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DESIGN OF FLEXIBLE PAVEMENT USING INDUSTRIAL WASTE

VISHAL MATHAPATI[1], VISHWANATH AWATI[2]

[1]Final year UG. Student, Dept. of Civil engineering, JCE, Belagavi-590014
[2]Assistant Professor, Dept. of Civil Engineering, JCE, Belagavi-590014

Abstract - *In this project the flyash is used in the soil sub grade stabilization and its structural strength improvements, and to reduce the cost of construction by increasing the CBR value of the subgrade. In this project we used flyash and cement for soil stabilization and we found that increase in CBR value by 7.60% of subgrade soil by using 30% of flyash with only soil, and further by testing the CBR value of subgrade soil by taking flyash 20% and cement 10% we found considerable increase in the CBR value of soil by 9.32%, the CBR test value of only soil was found 3.45%. Since this method of soil stabilization may workout economical for road construction. By this method the road project construction can be made easy and economical.*

1. INTRODUCTION

1.1 GENERAL

Transportation contributes to the economic industrial social and cultural development of any country. Transportation is vital for the economic development of any region since every commodity produced whether it is food, clothing, industrial, products or medicine needs, transports at all stages from production to distribution. The inadequate transportation facilitates retard the process of social economic development of the country. The adequacy of transportation system of country indicates its economic and social development. With over 78% of the population of the country living in the villages, the developments in urban centers alone do not indicate the overall development of the country. Only with the improvement facilities in rural areas, there could be faster development of the rural centers. The constitution cost of roads can be considerably decreased by selecting local materials including local soils. If the stability of the local soil is not adequate for supporting wheel loads, the properties are improved by soil stabilization techniques. Thus the principle of soil stabilized road construction involves effective utilization of local soil and other suitable stabilizing agent. In developing countries like India soil stabilization methods using locally available material have scope in reducing the initial construction of pavement generally granular materials like natural sand, moorum, gravel, laterite, kankar or other naturally occurring or artificial soft aggregates like slag, cinder in the, broken brick aggregates and low grade iron ores are most commonly used apart from these industrial waste such as fly ash, lignin and molasses can be used which contribute only transportation cost.

Fly ash disposal and utilization shall continue to be an important area of natural concern due to India's dependence on thermal power generation for its energy supply. The scenario with respect to fly ash management has undergone considerable improvement over the past few days. Due to increasing environmental concern and growing magnitude of the problem it has become imperative to manage it. More importantly tremendous potential to be utilized. Fly ash is a waste derivative from thermal power plants. It is estimated that about 100 million tons of fly ash is being produced from different thermal power plants in India consuming several 1000 hectares of precious land for its disposal crusting severe health and environmental hazards. Inspite of continuous efforts made and incentives offered by the government, hardly 5-10% of the produced ash is being used for gainful purposes like brick making, cement manufacture, soil stabilization and as fill material. In order to utilize fly ash in bulk quantity, ways and means zone being explore all over the world to use it for the construction of embankment in roads, as fly ash satisfies major systems requirements of strength and compressibility except liquefaction under extreme conditions. With an increase in fly ash content engineering characteristics of soil even be improved.

1.2 SCOPE OF PROJECT

The scope of study is to improve the safe bearing capacity of the soil of the pavement to carry the desired load and to fulfill the requirements of the pavements with efficiency and economically, also by using industrial wastes the soil stabilization is done economically as compared to artificial stabilizers and also and present practice of soil pavement stabilization. The main aim of this project is to improve the bearing capacity of soil by using industrial wastes like Fly ash, and also using combinations of other additives like cement. With this combination of materials proper gradation of additives is determined and also the optimum mix is determined and calculated by conducting various CBR tests on different soil combinations are (soil, soil + fly ash, soil + fly ash + cement) and the properties of the materials is determined and the optimum CBR value is calculated. By this we can improve the design of pavement and cost is reduced and also the wastes generated by industries is utilized sufficiently and also environmental impacts can be significantly reduced.

1.3 OBJECTIVES OF THIS PROJECT

- Stabilizing the soil with flyash stabilizers as industrial waste.

- Cost analyses and comparisons between the unstabilized pavement cost and stabilized pavement cost.

2. STUDY AREA

2.1 INTRODUCTION

The study area is located between Kallehol village and Bachi Raicher highway, in Belagavi taluk of Karnataka state as shown in the fig: 2.1. It is an important road which links Kallehol and its surrounding localities and Belagavi City, the distance between this road and Belagavi taluk headquarter is 9.1 km. The main purpose of this road carrying and transporting agriculture and other industrial products. The distance of study area covers 1.0 km from Kallehol cross towards Kallehol.

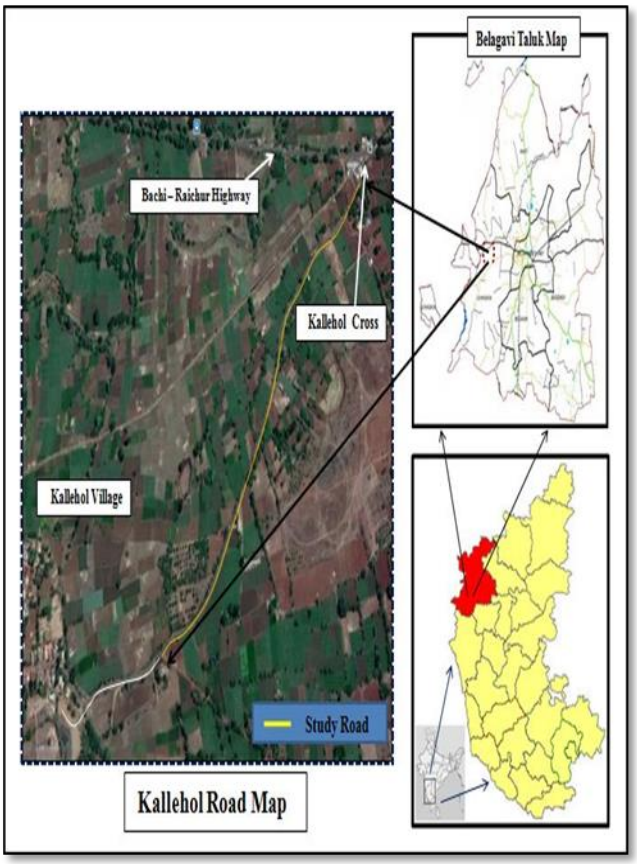


Fig: 2.1 Location map of study area

2.2 CLIMATE

The area is known for pleasing climate throughout year, is at its coldest in winter November to February at 7° C and hottest in summer March to May maximum 39° C. The area experiences almost non – stop monsoon rains from June to September of 244 – 455 mm.

2.3 CONNECTIVITY OF ROAD

The road connects SH20. And ayacut roads near kallehol village. The irrigators grow lot of agricultural products in the vicinity of this road, and also many agricultural products have to be transported to market. Since it's an important road in the vicinity of Kallehol area, where the development of existing road and the road widening is necessary with minimum cost and maximum efficiency.

2.4 EXISTING ROAD

It is a Major District Road and the length of road considered for study purpose is 1.0 Km and needs improvement for same as there are many pot holes and undulations in the existing pavement and also increase in traffic. Since the existing pavement is of old design method and which is necessary for design of pavement using new technologies and methods to work out the economic cost for construction of road. Thus the road runs in fine grained soil which is considered to stabilize, the road using industrial waste like Flyash, Rice husk etc., to increase the CBR value of the road pavement and to propose the new pavement design.

2.5 PROPOSED IMPROVEMENTS

The estimate is prepared for dozing existing uneven width road proposed to be widen for 5.5 meter with earth from borrow pits shown the cross section the necessary 30cm for un stabilized and 23 cm for stabilized base thick embankment for Sub Base is proposed strengthening with earth from borrow pits and GSB, WMM, DBM and BC with necessary to improve the road from 0.0 to 1.0 km for a width of 5.50 m are proposed.

Fig-2.2 EXISTING ROAD

3. METHODOLOGY

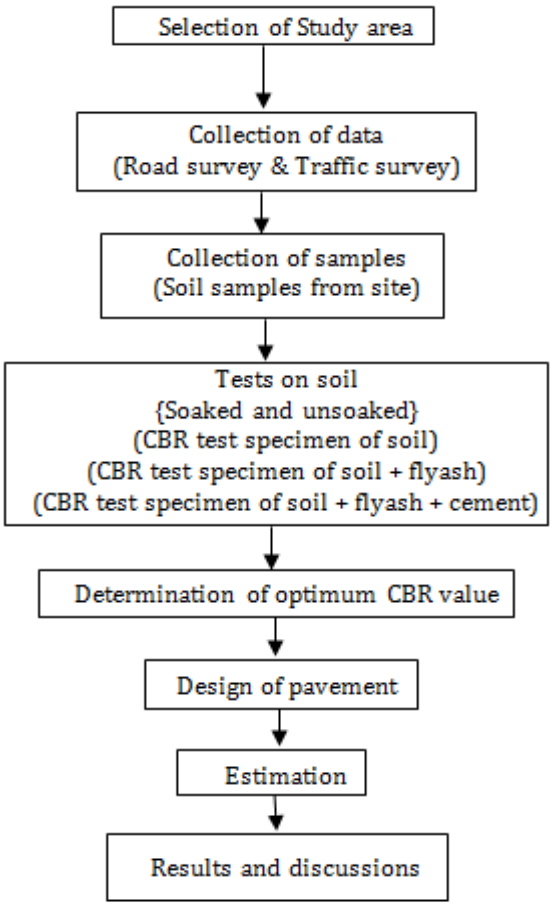


Fig: 3.1 General methodology of project work

3.1 SELECTION OF STUDY AREA

Kallehol road is the study area selected for design of pavement using industrial waste, since this road is located in the Belagavi taluk at Kallehol which is also called as the Major District Road. This road is selected as a study area due to demand of construction of new pavement and widening of road by soil stabilization.

3.2 COLLECTION OF DATA

TRAFFIC DATA – Factual studies of traffic operation provide the foundation for developing methods for improvement in general and for solving specific problems. Study of traffic characteristics is the most essential prerequisite for any improvement of traffic facilities. The traffic characteristics are quite complex with various types of road users in the roads moving with different motives. The human psychology is to be given particular attention. The study of vehicular characteristics is an essential pan. Apart from these the various studies to be carried out on the actual traffic include speed, volume, capacity, travel patterns, origin and destination, traffic flow characteristics; parking and accident studies. Traffic planning is a separate phase for major highways like express-ways, arterial roads, mass transit facilities, and parking facilities. All the aspects such as cross section and surface details, sight distance requirement, horizontal and vertical alignment, man oeuvre areas and intersections and parking facilities are to be suitably designed for better performance

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 available toposheet 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 cross-sections, 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. Soil profile is obtained by drawing the

longitudinal section along the proposed road alignment upto the depth of exploration. The types of soils encountered along the route upto the depth under consideration are marked on the soil profile either symbolically or by suitable colour coding.

3.3 TESTS AND RESULTS ON SOIL

- **Result: CBR of soil**

  1. CBR value of the soil unsoaked in percentage = 5.52%
  2. CBR value of the soil soaked in percentage = 3.45%

- **Result: CBR of soil + flyash**

  1. CBR value of the soil + flyash (5%) unsoaked in percentage = 5.98%
  2. CBR value of the soil + flyash (10%) unsoaked in percentage = 6.39%
  3. CBR value of the soil + flyash (15%) unsoaked in percentage = 6.91%
  4. CBR value of the soil + flyash (20%) unsoaked in percentage = 7.08%
  5. CBR value of the soil + flyash (25%) unsoaked in percentage = 7.25%
  6. CBR value of the soil + flyash (30%) unsoaked in percentage = 7.60%
  7. CBR value of the soil + flyash (35%) unsoaked in percentage = 6.79%
  8. CBR value of the soil + flyash (40%) unsoaked in percentage = 1.38%

- **Result: CBR of soil + flyash**

  1. CBR value of the soil + flyash (20%) + cement (5%) unsoaked = 19.33%
  2. CBR value of the soil + flyash (20%) + cement (5%) soaked = 6.73%
  3. CBR value of the soil + flyash (20%) + cement (10%) unsoaked = 24.63%
  4. CBR value of the soil + flyash (20%) + cement (10%) soaked = 9.32%

3.4 OPTIMUM CBR VALUE

- The optimum CBR from only soil sample adopted for design of pavement is called as **CBR – 1 say as 3.5%**.
- The optimum CBR from soil + flyash samples is 7.60 at 30% flyash unsoaked, hence this value is adopted for design of pavement is called as **CBR – 2 say as 7.5%.**
- The optimum CBR from soil + flyash + cement samples is 24.63% for unsoaked and 9.32% for soaked at 20% flyash and 10% cement, hence this value is adopted for design of pavement is called as **CBR – 3 say as 9%.**

3.5 PAVEMENT DESIGN RESULTS

The pavement thickness for effective CBR – 3.5% and Traffic 17.5 MSA

Table: 3.1 Crust thickness for CBR – 1

IRC: 37-2012 Requirements	As per Design	Proposed	
	Effective CBR 3.5%		
		300	Sub grade
Granular Sub Base	380	380	GSB
Base	250	250	WMM
Dense Bituminous Macadam	105	105	DBM
Bituminous Concrete	40	40	BC
Total Thickness in 'mm'	775	775	

The pavement thickness for effective CBR – 7.5% and Traffic 17.5 MSA

Table: 3.2 Crest thickness for CBR – 2

IRC: 37-2012 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	

The pavement thickness for effective CBR – 9% and Traffic 17.5 MSA

Table: 3.3 Crust thickness for CBR – 3

IRC: 37-2012 Requirements	As per Design	Proposed	
	Effective CBR 9%		
		230	Sub grade
Granular Sub Base	200	200	GSB
Base	250	250	WMM
Dense Bituminous Macadam	72.5	73	DBM
Bituminous Concrete	40	40	BC
Total Thickness in 'mm'	562.5	563	

3.6 ESTIMATION COMPARISON

Table: 3.4 Comparison of estimate

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

- Since we found that the decrease of cost compared to CBR – 1 with CBR – 2 is minimum and thus it can be worked out economical for construction of road.
- And also for CBR – 3 when higher strength of sub grade required.

4. RESULTS AND DISCUSSIONS

4.1 TESTS ON SOIL SAMPLES

The basic tests were conducted for soil to check the pre – requirements of soil materials and test results are in Table no: 4.1 the tests are found within permissible limits. Hence the further CBR tests were conducted by soil stabilization using Flyash and Cement.

Table: 4.1 Basic test results and values

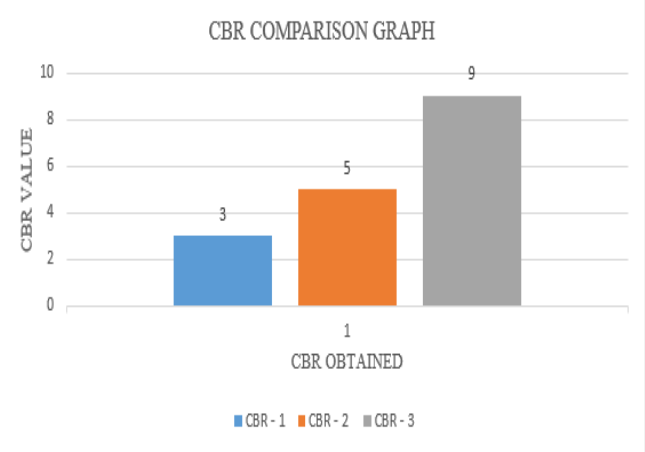
SL No.	Name of the basic test	Test results	Standard Permissible values
01	Specific gravity of soil	2.713	2.70 – 2.75
02	Natural moisture content of soil	20.08%	---
03	Standard Procter test	OMC – 16% (oven dry) MDD – 1.675	OMC: 15% - 20% MDD: 1.6 – 1.8

The results obtained after the soil stabilization are shown in the below Table no. 4.2. From the tests results of table no. 4.2 the CBR value is significantly increased by addition of flyash and cement.

Table: 4.2 CBR Tests on stabilized soil

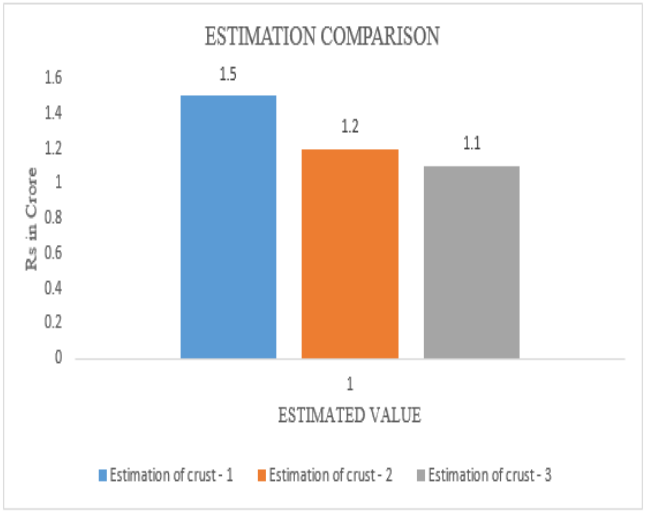
SL NO.	Name of the test	OBTAINED CBR VALES
04	Basic CBR test on Soil	5.52% (Unsoaked) 3.45% (Soaked)
01	CBR test on soil + flyash 30%	7.60% (Unsoaked)
02	CBR test on soil + flyash 20% + cement 10%	9.32% (Soaked)

CBR COMPARISON GRAPH



Graph: 4.1 CBR Comparison

COMPARISONS ON ESTIMATE



Graph: 4.2 Estimate comparison graph

4.2 ADVANTAGES OVER FLYASH SOIL STABILIZATIONS

- Flyash can be used as a best and economical soil stabilizing agent for pavement design and construction.
- It will reduce the cost of construction and contribute to the strength of the pavement when used in optimum dosage.

Since the production of flyash is increasing in India by thermal plants and disposal is difficult, to overcome it the fly ash can be used in construction of pavement.

5. CONCLUSIONS

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 increases which 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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BIOGRAPHIES

Mr. Vishal Mathapati (BE. In Civil Engineering) U.G Student, Department of Civil Engineering, Jain college of Engineering, Belagavi, Karnataka, India.

Mr. Vishwanath Awati (B.E in Civil Engineering, M.Tech. in Water and Land Management). Working as Assistant Professor in Department of Civil Engineering, Jain college of Engineering, Belagavi, Karnataka, India. Research areas are Land and Water resource management using Remote Sensing and GIS