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Geopolymer – a green concrete

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Since ages, our modern world has been constructive in nature. Today we have an ever-increasing demand for infrastructure development. With the increasing infrastructure development and the housing sector booming, the demand for cement is also bound to increase. It marks the concrete, the durable construction material as an essential part of our daily life. However, the cement industry is extremely energy intensive.Producing one tonne of cement requires about 2 tonnes of raw materials (shale and limestone) and releases 0.87 tonne of CO_2, about 3 kg of Nitrogen Oxide, an air contaminant that contributes to ground level smog and 0.4 kg of PM10 (particulate matter of size 10 µm), an air borne particulate matter that is harmful to the respiratory tract when inhaled. The global release of CO_2 from all sources is estimated at 23 billion tonnes a year and the Portland cement production accounts for about 7% of total CO_2 emissions. The cement industry has been making significant progress in reducing CO_2 emissions through improvements in process technology and enhancements in process efficiency, but further improvements are limited because CO_2 production is inherent to the basic process of calcinations of limestone. Mining of limestone has impact on land-use patterns, local water regimes and ambient air quality and thus remains as one of the principal reasons for the high environmental impact of the industry. Dust emissions during cement manufacturing have long been accepted as one of the main issues facing the industry. The industry handles millions of tonnes of dry material. Even if 0.1 percent of this is lost to the atmosphere, it can cause havoc environmentally. Fugitive emissions are therefore a huge problem.

The cement industry does not fit the contemporary picture of a sustainable industry because it uses raw materials and energy that are non-renewable; extracts its raw materials by mining and manufactures a product that cannot be recycled. Through waste management, by utilizing the waste by-products from thermal power plants, fertiliser units and steel factories, energy used in the production can be considerably

reduced.This cuts energy bills, raw material costs as well as greenhouse gas emissions. Concept of a novel binding material named 'Geopolymer' appeared in the 1940s as a viable solution to these issues. In the process, it can turn abundantly available wastes, such as fly ash and slag into valuable products, such as geopolymer concretes.

'Geopolymer cement concretes' (GPCC) are inorganic polymer composites, which are prospective concretes with the potential to form a substantial element of an environmentally sustainable construction by replacing/supplementing the conventional concretes. GPCC have high strength, with good resistance to chloride penetration, acid attack, etc. These are commonly formed by alkali activation of industrial aluminosilicate waste materials such as FA (Fly ash, the waste product from thermal power plants)and GGBS (Ground granulated blast furnace, by-product of blast furnaces used to make iron), and have a very small Greenhouse footprint when compared to traditional concretes.

Geopolymer concrete is a revolutionary sustainable building material that will pave the way for green building.Geopolymer concrete is also much more durable that ordinary concrete due to its resistance to corrosion. It is also much stronger than ordinary concrete. In fact, ancient buildings such as the Roman Coliseum and the Egyptian Pyramids were made out of a type of concrete very similar to the geopolymer concrete that is under development today. If it could be used thousands of years ago, then there should be nothing preventing today's engineers from modernizing this ancient technology so that it can fit the needs of society in the 21stcentury.

It is evident from earlier researches that GPC is certainly economically, eco-logically and environmentally more viable choice than OPC based concrete. This is such a versatile material that tailoring can be done at any part of the process from material development, to manufacturing to hardened state. It is time now, to step further and to try to make GPC as commercially acknowledged option because as superior as GPC to OPC is, there are no codes available for GPC unlike OPC based concrete which is well developed in ACI, ASTM, BS, Euro, German, Australian, Japanese and Indian codes. GPC, with its better mechanical properties, higher resilient behaviour to aggressive environments, better utilization of waste products and more environmental friendly behaviour, can be the concrete for the future world and become a friendly solution to GHG emission by concrete industry without increasing the green house effect further. Geopolymer concrete is still in the developmental stages of its life and therefore has yet to see any major incorporation into the construction industry. The durability attributes of geopolymers make them attractive for use in high-cost, severe-environment applications. The faster the switch from ordinary concrete to geopolymer concrete is made, the better off the environment and society will be. Hopefully one day in the near future geopolymer concrete will replace ordinary Portland cement as the most abundant man-made material on earth.