REUSE OF IRON SLUDGE IN ROAD CONSTRUCTION

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Abstract

Rapid industrialization have put the environment and natural resources under lot of strain. Sustainable development is the solution to the problem. Recycling is the process of making or manufacturing new products from a product that has originally served its purpose. Recycling helps in reduction of the quantity of waste that needs to be disposed properly and also help in conservation of the resources as the recycled material itself act as a resource. It also helps in reduction of the quantity of waste that needs to be disposed properly. Main aim of this project is to use sludge produce from industry which contains high amount of iron as a construction material for RCC pavement. Impact of using the iron sludge on the strength of the pavement as well on the environment will be evaluated. Using the iron sludge as a construction material which is highly pollutant in nature is recycled in the pavement of road, as well as the natural and environmental effects are being analysed. By using this iron sludge in the sub-grade of the RCC pavement we shall increase the strength of the RCC pavement by reducing the thickness of the pavement and minimize the cost of RCC pavement.

I. INTRODUCTION

Rapid industrialization and unprecedented population growth have put the environment and natural resources under lot of strain.Development has to be done, but not at the cost of the future generation. Sustainable development is the solution to the problem. Recycling is one of the important measures, which can be used to achieve sustainable development.Recycling is the process of making or manufacturing new products from a product that has originally served its purpose. Recycling helps in reduction of the quantity of waste that needs to be disposed properly and also help in conservation of the resources as the recycled material itself act as a resource. Sludge refers to the residual, semi-solid material left from industries or sewage/water treatment processes. Its proper disposal is important for complete water/wastewater treatment. Depending upon its chemical and biological properties it can be used for production of energy or can be reuse in some of the construction projects.

Our main aim of this project is to use sludge produce from industry which contains high amount **(by chemical process)** of iron as a construction material for RCC pavement. Impact of using the iron sludge on the strength of the pavement as well on the environment will be evaluated. By using this iron sludge in the sub-grade of the RCC pavement we shall increase the strength of the RCC pavement by reducing the thickness of the pavement and minimize the cost of RCC pavement.

II. MATERIALS AND METHODS

A. Materials:

Iron sludge used for the testing was brought from industry manufacturing pharmaceutical intermediates; sand used was from thr nearby construction site. Properties of the Iron sludge are shown in table 1:

NO	Parameters	Unit	Results
1	Colour	PtCo.So.	600.0000
2	Ph	Unit	7.3300
3	Total Acidity as CaCO3	gm/kg	0.6000
4	Total Alkalinity as CaCO3	gm/kg	0.9000
5	Total Inorganic Solids (TIS)	gm/kg	921.2000
6	Bio-Chemical oxygen demand (5 days 20oc)	gm/kg	1.2500
7	Chemical oxygen demand	gm/kg	4.0700
8	Oil & Oil Emulsions	gm/kg	0.1200
9	Iron	gm/kg	447.1000
10	Ammonical Nitrogen	gm/kg	0.0220
11	Chloride	gm/kg	1.8000

12	*Sulphate*	*gm/kg*	*5.5000*
13	*Total dissolved Solids*	*gm/kg*	*14.6000*
14	*Calcium*	*gm/kg*	*0.1600*
15	*Magnesium*	*gm/kg*	*0.0240*
16	*Percent Sodium*	*%Na*	*94.000*

B. Sieve analysis of sand to be used in subgrade

Sieve analysis was done to ensure the class of sand used in test. Procedure adopted for the sieve analysis is described below.

Description of Sieve analysis [5]:

A gradation test was performed on a sample of aggregate in a laboratory. A typical sieve analysis involves a nested column of sieves with wire mesh cloth (screen).. A representative weighed sample was poured into the top sieve which has the largest screen openings. The column is typically placed in a mechanical shaker. After the shaking was complete the material on each sieve was weighed. The weight of the sample of each sieve was then divided by the total weight to give a percentage retained on each sieve. The size of the average particle on each sieve was then analysed to get a cut-off point or specific size range, which is then captured on a screen. After the aggregate reaches the pan, the amount of material retained in each sieve was weighed.

$$\% \, retained = \frac{W_{Sieve}}{W_{Total}} \, x \, 100$$

Where

WSieve= Weight of aggregate in the sieve

WTotal = Total weight of the aggregate. The cumulative percent of aggregate retained in each sieve was found out. To do so, add up the total amount of aggregate that is retained in each sieve and the amount in the previous sieves. The cumulative percent passing of the aggregate is found by subtracting the percent retained from 100%.

C. California Bearing Ratio Test

To know the strength of sub grade prepared from the mixture of iron sludge and sand, CBR was done and the detail procedure of CBR is shown below.:

Normally 3 specimens each of about 7 kg must be compacted so that their compacted densities range from 95% to 100% generally with 10, 30 and 65 blows. Weigh of empty mould Add water to the first specimen (compact it in five layer by giving 10 blows per layer) After compaction, remove the collar and level the surface. Take sample for determination of moisture content. Weight of mould + compacted specimen. Place the mold in the soaking tank for four days (ignore this step in case of unsoaked CBR. Take other samples and apply different blows and repeat the whole process. After four days, measure the swell reading and find %age swell. Remove the mould from the tank and allow water to drain. Then place the specimen under the penetration piston and place surcharge load of 10lb. Apply the load and note the penetration load values. Draw the graphs between the penetration (in) and penetration load (in) and find the value of CBR. Draw the graph between the %age CBR and Dry Density, and find CBR at required degree of compaction.

= CBR [%]

= measured pressure for site soils [N/mm²]

= pressure to achieve equal penetration on standard soil [N/mm²].

III. RESULTS AND ANALYSIS

As CBR is an important parameter to get the idea of the strength of the subgrade CB Rwas done for different proportions of sludge and sand mixing. Different proportionstried were 5,6.25,7.5,8.75,10,11.25 12.5% of sludge. Results of the CBR of different proportions at 2.5 mm penetration and at 5.00 mm penetration are shown in Fig. 1 & Fig. 2 and also in table.

TABLE 1 : CBR AT2.5mm & 5.00mm PENETRATION

% of Iron Sludge	**CBR at 2.5mm Penetration**	**CBR at 5.0mm Penetration**
0.00	4.495	7.185
5.00	0.890	0.903
6.25	0.996	1.007
7.50	1.802	2.743
8.75	4.760	10.240
10.00	5.280	10.900
11.25	5.400	10.110
12.75	5.250	9.875

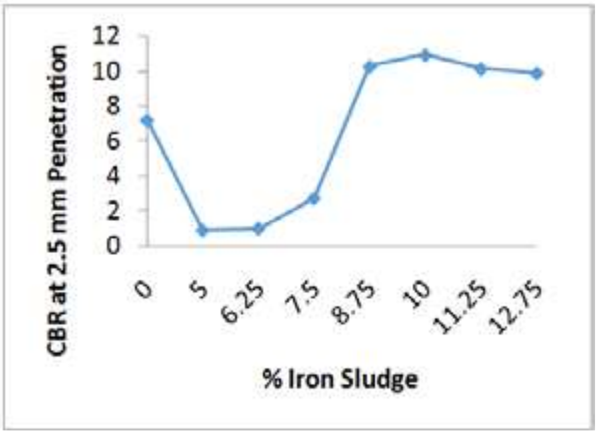

FIGURE 1 : CBR AT 2.5mm PENETRATION

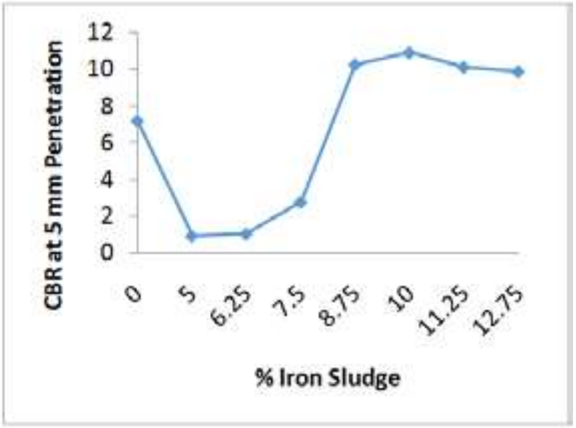

FIGURE 2 : CBR AT 5.0mm PENETRATION

From Fig. 1and fig 2 it can be seen that the CBR value goes on decreasing up to the point where the percentage of iron sludge is 7.5%. But beyond that value the CBR value goes on increasing with respect to the CBR value of only sand.It can be seen that maximum CBR value at 2.5 mm penetration was achiceved when 11.25% sludge was added to the sand and from Fig. 2 maximum value of CBR was achieved at 5.00mm penetration when 10% of sludge was added to the sand. So from both the results optimum results was found when 10% of sludge added to the sand. The reason for increase in the CBR value with increasing percentage of iron sludge above 7.5 % may be that iron sludge being finer than sand, as found out by the sieve analysis can fill the voids of the sand particles. When these voids gets completely filled with iron sludge, further addition of iron sludge will not cause increase inthe CBR value, in fact iron sludge beingvery fine it has property similar to silt. Higher amount of iron sludge may cause slipping of the sand particles. The same reason may be attributed to lesser CBR value when iron sludge percentage is less than 8.75%. natural silt may have clay which can act as binder but in the iron sludge no binder is resent so slipping and dilatancy can occur ah low and very high concentration.

Subgrade Thickness Calculation :

Assuming 2-lane of 1 km2 road have the equivalent single load = 100KN/m2. And the thickness adjustment factor = 1.2. Thickness can be calculated as per Eq. (2)

$$t = \alpha . \sqrt{\frac{ESWL}{8.1.CBR} - \frac{A}{\pi}} \qquad (2)$$

Where:
t = design thickness;
ESWL = equivalent-single-wheel load
CBR = represents the soil strength at the depth "t"
A = contact area for the ESWL which is assumed be constant and equal to the contact area of a tire in the gear assembly
a = thickness adjustment factor that is a function of traffic volume and number of tires in the tire group.

By calculation we get thickness
For sand, t = 1.87 m
For (90% Sand+10 % Sludge) , t = 1.70 m.
Additionof 10% of iron sludge with sand for subgrade can cause approximately 10% reduction in the thickness required for the subgrade if only sand is used. This will result in cost saving as sand requirement will be reduced and also solve the environmental problem of iron sludge disposal.

IV. CONCLUSIONS

This paper has demonstrated the benefits of using iron sludge in enhancing the performance of subgrade soils. The enhanced stability would result in pavements of smaller thickness or longer service life. By adding 10% of iron sludge in the sand we got the optimum values of CBR and due to that we can increase the strength of the pavement and also reduction in the thickness of the pavement. It will also help achieving the goal of sustainable development as reusability and recycling are very important concept for waste minimization and protection of our mother earth.

V. REFERENCES

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