ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
Vol. 1, Issue 3, November 2014

PROPERTIES OF CEMENT MORTAR BY MIXING FIBRES STEALTHe3, CEM-FIL

A.Narender Reddy[1], N. Siva Rani[2], K. Naveen[3], K. Rohini Kumari[4], V. Durga Bhavani[5]

M. Tech Student, Department of Civil Engineering, Newton's Institute of Science and Technology,Macherla, Guntur District, Andhra Pradesh, India [1]

Assistant Professor, Department of Civil Engineering, Nalanda Institute of Technology, Sattenapalli, Guntur District, Andhra Pradesh, India [2,4]

Assistant Professor, Department of Civil Engineering, Nalanda Institute of Engineering &Technology, Sattenapalli, Guntur District, Andhra Pradesh, India [3,5]

Abstract: Concrete mortar possess very low tensile strength, limited ductility and little resistance to cracking. Addition of small closely spaced, uniformly distributed fibres act as crack arrester, substantially increase static and dynamic properties with increasing water content bleeding, plastic shrinkage and reduction in strength will occur with decreasing water content hydration process is incomplete, increase in gel/ space ratio will happens by adding plasticisers and other chemicals for workability and to achieve strength will act temporarily. To come across these two problems by the addition of small amount of fibres effectively control early age plastic shrinkage and cracking. In the present work two types of fibres Poly propylene (PP) fibre STEALTHe3, Alkali Resistant (AR)fibre CEM- FIL was used. PP fibre act mechanically in the cement mortar and act as crack arrester with increased Flexural, Compressive, and Split tensile strength properties. AR fibre act chemically with the cement mortar by the formation of ZrO_2 and SiO_2 .These two oxidants act with the C-S-H gel and $CaOH_2$ which are by products of hydration. By increasing alkali content in the cement mortar, durability properties are shown in our work. Both fibres have increased mechanical and durability properties when compared to control mix. In water absorption test both fibres have no effect because fibre will evaporate at the temperature of 110^0C. Finally as result we conclude that addition of small amount of fibres will increase 5 to 15 % in strength and durability properties of cement mortar.

Keywords: Concrete mortar, Poly propylene fibre STEALTHe3, Alkali resistant fibre CEM- FIL, strength and durability.

I. INTRODUCTION

Plain concrete possesa very low tensile strength, limited ductility and little resistance to cracking. By the addition of small closely spaced and uniformly dispersed fibers to concrete would act as crack arrester and substantially increase static and dynamic properties. Each type of fiber has its own characteristic properties and limitations. So fara very limited quantity of research work has been done on the application of fibers in structural concrete. Hence, the present research would lead to a stronger and durable Fiber Reinforced mortar which can be recommended for applications like construction of special building, shelters, slab panels, wall planes etc. Conventional concrete mixes are usually prone to plastic shrinkage during the curing phase and often lead to crazing and cracking. The addition of relatively small amounts of fibers can effectively eliminate this problem by controlling this early age plastic shrinkage cracking. Not only the fiber concrete is easy and cost effective to use, but also enables to produce a hardened concrete which has improved surface quality and greater
impact resistance. In the present experimental investigation, attempts are made to study on the various strength properties Like compressive strength, split tensile strength, flexural strength and also durability properties like water absorption, Acid and Sulphate attack on both ordinary cement mortar and by adding poly propylene Fiber and alkali resistant Glass fiber, at stipulated ages with different percentages of fibers separately. Studies were made on residual compressive strength, weight loss and Acid attack at specified ages.

II. PROPERTIES OF MATERIALS

A. Poly Propylene FibreSTEALTHe3

2.1.1 Application Rate: The application rate for Stealth e3 fibres is 1 lb. per cubic yard.
2.1.2. Mix Designs: Stealth e3 micro reinforcing is a mechanical process. The addition of Stealth e3 fibres does not require any additional water or other mix design changes at normal application rates.
2.1.3. Mixing procedures: Stealth e3 fibres are added to the mixer before, during or after batching the other concrete materials. Mixing time and speed are specified in ASTM C-94.
2.1.4. Compatibility: Making Good Concrete BetterS tealth e3 fibres are compatible with all concrete

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
Vol. 1, Issue 3, November 2014

admixtures and performance enhancing chemicals, but requires no admixtures to work.

A. AR Glass Fibre CEM – FIL

CEM-FIL Alkali Resistant Glass fibres were first developedby the Building Research Establishment in the UK more since 1970, and were later manufactured under license in Japan and the USA. They have the longest service history, and have been used in more than80 countries worldwide to create some of the world's most stunning architecture.

2.2.1. Product Application: CEM-FIL productscan be produced by one of many manufacturing processes. The most common are thespray and vibration-cast premix, but products may also be spun, filament wound, laminated on amoving conveyor, pressed,vacuum formed, extruded, etc. A large range of fibres has been developed to satisfy the needs of the marketsand to provide optimum processing efficiency and performance in the chosen manufacturing methods. In addition to the manufacturing processes, guidelines and techniques for moulding, achieving different surface finishes and enhancedmechanical properties have also been developed.

TABLE I
PHYSICAL AND MECHANICAL PROPERTIES OF ALKALI-RESISTANT FIBRES

Property	Value
Virgin fibre tensile strength	3500 Mpa
Industrial stand tensile strength	1700 Mpa
Modulus of elasticity	72000 Mpa
Fibre length (If)	12 mm
Fibre diameter (df)	14 µm
Aspect ratio	857
Specific gravity	2.68
Strain fracture	2.4 %
Softening temperature	860^{O} C
Water uptake	< 0.1 %

TABLE II
CHEMICAL COMPOSITION OF GLASSES

Component	A-Glass	E-Glass	AR-Glass
Si O_2	73.0	54.0	62.0
Na_2 O	13.0	---	15.0
Ca O	8.0	22.0	---
Mg O	4.0	0.5	---
K_2 O	0.5	0.8	2.0

2.2.2 Effect of Fibres in Concrete:Fibres are usually used in concrete to control "Plastic shrinkage cracking" and "drying shrinkage cracking".These fibres truncate the permeability of concrete and thus decrease the bleeding of water.Some variety of fibres renders greater impact in terms of abrasion and shatter resistance in concrete.Generally fibres do not increase the flexural strength of concrete, so it cannot replace moment resisting or structural steel reinforcement.

2.2.3. Cem-FilAnti Crack HD (High Dispersion): These fibres are designed to be used with normal concrete mixes at very low addition levels typically 0.60 kg per cubic meter of concrete. Added directly to the mixer of ready mix truck, they disperse instantly in wet concrete giving distributed monofilament reinforcement and are highly effective in suppressing plastic shrinkage cracking. Massive number of filaments leaves no space among fibres whilst the high aspect ratio renders maximum effect in the setting period. Cem-fil Anti-fibres can be simply added to the mix either on site or at mixing plant without the need for any special equipment. Certain standard concrete mix designs are used for this purpose. Extended mixing times are redundant.

2.2.4.Cem-FilAnti-Crack HP (High Performance): The fibers are normally used at higher addition levels-usually from 3–10 kg per cubic meter of concrete. Cem-fil anti-crack high performance fiber is a highly integral product, which offers resistant to the fiber bundle break down in concrete mixing-useful when mixing time and conditions are variable. This physical form lets a greater rate of addition to achieve with workability factor untouched.To ensure performance in situ, precast and sprayed concretes this method allows a fair trial.

III.MIXTURE PROPORTIONS

*A. Ordinary Portland cement:*In this work ordinary Portland cement, KCP grade was used. The following tests were carried out to check the quality of cement.

a. Fineness
b. Specific Gravity
c. Normal consistency
d. Initial & Final setting times
e. Compressive strength test on 3,7,28 days for 1:3 cement mortars.

Compressive strength of cement was tested for ordinary Portland cement (kcp 53 grade) was tested with 1:3 (cement: sand ratio) by using Mortar cube vibrating machine. By preparing three samples each with cube mould size 7.06cm and area of the face of the cube was 50sqcm. Strength was tested at 3, 7 and 28 days intervals and results tabulated. Initial andfinal setting times are tested on Vicat apparatus and are also tabulatedas final values.

TABLE III
VALUES FOR SPECIFIC GRAVITY, SETTING TIME, COMPRESSIVE TEST VALUES

Specific Gravity	Setting Time		Compressive Test N/mm^2		
	Initial	***Final***	***3 days***	***7 days***	***28 days***
3.015	3h:15 m	5h:15 m	31.25	40.14	56.24

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
Vol. 1, Issue 3, November 2014

B. Fine Aggregate

Natural river sand of maximumSize 2.38 mm IS sieve was used as fine aggregate. The following tests were done to check the quality of sand.

- Sieve analysis
- Specific gravity
- Water absorption
- Properties of fine aggregate were studied. In which Sieveanalysis was done for sieves ranging from 4.75 mm, 2.36 mm, 1.18mm, 600 micron, 300 micron and 150micron. From this fineness modulus was calculated as cumulative percentage retained divided by 100 and water absorption was find out by calcium carbide methodresults are tabulated.

TABLE III
FINENESS MODULUS, BULK DENSITY, SPECIFIC GRAVITY, WATER ABSORPTION, ORGANIC IMPURITIES VALUES

Type of aggregate	Maximum size in mm	Fineness Modulus	Bulk density kg/m^3	Specific gravity
River sand	1.2	3.415	1590	2.65

Water absorption	Organic impurities
1%	Nil

To fix water/cement ratio rheological studies were carried out for w/c ratio varying from 0.4, 0.45, 0.5, 0.55, 0.6 with 1:3 cement mortars on rheometer for good workability and consistency. W/cratio was fixed as 0.45, workability is a measure of how easy or difficult it is to place, consolidate, and finish concrete. Consistency is the ability of freshly mixed concrete to flow.

C. Fibers Used

Poly Propylene Fibre Stealthe3:

Specific gravity	Aspect ratio	Diameter-micron	Length-mm
0.91	1200	10	12

Glass Fibre CEM – FIL:

Specific gravity	Aspect ratio	Diameter-micron	Length-mm
2.68	857.1	14	12

D. Preparation of Specimen

In this investigation IS 4031-1968(33) prescribed simple prism mould of size 40x40x160mm used to do different mechanical properties studies in Compressive testing machine dyes made with steel plates of thickness 10 mm and springs to maintain gap for placing the specimens as shown in Fig.1. To test mechanical and durability properties of cement mortar with different percentages of poly propylene fibre,Alkali resistant glass fibre were investigated. Instead of casting separate specimens for carrying out tests for flexural strength, compressive strength and split tensile strength only one set of specimens, prism specimen of size 40 x40 x 160 mm were cast as shown in Fig.2 and used to carry out all the three different strength tests.

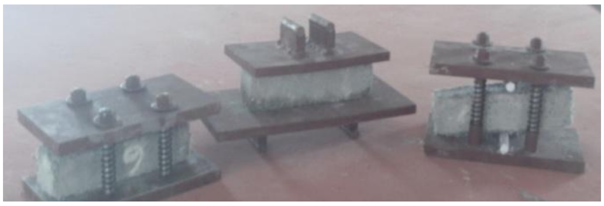

Fig.1Cast iron moulds to test mechanical properties

Fig.2 Casting of Prisms in wooden moulds

IV. PROPERTIES OF MORTAR MIXTURES WITH AND WITHOUT PP FIBRE STEALTH E3 ANDAR FIBRECEM-FIL

All six tests are conducted on test specimens at the ages of 3,7,14,28,56 days. Nine identical specimens at each age were tested in surface dry condition.

A. Mechanical Properties of Fibres:

Flexural Strength: The below Graphs Fig.3, Fig.4 shows the development of Flexural strength of control mix and mortar mixtures with 0.5, 1 % PP & AR Fibres by weight ofcement and sand. At all ages of test,both the Fibres shows increase in flexural strength when compared to control mixture.

TABLE IV
FLEXURAL STRENGTH OF CEMENT MORTAR WITH POLY PROPYLENE E3 FIBRE TWO POINT LOADING IN MPA

Mix	3 days	7 days	14 days	28 days	56 days
0%	1.5	2.15	2.312	2.46	2.52
0.5%	1.6	2.34	2.62	2.8	2.924
1 %	1.65	2.45	2.79	2.94	3.02

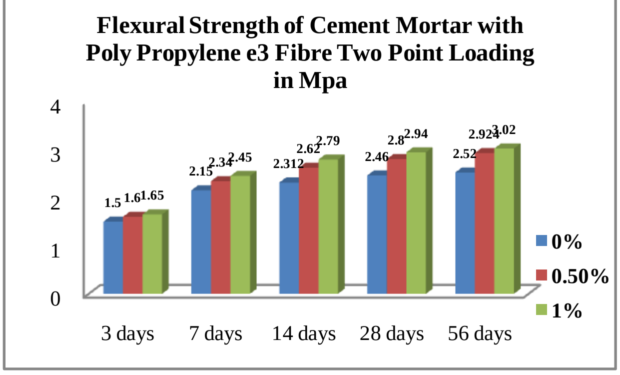

Fig.3Flexural Strength of Cement Mortar with Poly Propylene e3 Fibre Two Point Loading

TABLE V
FLEXURAL STRENGTH OF CEMENT MORTAR WITH AR GLASS CEM-FIL FIBRE TWO POINT LOADING IN MPA

Mix	3 days	7 days	14 days	28 days	56 days
0%	1.5	2.15	2.33	2.42	2.52
0.5%	1.6	2.34	2.65	2.87	2.90
1 %	1.65	2.40	2.56	2.75	3.55

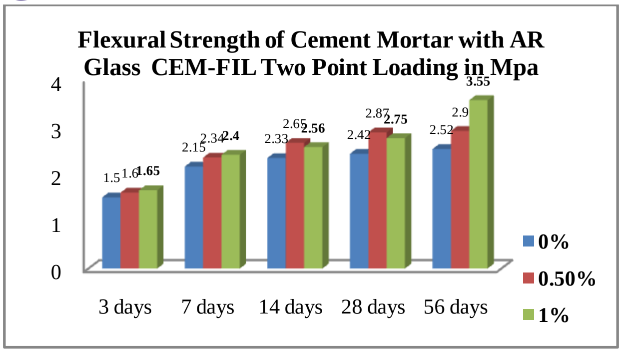

Fig.4Flexural Strength of Cement Mortar with AR Glass CEM-FIL Fibre Two Point Loading

CompressiveStrength:The below Graphs Fig.5, Fig.6 shows the development of compressive strength of control mix and mortar mixtures with 0.5, 1 % PP Fibre and AR Fibre by weight of cement and sand. At all ages of test, both the Fibres shows increase in compressive strength when compared to control mixture.

TABLE VI
COMPRESSIVE STRENGTH OF CEMENT MORTAR WITH POLY PROPYLENE E3 FIBRE IN MPA

Mix	3 days	7 days	14 days	28 days	56 days
0%	10.0	15.0	16.45	19.687	20.15
0.5%	11.56	17.45	18.95	20.565	21.075
1 %	11.78	18.12	19.75	21.165	21.95

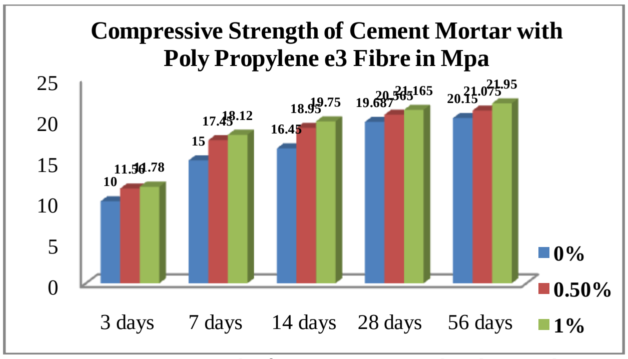

Fig.5Compressive Strength of Cement Mortar with Poly Propylene e3 Fibre

TABLE VII
COMPRESSIVE STRENGTH OF CEMENT MORTAR WITH AR GLASS CEM-FIL FIBRE IN MPA

Mix	3 days	7 days	14 days	28 days	56 days
0%	10.0	15.0	16.45	19.6875	20.15
0.5%	12.65	16.45	17.75	21.75	22.295
1 %	13.25	17.565	18.85	22.565	23.125

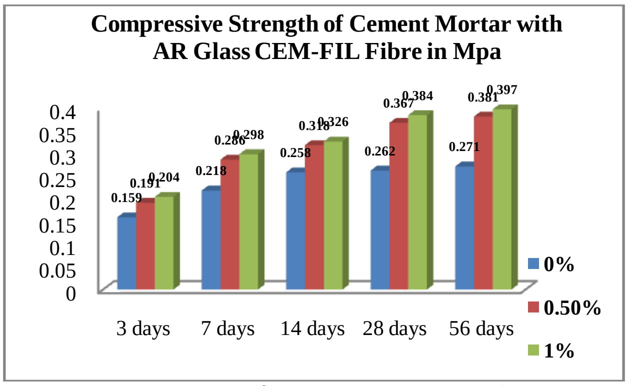

Fig.6Compressive Strength of Cement Mortar with AR Glass CEM-FIL Fibre

SplitTensile Strength: The below Graphs Fig.7, Fig.8 shows the development of split tensile strength of control mix and mortar mixtures with 0.5, 1 %PP Fibre and AR Fibre by weight of cement and sand. At all ages of test, both the Fibres shows increase in split tensile strength when compared to control mixture.

TABLE VIII
SPLIT TENSILE STRENGTH OF CEMENT MORTAR WITH POLY PROPYLENE E3 FIBRE INMPA

Mix	3 days	7 days	14 days	28 days	56 days
0%	10.0	15.0	16.45	19.6875	20.15
0.5%	12.65	16.45	17.75	21.75	22.295
1 %	13.25	17.565	18.85	22.565	23.125

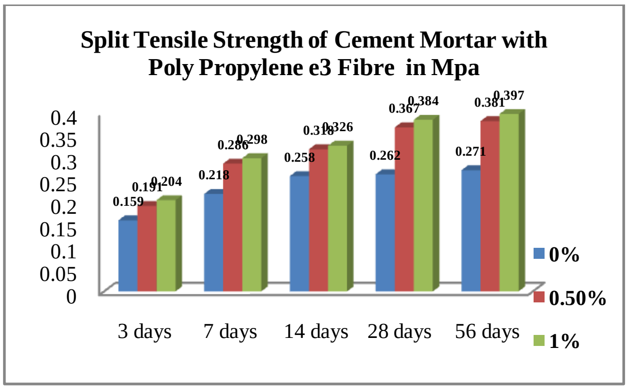

Fig.7Compressive Strength of Cement Mortar with Poly Propylene e3 Fibre

TABLE IX
SPLIT TENSILE STRENGTH OF CEMENT MORTAR WITH AR GLASS CEM-FIL FIBRE IN MPA

Mix	3 days	7 days	14 days	28 days	56 days
0%	0.159	0.218	0.258	0.262	0.271
0.5%	0.212	0.298	0.329	0.395	0.381
1 %	0.235	0.324	0.334	0.412	0.423

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
Vol. 1, Issue 3, November 2014

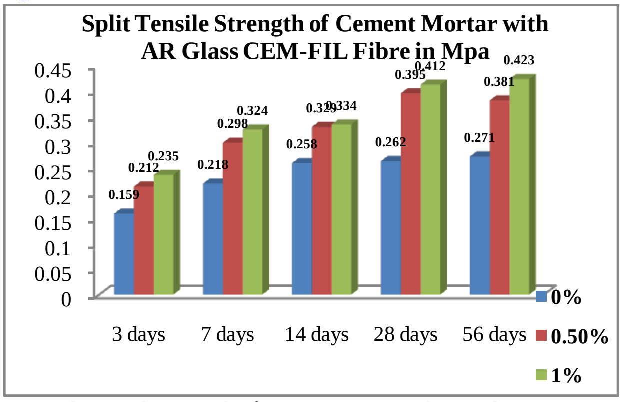

Fig.8Split Tensile Strength of Cement Mortar with AR Glass CEM-FIL Fibre

B. DurabilityProperties of Fibres:

Water Absorption Test: The below Graphs Fig.9, Fig.10 shows the Water absorption testof control mix and mortar mixtures with 0.5, 1 % PPfibre and AR fibre by weight of cementand sand. Test results show cumulative water absorption increased by increasing the percentage of PP and AR Fibres. But rate of absorption gets slows down time increases from 15 – 360 minutes and reaches to saturation point with very slight change afterwards.

TABLE X
CUMULATIVE PERCENTAGE OF WATER ABSORPTION IN % OF WEIGHT WITH POLY PROPYLENE E3 FIBRE

Time in min	0%control mix	0.5 % PP fibre	1 % PP fibre
15	1.76	3.65	4.88
30	2.08	6.42	8.67
45	3.43	7.65	10.34
60	4.87	9.63	12.45
120	5.26	10.26	13.92
240	5.42	10.84	14.45
360	5.49	10.92	14.66

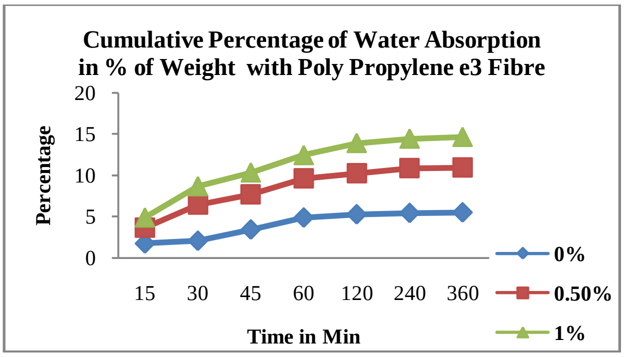

Fig.9Cumulative Percentage of Water Absorption in % of Weight with Poly Propylene e3 Fibre

TABLE XI
CUMULATIVE PERCENTAGE OF WATER ABSORPTION IN % OF WEIGHT WITH AR GLASS CEM-FIL FIBRE

Time in minutes	0% control mix	0.5 % AR fibre	1 % AR fibre
15	1.76	1.86	2.42
30	2.08	2.75	5.43
45	3.43	4.34	7.46
60	4.87	5.12	8.28
120	5.26	5.98	9.34
240	5.42	6.32	10.12
360	5.49	6.47	10.373

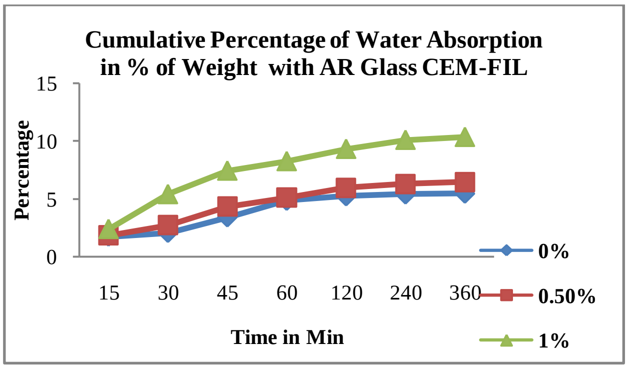

Fig.10Cumulative Percentage of Water Absorption in % of Weight with AR Glass CEM-FIL Fibre

Sulphate Resistant Test : Following Tables shows results obtained from Sulphate Resistance test of control mix and mortar mixtures with 0.5, 1 % PP Fibre, AR Fibre by weight of cementand sand. Test results shows weight loss decreases by increasing the percentage of PP and AR Fibre but when compared to AR Glass fibre PP Fibre loose more weight. Loss of compressive strength deceases by adding Fibres when compared to control mix.

TABLE X
PROPERTIES OF MORTARS OBTAINED FROM SULPHATE RESISTANCE TEST WITH PP FIBRE AFTER 28 DAYS

Mix	Weight loss in %	Durability factor in %	Loss of compressive strength in %
0% mix	2.24	0	5.3
0.5 % pp	2.13	4.3	4.88
1 % pp	1.97	23.8	3.59

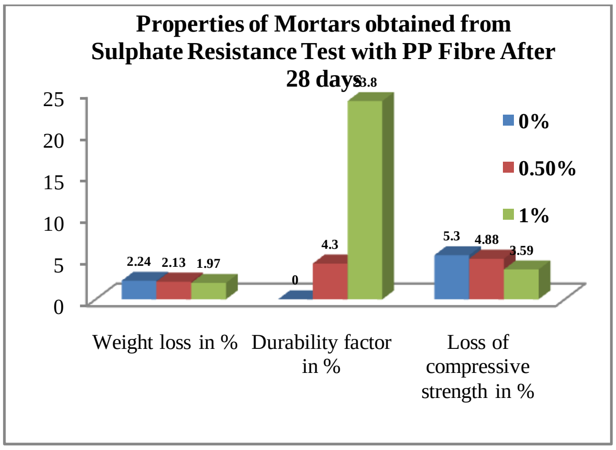

Fig.11Properties of Mortars obtained from Sulphate Resistance Test Results after 28 days

TABLE XI
PROPERTIES OF MORTARS OBTAINED FROM SULPHATE RESISTANCE TEST WITH PP FIBRE AFTER 56 DAYS

Mix	Weight loss in %	Durability factor in %	Loss of compressive strength in %
0% mix	6.52	0	18.6
0.5 % pp	3.46	185.7	6.51
1 % pp	2.21	289.12	4.78

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
Vol. 1, Issue 3, November 2014

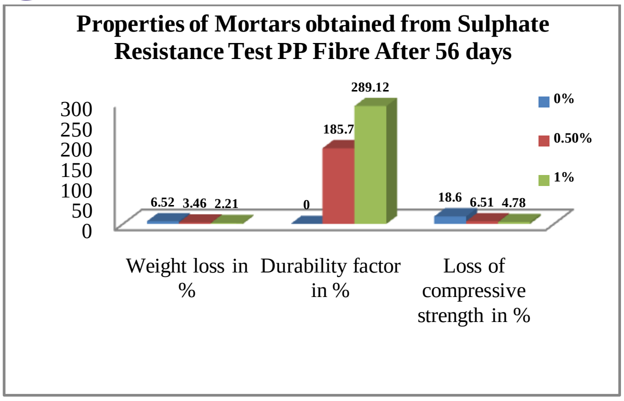

Fig.12Properties of Mortars obtained from Sulphate Resistance Test Results after 56 days

TABLE XII
PROPERTIES OF MORTARS OBTAINED FROM SULPHATE RESISTANCE TEST WITH AR FIBRE AFTER 28 DAYS

Mix	Weight loss in %	Durability factor in %	Loss of compressive strength in %
0% mix	2.24	0	5.3
0.5% AR	2.02	6.14	4.72
1 % AR	1.65	34.65	3.13

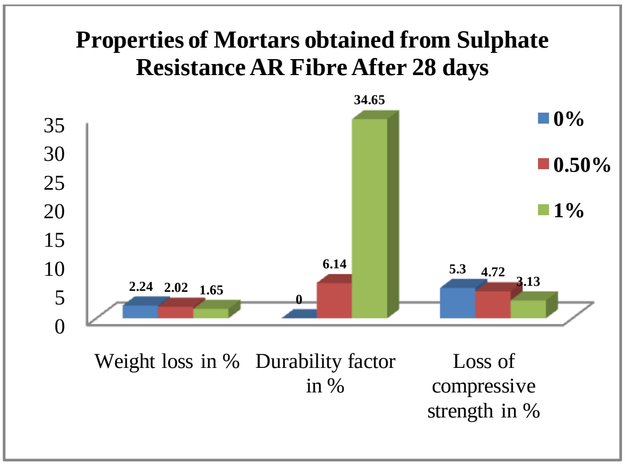

Fig.13Properties of Mortars obtained from Sulphate Resistance Test Results after 28 days

TABLE XIII
PROPERTIES OF MORTARS OBTAINED FROM SULPHATE RESISTANCE TEST WITH AR FIBRE AFTER 56 DAYS

Mix	**Weight loss in %**	**Durability factor in %**	**Loss of compressive strength in %**
0% mix	6.52	0	18.6
0.5% AR	2.84	217.4	5.86
1 % AR	1.98	339.71	4.23

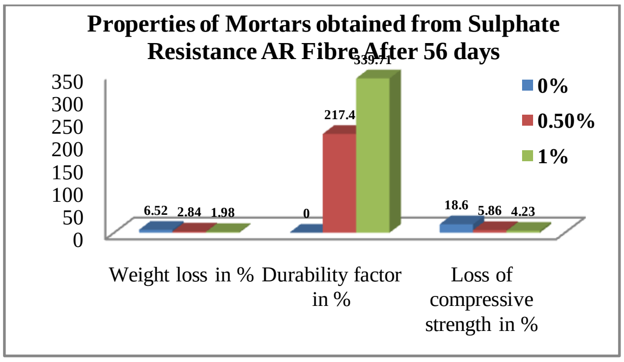

Fig.14Properties of Mortars obtained from Sulphate Resistance Test Results after 56 days

V. CONCLUSION

Reduction in bleeding is observed by addition of PP fiber in the Control mix when compared AR fiber. Reduction in bleeding improves the surface integrity of concrete, improves its homogeneity and reduces the probability of cracks.The percentage difference in flexural strength by the addition of PP fibres increases by 16% for 0.5% mixing, 19.8% for 1% mixing.The percentage difference in flexural strength by the addition of AR fibres increases by 17.4% for 0.5 % mixing, 23% for 1% mixing.When compared to PP and AR,fibres AR fibre shows 1.4% to 3.2% more Flexural strength for 0.5%, 1% mixing.The percentage difference in compressive strength by the addition of PPfibres increases by 4.5% for 0.5% mixing, 8.9% for 1% mixing.The percentage difference in compressive strength by the addition of AR fibres increases by 10.6% for 0.5% mixing, 14.7% for 1% mixing.When compared to PP and AR fibers, AR fiber shows 6.1% to 5.8% more Compressive strength for 0.5%, 1% mixing.The percentage difference in Split tensile strength by the addition of PP fibers increases by 40% for 0.5% mixing, 46% for 1% mixing.The percentage difference in Split tensile strength by the addition of AR fibers increases by 40% for 0.5% mixing, 56% for 1% mixing. When compared to PP and AR fibers, AR fiber shows 0% to 10% more Split tensile strength for 0.5%, 1% mixing.The percentage difference in Porosity by the addition of PP fibers increases by 73% for 0.5% mixing, 78.78% for 1% mixing.The percentage difference inPorosity by the addition of PP fibers increases by 56.25% for 0.5% mixing, 72% for 1% mixing.When compared to PP and AR fibers AR fiber shows 16.75% to 6.78% low Porosity for 0.5%, 1% mixing.Coefficient of water absorption by the addition of PPfiberincreases by 71% for 0.5% mixing, 82% for 1% mixing.Coefficient of water absorption by the addition of ARfiber increases by 23.4% for 0.5% mixing, 68.6% for 1% mixing. When compared to PP and AR fibers shows 67% to 16.34% low Coefficient of water absorption for 0.5%, 1% mixing.The percentage difference in weight loss for Sulphate resistance by the addition PP fibersdecreases by 46.9% for 0.5% mixing, 66.1% for 1% mixing. The percentage difference in weight loss for Sulphate resistance by the addition AR fibersdecreases by 56.4% for 0.5% mixing, 69.6% for 1% mixing. When compared to PP and AR fibres, AR fibre shows 16.84% to 5% decrease in weight

International Advanced Research Journal in Science, Engineering and Technology
Vol. 1, Issue 3, November 2014

loss for 0.5%, 1% mixing.Weight loss increases by 12% to 66% for PP fibre from 28 to 56 days against Sulphate resistance. Weight loss increases by 26.3% to 69.6% for AR fibre from 28 to 56 days against Sulphate resistance.Loss of compressive strength increases by 32.2% to 74.3% from 28 to 56 days against Sulphate resistance for PP fibre.Loss of compressive strength increases by 40.9% to 77.2% from 28 to 56 days against Sulphate resistance for AR fibre.

REFERENCES

[1] ASTM C 157-69 T , Cement mortar and concrete.
[2] Ardanuy, M. Claramunt – Fiber matrix interactions in cement mortar composites.
[3] BS: 1881- part5-1970 Methods of testing hardened concretes.
[4] Claramunt, j. Ardanuy (2011) – The hornification of vegetable fibres to improve durability of cement mortar composites pdf.
[5] Concrete technology theory & practice by M.S.Shetty.
[6] IS 4031- 1968 Methods of physical tests for hydraulic cement
[7] Concrete technology by A. M. Neville & J.J. Brooks.
[8] Durability of glass fibre reinforced cement composites byShashidharaMarikunte.
[9] IS 4031- 1968 Methods of physical tests for hydraulic cement.
[10] Inflenceof HCl corrosion on the mechanical properties of concrete by Pengfei Huang.
[11] Nano fibrillated cellulose as potential reinforcement for high performance cement mortar composites pdf.
[12] Studies on the durability of natural fibres by Rama Krishna.

BIOGRAPHIES

Mr. A. Narender Reddy is pursuing his M.Tech (structural Engineering) From Newton's Institute of Science & Technology, Macherla. He Had Completed His B.Tech(Civil Engineering) from Bapatla Engineering College, Bapatla.

Miss. N.Siva Rani has completed her B.Tech (Civil Engineering) from Priyadarshini Institute of Technology & Science for women, Tenali. At present she is working as Assistant Professor in NalandaInstitute of Technology, Sattenapalli.

Mr. K. Naveen has completed hisB.Tech (Civil Engineering) from Bapatla Engineering College, Bapatla. At present He is working as Assistant Professor in NalandaInstitute of Engineering & Technology, Sattenapalli.

Mrs. K. RohiniKumari has completed her B.Tech (Civil Engineering) from Nalanda Institute of Technology, Sattenapalli. At present she is working as Assistant Professor in Nalanda Institute of Technology, Sattenapalli.

Miss. V. DurgaBhavani has completed her B.Tech (Civil Engineering) from A.M.Reddy Memorial College of Engineering &Techonolgy, Narasaraopet. At present she is working as Assistant Professor in NalandaInstitute of Engineering & Technology, Sattenapalli.