USE OF COCONUT SHELL AS COARSE AGGREGATE AND FLY ASH AS FINE AGGREGATE IN CONCRETE

A PROJECT

Submitted in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision of

DR.VEERESH GALI

(Professor)

and

DR. ASHISH KUMAR

(Associate Professor)

By

RAHUL KANDPAL (121603)

GAURAV KATHPALIA (121704)

to

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

WAKNAGHAT SOLAN – 173 234

HIMACHAL PRADESH INDIA

June, 2016

<u>MESSAGE</u>

LEARNING IS NOT ATTAINED BY CHANCE, IT MUST BE SOUGHT FOR WITH ARDOR AND ATTENDED TO WITH DILIGENCE

CERTIFICATE

This is to certify that the work which is being presented in the project title **“Use of coconut shell as coarse aggregate and fly ash as fine aggregate in concrete”** in partial fulfillment of the requirements for the award of the degree of Bachelor of technology and submitted in Civil Engineering Department, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by Rahul Kandpal (121603), Gaurav Kathpalia (121704) during a period from July 2015 to June 2016 under the supervision of **Dr. Veeresh Gali** Professor **& Dr. Ashish Kumar** Associate Professor, Civil Engineering Department, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of my knowledge.

Date: - ………………………

Prof. Dr. Ashok Kumar Gupta	**Dr. Veeresh Gali**	**Dr. Ashish Kumar**
Professor and head	**Professor**	**Associate Professor**
Dept. of Civil Engineering	Dept. of Civil Engineering	Dept. of Civil Engineering
JUIT	JUIT	JUIT

External examiner:

ACKNOWLEDGEMENT

This project report gives a detailed description of the study work done on the project topic **"USE OF COCONUT SHELL AS COARSE AGGREGATE AND FLY ASH AS FINE AGGREGATE IN CONCRETE"** for the partial fulfillment of the requirements for the degree of Bachelor of Technology in Civil Engineering, under the supervision of **DR VEERESH GALI AND DR. ASHISH KUMAR.**

We gratefully acknowledge the Management and Administration of Jaypee University of Information Technology, Waknaghat for providing us the opportunity and hence the environment to initiate and complete our project now.

We are very grateful to our Faculty Coordinator MR. ABHILASH SHUKLA for his help and able guidance regarding the project. We are also very grateful to the support and assistance provided by the team of talented and dedicated technical staff comprising Mr. Jaswinder Singh and Mr. Hitesh, Department of Civil Engineering.

RAHUL KANDPAL (121603)

GAURAV KATHPALIA (121704)

CONTENT

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

The high cost of conventional building materials is a major factor affecting housing delivery in the world. This has necessitated research into alternative materials of construction. In this study, coconut shell & fly ash is used as light weight aggregate in concrete. The properties of coconut shell and fly ash as aggregate in concrete is examined and the use of coconut shell and fly ash aggregate in construction is tested. The project aims at analyzing flexural and compressive strength characteristics of with partial replacement using M20 and M25 grade concrete. The project also aims to show that Coconut shell and fly ash aggregate is a potential construction material and simultaneously reduces the environment problem of solid waste. Beams are casted, tested and their physical and mechanical properties are determined. The main objective is to encourage the use of these "seemingly" waste products as construction material..

Chapter 1 Introduction

1.1 General

Infrastructure development across the world created demand for construction materials. Concrete is the premier civil engineering construction material. Concrete manufacturing involve consumption of ingredients, aggregates, water and admixture(s). Among all the ingredients, aggregates form the major part. Two billion tons of aggregate are produced each year the United States. Production is expected to increase to more than 2.5 billion tons per by the year 2020. Similarly, the consumption of the primary aggregate was 110 million tons in U.K in the year 1960 and reached nearly 275 million tons by 2006. Use of natural aggregate in such a rate leads to a question about the preservation of natural aggregates sources. In addition, operations associated with aggregate extraction and processing are the principal causes of environmental concerns. In light of this, in the contemporary civil engineering construction, using alternative materials in place of natural aggregate in concrete production makes concrete as sustainable and environmentally friendly construction material. Different alternative waste materials and industrial byproducts such as fly ash, bottom ash, recycled aggregates, foundry sand, china clay sand, crumb rubber, glass were replaced with natural aggregate and investigated properties of the concretes.

Apart from above mentioned waste materials and industrial byproducts, few studies identified that coconut shells, the agricultural by product can also be used as aggregate in concrete. According to a report, coconut is grown in more than 86 countries worldwide, with a total production of 54 billion nuts per annum. India occupies the premier position in the world with an annual production of 13 billion nuts, followed by Indonesia and the

Philippines. Limited research has been conducted on mechanical properties of concrete with coconut shells as aggregate replacement. However, further research is needed for better understanding of the behavior of coconut shells as aggregate in concrete. Furthermore, there is no study available in the literature on the transport properties which determine durability of the concrete. Thus, the aim of this work is to provide more data on the strengths coconut shell concretes at different coconuts shells (CS) replacements and study the transport properties of concrete with CS as coarse aggregate replacement. Furthermore, in this study, the effect of fly ash as cement replacement and aggregate replacement on properties of the CS replaced concrete was also investigated. The high demand for concrete in the construction using normal weight aggregates such as gravel and granite drastically reduces the natural stone deposits and this has damaged the environment thereby causing ecological imbalance, there is a need to explore and to find out suitable replacement material to substitute the natural stone. In developed countries, many natural materials are used in construction works as substitutes for natural stone aggregates. In India, commercial use of non-conventional aggregates in concrete construction has not yet started.

1.2 Literature review

On reading various research papers we found that there were a lot of studies conducted on waste materials and their use in construction field. Many researches were done on coconut shell and various tests were carried out on coconut shell when mixed in concrete. These tests were conducted on grades of concrete like M10, M20 and M30 etc. Apart from this, fly ash enhances properties of concrete. So we also studied research papers related to use of fly ash in concrete.

R. Nagalaxmi (2013**)** performed experimental study on strength characteristics on M25 concrete with partial replacement of cement with fly ash and coarse aggregate with coconut shell. For this test the beams of dimension 100mmX100mmX500mm were casted.

Alengaram (2014) carried out experimental study on development of light weight concrete using industrial waste material, palm kernel shell as light weight aggregate and its properties. This paper reports the results of an investigation conducted to utilize the PKS as lightweight aggregate to produce M30 grade concrete with density of about 1850kg/m^3.

Reddy et al. (2014**)** carried out experimental analysis of use of coconut shell as coarse aggregate. The concretes had low slump, the slump values of the concretes were between 20-26 mm. Flat shaped coconut shell particles restricted overall movement of aggregate particles and reduced workability.

Dandagala (2014) conducted laboratory investigation on coconut shell in concrete**.** The technique adopted for this study was batching by volume, using a standard mould of 150x150x150 mm for casting the cubes. The mould was assembled prior to mixing and properly lubricated for easy removal of hardened concrete cubes, which were prepared by volume of 0 or 100 percent for granite and coconut shell of the 1:1:2 mix ratio. . The cubes were cured for 3, 7, 14 and 28days and tests were performed.

1.3 Objectives

1. To get better understanding of the coconut shell and fly ash as a construction material.
2. To compare the properties of M20 & M25 concrete made with coconut shell and fly ash.
3. To prepare lightweight concrete by using coconut shell and fly ash.

1.4 Limitations

1. Study was carried out on M20 and M25.
2. Proportion of coconut shell was kept 10% and 20%.
3. Fly ash proportion was kept 20% constant.

Chapter 2 Literature Review

2.1 General

Today the word green is not just limited to color, it represents the environment, which is surrounding us. Concrete which is made from concrete wastes that are eco-friendly are called as **"Green concrete".** The other name for green concrete is resource saving structures with reduced environmental impact for e.g. Energy saving, CO_2 emissions, waste water. "Green concrete" is a revolutionary topic in the history of concrete industry. Concrete wastes like slag, power plant wastes, recycled concrete, mining and quarrying wastes, waste glass, incinerator residue, red mud, burnt clay, sawdust, combustor ash and foundry sand. Green Concrete is a term given to a concrete that has had extra steps taken in the mix design and placement to insure a sustainable structure and a long life cycle with a low maintenance surface. e.g. Energy saving, CO_2 emissions, waste water. To enable this, new technology is developed. There are a number of alternative environmental requirements with which green concrete structures must comply.

Researchers throughout the world have been investigating way of replacing aggregate to make construction sustainable and economical. Various researchers have investigated the use of coconut shell and their derivative in civil engineering construction. Coconut shell is an abundantly available agricultural waste from local coconut industries, so its disposal is a serious problem for local environment. So, these wastes can be used as replacement material in the construction industry. This will reduce cost of construction materials and solve the problem of disposal of wastes. Coconut shell is used as light weight aggregate in concrete. The properties of coconut shell and coconut shell aggregate concrete is examined and the use of coconut shell aggregate in construction is tested. Coconut shell exhibits more resistance against crushing, impact and abrasion compared to conventional aggregate. Density of coconut shell is in the range of 550-650 kg/m3 and these are within the specified limits for light weight aggregate. There is no need to treat the coconut shell before use as an aggregate except for water absorption. The presence of sugar content in the coconut shell, as long as it is not in a free sugar form, does not affect the setting and strength of concrete. Hydration test on coconut shell fines with cement indicates that the inhibitory index for coconut shell fines with cement can be classified as low and no pre-treatment is required. Coconut shell-cement ratio has been optimized to satisfy the criteria of structural light weight concrete.

2.2 Reviews

Various researches have been conducted in the past. A few of these are discussed in the following section.

R. Nagalaxmi (2013) performed experimental study on strength characteristics on M25 concrete with partial replacement of cement with fly ash and coarse aggregate with coconut shell. For this test the beams of dimension 100mmX100mmX500mm were casted. Flexural strength, also known as modulus of rupture, fracture strength, a mechanical parameter for brittle material, is defined as a material's ability to resist deformation under load. The flexural strength represents the highest stress experienced within the material at its moment of rupture. The beam tests are found to be dependable to measure flexural strength. To calculate the compressive strength of concrete cubes the universal testing machine (UTM) having capacity of 300 ton was used. In this test the strength obtained in ton. These specimens are tested by compression testing machine after 7 days curing, 14 days curing, 28 days curing and 56 days curing. Load should be applied gradually at the rate of 140 kg/cm^2 per minute till the specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

Gopal & Ranjan (2013) concluded compressive strength reduces with increase in percentage of coconut shell aggregate. The reduction is prominent even for 10%. ACI-1985 and 1995 overestimate the split tensile strength. The overestimation percentages increase with increase in percentages of CSA.3 ACI-1992 highly overestimates the split tensile strength. The flexural strength decreases with increase in percentage of coconut shell aggregates. The decrease is not prominent up to 10%. ACI- 1985 well predicts the flexural strength while IS-456-2000 and ACI- 1992 overestimate the flexural strength. The overestimation percentages increase with increase in percentages of RCA.

Alengaram (2014) carried out experimental study on development of light weight concrete using industrial waste material, palm kernel shell as light weight aggregate and its properties. This paper reports the results of an investigation conducted to utilize the PKS as lightweight aggregate to produce M30 grade concrete with density of about 1850kg/m^3. The properties of both PKS and crushed granite aggregates were compared. The concrete produced using PKS referred to here after as palm kernel shell concrete (PKSC) and its properties were compared with properties of normal weight concrete (NWC) of M30 grade produced using crushed granite aggregates. The fresh and hardened concrete properties such as density, workability, compressive strength of PKSC and NWC were compared. Further, structural behavior through flexural test was investigated. It has been found that PKSC has produced workable concrete and compressive strength of about 35MPa was obtained within 90 days. The addition of 10% silica fume has effect on both workability and strength. The as-cured density of PKSC was found 22% lower than the NWC. Further, the moment capacity of PKSC beams was found higher than NWC beams. In addition, the mode of failure observed in PKSC was ductile compared to the brittle failure of NWC beams. However, concrete obtained from coconut shells exhibited a higher compressive strength than palm kernel shell concrete in the two mix proportions. The results also indicated cost reduction of 30% and 42% for concrete produced from coconut shells and palm kernel shells, respectively.

Reddy et al. (2014) carried out experimental analysis of use of coconut shell as coarse aggregate where moisture content and water absorption were 4.20% and 24% respectively. The mixes were compactable. The fresh state performance of the CS concretes was comparable with control concrete. The concretes had low slump, the slump values of the concretes were between 20-26 mm. The slump decreased with increase in CS percentage. This observation suggests that addition of CS decreases workability and addition of fly ash either as cement replacement or aggregate replacement increases workability in CS concrete. The decreased workability of CS concretes may be due to CS particle shape. The workability was found to be increasing with increase in the replacement percentage of aggregates with coconut shell. Coconut shell concrete probably has better workability due to the smooth surface on one side of the shells and also due to the smaller size of coconut shells compared to conventional aggregates.

Dandagala (2014) conducted laboratory investigation on coconut shell in concrete**.** The technique adopted for this study was batching by volume, using a standard mould of 150x150x150 mm for casting the cubes. The mould was assembled prior to mixing and properly lubricated for easy removal of hardened concrete cubes, which were prepared by volume of 0 or 100 percent for granite and coconut shell of the 1:1:2 mix ratio. The moulded concrete cubes were given 24 hrs to set before demoulding. They were then immerse into a curing tank in order to increase the strength of the concrete, promote hydration, eliminate shrinkage, and absorb heat of hydration until the age of test. The cubes were cured for 3, 7, 14 and 28days. The cubes were then weighted before testing, while densities of the cubes at different times of testing were measured. Prior to testing, the specimen were brought out of the curing tank, left outside in an open air for about 3 hrs before crushing. Coconut shells can be used as full replacement of crushed granite or other conventional aggregates in concrete construction. There is no need to treat the coconut shell before use as an aggregate except for water absorption. It was observed that coconut shell concrete is showing 65% of compressive strength to that of normal concrete. The 28-days air-dry densities of coconut shell aggregate concrete are less than 2000 kg/m^3.

Dewanshu Ahlawat and L.G. Kalurkar (2014) analyzed coconut shell as partial replacement of coarse aggregate in Concrete. They concluded increase in percentage replacement by coconut shell reduces compressive strength of concrete, increase in percentage replacement by coconut shell increases workability of concrete. Coconut Shell can be used as partial replacement of coarse aggregate in R.C.C concrete. They also recommended effect of different admixtures can be studied on Coconut Shell Concrete (C.S.C) and evaluating Bond Strength of Coconut Shell Concrete (C.S.C) Coconut Shell-Cement compatibility.

Kambli (2014) from the experimental results and discussion, the coconut shell has potential as lightweight aggregate in concrete. Also, using the coconut shell as aggregate in concrete can reduce the material cost in construction because of the low cost and abundant agricultural waste. Coconut Shell Concrete can be used in rural areas and places where coconut is abundant and may also be used where the conventional aggregates are costly. Coconut shell concrete is also classified as structural lightweight concrete. It is concluded that the coconut shells are more suitable as low strength-giving lightweight aggregate when used to replace common coarse aggregate in concrete production. From one cube calculation bulk amount of shell replacement can be evaluated & reduces over all construction cost. This can be useful for construction of low cost housing society.

B. Rajeevan (2015) based on the limited number of experimental investigation carried out to determine the mechanical properties of concrete namely, compressive strength, split tensile strength and flexural strength of concrete, an optimum replacement of coarse aggregate with coconut shell aggregate, corresponding to the mix ratio 1: 1.63: 3.13, was determined as 15%. Cement content for 15% replacement was kept at 387 kg/m^3. The observed value of 28 day compressive strength, split tensile strength and flexural strength were 24.6 N/mm^2, 2.57 N/mm^2 and 2.89 N/mm^2 respectively. This indicates that concrete made with coconut shell aggregate has strength comparable with that of conventional concrete.

Vasoya & Varia (2015) investigated and cleared that these various wastes are suitable in the construction industry especially in concrete making. Industrial and agricultural waste materials such as fly ash, blast furnace slag, quarry dust, tile waste, broken glass waste, waste aggregate from demolition of structures, ceramic tiles, E-waste, waste paper mill pulp, iron filling, waste coconut shell, rice husk ash, marble dust powder, hypo sludge, machine crushed animal bones, chicken feather, eggs shell, granite quarry sludge, palm oil fuel ash, copper dust, human hair etc. are used in varying proportion as a partial replacement of concrete ingredients. Researchers have indicated their potential for usage in both structural and non-structural concrete. They were found to be performing better than normal concrete, in properties such as workability, durability, permeability and compressive strength. As disposal of wastes, by-products is a major problem in today's world due to limited landfill space as well as its escalating prices for disposal, utilization of these wastes in concrete will not only provide economy but also help in reducing disposal problems. They concluded that compressive strength in N/mm2 of coconut shell at 7, 14 21, and 28 days with mix ratios of 1:2:4, 1:1.5:3 and1:3:6 are (8.6, 8.9, 6.4), (9.6, 11.2, 8.7), (13.6, 13.1, 10.7) and (15.1, 16, 5, 11) respectively for gravel (19.1, 18.5, 9.6) (22.5, 23.0, 10.4) (26.7, 24.9, 12.9) and (28.1,30.0, 15) respectively. Since the concrete strength of coconut shell with mix ratio

1:1.5:3 attained 16.5N/mm^2 at 28 days it can be used as plain concrete. Hence cost reduction of 48% was obtained.

2.3 Concluding remarks:

- Following conclusion may be drawn on the basis of literature review:

  a) Increases the workability of concrete.

  b) Also show good relation between compressive strength and tensile strength.

  c) Water absorption capacity of concrete increases with addition of coconut shell.

  d) Also coconut shell is eco friendly product which don't cause any to nature

Chapter 3 Materials and Method

3.1 Introduction

The main aim of our project is to use the coconut shell as coarse aggregate and fly ash as fine aggregate in concrete. In order to achieve the objective, experiments in laboratory was conducted.

Coconut shell and fly ash in the concrete were added in proportion (10%, 20% in M20, M25, M25 with fly ash) while keeping fly ash content constant (20% in M25 grade concrete). The test on strength properties for these proportions was conducted.

3.2 Experimental program

Following experiments were carried out in laboratory for aggregates and concrete strength properties and their results were obtained.

- **First series of tests for aggregate**

1. Sieve analysis
2. Specific gravity

- **Second series of test for concrete**

1. Flexural strength
2. Compressive strength

Table 3.1: Shows the details of number of experiments conducted

Concrete mix for which cubes/beams casted	**No. of cubes casted for compressive strength**	**No. of beams casted for flexural strength**
M20	1	**1**
M20 with 10% coconut shell	**1**	**1**
M20 with 20% coconut shell	**1**	**1**
M25	**1**	**1**
M25 with 10% coconut shell	**1**	**1**
M25 with 20% coconut shell	**1**	**1**
M25 with 20% fly ash	**1**	**1**
M25 with 20% fly ash and 10% coconut shell	**1**	**1**
M25 with 20% fly ash and 20% coconut shell	**1**	**1**

3.3 Materials used

Different materials are used such as cement, aggregates, sand, coconut shell, fly ash. Tests will be conducted on M20, M25 and M25 concrete with fly ash. Cement will be replaced by fly ash by weight keeping 20% constant throughout in M25 concrete. In M20, M25 and M25 concrete with fly ash proportions of coconut shell will be varied as 10% and 20%. Curing of concrete would be done for 7 days and 28 days.

3.3.1 Cement

Cement must develop the appropriate strength. It must represent the appropriate rheological behavior. Generally same types of cements have quite different rheological and strength characteristics, particularly when used in combination with admixtures and supplementary cementing materials. Specific gravity of cement is 3.15

Figure 3.1: Cement used

3.3.2 Coarse aggregates

As coarse aggregates in concrete occupy 35 to 70% of the volume of the concrete it may be proper to categories the properties into two groups: exterior features (maximum size, particle shape, textures) and interior quality (strength, density, porosity, hardness, elastic modulus, chemical mineral composition etc.). Smaller sized aggregates produce higher concrete strength. Usually an aggregate with specific gravity more than 2.55 and absorption less than 1.5% (except for light weight aggregates) can be regarded as being of good quality. Where aggregates strength is higher, concrete strength is also higher.

Figure 3.2: Coarse aggregate used

3.3.3 Fine aggregates

Fine aggregate normally consists of natural, crushed, or manufactured sand. Natural sand is the usual component for normal weight concrete. In some cases, manufactured light weight particles used for lightweight concrete and mortar. The maximum grain size and size distribution of the fine aggregate depends on the type of product being made.

Figure 3.3: Fine aggregate used

3.3.4 Coconut shell

The coconut shells are obtained from a local coconut field. They are sun dried before being crushed manually. Coconuts show a wide diversity in size, weight, shape and color, depending on genetic variety and maturity of the nut at harvest. The particle sizes of the coconut shell range from 5 to 20 mm. The surface texture of the shell was fairly smooth on concave and rough on convex faces. The absorption of water in the concrete will not affect its strength since lesser voids can be formed. Moisture retaining and water absorbing capacity of Coconut Shell are more compared to conventional aggregate. The amount of cement content may be more when Coconut Shell are used as an aggregate the production of concrete compared to conventional aggregate concrete. Particle sizes of coconut shell used are 10 mm. Below is the figure 3.1 & 3.2 depicting the coconut shell used.

Figure 3.4: Coconut shell

Figure 3.5: Crushed coconut shell

3.3.5 Fly ash

Electricity is the key for development of any country. Coal is a major source of fuel for production of electricity in many countries in the world. In the process of electricity generation large quantity of fly ash gets produced and becomes available as a byproduct of coal-based power stations. It is a fine powder resulting from the combustion of powdered coal - transported by the flue gases of the boiler and collected in the Electrostatic Precipitators (ESP). Conversion of waste into a resource material is an age-old practice of civilization. The fly ash became available in coal based thermal power station in the year 1930 in USA. For its gainful utilization, scientist started research activities and in the year 1937, R.E. Davis and his associates at university of California published research details on use of fly ash in cement concrete. This research had laid foundation for its specification, testing & usages. Below is the figure showing fly ash used.

Figure 3.6: Fly ash used

3.4 First series of experiments for aggregate

Following are the details of the experiment carried and results are shown below.

(a) Sieve analysis

In this method we used 10mm tray, 4.75 mm tray to pass the coconut shell so that we can see that how much coconut shells are passing through each sieve and how much fine is the coconut shell that we are use to check the strength of cubes and beam and also the durability of the concrete and method of shaking the sieve is either horizontally or vertically .it can also be done using sieve shaker machine by this machine process can be done very quickly and very fast. The size distribution is often of critical importance to the way the material performs in use. A sieve analysis can be performed on any type of non-organic or organic granular materials including sands, crushed rock, clays, granite, feldspars, coal, soil, a wide range of manufactured powders, grain and seeds, down to a minimum size depending on the exact method. Being such a simple technique of particle sizing, it is probably the most common. Gradation affects many properties of an aggregate. It affects bulk density, physical stability and permeability. With careful selection of the gradation, it is possible to achieve high bulk density, high physical stability, and low permeability. This is important because in pavement design, a workable, stable mix with resistance to water is important. With an open gradation, the bulk density is relatively low, due to the lack of fine particles, the physical stability is moderate, and the permeability is quite high. With a rich gradation, the bulk density will also be low, the physical stability is low, and the permeability is also low. The gradation can be affected to achieve the desired properties for the particular engineering application.

Following are the results obtained:

- 77.6% of the coconut shells are able to pass through the 10mm sieve for M20
- 80% of the coconut shells are able to pass through the 10 mm sieve for M25

Figure 3.7: Photo view of different sieves used

(b) Specific gravity

Specific gravity is the ratio of the density of a substance to the density of a reference substance; equivalently, it is the ratio of the mass of a substance to the mass of a reference substance for the same given volume. Apparent specific gravity is the ratio of the weight of a volume of the substance to the weight of an equal volume of the reference substance. Nonetheless, the temperature and pressure must be specified for both the sample and the reference. Pressure is nearly always 1 atm (101.325 kPa). Temperatures for both sample and reference vary from industry to industry.

It is done in the following steps:

a) It is done in the following steps first of all weight of empty tray is taken W_1 and then weight of tray with coconut shell is taken, W_2.

b) After that coconut shell is dipped in water using water bucket and weight that is taken using specific gravity meter, W_s.

c) After that empty weight of the bucket is also taken using specific gravity meter, W_3.

d) After that coconut shell are dried using cloth and kept in oven for oven dry for 24 hrs and weight is taken, W4.

Specific gravity of coconut shell = W_4/W_3-W_s = 1.17

Specific gravity of Fly ash (From code IS: 3812-1) = 2.36

3.5 Second series of experiment for concrete

(a) Compressive strength of concrete

Out of many test applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. For cube test two types of specimens either cubes of 15 cm X 15 cm X 15 cm or 10cm X 10 cm x 10 cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15 cm x 15cm x 15 cm are commonly used. This concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimens should be made even and smooth. This is done by putting cement paste and spreading smoothly on whole area of specimen. Below are the figures of mixing for concrete and cubes casted.

Compressive strength (N/mm^2) = load /area

Figure 3.8: Photo view of compressive testing machine

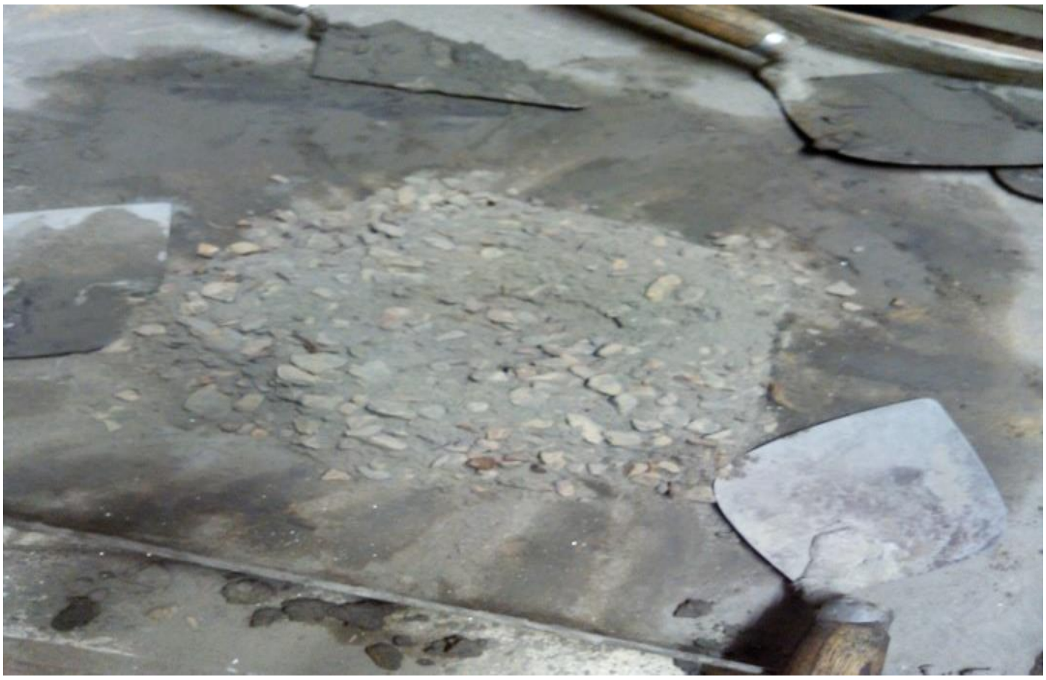

Figure 3.9: Photo view of mixing of concrete

Figure 3.10: Photo view of casting of cubes

(b) Flexural Test (Centre point load method)

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measured by loading 100x100x500mm concrete beams with a span length at least three times the depth. The flexural strength is expressed as Modulus of Rupture (MR) in psi (MPa) and is determined by standard test methods ASTM C 78 (third-point loading) or ASTM C 293 (center-point loading).

Flexural Strength of Concrete Flexural MR is about 10 to 20 percent of compressive strength depending on the type, size and volume of coarse aggregate used. However, the best correlation for specific materials is obtained by laboratory tests for given materials and mix design. The MR determined by third-point loading is lower than the MR determined by center-point loading, sometimes by as much as 15%. Below is the figure of beams casted.

$$\mathbf{F=Pl/bd^2}$$

P= max load (N)

l= length of beam (mm)

b= width of beam (mm)

d= depth of beam (mm)

Figure 3.11: Universal Testing Machine (UTM)

Figure 3.12: Casting of beams

Chapter 4 Results and Discussions

4.1 Introduction

A number of specimens were casted according to the mix design as calculated in the previous chapter and various tests were performed. Specimens related to M20, M25, and M25 concrete with fly ash (20% constant replaced with cement by weight) were casted. In these specimens coconut shell with different proportions i.e. 10% and 20% were added as coarse aggregate by weight. These were kept in curing tank for a period of 7 days and 28 days. Results were obtained when cubes were tested for their strength properties in CTM and UTM.

4.2 Flexural Strength Result

Specimen No. 1: M20 +Coconut shell

Following is the graph showing the result for M20 concrete with different proportions of coconut shell. Three samples were casted and cured for 7 days and 28 days. Graph below shows the flexural strength properties of M20 concrete with 10% coconut shell (CS) and 20% coconut shell (CS). 7 days and 28 days strength for normal M20 concrete are 5.4MPa and 5.9MParespectively. Similarly, 7 days and 28 days strength for M20 concrete with 10% coconut shell (CS) are 6MPa and 6.3 MPa. Also, 7 days and 28 days strength for M20 concrete with 20% coconut shell (CS) are 6.2MPa and 6.4MPa. Here we observe that flexural strength increases as percentage of coconut shell increases for M20 grade concrete. Figure 4.1 shows the graph plotted for the readings of the table 4.1 in appendix.

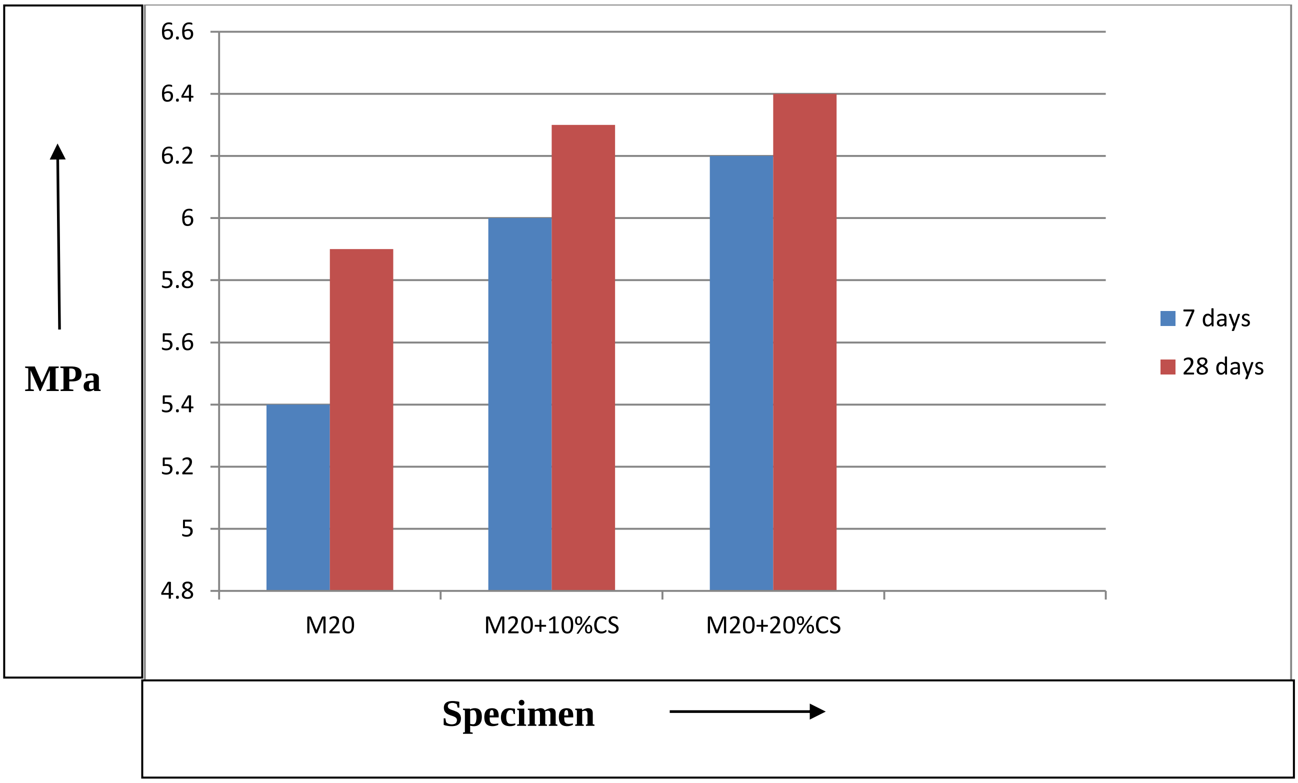

Figure 4.1: Flexural strength of M20 with coconut shell for 7 days & 28 days

Specimen No. 2: M25 +Coconut shell

Following is the graph showing the result for M20 concrete with different proportions of coconut shell. Three samples were casted and cured for 7 days and 28 days. Graph below shows the flexural strength properties of M25 concrete with 10% coconut shell (CS) and 20% coconut shell (CS). 7 days and 28 days strength for normal M25 concrete are 6.9MPa and 7.92MPa respectively. Similarly, 7 days and 28 days strength for M25 concrete with 10% coconut shell (CS) are 6MPa and 6.85MPa. Also, 7 days and 28 days strength for M20 concrete with 20% coconut shell (CS) are 5.6MPa and 6.4MPa. Here as higher grade of concrete is mixed with coconut shell strength decreases on increasing the percentage of coconut shell as compared to M20. Figure 4.2 shows the graph plotted for the readings of the table 4.2 in appendix.

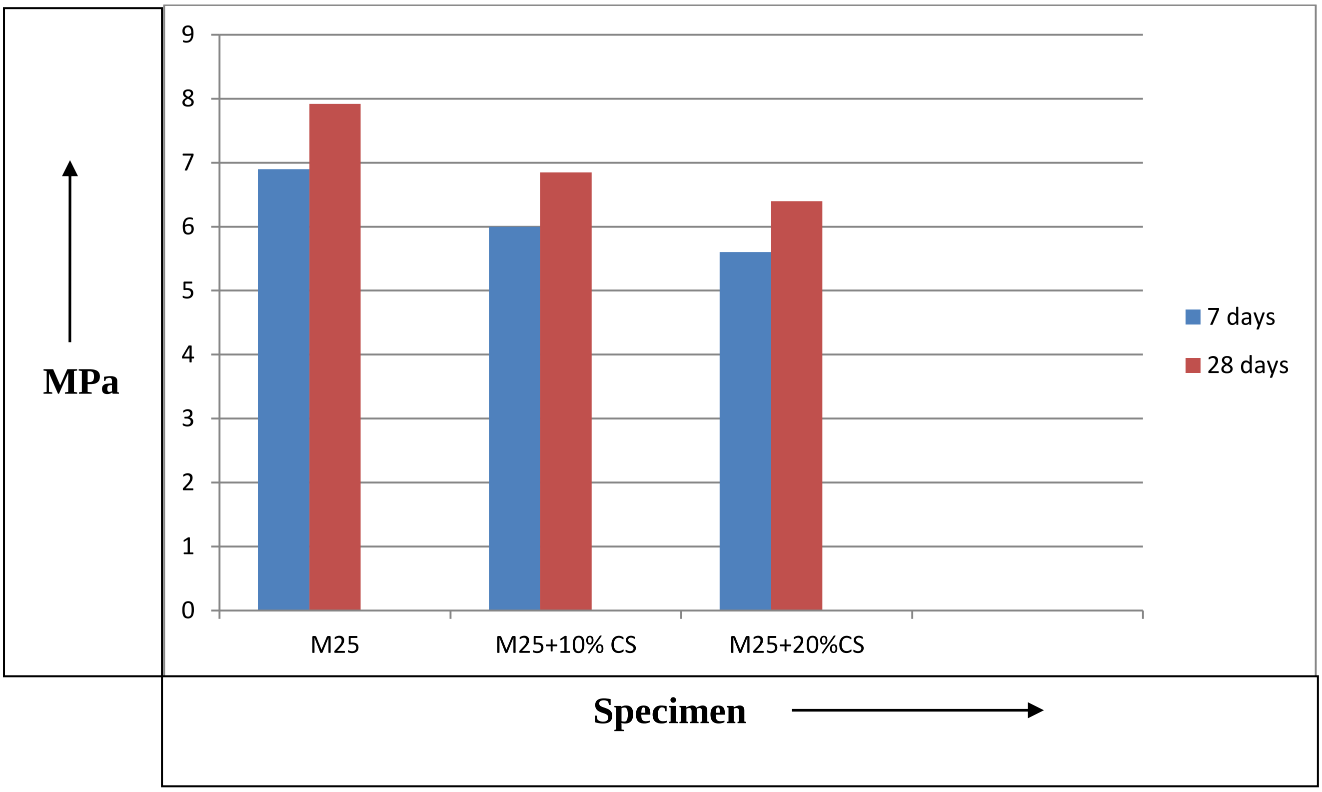

Figure 4.2: Flexural strength of M25 with coconut shell for 7 days and 28 days

Specimen No. 3: M25 + Coconut shell + Fly Ash

Following is the graph showing the result for M25 concrete with 20% fly ash kept constant and different proportions of coconut shell. Three samples were casted and cured for 7 days and 28 days. Graph below shows the flexural strength properties of M25 concrete with 20% fly ash concrete with 10% coconut shell (CS) and 20% coconut shell (CS). 7 days and 28 days strength for normal M20 concrete are 6.5MPa and 7.8MPa respectively. Similarly, 7 days and 28 days strength for M20 concrete with 10% coconut shell (CS) are 5.94MPa and 6.54MPa. Also, 7 days and 28 days strength for M20 concrete with 20% coconut shell (CS) are 5.2MPa and 5.98MPa. Addition of fly ash is here by decreasing more strength when compared to previous grade concrete strength. Figure 4.3 shows the graph plotted for the readings of the table 4.3 in appendix.

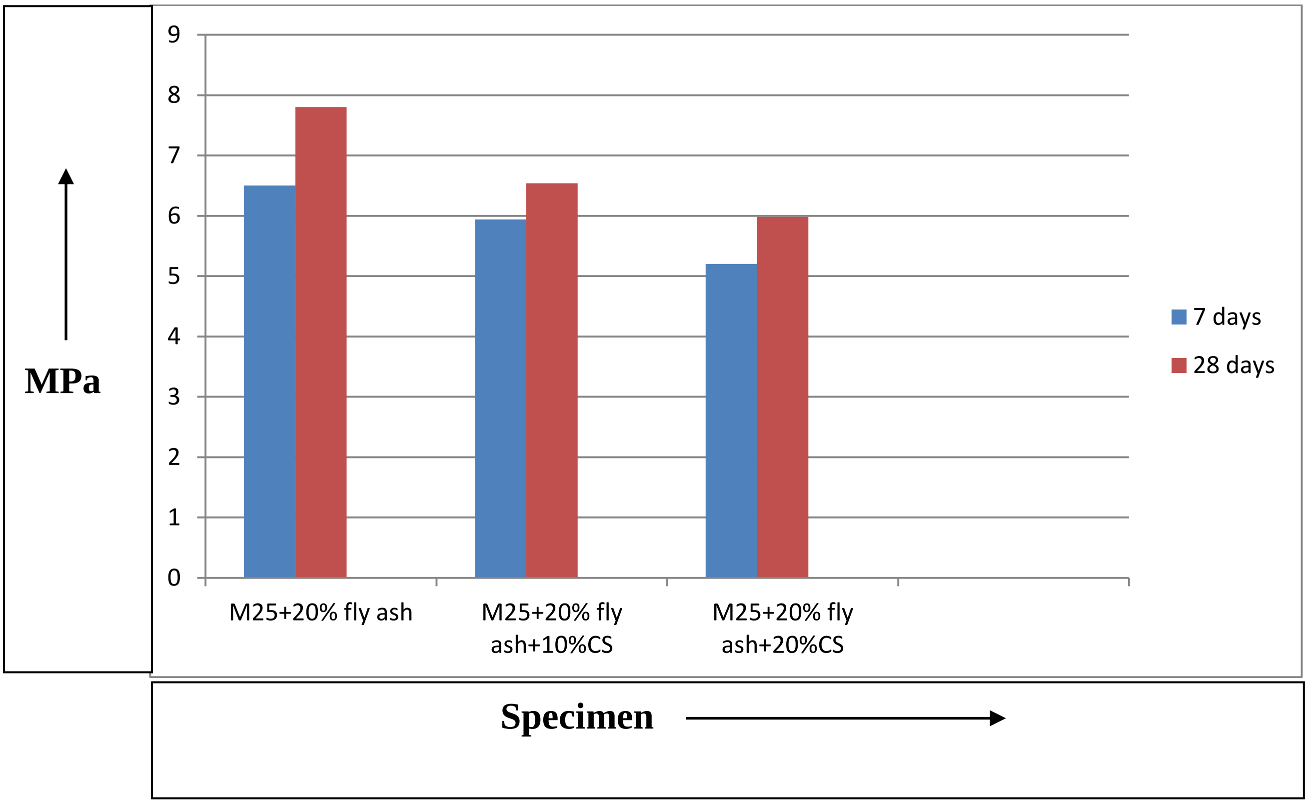

Figure 4.3: Flexural strength of M25 with fly ash and coconut shell for 7days & 28 days

Percentage increase in flexural strength

Here it is observed that there is an overall increase in percentage of flexural strength of all the samples when compared with the strengths of their respective normal grades. Figure 4.4 shows the graph plotted for the readings of the table 4.4, 4.5, 4.6 in appendix.

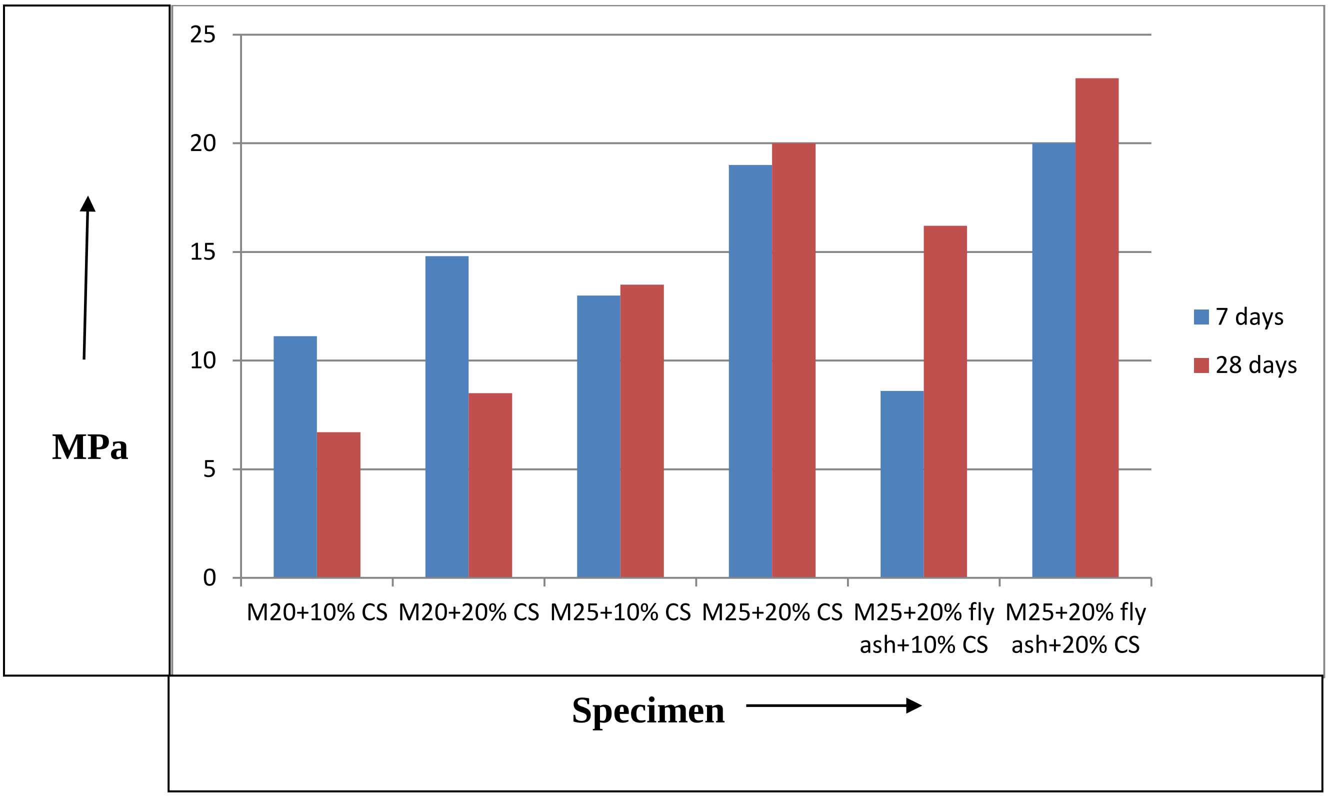

Figure 4.4: Increase in percentage for flexural strength of M20, M25, M25 with fly ash and coconut shell for 7 days and 28 days

4.3 Compressive Strength Result

Specimen No. 4: M20 +Coconut shell

Following is the graph showing the result for M20 concrete with different proportions of coconut shell. Three samples were casted and cured for 7 days and 28 days. Graph below shows the flexural strength properties of M20 concrete with 10% coconut shell (CS) and 20% coconut shell (CS). 7 days and 28 days strength for normal M20 concrete are 20.53MPa and 27.58MPa respectively. Similarly, 7 days and 28 days strength for M20 concrete with 10% coconut shell (CS) are 18.14MPa and 23.46MPa. Also, 7 days and 28 days strength for M20 concrete with 20% coconut shell (CS) are 16.83MPa and 20.95MPa. Here we observe that compressive strength decreases as percentage of coconut shell increases for M20 grade concrete. Figure 4.5 shows the graph plotted for the readings of the table 4.7 in appendix.

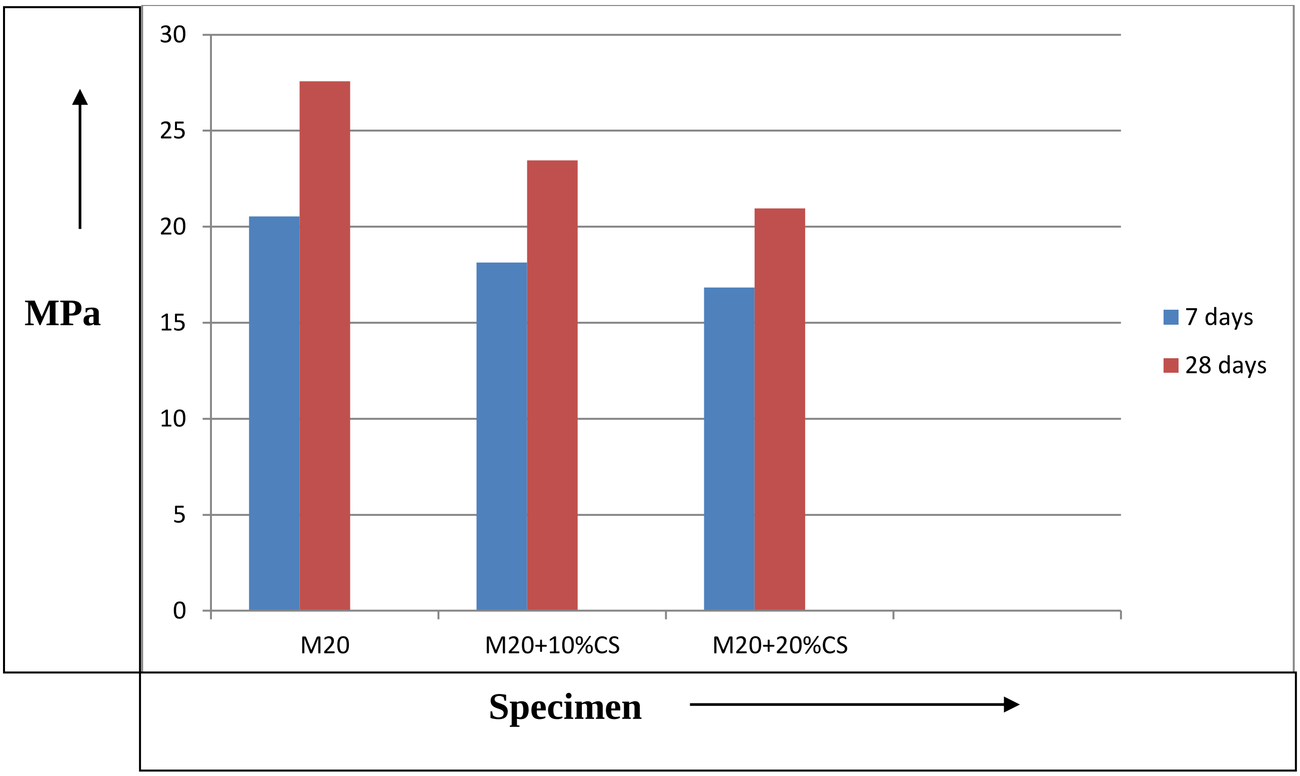

Figure 4.5: Compressive strength of M20 with coconut shell for 7 days & 28 days

Specimen No.5: M25 + Coconut shell

Following is the graph showing the result for M25 concrete with different proportions of coconut shell. Three samples were casted and cured for 7 days and 28 days. Graph below shows the compressive strength properties of M25 concrete with 10% coconut shell (CS) and 20% coconut shell (CS). 7 days and 28 days strength for normal M25 concrete are 25.77MPa and 34.10MParespectively. Similarly, 7 days and 28 days strength for M25 concrete with 10% coconut shell (CS) are 19.3MPa and 28.53MPa. Also, 7 days and 28 days strength for M25 concrete with 20% coconut shell (CS) are 15.8MPa and 22.32MPa. Here we observe that compressive strength decreases as percentage of coconut shell increases for M25 grade concrete. Figure 4.6 shows the graph plotted for the readings of the table 4.8 in appendix.

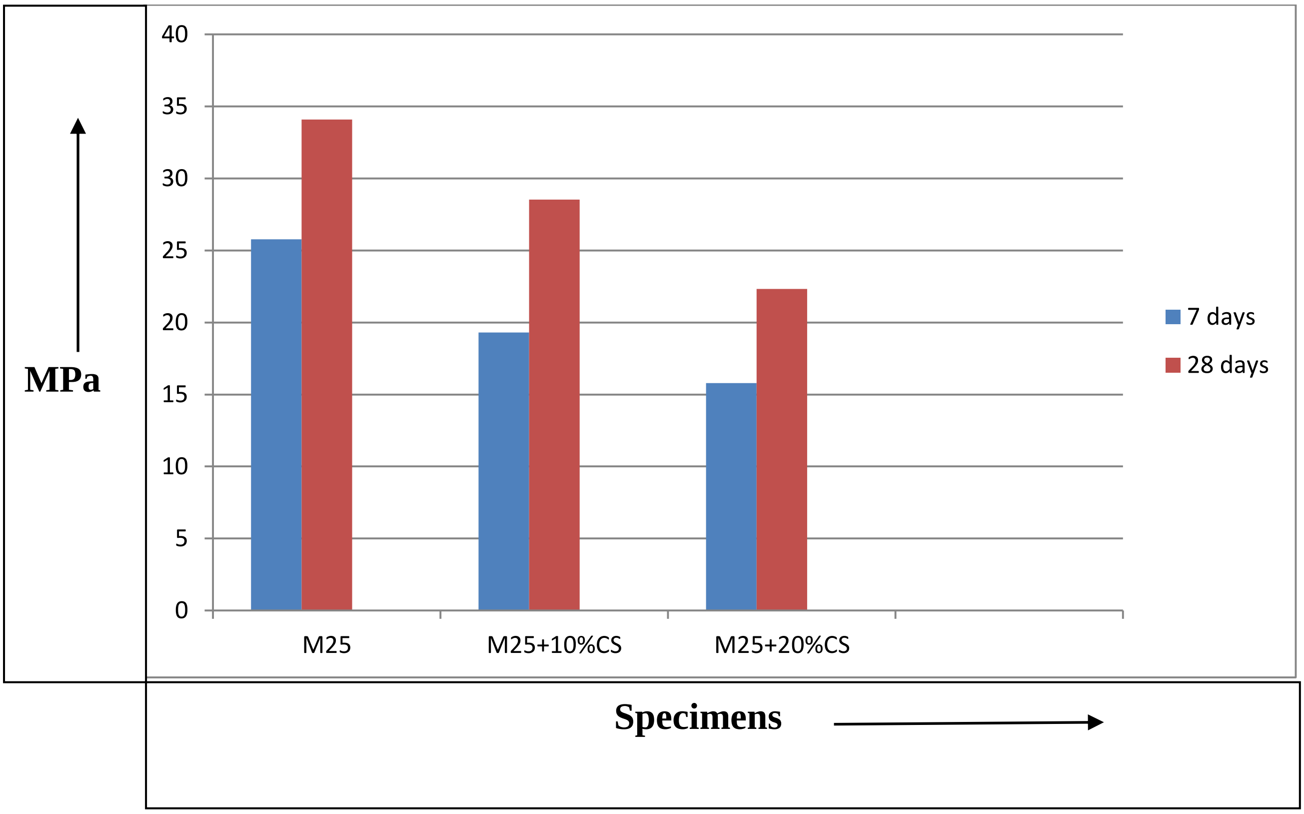

Figure 4.6: Compressive strength of M25 with coconut shell for 7 days and 28 days

Specimen No.6: M25 + Fly ash + Coconut shell

Following is the graph showing the result for M25 concrete with 20% fly ash kept constant with different proportions of coconut shell. Three samples were casted and cured for 7 days and 28 days. Graph below shows the compressive strength properties of M25 concrete with 20% fly ash and with 10% coconut shell (CS) and 20% coconut shell (CS). 7 days and 28 days strength for normal M25 concrete are 22.33MPa and 32.60MParespectively. Similarly, 7 days and 28 days strength for M25 concrete with 20% fly ash and with 10% coconut shell (CS) are 14.44MPa and 24.52MPa. Also, 7 days and 28 days strength for M25 concrete with 20% fly ash and with 20% coconut shell (CS) are 12.72MPa and 22.24MPa. Here we observe that compressive strength decreases as percentage of coconut shell increases for M25 grade concrete. So it can be concluded that higher grade of concrete results in lower strengths with increase in percentages of coconut shell. Figure 4.7 shows the graph plotted for the readings of the table 4.9 in appendix.

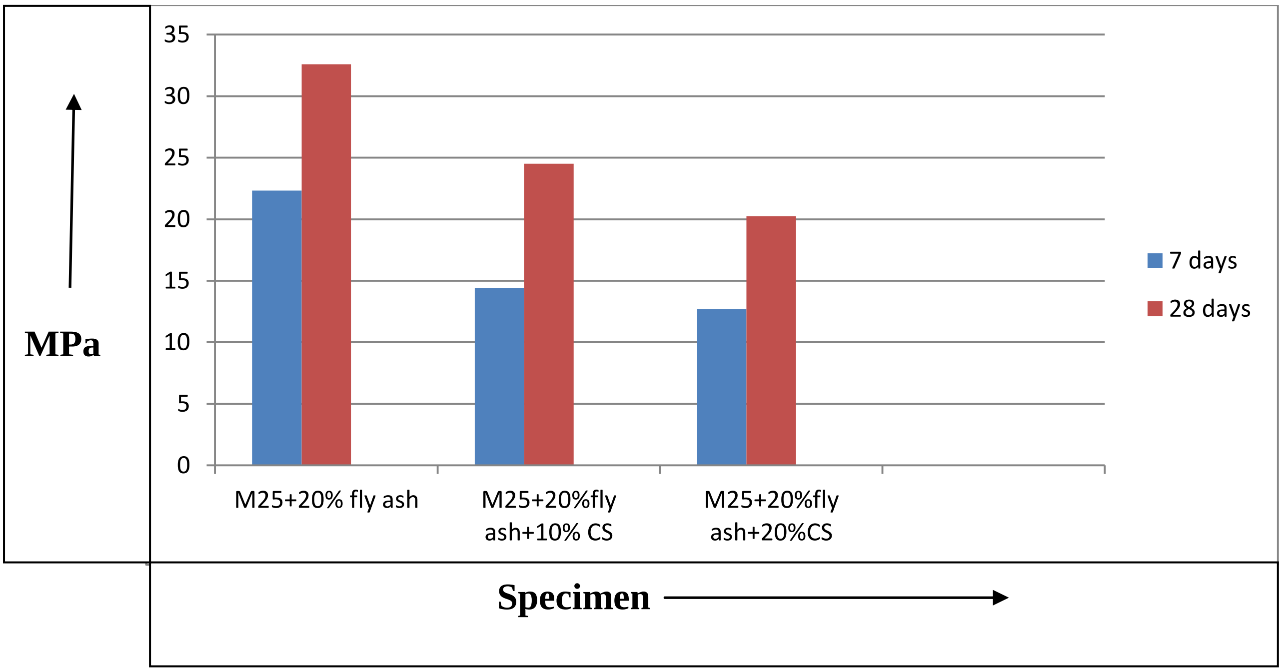

Figure 4.7: Compressive strength for M25 with fly ash & coconut shell for 7days & 28 days

Percent decrease in compressive strength

Here it is observed that there is an overall decrease in percentage of compressive strength of all the samples when compared with the strengths of their respective normal grades. Figure 4.8 shows the graph plotted for the readings of the table 4.10, 4.11, 4.12 in appendix.

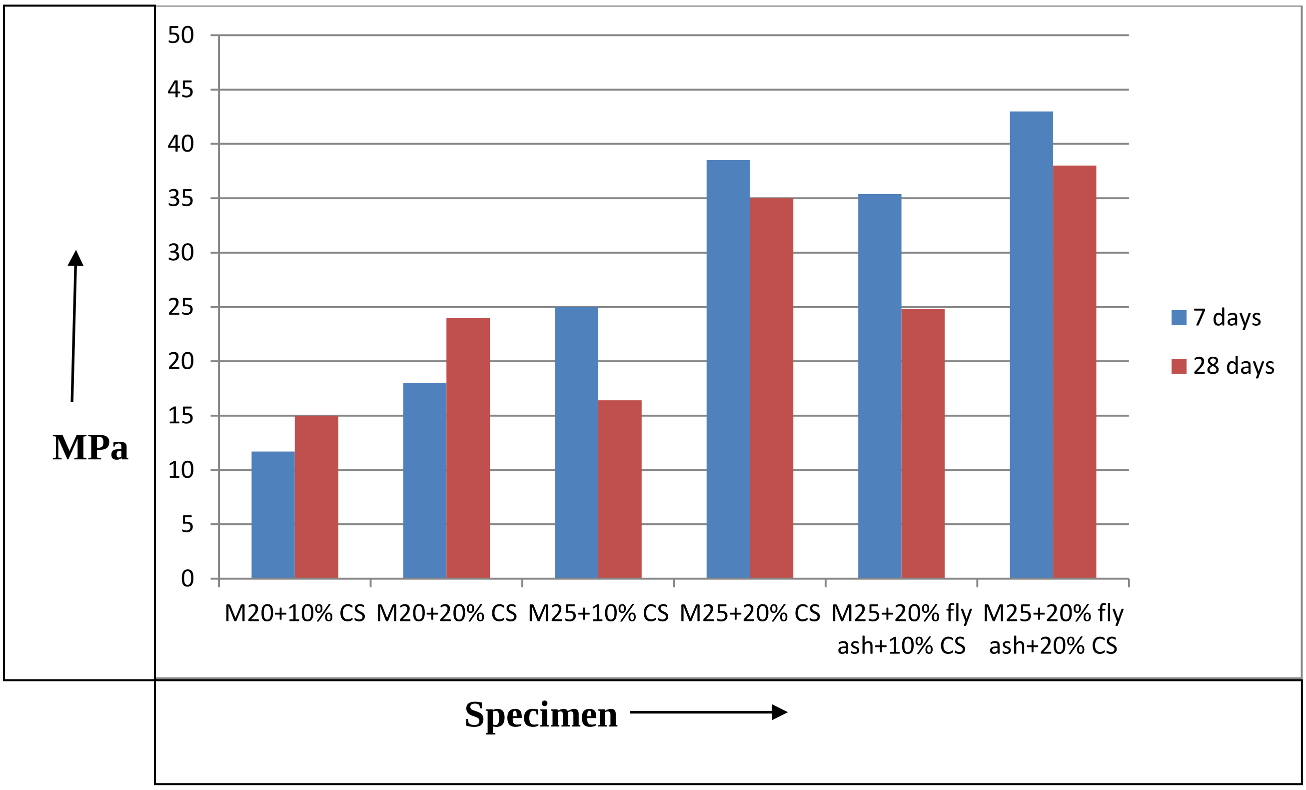

Figure 4.8: Decrease in percentage of compressive strength of M20, M25, M25 with fly ash & coconut shell for 7 days & 28 days

Chapter 5 Conclusions

In our study, we replaced coarse aggregate with coconut shell by weight and fly ash with cement. Specimens were casted by replacing 10%, 20% of coarse aggregate with coconut shells for M20, M25 concrete and constant proportion of 20% fly ash with 10%, 20% coconut shell in M25 concrete. Tests were conducted on the casted specimens after 7 days and 28 days as mentioned in the IS code. Tests for flexure, compression strength were conducted and results were obtained, also the test for specific gravity was conducted and results were obtained. Coconut shell concrete has better workability because of the smooth surface on one side of the shells and due to the smaller size of coconut shells. So we could possibly use coconut shell concrete in concretes where high workability is desirable. From the above results we can see that in CSC where 10% of the coarse aggregate is replaced, shows properties similar to the nominal mix and 20% replaced CSC & fly ash shows properties similar to light weight concrete which can be used as filler materials in framed structures.

Following points were concluded at the end of the project:

- These test result observed proved that the dispersion of coconut shell and fly ash in the concrete was perfect.
- Using fly ash and coconut shell showed that they improved workability, reduced external cracking and permeability.
- Both are cheaper and easily available
- Both reduced bleeding, adsorption and segregation of concrete.
- In case of coconut shell and fly ash flexural strength and compressive strength gets decreased.

Appendix

Mix Design

M-20 Concrete (1:1.5:3)

Specific gravity of cement = 3.15

Nominal Maximum aggregate size = 20mm

Exposure condition = moderate

Specific gravity of coarse aggregate = 2.88

Code used: IS10262 for mix designing of concrete.

Specific gravity of coconut shell = 1.17

Specific gravity of sand = 2.065

Cement grade 43

For cube 150x150x150 mm^3 for compressive strength test

Volume of cube mould = 0.00375 m^3

Density = mass/volume

Density of concrete (kg/m^3) = 2400

Mass = 2400 x 0.00375 kg = 9 kg

Water /cement = 0.5

Water = 1.5 x 0.5 = 0.700 ml

For normal M20

Volume of wet cement concrete = 1.54

Unit wt of cement = 1440 kg/m^3

Cement for 1 m^3 = [1/(1+1.5+3)]*1.54 = 0.29 x 1440 =415 kg/m^3

For 0.00375 m^3, cement required = 1.50 kg

Coarse aggregate (gravel) = 4.5 kg

Fine aggregate (sand) = 2.25 kg

For M20 with 10% Coconut Shell (CS)

Coconut shell = 10% replacement of coarse aggregate

= 0.450 kg

Cement = 1.5 kg

Coarse aggregate = 4.050 kg

Fine aggregate = 2.25 kg

For M20 with 20% coconut shell (CS)

Coconut shell = 20% replacement of coarse aggregate

=0.900 kg

Cement = 1.5 kg

Coarse aggregate = 3.600 kg

Fine aggregate = 2.25 kg

For beam 100X100X500 mm^3 for flexural strength test

Volume of beam mould = 0.005 m^3

Density of concrete (kg/m^3) = 2400

Mass = 2400 x 0.005 kg = 12 kg

Water /cement = 0.5

Water = 0.5 x 2.075 =1.080

For normal M20

Volume of wet cement concrete = 1.54

Unit wt of cement = 1440 kg/m^3

Cement for 1 m^3 = [1/(1+1.5+3)]*1.54 = 0.29 x 1440 =415 kg/m^3

For 0.005m^3, cement required = 2.075 kg

Coarse aggregate (gravel) = 6.23 kg

Fine aggregate (sand) = 3.12 kg

For M20 with 10% Coconut Shell (CS)

Coconut shell = 10% replacement of coarse aggregate

= 0.623 kg

Cement = 1.5 kg

Coarse aggregate = 5.600 kg

Fine aggregate = 2.25 kg

For M20 with 20% coconut shell (CS)

Coconut shell = 20% replacement of coarse aggregate

= 1.250kg

Cement = 1.5 kg

Coarse aggregate = 4.980 kg

Fine aggregate = 2.25 kg

M-25 Concrete (1:1:2)

Specific gravity of cement = 3.15

Nominal Mix aggregate size = 20mm

Exposure condition = moderate

Specific gravity of coarse aggregate = 2.88

Code used: IS10262 for mix designing of concrete.

Specific gravity of coconut shell = 1.17

Specific gravity of sand = 2.065

Cement grade 43

COMPRESSIVE TEST

For cube 150x150x150 mm^3

Volume of cube mould = 0.00375 m^3

Density = mass/volume

Density of concrete (kg/m^3) = 2400

Mass = 2400 x 0.00375 kg = 9 kg

Water /cement = 0.5

Water = 2 x 0.5 = 1000 ml

For normal M25

Volume of wet cement concrete = 1.54

Unit wt of cement = 1440 kg/m^3

Cement for 1 m^3 = [1/(1+1+2)]*1.54 = 0.29 x 1440 =554 kg/m^3

For 0.00375m^3, cement required = 2 kg

Coarse aggregate = 4 kg

Fine aggregate = 2 kg

For M25 with 10% Coconut Shell (CS)

Coconut shell = 10% replacement of coarse aggregate

= 0.400 kg

Cement = 2 kg

Coarse aggregate = 3.6kg

Fine aggregate = 2kg

For M25 with 20% coconut shell (CS)

Coconut shell = 20% replacement of coarse aggregate

=0.800 kg

Cement = 2 kg

Coarse aggregate = 3.2 kg

Fine aggregate = 2 kg

For M25 with 20% fly ash

Cement = 1.6kg

Fly ash = 0.400kg

Coarse aggregate = 4kg

Fine aggregate = 2kg

For M25 with 10% Coconut shell and 20% fly ash

Fly ash used = 0.400kg

Cement required = 1.6 kg

Coarse aggregate = 3.6kg

Fine aggregate = 2 kg

Coconut shell = 10% replacement of coarse aggregate

= 0.400 kg

For M25 with 20% Coconut shell and 20% fly ash

Fly ash = 20% replacement of coarse aggregate

= 0.400 kg

Cement = 1.6 kg

Coarse aggregate = 3.2 kg

Fine aggregate = 2 kg

Coarse aggregate = 20% replacement of coarse aggregate

=0.800 kg

FLEXURAL STRENGTH TEST

For beam 100X100X500 mm^3

Volume of beam mould = 0.005 m^3

Density of concrete (kg/m^3) = 2400

Mass = 2400 x 0.005 kg = 12 kg

Water /cement = 0.5

Water = 0.5 x 2.77 =1.035

For normal M25

Volume of wet cement concrete = 1.54

Unit wt of cement = 1440 kg/m^3

Cement for $1m^3$ = [1/(1+1+2)]*1.54 = 0.29 x 1440 =554 kg/m^3

For $0.005m^3$, cement required = 2.77 kg

Coarse aggregate = 5.54 kg

Fine aggregate = 2.77kg

For M25 with 10% Coconut Shell (CS)

Coconut shell = 10% replacement of coarse aggregate

= 0.554 kg

Cement = 2.77 kg

Coarse aggregate = 5 kg

Fine aggregate = 2.77 kg

For M25 with 20% coconut shell (CS)

Coconut shell = 20% replacement of coarse aggregate 1

= 1.108kg

Cement = 2.77 kg

Coarse aggregate = 4.5 kg

Fine aggregate = 2.77 kg

For M25 with 20% fly ash

Cement = 2.2 kg

Fly ash = 0.55 kg

Fine aggregate = 2 kg

Coarse aggregate = 4 kg

For M25 with 10% coconut shell and 20% fly ash

Cement = 2.2 kg

Fly ash = 0.55 kg

Fine aggregate = 2.77 kg

Coarse aggregate =5 kg

Coconut shell = 0.55 kg

For M25 with 20% coconut shell and 20% fly ash

Cement = 2.2 kg

Fly ash = 0.55 kg

Fine aggregate =2.77 kg

Coarse aggregate = 4.5 kg

Coconut shell = 1.10 kg

TABLE: 4.1 FLEXURAL STRENGTH OF M20 WITH COCONUT SHELL FOR 7 & 28 DAYS

Specimen	7 days (MPa)	28 days (MPa)
M20	5.4	5.9
M20 + 10% CS	6	6.3
M20 + 20% CS	6.2	6.4

TABLE: 4.2 FLEXURAL STRENGTH OF M25 WITH COCONUT SHELL FOR 7 & 28 DAYS

Specimen	7 days (MPa)	28 days (MPa)
M25	6.9	7.92
M25 + 10% CS	6	6.85
M25 + 20% CS	5.6	6.4

TABLE: 4.3 FLEXURAL STRENGTH OF M25 WITH FLY ASH & COCONUT SHELL FOR 7 & 28 DAYS

Specimen	7 days (MPa)	28 days (MPa)
M25 + 20% fly ash	6.5	7.8
M25 + 20% fly ash + 10% CS	5.94	6.54
M25 + 20% fly ash + 20% CS	5.2	5.98

TABLE: 4.4 INCREASE IN FLEXURAL STRENGTH OF M20 WITH COCONUT SHELL FOR 7 & 28 DAYS

Specimen	7 days	28 days
M20 + 10% CS	11.12%	6.7%
M20 + 20% CS	14.8%	8.5%

TABLE: 4.5 INCREASE IN FLEXURAL STRENGTH OF M25 WITH COCONUT SHELL FOR 7 & 28 DAYS

Specimen	7 days	28 days
M25 + 10% CS	13%	13.5%
M25 + 20% CS	19%	20%

TABLE: 4.6 INCREASE IN FLEXURAL STRENGTH OF M25 WITH FLY ASH & COCONUT SHELL FOR 7 & 28 DAYS

Specimen	7 days	28 days
M25 + 20% fly ash + 10% CS	8.6%	16.20%
M25 + 20% fly ash + 20% CS	20%	23%

TABLE: 4.7 COMPRESSIVE STRENGTH OF M20 WITH COCONUT SHELL FOR 7 & 28 DAYS

Specimen	7 days (MPa)	28 days (MPa)
M20	20.53	27.58
M20 + 10% CS	18.14	23.46
M20 + 20% CS	16.83	20.95

TABLE: 4.8 COMPRESSIVE STRENGTH OF M25 WITH COCONUT SHELL FOR 7 & 28 DAYS

Specimen	7 days (MPa)	28 days (MPa)
M25	25.77	34.10
M25 + 10% CS	19.3	28.53
M25 + 20% CS	15.8	22.32

TABLE 4.9: COMPRESSIVE STRENGTH OF M25 WITH FLY ASH & COCONUT SHELL FOR 7 & 28 DAYS

Specimen	7 days (MPa)	28 days (MPa)
M25 + 20% Fly ash	22.33	32.60
M25 + 20% Fly ash + 10% CS	14.44	24.52
M25 + 20% Fly ash + 20% CS	12.72	20.24

TABLE 4.10: DECREASE IN COMPRESSIVE STRENGTH OF M20 WITH COCONUT SHELL FOR 7 DAYS & 28 DAYS

Specimen	7 days	28 days
M20 + 10% CS	11.7%	15%
M20 + 20% CS	18%	24%

TABLE 4.11: DECREASE IN COMPRESSIVE STRENGTH OF M25 WITH COCONUT SHELL FOR 7 DAYS & 28 DAYS

Specimen	7 days	28 days
M25 + 10% CS	25%	16.40%
M25 + 20% CS	38.50%	35%

TABLE 4.12: DECREASE IN COMPRESSIVE STRENGTH OF M25 WITH FLY ASH & COCONUT SHELL FOR 7 DAYS & 28 DAYS

Specimen	7 days	28 days
M25 + 20% fly ash + 10% CS	35.40%	24.80%
M25 + 20% fly ash + 20% CS	43%	38%

REFERENCES

1. IS: 10262-2009, “Recommended Guidelines for Concrete Mix Design”.
2. IS: 456:2000, “Plain and Reinforced Concrete”.
3. IS 383-1970: ―Specifications for Coarse and Fine Aggregates from Natural Sources for Concrete.
4. Rashid, M. A.; Mansur, M. A.; Paramsivam, Correlations between mechanical properties of high strength concrete. Journal of Materials in Civil Engineering, May-June 2002, 230-238.
5. Filipponi P, Polettini A, Pomi R, Sirini P. Physical and mechanical properties of cement based products containing incineration bottom ash. Waste Management 2003; 23(2):145-156.
6. Dhir Rk Paine KA, Dyer TD, Tang MC. Value added recycling of domestic industrial and construction arising as concrete aggregate. Concrete Engineering International 2004; 8(1):43-48.
7. Khatib ZM. Properties of concrete incorporating fine recycled aggregate. Cement and Concrete Research 2005; 35(4):pp.763-769.
8. Andrade LB, Rocha JC, Cheriaf M. Evaluation of concrete incorporating bottom ash as a natural aggregates replacement. Waste Management 2007; 1190-1199.
9. Sumit A. Balwaik and S. P. Raut, “Utilization of Waste Paper Pulp by Partial Replacement of Cement in Concrete”, International Journal of Engineering Research and Applications,2007 Vol. 1, Issue 2, pp.300-309.
10. Jamshidi A., Mehrdadi N., Jamshidi, M., “Application of Sewage Dry Sludge as Fine Aggregate in Concrete”, Journal of Environmental Studies, Vol. 37, No. 59, Dec., 2011.