CHRIST
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Notice for the PhD Viva-Voce Examination

Mr Tanu H M (Registration Number: 2170004), PhD scholar at the School of Engineering and Technology, CHRIST (Deemed to be University), Bangalore will defend his PhD thesis at the public viva-voce examination on Wednesday, 19 June 2024 at 12.30 pm in the CDI Conference Room, Block V, Bangalore Kengeri Campus, Bengaluru 560074.

Title of the Thesis	:	**Investigation on Mechanical and Durability Properties of Geopolymer Concrete with Ground Granulated Blast Furnace Slag Incorporating Sugarcane Bagasse Ash**
Discipline	:	**Civil Engineering**
External Examiner (Outside Karnataka)	:	**Dr A Bahurudeen** Associate Professor Department of Civil Engineering Birla Institute of Technology and Science, Pilani Hyderabad Campus Secunderabad, Telangana - 500078
External Examiner (Within Karnataka)	:	**Dr B B Das** Professor Department of Civil Engineering National Institute of Technology Surathkal, Mangaluru Karnataka - 575025
Supervisor	:	**Dr Sujatha Unnikrishnan** Associate Professor Department of Civil Engineering School of Engineering and Technology CHRIST (Deemed to be University) Bangalore Kengeri Campus Bengaluru - 560074 Karnataka

The members of the Research Advisory Committee of the Scholar, the faculty members of the Department and the School, interested experts and research scholars of all the branches of research are cordially invited to attend this open viva-voce examination.

Registrar

Place: Bengaluru
Date: 13 June 2024

ABSTRACT

This study deals with strength, durability, elevated temperature behaviour, cost, energy and carbon efficiency of sustainable GPC developed with GGBS and SCBA. Sodium hydroxide (NaOH) of 8M, 10M, and 12M and sodium silicate (Na2SiO3) were used as alkaline activators with sodium silicate to sodium hydroxide ratio being 2.5. Fifteen different binary blend GPC mixes were prepared by varying SCBA content (0%, 5%, 10%, 15% & 20% by mass of precursor) and also by varying molarity of NaOH by 8M, 10M and 12M. The developed GPC's fresh, hardened, microstructural, and correlation characteristics have all been assessed. Various tests such as the slump cone test, Cs, Sts, Fs, and UPV test were conducted. SEM, Edax, and XRD analysis were examined for understanding the microstructural characteristics. For a target strength of 40 MPa, the GPC produced with 20% SCBA and 80% GGBS with an 8M NaOH solution and an SS/SH ratio of 2.5 can be utilized. The reason for the development of higher strength in higher molarity of GGBS-SCBA based GPC samples is clearly shown by SEM micrographs, which indicate a dense and packed matrix.

The presence of CASH gel confirmed this in the GP matrix. Durability studies such as rapid chloride permeability, sorptivity and early and long-term effect of sulphate attack were conducted on GGBS-SCBA based GPC. Also elevated temperature behaviour of GPC specimen subjected to different temperatures of 200°C, 400°C, 600°C and 800°C were studied to evaluate the strength, mass loss and effect on microstructures due to elevated temperature. The degradation of geopolymer concrete at different elevated temperatures was observed by SEM, Edax, XRD and FTIR. From the test findings it is noticed that the GPC developed have good durability characteristics. It is also noticed that geopolymer concrete retains more than 50% of strength up to a temperature of 600°C. From scanning electron microscope analysis of GPC developed with GGBS and SCBA, it is found that there are larger crack formations and pores which are visible in the geopolymer concrete matrix when the specimens are exposed to an elevated temperature of 800°C which confirms the degradation of C-A-S-H gel in the GPC mixes developed. Additionally, incorporation of sugarcane bagasse ash in GPC will reduce disposal problems and also carbon dioxide emission.

Keywords: CASH, SEM, XRD, UPV, GPC, Rapid chloride permeability, Sorptivity, Sulphate attack, Elevated temperatures, Regression analysis, Carbon dioxide efficiency.

Publications:

1. **Tanu H.M.**, & Unnikrishnan, S. (2023). Mechanical Strength and Microstructure of GGBS-SCBA based Geopolymer Concrete. Journal of Materials Research and Technology, 24, 7816-7831 https://doi.org/10.1016/j.jmrt.2023.05.051 - Q1 SCIE Indexed / Elsevier.
2. **Tanu H.M.**, & Unnikrishnan, S. (2023). Durability and elevated temperature behaviour of geopolymer concrete developed with ground granulated blast furnace slag and sugarcane bagasse ash, J. Build. Pathol. Rehabil. 8 (2023). https://doi.org/10.1007/s41024-023-00354-7. – Q2 Scopus Indexed / Springer.
3. **Tanu H.M.**, & Unnikrishnan, S. (2022). Utilization of industrial and agricultural waste materials for the development of geopolymer concrete- A review. Materials Today: Proceedings, 65, 1290-1297 https://doi.org/10.1016/j.matpr.2022.04.192. - Q2 Scopus Indexed.
4. **Tanu H.M.**, & Unnikrishnan, S. (2023). Review on Durability of Geopolymer Concrete Developed with Industrial and Agricultural Byproducts. Materials Today: Proceedings https://doi.org/10.1016/j.matpr.2023.03.335.4.- Q2 Scopus Indexed.

Patent:

1. Title of the invention: "Development of Sustainable Geopolymer Concrete Incorporating Industrial and Agricultural Residue" [Application no.202341057865 A]

CHRIST
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Notice for the PhD Viva-Voce Examination

Ms Gowram Iswarya (Registration Number: 1982304), PhD scholar at the School of Engineering and Technology, CHRIST (Deemed to be University), Bangalore will defend her PhD thesis at the public viva-voce examination on Thursday, 20 June 2024 at 11.00 am in the CDI Conference Room, Block V, Bangalore Kengeri Campus, Bengaluru 560074.

Title of the Thesis	:	**Performance Investigation of the High Strength Concrete Using Natural Zeolite with Industrial Waste Materials**
Discipline	:	**Civil Engineering**
External Examiner (Outside Karnataka)	:	**Dr Dipti Ranjan Biswal** Associate Professor School of Civil Engineering Kalinga Institute of Industrial Technology KIIT Road, Patia, Bhubaneswar, Odisha -751024
External Examiner (Within Karnataka)	:	**Dr Radha Krishna** Professor and Head R V College of Engineering Mysore Road, Bengaluru Karnataka -560059
Supervisor	:	**Dr Beulah M** Associate Professor Department of Civil Engineering School of Engineering and Technology CHRIST (Deemed to be University) Bangalore Kengeri Campus Bengaluru - 560074 Karnataka

The members of the Research Advisory Committee of the Scholar, the faculty members of the Department and the School, interested experts and research scholars of all the branches of research are cordially invited to attend this open viva-voce examination.

Registrar

Place: Bengaluru
Date: 12 June 2024

ABSTRACT

Concrete is used in the construction of various structural elements. High Strength Concrete (HSC) production for huge infrastructure projects is challenging. The manufacture of cement significantly causes global carbon dioxide (CO2) emissions. Modifications have been made to cement concrete problems to minimize CO2 emissions and Ordinary Portland Cement (OPC) consumption. This research focuses on developing HSC blended with Natural Zeolite (NZ) and by-products of industries like Silica Fume (SF), Fly Ash (FA), and Metakaolin (MK) to enhance concrete quality, sustainability, and performance. Partial replacement of OPC with 5% NZ and industrial waste materials in 5%, 10%, and 15% amounts to produce M60 grade HSC mixes. In the laboratory, 1,200 concrete specimens were tested for mechanical properties for 3, 7, 28, 60, and 90 days, as well as durability tests such as the Rapid Chloride Penetration Test (RCPT) for 28 days and the acid attack test for 60 days. Mix M3 (85% OPC + 5% NZ + 10% MK) exhibited the highest compressive strength at 72 MPa, split tensile strength at 5.3 MPa, and flexural strength at 9.4 MPa for 90 days curing period, attributed to its low porosity. The reactive silica (SiO2) and alumina (Al2O3) in the mix transformed calcium hydroxide (Ca(OH)2) into calcium silicate hydrate (C-S-H) gel and aluminate compounds. This process improved the microstructure of the hardened concrete, resulting in increased imperviousness. The study also includes the effect of these industrial waste materials on Zeolite concrete by microstructure analysis.

The mathematical models were developed using SPSS software to predict the durability and mechanical properties of all the concrete mixes based on the laboratory data, considering parameters like mix proportions and curing days. The developed model can be used for various types of HSC with pozzolanic material to predict the mechanical properties and durability characteristics of the HSC with high accuracy and R2 values (95% for flexural strength of concrete with NZ and MK). In contrast, finite element analysis simulates concrete behaviour under varying loads and pre-defined parameters. Comparing laboratory experimental data with ANSYS numerical values indicated the best mechanical property results, with an acceptable compressive strength difference of 0.002%. The study analyses numerical simulation accuracy and finds experimental and numerical differences.

Keywords: High Strength Concrete, Pozzolanic Material, Natural Zeolite, Fly Ash, Metakaolin, Silica Fume, Mechanical Properties, Durability Properties, Regression analysis.

Publications:

1. **Gowram, Iswarya,** Beulah, M., "Experimental and Analytical Study of High-Strength Concrete Containing Natural Zeolite and Additives." Civil Engineering Journal 8, no. 10 (2022): 2318-2335.
2. **Gowram Iswarya.,** & Beulah, M. "Mathematical Modeling for Evaluating the Mechanical Properties of High Strength Concrete with Natural Zeolite and Additives." Mathematical Modelling of Engineering Problems, 10(3), (2023): 781-789.
3. **Iswarya, Gowram,** and M. Beulah. "Use of zeolite and industrial waste materials in high strength concrete – A review." Materials Today: Proceedings 46 (2021): 116-123.