Research Paper

FEW ASPECTS OF DURABILITY OF GEOPOLYMER CONCRETE CONTAINING METALLIZED PLASTIC WASTE

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ABSTRACT:

This experimental study is intended to the durability aspects of fly ash and metallized polymer plastic waste based geopolymer concrete prepared with sodium hydroxide (NaOH) and sodium silicate (Na_2Sio_3) as alkaline activators. The performance of geopolymer concrete was studied, using test of oxygen permeability and water sorptivity. In oxygen permeability test ingress of gases and water vapor occurs while in water sorptivity test ingress of water and hazardous liquid occurs. Experimental work was done on fly ash and waste metallized polymer plastic based geopolymer concrete by different sodium silicate to sodium hydroxide ratio 1, 2 and 3, different molar content of sodium hydroxide 8M, 12M and 16M , percentage of metallized polymer plastic waste 0%, 0.5%, 1.0% and 1.5% and cured with hot air at 100°C for 24hr. Result shows oxygen permeability and water sorptivity decreases with increase in molar content of sodium hydroxide, ratio of sodium silicate to sodium hydroxide and metallized polymer plastic which is favorable for geopolymer concrete.

KEY WORDS: Geopolymer, Alkali activated fly ash, alkaline solution, and Metallized polymer plastic.

1. INTRODUCTION:-

Nowadays, Portland cement is widely used as a construction material. The production of one ton of cement liberates about one ton of carbon dioxide to the atmosphere which adversely affect the global warming effects. With time, the researchers in the field of concrete practices are diverted towards utilization of various wastes in the concrete. Metallized polymer plastics that are not easily biodegradable even after a long period and recyclable, so more landfill space is needed for disposal every year. Large range of various wastes are added to concrete as dual solution towards mitigation of waste management problems and reducing natural material use as concrete constituent. So one of the ways to produce eco-friendly concrete is called Geopolymer concrete. In this concrete ordinary Portland cement is replaced by waste product material fly ash and metallized polymer plastic. Geopolymer is also known as inorganic alumino-hydroxide polymer which reacts with silicon (Si) and aluminum (Al) materials of geological origin. The most severe durability problems always involve the penetration of gases, water vapor, water and hazardous liquid into the concrete. The durability of concrete is the major aspect for construction of concrete in aggressive environments. It normally refers to trouble free performance of concrete throughout its lifespan.

2. MATERIALS:-

2.1 Fly ash:-

Fly ash is a by-product obtained during the combustion of coal in Thermal Power Plants. In this present study, low-calcium (Class F) fly ash was taken from Wanakbori Thermal Power Station, Gujarat, India and was used as a source material. Specific gravity of fly ash was 2.25. The chemical composition of fly ash as determined by X-Ray fluorescence (XRF) analysis is shown in table 1.

Table-1 Chemical compositions of fly ash

Oxides	(%) by mass
Silica (Sio_2)	52.8
Alumina (Al_2O_3)	22.3
Ferric Oxide (Fe_2O_3)	9.2
Calcium Oxide (CaO)	2.40
Magnesium Oxide (MgO)	0.2
Sodium Oxide (Na_2O)	0.37
Potassium Oxide (K_2O)	0.82
Sulphur Trioxide (SO_3)	0.7
Loss On Ignition (LOI)	1.39

2.2 Metallized polymer plastic waste:-

Metallized polymer plastic being widely used in food packing and wrapping is not biodegradable or recyclable. In this study waste metallized polymer plastic was collected as plastic food packet bags from ROTOTON, Atika GIDC, Rajkot and shredded it into average flakes size of 6 mm at Radhe Krishna industries, Rakhial Ahmedabad.

Property of plastic waste bag:- Plastic waste bag of Polythene film (Metallized) type having Metallized food packing grade of 60Micron thickness and density 1.412 gm/cc was used.

2.3 Aggregates:-

Both the coarse and fine aggregate were taken from the local sources in Ahmadabad, Gujarat. A good quality, well graded coarse aggregate of size 20 mm and 10 mm were used in the preparation of all test specimens. 20 mm and 10 mm size with fineness modulus 7.59 and 5.75 respectively were used as Coarse aggregate. Fine river sand with the fineness modulus of 2.28 was used as a fine aggregate.

2.4 Alkaline solution:-

The alkaline solution was prepared by combination of sodium silicate (Na_2SiO_3) solution and sodium hydroxide (NaOH) solution. The sodium silicate (Na_2SiO_3) solution and sodium hydroxide (NaOH) flakes were purchased from Bhavani Ceramics Pvt. Ltd. Mahesana, Gujarat. Sodium hydroxide in flakes form was used in different Molar contents 8M, 12M, and 16M. The chemical composition of sodium silicate (Na_2SiO_3) is given in table 2.

Table-2 Chemical compositions of sodium silicate (Na_2SiO_3)

Sr. No.	Constituents	$(SiO_2)/(Na_2O)=2.25$
1	Sodium Oxide (Na_2O)	14.46
2	Silicate Oxide (SiO_2)	32.53
3	Water	53

3. MIXTURE PROPORTION:-

After doing a number of trial mixes finally 32 batches of concrete have been casted. The details of mixture proportions are given below.

Taken the ratio of alkaline solution to fly ash was fixed at 0.5, ratio of Silicate Oxide (SiO_2) to Sodium Oxide (Na_2O) was fixed at 2.25, ratio of sodium silicate (Na_2SiO_3) to sodium hydroxide (NaOH) solution was taken as 1, 2, and 3 (by mass), Metallized polymer plastic was taken 0%, 0.5%, 1%, and 1.5% of volume of concrete, Curing temperature was fixed at 100°C for 24 hr. for all mixes. Also Super plasticizer was taken 0.5% of fly ash by mass for all mix.

The mix proportion of one cubic meter of geopolymer concrete contains 368 kg fly ash, 443.52 kg coarse aggregate 20mm, 850.05 kg coarse aggregate 10mm and 554.4 kg fine aggregate.

When the ratio of Na_2SiO_3 to NaOH was taken as 1 and molar content of NaOH was taken as 8M, 12M and 16M , quantity of Na_2SiO_3 and NaOH was taken as 92kg/m³, Similarly when the ratio of Na_2SiO_3 to NaOH was taken as 2, quantity of Na_2SiO_3 and NaOH was taken as 122.667 kg/m³ and 61.333 kg/m³ respectively and when the ratio of Na_2SiO_3 to NaOH was taken as 3, quantity was 138 kg/m³ and 46 kg/m³ for Na_2SiO_3 and NaOH.

Metallized polymer plastic flakes were taken as 7.06 kg/m^3, 14.12 kg/m^3 and 21.18 kg/m^3 for 0.5%, 1% and 1.5% of concrete volume respectively.

4. MIXING AND CURING:-

Sodium silicate solution and the sodium hydroxide solution were required to mix at least one day prior to use for preparing alkaline liquid. On the day of casting specimens, super plasticizer was mixed with liquid component of the above mixture. The fly ash, metallized polymer plastic, and aggregates were first dry mixed in the electrical tilting drum mixture machine for about 2 to 3 minutes as shown in fig.1, then liquid components were added and further mixing is done for 2 to 3 minutes. Mixing was followed by slump test and compaction factor test of fresh geopolymer concrete. After the test of workability the fresh concrete was placed in the cylinder disc (150mm Dia. × 50mm height) in the oven for curing at 100°C for 24 hr. After curing, the discs were left to open air in the laboratory. After 7 days, oxygen permeability and water sorptivity tests for durability as shown in fig.4 and fig.5 respectively were done.

Fig.1 Dry mix

Fig.2 casting of concrete mix

Fig.3 curing of concrete batch at 100˚C at oven

Fig.4 Oxygen permeability test

Fig.5 Water sorptivity test

5. OBSERVATION AND TEST RESULTS

In this work, Molarities of Sodium hydroxide (NaOH) solution, ratio of Sodium silicate (Na_2SiO_3) to Sodium hydroxide (NaOH) and Percentage of metallized polymer plastic waste were studied by keeping ratio of alkaline solution 0.50 constant and curing at 100˚C for 24 hr.

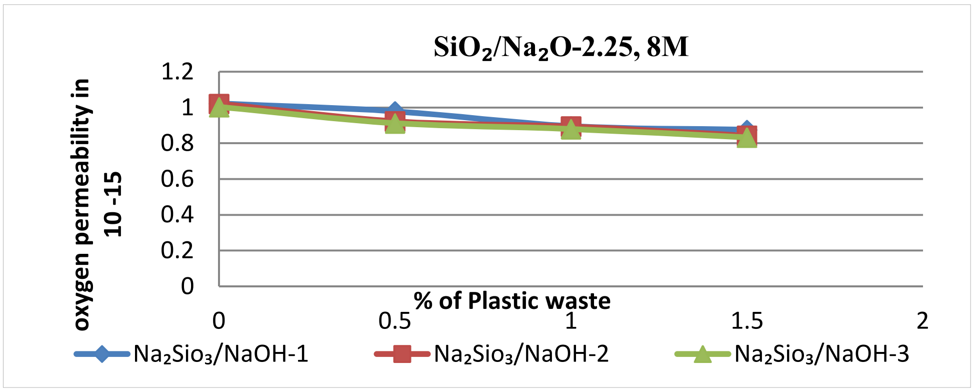
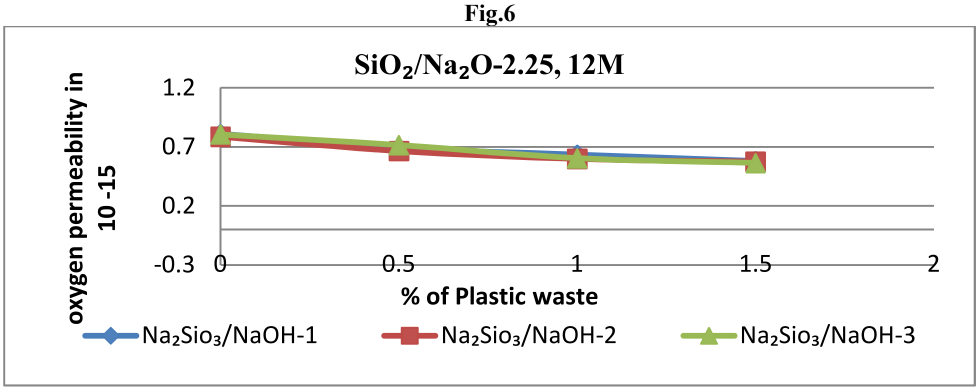


Fig.6



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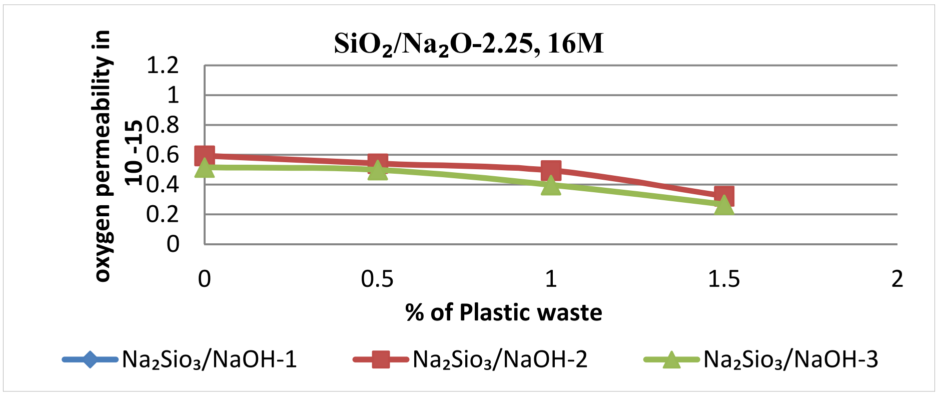

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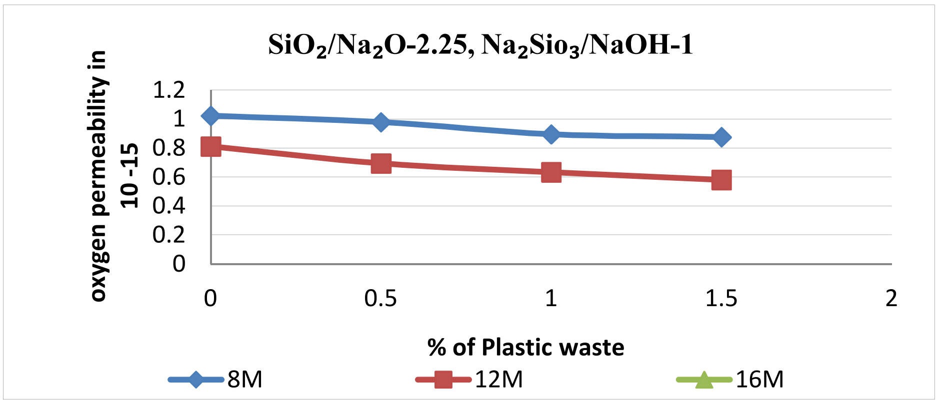

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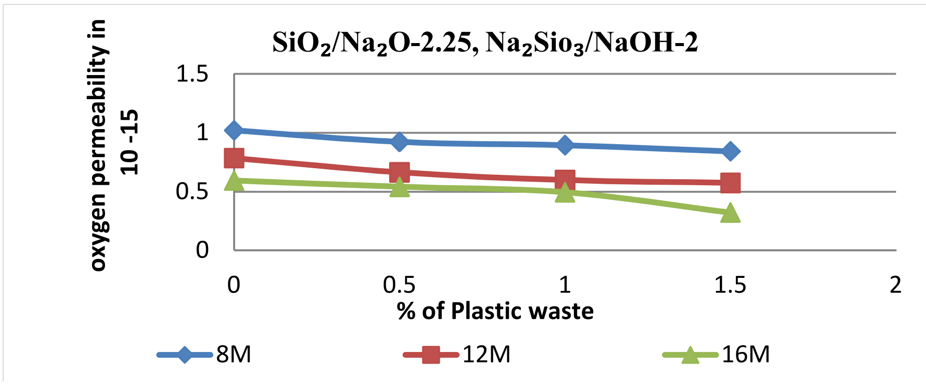


Fig.10

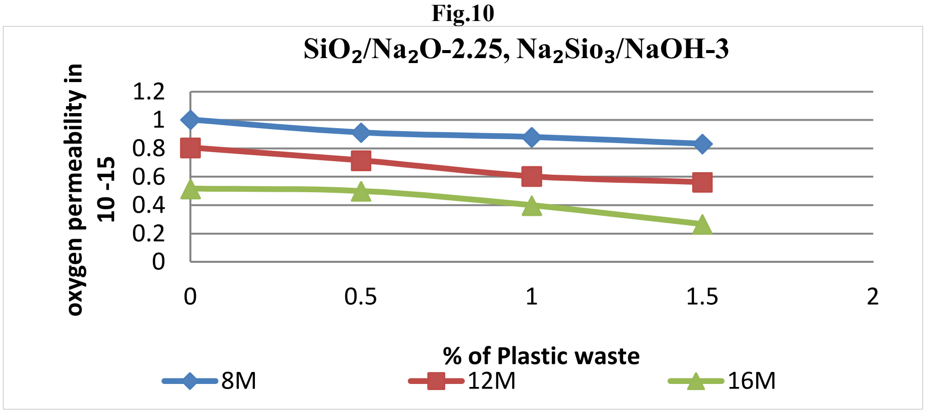


Fig.11

5.1 Observation:-

Fig.6, 7 and 8 shows when the ratio of Na_2SiO_3 to NaOH increases by 1, 2 and 3 then 8M, 12M and 16M Oxygen permeability decreases from 0.19% to 6.79%, 0.97% to 5.65% and 7.74 to 19.43% respectively. Fig.9, 10 and 11 shows when the molar content of NaOH increase by 8M, 12M and 16M then Oxygen permeability for ratio of Na_2SiO_3 to NaOH 1, 2 and 3 decreases from 20.72% to 33.70%, 17.19% to 43.76% and 19.64% to 52.61% respectively.

In the ratio of Na_2SiO_3 to NaOH=1 and 16M NaOH, casting was not done because of sodium content was higher in that solution and flash set occurring.

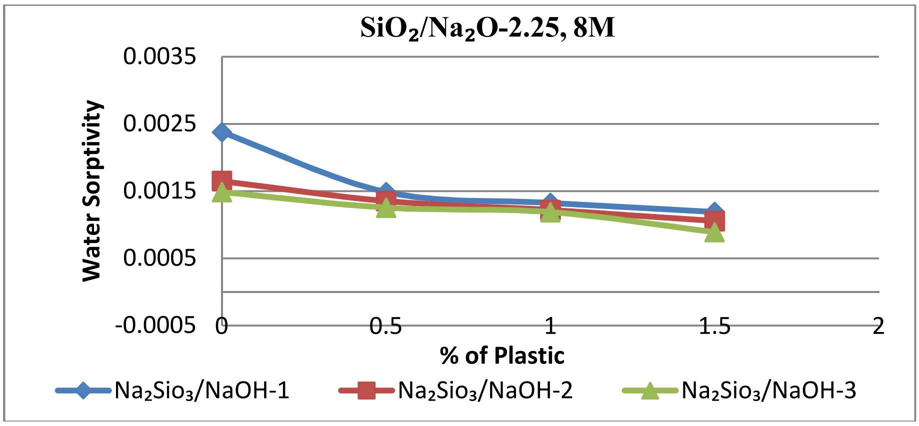


Fig.12

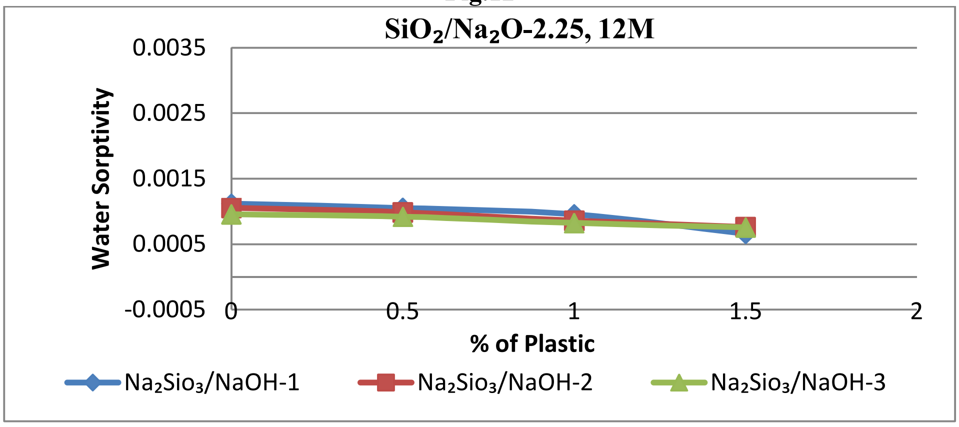
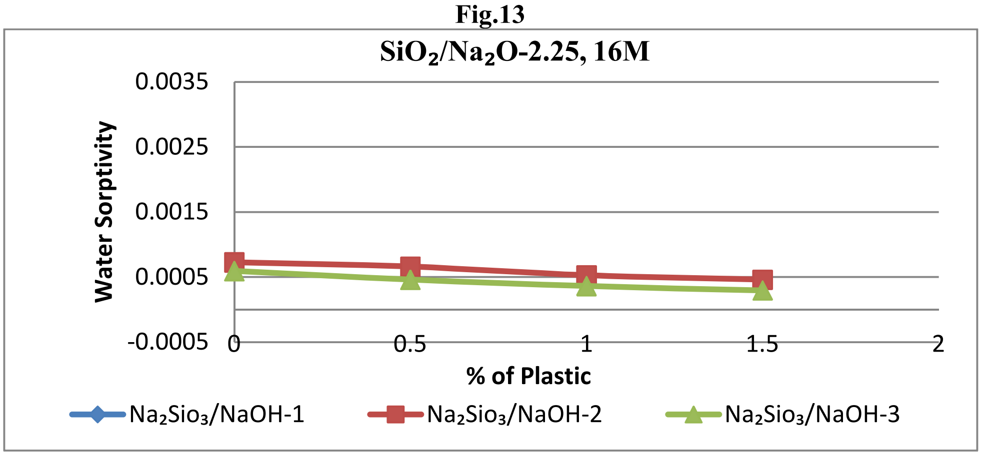


Fig.13



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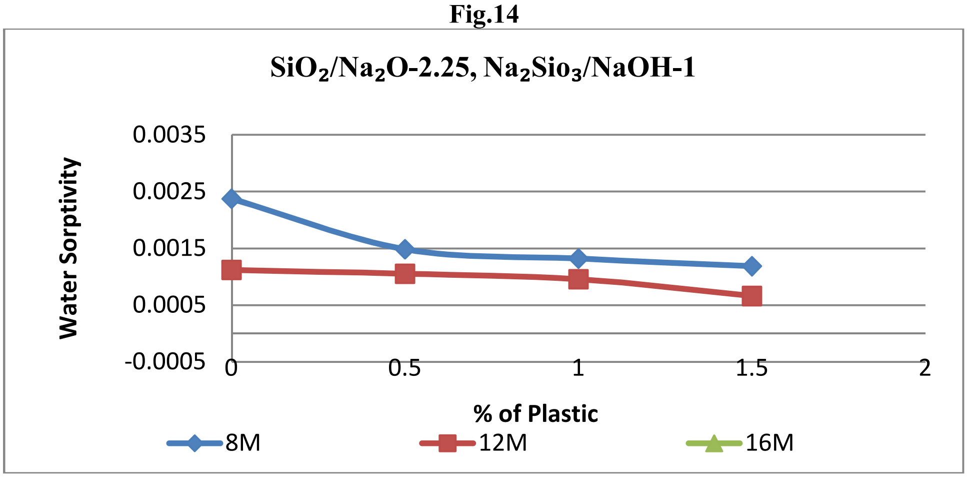

Fig.15

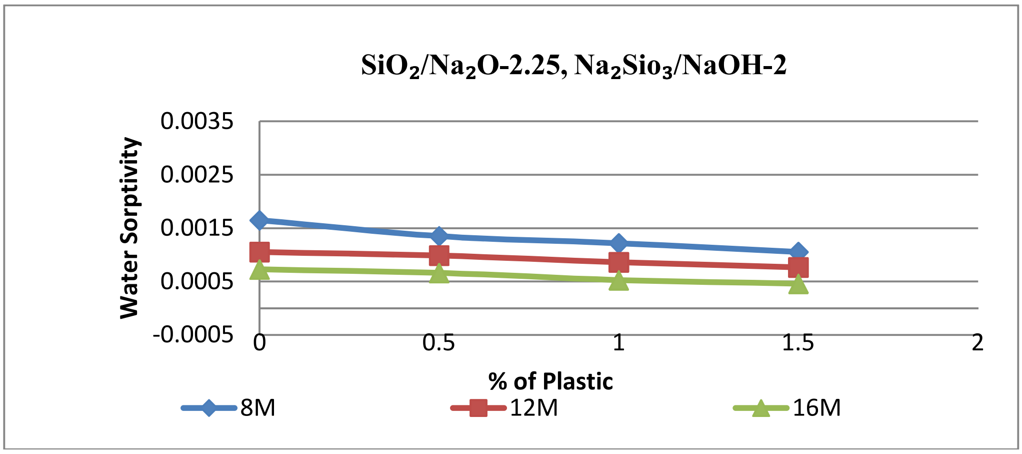

Fig.16

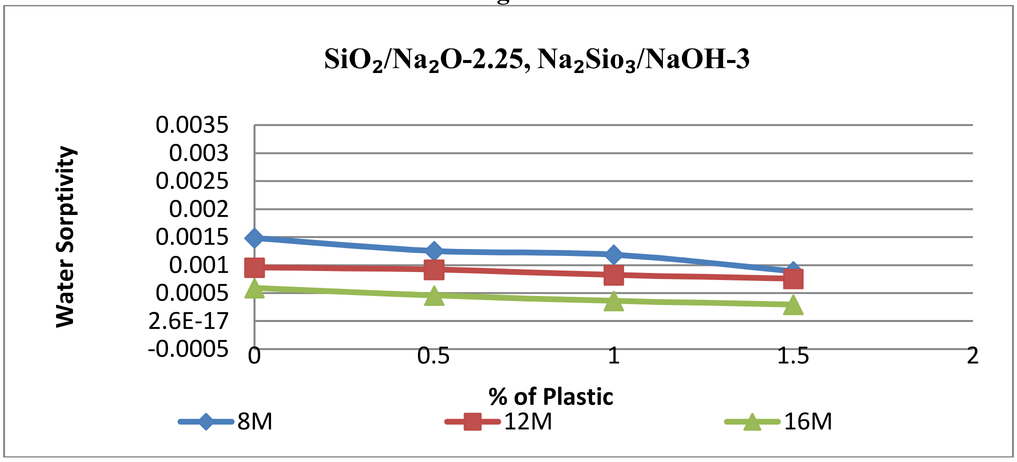

Fig.17

5.2 Observation:-

Fig.12, 13 and 14 shows when the ratio of Na_2SiO_3 to NaOH increases by 1, 2 and 3 then in 8M, 12M and 16M Water sorptivity decreases from 7.83% to 37.50%, 5.95% to14.58% and 18.35 to 35.51% respectively.

Fig.15, 16 and 17 shows when the molar content of NaOH increase by 8M, 12M and 16M then Na_2SiO_3 to NaOH ratio 1, 2 and 3 Water sorptivity decreases by 27.53% to 52.81%, 26.91% to 39.74% and 14.98% to 60.79% respectively.

6. CONCLUSIONS:-

Molar content of Sodium hydroxide (NaOH) when increased from 8M to 16M then Oxygen permeability and Water sorptivity of geopolymer concrete decreases.

Sodium silicate (Na_2SiO_3) to Sodium hydroxide (NaOH) ratio when increased from 1 to 3 then Oxygen permeability and Water sorptivity of geopolymer concrete decreases.

Metallized polymer plastic waste increased from 0% to 1.5% and then Oxygen permeability and Water sorptivity of geopolymer concrete decreases.

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