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EVALUATION ON COMPRESSIVE STRENGTH OF PAVER BLOCK BY USING GEOPOLYMER

M.MUTHUKUMAR[1], L.MAREESWARAN[2] AND S.SUBBURAMAN[3], B.JEYAPRAKASH[4] DAA, B.E., M.E.,
[123]UG Students, [4]Assistant Professor
Department Of Civil Engineering, Renganayagi Varatharaj College Of Engineering, Sattur.

***Abstract:* -** Paver block has been always one of the most used material in the construction sector. This content has been encouraged the development and use of new building materials such as Geopolymer. In this concrete, the cement is totally replaced by fly ash and alkaline solution to act as a binder in the concrete mix Geopolymer concrete achieve strength, an experimental investigation has been carried out for the geopolymer concrete and the mix design procedure is proposed of the quantity of fly ash, quantity of water, grading of fine aggregate, fine to total aggregate ratio, and sodium silicate to sodium hydroxide solution ratio. Sodium silicate solution and sodium hydroxide solution having various concentration (8M, 10M, and 12M) were maintained constant throughout the experiment. Water to geopolymer binder ratio of 0.35, alkaline solution to fly ash ratio of 0.61 and sodium hydroxide to sodium hydroxide ratio 1:1 of by mass were fixed on the basis of compressive strength. The temperature of oven heating was maintained at 70 °C for 24 hour duration and tested. It is observed that the results of compressive strength are well match with the required degree of compressive strength.

Keywords: Compressive strength, Crusher Dust, Fly ash, Super plasticizer, coarse aggregate.

I.INTRODUCTION

For the construction of any structure, Concrete is the main material. The main ingredient to produce concrete is Portland cement. On the other side global warming and environmental pollution are the biggest menace to the human race on this planet today. The production of cement means the production of pollution because of the emission of CO_2 during its production. There are two different sources of CO_2 emission during cement production. Combustion of fossil fuels to operate the rotary kiln is the largest source and other one is the chemical process of calcining limestone into lime in the cement kiln also produces CO_2. The cement industry contributes about 5% of total global carbon dioxide emissions. And also, the cement is manufactured by using the raw materials such as lime stone, clay and other minerals. Quarrying of these raw materials is also causes environmental degradation. To produce 1 ton of cement, about 1.6 tons of raw materials are required and the time taken to form the lime stone is much longer than the rate at which humans use it. But the demand of concrete is increasing day by day for its ease of preparing and fabricating in all sorts of convenient shapes. So to overcome this problem, the concrete to be used should be environmental friendly. To produce environmental friendly concrete, we have to replace the cement with some other binders which should not create any bad effect on environment. The use of industrial by products as binders can reduce the problem. In this respect, the new technology geo-polymer concrete is a promising technique. In terms of reducing the global warming, the geo-polymer technology could reduce the CO_2 emission to the atmosphere caused by cement and aggregates industries by about 80%. And also the proper usage of industrial wastes can reduce the problem of disposing the waste products into the atmosphere.

1.1. AIM OF THE PROJECT

- To aim of the project is to replace cement with fly ash and Alkaline solutions.
- To study the properties of materials.'
- To study the compressive strength of paver block specimen with crusher dust, fly ash, Alkaline Solution and Coarse Aggregate.

1.2. SCOPE OF THE PROJECT

- The main objective of this present study is producing Geopolymer paver blocks.
- To develop geopolymer concrete of different grades using locally available fine and coarse aggregate using fly ash as a binder material.
- Commercially available chemicals will be used for preparing alkali solutions for activation of fly ash to act as binder material.
- This study was extended to find the comparison of compressive strength of Geopolymer concrete to OPC concrete.

II. LITERATURE SURVEY

1.**K.Ashokkumar and Dr. P.Partheeban (2017),** describes the effects of several factors on the properties of fly ash based Geopolymer concrete, especially the compressive strength. The test variables included were the age of concrete, curing time, curing temperature, quantity geo-polymer of super-plasticizer, the rest period prior to curing, and the water content of the mix. They concluded that compressive strength of concrete does not vary with age, and curing the concrete specimens at higher temperature and longer curing period will result in higher compressive strength.

2.**Aaron Darius Vaz ., Donal Nixon D' Souza., NoothanKaliveer., Satish K.T., and Amar S.M (2012),** Based on compressive strength attained in this study, the paver blocks developed can be used for light and medium traffic applications. From the flexural strength point of view, paver blocks developed using fly ash and GGBS can be used for heavy duty or industrial roads. The individual paver blocks absorbs water less than 7% and the average water absorption is less than 6% which makes them suitable for practical applications. Hence the paver blocks can be used for general purpose applications.

3.**BasilM.Mali., Renjan Abraham (2016),** The GPC paver block attained higher strength at 7th day than the OPC pavers at 28 days. The variation of GPC paver block at 7th day strength to 28 day strength is very small. So it can be concluded that the GPC paver attain early strength than OPC pavers. GPC paver blocks have superior resistance to chemical attack making them suitable for aggressive soils. Compressive strength, Abrasive resistance & other most of them properties of polypropylene fiber reinforced geopolymer concrete at 28 days increases with respect to increase in percentage volume fraction of polypropylene up to 0.2% by weight.

4. **C. Banupriya, Sharon John, R. Suresh, E. Divya and D. Vinitha (2016),**Studied the strength behaviours of Geopolymer concrete over ordinary Portland cement concrete and focused to produce Geopolymer bricks and paver blocks using the different ratios of FA and GGBS. The results are as follows. GPCC with 50% sand and 50% quarry dust produced maximum compressive, Flexural strength and Split tensile strength, which is on a par with Ordinary Portland cement concrete. Thus, this study reduced the cost of 50 % for sand and utilizes 50 % of quarry dust, which are considered as waste product. GPC paver block using 75% GGBS and 25% fly ash shows excellent compressive strength (up to 50MPa). Geopolymer bricks using 75% GGBS & 25% FA show excellent compressive strength (up to 19MPa).

III. MATERIALS PROPERTIES

3.1 OPC CEMENT

In this project OPC 53Grade cement used.

Description of Test	Results
Specific Gravity	3.147
Initial setting Time	30 mins
Final setting time	600 mins

Table No 3.1.Properties of Crusher Dust

3.2 CRUSHER DUST

To produce geo-polymer concrete mix, the quarry dust is used as a fine aggregate and it was taken from local quarries. It has following properties.

Description of Tests	Results
Specific gravity	2.60
Absorption (%)	0.84
Sieve Analysis	Zone III

Table No 3.2.Properties of Crusher Dust

3.3 FLYASH

Fly ash is taken from KRISHNATHERMAL POWER STATION, KUNDAMPATTI in VIRUDHUNAGAR DISTRICT, TAMIL NADU.

S.No	Oxide composition (%by mass)	Fly ash
1	SiO2	59.2
2	Al2O3	38.02
3	CaO	0.94
4	MgO	0.28
5	Na2O3	0.47
6	K2O	0.22
7	Loss of ignition	1.05

Name of the mixture	Fly ash (kg)	Fine aggregate (kg)	Coarse Aggregate (kg)	Sodium Hydroxide Solution (kg)	Sodium Silicate solution (kg)	Super plasticizers (ConplastSP430) (ml)
GP1	6.875	6	10.6	2	2.09(8M)	68.75
GP2	6.875	6	10.6	2	2.09(10M)	68.75
GP3	6.875	6	10.6	2	2.09(12M)	68.75

Table No 3.3 Properties of Fly ash

IV. MIX DESIGN

DIMENSON OF PAVER BLOCK = 22.5X11.5X8 cm
Volume of Specimen = 22.5x11.5x8cm
= 0.002025m^3 x 6 Nos
= 0.1215 m^3

Name of the Mixture	Fly ash (kg/m^3)	Fine aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)	Water content (kg/m^3)	Sodium Hydroxide Solution (kg/m^3)	Sodium Silicate solution (kg/m^3)
GP1	550	479.32	853.2	22	167.75 (8M)	167.75
GP2	550	479.32	853.2	22	167.75(10M)	167.75
GP3	550	479.32	853.2	22	167.75(12M)	167.75

Table No. 4.1 Mix Design

V. MANUFACTURING AND CASTING OF GEO-POLYMER CONCRETE

The conventional method used in the making of normal concrete is adopted to prepare geo-polymer concrete. First, the quarry dust, coarse aggregate and Fly ash are mixed in dry condition for 3-4 minutes and then the alkaline solution which is a combination of Sodium hydroxide solution and Sodium silicate solution with super-plasticizer is added to the dry mix. The mixing is done about 6-8 minutes for proper bonding of all the materials. After the mixing, the cubes are casted with the mixes by giving proper compaction. The size of the zigzag specimen is 22.5x11.25x8 cm.

Figure 5.1 Mixing of Geopolymer Concrete.

Figure 5.2 Fresh Geopolymer concrete

Figure 5.3 Vibration Table

Figure 5.4Casting of Concrete

5.1 CURING OF GEO-POLYMER CONCRETE

For the curing of geo-polymer concrete cubes, the cubes are placed in direct heat chamber. For the heat curing, the Specimens are demoulded after 1 day of casting and they are placed in the heat chamber for 24 hours @70°C.

Required Molarity	Weight in g. of Sodium hydroxide flakes
8M	266
10M	306
12M	354

Figure5.5 Heat Chamber

5.2 COMPRESSIVE STRENGTH

Compressive strength is the capacity of a material or structure to withstand axially directed pushing forces. Specimens were casted and compressive strength test was conducted. To conduct the test the specimens are placed in a compression testing machine and the load is applied to the Specimen and the load at failure is noted as failure load.

Figure 5.7 Compression testing Machine (CTM)

The compressive strength is calculated by using the formula,

Compressive strength $= \frac{Ultimate Load\ (\mathrm{N})}{Cross section of Specimen\ (\mathrm{mm^2})}$

VI. EXPERIMENTAL RESULTS:

6.1 COMPRESSIVE STRENGTH

The average compressive strength for the paver block at different percentages concrete strength compare with Conventional Paver block. The figure shows the ductile failure of Specimens. The graphical representation shows the compressive strength of Geoplymer paver block.

Table No. 6.1.1Specimen – Conventional Paver Block

S.No	Specimen	Load(KN)	Compressive strength (N/mm^2)
1.	1	540	21.33
2.	2	620	24.49
3.	3	580	22.91

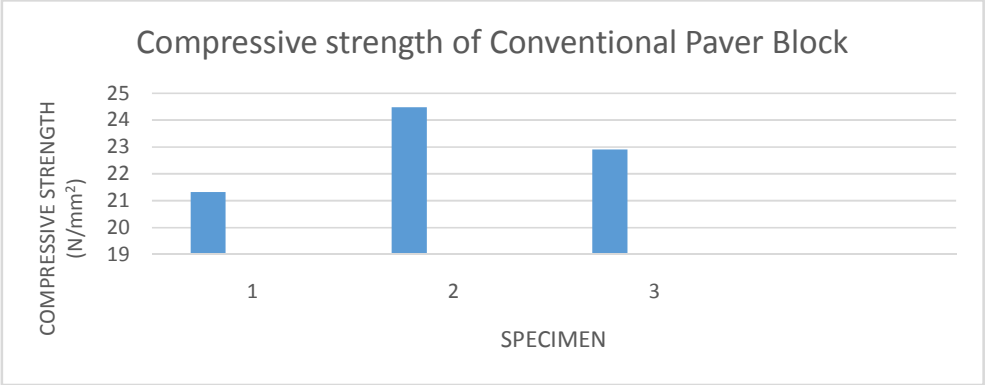


Table No. 6.1.2 Specimen – Geopolymer Paver Block (8M)

S.No	Specimen	Load(KN)	Compressive strength(N/mm^2)
1.	1	700	27.65
2.	2	750	29.62
3.	3	730	28.83

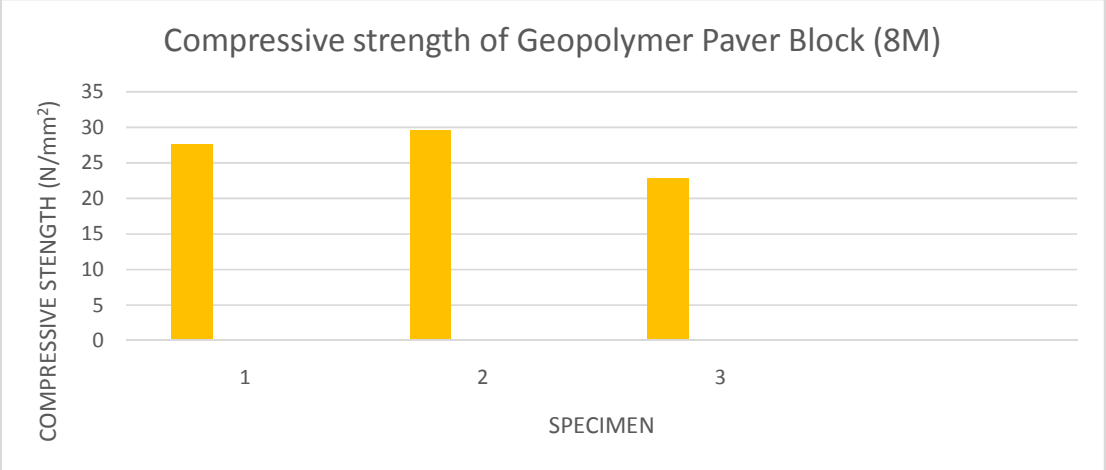


Table No. 6.1.3
Specimen – Geopolymer Paver Block (10M)

S.No	Specimen	Load(KN)	Compressive strength(N/mm^2)
1.	1	720	28.44
2.	2	740	29.2
3.	3	760	30.02

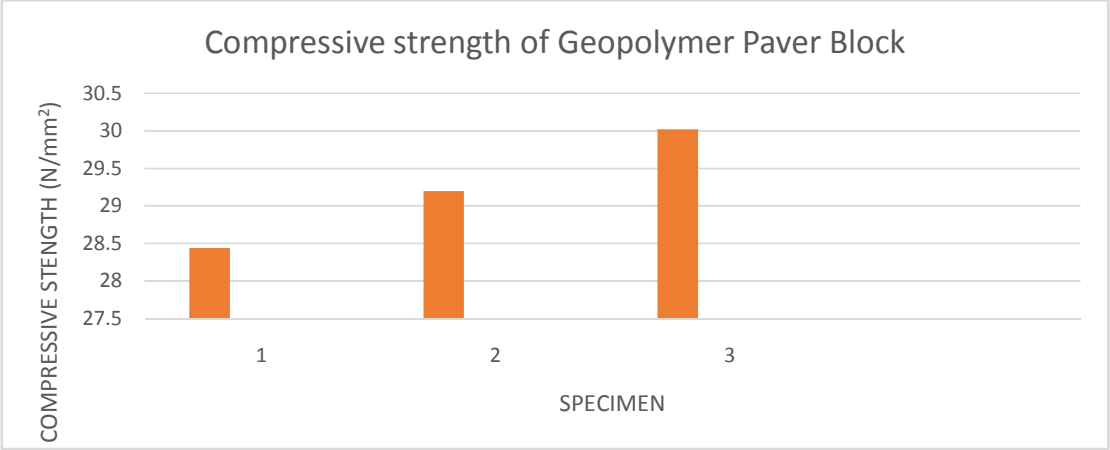
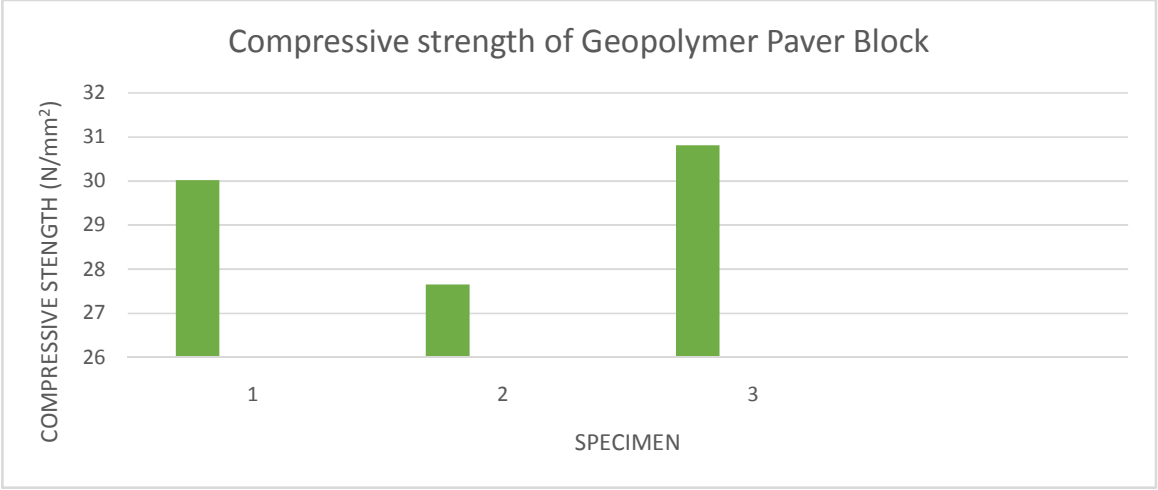
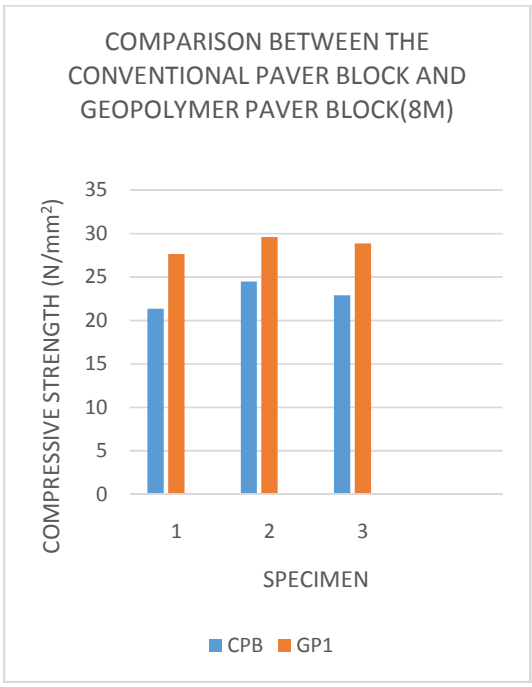
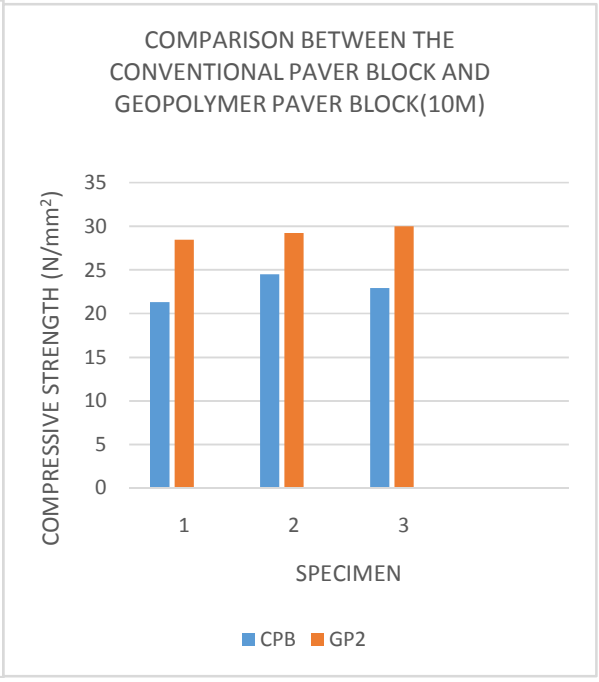


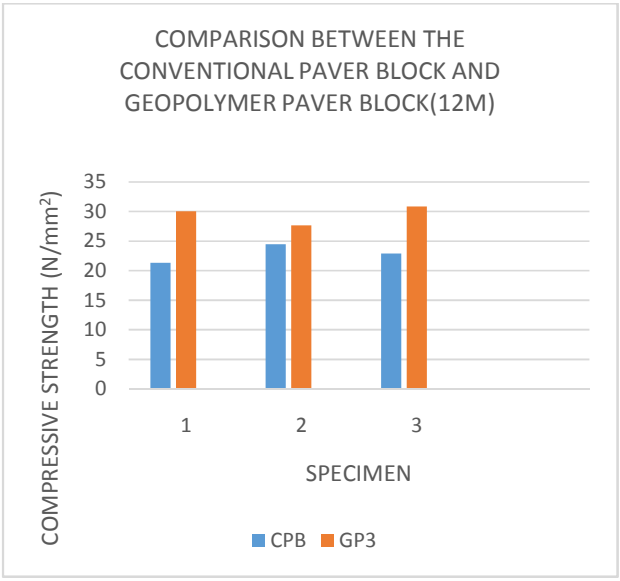
Table No. 6.1.4
Specimen – Geopolymer Paver Block (12M)

S.No	Specimen	Load	Compressive strength(N/mm^2)
1.	1	760	30.02
2.	2	700	27.65
3.	3	780	30.81









6.2.CONCLUSION

Based on the experimental work reported in this study, the following conclusions are drawn.

- Higher concentration (in terms of molar) of sodium hydroxide solution results in higher compressive strength of fly ash & quarry dust based geo-polymer concrete.
- Longer curing time, in the range of 4 to 96 hours (4 days), produces higher compressive strength of fly ash &quarry dust based geo-polymer concrete. However, the increase in strength beyond 24 hours is not significant.
- The mix GP3 gives higher compressive strength, as it has high molarity of NaOH
- we Observe that the compressive strength is increased with the increase in the molarity of the sodium hydroxide

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