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Effect of Alkaline Activator & Foaming Agents on Development of Neat Geopolymer Block

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Abstract: ***The subject of study of this paper is the effect of alkaline activator as a separate form with the help of fly ash and gypsum powder .And also studies the effect of alkaline activator with the help of fly ash and gypsum based dry material as a neat geopolymer block. Geopolymer provide a progressive solution, and the presence of aluminium and silicon oxides in fly ash has encouraged its use as a source material. To promote the employment of geopolymer for practical geopolymer paste as binder applications, the present study investigated the material's Density, Compressive strength, water absorption and such other properties like as effect of percentage on foaming agents (Aluminium flask and Hydrogen peroxide), practices and applications. An experimental program was also executed to establish a relationship between the alkaline activator composition {12.5M} and the properties of geopolymer paste. Concentrations of sodium hydroxide and sodium silicate {SH/SS-2.5} were ascertained that are advantageous for constructability and physical properties. Test results indicate that there is potential for the concrete industry to utilize alkaline activated fly ash as an alternative to Portland cement in structural building applications and if possible that to use neat geopolymer block as a zero aggregate product or the form of Neat Geopolymer Light Weight Block.***
Keywords: Geopolymer, Fly ash, Foaming agent, Compressive strength, Water absorption, Alkali Activator.

I. INTRODUCTION

Today, the need for production of new eco-friendly building materials from nation's natural sources and waste by products has been amplified vastly with an increase of general awareness about environmental issues which led to a rising concern over waste cohort and the comprehension that such materials must be pickled, omitted or re-claimed. Increasing consumption and the simultaneous increase in the industrial production has caused both a rapid deterioration in natural sources and generation of hefty volumes of waste or by products {1}.Recent studies into the economically sustainable re use of wastes have given upsurge to different offers, including the opportunity of its inclusion in building materials {2, 3}.

These materials characterised under the alkali activated materials and usually known as geopolymer if their resources are from nature of geological pedigrees reach in silicon and aluminium, whereas industrial by products rich in silica and aluminium oxides such as coal fly ash ,silica fumes and granulated blast furnace slag considered as alkali activated materials .Which is the major category ,while the geopolymer can be careful as subset from this as accord with the French scientists Joseph Davidovits in 1978{4,5},who revealed and recognized of the research in geopolymer binder.

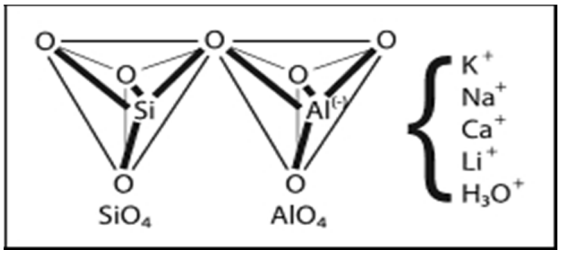


Fig.1- Tetrahedral Configuration of Sialate (Davidovits, 1976).

The binding phase in geopolymer is an amorphous aluminosilicate gel that be inherent in of a three dimensional framework of SiO_4 and AlO_4 tetrahedral linked by corner shaded O atoms in figure1,{6-8}.Geopolymer binders clasp many advanced properties over traditional ones although the most important is their low manufacturing energy intake and low CO_2 emission {9,10},which can be fixed as a Green Materials{11}.The important of green materials increased also immensely with the increased ability for producing lightweight building materials in construction sector that can shield heat and sound, where traditionally ,ordinary Portland cement

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(OPC) has been used as the binder for concrete{12-14},exhibits high thermal transmission and said to be responsible for about 7% of the CO_2 emission wide-reaching.

Provide better thermal insulation for buildings, and cost less to transport and stiff when pre-fabricated structural components are made in factories, where using lightweight block is one of the important ways to making geopolymer as a light weight building materials.

The use of lower densities block is useful in terms of structural load bearing, and as an acoustic and thermal insulation. The densities can be reduced by replacing part of solids by air voids {15, 16}.

Numerous materials are available to suit lightweight production one of such chemical to generate gas within the mixture is metallic aluminium powder or flask and hydrogen peroxide (H_2O_2), which is very reactive in alkaline environments, such as calcium hydroxide or sulphate; the hydrogen peroxide and aluminium both has released the H_2 gas. Aluminium dissolved as aluminate AlO_2 and H_2 gas is enlightened and trapped within the cementious paste expanding to surge the volume. In order to avert the escape of the gas, the paste much has a proper consistency and fast setting times {17, 18}.

The objective of this contribution is to investigate the effect of ascertain 12.5Molarity concentrations of sodium hydroxide (NaOH) and sodium silicate (Na_2SiO_3),gypsum ,water are expedient for the constructability of neat geopolymer blocks the effect of foaming agents using to make lightweight geopolymer blocks .Physical properties of GPB and lightweight blocks (use of Al flask and hydrogen peroxide as different percentage) and also sodium hydroxide and sodium silicate blocks as separate constituents form .The following factors were investigated

A. Density
B. Compressive Strength
C. Water absorption

II. EXPERIMENTAL PROCEDURES

A. Materials

1) *Fly Ash:* FA is a by-product of coal combustion power plants. The siliceous and aluminous material is classified as a pozzolan due to its ability to chemically react with $Ca(OH)_2$ to form cementious compounds. FA produced from anthracite and bituminous coals are Class F, while sub-bituminous and lignite coals produce Class C FA. Class F FA contains large amounts of Al_2O_3 and SiO_2 but less than 10% CaO. Alternatively, Class C FA has CaO content greater than 10%, giving it unique self-hardening characteristics as per IS3812 {19}. FA is selected for the investigational manner. It is the largest coal fired Power station generating about 1400 megawatt in Madhya Pradesh, contributing to approximately 70% of total electricity Supply of the state. The typical fly ash was chosen for geopolymer Paste binder component because of its local availability and excellent reactivity. The collection of Fly ash was done by means of electrostatic precipitators at the thermal power station.
2) *Alkaline Activator:* The alkali polysiliate solution is most commonly composed of NaOH and Na_2SiO_3 for geopolymer based on FA. It is also recommended for the NaOH, Na_2SiO_3, H_2O .The constituent of sodium silicate or water glass allows the quantity of the mineral component to be attenuated, and including it in the intermixture is also advantageous for faster solidification of the binder. The benefit of incorporating NaOH into geopolymer mixtures is its exothermic capacity as a strong chemical base to increase dissolution and poly condensation of the source material (Davidovits, 1975). We have used 12.5 molarity alkali solution prepared a day before.
3) *Gypsum:* Gypsum is calcium sulphate ($CaSO_4.2H_2O$), which is added to increase the compressive strength of the block. Moreover, it is added to avoid the cake collapsing in low densities .Gypsum has primarily an influence on the setting times .Water is used two purposes for generating steam and for the process itself .Water has a significant influence on the strength development and final strength of the paste with the help of sodium hydroxide and sodium silicate.
4) *Foaming Agent:* Aluminium flask and hydrogen peroxide both provides the process with required hydrogen H_2 to expand the product when aluminium power or flask is mixed with the other ingredients, hydrogen gas will raise with solids to the surface and this will double the size of the cake the porosity is achieved by a gas generation agent (aluminium powder or paste or flask).the aluminium react with the hydroxide from the paste and gypsum hydrogen gas makes the mass expand of double the cake. And also hydrogen reacts with water and calcium and release hydrogen gas.
5) *Water:* Clean tap water was used for the solution preparation. Water is used as a potable water according to as per IS Code456:2000{22}.

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III. METHODOLOGY

A. Tests Perform

1) NaOH Blocks
2) Na2SiO3 Blocks
3) Geopolymer Blocks
4) Geopolymer Blocks with foaming agents (Al +H_2O_2)

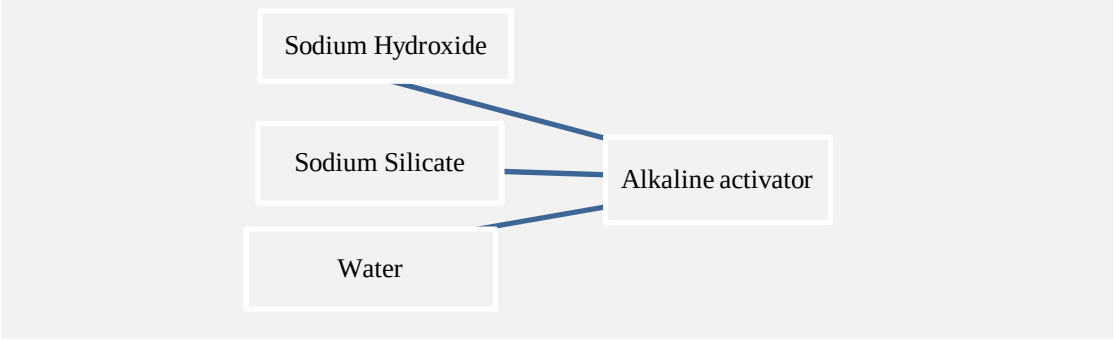


Fig.2- Alkali Activation

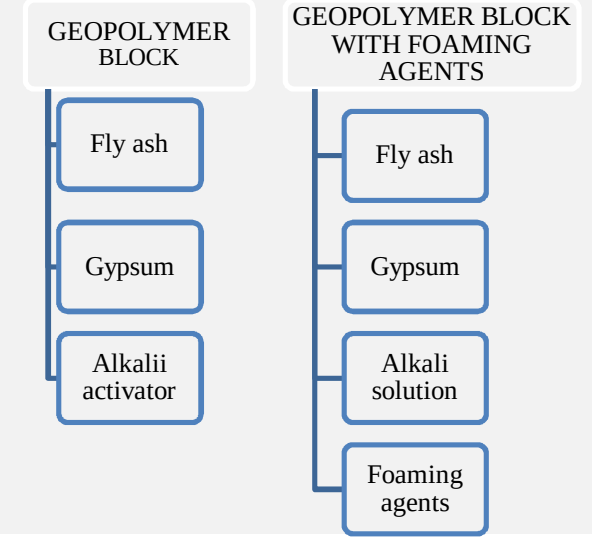


Fig3.Sodium Hydroxide and Sodium Silicate Blocks

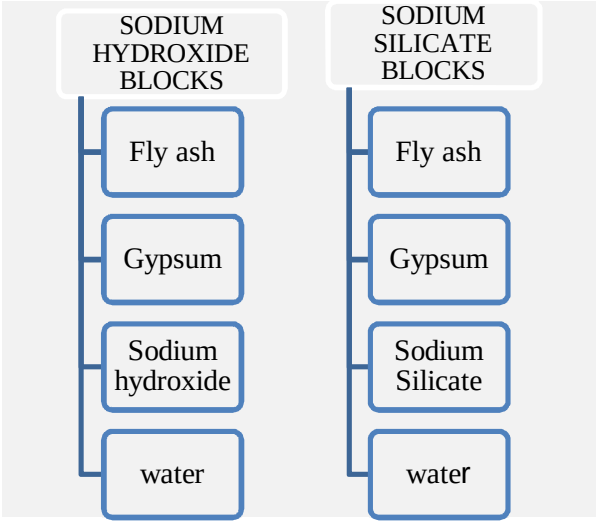


Fig4.Geopolymer block and lightweight Block

Sr. no.	Material	Composition	Quantity/3 specimen	Quantity of weight (in kg/Litre)
1	Fly Ash	-	15	Kg
2	Alkali solution	NaOH+Na_2SIO_3+WATER	3500-4300	Litre
3	Gypsum	-	30	gm.
4	Foaming Agent Al H_20_2	 - -	 66-37.5 72-15	 gm. Ml
5	Water	-	6	Litre
6	SMS	-	$7^1/_2$	Kg
7	NaOH	-	6	Kg

3.1. Details of Materials which is used in Testing Table-1.

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B. Procedure

1) *Mixing:* Component of the GPB were stored in sealed container in a laboratory. Prior to beginning the mixing procedure ,each component was measured as per the mix ratio of specification .Due to the tendency of geopolymer based class F fly ash to set in unfavourable condition ,the GPB was mixed by the hand to prevent unnecessary damage to laboratory equipment. First the FA and gypsum were dry mixed, and then water and then alkaline solution added to in it and finally after some time when the paste is being ready we were mixed foaming agent on it .After homogeneous mixing the paste is on filled in specimens.



Image.1 preparing of geopolymer paste

2) *Casting:* The fresh geopolymer paste was cast into specimens and then subjected to external vibration for 3-4 second if required in accordance with ASTM 109(2011){21}. Moulds were stored in ambient condition and sealed with iron plate .Specimen were de-moulded after 24 hours measuring the weight of it.

3) *Curing:* Later than the de-mould of specimen measured the weight of cubes and after stored in oven curing 65°C .We have initially take 6 hours per two day oven dry and after room temperature count as a 24 hours curing time and after room temperature is taken .it is also considered as alternate curing time . Heat Curing is performed by Hindustan Company Oven.

4) *Density:* To find out the density of cubes we have to apply the Ratio of Mass and Volume.

a) Density =Mass of cube / Volume of cube.

b) Now we have to calculate the density of cube in kg per cubic meter units.

5) *Compressive Strength:* The compressive strength of the specimens in the factorial design was measured 1, 3,7,28 days after oven dry. We have initial 3 cubes average to determine the compressive strength of cubes**.** Compressive testing was performed by Lawrence and Mayo Company testing Machine LYNX. Its capability of testing is 200 ton according to IS code as per IS 516-1959{22}, and the results were reported in mega Pascal.



Image.2 Compressive strength Machine

6) *Water Absorption:* Water absorption is an important character which affects the durability of the block .The test procedure involves casting of the blocks .Then the specimen was cured according to curing condition those given in curing .Then the specimen was oven dried and the weights of block were measured .The cubes were immersed in water for 24hours .Aft that, the cubes were taken out and the weight was measured The increased in weight as a percentage of original weight is expressed as its absorption(in percentage). The average absorption of the test sample as per IS- 2185(Part4)2008) {23} which is calculated by the given formula. The average value of the water absorption for three trials was obtained

a) Water absorption = W2-W1 X 100/W_1

b) {Where W_1=Weight of dry Block (gm.), W2 = weight of saturated block}



Image.7 Cube for water absorption

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IV. RESULT AND DISSCUSION

For making cement free-geo-polymer composite fly ash, gypsum and alkali activators solution of optimized composition were mixed thoroughly. The experimental procedure involves the evaluation of the compressive strength and the density and water absorption of the GPB and LWB geo-polymer specimen. Many set of specimen were casted for the experimental purpose

Curing regime condition involved in the experiment, which includes the curing at 65^0C 6 hours per multiple days in oven and remaining room temperature for 24 hours (oven dry method). And remains ahead a day is calculating same day at room temperature for Curing. The specimens were taken out from the oven and were left undisturbed in laboratory at ambient conditions until these were tested for compressive strength for 3, 7 and 28 days. This was resulted into finding out the increase or decrease in the compressive strength. Water absorption and density test is also conducted. When the mixture achieved their homogeneity; the alkaline solution was added gradually in the mixer. Mixing was continued for further 20 minutes or until it develops a uniform mix. The standard cubes of size 15 cm x 15cm x 15cm were casted.

The procedure of mixing and casting geo-polymer cubes is as per IS 4031{24}.After casting, the cubes were kept in oven and Thermal cured at room Temperature. Geo-polymer paste specimen cubes were tested.

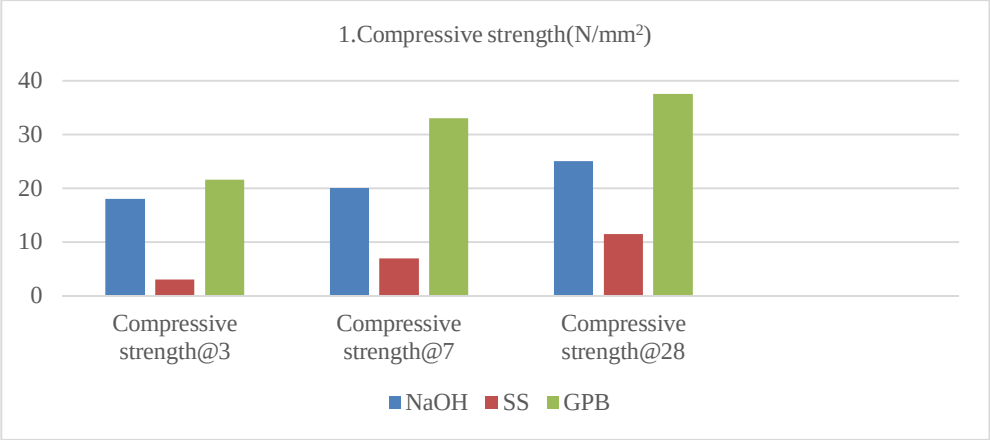
Results are shown in table-2.

Sr. No.	Name of Sample	Material			Quantity			Avg.strength in Days (Unit is taken N/mm^2)				Density in kg/m^3	$^0/_0$ of Water Absorption
								1	**3**	**7**	**28**		
1	NaOH Block	NaOH	Water	Fly Ash+ gypsum	2kg	4 litre	15kg	-	18	20	25	1580	6.67
2	SMS Block	SMS	Water	Fly Ash+ gypsum	2kg	4 litre	15kg	-	3	7	11.5	1537	5.72
3	GPB Block	NaOH +SMS/ Alkali Solution	Water	Fly Ash+ gypsum	-	-	15kg	-	21.64	33	37.5	1697	6.11
4	GPB+Al $0.44^0/_0$	Alkali solution	-	Flu ash+ gypsum	-	3.6 litre	15kg	-	-	14.00	9.64	1480	7.61
5	GPB+Al $0.33^0/_0$	Alkali solution	-	Fly ash+ gypsum	-	3.5 litre	15kg	-	-	17..50	10.89	1525	7.54
6	GPB+Al $0.25^0/_0$	Alkali solution	-	Fly ash+ gypsum	-	3.5 litre	15kg	-	-	23	14.11	1575	7.48
7	GPB+HP $0.10^0/_0$	Alkali solution	-	Fly ash+ gypsum	-	3.6 litre	15kg	31.64	28.00	26.38	20.79	1689	7.11
8	GPB+HP $0.16^0/_0$	Alkali solution	-	Fly ash+ gypsum	-	3.6 litre	15kg	29.78	26.52	23.61	18.68	1560	7.34
9	GPB+HP $0.48^0/_0$	Alkali solution	-	Fly ash+ gypsum	-	3.5 litre	15kg	27.54	24.22	19.93	15.22	1422	7.43

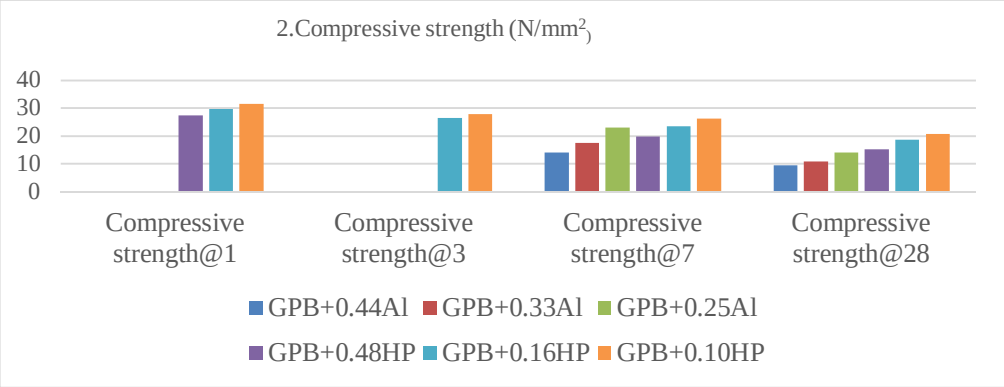
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A. Result

Compressive strength



Compressive strength {NaOH+SMS}.



Compressive strength {GPB+foaming agents (+0.44Al, +0.33Al, +0.25Al), (0.48HP, +0.16HP, +0.10HP)}

B. Disscusion

1) Compressive strength (NaOH+SMS).

a) The compressive strength of sodium hydroxide(NaOH) block is 18,20,25 as a days of 3 ,7 and 28 days and Sodium silicates (Na2SiO3) are 3, 7,11.5 as a days of 3 ,7 and 28 days. As per data, it is clearly shown that the sodium hydroxide strength is 2.18 to 6 more than ratio of sodium silicate block.

b) It has been shown that compressive strength and apparent density of geopolymer increase as NaOH solution concentration.

c) It has to obtained geopolymer with high compressive strength a high gel phase and high ratio gel to non-polymeric phase is required.

2) Compressive strength of GPB

a) The compressive strength of GPB block is 21.64, 33, 37.5 as a days of 3 ,7 and 28 days
compressive strength of geopolymer block as compared to 1.5 times more than of NaOH block and 3 to 7 more than times of higher at same days ratio of sodium silicate block.

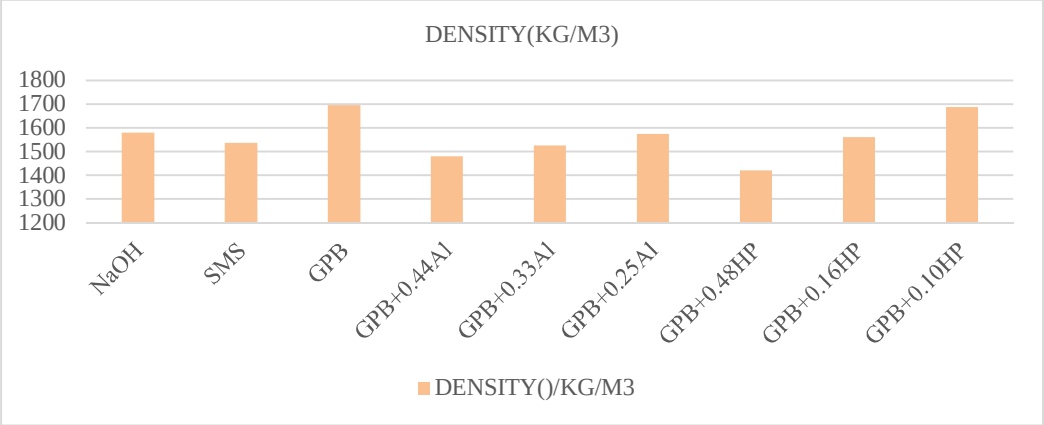
b) The reason of higher strength of geopolymer block is using alkali solution composed of alkali hydroxide and dissolved silicate has been found to be beneficial for compressive strength relative to alkali hydroxide as per IS Code 2185 part1{26} block which density minimum 1500 is count as grade A and average compressive strength lies between 3.5-15 N/mm2 and other is grade B.as per IS2185 part1{25} block which density not less than 1800 kg/m3 is count as solid block ,grade C and average compressive strength lies between 4-5 N/mm^2.

c) As per IS code 456, our GPB block compressive strength is also higher than M-35 mix grade of concrete as per records

d) Compressive strength of light weighted block is also decreased , increased the percentage of aluminium and hydrogen peroxide.

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V. DENSITY



A. Density

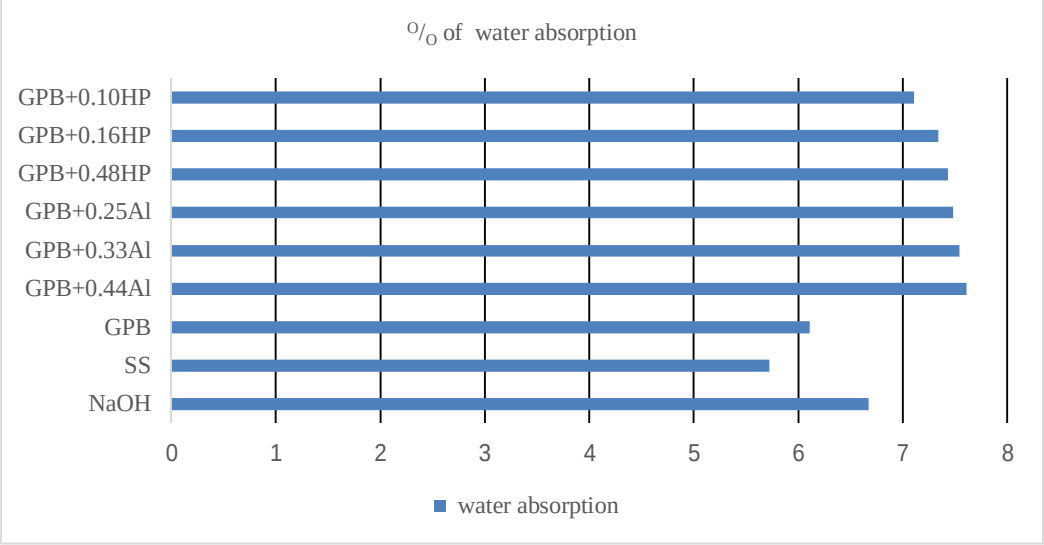
(GPB+Al and GPB+HP)

1) The density of material decreases with increase in quantity of aluminium flask. Density decreases between the range of1480 - 1575 at 0.44 percentages as minimum and 0.25 percentage or maximum. (G17.5)

2) The density of material decrease with increase in quantity of hydrogen peroxide. Density decreases between the range of1689-1422. (G12-G25).

3) The density of AAC block according to IS2185-4,{23} these blocks in density range 1200-1800kg/m3 having computation in load bearing units. And our block is categorized as G12-G25grade

VI. WATER ABSORPTION



A. Water absorption of LWB is increased in aluminium percentage 0.25-0.44.

B. Water absorption of light weighted block is also increased by the higher percentage of hydrogen peroxide.

C. Maximum limit of NAAC Block is 400/0 (anshulshrivastav et al. 2017IJRASET){26}

D. Water absorption of Sodium hydroxide block is 6.67

E. Water absorption of Sodium silicate block is 5.72

F. Water absorption of geopolymer block is6.11

G. Water absorption of GPB+Al is7.61-7.48, and GPB+HP is 7.43-7.11

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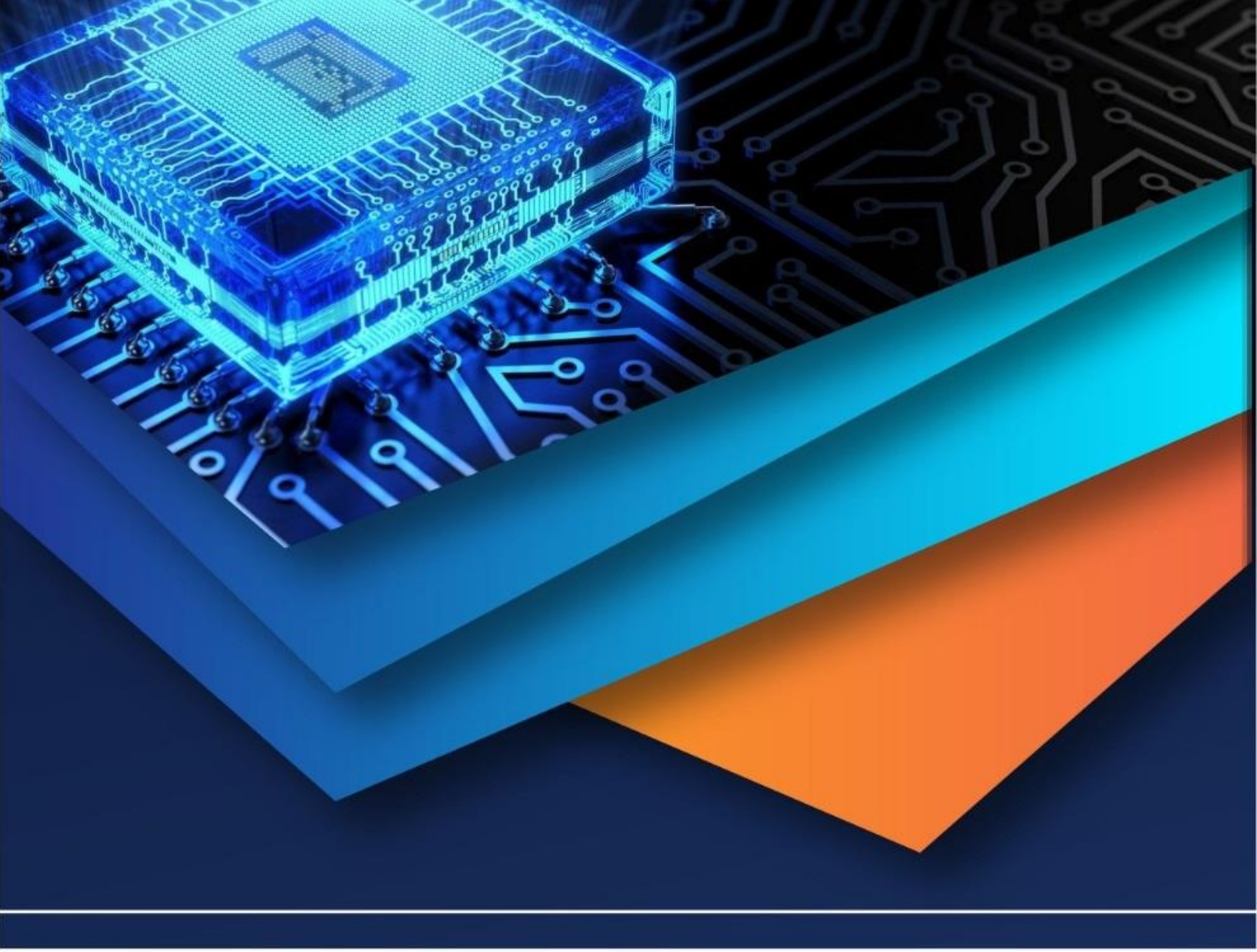
VII. CONCLUSION

1) GPB is a promising construction material due to its low carbon dioxide emission
2) High early strength and low shrinkage, acid resistance, fire resistance makes it better in usage than OPC
Wide spread applications in precast industries due to is high production in short duration less breakage during transportation.
3) Enhanced research along with acceptance require to make it great advantage to the industry
It has to induced the direct or neat use of Geopolymer such as block or light weighted block to use
4) The Geopolymer block compressive strength initiate can be inflate 24 hours.
5) The fly ash used to produce the Geopolymer binder phase .Fly ash bind to the Geopolymer block .Therefore these block is considered as Eco-friendly materials.
6) GPB is a zero aggregate products and their strength is also similar to GPM or GPC as mix design of M-30 .Means it can also applicable as a neat form. And also increases by future research work.
7) LWB strength is higher than Aerated autoclaved block that means it is more strengthen than AAC Block at similar density.
8) When we add of Alkaline Activator solution then workability is also increased.

REFERENCE

[1] Pinto, S. – Almeida, M. – Correia, A. M. S. – Labrincha, J. A. – Ferreira, V. M. – Rosenbom, K. (2004): Use of recycled materials in buildings and structures. Proceedings of International RILEM Conference on the use of recycled materials in buildings and structures, 2004, 2: 771-777.
[2] Dondi, M. – Marsigli, M. – Fabbri, B. (1997): Recycling of urban and industrial wastes in brick production: a review. Tile & Brick International, 1997, 13(4): 302-315.
[3] Tay, J. H. – Show, K. Y. – Hong, S. Y. (2001): Reuse of industrial sludge as construction aggregates. Water Science Technology, 2001, 44 (10): 269-272. https://doi.org.10.2166/wst.2001.0638.
[4] Davidovits, J. (2002): 30 Years of Successes and Failures in Geopolymer Applications. Market Trends and Potential Breakthroughs, Geopolymer 2002 Conference, October 28–29, 2002, Melbourne, Australia.
[5] Davidovits, J. (1989): Geopolymers and geopolymeric materials, Journal of Thermal Analysis, 1989, 35:425–441. https://doi.org/10.1007/BF01904446.
[6] Cheng, T. W. – Chiu, J. G. (2003): Fire-resistant geopolymer produced by granulated blast furnace slag, Minerals Engineering, 2003, 16:205–210. https://doi.org/10.1016/S0892-6875(03)00008-6.
[7] Komnitsas, K. – Zaharaki, D. (2007): Geopolymerisation: a review and prospects for the minerals industry, Minerals Engineering, 2007, 20:1261-1277. https://doi.org/10.1016/j.mineng.2007.07.011.
[8] Khale, D. – Chaudhary, R. (2007): Mechanism of geopolymerization and factors influencing its development, a review, Journal of Materials Science, 2007, 42:729-746. https://doi.org/10.1007/s10853-006-0401-4.
[9] Duxson, P. – Van Deventer, J. (2009): Geopolymers, structure, processing, properties and applications. In: Provis J, Van Deventer J, editor. Geopolymers, structure, processing, properties and applications, Woodhead Publishing Limited Abington Hall, Cambridge, UK, 2009.
[10] Weil, M. – Dombrowski, K. – Buchawald, A. (2009): Life-cycle analysis of geopolymers. In: Provis J, Van Deventer J, editor. Geopolymers, structure, processing, properties and applications, Woodhead Publishing Limited Abington Hall, Cambridge, UK, 2009.
[11] Liyana, J. – Kamarudin, H. – Mustafa Al Bakri – A. M., Binhussain – M., Ruzaidi – C.M. Izzat, A.M. (2013) Reviews on Fly Ash based Geopolymer Materials for Protective Coating Field Implementations, Australian Journal of Basic and Applied Sciences, 2013, 7(5): 182-18
[12] Lyon, R. E. (1996): Fire Response of Geopolymer Structural Composites, DOT/FAA/AR-TN95/22/1996.
[13] Khater, H. M. (2014): Studying the Effect of Thermal and Acid Exposure on Alkali Activated Slag Geopolymer, Advances in Cement Research, 2014, 26(1):1–9.https://doi.org/10.1680/adcr.11.00052.
[14] Davidovits, J. (1999) In: Proc. Int. Conf.Geopolymer , France, 1999: 9.
[15] Omar, A. A. – Mustafa Al Bakri, A.M. – Kamarudin, H. – Khairul Nizar, I. – Saif, A.A. (2014): Effects of elevated temperatures on the thermal behavior and mechanical performance of fly ash geopolymer paste, mortar and lightweight concrete, Construction and Building Materials, 2014, 50:377-387. https://doi.org/10.1016/j.conbuildmat.2013.09.047.
[16] Pinto, S. – Almeida, M. – Correia, A. M. S. – Labrincha, J. A. – Ferreira, V. M. – Rosenbom, K. (2004): Use of recycled materials in buildings and structures. Proceedings of International RILEM Conference on the use of recycled materials in buildings and structures, Vol. 2 (2004), pp. 771-777.
[17] Bean, D. L. – Malore, P. G. (1997): United States patent 5605570.
[18] Vargel, C. (2004): Inorganic bases. In: Vargel, C., editor. Corrosion of aluminium.United Kingdom: Elsevier Science, 2004:385–93.
[19] IS 3812-2 (2033): Specification for Pulverized Fuel Ash, Part 2: For Use as Admixture in Cement Mortar and Concrete.
[20] IS 456 (2000): Plain and Reinforced Concrete - Code of Practice [CED 2: Cement and Concrete].
[21] ASTM 109(2011) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars.
[22] IS 516 (1959): Method of Tests for Strength of Concrete.
[23] IS 2185-4 (2008): Concrete masonry units, Part 4: Preformed foam cellular concrete blocks [CED 53: Cement Matrix Products].
[24] IS 4031-4 (1988): Methods of physical tests for hydraulic cement, Part 4: Determination of consistency of standard cement paste [CED 2: Cement and Concrete].
[25] IS 2185-1 (2005): Concrete masonry units, Part 1: Hollow and solid concrete blocks [CED 53: Cement Matrix Products].
[26] Anshul Shrivastava1 , Prof. Archana Tiwari2 : Non Autoclaved Aerated Concrete (NAAC) Blocks: An Alternative Building Construction Material , International Journal for Research in Applied Science & Engineering Technology (IJRASET) Volume 5 Issue VIII, August 2017.

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