

Strength Properties of Liquid Penetrating Geopolymer No Fines Concrete with Recycled Coarse Aggregate

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Abstract – The aim of this study is to explore the possibility of using abundantly available raw materials such as fly ash from thermal power generation plants subsequent to firing of coal and recycled concrete aggregates obtained from demolished concrete buildings in pervious geopolymer concrete along with chemical activator contents as binding agents without the need to use water. Due to increased demand for housing in urban areas, the existing single storey structures are converted into multi-storey structures to create more housing units. From demolished buildings recycled coarse aggregates are generated. Usage of these aggregates not only reduce the requirement of natural aggregates but also prevent us from finding a place for dumping of these aggregates.

Keywords– Geopolymer binder, coarse aggregate, fly ash

I. INTRODUCTION

Universally, Cement is the major raw materials used in all type of concrete. Since production of cement is not environmental friendly, there is imminent need to ascertain a substitute material. In this connection, Fly ash and GGBS, which reduces carbon release, have been considered as substitute materials. Thus, Geopolymer concrete contains chemically activator contents in addition to fly ash and GGBS. With the addition of chemically activator contents, polymerisation takes place through which bonding occurs in Geo-polymer concrete. An added advantage in Geo-polymer concrete is that it can overcome damage, if any, being caused by chemicals.

Consequent to increasing requirement of infrastructure to cater to the needs of increasing industrial development, development of wider rigid pavements for fast movement of finished goods from the place of manufacture to the place of marketing etc., there is inevitably huge requirement of cement and normal aggregates. Fly ash, GGBS and recycled concrete aggregates will, to a greater extent, act as a substitute materials in lieu of cement and normal aggregates for infrastructure development.

Due to Government's continuous impetus on infrastructure, the need for building materials is on the increase for laying of new rigid pavements, housing units etc. In urban areas, due to exorbitant requirements, single story structures are demolished to convert them into multi story structures in order to increase housing units. Finding a place for dumping the debris from demolition of existing structures is of great concern. Hence, recycled

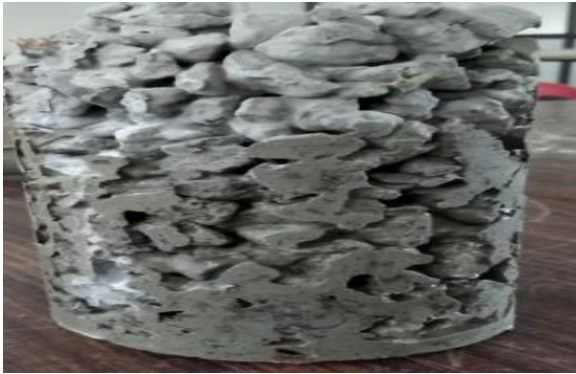
coarse aggregates from demolished structures can, to a certain extent, replace natural coarse aggregates in concrete. In view of this, blasting of rocky mountain can be considerably reduced which, otherwise, pollute the environment.

Ground granulated blast furnace slag is generated from dowsing melted stoney matter from iron during production. It can also be referred as 'GGBFS' or 'GGBS cement' and the concrete which is made using GGBS is called 'furnace concrete' or 'GGBS concrete'. Fly ash is normally generated in thermal power generation plants subsequent to firing of coal. Chemical activators considered in this geo-polymer concrete are Sodium Silicate and Sodium Hydroxide which acts as binding agents.

II. TESTS PERFORMED



CUBE 1:8 Proportion



CYLINDER 1:8 Proportion

III. PHYSICAL PROPERTIES

Table –I: Physical Properties of Materials

Aggregate impact strength	32.93%
Sieve analysis for M Sand	2.960%
Sieve Analysis for coarse aggregate	5.590
Specific Gravity of coarse aggregate	2.470
Bulk density of rodded Coarse aggregate	1.6kg/l
Bulk density of loose aggregate	13.4kg/l

1.MIX Proportions

This Experiment is performed by taking Fly ash to coarse aggregate ratio as 1:5, 1:6, 1:7, 1:8. Quantity of fly ash used was 221 kg. The alkaline liquid ratio of 0.35, 0.4 and 0.45 were the mix proportions of pervious Geopolymer Concrete. In this experiment, in order to study the effects of NH concentration proportions, 10M, 12M and 20M were considered, however, 12M was used. The dimensions of moulds used for this experiment was 150x150x150mm for Cube and 100mm x 200mm for Cylinder. One litre of alkali content weigh 380g. The casting was done by mixing of Fly ash, GGBs, Sodium silicate, Sodium hydroxide, recycled aggregates and normal aggregates. After casting, the specimens were retained in the mould for 5 days. Once the flyash and chemicals were bonded together due to chemical reaction (Ambient curing), the specimens were demoulded.

Table –II: Mix Proportions

Mix No.	Fly ash (kg)	Aggregate
PGC 01	221kg	1105
PGC 02	221kg	1326
PGC 03	221kg	1564
PGC 04	221kg	1768

IV. TEST RESULTS

1.Compressive test results

Concentration of sodium hydroxide solution used was 12M with ambient curing. The specimen is made of concrete cube with dimension 150mmx150mm x150mm. Compressive strength tests were performed when the concrete was 7days cured. As can be seen from the data provided in Table 3, Figure 1, the test results indicate that with considerable replacement of normal aggregates with recycled concrete aggregates in geo-polymer concrete, 1:8 proportion provides optimum compressive strength.

Table -III : Compressive strength in MPa

Name	Specimen 01	Specimen 02	Specimen 03	Average
GPC 01 (1:5)	1.25	1.21	1.15	1.203
GPC 02 (1:6)	0.67	0.69	0.71	0.69
GPC 03 (1:7)	2.67	2.71	2.84	2.74
GPC 04 (1:8)	5.78	5.63	5.85	5.753

Compressive Strength in MPa

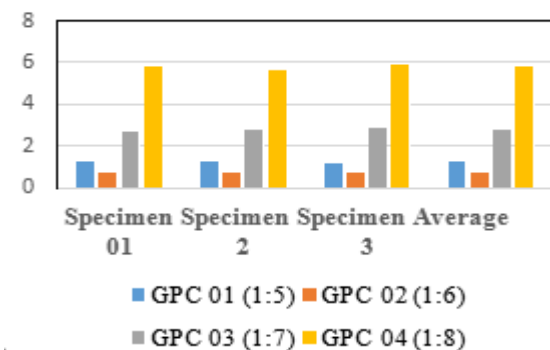


Fig.1.Compressive Strength in MPa.

2. Split tensile strength tests

Split tensile strength of cylinder are increased gradually with increase in aggregate content of each proportions. Four proportions were tested, they are proportions of 1:5, 1:6, 1:7, 1:8. Out of these 4 proportions, 1:8 proportion showed more optimum result.

Table -IV: Split Tensile Strength in MPa

Name	Specimen 01	Specimen 02	Specimen 03	Average
GPC 01	0.98	0.97	0.95	0.967
GPC 02	1.25	1.2	1.16	1.203
GPC 03	0.89	0.8	0.77	0.82
GPC 04	1.56	1.49	1.5	1.516

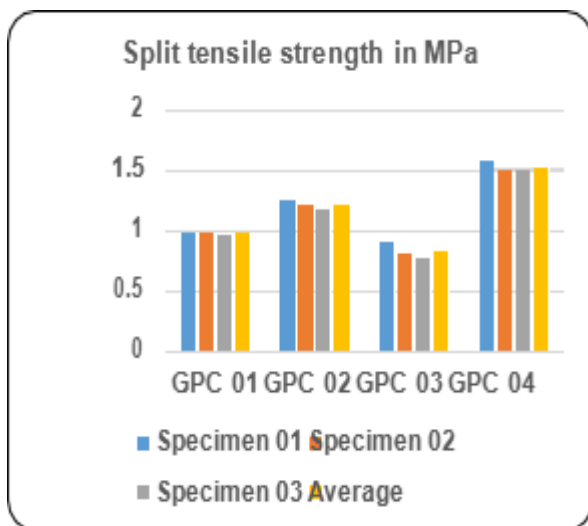


Fig.2. Compressive Strength in MPa

V.CONCLUSION

With a view to increasing the use of Fly ash and GGBS as well as recycled concrete aggregates in construction, geopolymer concrete study has been undertaken. For binding the geo-polymer concrete, in lieu of water, chemical activators are used. The pervious geo-polymer concretes were designed for M30 grade. Upon completion of 7 day curing, tests for cube and cylinder specimens were carried out.

Out of four proportions, in 1:8 proportions not only compressive strength and split tensile strength were found to be higher compared to other three proportions but also water permeability was considerably high. Thus, 1:8 proportion cubes and cylinders specimens shown maximum results compared to other proportions. During the tests, it has also been observed that compressive strength increases when recycled coarse aggregate content is increased. In addition, infiltration rate is also increased

keeping the other materials Fly ash, GGBs etc. without any change in quantities. Compressive Strength Test.

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