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Planning and Designing of Green Road for Single Lane

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Abstract - *As per census of 2011, rural roads accounts of 70% of Indian total population. Rural account of 60% of the total road length in India. It covers 24,50,559 km over the country. In that more 7,81,900 km are single lane road. So we are planned to design a green road for single lane in an economical way. We use prefabricated plastic Blocks for road construction by utilizing waste plastic material. The main objective of our project is rural road development and make the India as developed country. We prepare road only for the movement of tyre. Other spaces kept empty for futuristic basis. The design of the single lane road is completely different from the conventional single lane road. These roads consist of fluorescent marking. The modeling of this single lane road is done using AUTO CADD Architecture.*

***Key Words*: PLASTIC ROADS, SINGLE LANE, FLUROSCENT, MARKING**

1. INTRODUCTION

Road transport is faster, more convenient and more flexible. It is particularly good for short-distance travel for the movement of goods. Door-to-door collection and delivery is possible in the case of road transport. Rural connectivity turns a censorious composing in the sociology-saving elaboration of rural nation by afford accessibility to creature comforts like education, health, supplies, etc. The design of green road for single lane is mainly for the rural road development and it make our country to step up as a developed countryThe need for an adequate road network for the development of the country was soon understood in India.We use prefabricated plastic blocks for the road constructionPlastic waste represents a great threat to the environment. Plastic wastes consisting of mainly polyolefin from items such as carry bags, cups, thermocoles and packaging films pose a major problem for their disposal. Those waste are recycled and reused for the manufacturing of prefabricated plastic material. Consumer plastic waste represents a serious problem that is damaging the environment and many species on the planet. The innovative and unique concept of building roads made of plastic contributes to solving the overwhelming problem of plastic pollution.

If roads in smart cities should have an increasingly longer lifespan, shorter construction and maintenance time, be more sustainable, achieve ever-higher noise reductions, and also be financially competitive then roads made of plastic is what ticks all the boxes and what inspired the idea of the Plastic Road initiative.

1.1 Objective

The objective of our projects are

- To reduce the cost of road construction and development.
- To increase the life time of road.
- To introduce new lane idea to the world.
- Reducing the time of whole road construction work by utilizing prefabricated plastic member.
- To provide sustainable environment to the surrounding by utilizing waste plastic material.
- To prevent road rage**.**

2. LITERATURE REVIEW

Asif Faiz, Aysha Faiz, Wei Wang, and Christopher Bennett,et.al., (2012) studied the categorized roads that girdle the globe, closely all unsealed roads and an estimated 85% of paved roads are low volume roads (LVR) with ADTs of less than 1000 vehicles / day. Rural LVRs have a accurate role in domestic advancement and scantiness conquest, and a conspicuous activity in conjuncture preparation, mishap relief, and rural job nature. This paper examines the intent of sustainability and its more practical subset—livability and terminate that the rural roads and how the relevance application of context-sensitive solutions could help achieved.

Jhonsan k. Appiah, Victo N. Berko-Boateng and Trinity A. Tagbor.,et.al., (2017) investigated that this paper forms part of research to solve two main problems in Ghana: firstly, the management of municipal solid waste (MSW), particularly with regards to used plastics which have overwhelmed major cities and towns; secondly, the formation of potholes on roads due to excessive traffic and axle weight

Pradeep Kumar Samanta., et.al., (2015) studied the methodology to improved connectivity and accessibility to rural areas will provide a vital impetus to the country's economic growth.

Nisarga K. and Vinoda Amate.,et.al, (2018) studied AutoCAD is a software application used by civil engineers and professionals to plan and design the projects. This paper lavishes on a total geometric design of rural road using AutoCAD software. AutoCAD associate design and production drafting, greatly reducing the time it takes to implement design changes and assess multiple sets of circumstances. The main aim of this project is to exemplify the proposed road alignment in a comfortable way using AutoCAD.

Yagar and Aerde., et, al., (1983) investigated that speed changes exponentially with the change in lane width. For a practical range of lane width from 3.3 to 3.8 m, it was found that the operating speed of a given location decreases by approximately 5.7 km/h for each meter reduction in the width.

3. METHODOLOGY

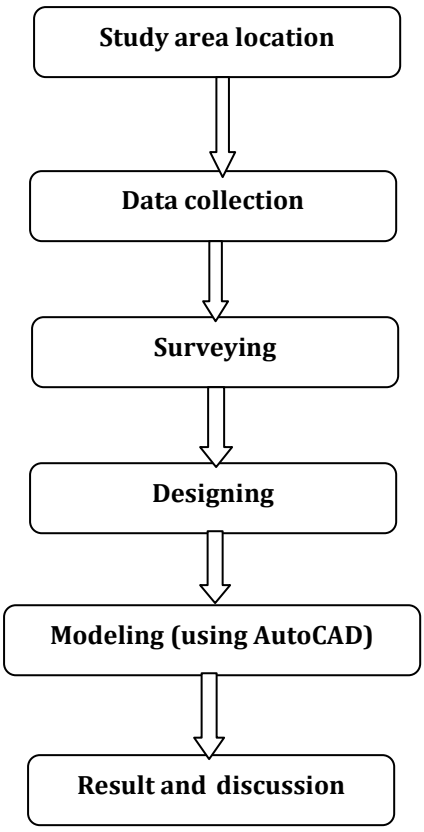


Fig: 3.1FLOW CHART

4. RURAL ROAD DEVELOPMENT

The necessity of a proper road network for the socio-economic development of rural India and consequently the whole country as understood quite early in India. To make the as developed country. The rural road network increases the commodities in India, thus increase the economic status of India. India has rural road length of about 27 lakhs km which is about 80 % of the total road network. The useful condition of this is crucial for rural / agricultural growth and offers means of access for millions of rural people to social structures, viz. medical, education as also to market. Lack of public investment in infrastructure influences the viability and effectiveness of private investment in negative manner. This green road provide solution for all the problem and it increase the rural road development. It steps up our country to become a developed country.

5. STUDY AREA LOCATION DATA COLLLECTION

Samiyam is a small village it comes under "Group Grama Panchayat" Thaikkal of district Nagai, Tamil Nadu. Nearest railway station from samiyam is kollidam. Distance of kollidam from samiyam, is 5km. The transportation of samiyam is risky, hard rock patches due to the improper road construction. That region is coming under residential area. Samiyam is a village in thaikkal, District-Nagai, State-Tamil Nadu. Popular language in Samiyam is Tamil. The income source of that village is crop cultivation. The crop production is rice, sugarcane, cotton, vegetables. Samiyam is a medium village which is connected with other villages such as sarasavilagam, kumilankadu, kizhavellam, mellavelemetc and all this village required this road for transportation facility.

Fig 5.1 satellite view of selected area

5.1 DATA COLLLECTION

Collecting the data and quantifying the information from a survey in the field or the study area in a systematic path in order to get proper and scrupulous picture of an area of interest, also to analyze and evaluate the outcomes and retort to the research problems.

5.1.1 TRAFFIC VOLUME COUNT

To decide the number of lanes and roadway width, pavement design economic analysis traffic surveys are conducted. The main objective of the traffic survey is to

determine the composition of the vehicle in the traffic flow that helps to design the geometric characteristics of the road

For estimating design traffic the cumulative number of standard axles carried by the pavement during the design life is considered. This required the following information:

1. Initial traffic in terms of CVPD
2. Traffic growth rate
3. Design life in number of years
4. Vehicle damage factor (VDF)
5. Distribution of commercial traffic

6. SURVEYING

Surveys are carried out before starting the project such as Map study, Reconnaissance survey, Preliminary survey, Final location. Map study is to identify the rough image of the field. Reconnaissance survey is to visit the site and scrutinize the main features of the area but not in detail. Data derived from reconnaissance investigations is typically used to plan and schedule detailed investigations and investigations, and some possible alignments can be chosen for any alteration or modification. In preliminary surveys, survey specialists and party performs field surveying duties using total station and collects all data which are necessary like latitude, longitude, elevation and other required measurements and data in the alternate alignment proposed. At last, final locating the center line of the ground.

File Edit Format View Help

ST.P	EAST	NORTH	RL
1	1000	1000	100
2	1000.02	1000.20	100.5
3	1000.01	1000.4	100.05
4	1000.03	1000.02	100.01
5	1000.05	1000.02	100.01
6	1000.01	1000.3	100.3
7	999.9	1000.2	100.2
8	1000	1000.21	100.5
9	1000.25	1000.22	100.51
10	1000.50	1000.20	100.5
11	999.6	1000.40	100.10
12	999.85	1000.41	100.11
13	1000.10	1000.42	100.12
14	1000.35	1000.40	100.10
15	1000.60	1000.40	100.10
16	999.5	1000.6	100.06
17	999.75	1000.63	100.04
18	1000	1000.61	100.24
19	1000.25	1000.64	100.26
20	1000.5	1000.60	100.20
21	1000	1001.3	101.03
22	1000.35	1001.34	101.3
23	1000.70	1000.40	100.04
24	1000.5	1000	100
25	1000.5	1000.2	100.02
26	1000.53	1000.40	100.4

7. MATERIAL USED

7.1 SUB BASE COURSE

Sub-base materials comprise natural sand, moorum, gravel, laterite, kankar, brick metal, crushed stone, crushed slag, crushed concrete or combinations thereof meeting the prescribed grading and physical requirements. When the sub-base material consists of combination of materials, mixing shall be done mechanically either using a suitable mixer or adopting mix-in-place method.

7.2 BASE COURSE

Unbound granular bases will be adopted including traditional water-related macadamia (WBM), wet macadam (WMM) or other equivalent granular construction compliant with the IRC / MORT & H specifications. The materials to be used in the base course must meet with the physical and qualification requirements prescribed in the IRC / MORT & H specifications. The minimum recommended thickness of the granular base is 225 mm for traffic up to 2 msa and 250 mm for traffic over 2 msa.

7.3 SURFACE COURSE

As new innovations go plastic road actually has numerous advantages when compared to conventional roads, both in terms of construction and maintenance. “The idea for the concept was conceived by Anne Koudstaal and Simon Jorritsma of KWS infra in Netherland, who claim that plastic road, which consists of 100% recycled material, is the ideal sustainable alternative to conventional road structures and opens the door for a number of ne innovation such as power generation, quitter road surfaces, heated roads and modular construction”. While asphalt is a great product to build roads, and more demands concerning noise reduction, water permeability, and flatness. These questions and conditions were the inspiration which have led to the idea of the plastic road. The prefabricated plastic Road concept has been designed in line with initiatives such as Cradle to Cradle and The Ocean Cleanup: the initiative to free the seas of ‘plastic soup’. Recycled plastic is made into prefabricated road parts that can be installed in one piece that would last 50 years and be recyclable into a new plastic Road module. The prefabricated production and the lightweight design also make the construction of a plastic Road into a much simpler task. Roads can be built in weeks instead of months. It is also much easier to control the quality of the road (stiffness, water drainage etc.,). The plan is to place the plastic Road directly on a surface of sand, which removes the need for a foundation, as well as the current heavy construction that no longer needs to be produced. This means less transport to construction site, but also less transport to from the location here resources are extracted to the production plant.

7.4 FLORESCENT MARKING

. This florescent marking provides more visibility in night time, thus reduce the usage of high intensity bulb on vehicle. We use polyurethane based florescent coating material on our green road.

8. DESIGN OF GREEN ROAD

8.1 DESIGN OF SLAB THICKNESS

Flexural strength of plastic = 200kg/cm^2

Effective Modulus of subgrade

Reaction of the DLC sub-base = 8 kg/cm^2

Elastic modulus of plastic = 0.27*10^5 kg/cm^2

Poisson's ration = 0.35

Coefficient of thermal

Coefficient of plastic = 30.4*10^-6/•c

Tyre pressure = 8kg/cm^2

Rate of traffic increase = 0.075

Spacing of contraction joints= 5 m

Width of slab = 1.9m

The axle lead spectrum obtained from axle lead survey is

Given the following:

Present traffic =120 cvpd

Design life = 40 yrs, r =0.075

Cumulative repetition in 20 yrs.

=120*365[((1.075)^{40}-1)/0.075)]

= 9,953,836 commercial vehicles

Design traffic = 25 percent of the total repetitions of commercial Vehicle=2,488,459

CHECK FOR TEMPERATURE STRESSES

Edge warping stress = 13.05 kg/cm^2

L= 450 cm

B= 190 cm

I= 103.5 (see below under corner stress)

L/I= 10.57

C=1.06

The temperature differential was taken as 30•c for the Kollidam region. Total of temperature warping stress and the highest axle load stress =30+13.05 = 43.05 kg/cm^2 which is less than 200 kg/cm^2, the flexural strength. So the pavement thickness of 25 cm is safe under the combined action of heel load and temperature.

CHECK FOR CORNER STRESSES

Corner stress is not critical in a dowelled pavement. The corner stress can be calculated value from the following formula.

Corner stress

$$= \frac{3p}{h^2}\left(1 - \frac{a\sqrt{2}}{I}\right)^{1.2}$$

The 98 percentile axle load is 16 tones. The wheel load therefore, is 8 tones.

Radius of relative stiffness, I = $\sqrt[4]{\frac{Eh^{\wedge}2}{12(1-\mu^2)k}}$

E = 3*10^5 kg/cm^2

h = 33 cm

μ = 0.15

k = 8 kg/cm^3

Tyre pressure = 8 kg/cm^2

Therefore I = $\sqrt[4]{\frac{0.27*10^5*25^3}{12(1-0.35^2)8}}$

= 47.30 cm

a = radius of area of contact of wheel.

Considering a single axle dual wheel,

$$a = [0.8521*\frac{p}{q*\pi} + \frac{s}{\pi}(\frac{p}{0.5227*q})^{\wedge}0.5]^{\wedge}0.5$$

where

p = Load

s = C/c distance between two tyres = 31cm

q = tyre pressure

$$= \left[0.8521 * \frac{8000}{8*\pi} + \frac{31}{\pi}\left(\frac{8000}{0.5227} * \frac{1}{8}\right)^{0.5}\right]^{0.5}$$

= 26.51cm

Therefore corner stress = $\frac{3*8000}{25^2}\left[1-\left(\frac{26.51*\sqrt{2}}{47.30}\right)^{1.2}\right]$

$=\frac{3*8000}{25^2}[1-0.75]$= 9.43kg/cm²

The corner stress is less than the flexural strength of the plastic, i.e., 200kg/cm² and the pavement thickness of 25 cm assumed is safe.

8.3DESIGN OF TIE BARS

DESIGN PARAMETERS

Slab thickness = 25cm

Lane width, b = 1.9m

Coefficient of friction, f = 1.5

Density of plastic kg/m² = 1000

Allowable tensile stress in plain bars

Kg/cm² (As per IRC:21-2000) = 1250

Allowable tensile stress in deformed bars,

Kg/cm² (As per IRC:21-2000) = 2000

Allowable bond stress for plain tie bars,

Kg/cm² = 17.5

Allowable bond stress for deformed

tie bars, kg/cm² = 24.6

diameter of tie bar, d = 12mm

SPACING AND LENGTH OF THE PLAIN BAR

Area of steel bar per metre width of joint to resist the frictional force at slab bottom

$A=\frac{bfw}{S}$

= 2.57cm²/m

Assuming a diameter of tie bar of 12mm, the cross sectional area

$A=\frac{1.2^2*\pi}{4}$

= 1. 13sq.cm

Perimeter of tie bar, P = πd

= 3.77cm

Spacing of tie bars = A/A_s

=100*1.13/0.57

= 45.2 cm

Provide at a spacing of 45cm c/c

Length of tie bar, L = $\frac{2*s*A}{B*P}$

$=\frac{2*1250*1.13}{17.5*3.77}$

= 42.82cm

Increase length by 10cm for loss of bond due to painting and another 5 cm for tolerance in placement. Therefore, the length is

42.82+10+5 =57.82cm, say 58cm

SPACING AND LENGTH OF THE DEFORMED TIE BAR

Area of steel bar per metre width of joint to resist the frictional force at slab bottom

$A_s=\frac{bfw}{S}$

$=\frac{1.9*1.5*0.33*1000}{2000}$

= 1.079cm²/m

Spacing of tie bars = A/A_s

= 100*1.13/1.079

= 105cm

Provide at a spacing of 54cm c/c

Length of tie bar, L = $\frac{2*s*A}{B*P}$

$=\frac{2*200*1.13}{24.6*3.77}$

= 48.74cm

Increase length by 10cm for loss of bond due to painting and another 5cm for tolerance in placement. Therefore, the length is

48.74+10+5 = 63.74cm, say 64cm

9. OUTPUT OF THE DESIGN

9.1GENERAL

Drawings are the results obtained for the proposed road and simultaneously tabular column are generated automatically with details. We will get the formation level, cross sections details along with information of depth of foundation of the entire project stretch. The various cross section details of green roads are shown in figure.

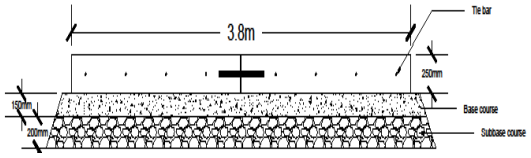


Fig 9.1 Cross section of full green road

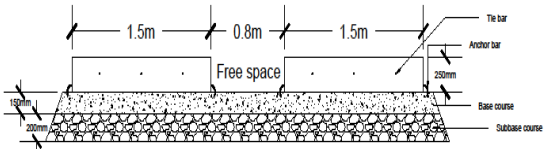
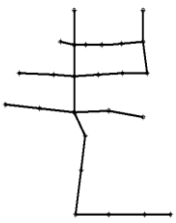
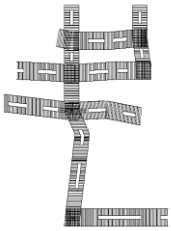


Fig 9.2 Cross section of partial green road

The center line plan of the green road is drawn by using AutoCAD 3d civil with the measurement taken by using total station. The points on the center line plan indicates the various station point.



centre line plan of green road



Top view of green road

9.2 ECONOMIC ANALYSIS OF GREEN ROAD

Cost analysis assuming cost of plastic waste (collection, segregation and processing) = Rs.5 per kg. cost of bitumen per drum (200 kg) =10,000 cost of bitumen per kg =Rs50 then cost of bitumen per ton =Rs50,000. Generally, roads in India are constructed in basic width of 3.8m. consider 1Km length road. To lay 1Km of road 10 tons of bitumen is required, cost of bitumen required per Km= Rs 5,00, 000.The construction cost of green road is 4times lesser than conventional road. To manufacture 1 block of prefabricated plastic, we have to spend Rs 150(including raw material, processing, transportation). The green road consists of 800 blocks per Km. The total cost to manufacture green road for 1Km =Rs 1,25,000. The total savings by providing green road=5,00,000- 1,25,000=3,75,000 per Km. The total cost we approximately estimate to construct green road in our locality around Rs6.5 lakhs. It is hoped that in near future we will have strong, durable and eco-friendly roads which will relive the earth from all type of plastic-waste.

9.3 FUTURISTIC SCOPE

The open space in the center of green road can be utilized for various purposes in future. We suggested some futuristic scope of the green roads are discussed as follows.

9.3.1 SOLAR PANEL INSTALLATION

The open space in the center of green road can be used to install solar panel. The rate of output for the $1m^2$ area solar panel is 150-200W. For every 10m there will be a full road. The total area obtained from one open space is 1600W. The total open space of that area produce more than 3200KW. Those current is used for various purposes.

9.3.2 WIRELESS CHARGING BATTERY INSTALLATION

These wireless charging electric pads are used to charge the electric vehicles in future. These things are completely used for future. These things are used to save the time of charging.

9.3.3 VEGETATION GROWTH

The open space at the center of the road is used to cultivate the greens and some other minor crop. Thus increase 0_2 level by reducing co_2 level in the atmosphere.

Fig 9.4 Futuristic scope

Fig 9.5 Realistic view of green road for single lane

10. CONCLUSION

The use of the innovative technology in road alignment and construction not only strengthened the road construction but also increased the road life as well as will help to improve the environment and also creating a source of income. The planning and designing of the green road is done for the selected area. This new form of road alignment completely reduces the road rage and avoid maximum accident. The pre-fabricated plastic blocks increase the portability of road.

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