

Experimental Study of Use of Brine Sludge in Cement Concrete

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Abstract— Concrete is most widely used in the construction industry in which mainly cement is used as the binding material but with the fast development of construction industry cement consumption has been also increased. But Production of cement also increases the greenhouse gases i.e., carbon dioxide, methane, nitrous oxide, etc. Therefore it was needed to search alternative materials for cement in construction. Millions of tons of solid industrial wastes are produced in India every year. A huge quantity of this is contributed by paper industry where mainly two kinds of wastes are generated, i.e. fibrous sludge which is biodegradable called as Hypo sludge, and the waste removed at the time of whitening of the paper known as Brine Sludge. Brine Sludge (paper waste) is obtained as waste by goods from paper industry. The paper industry requires large percentage of land space in nearby vicinity every year. Some of the wastes are spread on the land on reap as a disposal technique and some companies dispose their industrial waste in incinerators which raise concerns about major land and air pollution problems. Use of Brine Sludge as partial replacement of cement can help in disposal and pollution problems related with paper industry waste as well as helps in reducing the cost in making of concrete as the paper waste is cheaply available as compared to cement. This research investigated the use of Brine Sludge as partial replacement in cement concrete. In this study partial replacement of cement by 3%, 5%, 7%, 10% and 12% with Brine Sludge in conventional concrete of M30 and M40 grades is studied. A comparison of the properties of conventional concrete with Brine sludge concrete is studied. The result of this study shows that optimum percentage of Brine sludge on the basis of compressive strength, which can replace cement in concrete is 7%.

Key words: Cement, Concrete, Compressive strength, Brine Sludge

I. INTRODUCTION

Natural resources are not unlimited therefore, they must be carefully consumed. This will help not only to control degradation of environment but also conserve them for the use of future generation. This can be achieved by the process of recycling and, making use of industrial wastes, disposal of which otherwise is a serious problem. To make concrete industry grow faster natural resources should be used so that the consumption of cement and other materials is in the limit. Industrial waste is produced by industrial activity which includes any material that is rendered useless during a manufacturing process such as that of factories, mills and mines.

S.No.	Mix Name	Water content (litres)	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	Brine Sludge (kg)
1.	A0	171	380	772.26	1158.39	0
2.	A1	171	368.6	772.26	1158.39	11.4

Brine sludge is a type of paper industry waste. It is the by-product of the paper waste produced at the time of whitening of paper. This brine sludge contains low calcium and minimum amount of silica. Brine sludge behaves like cement because of its chemical compositions. Brine sludge may be used as partial replacement of cement. It is usually used as a replacement of some percent of cement content in the concrete mix.

II. METHODOLOGY

Brine sludge is also known as paper industry waste. It is the by-product of the paper waste produced at the time of whitening of paper. The brine sludge contains low calcium and minimum amount of silica. Brine sludge behaves like cement because of its chemical compositions. Brine sludge may be used as partial replacement of cement. It is usually used in proportion of percent of cement content of the mix. Brine sludge obtained from Orient paper mill Pvt. Ltd. district Shahdol Madhya Pradesh. The brine sludge we brought was in wet form. So it had been dried in oven at 100+5°C for 24 hours then grinded it in Los Angeles Abrasion machine and then sieved the material to make it fine so that it can replace cement. The specific gravity of brine sludge was calculated using pycnometer method. The specific gravity of brine sludge was 3.25 which is quite similar to cement.

Cement used in this project is ordinary Portland cement of grade 43. River sand and crushed aggregate used as fine and coarse aggregate respectively. Mix design is done as per IS 10262 and grade of concrete is M30 & M40. Slump cone test and compressive strength is performed in concrete. Mix designation of concrete cubes is given in table 1 and table 2.

S. No.	Grade of Concrete	Mix Name	Brine Sludge content	Cement content
1.	M30	A0	0%	100%
2.	M30	A1	3%	97%
3.	M30	A2	5%	95%
4.	M30	A3	7%	93%
5.	M30	A4	10%	90%
6.	M30	A5	12%	88%
7.	M40	B0	0%	100%
8.	M40	B1	3%	97%
9.	M40	B2	5%	95%
10.	M40	B3	7%	93%
11.	M40	B4	10%	90%
12.	M40	B5	12%	88%

Table 1: Mix Designation of Different Concrete
Quantity of different M30 and M40 concrete per cubic meter with and without replacement is as shown in table below.

3.	A2	171	361	772.26	1158.39	19
4.	A3	171	353.4	772.26	1158.39	26.6
5.	A4	171	342	772.26	1158.39	38
6.	A5	171	334.4	772.26	1158.39	45.6
7.	B0	164	410	769.86	1154.79	0
8.	B1	164	397.7	769.86	1154.79	12.3
9.	B2	164	389.5	769.86	1154.79	20.5
10.	B3	164	381.3	769.86	1154.79	28.7
11.	B4	164	369	769.86	1154.79	41
12.	B5	164	360.8	769.86	1154.79	49.2

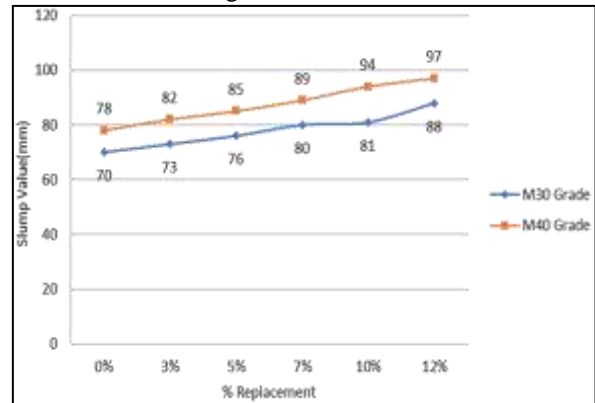
Table 2: Mix Proportion of Concrete with Brine Sludge

III. RESULT & DISCUSSION

To check the workability Slump cone test was performed and its results are shown in Table 17 and Graph 4.

Mix Ratio		M30 Grade	M40 Grade
Cement	Brine Sludge		
100%	0%	70	78
97%	3%	73	82
95%	5%	76	85
93%	7%	80	89
90%	10%	81	94
88%	12%	88	97

Table 3: Slump Values of Different Concrete Mix

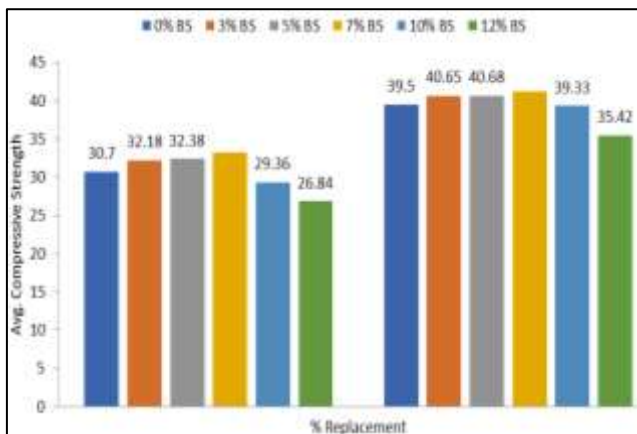


Graph 1: Slump Values of Different Mixes

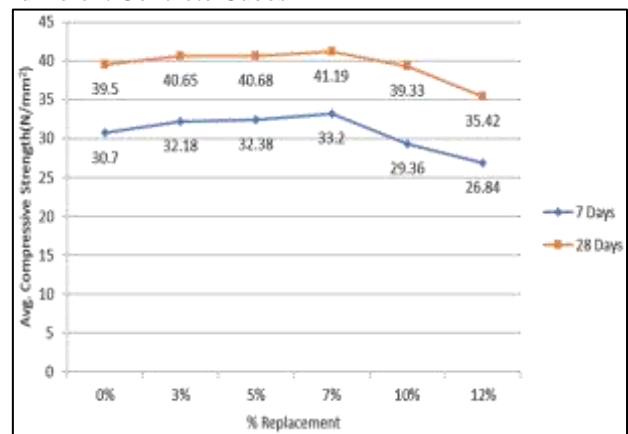
The Slump value of M30 grade Concrete increased from 70 mm at 0% to 88 mm at 12% replacement. The Slump value of M40 grade Concrete increased from 78 mm at 0% to 97 mm at 12% replacement. Compressive strength of Concrete was increasing till 7% and was decreasing afterwards at 10% and 12%.

S.No.	% Replacement	Mix Name	Compressive Strength (N/mm ²)		Mix Name	Compressive Strength (N/mm ²)	
			M30 7 Days	M30 28 days		M40 7 Days	M40 28 Days
1.	0%	A0	30.70	39.50	B0	35.92	49.1
2.	3%	A1	32.18	40.65	B1	36.26	49.13
3.	5%	A2	32.38	40.68	B2	36.56	49.83
4.	7%	A3	33.20	41.19	B3	37.18	50.23
5.	10%	A4	29.36	39.33	B4	35.70	48.91
6.	12%	A5	26.84	35.42	B5	33.52	47.53

Table 4: Compressive Strength of different Concrete Cubes



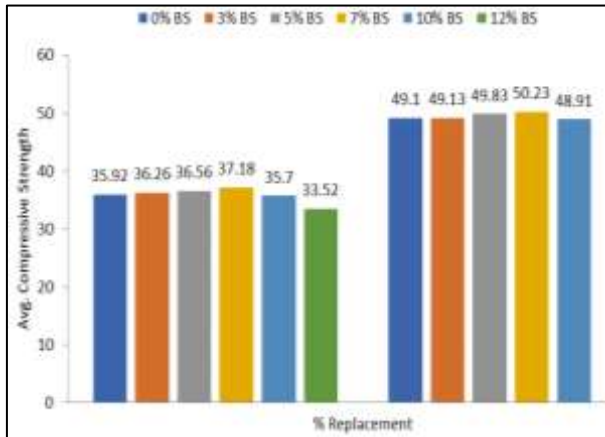
Graph 2: Comparison of M30 Grade Concrete



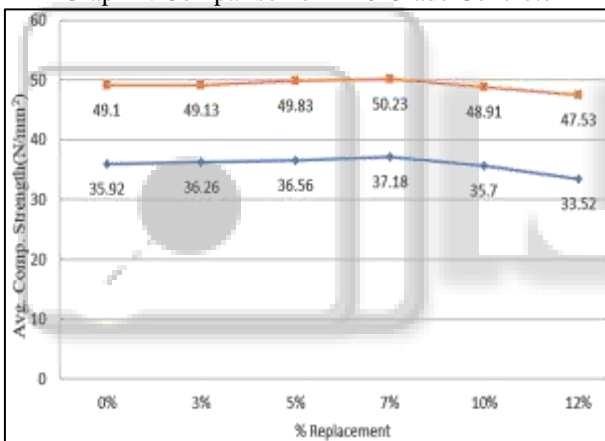
Graph 3: Comparison of M30 Grade Concrete

M30 concrete replacing brine Sludge with cement the compressive strength of concrete increases till the 7% replacement and decreases after 7%. The Compressive

Strength of M30 Grade of concrete reached to 41.19 N/mm² at 7% cement replacement with Brine Sludge. At 10 % the compressive strength of concrete is 39.33 N/mm² which nearly same to that of conventional concrete i.e., 39.5 N/mm² the compressive strength decreases further when 12% cement was replaced. So, on comparing results it is clear that 7% replacement of cement with brine sludge is optimum for this study. M40 concrete, Compressive strength of Concrete was increasing till 7% and was decreasing afterwards at 10 % and 12%.



Graph 4: Comparison of M40 Grade Concrete



Graph 5: Comparison of M40 Grade Concrete

Replacing brine Sludge with cement the compressive strength of concrete increases till the 7 % replacement and decreases after 7 %. The Compressive Strength of M40 Grade of concrete reached to 50.23 N/mm² at 7% cement replacement with Brine Sludge. At 10 % the compressive strength of concrete is 48.91 N/mm² which nearly same to that of conventional concrete i.e., 49.1 N/mm² the compressive strength decreases further when 12% cement was replaced. So, on comparing results it is clear that 7% replacement of cement with brine sludge is optimum for this study.

IV. CONCLUSIONS

Based on the results presented in Chapter 5, the following conclusions can be drawn:

- 1) The Normal Consistency of Cement is increased when the Brine Sludge was partially replaced with it. Thus, Initial and Final Setting time also increased.
- 2) There has been an increase in water absorption of the concrete mixes as the content of the Brine sludge

increased. This phenomenon is expected since more amount of Brine Sludge in term of quantity will involve in the hydration process. Therefore, additional amount of water was required for cement hydration which is the common solution to this kind of problem. However, higher water content decreases the strength of concrete.

- 3) The slump value increased as the cement content decreased and Brine Sludge content increased in concrete.
- 4) The compressive strength of mortar increased till 7% replacement of brine sludge with cement and decreased at 10% and 12%
- 5) Similarly, the compressive strength of concrete increased up to 7% replacement of Brine Sludge and further increase in Brine Sludge reduces the strength to normal at 10% and further decreased at 12%.
- 6) The most suitable mix proportion is the 3%, 5%, 7 % replacement of Brine sludge to cement.
- 7) The optimum Compressive Strength for mortar and concrete has been achieved at 7 % replacement thus, the optimum replacement for this study is 7%.
- 8) From this study it can be concluded that Brine Sludge is a good substitute for cement up to certain extent and use of Brine Sludge in concrete can save the pulp and paper industry disposal costs and produce a 'greener' concrete for construction.
- 9) The use of Brine Sludge as a partial replacement of cement can make a project economical as the cost of land disposal of the paper mill wastes as well as the cost of production of cement will be saved.

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