A Theoretical Study on Replacement of Natural River Sand with Geo-Polymer Fly Ash Sand

S.Sivaprasath[1], J. Govarthani[2], S. Leyohtha[3], S. Bhavadharani[4], K. Aruna[5]

[1]Assistant Professor, Sri ManakulaVinayagar Engineering College, Puducherry, India
[2345]UG ,StudentsSri ManakulaVinayagar Engineering College, Puducherry, India

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Abstract – This paper presents the possibility and effect of Geo-Polymer fly ash sand as a replacement of Natural river sand in concrete. Eco friendly concrete is the latest research in the field of concrete technology to reduce the hazardous effect in the environment. River sand are primary ingredients in the making of concrete which is obtained from mining of river beds which leads to depletion in ground water table to overcome this crises GFS can be used as an alternative material. GFS helps in reducing the carbon dioxideemission in concrete and helps in reusing the fly ash the waste product of power plants which contaminate the land.

***Key Words*:**Geo-polymer fly ash sand (GFS), Natural river sand (NRS), carbon dioxide and fly ash.

1. INTRODUCTION

The increasing demand of the river sand especially in the developingcountries like India are leading to several environmentalproblems such as lowering of the water table, destroying flora &fauna of river, soil erosion etc. Manyresearchers have worked on crushed stone sand or quarry dustas a replacement to natural river sand in the concrete. Itwas observed that the replacement of the river sand with thequarry dust decreases the workability of the concrete due to theuneven shape and texture of these particles and therefore highdosages of superplasticizers and water reducing admixtures needto be added in the concrete mixture to improve its workability.

India, the annual production of 200million metric ton of fly ash from the coal based thermal powerplants has also become the burning issue. Out of the total fly ashproduced only 50% is consumed while the rest is dumped intoash ponds losing the fertile agricultural land and also causing variousenvironmental problems including air and water pollution. Fly ash is known for its pozzolanic properties in the concrete. It is the by-product from the thermal power plants. Flyash has been used widely as the replacement to the cement inthe concrete. Various researchers have reported the increase inthe durability when OPC cement was replaced by 20% of fly ash.

2. Literature Review

Steenie Edward Wallah et al (2009) has discussed about the fly ash performance as geo-polymer cement concrete, he used fly ash as the complete replacement for cement, and heat cured the concrete for reducing the shrinkage cracks. And the result sates that heat cured fly ash cement concrete shows low shrinkage cracks when compared with the conventional concrete. From this journal the reaction of heated fly ash in concrete is studied as fly ash is preheated before use for the preparation of GFS.

Rafat Siddique et al (2003) have studied the performance characteristics of class F fly ash concrete. This paper was studied as we were opting class F fly ash for the preparation of GFS, hence its properties with concrete was analyzed. Form this paper we learnt that fly ash used concrete provide aged strength, comparatively after 28 days its performance was quite greater than river sand concrete. He also states that class F fly ash was utilized because of the 88 million tonnes of fly ash generated in India, most of the fly ash is of class F. He also stated that the abrasion resistance was found to increase with the increase in age of the concrete. Depth of wear was found to be at 60 min (max) of abrasion time for the concrete mixture.

In another reference journal Siddique has studied the effect of fine aggregate replacement with class F fly ash on the mechanical properties of concrete, where he has replaced river sand with 30%, 40%, and 50% of river sand with class F fly ash and mechanical tests were carried out to compare the mechanical properties of GFS with NRS. From this paper we learnt that compressive strength, split tensile strength, flexural strength, and modulus of elasticity of GFS concrete specimen where higher than the conventional concrete and the strength differential was more distinct after 28 days. And that the strength of the geo-polymer fly ash sand concrete continued to increase with age. In this paper he concluded that Class F fly ash could be conveniently used in concrete as a replacement for fine aggregate.

S. P. Wanjari et al (2018) has studied the characteristics of geo-polymer fly ash sand by partially replacing it with natural river sand, and computed compressive strength of the concrete and inferred that compressive strength of the concrete increased with increase in the curing time of the concrete. He also stated that geo-polymer fly ash sand are light weight particles and hence they decrease the density of concrete making them light in weight. From this journal we learnt the methodology for preparation of geo-polymer fly ash sand and we also found that the mechanical properties of geo-polymer fly ash sand concrete met with that of the conventional concrete. He concluded that geo-polymer fly ash could be used as a suitable alternative for the natural river sand in construction activities.

P. Chindaprasirt et al (2014) has conducted a study on effects of sodium hydroxide concentration on chloride penetration and steel corrosion of fly ash based geo-polymer under marine condition. In this journal he has conducted a study to study the effects of class C fly ash based concrete under marine condition. He stated that the geo-polymer based concrete with high NaOH continuously gain strength faster than that with low NaOH concentration, and the increase in NaOH concentration resulted in decrease of chloride diffusion

coefficient and steel corrosion in concrete. From this paper we learnt that geo-polymer fly ash not only improved the mechanical characteristics of concrete but also the durability characteristics even at worse conditions. We also came to know that NaOH concentration doesn't affect the durability characteristics, as we were to utilize Sodium Hydroxide pellets (NaOH) for the preparation of alkaline activator solution.

Mingjie Mao et al (2019) conducted a study on durability characteristics of concrete with fly ash as fine aggregate on alternate freezing and thawing. He conducted tests under single carbonation, single freeze and thaw, and alternative freeze and thaw and carbonation cycle to reveal the deterioration mechanism. And the results confirmed that carbonation is beneficial for refining the pore structure and increasing concrete strength at initial stages. He concluded that the carbonation coefficient of concrete with fly ash as fine aggregate continues to increase under single freeze- thaw and carbonation.

Junaid et al (2018) partially replaced fine aggregate with fly ash up to 20% and studied its compressive strength. He concluded that at 20% replacement geo-polymer fly ash sand concrete met the compressive strength of the conventional concrete. This journal was analyzed to learn about the mechanical properties of concrete at partial replacement of fine aggregate with geo-polymer fly ash sand and the results obtained on comparison.

Mehmet Gesoglu et al (2018) reported a reduction in shrinkage cracking and water absorption was also reported by with the use of fly ash in concrete. In this article an effort has been made to present the results of an investigation carried out to study the effect of replacement of sand with high volume of Class F fly ash on the properties of concrete.

K. Naga Lakshmi et al (2018) studied the strength characteristics of concrete by replacing fine aggregate with rice husk ash. This paper was studied by us to compare the mechanical properties of the concrete containing geo-polymer fly ash sand as replacement and rice husk ash as replacement for fine aggregates. We found that concrete replaced with rice husk ash as fine aggregate was light in weight but strength wise geo-polymer fly ash sand proved better results.

Akshay C. Sankh et al (2014) have discussed about the new trends in replacing the river sand with different alternatives. Materials such as copper slag, granulated blast furnace slag, washed bottom ash, quarry dust, foundry sand, construction and demolition waste, fly ashes, and spent fire bricks where studied based on their physical, mechanical properties and chemical properties and compared it with that of the natural river sand. From this paper we learned that among other materials fly ash provided increased workability, reduction of cement consumption, increased sulphate resistance, increased resistance to alkali-silica reaction, and decreased permeability. Other materials lacked certain properties which prevented in utilizing them as a complete replacement for the natural river sand. This journal was studied.

LucynaDomagala (2015) studied the effect of light weight aggregate water absorption on the reduction of water- cement ratio in fresh concrete. The research was carried out on 18 concrete mixtures made of sintered fly ash aggregate and cement- pastes of different nominal water-cement ratios. From this paper we learnt that the most important factors deciding the absorption of water by the aggregate and in turn determining the reduction of water- cement ratio are: moisture content of LWA (Light Weight Aggregate) in relation to its water absorption, the LWA content, and the cement paste properties. It was also stated that reduced water- cement effect on hardened concrete revealed increased strength in case of LWA.

PodilaSankaraPitchaiah et al (2017) have states about the ill effects of sand mining and its impact created on the environment. From this literature various impacts created on earth due to mining of river bed is studied. Minerals are part of a nation's natural wealth. The nation is to advance industrially and economically by the proper development and exploitation of these resources. It has to be remembered that the sand once removed cannot be replaced in the next generation. It will take centuries for replacement. Sand sustains the rivers and the percolation of water to far off distances both for the growth of trees to sustain drinking water and raise cultivation. It is almost a lifeline to the human existence. Without considering the precise gift provided by nature, commercial exploitation for short term gains by pumping out the sand indiscriminately from the rivers, dunes, and beaches will destroy whole environment. People employ huge machineries like cranes and other pumping mechanism causing untold natural calamities and loss to the society. He concludes stating that mining activities are to be controlled and a suitable alternative should be chosen as a replacement for Natural River sand.

3. Conclusion

From the study it is clear that the effect of sand mining and its hazardous to the environment and the importance of replacing the river sand with a suitable material. This study helps us to know the various replacement of fine aggregate to concrete and its behavior.

Geo polymer fly ash sand obtained from the byproduct of fly ash competes with the natural river sand in all the parameters of the test. The only disadvantage in using the GFS is the workability, high water absorption and requires more curing period when compared to the natural river sand concrete which can be rectified by using of admixtures. Therefore GFS can be used as alternative material for natural river sand so that the environment is safe guarded.

4.References

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