Experimental Study on Effect of Fly Ash as Partial Replacement of Cement in Strength Characteristics of Self Cured Fibre Reinforced Concrete

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Abstract

Among most of the challenges faced by concrete the one critical hurdle is lack of curing due to many factors like labours unavailability, scarcity of water inaccessibility of structures etc. The present study involves the use of self-curing agent super absorbent polymers (SAP) as an admixture in concrete which is also added fibers. The fibers are added were Alkali Resistance (AR) glass fiber which has high dispersion and tensile strength in idea to enhance the strength properties of concrete. On the other hand the incredible material fly ash is to be used as partial replacement of cement. The ideology of the investigation in the study is by fixing the SAP percentage as 0.3% of weight of cement and AR glass fibers as 0.03% of volume fraction of concrete and varying the fly ash percentage as 0%, 10%, 20%, 30%, 40% and 50% for partial replacement of cement and to observe the optimum mix proportion for better strength characteristics of fixed grade of concrete (M40).

The idea of varying the fly ash content aroused from looking upon the gap in researches that deals with the SAP as internal curing agent and AR glass fibers. Many papers showed that fly ash percentage is fixed and works were carried out. Since optimization of fly ash content is necessary when each different type of concreting are to be tried practically and the same is taken as main goal of this study.

Keywords *- Super absorbent polymers(SAP),Sodium polyacrylate, AR glass fibres, flyash, self- curing concrete, SEFFCON,SEFCON.*

I. INTRODUCTION

A. *Self Curing*

Curing plays a major role in developing the concrete microstructure and pore structure. Good curing is not practically possible in most of the cases. The self-curing concrete means that no external curing required for concrete. The concept of self-curing is to reduce the water evaporation. As defined by ACI, “Self or 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.” Self-curing distributes the extra curing water (uniformly) throughout the entire 3-D concrete microstructure so that it is more readily available to maintain saturation of the cement paste during hydration, avoiding self-desiccation (in the paste) and reducing autogenous shrinkage.

Laxity in curing will badly affect the strength and durability of concrete. This happens due to human negligence, paucity of water in arid regions, inaccessibility of structures in difficult terrains. In areas where the water is contaminated by fluorides and other chemicals will affect the character of concrete undesirably. Self-curing is one of way to mitigate the above problems. Self-curing is phenomenon by which the water required for curing is provided from internally i.e. inside from concrete mass itself, while conventional curing is mostly done externally. Self-curing of concrete is attained by many methods now a days as some important methods are using water saturated light weight coarse aggregates like pumice, expanded shale etc., by usage of saturated wood fibers and wetted crushed fines in concrete, and also with the help of some chemical compounds like Polyethylene Glycol and some bio materials. In this experimental study the trending material in research as self-curing agent used was Super Absorbent Polymer (SAP) chemical name is sodium polyacrylate.

B. *Fiber Reinforced Concrete*

Experimental trials and patents involving the use of discontinuous steel reinforcing elements—such as nails, wire segments, and metal chips—to improve the properties of concrete date from 1910. During the early 1960s in the United States, the first major investigation was made to evaluate the potential of steel fibers as reinforcement for concrete. Since then, a substantial amount of research, development, experimentation, and industrial application of steel fiber reinforced concrete has occurred. Use of glass fibers in concrete was first attempted in the USSR in the late 1950s. It was quickly established that ordinary glass fibers, such as borosilicate E-glass fibers, are attacked and eventually destroyed by the alkali in the cement paste. Considerable development work was directed towards producing a form of Alkali-resistant glass fibers containing zirconia. This led to a considerable number of commercialized products.

C. Fly-ash

Fly ash is one of the residues generated in combustion, and comprises the fine particles that rise with the flue gases. Ash which does not rise is termed bottom ash. In an industrial context, fly ash usually refers to ash produced during combustion of coal. Fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys of coal fired power plants, and together with bottom ash removed from bottom of furnace is in this case jointly known as coal ash. In present experimental study the idea is to use the fly ash as partial replacement for cement at various proportions and to optimize its value for strength characterizations.

II. LITERATURE REVIEW

[1]S. Jemin Joel, S. Varatharajan, D. Maruthachalam, S. Antony Jeyendran (2014) investigated the influence of Polypropylene fiber on fresh and hardened properties of concrete which is self-cured with super absorbent polymer. Their work main aim is to optimize the percentage of polypropylene fiber content in self-curing concrete and they achieved it. The self-curing is attained by use of super absorbent polymer of 0.3% by weight of cement. The polypropylene fiber content is varied as 0.1%, 0.2%, 0.3% & 0.5% by weight of cement and they optimized 0.3% of fiber for its strength characteristics for M40 grade concrete. They have recommended that the effectiveness of internal curing by means of SAP applied to concrete is the highest if 45 kg/m3 water is added by means of 1 kg/m3 of SAP.

[2] B.J. Olawuyi & W.P. Boshoff (2013) reported on the absorption capacity of super-absorbent-polymer (SAP) in water and cement pore solution. This was considered for the free water requirement for high-performance concrete containing SAP. The rheology and compressive strength properties of this low water/binder (w/b) concrete are reported.

[3] Vivek hareendran, V. Poornima and G. Velrajkumar (2014) experimentally investigated the strength aspects of internal curing concrete using super absorbent polymer and studied 0.2, 0.25, 0.3, 0.35 and 0.4 percentages of SAP are used to produce different mixes of self-curing concrete. The optimum dosage for M50 grade concrete is determined. The control mix was proportioned by IS 10262: 2009 to obtain compressive strength of 50 Mpa. The mixes 1, 2, 3, 4, 5 and 6 were obtained by adding SAP content 0%, 0.2%, 0.25%, 0.3%, 0.35% and 0.4% of weight of cement. Additional water added to the mix depends upon the amount of SAP added (for 1 kg SAP add 45 liters water). .They have concluded that the maximum compressive strength , split tensile strength and flexural strength developed in M-50 grade self-curing concrete by adding SAP 0.35% of cement. [5] Chandramouli K., Srinivasa Rao P., Pannirselvam N., Seshadri Sekhar T. and Sravana P.(2010) investigated the strength properties of AR Glass fiber concrete. They experimentally investigated the alkali resistance glass fibers has been used to study the effect on compressive, split tensile and flexural strength on M20, M30, M40 and M50 grades of concrete.

[18] Jo Jacob Raju and Jino John (2014) studied the strength of high volume fly ash concrete with fibers. They have done attempt to study the mechanical properties of High Volume Fly-Ash Concrete with addition of fibers at 0.1, 0.2, and 0.3% of cement and with 60% fly ash replacement with cement. The fibers used are polypropylene fibers. They developed the mathematical model (regression model) for compressive strength, split tensile strength and flexural strength at 90 days. They optimized mix with 0.2% of steel fiber as optimum for compressive strength. [19] Md. Moinul Islamc and Md. Saiful Islam (2010) reported the strength behavior of mortar using fly ash as partial replacement of cement. The cement mortar is made with partially replaced the cement with six percentages (10%, 20%, 30%, 40%, 50% and 60%) of class F fly ash by weight. OPC cement is used. Among the six fly ash mortars, the optimum amount of cement replacement in mortar is about 40%, which provides 14% higher compressive strength and 8% higher tensile strength as compared to OPC mortar.

III. SUMMARY OF LITERATURE AND RESEARCH SIGNIFICANCE

The research works with SAP were carried out satisfyingly by mixing with concrete and optimizing it values for content proportion with concrete to achieve self-curing concrete for better strength character and the values were optimized for SAP is 0.3 to 0.35 % of weight of cement. It is also carried out the studies of the strength behavior of fibers with concrete when it is self-cured either SAP or by other means of IC agents. From the journals which completely dealing with fibres it is came to AR Glass fibers have many superior characters than other fibers. Many research carried out by replacing the cement content by fly ash but in self-curing concrete the varying content of fly ash used less significantly**.**

Even the experimental studies with SAP in concrete in previous research works and others are quite satisfactory they were represented only general cement types such as OPC and PPC. The influence of fly ash amount with the SAP content is not yet studied since it becoming massive partial/full replacement of cement now-a-days. The combination of AR Glass fiber reinforced concrete which is self-cured with help of SAP and with varying percentage of fly ash is also not yet investigated. Certainly the objective of my work is also tried to fill the above stated gaps in researches.

IV. IDEOLOGY

The ideology of the investigation in this study is by fixing the SAP percentage as 0.3% of weight of cement and AR glass fibers as 0.03% of volume fraction of concrete and varying the fly ash percentage as 0%, 10%, 20%, 30%, 40% and 50% for partial replacement of cement and to observe the optimum mix proportion for better strength characteristics of fixed grade of concrete (M40).

V. MATERIALS USED AND ITS PROPERTIES

The details and properties of materials used in the study was given below

A. Cement

Cement is a binder, a substance that sets and hardens as the cement dries and also reacts with carbon-di-oxide in the air dependently, and can bind other material together

GRADE OF CEMENT: Ordinary Portland Cement 53 grade *(DALMIA 53 GRADE SUPER ROOF)* conforming to IS: 12269 -1987 and IS: 4031 (Part 6) – 1988.

Table I. Cement Properties

S.No.	Description	Obtained result	Reference
1	Specific Gravity	3.15	IS : 2720 (Part III/Sec1) - 1980
2	Fineness	4%	(IS : 4031 – 1996 Part 1)
3	Consistency	30%	IS : 4031 – 1988 Part 4)
4	Initial setting time	32 minutes	(IS : 4031 – 1988 Part 5)

B. Coarse aggregate

Hard blue metal granite broken stones were used as coarse aggregate with 20 mm – 9.5mm. The specific gravity, fineness modulus, water absorption and bulk density of the coarse aggregate were tested as per IS 383-1970.

C. Fine aggregate

The fine aggregate serve the purpose of filling all the open spaces in between the coarse particles. Thus it reduces the porosity of the final mass and considerably increases its strength. Usually natural river sand is used as a fine aggregate, confirmed to grading zone II of IS 383-1970.

TABLE II. PHYSICAL PROPERTIES OF FINE AGGREGATE AND COARSE AGGREGATE

DESCRIPTION	FINE AGGREGATE	COARSE AGGREGATE
Specific gravity	2.67	2.74
Water absorption	1.57%	2.3%
Fineness modulus	3.15(zone II)	6.4
Surface moisture	Nil	Nil
Bulk density	1725 kg/m^3	1773kg/m^3

D. Fly ash

The fly ash originated from Mettur thermal power plant is collected from Rank Enterprises, Salem which brick making company using fly ash. The fly ash originated in MTP is class F conforming to IS 3812 part I which is used as partial replacement for cement at varying proportions.

TABLE III. PHYSICAL PROPERTIES OF FLY ASH

S.No.	Description	Obtained result	Reference
1	Specific Gravity	2.37	IS : 2720 (Part III/Sec1) - 1980
2	Fineness	2%	(IS : 4031 – 1996)

TABLE IV. CHEMICAL PROPERTIES OF FLY ASH

Characteristics	Percentage (%)
Silica	42.50
Iron Oxide	8.3
Aluminum Oxide	38.3
Calcium Oxide	2.24
Magnesium Oxide	0.6
Titanium Oxide	<1
Phosphorous	<1
Sulphates	0.1

E. Alkali Resistance Glass fibres

AR Glass fibre consumed from Chemzest Enterprise , Chennai which they imported it from Nippon Electric Glass ,Co., Ltd. The properties of AR Glass fibres given by them are shown following table v

<table>
<tr><th colspan="2">ITEM</th><th>PROPERTIES</th><th>IN CONV UNITS</th></tr>
<tr><td colspan="2">DENSITY</td><td>170 pcf</td><td>2723 kg/m^3</td></tr>
<tr><td colspan="2">FIBRE DIAMETER</td><td>0.00053 inch</td><td>13.462 microns</td></tr>
<tr><td colspan="2">TENSILE STRENGTH</td><td>> 1.85 X 10^5 psi</td><td>> 1276N/mm^2</td></tr>
<tr><td colspan="2">YOUNGS MODULUS</td><td>1.1 X 10^7 psi</td><td>> 75843 N/mm^2</td></tr>
<tr><td colspan="2">STRAIN</td><td>> 1.5 %</td><td>> 1.5 %</td></tr>
<tr><td rowspan="4">ALKALI RESITIVITY</td><td rowspan="2">WEIGHT LOSS</td><td>ARG FIBER</td><td>0.85%</td></tr>
<tr><td>E-type glass fibre</td><td>10.5%</td></tr>
<tr><td rowspan="2">TENSILE STRENGTH RETENTION</td><td>ARG FIBRE</td><td>75%</td></tr>
<tr><td>E-type glass fibre</td><td>14%</td></tr>
</table>

TABLE V. PROPERTIES OF AR GLASS FIBRES

F. Super Absorbent Polymer(SAP)

Super absorbent polymer or chemical name as Sodium polyacrylate (also called as slush powder) is polymers that can absorb and retain extremely large amounts of a liquid relative to their own mass. A SAP's ability to absorb water is a factor of the ionic concentration of the aqueous solution. In deionized and distilled water, a SAP may absorb 500 times its weight (from 30 to 60 times its own volume) and can become up to 99.9% liquid, but when put into a 0.9% saline solution, the absorbency drops to maybe 50 times its weight. The presence of valence cations in the solution impedes the polymer's ability to bond with the water molecule.

SAP also consumed from Chemzest Enterprise, Chennai the properties given by them for absorbency limits were shown also for purpose of the free water absorbency test is done by tea bag test method and filter paper test method. The procedure is very simple that known weight (0.1 gram) of SAP is taken and put in fitter paper or tea bag which wet empty weight is already determined. Now the filter paper or tea bag is allowed to suspend inside water that SAP fully immersed in water. The SAP is gradually absorbs water and tea bag or filter paper is weighed which may be deducted from earlier empty wet weight + dry SAP weight taken. The absorbency gradually increases and reduced with time and after 90 mins the resorption takes places in very slow manner.

TABLE VI. PROPERTIES OF SAP

Item		SAP
Appearance		White fine granular powder
g/g Free Absorbency	Distilled water	350 – 500
	0.9 % NaCl	≥ 50
(CRC), g/g Centrifugal Retention Capacity		≥ 30
(AUL) (0.3 PSI), g/g Absorbency Under Load		≥ 28
(AUL) (0.7 PSI), g/g Absorbency Under Load		≥ 20
Absorption Speed (by Vortex Method)		≤70
Particle Size		85 -50 mesh
pH Value		6.0 -7.0
% of moisture		≤5

Table VII. Test Results of Tea Bag Method and Filter Paper Method

Time	Absorbency by tea bag test	Absorbency by filter paper test
5 MINS	110 g/g	110 g/g
10 MINS	140 g/g	140 g/g
30 MINS	80 g/g	112 g/g
>90 MINS	56 g/g	85 g/g

The free water absorption is assessed to be good that is greater than 50 g of water by 1 g of SAP is absorbed by both preliminary tests. The water absorption capacity of SAP may be reduced when mixed with concrete at fresh state and also suggestions from literature that water absorption of SAP is considered as 30 g/g and additional water is added to mix.

VI. MIX DESIGN

The mix design for concrete M40 grade is arrived based on the code IS 10262:2009. From this mix design, we can get the quantities of ingredients by weight for 1m^3 of concrete. From these values, the quantities of ingredients for the required volume of concrete are determined. In this way, the quantities of ingredients by weight are determined for all the percentage of replacement such as 0% to 50% replacement of cement with fly ash and additives AR glass fibre and SAP.

TABLE VIII. MIX PROPORTION VALUES FOR ALL MIX DESIGNS

Mix Name	% fly ash replace-ment	Cement (kg /m^3)	Fly ash (kg/m^3)	Water (Lit / m^3)	FA (kg /m^3)
CONVENTION	0	490	0	186	626
SEFFCON – 0	0	490	0	186	626
SEFFCON – 1	10	485.1	53.9	186	606
SEFFCON – 2	20	431.2	107.8	186	601
SEFFCON – 3	30	377.3	161.7	186	595
SEFFCON – 4	40	323.4	251.6	186	590
SEFFCON – 5	50	269.5	269.5	186	585

CONT…..

Mix Name	CA (kg /m^3)	SAP (kg /m^3)	Additional water content for SAP (kg /m^3)	Total water content (lit /m^3)	Fiber content (kg /m^3)
CONVENTION	1163	0	0	186	0
SEFFCON – 0	1163	1.47	44.1	230	0.816
SEFFCON – 1	1125	1.617	48.51	234.51	0.816
SEFFCON – 2	1115	1.617	48.51	234.51	0.816
SEFFCON – 3	1105	1.617	48.51	234.51	0.816
SEFFCON – 4	1095	1.617	48.51	234.51	0.816
SEFFCON – 5	1085	1.617	48.51	234.51	0.816

A. Methodology & Preparation Of Specimen

The specimens are cast for the various percentages of replacement of cement with fly ash such as 0 %, 10% to 50% . In every percentage of replacement 3 numbers of cube and cylinders and 2 numbers of prism were casted. Before casting, the specimens are cleaned, and then oil coating is applied to the inner side of mould. Then the concrete is poured into the moulds, and then compacted manually and then finishing is done by using trowel. Then the specimens are kept undisturbed for one day for the purpose of the hardening of the concrete. After one day, the specimens are demoulded, and then specimens allowed for self-curing. After 28 days from the day of casting, the specimens are tested.

VII. RESULTS AND DISCUSSION

A. Fresh Concrete Property

Slump is a measure indicating the consistency or workability of fresh concrete. Slump test as per IS: 1199:1959 is followed. It gives an idea of water content needed for concrete to be used for different works. The apparatus used for doing slump test are Slump cone and tamping rod. Bottom diameter is 200mm, top diameter is 100mm and height is 300mm.ber equations consecutively. The design slump taken for mix design is 25-50mm as per IS 456-2000.

Table IX. Slump Value All Mix Designs

MIX	SLUMP VALUES (mm)
CONVENTIONAL	32
SEFFCON-0	51
SEFFCON-1	44
SEFFCON-2	35
SEFFCON-3	27
SEFFCON-4	25
SEFFCON-5	22

The slump values are determined to be within design limit. With addition of SAP slump value increased and with increase in replacement percentage of fly ash slump value decreases.

B. Hardened Concrete Property

1) Compressive Strength

The important property of concrete is its strength in compression. Compression test is the most common test conducted on hardened concrete property, partly because it is an easy test to perform, and partly because most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength. Cubes of size 150mm×150mm×150mm were casted and after 28 days the specimen was tested under compression testing machine.

SEFFCON-SElf cured Fibre reinforced Fly ash replaced CONcrete
The numbers 0to 5 indicates 0% to 50% replacement of fly ash

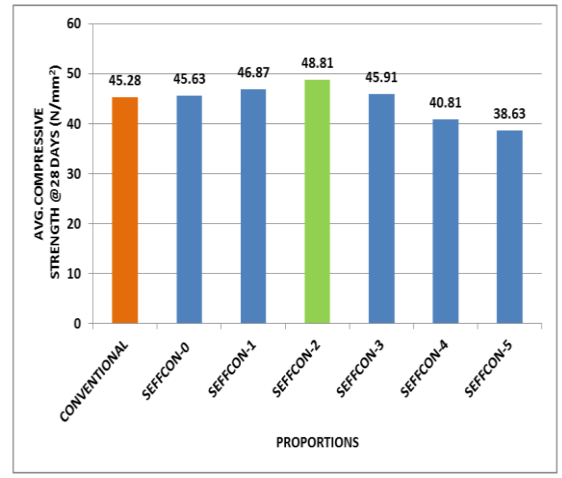

Fig 1. Comparison of Compressive Strength Test Results

From the "Fig.1" it can be seen that the compressive strengths of self-cured fibre reinforced concrete is more than conventional 0% to 30% and then reduced for 40% and 50%.The optimum compressive strength is investigated to be for the mix SEFFCON-2 (20% replacement with fly ash).

2) Split Tensile Strength

To find split tensile strength of concrete cylindrical specimen (150mm diameter and 300mm height) were casted and tested under CTM at horizontal position. The results of split tensile strength for various proportions are presented in graph below

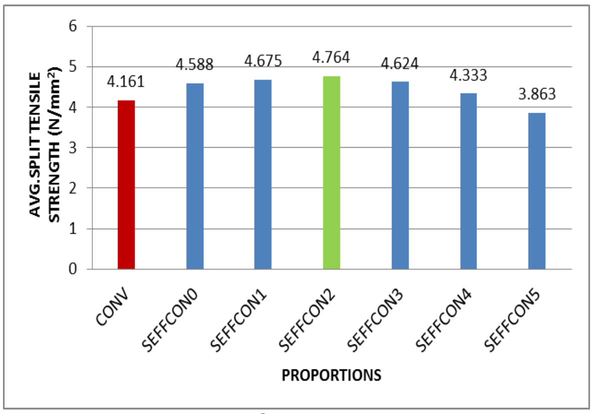

Fig 2. Comparison of Split Tensile Strength Test Results

From "Fig 2" the split tensile strength of proportions from 0% to 40% are higher than conventional only 50% replacement is lower .Among the proportions 20% (SEFFCON-2) has higher strength.

*3) **Flexural Strength using Prisms***

To find flexural Strength of concrete prism specimen (100mm x100mm x500mm) were casted for all proportions and tested according to IS 516-1959.

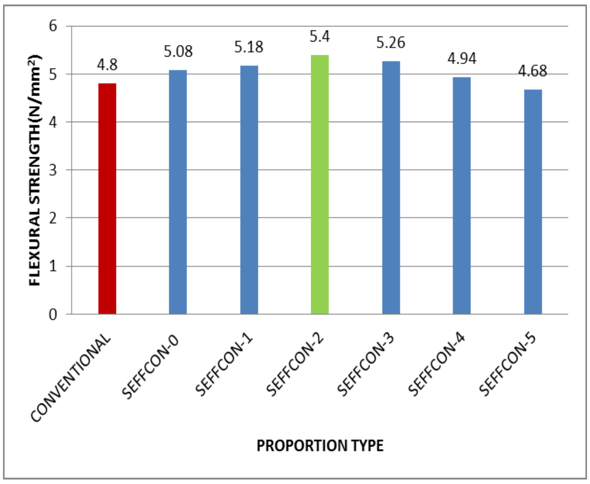

Fig 3. Comparison of Flexural Strength TEST Results

From Fig 3. the flexural strength for all proportion are higher than conventional except 50% replacement and here also the optimum percentage for strength is 20% replacement proportion.

*4) **Reinforced Concrete Beams***

From the strength tests it is investigated that SEFFCON-2,i.e.,20% of cement replaced with fly ash giving the optimum values of strength. RC Beams were casted for optimum proportion.

1) Proportion details of beams

a) ORDINARY : Conventional mix and curing M40 grade,

b) SEFFCON-2 : Beam self-cured with SAP , 20% cement replaced with fly ash WITH fibres

c) SEFCON-2 : Beam self-cured with SAP , 20% cement replaced with fly ash WITHOUT fibres.

2) Reinforcement details of beams

Cross sectional details and longitudinal details of R.C.C rectangular beams are shown in Fig.4

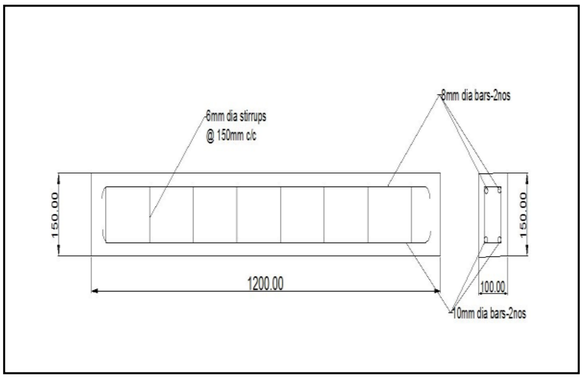

Fig 4. Reinforcement Details (All dimensions are in mm)

3) Flexural strength test

R.C.C beam of dimensions 100mmx150mmx1200mm were casted and tested under UTM with bearing length of 100mm on both sides. The beams are tested under three point load condition and ultimate loads were determined for each beam and deflection was taken nearer to breaking loads.

Fig 5. Three Point Loading Flexural Test of RC Beam

4) Test Results

For M40 grade conventional, optimized 20% fly ash replacement with fibre (SEFFCON-2) and same proportion without fibre addition (SEFCON-2) were casted and tested at age of 28 days then the flexural behaviors were compared.

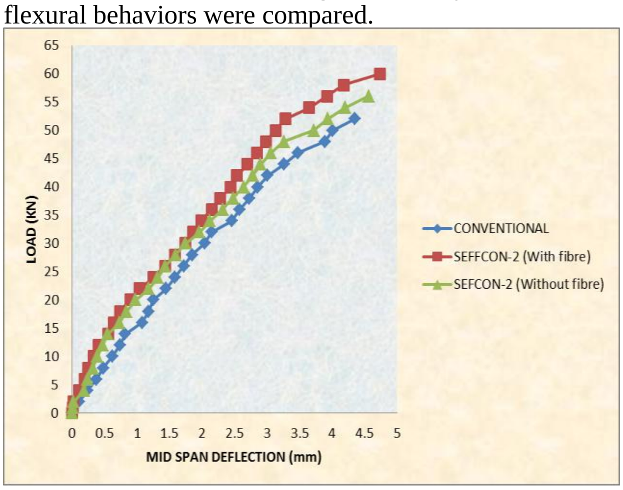

Fig 6. Comparison of Load Vs Deflection curve for Conventional , SEFFCON-2,SEFFCON-2(all are M40 grade)

From test done for beam and its load deflection curve some important properties of beam for flexural behavior is determined and given below in Table X

Table X. Flexural Behavior of RCC Beams

S.NO	PARAMETERS	CONVENTIONAL	SEFCON-2 (WITHOUT FIBRE)	SEFFCON-2 (WITH FIBRE)
1	INTIAL CRACK LOAD (kN)	14	16	22
2	ULTIMATE CRACK LOAD (kN)	62	68	76
3	TOUGHNESS INDEX **(I_5)**	6.38	5.88	7.38
4	ENERGY ABSORBTION CAPACITY (kN-mm)	240.10	254.13	360.92
5	MODE OF FAILURE OF SPECIMEN	Flexure	Shear	Flexure

The Fig.7 shows tested beams top-SEFFCON-2, middle-SEFCON-2, and bottom SEFFCON-2 and their crack plus deformation and failure patterns.

Fig 7. Tested RC Beam Specimens

VIII. CONCLUSION

From the summary of this experimental work, the following conclusions were arrived.

- The optimum percentage of fly ash for maximum strength (compressive, split tensile and flexural) was found to be 20% for concrete which is self-cured fibre reinforced concrete with 0.3% by weight of cement of SAP and 0.03% volume of concrete of AR glass fibre respectively.
- Workability increases with SAP addition compared to conventional concrete and decreases after 30% replacement of fly ash.
- From all strength test conducted it have been seen that the optimum percentage replacement (SEFFCON-2) have considerably higher strength than conventional concrete. That is SEFFCON-2 have compressive strength-7.8%, split tensile strength-14.5%, flexural strength-12.5% more than conventional concrete.
- From flexural test by RCC Beam it is noted that the first crack load and ultimate load are quite higher for proportion with fibre SEFFCON-2 than proportions without fibre conventional and SEFCON-2.
- It is observed that compared to conventional and SEFCON-2 the beam for SEFFCON-2 proportion developed minimum cracks. It shown clearly that AR Glass fibre successfully arrested the cracks and increases the performance of beam.
- Since the SAP's performance alone with concrete studied satisfyingly in earlier researches , in this work it is quite satisfactory to say that its strength character with two other materials fly ash and AR Glass fibres are investigated.

IX. SCOPE FOR FURTHER STUDIES

- There is an idea in this project work to study hydration property cement with SAP and fly ash replacement to know how hydration affected by these two materials.
- Also the shrinkage and other durable properties are recommended to study since it is self-curing and fly ash added.
- In this study the AR glass fibre content is fixed as 0.03% by volume of concrete it can be studied in future by varying its percentage upto 0.1% in which earlier researches done for conventional concrete.
- In this study no super plasticizers used even it is M40 grade because to obtain virgin results, it is also recommended to study with super plasticizers.
- From this work it can be observed that for higher percentage of replacement of fly ash (40% and 50%) the strength result considerably low and in future it is recommended to make use of some alkaline activators and also using class C fly ash which may increase strength and pave a pathway to develop the Geopolymer concrete, the eco-friendly and sustainable concrete.

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REFERENCES

[1] S. Jemin joel, S. Varatharajan, D. Maruthachalam, S. Antony jeyendran "Influence of Fibres on Fresh and Hardened Properties of Self-Curing Concrete" International Journal of Advanced Structures and Geotechnical Engineering ISSN 2319-5347, Vol. 03, No. 01, January 2014,pp 7-10.

[2] B.J. Olawuyi & W.P. Boshoff "Compressive strength of high-performance concrete with absorption capacity of Super-Absorbing-Polymers (SAP)" Research and Applications in Structural Engineering, Mechanics and Computation – Zingoni (Ed.)© 2013 Taylor & Francis Group, London, ISBN 978-1-138-00061-2.

[3] Vivek hareendran, V. Poornima and G. Velrajkumar "Experimental investigation on strength aspects of internal curing concrete using super absorbent polymer" International Journal of Advanced Structures and Geotechnical Engineering ISSN 2319-5347, Vol. 03, No. 02, April 2014 pp. 134-137.

[4] M.Manoj Kumar and D.Maruthachalam "Experimental Investigation on Self-curing Concrete" International Journal of Advanced Scientific and Technical Research Issue 3 volume 2, March-April 2013 pp. 300-306.

[5] Chandramouli K, Srinivasa Rao P., Pannirselvam N., Seshadri Sekhar T. and Sravana P "STRENGTH PROPERTIES OF GLASS FIBRE CONCRETE" ARPN Journal of Engineering and Applied Sciences, ISSN 1819-6608, VOL. 5, NO. 4, April 2010.

[6] R. Aarthi, R. Venkatakrishnaiah "Strength Behavior of Self-Curing Fly Ash Concrete using Steel Fiber" International Journal of Advanced Research in Civil,Structural,Environmental and Infrastructure Engineering and Developing, Volume: 2 Issue: 1 08-May-2014,ISSN_NO: 2320-723X.

[7] Deshmukh S.H. ,Bhusari J.P , Zende A.M. " Effect of glass fibres on ordinary portland cement concrete" IOSR journal of engineering ,june 2012, vol. 2(6) pp: 1318-1322.

[8] Shrikant Harle "Glass Fiber Reinforced Concrete & Its Properties" INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY, [Harle, 3(1): January, 2014] , ISSN: 2277-9655 pp.118-120.

[9] Moayyad Al-Nasra1, Mohammad Daoud2 "Investigating the Use of Super Absorbent Polymer in Plain" International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 8, August 2013.

[10] O. Mejlhede Jensen (Denmark) "Use of Superabsorbent Polymers in Concrete" Journal on Concrete international, january 2013, pp.48-52.

[11] Prof. Jayeshkumar Pitroda, Dr. L.B.Zala, Dr.F.S.Umrigar "Experimental Investigations On Partial Replacement Of Cement With Fly Ash In Design Mix Concrete" International Journal of Advanced Engineering Technology E-ISSN 0976-3945 Vol.III/ Issue IV/Oct.-Dec., 2012/126-129.

[12] Khadake S.N.*, Konapure C.G. "An Experimental Study of Steel Fiber Reinforced Concrete with Fly Ash for M35 Grade" International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 Vol. 3, Issue 1, January -February 2013, pp.950-953.

[13] S. U. Kannan, Selvamony C., M. S. Ravikumar and S. Basil Gnanappa "INVESTIGATIONS AND STUDY ON THE EFFECT OF AR GLASS POLYMER FIBRES IN SELF-COMPACTING SELF-CURING CONCRETE" ARPN Journal of Engineering and Applied Sciences, VOL. 5, NO. 2, FEBRUARY 2010, ISSN 1819-6608, pp. 41-45

[14] Agnieszka KLEMM, Karol SIKORA "SUPERABSORBENT POLYMERS IN CEMENTITIOUS COMPOSITES" Glasgow Caledonian University, Glasgow, UK

[15] Mohammad J. Zohuriaan-Mehr* and Kourosh Kabiri "Superabsorbent Polymer Materials: A Review" Iranian Polymer Journal 17 (6), 2008, 451-477.

[16] Prof. Vinayak Vijapur, Manjunath .G. Tontanal "An Experimental Investigation On Behavior Of Self Cured Steel Fiber Reinforced Concrete" International Journal of Emerging Trends in Engineering and Development Issue 3, Vol.5 (September 2013) ISSN 2249-6149.

[17] T.G.S Kiran, M.K.M.V Ratnam "Fly Ash as a Partial Replacement of Cement in Concrete and Durability Study of Fly Ash in Acidic (H2so4) Environment" International Journal of Engineering Research and Development , e-ISSN: 2278-067X, Volume 10, Issue 12 (December 2014), PP.01-13

. JO JACOB RAJU and JINO JOHN "Strength study of high volume fly ash concrete with fibres" International Journal of Advanced Structures and Geotechnical Engineering ISSN 2319-5347, Vol. 03, No. 01, January 2014.

[18] Md. Moinul Islamc and Md. Saiful Islam "Strength Behaviour of Mortar Using Fly Ash as Partial Replacement of Cement" Concrete Research Letters Vol. 1 (3) – September 2010.

[19] Saint Gobain Vetrotex: CEM-FIL alkali-resistant glass fibres "Fibres in Concrete" The Indian Concrete Journal March 2003 pp.943-945.

[20] Sven Mönnig "Water Saturated Super-Absorbent Polymers Used In High Strength Concrete" Otto-Graf-Journal Vol. 16, 2005 pp.193-202

[21] STAR 225-SAP "Application Of Super Absorbent Polymer" Springer publications 2012 ISBN 978-94-007-2732-8 final version unpublised.

[22] Athiappan.K, Vijaychandrakanth. S "Experimental Study on Flexural Behavior of Sisal Fibre in Reinforced Concrete Beam" International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Vol. 3 Issue 5, May - 2014

[23] ACI Committee 544. 1982. State-of-the-Report on Fibre Reinforced Concrete, (ACI 544.1R-82), Concrete International: Design and Construction. 4(5): 9-30, American Concrete Institute, Detroit, Michigan, USA.

[24] Relevant Indian Standatard Codes publised by Bureau of Indian Standards

[25] ASTM C-1018-97 Standard Test Method for Flexural Toughness and First-Crack Strength of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading)1

[26] Book – "Concrete Technology" M.S.Shetty, published by S.Chand 2009.

[27] Book-"Concrete Technology" M.L.Gambhir, TATA McGraw-Hill Publishing 2004.