ABSTRACT

It would not have ever been imagined that the earth would be under “water”. Scientists and eminent climatologists have warned of another “Great flood”, hitting the world very soon. Another apocalyptic scenario is expected to be repeated after the “floods”. These are nothing but the terrifying consequences of huge amount of CO₂ emissions into atmosphere, which are anticipated through collated scientific evidences, archive footage, location photography and CGI from different sources, which ultimately end up with global warming and global cooling. Therefore, utmost attention of the scientists and technocrats is directed towards this global warming. It has become the prime concern of research fraternity throughout the world. Nowadays, efforts are constantly put in by scientists to find avenues to lower the escalating global temperature. The rise in temperature would lead to the melting of glaciers in both the northern and southern hemispheres which would ultimately pave way for the upturn of sea level.

Industrialization has contributed to a great extent, to the emission of green house gases. The main green house gas responsible for global warming is carbon-di-oxide (CO₂). This CO₂ is emitted into atmosphere by many industries and in particular by cement industries.

Portland cement is used as binder in the production of cement concrete which has been found to be satisfactory in most of the Civil Engineering structures. However, Portland cements are highly internal-energy sensitive and cause emission of greenhouse gas CO₂ during their production
leading to global warming. Cement is the second largest product being utilized by mankind due to the phenomenal growth of infrastructures and other construction activities. It is predicted by scientists that production of one ton of cement leads to emission of approximately 0.8 ton of CO$_2$ into the atmosphere. The quantity of cement produced globally, in 2011 was 3.4 billion tonnes, according to data from the United States Geological surveys and it clearly indicates the quantum of CO$_2$ emitted into atmosphere.

Leaders of most industrialized countries are very much concerned about global warming and the leaders of developing countries urge the industrialized nations to lower the quantity of green house gases being emitted into the atmosphere. Scientists are urged to take measures by exploring the possibilities to remedy such critical situations.

Many civil engineers and researchers are keenly interested in finding a suitable solution to this much talked about problem by inventing a new and ideal substitute for cement. Hence, it does not always warrant OPC concrete as the primary material or technology. Yet, we are building today as if there were no substitutes. In this connection, French chemist Prof. Davidovits has found out the most versatile material ‘Geopolymers’ which matches the properties of materials used in the construction of pyramids in Egypt. The outcome of this invention has revolutionized in Civil and Structural Engineering fields.

Prof. Vijayarangan, Curtin University, Australia found the usefulness of Geopolymers in Civil Engineering field. This concrete made
using geopolymer technology would become a welcome material in construction practices, since it totally eliminates cement in the manufacture of concrete. In this respect, Geopolymer technology shows considerable promise for application in concrete industry as an alternative binder to the Portland cement.

This research is aimed at finding the usefulness and applicability of Geopolymer concrete as structural elements in India using Indian fly ash. This research not only aims at elimination of cement from concrete industry but also finds fly ash, considered a waste and land fill material, to be a source material for Geopolymer concrete.

Low calcium class F fly ash obtained from Tuticorin Thermal Power Station [TTPS], Tamilnadu, India mixed with alkaline solution made of sodium silicate and sodium hydroxide has been used throughout this research to obtain Geopolymer paste to act as binding material, thus eliminating cement completely.

The main objective of this research is to obtain first-hand information about the strength and behaviour of reinforced no-cement concrete short and slender columns; the Load-axial deformation characteristics and evaluation of ductility of both the columns, the ultimate load carrying capacity of both columns for axial compression and axial load with uniaxial and bi-axial eccentricities and stiffness and compressive strength indices.
Several plain Geopolymer concrete cubes were cast and subjected to various parametric studies to ascertain their compressive strength. Plain Geopolymer concrete cubes were cast to 30N/mm² and tested in brick making kiln at 500°C to ascertain thermal stability of the concrete and the test results were compared with the ordinary Portland cement concrete counter parts. Geopolymer concrete cube with helical spring is kept inside and rebar embedded to study the bond strength of Geopolymer concrete with rebars. Square and circular shaped short and long Geopolymer concrete columns were cast and tested and the test results were compared with ordinary Portland cement concrete columns of the same size and shape. Concrete compressive strength of 30N/mm² and 50N/mm², varying percentage of longitudinal reinforcement and change in molarity of sodium hydroxide were considered as test parameters.

Out of all the tests conducted, it is concluded that the strength and load carrying capacity of Geopolymer concrete are considerably large enough to adopt Geopolymer concrete columns in structural applications. It is also needless to elaborate that Geopolymer concrete is going to play a major role in future construction field.