Experimental study on strengthening Of Geo Polymer Concrete Slab With Bubble Technology

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Abstract- *The Bubble Deck technology developed in Europe makes use of high-density polyethylene hollow spheres to replace the ineffective concrete in the centre of the slab, thus decreasing the dead weight and increasing the efficiency of the floor. This method is used in the concrete floor system. Concrete is good in compression and hence is more useful in the compression region than in the tension region. The reduction in concrete can be done by replacing the tension zone concrete. Keeping the same idea in mind, an attempt has been made to find out the effectiveness of plastic bubbles by replacing concrete in the tension zone of Ordinary Portland Cement Concrete (OPCC) and Geo-Polymer Concrete (GPC) beam. Ingredients selected are cement, sand and coarse aggregate for OPCC and for GPC cement is completely replaced with 70% flyash, 15% GGBS and 15% glass powder. NaOH solution of 12M is added in place of water for GPC. Geo-Polymer Concrete does not form calcium- silicate-hydrates (CSHs) for matrix formation and strength like OPCC but utilizes the poly condensation of silica and alumina precursors to attain structural strength. In this project, M45 concrete mix is used to prepare both OPCC and GPC beams. The trial mix is tested for compressive strength in 7 days and 28 days. Flexure test is done for 7 days and 28 days of curing of the beams. The procedure is repeated for beam samples with bubble mesh and bubble mesh along with shear reinforcement. Comparative analysis of the OPCC and GPC beams are done to observe the percentage reduction in self-weight and cost ii effectiveness. Analysis of behavior of GPC beam in comparison with that of OPCC beam is also carried out.*

Keywords- Bubble technology, Geopolymer concrete, Ordinary Portland Cement Concrete, Sodium hydroxide, GGBS, Glass powde

I. INTRODUCTION

For the construction of any structure, Concrete is the main material. Concrete usage around the world is second only to water. The main ingredient to produce concrete is Portland cement. On the other side global warming and environmental pollution are the biggest menace to the human race on this planet today. The production of cement means the production of pollution because of the emission of CO_2 during its production. There are two different sources of CO_2 emission during cement production. Combustion of fossil fuels to operate the rotary kiln is the largest source and other one is the chemical process of calcining limestone into lime in the cement kiln also produces CO_2.In India about 2,069,738 thousand of metric tons of CO_2 is emitted in the year of 2010. The cement industry contributes about 5% of total global carbon dioxide emissions. And also, the cement is manufactured by using the raw materials such as lime stone, clay and other minerals. Granite of these raw materials is also causing environmental degradation. To produce 1 ton of cement, about 1.6 tons of raw materials are required and the time taken to form the lime stone is much longer than the rate at which humans use it. But the demand of concrete is increasing day by day for its ease of preparing and fabricating in all sorts of convenient shapes. So, to overcome this problem, the concrete to be used should be environmentally friendly.

II. MATERIALS USED

Terminology and Chemistry:

The term geo-polymer was first coined by Davidovits in 1978 to represent a broad range of materials characterized by chains or networks of inorganic molecules. Geo- polymers are chains or networks of mineral molecules linked with co-valent bonds. Geo-polymer is produced by a polymeric reaction of alkaline liquid with source material of geological origin or by product material such as fly ash, rice husk ash, GGBS etc. Because the chemical reaction that takes place in this case is a polymerization process, Davidovits coined the term ‘Geo-polymer’ to represent these binders. Geo-polymers have the chemical composition similar to Zeolites but they can be formed an amorphous structure. He also suggested the use of the term ‘poly (sialate)’ for the chemical designation of Geo-polymers based on silico - aluminate. Sialate is an abbreviation for silicon Oxo - aluminate. Poly (sialates) are chain and ring polymers with Si^{4+} and AL^{3+} in IV-fold coordination with oxygen and range from amorphous to semi-crystalline with the empirical formula: Mn (-(SiO_2) z–AlO_2) n. wH_2O Where “z” is 1, 2 or 3 or higher up to 32; M is a monovalent cation such as potassium or sodium, and “n” is a degree of poly condensation (Davidovits, 1984, 1988b, 1994b, 1999). Davidovits (1988b; 1991; 1994b; 1999) has also distinguished 3 types of polysialates, namely the Poly (sialate) type (-Si-O-Al-O), the Poly (sialatesiloxo) type (-Si-O-Al-O-Si-O) and the Poly (sialate-disiloxo) type (-Si-O-Al-O-SiO). The structures of these poly-sialates can be schematized

FLY ASH Fly:

ash is manufactured by the burning of coal in an electrostatic precipitator, a by-product of industrial coal. The cementitious properties of fly ash were discovered in late 19th century and it has been widely used in cement manufacture for over 100 years. In UK, fly ash is supplied as a separate component for concrete and is added at the concrete at the mixer. It generally replaces between 20 and 80 per cent of the normal Portland cement

GGBS:

GGBS is an environmentally friendly product and made from a by-product of iron manufacturing. It is a high quality, low CO2 material. Because GGBS has low embodied CO2, it allows designing concrete mixes for sustainable construction. The manufacture of GGBS requires less than 20% of the energy and produces less than 10% of the CO2 emissions compared to Portland cement production

GLASS POWDER:

Quite simply, a glass powder (ground glass) is a powder of a glass. But its properties stem not mostly from the grind size but of the identity of the glass itself. A glass is a solid, non-crystalline, typically transparent, amorphous (meaning it lacks long range order in the solid phase) material. The most common type of glass is sodalime glass, which comprises mostly of silicon dioxide, SiO2, along with sodium oxides, calcium oxide and alumina. Other minor components are added to fine tune properties to make the soda-lime suitable for use as plate glass or as container glass

BUBBLE DECK:

Bubble Deck is a biaxial technology that increases span lengths and makes floors thinner by reducing the weight while maintaining the performance of reinforced concrete slabs. The concept is based on the fact that the area between columns of a solid slab has limited structural effect beyond adding weight. Replacing this area with a grid of “voids” sandwiched between layers of reinforcing welded wire steel and an internal lattice girder yields a slab typically 35% lighter that performs like solid reinforced concrete. Once the steel lattice/void “sandwich” is concreted, it is then precast into panels of various sizes and craned into position on shoring. Once concrete is poured over the balls in the panels, the Bubble Deck system effectively becomes, and behaves like, a monolithic two-way slab that distributes force uniformly and continuously

CASTINGPROCEDURE:

The inner faces of the formwork were brushed with oil before placing concrete. Total fivemixes were cast, which comprises of slab specimens for control and optimum mix. aftercasting the specimens,ambient curing is done for 28 days.

Thespecimens’ size are asfollows1.Cube(100x100x100mm),2.Cylinder(100mmdia.&200mmheight),3.Impact(150x50mm),4.ImpactSlab(500x500x50mm),5.Sorptivity(100mmdia.&50mm height), 6. Porosity (100 mm dia. & 50 mm height), 7. Acid curing (100 x 100 x 100mm).

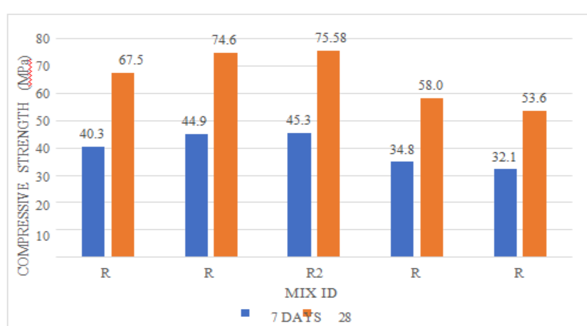
CURING:

The cubes were demoulded after 24 hours of casting. The cubes of Geopolymer concretewere kept for curing Under Ambient Curing at laboratory temperature 27 ± 2 ^{0}C for 7, 14and 28 Days.

III. TESTING OF SPECIMEN

COMPRESSIVE STRENGTHTEST

Compressivestrengthorcompressionstrengthisthecapacityofamaterialorstructure to withstand loads tending to reduce size, as opposed to tensile strength, whichwithstands loads tending to elongate. In other words, compressive strengthresists compression (being pushed together), whereas tensile strength resists tension (beingpulled apart). In the study of strengthof materials, tensile strength,compressive strength,andshear strengthcanbeanalysedindependently**.**



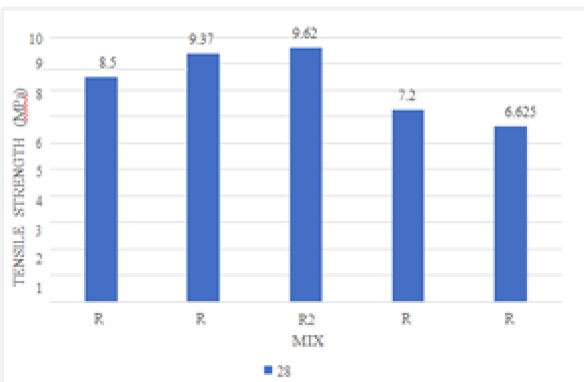
SPLITTENSILESTRENGTHTEST:

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. After the curing period, the specimen is taken out from the curing tank and wipes it clean. Then the specimens are placed horizontally between the loading surface of the Compression testing machine and the load is applied till the specimens fails. The ultimate load at the time of the failure is noted down.

F=2P/LDinN/mm^2

Where,

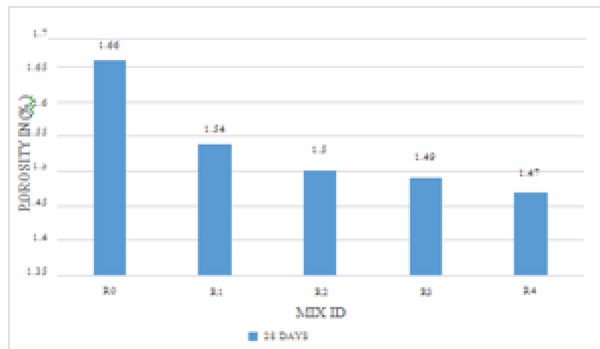
P	=	Compressiveload, D=	Diameterofthecylinder
L	=	Lengthofthecylinder,	.



Split Tensile Strength testing

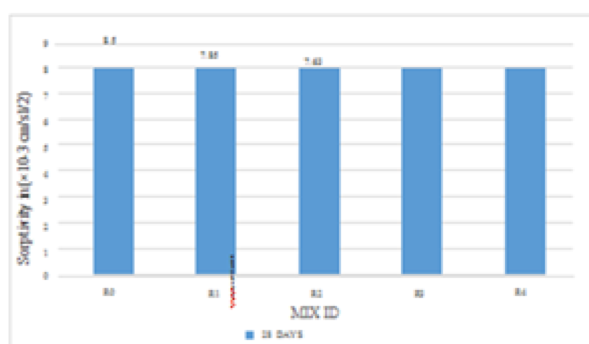
POROSITY TEST

Porosity is the number of pores in a material for instance pores in certain concrete. Porosity is usually expelled in volume percent. The porosity of concrete has influence on the properties in many aspects. Composition of concrete, casting in practice, maturing and hardening, cement reactions and risks at freezing, all are influenced by porosity. The possibilities to influence the type of porosity are important. Composition of concrete technology deals in very great extent about the porosity of concrete. Concrete consists of gravel, sand and cement, all particles, and water plus air and eventual additives. The firm substances give the concrete strength. Aggregates are cheap and therefore should fill up the space as much as possible. Therefore the particle size grading should be such that this is possible. The fine cement particles find room in spaces between the aggregate particles. More cement means that the spaces between aggregates are better filled. Consequently, more cement added, stronger concrete. Water fills the rest of the spaces.



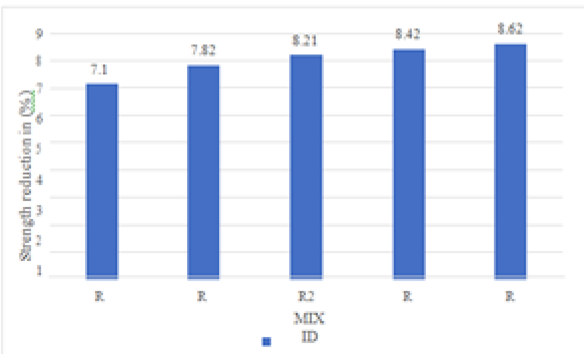
SORPTIVITY TEST

Sorptivity was used to assess the penetration of water through capillary pores from one side of the unsaturated concrete. The size of specimen tested was disc of 100 mm diameter and 50 mm thickness obtained from cylinder of size 100 mm x 50 mm by saw cutting machine. The samples were tested at the curing age of 28 days. Before testing, specimens were dried in the oven at the temperature of 105 ± 5 0C until constant mass of 0.1% was achieved between two successive readings after an interval of 24 hr. After attaining the constant mass, samples were kept in the desiccators to cool down over the period of 24 hr at temperature of 27 ± 2 0C.



ACID ATTACK TEST

After immersion in acid (H2SO4) solution for concrete specimens, after immersion in H2SO4 solution for 28 and 56 days the loss in compressive strength was determined as per ASTM standard. Fig 6.12 shows the compressive strength 5 %, 10 %, 15 %, 20 % respectively at the age of 28 and 56 days. The remaining mixes exhibited reduced compressive strength (difference) in the range of minimum 2 MPa to maximum 6 MPa indicating that 50% of strength was lost in acid solution at the age of 56- days. When acid reacts with concrete, the inter locking between the cement matrix and aggregate as C-S-H gel was broken down. The specimens kept under acid curing exhibited white patches on their surfaces. Honeycombing was also noticed on their surfaces due to acid attack.



Acid Attack

IV. CONCLUSION

Based on the experimental studies that were carried out on the conventional concrete slab and geopolymer concrete slab, it can be concluded that the strength characteristics of GPC is higher than the CC. • The load Vs deflection behaviour of Geopolymer concrete slabs is more than the CC slab. • The load Vs deflection behaviour of Geopolymer concrete slab with plastic bubbles is slightly less than the GPC slab. • The load Vs deflection behaviour of Geopolymer concrete slab with rubber bubbles is slightly less than the GPC slab, and slightly higher than GPC with plastic bubbles. • Water absorption of GPC is little lower than normal concrete. • Geo-polymer concrete has less pores in it. Due to this nature, sorptivity values of glass geo-polymer concrete was lower than those of normal conventional concrete. • Shear strength of any concrete slab is chiefly dependent on the effective mass of concrete. Due to the inclusion of plastic bubbles, the shear resistance of a bubble deck slab is greatly reduced compared to a solid slab. • The Geopolymer concrete slabs were used as the structural members due to its high strength and early strength gaining capacity. • There is a 20 – 30 % reduction in use of concrete which leads to reduction in self-weight of slab with same flexural strength of the slab compared to the conventional slab. • Due to the voids in the slab, it has excellent thermal insulation property. Lower total cost, decreased construction time and green technology compared to conventional slab.

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