International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 3, No. 3, Sep.-Nov 2018
Pages 161-173 | Cosmos Impact Factor (Germany): 5.195
Received: 02.10.2018 Published: 28.11.2018

STUDY ON PROPERTIES OF CONCRETE BY USING PALM OIL FUEL ASH AS A PARTIAL REPLACEMENT OF CEMENT

Dr Shrikrishna H Gurlhosur[1*], Srinivas Halemani[2]

1*. Department of Engineering Chemistry, , R. T. E. Society's Rural Engineering college Hulkoti, Gadag, Karnataka , India-582205

2. Department of Civil Engineering ,R. T. E. Society's Rural Engineering college Hulkoti, Gadag, Karnataka , India-582205
*Corresponding Author Email: krishg.libra@gmail.com

ABSTRACT
Cement is a powdered material which is most widely used as binding material in all construction works. Due to its high cost and heat liberation property many attempts have been made to replace cement in concrete by using agricultural or industrial waste. This study involves partial replacement of cement in concrete by palm oil fuel ash (POFA). Palm Oil Fuel Ash is obtained by burning palm fruit and dry leaves of palm oil tree in palm oil mills is also used to control heat of hydration effect on concrete, in the wake of beating and making it in to fine powder. It is an agro based waste which is generated in palm oil industry. It also has pozzolanic properties due to which it has economic and technical advantages when used in concrete. In this present study the workability on fresh concrete, compressive strength test and split tensile strength test were carried out on hardened concrete by replacing cement with 10%, 20% and 30% of POFA. It is shown that the workability increases with addition of Palm Oil Fuel Ash. It is then compared with normal M25grade concrete and it has been observed that 10% replacement of POFA gives the highest compressive and split tensile strength.

Keywords: Palm Oil Fuel Ash, Spilt Tensile Test, compressive strength test

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 3, No. 3, Sep.-Nov 2018
Pages 161-173 | Cosmos Impact Factor (Germany): 5.195
Received: 02.10.2018 Published: 28.11.2018

Introduction Cement concrete is an artificial building material that is obtained by mixing together cement, water and some other inert materials. The mixture in a plastic condition when allowed to set becomes as hard as stone. By suitably adjusting the proportions of various ingredients, concrete with sufficient compressive strength for various uses can be developed. The strength of concrete depends mainly on its ingredients, their relative quantities and the manner in which they are mixed and placed. Because of its high strength, it is used extensively for construction of roads, heavy structural member-like columns, gravity dams, etc., and also for foundations.

Palm Oil Fuel Ash (POFA) is an agro-waste generated in palm oil industry. It is obtained from the combustion of palm fruit residues of oil palm tree. Generally the wastage of palm oil from palm oil industry was increasing eventually. It has become a major problem to palm oil power plants because this waste is not reused and recycled in any works. Therefore POFA whose chemical composition contains a large amount of silica, can be used in cement replacement.[1]

With the improvement of urban areas and their foundation and the headways of apparatuses the utilization of cement is picking up significance. Because of headways in material innovation shows up to 100Mpa are utilized, by and large these high quality cement requires high measure of bond which prompts to increment in the warmth of hydration prompting to development of breaks. This higher use of bond prompting to increment in warmth of hydration can be handled by lessening the measure of concrete with some other solidifying operators, and one such among is PALM OIL FUEL ASH.[2]

The oil palm is a tall-stemmed tree which belongs to palm family Palmea. The countries in the equatorial belt that cultivate oil palm are Benin Republic, Colombia, Ecuador, Nigeria, Zaire, Malaysia and Indonesia of which Malaysia is the largest producer of palm oil and palm oil products. It has been estimated that the total solid waste generated by this industry in some two hundred palm oil mills in the country has amounted to about ten million tons a year[3].

The ash, popularly known as palm oil fuel ash or POFA is a waste material the disposal of which poses enormous environmental pollution. This ash is simply disposed of without any commercial return. It has been identified that POFA has good pozzolanic properties that can be used as a cement substitute in mortar and concrete mixes . The use of supplementary

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 3, No. 3, Sep.-Nov 2018
Pages 161-173 | Cosmos Impact Factor (Germany): 5.195
Received: 02.10.2018 Published: 28.11.2018

cementing materials, like fly ash in concrete has attracted attention over the past decades. Apart from industrial waste, ashes from agricultural origin like rice husk, coconut husk, corn cob, peanut shell etc have been identified as supplementary cementing materials in many parts of the world. It improves the durability, reduces cost due to less use of cement. It will also be beneficial for the environment with respect to reducing the waste disposal volume of landfills . POFA is an agro-waste ash from which palm oil residue, such as palm fiber and shells, are burnt at temperatures of about 8000C –10000C to produce steam for electricity generation in biomass thermal power plants.[4]

The concrete with 15% replacement by POFA gave the highest compressive strength and only series of concrete using fly ash surpass the strength of palm oil fuel ash concrete. Nevertheless, by adding palm oil fuel ash into the concrete mixture, it gave the compressive strength up to 45MPa at 28 days of curing.[5] The result is palm oil fuel ash (POFA), which is about 5%, by weight, of solid waste product. The silica oxide content in POFA can react with calcium hydroxide (Ca (OH) 2) from the hydration process which is deteriorated to concrete and the pozzolanic reactions produce more calcium silicate hydrate (C-S-H) which is a gel compound as well as reducing the amount of calcium hydroxide. Thus, this contributes to the strength of the concrete thus produce stronger and denser concrete as well as enhanced the durability of the concrete.[6]

Experimental Procedure

A cement is binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together.

Table 1: Test conducted on Cement to determine its properties

Sl.No.	Characteristics	Value
1	Specific gravity test	2.85
2	Normal consistency test	32%
3	Initial setting time	82 minutes
4	Final setting time	203 minutes

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 3, No. 3, Sep.-Nov 2018
Pages 161-173 | Cosmos Impact Factor (Germany): 5.195
Received: 02.10.2018 Published: 28.11.2018

Similarly Test conducted on Properties of fine aggregate are:

Sieve analysis, Specific gravity, Water absorption & Moisture content determination

Palm kernel shells along with fiber wastes are burned together in chimneys to produce heat at temperature of 450^0C. After burning the ash generated tries to escape due to less weight, to avoid this water is sprinkled from top and then this is collected, pulverized and passed through IS 90mm sieve. Test conducted on Palm Oil Fuel Ash(POFA) to determine its physical and chemical properties are: Silicon dioxide, Aluminium oxide, Iron oxide, Lime, Magnesium oxide, Potassium oxide & Loss of ignition

Fig :1 Palm oil fuel ash sample

Chemical admixtures are necessary for workability retention. In the present study high range water reducing admixture conplast SP 430 ES2 from Fosroc chemical limited Bangalore was used.

Slump Cone Test

The slump cone test is carried out to find out the workability of concrete for M25 grade for various percentage of POFA from 0 to 30%.

Procedure:

Place the cone on a level water proof base. Place your feet on the holding down lugs. Place 75mm of concrete in the cone and tamp 25 times.Repeat this procedure 3 more times until the cone is full and screed off the top. Gently lift cone from the concrete. Area cone decide concrete and put tamping rod across the top of the cone.Measure down from bottom of tamping rod to top of concrete. The measurement is the slump of the concrete.

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 3, No. 3, Sep.-Nov 2018
Pages 161-173 | Cosmos Impact Factor (Germany): 5.195
Received: 02.10.2018 Published: 28.11.2018

Fig 2: Slump cone test apparatus

Fig 3: Slump obtained after the test

Casting Of Cubes And Cylinder For 7 Days And 28 Days

Casting,Batching as per mix design proportion, Mixing,Compaction,Finishing & Curing

Fig 4:Casting of cubes and cylinder

Compressive Strength Test

Test to be carried out to find the compressive strength of the concrete for various percentage

of Palm Oil Fuel Ash

Procedure:

Prepare a concrete mix with a proportion suggested. Prepare the testing cubes; make sure that they are clean and greased or oiled thinly.Metal moulds should be sealed to their base plates to prevent loss of water.Fill the cube in three layer, tamping each layer with 25

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 3, No. 3, Sep.-Nov 2018
Pages 161-173 | Cosmos Impact Factor (Germany): 5.195
Received: 02.10.2018 Published: 28.11.2018

strokes using tamping rod.Fill the moulds completely, smooth of the tops evenly.Leave the specimen for curing for 24 hours.After that open the moulds and immerse the concrete cubes in water for 7days and 28days.Carefully center the cube on the lower plate and ensure that the load will be applied to opposite cast face of the cube.Apply and increase the load continuosly at nominal rate within the range until no greater load can be sustained.

Spilt Tensile Test

Test to be carried out to find the spilt tensile strength of the concrete for various percentage of Palm Oil Fuel Ash.

Procedure:

Prepare cyclindrical concrete specimens After moulding and curing the specimen for 7days in water, they can be tested. The cyclindrical specimen is palced in a manner that the longitudinal axis is perpendicular to the load

ft= 2P/Ld

L=lenthgh of the cyclinder

d=dia of the cyclinder

Two strips of a nominal thick plywood, and of lentgh equal to or slightly longer than that of the specimen should be provided for each specimenThe bearing strips are placed between the specimen and both and both upper and lower bearing blocks of the testing machine.The load shall be applied and increased continously at a nominal rate within the range. Record the maximum applied load indicated by the testing machine at failure note the type of failure and apperance of the fracture.

Fig 5: Cylinder Before Testing Of Split Tensile Strength

Fig 6: Conduction Of Split Tensile Test On Cylinder

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 3, No. 3, Sep.-Nov 2018
Pages 161-173 | Cosmos Impact Factor (Germany): 5.195
Received: 02.10.2018 Published: 28.11.2018

Design Mix: The design of mix for M25 grade is done for various percentage of palm Oil Fuel Ash(POFA) from 0 to 25% as per IS 10262:2009.

Selection of Water Cement Ratio

From Table 5 of IS 456, maximum water-cement ratio (see Note under 4.1) = 0.5Based on experience. adopt water-cement ratio as 0.5 (0.5 > 0.45, hence, O.K.)

Selection of Water Content: Maximum water content for 20 mm aggregate = 186 litre (for 75 to 100 mm slump range). Estimated water content for 75 mm slump= 186+(3/100)*186 = 191.58 litre. As super plasticizer is used the water content can be reduced up 20 percent. Based on trials with super plasticizer water content reduction of 20 percent has been achieved, Hence, the arrived water content = 191.58 x 0.8 = 153.26 liters

Proportion of Volume of Coarse Aggregate and Fine Aggregate Content

In the present case water-cement ratio is 0.45 Therefore. volume of coarse aggregate is required (0 be increased to decrease the line aggregate content. As the water-cement ratio is lower hy 0.10. the proportion of volume of coarse aggregate is increased by 0.02 (at the rate of -/+ 0.01 for every ± 0.05 change in water-cement ratio) ,Therefore. corrected proportion of volume of coarse aggregate for the water-cement ratio of 0.45 = 0.61

Volume of coarse aggregate =0.61 x 0.9 =0.55

Volume of fine aggregate content = 1- 0.55 = 0.45

Table 2: Mix proportions (Kg/m^3) and Mix ratio

Cement	Fine aggregate	Coarse aggregate	Water
340.58	827.46	971.68	153.26
1	2.43	2.85	0.45

Table 3: Concrete Mixtures with Different Proportions of POFA with Cement

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 3, No. 3, Sep.-Nov 2018
Pages 161-173 | Cosmos Impact Factor (Germany): 5.195
Received: 02.10.2018 Published: 28.11.2018

Sl.No	Cement palm oil fuel ash replacement	Water Lit/m^3	Cement Kg/m^3	Fine aggregate Kg/m^3	Palm oil fuel ash Kg/m^3	Coarse aggregate Kg/m^3
1	100-0%	153.26	340.58	827.46	0	971.68
2	90-10%	153.26	306.52	827.46	34.016	971.68
3	80-20%	153.26	272.46	827.46	68.032	971.68
	70-30%	153.26	238.41	827.46	102.048	971.68

Table 4: No. of Specimens to be casted

Sl. No.	Test To be Conducted	7 Days	28 Days	Total x No. of Mixtures
1.	Compressive Strength Test on Cube 150 x 150 x 150 mm	2	2	4 x 4 =16
2.	Split Tensile Strength on Cylinder 150 mm Dia. X 300 mm Height	2	2	4 x 4=16

Methodology: Slump Cone Test, Compressive Strength Test, Spilt Tensile Test

RESULTS AND DISCUSSION

The present study is based on trial mixes and achieving target strength. Mix proportions have been obtained for M25 grade Control concrete. Then palm oil fuel ash is replaced by 10%, 20% and 30% of cement to study the slump test,Compressive strength, split tensile strength of concrete.

Slump Test

Slump test is a measure of the ease with which a fresh mix of concrete or mortar can be handled and placed..The useful internal work is a physical property of concrete alone and is the work or energy required to overcome the internal friction between the individual particles in the concrete.

Table 5: Replacement of palm oil fuel ash with cement.

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 3, No. 3, Sep.-Nov 2018
Pages 161-173 | Cosmos Impact Factor (Germany): 5.195
Received: 02.10.2018 Published: 28.11.2018

Sl. No.	Percentage of cement	Percentage of palm oil fuel ash replacement	Slump values in mm
1	100	0	70
2	90	10	72
3	80	20	75
4	70	30	80

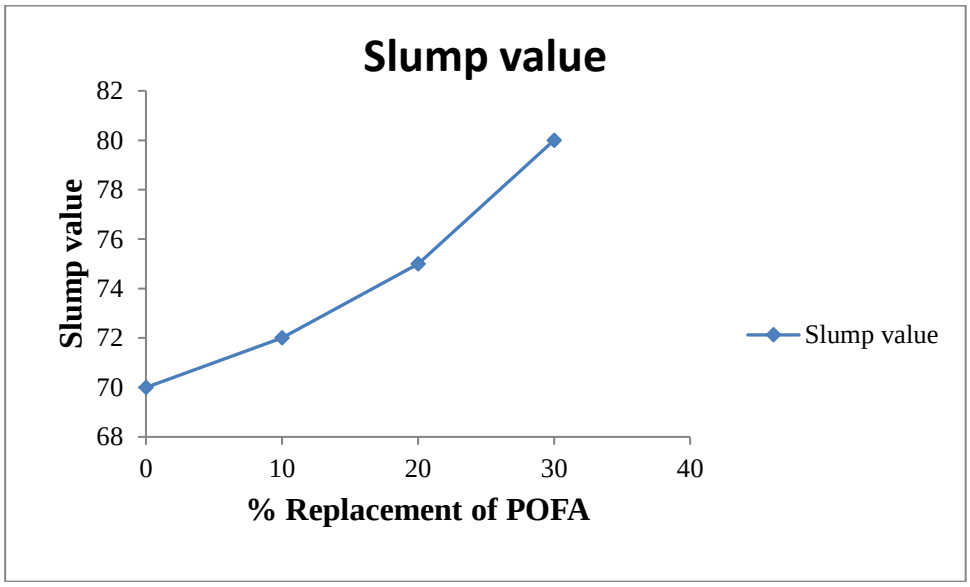

Fig 7: Percentage Of Replacement Of POFA

This figure 7 shows that the slump test was conducted on fresh concrete for various percentage of palm oil fuel ash with cement, slump values are increasing with increase in percentage of palm oil fuel ash as compared to the conventional concrete.

Compressive Strength Test

Compressive strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate.

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 3, No. 3, Sep.-Nov 2018
Pages 161-173 | Cosmos Impact Factor (Germany): 5.195
Received: 02.10.2018 Published: 28.11.2018

Table 6: Mix proportions for normal concrete

Sl no	Proportion	w/c ratio	Percentage of chemical admiture	Percentage of palm oil fuel ash	Compressive strength 7 days MPa	Compressive strength 28 days MPa
1	1:2.43:2.85	0.45	2	0	22.16	28.808
2	1:2.7:3.17	0.45	2	10	22.45	29.185
3	1:3.04:3.57	0.45	2	20	18.312	23.81
4	1:3.47:4.07	0.45	2	30	13.95	18.135

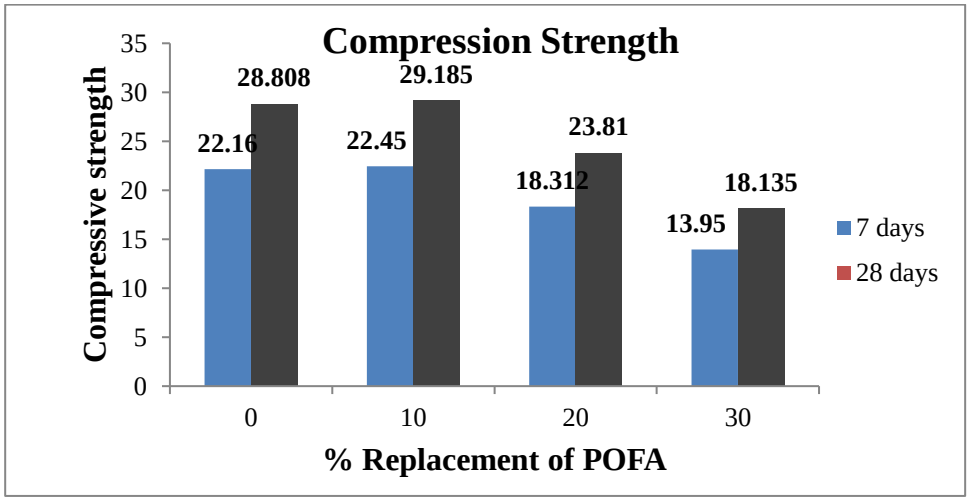

Fig 8: Compressive strength for various replacement of POFA

Here 0 to 30% of palm oil fuel ash was replaced with cement as shown in figure 8 since optimum percentage of replacement was obtained at 10% replacement of palm oil fuel ash with cement and for control concrete the compressive strength was found to be 28.80N/mm^2 for 28 days. On the other hand, for replacement of 10% POFA the compressive strength obtained was 29.185 N/mm^2, for 20% the strength was 23.81 N/mm^2 and for 30% the strength was 18.13 N/mm^2.The compressive strength of the palm oil fuel ash admixed concrete shows higher value upto 10% and goes on decreasing with addition of palm oil fuel ash.

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 3, No. 3, Sep.-Nov 2018
Pages 161-173 | Cosmos Impact Factor (Germany): 5.195
Received: 02.10.2018 Published: 28.11.2018

Split Tensile Strength Test

Split tensile strength in concrete. A method of determining the tensile strength of concrete using a cylinder which splits across the vertical diameter. It is an indirect method of testing tensile strength of concrete.

Table 7: Split tensile strength test values

Sl. No.	% Of Palm Oil Fuel Ash	Split Tensile Strength At The Age Of 7 Days In Mpa	Split Tensile Strength At The Age Of 28 Days In Mpa
1	0	2.38	3.4
2	10	2.94	4.2
3	20	2.34	3.35
4	30	2.065	2.95

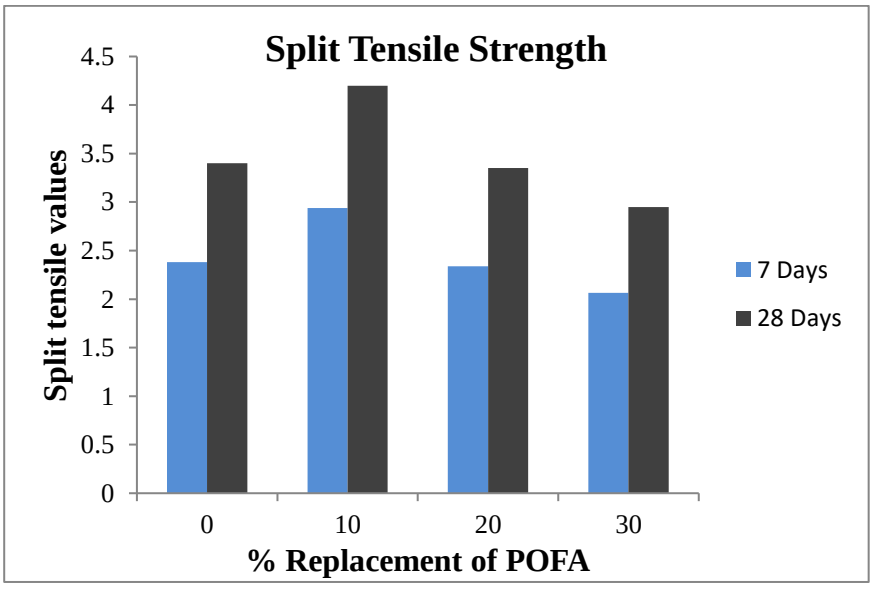

Fig 9: Split tensile strength for various replacement of POFA

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 3, No. 3, Sep.-Nov 2018
Pages 161-173 | Cosmos Impact Factor (Germany): 5.195
Received: 02.10.2018 Published: 28.11.2018

Here 0 to 30% of palm oil fuel ash was replaced with cement as shown in figure 9, since optimum percentage of replacement was obtained at 10% replacement of palm oil fuel ash with cement and for control concrete the split tensile strength was found to be 3.4N/mm^2 for 28 days. On the other hand, for replacement of 10% POFA the split tensile strength obtained was 4.2N/mm^2, for 20% the strength was 3.35N/mm^2 and for 30% the strength was 2.95N/mm^2 .The split tensile strength of the palm oil fuel ash admixed concrete shows higher value upto 10% and goes on decreasing with addition of palm oil fuel ash.

CONCLUSION

After careful experimentations done on concrete of grade M25 with varying percentage of palm oil fuel ash from 0- 30%,by conducting tests like slump, workability, compressive strength and split tensile strength test, the following conclusion are obtain

The workability increases as a the percentage of palm oil fuel ash increases.The maximum compressive strength of concrete increases upto 29.185N/mm^2 for 10% replacement of cement by palm oil fuel ash as compared to normal concrete for 28 days.The maximum split tensile strength of concrete increases upto 4.2N/mm^2 for 10% replacement of cement by palm oil fuel ash as compared to normal concrete for 28 days.Increase in the POFA replacement beyond certain limit causes decrease in the strength properties.POFA used as cement replacement increases large utilization of waste products.

ACKNOWLEDGEMENTS

We are greatly indebted to the Principal of our college **Dr.V.M.Patil, HOD of Civil Engineering Department, Prof. Satish Jyanopanthar** and all other staff for their whole hearted suggestions and guidance for bringing excellent academic climate to finish our work successfully.

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 3, No. 3, Sep.-Nov 2018
Pages 161-173 | Cosmos Impact Factor (Germany): 5.195
Received: 02.10.2018 Published: 28.11.2018

REFERENCE

1. Preethi M, "Palm Oil Fuel Ash As A Partial Replacement Of Cement In Concrete". (IJERT) ISSN:2278-0181 Vol.6 Issue 03.March (2017)
2. T Subramani, "Experimental Study Of Palm Oil Fuel Ash As Cement Replacement Of Concrete". (IJAIEM) ISSN:2319-4847 Vol.6, Issue 3, March (2017)
3. Dr. M. Swaroopa Rani, "Performance Of High Strength Concrete Using Palm Oil Fuel Ash As A Partial Cement Replacement". (IJERA) ISSN:2248-9622, Vol.5, Issue 4(Part 1) April (2015)
4. Deepak T J, "Investigation Of Properties Of Concrete With Palm Oil Fuel Ash As Cement Replacement".(IJSTR) ISSN:2277-8616 Vol.3, Issue 1, January (2014)
5. Sooraj V M, "Effect Of Palm Oil Fuel Ash On Strength Properties Of Concrete".(IJSRP) ISSN:2250-3153 Vol.3, Issue 6, June (2013).
6. L.Subhashini, "Experimetal Investigation On Partial Replacement Of Cement By Palm Oil Fuel Ash In Concrete". (IJARTET) ISSN:2394-3785 Vol.3, Issue 4, April (2016).
7. Ahmed.A.T, "A Study Of Partial Replacement Of Cement With Palm Oil Fuel Ash In Concrete Production". (IJAT) ISSN:1686-9141, Vol.12 (4):619-631,(2015).
8. Saleh.A.M ,Rahmat.M.T, "Utilization Of Palm Oil Fuel Ash And Rice Hucks In Unfired Bricks For Sustained Construcion Material Development", EDP Science, (2014).