National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: Fly Ash Based Innovations in Structural Concrete with Development of Angular Aggregates, Fabrication of Tiles, Paver Blocks and ANFIS Modelling of RC Wall Panels
Speaker	: Pritam Kumar Pati (Rollno : 517ce1003)
Supervisor	: Prof. Shishir Kumar Sahu
Venue	: Seminar Room, Civil Engineering Department
Date and Time	: 31 Dec 2024 (11: 00 AM)

Abstract : With the progressing world, industrialization has become an inseparable part of the modern economy. Coal driven power sectors are the backbone of every industry and every developing nation. The increasing reliance on coal fueled power sectors is increasing the generation of fly ash every year. The concern for the environmental impact due to huge amount of fly ash production is grabbing attention of everyone worldwide. The disposal of fly ash has been causing a severe headache to the environmentalists all across the globe. The effective utilization of fly ash is restricted only to manufacture of bricks, producing fly ash based pozzolanic cement and use in pavements. But to utilize the fly ash in high volume the innovative idea is to utilize it in various other potential areas. The present research deals with the production of innovative lightweight fly ash angular aggregates and its utilization in concrete. The current research also deals with the utilization of fly ash in concrete paver blocks and tiles as a replacement of cement and fine aggregate. Consequently, wall panels with different percentages of fly ash as a cementitious material are cast and a model is proposed for the prediction of ultimate load carrying capacity of reinforced concrete wall panels using Adaptive Neuro-Fuzzy Inference System (ANFIS).

The present investigation deals with the production of the innovative lightweight fly ash angular aggregates (FAA) first time in India using local class &lsquoF&rsquo fly ash, its characterization, and exploring the potential for its utilization as alternative coarse aggregates in structural concrete applications. The manufacturing process involves mixing fly ash, binder, and water, followed by the briquetting process, sintering and crushing them into suitable size aggregates. Tests are conducted on fly ash angular aggregates to measure their physical properties such as crushing value, impact value, specific gravity, water absorption, bulk density, and percentage of voids. Study shows that the physical parameters are significantly enhanced as compared to commercially available fly ash pellets (FAP). The developed FAA are used in concrete vis-à-vis conventional granite aggregates and FAP to determine their compressive, split tensile and flexural strengths. Although being lightweight, the strength parameters for concrete containing FAA are well compared with conventional concrete. This might be due to the high pozzolanic reaction between FAA and cement paste. Also, RCC beams are cast and the load-deflection behaviour and ultimate load carrying capacity signify that FAA can be suitably used for RCC construction. Hence, the utilization of fly ash as angular aggregates can reduce the dead load of the structure and at the same time serves as a solution for fly ash disposal and mineral depletion problem.

The present study also deals with the production and characterization of high-grade precast concrete paver blocks for medium traffic roads and tiles utilizing fly ash as the fine aggregate and cementitious material. The influence of the addition of fly ash on strength, durability, microstructure, and mineralogy of the tiles and paver block specimens are evaluated experimentally. Substantial enhancement in mechanical strength is observed when fly ash replaces cement and sand up to 30 %. The water absorption and weight loss due to the freeze-thaw test for durability are within the permissible limit. The resistance to abrasive action mainly depends on the compressive strength of concrete. The XRD (X-Ray Diffraction) test on test specimens confirms the pozzolanic reaction of fly ash-based samples and the formation of strength-enhancing compounds such as calcium silicate hydrate and calcium aluminate silicate hydrate. The microstructure of fly ash-based samples up to 30 % replacement shows more compact and stable structure as compared to the sample with the control mix. Hence, the fly ash based precast concrete paver blocks and tiles must be implemented for construction purposes, as they provide better strength, less gestation period, minimize the depletion of mineral resources and help in reducing the load on cement industry for a cleaner, greener and sustainable future.

Consequently, the current research proposes a model for the prediction of the ultimate load carrying capacity of one-way Reinforced Concrete (RC) wall panels using an adaptive neuro-fuzzy inference system (ANFIS). Wall panels with different percentages of fly ash (0 % - 30 % at an interval of 10 %) as a cementitious material are cast and their ultimate loads are determined. Total 90 sets of data including 20 sets of data from the current experimental study was used in the ANFIS model. The input parameters (IPs) for the current ANFIS model include the gross cross-sectional area of the specimen under compression, compressive strength of concrete, aspect ratio, slenderness ratio, vertical reinforcement percentage, and yield strength of steel, whereas the ultimate load is the output parameter (OP). A parametric analysis was also carried out to ascertain the impact of individual IPs and the combined impact of two IPs on the output. After comparing the ANFIS forecasts with the available theoretical models, it turns out that the current ANFIS model has more accuracy than the available theoretical models. Additionally, a thorough comparison of the experimental results and the ANFIS forecasts indicates that there is a strong correlation between the ANFIS results and the experimental outcomes.