STRENGTH PROPERTIES OF HIGH VOLUME FLY ASH CONCRETE USING RECRON-3S FIBERS

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ABSTRACT

Concrete plays a vital role as a Construction material in the world. But the use of Concrete as a structural material is limited to certain extent by deficiencies ductility like brittleness, poor tensile strength and poor resistance to impact strength, fatigue, low ductility and low durability. In the present Scenario, waste materials from various industries and admixtures are added to the mix. Over 300 million tons of industrial wastes are being produced per annum by chemical and agricultural process in India. These materials pose Problems of disposal and health hazards. Recron-3s acts as "Secondary reinforcement" in Concrete which arrests shrinkage cracks resistance to impact/abrasion & greatly improves quality of construction. In this study, an experimental investigation shall be conducted on strength of concrete containing fly ash and Recron-3s fibers. Fly ash has to be added at a dosage of 30% and 40% and Recron-3S fibers has to be added at a dosage of 2% . In this paper, studies shall be conducted on M_{30} mix and tests like Compression test and Split tensile test shall be conducted. Finally the results of fiber reinforced concrete shall be compared with the conventional Concrete.

Key words: Concrete Industrial wastes, Fly ash, Recron-3s Fibers, secondary reinforcement, Fiber reinforced concrete, Conventional concrete.

INTRODUCTION

Concrete is a composite construction material, composed of cement (commonly Portland cement) and other cementitious materials such as fly ash and slag cement, aggregate (generally a coarse aggregate made of gravel or crushed rocks such as granite, plus a fine aggregate such as sand), water and chemical admixtures.

Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. The water reacts with the cement, which bonds the other components together, eventually creating a robust stone-like material. Concrete is used to make pavements, pipes, architectural structures, foundations, motorways/roads, bridges/overpasses, parking structures, brick/block walls and even boats.

The inclusion of Fly ash affects all aspects of concrete. As a part of the composite concrete mass, it can be used both as a fine aggregate as well as a cementitious component. It influences the rheological properties of fresh concrete as well as the finished product. It improves the strength, finish and durability of the hardened mass. It reduces segregation, bleeding and lowers the heat of hydration apart from the energy and

Fly ash:

Figure: Fly ash

Fly ash is a pozzolanic material that is chemically similar to ordinary Portland cement, however, the chemical constituents exist in varying degrees. When Portland cement product, calcium hydroxide or lime. Fly ash combines with this calcium hydroxide and forms calcium silicate hydrate. hydrates the reaction forms a material called calcium silicate hydrate and a by-

Table: Physical Properties of Indian Fly ash

S.No.	Properties	Range
1.	Percent passing 75 micron I.S sieve	71.4 to 95.90
2.	Percent passing 45 micron I.S sieve	45.0 to 88.80
3.	Fineness (Blain's air method) (cm^2/gm)	3300 to 6250
4.	Lime reactivity ($kg/cm^{2)}$)	50 to 62.40

Table: Chemical Composition of Indian Fly Ash

S.No	Properties	Range
1.	Silicon dioxide (SiO_2)	37.15 – 66.74
2.	Aluminium oxide (AbO_3)	18.31 – 28.87
3.	Iron oxide (Fe_2O_3)	3.23 – 21.94
4.	Calcium oxide (CaO)	1.30 – 10.80
5.	Magnesium oxide (MgO)	0.80 – 5.25
6.	Sulphur trioxide (SO_3)	Traces – 2.91
7.	Sodium oxide (Na_2O)	0.1 – 0.2
8.	Potassium oxide (K_2O)	0.3 – 0.5
9.	Loss –an-Ignition(L.I.O)	0.3-16.60

Advantages of fly ash:

- Superior pozzolanic action.
- Reduced water demand (for fly ash with low carbon content and high fineness).
- Improved workability.

- More effective action of water reducing admixtures.
- Reduced segregation and bleeding

Disadvantages of fly ash:

- Lower early strength.
- Finishing difficulties with concretes containing very high proportion of fly ash.
- Lower modulus of elasticity at early ages.

Uses:

Fly ash can be used for the following.

- For filing of mines
- For replacement of low lying waste land and refuse dumps.
- As a replacement in cement mortar
- For air pollution control
- For production of ready mixed fly ash concrete.
- For building of roads and embankments.

Artificial Fibers:

Figure : Recron -3S

Recron-3S is a secondary reinforcement product for construction developed in house by Reliance Industries Limited at state of Art R&D facility at Patalganga. The uniqueness of Recron-3S fiber is its triangular shape, which give better anchoring with concrete, which is not found in most of the fibers available worldwide.

Recon-3S Fibers act as an internal support system, facilitating the retention of a homogeneous mix. Fibers randomly oriented in the concrete matrix provide a unique bridging mechanism by virtue of which intrinsic cracks formed are intercepted and bridges by the fiber right at the micro level. Fiber parameters which govern the crack control and failure inhibition action include:

- High Fiber Area
- High Bond Strength
- Balanced Fiber Pull-Out & Rupture Strengths
- High Fiber Aspect Ration (L/D)

Recon-3S Fibers not only retards crack initiation but also reduces the crack width Expansion caused by long term thermal gradient exposure & induced stress due to dynamic & static loading on the structure.

Recon-3S Fiber exhibits better ductile characteristics & is found to sustain more load after peak before brittle failure.

Specifications of Recron 3S :

S.No	Specifications	Unit	Value
1	Chemical composition		Modified Polyester
2	Cross-section		Triangular
3	Diameter	Micron	30-40
4	Elongation	%	>100
5	Cut Length	Mm	6,12&18
6	Moisture Flat	%	<1.0
7	Melting Point	^{0}C	240-260
8	Softening Point	^{0}C	220
9	Specific Gravity	cc/g	1.34-1.40

APPLICATIONS OF RECRON 3S

- PCC & RCC like lintel,beam ,column ,flooring and
- Wall plastering.
- Foundation , tanks , manhole cover and tiles
- Plastering
- Roads and pavements
- Hollow blocks and precast

ADVANTAGES :-

- Rebound loss reduced by 50-70%
- Results in Saving of expensive mortar ,cement and sand
- Time taken for plastering is reduced and work is completed faster.

DOSAGE RATE:-

FOR CONCRETE

Use 12mm Recron -3S 900gms/ cubic meter

FOR PLASTER

Use 6mm Recron- 3s @ 125 gms/bag of cement of 50kgs,
In 1:4 cement sand ratio.

Dosage rate can be altered as per requirement.

Experimental work

Materials:

Raw materials required for the concreting operations of the present work are cement, fly ash, fine aggregate , coarse aggregate, water and Artificial (RECRON-3S) fibers.

Table : Quantities required for M30 grade concrete

S. No	CONSTITUENTS	CC	HVFAC	
			30% FA	40% FA
1.	Cement(kg/m^3)	415	207.5	166
2.	Fly ash(kg/m^3)	-----	207.5	249
3.	Total Cementitious material	415	415	415
4.	F.A(kg/m^3)	672	672	672
5.	C.A(kg/m^3)	1232	1232	1232
6.	Water (l/m^3)	166	133	127
7.	w/c ratio	0.40	0.32	0.31

Observations and Discussions

Design mixes without replacement of cement and with partial replacement of cement by fly ash were cast. These mixes have been denoted as CC for conventional concrete mix and HVFAC for High Volume fly ash Concrete mixes. M30 CC with a proportion of 1:1.52:2.97 and W/C ratio 0.40.

The concrete in fresh state was tested for slump and compaction factor for all mixes. After casting, the cubes and cylinders were tested for Compressive strength and split tensile strength. These tests were carried out at the age of 7days, 14days and28 days.

Fresh concrete properties:

Table: Slump Cone Test Results

S. No	MIX	SLUMP IN mm
1	M30 CC	91
2	M30 HVFAC 30%	82
3	M30 HVFAC 40%	73
4	M30 HVFAC 30% with 2% of Recron-3S (Admixtures)	84
5	M30 HVFAC 40% with 2% of Recron-3S (Admixtures)	78

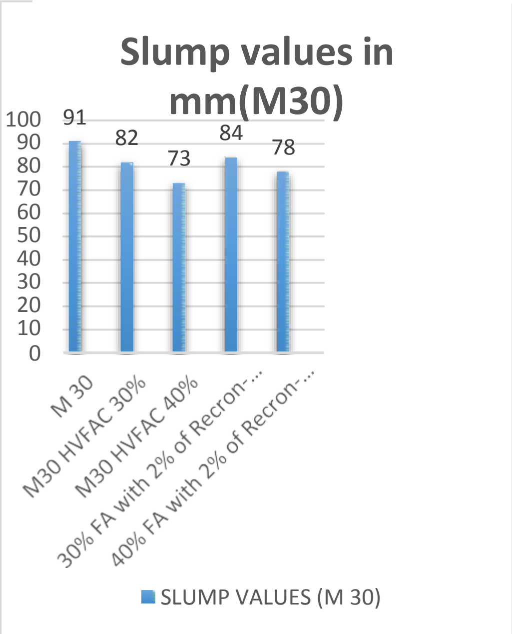

Figure : Graph showing slump values for M30 grade concrete

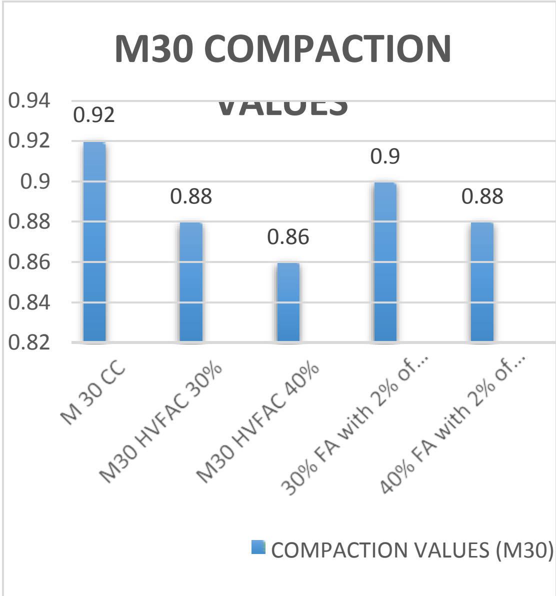

Figure : Graph showing C.F values for M30 grade concrete

Table : Compaction Factor Test Results

S NO	MIX	COMPATION FACTOR
1	M 30 CC	0.92
2	M 30 HVFAC 30 %	0.88
3	M 30 HVFAC 40 %	0.86
4	M 30 HVFAC 30 % With 2% of Recron-3S (Admixtures)	0.90
5	M 30 HVFAC 40 % With 2% of Recron-3S (Admixtures)	0.88

Hardened Properties

M30 grade of concrete:

Table: Compressive Strength Test Results

DESIGNATION OF MIX		Compressive STRENGTH(N/mm^2)		
		7 DAYS	**14 DAYS**	**28 DAYS**
M 30	CONVENTIONAL CONCRETE	36	45	47
	HVFAC (30% FLY ASH)	30	38	42
	HVFAC (40% FLY ASH)	18	31	36
	HVFAC (30% FLY ASH) With 2% of Recron-3S (Admixtures)	36	40	44
	HVFAC (40% FLY ASH) With 2% of Recron-3S (Admixtures)	32	32	38

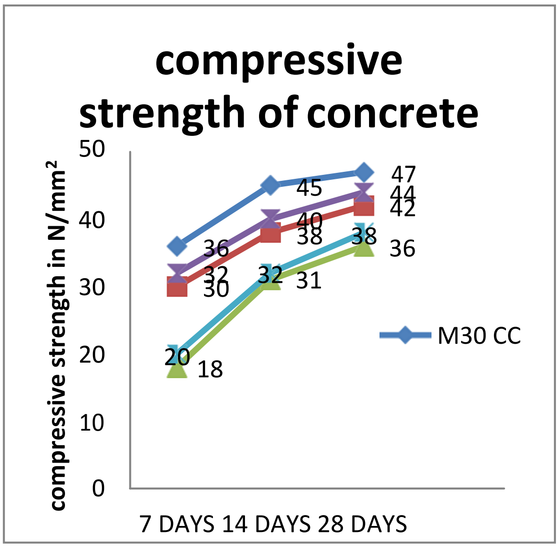

Figure: Graph between Compressive strength of concrete and no of days

Table: Tensile Strength Test Results

DESIGNATION OF MIX		TENSILE STRENGTH(N/mm²)		
		7 DAYS	14 DAYS	28 DAYS
M 30	CONVENTIONAL CONCRETE	3.55	4.21	5.21
	HVFAC (30% FLY ASH)	2.97	3.89	4.39
	HVFAC (40% FLY ASH)	1.94	2.43	3.36
	HVFAC (30% FLY ASH) With 2% of Recron-3S (Admixtures)	3.12	4.00	4.52
	HVFAC (40% FLY ASH) With 2% of Recron-3S (Admixtures)	2.12	3.13	4.26

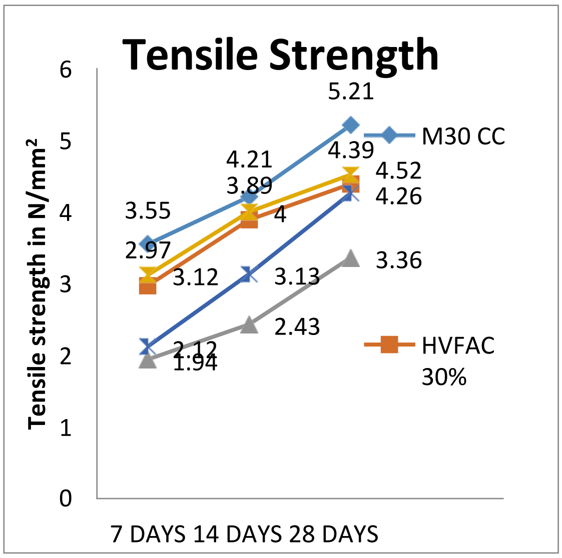

Figure : Graph between Split tensile strength of concrete (M30) and no of days

Conclusions:

Following conclusions can be drawn from the experimental investigations carried out:

- The slump has decreased by 9% and 18% for M30 HVFAC30% and M30 HVFAC40% mixes when compared with M30 CC mix. Hence the degree of workability was found to be good.
- The compaction factor has decreased by 2% and 6% for M30 HVFAC30% and M30 HVFAC40% mixes when compared with M30 CC mix. Hence the degree of workability was found to be almost same as conventional concrete mix (M30 CC).
- The setting time for the HVFAC mixes was delayed by 48 hours.
- Replacement of cement with fly ash can be carried out in M30grade. The experimental investigation shows that cement can be successfully replaced by fly ash. This would result in minimize the production of cement and the other hand it would also reduce the pollution while utilizing

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