UTILIZATION OF HYPO SLUDGE AND LIME SLUDGE AS PARTIAL REPLACEMENT OF CEMENT

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Abstract : The manufacturing process of 1 ton Ordinary Portland Cement emits an equal amount of carbon di- oxide into the atmosphere. The carbon-di-oxide emissions perform as a silent killer in the environment under various forms. In this Backdrop, the exploration for cheaper substitute to OPC is a needful one. This paper presents the effect of Hypo sludge and Lime sludge as partial replacement of cement and Foundry sand as partial replacement of fine aggregate. 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. Concrete mix of M20grade was used in this study with Hypo sludge and Lime sludge as partial replacement of cement by 5%, 10% and 15% and foundry sand as partial replacement of fine aggregate by 10%. The compressive strength of all mix ratios are recorded and the test results concluded that partial replacement of cement and fine aggregate by 10% Hypo sludge, Lime sludge and Foundry sand exhibit an increase of about 35.97% in compressive strength after 28days of curing when compared to that of conventional concrete.

IndexTerms **- Compressive strength, foundry sand, hypo sludge, lime sludge.**

I. INTRODUCTION

Energy plays a crucial role in growth of developing countries like India. In the context of low availability of non-renewable energy resources coupled with the requirements of large quantities of energy for Building Materials like cement, the importance of using industrial waste cannot be underestimated. While producing paper the various wastes are comes out from the various processes in paper industries. From the preliminary waste named as hypo sludge, due to its low calcium is taken out for our project to replace the cement utilization in concrete. Due to the cement production greenhouse gases are emitted in the atmosphere. For producing 4 million t of cement, 1 million t greenhouse gases are emitted. Also, to reduce the environmental degradation, this sludge has been avoided in mass level disposal in land. MehtabAlam and Vebhav Berera (2015) conducted an experimental study the use of hypo sludge in cement concrete. The authors concluded that the compressive strength of pervious concrete is increases when the replacement of cement with hypo sludge up to 10% replacement by weight of cement. Abdullah Shahbaz Khan (2014) made an attempt in introducing low cost concrete from paper industry waste. The study was carried out with M20 & M30 grade concrete with W/c ratio of 0.55 & 0.45 as a reference specimen and hypo sludge replacement level was 10%, 20%, and 30% by weight of cement. Compression test after 3, 7 and 28 days curing was conducted to enumerate the mechanical properties of concrete.

The large quantities of lime required for implementing global soil stabilization, it is to the interest of transportation agencies if inexpensive sources of soil stabilizer can be utilized for sub grade stabilization. The resultant savings will be significant. One potential resource is the lime sludge produced from the residuals generated by drinking water plants. Drinking water plants annually produce thousands of tons of lime sludge from the water treatment procedures. The lime sludge is typically discharged into a retention pond. When storage limit is reached, lime sludge is usually disposed into landfills with a fee, where they are treated as solid waste.

Foundry sand is high quality silica sand with uniform physical characteristics. It is a by-product of ferrous and non-ferrous metal casting industries, where sand has been used for centuries as a molding material because of its thermal conductivity. It is a by-product from the production of both ferrous and non-ferrous metal castings. The physical and chemical characteristics of foundry sand will depend in great part on the type of casting process and the industry sector from which it originates. In modern foundry practice, sand is typically recycled and reused through many production cycles. Anil Kumar and Devika Rani (2016) studied the performance of adding paper sludge ash and foundry sand in concrete. The authrs studied the strength parameters such as compressive and tensile strength of Paper Sludge Ash (5%, 10%, and 15%) as a partial replacement of cement and foundry sand (20%, 40% and 60%) as a partial replacement of fine aggregate for a design mix of M25. Sarma (2016) stated that the Compressive strength of concrete achieves the target strength up to 10% replacement of cement with hypo sludge. Further replacement of cement with hypo sludge there is a decrease in the compressive strength.

An attempt has been made in this study to determine the influence of the hypo sludge & lime sludge on the compressive strength of concretes made with different replacement levels in cement and fine aggregate.

II. MATERIALS AND METHODS

Ordinary Portland Cement of Ultra tech brand of 43 grade confirming to IS: 12269-1987 was used in this present study. Natural sand as per IS:383-1987 was used. Crushed aggregate confirming to IS: 383-1987 was used. Lime sludge samples were collected from the lagoon of Massillon water plant. It appears to be paste with high natural water content (over 90% on the gravimetric basis). The properties of concrete making materials considered in this study are presented in Table 1.

Table 1 Properties of Concrete making materials

Properties	Values
Cement	
Specific gravity	3.15
Normal consistency	32%
Initial setting	30 mins
Fineness	5%
Fine Aggregate	
Type	Natural Sand
Specific gravity	2.57
Fineness modulus	2.28
Grading zone	II
Coarse Aggregates	
Type	Crushed
Specific gravity	2.77
Maximum size	20mm
Properties of Hypo Sludge	
Moisture	56.8
Magnesium oxide (MgO)	3.3
Calcium oxide (CaO)	46.2
Loss on ignescent	27.00
Acid insoluble	11.1
Silica (SiO_2)	9.0
R_2O_3	3.6
Properties of Lime Sludge	
Color	Color White to light grey
Odor	None
Hardness	Soft, greasy
Wetness	Wet, natural moisture content 98.4%
Flow ability	Non-flow able at natural status
Density	Light
Dry status	Fine powder
Vegetation	No vegetation in lime pond
Chemical properties of Foundry Sand	
Sio_2	83.93
Al_2O_3	0.021
Fe_2O_3	0.950
CaO	1.03
MgO	1.77
SO_3	0.057
LOI	2.19

The mix ratio of concrete with various replacement levels were achieved by concrete mix design as per IS: 10262-2009. Grade of concrete used was M20 with water cement ratio 0.5. The various mix proportions considered in this study are presented in the Table 2.

Table 2. Mix Proportions with various Replacement Levels

S.No.	Mix	Cement Kg/m^3	Hypo Sludge Kg/m^3	Lime Sludge Kg/m^3	Fine Aggregate Kg/m^3	Foundry Sand Kg/m^3	Coarse Aggregate Kg/m^3	Water (Lit)	Water Cement Ratio (W/C)
1.	CC Mix	394	0	0	564.0	0	1098	197	0.5
2.	5% HS Mix	315.2	19.7	59.1	507.6	56.4	1098	197	0.5
3.	10% HS Mix	315.2	39.4	39.4	507.6	56.4	1098	197	0.5
4.	15% HS Mix	315.2	59.1	19.7	507.6	56.4	1098	197	0.5

Figure 1 Testing of Concrete Specimens in Compression Testing Machine

Thorough mixing of material is essential for the production of uniform concrete. The mixing should ensure that the concrete becomes homogeneous, uniform in colour and consistency. Concrete grade M20 is proportional by adopting IS method of designing. The mixing is done using hand mixing. The specimen's size used for the test included Cube - 150mm × 150mm ×150mm. The test cube specimens are made as soon as practicable after mixing and in such a way as to produce full compaction of the concrete with neither segregation nor excessive laitance. All the specimens are marked and removed from the moulds and immediately submerged in clean fresh water and kept there until take out just prior to test. The compression tests were conducted after 7 and 28 days of curing. The total numbers of specimen were casted for testing is 24 cube specimens.

III. RESULTS AND DISCUSSION

The compressive strength test is the most common test conducted because most of the desirable characteristic properties of concrete and the structural design are qualitatively related compressive strength. The compressive strength of all mixes with different replacement level of cement by hypo sludge and lime sludge and fine aggregate by foundry sand is presented in Table 2 and Fig.3. The compressive strength results were compared with those of Conventional Concrete Mix (CC Mix) which has been served as control specimen.

Table 2 Compressive strength of all mixes

Mix Designation	7Days	28Days
CC Mix	15.03	23.10
5% HS Mix	13.23	22.92
10% HS Mix	16.08	31.41
15% HS Mix	11.83	22.00

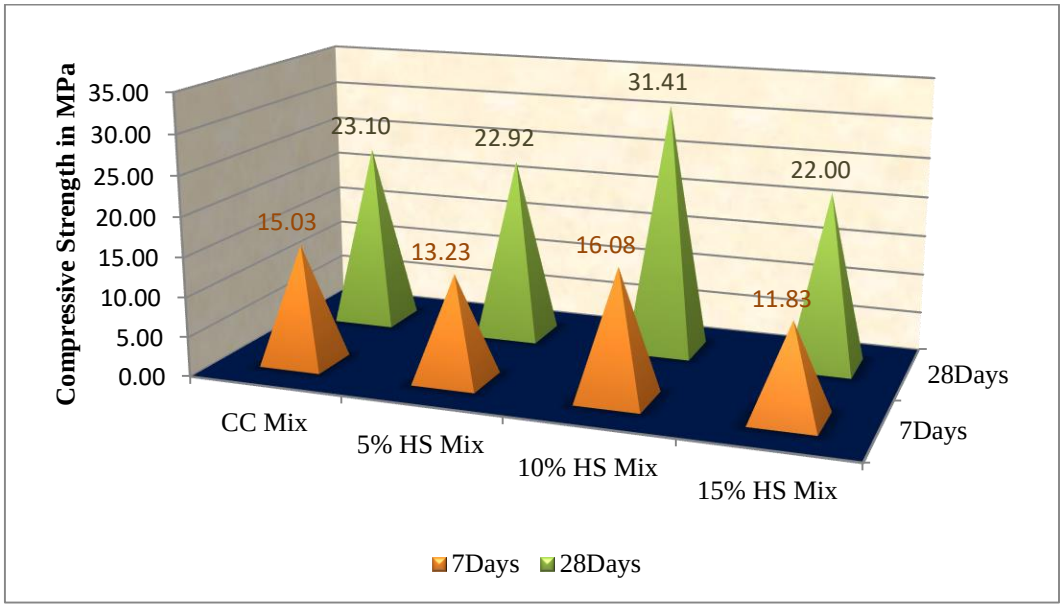

Fig. 3 Compressive strength of all mixes

Table 2 and Fig.3 inferred that the effect of hypo sludge as 10%partialreplacement of cement (10% HS Mix) exhibit an increase of about 7% when compared to that of conventional concrete during 7days test. In 28days compression test 10% HS Mix exhibit an increase of about 5.97% when compared to that of conventional concrete

IV. CONCLUSIONS

The properties of Hypo - Lime Sludge and foundry sand wastes proved to be favorable for use in concrete. Only at 10% replacement level of hypo sludge, lime sludge and foundry sand the strength is higher than normal concrete mix. The cost of 20% cement and 10% fine aggregate cost is reduced when compared to conventional concrete. The strength and stability of the concrete is high compared to the conventional concrete. The partial replacement of cement by 10% Hypo - Lime sludge and partial replacement of fine aggregate by 10% Foundry sand exhibit an increase of about 35.97% in compressive strength after 28days of curing when compared to that of conventional concrete.

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