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GREEN CONCRETE STRENGTH CHARACTERISTICS THAT CONTRIBUTE TO SUSTAINABILITY AND ITS ENVIRONMENTALY BENIGN NATURE.

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Abstract— To fulfill the demands of globalization in the construction of buildings and infrastructure, India has recently made a significant effort in constructing the infrastructure, including expressways, power projects, and industrial structures, among other things. Concrete and cement are commonly utilized in construction and building techniques across the globe. It is necessary to switch to green concrete from Ordinary Portland Cement (OPC), since OPC uses more energy and harms the environment. In this study fly ash is used as an alternate to OPC, as fly ash has a high silicate and alumina content, it combines with an alkaline solution to form an alumino-silicate gel, which bonds the aggregate and results in high-grade concrete. The concrete mix proportioning used is M30 GRADE and activation of geo polymer concrete is done using alkaline activators such as sodium hydroxide and sodium silicate solutions, finally checking the mechanical strength properties of GPC in comparison with conventional concrete.

KEYWORDS*:* Alkaline Activators, Durability, Fly ash, Strength.

Introduction

In India nowadays the concept of smart city is growing very faster. As the main emphasis is on green and sustainable development .It is the most widely used construction material next to water globally, owing to its better controllable structural properties, which significantly increased its demand in construction industry, it has property such as Strength, Durability and Resistance to Absorption. An important ingredient in the conventional concrete is the Portland cement. This has lead increase in the usage of ordinary Portland cement (OPC) but the increase in use of OPC result in release of huge amount of carbon dioxide (CO_2) gas into the atmosphere as the process of cement manufacturing associates with heating of raw materials to elevated the temperatures.CO_2 is the major greenhouse gas reported to be contributing in a significantly higher percentages towards global warming. Cement production accounts 5% of global CO_2 emissions. These industries wastes are dumped in the nearby land and the natural fertility of the soil is spoiled. The slower reaction fly ash will increase the strength of concrete so curing play vital role in the performance of fly ash.

The production of one tone of cement leads to release of approximately 1 tonne of CO_2 into the atmosphere, Therefore to reduce the pollution, it is necessary to reduce or replace e cement from concrete by other cementations materials like fly ash, blast furnace slag, rice husk ash etc. Adding of fly ash in cement concrete reduces the releasing of CO_2 .Among the entire available mineral admixture; fly ash is available in large quantities which are the by-product of coal in thermal power plant. Usage of fly ash in India is less than 25% of the total fly ash generated in power plants. Alkaline solutions suitable for geopolymerisation are combination of NaOH and NA_2SiO_3 .Reducing the consumption of natural resources and energy. Fly ash can replace or displace manufactured cement, sand, clay, and other materials in the production of concrete, bricks, tiles, plaster, and other building products. This can conserve the natural resources and reduce the energy required for mining, processing, and transporting them. Fly ash can also increase the life span of concrete roads and structures by reducing the heatof hydration and the risk of cracking.

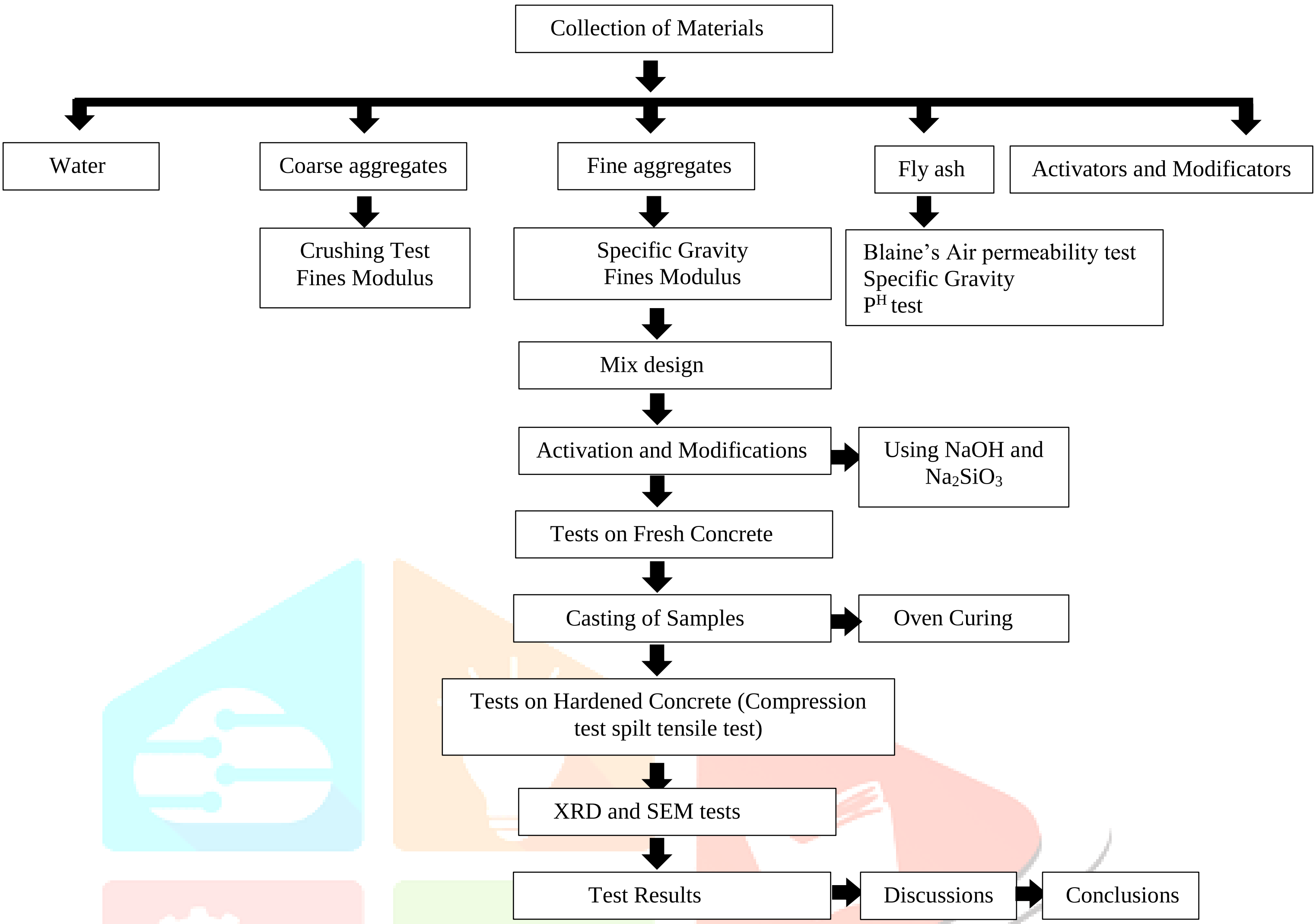
Fly ash can reduce the amount of coal combustion products that must be disposed in landfills, which can pose a threat to human health and the environment. Therefore, fly ash is a valuable resource that can help the industrialization and development of a nation by providing economic, environmental, and social benefits. The utilization of fly ash in the construction industry is not a new technology but it is a growing technology in improving the construction quality as well as the environment quality.

Adding fly ash in concrete give benefits in term of economical, ecological and technical currently, fly ash is used by cement industries as a pozzolanic material for manufacturing of Portland Pozzolana Cement since the SiO2 and Al2SiO3 content is very similar to Portland cement. In the presence of moisture and at room temperature, it reacts chemically with calcium hydroxide to derive compounds possessing cementations properties.

Fly ash can be used as a partial cement replacement by cement weight or as an admixture to the concrete mix. The utilization fly ash as a component of blended cement can save a significantamount of energy and cost in cement manufacturing. Normally fly ash was used in blended cement to produce in-situ concrete mix however fly ash also can be used in high strength precast and prestressed concrete. Utilization of fly ash in road and embankment construction has many advantages compared with the conventional method. It saves top soil which otherwise is conventionally used, avoids the creation of low-lying areas. Fly Ash may be also used in road construction for filling purposes, stabilizing and constructing sub-base or base. The role of adding CaO in a fly ash sample is typically to enhance the pozzolanic properties of the fly ash. Fly ash is a byproduct of coal combustion and contains many mineral impurities that can hinder its reactivity as a pozzolana. By adding CaO, also known as quicklime or calcium oxide, the alkalinity of the mixture is increased, allowing for a more efficient and effective reaction. The addition of CaO helps in the activation of the pozzolanic reaction, where the fly ash reacts with calcium hydroxide (Ca (OH) 2) to form calcium silicate hydrates (C-S-H), which are responsible for the strength and durability of the final product. This reaction, known as pozzolanic reaction, leads to the development of a cementations material that binds together the particles of the fly ash, thereby improving the overall Strength and performance of the concrete or mortar mix.

In addition to enhancing the reactivity of fly ash, the addition of CaO can also aid in the carbonation of fly ash. Carbonation is a chemical process where carbon dioxide from the atmosphere reacts with the calcium hydroxide present in the fly ash, forming calcium carbonate. This carbonation process can further improve the strength and durability of the concrete by providing additional binding and reducing the alkalinity of the mixture. Overall, the role of adding CaO in a fly ash sample is to improve its reactivity as a pozzolona, enhance the strength and durability of the final concrete or mortar mix, and aid in the carbonation process. Main objective is to replace the cement using geo-polymer based Fly-ash to reduce the global warming due to CO_2 emission, in turn increasing the strength of the concrete. To experimentally investigate the strength development and durability properties using various chemical activators. To achieve a new product which should give green concrete’s strength characteristics that contribute to sustainability and its environmentally benign nature

I. METHODOLOGY



II. MIX DESIGN

Table 01 Quantity of materials required per cubic meter for M30 grade of Conventional concrete

Ingredients of Concrete	Cement	M-Sand	Coarse aggregate	Water
Quantity (kg/m^3)	240	600	2025	120 lt
Proportion	1	1.52	2.76	0.20

Table 02 Quantity of materials required per cubic meter for M30 grade of geopolymer concrete

Ingredients of geopolymer Concrete	Fly ash	NaOH	Na_2SiO_3	M-Sand	Coarse aggregate	Total water (W/GPB)	Extra water
Quantity (kg/m^3)	400	70	70	660.88	1227.37	140	81.75 lt

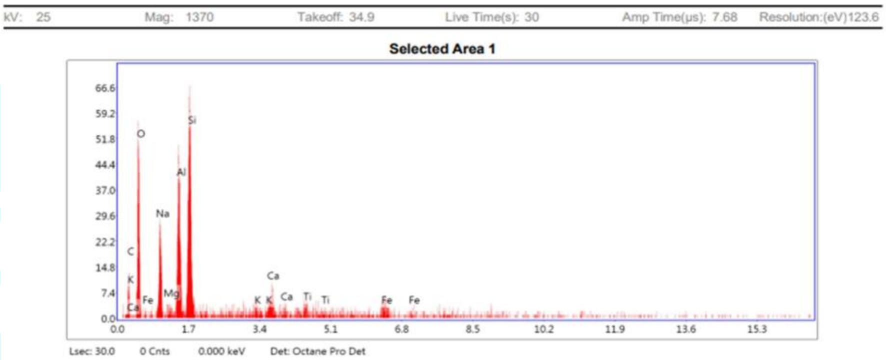
Proportion	1	0.35	1.65	3.06	0.35	0.20

III. Tests Results:

❖ SLUMP CONE TEST:

Conventional concrete: The value of true slump is 4 mm.
Geopolymer concrete: The value of true slump is 5 mm.

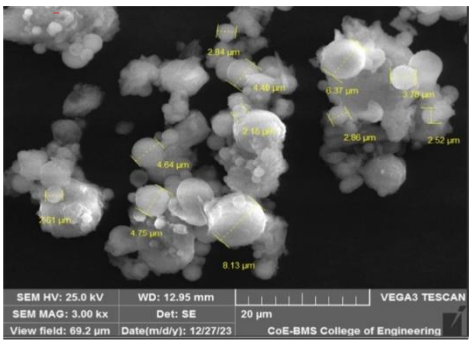
❖ X-RAY DIFFRACTION (XRD):



eZAF Smart Quant Results with Oxides

Element	Weight %	Atomic %
C O2	46.75	58.49
Na 2O	12.15	10.79
Mg O	1.03	1.41
Al 2O3	13.14	7.10
Si O2	18.80	17.23
K 2O	0.81	0.47
Ca O	1.98	1.95
Ti O2	2.10	1.44
Fe 2O3	3.23	1.11

❖ SCANNING ELECTRON MICROSCOPY (SEM):



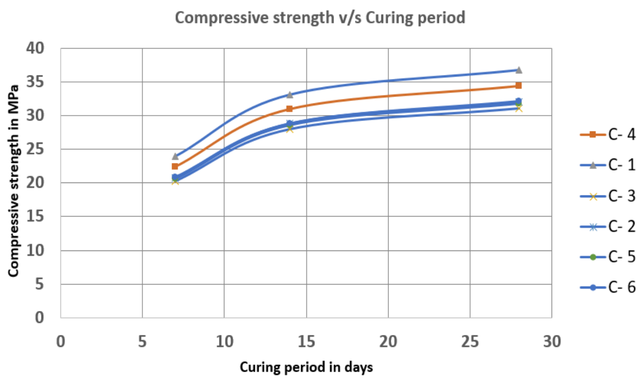
IV. Tests results on Harden concrete:

❖ COMPRESSION STRENGTH TEST

Results on conventional concrete:

Table No:03. Different specimens with their compressive strength test results

Sl. No.	Designation	Load in KN (P)	Area in mm^2	Compressive Strength in N/mm^2
1	NC-1	828	22500	36.8
2	NC-2	720		32.0
3	NC-3	700		31.11
4	NC-4	802		34.4
5	NC-5	678		31.8
6	NC-6	708		32.1



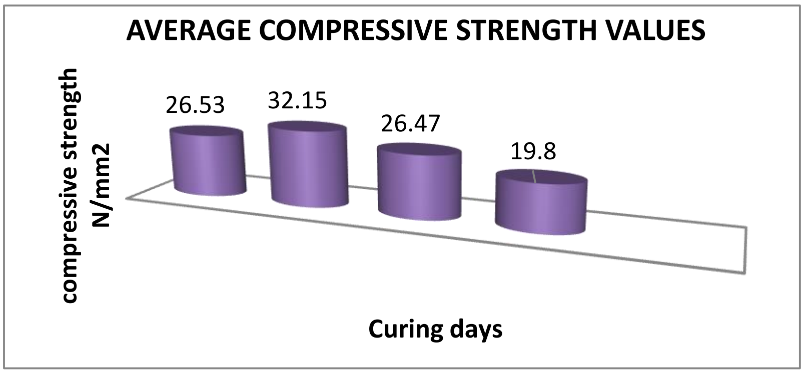
Results on Geopolymer concrete

Table No. 04 Different specimens with their compressive strength test results

Designation	Curing method	Load in KN (P)	Area in mm^2	Compressive Strength in N/mm^2
NC-1*	7 OH+ 3R	723.5	22500	32.15
NC-2*		731.6		32.51
NC-3*		716.4		31.84
NC-4*	3 OH+ 7 R	611.9		27.19
NC-5*		623.8		27.72
NC-6*		556.7		24.72
NC-7*	14 OH + 3R	691.2		30.72
NC-8*		543		24.13
NC-9*		571		25.37
NC-10*	28 OH + 3R	446		19.8

Average compressive strength values:

Curing days	Average compressive strength values in N/mm²
7 OH + 3R	32.15
3 OH + 7R	26.53
14 OH +3R	26.47
28 0H + 3R	19.8



❖ SPILT TENSILE TEST:

Table No: 05 Different specimens with their split tensilestrength For Conventional concrete

Sl. No.	Specimen	Load in KN (P)	Area in mm²	Split tensile strength N/mm²
1	NC- 1	256	47124	3.62
2	NC-2	250		3.53
3	NC-3	236		3.33
4	NC-4	252		3.56
5	NC-5	260		3.68
6	NC-6	258		3.65

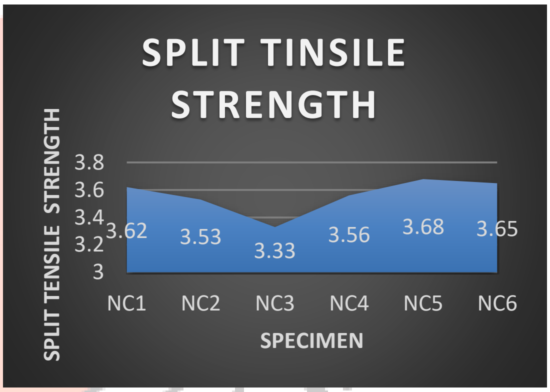
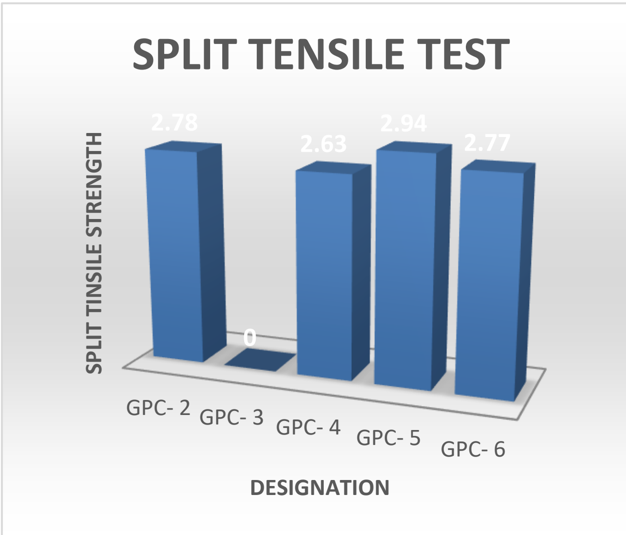


TABLE NO:06. DIFFERENT SPECIMENS WITH THEIR SPLIT TENSILE STRENGTH FOR GEOPOLYMER CONCRETE

Sl. No.	Specimen	Load in KN (P)	Area in mm²	Split tensile strength N/mm²
1	GPC-1	205	47124	2.89
2	GPC-2	198		2.78
3	GPC-3	177		2.49
4	GPC-4	187		2.63
5	GPC-5	208		2.94
6	GPC-6	197		2.77



❖ pH TEST ON FLY ASH:

Table No. 7: P^H Values for concrete related materials

Sl. no.	Category	P^H
1	Fresh concrete	12.5
2	Fly ash (class f)	13.0
3	Mixed water for concrete	6.0-9.0

V. CONCLUSIONS

- The results of a 7-day oven heating time and a 3-day rest period showed favourable compressive strength, indicating that this length successfully increases the strength of the geopolymer concrete.
- The concrete's compressive strength was not noticeably weakened by the shorter rest period of three days following the seven-day oven heating, suggesting possible time-saving advantages in real-world applications without compromising performance.

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