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Research Paper

Use of Iron Sludge in Subgrade of Pavment to Improve the Strrength.

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ABSTRACT

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.Main aim is to use sludge produce fromindustry 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 evaluated.

KEYWORDS

1. INTRODUCTION :

Extensive research has been performed during the past two decades to protect the environment. The use of waste materials in construction applications has many environmental benefits including costs saving in terms of their disposal and potential recyclability. Examples of such waste materials are iron sludge from the Pharmaceutical companies,Pulp and Paper plants,Municipal waste incineration bottom ash [1] , recycled solid waste material [2] , marble quarry waste [3] , water treatment sludge [4]. In this study iron sludge obtained from the industry manufacturing pharmaceutical intermediates was used as a waste material. Effect of adding iron sludge in different proportion with sand on the strength and thickness of the subgrade was checked. Effort were made to find out the optimum ratio of iron sludge and sand which could result in better strength of subgrade and also solving the problem of disposal of iron sludge.

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 research 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.

2. MATERIALS AND METHODS :

2.1 Materials

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

Table 1: Properties of Iron Sludge

NO	Parameters	Unit	Results
1	Colour	Pt Co.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

2.2Sieve 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

W_{Sieve}= Weight of aggregate in the sieve W_{Total} = 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%.

2.2 California Bearing Ratio Test :
To know the strength of subgrade prepaed 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].

3. 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 tabke

TABLE 2: CBR at 2.5mm penetration

% of IRON SLUDGE	CBR at 2.5 mm Penetration
0.00	4.495
5.00	0.890
6.25	0.996
7.50	1.802
8.75	4.760
10.00	5.280
11.25	5.400
12.75	5.250

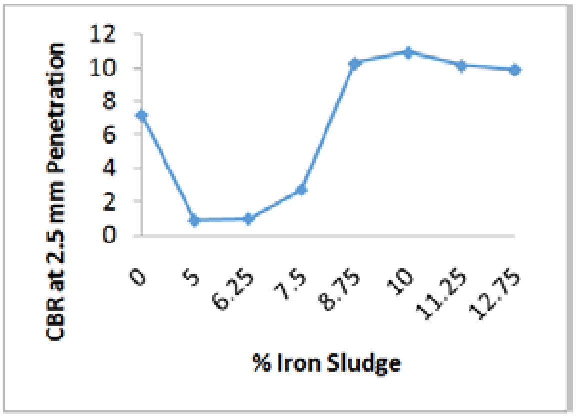

Fig 1 CBR at 2.5 mm Penetration
Table 3 CBR at 5.00mm penetration

% of IRON SLUDGE	CBR at 5.00 mm Penetration
0.00	7.185
5.00	0.903
6.25	1.007
7.50	2.743
8.75	10.240
10.00	10.900
11.25	10.110
12.75	9.875

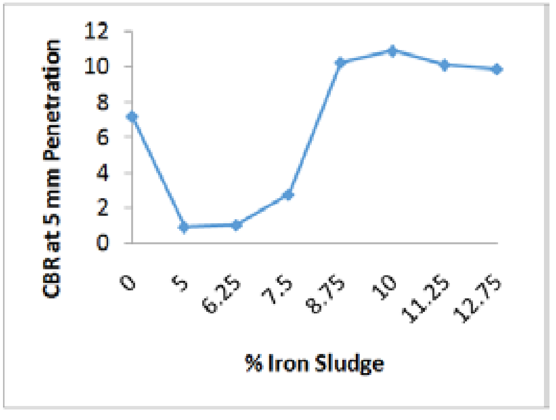

Fig. 2 CBR at 5 mm Penetration
From Fig. 1and fig 2 it can be seen that the CBR value goes on decreasing up to the point where the percentage of iron

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 achieceved 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.

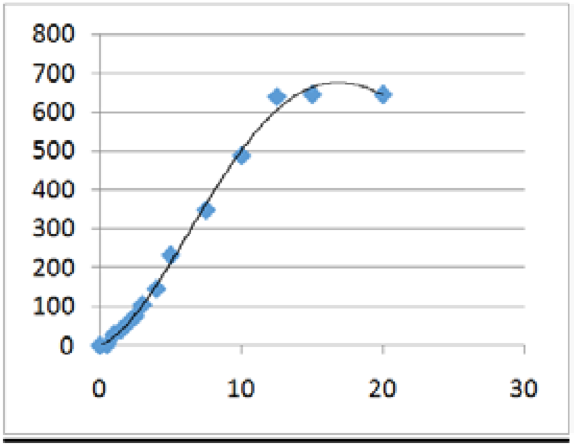

Fig.3 CBR values when 10% sludge added

Subgrade Thickness Calculation :

Assuming 2-lane of 1 km^2 road have the equivalent single load = 100KN/m^2. 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.

4. 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.

REFERENCES

(1) C. Lin , C. Wu , H. Ho,;Recovery of municipal waste incineration bottom ash and water permeable pavment materials",Waste Management 26 (2006) 970–978. | (2) Yue Huang, Roger N. Bird1, Oliver Heidrich,"A review of the use of recycled solid waste materials in asphalt pavements/Resources", Conservation and Recycling 52 (2007) 58–73. | (3) H. Akubulut , C. Gurer,"Use of aggregate produced from marble quarry waste in asphalt pavment",Building and Environment 42 (2007) 1921-1930 | (4) Cheng-Fang Lin a, Chung-Hsin Wu b,*, Hsiu-Mai Ho," Recovery of municipal waste incineration bottom ash andwater treatment sludge to water permeable pavement materials",Waste Management 26 (2006) 970–978. | (5) Pulp and paper plant wastes valorisation in bituminous mixes | R. Modolo a,*, A. Benta b, V.M. | Ferreira a, L.M. Machado c