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EXPERIMENTAL INVESTIGATION OF STRENGTH AND CHARACTERISTICS OF FLYASH BASED GEOPOLYMER CONCRETE

[1]M.Govardhan Reddy, PG Scholar, Dept of Structural Engg, Geethanjali College of Engineering and Technology, Nannur, Kurnool.

[2]M.Mujahid Ahmed, Assistant Professor, Dept of Civil Engineering, Geethanjali College of Engineering and Technology, Nannur, Kurnool.

Abstract:

To produce one tonne of ordinary Portland cement about 1.5 tonnes of raw materials areacquired and at the same time one tonne of carbon dioxide (CO_2) is released into the environment.Therefore the production of Portland cement is extremely resources and energy intensive process.In this circumstance, an inorganic alumino silicate polymer called geoploymer was introduced as binder material instead of cement paste. The geoplymer paste binds fine, coarse aggregates and other unreacted materials together to form the geopolymer mortar. As in the Portland cement mortar, the aggregates occupy the largest volume of nearly 75 to 80% by mass in the geo-polymer mortar also. Fly ash is used which is rich in silica and alumina, further fly ash is a byproduct of thermal power station and it is abundantly available. Silica and alumina in fly ash are activated by a alkaline liquid i.e. combination of sodium hydroxide and sodium silicate solutions to form the geopolynmer paste.

Keywords: Portland, Geopolymer, Fly ash.

1. INTRODUCTION

Throughout the world, much research is being conducted on the use of waste materials in order to either avert an increasing toxic threat to the environment or to streamline present waste disposal techniques by making them more affordable. Therefore, follows logically that an economically viable solution to this problem should include utilization of waste materials in new products for other applications rather than disposal in a landfill. Fly ash is ash separated from the flue gas of a power station burning pulverized coal (Taylor, 1997). It is fine particulate material precipitated from the stack gases of industrial furnaces burning solid fuels, such as coal. The chemical and phase compositions depend on those of the minerals associated with the coal and on the burning conditions. Internationally, millions of tons of fly ash are generated each year by coal-fired power stations as well as the petrochemical industries. The development of geopolymer concrete is the result of the concern for two environment-related situations, viz. the high amount of carbon dioxide released into the atmosphere during the production of Ordinary Portland cement (OPC), and the abundant availability of fly ash, a by-product from power stations worldwide. In 1978, Professor Joseph Davidovits proposed that binders could be produced by a polymeric reaction of alkaline liquids with the silicon and the aluminium in source materials of geological origin or by-product materials such as fly-ash and rice husk ash. He termed these binders as geopolymers. Several engineers and scientists suggested that pozzolonas such as blast furnace slag might be activated using alkaline liquids to form a binder and hence totally replace the use of OPC in concrete.

2. RELATED WORK

In this scheme, the main contents to be activated are silicon and calcium in the blast furnace slag. The main binder produced is a C-S-H gel, as the result of the hydration process.The stage of any natural economic development is reflected by the growth rate of infrastructure and highlighted by the growth rate cement production. The atmospheric carbon-dioxide concentration increases for the time range 1840-2000 and the development of word Portland cement manufacture since its invention in 1840. since the 1970 decade, due to exponential use of concrete, cement production has increased at much higher speed than atmospheric carbon-dioxide concentration i.e. the all major carbon dioxide emissions caused by human activities such as energy and transportation. As time goes by, it will thus have a greater influence on the trend of co_2 emissions and the predicted Bace (Business as usual) values for future atmospheric carbon-dioxide concentration should be corrected accordingly. atmospheric co_2 concentration (PPM) and world Portland cement production (million tones) for the period of 1840-2000; source IPCC and cembuireau. For instance in the short period 1980-1984, the US production of blast furnace slag dropped sharply from about 26 million tones to 13 million tones. Actually conventional steel manufacture technology provides a crystalline slag, which has no hydraulic properties, and is used as road based material or as stone like aggregate or simply disposed of as a waste product. Hence the use of slag for its cementitious properties requires the material to be in the amorphous vitreous state. Obtained by quenching the slag from the melt, either in water or in air. A world production growth of 2.5% to 5% yearly for the nest 25 years could represent the availability of 290 or 590 million tones of blast furnace slab, in the year 2015 for cement applications. In short, cementitious slag would have at most 16% of the world market. The thickness of metallic sheet for the mould should not be less than 1.67mm. Sometimes the mould is provided with suitable guides for lifting up. For tamping the concrete, a steel tamping rod of 16mm diameter, 0.6m long, with a bullet end, is used. The internal surface of the mould is thoroughly cleaned and freed from superfluous moisture and adherence of any old set concrete, before commencement of the test. The mould is placed on a smooth, horizontal, rigid and non-absorbent surface.

3. PROPOSED SYSTEM

The mould is then filled in three layers each approximately one-third of the height of the mould. Each layer is tamped 25 times with the tamping rod, taking care to distribute the strokes evenly over the cross-section. After the top layer has been tamped, the excess concrete is struck-off with a trowel and the tamping rod. The mould is removed from the concrete immediately by raising it slowly and carefully in vertical direction. This allows the concrete to subside. The subsidence is referred as slump of concrete. The specimen should be tested immediately after removal from water while they are in wet condition. cleaned the surface of supporting and loading surface, removed any coarse sand or other material from surface of specimen, placed the specimen in such a way that the load should be applied to the uppermost surface as cast is mould along the loose 5 cm apart, align the axis of specimen along the axis of loading device and apply the load without shock and increase it continuously at a rate such that extreme fiber stress increases at the load and finally increase the load until the failure and noted down dial gauge reading .

S.No	Age in days	Concentration of NaOH In molarities	Curing	Alkaline Solution + Flyash	Test Specimen Size in mm.	Compressive strength In N/mm^2
1	7	16	Water	(0.5:1.0)	100x100x 100	27.56
2	14	16	Water	(0.5:1.0)	100x100x 100	27.68
3	21	16	Water	(0.5:1.0)	100x100x 100	27.92
4	28	16	Water	(0.5:1.0)	100x100x 100	28.32

Table.1.Strength Results

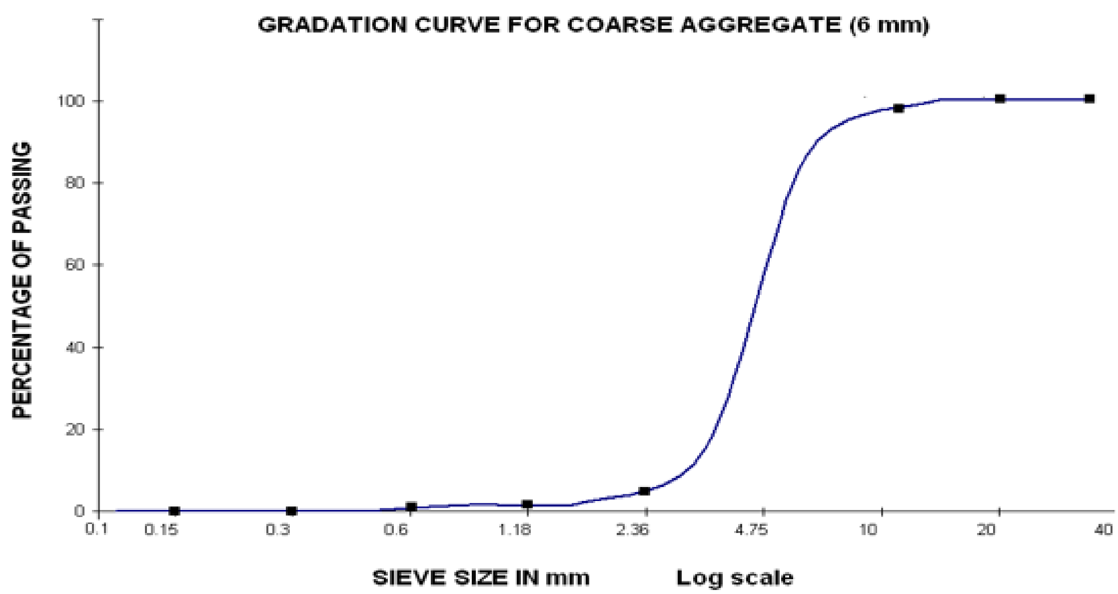

Fig.1.Result Analysis

Professor Joseph Davidovits reported that the fly-ash possesses excellent mechanical properties, does not dissolve in acidic solutions, and does not generate any deleterious alkali aggregate reaction even in the presence of high alkalinity. Very little research data is available about geopolymer concrete. Most of the past research on the behavior of geopolymeric material was based on the binder paste or mortar using small sized samples. In addition, some of the conclusions are contradictory. Based on the laboratory tests on fly-ash based geopolymer binder, Palomo, Grutzeck and Blanco have shown that the curing temperature, curing time and the type of activator affected the compressive strength, while the solution to fly-ash ratio was not a relevant parameter. Increase in the curing temperature increased the compressive strength. The type of alkaline activator that contained soluble silicates resulted in a higher reaction rate than purely alkali based activator.

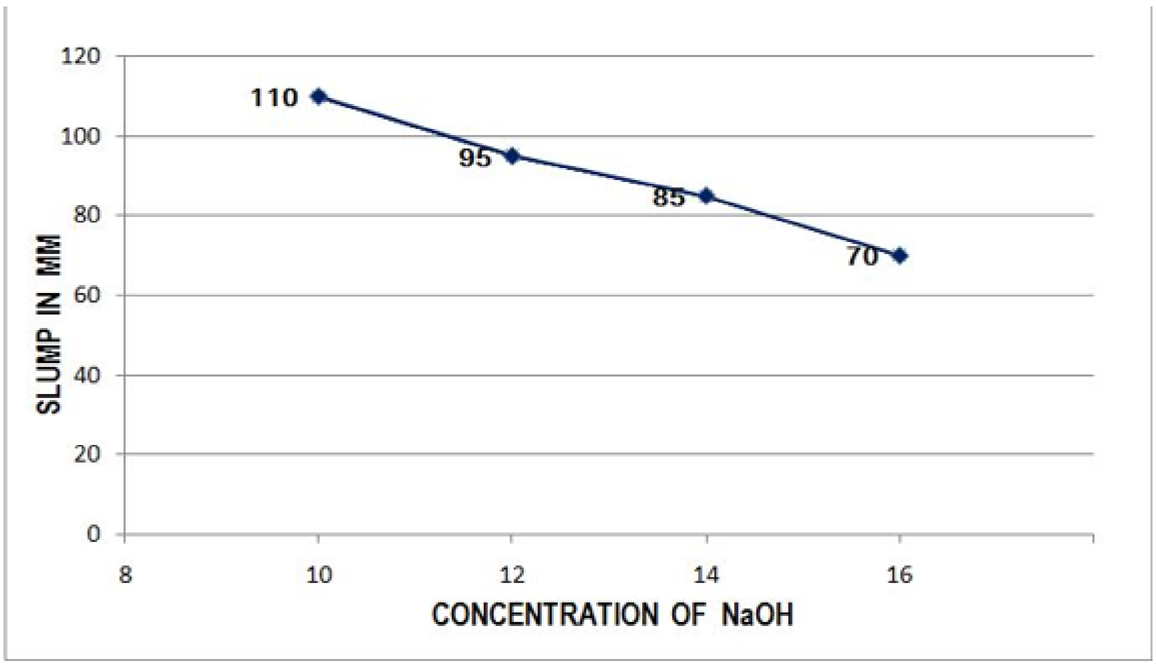

Fig.2.Variation of Slump

These days, super plasticizers are powerful enough to keep concrete mix highly workable for more time with much less water quantity. The use of super plasticizer is practiced for production of flowing, self-leveling and self-compacting concrete and for the production of high strength and high performance concrete. It is observed that fly-ash concrete is much stiff, resulting in decrease in workability. So naphthalene based super plasticizer with a brand name CONPLAST-SP430 was used in the preparation of fly-ash concrete. Slump test is the most commonly used method for measuring consistency and workability of concrete, which can be employed either at the laboratory or at the site of work. It is not suitable for very wet or very dry concrete. It does not measure all factors contributing to workability, nor is it always representative of the practicability of the concrete. However it is used conveniently as control test and gives an indication of the uniformity of the concrete from batch to batch. Repeated batches of the same mix, with same slump, will have the same water content, provided the weights of the aggregates, fly-ash, sodium silicate solution.

CONCLUSION

This project presented the development of geopolymer concrete. The binder in this concrete, the geopolymer paste, is formed by activating by-product materials such as low-calcium fly-ash that are rich in silica (SiO_2) and alumina (Al_2O_3).In the experimental work, the fly-ash from a local power station (RTPS) was used as source material. A combination of sodium silicate and sodium hydroxide solutions was used as activator. The geopolymer paste binds the loose coarse and fine aggregate and any un-reacted materials to form the geopolymer concrete. Based on the experimental work reported in this project, the following conclusions are given.

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