DURABILITY PARAMETERS OF GEOPOLYMER CONCRETE USING GGBFS

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ABSTRACT

In the study, Concrete is the most extensively used construction material in the world with about six billion tones being produced every year. geopolymer concrete has the potential to substantially control CO2 emission. To produce more durable infra -structure capable of design life measured in hundreds of years. GPC is a hardened cementation paste made from GGBS and alkaline solution. The objective of the present study is to observe the effect of GGBS based on GPC and by replacing of 100% GGBS with OPC. The molarity of sodium hydroxide is 6molar, 8molar, and 10molar. The proportion of soluble activators is 1:2. Calcium silicate is framed when GGBS gets responded with sodium hydroxide and sodium silicate. A mix proportion for Geopolymer concrete was designed by assuming the unit weight of geopolymer concrete as 2400 kg/m3 . To conduct the GPC with GGBS to analyse the progressions of properties like strength and durability.

Key words: Ground Granulated Blast Furnace Slag (GGBS), Alkali Activators, Molarities and Ambient Curing.

INTRODUCTION

1.1 General

Portland Cement is currently the most widely used material in the construction industry .It is a fine powder produced by heating materials in a kiln .It mainly consists of silicates and aluminates in its chemical composition.This cement when mixed with water, sand and aggregates produces Portland Cement Concrete.This Concrete is used nowadays in the construction industry with the fact that it is even cheaper than water. For manufacturing of 1 ton of Cement approximately 1 Ton of CO_2 is released as per the environmental reports which is not good from environmental point of view.Several studies have been done to reduce the usage of Portland Cement and find its alternatives.The studies suggested the usage of Fly-Ash , Slag, Rice Husk and Metakaolin as Pozzolanic Materials to partially replace the cement.

A new binder material named as “geopolymer” was introduced by Joseph Davidovits in 1978 with an amorphous chemical microstructure. Geopolymers consist of a polymeric Si–O–Al framework, similar to zeolites. The main difference to zeolite is geopolymers are amorphous

instead of crystalline. The first geopolymer cement developed in the 1980s was of the type (K,Na,Ca)-poly(sialate) (or slag-based geopolymer cement) and resulted from the research developments carried out by Joseph Davidovits and J.L. Sawyer at Lone Star Industries.The main benefit of Geopolymer is that it does not require water for formation of bond which is the case in Cement based Concrete.In cement based concrete C-S-H Gel is formed where as in geopolymers bonding is formed by polycondensation reaction which occurs between silica and alumina providing a strong bond.Geopolymers consists of 2 main constituents i.e Source Material and Alkaline Solution.The source material to be used for making geopolymer concrete should have high silica and alumina content.Materials such as Fly-Ash,GGBFS(Ground Granulated Blast Furnace Slag),Rice Husk ,Metakaolin,etc can be used as these materials as they have high silica and alumina content.Alkaline solution consists of Alkali Silicates and Alkali Hydroxides .Alkaline solution plays a role of an activator for bonding between Si and Al in Source material.

1.2 Research Objectives

The main objective of this research is to evaluate the durability parameters of GGBFS based Geopolymer Concrete as compared to Fly-Ash Based Geopolymer Concrete and Ordinary Portland Cement Concrete.It includes study of GGBFS based Geopolymer concrete of different molarities under different curing and ponding condition and its comparison with Fly-Ash Based Geopolymer Concrete and Ordinary Portland Cement Based Concrete.

1.3 Scope Of Work

Scope Of Work Involves the following :

1) Preparation of different concrete mix using Slag
2) Use of different Molarity of NaOH Solution and curing them at ambient temperature and oven curing at 50^{O} C for Slag and 60^{O} C for Fly-Ash.
3) Ponding of cubes in H_2SO_4 and NaCl solution with alternate wetting and drying condition for durability parameters.
4) Testing of cubes for Loss/Gain in compressive strength at 28 and 56 days.

LITERATURE REVIEW

2.1 Slag

Slag is a left over by-product obtained from a raw ore of metal .It is usually produced alongside steel from b;ast furnace or electric arc furnace.The major components of slag include

$MgO, SiO_2, CaO, FeO, Al_2O_3$ with lesser amounts of manganese and phosphorous in it.Slag has no risk of alkali aggregate reaction.The advantages of using Ground Granulated Blast Furnace Slag is its increasing strength over longer period of time,low rate of heat of hydration when it reacts with water as compared to Ordinary portlad cement and high chemical durability .

Advantages

1. It has high resistance to seawater and to chemicals, and can improve durability.
2. It has a low chloride ion diffusion coefficient (resists rebar corrosion).
3. It can reduce alkali-aggregate reaction.
4. Its strength increases over time.

2.2 What is Geopolymer ?

Geopolymer concrete is a new material that does not need the presence of Portland cement as a binder instead activating the source materials such as fly-ash ,slag,rice husk,metakaolin etc. that are rich in Silicon and Aluminium using high alkaline liquids produces the binder required to manufacture the concrete .

Figure 5 : Mixing NaOH Flakes in water

Figure 6 : Mixing NaOH Solution with Na_2SiO_3

Figure 7 : NaOH Flakes

3.4.3.2 Acid Attack Test:

The effect of different exposure condition will be different on concrete. To study the effect of exposure to acidic environment, specimen were immersed in 5% of solution of Sulphuric Acid (H_2SO_4), after curing for 28 days in atmosphere, for 28 and 56 days. The acidic solution is refreshed after 2 weeks with the same solution.

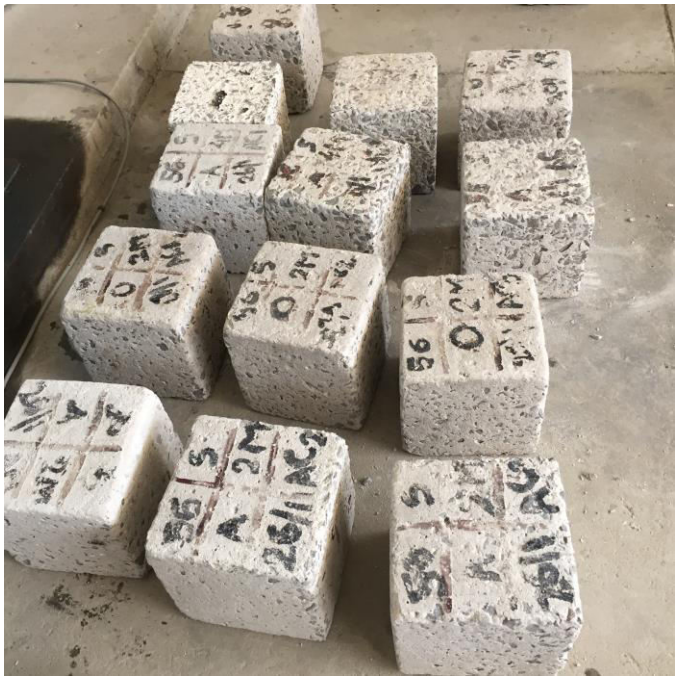

Figure 8 Cube After Acid Curing

CONCLUSION AND FUTURE SCOPE

5.1 Summary & Conclusion

- The present study was carried out for M25 Grade concrete mix with replacement of cement with different proportions of MD (10%, 15%, 20%, 25%, and 30%) and 5% of Alccofine.
- The study clearly reveals that cement replacement by 10%, 15%, and 20% of MD achieves required strength at 7 days.
- At 28^{th} day required strength gain was possible in 10%, 15% and 20% replacement of cement with MD.
- From compressive strength tests it can be concluded that the best proportion of UMD is 10% with 28 days of curing.
- From this experiment it is clear that percentage MD replacement with cement can be increased up to 25% with added Alccofine at 28 days of curing which is suggested 10% by the several literature.
- In Durability aspect there is no significant weight loss is observed. And compressive strength loss is about average 15%.

5.2 Future Scope

- One can extend the work in this area by taking concrete grade other than M25 and by taking MD from the different region.
- The properties studied in this experimental work were compressive strength, tensile strength and Durability of concrete. Other properties such as Flexural strength, Modulus of Elasticity, Abrasion resistance etc… can also be studied in detail.

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