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Use of Paper Industry Waste (Hypo Sludge) in Design Mix Concrete

[1*] Shakir Ahmad, [1] Muhammad Mannal Kaleem, [1]Muhammad Bilal Zahid, [1] Muhammad Usman
[1]Junior Lecturer-Civil Engineering Department,
University of Management & Technology,
Lahore, Pakistan.

***Abstract*— For a greener and sustainable future we have to develop innovative ways to save fuel and mitigate carbon footprints therefore develop alternative ways by which building materials can be modified To produce low cost concrete by blending various ratios of cement with hypo sludge & to reduce disposal and pollution problems due to hypo sludge it is most essential to develop profitable building materials from hypo sludge. The cement has been replaced by waste paper sludge accordingly in the range of 0% (without Hypo sludge), 7.5%, 10%, & 15% by weight. Concrete mixtures were produced, tested and compared in terms of strength with the conventional concrete. These tests were carried out to evaluate the mechanical properties like compressive strength of 3, 7 up to 28 days. For workability we use more water cement ratio for maintain the workability with increase the percentage of hypo sludge because hypo sludge absorb the water and also crush the hypo sludge up to that it pass through the 40 no. sieve for maintain the workability of concrete. We casted 45 cubes total, 9 cubes for each trial. As a result, the compressive increased to 10% addition of hypo sludge and further increased in hypo sludge reduces the strengths gradually. Keeping all this view, the aim of investigation is the behavior of concrete while adding of waste with different proportions of Hypo sludge in concrete by using tests like compression strength.**

Keywords*— *Hypo Sludge, Partial Replacement, Compressive Strength, Cement, Fine, Aggregate, Cost

I. INTRODUCTION

Paper mill sludge is a major environmental problem for the paper and board industry. The material is by-product of the de-inking and re-pulping of paper .The million tons quantity of paper mill sludge produced in the world. Paper sludge behaves like cement because of silica and magnesium properties which improve the setting of the concrete. The quantity of sludge varies from mill to mill. The amount of sludge generated by a recycled paper mill is greatly dependent on the type of furnish being used and end product being manufactured. Paper mill sludge can be used as an alternative material applied as partial replacement of fine aggregates in manufacturing fresh concrete intended to be used for low cost housing projects. About 300 kg of sludge is produced for each tone of recycled paper. This is a relatively large volume of sludge produced each day that makes making landfill uneconomical as paper mill sludge is bulky. By adjusting the mixture to an equivalent density, concrete mixtures containing the residuals can be produced that are equal in slump and strength to a reference concrete without residuals. The main recycling and disposal routes for paper sludge are land spreading agricultural fertilizer, producing paper sludge ash, or disposal to landfill. In functional terms, paper sludge consists of cellulose fibers, calcium carbonate and china clay and residual chemicals bound up with water. [1] The material is viscous, sticky and hard to dry. To produce low cost concrete by blending various ratios of cement with hypo sludge and to reduce disposal and pollution problems due to hypo sludge it is most essential to develop profitable building materials from hypo sludge. To make good quality paper limited number of times recycled Paper fibers can be used which produces a large amount of solid waste. The innovative use of hypo sludge in concrete formulations as a supplementary cementitious material was tested as an alternative to conventional concrete. To reduce disposal and pollution problems emanating from these industrial wastes, it is most essential to develop profitable building materials from them.[2] Keeping this in view, investigations were undertaken produce low cost concrete by blending various ratios of cement with hypo sludge. Paper mill sludge is often incinerated for heat recovering and also for an important volume reduction. In Italy about 6x105tons of paper sludge is yearly produced giving 60kg of paper ash per ton. In this project, the ash coming from burning of paper mill sludge from primary mechanical separation process, fired as single fuel, was studied in order to evaluate its use as supplementary cementations material in concrete manufacturing. On the basis of the data collected it can be concluded that the paper mill sludge ash, if replaced by 5 to 10% of Portland cement, show a positive effect on the mechanical performance of the concrete. Waste paper is composed of previously discarded paper or paperboard products. [3] Both contain cellulose fiber that can be subsequently combined with other inputs to manufacture paper, paperboard, or other wood-fiber-based products. So, by using this paper waste we can solve the disposal problem. In Urban cities, Solid waste management is one of the most challenging issues, which are facing a serious pollution problem due to the generation of huge quantities of solid waste. This paper presents an assessment of the existing situation of solid waste management .In this paper presents making hypo sludge from paper waste, which is use as a construction material. The global cement industry contributes about 7% of greenhouse gas emission to the earth's atmosphere. [4] In order to address environmental effects associated with cement manufacturing

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and constantly depleting natural resources, there is a need to develop alternative binders to make concrete industry sustainable. This work examines the possibility of using waste paper sludge ash as partial replacement of cement for new concrete. From the results obtained, it is found that Waste Paper Sludge Ash can be used as cement replacement up to 5% by weight further waste paper sludge has very high calorific value and could be used as a fuel before using its ash as partial cement replacement. To produce low cost concrete by blending various ratios of cement with hypo sludge & to reduce disposal and pollution problems due to hypo sludge it is most essential to develop profitable building materials from hypo sludge.[5] The innovative use of hypo sludge in concrete formulations as a supplementary cementations material was tested as an alternative to traditional concrete. These tests were carried out to evaluate the mechanical properties like compressive strength up to 28 days. As a result, the compressive increased up to 10% addition of hypo sludge and further increased in hypo sludge reduces the strengths gradually. This research work is concerned with experimental investigation on strength of concrete and optimum percentage of the partial replacement by replacing cement via 5%, 10%, 15%, and 20% of Hypo Sludge [6]

II. OBJECTIVES

The objectives of the present study are:

1. To select the Hypo Sludge mix proportion for concrete mix.
2. To investigate changes in compressive strength of concrete mix with Hypo sludge replacement.
3. To perform the experiments on the time-dependent compressive strength of cement mortar with Hypo Sludge. The strengths were measured at the age of3& 7 & 28 day

III. MATERIAL PROPERTIES

III.1 Hypo Sludge:

The hypo sludge is procured from industrial Hitar area. This plant is located near Taxila. Hypo sludge contains low calcium and maximum calcium chloride and minimum amount of silica. Hypo sludge behaves like cement because of silica and magnesium properties. This silica and magnesium improve the setting of the concrete.[7-8] we replaced cement with hypo sludge by 0,5,7.5,10,15 %. Fig. 1 shows the Hypo sludge material. The constituents of Hypo sludge are given in Table 1.

Fig 1: Hypo Sludge

Table 1: Constituents of Hypo Sludge

Sr. #	Constituent	Percentage (%)
1	Acid insolunle	11.1
2	Silica (SiO_2)	9.0
3	Magnesium	3..3
4	Calcium Sulphate	46.2
5	Moisture	56.8

III.2. Cement:

Ordinary Portland cement cement conforming to ASTM C 150 type 1 is utilized in the research work. Details of properties of cement are given in Table 2.

Table 2. Physical Properties of cement

Sr #	Properties of cement	Result	Requirment as Standard ASTMC-150
1	SpecificGravity	3.03	3.07
2	Initial Setting Time (45 min by Vicat niddle)	85 min	60min(min)
3	Final Setting Time (10 hours)	250 min	600 min(max)
4	Compressive Strength 7days	37.12MPa	17.93 MPa

III.3 Coarse Aggregate:

The fractions from 12.5 mm(0.5 in) to 25mm(1 in) are used as coarse aggregate. The properties of coarse aggregate are used as per ASTM C33-03.

III.4 Fine Aggregate:

Those fractions from 4.75 mm are termed as fine aggregate. The river sand and crushed sand is used in combination as fine aggregate conforming to the requirements of ASTM C33-03. Details of aggregates are given n Table 3.

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Table 3. Properties of aggregates

Property	Fine Aggregate	Coarse Aggregate
Specific Gravity	2.4	2.65
Bulk Density (kg/m^3)	1675	1550

III. 5 Water:

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. We used the tap water for our experiment. Quality of water is required to be looked into very carefully. Water cement ratio used is different for 5 trials to maintain the workability. Properties of water are given in Table 4.

Table 4. Properties of water

Sr #	Properties	Units
PH	7.15	-
Turbidity	4.23	NTU

IV. MIX DESIGN METHODOLOGY

A mix grade was designed as per BS-4550 4:1978 and the same was used to prepare the test samples. The concrete of ratio 1:2:4 was used. 45 cubes were prepared for 5 Mix Design (9 cubes for each trial). The strengths of these cubes were found on 3, 7 and 28 days. Details of design are given in Table 5. Concrete mixing is shown in Fig. 6. Casting of cube samples is shown in Fig. 7.

Table 5. Replacement of Hypo Sludge

Design	Hypo sludge replacement by percentage	w/c ratio	Slump(mm)
1	0	0.55	30
2	5	0.6	30
3	7.5	0.65	30
4	10	0.7	30
5	15	0.75	30

V. DESIGN DETAILS

V.1 Design No 1:

1. In 0% hypo-sludge find the compressive strength of 3,7,28 days with w/c ratio of 0.55 with the slump of 30mm.To find the best result of compressive strength use 3 trial for each 3,7 and 28 days for testing.

2. The design No 1 gives us the full compressive strength as per standard & we compare its strength with others design mix (in which strength gradually decrease with increase with hypo sludge). Details are given in Table 6.

Table 6. Design No 1

Sr #	Comp. Strength at days	Concrete Type	Concrete Design Mix				Cement Replacement By Hypo Sludge (kg)
			W/C Ratio	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	
1	3	A1	0.55	1.2	2.5	5.1	-
2		A2	0.55	1.2	2.5	5.1	-
3		A3	0.55	1.2	2.5	5.1	-
4	7	B1	0.55	1.2	2.5	5.1	-
5		B2	0.55	1.2	2.5	5.1	-
6		B3	0.55	1.2	2.5	5.1	-
7	28	C1	0.55	1.2	2.5	5.1	-
8		C2	0.55	1.2	2.5	5.1	-
9		C3	0.55	1.2	2.5	5.1	-

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V.2 Design No 2:

1. In 5 percent hypo-sludge find the compressive strength of 3,7,28 days with w/c ratio of 0.60 with the slump of 30mm.To find the best result of compressive strength use 3 trial for each 3,7 and 28 days for testing.
2. Use more water cement ratio due to hypo-sludge which absorb more water than cement to maintain the slump of 30mm. Design details are given in Table 7.

Table 7. Design No 2

Sr #	Comp. strength at days	Concrete Type	Concrete Design Mix				Cement Replacement By Hypo Sludge (kg)
			W/C Ratio	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	
1	3	A1	0.6	1.14	2.5	5.1	0.06
2		A2	0.6	1.14	2.5	5.1	0.06
3		A3	0.6	1.14	2.5	5.1	0.06
4	7	B1	0.6	1.14	2.5	5.1	0.06
5		B2	0.6	1.14	2.5	5.1	0.06
6		B3	0.6	1.14	2.5	5.1	0.06
7	28	C1	0.6	1.14	2.5	5.1	0.06
8		C2	0.6	1.14	2.5	5.1	0.06
9		C3	0.6	1.14	2.5	5.1	0.06

V.3 Design no 3:

1. In 7.5 % hypo-sludge find the compressive strength of 3,7,28 days with w/c ratio of 0.65 with the slump of 30mm.To find the best result of compressive strength use 3 trial for each 3,7 and 28 days for testing.
2. Use more water cement ratio due to hypo-sludge which absorb more water than cement to maintain the slump of 30mm. Details of Design are given in Table 8.

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Table 8. Design No 3

Sr #	Comp. strength at days	Concrete Type	Concrete Design Mix				Cement Replacement By Hypo Sludge (kg)
			W/C Ratio	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	
1	3	A1	0.65	1.11	2.5	5.1	0.09
2		A2	0.65	1.11	2.5	5.1	0.09
3		A3	0.65	1.11	2.5	5.1	0.09
4	7	B1	0.65	1.11	2.5	5.1	0.09
5		B2	0.65	1.11	2.5	5.1	0.09
6		B3	0.65	1.11	2.5	5.1	0.09
7	28	C1	0.65	1.11	2.5	5.1	0.09
8		C2	0.65	1.11	2.5	5.1	0.09
9		C3	0.65	1.11	2.5	5.1	0.09

V.4. Design no 4:

1. In 10% hypo-sludge find the compressive strength of 3,7,28 days with w/c ratio of 0.70 with the slump of 30mm.To find the best result of compressive strength use 3 trial for each 3,7 and 28 days for testing.
2. Use more water cement ratio due to hypo-sludge which absorb more water than cement to maintain the slump of 30mm. Details of design are given in Table 9.

Table 9. Design No 4

Sr #	Comp. strength at days	Concrete Type	Concrete Design Mix				Cement Replacement By Hypo Sludge (kg)
			W/C Ratio	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	
1	3	A1	0.70	1.08	2.5	5.1	0.12
2		A2	0.70	1.08	2.5	5.1	0.12
3		A3	0.70	1.08	2.5	5.1	0.12
4	7	B1	0.70	1.08	2.5	5.1	0.12
5		B2	0.70	1.08	2.5	5.1	0.12
6		B3	0.70	1.08	2.5	5.1	0.12
7	28	C1	0.70	1.08	2.5	5.1	0.12
8		C2	0.70	1.08	2.5	5.1	0.12
9		C3	0.70	1.08	2.5	5.1	0.12

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V.5. Design No 5:

1. In 15 percent hypo-sludge find the compressive strength of 3,7,28 days with w/c ratio of 0.75 with the slump of 30mm.
2. To find the best result of compressive strength use trial 3 for each 3, 7 and 28 days for testing. Use more

   Use more water to cement ratio due to hypo-sludge which absorbs more water than cement to maintain the slump of 30mm. Details of design are given in Table 10.

Table 10. Design No 5

Sr. No.	Comp. Strength at days	Concrete Type	Concrete Design Mix				Cement Replacement By Hypo Sludge (kg)
			W/C Ratio	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	
1	3	A1	0.75	1.02	2.5	5.1	0.18
2		A2	0.75	1.02	2.5	5.1	0.18
3		A3	0.75	1.02	2.5	5.1	0.18
4	7	B1	0.75	1.02	2.5	5.1	0.18
5		B2	0.75	1.02	2.5	5.1	0.18
6		B3	0.75	1.02	2.5	5.1	0.18
7	28	C1	0.75	1.02	2.5	5.1	0.18
8		C2	0.75	1.02	2.5	5.1	0.18
9		C3	0.75	1.02	2.5	5.1	0.18

VI. RESULTS

Standard metallic cube molds (150*150*150 mm) were casted for compressive strength. A compacting rod was used for compaction of the hand filled concrete cubes. The specimens were de molded after 24 hours and subsequently immersed in water for different age of testing(i.e. 3,7 & 28). For each age 15 specimens were tested for the determination of average compressive and split strength. Test was performed on compression testing machine.

VI.1. Effect on compressive strength at 3 days:

1. It can be seen from above graph that as the percent of hyposludge increases the strength of concrete decreases. Compressive strength test is shown in Fig. 9.
2. By using hyposludge upto 7.5% we get optimum strength of concrete that can be used in construction
3. After 7.5 % increase in hypo-sludge decrease in strength so we use high percentage in house construction. Graph is shown in Fig. 2.

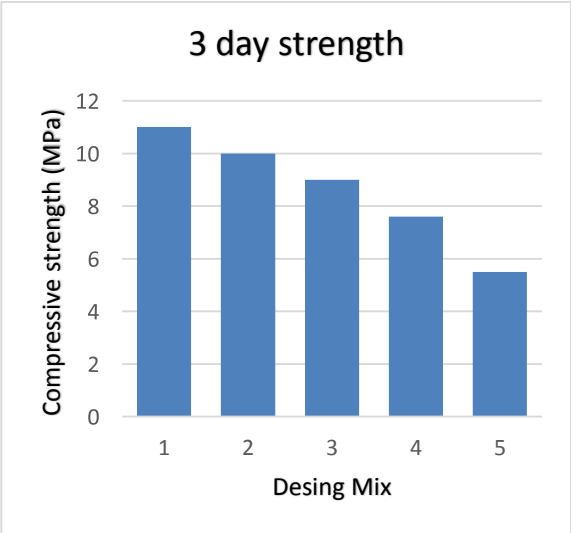

Fig. 2. Compressive strength at 3 days

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VI.2. Effect on compressive strength at 7 days:

28 day compressive strength is 32(MPa) and 7 day compressive strength is 25 (MPa) According to the standard achieved the strength. Graph is shown in Fig. 3.

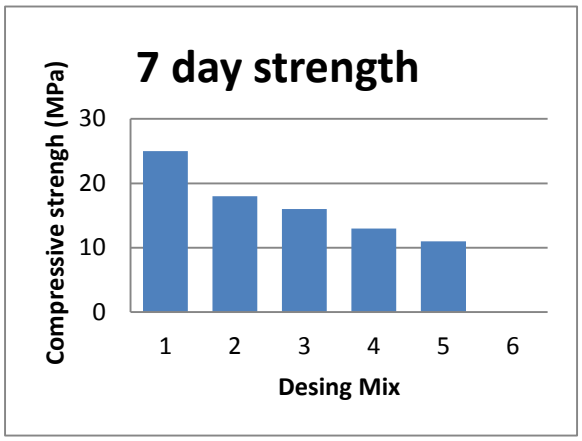

Fig. 3. Compressive strength at 7 Days

VI.3. Effect on compressive strength at 28 days:

The strength at 28 day is the max strength we get from mix design and design the building according to that strength.

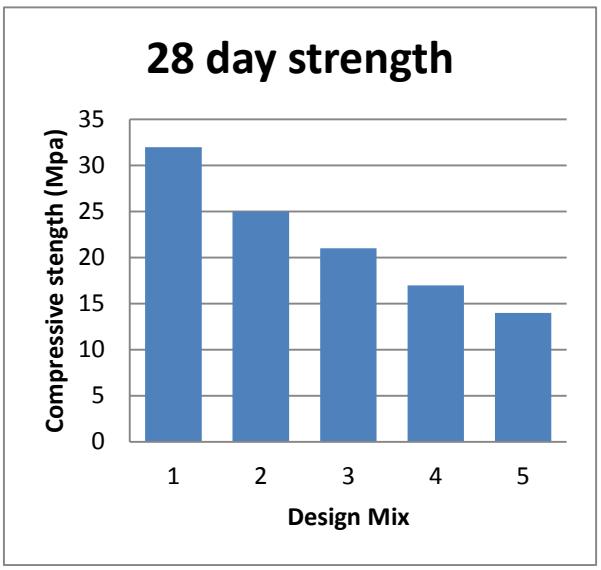

Fig. 4. Compressive strength at 28 days

VII. DISCUSSION

1. It can be seen from Fig. 2, Fig. 3, and Fig.4, that as the percent of hyposludge increases the strength of concrete decreases.
2. By using hyposludge upto 7.5% we get optimum strength of concrete that can be used in construction.
3. After 7.5 % increase in hyposluge decrease in strength so we use high percentage in smal house construction.
4. We preferred use of high percentage of hypo sludge in small construction due to that the environmental problem produce by hypo sludge (paper waste) easily control.
5. Comparison of strength at various ages is given in Fig. 5.

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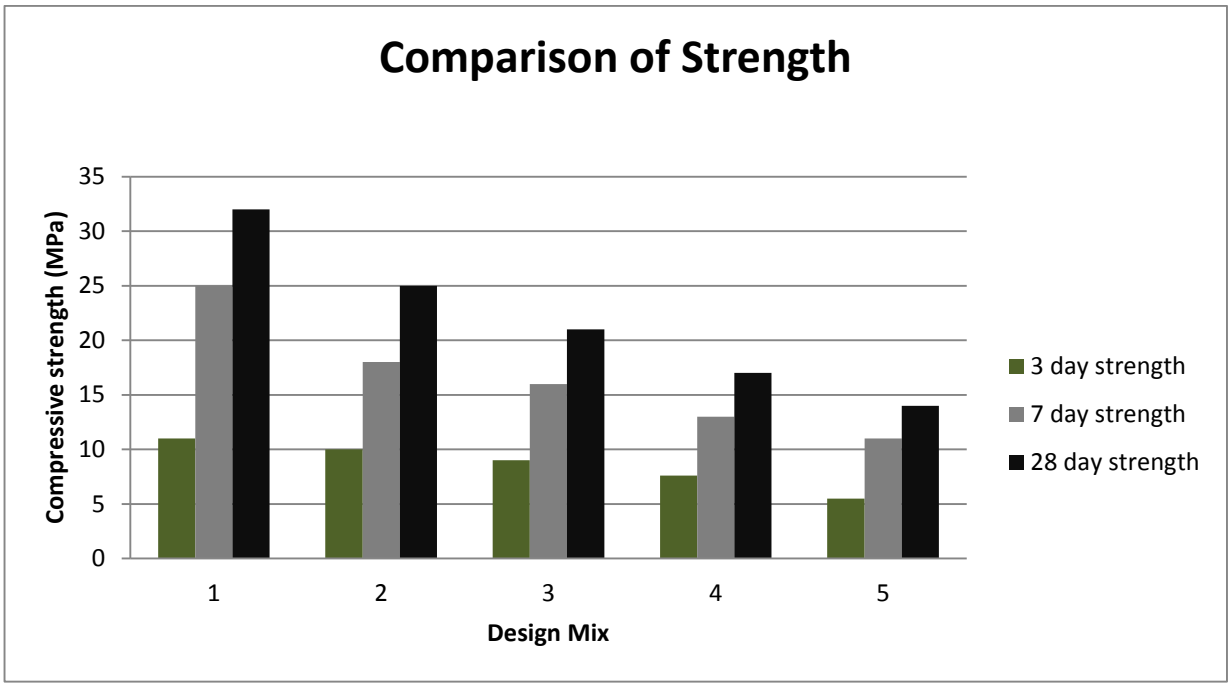

Fig. 5. Comparison of compressive strength at various ages

Fig. 6. Concrete mixing

Fig. 7. Casting of cube samples

Fig. 8. Compressive strength test

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VIII. CONCLUSION

1. When government implement the projects for temporary shelters for who those affected by natural disaster, this material can be used for economic feasibility.
2. As the % replacement of hypo sludge increase, compressive strength decreases.
3. Optimum replacement level is 7.5%.
4. As the cost of hypo sludge is less this mortar can be used at the place where strength is not of more importance or rather structure is for temporary basis.
5. Use of hypo sludge in concrete can save the paper industry disposal costs and produces a greener concrete for construction
6. The cost analysis indicates that percent cement reduction decreases cost of concrete
7. Environmental effects from waste and residual amount of cement manufacturing can be reduced through this research
8. This research concludes that hypo sludge can be innovative supplementary cementations construction material but judicious decisions are to be taken by engineers
9. Environmental effects from wastes and residual amount of cement manufacturing can be reduced through the low cost concrete.
10. If silica is added means the strength will be considerably increased because of lack of silica in hypo sludge considerably this type of concrete will be used for road works for rural areas
11. A better measure by an innovative construction material is formed through this research
12. Disposal problem of the hypo sludge can be minimized by this project, now a days it is a big problem of getting the landfill

IX. REFERENCES

[1] Yusuf Ali UET Taxila, Punjab, Pakistan, "Sustainable use of paper wastes (hypo sludge) in concrete design mix". 2014

[2] Prof. Jayeshkumar Pitroda1, & Dr. L. B. Zala, Dr. F. & S. Umrigar, "Innovative use of paper industry waste (hypo sludge) in design mix concrete",2013. IJAET, Volume IV, Issue I, pp 31-35.

[3] Prof. Jayeshkumar Pitroda1, Dr. L.B. Zala, Dr. F. S. Umrigar, "Utilization of Hypo Sludge by Eco-Efficient Development of Rigid Pavement in Rural Roads", 2013. IJETT, Volume 4.

[4] Rushabh a. shah&prof. jayeshkumar pitroda**, "Effect of hypo sludge as partial replacement with cement in mortar" 2013. International Journal of Engineering Research and Applications, (IJERA) ISSN: 2248-9622,

[5] Mr. R. balamuruga & Mr. R. karthickraja, "An experimental investigation of partial replacement of cement by industrial waste (hypo sludge)", 2014. International Journal of Engineering Research and Applications, (IJERA) ISSN: 2248-9622.

[6] Valeria Corinaldesi, Gabriele Fava, and Maria Letizia Ruello, "Paper Mill Sludge Ash as Supplementary Cementitious Material". Second International conference on sustainable construction materials and technologies, ISBN 978-1-4507-1490-7

[7] Mamta B. Rajgor, Jayeshkumar Pitroda, "A Study on Paper Industry Waste: Opportunities for Development of Low Cost Concrete in Indian Context"

[8] Sajad Ahmad, M. Iqbal Malik, Muzaffar Bashir Wani, Rafiq Ahmad, "Study of Concrete Involving Use of Waste Paper Sludge Ash as Partial Replacement of Cement". IOSR journal of Mechanical & Civil Engineering.