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MUHAMMADAMIN KABULOVICH TOHIROVNING TAVALLUDINING 80 YILLIGIGA BAG'ISHLANGAN "SAMARALI QURILISH MATERIALLARI, KONSTRUKSIYALARI VA TEXNOLOGIYALARI" MAVZUSIDAGI XALQARO ILMIY-AMALIY KONFERENSIYASI ILMIY ISHLARI TO'PLAMI

Toshkent davlat transport universiteti Rossiya Arxitektura va qurilish fanlari akademiyasining akademigi, O'zbekiston Respublikasida xizmat ko'rsatgan yoshlar murabbiysi, texnika fanlari doktori, professor **Muhammadamin Kabulovich Tohirovning tavalludining 80 yilligiga** bag'ishlangan **"Samarali qurilish materiallari, konstruksiyalari va texnologiyalari"** mavzusidagi xalqaro ilmiy-amaliy konferensiya ilmiy ishlari to'plami chop etildi.

Muhammadamin Kabulovich kompozitsion qurilish materiallarining polistrukturaviy nazariyasini rivojlantirishga ulkan hissa qo'shgan olimdir. 1995-yilda Muhammadamin Kabulovich Rossiya Arxitektura va qurilish fanlari akademiyasining (RAASN) xorijiy a'zosi etib saylangan, bu esa ularning qurilish materialshunosligi sohasiga qo'shgan ilmiy hissasining xalqaro miqyosdagi e'tirofi bo'ldi. Ular o'z ilmiy faoliyati davomida 6 ta monografiya, 200 dan ortiq ilmiy maqola va 25 ta ixtiroga mualliflik guvohnomasi yaratganlar.

Ushbu konferensiyaning asosiy maqsadi – qurilish materialshunosligi, bino va inshootlarni loyihalash hamda qurilish sohasidagi zamonaviy ilmiy tadqiqotlar natijalarini muhokama qilish, shuningdek, muhandislik ta'limini takomillashtirish yo'llarini aniqlashdir.

Konferensiyada O'zbekiston Respublikasi hamda xorijiy mamlakatlarning oliy o'quv yurtlari va ilmiy-tadqiqot institutlari olimlari, shuningdek, muhim ilmiy tadqiqot natijalariga ega bo'lgan ishlab chiqarish vakillari o'z ilmiy ishlari bilan ishtirok etdilar.

"Samarali qurilish materiallari, konstruksiyalari va texnologiyalari" mavzusidagi xalqaro ilmiy-amaliy konferensiyaning asosiy yo'nalishlari quyidagilardan iborat:

1. **Resurs va quvvatni tejaydigan qurilish materiallari va texnologiyalari** – zamonaviy ekologik va iqtisodiy talablarni qondirishga qaratilgan innovatsion yechimlar.
2. **Bino va inshootlarning qurilish konstruksiyalari, zamonaviy hisoblash va loyihalash usullari - muhandislik** va texnologik yechimlarni takomillashtirish yo'nalishlari.
3. **Arxitektura va shaharsozlik** – estetik va funksional jihatlarni uyg'unlashtirgan zamonaviy loyihalar yaratish.
4. **Zamonaviy muhandislik ta'limi tizimini takomillashtirish** – kelajak mutaxassislarini yuqori malakali darajada tayyorlash uchun ta'lim jarayonini modernizatsiya qilish.

Mazkur konferensiya ilmiy hamjamiyatning turli vakillarini bir joyga jamlab, qurilish materialshunosligi sohasidagi zamonaviy muammolar va istiqbollarni muhokama qilish uchun qulay platforma vazifasini bajardi.

Application of geopolymer concrete

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Abstract: The requirement for concrete is growing daily and cement is utilized for meeting the needs of infrastructure facility development. One ton of cement production generates one ton of CO2, which negatively impacts the environment. To decrease the utilization of Ordinary Portland Cement and CO2 generation, innovative next-generation concrete has been created, such as Geopolymer concrete. It employs fly ash and alkaline solution as its Binding Materials. Geopolymer necessitates oven curing in temperature ranges from 60° C to 100° C for a duration of 24 to 96 hours. This paper determined that all investigators have devoted their efforts to demonstrate the influence of Ground Granulated Blast Slag on Geopolymer Concrete. Nevertheless, it should be noted that modifications in parameters like Na2SiO3/NaOH Proportion, Molarity of NaOH, Curing temperature, and Curing time create Variations in the Strength. Substitution of Fly ash with Ground Granulated Blast Slag progressively enhances the Strength without Oven curing provision. An insufficiency of information regarding certain aspects of geopolymerisation has become evident, and the scientific community should concentrate on these gaps.

Keywords: Geopolymer Concrete, Sodium, Silicate, Sodium Hydroxide, Fly ash, Ground granular blast furnace slag, Compressive strength, Split Tensile strength, Flexural strength, and Temperature effect

1. Introduction

The quest for eco-friendly construction materials is crucial, as the globe faces serious challenges due to environmental deterioration. There exists a considerable expectation on the industry to minimize carbon dioxide (CO_2) emissions into the atmosphere. In light of this, one of the endeavors to create environmentally friendly concrete is to diminish the usage of Portland cement by utilizing by-product materials, such as fly ash. It is recognized that manufacturing one ton of Portland cement accounts for approximately one ton of carbon dioxide released into the atmosphere, resulting from limestone decarbonation in the kiln during cement production. A notable advancement in the utilization of fly ash in concrete is the creation of high volume fly ash (HVFA) concrete, which partially substitutes the use of Portland cement in concrete (up to 60%), while preserving excellent mechanical characteristics with enhanced durability performance. Another innovation is geopolymer, i.e., inorganic Alumino-silicates polymer synthesized from minerals of geological origin or by-product materials, such as fly ash, rice husk ash etc., that are abundant in silicon (Si) and aluminum (Al). Fly ash is copiously available worldwide, and attempts to employ it in concrete production are of significant interest to concrete technologists and the industry. Ground Granulated Blast Slag is a waste material generated in iron or slag industries that has a substantial impact on Strength and Durability of Geopolymer Concrete. This document provides a brief examination of the evolution of geopolymer concrete. The elements that affect the production of geopolymer concrete such as source minerals, workability, curing time, and curing temperature are discussed in the paper. The prospective application of geopolymer concrete and the future challenges are also mentioned.

2. Research methodology

Literature Review. Numerous authors have documented the utilization of Ground Granulated Blast Slag in Geopolymer Concrete for various civil engineering applications.

Abdul Aleem M.I and Arumairaj (2012) attempted to identify an optimal mixture for Geopolymer concrete and fashioned concrete cubes measuring 150 x 150 x 150 mm, subjected to Steam curing for 24 hours based on compressive strength. The ideal blend is Fly ash: Fine aggregate: Coarse aggregate (1:1.5:3.3) with a solution (NaOH & Na_2SiO_3 combined together) to fly ash ratio of 0.35. Elevated and swift strength was attained in the Geo-polymer concrete mixture.

Abdul Aleem M.I and Arumairaj P.D (2012) performed a survey review on Geopolymer concrete. They highlighted that due to the high early strength, Geopolymer Concrete could be effectively employed in precast industries, enabling substantial production in brief periods while minimizing breakage during transportation. They exposed the attributes of geopolymer concrete and conveyed that Geopolymer Concrete can substitute ordinary Portland cement concrete.

Balaguru. P (1997) undertook research on employing Geopolymer concrete for Restoration and rehabilitation of reinforced concrete Beams. The chief objective of the investigation was to establish whether Geopolymer can be utilized for concrete repair. They concluded that Geopolymer concrete can be successfully applied to bond carbon fabrics to reinforced concrete beams.

Ganapathi Naidu.P et al (2012) exhibited a Study on strength characteristics of Geopolymer concrete with the addition of Ground Granulated Blast Slag. In this document, an effort was made to examine the strength properties of Geopolymer concrete using Low calcium fly ash replaced with slag in 5 different percentages. They discovered that Compressive strength of geopolymer concrete increases with a rise in the percentage of replacement of fly ash with Ground Granulated Blast Slag up to 28.57% of replacement, where normal setting was observed, while fast setting

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occurred beyond this level. They determined that a maximum of 25% reduction in compressive strength was observed when geopolymer was exposed to a temperature of 500° C for two hours.

Joseph Davidovits (1994) executed research on Properties of Geopolymer cements. This paper concentrated on Geopolymer concrete possessing exceptional properties and being well-suited for manufacturing precast concrete products needed in rehabilitation and retrofitting of structures following disasters. The author concluded by introducing low- CO_2 geopolymeric cements, not only for environmental applications but also in construction and civil engineering, which would decrease CO_2 emission caused by cement and concrete industries by 80%.

Leopoldo franco et al (2000) conducted investigation on concrete strength and longevity of prototype tetrapod and contrasted the outcomes of field and laboratory tests. This document was presented to explore the material properties after extended exposure at sea. They found minimal or no degradation had transpired after a 16 to 24 years period at sea.

LIoyd N.A and B.V Rangan (2010) performed experiments on geopolymer concrete with fly ash. They deduced that Geopolymer concrete possesses excellent properties and is appropriate for manufacturing precast concrete products required in rehabilitation and retrofitting of structures post-disaster. Current research is focusing on the resilience of Geopolymer in aggressive soil conditions and marine settings.

Lyon E et al (1996) examined the Fire Response of Geopolymer structural composites. They investigated the application of Geopolymer composites in infrastructure and transportation applications. They disclosed that Geopolymer composites are non-combustible structural materials suitable for infrastructure applications where substantial fire resistance is needed at low to moderate cost. Additionally, they noted that load-bearing capability during fire exposure, where temperatures reach several hundred degrees centigrade, will be significantly higher than organic resin composites.

Madheswaran C. K et.al (2013) investigated the variation of strength for different grades of geo polymer concrete by altering the molarities of sodium hydroxide. Various molarities of NaOH (3M, 5M, and 7M) were employed to prepare different mixtures and cured at ambient temperature. Geopolymer concrete mix formulations with compressive strength ranging from 15 to 52 MPa were developed. The specimens were assessed for compressive strength at ages of 7 and 28 days. The compressive strength of Geopolymer concrete increased with rising concentration of NaOH.

Mahesh Patel et al. (2013) examined the Strength of High Performance Concrete with Ground Granulated Blast Slag and Crusher Sand by substituting fine aggregates with crusher sand and cement with Ground Granulated Blast Slag. It was determined that 20% replacement of find aggregates by crusher sand was optimal, based on Compressive strength and Split Tensile strength measurements.

Mohemed aquib javeed et al (2015) carried out Studies to determine the optimal level of sustainable Geopolymer concrete combining manufactured sand and pond ash as fine aggregate material replacing conventional natural river sand and employing ambient curing for strength development. They confirmed that 60% of m-sand and 40% of pond ash as a substitute for natural sand was the ideal amount to achieve favorable strength.

Muhd Fadhil Nuruddin et al (2011) conducted research on Compressive Strength and Interfacial Transition Zone Characteristics of Geopolymer Concrete with varying cast in-situ curing conditions. They concluded that compressive strength of geopolymer concrete was significantly influenced by the curing conditions. Therefore, appropriate curing methodology was crucial to obtain acceptable strength in geopolymer concrete structures.

Pithadiya.S et al (2015) executed an experimental investigation on Geopolymer concrete by incorporating Ground Granulated Blast Slag. They performed tests on Geopolymer concrete by substituting fly ash with Ground Granulated Blast Slag, and the specimens underwent curing at room temperature as well as oven curing of 60 to 100 degrees centigrade. They confirmed that substitution of fly ash with Ground Granulated Blast Slag enhanced the strength progressively without oven curing provision. Thus, by utilizing Ground Granulated Blast Slag, oven curing challenges can be eliminated.

Vijai et al (2010) carried out tests on Geopolymer concrete cubes, cylinders, and prism specimens by employing fly ash and aggregates, and also incorporating ordinary Portland cement along with fly ash and aggregates. It was observed that the density of Geopolymer Concrete ranges from 2336 to 2413 kg/m³ and density of Geopolymer Portland Cement Concrete ranges from 2356 to 2424 kg/m³. They also noted that Geopolymer Concrete has two limitations: delay in setting time and necessity of heat curing to achieve strength.

Vijaya Rangan B conducted research on the durability of geopolymer concrete for environmental protection. This paper describes the outcomes of tests performed on large-scale reinforced Geopolymer concrete members and illustrates the application of Geopolymer concrete in construction industries. Excellent resistance to sulphate attack and fire, good acid resistance, and low creep were highlighted as benefits of utilizing Geopolymer concrete.

3. Discussion

Based on diverse researchers' findings, it is observed that Geopolymer Concrete composed of Fly ash and Alkaline Solution introduces a new era in the Construction Industry. Sodium Silicate (Na_2SiO_3) and Sodium Hydroxide (NaOH), when reacting with fly ash, initiate the Geopolymerization Process, which is accountable for Strength generation. Geopolymer Concrete Necessitates Oven Curing of 60°C to 100°C for 24 to 96 Hours. Ground Granulated Blast Slag creates a substantial impact on the strength of Geopolymer concrete.

4. Conclusion

Based upon the above literature review, it could be inferred that all researchers have dedicated their efforts to demonstrate the influence of Ground Granulated Blast Slag on Geopolymer Concrete. Nevertheless, it should be noted that variations in parameters such as Na_2SiO_3/NaOH Ratio, Molarity of NaOH, Curing temperature, and Curing time create fluctuations in Strength. Replacement of Fly ash with Ground Granulated Blast Slag progressively enhances Strength without Oven curing provision. A deficiency of information regarding certain aspects of geopolymerisation has become evident, and the scientific community should concentrate on these gaps. Despite the current status and widespread acceptance of Portland cement, the desirable properties of Geopolymers, their environmental advantages, and the robust academic and commercial Research and Development activity suggest that Geopolymer technology is positioned for significant advancement in the near future.

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V. Soy, N. Mukhammadiev, G. Malikov, G. Tianyu
*Development of a fine-grained basalt fiber concrete composition for the carriageway structures of reinforced concrete highway bridges.****56***

Z. Kakharov, R. Ashimov
*Energy analysis of concrete setting process.…………………………….****59***

A. Nazibekov
*Application of geopolymer concrete..…………………………………….****62***

Z. Sattorov, N. Madraimov
*Experimental test methods for the properties of building materials based on class "f" and "c" ash from a thermal power plant ………****65***

I. Makhamataliev, A. Karabaev, S. Avabde
*On the new classification of minera l fillers used in asphalt concrete technology…………………………………………………………….****69***

U. Turgunbaev, N. Sunnatillaeva
*Preparation of polymer cement adhesive (PCA) by dry construction mixtures technology (DCT)……………………………………………….****76***

S. Abdieva, U. Abdullaev
*High quality composite concrete binders with improved performance…………………………………………………………………….****81***

D. Abdullayeva, Sh. Sabirova
*Study of the influence of the specific surface of river aggregate on the structure formation of non-autoclaved aerated concrete.……………****85***

V. Soy, D. Abdullayeva, G. Nuriddinova
*Methodological basis for the use of additives for the production of complex modified cement binders………………………………………****89***

U. Abdullayev
*Mechanical activation of limestone and study of its granulometric composition.………………………………………………………………****94***

J. Turgunbaeva, I. Makhamataliyev, I. Kuznetsova
*Prospects for the use of artificial intelligence capabilities in the production of gypsum-concrete tongue-and-groove boards…………****99***

A. Alinazarov, A. Tukhtabaev, S. Adasheva
*Thermophysical properties of multicomponent building materials during heat and moisture treatment using solar energy……………****104***

R. Narov, N. Rakhimova
*The effect of a complex additive on the homogeneity of cast concrete…………………………………………………………………****107***

CONTEXT / MUNDARIJA