Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

Experimental Investigation on Partially Replacement of Cement and Fine Aggregate by Glass Powder and Vermiculite

P. Vanmathi[a] , A.Dharani[b]

[a]PG student (Structural Engineering),Department of Civil Engineering, Paavai Engineering College , Pachal.
[b] Assistant Professor, Department of Civil Engineering,Paavai Engineering College, Pachal.

-------------------------------------*************************-----------------------------------

Abstract:

Concrete is the most widely used manmade material in the construction industry. So, it is essential to utilize industrial by - products and waste products instead of concrete, which has many advantages. Waste glass from glass manufacturing industries can be grounded and used as an alternative for cement. Glass has high silica content, thus making it potentially pozzolanic. Finely ground glass does not contribute much to alkali - silica reaction, which can be prevented by adding mineral admixtures. Vermiculite is a low density material obtained by exfoliating rock. It can be used as replacement for fine aggregate because of it's specific properties such as light weight, improved workability, fire resistance.

This project work aims at studying the effects of replacing cement and fine aggregate by glass powder and vermiculite respectively in M_{35} grade concrete. Vermiculite is added in 12 %, 15 % and 18 % of fine aggregate and glass powder is added in 15 %, 18 % and 20 % of cement. The main objective is to analyse compression, splitting tensile and flexural strengths for various proportions of vermiculite and glass powder are compared with conventional specimens.

Keywords: Vermiculite ,glass powder

-------------------------------------*************************-----------------------------------

1.Introduction:

Environmental pollution is the major problem associated with rapid industrialization, urbanization and rise in living standards of people. Waste reduction and reuse have recently become the most preferable methods in solid waste management. Waste glass powder is a waste product obtained from glass company. This can be used in the reduction of using cement in concrete. Vermiculite is extracted from rocks. These are fine particles used in the reduction of using fine aggregate. These materials are eco friendly.

The increasing demand for cement mortar is met by partial cement & sand replacement. Substantial energy and cost savings can result when industrial by products are used as an admixture in mortar is known to impart significant improvements in workability and durability.

It is estimated that the production of cement will increase from about from 1.5 billion tons to 4.2 billion tons. Most of the increase in cement demand will be met by the use of supplementary cementing materials, as each ton of portland cement clinker production is associated with a similar amount of CO_2 emission.

Vermiculite is a hydrous phyllosilicate mineral. It under goes siginificant expansion when heated. Exfoliation occurs when the mineral is heated suffiently, and the effect is routinely produced in commercial furnaces. Large commercial vermiculite mi

2. MATERIAL USED

Cement

Cement is a material, generally in powder form, that can be made into paste usually by addition of water and when poured, will set into solid mass. Numerous organic compounds used for adhering or fastening materials, are called cement.

Fine Aggregate

Fine aggregate or sand is an accumulation of grain of material matter derived from the disintegration of rocks. It is distinguished from gravel only by the size of the grains or particles, but is distinct from clays which contain organic matter.

Water

Water fit for drinking is generally fit for making mortar. Water should be free from acids, oils, alkalis and organic impurities. Portable water is generally considered satisfactory for mixing concrete.

Vermiculite

It also occurs in carbonatites and metamorphosed magnesu m rich limestone. Associated mineral phases include : corundum,apatite ,serpentine and talc. It occurs interlayered with chlorite,biotite and phlogopite. Vermiculite is a clay, meaning it has two tetrahedral sheets for every one octahedral sheet and their properties are explained in Table. It is a limited-expansion clay with a medium shrink-swell capacity. Vermiculite is fire proofing material.

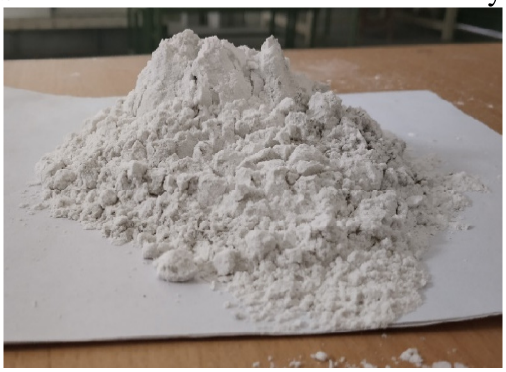
Properties of Vermiculite

Hardness	1.5 to 2
Colour	Gold Brown, green, yellow
Free Moisture	1.4
Water Absorption	6.33
Specific gravity	2.5

Vermiculite

Glass Powder

The cement industry is facing challenges such as cost increases in energy supply of raw materials in sufficient qualities. Usage of waste glass reduces the cost of cement and CO_2 production, thereby reducing global warming. When waste glass is milled down to micro size particles, it is expected to undergo pozzolanic reactions with cement hydrates, forming secondary Calcium Silicate Hydrate.



Glass Powder

Methodology

They studied the strength parameters such as compressive strength, split tensile and flexural strength of concrete using vermiculite as partial replacement with 40 %, 50 % and 60 % by weight. The main aim of this study is to make economical and eco-friendly concrete. The optimum strength in compacting the strengths for different vermiculite was observed to be 50 %. Addition of vermiculites in concrete makes it heat resisting and resists shrinkage and cracks in concrete**".** In this study, they conducted compressive strength tests on mortar and concrete by adding 0 to 25 % grounded glass, in which water to binder (cement +glass) ratio is kept constant. In this research, chemical properties of both clear and coloured glass were evaluated. The chemical compositions of clear and coloured glass powders are very similar. The optimum glass content is 20 % considering mortar and concrete compressive strength at 90 days. In this age, the compressive strength was found slightly higher (2 %) than the control specimen

Test on Specimen

Compressive strength test

The strength gain at various percentages of glass powder and vermiculite at 7^{th} and 28^{th} days of curing are noted. It can be seen clearly that there is a reduction in the strength at the 20 % replacement . Waste glass when ground to a very fine powder, SiO_2 reacts chemically with alkalis in cement and form cementigous product that contributes to the strength development. Also, it may be due to the glass powder effectively filling the voids and giving rise to a dense concrete. The strength for glass powder and vermiculite blended concrete for different curing periods upto 10 % performs well comparing to control concrete.

Splitting tensile strength test

This is a method of determining the tensile strength of concrete using a cylinder, which splits across the vertical diameter. The bearing surfaces of the specimen should be cleaned and any loose sand or other materials should be removed from the surface of the specimen where they make contact with the machine. The compression load is applied diametrically and uniformly along the length of the cylinder until the cylinder fails along the vertical diameter. The load shall be applied without shock and increased continuously at a nominal rate until the failure occurs.

Result and Discussion:

Compression strength test

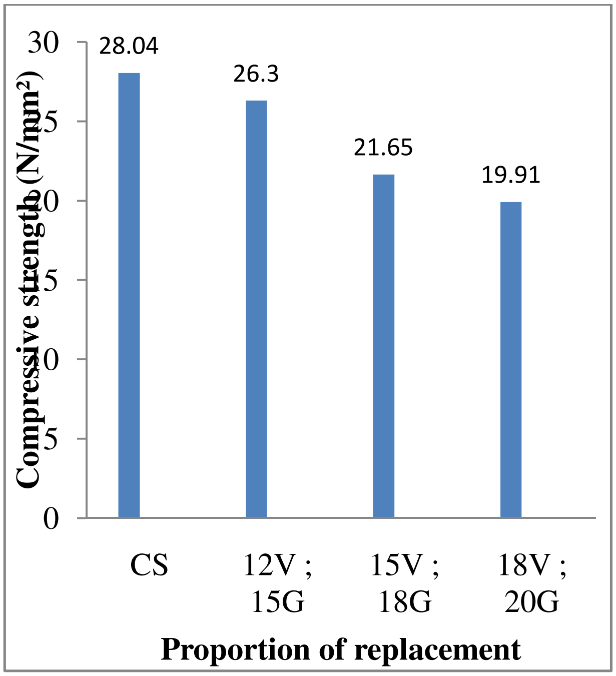
The compressive strength of the concrete cubes of size 150 * 150 * 150 mm are determined by using compression testing machine. After curing periods of 7 and 28 days, the concrete cubes are tested to find their compressive strength by using the following formula,

$$\text{Compressive strength} = \frac{P}{A}$$

Where,

P = Applied load (N)

A = Area of cross section (mm^2)



Splitting tensile strength test

$$\text{Splitting Tensile, } T = \frac{2P}{\pi Dl}$$

Where,

T = Splitting tensile strength
P = Maximum applied load
l = length of the specimen
D = Diameter of the specimen

7 days curing splitting tensile strength test results

Proportion	Cube 1 (KN)	Cube 2 (KN)	Cube 3 (KN)	Average (KN)	Strength (N/mm²)
Control specimen	360	392	230	327.34	4.6
12V ; 15G	364	476	305	381.66	5.39
15V ; 18G	340	452	310	367.33	5.1
18V ; 20G	318	322	368	336	4.76

Conclusion:

- . From the compressive strength results, it can be concluded that the strength is almost similar to conventional specimen strength for the 12V ; 15G proportion.
- For 15V ; 18G and 18V ; 20G, proportion the compressive strength is found to decrease gradually.
- For splitting tensile and flexural tests, the strength for proportions of 12V ; 15G and 15V ; 18G are similar to the control specimen strength.
- Beyond this, for the proportion of 18V ; 20G the strength decreases slightly.
- From the results, it can be concluded that the proportion 12V ; 18G can be conveniently used as a replacement for constructions materials fine aggregate and cement respectively, thereby reducing the environmental impacts.

REFERENCES

- Ashutosh Sangamnerkar and Ashutosh Sharma (2015), 'Glass Powder – A Partial Replacement for Cement', International Journal Of Core Engineering & Management, IJCEM-Volume 1.
- Dhivya, M.R., Rajalingam, M and Sunilaa George (2016), 'Study on Concrete with Replacement of Fine Aggregate by Vermiculite', International Journal of New Technology and Research, IJNTR-Volume 2.
- Govindarajulu, D., Vijayakumar, G and Vishaliny, H (2013), 'Studies on Glass Powder as Partial Replacement of Cement in Concrete Production', International Journal of Emerging

Technology and Advanced Engineering, IJET

- IS 10262-2009, 'Indian Standard Recommended Guidelines for Concrete Mix Proportioning', Bureau of Indian Standards, New Delhi, India.
- IS 12269-2013, 'Indian Standard Specification for Ordinary Portland Cement 53 Grade', Bureau of Indian Standards, New Delhi, India.
- IS 2386 (Part 3) -1963, 'Indian Standard Methods of Test for Aggregates for Concrete Part III Specific Gravity, Density, Voids, Absorption and Bulking', Bureau of Indian Standards, New Delhi, India.
- IS 383-2016, 'Indian Standard Code of Practice for Coarse and Fine Aggregate for Concrete - Specification', Bureau of Indian Standards, New Delhi, India.
- IS 456-2000, 'Indian Standard Code of Practice for Plain and Reinforced Concrete – Code of Practice', Bureau of Indian Standards, New Delhi, India.
- IS 516-1959, 'Indian Standard Specification for Methods of Tests for Strength of Concrete', Bureau of Indian Standards, New Delhi, India.