

**Synergistic effect of metakaolin and nano-silica in concrete:
A comprehensive experimental study on concrete properties
thermal stability and eco-efficiency**



**A thesis submitted in partial fulfilment
for the Award of Degree**

Doctor of Philosophy

by

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It is certified that the work contained in the thesis titled "**Synergistic effect of metakaolin and nano-silica in concrete: A comprehensive experimental study on concrete properties, thermal stability and eco-efficiency**" by **Abhilash P P** has been carried out under my supervision and that this work has not been submitted elsewhere for a degree.

It is further certified that the student has fulfilled all the requirements of Comprehensive Examination, Candidacy and State of the Art (SOTA) for the award of Ph.D. Degree.

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DECLARATION BY THE CANDIDATE

I, **Abhilash P P**, certify that the work embodied in this thesis is my own bonafide work and carried out by me under the supervision of **Prof. Rajesh Kumar** from July 2018 to December 2023, at the **Department of Civil Engineering, Indian Institute of Technology (BHU), Varanasi**. The matter embodied in this thesis has not been submitted for the award of any other degree/diploma. I declare that I have faithfully acknowledged and given credits to the research workers wherever their works have been cited in my work in this thesis. I further declare that I have not willfully copied any other's work, paragraphs, text, data, results, etc., reported in journals, books, magazines, reports, dissertations, theses, etc., or available at websites and have not included them in this thesis and have not cited as my own work.

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*Dedication
To
Spiritual Master*

A C Bhaktivedanta Swami Srila Prabhupada

*Your profound wisdom illuminated the path to self-realization
and revealed the true purpose of life and your guidance is the
light that leads me toward eternal truth.*

हन्त भाग्यं जनानाम्

Sri Guruvayurappan

परं ब्रह्म परं धाम पवित्रं परमं भवान्।

पुरुषं शाश्वतं दिव्यमादिदेवमजं विभुम्। ।

To

My Parents

Sri. Padmanabhan Nair & Geetha Nair

&

My wife Vidya Menon & daughter Mitravinda Menon

To

My mentor

Prof. Veerendra Kumar

For over a decade of inspiration, guidance, and unwavering support

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