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A Review on Effect of Glass Fiber on Fly Ash based Geopolymer Concrete using Recycled Aggregates

Murtaza Joya[1], Shalika Mehta[2]

[1]Fourth Semester student, Master of CTM, Chandigarh University, Punjab, India
[2]Assistant Professor, Civil Engineering, Chandigarh University, Punjab, India

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Abstract - *Now-a-days, Construction Technology has advanced through many investigations and experiments to reinforce the sturdiness and strength of concrete. Concrete usage around the globe is second solely to water. Ordinary Portland Cement (OPC) is formally used as the initial binder to supply concrete. World release of carbon dioxide from all sources is calculable as twenty three billion tons per annum, and also the Portland cement production accounts for concerning seven percent of total carbon dioxide emissions. Therefore finding the other item for cement was required to cut back pollution done throughout production of cement. Therefore Innovative construction materials which turn out by chemical action of inorganic molecules can replace cement in concrete which is known as Geo polymer concrete. Fly ash-based Geo polymer concrete is a 'new' material that does not need Portland cement as a binder. On the other hand Waste arising from construction and demolition constitutes one amongst the largest waste streams within the developing nations. The use of recycled aggregates and fly ash is one of the accede towards this need. Use of recycled aggregates and fly ash in concrete can be gracious for environmental protection, it reduces the waste materials and economical statue. In addition With the evolution of fiber and its special characteristics, such as the superb mechanical and permanence properties, the fiber has been consume as one of the common additions of concrete, Among the several fibers, glass fiber (GF) shows great performance on curing the concrete properties, compression, the flexure and the shear toughness all raise with an addition in the fiber content. The Previous study shows better consequence on mechanical properties such as flexural strength, compressive strength, and split tensile strength of Geopolymer concrete using Glass fiber compare to plain Geopolymer concrete and ordinary concrete.*

Key Words: Glass fiber, Geopolymer concrete, Recycled aggregates, fly ash, flexural strength, compressive strength, split tensile.

1. INTRODUCTION

The evolution of science and technology is continues process for growth of infrastructure all over the globe. As infrastructure growth with technology there is increasing require for concrete as construction material extending throughout the world, this eventually increases the demand for cement. Ordinary Portland cement is the most commonly use building material which is the main material of concrete, mortar and grouts. From last few years cement production in India raised from 207 million metric tons in 2010 to 480 million metric tons in 2019. That statistics makes India second largest cement producer in the globe. Cement is the most energy violent component of concrete and partial replacement of this expensive component with industrial waste can not only make concrete economical but also tendentiously solve the problem of the industrial waste access. The employment of recycled aggregate is exclusively very promising as seventy five to eighty percent of concrete is made of aggregates. In order to decrease the utilization of natural aggregate, recycled aggregate can be used as the substitution materials. Although, addition of industrial wastes can change the properties of concrete. Chemical and Mineral Admixtures and supplements are commonly added to concrete to elevate one or more properties of concrete required for a particular application. However their dosage has to be obtained after executing a series of experiments. Due to prudently low tensile strength of concrete, researchers and designers have been searching for remedy to develop the stability against cracking. Small closely spaced and uniform shed Glass fibers with high strength and elastic modulus are found to be extremely good crack arresters, therefore improving its static and dynamic properties. Mass concreting produces lot of heat of hydration and Fly ash in large amount is found to mitigate this problem thereby reducing (quickly) thermal cracks. however, fly ash concrete is widely being adopted in construction industry, its delayed pozzolanic reaction is preventing from high volume replacement with cement. This work presents the effect of combined usage of fly ash and Glass fiber on mechanical properties of concrete.

1.1 Scope

- Geopolymers are thought-out environmentally friendly products because they can apply waste materials like fly ashes to their production, and have shown an excellent potential as an alternative to Portland cement with a considerable reduction of green house gas emissions. In addition, they exhibit high mechanical strength and stability, and they are also acid and fire resistant.
- The employment of recycled aggregate is exclusively very promising as seventy five to eighty percent of concrete is made of aggregates. In order to decrease the utilization of natural aggregate, recycled aggregate can be used as the substitution materials.

- With the evolution of fiber and its special characteristics, such as the superb mechanical and permanence properties, the fiber has been consume as one of the common additions of concrete, which is known as by it is best performance of compressive strength, flexural strength and split tensile strength.

1.2 Materials

The materials which is used in this study (Effect of Glass fiber on Fly Ash based Geopolymer Concrete using recycled aggregates) are as following, and it is effects are commonly expressed on the literature review based previous experiments and studies.

1.2.1 Glass fiber

Glass fibers are made of silicon oxide with addition of small amount of other oxides, Glass fibers are known for their high strength, good temperature resistance, corrosion resistance and available at low price, Glass fibres are usually round and straight with diameters from 0.005 mm to 0.015 mm. They can be also bonded together to produce the bundle of glass fibres with diameter up to 1.3 mm.

1.2.2 Fly Ash

Fly ash is the leftover of combustion of pulverized coal collected by mechanical or electrostatic separators from the chimney gasses of thermal power plants. The spherical form of fly ash particles improves the flow ability and decrease the water demand, Fly ash particles are typically spherical ranging in diameter from 1 to 150 microns. The type of dust collection equipment used mainly determines the range of particles size in any given fly ash.

1.2.3 Geopolymer concrete

The development of geopolymer concrete is associated to Davidovits who, in 1978, first proposed that a geopolymer matrix could shift cement as the binder in concrete. It can be defined: Geo as an Earth, poly as many and mer means parts. Geopolymer concrete is made from utilization of waste materials like Fly Ash, Geopolymer concrete produces very less amount of carbon dioxide and it is made of waste materials such as Fly ash, though it has great mechanical properties, it is eco-friendly material.

1.2.4 Recycled Aggregates

Recycled aggregates are consists of crushed, graded inorganic particles furnished from the materials that have been used in the construction and demolition debris. These materials are mainly from buildings, roads, bridges, and sometimes even from adversity, such as wars and earthquakes.

2. Literature Review

K. Lakshmi and M. Sai Narasimha Rao the study shows that the cost of chemicals used in geopolymer concrete had made it a bit expensive compared to Portland cement concrete.
On the other hand the experiment which is done by the authors used different percentage of Glass fiber one to four percent, the result shows that the geopolymer concrete with glass fibre given Maximum tensile strength at 3% of glass fibre which is 6.12 KN/M2, in addition goepolymer concrete with glass fibre given flexural strength at 3 % of glass fibre which is 6.32 KN/M2 and finally the Maximum strength at 3 % of glass fibre which is 41.17 KN/M2 is belongs to compressive strength which is suitable for structure applications. [1]

Raijiwala D.B et. al presented on Geopolymer concrete: A CONCRETE OF NEXT DECADE" the development of the research on making geo polymer concrete using fly ash. KOH and NAOH were used as alkali activators. He empirically conducted the tests for compressive strength, split tensile strength, flexural strength, pull out strength and durability. Finally he made decision that compressive strength of Geopolymer concrete increases over controlled concrete by 1.5 times. Split tensile strength of Geopolymer concrete increases over controlled concrete by 1.45 times. Flexural strength of Geopolymer concrete increases over controlled concrete by 1.6 times. In pullout test, Geopolymer concrete increases over controlled concrete by1.5 times. At 12% molarity of KOH, the cost per cubic meter of Geopolymer reduces by 12% over the controlled concrete. [2]

Shankar H.sanni et. al presented on the "Performance of geopolymer concrete under severe environmental conditions" experimental investigation on performance of geopolymer concrete subjected to severe environmental conditions. The grades were used for investigation are M-30, M-40, M-50 and M-60.Sodium silicate and sodium hydroxide are used as alkaline solution. Test specimens were 150*150*150mm cubes, 100*200mm cylinders heat-cured at 60˚C in an oven. Durability of specimens was distinguished by immersing Geopolymer concrete specimens in 10% sulphuric acid and 10% magnesium sulphate solutions individually tested. The test results illustrate that the heat cured fly ash based geo polymer concrete has an excellent resistance to acid and sulphate attack compared to the conventional concrete. [3]

DR.Akram S. Mahmoud states that Fly ash based geopolymer concrete compressive strength does not progress with age its gain almost strength at an early age, unlike compressive strength of normal concrete which develop with age. [4]

Srishti Saha et. Al states that up to 10% of Recycled aggregate have comparable strength of natural coarse aggregate and it is the recommended percentage of RCA suitable in concrete industry. [5]
S. T. Tassew and A. S. Lubell presented on the "Construction Build. Material" the flexure and the shear toughness all increased with an increase in the fiber content, while the workability decreased with an increase in fiber content. [6]

A. K. Singh et. Al presented on the natural science foundation, that glass fiber reduce the permeability of Geopolymer concrete based fly ash. [7]
Ganjeen J. Khoshnaw et. Al the compressive strength of geopolymer concrete at an early age is higher than normal concrete. Also, the compressive strength of normal concrete recorded fewer values than compressive strength of geopolymer concrete at early age by (58-83)% and (6-40)% at 3 and 7 days respectively. [8]

Raijiwala O.B. and PatH H. S. Presented that Fly Ash based Geopolymer concrete at twelve molarity of KOH, the gain in strength remains very moderate and the reason is at spread temperature of 60°C for 24 hours the poly condensation flow has already completed and particle ingredient is also achieved. Further on excellent structure properties can be achieved with arising in polymerization temperature along with extended curing period in oven. [9]

Yunsheng Zhang and Liguo Ma the experimental study shoes that The hydration heat evolution process of the cement- fly ash binary system whose water binder ratio(w/b) was 0.35 by using isothermal calorimeter(TAM Air). The fly ash substitution in cement-fly ash binary system was 10%, 30% and 50% correspondingly. The experiments results indicated that the adding of fly ash postpones the induction period and the acceleratory period and reduces the peak and total hydration heat of cement mixtures at low water binder ratio 0.35. The adding of fly ash to replace cement increases the porosity in cement admixtures. [10]

Fu Weihua and Wang Chang-long presented that By using Handan leading material, when fly ash content is 25%, recycled aggregate size is 25mm, and water-binder ratio is 0.35, the fly ash concrete that slump is 23cm and 28d the compressive strength is moving above 60Mpa. [11]

Vivian W.Y.Tam and C.M.Tam The apparent density of recycled aggregates is lower than that of the natural aggregates, because most of the recycled coarse aggregates are usually completely or partly wrapped up by hardened cement mortar. Higher porosity and lower density of the mortar account for recycled aggregates' lower apparent density.

The apparent density value of recycled aggregates ranges in wider scope and is more discrete. It is due to the fact that the aggregates studied in different researches come from different sources. However, the strength, construction quality, service environment and age of the original concrete vary form case to case, which inescapably result in the difference in the apparent density of the recycled aggregates. [12]

S.C.Kou and C.S.Poon, "Properties of self-compacting concrete prepared with coarse and fine recycled concrete aggregates," represents That high water absorption level has always been one of the main bottle-necks in the spacious application of recycled aggregated the water absorption rate of recycled aggregates differ from 3.48% to 8%. Due to source priority, in some laboratory environment, the water absorption rate can be as high as 15% . With minimal porosity, nature gravels' water absorption rate is almost low, while with hardened mortar adhered to the surface, recycled aggregates will absorb huge amount of water due to the porous structure of the mortar. Therefore, after mechanical dissection and crushing, the surface of the recycled aggregates is covered with micro-cracks which will latter increase the water absorption rate of them. [13]

M. Ohtsu and H. Akiyama The concrete which is made by the recycled coarse aggregate has enough strength as the construction material. [14]

Benjamin Galvin and Natalie Lloyd The addition of the recycled aggregates to the geopolymer concrete did not result in an increase in the standard deviation of the compressive strengths the studies showing that the batches had enough consistency compared with the non recycled aggregates contrary to the compositional variability of the recycled aggregates. [15]

3. CONCLUSIONS

The Fly ash based geopolymer using recycled aggregates may be treated as future environment-friendly alternative to Portland cement in certain industrial application, the conclusions of this study:

1. The Geopolymer concrete mixes can be produced easily as alternative materials of concrete, also using the same items that used in normal concrete. The main difference in curing system between fly ash geopolymer concrete and Portland cement concrete.
2. The compressive strength of geopolymer concrete at an early age is higher than normal concrete. Also, the compressive strength of normal concrete recorded fewer values than compressive strength of geopolymer concrete at early age by (58-83) % and (6-40) % at 3 and 7 days respectively.
3. The addition of the recycled aggregates to the geopolymer concrete did not result better in arising in the standard deviation of the compressive strengths the studies showing that the batches had enough consistency compared with the non-recycled aggregates contrary to the compositional variability of the recycled aggregates.
4. When fly ash content is 25%, recycled aggregate size is 25mm, and water-binder ratio is 0.35, the fly ash concrete that slump is 23cm and 28d the compressive strength is moving above 60Mpa.
5. The adding of fly ash postpones the induction period and the acceleratory period and reduces the peak and total hydration heat of cement mixtures at low water binder ratio 0.35.

6. Recycled aggregates shows greater shrinkage compared to the non-recycled aggregates, but it cannot count an issue because the lower shrinkage values of geopolymer concrete balances the increased shrinkage associated with the recycled aggregates. This leads to shrinkages that are significantly below the predicted values of equivalent strength Geopolymer concrete.
7. Geopolymer concrete produces very less amount of carbon dioxide and it is made of waste materials such as Fly ash, though it has great mechanical properties, it is eco-friendly material. On the other hand concrete includes almost eighty percent of aggregates, to reduce the usage of natural aggregates, Recycled aggregates can be great option and also helps to economy and eco-friendly.

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BIOGRAPHIES

Murtaza Joya is currently student of ME.CTM (Construction Technology and Management) in Civil Engineering Department of Chandigarh University, Punjab, India. Completed his B.Tech in Aburayhan University, Kabul, Afghanistan.

Shalika Mehta is presently working as Assistant Professor Chandigarh University, Punjab, India.