DESIGN OF LOW COST PAVEMENT FOR RURAL AREAS OF KARIAPATTI USING INDUSTRIAL WASTE MATERIAL

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Abstract

In present scenario safe disposal of industrial wastes is a great problem. These waste materials create environmental pollution in the vicinity because many of them are non-biodegradable. Studies reveal that in recent years, industrial wastes were successfully used in road construction in many developed countries. The use of these materials in road making in based on technical, economic, and ecological criteria. Indian has a vast network of industries located in different parts of the country and many more are to come in the near future. Million metric tons industrial wastes are produced in these industries. The pollution and disposal problems may be minimized by properly utilizing these materials in highway construction. It is important to test these materials and to develop a methodology and specifications to enhance the use of these industrial wastes for their effective utilization in road construction in India. The probable use of these materials should be developed for construction of low-volume roads in different parts of our country. A review of various industrial wastes to be used in the construction of highway has been discussed in this paper. The common waste materials are fly ash, blast furnace slag, cement kiln dust, Phosphogypsum, waste plastic bags, foundry sand and collierysand.

Introduction

Electricity is important for development of any country. Coal is a major source of fuel for production of electricity in many countries in of the world. In the electricity generation process, a large quantity of fly ashgets produced and becomes available as a byproduct of coal-based power stations. Fly ash is a fine powder resulting from the combustion of powdered coal which is transported by the flue gases of the boiler and collected in the Electrostatic Precipitators (ESP). Conversion of waste into a resource material is an old practice of human society. In the year 1930, in USA, the fly ash became available in coal based thermal power station.

Definition of the Problem

- In present scenario safe disposal of industrial waste is a great problem.
- Studies reveal that in recent years, industrial waste were successfully used in road construction in many developed countries.
- The pollution and disposal problems may be minimized by properly utilizing the industrial waste material in highway construction.
- The common waste materials are fly ash, blast furnace slag, cement kiln dust, waste plastic bags, foundry sand and colliery sand.

Objective

- To identify the area of sample collection and industrial waste material.
- To study the various cost parameters involved in the pavement.
- To study the characteristics and classification of sample collected.
- To stabilize the soil with industrial waste material.
- To analyse the cost and comparisons both the unstabilized pavement cost and stabilized pavement cost.

Purpose

- Pollution and disposal problems may be minimized in many industries.
- The effective use of waste material reduce the cost of construction and contribution to the strength of the pavement when used in optimum dosage.

Literature Review

-K A sunil, K sahithi

- The study promotes the usage of industrial wastes to reduce the cost of construction of flexible pavements and helps in preserving the natural reserves.
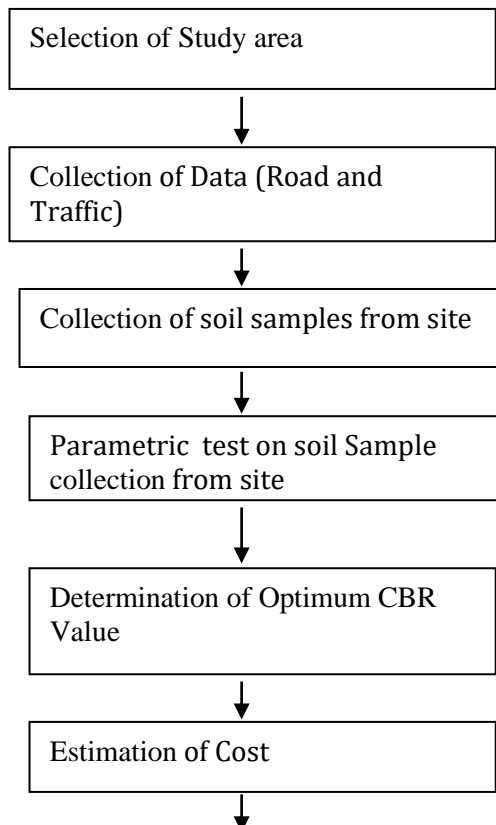
Lakshmi Keshav, Mangaiarkarasi.v

- To study the effect of fly ash on an expansive soil for flexible pavement design and to reduce the quantity of lime in lime fly ash by the effective use of fly ash itself.

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- To study the effective fly ash and industrial waste material to reduce the cost of material flexible pavement to reduce the quality of CBR value.

Methodology

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┌─────────────────────────────┐
│ Selection of Study area     │
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┌─────────────────────────────┐
│ Collection of Data (Road and│
│ Traffic)                    │
└─────────────────────────────┘
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              ▼
┌─────────────────────────────┐
│ Collection of soil samples from site │
└─────────────────────────────┘
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┌─────────────────────────────┐
│ Parametric test on soil Sample │
│ collection from site        │
└─────────────────────────────┘
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┌─────────────────────────────┐
│ Determination of Optimum CBR│
│ Value                       │
└─────────────────────────────┘
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┌─────────────────────────────┐
│ Estimation of Cost          │
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Result and Discussions

Selection of Study Area

Kariapatti village road is the study area selected for design of pavement using industrial waste.This road is selected as a study area due to demand of construction of new pavement and widening of road by soil stabilization.

Collection of Data

Traffic Data–The Traffic census gives the particulars of average Daily Traffic (ADT) in numbers and in Passenger Car Units (PCU) on the entire PWD road in the State as prevailed during the period of census. Information on traffic is necessary for any highway project, since it would form the basis for design of pavement, fixing the number of traffic lanes. One of the fundamental measures of traffic on a given interval of time. It is also termed as traffic flow and expressed in vehicle per hour or vehicle per day. The survey data is being used by the authorities concerned in taking policy decisions like improvements to existing road, upgradation of roads to higher categories, surface improvements, widening and number of traffic lanes etc., to fulfill these objectives it is necessary that the annual road traffic survey should be a regular periodical operation with vehicle counts taken at specified intervals.

Road Survey– All different possible alignments and nature of the terrain should be studied with the help of availabletoposheet and map of the area. Reconnaissance Survey starts with a field of inspection by the surveyors. In this survey the details of the area i.e., whether plane, area, rolling or hilly area is collected. Preliminary Survey is large scale investigations of the results of reconnaissance survey. Its objective is to prepare a plan showing the location & nature of the field. The survey consists of establishing a base line traverse, which is series of straight lines along the selected alignment. The physical such as buildings, trees, monuments utilities, railway lines canals etc. are located. Also the information of ground water level, rainfall intensity type of the soil, catchment area, etc. are collected. The detailed survey is done to fix the selected alignment in the field and to collect the additional for the preparation of the drawings. In this project detailed survey is done to determine the existing profile of road and ground. It also included the preparation of longitudinal and crosssections, computation of earth quantities etc.

Soil Survey – It is an essential part of the preliminary survey as the suitability of the proposed location is to be finally decided based on the soil survey data. The soil survey conducted at this stage also helps in working out details of earth work, slopes, suitability of materials, subsoil and surface drainage requirements and pavement type and the approximate thickness requirements. All these details are required to make a comparative study of alternate proposals. The soil samples collected during the field work are subjected to identification and classification test in the laboratory.

Experimental Tests:
1) Specific Gravity:
The specific gravity of the soil is ratio between weight of the solids and weight of equal volume of water.It is measured by the help of a volumetric flask in a very simple experimental setup where the volume of the soil is found out and its weight is divided by the weight of equal volume of water. The specific gravity is denoted by "G".

Specific Gravity G= (W2−W1)/(W4−W1)
−(W3−W2)

       W1- Weight of bottle in gms
       W2- Weight of bottle + Dry soil in gms
       W3- Weight of bottle + Soil + Water
       W4- Weight of bottle + Water

2) Liquid Limit:

Weigh about 120gm of soil passing through 420 micron (I.S sieve).The soil sample is placed on the operating dish and thoroughly mixed with water using spatula until the mass becomes a thick paste of putty like consistency.Thecasagrande's device is checked to have a correct fall of 10mm and placed a portion of the prepared paste over the brass cup.A portion of the mixture is placed in the cup and leveled with the spatula to a maximum depth of 1cm.The grooving tool is used to cut a groove in the middle of the soil cake.The cam is rotated at a rate of 2 blows per second and the rotation are counted until the groove closer over a length of 12mm.A small quantity near the centre of test sample is collected in a container and weighed it.The sample is kept in the oven for 24 hours and weighed.The difference of the two weight will give the weight of water and from the moisture content is found out by the dry weight.The experiment is repeated by adding little more water. Four trials are made so that the numbers of blows are more than 25 in two cases and less than 25 in order two cases.In each trial the moisture content is determined the result of the test are plotted as a flow curve.The moisture content values are plotted to a natural scale against the number of blows to a logarithmic scale.The moisture content corresponding to 25 number of blows will give the liquid limit for the sample.It is denoted by WL.

3) Plastic Limit:

A Sample of about 50gm is taken from the given soil sample.The sample is thoroughly mixed with water on the glass plate until it is plastic enough to be rolled into a ball.Theball of soil is taken rolled between the hand and the glass plate so as to form the soil mass into a thread of 3mm diameter without breaking.The soil is then kneaded together and rolled out again. The process of kneading and rolling thread is repeated until the soil just ceases to be plastic and crumbles.The portion of crumbled soil are gathered together and placed in a container for moisture content determination.The test is repeated twice more than fresh samples.The average of the three water contents gave the plastic limit of the soil.Plastic limit is denoted by WP.

4) Proctor Compaction Test:

Weigh the standard proctor mould with base and without collar(w1) gm.Take about 3kg of air

dried soil passing through 4.5mm sieve.Take known quantity of water (6% by the weight of dried soil) and mix well with the soil.Attach the collar with proctor mould and fill the mixed soil in the mould in the three equal layers. compact each layer by the rammer weighing 2.6 kg allowing into drop 25 times from the height of 310mm.The total height of the compacted soil should be slightly more than the height of the mould.Remove the collar and cut out the projected soils to have a level surface with the top of the mould.Weight the mould with the soil (w2) gm.Remove the soil from the cylinder and break up the soil by hand. Now Increase the moisture content by 2% mix thoroughly. Repeat the experiment .In the repeating process each time rise the moisture content by 2% until there is a considerable fall in the weight of the mould with compacted soils.Take samples from which operations and calculate the moisture content and corresponding dry density.Draw the graph between dry density and moisture content. Find the dry density and optimum moisture content from the graph.The equations used in this experiment are as follows

Dry density= $(G \times YW)$ / $(1+WG)$

6) California Bearing Ratio Test:

Place the mould assembly with surcharge weight on the penetration testing machine.Seat the penetration piston at the center of the specimen with the smallest possible load, but in no case in excess of 4kg so that full contact of the piston on the sample is established.Set the stress and strain dial gauge to read zero. Apply the load on the piston so that the penetration rate is about 1.25mm/min.Record the load readings at penetration of 0.5,1.0 ,1.5 ,2.0 ,2.5 ,3.0 ,4.0 ,5.0 ,7.5, 10 and 12.5mm.Note the maximum load and corresponding penetration if it occurs for a penetration less than 12.5mm.Detach the mould from the loading equipments.Take about 20 to 50 g of soil from the top 3cm layers and determine the moisture content.

CBR = P/Ps X100

Results and Discussions

Determination of Specific Gravity of Fine Aggregates

S. N O	PARTICULARS	WEIGHT(KG) TRIAL 1	WEIGHT (KG) TRIAL 2
1	Weight of pycnometer(	0.519	0.519

	w1)		
2	Weight of pycnometer+ Fine aggregate(w2)	1.782	1.828
3	Weight of pycnometer+ Fine aggregat+water(w3)	2.178	2.238
4	Weight of pycnometer+ Water(w4)	1.470	1.470

$=W2-W1/(W2-W1)-(W3-W4)$
$=1.782-0.519/(1.782-0.519)-(2.178-1.970)$
$=2.56$

Determination of Liquid Limit Of Soil

S.NO	Percentage of moisture Content (m)	Quantity of water Added in cc	Number of blows (N)
1	10	12	50
2	12	14	31
3	14	16	27
4	16	18	23

Liquid limit of the soil=11
flow index $=(M1-M2)/\log(N1/N2)$
$=(14-16)/\log(27-23)$
$=3.32$

DETERMINATION OF PLASTIC LIMIT OF SOIL

Type of soil   :clay soil
Weight of can (W1) gm   :20
Weight of wet soil with can (W2) gm:68
Weight of dried soil with can (w3) gm   :40

Weight of water (W2-W3) gm   :28
Weight of wet soil (W3-W1) gm   :40
Moisture content   :5%
W=(W3-W2)/(W3-W1)*100
=28/40*100
=70

Standard Proctor Compaction Test

SI.NO	WATER CONTENT (W) %	WEIGHT OF MOULD+ SOIL(W2g)	WEIGHT OFSOIL(W) =W2-W1	BULK DENITY Γ=W/V	DRY DENSITY Γd=γ/(1+W)	Γd 100% Saturation g/cc
1	6%	6207	1990	2.028	1.913	2.249
2	8%	6433	2216	2.258	2.090	2.152
3	10%	6388	2171	2.212	2.010	2.063
4	12%	6327	2110	2.150	1.919	1.982

=G*Γw/(1+WG)
=2.6*1/(1+6/100*2.6)
=2.249
sieve analysis

S.NO	IS SIEVE	EMPTY WEIGTH OF SIEVES	RETAINED WEIGHT OF SIEVE	RETAINED WEIGHT OF SOIL	CUMULATIVE WEIGHT RETAINED	CUMULATIVE % RETAINED	%FINER
1	4.75	369	410	41	41	4.1	95.9
2	2.36	344	415	71	112	11.2	88.8

3	1.18	362	596	234	346	34.6	65.4
4	1	363	411	48	394	39.4	60.6
5	600	301	356	55	449	44.9	55.1
6	300	303	535	232	681	68.1	31.9
7	150	304	583	279	960	96.0	4
8	PAN	300	340	40	1000	100	0

Fineness modulus =total sum of cumulative % retained/100
=398/100
=3.98

DETERMINATION OF CBR VALUE

PENETRATIONDIAL	LOAD DIAL		
Reading(Div)	Penetration(mm)	Proving ring reading (Div)	Load(kg)
0.5	500	35	424.55
1	1000	75	904.75
1.5	1500	120	145.52
2	2000	165	200.145
2.5	2500	240	291.12

3	3000	270	327.51
4	4000	340	412.212
5	5000	415	503.395
7.5	7500	515	709.605

CBR value of soil for 2.5 mm penetration=(load at 2.5 mm penetration/standard load)*100
=2(200.145/370)*100
=108.18 mm
CBR value of soil for 5mm penetration=(load at 5 mm penetration/standard load)*100
=2(503.395/2055)*100
=24.49 mm

Determination of Impact Strength of Coarse Aggregate

S.NO	TYPE OF PAVEMENT	TRIAL1	TRIAL2
1	Empty weight of mould(w) in g	1530	1520
2	Weight of sample with steel cup(w1) in g	2170	2210
3	Weight of sample passing through 2.36 mm is sieve (w2) g	90	90
4	Aggregate impact value =(w2/{w1-w})*100	14.06	13.43
	Mean value	13.74	

Aggregate impact value of given aggregate sample is =13.74

S.NO	PARAMETER	TEST RESULT
1	SIEVE ANALYSIS	3.89
2	DETERMINATION OF SPECIFIC GRAVITY OF FINE AGGREGATE	2.56
3	DETERMINATION OF LIQUID LIMIT OF SOIL	3.32
4	DETERMINATION OF PLASTIC LIMIT OF SOIL	70
5	STANDARD PROCTOR COMPACTION TEST	2.249
6	DETERMINATION OF CBR TEST	FOR 2.5mm =108.18 FOR 5mm = 24.49
7	DETERMINATION OF IMPACT STERNGTH OF COARSE AGGREGATE	13.74%

CBR OF SOIL + FLYASH

- CBR value of the soil + flyash (5%) unsoaked in percentage=5.98%
- CBR value of the soil + flyash (10%) unsoaked in percentage=6.39%
- CBR value of the soil + flyash (15%) unsoaked in percentage=6.91%
- CBR value of the soil + flyash (20%) unsoaked in percentage=7.08%
- CBR value of the soil + flyash (25%) unsoaked in percentage=7.25%
- CBR value of the soil + flyash (30%) unsoaked in percentage=7.60%
- CBR value of the soil + flyash (35%) unsoaked in percentage=6.79%
- CBR value of the soil + flyash (40%) unsoaked in percentage=1.38%

CONCLUSION

SL NO	PARTICULARS	ESTIMATED COST	DIFFERENCE IN COST FROM CBR-1
1	FOR CBR-1	RS.15,503,074.44	_
2	FOR CBR-2	RS.12,438,430.44	RS.30,64,644.00
3	FOR CBR-3	RS.11,935,308.44	RS.3,567,766.00

REQUIREMENTS	AS PER DESIGN	PROPOSED	
	EFFECTIVE CBR 7.5%		
		300	Sub grade
Granular sub base	215	215	GSB
Base	250	250	WMM
Dense bituminous macadam	73.75	75	DBM
Bituminous concrete	40	40	BC
Total thickness in 'mm'	578.75	580	

In this project we used flyash as a soil stabilizing material with alternative material as cement. By conducting tests on soil we found that the soil CBR is 3% for soaked soil and for soil stabilized with flyash of 30% by the weight of soil is found to be 7.6% unsoaked since

we found that there is a gradual increase in the CBR of soil which found to be 30% flyash is optimum dosage by this tests. Tests carried for 5% of fly ash to 40% of fly ash, at the point of 35% the CBR gradually decreased to 6.79% and & 40% it was only 1.38% since the increase of flyash above 30% leads to decrease of strength due to increase in the content of flyash in the soil since the optimum dosage value is adopted. Also we have conducted the tests on flyash 20% and cement 5% & 10% by weight of soil. We found that the CBR for flyash 20% and cement 5% with soil was found to be 19.33% for unsoaked and 6.73% for soaked. For combination of soil + flyash 20% + cement 10%, we found that CBR value for unsoaked is 24.63% and for soaked is 9.36% for soaked. The value of CBR is increased due to increase of cement content, since the cement content is to be used for only optimum dosage from 5% to 15% of weight of soil, as the content of cement is increased the strength increases and cost also increaseswhich leads to uneconomical. By this we conclude that the flyash is a useful industrial waste in construction industry. By this project we conclude that the use of flyash in soil stabilization is economical and reduces the cost of construction and increases the strength of the soil, when combined with cement, the flyash gives desirable strength to the pavement, as flyash has the pozzolanic property it can be widely used in construction industry.

- The suitable stabilizers Flyash is chosen for soil stabilization with cement and without cement.
- Cost analyses and comparisons between the unstabilized pavement cost and stabilized pavement cost found to be decreased when stabilized

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