Incorporation of Rice Husk Ash and Waste Paper Sludge Ash as Partial Replacement of Cement in M20 Concrete

1st Author
Tahir Hussain ,M.Tech Scholar ,Deptt of Civil Engg. DBU Punjab
2nd Author
Er. Jagdeep Singh , Supervisor & Professor
3rd Author
Dr. Pooja Sharma , HOD Civil Engg. Deptt. DBU Punjab

Abstract:-
In this developing era concrete and cement mortar are widely used by the construction industry, with this development .Large amount of industrial wastes are generated and if these wastes are not properly used it will create severe problems, keeping the environment in mind, concrete engineers are trying to find some alternative materials which will not only replaces the cement content but also improves the strength of concrete As we also know that during the manufacturing of cement large amount of Co_2 is released into the environment, but if we use such material that will replace the quantity of cement content therefore indirectly we are contributing towards the prevention of our planet from global warming and other pollutions. Also in this research work the Rice Husk Ash and waste Paper Sludge are used .The paper sludge which is the byproduct collected from paper mill and rice husk ash obtained from the rice processing units ,by adding these two products with concrete ,not only replaces the cement content but also increases the strength of concrete like compressive, flexural & split tensile strength etc. .These two materials RSH & WPSA were incorporated with concrete with varying percentages of 2%,4%,8%, & 10% .The proper codal precautions were followed during the manufacturing the concrete cubes of 150 X 150 X 150mm and cylinders of size 150 mm X 300 mm casted with varying percentages of RHA & WPSA . The total number of specimen which were prepared 78 cubes and cylinders were casted with proper curing and the series of tests were conducted on these specimens like Split tensile ,Flexural ,Compressive strength ,Normal consistency test etc. .It was concluded that the strength of concrete increased by incorporated the Rice Husk Ash & Waste paper sludge Ash.

Keywords: Rice Husk Ash, Waste Paper Sludge Ash ,Split Tensile strength test, Flexural strength Test

1. Introduction

Concrete is one of the mostly widely used material in the world .it is the mixture of cement, fine aggregate, coarse aggregate and water. The strength of concrete depends upon the ingredients which are used in preparing this .The cost of constructional materials increases day by day due huge demand of it, so the concrete engineers look towards the alternative material that not only improves the strength of concrete but replaces the cement content which intern relate the cost of our construction work. The main advantage of incorporating the supplementary cementing material not only improves the strength but also help in preventing the pollution. It also improves the durability. Durability id linked to the physical, chemical and mineralogical properties of material and permeability. Rice Husk Ash (RHA) and waste paper sludge ash (WPSA). Several studies in the developing countries including Thailand, Pakistan and Brazil worked on the materials like Rice Husk Ash and paper sludge ash, these materials not only enhance the properties on concrete but also contributes towards the green environment.

1.2 Rice Husk Ash

Rice husk ash (RHA) is a by-product from the burning of rice husk. Rice husk is extremely prevalent in East and South-East Asia because of the rice production in this area. The rich land and tropical climate make for perfect conditions to cultivate rice and is taken advantage by these Asian countries. The husk of the rice is removed in the farming process before it is sold and consumed. It has been found beneficial to burn this rice husk in kilns to make various things. The rice husk ash is then used as a substitute or admixture in cement. Therefore the entire rice product is used in an efficient and environmentally friendly approach. Rice husk ash is produced in large quantities globally every year and due to the difficulty involved in its disposal, can lead to RHA becoming an environmental hazard in rice producing countries, potentially adding to air and water pollution. Rice husk ash is a natural pozzolan, which is a material that when used in conjunction with lime, has cementations properties. Several studies have shown that due to its high content of amorphous silica, rice husk ash can be successfully used as a supplementary cementations material in combination with cement to make concrete products. RHA can be carbon neutral, have little or no crystalline $Si0_2$, or no toxic materials, as in the case of off-white rice husk ash. According to the Food and Agricultural Organization of the United Nations, global production of rice, the majority of which is grown in Asia, totaled 746.4 million tons in 2013. This means that the volume of unused rice husks amounted to 150 million tons. Due to their abrasive character, poor nutritive value, very low bulk density, and high ash content only a portion of the husks can be used as chicken litter, juice pressing aid, animal roughage and pesticide carrier. The remaining husks are transported back to field for disposal, usually by open field burning. RHA is obtained by burning of rice husk. When RH is properly brunt, it has high silica content and can be used as an admixture in mortar and concrete. India produces about 122 million tons of Paddy every year. About 20-22% rice husk is generated from paddy and 20-25% of the total husk becomes a Rice Husk ash after burning. The RHA is used as Pozzolanic material for making concrete.

1.2.1 Properties of RHA

The utilization of rice husk for use as a cementations material in cement and concrete depends on the pozzolanic property of its ash. The pozzolanic reactivity of the ash is closely related to the form of silica present and the carbon content. Since the physical and chemical properties of silica in RHA are strongly influenced by the temperature and the duration of thermal treatment, the yield of a highly reactive ash requires a burning method that can remain a low firing temperature and a short retention period in order to give ash with low carbon content and a high surface area.

1.2.2 RHA Production

For every 1000 kg of milled paddy, about 200 kg (20%) of husk is produced. When this husk is completely burnt, about 50 kg (25%) of RHA is generated. The husk contains about 50% cellulose, 25-30% lignin, and 15-20% of silica. Upon burning, cellulose and lignin are removed, leaving behind silica ash. The use of RHA as a supplementary cementing material requires silica in an amorphous reactive form. Crystalline phases of silica have a negligible pozzolanic reactivity with lime. Generally, the quality of RHA relates to the amorphous SiO_2 content, the porous structure of ash particles and the specific surface area. The amorphous SiO_2 content and the porous structure of RHA depend on the temperature, the duration, and the environment of thermal treatment, as well as the pretreatment of husk before combustion. Analysis of the reports on the influence of combustion conditions on the nature of silica suggests that temperatures below 750°C will be sufficiently safe to produce rice husk ash with high reactivity.

2. Experimental Work and Methodology

This section describes the properties of material used for making concrete mixis determined in laboratory as per relevant codes of practice. Different materials used in tests were OPC, coarse aggregates, fine aggregates, rice husk ash and waste paper sludge ash. The description of various tests which were used in this study is given below:

2.1 Ordinary Portland Cement

Ordinary Portland Cement (OPC) of 53 Grade (Ambuja cement) was used throughout the course of the investigation. The physical properties of the cement as determined from various tests conforming to Indian Standard IS: 12269:1987 are listed in Table 2.1.

Table 2.1: Properties of OPC 53 Grade

Sr. No.	Characteristics	Values Obtained Experimentally	Values Specified By IS 12269:1987
1.	Specific Gravity	3.10	3.10-3.15
2.	Standard Consistency	31%	30-35
3.	Initial Setting Time	115 minutes	30min(minimum)
4.	Final Setting Time	283 minutes	600min(maximum)
5.	Compressive Strength(N/mm^2) 7 days 28 days	 38.49 N/mm^2 52.31 N/mm^2	 37 N/mm^2 53 N/mm^2

2.2 Aggregates

Aggregates constitute the bulk of a concrete mixture and give dimensional stability to concrete. The aggregates provide about 75% of the body of the concrete and hence its influence is extremely important.

2.2.1 Fine Aggregates

The sand used for the work was locally procured and conformed to Indian Standard Specifications IS: 383-1970. The results are given below in Table 4.2.1 (A) and 4.2.1(B). The fine aggregated belonged to grading zone III.

Table 2.2.1(A): Sieve Analysis of Fine Aggregate

Weight of sample taken =1000 gm					
Sr. No	**IS-Sieve (mm)**	**Mass Retained (gm)**	**Cumulative mass Retained**	**Cumulative %age mass Retained**	**Cumulative %mass passing through**
1	4.74	1	1	0.1	99.9
2	2.36	22	23	2.3	97.7
3	1.18	77	100	10	90
5	600µ	153	253	25.3	74.7
6	300µ	264	517	51.7	48.3
7	150 µ	425	942	94.2	5.8
8	Below150µ	58	1000	100	0
	Total			**Σ283.6**	

FM of fine aggregate = 283.6/100=2.836

Table 2.2.1(B): Physical Properties of fine aggregates

Characteristics	Value
Specific gravity	2.63
Bulk density	5%
Fineness modulus	2.83

2.2.2 Coarse Aggregates

Locally available coarse aggregate having the maximum size of 20 mm was used in this work. The aggregates were tested as per IS: 383-1970. The results are shown in Table 4.2.1(A) and Table 4.2.2(B).

Table 2.2.2(A): Sieve Analysis of Coarse Aggregate (20 mm)

Weight of sample taken =2000 gm					
Sr. No	**IS-Sieve (mm)**	**Mass Retained (gm)**	**Cumulative mass retained**	**Cumulative %age mass Retained**	**Cumulative % mass passing through**
1	40	0	0	0	100
2	20	145	145	7.25	92.75
3	10	1829	1974	98.7	1.3
5	4.74	124	1998	99.9	0.1
6	2.36	0	1998	99.9	0.1
7	1.18	0	1998	99.9	0.1
8	600µ	0	1998	99.9	0.1
9	300µ	0	1998	99.9	0.1
10	150 µ	0	1998	99.9	0.1
11	Below150µ	2	2000	100	0
	Total			**Σ805.35**	

FM of Coarse aggregate = 805.35/100=8.0535

Table 2.2.2(B): Properties of Coarse Aggregates

Characteristics	**Value**
Type	Crushed
Colour	Grey
Shape	Angular
Nominal Size	20 mm
Specific Gravity	2.62
Total Water Absorption	0.89
Fineness Modulus	8.05

2.3 RHA

In this work, Rice Husk was taken from R. K. Enterprises, Bhangrotu, (Mandi), Himachal Pradesh, India. Rice husk firstly wash with portable water then dried in the sun. After then rice husk burnt in the open atmosphere so as to convert it into ash.

Table 2.3: Physical properties of Rice Husk Ash

Appearance	Fine powder
Particle Size	Sieved through 90 micron sieve
Specific gravity	2.21
Color	Light grey

3. Results and Discussion

This section presents a summary of the results obtained from laboratory tests that have been done on the specimen. Tests were done on materials (cement, fine aggregates, coarse aggregates, RHA and WPSA), fresh and hardened concrete.

3.1 FRESH CONCRETE

3.1.1 Slump Test

The slump value of all the mixture are represented in Table 3.1.1

Table 3.1.1: Slump Tests Results

Mix	**Percentage**	**SlumpValue**
Control	0%	90mm
RHA	2%	65mm
	6%	55mm
	8%	25mm
	10%	20mm
WPSA	2%	60mm
	4%	55mm
	6%	50mm
	8%	20mm
Mix (RHA+WPSA)	2%	30mm
	4%	20mm
	6%	15mm
	8%	7mm

The slump value v/s percentage of replacement was shown in Fig 3.1.1. The slump decreased when a higher amount of RHA, WPSA and combination of both (RHA+WPSA) was mix was added in concrete.

3.1.2 Compaction Factor Test

The Compaction factor values of all the mixture are represented in Table 3.1.2

Table 3.1.2: Compaction Factor Results

Mix	Percentage	Compaction Factor
CONTROL	0%	0.93
RHA	2%	0.90
	4%	0.87
	6%	0.83
	8%	0.82
WPSA	2%	0.92
	4%	0.90
	6%	0.85
	8%	0.81
MIX (RHA+WPSA)	2%	0.84
	4%	0.83
	6%	0.80
	8%	0.78

The compaction factor value of control concrete is 0.93. As we go on increasing the % replacement of cement with the RHA from 5 to 20% the compaction factor value decreases from 0.92 to 0.82. In the case of WPSA the compaction factor value decreases gradually from 0.92 to 0.81. And same as in case of Mix (RHA+WPSA) the compaction factor value decreases gradually from 0.84 to 0.78.

3.2 Hardened Concrete

3.2.1: Effect of Age on Compressive Strength

The 28 days strength obtained for M20 Grade Control concrete is 30.93 N/mm^2.The strength results reported in table no 5.2.1 are presented in the form of graphical variations, where the compressive strength is plotted against the % of cement replacement.

Table 3.2.1: Compressive Strength of Control concrete in N/mm^2

Grade of concrete	7Days	28Days
M20	20.4	30.93

The strength achieved at different ages namely, 7 and 28 for Control concrete.

Fig.3.2.1: Compressive Strength of Control Concrete

It is clear that as the age advances, the strength of Control concrete increases. The rate of increase of strength is higher at curing period up to 28 days. However the strength gain continues at a slower rate after 28 days.

3.2.2 Effect of Age on Split Tensile Strength of Control Concrete

The 28 days tensile strength obtained for M20 Grade Control concrete is 2.71 N/mm^2.The strength results reported in table no 5.2.2 are presented in the form of graphical variations, where the compressive strength is plotted against the % of cement replacement.

Table 3.2.2: Split Tensile Strength of Control concrete in N/mm^2

Grade of concrete	7Days	28Days
M20	1.94	2.71

3.2.2: Split Tensile Strength of Control Concrete

It is clear that as the age advances, the split tensile strength of Control concrete increases. The rate of increase of strength is higher at curing period up to 28 days. However the strength gain continues at a slower rate after 28 days.

3.2.3: Effect on Compressive Strength of Concrete Containing various percentages of RHA.

Table 3.2.3: Compressive Strength of RHA Concrete

Mix	Percentage of Cement Replacement	Cube Compressive Strength (N/mm^2)	
		7 days	28 Days
CONTROL	0%	20.4	30.93
RHA	2%	19.67	29.26
	4%	19.63	28.85
	6%	18.66	24.74
	8%	15.22	21.48

3.2.3(A): Compressive Strength of RHA Concrete at 7 Days

As per experimental program and results shown in table no. 5.2.3. We can replace cement by RHA up to 4%. Because the compressive strength up to 4% replacement of cement is comparatively equal to control mix design. If cement is replaced by RHA more than 4% the loss in compressive strength is comparatively greater than the replacement up to 4%.

3.2.4: Effect on Split Tensile Strength of Concrete Containing various percentages of RHA.

Table 3.2.4: Split Tensile Strength of RHA Concrete

Mix	Percentage of Cement Replacement	Split Tensile Strength (N/mm^2)	
		7 days	28 Days
M20	0%	1.94	2.71
RHA	2%	2.03	2.94
	4%	1.99	2.72
	6%	1.89	2.34
	8%	1.34	1.97

Split Tensile Strength of RHA Concrete at 28 Days

As per table no.5.2.4 the split tensile strength for replacement of 2% is higher than control mix design and decreases with further increase in RHA but up to 4% of replacement the split tensile strength is still more than the split tensile strength of control mix design.

3.2.5: Effect on Compressive Strength of Concrete Containing various percentages of WPSA

Table 3.2.5: Compressive Strength of WPSA Concrete

Mix	Percentage of Cement Replacement	Cube Compressive Strength (N/mm^2)	
		7 days	28 Days
CONTROL	0%	20.4	30.93
WPSA	2%	24.07	31.26
	4%	22.3	27.59
	6%	19.67	25.1
	8%	16.89	23.04

Compressive Strength of WPSA Concrete at 28 Days

As per the results shown in table no.5.2.5 the compressive strength at 7 days for 2% and 4% replacement of cement by WPSA are higher than Control Mix, further increases in % replacement the compressive strength goes on decreases. The compressive strength at 28 Days for 2% replacement is found out to be 31.26 N/mm^{2}which is higher than the compressive strength of 30.93N/mm^2 of control mix. For 4% replacement the compressive strength is comparatively nearer to the control mix and for further increases in % replacement the compressive strength decreases.

3.2.6: Effect on Split Tensile Strength of Concrete Containing various percentages of WPSA

Table 3.2.6: Split Tensile Strength of WPSA Concrete

Mix	Percentage of Cement Replacement	Split Tensile Strength (N/mm^2)	
		7 days	28 Days
M20	0%	1.94	2.71
WPSA	2%	2.34	3.11
	4%	2.1	2.92
	6%	1.82	2.78
	8%	1.69	2.02

Split Tensile Strength of WPSA Concrete at 28Days

From the results shown in table no5.2.6 the split tensile strength at 7 Days and 28 Days for 2% and 4% replacement by WPSA is found to be higher than the Control Mix. For 6% the split tensile strength is comparatively equal to the control Mix and for further increase in % replacement of cement the split tensile strength decreases.

3.2.7: Effect of Compressive Strength of Concrete Containing various percentages of Mix (RHA+ WPSA)

Table 3.3.7: Compressive Strength of Mix (RHA+ WPSA) Concrete

Mix	Percentage of Cement Replacement	Cube Compressive Strength (N/mm^2)	
		7 days	28 Days
CONTROL	0%	20.4	30.93
MIX (RHA+WPSA)	2%	19.84	28.89
	4%	18.82	27.66
	6%	18.6	24.52
	8%	16.03	18.82

3.2.7(B): Compressive Strength of Mix (RHA+WPSA) at 28 Days

The results from table no 5.3.7 represents that 10% replacement with Mix(RHA+WPSA) the compressive strength are comparatively equal to Control Mix strength, and further increase in % replacement the strength decreases.

3.2.8: Effect of Split Tensile Strength of Concrete Containing various percentages of Mix (RHA+ WPSA)

Table 3.2.8: Split Tensile Strength of Mix (RHA+ WPSA) Concrete

Mix	Percentage of Cement Replacement	Splitting Tensile Strength (N/mm^2)	
		7 days	28 Days
M20	0%	1.94	2.71
MIX (RHA+WPSA)	2%	1.96	2.95
	4%	1.86	2.81
	6%	1.71	2.64
	8%	1.65	2.24

Split Tensile Strength Mix (RHA+WPSA)

As per the results from table no.5.2.8. The split tensile strength of 2% replacement of cement with Mix (RHA+WPSA) has higher value than the control mix and 4% replacement has comparatively equal split tensile strength to Control Mix. For the 6% and 8% the split tensile structure decreases gradually.

4. Conclusions

The Conclusion of this experimentation has been to evaluate the possibility of successful replacement of cement with RHA, WPSA and MIX (RHA+WPSA) in concrete. The conclusion drawn during the experimentations are as follows:

4.1: Split Tensile Strength of Control Concrete, RHA Concrete, WPSA Concrete & Mix (RHA+WPSA) at 28 Days

- The compressive strength and split tensile strength increased up to 10% with 4% replacement of WPSA. Further increase in WPSA decreases the strength gradually and up to 8% replacement it can be used as a supplementary material in M20 grade of Concrete.
- The above results shows that it is possible to design M20 grade of concrete incorporating with RHA content up to 10%.
- As test results shows the Mix (RHA+WPSA) can also be used as a replacement of cement.
- Control mix with 2% WPSA showed higher Compressive Strength than Control mix, RHA concrete and Mix (RHA+WPSA) concrete.

- The study showed that the early strength of RHA, WPSA and Mix (RHA+WPSA) concrete was found to be less and the strength increased with age.
- The workability of RHA, WPSA and Mix(RHA+WPSA) concrete has been found to decrease with the increase in replacements.
- Based on the results of Split Tensile Strength test,it is convenient to state that there is substantial increase in Tensile Strength due to the addition of RHA, WPSA and Mix (RHA+WPSA).
- Use of Waste Paper Sludge Ash, Rice Husk Ash and Mix (RHA+WPSA) in concrete can prove to be economical as it is non useful waste and free of cost.
- Use of waste paper sludge ash in concrete will preserve natural resources that are used for cement manufacture and thus make concrete construction industry sustainable and waste paper sludge can be used as fuel before using its ash in concrete for partial cement replacement and also the disposal problem for paper industries for this waste material is fully solved.

5. Future Scope

Study has shown that rice husk ash and waste paper sludge ash can be used in concrete. There are several areas in which further work can be extended:

- Some tests relating to durability aspects such as water permeability, resistance to penetration of chloride ions, corrosion of steel reinforcement, resistance to sulphate attack durability in marine environment etc. with Rice husk ash and Waste Paper Sludge Ash need investigation.
- The study may further be extended to know the behavior of concrete whether it is suitable for pumping purpose or not as present day technology is involved in RMC where pumping of concrete is being done to large heights.
- For use of Rice husk ash and Waste Paper Sludge Ash concrete as a structural material, it is necessary to investigate the behavior of reinforced Rice husk ash and Waste Paper Sludge Ash concrete under flexure, shear, torsion and compression
- Work can be done on the microscopic structure of Rice Husk Ash and Waste Paper Sludge Ash so that chemical properties can be known.
- Further research is needed to establish the long-term durability of concrete containing mineral admixtures. The microstructure properties of concrete are needed to be further researched.
- Research can be done to find out the characteristics strength of concrete using properly grinded and controlled temperature burnt RHA and WPSA.

References

1. Ahmad S, Malik M.I., Wani M.B., Ahmad R. (2013). "Study of Concrete Involving Use of Waste Paper Sludge Ash As Partial Replacement of Cement." IOSR Journal of Engineering (IOSRJEN), Vol. 3, Issue 11, pp. 6-15.
2. Alwash J.J.H., "Use of Rice Husk Ash in cement mortar."
3. Balwik S.A., Raut S.P. "Utilization of Waste paper Pulp by Partial Replacement of Cement in Concrete." Int. Journal of Engineering Research and Applications (IJERA), Vol. 1, Issue 2, pp. 300-309.
4. Chun Y.M., Naik T.R., Kraus R.N. (2005). "Durable concrete through use of pulp and paper mill residuals." Composites in Construction, pp. 1-8.
5. Hossain T., Sarker S.K., Basak B.C. (2011). "Utilization potential of Rice Husk Ash as a construction material in rural areas." Journal of Civil Engineering (IEB), pp. 175-188.
6. IS: 10262-1982 (Reaffirmed 1999). "Recommended guidelines for Concrete Mix Design." Bureau of Indian Standards, New Delhi (India).
7. IS: 2386 (Part IV)-1963 (Reaffirmed 1997). "Methods of test for aggregates for concrete." Bureau of Indian Standards, New Delhi (India).
8. IS: 383-1970 (Reaffirmed 2002)." Specification for coarse and fine aggregates from natural sources for concrete." Bureau of Indian Standards, New Delhi (India).
9. IS: 4031 (Part 11)-1988. "Methods of physical tests for hydraulic cement." Bureau of Indian Standards, New Delhi (India).
10. IS: 4031 (Part 15)-1991 (Reaffirmed 2005). "Methods of physical tests for hydraulic cement." Bureau of Indian Standards, New Delhi (India).
11. IS: 456-2000 (Reaffirmed 2005). "Plain and reinforced concrete-Code of practice." Bureau of Indian Standards, New Delhi (India).
12. IS:1199-1959 (Reaffirmed 1999). "Methods of sampling and analysis of concrete." Bureau of Indian Standards, New Delhi (India).
13. Ishimoto B.H, Origuchi T., Yasuda M. (2000) "Use of Papermaking Sludge As New Material." Journal of Material in Civil Engineering, Vol. 12, pp. 310-312.
14. Kartini. K (2011). "Rice Husk Ash-Pozzolanic material for sustainability." Int. Journal of Applied Science and Technology, Vol. 1 No.6, pp. 169-178.
15. Kene S.D., Domke P.V., Deshmuh S.D., Deotale R.S. "Assessment of concrete strength using Fly Ash and Rice Husk Ash." Int. Journal of Engineering Research and Applications (IJERA), Vol. 1, Issue. 3, pp. 524-534.
16. Khassaf S.I., Jasim A.T., Mahdi F.K. (2014). "Investigation the properties of concrete containing Rich Husk Ash to reduction the seepage in canals." Int. Journal of Scientific and Technology Resaearch, Vol. 3, Issue 4, pp. 348-354.
17. Kumar Sathish (2012). "Experimental study on the properties of concrete made with alternate construction materials" Int. Journal of Modern Engineering Research (IJMER), Vol. 2, Issue. 5, pp. 3006-3012.
18. Pitroda J.R., Umrigar F.S. (2013). "Evaluation of Modulus of Elasticity of concrete with partial Replacement of Cement By Thermal Industry Waste (Fly Ash) and Paper Industry Waste (Hypo Sludge)." Int. Journal of Engineering Science and Innovative Technology (IJESIT), Vol. 2, Issue 1, pp. 133-138.
19. Pitroda J.R., Zala L.B, Umrigar F.S.(2013). "Utilization of Hypo Sluge by Eco- Efficient Development of Rigid Pavement in Rural Roads." Int. Journal of Engineering Trends and Techonology (IJETT), Vol. 4, pp. 3994-4000.
20. Potty N.S., Vallyutham K., Yusoff M.F., Anwar A., Haron M.F., Alias M.N. (2014). "Properties of Rice Husk Ash (RHA and MIRHA) mortar." Research

Journal of Applied Sciences, Engineering and Technology, pp. 3872-3882.

21. Rajput J., Yadav R.K., Chandak R. (2013). "The effect of Rice Husk Ash used as supplementary cementing material on strength of mortar." Int. Journal of Engineering Research and Applications (IJERA), Vol. 3, Issue. 3, pp. 133-136.
22. Ramezanianpour A.A., Khan M.M., Ahmadibeni Gh. (2009). "The effect of Rice Husk Ash on mechanical properties and durability of sustainable concretes." Int. Journal of Civil Engineering, Vol. 7, No. 2, pp. 83-91.
23. Rao P.P., Kumar A.P., Singh B.B. (2014). "A study on use of Rice Husk Ash in concrete." Int. Journal of Education and Applies Research (IJEAR), Vol. 4, Issue Spl-2, pp. 75-81.
24. Seyyedalipour S.F., Kebria D.Y., Malidarreh N.R., Norouznejad G. (2014). "Study of Utilization of Pulp and Paper Industry Wastes in Production of Concrete." Int. Journal of Engineering Research and Applications (IJERA), Vol. 4, Issue 1, pp. 115-122.
25. Shah R.A., Pitroda J.R. (2013). "Effect of Hypo Sludge as Partial Replacement with Cement in Mortar." JIARM, Vol. 1, Issue 3, pp. 195-205.
26. Shukeri R.B.M., Ghani A.N.A. (2008). "Concrete mix with waste paper." 2nd Int. Conference on Built Environment in Developing Countries (ICBEDC), pp. 567-575.
27. Srinivasan R., Sathiya K., Palanisamy M. (2010). "Experimental Investigation in Developing Low Cost Concrete from Paper Industry Waste." pp. 43-56.