Study On Geopolymer Concrete Using Manufactured Sand

J Gomathi[1], J Doraikannan[2]
[1]PG scholar, Department of Civil Engineering, Paavai engineering College, India
[2]Assistant Professor, Department of Civil Engineering,Paavai engineering College, India

***Abstract*—Geopolymer concrete (GPC) is the most important construction material. It is composed of fly-ash, fine aggregate, coarse aggregate and alkaline solution. Constructability and long term performances are influenced by the physical properties of the aggregates used. Common river sand, which is the most commonly used fine aggregate, is expensive due to excessive cost of transportation from natural sources. Also large scale depletion of these resources creates environmental problems. Economy and sustainability objectives are better served; if locally available durable aggregates can be used-even if some of individual aggregate sizes do not meet grading of other physical properties normally specified. This will help minimize cost. In such a situation the manufactured sand (MS) can be an economic alternative to the river sand in concrete. The scope of this paper is to study the properties of GPC by using manufactured sand as fine aggregate in various proportions.**

***Index Terms*—Geopolymer concrete,Fly ash, Manufactured sand,alkaline solution.**

I. INTRODUCTION

In construction industry, concrete is the most important material for construction. Concrete is composed of cement, coarse aggregate, fine aggregate and water. Geopolymer are a new promising binder, manufactured by activation of a solid alumino-silicate source material with a highly alkaline activating solution. Fly ash, as considered to be a waste material, rich in silica and alumina and hence can be used as a source material for manufacture of geopolymer. These binders have been reported to achieve high early strength and better durability as compared to ordinary Portland cement based counterparts. Demand for concrete as construction material is increasing day to day which increases the production of cement. The production of the cement is increasing by 3% annually. Among the greenhouse gases, CO_2 contributes about 65% of global warming. The production of one ton of cement directly liberates about 1 ton of CO_2 .In terms of reducing global warming, geopolymer technology could reduce approximately 80% of CO_2 emission to the atmosphere caused by cement and aggregate industry. Compared with ordinary Portland cement concrete geopolymer shows many advantages. Geopolymer mortar shows substantially superior resistance to fire and acid attack and much less shrinkage than OPC concrete. The natural RS was the cheapest resources of sand. However, the excessive mining of river bed to meet the increasing demand for sand in construction industry has lead to the ecological imbalance in the state. Now the sand available in the river bed is very coarse and contains very high percentage of silt and clay. The silt and the clay presence in the sand reduce the strength of the concrete and holds dampness. Acute shortage and high price of RS has lead to adulteration of sand with salty sea sand which has raised serious concern among builders. In order to reduce the above problems, the useful RS is replaced with the MS in GPC.

II. OBJECTIVE

1. To find the optimum replacement level of fine aggregate by MS in GPC.
2. To study the properties of GPC with various replacement level of MS.

III. SCOPE

1. To derive a GREEN CONCRETE in construction field by elimination of cement and River Sand.

IV. LITERATURE REVIEW

The various properties of Geopolymer concrete andManufacture sand has been studied to gain a understanding on replacement requirement.

GPC results from the reaction of a source material that is rich in silica and alumina with alkaline liquid.

Fly ash reacts with alkaline solution (e.g. NaOH) and Sodium silicate (Na2SiO3) to form a gel which binds the fine and coarse aggregates.

The compressive strength of the concrete increases with increase in morality of solution. Curing also plays a vital role in increase in compression strength.

The 24 hours of hot curing under 80 to 100o C increases the compressive strength and gives a 24 days strength.

V. METHODOLOGY

A. Material collection

The raw material used for specimen casting such as coarse aggregate, fine aggregate, Fly ash,M-sand are collected from various sources.

B. Material test

The materials properties such as specific gravity, fines modulus, impact test, Bulk density were tested and results are tabulated below.

Table 1 Physical properties of Fly ash

S.no	Description	Result
1.	Specific Gravity	2.45
2.	Initial Setting Time	110 minutes
3.	Final Setting Time	210 minutes
4.	Consistency	33%
5.	Type of Fly Ash	Class C
6.	Bulk Density	1435.28kg/m^3

Inference: From the Table it was found that the properties of Fly Ash are within the allowable limit.

Table2 Physical properties of fine aggregate

Description	RS	MS
Specific Gravity	2.68	2.65
Water Absorption	1.33%	1.35%
Surface Moisture	Nil	Nil
Bulk Density	1592.14 kg/m^3	1610.37kg/m^3
Zone	III	
Fineness Modulus	2.48	3.21

Inference: From the Table3.3.4 it was found that the properties of in aggregate (RS) satisfies the standard of IS 383-1970

Table 3 Physical properties of Coarse aggregate

S.No	Description	Result
1.	Specific gravity	2.79
2.	Water absorption	0.6%
3.	Surface moisture	Nil
4.	Bulk density	1857.78 kg/m^3
5.	Crushing value	19.64%
6.	Impact value	24.98%
7.	Fineness modulus	6.98

C. Mix design

Mix proportion is arrived for M30 grade concrete by Indian standard recommended method of concrete mix design as per design code IS: 10262-2000. The ratio of alkaline liquid to fly ash

Unit weight of concrete = 2400 kg/m^3

Range of combined aggregates in concrete = 60 – 80 %

Taking mass of combined aggregates = 70% of Mass of concrete

= **1680 kg/m^3**

Mass of low calcium fly ash (F.A.) & Alkaline Liquid (A.L.) = 2400 – 1680

= 720 kg/m^3

Taking, the ratio of alkaline liquid to fly ash by mass = 0.52

{B.V.Rangan (2005)}

i.e. By mass NaOH = **82 kg/m^3**

Mass of Na_2SiO_3 = **164 kg/m^3**

The GPC Mix Proportion is, therefore as follows:-

Low Calcium Fly ash (ASTM Class F) = **474 kg/m^3**

Aggregates:

20 mm aggregates (15% by mass) = **252 kg/m^3**

14 mm aggregates (20% by mass) = **336 kg/m^3**

7 mm aggregates (35% by mass) = **588 kg/m^3**

Fine sand (30% by mass) = **504 kg/m^3**

(i) NaOH solution = **82 kg/m^3**

(ii) Na_2SiO_3 solution = **164 kg/m^3**

The Mix proportion is

Fly ash: Alkaline liquid: aggregates

1: 0.52: 3.54

The mix proportion of various replacement level is tabulated as follows:

Table 4
Mix Design for various Proportions

Materials / Specimen	Fly ash (kg/m^3)	Coarse aggregate (kg/m^3)	Fine aggregate		NaOH (kg/m^3)	Na_2SiO_3 (kg/m^3)
			RS (kg/m^3)	M-Sand (kg/m^3)		
A	474	1176	504	0	82	164
B	474	1176	378	126	82	164
C	474	1176	252	252	82	164
D	474	1176	126	378	82	164
E	474	1176	0	504	82	164

D. Testing of specimen

Testing of hardened concrete plays an important role in controlling and confirming the quality of cement concrete work. Systematic testing of raw materials, fresh concrete and hardened concrete are inseparable part of any quality program for concrete, which helps to achieve efficient of the material used and greater assurance of the performance of the concrete with regard to both strength and durability.

Workability of Concrete by Slump Test

Slump test is the most common test used method of measuring the consistency of concrete. It is normally used in the field as well as in the laboratory to measure the workability of the concrete.

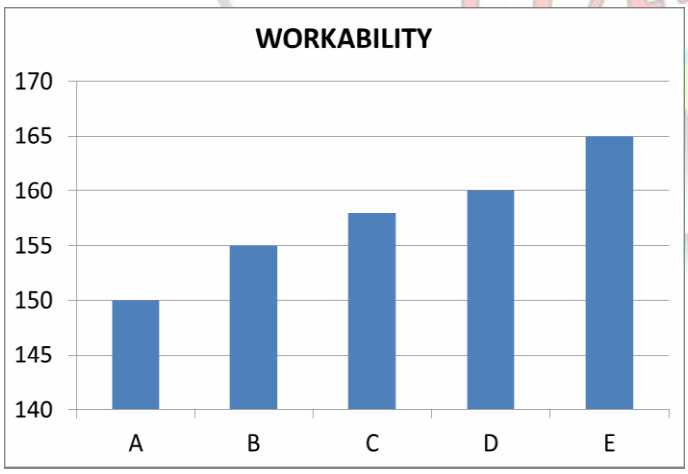

Fig 1-Workability -slump value in mm

Compressive Strength

The important property of concrete is its strength in compression. The strength in compression has definite relationship with all other properties of concrete i.e. these properties are improved with the improvement in compressive strength. The aim of these experimental tests is to determine the maximum load carrying capacity of the specimen. Cubes of size 100 mm x100 mm x100mm were cast and tested to find out the compressive strength of the specimen.

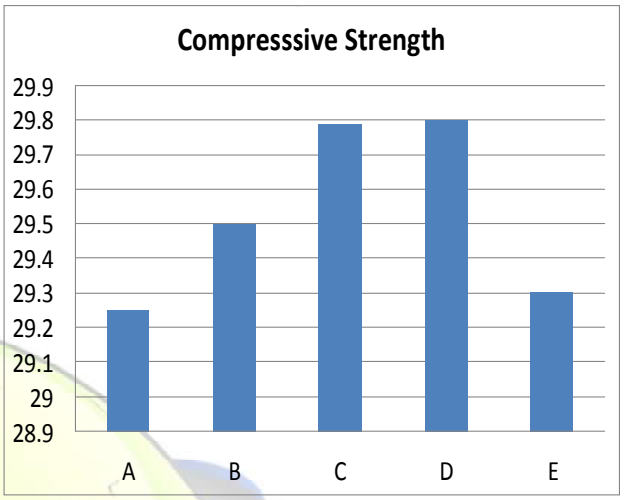

Fig2-Compressive strength in N/mm^2

Split Tensile Strength test

The cylinder specimen is of the size 150mm diameter and 300mm height. It is used to determine the split tensile strength of concrete. The compressive testing machine is used to find out the tensile strength of the concrete.

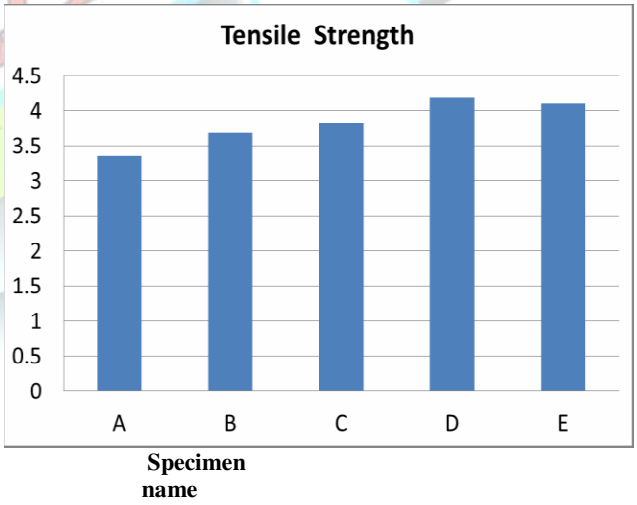

Fig 3 Tensile strength in N/mm^2

Modulus of Elasticity of Concrete

The beam specimen is of the size 500 mm x 100mm x100mm, the modulus of elasticity of concrete is determined by using universal testing machine

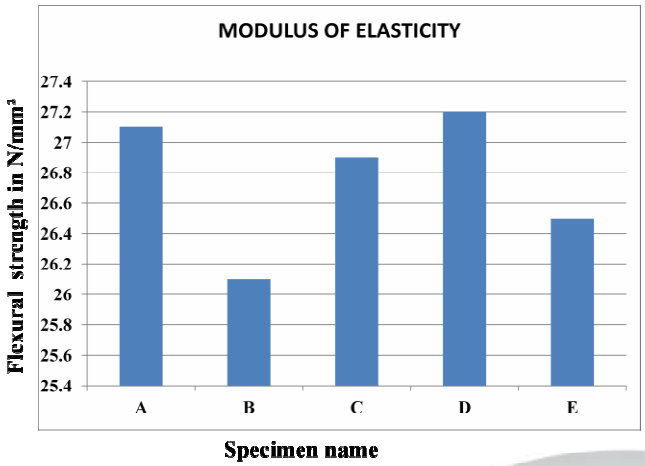

Fig 4 Modulus of elasticity

Flexural strength

The beam specimen of the size 500mm X 100mm X 100mm, is used to find out the flexural strength of the concrete. Universal testing machine is used to find out the flexural strength of the concrete.

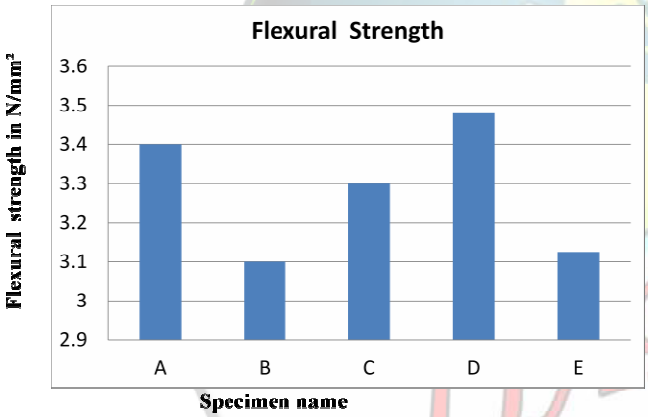

Fig 5 Flexural strength

E. CONCLUSION

Based on the study the following conclusion is arrived

- When the proportion of MS increases workability also increases. So the usage of superplasticisers is not needed.
- The Compressive strength is maximum of 29.8 at 75% replacement of natural RS by MS.
- The Split tensile strength is maximum of 4.2 at 75% replacement of natural RS by MS.
- The Flexural strength is maximum of 3.48 at 75% replacement of natural RS by MS.
- The Modulus of elasticity is maximum of at 75% replacement of natural RS by MS
- So the optimum percentage of replacement of manufactured sand by RS is 75%,

Hence it proves the M-sand is an promising alternative material for river sand.

There are both environmental and economical benefits of using MS.

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