International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET)

| e-ISSN: 2319-8753, p-ISSN: 2320-6710| www.ijirset.com | Impact Factor: 7.512|

|| Volume 9, Issue 7, July 2020 ||

Use of Pulp Black Liquor as an Effective Admixture in Concrete

Ehthisam CK.[1], Shamsudheen KP.[1], Shibila KK. [1], Shibila Jabeen KK. [1], Asharuddeen Tharammal.[2]

U.G. Student, Department of Civil Engineering, MEA Engineering College, Perinthalmanna, Kerala, India[1]

Assistant Professor, Department of Civil Engineering, MEA Engineering College, Perinthalmanna, Kerala, India[2]

ABSTRACT: Concrete plays a major role in the field of construction. The main composition of concrete is cement, coarse aggregate, fine aggregate and water. One major challenge facing the civil engineering community is to execute projects in harmony with nature using the concept of sustainable development involving the use of high performance, environment friendly materials produced at reasonable cost. Here in this project, we introduce easily available and cost effective admixture pulp black liquor (PBL), a byproduct from paper industry. The continuous discharge of pulp black liquor to the land will cause serious environmental issues. So by adding pulp black liquor to concrete as an admixture, can reduce environmental issues and improve the properties of concrete like workability, compressive strength and split tensile strength.

KEYWORDS: Pulp black liquor(PBL),Economic Admixture.

I. INTRODUCTION

Concrete is a composite material composed of coarse aggregates and filler materials embedded in a hard matrix of material (the cement or binder) that fills the voids between the aggregate particles and glues them together. Here we should indicate that admixtures are almost always used in modern construction practice and thus become an essential component of modern concrete. Admixtures are defined as materials other than fine and coarse aggregate, water, fiber and cement, which are added into concrete batch immediately during or before mixing. Here in this project, we introduce easily available and cost-effective admixture pulp black liquor (PBL), a by-product from paper industry. The continuous discharge of pulp black liquor to the land will cause serious environmental issues. So, by adding pulp black liquor to concrete as an admixture, can reduce environmental issues and improve the properties of concrete like workability, compressive strength and split tensile strength.
The study is carried out to investigate the behaviour of concrete while adding pulp black liquor with different proportions. With the following objectives

1. To develop Pulp Black Liquor (PBL) modified concrete by introducing pulp liquor produced during the pulping process in paper industry.
2. To study the effect of PBL in the properties of ordinary concrete.
3. To find the proportion which produce increase in compressive strength, split tensile strength and flexural strength.
4. To eradicate pollution from paper industry.

II. RELATED WORK

An studied experimental and analytical study of effective utilisation of lime sludge and pulp black liquor in concrete by Asharuddheen Tharammal. Compressive Strength, split tensile strength and Modulus of rupture were tested respectively on cubes, Cylinders and prisms. In Compressive strength PBL Specimen has maximum strength.

Ganesh R. Mahallea ,He introduces both this material PBL and lime sludge. Lime sludge is used as replacement to the cement as it has similar properties as cement. Pulp black liquor is used as an admixture in concrete. The maximum compressive strength is observed while using 10% of lime sludge and 1% PBL.

Joffin George (2019), studied about pulp black liquor as an admixture in concrete And he found that The addition of PBL waste to cement led to the formation of electrostatic repulsive forces between cement particles and in turn the adsorption of the liquor waste onto the cement surface which reduces the inter particle attraction between the cement particles and helps to enhance the compressive strength .

| e-ISSN: 2319-8753, p-ISSN: 2320-6710| www.ijirset.com | Impact Factor: 7.512|

|| Volume 9, Issue 7, July 2020 ||

III. METHODOLOGY

The specimens were casted by using a concrete mix of M25 grade consisting of cement (PPC), fine aggregate, coarse aggregate, Pulp Black Liquor and water. The specimens are casted by adding 0%,1%,3%,5%,7% of PBL to the water. Details of specimen casted is given in the table.

Table 1 Details of specimens casted

SI No	PBL%	Cube	Cylinder	Beam
1.	0%	3	3	3
2.	1%	3	3	3
3.	3%	3	3	3
4.	5%	3	3	3
5.	7%	3	3	3
TOTAL		45		

As per the code book IS: 10262-2009, the mix design was done for M25 grade mix and the amount of materials was calculated. Table 2 gives the quantities required for M25 grade of concrete mix.

Table 2 Mix Proportion

Grade	Cement (kg/m3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)	Water	W/C ratio	Mix Proportion
25	438.13	753	1061	197.16	0.45	1:1.71:2.42

Fig 1: Casted Specimens

Fig 2: Specimens after 28 days of curing

Three cubes, cylinders and beams each were casted for each mixes. Tests on Compression strength, Split Tensile Strength and Flexural strength were conducted on the specimens after 28 days of curing. Based on the results obtained suitable mix proportion was selected for casting. Also Workability tests were conducted on fresh concrete such as Slump test and Compaction Factor Test. These results were compared with results of tests done nominal concrete mix

| e-ISSN: 2319-8753, p-ISSN: 2320-6710| www.ijirset.com | Impact Factor: 7.512|

|| Volume 9, Issue 7, July 2020 ||

IV. EXPERIMENTAL RESULTS

A.Slump Test on specimens

Slump test is the most commonly used method of measuring workability of concrete. The apparatus for conducting the slump test consists of a metallic mould in the form of a frustum of a cone. The slump value for each mix is tabulated in Table 3 and a graph is also plotted. It is observed that the slump value decreases with the addition of copper slag

Table 3 Slump Values

PBL %	Slump Value (mm)
0 %	30
1 %	34
3 %	40
5 %	60
7 %	75

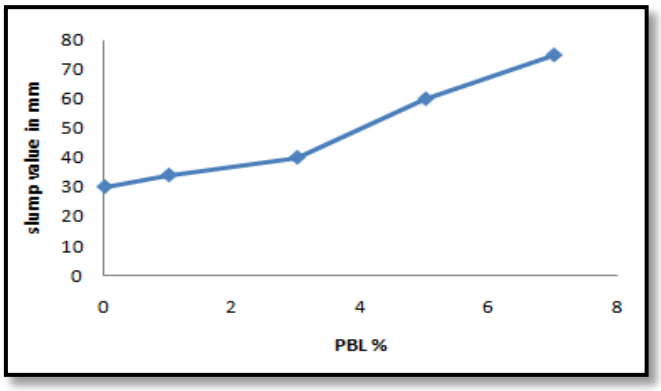

Fig 3: Variation in Slump

B. Compaction Factor Test on specimens

The compaction factor value for each mix is tabulated in Table 4 and a graph is also plotted. It is observed that the compaction factor value decreases with the addition of copper slag.

$$\text{Compaction Factor} = \frac{Weight\ of\ Partially\ compacted\ concrete}{Weight\ of\ fully\ compacted\ concrete}$$

Table 4 Compaction Factor Values

PBL	Compaction Factor
0 %	0.8
1 %	0.82
3 %	0.85
5 %	0.87
7 %	0.92

| e-ISSN: 2319-8753, p-ISSN: 2320-6710| www.ijirset.com | Impact Factor: 7.512|

|| Volume 9, Issue 7, July 2020 ||

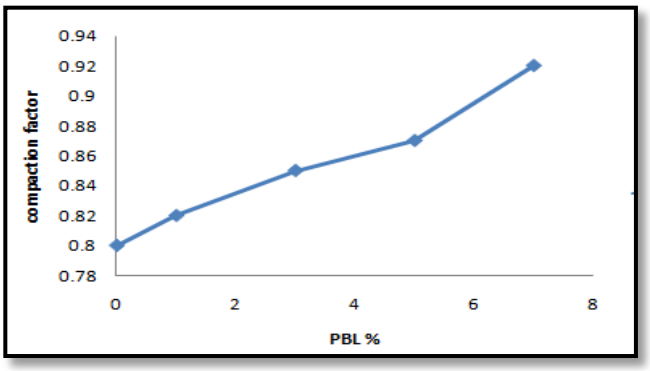

Fig 4: Variation in Compaction Factor

The workability is found to be in increasing order From the workability results, it is confirmed that, the addition of Pulp Black Liquor is increases the workability of concrete.

C.Compression Test on Cube Specimens

The compressive strength of cubes were tested at 28 days. The compressive strength of cube at 28 with the addition of 0%,1%,3%,5% and 7% shown in Table 5.

Fig 5: Compression test on cube specimen

Table 5 Compressive Strength of concrete at 28 days

PBL (%)	Compressive Strength (N/mm^2)	% Increase in Strength
0	25.8	0
1	35.58	37.90
3	44.22	71.31
5	39.66	53.72
7	37.25	44.3

The results in Table 5 show the compressive strength of concrete with varying PBL content at 28 days. The percentage change in strength with respect to normal concrete at 28 days is graphically plotted. Fig. 5 shows the testing of sample. Compressive strength of mix 00:00 obtained at 28 days is 25.8 N/mm^2. Compressive strength of 0% PBL content at 28 days is 25.8 N/mm^2, mix with 1% of PBL is 35.58 N/mm^2, mix with 1% of PBL is 44.22 N/mm^2, mix with 5% of PBL is 39.66 N/mm^2 , mix with 7% of PBL is 37.25 N/mm^2. Also the % increase in strength is calculated .

| e-ISSN: 2319-8753, p-ISSN: 2320-6710| www.ijirset.com | Impact Factor: 7.512|

|| Volume 9, Issue 7, July 2020 ||

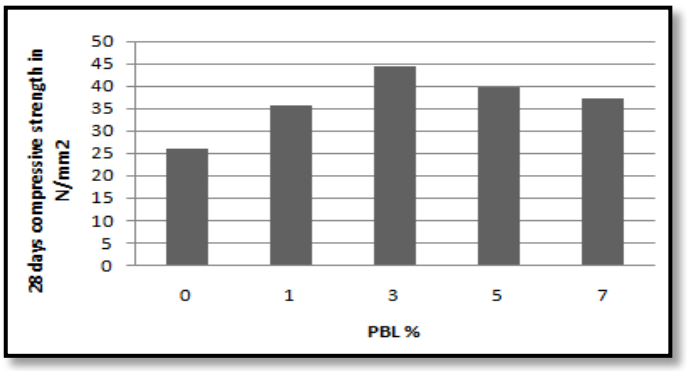

Fig 6: Variation in Compression strength

Compressive strength of concrete is increases by addition of PBLup to 3%and then slight decreases with subsequent addition.

A. Split Tensile Test on cylindrical specimen

The tensile strength of concrete is determined by splitting the cylinder across the vertical diameter. Split tensile strength is an indirect method of finding out the tensile strength of concrete. The test was carried out by placing a cylindrical specimen horizontally between the loading surfaces of a compression testing machine. The load was applied until the specimen fails. The split tensile strength is calculated using the formula**, F = 2P / ΠdL**
Where,
P=applied load, d=diameter of the specimen, L=length of the specimen

Fig 7: Split tensile test on cylindrical specimen

Table 6 Split tensile strength of concrete at 28 days

PBL (%)	Split Tensile Strength (N/mm^2)	% Increase in Strength
0	3.11	0
1	3.25	4.50
3	3.62	16.39
5	3.29	5.78
7	2.92	-6.10

| e-ISSN: 2319-8753, p-ISSN: 2320-6710| www.ijirset.com | Impact Factor: 7.512|

|| Volume 9, Issue 7, July 2020 ||

The results in Table 6 show the split tensile strength of concrete with varying percentage of PBL at 28 days Along with split tensile strength, the percentage change in split tensile strength with respect to normal concrete is plotted. Fig. 7 shows the testing of Sample for Split Tensile Strength. Split Tensile strength of mix 0% of PBL obtained at 28 days is 3.11 N/mm^2, mix with 1% of PBL is 3.17 N/mm^2. Split tensile strength of mix with 3% of PBL at 28 days is 3.62 N/mm^2,mix with 5% of PBL at 28 days is 3.29 N/mm^2,mix with 7% of PBL at 28 days is 2.92 N/mm^2. Also the %increase in strength is calculated.

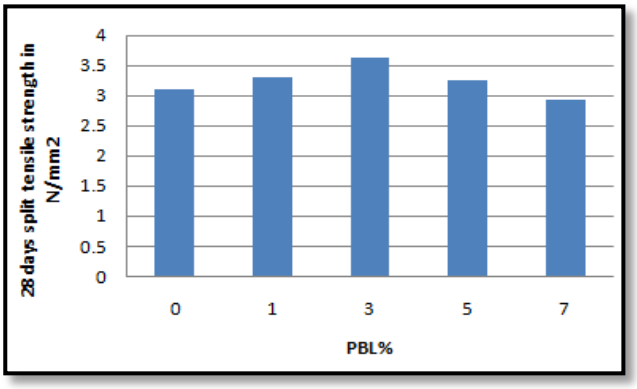

Fig.8 Variation in Split tensile strength

Slight increase in split tensile strength by addition of PBLin varying percentage and it is maximum at 3% then decreases subsequent addition.

D. Flexural Strength test on beam specimen

The standard size of the specimens 50 x 10 x 10 cm is used. The mould should be made of metal or cast iron, with sufficient plate thickness to prevent spreading or warping. The testing machine may be of sufficient capacity for the testing and rate of loading as specified. The load is applied through the roller (third-point load).The flexural strength of specimen is expressed as modulus of rupture, f_b.

Flexural strength, $f_b = 1.5PL / bd^2$

Where P = Applied load, L = Length of specimen ,b, d = Cross section dimensions of specimen.

Fig 9: Flexural strength test on beam specimen

| e-ISSN: 2319-8753, p-ISSN: 2320-6710| www.ijirset.com | Impact Factor: 7.512|

|| Volume 9, Issue 7, July 2020 ||

Table7: Flexural strength of concrete at 28 days

PBL (%)	Flexural Strength (N/mm^2)	% Increase in Strength
0	4.45	0
1	6.86	54.15
3	8.38	88.31
5	8.95	101.1
7	8.35	87.6

The results in Table 7 show the Flexural strength of concrete with varying percentage of PBL at 28 days. Along with Flexural strength, the percentage change in Flexural strength with respect to normal concrete is plotted. Fig. 9 shows the testing of flexural strength. Flexural strength of mix 0% PBL obtained at 28 days is 4.45 N/mm^2, mix with 1% PBL is 6.86 N/mm^2. Flexural strength of mix 3% of PB at 28 days is 8.38 N/mm^2, mix with 5% PBL is 8.95 N/mm^2,mix with 7 % PBL is 8.35 N/mm^2 .Also the percentage increase in strength is calculated.

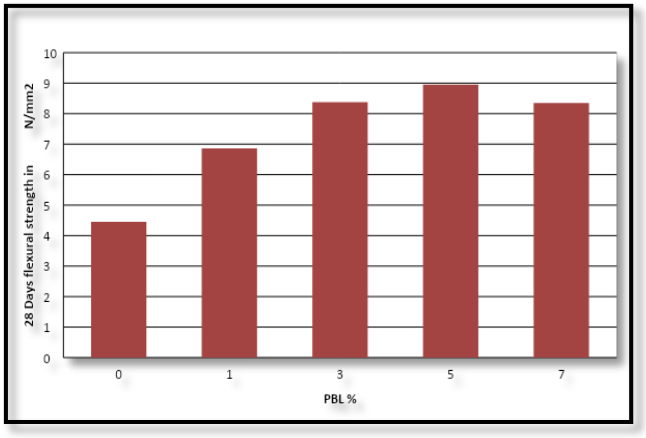

Fig 10: Variation in flexural strength

The flexural strength of concrete increases by addition varying percentage of PBL, and it is maximum at 5 % then decreases subsequent addition.

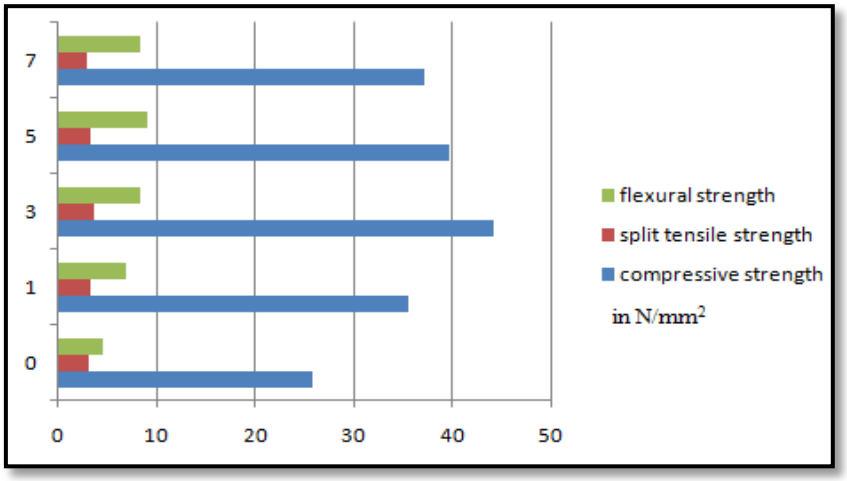

Fig 11: Combine graph of waste replacement

| e-ISSN: 2319-8753, p-ISSN: 2320-6710| www.ijirset.com | Impact Factor: 7.512|

|| Volume 9, Issue 7, July 2020 ||

V. CONCLUSION

Black liquor is considered as a low-cost admixture to increase the workability and retard setting of concrete. The results of this research show that black liquor noticeably increases the workability of concrete. The PBL waste activates the cement phase and improves the rate of hydration. The incorporation of PBL with cement decreases the setting time, so it can be used as an accelerator. The compressive strength is also increased up to certain concentration of PBL beyond this concentration, it adversely affects the cement characteristics. The activation effect of the PBL increases the rate of hydration which enhances the cementing characteristics of hardened cement paste and also slight increase in split and flexural strength. The study clearly revealed that application of 1%PBLadmixture improve the compressive strength of M25grade to35.58MPa.this show the positive effect of PBLon the proprieties of concrete The addition of PBL waste to cement led to the formation of electrostatic repulsive forces between cement particles and in turn the adsorption of the liquor waste onto the cement surface which reduces the inter particle attraction between the cement particles and helps to enhance the compressive strength. Compressive strength is maximum by adding 3% of PBL it is the optimum dosage Increasing the black liquor amount above a certain limit may reduce concrete compressive strength due to the extra amount of the charged ions that may recharge the solids again reducing their ability to mix with water. It can be observed that split tensile strength and flexural strength increases with increasing addition of PBL from 3.11MPa to 3.62MPaand 4.45MPa to8.95MPaproperties. It is finally concluded that the use of black liquor prod can be used as an admixture with improved workability, compressive strength, split strength and flexural strength. Also help to solve environmental issues due to accumulation waste from paper industry by using PBL as admixture we can make environmental more sustainable.

REFERENCES

[1] Asharuddeen Tharammal-*Experimental and Analytical Study of Effective Utilization of Lime Sludge and Pulp Black Liquor in Concrete* International Research Journal of Engineering and Technology (IRJET) ISSN:2278-0181 Volume:08 Issue:05/ May 2019

[2] Joffin George- *Pulp Black Liquor as an Admixture in Concrete* International research Journal of Engineering and Technology (IRJET) e-ISSN:2395-0056 Volume:06 Issue on: 05/May 2019

[3] Ganesh R.Mahallea- *Use of Lime Sludge and Pulp Black Liquor in Concrete* International Research Journal of Engineering and Technology Volume:02 Issue: June 2018

[4]]IS: 383 – 2016, *Coarse and Fine Aggregate for Concrete – Specification*, Bureau Of Indian Standards, January 2016

[5] IS 2386 – 1963, *Methods of test for aggregates for concrete Part I, Particle size and shape,* Bureau of Indian Standards, August 1997

[6] IS: 2250 – 1981, *Code of practice for preparation and use of masonry mortars,* Bureau of Indian Standards, July 1981

[7] [IS: 455 – 1989, *Portland slag cement- specification*, Bureau of Indian Standards, May 1990

[8] IS 516 – 1959, *Methods of tests for strength of concrete*, Bureau of Indian Standards, December 1959

[9] IS: 2185 – 2015, *Concrete masonry unit's specification*, Bureau of Indian Standards, August 2005