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Review on Geopolymer Concrete Using Flyash Ggbs and Granite Powder

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ABSTRACT:This paper presents a review of literature regarding the sustainable replacement of ordinary concrete by means of the Geopolymer concrete with materials like Ground Granulated Blast Furnace Slag,Granite powder. Geopolymer concrete usually includes the fly ash,fine aggregate and coarse aggragate activated by means of alkaline liquids like sodium silicate and sodium hydroxide which is effective in oven curing.For the purpose of utilizing Geopolymer concrete for the insitu applications, fly ash is partially replaced by means of Ground Granulated Blast Furnace slag which requies ambient curing conditions. Further the Waste granite powder an industrial by product obtained from Granite making industry can be used as the replacement material. By using this in construction purpose, it reduces the solid waste disposal problem and other environmental issues.This work involves the study of literature on the previous work involving strength and durability characteristics of GGBS,Granite powder used in the concrete.

KEY WORDS:GPC, Fly ash, GGBS, Alkaline liquids, Granite Powder

I.INTRODUCTION

Geopolymer concrete is one of the building materials that has become more popular in recent years due to the fact that it is significantly eco-friendly than the standard concrete.It deals with the problem of depletion on natural resources such as limestone, which is the primary ingredient to produce cement, and in turn the concrete in India. Ordinary Portland cement (OPC) is used as the primary binder to produce the concrete. The demand of concrete is increasing day by day for the need of development of infrastructure facilities. However, it is well known that the production of OPC not only consumes significant amount of natural resources and energy but also releases substantial quantity of carbon dioxide to the atmosphere.Newer materials are used in the concrete, so that deficient properties of concrete can be enhanced to our convenience of making concrete a versatile material and eco friendly.Some of the such materials are fiber, slag, fly ash etc . In addition, as the industries grow, their production of waste also increased many times. One of such industrial waste product is Waste granite powder that are greately accumulated from the industries and therefore usage of those wastes in efficient manner is also taken to account. The utilisation of GGBS,Fly ash and Granite powder thus find its importance in the Geopolymer concrete. The main objective of this paper is to present a review of literature regarding the usage of the materials Fly ash, GGBS and Granite Powder in concrete.

II.LITERATURE REVIEW

Pradip Nath, Prabir Kumar Sarkar, Vijaya B Rangan (2015)experimented on low calcium fly ash based geopolymer concrete cured in ambient temperature without additional heat. The geopolymer mixtures were tested for workability, setting time and compressive strength. The flow values were decreased significantly when either 10% GGBFS or 8% OPC was added with fly ash. The results suggest that fly ash based geopolymer can be modified by adding the additives such as GGBFS, OPC and CH to develop desired early age properties when cured in normal ambient condition. However, the amount of additives will governs the rate of setting as well as workability of the mixture. At ambient curing condition , fly ash geopolymers blended with GGBFS, OPC or CH reduced the setting time to a value comparable to that of OPC.Compressive strength of the mixtures blended with the additives is found to be increased with the increase of the binder content for fly ash blended with 10% OPC. The 28-day strength increased from 26 MPa to 58 MPa by increasing the binder content from 450 kg/m3 to 730 kg/m3.The results suggest that fly ash geopolymers blended with GGBFS, OPC or CH in small percentages can be a good binder for low to moderate strength concrete production at ambient curing condition.

Dodda Sravanthi, Y Himath Kumar and B Sarath Chandra Kumar (2020) studied the strength and durability of geopolymer concrete by using the GGBS.The grade of concrete tested are M30 and M40 by using OPC 53 grade and compared the strength with geopolymer concrete M40 by using GGBS with River sand and M-sand. Strength comparison with different molarities 8M to 16M are used in this work. In GPC strength is directly proportional to the molarity of NaOH. Experimental study on geopolymer concrete and normal concrete concluded that the slump of 8M is higher than the 16M.Durability test is conducted by immersing concrete in chloride,sulphate acid,magnesium sulfate acid and water absorption. The results observed were satisfactory. Also mechanical properties shows an increasing trend concerning the age of concrete.The strength increases with the increase in the molarity of the concrete.The strength of geopolymer concrete with GGBS showed good results than conventional concrete.

Mohammed haloob Al Majidi,Andreas Lampropoulos(2016) conducted an experimental investigation on the mechanical and microstructural properties of geopolymer concrete mixes preparedwith a combination of fly ash and slag cured under ambient temperature. Geopolymer mixes were produced using fly ash (FA) and Ground Granulated Blast furnace Slag (GGBS) mixed together with potassium silicate with molar ratio equal to 1.2 (as the activator) and water. The results indicated that heat curing treatment can be avoided by partial replacement of fly ash with slag. The compressive strength of the examined mixes was found to be in the range of 40–50 MPa for 40% and 50% GGBS replacement mixtures respectively. Moreover, the flexural and direct tensile strengths of geopolymer mixes are considerably improved as the GGBS content is increased. Based on FTIR and SEM/EDS analysis, the inclusion of a higher content of GGBS resulted in a denser structure by formation of more hydration products.

Shehdeh Ghannama, HusamNajmb, Rosa Vasconez c(2016) investigated the possibility of using the granite powder and iron powder as a partial replacement of sand in concrete. Twenty cubes and ten beams of concrete with Granite powder(GP) and twenty cubes and ten beams of concrete with Iron powder(IP) were prepared and tested. The percentages of GP and IP added to replace sand were 5%, 10%, 15%, and 20% of the sand by weight. It was observed that substitution of 10% of sand by weight with granite powder in concrete was the most effective in increasing the compressive and flexural strength compared to other ratios. The test resulted showed that for 10% ratio of GP in concrete, the increase in the compressive strength was about 30% compared to normal concrete. Similar results were also observed for the flexure showed that the usage of 10% granite powder in concrete gave the best result (highest increase in compressive strength) compared to other ratios. The flexural strength of concrete increased with the addition of granite powder as partial replacement of sand. The maximum increase was observed for 10% GP ratio. For the split-cylinder tensile strength, the optimum value of the percentage of GP in concrete was 15% compared to 10% for flexural and compressive strength. The increase in tensile strength for 15% and 10% of Granite powder was approximately 30% and 15% respectively. For 20% granite powder in concrete the split tensile strength was actually lower than that of the control mix.

Rajat saxena, Trilok gupta(2021) usedGranite waste as fractional replacement of natural fine aggregates (sand) in varied proportions from 0 to 20% by weight in 5% incremental order to the geopolymer concrete.Strength and durability studies such as dry density, compressive strength, ultrasonic pulse velocity, modulus of elasticity, water permeability, chloride penetration depth, acid attack, and carbonation of geopolymer concrete incorporated with granite waste was carried out. Geopolymer concrete mass change was determined using thermogravimetric analysis and differential thermogravimetry. The strength and durability test results for the geopolymer concrete with 15% substitution of natural fine aggregates with granite waste showed superiority regarding mechanical properties and durability characteristics in contrast with control geopolymer concrete.

G.Jayarajan,S.Arivalagan(2021) studied thatGGBS with Quare sand and M.Sand are substituted for the fine aggregate. The ratio M40 and M60 were used. Coarse (20 mm) aggregates are replaced by 10 mm coarse. For material binding, alkaline solutions are used. In this analysis, sodium hydroxide (NaOH) and sodium silicate (Na2Sio3) are used for polymerisation.. In M40 grade cement replacement by weight of Flyash and GGBS shows better results in hardened concrete characteristics as compressive resistance and tensile strength. With the increasing curing time,the compressive strength of geopolymer concrete increases. At 5% and 1.0% of the incorporation of steel fibres, there is an increase in strength. The study results suggest that properties are improved by increasing the GGBS content in the reinforced geopolymer concrete, both in plain and hardened fibre.

R. Hyde, S. Nanukuttan and M. Russell(2017) studied the suitability of three locally available quarry dust materials – basalt, greywacke and granite. The size distribution analysis involving Sieve and Laser Diffraction analysis of the materials was input to the software to produce a model which compares the particle size distribution with that of an optimised mix. The natural distribution profiles of the quarry dust materials are identical thus enabling it as a replacement aggregate in the geopolymer mix.. The test was conducted to study the reaction of materials with alkali activator and established that none of the 3 quarry dust materials had a mineral content which would impact on the alkali activation of the aluminosilicate geopolymer binder.

H.M. Khater, A.M. El Nagar, M. Ezzat and M. Lottfy(2020) worked for finding the optimum amount of granite waste to be used with geopolymer concrete by conducting water absorption and compressive strength tests..The compressive strength of geopolymer specimens cured for 28 days with 7.5% granite waste increased by about 30%, and declined by about 12% with increasing of granite waste up to 15%.The optimum percentage obtained iswith 7.5% granite waste. Geopolymer specimens cured for 60 days with 7.5% granite waste increased by about 60% compared to the control geopolymer specimen and declined by about 14% with increase in granite waste up to 15%. .

Zhu Xiaoxiong Zha, Jiayuan(2018) used completely decomposed granite as the main cementicious material with varying percentages of GGBS and their mechanical properties are studied. The compressive strength of geopolymer specimen at 7 days curing time increases with increasing proportion of OPC or GGBFS. As the calcium content increases, the compressive strength of geopolymer increases. The compressive strength of GGBFS-Completely decomposed granite(CDG) base-geopolymer has higher value of compressive strength than OPC-CDG base-geopolymer with the same material proportion of Substitution.

Ying Li a (2013) incorporated Granite waste and fly ash into magnesium oxychloride cement (MOC) and investigated its compressive strength.The water absorption of granite waste from the slurry is found to be increased.The higher concentration of brine showed higher the compressive strength.The compressive strength of the specimen with 10% granite shows 6.4%, 14.4%, and 12.8% higher than that of the control mixture at 3, 7, and 28 days.The specimen with 40% showed 28.4%, 8.2%, and 5.4% lower compressive strength than those of control mixture. The fine particles of granite waste helps in filling the large pores and internal gaps in the slurry and generate a compact microstructure, which is beneficial for the increase of compressive strength

Abhijeet Koshti(2018) worked on a concrete with cement replacement levels 40% of Granite powder and GGBS as an addition 15,20 and 25%.The strength properties of concrete increases as the GGBS content increased up to an optimum point. The optimum level of GGBS content for maximizing strengths is at about 20% of total binder content.plain concrete. Theearly age Tensile strength of concrete with GGBS and granite powder is low as compared to plain concrete.But after 28 days strength of concrete with GGBS and granite powder is more than plain concrete.The tensile strength of concrete with GGBS and granite powder is more at 28 days than plain concrete hence it is used for pavement concrete and runways. It is also used for water retaining structure.

L.N. Tchadjié(2015) worked to investigate the potential of using granite waste (GW) as raw material for geopolymer synthesis.They performed compressive strength, water resistance, XRD, IR spectroscopy and SEM/EDS analyzes.The reactivity of granite waste through geopolymerization is significantly improved by alkali fusion method.The properties of geopolymers obtained depend on the amount of reactive phase depend on the amount of Na2O used during the fusion process.The excess of alkali is found to affect negatively.Compressive strength results of geopolymer mortars showed a variation between 6.25 and 40.5MPa depending on the amount of Na2O used during the alkali fusion process.

III. CONCLUSIONS

From the literatures collected regarding the Geopolymer concrete incorporated with the efficient materials like Granite waste, GGBS the following inferences were made

1. The fly ash based geopolymer blended with GGBS slag proved to be good binder.

2. The heat curing treatment can be avoided by partial replacement of fly ash with slag.
3. The flexural and tensile strength of concrete were found to increase when the concrete is incorporated with granite powder.
4. Gepolymer concrete with 15% replacement of granite waste with fine aggragate showed better strength and durability characteristics.
5. The use of GGBS and granite powder as the cementious material with fly ash could be an better alternative for the insitu applications.

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