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Experimental investigation of partial replacement of fine aggregate with plastic powder in geopolymer concrete.

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INTRODUCTION

1.1 GENERAL

Portland cement has been a very satisfactory hydraulic binder for structural applications for a long time now; however, there are many new issues stemming from its ever increasing use. Cement production consumes huge quantities of virgin materials, is energy-intensive, and leads to high emission of the greenhouse gas i.e., CO_2. Again, sulphur dioxide emission also can be very high, depending upon the type of fuel used. Installation of new cement plants is becoming increasingly capital- intensive. Finally, of late, many cement concrete structures have exhibited early distress and problems, which has an adverse effect on the resource productivity of the industry.

Geo-polymer concrete is a type of inorganic polymer composite, which has recently emerged as a prospective binding material based on novel utilization of engineering materials. It has the potential to form a substantial element an environmentally sustainable construction industry by replacing/supplementing the conventional concretes. GPC can be designed as high strength concrete with good resistance to chloride penetration, acid attack, sulphate attack, etc. The geo- polymeric concretes are commonly formed by alkali activation of industrial alumina silicate waste materials such as fly-ash (FA) and ground granulated blast furnace slag (GGBS), and have very small footprints of greenhouse gases when compared to traditional concretes. Because of possible realization of even superior chemical and mechanical properties compared to ordinary Portland cement (OPC) based concrete mixes, and higher cost effectiveness.

1.2 NEED OF GEO POLYMER CONCRETE

To produce environmental friendly concrete, we have to replace the cement with some other binders which should not create any bad effect on environment.

The use of industrial by products as binders can reduce the problem. In this respect, the new technology geo-polymer concrete is a promising technique. In terms of reducing the global warming, the geo-polymer technology could reduce the CO_2 emission to the atmosphere caused by cement and aggregate industries by about 80%. and also the proper usage of industrial wastes can reduce the problem of disposing the waste products in to the atmosphere.

1.3 GEO POLYMER

In 1978, Davidozvits proposed that a binder could be produced by a polymerisation process involving a reaction between alkaline liquids and compounds containing aluminium and silicon. The binders thus created were termed

as "geo-polymer". Unlike ordinary Portland/pozzolanic cements thus created, geo- polymers do not form calcium-silicate-hydrates for matrix formation and strength,

but silica and alumina reacting with an alkaline s o lution produce an alumina- silicates gel that binds the aggregates and provides the strength of concrete. Source materials and alkaline liquids are the two main constituents of geo-polymers, the strengths of which depend on nature of the materials and the types of liquids. Materials containing Silicon (Si) and Aluminium (Al)i n amorphous form, which come from natural minerals or by-product materials, could be used as source materials for geo-polymers. Kaolinite, clays are included in the natural minerals group whereas fly-ash, silica fume, slag, rice-husk ash, plastics, etc, are by-product materials. For the manufacture of geo-polymers, the choice of source materials depends mainly on their availability and cost, the type o f application and the specific demand of the users. Fly-ash based geo-polymer concretes provide excellent engineering properties that make them suitable materials for structural applications.

The type of alkaline liquid used plays an important role in the polymerisation process. Sodium hydroxide (NaOH) with sodium silicate (Na_2SiO_3) and potassium

hydroxide (KOH) with potassium silicate (K_2SiO_3) are the most common alkaline liquids used in geo-polymerisation. Both sodium hydroxides and potassium

1.4 PREPARATION OF ALKALINE LIQUIDS

1.4.1Preparation of sodium hydroxide solution

A correct procedure could have been to take some quantity of water, say, about 500 ml of water and mix slowly in very small steps 480 grams of sodium hydroxide solids. After complete dissolution of solids, the volume of SHS is checked to see whether it is 1 litre. If it is less than 1 litre, extra water is added to make up to 1 litre exactly. If the SHS prepared was more than 1 litre then again, 480 grams of sodium hydroxide solution is added to a quantity of water less than that used in the earlier preparation and the procedure mentioned above is continued.

1.4.2 Molarity calculation

The solids must be dissolved in water to make a solution with the required concentration. The concentration of sodium hydroxide solution can vary in different Molar. The mass of NaOH solids in a solution varies depending on the concentration of the solution. For instance, NaOH solution with a concentration of

16 Molar consists of 16x40 = 640 grams of NaOH solids per litre of water, were 40

is the molecular weight of NaOH. It should be noted that the mass of water is the major component in both the alkaline solutions. The mass of NaOH solids was measured as 640 grams per kg of NaOH solution with a concentration of 16 Molar. Similarly, the mass of NaOH solids per kg of the solution for other concentrations was measured as 10 Molar: 400 grams, 12 Molar: 480 grams, and 14 Molar: 560 grams.

1.5 PROPERTIES OF GEOPOLYMER CONCRETE

- Increased compressive strength.
- Good abrasion resistance
- Fire resistance (up to 1000$_0$C) and no emission of toxic fumes when heated
- High level of resistance to a range of different acids and salt solutions
- Low shrinkage and low thermal conductivity
- High surface definition that replicates mould patterns
- Inherent protection of steel reinforcing due to high residual PH and low chloride diffusion rates

1.6 OBJECTIVES OF PRESENT STUDY

- To understand properties of geo-polymer concrete in order to use it as alternative for Ordinary Portland Cement concrete.

- To establish the economical, technological and environmental benefits of geo- polymer binders over Ordinary Portland Cement
- To verify the improvement of properties such as compressive strength, tensile strength, flexural strength etc by using geo-polymer binders instead of OPC
- To draw conclusion on whether geo-polymer technology can provide an appropriate alternative of OPC

CHAPTER 2 LITERATURE REVIEW

2.1 GENERAL

The literature review was carried out done under different topics relevant to the study such as GPC, workability and durability studies with the use of different materials. The discussions would provide a lead to the study on using Silica fume and using super plasticizer.

2.2 REVIEW OF LITERATURE

1) **B.G. Vishnuram et al, "Effect of types of curing on strength of Geo- polymer concrete" International Journal of the Physical Sciences Volume 5(9), 18 August 2010**

In order to address environmental effects associated with Portland cement, there is need to develop alternative binders to make concrete. An effort in this regard is the development of geo-polymer concrete, Synthesized from the materials of geo-logical origin or by-product materials such as fly-ash, which is rich in silicon and aluminium. This paper presents results of an experimental study on the density and compressive strength of geo-polymer concrete. The experiments were conducted on fly-ash based geo-polymer concrete by varying the types of curing namely ambient curing and heat curing. For heat curing, the temperature was maintained at 60^{0}C for 24 hrs in hot air oven. The compressive strength test was conducted for each sample and the results showed that there is an increase in compressive strength with the increase in age for ambient cured specimens. For hot cured samples the increase in compressive strength with age was very less as compared to that of specimens subjected to ambient curing. The density of geo- polymer concrete was around 2400kg/m$_3$ which is equivalent to that of conventional concrete.

2) **Soner Tob et al, "Properties of fly-ash based geo-polymer concrete prepared using pumice and expanded perlite as aggregates" Material science and Nanotechnology Engineering Department**

The present paper aims to utilize the fly-ash wastes with light weight aggregates for geo-polymer concrete production process in which sodium hydroxide and sodium silicate were used as alkali activators respectively. The designed experiments were examined by the Yates analyses and so the production of geo- polymer concrete were investigated depending on curing temperature, solid/liquid rate and concentration of alkali activators. The curing temperature and alkali activator concentration were revealed as effective parameters in geo-polymerisation. The effects of expended perlite and acidic pumice aggregates were discovered for

the production of light weight geo-polymer concretes. The micro-structural properties of each produced geo-polymer concrete were characterized using SEM, EDS and laser particle analyses. The specification of the concrete were evaluated based on their uni-axial compressive strength, point load strength, sonic speed and water absorption ratio results. In addition, the effects of pre-wetting of EP aggregates, which have hydrophilic nature, were examined. To the best of our knowledge, this is the first time that pre-wetted lightweight EP aggregates were

used to produce lightweight GP concretes. As a result of pre-wetting, chemical usage decreased by 32.5%. The UCS of the lightweight geo-polymer concretes were in a range of 10-50MPa and their unit weights changed between 1250 and 1700 kg/m^3. Lighter concretes were obtained by the addition of EP aggregates rather than AP ones.

3) **Y. H. Mugahed Amran et al, "Clean production and properties of geo- polymer concrete: A review" Journal of cleaner production**

The incessant production of cement has increased the amount of C_2O being released into the atmosphere; thus aggravating the issue of global warming which has an adverse effect on the environment. Therefore, a more sustainable approach and a careful review of the existing admixtures used to replace conventional

concrete have become highly imperative. To this end, many investigations on geo- polymer concrete, which exhibit similar or better durability and high strength when compared to conventional concrete, have been carried out by various researchers. Geo- polymer concrete has the advantage of cement replacement with supplementary cementious materials that are combined with alkali activated solutions. Geo-polymer concrete is a relatively new innovative and sustainable engineering material with many advantages over ordinary concrete. For example, it exhibits higher early strength, lower natural resource composition, low cost and ability to form various structural shapes. Geo-polymer concrete is an essential material that can be used for concrete building repairs, maintenance of road transport infrastructure and reducing the negative environmental effects. Therefore, this paper presents a comprehensive review of geo-polymer material, its constituents, production techniques, curing regimes, properties and its potential in the construction industry.

4) **Ahmed Nmir1 et al, “Replacement of alkali silicate solution with silica fume in Meta-kaolin based geo-polymers” Springer Journal of International Journal of Minerals, Metallurgy and Materials Volume 26, May 2019**

A meta-kaolin based geo-polymer cement from Tunisian MK mixed with different amounts of silica fume (SiO_2/Al_2O_3 molar ratio varying between 3.61 and 4.09) and sodium hydroxide (10 M) and without any alkali silicate solution, is developed in this work. After the samples were cured at room temperature under air for 28 days, they were analysed by X-ray diffraction (XRD), Fourier transform infrared spectroscopy, environmental scanning electron microscopy, mercury intrusion porosimetry, nuclear magnetic resistance spectroscopy and compression testing to establish the relationship between microstructure and compressive strength. The XRD analyses showed that the use of silica fume instead of alkali silicate solutions was feasible for manufacturing geo-polymer cement. The MK based geo-polymer with a silica fume content of 6%, corresponding to an

7) Smita Singh et al, "Experimental study on Plastics based Geo-polymer concrete with Fly-ash and GGBS in Ambient temperature curing" International Journal 2017

This paper contents the necessity to reduce the use of OPC and increase the utilisation of industrial waste like plastics, fly-ash and GGBS using geo- polymerisation. Technique to overcoming the drawbacks of plastics as source material in geo-polymer concrete is discussed in this paper. Mix proportion for desirable properties concrete along with its method of mixing and casting are described. Along with the test results and cost, use plastics based geo-polymer is suggested for sustainable construction.

2.3 SUMMARY OF LITERATURE

- Waste Plastics in the powder form can be used as a source material for replacement to sand for OPC concrete as well as geo-polymer concretes.
- Increasing of plastics powder content increases the compressive strength of concrete.
- Setting time increases with the increase of plastics.
- Higher the molarity value higher will be the strength of geo-polymer concrete.
- Workability increases with increase of content of waste plastic powder.

METHODOLOGY

TOPIC SELECTION

LITERATURE REVIEW

COLLECTION OF MATERIALS

STUDY ON MATERIAL PARAMETERS

MIX PROPORTION OF GPC

CASTING AND CURING OF SPECIMEN

TEST ON SPECIMENS

STRENGTH TEST ON SPECIMEN

RESULT AND DISCUSSION

CONCLUSION

STUDY OF MATERIALS

4.1 GENERAL

Material testing is essential for the mix design of concrete. It gives the optimum amount of materials required for a given strength and workability of concrete. Hence studies properties of the following materials were carried.

4.2 FLYASH

Any country's economic and industrial growth depends on the availability of power. In INDIA also, coal is a major source of fuel power generation. About 60% power is produced using coal as fuel. Indian coal is having low calorific value (3000-

3500 K. Cal) and very high ash content (30-45%) resulting in huge quantity of ash generated in the coal based thermal power stations. During 2005 -06 about 112 million tonne of ash has been generated in 125 such power stations. With the present

growth in power sector, it is expected that ash generation will reach to 175 million tonne per annum by 2012.

Any coal based thermal power station may have the following four kinds of

ash:

Fly-ash: This kind of ash is extracted from the gases through electrostatic precipitator in dry form. The ash is fine material and possesses good pozzolanic property. **Bottom Ash:** This kind of ash is collected in the bottom of boiler furnace.

It is comparatively coarse material and contains higher un-burnt carbon. It possesses zero or little pozzolanic property. Fly-ash produced in modern power stations of India is of good quality as it contains low sulphur and very low un-burnt carbon. In order to make fly-ash available for various applications, most of the new thermal power stations have set up dry fly-ash evacuation and storage system. In this system fly-

ash from Electrostatic precipitators (ESP) is evacuated through pneumatic system

and stored in silos. From silos, it can be loaded in open truck/closed tankers

4.3 SODIUM HYDROXIDE

Generally the sodium hydroxide are available in solid state by means of pellets and flakes. The cost of the sodium hydroxide is mainly varied according to the purity of the substance. Since our geo-polymer concrete is homogenous material and its main process to activate the sodium silicate, so it is recommended to use the lower cost i.e. up to 94% to 96% purity. In this investigation the sodium hydroxide pellets were used, and whose chemical and physical properties are given by the manufacture is shown in table 4.2 and 4.3

SODIUM HYDROXIDE

PHYSICAL PROPERTIES OF SODIUM HYDROXIDE

Colour	**Colour Less**
Specific Gravity	
20%	1.22
30%	1.33
40%	1.43
50%	1.53

CHEMICAL PROPERTIES OF SODIUM HYDROXIDE

Assay	97%	Min
Carbonate (Na_2CO_3)	2%	Max
Chloride (Cl)	0.01%	Max
Sulphate (SO_2)	0.05%	Max
Lead (pb)	0.001%	Max
Iron (Fe)	0.001%	Max
Potassium (k)	0.1%	Max
Zinc (zn)	0.02%	Max

4.4 SODIUM SILICATE

Sodium silicate (FIG 4.5) is also known as water glass or liquid glass, available in liquid form. In present investigation sodium silicate 2.0 (ratio between Na_2O to SiO_2) is used. From the literature studies, it has been established that sodium silicate is used for the making of geo-polymer concrete. The physical properties and the chemical properties of the silicates are given by the manufacture is shown in table 4.4

SODIUM SILICATE

CONPLAST SP430

ADVANTAGES

1. Improved Workability – Easier, quicker placing and compaction.
2. Increased Strength – Provides high early strength for precast concrete with the advantage of higher water reduction ability.
3. Improved Quality – Denser, close textured concrete with reduced porosity and hence more durable.
4. Higher Cohesion – Risk of segregation and bleeding minimized; thus aids pumping of concrete.
5. Chloride Attack – Safe in pre-stressed concrete and with sulphate resisting cements and marine aggregates.

USES

1. To produce pump able concrete.
2. To produce high strength, high grade concrete substantial reduction in water resulting in low permeability and high early strength.
3. Able to produce high workability concrete requiring little or no vibration during placing.

4.5 GROUND GRANULATED BLAST FURNACE SLAG (GGBS)

Ground granulated blast furnace slag produced by grinding of blast furnace slag available in steel plants. GGBS is widely accepted for use in Portland cement

4.6 FINE PLASTICS

Plastics Shown in fig 4.8 is a by-product which is obtained by extracting from the crushing of the plastic in industries. For-every 1 ton of plastic crushing around 0.5 – 0.75 tons of plastics is generated as a by-product from 3 tons of fine plastic waste. The physical and chemical properties are listed in Tables 4.7 & 4.8 respectively.

FIG.4.8 PLASTICS

TABLE 4.7 PHYSICAL PROPERTIES OF PLASTICS

S. NO	PROPERTIES	% MASS
1	Specific Gravity	2.51
2	PH	10.5 to 12.5
3	Fineness of Plastics	1000 – 3000 cm^2/gm

TABLE 4.8 CHEMICAL PROPERTIES OF PLASTICS

S. NO	INGREDIENTS	PLASTICS IN %
1	Fe_2O_3	38.3
2	Al_2O_3	21.6
3	SiO_2	11.4
4	CaO	1.47
5	Na_2O	6.87

CHAPTER 5 TESTING OF MATERIALS

5.1 GENERAL

Material testing is essential for the mix design of concrete. It gives the optimum amount of material required for a strength and workability of concrete. Various test conducted on materials for conventional and fly-ash based geo-polymer concrete are discussed in this chapter

5.2 TESTS FOR FINE AGGREGATE

5.2.1 Sieve analysis for fine aggregate (as per IS 2386: 1986 part I)

The grain sizes characteristics of soils are predominantly coarse grained are evaluated by a sieve analysis. A set of sieves is prepared by stacking test sieves one above the other with the largest opening at the top followed by sieves of successively smaller openings and a catch pan at the bottom.

SIEVE ANALYSIS SET

PROCEDURE

1. A sample of dry soil is poured onto the top sieve, the nest is covered, and it is then shaken by hand or mechanical sieve shaker until each particle has

Specific gravity of fine aggregate (as per IS 2386: 1963 part III)

The specific gravity of aggregate is determined using a pycnometer shown in fig. Specific gravity is the ratio of the mass of unit volume of soil at a stated temperature to the mass of the same volume of gas free distilled water at a stated temperature. The specific gravity of a soil is used in the phase relationship of air, water and solids in a given volume of the soil.

SPECIFIC GRAVITY OF FINE AGGREGATE

PROCEDURE

1. The weight of the empty clean and dry pycnometer is determined and recorded (W_1).
2. 10g of a dry soil sample is placed in the pycnometer. Then the weight of the pycnometer containing the dry soil is determined and recorded, W_2.
3. Water is filled in the pycnometer. Then the sample is soaked for 10 minutes and weighted. Let it be W_3.
4. Then the pycnometer was emptied and cleaned. Then it is filled with water only. The exterior surface of the pycnometer is cleaned with a clean, dry cloth. Then the weight of the pycnometer and water is determined, W_4.

BULK DENSITY OF FINE AGGREGATE

PROCEDURE

1. Weighed out to the nearest 0.1 gram, 50 grams of the sample (or a weight as directed on the B8D document.
2. Then it is transferred into a suitable graduated cylinder.
3. The base of the cylinder is placed gently on a slightly resilient surface, such as a rubber pad or book, until the height of the sample in the cylinder is at a minimum, i.e. the sample height does not reduce with further tapping.
4. Read off volume of sample in cc (ml).

OBSERVATION

TABLE 5.3 BULK DENSITY OF FINE AGGREGATE

S.NO	DESCRIPTION	RESULT (kg)
1	Empty weight of the container (W_1)	2.658
2	Wt. Of container + Loose F.A. (W_2)	6.883
3	Wt. Of container + compacted F.A (W_3)	7.227
4	Wt. Of container + Water (W_4)	5.38

5.3 TEST FOR COARSE AGGREGATE

5.3.1 Specific gravity of coarse aggregate (as per IS 2386: 1963 part III)

The specific gravity of coarse aggregate is tested using pycnometer shown in Fig. 5.4 to calculate the specific gravity of a coarse aggregate sample by determining the ratio of the weight of a given volume of aggregate to the weight of an equal volume of water.

SPECIFIC GRAVITY OF COARSE AGGREGATE

PROCEDURE

1. The weight of the empty clean and dry pycnometer is determined and recorded as W_1.
2. Some amount of sample is placed in the pycnometer. The weight of the pycnometer containing the aggregate is determined as W_2.
3. Water is added to fill the pycnometer. The sample is soaked for 10 minutes and weighed. The weight is recorded as W_3.

4. The pycnometer is emptied and cleaned. Then it is filled water only. The exterior surface of the pycnometer is cleaned with a clean, dry cloth. The weight of the pycnometer and water is determined as W_4.

FIG. 5.5 BULK DENSITY OF COARSE AGGREGATE

PROCEDURE

1. The weight of empty cylinder measured (W).

2. Measure cylinder is filled with aggregates sample for about one third height and tamped evenly with 25 strokes of the rounded end of the tamping rod.

3. Similar quantity of aggregate is filled as second layer and tamped it evenly with 25 strokes.

4. Then the measure is filled with a third layer of aggregate up to over flowing and tamped with 25 strokes.

5. Surplus aggregate is striked off using the tamping rod as a straight edge.

6. Then the weight is taken (W_2).

7. The measure emptied and filled it again to over flowing by means of a shovel, the aggregate being discharged from a height not exceeding 5 cm above the top of the measure.

8. The surface of the measure is levelled and weighed (W_3).

9. Then container is emptied completely and filled with water and weighed (W_4).

CHAPTER 6 PROPOORTIONING OF

GEO POLYMER CONCRETE MIX

6.1. MIX DESIGN OF GEO POLYMER CONCRETE

Density of GPC = 2400 kg/m^3 (assumed)

FA+CA = 77% (assumed)

Total Aggregate = 77/100 X 2400 = 1848 kg/m^3

Fine Aggregate (30% of TA) = 555 kg/ m^3 Coarse

Aggregate (70% of TA) = 1293 kg/ m^3

Now we can say that 2400 - TA = flyash + alkaline liquids i.e. 2400 – 1848 = 552 = flyash + alkaline liquids

Assume sodium silicate / sodium hydroxide

= 2.5 (from literature)

alkaline liquid / flyash = 0.4 (from literature)

Alkaline liquid = 0.4 flyash (from above equation) Flyash + alkaline liquid = 552 kg/m^3

Flyash + 0.4 flyash = 552 kg/m^3

1.4 Flyash = 552 kg/m^3

Flyash = 552/1.4 = 394.3 kg/m^3

Total alkaline liquid = 0.4 x 394.3 = 158 kg/m^3

i.e Na_2SiO_3 + NaOH = 158 kg/m^3

Since Na_2SiO_3 = 2.5 NaOH, we can write the above equation as

2.5NaOH + NaOH = 158 kg/m^3

From which NaOH = 45.14 kg/m^3

Now, we know that Na_2SiO_3 + NaOH = 158 kg/m^3

Na_2SiO_3 = 158 - 45.14 = 112.85 kg/m^3

Fine Aggregate = 555kg/m^3

Coarse Aggregate = 1293kg/m^3

Sodium Silicate = 112.86 kg/m^3

Water Content= 39.43 kg/m^3 Super plasticizer = 11.829 kg/m^3 Fly Ash

= 394.3kg/m^3

Sodium Hydroxide = 45.14 kg/m^3 Above

results are for a per m^3 of ***GPC***

ALKALINE SOLUTION

1M= 40 grams of NaOH diluted in 1kg of water. Molarity of concrete = 10M

Volume of cube = 0.00375kg/m^3

from mix design

Sodium Hydroxide = 45.14 kg/m^3

Sodium Silicate = 112.86 kg/m^3

Volume of alkaline solution = (45.14 +112.86) X 0.00375 = 0.533kg/m^3

Na_2SiO_3 / NaOH = 2.5

Na_2SiO_3 = 2.5 NaOH

NaOH + 2.5 NaOH = 0.533

NaOH = 0.533 / 3.5 = 0.152kg/m^3

Na_2SiO_3 = 2.5 X 0.152 = 0.38 kg/m^3

Water = 1000/400 X 0.152 = 0.38 kg/m^3

When the alkaline solution is prepare 24 hours before concrete casting.

FIG. 7.1 SLUMP TEST

7.4 COMPRESSIVE STRENGTH TEST

One of many test applied to specimen, this is the almost important which gives an idea about all the characteristics of cube. For the cube test of specimen mould size is 150 x 150 x 150 mm as per IS 516-1959 are used.

In this, project casted concrete in the cube of four different type of proportions. The specimen should be given sufficient time for hardening (approx 24 h) and then it should be cured for adequate time based on the type of concrete. After curing, it should be loaded in the compression testing machine and tested for maximum load. Compressive strength should be calculated by dividing maximum load by the cross sectional area. The load applied to opposite side of the cubes as cast. The maximum load was applied to the specimen until the failure recorded.

Compressive Strength = Ultimate load / Contact area of the cube.

COMPRESSIVE STRENGTH TEST

7.5 SPLIT TENSILE STRENGTH

The objective of this is to find the splitting tensile strength of concrete cylinders. To investigate split tensile strength, standard cylinder (150 mm x 300 mm) are cast and tested as per IS 5816-1970 this is indirect test on finding the tensile strength of concrete. This is also sometimes referred as "Brazilian Test". Specimens are kept in rest condition for 24 hours before testing in ordinary compression testing machine.

The wet cylinder specimen is placed on the strip horizontally with its axis perpendicular to the loading direction. The second steel rod is then placed length wise on the cylindrical centrally. The load is then applied without shock and increased continuosly at a rate to produce approximately a splitting tensile strength
of 14 to 21 kg/cm ^{2}/min until failure. The maximum load is applied to the specimen
is noted and the splitting tensile strength is calculated as follows,

Split Tensile Strength = 2P / Π L D

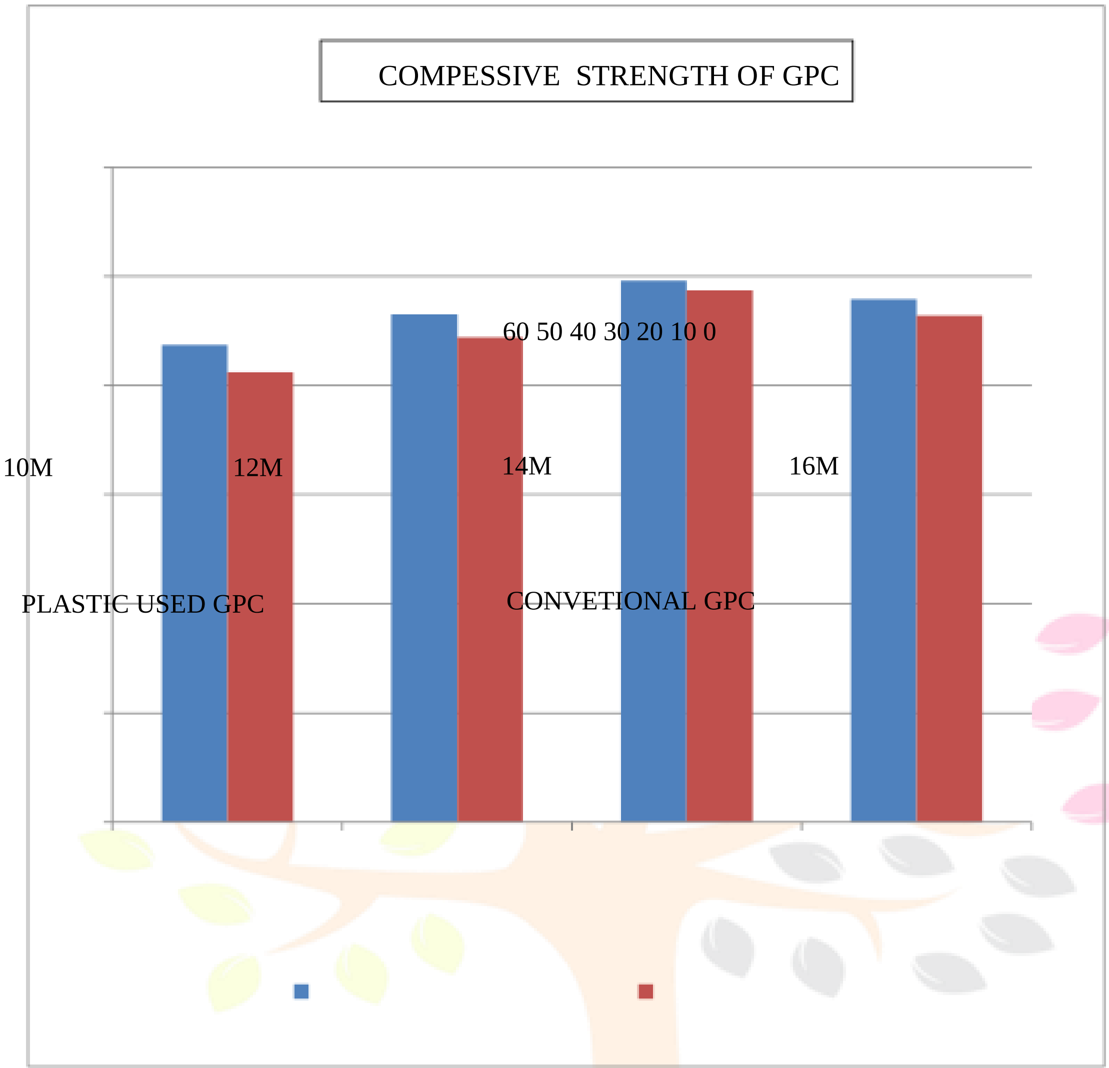
Where,

P = Compressive load on cylinder in N

L = Length of cylinder in mm

D = Diameter of the cylinder in mm

SPLIT TENSILE STRENGTH TEST



COMPRESSIVE STRENGTH OF GEOPOLYMER CONCRETE

SPLIT TENSILE STRENGTH OF GEOPOLYMER CONCRETE

CHAPTER 9

SUMMARY AND CONCLUSION

SUMMARY

An experimental study was conducted in the concrete laboratory to find this scope for application of Geopolymer concrete mix where in partial replacement for sand by waste plastic in the powder form for 10% was used fine aggregate. The geo polymer mix used in this study consist flyash, GGBS as binder, sand and waste plastic powder as fine aggregate and 20mm size coarse aggregate frp, the gramote quarry for geo polymeration aquous solution consist of $NaOH$ & Na_2SiO_3 in pellet form where adopted. The test is specimen of cube size 150mm X 150mm X 150mm and cylinder size 300mm X 150mm.

The cast at room temperature and tested at compression testing and spolit tensile strength on Geo polymer mixes. From the tested result the following conclusion are drawn.

CONCLUSION

- All the mixes with waste plastic powder as partial replacement had show good increase in compressive strength as well as split tensile strength, however the molarity values used in this study influenced the rate of increase in strength.
- It was found that geo polymer mix with molarity value 14M had shown the maximum values of compressive strength & split tensile strength compared to other mixers.
- Since Geo polymer mixes do not have cement, It has reduced pollution aspects of the surroundings.
- There was complete elimination of waste of water since geo polymer mixes didn't required water curing.
- The geo polymer mix with 14M value had shown maximum compressive & split tensile strength.

- It was observed that the setting action of the hardening of geo polymer was faster than ordinary concrete. The geo polymer shall be used in the fast track construction industry where the duration of time has to be considerably reduced.
- Due to its sustainability characteristics, good fresh properties, strength and durability properties plastics based geo polymer concrete can be used as a replacement of conventional concrete.

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