

EXPERIMENTAL STUDY ON SELF CURING FIBRE REINFORCED CONCRETE USING MONOFILAMENT POLYPROPYLENE FIBRE WITH PARTIAL REPLACEMENT OF CEMENT BY GROUND GRANULATED BLAST SLAG

Concrete is most widely used construction material in the world due to its ability to get cast in any form and shape. Concrete is a mixture of cement, aggregate and water with and without suitable admixtures. Curing is the process of maintaining the proper moisture content to promote optimum cement hydration immediately after placement. Proper curing of concrete structures is important to meet performance and durability requirements. In conventional concrete, curing is achieved by external curing applied after mixing, placing and finishing while self curing is a internal curing without external application of water. Concrete is typically the most massive individual material element in the built environment. If the embodied energy of concrete can be reduced without decreasing the performance or increasing the cost, significant environmental and economic benefits may be realized. Concrete is primarily comprised of portland cement, aggregates and water. The concrete mass, it accounts for approximately 93% of the total embodied energy of concrete and 6% to 7% of the world wide Carbon dioxide (CO₂) emissions. Besides this, dust emission during cement manufacturing is one of the main issues facing the industry. The industry handles millions of tons of dry material. Even if 0.1% of this is lost to the atmosphere, it can cause havoc environmentally. This has made the researchers worldwide to look for addition of cementitious materials in concrete to reduce the usage of cement in concrete. Efforts are being carried out to conserve energy by means of promoting the use of industrial wastes or by-products, which contain amorphous silica in its chemical composition, as mineral admixture for partial replacement of cement. The utilization of pozzolanic materials in concrete as partial replacement of cement by Ground granulated blast slag. The addition of fibre in concrete significantly improve tensile strength.

SELF CURING CONCRETE

The self-curing concrete means that no external curing required for concrete. The

ACI-308 Code states that “internal curing refers to the process by which the hydration of cement occurs because of the availability of additional internal water that is not part of the mixing water.” ‘Internal curing’ is also referred as self-curing.’ Conventionally curing of concrete refers to creating conditions such that water is not lost from the surface i.e., curing is taken to happen ‘from the outside to inside’. In contrast, ‘internal curing’ is allowing for curing ‘from the inside to outside’ through the internal reservoirs (in the form of saturated lightweight fine aggregates, superabsorbent polymers). The process of reducing the evaporation of water from the concrete is the principle behind internal curing or self-curing. Self-curing agents forms hydrogen bonds with water molecules and reduces the evaporation loss. Thus it cures itself and forms self-curing concrete.

GROUND GRANULATED BLAST FURNACE SLAG

Ground Granulated Blast furnace Slag is a by-product of iron manufacturing industry. Iron ore, coke and limestone are fed into the furnace, and the resulting molten slag floats above the molten iron at a temperature of about 1500°C to 1600°C. The molten slag has a composition of 30% to 40% Silicon Dioxide (SiO_2) and approximately 40% Calcium Oxide (CaO), which is close to the chemical composition of portland cement. After the molten iron is tapped off, the remaining molten slag, which mainly consists of siliceous and aluminous residues, is then rapidly water- quenched, resulting in the formation of a glassy granulate. This glassy granulate is dried and ground to the required size which is known as Ground Granulated Blast furnace Slag. It has been reported that the manufacture of one ton of Portland cement would require approximately 1.5 tons of mineral extractions together with 5000 MJ of energy, and would generate 0.95 tons of CO_2 equivalent. As GGBS is a byproduct of iron manufacturing industry, it is reported that the production of one ton of GGBS would generate only about 0.07 tons of CO_2 equivalent and consume only about 1300 MJ of energy. The replacement of portland cement with GGBS will lead to a significant reduction of carbon dioxide gas emission. In India, we produce about 7.8 million tons of GGBS. The disposal of such slag even as a waste fill is a problem and may cause serious environmental hazards with the projected economic growth and development

in the steel industry. The amount of production is likely to increase many folds and environmental problem will thus pose a large threat. It is seen that high volume eco-friendly replacement by such slag leads to the development of concrete which not only utilises the industrial wastes but also saves a lot of natural resources and energy. This in turn reduces the consumption of cement

NEED FOR THE STUDY

- The Ordinary Portland Cement (OPC) is one of the main ingredients used for the production of concrete, as there is no alternative in the civil construction industry. Unfortunately, production of cement involves emission of large amounts of carbon-dioxide gas in to the atmosphere, a major contributor for greenhouse effect and global warming. Hence it is inevitable either to search for another material or partly replace it by some other material. The search for any such material, which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact. A number of studies are going on in India as well as abroad to study the impact of use of these pozzolanic materials as cement replacement.
- The concept of self-curing is to reduce the evaporation of water from concrete and hence increase the water retention capacity of the concrete, compared to conventional concrete. When the mineral admixtures react completely in a blended cement system, their demand for curing water (external or internal) can be much greater than that in a conventional ordinary Portland cement concrete. When this water is not readily available, significant auto-geneous deformation and early-age cracking may be formed. Due to the chemical shrinkage occurring during the hydration of cement, empty pores are created within the cement paste, leading to a reduction in its internal relative humidity and also to shrinkage. This may cause early-age cracking.
- The usage of monofilament polypropylene fibre significantly improve the flexural strength of concrete.

OBJECTIVE OF THE STUDY

- To study the flexural behavior of control reinforced concrete beams and self cured fibre reinforced GGBS concrete beams with respect to various parameters like cracking behaviour, load carrying capacity, load-deflection, stress strain behaviour, stiffness, Energy absorption & ductility of concrete beams

LITERATURE REVIEW

Amal Francis k, Jino John (March 2013) studied the experimental investigation on mechanical properties of self curing concrete to predict the compressive strength, split tensile strength and flexural strength of the concrete containing Super Absorbent Polymer(SAP) at a range of 0%,0.2%,and 0.4% of cement and compared with cured concrete. Concluded that the addition of SAP leads to a significant increase of mechanical strength (Compressive and Split tensile) .Split tensile strength and flexural strength of self curing concrete for dosage of SAP 0.3% of cement was higher than non self curing concrete.

A.Aielstein Rozario, Dr.C.Freeda Christy (April 2013) investigated the experimental studies on effects of sulphate resistance on self-curing concrete. They conducted a detailed experimental study on sulphate attack measurement on self-curing concrete at ages 28 days, and 56 days. The main investigation in this study is variation of water soluble polymer dosage of 0.05% and 0.1%. The concrete produced by the addition of fly ash as a partial replacement of cement. The results of this paper they concluded that, the permeability of concrete decreases with increase in the replacement of fly ash with cement and in addition of PEG dosages. So, the penetration of chemicals is decreased with the addition of PEG and the concrete is safe against sulphates.

Raghu et al (2004) reported that due to the slow pozzolanic reaction developed and due to the addition of admixtures to the cement or concrete during mixing, both initial and final setting times get delayed. This delayed setting is beneficial during the hot weather concreting. The blended cement concrete showed considerable strength development and continues for longer period beyond 28 days.

Matsuda et al (2005) investigated the applications of GGBS to reduce seismic earth pressure. GGBS shows a similar particle formation similar to natural sand and also low

weight, high shear strength, well permeability and especially a latent hydraulic property by which GGBS hardens like a rock. Model wall tests were carried out on GGBS, in which the resultant earth pressure, wall friction and the earth pressure distribution at the wall surface were measured, and the test results were compared with those of standard sand. It was clarified that the resultant earth pressure obtained by using GGBS was smaller than sand, especially in the active-earth pressure side.

Vinayak , Manjunath.G. Tontanal (May 2013) evaluated that the self cured steel fiber reinforced concrete produced with 30% replacement of coarse aggregates by pumice aggregates will yield higher compressive strength. The concrete produced without replacement of coarse aggregates by pumice aggregates and with water curing show higher compressive strength. It can be concluded that the compressive strength of self cured steel fiber reinforced concrete will be slightly affected. The self cured steel fiber reinforced concrete produced with 30% replacement of coarse aggregates by pumice aggregates will yield higher tensile strength.

C. Chella, Gifta (May 2014), conducted experimental studies on High performance concrete. They concluded that, the internal cured specimens are proved to be better than conventional cured specimens in all means. Also, they suggested that the addition of internal curing agent increases the degree of hydration, producing a denser microstructure leading to better results. Compressive strength results reveal that compressive strength of internal cured specimens at 7 days and 28 days are greater but at the age of 3 days the strength is lower than conventionally cured specimens. SAP specimens show a significant improvement of about 6.88 % increase in compressive strength and LWA specimens are found to be 12.35% on 28 days compressive strength than the control concrete mix. Hence, the incorporation of internal curing components in high performance concrete means that LWA has proven to be effective than internal cured HPC using SAP with respect to strength. The durability studies have shown that internal curing by means of SAP has less chloride penetration than internal cured specimens using LWA. The RCPT value for the control mix was 783 coulombs which was greater than both the internal cured specimens, while the mix using SAP had a lower RCPT value of 483 coulombs which proved to be the best. The coefficient of permeability of mix M2

was 13.68×10^{-12} m/sec which was lesser than all the other mixes. Lesser the coefficient of permeability betters the results.

