Axial Compressive Behaviour of Ultra High Strength Concrete Filled In Fiber Reinforced Polymertubes

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Abstract *- UHSC is widely used in bridges, high raise structures, replacing with Heavy weight structural elements etc. However higher the strength of UHSC, higher the material brittleness. Therefore, it is important to improve the ductility of UHSC. Concrete-filled FRP tubes owe their improved deformation capacities to the confinement action provided by the surrounding FRP tube. The lateral confinement can enhance both the strength and ductility of concrete. Thus the ductile behaviour of UHSC filled in GFRP tubes has to be studied. The effect of confinement with respect to corner radius and aspect ratio will be studied. Thus this experimental study will include the strength and ductile behaviour of the circular ultra high strength concrete filled FRP tubes.*

Key words: *Ultra high strength concrete, Glass Fiber reinforced polymer tubes, Strength, ductility.*

INTRODUCTION

Ever since the time of Romans, there has been a continuous effort by research scholars in the field of cement and concrete technology to produce better quality concrete. But it has two major drawbacks, namely low tensile strengthand limited deformation capacity

(i.e., low ductility). Due to this, reinforced concrete Structures, unlike steel structures, tent to fail in relatively brittle manner. The brittle failure of reinforced concrete members can be avoided only if the concrete is made to behave in ductile manner, so that, the member can undergo a large amount of inelastic deformation. It has been observed from the literature that the brittleness of concrete can be modified by confinement using GFRPTs.

1. ULTRA HIGH STRENGTH CONCRETE

In IS: 10262-1982, concretes are grouped in to three categories viz. ordinary concrete (M10 to M20), Standard Concrete (M25 to M55), high strength concrete (M60 to M100), and ultra high strength concrete (M100 to M150).

Conventional concrete has the following draw backs

- Permeable to moisture and air resulting in corrosion of steel reinforcement.
- Less resistance to abrasion and chemical attack.
- Unable to achieve the required / intended life span of structures due to environmental effects.

In order to overcome the above problems, considerable efforts have beenmade worldwide to develop Ultra High Strength Concrete.

1.1.Composition of Ultra High Performance Concrete

The composition of HPC usually consists of cement, water, fine sand, super-plasticizer, fly ash and silica fume. Sometimes, quartz flour and fiber are the Components as well for HPC having ultra strength and ultra ductility, respectively. The key elements of high performance concrete can be summarized as follows:

- Low water-to-cement ratio,
- Large quantity of silica fume (and/or other fine mineral powders),
- Small aggregates and fine sand,

- High dosage of super-plasticizers

1.2. Strength

In practice, concrete with a compressive strength less than 50MPa is regarded as NSC, while ultra-high strength concrete (UHSC) may be defined as that having a compressive strength of about 50MPa.Recently, concrete with the compressive strength of more than 200MPa has been achieved .Such concrete is defined as ultra-high strength concrete.fig1.2.shows FRPT experimental set up.

1.3. Ductility

UHSC is usually more brittle when compared with NSC, especially when high strength is the main focus of the performance. Based on the above discussion, it is known that the ductility can be improved by applying a confining pressure on UHSC. Besides confinement, the ductility of UHSC can be improved by altering its composition through the addition of fibers in the design mix.

1.4. Durability

The majority of concrete durability problems are related to the resistance of concrete to permeation of water and chemical ions. Such problems include corrosion of steel reinforcement, freeze-thaw damage, and alkaline-silica reaction. The durability evaluation of concrete may be inferred by measuring the resistance of cover layer to transport mechanisms such as diffusion coefficient, coefficient of permeability, rate of absorption, concrete resistivity and corrosion rate .The permeability of concrete is a key factor influencing the durability of concrete.

2. COMPOSITIONS OF DIFFERENT TYPES OF CONCRETE

UHSC is considerably more brittle than NSC. Meanwhile, UHSC has a larger Young's modulus than NSC and the post-peak softening branch is steeper. UHSC behaves linearly up to a stress level which is about 90% of the peak stress, whereas lower strength concrete shows nearly no linear part at all. When the peak stress has been reached, the stress decays rapidly in high strength concrete .A qualitative comparison of uni-axial compressive stress-strain curve of HSC with that of NSC is given in Figure 1.1.

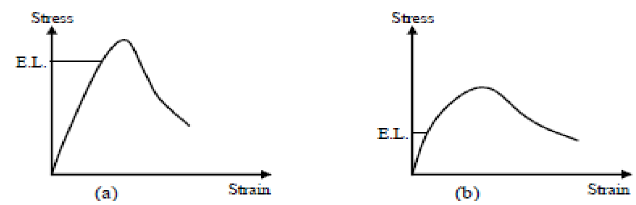

Fig 1.1 Schematic of Stress-strain Curve in (a) UHPC and (b) NSC under Uniaxial Compression.

3.EXPERIMENTAL INVESTIGATION

3.1 MATERIALS USED

Cement : The cement used in all mixture was commercially available Ordinary Portland Cement (OPC) of 43 grade confirmed to IS: 8112-1989. The initial and final setting times were found as 80 minutes and 453 minutes respectively.

Fine Aggregate : Locally available Natural River sand of size below 4.75 mm confirming to zone II of IS 383-1970 is used as Fine aggregate.the Laboratory tests were conducted for fine aggregate to determine its physical properties asIS: 2386 (Part III).

*Coarse Aggregate :*Coarse aggregate used in this study consist of crushed stone of size 12mm and below. Laboratory tests were conducted on coarse aggregate to determine the different physical properties as per IS: 383-1970.

Silica Fume: Silica Fume is a by-product of electric arc furnace used for the production of silicon metal or alloy, having specific gravity of 2.2 and bulk density of 720kg/m3.

Fibers tubes: fiber reinforced polymer tubes with dia of 75 cm, 100 cm, 150 cm with the various thickness of 03 cm, 0.6 cm, 0.9 cm and with the winding angle of 88 degrees.

*Super plasticizers:*Conplast SP430 is based on Sulphonated Naphthalene Polymer and supplied as brown liquid instantly dispersible in water, having specific gravity of 1.220 to 1.225@ 30°C

3.2. QUANTITIES OF MATERIALS

Cement = 650 kg

Fine aggregate = 488kg

Coarse aggregate = 975kg

Water = 150kg

Field density of fresh concrete = 2263 kg/m^3

4.EXPERIMENTAL PROGRAMME

4.1. GENERAL

The experimental program consisted of casting, curing and testing the cube of size 150x150x150 mm. To improve the workability of concrete Conplast is added while mixing the concrete.

4.2. CONDUCTING TEST TRAILS

The test mixes were started by taking the initial mix from the literature "Experimental investigation on ultra high strength concrete containing mineral admixtures under different curing conditions", studied and the further mixes were improved proportionally. For the same mixes, the additive material used is replaced with other materials. The mixes used for the test trails are given below. From the trail mixes, the best mix is deduced.

MATERIAL	RATIO	WEIGHT(Kg)
Cement	1	4.35
Fine aggregate	1	7.4
Silica fume	0.65	0.65
Coarse Agg	2	9.00
Water	0.285	1.50
Plasticizer	0.075	75

Table 4.1 Trial Mix

MATERIAL	RATIO	WEIGHT (Kg)
Cement	1	4.22
Fine aggregate	0.75	4.88
Silica fume	0.632	0.65
Coarse Agg	1.5	9.75
Water	0.285	1.50
Plasticizer	0.075	75

Table 4.2 Trial Mix

4.3 CASTING AND CURING:

Steel mould was used for casting the cubes. Before casting, machine oil was applied on the inner surface of the mould. Concrete was mixed using a tilting type laboratory mixer and was poured into the moulds in layers. Compaction of concrete was done using a needle vibrator. After 24 hours from casting, all the cubes were cured under water for a period of 28 days.

4.4 TESTING:

The specimens shall be tested in accordance with IS: 516-1959.All the cubes were tested under Compression Testing Machine (CTM).For loading the Cubes 2000 KN capacity hydraulic compression testing machine was used.

Fig 4.1.1 Specimen placed in CTM

Fig 4.1.2 Specimen placed in CTM

RESULTS AND DISCUSSION

The target mean strength of the concrete was to attain M120 using coarse aggregate in concrete. We have achieved M73 using coarse aggregate instead of using steel fibre in Ultra high strength concrete. Mixing of steel fibre with other ingredients in concrete is much difficult.

Neglecting steel fibre makes Ultra high strength concrete economical in every aspect. The Aggregate replacement gives good results but the Target strength can't be achieved. The Mixing of the Concrete was done with the help of Super plasticizer In order to achieve the workability. Basically the Water content is very less in ultra high performance concrete. A different size of coarse aggregates gives economical benefit comparing to Normal Concrete.

CONCLUSION

Following are the conclusions arrived based upon the studies:

- The compressive strength of UHSC specimens made using different proportion of coarse aggregate shows good results which are equal to M80 grade concrete.
- UHSC made using 0.53 coarse aggregate proportion had the highest compressive strength of 73 N/mm^2
- Neglecting steel fibre makes Ultra high strength concrete economical in every aspect.
- The optimum percentage of fine aggregate to be added to UHSC was found to be 70% of cement. Addition of silica fume decreases the particle size in concrete thus increases the compressive strength of the UHSC.

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