The conventional binding agent in concrete is Ordinary Portland Cement (OPC). However, cement production is highly energy intensive and involved in CO₂ emission to the atmosphere. The search for a cementitious material which resists against nature has started long back. On the other hand disposal of solid wastes from power plants that use coal for production poses great environmental problem for India and requires a mission-mode approach.

The development and use of mineral admixture for cement replacement is growing in construction industry mainly due to the consideration of cost saving, energy saving, environmental protection and conservation of resources. But the utilization of fly ash in construction is limited only to road works and for the manufacture of fly ash bricks and Portland Pozzolanic cements in India. The cement production consumes vast amounts of limestone and clay, besides being energy-intensive. Fly ash in cement concrete is one of the areas where huge potential exists for large-scale value added fly ash utilization on sustainable basis as in India, concrete industry is the largest consumer of Portland and modified Portland cements at an annual rate of about 320 million tons.

The utilization of fly ash as construction material largely depends on its mineral structure and pozzolanic property. These two properties of fly ash can be enhanced by different methods of activation. Mechanical activation by grinding and thermal activation by heating needs advanced and
costly equipments. At the same time the chemical properties like pH and corrosion inhibition are not improved much. Whereas chemical activation by adding chemicals like gypsum, sodium hydroxide, sodium silicate, calcium oxide is cheap and economical.

The aim of this study is to gain an improved knowledge on flexural behaviour and corrosion potential of activated fly ash concrete. To achieve this, the study is broadly divided into experimental programme, analytical predictions and numerical simulations.

The study highlights the chemical activation of fly ash by using CaO paste and Na$_2$SiO$_3$ in the ratio 1:8 in reinforced cement concrete for structural applications. Activated fly ash as replacement material in cement at various levels ranging from 10%, 20%, 30%, 40%, 50% and 60% for three different mix proportions are studied to find the maximum possible replacement. Mechanical properties like compressive strength, split tensile strength and modulus of rupture are studied on triplicate specimens. Activated fly ash concrete’s behaviour in flexure was evaluated for finding the maximum possible replacement of cement by activated fly ash in reinforced concrete. In this experimental investigation, 39 series beams are tested under two point static loading to evaluate flexural behaviour. The behaviour of activated fly ash concrete in shear has been studied by testing 13 series beams and push off specimens.

It is not only the strength improvement and enhancement in ductility of concrete, but also the durability aspect need to be considered to
predict the long-term behaviour of reinforced structural components. The main aspect of durability is the permeability which leads to corrosion of steel in concrete, which in turn leads to the deterioration of concrete. In this experimental investigation resistive capacity of activated fly ash concrete to corrosive environments was studied using water absorption test on cubes, acid resistance test, permeability test, impressed voltage on cylindrical specimens. Half cell potential method of evaluation was used to find the corrosion performance of reinforcement steel in activated fly ash concrete beams. 39 series beams are tested to find the corrosion performance and load carrying capacity of corroded beams.

From the regression analysis of the mechanical property, a model for predicting the compressive strength was obtained. In the analytical investigation, Models for predicting the split tensile strength and modulus of elasticity are obtained from the mechanical property study and from permeability test results a model for predicting the corrosion rate was developed.

An equation for the deflection of beams was developed from modified Branson’s equation. The analytical expressions developed are in full agreement with experimental results in predicting the deflection behaviour.

Numerical models for predicting the performance of activated fly ash concrete beams was made using commercial finite element software ANSYS. The consistency of the model is demonstrated by comparisons with experimental and theoretical results.