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A Review on Geopolymer Concrete Using Partial Replacement of Demolished Aggregate

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Abstract: *This paper reviews the literature related to geopolymer concrete. Concrete is widely used material for various construction activities due to its versatile character. But it causes environmental pollution due to production of Portland cement and quarrying of aggregate. Low calcium Fly ash and alkaline liquid as a binder is being used to replace the Portland cement to produce geo polymer concrete. In geopolymer concrete use of cement is completely evaded. This can be one of the methods to reduce the environmental pollution. The alkaline liquid has been used in geopolymerisation is the combination of sodium hydroxide and sodium silicate. The study revealed that there is possibility to replace natural coarse aggregate with demolished concrete in the geopolymer concrete. By the use of demolished aggregate in concrete, environmental pollution and reduction in valuable landfill will be evaded.*

Keywords: *Fly ash , Alkaline solutions, demolished aggregate, geopolymer.*

I. Introduction

The usage of concrete is the second only to water. Concrete is one of the most widely used construction material and Ordinary Portland cement is the key ingredient of concrete. However, large amount of natural resources such as limestone, fossil fuels, electricity, and natural gas are required in Portland cement concrete production. High temperatures are required in the production of Portland cement (PC), and calcination of limestone has resulted in a larger amount of carbon dioxide (CO_2) emission into the atmosphere. The production of PC is enormously resource and energy intensive process. Several studies have been carried out to reduce the use of Portland cement in concrete to check the global warming issues. To reduce utilization of PC, supplementary cementing materials such as fly ash, silica fume, ground granulated blast furnace slag (ggbfs), rice husk ash and Metakaolin are used. These pozzolanic materials contain more percentage silicon (Si) and aluminium (Al). It can also be used to produce geopolymer binder when mixed with alkaline solutions. Geopolymer concrete (GPC) introduced by Joseph Davidovits [1]. It is an alternative binder system which results in production of concrete without cement. The most common alkaline liquid used in geopolymerisation is a combination of sodium hydroxide or potassium hydroxide and sodium silicate or potassium silicate. Geopolymer binders are used together with aggregates to produce geopolymer concretes which are ideal for building and repairing infrastructures and for pre-cast units. Production and utilization of concrete is fast increasing, which results in enlarged consumption of natural aggregate as the largest concrete component. A possible solution for the problems is to replace natural aggregate, recycle demolished concrete and produce an alternative aggregate for structural concrete. Hence in recent years, the use of recycled concrete aggregate has gained remarkable momentum in constructional engineering. In this project demolished concrete is used as a coarse aggregate for making the geopolymer concrete. It involves breaking, crushing and removing irrelevant and contaminated materials from existing concrete and then using it for making geopolymer concrete.

II. Literature Review

Thomas et al **[2]** suggested that the alkaline liquid that been used in geopolymerisation is the combination of sodium hydroxide (NaOH) and sodium silicate (Na_2SiO_3). This study discusses the possibility to replace natural coarse aggregate with demolished concrete in the geo polymer concrete and the structural characteristics of geo polymer concrete were studied using demolished concrete as a complete replacement for coarse aggregate. Different molar of sodium hydroxide (NaOH) which are 8M, 10M and 12M were adopted. The development of compressive strength, split tensile strength and flexural strength of geopolymer concrete at the age of 3 and 7 days were studied after oven curing at 80^oC. ***Subramani et.al*** **[3]** had used the recycled aggregates from construction and demolished wastes which are showing prospective application in construction as alternative to primary (natural) aggregates. The recycling of demolished construction waste in to aggregates to be used in new engineering application provides a promising solution problems. The authors revealed that the properties of the constituents of geopolymer concrete including the demolished concrete wastes which shall be

used as coarse aggregates in new concrete with the aim of producing a green concrete. ***Alexander et al*** **[4]** Studied the synthesis of geopolymers based on alkaline activation of concrete demolition waste (CDW) was investigated using sodium hydroxide and sodium silicate as alkaline activators. To create hybrid and binary geopolymers, Portland cement and Metakaolin were added at levels up to 30% by weight with respect to the CDW. The geopolymer, based on the 100% CDW, reached a maximum compressive strength of up to 25 MPa, and the hybrid geopolymer CDW + 30% OPC reached up to 33 MPa at 28 days with curing at normal temperature. ***Anuar et al*** **[5]** have an experimental investigation of geopolymer concrete incorporating with recycle concrete aggregate (RCA). Waste Paper Sludge Ash and alkaline liquid as a binder are being used to replace the Portland cement to create geopolymer concrete. The alkaline liquid that been used in geopolymerisation is the combination of sodium hydroxide and sodium silicate.

Peem Nuaklong et al **[6]** concluded that geopolymer binder and recycled aggregate are environment friendly products and is thus considered as part of sustainable development. In this paper they presents a study of the effect of recycled aggregate on strength and durability of fly ash based geopolymer concrete. Geopolymer concrete were prepared from high calcium fly ash, sodium hydroxide solution, sodium silicate solution, fine aggregate from river sand, and two types of coarse aggregate –i)recycled concrete aggregate and ii)crushed limestone coarse aggregate. The results indicated that recycled concrete aggregate can be used as a coarse aggregate in high calcium fly ash geopolymer concretes with the 7-day compressive strengths of up to 30.6-38.4 MPa which were slightly lower than those of high calcium fly ash geopolymer concrete with crushed limestone. ***Djwantoro Hardjito et al*** **[7]** investigated to reduce greenhouse gas emissions, efforts are needed to develop environmentally friendly construction materials. The investigation shows that development of fly ash-based geopolymer concrete. In geopolymer concrete, a by-product material which is rich in aluminum and silicon, such as low-calcium fly ash, is chemically activated by a high-alkaline solution to form a paste that binds the coarse and fine aggregates, and other unreacted materials in the mixture. The test results presented in this paper indicate the effects of various parameters on the properties of geopolymer concrete. ***Lloyd and Rangan*** **[8]** have conducted research on fly ash-based geopolymer concrete. Authors test are used to identify the effects of salient factors that influence the properties of the geopolymer concrete and to propose a simple method for the design of geopolymer concrete mixtures. The test data of various properties of the geopolymer concrete and the results of the tests conducted on large-scale reinforced geopolymer concrete members' shows that geopolymer concrete is well-suited to manufacture the pre-cast concrete products that can be used in the infrastructure developments. ***Gokulnath et al*** **[9]** investigated that there is an oversized quantity of dismantled waste generated each year in Republic of India and alternative developing countries. As terribly bit of this waste is recycled. Hence, disposing of this waste may be a terribly major problem as a result of it needs an oversized quantity of house. Their study shows an comprehensive program whereby experimental investigations are distributed to judge the impact of the partial replacement of the coarse aggregate on workability and compressive strength of demolished mixtured concrete. ***Charitha et al*** **[10]** studies were shown various short and long-term properties of the geopolymer concrete and the results of the tests performed on large-scale reinforced geopolymer concrete members. They also enlightened some recent applications of geopolymer concrete. ***Rao et al*** **[11]** had discussed different aspects of the problems beginning with a brief review of the international scenario in terms of Concrete Demolished Waste (CDW) generated, Recycled Aggregates (RA) produced from Concrete Demolished Waste and their utilization in concrete and governmental initiatives towards recycling of Concrete Demolished Waste. The brief overview of the engineering properties of recycled aggregates, the paper also gives a summary of the effect of uses of recycled aggregate on the properties of fresh and hardened concrete. This paper concludes by identifying some of the major barriers in more widespread use of RA in recycled aggregate concrete, including lack of awareness, lack of government support, non-existence of specifications and codes for reusing these aggregates in new concrete.

III. Conclusion

Previous investigators have revealed that the use of concrete demolished aggregate in ordinary concrete can be adopted. Also the production of geopolymer concrete and research on various parameter of GPC such as fineness of fly ash, fly ash content, type and quantity of activator solution, molarity of sodium hydroxide solution, type of source materials, blended source materials, various types of fine and coarse aggregates, water-to-geopolymer binder ratio, water to sodium oxide ratio, curing time and conditions, effect on properties of geopolymer concrete. However little information is available on the production of recycled waste aggregate with varying percentage.

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