"STUDY ON STRENGTH PROPERTIES OF A GEOPOLYMER CONCRETE WITH PARTIAL REPLACEMENT OF COARSE AGGREGATE BY CERAMIC TILES"

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ABSTRACT

The major problem the world is facing today is the environmental pollution. In the construction industry mainly the production of portland cement will causes the emission of pollutants results in environmental pollution. We can reduce the pollution effect on environment by increasing the usage of industrial byproducts in our construction industry. Geopolymer concrete is such a one and in the present study, to produce geopolymer concrete the portland cement is fully replaced with flyash, GGBS, rice husk ash and coarse aggregate is partially replaced with tile aggregate and alkaline liquids are used for the binding of materials. The alkaline liquids used in this study for the polymerization are the solution of hydroxide and sodium silicate. 10 molars of sodium hydroxide solution are taken to prepare different mixes. Compressive strength is calculated for each of the mix. The cube specimens are taken of size 150mmX150mmX150mm and tested for 7, 14 and 28 days. Similarly flexure and tensile strength are also calculated. The result shows that the strength of goepolymer concrete is increasing up to 25% replacement of tile aggregate.

KEYWORDS: Geopolymer concrete, fly ash, ggbs, ricehusk ash

INTRODUCTION

Generally used building materials are cement and concrete. However their environmental effects are in a large range. At present the annual utilization of ordinary portland cement is nearly 1.56 billion tonnes and it is having major role in global warming. CO2 is a one of the byproducts of cement which is largely contributed to emission of greenhouse gas and overall, it accounts for about 7% of CO2 loading. Cement is the most essential and required material of the concrete which will hold all the aggregates together in the concrete mix but cement is both resource and energy intensive material. All of these situations have led the researches to think and find the new alternative material which is of high compressive strength and also are cheap and more environmentally friendly to use as a construction material. And a new building material being researched is a geopolymer concrete as a replacement of cement in concrete by various pozzolanic materials such as fly ash, rice husk, ground granulated blast furnace slag (ggbs), metakaolin etc. One of the major advantages of using geopolymer concrete over an OPC is that the raw material used is industrial wastes and its manufacturing process is environmental friendly. Industrial waste which were dumped are used here which also saves the land used for dumping. And also the use of natural aggregates can be reduced by partially replacing the coarse aggregate with ceramic tile wastes which makes the concrete more sustainable.

MATERIALS

Fly ash (FA)

Fly ash is a byproduct from coal heating which produces alumina silicate needed for geo polymerization which is an excellent geo polymer material. The fly ash obtained is of grey colour.

GGBS

GGBS is gotten from heating liquid iron slag from steam so as to deliver a polished sort granular item that is then dried and ground into a fine undefined powder. GGBS is also usable in concrete along pozzolana to make a durable structure. The colour of GGBS is white.

Rice husk ash (RA)

Rice husk ash is the another geo polymer material is the byproduct of rice processing ventures which is left after the production of biomass vitality from the rice has a SiO2 content what's more its greater part are in nebulous structure when it is heated at a controllable temperature. Rice husk is obtained from the rice mill industry in panemangalore, Bantwal. Due to presence of abundant silica content it shows excellent pozzolanic behavior so it is used as source material in geopolymers also the fact that they are not lime based clinkers so the direct carbon dioxide emission are removed immediately. Chemical constituents of cementitious materials are tabulated in table 1.

Fine aggregate

Natural river sand is used as the fine aggregate for concrete casting such as for cubes, beams, cylinders. And it is obtained from the river beds.

Coarse aggregate

The coarse aggregate used for this project is 20 mm down size and it should be free from any dust or organic matter.

Alkaline solutions

The alkali activators used in this project are sodium hydroxide and sodium silicate and it is most commonly used alkaline solutions. Sodium silicates used here are in the form of flakes and it is purchased from the market. The commercial grade sodium hydroxide of 97 to 100% purity in flakes form is used here. Sodium silicates used here are of liquid nature. The required molarity of mix can be prepared by using sodium silicate solution.

METHODOLOGY

Trial mixes of different binders are casted with mortar cubes of size 70*70*70 mm and are tested after 7, 14 and 28 days. Results are calculated and cube which produces higher strength

are taken for further study on geopolymer concrete. Geopolymer concrete cubes, beams, cylinders are casted for a mix in order to obtain a high strength which can be done by making trial mixes using filler materials such as fine aggregate, coarse aggregate and tile wastes. Cylinders, beams and cubes were casted for the percentages of 80%FA + 11%GGBS + 9%RA + 0% TW replacement for CA, 80%FA + 11%GGBS + 9%RA + 25% TW replacement for CA, 80%FA + 11%GGBS + 9%RA + 50% TW replacement for CA and 80%FA + 11%GGBS + 9%RA + 75% TW replacement for CA.

Chemical Chemical Constituents	Fly ash (%)	GGBS (%)	Rice husk ash (%)
SiO2	61.19	34.5	91
Al2O3	31.25	14.2	0.39
CaO	3.21	43.5	1.25

Fe2O3	1.49	0.12	0.42
Na2O	1.35	0.29	0.09
MgO	0.72	6.5	0.82

Table 1: Chemical constituents of cementitious materials

70*70*70* mm sized cube specimens as shown in figure 1 are casted only for binder paste that is without using the filler materials. The sodium silicate and sodium hydroxide solution of 10 molar is used for mix.

Figure 1: Prepared mortar cubes and concrete specimens

PREPARING ALKALINE SOLUTIONS

In this task the compressive quality of geopolymer concrete is studied for mix of differing molars of Sodium hydroxide (10M). The sodium silicate and the sodium hydroxide course of action were prepared one day before use. And the solution is used for the mix during the day of concreting and extra solution if required is also prepared prior to one day.

CASTING OF GEOPOLYMER CONCRETE

The customary technique utilized really taking shape of typical cement is received to get ready geo-polymer concrete. To start with fine aggregate, coarse aggregate, tile aggregate flyash, ggbs and rice husk are blended in solid condition for 3 minutes and afterward the antacid arrangement a mix of NaOH arrangement and Na2SiO3 arrangement is joined to the dry blend. Blending is done around 8 minutes for legitimate holding of the considerable number of materials. There after the blending of cubes, cylinders and beams are done with legitimate compaction.

DISCUSSION OF RESULTS

Figure 2: Testing of concrete cube in compression testing machine

Figure 2 indicates testing of concrete cube specimen. From the consequences of compressive strength as shown in figure 3, it is uncovered that the most noteworthy quality is watched for the mix in with 25% tile aggregate. Further increment in tile aggregate there was decline in quality. In this way, it tends to be considered that to be the level of tile aggregate is expanded till 25% and there was increase in compressive quality and further increment in tile aggregate diminishes the compressive strength. This implies that the holding of tile aggregate with the fly ash and other geopolymer material was generally excellent till 25% substitution and further increment influences the boding as the mix become fragile and consequently the compressive quality decreases.

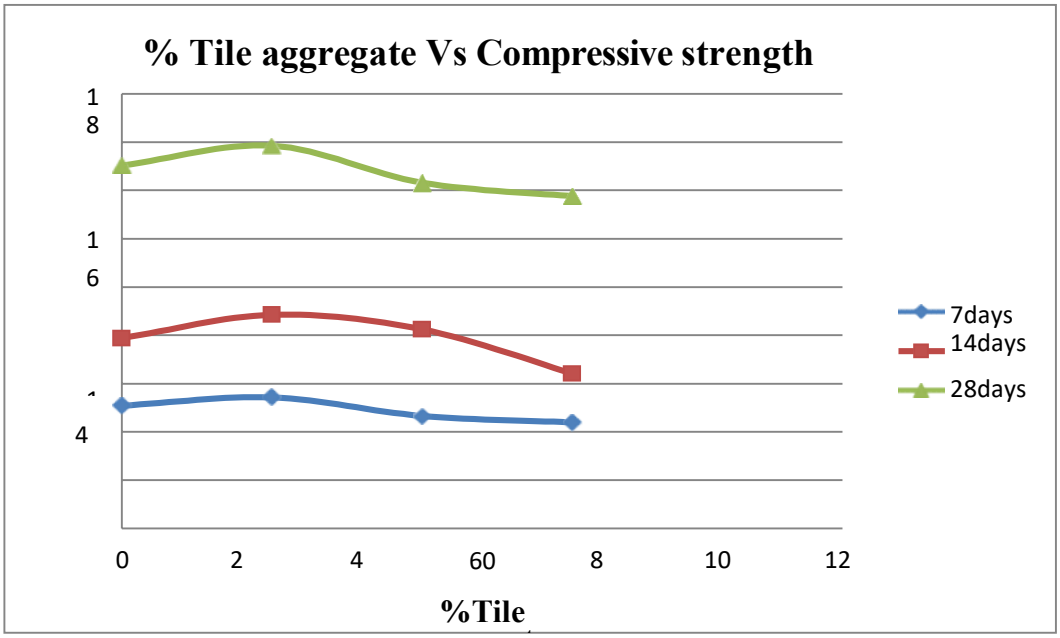

Figure 3: % Tile aggregate Vs Compressive strength graph

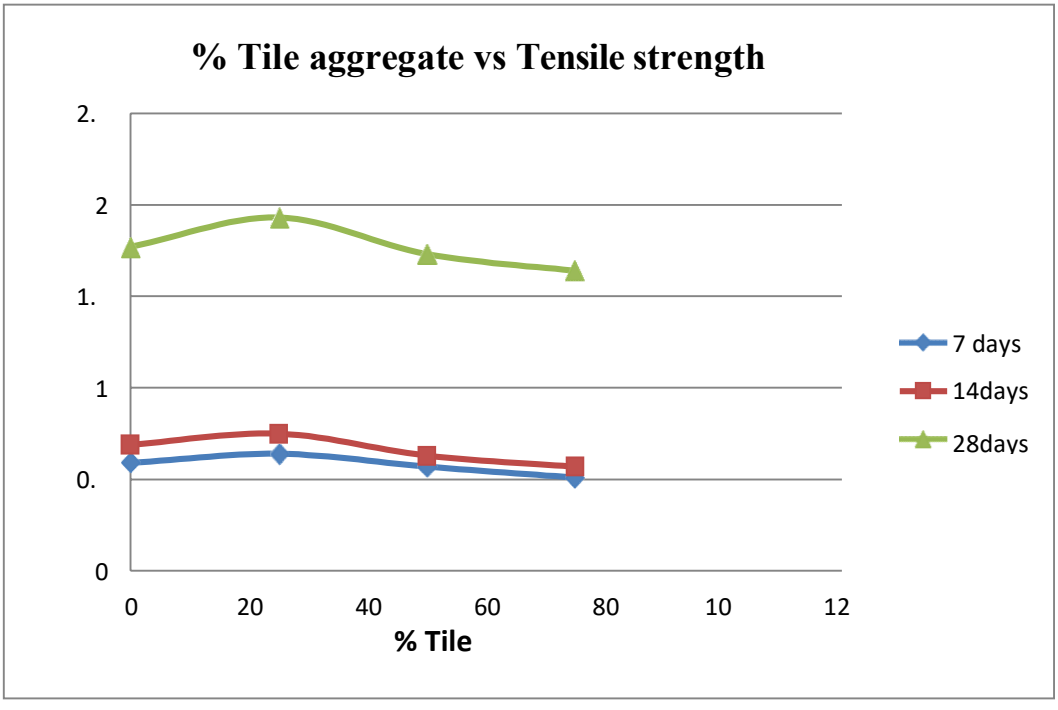

Figure 4: % Tile aggregate Vs Tensile strength graph

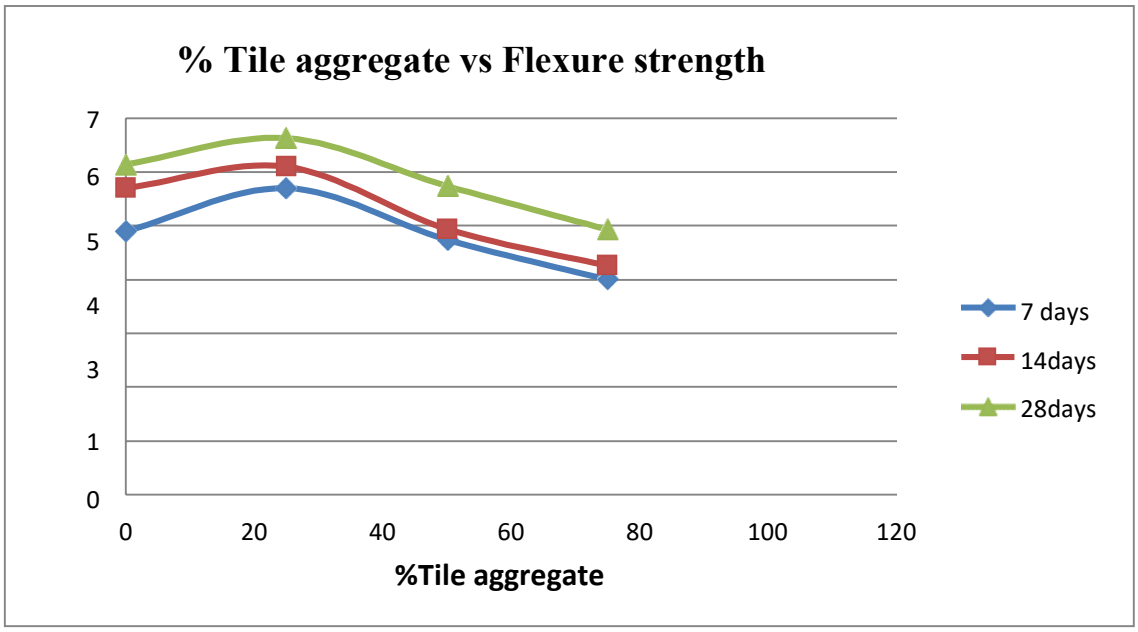

Figure 5: % Tile aggregate Vs Flexure strength graph

It is noted from the diagram 4 that, for 25% of calcium carbonate the quality was high however 7 days strength and 14 days strength were found practically comparative. Despite the fact that at 28 days, there was a progressive ascend in strength. It was watched that the geopolymerisation response happens at a decent pace following 14 days of curing.

It is clear from the figure 5 that, the flexural quality acquired at 25% tile aggregate is higher with the most elevated quality of 6.63 N/mm2. It is because of sufficient disintegration of materials bringing about better holding of and henceforth expanded quality.

CONCLUSIONS

From the examination on geo polymer mortar and geo polymer concrete, the exploratory examinations, leading of preliminary blends, tests being investigated blends and cover blend, freezing the plan blend, throwing of examples of geopolymer concrete blends and different tests on new and solidified geopolymer concrete, and from the consequences of different tests led, results arranged, broke down and talked about, after normal ends are drawn what's more, are introduced.

Consolidation of moderate measure of tile aggregate (up to 25%) to the Geopolymer concrete shows positive effect on the quality properties of geopolymer concrete.

On the off chance that the expansion of tile aggregate becomes an abundance of 25%, there will be negative impact on the quality of geopolymer concrete due to geopolymer gel development.

The addition of rice husk to the fly ash based Geopolymer concrete reduces the setting time.

Along with fly ash, ggbs etc can be successfully utilized and consequently no land area is required to dump

Geopolymer concrete can be utilized in development material as a substitute to regular concrete and its decreased effect on nature.

Geopolymer concrete can also be used in the Infrastructure works.

REFERENCES

[1]Davidovits, J. (1988), "Geopolymer Chemistry and Properties", paper presented at the Geopolymer 88, First European Conference on Soft Mineralurgy, Compiegne,France.

[2]B. VijayaRangan, DjwantoroHardjito, Steenie E. Wallah, and Dody M.J. Sumajouw, "Studies on fly ash-based geopolymer concrete", Geopolymer: green chemistry and sustainable developmentsolutions.

[3]Rangan, B.V., Hardiito, D., Wallah, S.E., &Sumajouw, D.M.J. (2005), "Studies of fly ash-based geopolymer concrete", paper presented at the World Congress Geopolymer 2005, Sain t-Quentin,France.

[4]Zhu Pan , Jay G. Sanjayan , B. V. Rangan,(2007) "An investigation of the mechanisms for strength gain or loss of geopolymer mortar after exposure to elevated temperature" , published in J Matera Science 44:1873–1880.

[5]Smith Songpiriyakij, TeinsakKubprasit , Chai Jaturapitakkul , PrinyaChindaprasirt(2010) "Compressive strength and degree of reaction of biomass- and fly ash-based Geopolymer" published in Elsevier .Ltd, Construction and Building Materials 24 (2010)236–240.

[6]Hou, (2017)"Creep Behaviour of Geopolymer Concrete," no. July, pp. 14326–14330.

[7]P. Nath and P. Sarker, (2012), "Geopolymer concrete for ambient curing condition," Australas. Struct. Eng. Conf. 2012 past, Present Futur. Struct. Eng., no. January, pp. 1–9.