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STUDY OF PARTIAL REPLACEMENT OF CEMENT WITH HYPO SLUDGE

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ABSTRACT

A large quality of sludge is generated each year from water treatment plants in India. Disposing the sludge to the nearest water course is the common practice in India. Disposing rise, the aluminum concentrations in water and consequently in human bodies. This practice has been linked to occurrence of disease due to Landfill disposal of the sludge is impractical because of high cost of transportation and depletes the capacity of landfill. The use of sludge in construction industry is considered to be the most economic and environmentally sound option and also other technically feasible alternative for sludge disposal similar mineralogical composition of clay and sludge. The main objectives are to increase the value of sludge from a water treatment plant and to make a sustainable and profitable disposal. Sludge use as additive material in the concrete mix. This study focused on making bricks, concrete filler and concrete aggregate. The study investigated the use of sludge s partial substitute for Waste may be defined as an unwanted material generated after the manufacturing process from industry, agriculture, or from house hold activity. Waste causes many nuisances in the environment. It produces many types of infection, for human and animal. Dewatered sludge is disposed of by land filling. However, it is not an appropriate solution, due to the land limitation. In addition, the constraint to treat sludge is very high in cost and time-consuming, which is the disadvantage to the responsible parties. Therefore, this study was carried out to utilize that dry sludge produced from the water treatment plants as a concrete additive material. Tests were conducted such as workability test (slump cone test) and compressive strength. As the conclusion, compressive strength of the concrete does not affect to use of sludge.

KEYWORDS: ***Sludge drying bed free swelling index box shear test, Compressive strength Liquid limit apparatus.***

INTRODUCTION

In the water treatment plant the river water treated for the water supply/distribution to use in drinking and other purpose .in river water dissolved the silt, clay and dust particles to remove in treatment plant to collect at the chamber is waste material. Sludge is semisolid or solid slurry that can be produced from a range of industrial process from water treatment or on site sanitation system. The sludge obtained from the treatment plant and study the its physical properties can be used as the building construction material. The increase in demand for construction materials in the recent years as a result of development has called for an alternative way to develop or derive construction materials from other sources. In order to meet the increased demand, attention has been given to the development of sustainable construction material. The usage of improved construction materials in construction industry has been on increase daily which has led to the investigation of its environmental impact and meeting required standards when waste is used in developing sustainable construction material. Much water treatment sludge is produced in the production of service water and drinking water.

Objectives / Aim of the study - the main objectives of the project to study the properties of the sludge and reduce the disposing and transporting cost and used in construction.

EXPERIMENTAL ANALYSIS

Methodology

For the characterization of the sludge concrete the compressive strength of the specimen are determined along with mechanical properties (like, Density, Specific Gravity, Fineness modulus etc...) to as representative parameter for the modified concrete. Firstly, the values of compressive strength for plain cement concrete are determined (M25). The compressive strength value is compared for 7-days, 14-days and 28-days with the replaced cement with sludge concrete of varying proportions. Sludge collected from water treatment plant. Different size is obtained as a cement particle 90µm, 150µm,300µm. and use as a cement in concrete

Mixing, Casting & Curing

The sludge concrete is manufactured by as similar to the classical concrete. Initially the dry materials Cement, Aggregates & Sand are mixed. The liquid component of the mixture was then added to the dry materials and the mixing continued for further about 4 minutes to manufacture the fresh concrete. The fresh concrete was cast into the mould immediately after mixing, in three layers for cube specimens. For compaction of the specimens, each layer was given 60 to 80 manual strokes using a rodding bar, and then vibrated for 12 to 15 seconds on a vibrating table. Before the fresh concrete was cast into the mould, the slump value of the fresh concrete was measured.

RESULT & DISCUSSION

An Experimental Study on Mechanical Properties of Waste Plastic Fiber Reinforced Concrete Resource management plays the vital role in engineering community because of the increasing population, life style and socio-economic status the inherent use of resources made Depletion to the natural sources and provokes us to manage wastes. Plastic is one among such Waste which is the parts and parcel of our live in all the aspects. Hence recycle and reutilize that waste is become essential nowadays. Due to the increase in generation, plastic wastes are becoming a major stream in solid wastes.

TESTING PROCEDURE

DETERMINATION OF FREE SWELL INDEX OF SLUDGES STANDARD

IS: 2720(Part40)1977

DEFINITION

Free swell index is the increase in volume of sludge without any external constraints, on submergences in water.

APPARATUS

425 microns IS Sieve, Graduated glass cylinders l00 ml capacity 2 No. (IS: 878-1956), Glass rod for stirring, Balance of capacity 500 grams and sensitivity 0.01 grams.

PROCEDURE

Take two representative oven dried sludge samples each of 5 grams passing through 425-micron sieve. Pour each sludge sample in to each of the two glass graduated cylinders of 100 ml capacity. Fill one cylinder with kerosene and the other with the distilled water up to the100 ml mark. Remove the entrapped air in the cylinder by gentle shaking and stirring with a glass rod. Allow the samples to settle in both the cylinders. Sufficient time, not less than 24 hours shall be allowed for sludge sample to attain equilibrium state of volume without any further change in the volume of the sludge. Record the final volume of the sludge in each of the cylinders.

Figure: Sample Kept for Free Swell Index

OBSERVATION TABLE

- Weight of sludge sample = 5 grams
- Volume of the kerosene and distilled water = 25 ml

Table no: for free swelling index

Determination No.	Measuring Cylinder No.		Reading After 24 Hours		Free Swell Index, %
	Kerosene (ml)	Distilled Water (ml)	Kerosene (ml)	Distilled Water (ml)	
1.	5	6	5	6.5	30%

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CALCULATIONS

V_d = Volume of the sludge specimen read from the graduated cylinder containing distilled water = 6.5ml

V_k = Volume of the sludge specimen read Form the graduated cylinder containing kerosene.

$(V_d - V_k)$ = 5ml

Free Swell Index, (%) = 30%

REPORT: Reed the level of the sludge in the kerosene graduated cylinder as the original volume of the sludge samples, kerosene testing non polar liquid does not cause swelling of the sludge. Read the level of the sludge in the distilled water cylinders as free swell level. Record the individual and the mean results to the nearest second decimal.

DETERMINATION OF THE SPECIFIC GRAVITY OF SLUDGE PURPOSE

This lab is performed to determine the specific gravity of sludge using a pycnometer. Specific gravity is the ratio of the mass of unit volume of sludge at a stated temperature to the mass of the same volume of gas-free distilled water at a stated temperature.

STANDARD REFERENCE

ASTM D 854-00 – Standard Test for Specific Gravity of Sludge Solids by Water Pycnometer.

SIGNIFICANCE

The specific gravity of sludge is used in the phase relationship of air, Water and solids in a given volume of the sludge.

EQUIPMENT

Pycnometer, Balance, Vacuum pump, Funnel, Spoon.

TEST PROCEDURE

- Determine and record the weight of the empty clean and dry Pycnometer, WP. Place 125g of a dry soil sample (passed through the sieve No. 10) in the pycnometer. Determine and record the weight of the Pycnometer containing the dry soil, WPS.Add distilled water to fill about half to three-fourth of the Pycnometer. Soak the sample for 10 minutes. Apply a partial vacuum to the contents for 10 minutes longer, to remove the entrapped air. Stop the vacuum and carefully remove the vacuum line from Pycnometer. Fill the pycnometer with distilled (water to the mark), clean the exterior surface of the pycnometer with a clean, dry cloth. Determine the weight of the pycnometer and contents, WB. Empty the pycnometer and clean it. Then fill it with distilled water only (to the mark). Clean the exterior surface of the pycnometer with a clean, dry cloth. Determine the weight of the pycnometer and distilled water, WA. Empty the pycnometer and clean it.

TABLE: OBERAVATION TABLE FOR SPECIFIC GRAVITY

SPECIFIC GRAVITY OF SOIL IS 2720 Part-III (Pycnometer Method)

Sr. No.	Determination Number			
1	Weight of Pycnometer gms	W1	510	
2	Weight of Pycnometer With Dry Soil gms	W2	710.5	
3	Weight of Pycnometer With Dry Soil & Water gms	W3	1664.5	
4	Weight of Pycnometer full of Water gms	W4	1555	
5	Weight of Dry Soil gms	W2-W1	200	
6	Weight of an equal Volume of water gms	(W2-W1)-(W3-W4)	91	
7	Specific Gravity	Value of 5 / 6 as above	2.197	

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DATA ANALYSIS

Calculate the specific gravity of the soil solids using the following

Formula:

$$\text{Specific Gravity, Gs} = \frac{(W2-W1)}{(W2-W1)-(W3-W4)} = \frac{710-510}{(710-510)-(1664-1555)}$$

$$= 2.197$$

Where: W_2-w_1 = weight of sample of oven-dry soil, gms

$(W2 - W1) - (W3 - W4)$ = weight of pycnometer filled with water

DETERMINATION OF WATER CONTENT-DRIES DENSITY RELATION (HEAVY COMPACTION): STANDARD IS: 2720 (Part 8) 1983

OBJECTIVE: To determine the required amount of water to be used when compacting the soil in the field and the resulting degree of denseness, which can be expected from compaction at optimum moisture content?
APPARATUS: cylindrical metal mould shall be either of 100mm diameter and 1000cm3 volume or 150m diameter and 2250cm3 volume and shall confirm to IS: 10074 – 1982, Balance of capacity 500grams and sensitivity 0.01gram.,Balance of capacity 15Kg and sensitivity one gram, Thermostatically controlled oven with capacity up to 250 0C.,Airtight containers, Steel straight edge about 30cm in length and having one beveled edge,4.75mm, 19mm and 37.5mm IS sieves confirming to IS 460 (Part 1),Mixing tools such as tray or pan, spoon, trowel and spatula or suitable mechanical device for thoroughly mixing the sample of soil with additions of water, Heavy compaction rammer confirming to IS: 9189 -1979.

PROCEDURE: Take a representative sample of air dried soil of about 5 kg (soil not susceptible to crushing during compaction) or 3 kg from 15 kg sample (soil susceptible to crushing during compaction) passing through 19mm IS sieve and mix thoroughly with a suitable amount of water depending on the type of soil, generally 4 to 6 percent for sandy and gravelly soils and plastic limit minus 8% to 10% for cohesive soils. For soils susceptible to crushing during compaction take different samples for every determination and for soils not susceptible to crushing during compaction use the same sample for all the determinations. Weight the 1000cc capacity mould with base plate attached and without extension to the nearest gram (m1).Place the mould on a solid base such as a concrete floor or plinth and compact the moist soil into the mould, with the extension attached in 5 layers of approximately equal mass, each layer being given 25 blows with the 4.90kg hammer dropped from a height of 450mm above the soil. Distribute the blows uniformly on each layer. The amount of soil used shall be sufficient to fill the mould leaving not more than about 6mm to be struck off when the extension is removed. Compaction of soil in to mould. Remove the extension and carefully level the compacted soil to the top of mould by means of straight edge. Weight the mould and the soil to the nearest gram (m2). Remove the compacted Soil from the mould and place on the mixing tray. Collect a representative sample from the soil in the tray and keep in the oven for 24 hours maintained at a temperature of 1050 to 1100 C to determine the moisture content (W).

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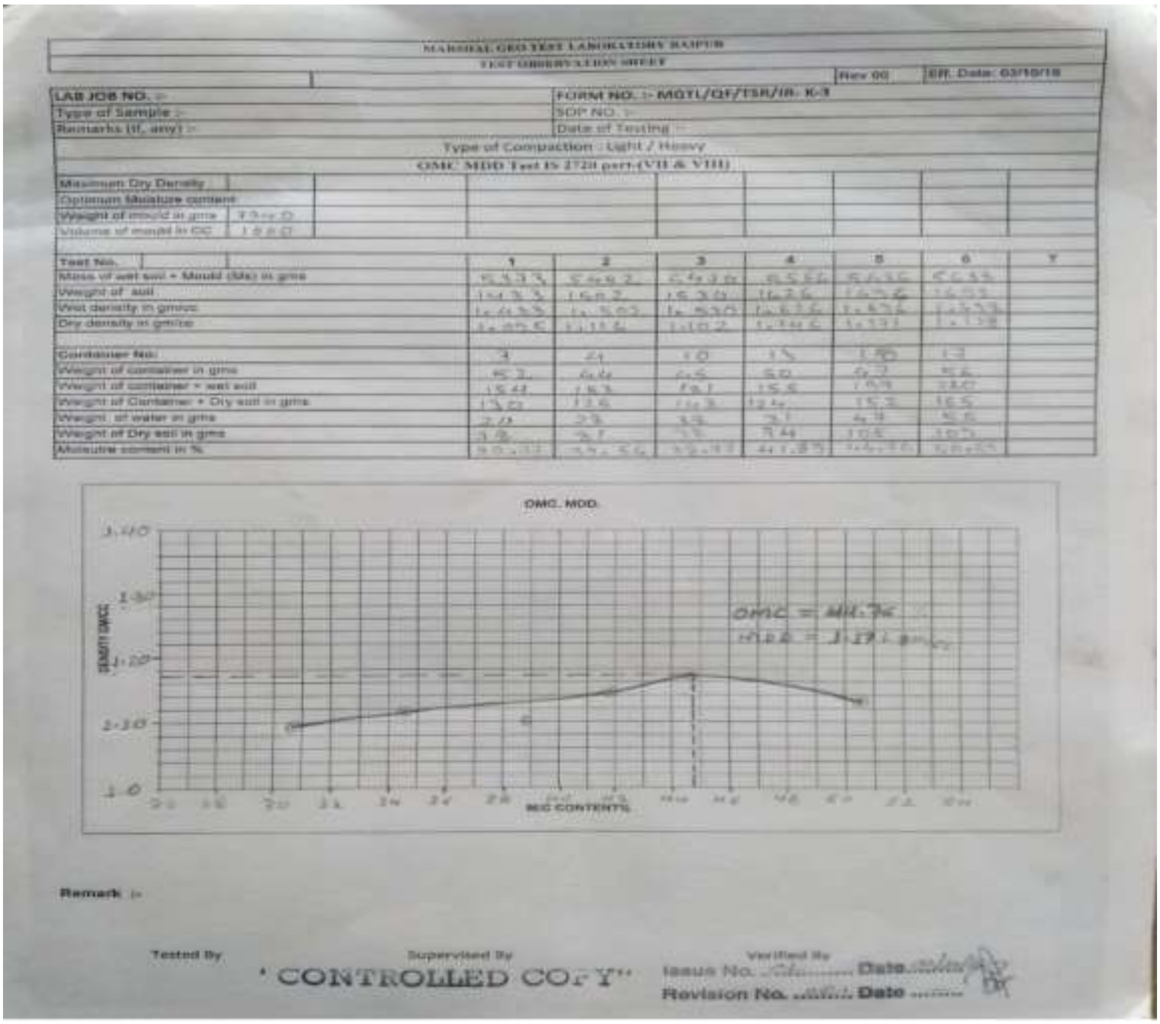

MARSHAL GEO TEST LABORATORY RAIPUR
TEST OBSERVATION SHEET

Rev 00 | Eff. Date: 03/10/18

LAB JOB NO. :-	FORM NO. :- MGTL/QF/TSR/IR- K-3
Type of Sample :-	SOP NO. :-
Remarks (If, any) :-	Date of Testing :-

Type of Compaction : Light / Heavy
OMC MDD Test IS 2720 part-(VII & VIII)

Maximum Dry Density	
Optimum Moisture content	
Weight of mould in gms	7900
Volume of mould in CC	1000

Test No.	1	2	3	4	5	6	7
Mass of wet soil + Mould (Ms) in gms	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Weight of soil	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Wet density in gm/cc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Dry density in gm/cc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Container No.	3	4	10	15	[illegible]	[illegible]	
Weight of container in gms	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Weight of container + wet soil	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Weight of Container + Dry soil in gms	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Weight of water in gms	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Weight of Dry soil in gms	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Moisture content in %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

Observation table: MDD and OMC

CALCULATIONS

- Calculate the bulk density □w in g / cm3 of each compacted specimen from the equation
- w = (m2 – m1) / V
- m1 = Weight of mould with base plate.
- m2 = Weight of mould with compacted soil.
- V = Volume of mould in cm3.
- Calculate the dry density d in g/cm3 from the equation,
- d = w / (1+W/100)
- w = Bulk density
- W = % of moisture content

REPORT

Plot the values obtained for each determination on a graph representing moisture Content on x-axis and dry density on y-axis.Draw a smooth curve through the resulting points and determine the position of the maximum in the curve. Report the dry density corresponding to the maximum point to the nearest 0.01.Report the percentage corresponding to the maximum dry density i.e. optimum moisture content to the nearest 0.2 %for values below 5% and to the nearest 0.5% For values from 5 to 10% and to nearest whole number for values exceeding 10 %.

DISCUSSION

Application of waste sludge in construction industry has been proven by various researchers in various ways. It is evident from the reviewed literatures that the major application of waste sludge in construction. Various test carried out to ascertain the properties of the end product satisfied all the

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available requirements in accordance with standards. The major properties investigated by most of the researchers were compressive strength and water absorption, while the environmental effect of the leachable materials from the end product were also investigated by some. In addition to the fact that the use of sludge in construction industry contributed to the sustainability of limited natural resources, it is also environmentally friendly. A new use of sludge in the construction industry without high energy consumption as compare to what we have in the production of fired bricks should be explored so as to develop energy saving products for future use. More study should be done on the use of different type of sludge in production of construction materials that are economical and environmentally friendly in term of energy usage and emission.

CONCLUSION

- Sludge can be used as an effective replacement of cement and it can be replaced 0, 10 and 20% in concrete.
- The compressive strength is increased with the addition of sludge.
- The maximum compressive strength value obtained were 25 Mpa respectively for OPC 43 grade cement.
- Thus replacement of sludge for cement is suitable up to 10% replacement.

Advantages

- Reduce disposal cost of sludge.
- Reduces uses of natural resources.
- Eliminating disposal of sludge.
- Make concrete economical and eco-friendly.

Limitation

- Only Up to 10%sludge can be used.
- Not used in road work and mass concrete.
- Sludge only which passes through 90-micron sieve used.

Future scope

- We can use sludge as a puzzolonic material.
- Sludge use as a fine aggregate and also used as a fertilizer.
- Production of energy efficient brick.
- Production of cement mortar.

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