International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 09 , September 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

Ligno Sulphonate: An Additive in Concrete

Jyoti Sharma[1], Nisha[2]

[1,2]*Department of Chemistry, Raj Rishi C*ollege Alwar

ABSTRACT

Additives play an important role to enhance properties of concrete. Now a day's wide range of additives are used to control properties like setting time, water cement ratio, workability and strength. To get perfect compressive strength, workability and setting time of concrete mixture an appropriate quantity of additive is required. Economic aspect also play important role to decide quantity and nature of additive.

In this study, we observed the effect of Lignosulphonate on concrete. Lignosulphonate has a function as a retarder which is able to extend the compressive strength of the cement concrete. The laboratory experiment indicate that the compressive strength of the concrete increased due to the addition of the Lignosulphonate. It reached a maximum value at the addition of 1% Lignosulphonate of the cement weight. An addition of the additive at a higher level resulted in a decrease in the compressive strength of the cement.

Keywords: compressive strength, retarder, temperature.

I. INTRODUCTION

Superplasticizers, also known as high range water reducers, are chemical admixtures used where well-dispersed particle suspension is required. These admixtures have the ability to increase the workability and reduce the amount of mixing water during the preparation of cement pastes or concrete [1-9]. Lignosulphonates, a byproduct of the pulp and paper industry obtained from the spent sulfite pulping liquors, are the most available which has excellent dispersing properties and are utilized as super plasticizers in concrete, cement. The Ca-lignosulphonate from molasses is a byproduct of sugar industry, to use as a retarding and water-reducing admixture for concrete[10]. Lignosulphonates are anionic surfactants which are excellent water-reducing agents in concrete construction. The Lignosulphonates are relatively inexpensive and their water reducing properties could be exploited at minimal cost. However, the variance in their composition, especially their sulphate group, could induce significant problems in set retardation and air entrainment [10, 11].

There is an interaction of the plasticizing additives of concrete mixtures due to their effective components with the surface of solid particles of the suspension, especially with that of cement [1, 3]. As a result, there is a considerable influence on the rheological properties of suspensions, the hydration kinetics and the formation of solid structure of the cement binder. The nature and mechanism of action of plasticizing additives have not yet been explained in a satisfactory way [5, 11]. The use of the various plasticizing admixtures or water soluble polymer modified systems as dispersing agents for improving and modifying the workability of cement pastes or concrete and air-entraining effect. These admixtures enhance the performance of concrete mixtures [1-6] .

The first recorded application of Lignosulphonate on a road was in 1916 when it was used as dust palliative on a gravel road in Sweden. It has been extensively used in United States since the late 1940 as a dust palliative and surface stabilizing agent for unsealed roads.

International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 09 , September 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

In South Africa, the product has been used since the establishment of a cellulose pulp factory in 1954 created a supply of Lignosulphonate. During these periods 1961-1964 an investigation was conducted into the use of Lignosulphonate on unsealed road under South African conditions. The work included laboratory testing, field experiments, and economic studies. Research has also identified numerous other uses of Lignosulphonate, including;

- Binders
- Resins (epoxy, ion exchange, plywood adhesives etc)
- Sequestering agents (plant micronutrients, leather tanning, batteries) and
- Dispersants (oil drilling ,concrete additives, bricks, tiles, fire fighting foam etc)

II. RESEARCH METHODOLOGY

2.1 Materials and Physical properties

a) Cement- Portland cement is widely used and well known cement. The invention of Portland cement is credited to 'Joseph Aspdin in 1824 who patented artificial cement made by calcination of argillaceous limestone. The name 'Portland Cement' was given originally due to the resemblance of the colour and quality of the hardened cement to Portland stone, a lime stone quarried in Dorset. The portland cement was manufactured first in USA in 1872. It was manufacture in India in 1914.

The three basic constituents of hydraulic cements are lime, silica and alumina. In addition most of the cement contains small proportion of Fe_2O_3, MgO, SO_3 and alkalis.

For the experimental purpose Ordinary Portland Cement, is used. Table-3 shows the results of the physical properties of cement used.

b) Coarse and Fine aggregates.

Aggregate are the material basically used as filler with binding material in the production of concrete. The aggregate is used primarily for the purpose of providing bulk to the concrete. To increase the density of the resulting mixture, the aggregate is frequently used in various sizes. The most important function of the fine aggregate is to assist in producing workability and uniformity in mixture. The fine aggregate also assists the cement paste to hold the coarse aggregate particles, in suspension. This action promotes plasticity in the mixture and prevents the possible segregation of paste the coarse aggregate.

The aggregates which have been used in this study were procured locally and tested. Usually more water and cement is required for small-size aggregates than for large sizes, due to an increase in total aggregate surface area. Coarse aggregate of 10 mm and 20 mm aggregates has been used for the concrete mixes. The most desirable fine-aggregate grading depends on the type of work, the richness of the mixture, and the maximum size of coarse aggregate. Table-3 shows the results of the physical properties of coarse and fine aggregate used.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

Fig. 1: Coarse and Fine aggregates

c) LignoSulphonate*:* Lignosulphonate is produced as part of a chemical wood pulping process when the cellulose and lignin are separated. The binding action of Lignosulphonate is both chemical and physical in nature and results from intermolecular forces between the sulphonated lignin molecules on the surface of the particles being bonded. Lignosulphonated based product have been used as dust palliatives and stabilizers. Lignosulphonate is retarder and water reducer in concrete industry. The several properties of Lignosulphonate as retarder admixture. Lignosulfonate is used 0, 0.5, 1.0, 1.5 and 2.0% by weight of cement.

Table-1: Properties of the several LignoSulfonate studied

	LignoSulphonate	**Sodium LignoSulphonate**	**Calcium LignoSulphonate**
Molecular Formula	$C_{20}H_{26}O_{10}S_2$	$C_{20}H_{24}Na_2O_{10}S_2$	$C_{20}H_{24}CaO_{10}S_2$
Molecular weight	490.54	534.51	528.61
P^H value	9.8	9.0	5-7
Colour	Yellow brown colour	Light brown colour	Brown colour

d) Water: Water available in the site campus conforming to the requirements of water for concreting and curing as per IS:456-2000[12].

TABLE- 2: GRADING ZONE AS PER: IS-383-2016

SIEVE SIZE (TM)	Wt. RET. IN (Grams)	CUM WT RETAINED	% RETAINED	% PASSING	Spec. Limit-IS:383-2016	
					LOWER	UPPER
10	0	0	0.0	100.0	100	
2.36	36	72	4.8	95.2	85	100
1.18	132	204	13.6	86.4	75	100
0.600	318	522	34.8	65.2	60	79
0.300	732	1254	83.6	16.4	12	40
0.150	228	1482	98.8	1.2	0	10

Table- 3: Physical Properties of Cement & Aggregate Used

Sl. No.	Description of Material	Value	Units	Test Method
1	**20 mm Aggregate**			
a	Specific gravity (Oven dry)	2.773		IS 2386 (part III) 1.963 Ref. 2007
b	Water absorption	0.49	%	IS 2386 (part III) 1.963 Ref. 2007
c	Aggregate Impact Value	15	%	IS 2386 (part III) 1.963 Ref. 2007
d	LA Abrasion Value	16	%	IS 2386 (part III) 1.963 Ref. 2007
e	Bulk density (loose)	1.37	g/cc	IS 2386 (part III) 1.963 Ref. 2007
f	Bulk density (Compacted)	1.57	g/cc	IS 2386 (part III) 1.963 Ref. 2007
2	**10 mm Aggregate**			
a	Specific gravity (Oven Dry)	2.77	-	IS 2386 (part III) 1.963 Ref. 2007
b	Water absorption	0.65	%	IS 2386 (part III) 1.963 Ref. 2007
e	Bulk density (loose)	1.24	g/cc	IS 2386 (part III) 1.963 Ref. 2007
f	Bulk density (Compacted)	1.42	g/cc	IS 2386 (part III) 1.963 Ref. 2007
3	**Fine Aggregate - Sand**			
a	Specific gravity (Oven Dry)	2.637		IS:2386 (part III) 1963 Ref. 2005
b	Water absorption	1.01	%	IS:2386 (part III) 1963 Ref. 2005
c	Bulk density (loose)	1.63	g/cc	IS:2386 (part III) 1963 Ref. 2005
d	Bulk density (Compacted)	1.70	g/cc	IS:2386 (part III) 1963 Ref. 2005
e	Fineness Modulus	2.38	-	-
f	Silt content	1.30	%	IS:2386 (part I) 1963 Ref. 2005
3	**Cement OPC 43 Grade**			
a	Specific gravity	3.14	-	IS:4031 (part 11) 1988 Reaff. 2005
b	Consistency	25.0	%	IS:4031 (part 4) 1988 Reaff. 2005

International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 09 , September 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

c	Initial Setting time	100	Minutes	IS:4031 (part 5) 1988 Reaff. 2005
d	Final Setting time	180	Minutes	IS:4031 (part 5) 1988 Reaff. 2005
e	Compressive Strength			
i	72± 1 hrs (3 days)-Min	32.5	N/mm^2	IS:4031 (part 6) 1988 Reaff. 2005
ii	168± 2 hrs (7 days)-Min	41.5	N/mm^2	IS:4031 (part 6) 1988 Reaff. 2005
iii	672± 4 hrs (28 days)-Min	52.5	N/mm^2	IS:4031 (part 6) 1988 Reaff. 2005

2.2 Mix. Design

(a) For M-25 Grade Concrete

Table-4: Quantity materials required for concrete

With 50 Kg cement in Kg based on dry weight basis

1	20 mm crushed aggregates	92.5 Kg
2	10 mm crushed aggregates	82.64 Kg
3	Natural Sand	99.17 Kg
4	Cement	50 Kg
5	Water	23.52 Liter.

MATERIALS RATIOS BY WEIGHT

1	CEMENT	1.000
2	FINE AGGREGATE SAND	1.983
3	COARSE AGGREGATE	3.503
4	WATER CEMENT RATIO	0.431

b) For M-30 Grade Concrete

Table-5: Quantity materials required for concrete

With 50 Kg cement in Kg based on dry weight basis

1	20 mm crushed aggregates	82.19 Kg
2	10 mm crushed aggregates	63.01 Kg
3	Natural Sand	101.64 Kg
4	Cement	50 Kg
5	Water	25.31 Liter.

MATERIALS RATIOS BY WEIGHT

1	CEMENT	1.000

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

2	FINE AGGREGATE SAND	2.033
3	COARSE AGGREGATE	2.904
4	WATER CEMENT RATIO	0.46

The mixture design of concrete was done according to Indian Standard guidelines for M 25 & M 30 grade. Based upon the quantities of ingredient of the mixtures, the quantities of LignoSulfonate is 0, 0.5, 1.0, 1.5 and 2.0% replacement by weight of cement were estimated. The ingredients of concrete were thoroughly mixed in mixer machine till uniform consistency was achieved. Before casting, machine oil was smeared on the inner surfaces of the cast iron mould. Concrete was poured into the mould and compacted thoroughly using table vibrator. The top surface was finished by means of a trowel. The specimens were removed from the mould after 24 hour and then cured under water for a period of 7 and 28 days.

III. EXPERIMENTAL RESULTS AND DISCUSSION

Concrete strength is affected by many factors, such as quality of raw materials, water/cement ratio, coarse/fine aggregate ratio, age of concrete, compaction of concrete, temperature, relative humidity and curing of concrete. Water cement ratio is one of the important factor that affects the concrete quality. By the addition of Lignosulphonate water cement ratio decrease and compressive strength increases. Lignosulphonate reduce the rate of hydration by reacting chemically with unhydrated cement components or by forming a physical coat on unhydrated particles thus preventing contact with water.

The hydration reactions can be expressed by:

$$2Ca_3SiO_5 + 7H_2O \rightarrow 3CaO.2SiO_2.4H_2O + 3Ca(OH)_2 + 173.6\ kJ$$

$$2Ca_2SiO_4 + 5H_2O \rightarrow 3CaO.2SiO_2.4H_2O + Ca(OH)_2 + 58.6\ Kj$$

Chemically it is adsorbed on cement grains through the Ca^{+2} bridging which reduces the calcium ion percentage in solution. This removal of Ca^{+2} ions will prevent them from entering into setting and hydrating reaction of cement systems which results in retarding the hydration[13].

The results obtained from the experimental investigations are shown in table. All the values are the average of the three readings. Determination of compressive strength of concrete is very important, because the compressive strength shows concrete quality. This strength help us to arrive at the optimal proportion for replacement. The compressive strength for 7 day, 28 day of various mixes were determined and given in tables below.

International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 09 , September 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

Table-6: For M25 Grade Concrete

SL. No.	Admixtures	MAX LOAD	STRENGTH IN N/ mm2	
	%	kN		AVER.
1	0	565	25.12	25.68
2		570	25.33	
3		599	26.6	
1	0.5	599	26.62	27.35
2		618	27.45	
3		630	27.99	
1	1	640	28.45	29.22
2		665	29.54	
3		668	29.67	
1	1.5	590	26.23	26.77
2		595	26.45	
3		622	27.65	
1	2	543	24.12	25.12
2		568	25.25	
3		585	25.99	

7 DAYS COMPRESSIVE STRENGTH

Table-7: For M25 Grade Concrete

SL. No.	Admixtures	MAX LOAD	STRENGTH IN N/ mm2	
	%	kN		AVER.
1	0	837	37.2	36.36
2		799.65	35.54	
3		817.875	36.35	
1	0.5	859.95	38.22	37.5
2		825.525	36.69	
3		846	37.6	
1	1	873.45	38.82	38.45
2		849.6	37.76	
3		872.775	38.79	
1	1.5	837.45	37.22	37.23
2		848.025	37.69	

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

3		827.55	36.78	
1	2	814.95	36.22	35.91
2		818.775	36.39	
3		790.2	35.12	

28 DAYS COMPRESSIVE STRENGTH

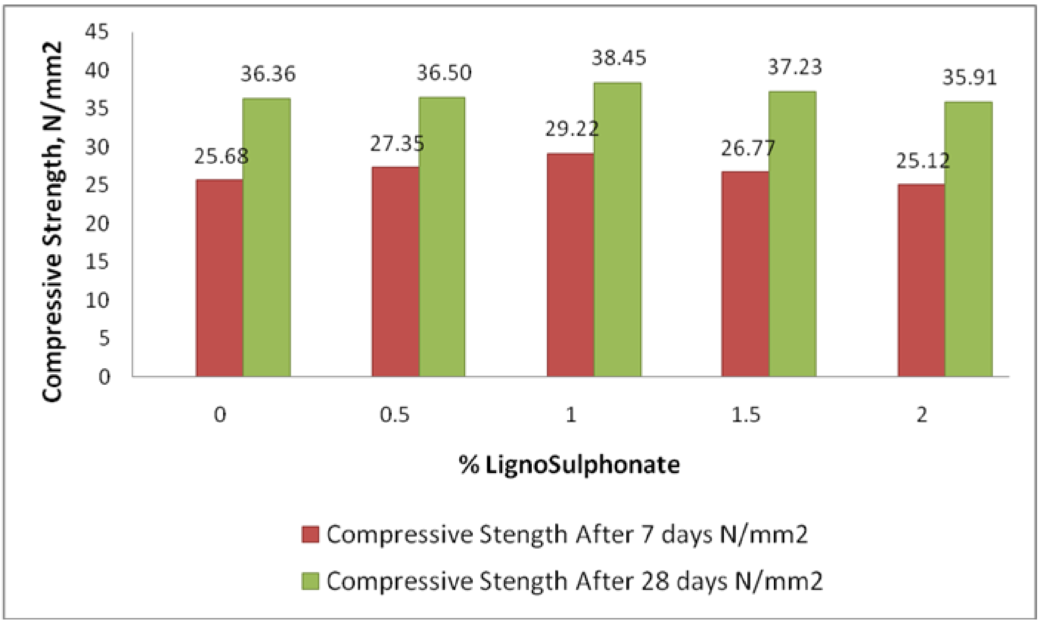

Fig. 2 Compressive strength of M25 Grade concrete

For M25 Grade concrete

- Compressive strength of concrete in 7 days varied from 25.68 to 29.22 N/mm ^{2}with 0% to 2% concentration of the admixtures Lignosulphonate**.**
- Compressive strength of concrete in 28 days varied from 36.36 to 38.45 N/mm^2 with 0% to 2% concentration of the admixtures Lignosulphonate**.**
- Compressive strength of concrete in 7 days increases from 25.68 to 29.22 N/mm^2 with concentration up to 1% and on further addition of Lignosulphonate admixtures decreases as depicted in Fig.2
- Compressive strength of concrete in 28 days increases from 36.36 to 38.45 N/mm^2 with concentration up to 1% and on further addition of Lignosulphonate admixtures decreases as depicted in Fig.2

Table-8: For M30 Grade Concrete

SL. No.	Admixtures	MAX LOAD	STRENGTH IN N/ mm2	
	%	kN		AVER.
1	0	666	29.6	30.38
2		681.525	30.29	
3		703.35	31.26	
1	0.5	712.125	31.65	31.83
2		704.025	31.29	

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

3		732.6	32.56	
1	1	739.125	32.85	32.81
2		740.7	32.92	
3		734.85	32.66	
1	1.5	711.45	31.62	31.83
2		703.125	31.25	
3		687.6	30.56	
1	2	682.65	30.34	29.96
2		659.025	29.29	
3		680.85	30.26	

7 DAYS COMPRESSIVE STRENGTH

Table-9: For M30 Grade Concrete

SL. No.	Admixtures	MAX LOAD	STRENGTH IN N/ mm2	
	%	kN		AVER.
1	0	905.175	40.23	40.39
2		913.725	40.61	
3		907.65	40.34	
1	0.5	946.8	42.08	42.15
2		960.525	42.69	
3		937.575	41.67	
1	1	969.3	43.08	43.64
2		987.3	43.88	
3		989.325	43.97	
1	1.5	924.3	41.08	41.14
2		915.075	40.67	
3		937.575	41.67	
1	2	900.45	40.02	39.96
2		904.275	40.19	
3		892.8	39.68	

28 DAYS COMPRESSIVE STRENGTH

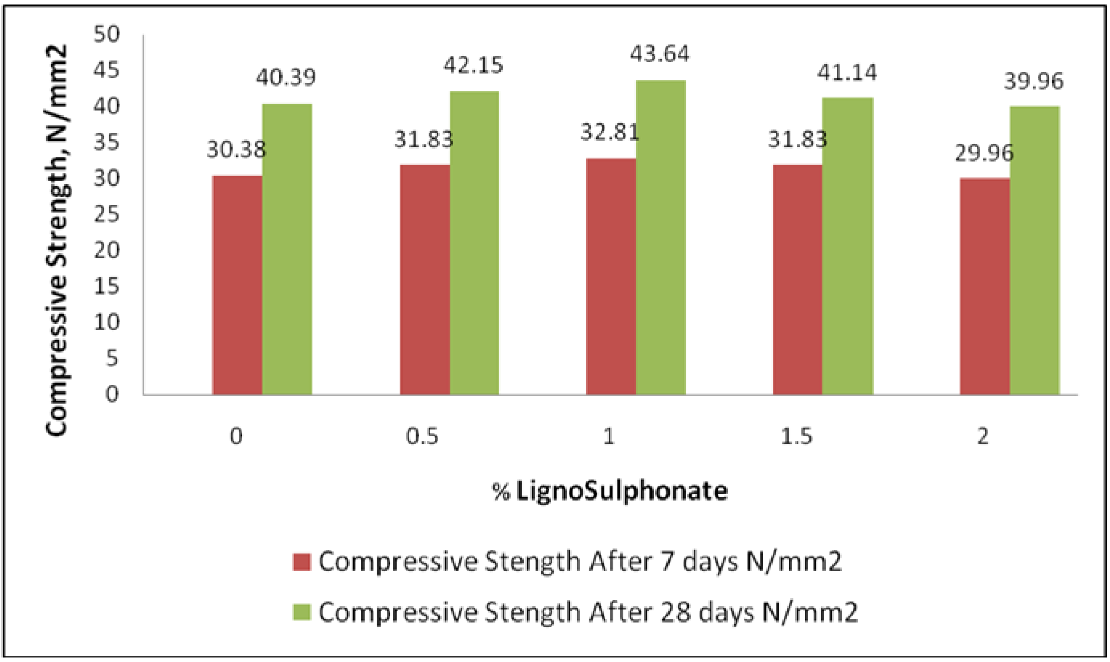

Fig. 3 Compressive strength of M30 Grade concrete

For M30 Grade concrete

- ❖ Compressive strength of concrete in 7 days varied from 30.38 to 32.81 N/mm^2 with 0% to 2% concentration of the admixtures Lignosulphonate**.**
- ❖ Compressive strength of concrete in 28 days varied from 40.39 to 43.64 N/mm^2 with 0% to 2% concentration of the admixtures Lignosulphonate**.**
- ❖ Compressive strength of concrete in 7 days increases from 30.38 to 32.81 N/mm^2 with concentration up to 1% and on further addition of Lignosulphonate admixtures decreases as depicted in Fig.3
- ❖ Compressive strength of concrete in 28 days increases from 40.39 to 43.64 N/mm^2 with concentration up to 1% and on further addition of Lignosulphonate admixtures decreases as depicted in Fig.3

IV. CONCLUSION

Based on the conducted experiment and according to the results obtained, it can be concluded that:

- The Lignosulphonate concrete gives higher compressive strength than the control concrete.
- The maximum compressive strength with both M25 grade & of M30 grade concrete was obtained with 1% Lignosulphonate replacement by weight of cement. Further addition of Lignosulphonate decreases compressive strength.
- Lignosulphonate are made from renewable materials and 14 kg of CO_2 is saved for every kg of Lignosulphonate used in concrete.

REFERENCES

[1] Abo-El-Enein, S.A., El-Ashry, S.H., El-Sukkary, M.M.A., Hussain M.H.M., Gad, E. A. M. (1997). Effect of admixtures based on naphtalene or benzene on the mechanical and physicochemical properties

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

of portland cement pastes. Silicates industriels, 62, 75–81.

[2] Jumadurdiyev, A., Ozkul, M.H., Saglam, A.R., Parlak, N. (2005). The utilization of beet molasses as a retarding and water-reducing admixture for concrete. Cement and Concrete Research, 35, 874–882.

[3] Ayoub, M.M., Nasr, H.E., Darweesh, H.H. (2006). Characterization and utilization of polystyrene and polyacrylamide-graft-methoxypolyethylene as cement admixtures, Polymer–Plastics, Technology and Engineering, 45, 1307–1315.

[4] Ayoub, M.M.H., Darweesh, H.H., Negim, S.M. Utilization of hydrophilic copolymers as super-plastisizers for cement pastes, Cement Hormigon, 919, 2007, 4–15.

[5] Amin, A.,Darweesh, H.H., Morsi, S.M., Ayoub, M.M.H. (2011). Employing of some maleic anhydride based hyperbranched polyesteramides as new polymer admixtures for cement, Journal of Applied Polymer Science, 121, 309–320.

[6] Amin, A., Darweesh, H.H., Morsi, S.M., Ayoub, M.M.H. (2011). Effect of Phthalic anhydride based Hyper-branched polyesteramide on cement characteristics, Journal of Applied Polymer Science, 120, 3054–3064.

[7] Kersener, Z.,Darweesh, H.H.M., Routil, L.(2011). Alkali-activated slag-rich cement pastes with sodium silicate and water glass. Cement Hormigon, 4, 18–26.

[8] Amin, A.,Morsi, S.M., Ayoub, M., Darweesh, H.H. (2012). Modification of cement with succinic anhydride-based hyperbranched polyesteramide, Journal of Applied Polymer Science, 124, 1483–1489.

[9] Amin, A., Darweesh, H.H.M., Ramadan, A.M, Morsi, S.M.M., Ayoub, M.M.H. (2013). New polymeric admixture for cement based on hyperbranched poly amide-ester with pentaerythritol core. Hindawi Publishing Corporation, ISRN Materials Science, Vol. 2013, Article ID 270987– 7.

[10] Ramachandran, V.S.,Malhotra,V.M.,Jolicoeur, C.,Spiratos, N.(1998). Superplasticizers: Properties and application in concrete. ottawa, Canada, 1998.

[11] Stránél, O., Sebök, T. (1997). Relationships between the properties of lignosulphonates and parameters of modified samples with cement binders. Part I–Characterizing lignosulphonates and studying their sorption properties. Cement and concrete research, 2.7, 185–191.

12] IS 456 -2000 “Code of Practice for Plain and Reinforced Concrete”, Bureau of Indian Standards, New Delhi.

13] Yousf, M., Mollah, A., Polta, P., Hess, Th.,Vempati, R.R.K.,Cocke, D.L.(1995). Chemical and physical effect of sodium LignoSulphonate Superplasticizer on the hydration of portland cement and solidification/ Stabilization consequences. Cement and Concrete Research, 25, 671–682.

ACKNOWLEDGEMENT: Author is thankful to UGC for providing financial assistance.