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Eco-friendly concrete produced through alkali activation by Utilizing Industrial Wastes

Asst. Prof. Shriram P Marathe ram.nmamit@gmail.com
Prof. R Mithanthaya Viceprincipal.nmamit@nitte.edu.in
Basaveshwara G V basavesh.gowda999@gmail.com
Dept. of Civil Engineering
NMAM Institute of Technology
Karkala, Karnataka, India

***Abstract*- The development of new, sustainable, low-CO_2 construction materials is essential if the global construction industry is to reduce the environmental footprint of its activities, which is incurred particularly through the production of Portland cement. One type of non-Portland cement that is attracting in particular attention is based on alkali-aluminosilicate chemistry, including the class of binders that have become known as geopolymers. This review discusses the synthesis of alkali-activated binders from blast furnace slag, calcined clay (metakaolin), and fly ash, including analysis of the chemical reaction mechanisms and binder phase assemblages that control the early-age and hardened properties of these materials, in particular initial setting and long-term durability. Perspectives for future research developments are also explored and also discuss about the various investigations carried out on alkali activated (Geopolymer) concrete produced using industrial byproducts which otherwise considered as waste disposal products.**

***Keywords* – construction materials, sustainable development, Alkali Activated cement, concrete, fly ash, blast furnace slag**

I. INTRODUCTION

Concrete is the first choice for construction in many countries today. Cement and concrete are central to modern civilization, with its reliance on the built environment to provide a high quality of life. Concrete is the second-most-used commodity in the world behind only water and is produced in volumes exceeding 10 billion tonnes per year worldwide.(Provis 2014, Shriram et al 2016). This has led to the fast vanishing of the natural resources.

The emission of carbon dioxide into the atmosphere from the production of cement, deterioration, poor performance and inadequate resistance to hostile environment of many concrete structure has led into the continuous research on concrete. The cost of the concrete is attributed to the cost of the ingredients which are becoming increasingly scarce and expensive. Concrete usage in the world is second in the world. Ordinary Portland cement (OPC) is conventionally used as the primary binder to produce concrete. The extent of energy required to produce OPC is only next to steel and aluminum.

Fly ash is abundantly available worldwide and hence creates an opportunity to utilize this bi-product of burning coal, as a substitute of OPC to manufacture concrete. When used as the partial replacement in OPC, in the presence of water and ambient temperature, fly ash reacts with calcium hydroxide during the hydration process of OPC to form the calcium silicate hydrate (C-S-H) gel. The development and application of high volume fly ash concrete, which enabled the replacement of OPC up to 60% by mass, is a significant development. Demand for new concrete technologies which use less energy and generates less carbon dioxide without compromising the strength and durability properties.

The industrial production of OPC is 1000 tons, whereas the production of the industrial wastes that can be used as a substitute to cement is more than the double this amount. As of now, the waste materials are used aggregate or fillers in concrete. The search for new environmental friendly construction material that will match the durability of ancient concrete has provoked the study of alkali activated cementations systems over the last two three decades.

Usage of conventional cement in various material leads to increase in greenhouse and global warming. The production of each metric ton of OPC results in roughly 900 kg of CO2 released into the atmosphere, and studies have shown that worldwide production of cement causes 6–7% of global greenhouse gas emissions.

The leading method for reducing the environmental impacts associated with cement stabilization is to replace a portion of OPC binders with supplementary cementitious materials (SCMs). This class of materials, which includes fly ash, silica fume, metakaolin, and natural pozzolans, contribute to the development of desirable mechanical properties through hydraulic or pozzolanic activity. In practice, the most commonly used SCMs are industrial by-products such as fly ash and ground granulated blast furnace slag, owing to their widespread availability and lower cost compared with cement. Alkali activated concrete has been found to have some superior properties as compared to OPC concrete, namely, low heat of hydration, high early strength, and excellent durability in aggressive environment.

The activators such as liquid sodium silicates (4±7% Na, mass of slag) and a multi-compound activator (NaOH + Na_2CO_3) (8% Na, mass of slag), and these activators accelerates early strength development and improves the mechanical properties and increases the durability. Thus an attempt is made to study and to develop masonry blocks using non-conventional alkali activated cement concrete without compromising the strength and durability properties.

II. LITERATURE REVIEW

This paper presents few key findings in the field of alkali activated concrete (geopolymer concrete) & its developments.

Provis and Bernal (2014)

Cement and concrete are central to modern civilization, with its reliance on the built environment to provide a high quality of life. Concrete is the second-most-used commodity in the world behind only water and is produced in volumes exceeding 10 billion tonnes per year worldwide. The binding phase that provides strength to a modern concrete is usually based on Portland cement. As such, the CO_2Savings achieved by the use of AAM binders are mainly due to the avoidance of carbonate precursors.

Such as the limestone (CaCO3), and the high-temperature processing of all the cement constituents in a fossil fuel–fired kiln. The main precursors used to produce Mare fly ash, blast furnace slag (BFS), and metakaolin. Both fly ash and BFS are in high demand for use in blended Portland cements, which can offer both performance and environmental advantages over a plain Portland cement in applications such as civil infrastructure and general concreting works, and particularly where sulfate resistance is required.

1. Alkaline-Activating Solution- The most apparent difference between an alkali activated binder and a traditional Portland cement is that the hardening of Portland cement is induced simply by mixing with water, whereas alkali activation requires the addition of an alkaline component in aqueous form. Thus, it is relevant to introduce the characteristics of the alkaline solutions used in this application. The solutions to be discussed are hydroxides and concentrated alkali metal silicates

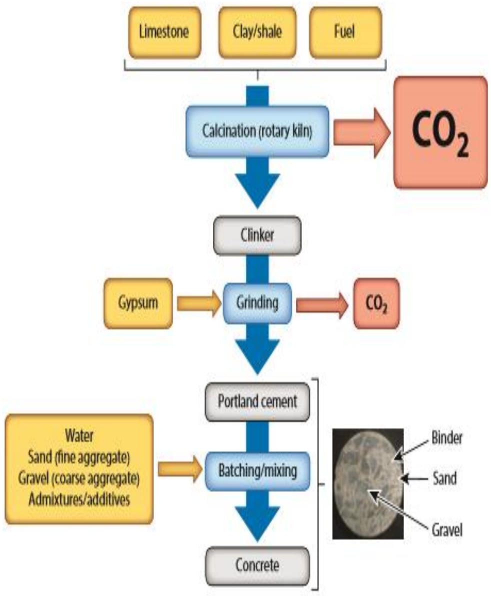

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Fig.1 This figure shows the Schematic depiction of the process of production of Portland cement concrete. (Provis 2014).

2. Alkali Hydroxides- The hydroxide solution most commonly used as an alkali activator is sodium hydroxide; potassium hydroxide sees some use in specialized applications, whereas lithium, rubidium, and cesium hydroxides are of limited large-scale application. Alkali hydroxides are generally produced electrolytically from chloride salts, which introduces some energy usage and associated CO2 emissions into the Alkali activated material (AAM) production process, although the exact emissions accounting around this process depends on whether the chlorine that is also generated in this process is considered to be a valuable commodity or a by-product.

3. Alkali Silicates- As for the alkali hydroxide solutions discussed above, the silicate solutions of greatest interest in alkaline activation are those containing sodium or potassium as the alkali cation. Alkali silicates are generally produced from carbonate salts and silica via melting to form a glass. This glass is then dissolved in warm water to form a viscous, sticky solution, also known as water glass. The major drawback associated with the use of alkali silicate solutions in alkaline activation is related to the often very high viscosity of these solutions.

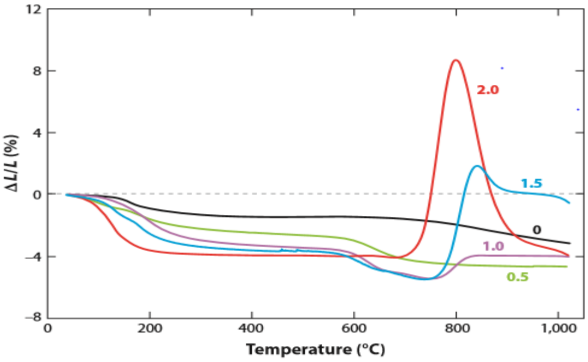

Fig. 2 This figure shows the dimensional stability of alkali-activated fly ash as a function of temperature. All samples are formulated with a constant alkali/ash ratio, with differences in the SiO2/Na2O molar ratio of the activator as marked. (Provis 2014).

4. Gel Chemistry of High-Calcium Alkali-Activated Systems- In discussions of the chemistry of alkali-activated binders, it is essential to first classify these systems according to the types of gel that dominates the structure. This distinction is drawn mainly on the basis of the calcium content in the system, as shown in Figure 5, in which the primary reaction product is either an alkali alumina silicate–type gel or a calcium (alumina) silicate hydrate (C-A-S-H1)–type gel. For the purposes of discussing AAMs, a high-calcium binder system is defined as having a Ca/(Si + Al) ratio of approximately 1; such materials are most commonly produced by the interaction of BFS with alkaline solutions.

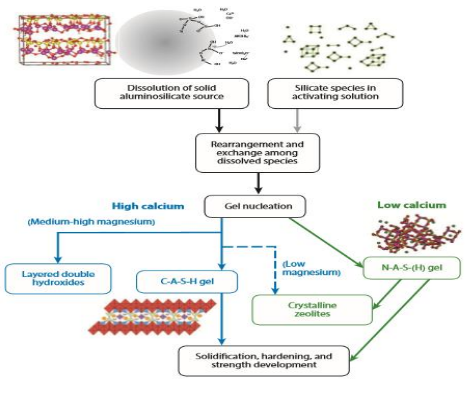

Fig. 3 This figure shows the Process and reaction products of alkaline activation of a solid aluminosilicate precursor. High-calcium systems react according to the left-hand (blue) pathway, with the nature of secondary products determined by Mg content, whereas low-calcium systems react according to the right-hand (green) pathway. For each type of precursor, hydroxide activation tends to increase the ratio of crystalline to disordered products compared with silicate activation. (Provis 2014).

5. Gel Chemistry of Low-Calcium Binders- This information then provides a useful structural model by which the nano structurally determined properties of these materials, such as thermo chemistry and ion exchange, can be understood and tailored. This approach is approximately analogous to the use of to bermorite as a model structure for the understanding of the C-A-S-H gels. Most importantly, this approach enables the design of material formulations that are suitable for desired applications. The key applications for low-calcium AAM technology fall into two distinct fields: (a) use as a cement-like binder (for example, in production of tiles, pavers, precast concrete, or ready-mix concrete, in which mechanical and physicochemical durability properties are essential for success) or (b) use as a low-cost alternative to fired (dense or porous) ceramics, such as mullite or alumina, in which optimized thermal characteristics may become important.

6. Alkali Activation of Metakaolin- Although metakaolin is derived from a crystalline, layered clay mineral structure, it does not showlong-rangecrystallineorderbutratherHasadisruptedresiduallayeredstructure, which plays a large role in making it suitable as a geo-polymer precursor. The reactivity of met kaolin in an alkaline environment is provided by the crystal graphically strained aluminum sites within the formerly octahedral coordinated layer of kaolinite. Figure 4 illustrates the pathways by which kaolinite is converted, via met kaolin as an intermediate, into either mullite (by further thermal processing) or a geo-polymer (by alkaline activation). The calcinations of kaolinite at temperatures between 500 and 750◦Cinduces a stepwise process of dehydroxylation and structural disordering by buckling of the layered clay structure, which is responsible for the reactivity of metakaolin under alkaline conditions, whereas either undercalcined or over claimed products would be un reactive in alkali activation.

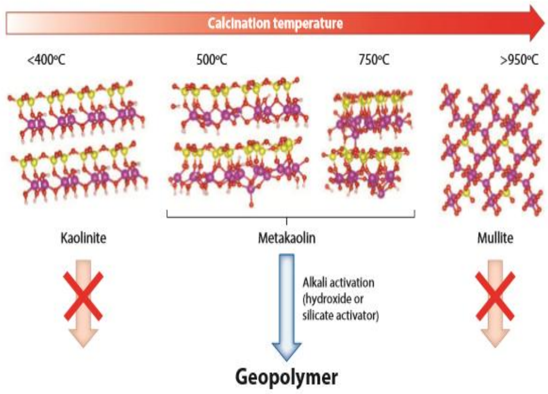

Fig.4 Pathways for the conversion of kaolinite to economically valuable products: calcination at moderate

temperatures (500–750◦C) followed by alkaline activation to form a geopolymer, or calcination beyond 950◦C to form mullite. (Provis 2014).

7. Alkali Activation of Fly Ash- Fly ash is a by-product of coal-fired electricity generation. It is the incombustible mineral associated with the coal, comprising predominantly aluminosilicate remnants of minerals associated with the coal deposit. Fly ash passes through the boiler furnace and is collected in the chimneys by electrostatic precipitators. Fly ash particles are often vitreous, close to spherical, and sufficiently reactive to be of value in alkali activation. Fly ash is almost always activated by alkali hydroxide or silicate solutions. The gel binder structures formed by alkali activation of low-calcium fly ash are similar to those of the met kaolin based geopolymer gels.

Analyzing the gel connectivity of fly ash–based AAMs using NMR spectroscopy is difficult because of the nonzero levels of iron within almost all fly ashes. However, the results show that the fly ash–derived binder gel is predominantlyQ4 in nature, with a distribution of Q4(1Al) site environments, depending on the Si/Al ratio of the reactive component of the fly ash and on the amount of silicon supplied by the activator. Crystalline zeolites and related phases also develop in these materials over a more extended curing time with higher temperatures and higher water contents favoring the development of more crystalline. Thermal or steam curing is usually applied to alkali hydroxide–activated fly ash binders, as strength development is slow at room temperature in these systems. Using FTIR to study the reaction mechanism of fly ash geopolymer formation, Fern´andez- Jim´enez&Palomo proposed two stages of gel evolution: gel 1, which was relatively enriched in aluminum, and gel 2, which showed greater incorporation of silicon.

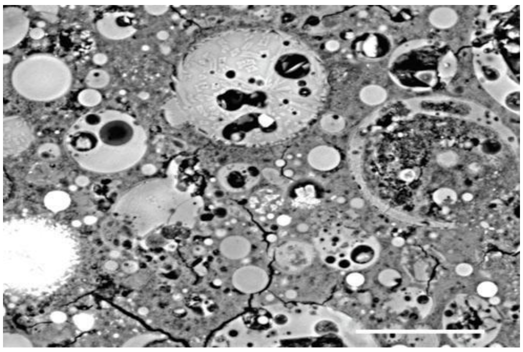

Fig.5 Scanning electron microscopy image of a polished section of a fly ash geopolymer that is activated by Na2SiO3 solution. (Provis 2014).

8. Blended Binder Systems And Gel Coexistence- Given that N-A-S-(H)-type gels offer the opportunity for production of binders with excellent chemical and thermal resistance, whereas C-A-S-H-type gels provide chemical binding of water that reduces permeability, there is interest in synthesizing binders in which these two types of gel can coexist and each can contribute to the performance of the material. The N-A-S-(H) gel may also offer some scope for anion-binding mechanisms that retard chloride ingress, thus increasing the service life of a reinforced concrete by prolonging the time taken to initiate corrosion of embedded steel.

Gel coexistence requires a pH that is not high enough to cause the calcium to precipitate as portlandite, which means that the use of moderate-pH activators such as alkali sulfates. The combination of fly ash, BFS, and an alkaline activator has long been considered to be a promising route to the production of high-performance alkali-activated binders. Such systems can show excellent mechanical strength, reaching 100 MPa after 28 days of sealed curing at 23◦Cand continuing to increase in strength beyond this time when the precursors are appropriately selected and blended and the activator content and modulus are selected to match the precursor chemistry.

9. Environmental Assessment- Discussions around the life-cycle analysis of alkali-activated binders have provided results that vary dramatically between mix designs and binder types. The estimated CO2 savings(comparing AAMs with Portland cement) range from 9% to 97%, depending on the choice of alkali-activated binder mix design, the curing conditions specified, the nature of the Portland cement system selected as the reference, and the geographical parameters surrounding material supply and transport. Some environmental impact is incurred through the production of the activators, particularly sodium silicate ,which is most commonly produced from sodium carbonate and silica in a high-temperature process involving a glass intermediate.

This high-temperature processing does bring associated energy consumption and CO2 emissions that must be attributed to the silicate activator in any environmental assessment of an AAM. However, because the activator usually accounts for <10% by mass of an AAM binder, the CO2 emissions per tonne of binder are still much lower than the process CO2 emissions associated with Portland cement production. A well-formulated alkali-activated concrete can often provide highly significant environmental benefits compared with a Portland cement concrete of comparable mechanical performance, which provides a strong driver for the further development and adoption of alkali activation technology on a global scale [2] Provis (2017).

10. Technology presentation- Additional terminology which is often used regard to these material scan include 'geopolymer' nomenclature which is used largely (although rather indiscriminately) to describe low-calcium alkali-activated alumino silicate binders, and discussion of 'hybrid binders' which include both Portland cement and a source of alkalis in addition to the main alumino silicate component. These material systems generally fall within the broader domain of alkali-activation, and so will be included implicitly in the discussion below.

There are two main pathways by which alkali-activated binders can be produced, either a one-part mix (dry powder combined with water) or a two-part mix (liquid activator) system. The two-part mix type is probably the main pathway that will be followed in the initial deployment of alkali-activation in most markets, and the majority of the products that are already in the market are produced in this manner.

However, it is likely that the one-part systems will become a more scale able technology in the future due to the scope for factory production and distribution as a bagged material, once this technology becomes mature and various issues related to the often-slow strength development of one-part mixes are resolved. The two-part mixture appears more likely to be scale able for precast work, where handling of chemicals and curing regimes can be more closely controlled.

The scope of application of alkali-activated binders is broad, and continues to grow, with demonstrated utilization in:

- Reinforced concrete.
- Plain concrete.
- Precast concrete components (including lightweight elements),both reinforced and unreinforced, and including pipes.
- Mortars, grouts and renders.
- Foamed and lightweight concretes.
- Matrices for the immobilization.

11. Durability of the technology:
The durability of alkali-activated binders is addressed in detail in a recent RILEM State of the Art Report as well as in published review papers. In general, chemical resistance of these cements (acidic or sulfate environments) is high, but there remain questions over carbonation and freeze-thaw resistance which are not yet fully understood and the value of some of the available information suffers due to limitations of standardized testing methods when applied to alkali-activated cements.

Performance with respect to chloride ingress (diffusion or migration) appears in general to be comparable to that of materials based on Portland cement, but depends fundamentally on achieving a satisfactory microstructure in the binder through judicious mix design. There are scattered reports of the in-service performance of alkali-activated concretes over extended timescales, but the data which have been released (which continue to increase in volume as these materials are deployed worldwide) tend to indicate satisfactory performance under a wide range of exposure conditions.

Studies of efflorescence in alkali-activated binder systems have generally concluded that the white 'bloom' which can appear on the surfaces of some alkali-activated mortars or concretes is usually related to the carbonation of mobile alkalis from the pore solution, and is best addressed through the implementation of curing conditions or addition of pore-refining additives (i.e. mineral admixtures rich in calcium and/or aluminum) to reduce the rate of moisture movement through the hardened cements.

Control of efflorescence is, however, probably most straightforwardly achieved through a reduction in the dose of the alkali activator. The very high alkalinity of alkali-activated binders seems to be favorable for protection of embedded reinforcing steel, and the use of these materials is well established in both reinforced and unreinforced applications.

III. POTENTIAL OF SCALABILITY

1. Raw materials- The main competitor for most of the aluminosilicate precursors used in production of alkali-activated binders is the use of the same materials in blends with Portland cement. The reserves and availability of those materials are thus generally limited by the same factors that influence their availability for Portland cement blends and vary markedly between regions. The fundamental source of alkali metals (particularly sodium)used in production of most alkali-activators is sodium chloride, obtained from seawater. This can be converted to sodium carbonate by the Solvay process (and thence to sodium silicate, or 'water glass', via thermal or hydrothermal routes), or to sodium hydroxide by the chlor-alkali process.

Competing markets for these potential activators are largely in the manufacture of commodity chemicals (detergents, zealots, adhesives) and in papermaking and glassmaking. Large-scale deployment of alkali-activation using silicate or hydroxide activators would need scale up of water glass production, and/or decoupling of NaOH from Cl2 production(i.e. using an alternative to the chlor-alkali process), for large scaled employment. Na2CO3 production is extremely saleable in regions with natural mineral resources, and existing production capacity is underutilized by several million tones per annum at present.

2. Materials processing and application- Mix design of alkali-activated concretes can broadly follow similar heuristics to those used for Portland cement concretes, particularly in terms of aggregate grading, but the binder must be designed and optimized on a case-by-case basis: the precursors available in each location will differ in chemistry, mineralogy and fineness, and will be combined with activators which are selected depending on both technical and commercial parameters.

There is not yet a universal mix design procedure which can be applied to alkali-activated binders or concretes, due to the differences in chemistry, mineralogy and particle characteristics between different precursor sources (although various protocols have been published which apply to single sources of raw materials, usually fly ash, these are of limited transferability between materials), so optimization of mixes needs to be carried out for each new precursor (or blend thereof) that is sourced.

Accurate quality monitoring and control of the characteristics of precursors which are sourced as wastes or by-products from other industries is also essential to the successful production of alkali-activated concretes or concrete products. Setting times of alkali-activated materials are in general similar to those of Portland cement-based materials. Alkali-activated slag cements tend to harden rather rapidly, and in some cases retarders are used to regulate the setting rates. For fly ash-based materials, heat curing is often applied to accelerate hardening of laboratory mixes, but the need for this treatment depends on the mix design (particularly activator dose and water content), and the reactivity of the fly ash. Many fly ashes, particularly those containing moderate amounts of calcium ,can readily be combined with activators to generate high strength at ambient temperature.

3. Barriers and incentives- The key barriers facing industrial-scale production of alkali-activated binders are largely outside the direct technical realm; these include the need for control of the supply chain, including reliance on alkali suppliers who have not historically been connected with applications in the construction industry, as well as competition for some precursor materials from existing uses in blended Portland cements. Key opportunities may therefore arise in areas in which this competition is less problematic.

Incentives for the uptake of alkali-activation technology include carbon emissions as discussed in above, as well as the valorization of natural resources, by product or waste materials which are not currently used in an economic way. The high technical performance which can be achieved by alkali-activated materials, particularly inters of resistance to chemical attack and to elevated temperature can also offer attractive possibilities in specialty applications such as sewer pipes or where fire resistance or refractory performance are desirable.

4. Investment and cost of production- The cost of production of alkali-activated binders is in general a closely-held trade secret, and is fundamentally dependent on the degree of control of the materials supply chain which is held by the producer. If precursors such as fly ash and slag must be purchased at a price which is similar to the unit price of Portland cement, the added cost of the activator will make these materials relatively more expensive. However, if the solid precursors can be sourced (or, in the case of clays, calcined) locally and cost-effectively, and the activator doses are kept low, cost-competitive production of alkali-activated binders is undoubtedly possible, as has been demonstrated by the successful commercial operations which are selling these products in several countries worldwide, as detailed above.

Yao et.al (2019): In this paper Fly ash and Ground granulated blast furnace slag are the waste material used as the binding material by replacing ordinary Portland cement. The alkaline activators used in mortars are sodium silicate solution and sodium hydroxide solution. The mortar sample were carried out trails on 7, 28 and 56 days curing. For finding the dynamic strength specification of rock, dynamic compressive and tension tests were carried out with the help of split Hopkinson pressure bar system. They have determined that with increase in load rate the dynamic compressive and tensile strength was increased.

Subhashree Samantasinghar et. al (2018): In this paper Fly ash and Granulated blast furnace slag are original materials and sodium hydroxide are used as alkaline activators. By using these materials geopolymer binders are prepared. The compressive strength of incorporated fly ash slag geopolymer, blended under identical state is examined. Leaching test and compressive strength test was performed. Mineralogical characterization and statistical modeling study is carried out. The outcome obtain was compressive strength and dissolution was highly affected by the alkali content and reactive component of the original material.

Irena Nikolic et. al (2014): In this paper they have studied on thermal stability of alkali activated slag. This alkali activated slag is produced from electric arc furnace slag using a mixture of alkaline activators that is sodium hydroxide & sodium silicate solutions. Alkali activated slag sample was exposed to temperature of 600°C to 1000°C, to determine before and after exposure of compressive strength AAS samples. Compressive strength testing is carried out for all the samples. The strength of alkali activated slag increased at certain temperature with decrease in porosity & the change of wustite to magnetite took place when alkali activated slag sample was heated above 600°C was the outcome.

Ali a. Aliabdo et. al (2019): In this research paper the mechanical properties such as compressive strength, splitting tensile strength and modulus of elasticity are analyzed. Five components such as sodium hydroxide (10, 12, 14M), alkaline solution content (0.4, 0.45, 0.5), curing temperature (30°,60°,90°C), curing time (1, 2, 3days), sodium hydroxide: sodium silicate mass ratio (1:1.75, 1:2.5, 1:3.5). the results obtain was with increase in sodium hydroxide: sodium silicate and sodium hydroxide molarity which increases all mechanical properties and increase in alkaline solution and curing temperature has badly affected the alkali activated slag concrete. They obtain 2 days is the best curing period.

Nabeel A. Farhan et. Al (2019): In this research paper the material used are fly ash and alkali activated slag mixed with alkaline solution with aluminium silicate. They compared engineering properties such as workability, dry density, ultra-sonic pulse velocity, compressive strength, direct and indirect tensile strength, flexural strength, stress strain behavior in compression and direct tension. And, microstructural study is carried out. The results obtain was dry density was lower than normal concrete, tensile strength was found to be equal when compressive strength of concrete was 35MPa while tensile strength of fly ash based geopolymer and alkali activated slag was found to be higher when the compressive strength was about 65MPa. Modulus of elasticity of FAGP and AAS was found to be lower than ordinary Portland cement. Microstructure of FAGP and AAS was found to be more compacted than OPC at 7days but less compacted in 28days of similar compressive strength.

Robert J. Thomas et al (2015): In this paper they investigated on tensile strength, modulus of elasticity, Poisson’s ratio, and stress strain relationship of alkali activated concrete (GGBFS). They found that AAC is shown to be stronger in tension and have lower Poisson’s ratio than ordinary Portland cement. Young’s modulus of elasticity varies linearly with alkali activated fly ash concrete while young’s modulus of elasticity remains constant for activated GGBFS and alkali activated fly ash concrete exhibits similar stress strain behavior to normal concrete. Whereas GGBFS concrete exhibits highly brittle behavior compare to normal concrete.

N.K. Lee et.al (2013): In this paper they have conducted study on “Setting and mechanical properties of alkali-activated fly ash/slag concrete manufactured at room temperature”. A series of tests of the compressive strength, elastic modulus, splitting tensile strength, workability, initial and final setting time, and porosity of the alkali-activated fly ash/slag concrete were carried out. Setting time tests were performed in order to ascertain the effects of molarity of NaOH solution. The replacement ratio of the slag for the fly ash by weight and the ratio of water glass to NaOH solution were 20% and 0.5 by weight, respectively. The test results showed that the setting time decreased as the amount of slag and the concentration of the NaOH solution increased the compressive strengths of the alkali-activated fly ash/slag concrete at 28 days increased with the amount of slag, except when the amounts of slag were 25% and 30% of the total binder weight. In addition, the splitting tensile strength and elastic modulus of the alkali activated slag concrete were lower than ordinary concrete.

Mithanthaya et al (2017): The experimental results indicated that replacement of fly ash by various percentages of the GGBS resulted in increase of the compressive strength, split tensile strength of the fly ash based GPC up to 15% and thereafter there is a decrease in the strength values. It has also been observed that use of naphthalene-based super plasticizer improves the fresh and hardened behaviour of GPC. Thus, the results of strength tests on GPC cubes prepared and cured at room temperature only indicate the development of compressive strength up to M40 can be achieved corresponding to the selected optimum replacement of fly ash by GGBS and glass powder. Hence the use of major industrial wastes such as fly ash, glass powder and GGBS is found to be feasible in the production of new sustainable green construction material of reasonably good strength.

Marathe et al (2019): Increased search for sustainable and eco-friendly construction materials has led to research on the development of new materials using industrial by-products or waste materials and new technologies. Partial or complete replacement of constituent materials of conventional cement concrete has been tried by different researchers depending on the availability and relative cost of industrial waste materials.

On taking into consideration of the above facts, an investigation was planned to study the effect of complete replacement of Portland cement by using fly-ash and GGBS, based alkali activated cement in producing standard solid masonry blocks of size. In the study a complete replacement of conventional river sand by locally available quarry dust was also made. The compressive strength and tensile strength of masonry blocks has been studied as per IS 2185-1-2005. The results have shown that the alkali activated concrete masonry blocks utilizing quarry dust will reduce the cost of the block without compromising the strength requirements.

IV. CONCLUSION

From various literature studied on alkali activated concrete (AAC) indicates that the major problems associated with using ordinary Portland cement (OPC) concrete has been overcome by using alkali activated concrete (AAC) on alkali activated system had shown a significant solution to prevailing problems. Thus, it can be concluded that, the alkali activated concrete can be used as a sustainable, economical and environment friendly alternative in the place of normal conventional concrete masonry elements produced using ordinary Portland cement.

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