International Journal of Applied Engineering Research
ISSN 0973-4562 Volume 10, Number 9 (2015) pp. 23053-23062

http://www.ripublication.com

Influence of Humic Acid as an Admixture in Concrete

P. V. Premalatha [*1], S.Senthilkumar[2], K. Ramamoorthy[3] and M.Senthilkumar[4]

*[*1]Corresponding author, Associate Professor, Department of Civil Engineering, CARE Group of Institutions, Tiruchirappalli, Tamil Nadu, India-620015.*
[2]Professor, Department of Civil Engineering, KSR College of Engineering, Tirunchengode, India-637215.
[3]Assistant Professor, Department of Civil Engineering, CK College of Engineering and Technology, Cuddalore, India-620015.
[4] Assistant Professor, Department of Civil Engineering, K.S.R.College of Engineering, Tiruchengode, India-637215.

Abstract

Humic acid is the byproduct obtained from thermal plants which use the coal as a fuel. For the research work humic acid was obtained from Neyveli Lignite Corporation (NLC), Tamil Nadu, India. Humic acid is insoluable in water thus manufactured in the commercial form of potassium humate. This research seeks to optimize the benefits of using humic acid as admixture in plain cement concrete and fly ash concrete. In this study humic acid of 0.7%, 0.8% and 1% are used as admixture in plain cement concrete and fly ash concrete, where 15%,20%,25%30% of cement replaced with fly ash. In this experimental investigation standard mixes of fly ash concrete and plain cement concrete with water cement ratio 0.5 were designed for a 28-day strength of 35N/mm2. Mixes of fly ash concrete and plain cement concrete with 0.7%, 0.8% and 1% humic acid as admixture were designed with 0.42 water cement ratio for 28-day strength of 35N/mm^2. The cubes were casted and cured properly the casted cube specimens was tested at 7,14 and 28 days. The results were analysed and compared with standard concrete. The following conclusions are drawn on the effect of humic acid on plain cement concrete and fly ash concrete. The results obtained shows improved workability and compressive strength by addition of humic acid as admixture in plain cement concrete and fly ash concrete

Introduction

Conventional concrete is a mixture of cement, sand, coarse aggregate and water. Concrete required for extensive construction can also be made available, since all the ingredients are of geological origin usage of such geological origin materials in large quantities leads to the depletion of the geological reserves.

To conserve geosphere various researchers used of alternative materials as replacement of cement, sand, coarse aggregate for certain percentage in concrete. In India thermal power is the chief source of energy and produces nearly 70 percent for total energy available in production. The coal ash generated from all the existing thermal power plants is over 100 million tones per year. Geological reserves of Lignite in the country have been estimated at around 34763 Million tones. Of this, 3300 M.T. spread over 480 Sq.km. is in the Neyveli Lignite fields in Cuddalore District of which around 2100 M.T. have been proved. Geological reserved of about 1168 M.T. of lignite have been identified in Jayamkondacholapuram of Trichy District of Tamilnadu.

Presently operation in two mechanized opencast mines with a capacity of 6.4 million tones and 9 million tones of lignite per annum. Prospected lignite reserve in the Neyveli region amounts to 80% of the total reserve (approximately 15835 million) in India. The installed capacity in NLC to produce liquid humic acid per annum is 1.8 million tons. The other major byproducts from the thermal plants are flyash, bottom ash, pond ash. Research works in the use of bottom ash, flyash, pond ash in concrete has been studied widely.

This study deals with the effect of NLC by product humic acid in plain cement concrete and fly ash concrete, where 15%, 20%, 25% and 30% of cement replaced by flyash. In this study 0.7%,0.8% and 1% humic acid are used as admixture in plain cement concrete and fly ash concrete.

Literature Review

A preview of previous research works was done to accomplish the objectives of this study. Many researchers have studied the effect of adding humic acid to the organic clay and lime treated organic clay. Some researchers have studied the benefits of humic acid in concrete. The literatures were reviewed and suitable proportion of humic acid in concrete for workability, compressive strength was finalized.

Sanjikar et ak (1998) has studied the physiochemical properties of humic acid revealed that viscosity measurement of HA at higher concentration behaved like uncharched polymers and at lower concentration molecules expanded and behaved like charged polymer.

The study of **sujana Reddy and chandrashekar Rao et al (2000**) indicated that humic acid behaved like a weak acids which they found from potentiometric titration.

William letlape et al (2000) investigated that humic acids are not fertilizer, they are chemically and structurally different from commercial fertilizer. Commercial fertilizers have high salt index approximately more than 15 while humic acid have low salt index is less than 1%.

Ohamayoshihiko et al(1998) studied the effect of humic acid on the flexural behavior of carbon fibre-reinforced cement paste and found that deflection at ultimate load and flexural toughness of the carbon fibre reinforced cement paste with a fibre content 5% by volume have improved by the addition of humic acid.

Moschopedis et al (1972) invented that coal derivatives such as humic acids, are characterized by their alkali solubility due to the presence in their molecule of acidic functional but they are water insoluable hence they are used to control the viscosity of oilwell drilling muds and as mud thinners.

K.R. Robertson and M.A. Rashid et al (1976) has studied that presence of humic compounds do not exert any long term adverse effect on concrete structure, and on the contrary may provide a protecting coat.

Sang chuljung et al oct (2001) has studied that the fluidity of concrete was increased at the addition ratio of humic acid ranged from 0.6% to 1.8% and decreased where the ratio exceeded 2.4%. the maximum compressive strength was obtained at 1.2% addition of humic acid.

Dr. Robert E. Pettit has studied that humic substances are the components of humus as such as higher molecular weight. Humic acid (HA) polymer readily bind clay minerals to form stable organic clay complexes.

N.Z. mohd yens, D. wanatowski, and L.R.Stace (2011) has investigated that the plastic limit increased with increasing humic acid content and the shear strength increased in a lime treated organic clay where the optimum lime content is 5%.

Summary of The Literature Review

In cement and concrete humic acids can be used as liquefiers in concrete. They do not only reduce the consumption of concrete, but also improve its physiochemical properties. They also have apotential as a special density control additive in cement or concrete. Due to their hydrophobic property, using humic acids results in very little water uptake.

Humic acids help to diminish the surface tension of water, resulting in an improved utilization of solid particles in concrete. They lead to a complete fine separation of the cement, whereby the friction between solid particles is reduced, resulting in a better versatility and workability of concrete.

Material Properties and Compositions

In the present study apart from conventional materials fly ash and humic acid are also used. The mix design was done for M20 grade of concrete as per IS 10262-2000. The concrete specimens of plain concrete and fly ash concrete, where 15% of cement replaced with fly ash and 0.7%, 0.8% and 1% of humic acid as admixture were casted. The workability of the concrete was measured by slump test and compaction factor test. The properties of different materials used namely cement, sand, coarse aggregate, humic acid are studied.

Average specific gravity of cement=3.104

Fineness test on cement

Average fineness = 5.67

Consistency of cement=39%

Fine Aggregate

specific gravity of sand=2.469
Fineness modulus of sand=2.6874
Gradation : conforms to zone III as per IS:383-1970

Coarse Aggregate:

The properties of coarse aggregate is as follows
Specific gravity of coarse aggregate=2.63
Fineness modulus of coarse aggregate=3.17
Abrasion value :24.55

Humic Acid

Rational use of natural resources of humus such as from peat and lignite is urged by the scientific community. Humic acid typically containes heterocyclic compounds with carboxylic, phenolic, alcoholic and carbonyl fractions extracted out from lignite with high molecular weight. Humic acid is insoluable in water, thus manufactured in the commercial form of potassium humate with a potential of 30t/annum by Neyveli Lignite Corporation (Khungar and Manoharan,2000). Humic acid has been extracted from various resources such as lignite, peat, coal, farmyard, manure,coir, pinth etc.. besides persistence in the soil. It is not a single acid; rather, it is a complex mixture of many different acids containing carboxyl and phenol groups so that the mixture behaves functionally as a dibasic acid, or occasionally, as a tribasic acid.

Figure 3.1: Humic Acid Specimen

Example of a typical humic acid, having a variety of components including quinine, phenol, catechol and sugar moieties. A typical humic substance is a mixture of many molecules, some of which are based on an aromatic nuclei with phenolic and carboxylic substituents, linked together; the illustration shows a typical structure. The functional groups that contribute most to surface charge and reactivity of humic substances are phenolic and carboxylic groups.

Humic acids behave as mixtures of dibasic acids, with a pK1 value around 4 for protonation of carboxyl groups and around 8 for protonation of phenolate groups. There is considerable overall similarity among individual humic acids. For this reason measured pKvalues for a given sample are average values relating to the constituent species. The other important characteristic is charge density. The molecules may form a supramolecular structure held together by non-covalent forces, such as van der waals force, π-π and CH-π bonds.

The presence of carboxylate and phenolate groups gives the humic acids the ability to form complexes with ions such as Mg+2, Ca+2,Fe+2 and Fe+3. Many humic acids have two or more of these groups arranged so as to enable the formation of chelate complexes. The formation of (chelate) complexes is an important aspect of the biological role of humic acids in regulating bioavailability of metal ions.

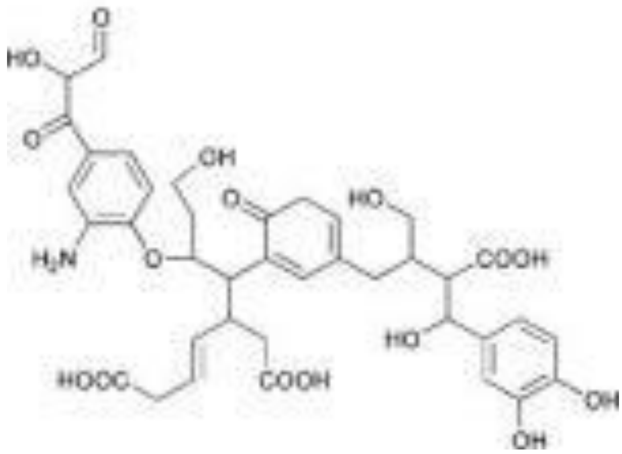


Figure 3.2: Structure of Humic Acid

Elemental Composition

- pH=8.0 to 9.5
- CEC=100 to 130 meq/100 gms
- Total potassium 7.64%
- Carbon and oxygen=90% to 95%
- Nitrogen and hydrogen=3% to 5%

It also contains plant nutrients nitrogen, potassium, sulphur, iron, molybdenum (0.10-6.0%) and copper, zinc, magnesium, boron(20-200 ppm)

Properties of Humic Acid

- Humic acid is a liquid and brown in colour.
- Specific gravity of it is 1.00-1.01
- Viscosity of the humic acid is 28-30 sus

Fly ash upto 35% by weight of total cementations material as per IS:1489. Fly ash conforming to grade of I of IS:3812 is recommended to be used as part replacement of

OPC provided uniform blending with cement is ensured. The fly ash is a pozzalana whereby it cementitious. It improves durability and long term strength.

Figure 3.3: Fly Ash

Experimental Program

General

Experimental investigation was carried out to study the effects of humic acid in plain concrete and fly ash concrete.

A total number of 36specimen of dimension 150X150X150 were cast. Out of which 9 numbers of plain concrete, fly ash concrete cubes and 9 numbers of plain concrete, fly ash concrete with 0.7%,0.8% and 1% of humic acid. The cement is replaced with NLC fly ash by 15%,20%,25% and 30% of its volume and water cement ration of 0.50 was adopted for mix. The specimens were compacted well. The specimen were cured for 7,14and 28 days.

Mix Proportion of Concrete

Mix proportion is 1:1.6:2.8 and water cement ratio is 0.5for plain cement and fly ash concrete. Mix proportion for plain cement concrete and fly ash concrete with humic acid is 1:1.6:2.8 with water cement ratio 0.42.

Table 4.1: Mix Proportion of M20 Concrete.

Cement	W/C	Water	Sand	Aggregate
400	0.43	172	635	1165
1		0.43	1.6	2.907

Result and Discussion

General

In the present study slump test and compaction factor test are performed for experimental investigation of the workability of the fresh concrete. In hardened concrete compressive stress is investigated to find out the effect of himic acid on concrete strength.

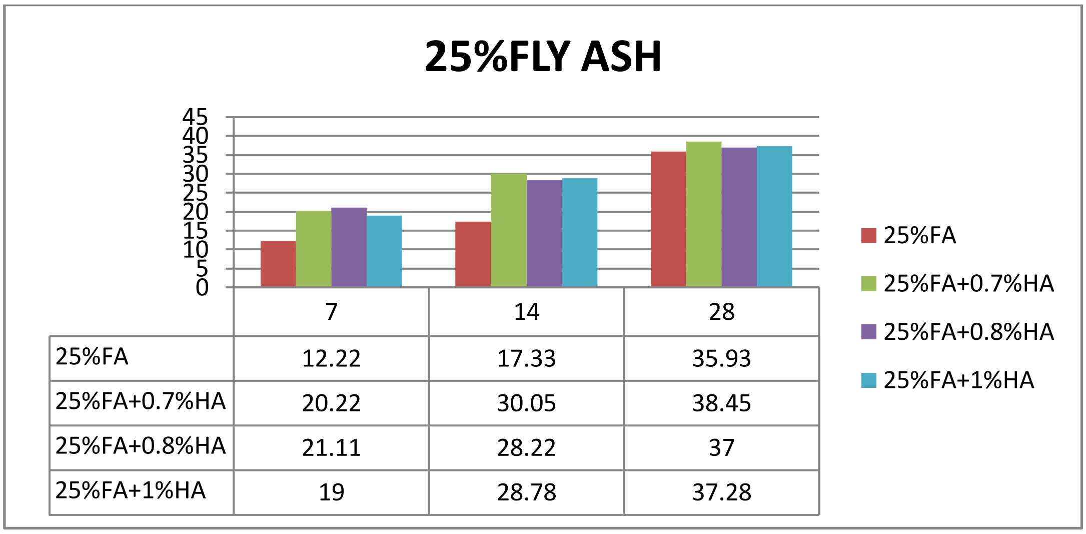
Compressive Strength

The compressive strength of concrete is one of the most important and useful properties of concrete. In most structural applications concrete is employed primarily to resist compressive stressed. In those cased where strength in tension or in shear is a primary importance, compressive strength is frequently used as a measure of these properties. In the present study the compressive strength of plain concrete is compared with the plain concrete with humic acid. In another study fly ash concrete is compared with fly ash concrete with humic acid.

Comparison of Compressive Strength]

FLY ASH	7 DAYS COMP STRENGTH ((N/mm^2)	14 DAYS COMP STRENGTH ((N/mm^2)	28 DAYS COMP STRENGTH ((N/mm^2)	AVERGAE
15%	12.84	17.77	35.56	36
	15.61	20.44	36.44	
20%	13.8	19.11	36.44	36.89
	15.11	20.44	37.33	
25%	11.11	16.22	35.42	35.93
	13.33	18.44	36.44	
30%	11.11	26.67	35.55	35.78
	13.33	28.89	36	

Fly Ash	Humic Acid	7 Days Comp Strength ((N/Mm^2)	14 Days Comp Strength ((N/Mm^2)	28 Days Comp Strength ((N/Mm^2)	Avergae
25%	0.7%	18.67	29.56	37.33	38.45
		21.78	30.54	39.56	
	0.8%	20.89	27.56	36.89	37
		21.33	28.89	37.11	
	1%	18.89	27.78	36.78	37.28
		19.11	29.78	37.78	



	7	14	28
25%FA	12.22	17.33	35.93
25%FA+0.7%HA	20.22	30.05	38.45
25%FA+0.8%HA	21.11	28.22	37
25%FA+1%HA	19	28.78	37.28

Figure 5.3: Compressive Strength For F25%

Normal Concrete	**7 Days Comp Strength ((N/Mm^2)**	**14 Days Comp Strength ((N/Mm^2)**	**28 Days Comp Strength ((N/Mm^2)**	**Avergae**
M35	13.33	22.22	36	36.67
	15.56	24.44	37.33	
M35 With 1% of Humic Acid	15.98	25.33	40	40.22
	17.77	27.45	40.44	

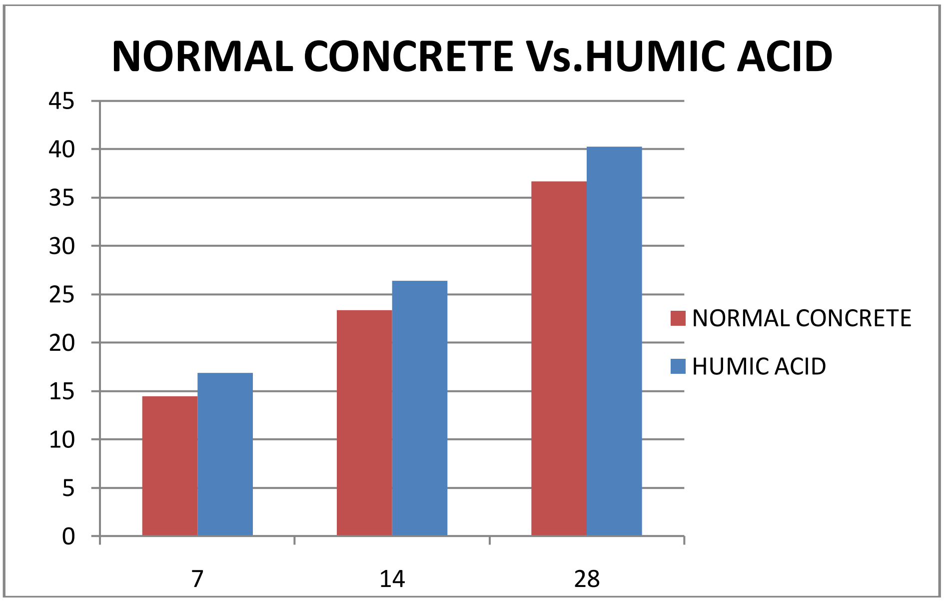


Figure 5.5: Normal concrete Vs. Humic acid Concrete

Summary and Conclusion

Summary

In the present study NLC by product humic acid as admixture in concrete has fulfilled most of the objective of the research work. The below is the conclusion based on the research.

Conclusion

- When Humic acid is added at 1% to water after replacing that volume from water there is a little increase in (i.e.11.1%) compressive strength on 28^{th} day.
- When the same replacement of 1% of Humic acid is done to concrete where the 20% cement is replaced with fly ash as that of cement there is a increase in compressive strength is 30.75% which is phenominal increase.
- From the above result it can be seen that humic acid is very much reacting with fly ash rather than that with cement.
- When humic acid is added to M35 concrete where W/C stands at 0.43 which is less than the normal W/C ratio of 0.5, the workability increase very much.
- With less W/C ratio the workability is affected and to increases the workability and strength admixtures are to be added, which becomes costly. A simple dose of 1% of humic acid which costs very less does the job increasing strength and workability.
- Humic acid a natural organic acid is identified as reagent.

Reference

[1] IS 456-2000 “plain and reinforced concrete code of practice, bureau of Indian standards.

[2] IS 10262-2000”Guidelines for concrete mix design”

[3] IS 383-1970 “specifications for coarse and fone aggregate for concrete”

[4] M.S. Shetty “Concrete Technology”

[5] Applied chemistry volume 5 october 2001 “A study on the quantity estimation o concrete using humic acid.

[6] International conference on transport, environment and Civil Engineering 9ICTECE’2012) August 25-26,2012 Kuala Lumpur (Malasiya)

[7] Asian Journal of Civil Engineering (building and housing) vol.11 no.5

[8] International Journal of Modern Engineering Research (IJMER)

[9] International Journal of Earth sciences and Engineering ISSN 0974-5904, volume 04, No 06 SPL October 2011.

[10] Seyedeh Marzieh Ghasemi Demneh, Bahram Nasernejad, Hamid Modarres* “colloids and Surfaces B: Biointerfaces 88(2011) 108-114”.

[11] Effect of Lignite By- products in plastic shrinkage property of concrete p. Priyadharshini, G.Mohan Ganesh, A.S. Santhi.

[12] Us patent “process for treating fly ash and bottom ash and the resulting by products.
[13] Ram Chandran. V.S. properties concrete mixes and Admixtures.
[14] Vance Dodson. Concrete admixtures. Structural engineering series. Van Nostrand Reinhole, New York.
[15] ACI committee 212, Guide for admixture in concrete, Journal of American concrete institute vol 68, No-09 sept.1971.pp 5-41.
[16] Banfill P.F.G, a viscometric study of cement pastes containing super plasticizers notes on experimental techniques.
[17] Kumar V. Roy B.N and A.S,Rsai, Effect of super plasticizer on concrete Inndian concrete Journal vol 68. June 1994,pp31-33.
[18] Livtan G.G, Air entrainment in presence of super plasticizers. Journal of American concrete ibstutute vol. July-August 1983.pp 236-330.
[19] Nabhrejar S K, use of super plasticizers: myth sand Reality. Indian concrete Journal Vol.68 juine 1994 pp 317-320.
[20] Neville, A.M., (1995) “properties of concrete”, pitman, London, 4th edition, ISBNo-582-23070-5