A Study on different types of Super plasticiser used for Self-Compacting Geo-polymer Concrete.

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Abstract- This paper presents an experimental study of the influence of different superplasticizer on compressive strength at 7th and 28th days with its flow test characteristics, this concrete is prepared with fly ash based self-compacting geopolymer concrete (SCGC). Two superplasticiser (SP)were taken for the comparision, which are being generally used and easily available in market.

MasterGlenium ACE 30 is an innovative second generation of polycarboxylic ether polymers superplasticiser.

Vs.

Conplast SP550 is based on Sulphonated Naphthalene Polymers and is supplied as a brown liquid instantly dispersible in water.

Both SP were added in same quantity and same mix design, both different SP mixes were ideal to each other for premiing, during mixing and post mix operations.

Amount of plasticiser and the type of plasticiser used are making major concentration points. Which is showen in this paper. This behaviour of plasticiser is tested on the all 8M, 12M and 16M mixes, flow test and 7th ,28th and 90th days strength are compared and on that basis conclusions are given.

Index Terms – Comparison of superplasti-ciser, Molar concentration in Self compacting Geo-polymer concrete, Self compacting Geo-polymer concrete.

I. INTRODUCTION

Geopolymer concrete (GC) is one of the recently developed construction material which in next future could partially re- place cement from concrete industry. Geopolymer comprises of two main components, namely the source materials and the alkaline liquids. The source material must be rich in silica (Si) and alumina (Al) content to have a full potential to be used for alumino-silicate based geopolymer concrete. The by-product materials, such as fly ash, rice husk ash or silica fume and GGBS or natural minerals such as kaolinite and clay could be used as source materials. The alkaline liquids could be from soluble alkali metals that are usually sodium or potassium based solution and the most common alkaline liquid used in GC is a combination of sodium hydroxide (NaOH) or potassium hydroxide (KOH) and sodium silicate (Na2SiO3) or potassium silicate (K2SiO3). Self-compacting geopolymer concrete (SCGC) can be considered as an advanced and innovative construction material in the concrete technology. As the name implies, it does not need any compacting efforts to achieve full compaction and utilizes fly ash together with alkaline solution and super plasticizer as a binder for matrix formation and strength. The geopolymer paste is used to bind the loose coarse aggregates, fine aggregates and other unblended materials together in the presence of super plasticizer to attain the required workability for SCGC. This improved concreting operation, which could offer many benefits and advantages over conventional concrete. These include; ease of filling in restricted and narrow sections, enhanced consolidation around reinforcement and bond with the reinforcement, better quality of concrete, reduction of on-site maintenance, faster rate of construction, lower overall costs, and improved concreting operation. A significant progress of health and safety could also be achieved through reduction of CO2 emission due to elimination of Portland cement production, suspending the use of vibrators and considerable minimization of environmental noise loading on and around a construction site.

The sustainable production of self compacting geopolymer binder hinges on controlling the mix proportion, determining the right quantities of NaOH and Na2SiO3 solution required to activate the source material Fly Ash and optimizing the super plasticizer dosage. The composition of SCGC mixes includes substantial proportions of fine-grained inorganic materials and this gives possibilities for utilization of mineral admixtures such as fly ash, which are currently waste products with no practical use and are costly to dispose-off. The particles fraction of size less than 0.125 mm is considered as the fines content of the geopolymer paste and should also be taken into consideration in calculating the water to geopolymer solids ratio because the water to geopolymer solids ratio is an important parameter to control the workability as well as the compressive strength of SCGC. Moreover, the fine aggregates significantly affect the fresh properties of SCGC than the coarse aggregate. In self-compacting concrete (SCC) mixes, it is believed that the high volume paste helps to minimize the friction between the sand particles and enhance the workability and use of improved particle size distribution is also very important. Self- compacting concrete mix design methods mainly use blended sands to achieve an optimized aggregate grading curve. The major role of super plasticizer in SCGC is to get adsorbed on to binder grains, impart a negative charge to them, which repel each other and get deflocculated and dispersed. This gives better work- ability and superior performance for the SCGC by improving the plastic and hardened properties, enhances the microstructure and leading to higher compressive strength. Similarly in cement based SCC, super plasticizer is used to produce flowable concrete in cases where placing in hard to reach areas or locations.

A. Materials Used:

Fly ash: Low calcium dry fly ash Containing 80% silicon and aluminum constitutes.

Alkaline liquid: Contribution of sodium silicate solution, and sodium hydroxide solution.

Aggregates: Local coarse aggregates like 20 mm, 14mm, 7mm and fine aggregates in saturated surface dry condition.

Super plasticizer: To improve workability, high range water reducing naphthalene based and polycarboxylic based super plasticizer is used.

SP dosages of 3%, 4% and 5% were found insufficient to produce the required workability such as flow- ability and resistance to segregation. However, mixes with super plasticizer dosage of 6% and 7% provided the desired workability properties and were within the range of EFNARC limits of SCC.

Water: To improve workability or to maintain the ratios which affect strength, Pure potable water having ph near to 7.

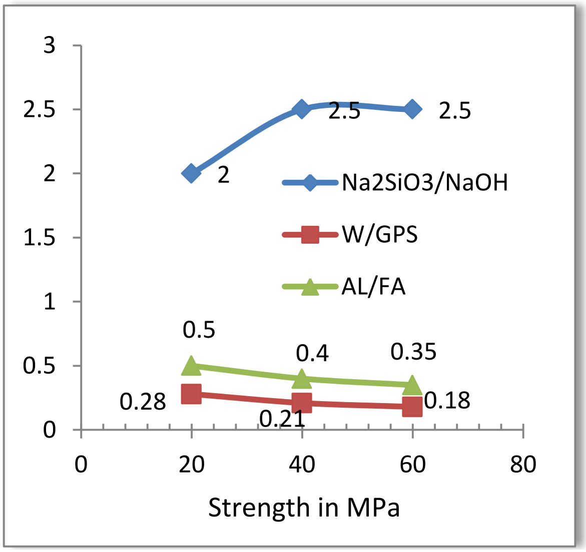

Figure 1 Main 3 ratios of GPC & its relation to strength of geopolymer concrete in normal curing conditions.

1. Water to Geopolymer Solids Ratio (W:GPS)

The W and GPS components are the total of water (from sodium silicate, sodium hydroxide and any extra water) and geopolymer solids (from fly ash, sodium hydroxide solids and sodium silicate solids) respectively. Testing has shown that the compressive strength of GPC increases as the W:GPS ratio by mass decreases, while the workability expectedly decreases. This is universally agreed upon by GPC researchers.

2. Alkaline Liquid to Fly Ash Ratio (AL:FA)

This ratio, second to the W:GPS, forms the second important ratio in the mix design of GPC. There is an interconnectivity between the ratios of W:GPS and AL:FA, therefore generally as AL:FA increases compressive strength increases. In some studies, AL:FA has been kept constant.

3. Ratio of SS to NaOH Solution (Na2SiO3:NaOH)

The Na_2SiO_3:NaOH solutions ratio, which then also affects the W:GPS and AL:FA ratios, is important as it contributes to the properties of the alkaline liquid which is the activator in the binder-producing reaction in any GPC. It is unanimously agreed upon that as this ratio increases so too does the compressive strength. This ratio has been bracketed as NaOH is costlier than Na_2SiO_3, and research of very high ratios (above 2.5) has not been carried out.

4. Molar Concentration of Sodium Hydroxide

A second parameter that affects the quality/content of the alkaline liquid is the molar concentration of NaOH. Experimental results from previous research have all shown that a higher concentration in the NaOH solution results in higher compressive strength Effects of a concentration greater than 16M have not been investigated yet.

This graph pericularly shows, the main 3 ratios which affects, major properties of SCGC or normal geo-polymer concrete.

Density of SCGC is in range of 2450-2600kg/m3.

II. MIX DESIGN

SCGC			Kg per m3
		Fly ash	400
		CA	780
		FA	870
		Na2SiO3	143
Molar Concen-tration	16	**NaOH solution total**	57
		Solid	25.308
		water	31.692
		SP	28
		Extra water	48

In this mix design like wise 16M, 8M and 12M can be made for low strength.

The mass of NaOH solids was measured as 444 grams per kg of NaOH solution with a concentration of 16 M. Similarly, the mass of NaOH solids per kg of the solution for other concentrations was measured as 8 Molar: 262 grams, 10 Molar: 314 grams, 12 Molar: 361 grams, and 14 Molar: 404 grams.

Same mix design was done with both SP polycarboxylic and Naphthalene based super plastisicer.

III. Results

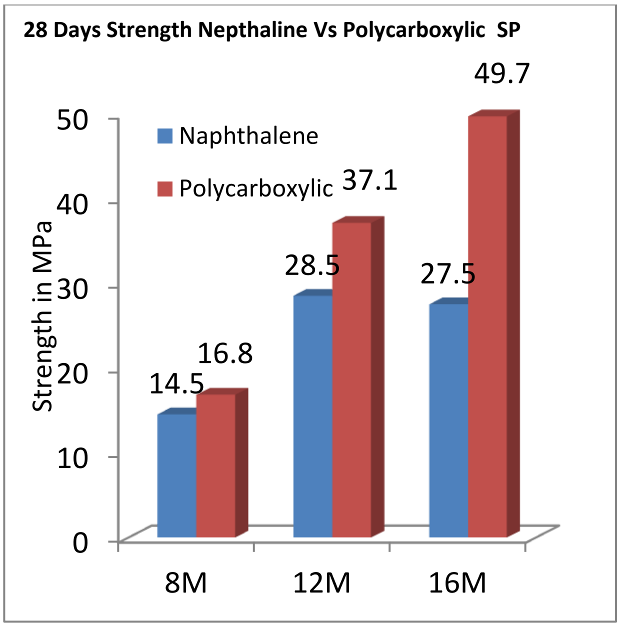

Figure 2 results of two similar mix designs with different SP, in that polycarboxylic based SP is ahead.

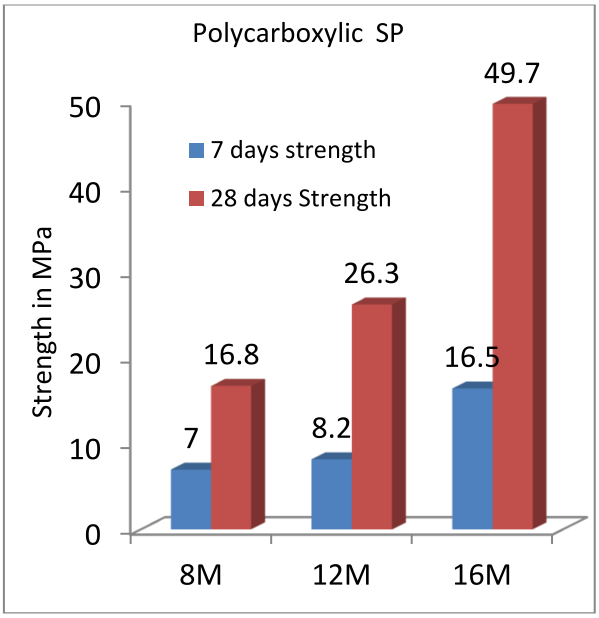

Figure 4 Separate result of Mix design with polycarboxylic SP

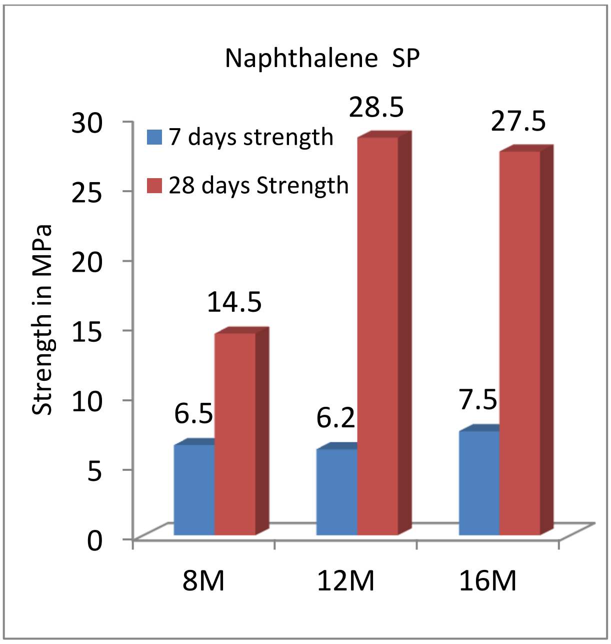

Figure 3 Separate results of Naphthalene SP for 7th and 28th day strength result

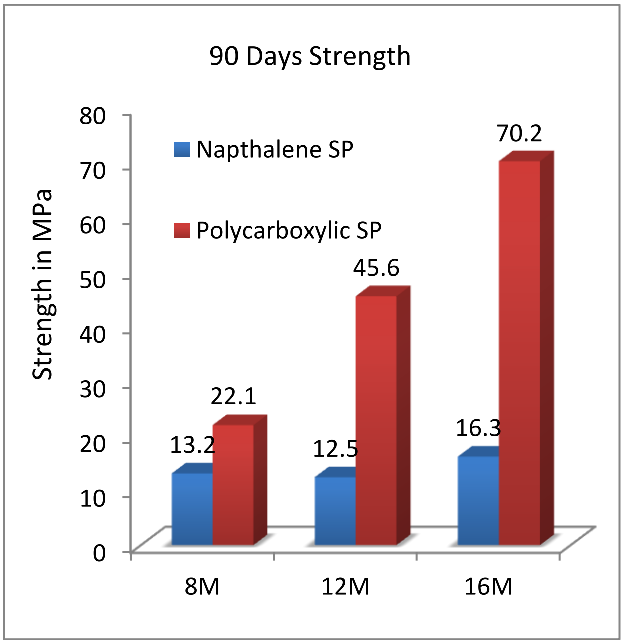

Figure 5 90 Days Strength comparison Polycarboxylic SP Vs. Naphthalene SP

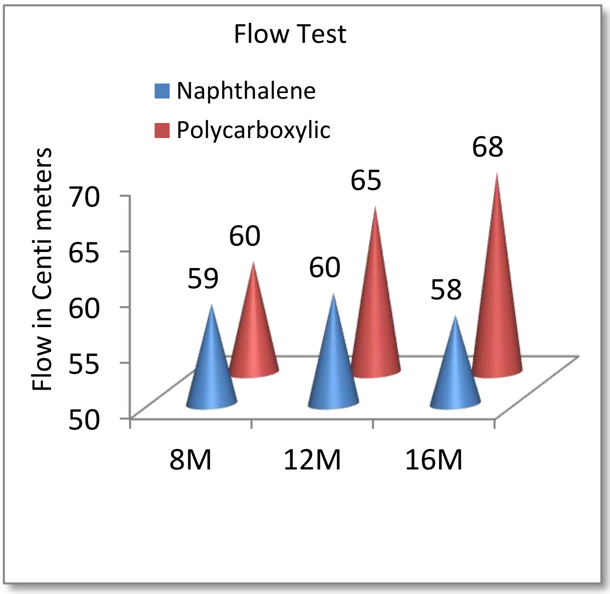

Figure 6 Here SP dosages was same for both SP and each mix but still variation is observed in the flow test result, moreover in flow test also polycarboxylic SP is performed well

IV. CONCLUSIONS:

1. It is clear that the polycarboxylic SP is more suitable SCGC in all aspects.
2. Also cube surface and setting of the concrete were comparitively better observed in case of polycarboxylic SP.
3. More-over 90 dyas strength was also reduced in the usage of the napthalene based SP.
4. Behaviour at 90 days of nepthalene SP was not desirable, so it is not advisable to use nepthalene based SP.

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