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Experimental Study on Ultra High Performance Concrete

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Abstract - *The present experimental study is on the behaviour of 3 design mix of UHPC in which 3 different fine aggregate are used. As UHPC is being one of the high strength concrete the amount of cement require is high. So, a replacement material for cement in ternary system is adopted. So that the water requirement for hydration process is less and at the same time the quantity of unhydrated cement is also reduced. The water cement ratio is maintained as 0.18. As decrease in water content increases the compressive strength and at a same time decrease the voids present in the concrete Matrix. Since the water content ratio is too low in order to enhance the workability is increases without compromising the strength of the concrete. Polycarboxylic ether is one such super plasticizer which has a ability to reduce the water requirement upto 40% to50%. Alkaline resistant glass fibre is introduced into the concrete mix to overcome the tension drawback of concrete. In this project, tests were carried out on fresh and harden concrete test. In fresh concrete slump cone test which shows that concrete is self compacting in nature. In harden concrete compression, tension and flexural strength test, crack pattern, deflection test will be taken.*

Key Words: UHPC-Ultra high performance concrete, micro silica, Ground granulated blast furnace slag, glass fibre

1.INTRODUCTION

Ultra High Performance Concrete may be a new concrete. UHPC additionally called as Reactive Powder Concrete (RPC) may be a high strength concrete, ductile material developed by combining Portland cement, small silicon dioxide, GGBS (ground granular furnace slag), fine silicon dioxide sand, high vary water reducer, water and steel or organic fibers. The fabric provides compressive strength up to two hundred MPa and flexural strength up to 48Mpa. This provides the chance of reducing the section of parts (beams or columns) fabricated from this kind of concrete, whereas the load capability remains high. It's a self compacting concrete.

1.1 Scope of the project

- To understand the behavior of the material combination.
- Alkaline resistant glass fiber is used to provide the maximum split tensile strength.
- Micro silica and GGBS is used to reduce the quantity of cement to be used.
- High range superplasticizer (polycarboxylate) is used to have low water cement ratio.
- To improve the density of the cement matrix to make itself compacting.

1.2 Objective

- To study the various properties exhibited by the ultra high performance concrete.
- To address some of the main design, service life and life cycle, cost issues associated with use of UHPC.
- To determine the compressive strength & split tensile strength of concrete in 7 days, 14 days and 28 days.
- To determine the flexural strength, deflection, crack pattern of concrete beam in 28 days.
- To make UPHC more economic by producing it with the locally available materials that available in abundant and cost efficient.

2. Materials used and Methodology

2.1. Cement

Cement could be a binder, a substance used for construction that sets, hardens and adheres to alternative materials, binding them along. Cement is rarely used on its own, however rather to bind sand and gravel (aggregate) along.

2.2 Fine aggregate

M-sand stands for factory-made sand. M-sand is crushed mixture created from exhausting granite stone that is cubically formed created by crushing stone, gravel. It's a particular gravity of 2.64 kg/m^3 that is bigger than stream sand. This sand is additionally employed in the dimensions of 2.36mm sieved in our project.

2.3 Coarse aggregate

Coarse combination crushed granite of 12.5 mm down size has been used as coarse combination. Tests like relative density, gradation, water absorption check, combination impact check and fineness modulus are tested. Crushed stone

generally used as coarse combination that is black in color, angular and native name referred to as black metal or Gitti.

2.4 Micro silica

A larger quantity of cement is being used in ultra high performance concrete when compare with conventional concrete. Earlier it was found that the increase in cement content increases the compressive strength of concrete. However when the cement content went beyond the optimum limit the compressive strength started decreasing because of very low water to cement ratio in UHPC. Only a part of cement is being hydrated, the unhydrated cement does not give any strength to the structure so the unhydrated cement is being replaced by another cementitious material called silica fume. It survives the purpose of both binder and a filler material which fills the voids between cement particles because of its microscopic structure.

2.5 Ground Granular Blast Slag (GGBS)

By nature, Ground Granular furnace scum (GGBS) hardens terribly slow and square measure employed in concrete. GGBS replacement enhances lower heat of association. It has to be activated by combining it with Portland cement. GGBS may be a by-product from iron production victimization furnace. GGBS may be a hydraulic binder. It improves the standard and sturdiness of concrete, and its production is nearly CO2 free. GGBS is wide used for its superiority in concrete sturdiness, high resistance to chloride penetration and extent the life time from fifty years to hundred years. Concrete created with GGBS can have a high star reflectivity that is concerning 2 hundredth, this reduces the warmth island result. considerably the mirrored daylight isn't actinic ray.

2.6 Superplasticizer

Superplasticizer is also known as high range water reducers, are chemical admixtures used where well dispersed particle suspension is required. The reduced workability of UHPC due to very low water cement ratio can be solved by using effective superplasticizer. The required dosage of superplasticizer depends on the material used in the mix. Polycarboxylate ether is a higher end superplasticizer which has the ability to reduce water content upto 40%.

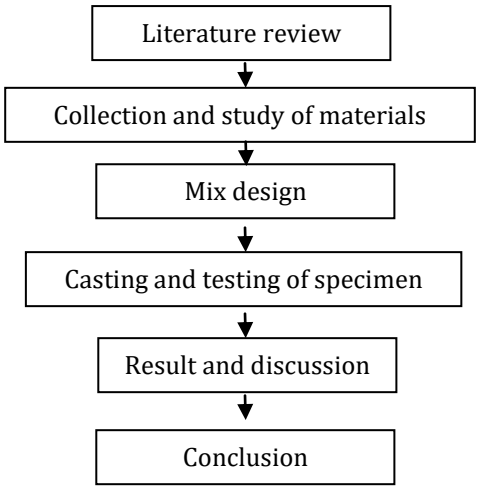
2.7 Alkaline resistant glass fibre

The alkaline resistant glass fiber is recent introduction in the field of concrete technology. Concrete being one of the most widely used material which is very strong in compression, but at the same time concrete is weak in tension. To overcome this drawback the concrete is reinforced with glass fibers which has the tensile strength of 1700 MPa.

2.8 Water

Concrete could be a chemical combined mass that is factory-made from binding materials and inert materials with water. The number of water within the combine plays a significant role on the strength of the concrete.

2.9 Methodology



2.10 Casting details

- Cube size 150mX150mmX150mmm
- No. of beams = 3 beams
- Size of beam 200mm X 130mm X 1200mm (depth × width × length)
- Clear cover on all faces for the reinforcement is 20mm.
- 2 no of 8mm diameter bar in compression zone
- 2 no of 10mm diameter bar in tension zone
- 8mm diameter stirrups @150mm spacing

3. Result and discussion

3.1 Compressive strength of concrete

Table -1: Compressive strength

Mix	Mix ratio of materials			Average split tensile strength		
	GGBS %	Micro silica%	Glass fibre %	7 days	14 days	28 days
M1	25	0	2	6.78	9.2	10.5
M2	0	10	2	7.65	10.5	12.1
M3	25	10	2	7.9	10.58	12.3

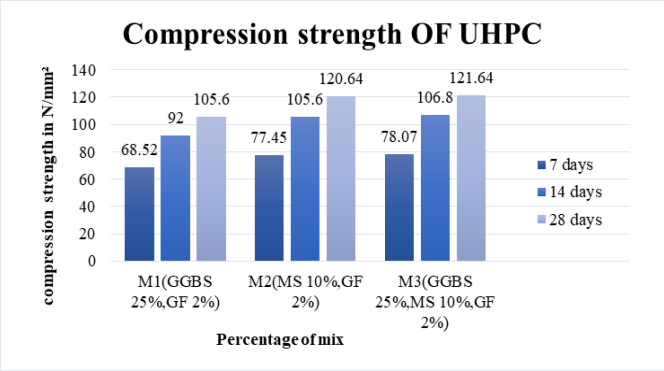


Chart -1: Compressive strength of UHPC

3.2 Split tensile strength of concrete

Table -2: Split tensile strength

Mix	Mix ratio of materials			Average split tensile strength		
	GGBS %	Micro silica%	Glass fibre %	7 days	14 days	28 days
M1	25	0	2	6.78	9.2	10.5
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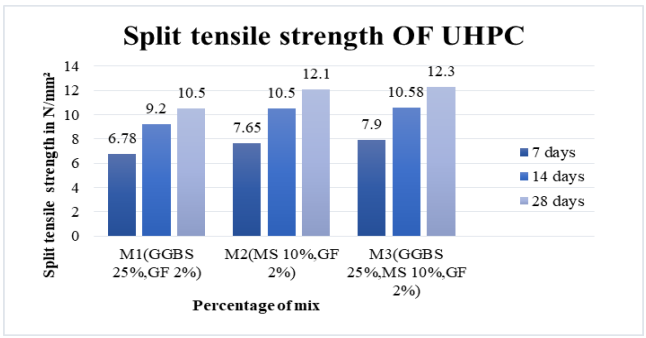

Chart -2: Split tensile strength of UHPC

3.3 Flexural strength of concrete

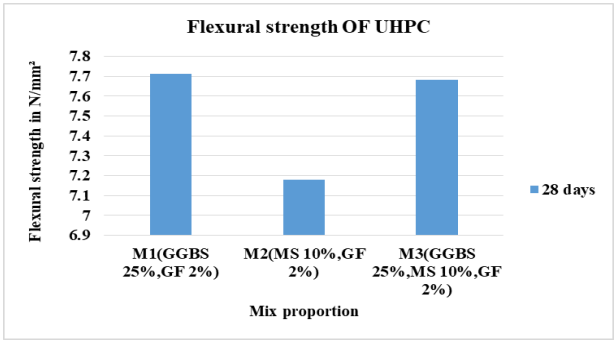

Chart -3: Flexural strength of UHPC

3.4 Deflection-Load relation

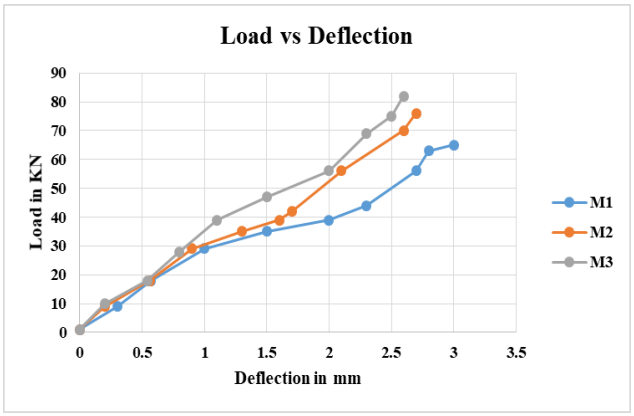

Chart -4: Deflection-Load relation of UHPC beam

3.5 Crack load

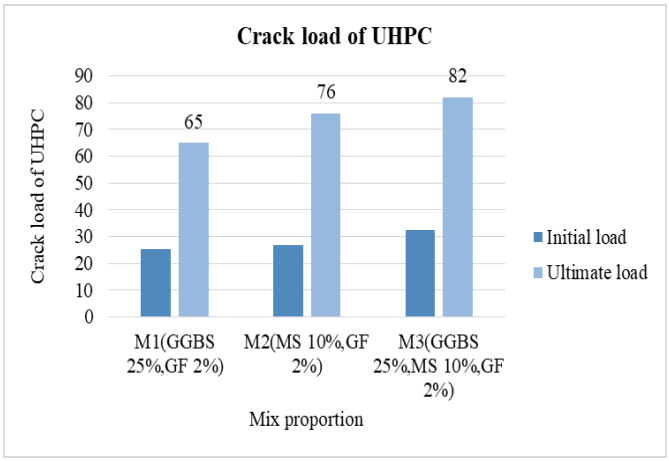

Chart -5: Crack load of UHPC beam

3.6 Crack width

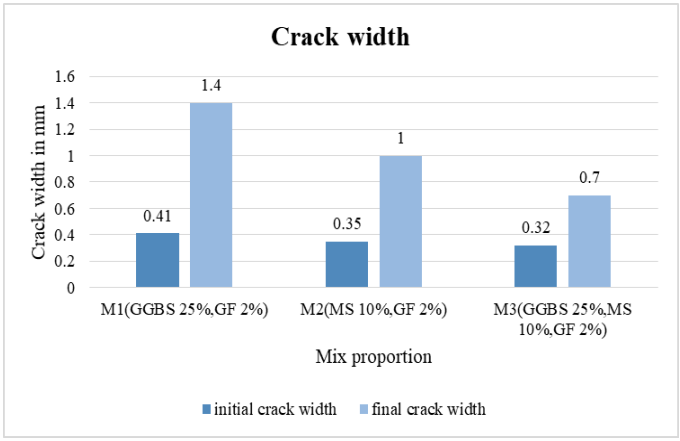

Chart -6: Crack width

3.7 Ductility factor

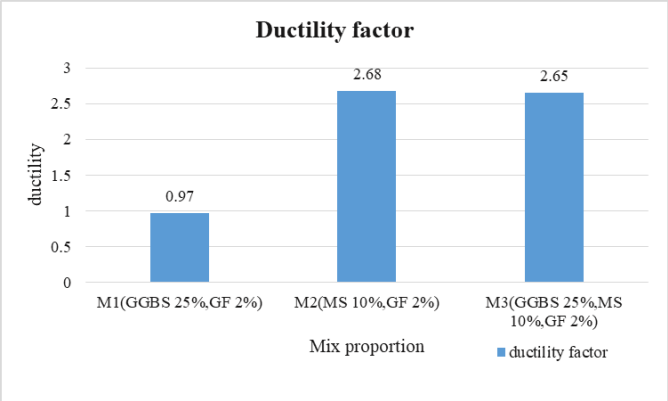

Chart -7: Ductility factor

4. CONCLUSIONS

- The mechanical properties were evaluated and it is been found that the compressive strength of 28 days was in the strength of 105 to 122 Mpa for M1 to M3 mix of concrete respectively. The flexural strength and splitting tensile strength were about 7.68 to 7.71 MPa and 10.5 to 12.3 MPa respectively, were similar to compressive strength result, thus confirming the effectiveness of utilizing the fibre, micro silica and GGBS.
- The use of alkaline resistant glass fiber has increased the tensile and flexural strength of concrete to a considerable level. We have used about 2% of glass fiber.
- The test on hardened concrete reveals that the strength obtained after curing for 28 days using micro silica is maximum when compared with other design mix.
- From the experimental result it can be observed that as the first crack load and ultimate load increases as micro is used.
- The deflection vs load graph shows that lesser deflection both micro silica and GGBS were added.
- The ductility of concrete beam is slightly greater when miro silica only used as GGBS reduces the ductility of concrete beam.

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