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Design & Construction of B.I.T. Driveway (As per rural specification)

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Abstract
The motive of undertaking this project of "Design & Construction of B.I.T. Driveway (As per rural specification)" is to study and evaluate the performance in real design and working conditions of the rural road flexible pavement with IRC:37-2001 and IRC:SP:20-2002. In this paper, the work is carried out to measure the traffic volume on the top surface of the B.I.T. Driveway. Rural connectivity is taken as one of the major component in increasing the agricultural output and earning capacity of the rural population. There is a marked improvement in quality of life by way of better educational facilities, improved health services, improved attendance by the school teachers as well as students.

I. Introduction

Rural roads are the last link of the transport network, however; they often form the most important connection in terms of providing access for the rural population. The permanent or seasonal absence of road access is a restricting factor in terms of providing rural communities with essential services such as education, primary health care, water supply, local markets as well as business opportunities. The availability of such services and opportunities are difficult to sustain without a good quality and well-maintained rural road network, which provides regular and efficient transport access throughout the year.

Rural roads are the backbone of the transportation system in rural India. They are critically important to residents, recreationists and resource managers. Rural roads are also associated with environmental impacts on water quality, fisheries and wildlife.

Good quality rural roads needs a particular skill requiring proper planning, experienced supervision, good workmanship and the selection of the correct design through technical planning, work organization, works implementation methods and procedures, site administration to reporting and control. The topics cover the skills required from technical staff responsible for carrying out rural road construction and rehabilitation works technology and work methods.

Fig 1: Rural Road

II. Project Goal

The goal of this educational project (Design & Construction of B.I.T. Driveway (As per rural specification)) is to provide governmental and non-governmental personnel involved with road management & IRC:37-2001 and IRC:SP:20-2002 with a comprehensive understanding of issues, design considerations and best management practices associated with rural roads in India. Specific objectives are:

- Describe the fundamental principles of rural road design and operations.
- Impact of construction on environment and ecology (EIA).
- Describe practices used to minimize the ecological imbalance.
- Review methods used for road assessment and inventory and prioritizing road construction.

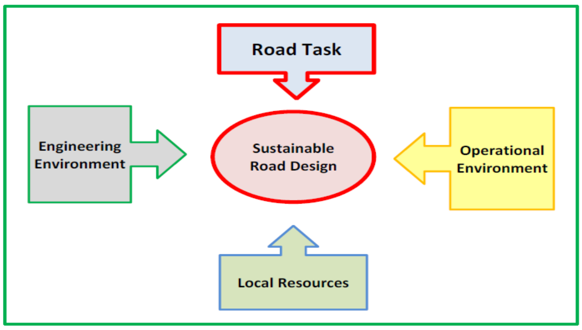


Fig: 2 key feature of a plan

III. Terms and definitions of Road

Alignment: The direction of the centre line of the road.

Back slope: The portion of the side drain from ditch invert to the intersection with the natural terrain.

Carriage way: That portion of the road way intended for movement of the vehicle (excluding the-shoulders)

Camber: The carriageway camber consist of a straight line cross-fall laterally from centre line to the shoulder. In super elevated curves the camber is replaced with a single cross-fall across the entire carriageway

Camber formation: The layer above the sub grade in its final shape, often consisting the excavated soil from the side drains. the camber formation is the layer on which the gravel course is placed.

Centre line: A theoretical line along its longitudinal axis dividing the road equally in two parts**.**

Crown: The highest point of the road, located on the centre line when surface is shaped with a camber

Ditch invert: The cross section profile of the side drain from the side slope to the back slope **Gravel**

course: The top layer of a gravel road. Also referred to as a surface course or gravel bearing course.

Road formation: The surface of the sub grade in its final form after completion of the earth work. **Road**

reserve: The cleared portion of the land where the road and its entire component will be built**.**

Roadway: The area normally used by traffic, consisting of the carriageway and shoulders.

Shoulders: The point at which the side slope of the ditch and carriageway intersect.

Side drain: The drainage channel along the shoulders of the road which collect run-off water from the carriageway and which prevent water from the surrounding terrain from the reaching the road surface

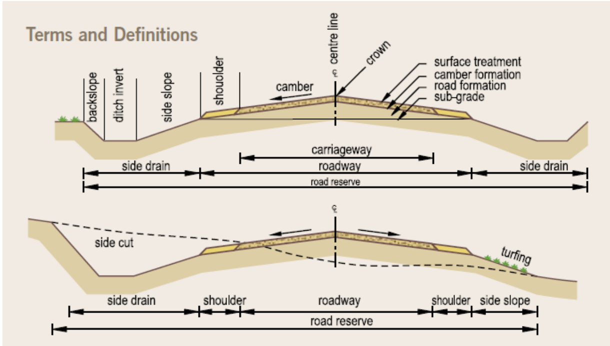


Fig: 3 Terms of Road

IV. Survey

The objective of the *preliminary survey* is to obtain a general idea of the future location and dimensions of the road and to assess how this alignment integrates with the surrounding environment. This relates particularly to the existing terrain as well as the impact of the road on local residents and their economic activities. By considering several alternative alignments, it is possible to arrive at a final solution that to the extent possible takes all these aspects into consideration. The survey methods used at this stage can therefore be implied without prejudicing the level of accuracy desired.

Fig: 4 Initial Survey at site

The *initial survey* is an essential input for the preliminary cost estimates and budget allocations. From the survey, rough quantities of work can be derived, soil conditions observed and productivity norms and costs assumed. This survey also provides an overview of potential social and environmental impacts caused by the new road alignment. The line established by the surveyor is clearly defined and marked properly so that it can be retraced during the detailed design.

Process:-

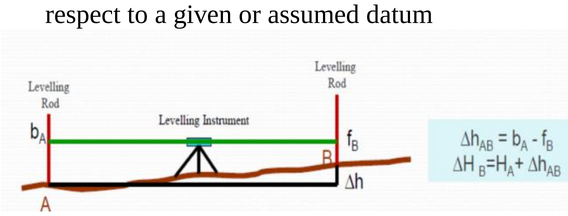
- Visual inspection of proposed road and environment of locality.
- Measurement of proposed site for estimation.
- Descriptions and sizes of marsh areas and other natural obstacles.
- Soil conditions and substrata conditions at proposed road sites.
- Levelling for finding the RL.
- Discrepancies noted in maps or aerial photographs.
- Availability of local materials, equipment, transportation facilities, and labour.
- Photographs or sketches of reference
- Points, control points, structure sites, terrain obstacles, and any unusual conditions.

V. Specifications of the Road

Length & Width of road -360.3m X 3.5m
Cross-slope/camber-2.5(for bituminous surface)
Drainage- Take the advantages of natural drainage
Gradient- 3.3% (1 in 30)

Levelling-: Levelling is a branch of surveying the object of which is:-

- To find the elevation of the given point with respect to a given or assumed datum



- To establish point at given elevation or at different elevation with respect to given or assumed datum. The first operation is required to unable the work to be design while the second operation is required in the setting out of all kind of engineering work. Levelling deals measurement in a vertical plane.

Station	BS	IS	FS	HI	RL	Calculation
1.	1.090			101.090	100	101.0
2.		1.285			99.805	101.090-1.285 = 99.805
3.	1.355		1.55	100.800	99.450	101.090-1.550 = 99.450 99.450+1.355 = 100.800
4.		1.30		|	99.500	100.800-1.30 = 99.500
5.	1.37		1.37	100.800	99.450	100.800-1.37 = 99.430 99.430+1.37 = 100.80
6.		1.28			99.520	100.80-1.28 = 99.520
7.		1.32			99.48	100.80-1.32 = 99.48
8.	.46		1.23	100.030	99.57	100.80-1.23 = 99.57 99.57+.46m = 100.03
9.		0.49			99.54	100.030-.49 = 99.54
10.		0.46			99.57	100.030-.46 = 99.57
11.		0.66			99.37	100.030-.66 = 99.37
12.			.22		99.81	100.030-.22 = 99.81

Table 1 Reading of Dumpy level and staff

Arithmetical Check:-
Total sum of B.S.= Total sum of F.S.
1.090+1.355+1.37+0.54=1.55+1.37+1.23+0.22
4.355=4.37

Error = Sum of FS ~ Sum of BS
=4.371~ 4.275
=0.015m
≈0

VI. Cutting and Filling (Embankment)

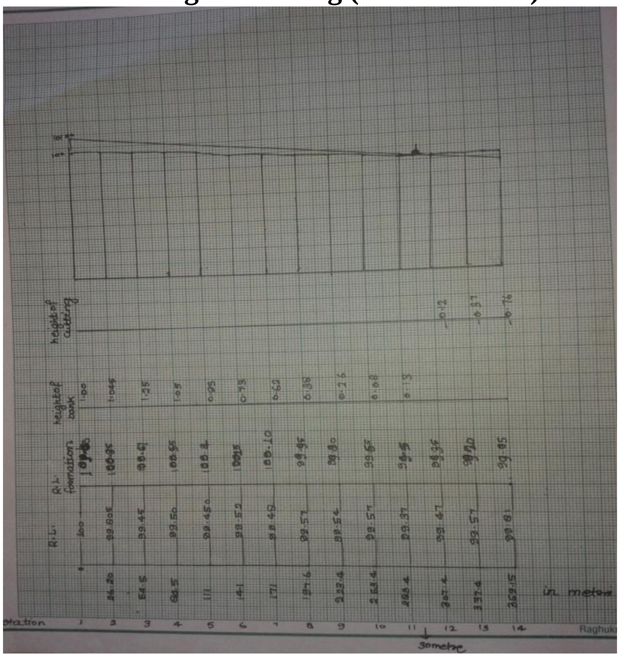


Fig: 5 Cutting and filling Data

There is the miner cutting and filling on Road at the site.

VII. Road Environment

The climatic conditions (moisture and temperature) under which the road will function, as well as the underlying sub-grade conditions, define the environment. The environment must be taken into account in the design of pavement structures. The Engineering Factors within that environment as indicated diagrammatically in Figure.

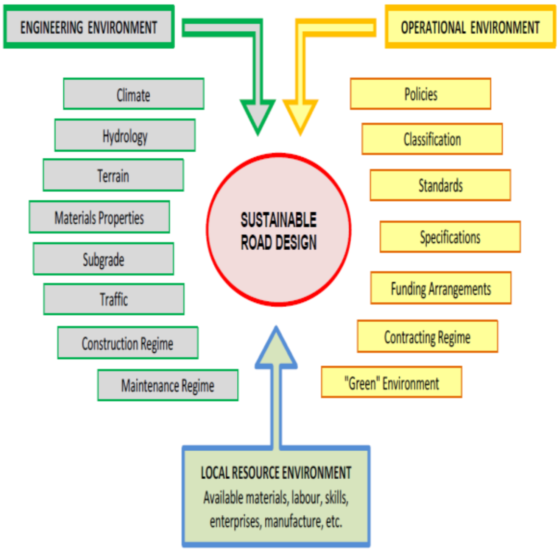


Fig: 6 Road environments

VIII. Design

The structural design of pavements aims to protect the sub grade from traffic loads by providing pavement layers which will achieve a chosen level of service, with maintenance and rehabilitation during the analysis period, as cost effectively as possible. It encompasses factors of time, traffic, pavement materials, sub grade soils, environmental conditions, construction details and economics.

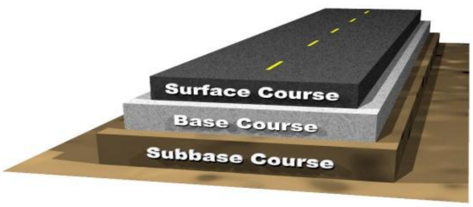


Fig:7 Layer of Flexible pavement

CBR test of sub-grade soil by soil mechanics lab - 10%

1-Design by *IRC-37-2001*

(a)Design traffic

The method considers traffic in terms of the cumulative number of standard axles (8160 kg) to be carried by the pavement during the design life. This requires the following information:

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

Initial traffic in terms of commercial vehicle per day	Terrain: Rolling/Plain	Terrain: Hilly
0-150	1.5	0.5
150-1500	3.5	1.5
More than 1500	4.5	2.5

Table No-2 Indicative VDF value

(b)Design equation

$$N = 365 \times \frac{[(1+r)^n - 1]}{r} \times A \times D \times F$$

Where-

N: The cumulative number of standard axles to be catered for in the design in terms of MSA
A: Initial traffic in the year of completion of construction in terms of number of commercial vehicles per day
D: Lane distribution factor
F: VDF
n: Design life in years
r: Annual growth rate of commercial vehicles (for 7.5% annual growth rate r=0.075)

(c)Numerical Calculation

- Two lane carriage way
- Initial traffic in the year of completion of construction = 300 CVPD (sum of both directions)
- Traffic growth rate = 7.5 %(by IRC-37)
- Design life = 15 years
- Vehicle damage factor based on axle load survey = 2.5 standard axle per commercial vehicle (by page-24)
- Design CBR of sub-grade soil = 10%. (by CBR Testing)
- Distribution factor = 0.75 (by clause-4.2.10)

$$N = 365 \times \frac{[(1+0.075)^{15} - 1] \times 300 \times 0.75 \times 2.5}{0.075}$$

=5.36msa

- Total pavement thickness for CBR 10% and traffic 5.36 msa from IRC:37 2001 chart1 = 475 mm
- Pavement composition can be obtained by interpolation from Pavement Design Catalogue (IRC: 37- 2001).

(a) Bituminous surfacing = 25mm SDBC + 50mm DBM
(b) Road-base = 250 mm Granular base
(c) Sub-base = 150 mm granular material.

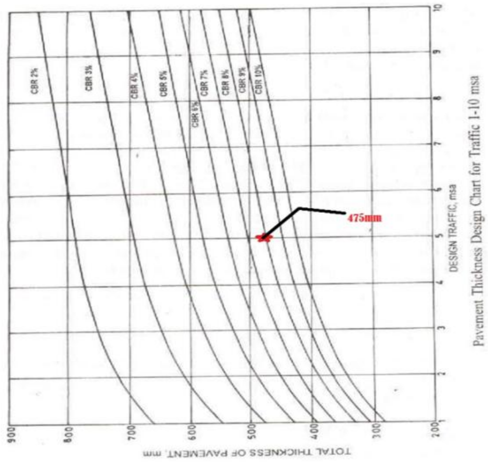


Fig:8 CBR curves for flexible pavement design

PAVEMENT DESIGN CATALOGUE
RECOMMENDED DESIGNS FOR TRAFFIC RANGE 1-10 msa

CBR 9% & 10%					
Cumulative Traffic (msa)	Total Pavement Thickness (mm)	PAVEMENT COMPOSITION			
		Bituminous Surfacing		Granular Base (mm)	Granular Sub-base (mm)
		Wearing Course (mm)	Binder Course (mm)		
1	375	20 PC		225	150
2	425	20 PC	50 BM	225	150
3	450	20 PC	50 BM	250	150
5	475	25 SDBC	50 DBM	250	150
10	540	40 BC	50 DBM	250	200

2-Design of Road by *IRC: SP-20:2002*(Rural Road Flexible Pavement)

Design for 150 to 450 CVPD (D curve in given fig)

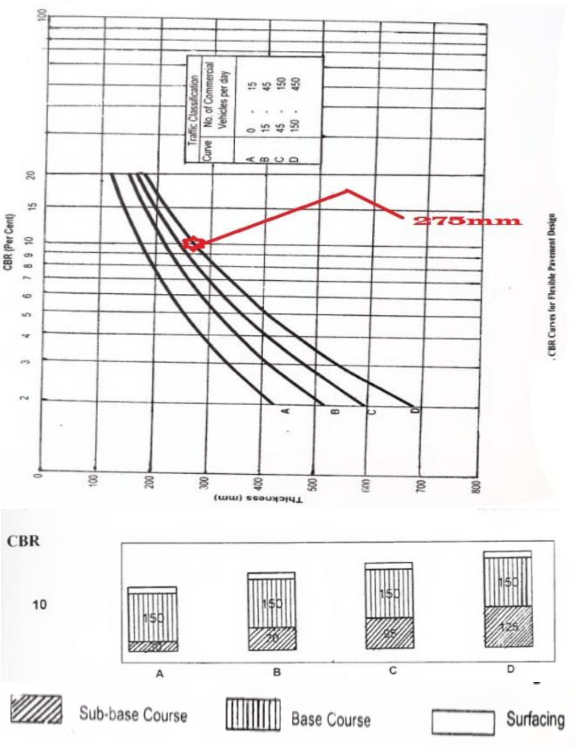


Fig:9 CBR curves for flexible pavement design

Total pavement thickness for CBR 10% and traffic 150 to 450 CVPD from ***IRC: SP-20:2002***chart = 275mm

Road designs IRC: SP-20:2002 is better than IRC-37:2001 for low traffic and rural area road, than design the project (Design & Construction of B.I.T. Driveway (As per rural specification)) on the basis of IRC: SP-20:2002, because see the economical & environmentally condition.

IX. Construction Process

(a)Road Materials - The most important pavement materials are soils, mineral aggregates, bituminous binders, and stabilisers like lime, cement, water etc. Mineral aggregates constitute bulk of total volume of road construction materials used. All roads have to be founded on soil and are required to make optimum use of the locally available materials, if it is to be constructed economically. Materials used in the structural layers of the pavement should be selected based on availability, economy and previous experience.

The most important pavement materials are-
Soils, mineral aggregates, boulder, bituminous binders, stabilisers like lime, Stone chips, Bricks, water etc........

Fig.10 survey of different road materials

(b)Construction process of driveway according to design

(i) Earthwork (cutting and filling)

(ii) Preparation of sub grade could include site clearance, grading ,and compaction process

(iii) preparation of sub-base

- Laying of boulder
- Size of boulder 45-90mm (according to IRC-SP-20-2002)
- Thickness of sub base 150mm (according to design)
- Compaction 95%

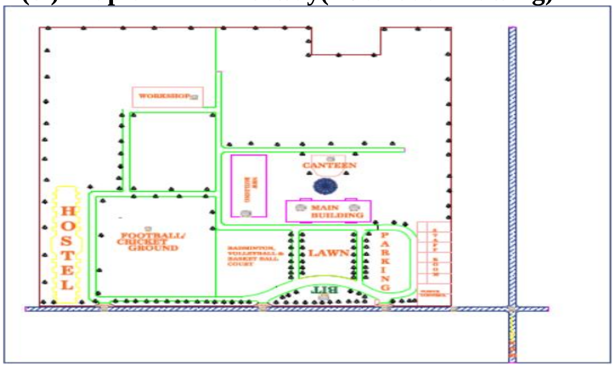
(iv) preparation of base

- Laying of boulder
- Size of boulder 20-50mm (according to IRC-SP-20-2002)
- Thickness of sub base 175mm (according to design)
- Compaction
- Sprinkling of water
- Again compaction 95%-98%

(v) preparation of surface

- Sprinkling of Binding material (bitumen)
- Laying the bituminous concrete mix material at 170 -190 °C
- Aggregate size 0-20mm
- Rolling of surface
- compaction 98%-100%

(vi) Map of BIT Driveway(Auto Cad Drawing)



X. Conclusions

The data collected on the different rural road & highways in the different parts of the country and at different times were used for developing mathematical models relating axle load distribution to the vehicular count. These models can be used to predict axle load distribution on a highway from its classified volume count.

One, it considers the average axle load distribution of all the sites which were spread all over the country and therefore the results are geographically transferable.

Two, it provides an economic way of determining ALD without actually going for axle load survey in field.

Three, it allows for the use of actual growth rates of different vehicle classes in determining the design traffic loading for a highway.

References

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