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Properties of Sustainable Concrete Using Volcanic Pumice Powder: A Review

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ABSTRACT:-
Environmental degradation is increasing due to pollution caused by the depletion of raw materials and increased demand for concrete products. That's why scientists and researchers are working to create a sustainable, environmentally friendly stone using recycled materials. Among these materials, volcanic ash (VA) and other natural pozzolans (NP) have emerged as promising complementary cementitious materials (SCM). VA and NP types play an important role in reducing the costs, energy consumption and environment associated with cement production. Therefore, it is necessary to study the properties of VA and NP and their influence on the properties of concrete and cement mortar. This paper presents a comprehensive review of previous studies examining the effect of VA and other NP types on the mechanical properties of concrete while evaluating their chemical, physical, and microstructure characteristics. The findings from these studies indicate that the properties of concrete primarily depend on the characteristics and quantities of NP employed. Notably, silica dioxide (SiO2) comprises the predominant component in VA compositions. In most cases, an increase in VA and NP content within concrete mixtures leads to a reduction in strength. Finally, recommendations and suggestions for future research are provided to enhance concrete properties and achieve the development of sustainable construction materials.

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I. INTRODUCTION:-

The construction industry is affected by the constant growth in the population of urban areas. The demand for cement production has an increasing environmental impact, and there are urgent demands for alternative sustainable solutions.[7] Volcanic Ash (VA) is an abundant low-cost material that, because of its chemical composition and amorphous atomic structure, has been considered a suitable material to replace Portland cement clinker for use as a binder in cement production[2]. In the last decade, there has been interest in using alkali-activated VA material as an alternative material to replace ordinary Portland cement. In this way, a valuable product may be derived from a currently under-utilized material.[5] Additionally, alkali-activated VA-based materials may be suitable for building applications because of their good densification behaviour, mechanical properties and low porosity.[4] This article describes the most relevant findings from researchers around the world on the role of the chemical composition and mineral contents of VA on reactivity during the alkali-activation reaction; the effect of synthesis factors, which include the concentration of the alkaline activator, the solution-to-binder ratio and the curing conditions, on the properties of alkali-activated VA-based materials; and the mechanical performance and durability properties of these materials. [1]
Section snippets

Materials
The VA used in this investigation was collected from the Rabaul area of the East New Britain province of PNG and the source was a volcano called Mount Tavurvur[3]. The Rabaul area is situated in the worldwide earthquake and volcanic zone known as the '*Belt of Fire*'[3]. Raw VA, collected from the source was dried and sieved to remove larger particles and other debris. The cement used was locally manufactured ordinary Portland cement (OPC) conforming to ASTM Type I.[3]
Properties of volcanic ash
ASTM C618-93, a standard specification for 'Fly Ash and Raw or Calcinated Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete' can be used to evaluate the physical and chemical properties of volcanic ash.[2]
Workability & Setting Time: According to Askarian, Fakhretaha Aval and Joshaghani, the workability of SCC consolidating concrete is defined by its filling ability, passing ability, and stability [4]. Filling ability indicates

the blend's capacity to cover all areas without vibration, whereas passing capability refers to the blend's ability to flow through reinforcing bars without being blocked. Slump flow and V-funnel experiments were utilized to determine the SCCs' filling capabilities.[4]

VOLCANIC PUMICE POWDER AS NATURAL POZZOLANAS: -

Volcanic pumice powder is one of the main natural types of pozzolans available in most countries and is high in silica and alumina.[1] NPs can be classified into many types according to different sources. NP includes volcanic rocks, shales, kaolinite, laterite, bauxite and sedimentary clays. The most common natural pozzolans are VA, fly ash, volcanic pumice, metakaolin, calcined shale and calcined clay. These types have been used in concrete production in previous studies. In this study, the authors focused on VA as one of the most important natural pozzolans among other species. VA has been used in various applications, such as in agriculture, to improve soil porosity.[1] VA has also been widely used in various aspects of the construction industry, such as absorbent materials and natural filters, thermal insulators, and the production of ceramic materials. A limited number of research studies have investigated the effect of VA, also called volcanic pumice powder (VPP), as a cement substitute in concrete production.[1] Previous studies have found that the chemical composition of VPP or VA can vary significantly depending on their location or source, particle size, density, and ambient conditions. In addition, the results obtained using this material may vary from country to country. VA is found in huge amounts and can be used as a construction material to replace cement in varying percentages to reduce its harmful effect.[1]

EFFECTS OF VOLCANIC PUMICE POWDER ON ENVIRONMENT: - Using VA as a concrete material instead of cement or aggregate has a significant impact on the environment in terms of reducing CO2 emissions, energy consumption and conserving natural resources for future generations.[2] The use of VA as a replacement for cement plays an important role in improving the environment, improving energy efficiency, reducing costs, and improving concrete's mechanical properties and durability. Cement concrete production is one of the main factors that increase CO2 emissions and cause various health and environmental problems. In addition, the high water, raw materials and high energy consumption required to extract these raw materials are some of the factors that negatively affect sustainability and the environment.[2] The philosophy of sustainable development associated with the concrete and construction industry has caused problems for governments and environmentalists. Therefore, many developing countries have started moving towards green and sustainable concrete to achieve an environmentally friendly environment. This study aims to demonstrate the use of VA as SCM to partially replace cement and thereby reduce the negative impact of cement production that causes environmental pollution. Therefore, VA as a renewable material can be used as cement and/or aggregates in conventional concrete, self-compacting concrete and ultra-high-performance concrete, as shown for sustainable concrete and to reduce CO emissions.[2]

Effect of volcanic ash(VA) on Hardened properties:- The result of the investigation to assess the suitable use of volcanic ash (VA) as a cement replacement material to produce high-performance concrete.[1] The effect of a high-performance HPVAC mixture was evaluated by conducting a comprehensive series of tests on fresh and Hardened properties as well as durability.[1] The durability of concrete is one of the most desirable properties and the concrete made with volcanic ash and pumice-based blended cement must be capable of preserving its durability throughout the life of the structure.[1] The development of non-expensive and environment-friendly high-performance volcanic ash (HPVAC) with acceptable strength and durability characteristics is extremely helpful for the sustainable development and rehabilitation of volcanic disaster areas around the world.[1]

II. Conclusions:-

Recent developments in recycles techniques have transformed renewable resources into partially renewable sources.[1] The function of supplementary Cementitious material in concrete in critical order to minimize extra waste going to landfills. In the manufacturing of eco-friendly concrete, there are several products and wastes of considerable importance.[2] The massive potential of utilization of volcanic pumice powder ash(VPPA) in the production of green concrete as a partial substitution or as an admixture to cement.[3]

The major goal of utilization is to lessen carbon dioxide emissions, as carbon dioxide is positively related to climate change and other forms of environmental pollution.

Furthermore, the reuse of byproducts and waste helps in mitigating problems associated with the disposal of waste materials.

The utilization of VPPA improves performance in the Flexural strength, splitting tensile strength and adding the durability character.[1],[2],[3]

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