EFFECT OF USING WASTE PLASTIC IN GEOPOLYMER CONCRETE

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Abstract : This study has been carry out to investigate the potential of geopolymer concrete in the construction industries with growing environmental and climatic change it has now become necessary to look for greener and sustainable building material**.** One such sustainable material is geopolymer concrete which utilize the waste material that are high in alumina and silica content like Fly ash, rice husk ash, GGBS, metakaolin etc. these material are activated by alkaline solution ($NaOH+Na_2SiO_3$) which forms a bond with conventional building material like sand and coarse aggregate. Therefore geopolymer concrete is a totally a cementless concrete with 0% of cement So by developing a geopolymer concrete we can rule out one of main concern of environmental issue of CO_2 emission from cement production.

IndexTerms **– Geopolymer , Plastic, Fly ash, curing, alkaline solution**

I. INTRODUCTION

CONCRETE IS THE SECOND MOST COMMONLY USED material on our planet Earth. Over 3000 year old material concrete lays its foundation on cement, water and gravel. With the advancement in cement production technology we are able to build ultra high performance concrete. Cement production involve crushing, heating and grinding of limestone which produces a high amount of carbon dioxide into our environment. For every one ton of cement being produce about three quarter ton on carbon dioxide is being released into our environment which is matter of great concern for our environment climatic change. According to report published by The Portland cement association (US) estimate about 4 billion tons of cement production all over the world for year 2018 which will emit about 3.2 billion tons of carbon dioxide into our environment which is equal to 581 million cars emission . India rank second for the cement production with 502 million tons of cement production in the year 2018. With such a huge amount of CO_2 emission into our environment it is our sole duty to look for alternatives that are more sustainable and greener which has minimal effect on our environment. One such material is Geopolymer Concrete that is one of the alternative of cement concrete geopolymer concrete is standard concrete without any Indian standard code but it produces result as same as that of normal cement concrete. Geopolymer concrete is composed from industrial waste production like fly ash, rice husk ash , water and municipal treated sludge GGBS, metakolin etc. which are high in alumina silica content and these waste material is activated by alkaline solution ($NaOH+Na_2SiO_3$) with other conventional material like sand and coarse aggregate. Adding waste plastic in form of powder form generated by crushing of HDPE plastic bottle as partial replacement of sand is one step forward towards making geopolymer concrete more greener and sustainable material. This paper also discusses the techniques of curing geopolymer concrete. With advancement in technologies like scanning electron microscope, energy dissipater, X-ray spectroscopy an X-ray diffraction studies are allowing us to develop more and more ultra high strength geopolymer concrete. Geoploymer is 100% cement free and it's a cementless concrete focusing on sustainability with involvement of industrial waste product .The requirement of water in geopolymer concrete for mixing and curing is very less as compared to conventional cement concrete.

CHEMICAL REACTION INVOLVED IN GEOPOLYMER CONCRETE

$$\text{Si-Al material} + \text{Activators} (NaOH + Na_2SiO_3) + H2O \longrightarrow \text{Geopolymer binder}$$

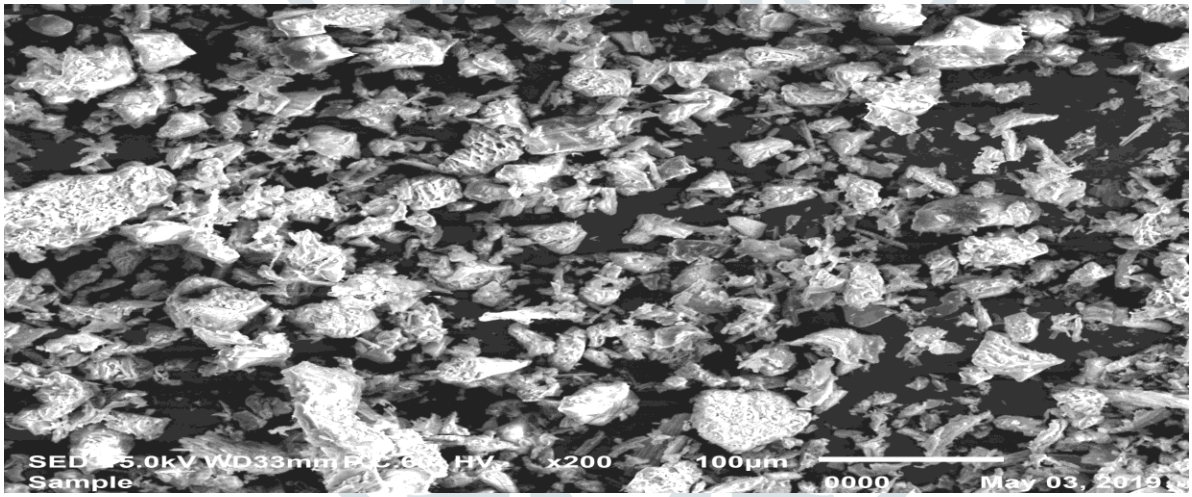
II. CONSTITUTIVE MATERIAL OF GEOPOLYMER CONCRETE

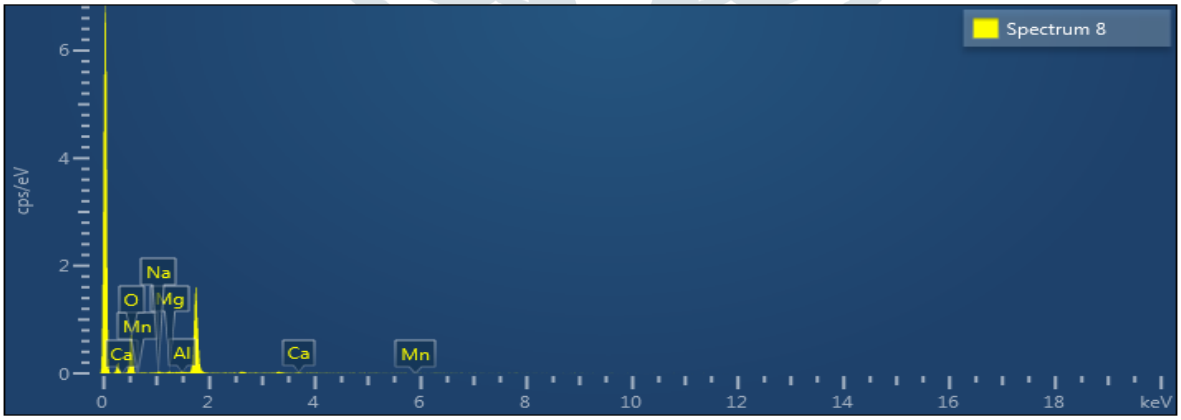
- Alumina silica waste material like fly ash, rice husk ash, GGBS etc.
- Alkaline solution ($NaOH+Na_2SiO_3$)
- Fine aggregates
- Coarse aggregate
- Distilled water (to make alkaline solution)

III. ANALYSIS OF ALUMINASILICA MATERIAL

The strength of geopolymer concrete depends on the content of alumina silica in the industrial waste product higher the concentration of alumina silica higher the strength obtain in geopolymer concrete. If the concentration of alumina and silica is lower in the material it is advisable to use a blend of two material like Fly ash and GGBS in different proportion as per the requirement of alumina and silica. The analysis and concentration of alumina and silica in industrial waste material can be done by Scanning electron microscope / Energy Dispersive X-Ray Spectroscopy machine(SEM/EDS) .In present research work fly ash from two different sources one from Rajpura thermal power plant and other was obtain from Ropar thermal power plant were collected and their SEM/EDS were performed. The analysis and result of fly ash are discuss below

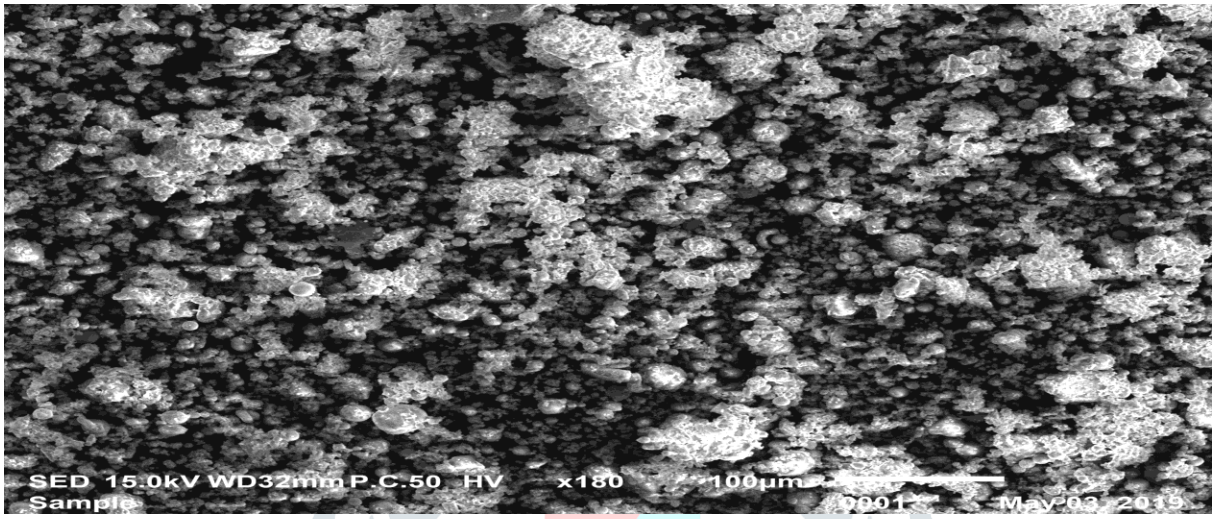
- **RAJPURA THERMAL POWER PLANT FLY ASH REPORT**

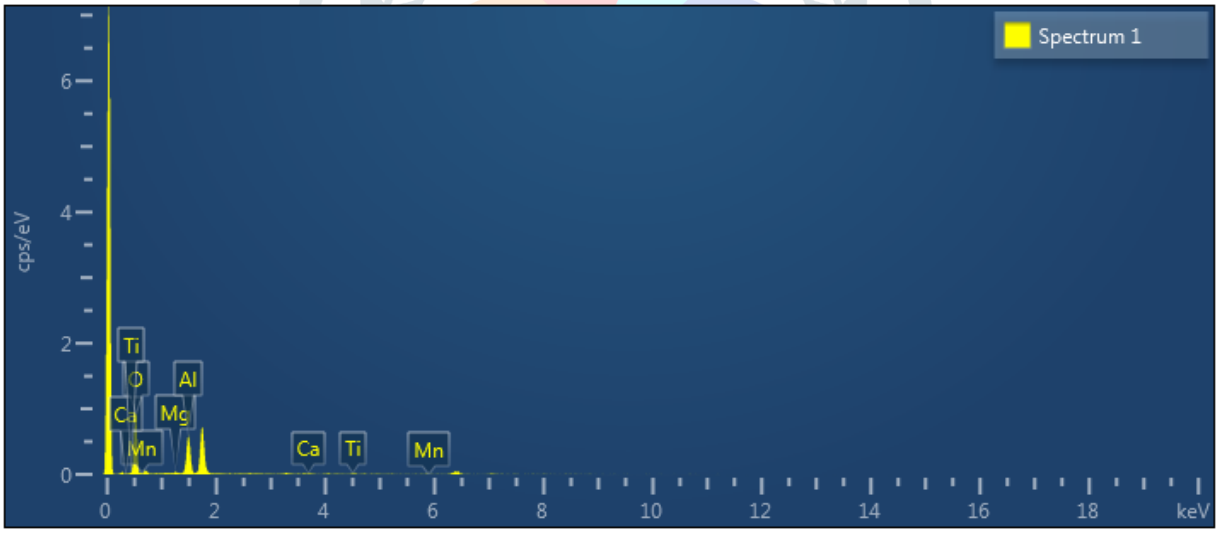




Spectrum 8				
Element	**Line Type**	**Weight %**	**Weight % Sigma**	**Atomic %**
Si	K series	43.95	0.95	31.24
O	K series	53.86	0.99	67.21
Ca	K series	0.62	0.25	0.31
Mg	K series	0.31	0.21	0.26
Mn	K series	0.15	0.37	0.06
Fe	K series	0.00	0.00	0.00
Al	K series	0.27	0.21	0.20
Na	K series	0.83	0.27	0.72
Total		100.00		100.00

- **ROPAR THERMAL POWER PLANT FLY ASH REPORT**





Spectrum 1				
Element	**Line Type**	**Weight %**	**Weight % Sigma**	**Atomic %**
O	K series	51.09	1.14	67.13
Al	K series	15.34	0.58	11.95
Si	K series	21.12	0.69	15.81
Fe	K series	10.54	0.92	3.97
Ca	K series	0.33	0.23	0.17
Mg	K series	0.63	0.21	0.55
Mn	K series	0.00	0.00	0.00
Ti	K series	0.96	0.31	0.42
Total		100.00		100.00

CONCLUSION OF FLY ASH TEST REPORT ANALYSIS

After performing the scanning electron microscope test on fly ash on both the samples it can be concluded that Ropar thermal power plant fly ash is far more better choice than Rajpura thermal power plant fly ash for geopolymer concrete. Fly ash from Ropar thermal power plant contain the appropriate amount of alumina and silica which are the key elements for the geopolymer reaction .It also satisfied the requirement of class F Fly ash conforming to IS 38I2 (Part I) which is the essential to make geopolymer concrete whereas Rajpura thermal power plant fly ash lack the key element of geopolymer reaction i.e. alumina this type of fly ash is suitable for brick making. Therefore Ropar thermal power plant fly was used to make the geopolymer concrete.

IV. PREPRATION OF ALKALINE SOLUTION

Sodium hydroxide(NaOH) solution of 12M was prepared before mixing of ingredients. Preparation of sodium hydroxide (NaOH) solution must be done at least 24hours before using it because it is highly exothermic process and releases a large amount of heat. Solution should be made in distilled water. Proper precaution must be taken while preparing solution due to its high alkaline nature it is very harmful for human skin if it is brought in contact with skin it causes severe burn to avoid the injurious effect surgical gloves can be used.

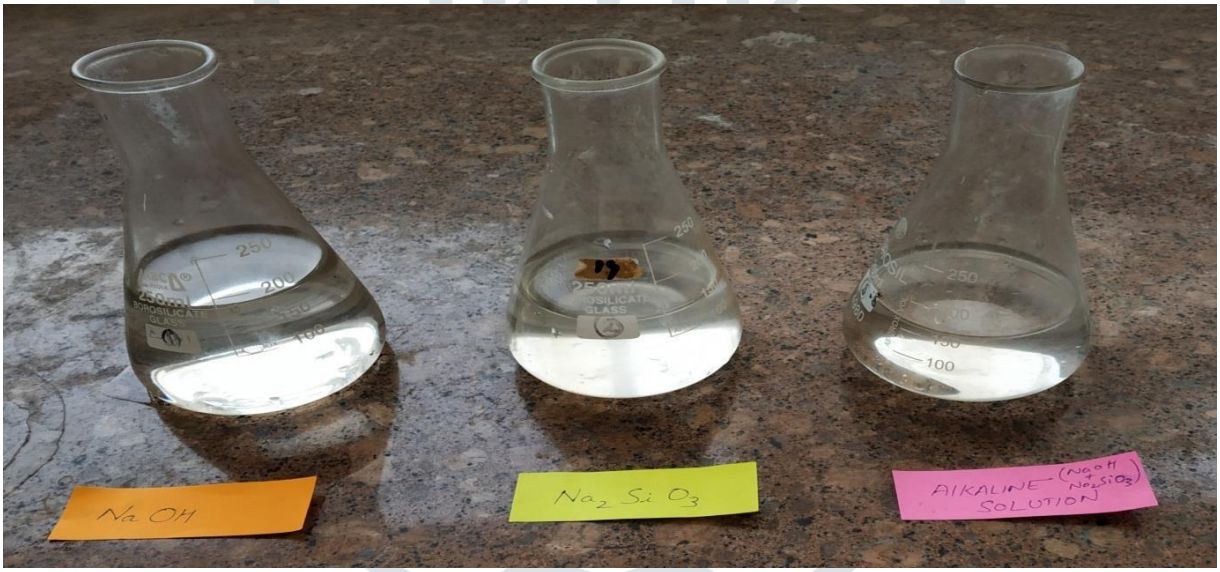


Figure 1 Preparation of alkaline solution

After the Sodium hydroxide solution is prepared and left for 24hours before it can be cool down to normal temperature and subsequently sodium silicate (Na_2SiO_3) should be mixed and kept for another 24hours to prepare the alkaline solution.

Sodium silicate (Na_2SiO_3) and sodium hydroxide are mixed in the ratio of 2:1. Alkaline solution is a mixer of sodium hydroxide (NaOH) and sodium silicate (Na_2SiO_3) after mixing they should be kept at room temperature for 24 hours to complete the reaction. From many trial mixes it was observed if both the chemicals are added separately in geopolymer concrete the setting time increases and it took almost 48 hours before we can actually demould the samples but after mixing the sodium hydroxide and sodium silicate solution together and keeping them for 24 hours actually makes the reaction more faster and better results are obtain through this process of producing geopolymer concrete.

V. CURING OF SAMPLES

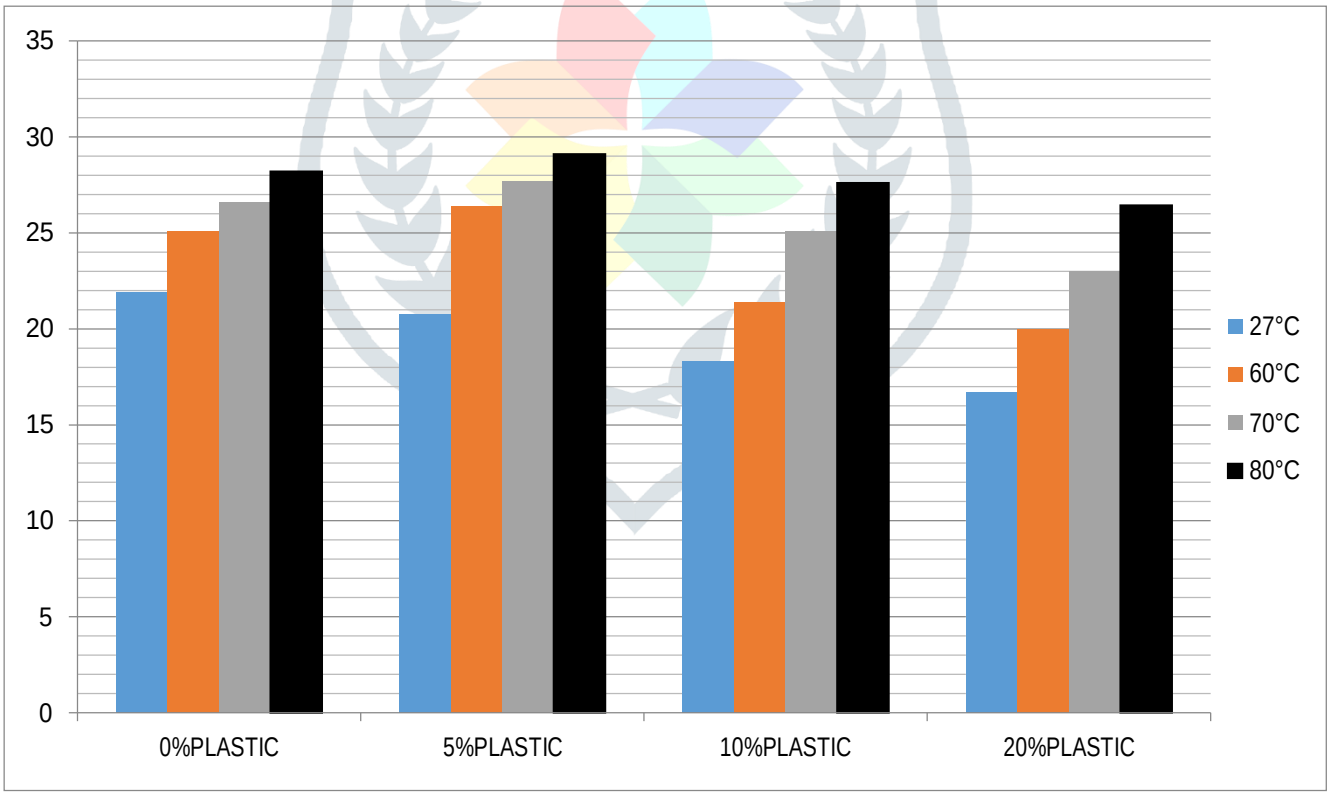
Level of understanding for geopolymer concrete curing is very low presently. Previous research were studied very carefully but none of them have clearly explained the process for curing of geopolymer concrete so an experiment was conducted during a thesis work for curing of specimens. Two samples were casted with exactly same mix design and under same condition. One of sample was cured in water and the other one was cured at room temperature for 7 days. They were tested after 7 days and it was found out that there is almost a decrease of 30KN in strength for the very first seven days after keeping in water so it was concluded from the test that geopolymer concrete should be cured in room temperature and it must be avoided for curing in water. This solve one of the problems of water usage in curing for normal cement concrete thus making geopolymer concrete more sustainable building material. To accelerate the process of polymerization reaction the samples can be cured in oven at an elevated temperature for 24hours before it can be cured at room temperature.

Figure 2 Strength obtain after 7 days of air curing (left image) and Strength obtain after 7 days of water curing (right image)

VI. RESULT OF COMBINED ANALYSIS OF COMPRESSIVE STRENGTH AT 28 DAYS

TABLE 1 COMPRESSIVE STRENGTH AT 28 DAYS

	27°C	60°C	70°C	80°C
0%PLASTIC	21.88	25.1	26.6	28.2
5%PLASTIC	20.78	26.4	27.7	29.1
10%PLASTIC	18.3	21.4	25.1	27.6
20%PLASTIC	16.7	20	23	26.44



VII. Result and conclusion

Maximum compressive strength was obtained at 28 days but further increase in compressive strength is possible at increase age of concrete as rate of polymerisation reaction in geopolymer concrete is slower than rate of reaction in normal concrete. It was observed at 28 days maximum compressive strength is observed at 5% of plastic replacement with fine aggregate. Further increase in compressive strength can be expected with the same mix design at higher temperature above 80°C as it is studied in detail while performing the lab work with increase in temperature the compressive strength increases. Air curing at room temperature is preferred in geopolymer concrete and water curing should be avoided as it lead to rapid decrease in compressive strength because water is released during geopolymer reaction.Age of curing is calculated after the samples are removed from oven curing.Oven curing is done for 24 hours only but if it is desired to obtain higher compressive strength at early ages it can be kept for longer period.

VIII. REFERNCE

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