and90.02N/mm^2 at 28 days of curing.

V.SubathraDevia, B.K.Gnanavelb et al (2014) [7] has studied the effect on the properties of concrete of grade M20 by replacing fine aggregates by steel slag. Their results are shown in table below.

Table: 7Compressive strength in MPa at 28 days of curing (V.SubathraDevia, B.K.Gnanavelbet al.2014)

Percentage of steel slag	Fine aggregate replacement	Coarse aggregate replacement
0	19.671	19.672
10	18.562	21.801
20	19.104	23.754
30	19.783	27.333
40	20.676	26.021
50	18.721	24.063

Here as we can see that when fine aggregate are replaced with steel slag compressive strength of concrete first starts increasing. At the replacement level of 10%, 20%, and 30% and at 40% it was found to be 19. 562MPa, 20.104MPa, 20.783MPaand 21.676MPa.and after that at 50% of replacement compressive strength was 19.321MPa. So it has been concluded that in case of fine aggregate compressive strength was maximum at replacement level of 40%. Whereas in case of coarse aggregate, when coarse aggregates are replaced with steel slag compressive strength was found to be maximum at the replacement level of 30% and it was 28.333MPa and after that at replacement level of 40% it was found to be 27.021Mpa. So from above study it has been concluded that when fine aggregates are replaced with steel slag the optimum level of replacement is 40% at which it gives maximum value of compressive strength whereas in case of coarse aggregate optimum level of replacement is 30%.

2.2 Flexural strength

Shreeshail.B.H et al (2015) [8] has studied the behaviour of concrete by adding coir fibre. As per his research he has found that there is increase in the flexural tensile strength of concrete by adding coir fibre in it. His results are shown below

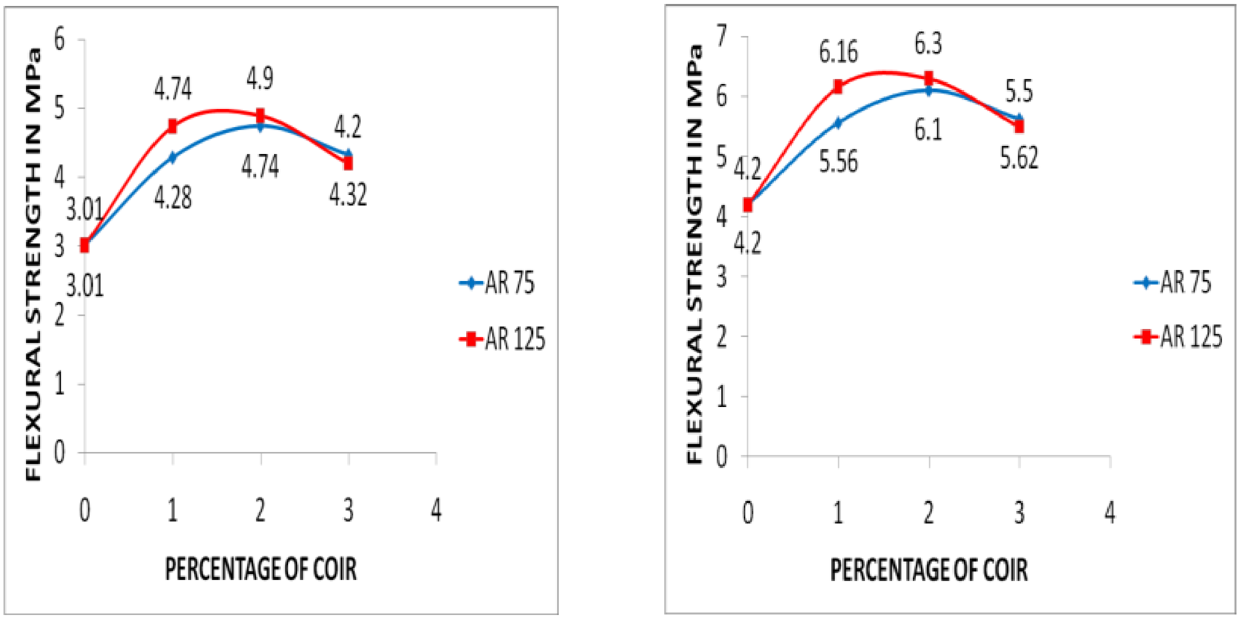

Fig.9Flexural strength at 7 days and 28 days by adding coir fibre (Shreeshail.B.Het al.2015)

Above graphs are showing the effect of addition of coir fibre on the flexural strength of M30 grade of concrete at different aspect ratios. For 7 days testing maximum value of flexural strength at aspect ratio 75 is obtained at 2% of coir fibre which was 4.74 MPa and after that it starts decreasing. At AR 125 max. Value of flexural strength was obtained at 2% of coir fibre which was 4.9 MPa. For 28 days testing max.Value of flexural strength was at 2% of coir fibre which was 6.1 MPa and 6.3 Mpa at AR 75 and 125 respectively.

Jayaprada et al. (2015) [9] has study the behaviour of concrete by adding coir fibre. She has added different type of natural fibres and fined out there effect on the properties of concrete. Her results are shown below.

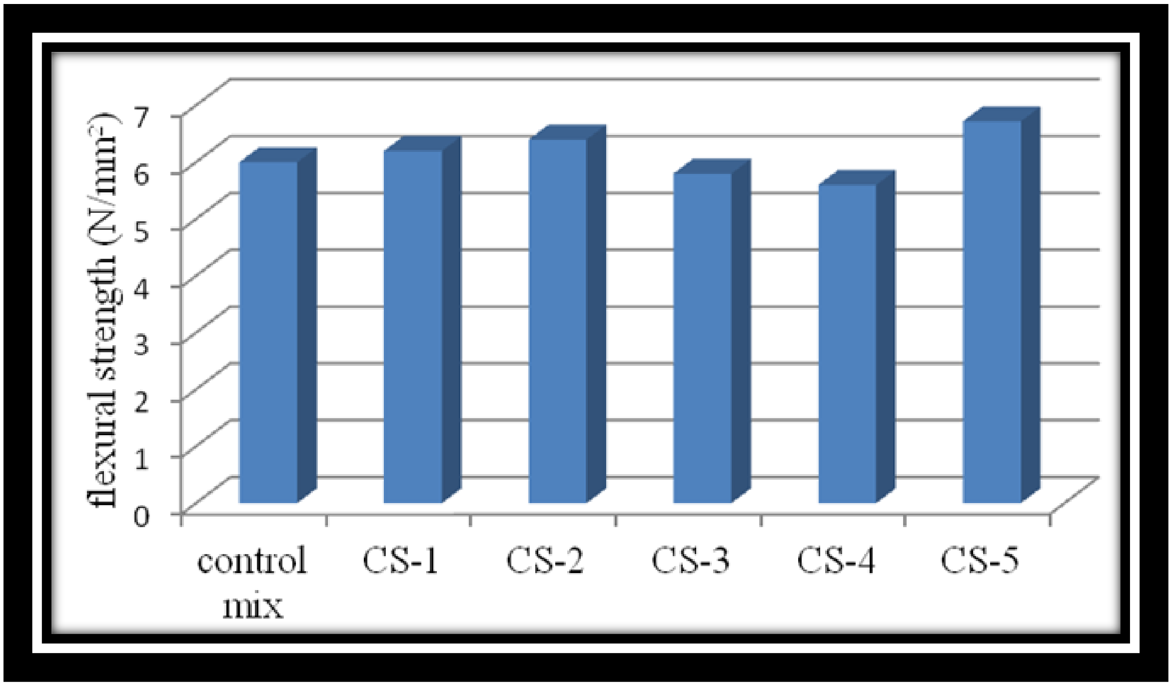

Fig.10 Flexural strength of concrete at 28 days of curing(Jayaprada et al.2015)

From above figure it can be seen that the maximum value of flexural strength was found to be at CS-5 which was corresponding to 0.25 percent of sisal fibre and 0.75 percent of coir fibre and flexural strength at CS-5 was 6.723N/mm^2.

Anthony Nkem Ede and Joshua OlaoluwaAgbede et al. (2007) [10] has studied behaviour of concrete in flexure by adding coir fibre in it.Figure below is showing 14 days and 28 days flexuralstrengthofconcreteat different percentage of coir fibre. It has been found that 0.25% fibre content offered the highest flexural strength and then followed closely by 0.5% fibre content.

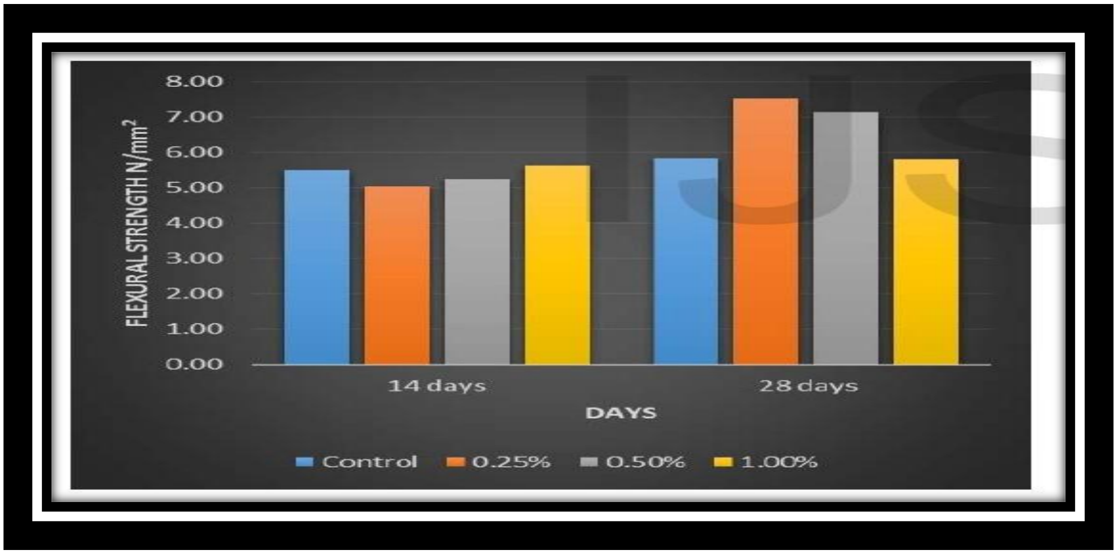

Fig.11 Flexural strength of concrete by adding coir fibre (Anthony Nkem Edeet al.2007)

Krishna Prasanna P et al [11] has studied the effect of steelsslag on the flexural strength of beams. The results are shown below.

Table: 8 Flexural strength of beams at different %age of steel slag **(**Krishna Prasanna P et al.2014)

Percentage of steel slag	7 days Flexural strength In N/mm^2	28 days Flexural strength In N/mm^2
0	4.81	7.41
5	5.12	7.62
10	5.14	7.83
15	5.21	8.01
20	5.43	8.01
25	5.22	7.81
30	5.51	8.01
35	5.11	7.93

From above table it has been found that flexural strength of concrete at 7 days of curing was found to be maximum at replacement level of 30% and it was $5.51 N/mm^2$. Similarly at 28 days of curing flexural strength was also maximum at replacement level of 30% and it was $8.01 N/mm^2$.

2.3 Split tensile strength

Shreeshail.B.H et al (2015) [12] has studied the behaviour of concrete by adding coir fibre. As per his research he has found that there is increase in the split tensile strength of concrete by adding coir fibre in it. His results are shown below

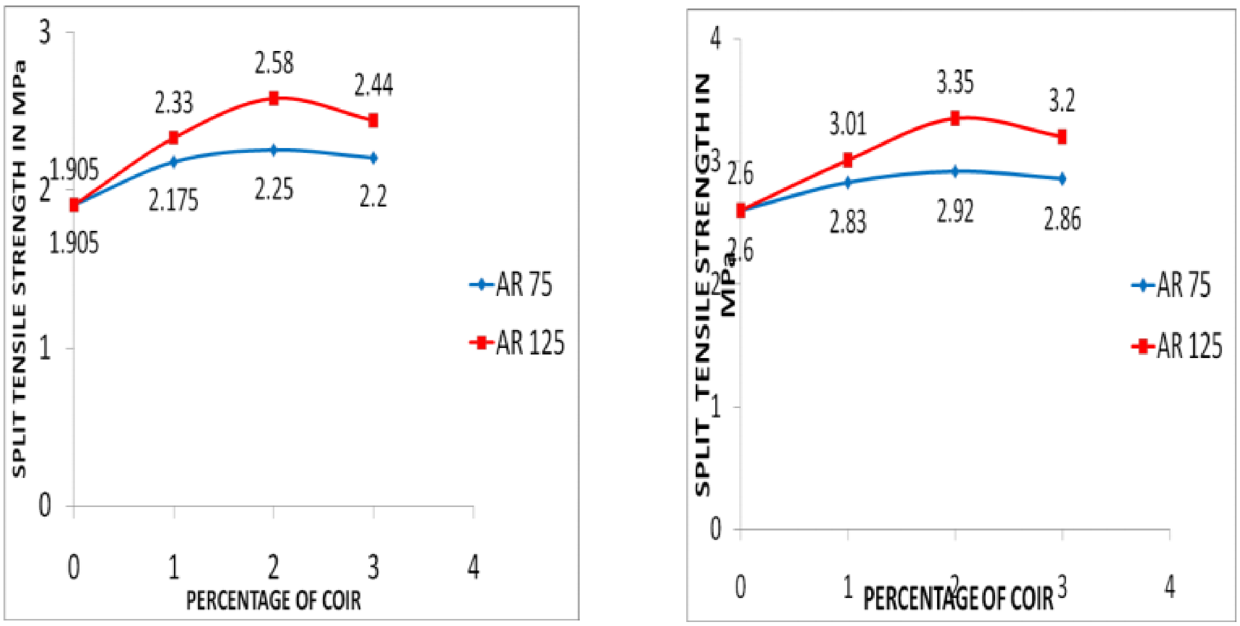

Fig.12Split tensile strength at 7 days and 28 days by adding coir fibre (Shreeshail.B.Het al.2015)

Above graphs are showing the effect of addition of coir fibre on the split tensile strength of M30 grade of concrete at different aspect ratios. For 7 days testing maximum value of split tensile strength at aspect ratio 75 is obtained at 2% of coir fibre which was 2.25 MPa and after that it starts decreasing. At AR 125 max. Value of split tensile strength was obtained at 2% of coir fibre which was 2.58 MPa. For 28 days testing max.Value of split tensile strength was at 2% of coir fibre which was 2.92 MPa and 3.35 Mpa at AR 75 and 125 respectively.

Jayaprada et al. (2015) [13] has studied the effect of coir fibre on split tensile strength of concrete. She has found that there increase in the split tensile strength of concrete by adding natural fibres in it. Her test results are shown below.

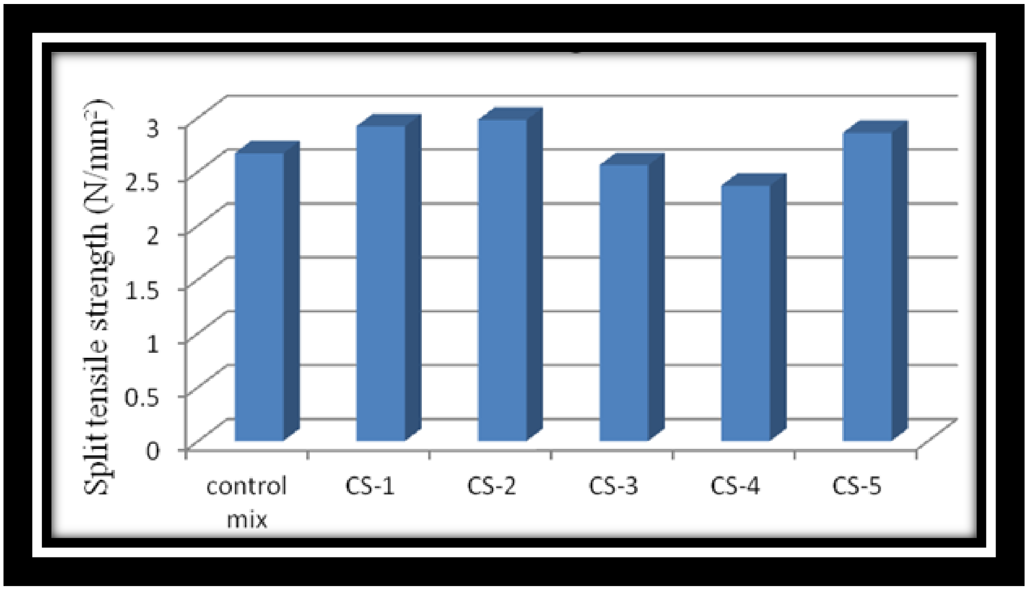

Fig.13 Split tensile strength of concrete at 28 days of curing (Jayapradaet al.2015)

From above figure it can be seen that the maximum value of flexural strength was found to be at CS-2 which was corresponding to 0.75 percent of sisal fibre and 0.25 percent of coir fibre and flexural strength at CS-2 was 2.981/mm^2.

CHAPTER 3

MATERIALS AND RESEARCH METHODOLOGY

3.1 General

Various tests have been performed to find out the properties of the aggregate used and on cement. After doing tests on aggregate and cement casting has done and compressive as well as tensile strength of concrete by adding CF and steel slag has been find out.

3.2 Materials

3.2.1 Portland Cement

Cement used is ordinary Portland cement. Portland cement concrete mixture is used as a binder. To make the design mix it is necessary to examine the physical and chemical properties of concrete. Therefore specific gravity, fineness of cement, Consistency of cement is checked. Usually three cement grade are OPC 33,43, 53 are available in the market. OPC 43 grade is used by me for making concrete. Grade 43 means that the when compressive strength of cement sand mortar cube of size $50mm^2$(face area) is measured it should not less than 43 MPa. Various tests are carried out to find out the properties of cement. The values obtained of these tests are shown below.

Table: 9 properties of cement

Sr no.	Properties	Values
1	Fineness test	5.28
2	Specific gravity test	3.15
3	Water absorption test	3.5%
4	Setting time	43 min(initial), 183 min(final)

3.2.2 Aggregate

Aggregates are the materials basically used as filler with binding material in the production of mortar and concrete. Aggregates from the body of concrete reduce the shrinkage and effect economy. They occupy 70 to 80% of the volume and have considerable influence on the properties of concrete. They should be clean, hard, strong, and durable and graded in size to achieve utmost economy from the paste. According to size aggregates are classified as coarse aggregates and fine aggregates.

3.2.3 Fine aggregates

The aggregates passing through 4.75mm sieve are defined as fine. They may be natural sand deposit by river, crushed stone sand obtained by crushing stones and gravel and gravel sand. Sand is essentially quartz. The smallest size of fine aggregates (sand) is 0.06mm.

Table: 10 Properties of fine aggregates

Sr no.	Properties	Values
1	Sieve analysis	Zone – 2
2	Specific gravity	2.65

3.2.4 Coarse aggregates

Aggregates retained on 4.75 mm sieve are identified as coarse aggregates. They are obtained by natural disintegration or by artificial crushing of rocks.The maximum size of aggregates can be 80 mm. Aggregates more than 20 mm are seldom used for reinforced cement concrete structural members. The aggregates remained washing away to eliminate dirt, dust and then dry to surface dry form. The angular shape aggregates are better resist the impact loads compared with flakiness and elongation aggregates.In this project I have usedboth 20 mm and 10mm size aggregates.

Table11. Properties of the coarse aggregates

Characteristics	Description
Water absorption	1.2%
Shape of the aggregates	Angular
Maximum size of the aggregates	20mm
Specific gravity of the aggregates	2.74

3.2.5 Water

The purpose of using water with cement is to cause hydration of the cement. Water in excess of that required for hydration act as lubricant between coarse and fine aggregates and produce a workable and economical concrete. In this project water used is potable water for making concrete.

3.3 Mix proportioning of M20 grade of concrete

Experimental values:

Specific gravity of cement = 3.15

Specific gravity of fine aggregates = 2.66

Specific gravity of course aggregates = 2.73

Concrete mix design of M20 grade of concrete.

1. Targeted mean strength

Fck = Fck+1.65*Standard Deviation

Fck = 20+1.65*4.5

= 27.42 N/mm^2

2. Water Cement ratio

Exposurte – mild

Minimum water content /m^3 of concrete =300kg

W/c ratio = 0.55

For 20 mm aggregates

Maximum water content / m^3 of concrete = 186 kg

Degree of workability = medium.

Slump value =50-100

Total water for 10mm slump = 6/100*186 =11.61 kg

Total = 186+11.61 = 197.16 kg

Now w/c ratio = 0.55

Cement = 197.19/0.55 = 394.32 kg

1. Water = 198 kg/m^3

2. Cement = 394.32 kg

3. W/c ratio = 0.55

4. Aggregates:

Course aggregates fraction =.60

Fine aggregates fraction = 1-0.60 = 0.40

5. Volume of concrete = $1m^3$

Volume of Cement = (395/2.92)*(1/1000) =$0.135m^3$

Volume of water =(198/1)*(1/1000) = $0.198m^3$

Volume of aggregates = 1-(0.135+0.198) = $0.667m^3$

Course aggregates = 0.677*0.61*2.74*1000 = $1132.285kg/m^3$

Fine aggregates = 0.677*0.39*2.65*1000 =$698.295kg/m^3$

Table: 12 Mix design for $1m^3$ of concrete

Water	Cement	Fine aggregates	Coarse aggregates
186 lts	394 kg	698.295 kg	1132.235 kg

Table:13 Workability of different mix proportions

Sr no.	Mix	Slump value
1	M20	74
2	M20 + 7% steel slag	65
3	M20 + 14% steel slag	59
4	M20 + 21% steel slag	48
5	M20 + 28% steel slag	35
6	M20 + 35% steel slag	22
7	M20 + 1% coir fibre	60
8	M20 + 2% coir fibre	44
9	M20 + 3% coir fibre	35
10	M20 + 7% steel slag + 1% coir fibre	39
11	M20 + 7% steel slag + 2% coir fibre	28
12	M20 + 7% steel slag + 3% coir fibre	22
13	M20 + 14% steel slag + 1% coir fibre	32
14	M20 + 14% steel slag + 2% coir fibre	23
15	M20 + 14% steel slag + 3% coir fibre	18
16	M20 + 21% steel slag + 1% coir fibre	33
17	M20 + 21% steel slag + 2% coir fibre	25
18	M20 + 21% steel slag + 3% coir fibre	21
19	M20 + 28% steel slag + 1% coir fibre	29
20	M20 + 28% steel slag + 2% coir fibre	29
21	M20 + 28% steel slag + 3% coir fibre	17

CHAPTER 4

EXPERIMENTAL WORK

4.1 Casting of specimen

In this project the experimental Studies consist of testing of 21 specimen (63 cubes and 63 cylinders 3 for each mix proportion) samples with 5 specimen of fine aggregates replaced with steel slag, 3 specimen of coconut fibre reinforced concrete, 11 specimens of composition of steel slag and coconut fibre with different proportions and 1 conventional specimen. All specimen cubes having same M20 grade of concrete. The concrete cubes having size of (150*150*150) mm3 and cylinder having size of 100 mm dia and 200 mm long.

Fig.14Concrete cube and cylinder mould

4.2 Mixing of normal concrete

The object of mixing is to make the concrete mass homogeneous and uniform in colour and consistency. All the aggregates particles should have a coat of cement paste and all ingredients of the concrete should blend into a uniform mass. In this work hand mixing is done. Measured quantities of coarse aggregate and fine aggregate are spread over the floor in alternate layers. Then cement is poured over it and ingredients are mixed dry with shovel until uniformity in colour is achieved. Then water is sprinkled. The mix is kept on turning over till uniform colour is achieved.

4.3 Mixing of concrete with replacement of steel slag

Mixing is done manually in lab. While mixing dry cement, coarse aggregates and fine aggregates mixed and then steel slag is added and after that water is added. First 7% steel slag is added by weight of fine aggregates and three cubes of this specimen are casted. After that 14%, 21%, 28 and 35% of steel slag is added to concrete in the same manner as explained above and three cubes of every specimen is prepared.

4.4 Mixing of concrete with coconut fibre

Before mixing fibre in concrete it is kept in water at least for 2 days because if it is added directly it will absorbed water from the concrete and affect the W/c ratio and ultimately will affect the strength of concrete. Mixing is done manually and random mixing of fibre is done. The coir fibre used have diameter 0.022cm, length 2.5 cm and having aspect ratio 113.

Fig.15 mixing of coir fibre with concrete

4.5 casting and curing

Cement gain strength and hardness because of the chemical action between cement and water. This chemical reaction requires moisture, favourable temperature and time referred to as the curing period. The process of keeping concrete damp for this purpose is called curing. In this work before casting the internal walls of the mould was oiled so that after hardening concrete don't get stuck with mould. After 24 hrs. specimen is remoulded and after that it is kept in water for 28 days of curing and then testing is done.

Fig.16 Concrete cube and cylinder after 28 days of curing

4.6 Testing for concrete cubes and cylinder

4.6.1 Compressive strength of concrete

Cement, fine aggregates and fine aggregates to be mixed for making concrete are brought to room temperature before commencing the test. The ingredients are weighted in ratio to be used and are mixed by hand mixing. First cement, sand and coarse aggregates are mixed thoroughly till a uniform colour is achieved. Water is then added and mixed until the concrete appears to be homogeneous and has a desired consistency.

Fig.17 Testing of cube in Compression testing machine

The test specimens are 150 * 150 * 150 mm cubes. The mixed concrete is filled into mould in three layers and compact after each layer to achieve maximum compaction. The test specimen is then kept in room temperature for 24 hrs. After that mould is removed from the specimen and it is kept in water for 28 days of curing. After that tenting is done on it. The specimens are tested immediately after taking out them from water with surface water wiped off.

Compressive strength = maximum load / cross-sectional area

4.6.2 Split tensile strength of concrete

The specimen is made of cylinder of dia. 100mm and height 200mm. the test consists of applying compressive line load along the opposite generators of the concrete cylinder placed with its axis horizontal between the platens as shown in fig. below. The load is applies at a rate so as to produce a tensile splitting stress of about 2.0 N/mm^2/minute until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The specimen finally fails by splitting along the load dia. The maximum load applied load is recorded. The split tensile strength is given by

$$T = 0.673 * P / D * L$$

Where P = Maximum load in N applied to the specimen

D = dia. Of specimen in mm

L = length of the specimen in mm

Fig.18 testing of cylinder in compression testing machine

CHAPTER 5

RESULT AND DISCISSION

5.1 General

The aim of this work was to find out the effect of coir fibre and steel slag to strength concrete. For this 21 different samples in which 63 cubes and 63 cylinders were casted and their results are compared with normal concrete of grade M20. The load at failure of each cube and cylinder is discussed. Testing of the specimens discovered that there is increase in the compressive as well as tensile strength of concrete by adding these materials.

5.2 Compressive strength test

For conducting this test cubes of size 150 mm * 150 mm * 150 mm are prepared. For this first cement, fine aggregates and coarse aggregates are mixed then water is added to them and mixed. And after that coir fibre and steel slag are added to them at different proportions as listed below. Then results are compared with the normal concrete of grade M20.

Table:14 Compressive strength at different proportion of coir fibre and steel slag

Sr. No.	MIX	28 days Compressive strength (N/mm^2)
1	M20	25.4
2	M20 + 7% steel slag	26.2
3	M20 + 14% steel slag	28.9
4	M20 + 21% steel slag	32.5
5	M20 + 28% steel slag	33.4
6	M20 + 35% steel slag	31.2
7	M20 + 1% coir fibre	27.0
8	M20 + 2% coir fibre	29.7
9	M20 + 3% coir fibre	26.8
10	M20 + 7% steel slag + 1% coir fibre	28.5
11	M20 + 7% steel slag + 2% coir fibre	29.7
12	M20 + 7% steel slag + 3% coir fibre	28.7
13	M20 + 14% steel slag + 1% coir fibre	29.2
14	M20 + 14% steel slag + 2% coir fibre	31.4
15	M20 + 14% steel slag + 3% coir fibre	29.5
16	M20 + 21% steel slag + 1% coir fibre	30.5
17	M20 + 21% steel slag + 2% coir fibre	32.4
18	M20 + 21% steel slag + 3% coir fibre	30.3
19	M20 + 28% steel slag + 1% coir fibre	32.5
20	M20 + 28% steel slag + 2% coir fibre	34.8
21	M20 + 28% steel slag + 3% coir fibre	31

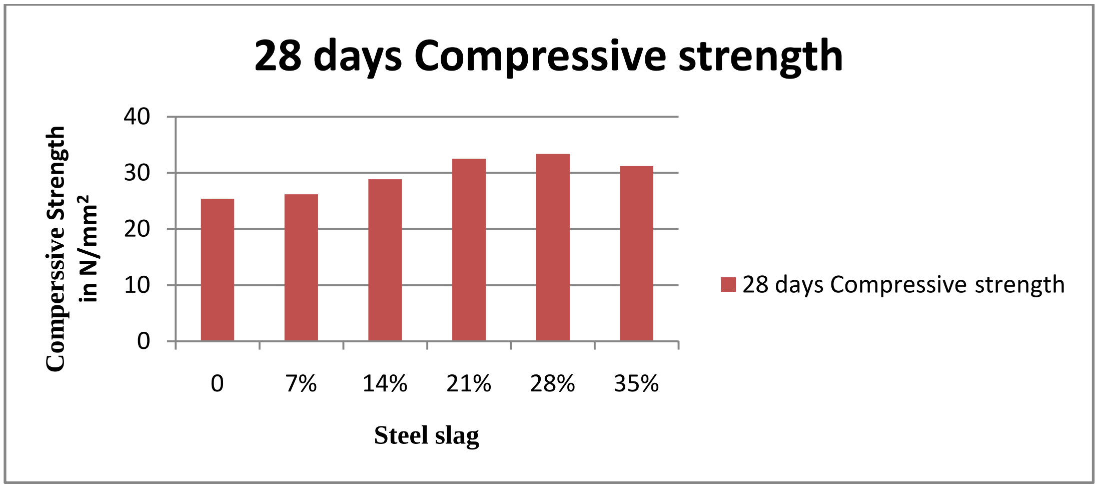

Fig: 19. 28 days compressive strength by replacement of fines by steel slag

According to this figure or graph it is clear that the value of compressive strength for 28 day with replacement of fine aggregates with the steel slag is start increasing with increase in the percentage of steel slag upto 28% and then it start decreasing. The maximum value of compressive strength is at 28% of the steel slag which was 33.4 N/mm^2.

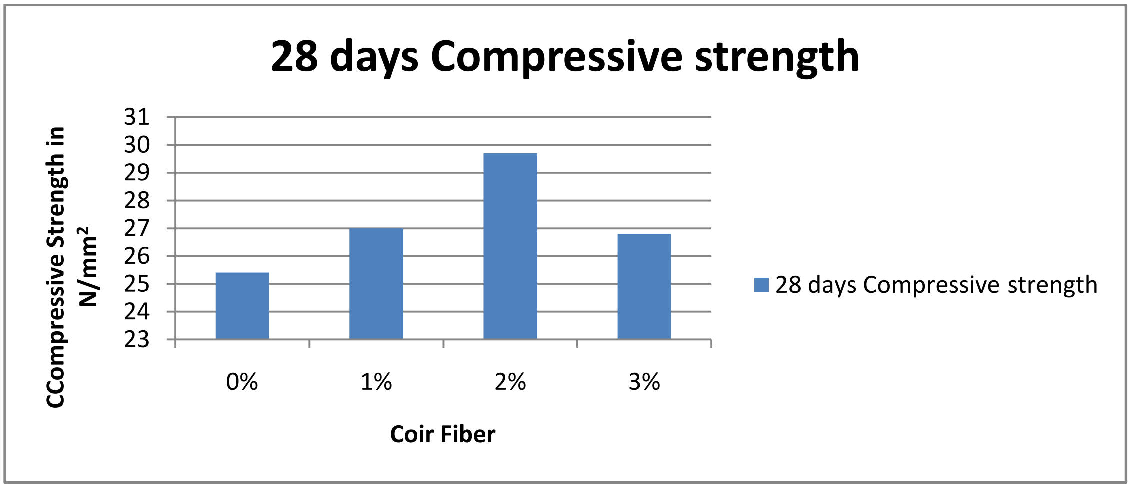

Fig: 20. 28 days compressive strength by adding coir fibre

According to this figure or graph it is clear that the value of compressive strength for 28 day with addition of coir fibre in M20 concrete is start increasing with increase in the percentage of coir fibre up to 2% and then it start decreasing. The maximum value of compressive strength is at 2% of the coir fibre. The maximum value of compressive strength with 2% of coir fibre is 29.7 N/mm^2. The decrease in value of compressive strength beyond 2% addition of coir fibre is because it will acquire more space in concrete matrix and there will be less space available for other materials and also it will become very difficult to mix the concrete.

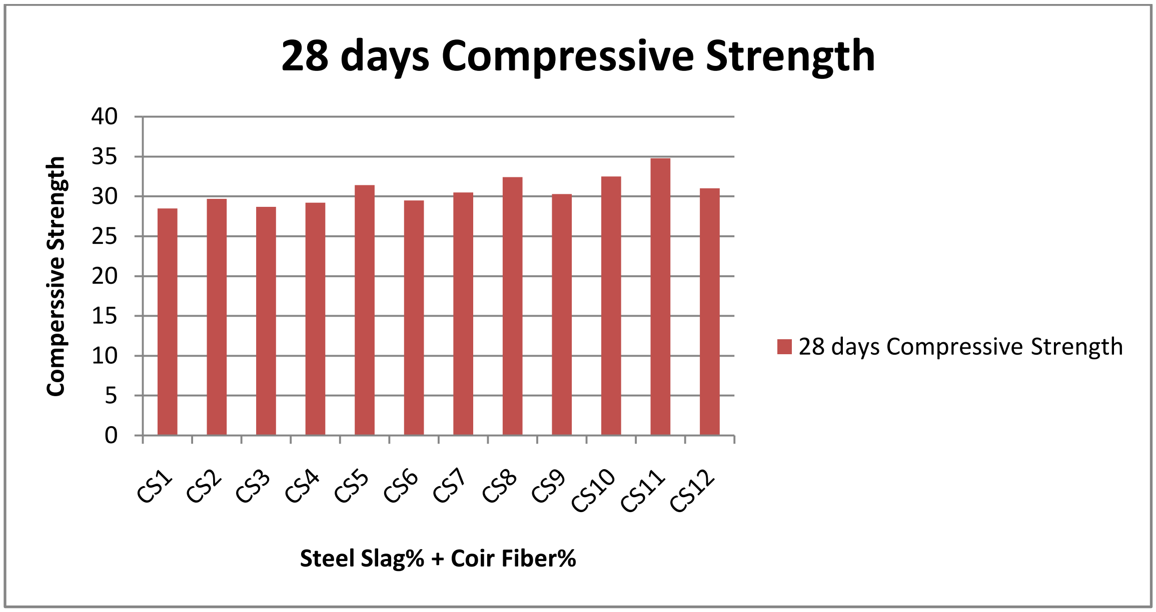

Fig.21 28 days compressive strength by adding coir fibre and steel slag

According to above figure it is clear that the value compressive strength for 28 days is vary when coir fibre is added and fine aggregates are replaced with the steel slag in M20 concrete. Variation is occurring when different percentage of coir fibre and steel slag is added. Sometimes the value of compressive strength is decreases or sometimes increases. But the maximum value of compressive strength is at CS11(28% steel slag + 2% coir fibre). Here CS1, CS2 and so on are the combination of both steel slag and coir fibre as explained below in table.

Table: 15 Different percentages of steel slag and coir fibre

Name	Steel Slag% + Coir Fibre%
CS1	7% + 1%
CS2	7% +2%
CS3	7%+ 3%
CS4	14% + 1%
CS5	14% + 2%
CS6	14% + 3%
CS7	21% + 1%
CS8	21% + 2%
CS9	21% + 3%
CS10	28% + 1%
CS11	28% + 2%
CS12	28% + 3%

As per above table CS1 is corresponds to replacement of 7% of steel slag and addition of 1% of coir fibre in the concrete. CS2 refers to 7 % of steel slag and 2% of coir fibre; CS3 refers to 7% of steel slag and 3% of coir fibre. Similarly CS4 refers to 14% of steel slag and 1% of coir fibre, CS5 refers to 14% of steel and 2% of coir fibre and CS6 refers to 14% of steel slag and 3% of coir fibre. CS7, CS8 and CS9 refer to 21% of steel slag each and 1%, 2% and 3% of coir fibre respectively. Similarly CS10, CS11 and CS12 refer to 28% of steel slag each and 1%, 2% and 3% of coir fibre respectively.

5.3 Split tensile strength test

For conducting this test cylinder of size 200 mm length and 100 mm dia. are prepared. For this first cement, fine aggregates and coarse aggregates are mixed then water is added to them and mixed. And after that coir fibre and steel slag are added to them at different proportions as listed below. Then results are compared with the normal concrete of grade M20.

Table: 16Tensile strength at different proportion of coir fibre and steel slag

S. No.	Mix	Tensile Strength (28 days)
1	M20	3.1
2	M20 + 7% Steel slag	3.8
3	M20 + 14% Steel slag	4.2
4	M20 + 21% Steel slag	5.5
5	M20 + 28% Steel slag	5.5
6	M20 + 35% Steel slag	4.5
7	M20 + 1% coir fibre	5.2
8	M20 + 2% coir fibre	6.4
9	M20 + 3% coir fibre	5.0
10	M20 + 7% Steel slag + 1% coir fibre	4.7
11	M20 + 7% Steel slag + 2% coir fibre	5.5
12	M20 + 7% Steel slag + 3% coir fibre	5.0
13	M20 + 14% Steel slag + 1% coir fibre	6.2
14	M20 + 14% Steel slag + 2% coir fibre	6.9
15	M20 + 14% Steel slag + 3% coir fibre	6.0
16	M20 + 21% Steel slag + 1% coir fibre	6.5
17	M20 + 21% Steel slag + 2% coir fibre	7.7
18	M20 + 21% Steel slag + 3% coir fibre	6.5
19	M20 + 28% Steel slag + 1% coir fibre	6.8
20	M20 + 28% Steel slag + 2% coir fibre	7.2
21	M20 + 28% Steel slag + 3% coir fibre	6.7

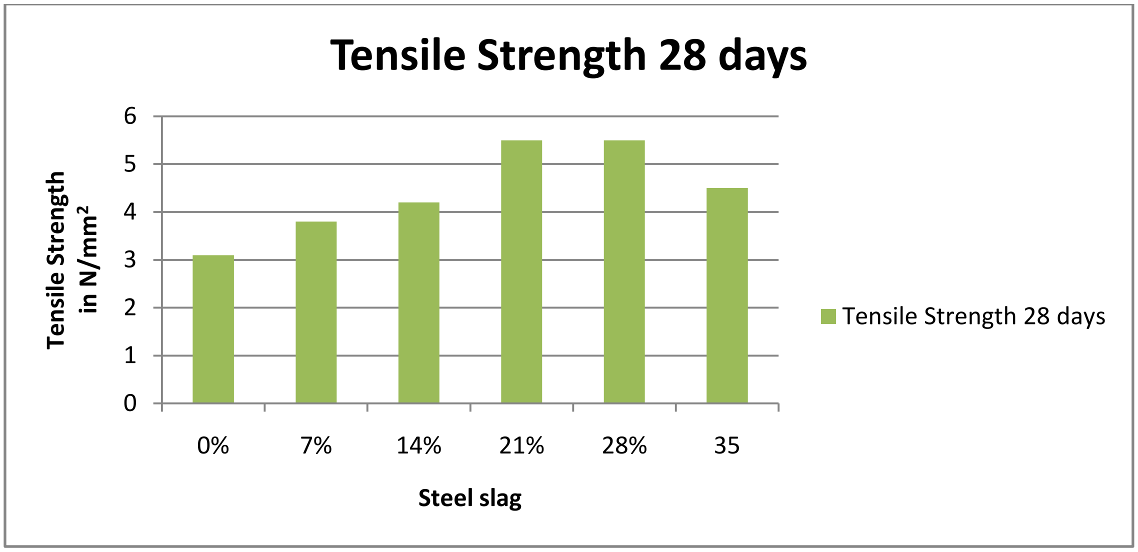

Fig.22 tensile strength of concrete with steel slag

According to this figure or graph it is clear that the value of tensile strength for 28 day with replacement of fine aggregates with the steel slag is start increasing with increase in the percentage of steel slag up to 28% and then it start decreasing. The maximum value of compressive strength is at 21% & 28% of the steel slag is 5.5 N/mm^2.

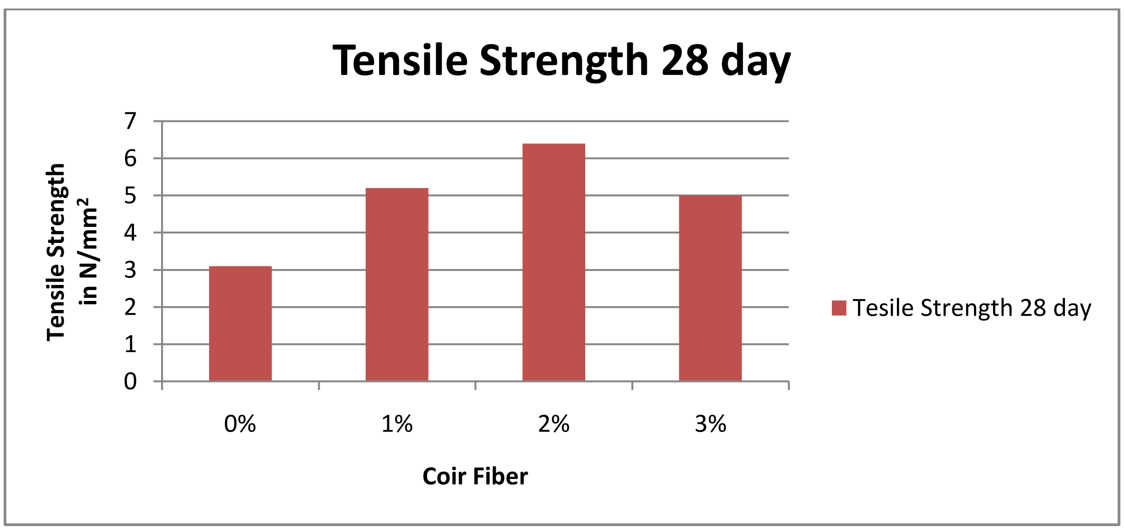

Fig.23 tensile strength of concrete with steel slag

According to this figure or graph it is clear that the value of tensile strength for 28 day with addition of coir fibre in M20 concrete is start increasing with increase in the percentage of coir fibre up to 2% and then it start decreasing. The maximum value of tensile strength is at 2% of the coir fibre is 6.4 N/mm^2.

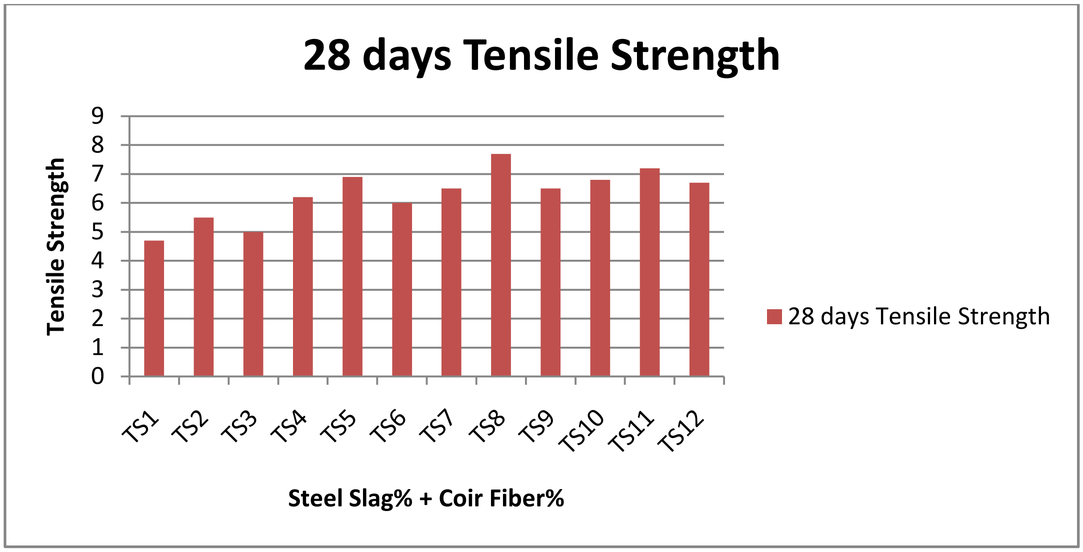

Fig.24 - 28 days tensile strength by adding coir fibre and steel slag

According to above fibre it is clear that the value tensile strength for 28 days is varying when coir fibre is added and replacement of the fine aggregates with the steel slag in M20 concrete. Variation is occurring when different percentage of coir fibre and steel slag is added. Sometimes the value of tensile strength is decreases or sometimes increases. But the maximum value of tensile strength is at TS8 (21% steel slag + 2% coir fibre) which was 7.7 N/mm^2.

Table: 17 Different percentages of steel slag and coir fibre

Name	Steel Slag% + Coir Fibre%
TS1	7% + 1%
TS2	7% +2%
TS3	7%+ 3%
TS4	14% + 1%
TS5	14% + 2%
TS6	14% + 3%
TS7	21% + 1%
TS8	21% + 2%
TS9	21% + 3%
TS10	28% + 1%
TS11	28% + 2%
TS12	28% + 3%

CHAPTER 6

CONCLUSION AND FURTHER SCOPE

6.1Conclusion

1 When coir fibre is added alone maximum compressive strength is obtained 29.7 N/mm^2 which was corresponds to 2% addition of coir fibre.

2. When steel slag is replaced with sand in concrete the maximum value of compressive strength is obtained at 28% of replacement level which was 33.4 N/mm^2.

3. When combination of both steel slag and coir fibre is used maximum value of compressive strength was obtained at 28% of steel slag and 2% of coir fibre.

4. Workability of concrete was decreasing when the materials used as alone as well as in combination also.

5. Maximum value of tensile strength when coir fibre is added alone was 6.4 N/mm^2 which was corresponds to 2% of coir fibre.

6. When steel slag is replaced with sand maximum value of tensile strength was at 21% and 28% of replacement.

7. When combination of both is used then maximum value of compressive strength was 7.7 N/mm^2 which was corresponds to 21% of steel slag and 2% of coir fibre.

6.2Future scope

The workability of concrete with fibres was found to be very less. Hence, it can be improved to have a better slump value air entraining agent and super plasticizers can be used so as to improve the flow characteristic of concrete. In steel making industries for every 1000 kg production of steel there is about 120 kg of waste material coming out in the form of steel slag so it can be best utilize in concrete to enhance its properties. Further the coconut coir and steel slag can be utilize to a large scale as steel slag and coconut coir are the waste product and hence can be available easily.

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