



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 6, June 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

 9940 572 462

 6381 907 438

 ijirset@gmail.com

 www.ijirset.com

Evaluation of Carbon Footprint in Alkali Activator Concrete

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ABSTRACT: Construction industry is dominated by new materials which are ecologically violable and feasible solution for ever growing architectural industry. Effort are in progress all over the world to develop environment friendly construction materials which minimizes the utility of natural resources and helps to decrease greenhouse gas emissions in to the atmosphere and for industrial sustainability. The greenhouse gas releases in the atmosphere increasing day by day due to ordinary Portland cement production Alkali activator concrete is an eco-friendly alternative to traditional concrete that uses inorganic polymers as binders instead of cement. It is known to reduce greenhouse gas emissions into the earth. In this connection, Geopolymer is in need, where the binders used in the production of Alkali activator concrete is inorganic polymers. Alkali activator concrete will be introduced as an alternative concrete which did not use any cement in its mixture and used fly ash and GGBS as alternative cement and industrial scrap granite is used to replace the coarse aggregate. The Alkali activator that used for the concrete is a mixture of sodium hydroxide and sodium silicate. The fixed ratio of sodium hydroxide to sodium silicate 1:2.5 and the concentration of sodium hydroxide is 12 Molar. The replacement of coarse aggregate is with wasted granite. The Alkali activator concrete specimens are casted and tested in the laboratory for compressive strength for 7 Days, 14 Days and 28 days and cured at ambient temperature. The carbon footprint of Alkali activator concrete and conventional concrete is determined and compared.

KEYWORDS: Alkali Activator Concrete, Alkali Activators, Compressive Strength, Water Absorption, Carbon Footprint.

I. INTRODUCTION

Concrete is one of the most widely used construction material. Portland cement production is a major contributor to carbon dioxide emissions. The global warming is caused by the emission of greenhouse gases, such as carbon dioxide, to the atmosphere by human activities. Among the greenhouse gases, carbon dioxide contributes about 65% of global warming and have ability to remain in the atmosphere for a thousand of years.

A type of direct and indirect amount of carbon dioxide is formed during the construction phase. The main carbon dioxide emission is formed from the Portland cement that used for it. The creation of Portland cement is the most carbon intensive portion of the concrete process. This comes down to two main activities; the calcination of limestone and the heating of cement kilns. To create Portland cement limestone undergoes calcination process which releases large amount of carbon dioxide from the chemical reaction. Many efforts are being made in order to reduce the use of Portland cement in concrete. These efforts include the utilization of supplementary cementing materials such as fly ash, silica fume, granulated blast furnace slag, rice-husk ash and metakaolin, and finding alternative binders to Portland cement. In terms of reducing the global warming, the geopolymer technology could reduce the carbon-dioxide emission to the atmosphere caused by Cement about 80%. There are two main constituents of geo polymers, namely the source materials and the alkaline liquids. The source materials for geopolymers based on alumina-silicate should be rich in silicon (Si) and aluminium (Al). The materials that contain alumina silicate compounds are fly ash, GGBS, metakaolin, silica fume etc. These materials will fully replace the cement and the materials can be added as a 100% replace or can be added by the combination of two or materials. Further studies are held on to adding the biomedical waste ash in to the mix as a binder material. The alkaline liquids are from soluble alkali metals that are usually sodium or potassium based. The most common alkaline liquid used in geo polymerization is a combination of sodium hydroxide (NaOH) and sodium silicate (Na₂SiO₃). The alkali activator helps the binder to bond together by its bonding nature. The alkali activator can be made in different molarity of sodium hydroxide solution. As the concentration of the molarity increases

the strength of the concrete also increase directly. One of the main advantages of these type of concrete is that it not need a water curing. Instead we can adopt an ambient curing method which give a compressive strength as that of the concrete cured in an water curing method. Due to the replacing of cement in the alkali activator concrete we can reduce carbon footprint in double as compared to the conventional type of concrete.

We can also replace other raw materials in the concrete in order to reduce more carbon footprint in the alkali activator concrete. One of the materials is the coarse aggregate. Coarse aggregate can be replaced by the wasted industrial waste in order to reduce the carbon emission and make the industrial sector more sustainable and stable. The wasted materials include, bricks, coconut shells, recycled aggregate etc.

II. METHODOLOGY

The alkali activator solution needed for the mixing should be prepared 24 hours before the mixing. For the preparation of the solution the chemicals like sodium hydroxide and sodium silicate are taken. Sodium hydroxide will be in the form of flakes and will contain a purity of about 98% -100%. 12 molarity of sodium hydroxide is taken for the mixing. sodium silicate will be in the form of a sticky gel. The amount of the both sodium hydroxide and sodium silicate solution is determined by taking an alkali binder ratio of 0.55 as same as that of water cement ratio taken in the conventional concrete mix. sodium hydroxide to sodium silicate ratio is taken as 1:2.5. safety measures like goggles and gloves should be use before the mixing of chemical. Take an amount of water and put the sodium hydroxide and stir well. An amount heat should be generated during the mixing process. After the cooling of sodium hydroxide solution mix it with the sodium silicate and leave it for 24 hours before its use.

After 24 hours the raw materials fly ash, GGBS, crushed stone, granite, M sand are taken and thoroughly mixed for 5 minutes. The solution is taken and stir it well. The solution is poured in to the dry mixture slowly. The materials should be mixed properly that the alkali activator solution should be reach to every point of the dry mix. The mix should be filled in the mould within 20 minutes. The size of the cube taken for the test is 150mm*150mm*150mm. The cubes are oiled and the mix is poured in to the cube in three layers. Each layer should be compacted for 25 blows or above it to avoid the honeycomb structures. Levelling the top of the mould cleanly and leave the specimen for 24 hours. After 24 hours demould the specimen and kept it for the curing in a room temperature.

III. EXPERIMENTAL RESULTS COMPRESSIVE

STRENGTH TEST

The compressive strength test is a fundamental measurement in material science and engineering used to assess the ability of a material to withstand axial compressive forces. It's particularly crucial in construction, civil engineering, and manufacturing industries where materials like concrete, metals, plastics, and composites are involved. Compressive test is held on the universal testing machine of 2000KN. The test is held on the 7,14 and 28 days. Compressive strength test is done as Per IS 516- 1959[15].



(a) Compressive strength testing

Table.1 Compressive Strength of Concrete In 7days

MIX	PROPORTION	LOAD(KN)	AREA(MM2)	COMPRESSIVE STRENGTH (N/mm ²)
CC	0%	404	22500	17.75
AAC-5%	5%	580	22500	25
AAC-10%	10%	930	22500	41.33
AAC-15%	15%	950	22500	42.2
AAC-20%	20%	981	22500	43.6
AAC-25%	25%	1110	22500	49.33

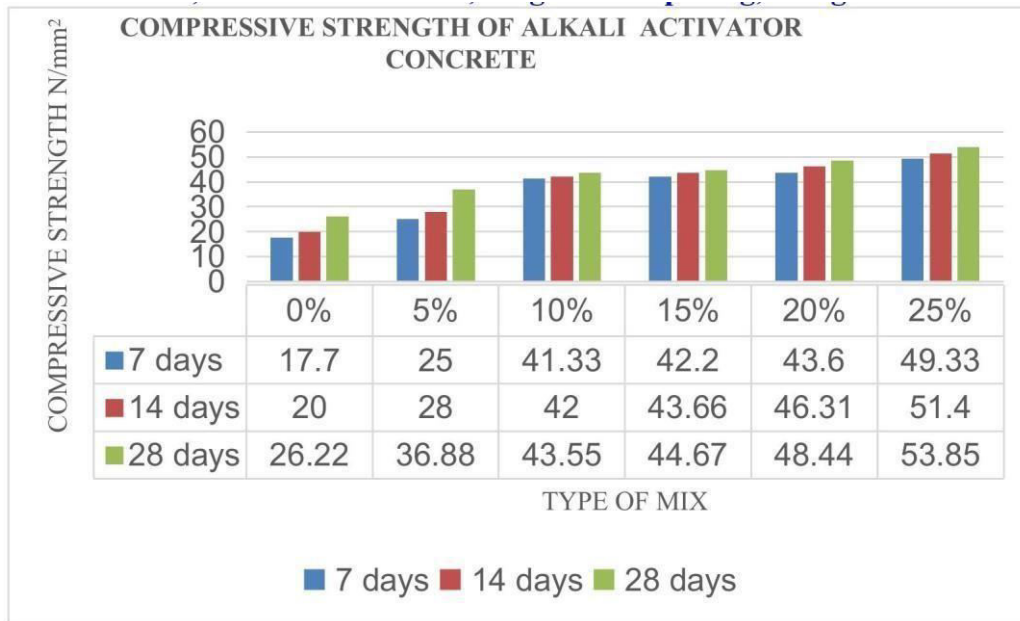
Table.2 Compressive Strength of Concrete In 14 Days

MIX	PROPORTION	LOAD(KN)	AREA (MM2)	COMPRESSIVE STRENGTH (N/mm ²)
CC	0%	450	22500	20
AAC-5%	5%	640	22500	28
AAC-10%	10%	960	22500	42
AAC-15%	15%	978	22500	43.66
AAC-20%	20%	1042	22500	46.31
AAC-25%	25%	1157	22500	51.4

Table.3 Compressive Strength of Concrete In 28 Days

MIX	PROPORTION	LOAD(KN)	AREA(MM2)	COMPRESSIVE STRENGTH (N/mm ²)
CC	0%	590	22500	26.22

AAC-5%	5%	830	22500	36.88
AAC-10%	10%	980	22500	43.55
AAC-15%	15%	1005	22500	44.67
AAC-20%	20%	1090	22500	48.44
AAC-25%	25%	1212	22500	53.85



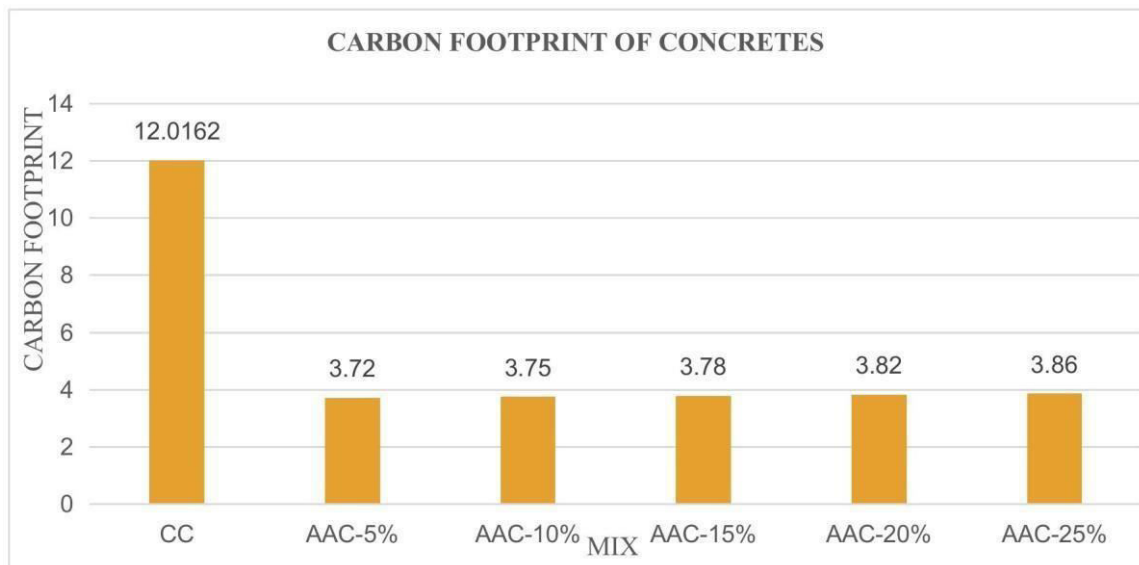
CARBON FOOTPRINT

The carbon footprint is determined by multiplying of emission factor and quantity of material used. Here the Portland cement is taken from the Ramco cement. The emission factor of the cement can be taken from the sustainable report of Ramco company. As per the analysis of sustainable report the latest emission factor is noted on 2021 of about 0.76. The emission factor of other materials is taken from sustainable reports and by referencing the studies based on carbon footprint.

Table.4 Carbon Footprint of Concretes

MIX	CARBON FOOTPRINT
CC	12.0162(Kg-CO ²)
AAC-5%	3.72(Kg-CO ²)

AAC-10%	3.75(Kg-CO ²)
AAC-15%	3.78(Kg-CO ²)
AAC-20%	3.82(Kg-CO ²)
AAC-25%	3.86(Kg-CO ²)



IV. CONCLUSION

1. When completing various tests on cement and GGBS and fly ash, there are certain similarities in their qualities since they are comparable types of binding property to retain the concrete. GGBS and fly ash is a cementitious substance that are mostly used in the concrete and is less expensive, a more cost effective and environmentally friendly than cement.
2. The coarse aggregate is replaced by the recycled granite in various percentage like 5%,10%,15%,20%,25% and cement replaced by fly ash and GGBS to produce alkali activator concrete or a green concrete.
3. The co₂ emission of AAC-5% gives 69% less co₂ emission, mix AAC -10% gives 68.75% less co₂ emission, mix AAC-15% gives 68.5% less co₂ emission, mix AAC-20% gives 68.1% and mix AAC -25% gives 67.6% less co₂ emission than the normal concrete.
4. The compressive strength of the AAC-5% gives 28% higher strength, mix AAC-10% gives 39% higher strength, mix AAC-15% gives 41% higher strength, mix AAC-20% gives 46% higher strength The AAC-25% haven 51% higher strength than normal one

As comparing the carbon emission of different mixes, the mix AAC-5% have less carbon emission.

Comparing compressive strength of all mixes AAC – 25% have high strength and also it is the effective mix proportion in the alkali activator concrete mixes.

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