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# BEHAVIOUR OF CONCRETE BY REPLACING AGGREGATES USING VERMICULITE AND INSULATOR WASTE

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**Abstract—** Concrete is the single most widely used building material throughout the world. Concrete is used in large amounts because it is only and extremely good building material. In this experimental study fine aggregate and coarse aggregate is partially replacement of vermiculite and ceramic waste. Use of vermiculite in concrete it will enhance the shrinkage and crack resistance, fire resistance and reduces environmental impact and also reduce the cost. In this study an attempt has been made to find the suitability of the ceramic waste as a possible substitute for conventional crushed stone Coarse aggregate. In this present study, an attempt has been made to study the mechanical properties of M30 grade concrete with 30% & 40% of partial replacement by vermiculite and ceramic waste .The concrete cubes is casted and tested for compressive strength after curing period of 7 &28 days. The integrated approach of working on safe disposal and utilization can lead to advantageous effects on the ecology and environmental also.

**Keywords—** vermiculite, insulator waste, compressive strength

## I. INTRODUCTION

Concrete is the basic civil engineering material used in most of the civil engineering structure. Many materials are used to manufacture good quality concrete. Cement, fine aggregate, coarse aggregate, mineral admixtures, chemical admixtures and water are the constituents of concrete. Cement is the most important constituent material, since it binds the aggregates and resists the atmospheric action. It is manufactured by calcining calcareous and argillaceous compounds at high temperature. Large amount of carbon dioxide gas is released in to the atmosphere by this process. It was found that 0.8 tons of co2 gas is released into the atmospheric with the manufactured of 1 ton of cement.

Fine and coarse aggregate make up the bulk of a concrete mixture. Sand, natural gravel and crushed stone are used mainly for this purpose. Recycled aggregates (from construction, demolition, and excavation waste) are increasingly used as partial replacements for natural aggregates, while a number of manufactured aggregates, including vermiculite and insulator waste are also permitted.

Aggregate generally occupy 60 to 80 percent of volume of concrete. River sand is most commonly used fine aggregate in the production of concrete poses the problem of acute shortage in many areas. In recent development the lightweight concrete is a versatile material, which offers a range of technical, economic and environmental advantages and is designed to become a dominant material in te millennium. For structural application of light weight concrete, the density is often more important.

A decreased density for the same strength level reduces the self weight, foundation size and construction cost. Structural light weight aggregate concrete is generally used to reduce dead weight of the structure as well as to reduce the risk of seismic damage to a structure because the seismic

forces that will influence the civil engineering structures are proportional to the mass of those structures.

### 1.1 VERMICULITE

Vermiculite is used as a replacement of fine aggregate. Vermiculite is a phyllosilicate mineral group. It was incorporated into home insulation products branded zonolite attic insulation in Canada. It belongs to the family of light weight aggregates. A decreased density for the same strength level reduces the self weight. It has high silica content and this lets out a strong constrain for replacing sand and good in bonding, covering of voids. It is typically platelets and its diameter is ranging from 0.04μ to 4mm. The particle shape and size mainly depended on the mineralogical phases and collection system. Characteristics of vermiculite is mainly based on its colour may be brown to golden brown, can also be white or yellow.

Used as an aggregate with Portland cement it forms an ultra lightweight concrete with an open structure idea for void filling suitable for use in most light industrial and domestic applications where thermal insulating and fire proof properties are required use around flue linings, behind fire backs and around pipes when fitting room heaters. Various types of vermiculite are available such as crude vermiculite, parabola vermiculite and expanded vermiculite.

A surface texture with tiny and uniformly distributed pores is preferred. Particle size and shape as well as surface condition of aggregate influence properties of fresh concrete. The strength of the lightweight aggregates particle decreases with decreasing density. On being suddenly heated to a high temperature of about 700-1000 C, the flakes expand due to steam forcing the lamination apart. The material produced consists of accordion granules containing many minute air layers.

#### 1.1.1 APPLICATION OF VERMICULITE

Vermiculite added to the garden or vermiculite in potting soil increase water and nutrient retention and aerates the soil, resulting in healthier, more robust plants. Add vermiculite to soil for conditioning and lightening either alone or in conjunction with peat or compost. This will accelerate the growth and promote anchorage for tender younger root system. Vermiculite spray coating is suitable for fire protection of structural steel columns, beams, metal ducts and cables as well as textures finishes. It is approved for both internal and external use, as well as acoustic and heat applications.

### 1.2 INSULATOR WASTE

Insulator waste is durable, hard and highly resistant to biological, chemical and physical degradation forces. As the ceramic waste in piling up every day, there is pressure on the ceramic industries to find a solution for its disposal. Meanwhile, conventional crushed stone aggregate reserves are depleting fast, particularly in some desert regions of the world. Use of inorganic industrial residual products in making concrete will lead to sustainable concrete design and greener environment. The need to develop concrete with non-conventional aggregates is urgent for environmental as well as economic reasons. Compressive strength was unchanged when ceramic waste was used to partially replace conventional crushed stone coarse aggregate. The main objective of this investigation is to study the performance of concrete with ceramic waste coarse aggregate.

### 1.3 BENEFITS OF THE MATERIAL

- Light weight material
- Posses a fire proof and insulation property
- Natural and easily available
- Reduce the cracking
- Largely eliminates autogenously shrinkage
- Better surface finish
- Low thermal conductivity
- Sound insulation property

### 1.4 SCOPE OF THE WORK

- To study compressive and flexural strength development of concrete by using vermiculite and insulator waste.
- To find out the optimum percentage of replacing materials.
- To minimize the utilization of cement and sand.
- To produce a light weight concrete

## II. MATERIALS USED

Material that go for making concrete for this study were tested before casting the specimens. The properties obtained from the tests were used in mix design.
The preliminary tests were conducted for the following materials.

### 2.1 VERMICULITE

Vermiculite is a hydrous phyllosilicate mineral. It undergoes significant expansion when heated. Vermiculite is chosen to replace fine aggregate in concrete because of its specific properties such as it is lighter in weight, improved fire resistance, improved resistance to cracking and shrinkage and mainly inert chemical nature. Vermiculites taken for concrete preparation which pass through 2.36mm sieve size. Vermiculite is used filler material and it is obtainable in golden brown, can also be white, colorless or yellow. Modern civil and industrial construction makes ever greater demands for building material for a variety of parameters such as less weight, efficiency, durability, environmental, fire safety, etc. To a large extent all the above qualities has modern building material expanded vermiculite. Due to its porous structure, expanded vermiculite is an excellent heat and sound insulator.

Fig.1. vermiculite

### 2.2 INSULATOR WASTE

Insulator waste was collected from manufacturing of electric transformer, in which ceramic insulator bushes are was done manually and made it into 20 mm and 12.5 mm size of aggregate. Centre part of these bushes has 20 mm thickness. Deglazing of insulator waste was done with chiseling and crushing.

Fig.2. insulator waste

## III. MIX DESIGN FOR M30 GRADE

| | |
|---|---|
| Cement | =350kg/m$^3$ |
| Water | =140 kg/m$^3$ |
| Fine aggregate | =873 kg/m$^3$ |
| Coarse aggregate | =1166kg/m$^3$ |
| Water cement ratio | = 0.40 |

## IV. CASTING AND TESTING OF CUBES

The quantities as per mix design are mixed with care and concrete cubes of size (150mmx150mmx150mm).The concrete specimens are cured for 7, 14 and 28 days in laboratory. Then concrete cubes are tested in laboratory to get their compressive strength values for various proportions.

**Fig.3. Casting of cube**

### 4.1 Testing of cube specimen

After curing harden concrete is tested in compression testing machine. The testing of cube is done for 7, 14, and 28 days.

#### 4.1.1 Compression strength test

Compression strength test is the most test conducted on hardened concrete, because it is easy to test and desirablecharacteristic properties of concrete are measured.

The cube specimen is of the size (150mmx150mmx150mm) isused for testing. The compressive strength test of concrete is done by using compressive testing machine. The specimen is placed in compression testing machine in such a way that load applied gradually in cast surface. The load at failure has been noted.

Compressive strength=(Failure load/Cross sectional area (N/mm$^2$)

**Compressive testing machine:**

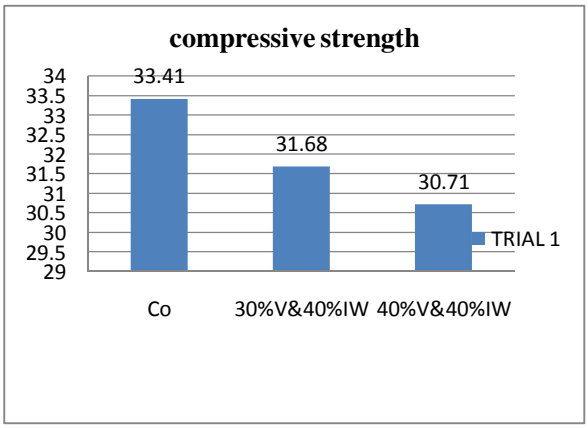
**Fig.4. Compressive testing machine**

## V. RESULT AND DISCUSSION

### TEST RESULTS OF COMPRESSIVE STRENGTH:

Compressive strength of concrete with various mix combination is determined at 7, 14 and 28 days for M30 grade of concrete. The result of compressive strength are given below in table:

**Compressive strength values of cubes for 28 days**




## CONCLUSION

- Based on this experimental investigation, it is found that vermiculite and insulator waste can be used as an alternative material to the fine aggregate and coarse aggregate.
- Use of vermiculite in concrete to gives a light weight concrete.
- The various strength parameters such as compressive strength of normal concrete in different combination of vermiculite and insulator waste are initially found out by using standard Indian codal provisions.
- Replacement of fine aggregate with vermiculite of 30% gives good further increases of vermiculite in concrete reduces the strength.
- Addition of vermiculites in concrete makes it heat resisting & resist shrinkage and cracks in concrete.
- Because of inert chemical nature of vermiculite when it is use in concrete it will not undergo any chemical reaction and also it is an eco-friendly material.
- The maximum compressive strength is obtained when 30% vermiculite and 40% ceramic waste aggregate was replaced with fine aggregate and coarse aggregate.
- Future work to be performed will include investigation of flexural strength of the concrete.

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