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# EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF CEMENT WITH CERAMIC WASTE POWDER AND COARSE AGGREGATE WITH COCONUT SHELLS

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**Abstract -** *Concrete is the most leading civil engineering material. Concrete manufactured by consuming the ingredients like cement, aggregates, water & admixture. The cost of natural resources has been increasing day by day. They have forced to focus on recovery, reuse of natural resources and to find other alternatives. The advancement in concrete technology reduces the consumption of natural resources and reduce the burden of pollutants in the environment. Cement is the main material which is used for binding. With the increase in demand and use of cement, scientists and researchers all over the world are always in quest for developing alternative binders or cement replacement materials. Coarse aggregates are the major part of concrete. There is very important need to explore and find out the apt material for natural stone substitution. In the present research, cement is replaced with 10% of ceramic waste and coarse aggregates are replaced with different percentages of coconut shells (10%, 20% & 30%). The following test results such as Compressive strength, flexural strength and split tensile strength of the replaced mixes were compared with normal concrete test results. The results from the study is expected to promote the use of ceramic waste powder as a substitute to cement and coconut shell as a substitute for conventional coarse aggregates. Finally, this project concludes that the compressive, Split tensile and flexural strength of concrete increases upto 10% replacement of cement with ceramic powder and coarse aggregate with coconut shells.*

***Key Words*: Coconut shells, ceramic waste powder, coarse aggregate replacement, cement replacement, Strength Characteristics.**

## 1. INTRODUCTION

From many years construction industry has been making some investigations in the utilization of waste materials as replacement in concrete. Proper utilization of waste material provides achievable economy and healthy environment. The first replacement used in this project is ceramic powder. The Indian ceramic industry production is 100 Million ton per year. The ceramic industry produces 15%-30% as waste material of the total production [1]. Different raw materials like china clay, ball clay, potash feldspar, dolomite, talc and different chemicals are used to prepare the ceramic products. The temperature used in Ceramic production is 200°C to 2000°C. The pozzolonic reactivity in such products is responsible for long term strength and good durability. The second replacement used in this project is coconut shells. The third largest producer of coconut products in the world is India. Researchers have also paid much attention towards some wastes from the agriculture to use as building construction material. In many tropical countries coconut shell (CS), is one of the most common agricultural solid wastes [2]. In the southern states of India Coconut trees are widely cultivated, especially in Kerala. Usage of Coconut shells as a substitute for coarse aggregates in concrete is reducing the waste products in the environment and finding an alternative for non-renewable natural stone aggregates. The properties of concrete using coconut shell as coarse aggregate were investigated in an experimental study and the study concluded coconut shell concrete can be classified under structural lightweight concrete [3]. Coconut shell contains ash, lignin, pentosans and cellulose in varying percentage when dried [4].

## 2. SCOPE AND OBJECTIVES OF THE STUDY

The main scope of the study is

- To examine the effectiveness of using Ceramic Waste Powder (CWP) and coconut shells (CS) as partial replacement by studying strength parameters.
- To study the necessity of waste material consumed for manufacturing sustainable concrete for construction.
- To reduce the cost of producing concrete by using locally available materials.

The main objective of the experimental investigation is to assess the utility of ceramic waste and coconut shells in the production of structural concrete.

To fulfill the objective, the work is aimed at the following.

- To carry out the mix design for medium grade M40 for both Conventional concrete and concrete on partial replacement of cement with ceramic waste and coarse aggregate with coconut shells.
- To Study the strength characteristics of concrete like compressive strength, split tensile strength and flexural strength.

- To arrive at the optimum percentage replacement of cement with ceramic Waste and coarse aggregate with coconut shells in the production of Structural Concrete.

## 3. MATERIALS

A. Cement:
Ordinary Portland Cement 53 grade was used in this project. Cement is a fine, grey powder. It is mixed with water and materials such fine aggregate, coarse aggregate and cement to make mortar and concrete. The binding material was formed by mixing cement and water.

B. Coarse aggregate:
Locally available crushed stones of 20mm as per IS 383-1970 are adopted. The physical properties of coarse aggregate like fineness modulus, specific gravity, gradation and are tested.

C. Fine aggregate:
Locally available river sand confirming to grading zone II of nominal size 1.18 mm as per IS 383-1970 [8].

D. Water :
Fresh concrete to be prepared with potable fresh water which is clean, colorless, odorless and free from harmful impurities such as oil, alkali, acid, etc.[5].

E. Coconut shells:
Coconut shells are collected and broken into pieces, air dried at a temperature of 20 - 25 degree Celsius for five days approximately and then fiber and husk was removed from dried shells. By using hammer chips were broken into small pieces and sieved through sieve analyzer. The material that is being replaced on behalf of coarse aggregate should pass through 20mm sieve and retained on 12mm sieve[6].

F. Ceramic tile powder:
The ceramic powder is a dumped solid waste and it is a industrial by – product. As the ceramic in landfill takes thousands of years to degrade and cause land pollution. Ceramic powder can also be obtained from the ceramic waste which cannot be recycled. The specific gravity of ceramic powder is found to be 2.95 and the fineness is found to be 7.5% [5].

G. Super plasticizer:
Conplast SP430 is used as the admixture. It is a brown liquid having the specific gravity of 1.18. It is high performance super plasticizing admixture having alkali content less than 55g [7].

FIGURE-1


FIGURE-2


FIGURE-3

## 4. DESIGN MIX

A mix for M40 grade was designed as per IS 10262: 2009 [9] and the same were used to prepare the test samples. The variation of strength of hardened concrete using ceramic waste powder as partial replacement of cement and coconut shells as a partial replacement to coarse aggregate is studied by casting 3 cubes, 3 cylinders and 3 prisms for each and every replacement. The specimens were tested for compression, split tensile and flexural strengths after curing period of 7days, 28 days, 56 days and 90 days as per the mix design. The quantities required for casting 3 cubes, 3 cylinders and 3 prisms for each percentage replacement are computed. The design mix proportion is done in table 1&table 2.

**Table -1: Design mix proportion for M40 mix**

| | W (Lit) | C Kg/m³ | F.A Kg/m³ | C.A Kg/m³ |
|---|---|---|---|---|
| By Volume | 0.43 | 1 | 1.48 | 2.81 |

W = Water, C = Cement,

F.A = Fine aggregate, C.A = Coarse aggregate

**Table -2: Concrete design mix (M40 mix) proportions**

| S. .No | Concrete type | Percentages | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | W/C ratio | C (%) | FA (%) | CA (%) | Adm-ixture (%) by weight of binder | CP (%) | CS (%) |
| 1 | $C_{(0,0)}$ | 0.4 | 1 | 1 | 1 | 0 | 0 | 0 |
| 2 | $C_{(10,10)}$ | 0.4 | 0.9 | 1 | 0.9 | 0.6 | 0.1 | 0.1 |
| 3 | $C_{(10,20)}$ | 0.4 | 0.9 | 1 | 0.8 | 0.6 | 0.1 | 0.2 |
| 4 | $C_{(10,30)}$ | 0.4 | 0.9 | 1 | 0.7 | 0.6 | 0.1 | 0..3 |

## 5. EXPERIMENTAL METHODOLOGY

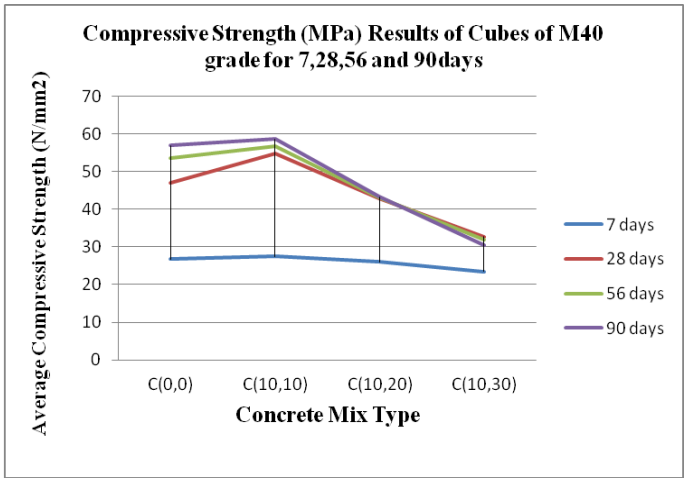
The experiment was conducted by replacing cement with 10% of ceramic waste powder and replacing different percentages of coconut shells(10%,20%,30%) with coarse aggregate. The results of concrete which is having different percentages of replacements compared with the results of conventional concrete. 3 cubes and 3 cylinders were casted for each and every replacement. After 24 hours the specimens were demoulded and curing was continued till the specimens were tested after 7, 28, 56 and 90 days for compression, flexural strength and split tensile strengths.

## 6. RESULTS AND DISCUSSIONS

Compressive strength test, Flexural strength test and Split tensile strength test were conducted at the end of 7, 28, 56 and 90 days on the concrete specimens. The test results and the related graphs are noted below:

**Table -3: Compressive Strength of Cubes for M40 mix**

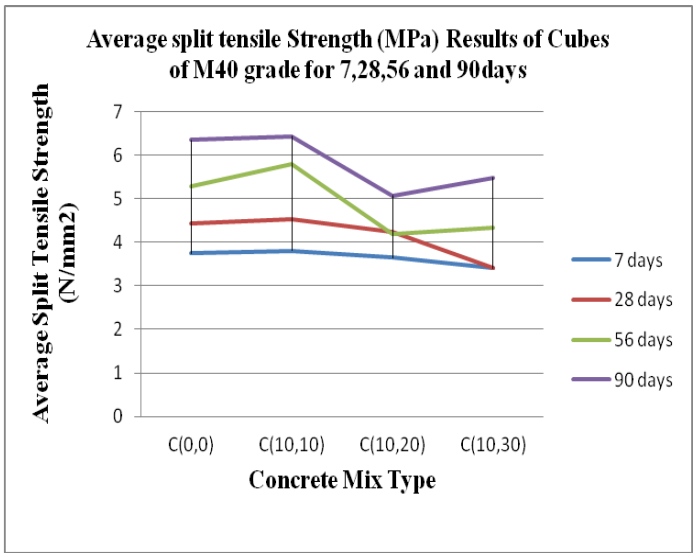
| Concrete type | Average Compressive Strength (N/mm2) | | | |
|---|---|---|---|---|
| | 7 days | 28 days | 56 days | 90 days |
| $C_{(0,0)}$ | 26.79 | 46.95 | 53.45 | 56.84 |
| $C_{(10,10)}$ | 27.45 | 54.86 | 56.76 | 58.66 |
| $C_{(10,20)}$ | 25.97 | 42.80 | 43.13 | 43.26 |
| $C_{(10,30)}$ | 23.43 | 32.68 | 31.97 | 30.36 |




**Graph-1**

**Table -4**: Split-Tensile Strength of Cylinders M40 mix

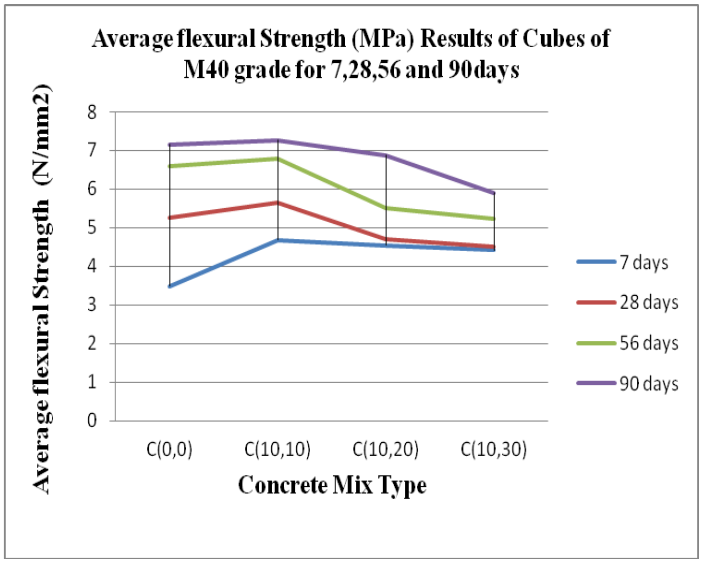
| Concrete type | Average Split-Tensile Strength (N/mm2) | | | |
|---|---|---|---|---|
| | 7 days | 28 days | 56 days | 90 days |
| $C_{(0,0)}$ | 3.74 | 4.42 | 5.29 | 6.35 |
| $C_{(10,10)}$ | 3.8 | 4.52 | 5.79 | 6.43 |
| $C_{(10,20)}$ | 3.65 | 4.23 | 4.2 | 5.07 |
| $C_{(10,30)}$ | 3.40 | 3.42 | 4.34 | 5.48 |




**Graph-2**

**Table -5**: Split-Tensile Strength of Cylinders M40 mix

| Concrete type | Average Split-Tensile Strength (N/mm2) | | | |
|---|---|---|---|---|
| | 7 days | 28 days | 56 days | 90 days |
| $C_{(0,0)}$ | 3.49 | 5.27 | 6.59 | 7.15 |
| $C_{(10,10)}$ | 4.68 | 5.65 | 6.79 | 7.27 |
| $C_{(10,20)}$ | 4.54 | 4.70 | 5.5 | 6.88 |
| $C_{(10,30)}$ | 4.42 | 4.50 | 5.23 | 5.90 |




**Graph-3**

## 7. CONCLUSIONS

The final conclusions that are made from this experimental study are

- It is observed that with increase in ceramic powder the workability of concrete has been decreasing.
- The Compressive strength of Concrete increases up to 10% replacement of cement by Ceramic waste powder and 10% replacement of coarse aggregate by coconut shells. The Compressive strength had been decreasing on further increase of the replacements.
- The Split Tensile strength of Concrete increases up to 10% replacement of cement by Ceramic waste powder and 10% replacement of coarse aggregate by coconut shells. The Split Tensile strength had been decreasing on further increase of the replacements.
- The Flexural strength of Concrete increases up to 10% replacement of cement by Ceramic waste powder and 10% replacement of coarse aggregate by coconut shells. The Flexural strength had been decreasing on further increase of the replacements.
- Finally it can be concluded that the unlimited usage of renewable resources can be reduced to some extent and the materials which are un-usable can be turned into the usable materials to reduce the environmental pollution.

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