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A STUDY ON RURAL ROADS AND ITS COST EFFECTIVE MEASURES

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ABSTRACT:

In rural India, village roads are the major channels of transportation for carrying goods and passengers. As the benefits derived from the construction of rural roads are reflected throughout the economy of the village, therefore, an adequate rural road network is absolute necessary for the improvement of the economic and social conditions of the rural folk. Thus roads plays significant role in the life of villagers and its multiple effects are evident.. As we all know transportation contributes to the economic, industrial, social and cultural development of any country. Pavements are a conglomeration of materials. These materials, their associated properties, and their interactions determine the properties of the resultant pavement. Thus, a good understanding of these materials, how they are characterized, and how they perform is fundamental to understanding pavement. The materials which are used in the construction of highway are of intense interest to the highway engineer. This requires not only a thorough understanding of the soil and aggregate properties which affect pavement stability and durability, but also the binding materials which may be added to improve these pavement features in the existing different sub grades. Due to any added material to improve these features may results in not economical which is expensive to lay and to Maintenance of these roads. Depending up on the different types of sub grades the cost effectiveness of construction of roads may vary. A study is carried out to check the different sub grade properties and to improve the properties and its cost effective measures which is to be economical.

Key Words: Rural Roads , Different Types of sub grades , cost effective measures.

1. INTRODUCTION

Transportation contributes to the economic, industrial, social and cultural development of any country. Transportation is vital for economic development of any region since every commodity produced needs transport at production and distribution stages. In the production stage transportation is required for carrying raw materials like seeds, coal etc. in the distribution stage, transportation is required from the production centers viz. farms and factories to the marketing centers for distribution to the retailers and the consumers. The inadequate transportation facilities retard the process of socio economic development of the country. The adequacy of the transportation system of a country its economic and social development. The purpose of pavement is to provide a functional surface for the safe operation of a Vehicle. The surface of the pavement should be stable and non-yielding. To allow the heavy wheel loads of road traffic to move with least possible resistance. The surface should also be even along the longitudinal profile to enable safe and fast movement of vehicles at design speed. However the earth road may not be able to fulfill the above requirements due to varying traffic loads, climatic conditions, unevenness, increased fuel consumption and discomfort to the passengers. Thus a pavement consist ion of a few layers of pavement material is constructed over a prepared soil sub-grade to serve as a carriageway.

2 .METHOD OF DESIGN

The methodology adopted in designing the pavement was presented here in the following the guidelines and specifications given in IRC: 58-2011.

2.1 Design Of Rigid Pavement

Wheel load:

The legal axle load in India being 102KN, the pavement may be designed for a wheel load of 51 KN.However, for link roads serving isolated villages where the traffic consists of agricultural tractors and trailers and light commercial vehicles only, a design wheel load of 30kn may be considered.

Tyre Pressure:

The tyre pressure may be taken as 0.7MPa where a wheel load of 51 kn is considered and 0.5 Mpa where a wheel load of 30KN is considered.

Design Period:

Cement concrete pavement may be designed to have a life span of 30 years or more however the design engineer should use his/her judgment about the design period taking into consideration factors such as volume, uncertainly of traffic volume, uncertainty of traffic growth rate, the capacity of the possibility of augmentation of capacity by widening.

Characteristics of the Sub grade:

The strength of sub grade is expressed in terms of modulus of sub grade reaction, k, which is determined by carrying out a plate bearing test, using 750mm diameter plate according to IRC 58-2011. An idea of the k value of a homogeneous soil sub grade may be obtained from its soaked CBR Value king Table 2.1

Table 2.1 Relation Between k-value and CBR Value for Homogeneous Soil Sub grade

Soaked CBR (%)	2	3	4	5	7	10	15	20	50	100
k-value (Mpa/m)	21	28	35	42	48	55	62	69	140	220

Sub-Base:

The main purpose of the sub base is to provide a uniform, stable and permanent support to the concrete slab laid over it. It must have sufficient strength so that it is not subjected to disintegration and erosion under heavy traffic and adverse environmental conditions.

2.2 GENERAL DESIGN CONSIDERATIONS:

Cement concrete pavements represent the group of rigid pavements. Here the load carrying capacity is mainly due to the rigidity and high modules of elasticity of the slab helf. I.e. slab action. H.M. Westergaard is considered the pioneer in providing the rational treatment to the problem of rigid pavement analysis.

2.2.1 Wheel Load Stresses

A.T. Gold beck indicated that many concrete slabs failed at the corners. He derived a corner load formula due to a point load at the corner of the slab. Gold beck's formula for stress due to corner load is given by:

$$S_c = 3P/h^2$$

Here, Sc = stress due to corner load, kg/cm^2

P = corner load assumed as a concentrated point load, kg

h = thickness of slab. Cm

However the assumptions of unsupported corner and concentrated point load at corner have been later found to be severe resulting in very high thickness requirement of slabs.

2.2.2 Temperature Stresses

Westergaard's Concept for Temperature Stresses

Temperature stresses are developed in cement concrete pavement due to variation in slab temperature. The variation in temperature across the depth of the slab is caused by daily variation whereas an overall increase or decrease in slab temperature is caused by seasonal variation in temperature.

During the day, the top of the pavement slab gets heated under the sun light when the bottom of the slab still remains relatively colder. The maximum difference in I' inpcrature between the top and bottom of the pavement slab may occur at some period after the mid-noon. This causes

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the slab to warp or bend, as the warping is resisted by the n i 1 weight of the slab, warping stresses are developed late in the evening, the bottom of the slab gets heated up due to heat transfer from the top and as the atmospheric the temperature falls, the top of the slab becomes colder resulting in warping of the slab in the opposite direction and there is a reversal in warping stresses at the different regions of ii slab. Thus the daily variation in temperature causes warping stresses in reverse directions at the corner, edge and interior regions of the slab.

3. THEORETICAL ANALYSIS, SOIL INVESTIGATION AND DATA COLLECTION

3.1 Sub Grades:

Sub Grade Location:

Location Beside to Ravulapalem -Amalapuram road a place called modekuru, East Godavari District in India.

Sub Grade 2 Location:

Location Beside to Kakinada - Kotipalli road a place in nadakudhuru, East Godavari District in India.

Sub Grade 3 Location:

Location Beside to Kakinada - Peddapuram road a place in rayabhupatnam road, East Godavari District in India.

Bagasse ash used in this study is taken from Sugar Factory near **samalkot, East Godavari District**. The Bagasse ash was collected from the boiler area. The Sugar Cane Bagasse Ash (SCBA) was collected from **samalkot.**

Fig 3.1: Bagasse

Fig 3.2: Bagasse Ash

3.2 Traffic Analysis

The ultimate aim of traffic analysis for the pavement design is to determine the magnitudes of wheel loads and the number of times each of these loads will be applied on the pavement during the design life. For highway pavements the computation of design traffic loadings involves the following steps:

1. Estimation of expected initial year traffic.
2. Estimation of expected annual traffic growth rate
3. Estimation of traffic stream composition
4. Computation of traffic loads
5. Estimation of directional split of design traffic loads
6. Estimation of design lane traffic loads

To design highway pavement, it is necessary to predict the number of repetitions of each axial load group during the design period. Information on initial traffic can be obtained from field measurements. The initial daily traffic in two directions over all traffic lanes and must be multiplied by the directional and lane distribution factors to obtain the initial traffic on the design lane.

Traffic data collection

A 24-hour traffic survey has been conducted at Thurangi (Nearer to Penuguduhuru) on 17.09.2016 details of the traffic survey have been presented in the following table.

Table 3.1 Details of traffic survey

S.No	Vehicle Type	Total Number of vehicles per day (in both directions)
1	Truck: 2-AXLE 4- TYPE	1264
2	2-AXLE 6-TYPE	792
3	3-AXLE OR MORE	1264

3.3 Design of Pavement

The crust of the proposed road is designed as per codal provision IRC: 58-2011 for rigid pavement. The required data for designing the pavement is collected as per the standard procedure. Sub grade soil samples were collected in different reaches of the road and the required tests such as Proctor Density test and CBR Test were conducted.

Design of Rigid Pavement (Using IRC-58-2011):

Step1: Design Parameters (Using IRC-58-2011 CBR-7%

Design wheel load, P = 5100Kg

Present day traffic intensity, p = 3320 CV/day

Tyre pressure in most of CVs: 0.7 to 1.0 Mpa≅ 0.8 Mpa

Radius of loaded area, a =15 cm

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Traffic growth rate, r = 7.5%

Design life, n = 30 years

Flexural strength of concrete, F = 45 Kg/cm^2 (min)

Modulus of elasticity of concrete E = 3 x $10^5 kg/cm^2$

Poisson's ratio, μ = 0.15

Coefficient of thermal expansion e = 10 x 10^{-6} per ^0C

Modulus of subgrade reaction, k = 4.8 Kg/cm^2

(Since for minimum CBR value of 7%, k = 4.8kg/ cm^2 but for DLC layer 150mm, effective k = 27.7kg/ cm^2

Location of pavement: Kakinada, Andhra Pradesh

Step 2: (Trail-1)

Assume tentative thickness of pavement as h = 18 cm

Step3: Joint spacing and lane width

Transverse joint = 4.5 m

Lane width = 3.5 m

Step4: Ascertain the temperature stresses at edge region,

$$-Ote = \frac{EXeXt}{2}[Cx] or\ [Cy]$$

$$Cx = \frac{lx}{l}\ Cy = \frac{ly}{l}$$

$$l = \left[\frac{EXh^3}{12XKX(1-\mu^2}\right]^{\frac{1}{4}}$$

$$= \left[\frac{3X10^5X18^3}{12X27.7X(1-0.15^2)}\right]^{\frac{1}{4}}$$

$$= 52.13cm$$

$$\frac{l_x}{l} - \frac{450}{52.13} - 8.63$$

$$\frac{l_y}{l} - \frac{350}{52.13} - 6.71$$

$$Values\ of\ coefficient\quad 'C'$$

$$Cx = 1.078$$

$$Cy = 0.98$$

$$Greater\ value\ to\ be\ taken$$

$$\sigma_{te} = \frac{3x10^5x10x10^{-6}x17}{2}x1.078$$

$$= 27.\frac{48kg}{cm^2}$$

Step5: Calculate residual available strength in CC slab

$$F_r = F - \sigma_{te}$$

$$= 45 - 27.48$$

$$= 17.\frac{52kg}{cm^2}$$

Step6: Calculate load stress at edge region

$$\sigma_e = \frac{0.572Xp}{h^2}\left[4xlog\left(\frac{l}{b}\right) + 0.359\right]$$

$$where$$

$$b = \sqrt{h^2 + 1.6a^2} - 0.675h$$

$$= \sqrt{20^2 + 1.6X15^2} - 0.675X20$$

$$= 14.068cm$$

$$\sigma_e = \frac{0.572X5100}{20^2}\left[4xlog\left(\frac{52.13}{14.068}\right) + 0.359\right]$$

$$= 19.\frac{18kg}{cm^2}$$

$$factor\ of\ safety = \frac{F_r}{\sigma_e}$$

$$factor\ of\ safety = \frac{F_r}{\sigma_e}$$

$$= 16.06 = 1.04\ \cong 1$$

Which is safe and acceptable value provide a tentative design thickness of 18cm

Step7

$$\sigma_e = \frac{3XP}{h^2}\left[1 - \left(\frac{a\sqrt{2}}{l}\right)^{1.2}\right]$$

$$= \frac{3x5100}{23^2}\left[1 - \left(\frac{15x\sqrt{2}}{57.90}\right)^{1.2}\right]$$

$$= 20.\frac{24kg}{cm^2}$$

$$\sigma_{tc} = \frac{Eet}{3(1-\mu)}\sqrt{\left(\frac{a}{l}\right)}$$

$$\sigma_{tc}\ \frac{3x10^5x10x10^{-6}x18.20}{3(1-0.15)}\sqrt{\left(\frac{15}{57.90}\right)}$$

$$= 10.\frac{87kg}{cm^2}$$

$$\sigma_c + \sigma_{tc} = 20.24 + 10.87$$

$$-31.\frac{11kg}{cm^2}$$

$$< \frac{40kg}{cm^2}$$

Hence the design is life

Step8:

A=p (1+r) $^{n+30}$

= 3320(1+0.075/100)33

=3403CV/day

No Adjustment in design thickness of CC Pavement.

The thickness of the pavement is 180mm.

3.4 Estimation and Rate analysis

Total cost per 1 KM Length of Pavement:

The following table shows the quantity of materials required, their unit cost total cost of pavement construction for 1 KM length of the two-lane dual carriageway rigid pavement:

Table 3.2 Estimation of cost for rigid pavement Gravel sub grade for CBR-10%

S.	Description	Unit	Length	Breadth	Thickness	Qty	Rate	Amount
1	Subgrade compaction	Cum	1000	7.50	0.50	3750	100	375000
2	Granular sub base	Cum	1000	7.50	0.15	1125	1150	1293750
3	Unreinforced cement concrete 1:1:2	Cum	1000	7.50	0.165	1237.5	3500	4331250
							TOTAL AMOUNT	**6000000**

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The following table shows a comparison of the total cost of construction of 1 KM length of a two-lane (7.5 m wide) dual carriageway rigid pavement on sub grade.

Table 3.3 Comparison of Total cost of construction of rigid pavements on different sub grades.

S.No	Type of Sub Grade	Cost (Rs)
1	Black Cotton soil Sub grade	7706250.00
2	Sandy soil sub grade	6393750.00
3	Gravel Sub grade	6000000.00

3.5 Improving the properties of sub grade

Now from the above experimental investigation , we came to know that pavement on the clayey sub grades results in expensive in pavement construction. To over come this improving the properties of subgrade by Bagase ash (A natural available Material)

Bagasse is a solid waste product associated with sugar mills. Previously, bagasse was burned as means of solid waste disposal. However, as the cost of fuel oil, natural gas, and electricity have increased, the definition of bagasse has changed from refuse to a fuel. Currently, most bagasse is burned as a fuel, not as the incineration of refuse. The bagasse residue is returned as fuel for generating steam for both facilities.

Table 3.4 Properties of Bagase ash

S.no	Description of roperty	Percentage (%)
1	Colour	Black
2	Specific Gravity	2.45
3	Silica (sio_2)	64.38
4	Mangnesium (MgO)	0.85
5	Calcium(CaO)	10.26
6	Iron(Fe_2O)	4.56
7	Sodium(Na_2O)	1.05
8	Potassium(K_2O)	3.57
9	Alumina(Al_2O_3)	11.67

Both treated and untreated samples were prepared by compacting different mixes to the maximum dry density of the soil. The initial moisture content for these samples was maintained at optimum moisture content of the untreated soil. The amount of chemical to be added to the amount of water was arrived at based on the optimum moisture content of the natural soil and the chemical solution was prepared. This solution was added to the dry soil and the mixture was thoroughly mixed.

4. RESULT:

In this chapter the results and observations of the tests conducted are presented, analyzed and discussed.

The results for different subgrades are given below

Table 4.1 sub grade -1 black cotton soil

S no	Description	Trail - 1	Trail -2	Trail – 3
1	Weight of empty mould	3805	3805	3805
2	Weight of mould + compacted soil	5900	5939	5895
3	Volume of mould(d=10cm, h= 12cm)	1000	1000	1000
4	Water content			
	W1	27	28	29
	W2	65	65	64
	W3	59	59	58
	W= (W2-23/W3-W1)X100	18.75	19.35	20.68
5	Wet density(W/V)	2.095	2.128	2.08
6	Dry density $\Upsilon_d = \Upsilon/1+w$	1.764	1.81	1.732

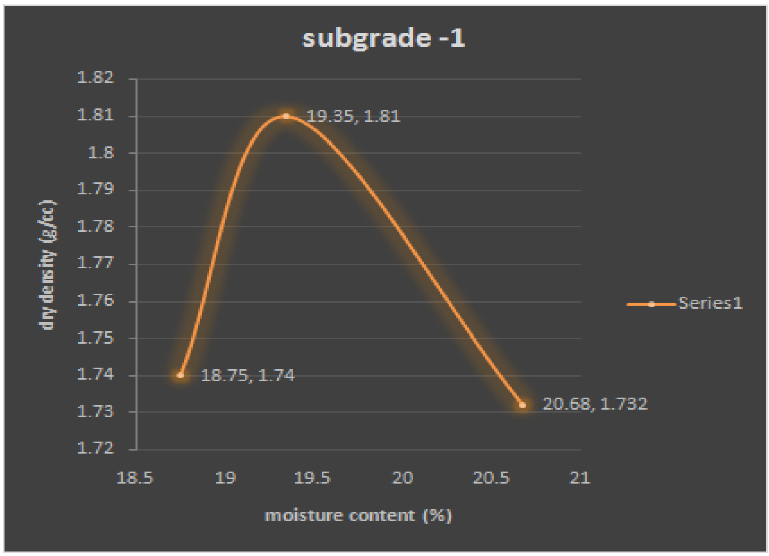

Fig: 4.1 Shows the compaction test results on sub grade soil (clay)

Table 4.2 sub grade -2 sandy soil

S no	Description	Trail – 1	Trail -2	Trail – 3
1	Weight of empty mould	3805	3805	3805
2	Weight of mould + compacted soil	5835	5835	5805
3	Volume of mould(d=10cm, h= 12cm)	1000	1000	1000
4	Water content			
	W1	29	29	30
	W2	70	71	91
	W3	63	63	79
	W= (W2-23/W3-W1)X100	20.5	23.53	24
5	Wet density(W/V)	2.03	2.03	2.0
6	Dry density $\Upsilon_d = \Upsilon/1+w$	1.62	1.64	1.61

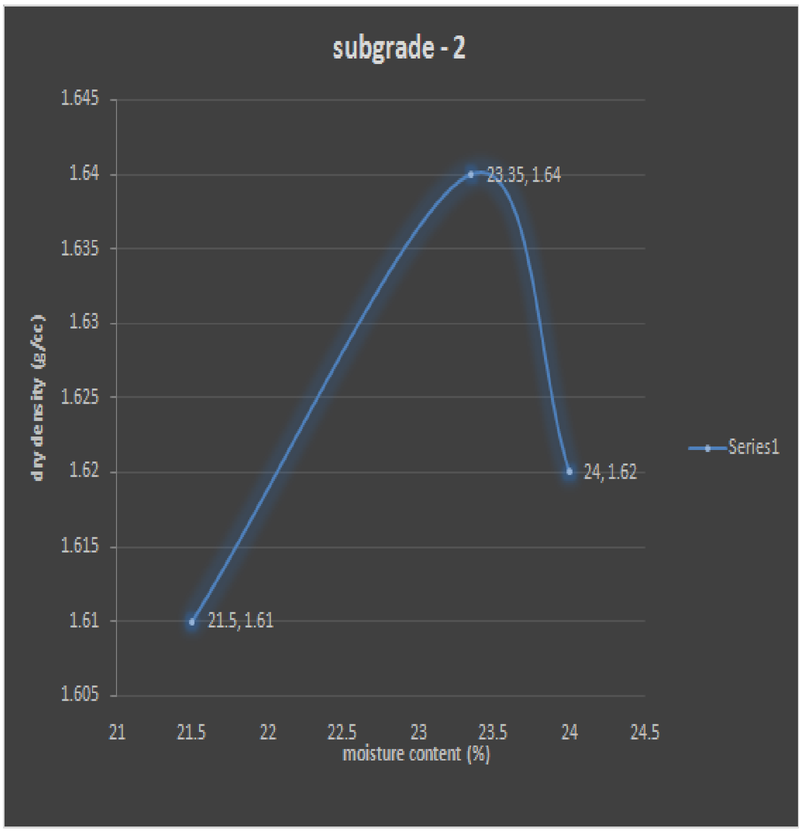

Fig 4.2 S the compaction test results on sub grade soil (sandy soil)

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Table 4.3 sub grade -3 gravel

S no	Description	Trail – 1	Trail -2	Trail – 3
1	Weight of empty mould	3805	3805	3805
2	Weight of mould + compacted soil	5775	5810	5800
3	Volume of mould(d=10cm, h= 12cm)	1000	1000	1000
4	Water content			
	W1	25	26.08	20
	W2	68	82	88
	W3	63	63	79
	W= (W2-23/W3-W1)X100	20.5	23.53	24
5	Wet density(W/V)	2.08	2.08	2.0
6	Dry density $\Upsilon_d = \Upsilon/1+w$	1.69	1.64	1.61

Fig: 4.3 shows the compaction test results on sub grade gravel

5. CONCLUSION

After analyzing the design of rigid pavements the following are the important conclusions emphasized. From the above Investigation of rural village rigid pavement we have observed that

1. We Have observed that economical analysis in laying of road which is effected by thickness of pavement from sub grade strength.
2. For silty and clayey soils which is having more cohesive in nature but they cant with stand to the traffic loads
3. For Sandy soils which moderately they can bear the traffic loads and their CBR values results in good.
4. For gravel soils they are good at the strength, shear and to bear and transfer the loads and due to this we can reduce the pavement thickness which can lead to economical and safe pavement in village roads.

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