(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :15/06/2026
(21) Application No.202621073962 A
(43) Publication Date : 17/07/2026

(54) Title of the invention : Predictive Performance Concrete Incorporating Fly Ash and Perlite Powder through Regression Modeling

(51) International classification	:C04B 18/08, C04B 14/18, C04B 28/02, C04B 28/04, C04B 111/20
(31) Priority Document No	:NA
(32) Priority Date	:NA
(33) Name of priority country	:NA
(86) International Application No Filing Date	: :01/01/1900
(87) International Publication No	: NA
(61) Patent of Addition to Application Number Filing Date	:NA :NA
(62) Divisional to Application Number Filing Date	:NA :NA

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(57) Abstract :
The present invention relates to the development of a sustainable high-performance M60 grade concrete incorporating fly ash and perlite powder as supplementary cementitious materials along with complete replacement of natural fine aggregate by manufactured sand (M-sand). Fly ash was used as a constant partial replacement of cement at 25%, while perlite powder was incorporated at replacement levels of 2%, 5%, 10%, and 15%. The concrete mixtures were designed as per IS 10262:2019 and evaluated through compressive strength and flexural strength tests at 7 and 28 days of curing. The experimental results indicated that the incorporation of fly ash and perlite powder significantly improved the mechanical properties of concrete. The optimum mix containing 25% fly ash and 5% perlite powder achieved the highest 28-day compressive strength of 79.80 MPa and flexural strength of 7.50 MPa. The enhanced performance was attributed to improved particle packing and matrix densification resulting from the combined action of fly ash and perlite powder. Response Surface Methodology (RSM) was employed to develop predictive models and optimize the mix composition. The developed models showed good agreement with experimental results and confirmed the optimum replacement level for achieving maximum strength. The proposed concrete provides a sustainable, economical, and high-strength alternative suitable for structural and infrastructure applications while reducing cement consumption and promoting the utilization of industrial by-products.

No. of Pages : 26 No. of Claims : 4