International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 06 | Jun 2023 www.irjet.net p-ISSN: 2395-0072

Optimum Cost Analysis For Selecting Best Suited Flexible Pavement Road Type For Reducing Direct Construction Cost Of Road Project

Omkar S.Patil[1]

Bachelor of Engineering, Dept. of civil Engineering, TKIET, Warananagar, Maharashtra, India.

---***---

Abstract - ***The goal of this study is to determine which of the five flexible road types listed in IRC 37-2012 will result in the lowest construction costs for a range of CBRs from 2% to 15% and a range of traffic volume circumstances in msa. Based on the district schedule rates the roads specifications, standards and the proportions of the cost of the materials, equipment and direct construction (MORTH Specifications). In order to choose the least expensive road crust type at a specific location of a particular CBR, a correlation between the cost, road forms, CBRs, and traffic volumes is computed.***

Key Words*: *Direct Construction Cost, Road Types, Traffic, CBRs, and Proportions of Construction Cost.

1. INTRODUCTION

For development of any specific region, we must unravel one thing or we should know about primary communication conveniences of that region. Besides is it in good condition or not? How can we communicate existing amenities with their proper suitability? Else someone can insinuate also. This is integral part of development of any region that's why road construction plays first rated role. There are a lots of road projects who has been facing various setbacks throughout their entire project life but yet it posses 3.64% of total GDP of India. In fact one main challenge is to realize cost difference which is frequently in increased manner due to time taking process of planning and during construction phase. Road construction costs vary on average by 16.73%, according to observations. Several studies have found that 9 out of 10 construction projects ran over budget by an average of 28%. When opposed to road construction with larger construction time and budget, smaller road projects with shorter construction periods have higher cost variation. For different combinations of flexible pavement crusts at different CBRs and different traffic volumes, the least direct construction cost technique can be employed to cut down on the direct construction cost. It is crucial to gather information on cost overruns at the key construction sites since changes in the kinds of road crust during ongoing development have a significant influence on planning for construction costs.

1.2. DISCUSSION AND OBSERVATION

As per mentioned in IRC-37 (flexible pavement) there are 5 types of flexible pavements. Their suitability depends upon ground conditions and available construction equipments for that particular region. It is obligatory that it should low budgetary with their appropriate functioning hence we should choose low budget road crust type of flexible pavement regarding with region on which we have to construct flexible pavement road. IRC-37 specifies five distinct types of flexible pavement road crusts. This study evaluates the effect on direct construction costs owing to changes in the resultant flexible road crust type of construction techniques or scope adjustments for any combination of subgrade CBRs ranging from 3 to 15% and traffic from 50 to 150 msa. A cost baseline can be established or altered based on the cost variation percentages described in this article.

1.3. OBJECTIVE

- To study of literature review.
- To calculate direct construction cost of five flexible road crust types given in IRC 37 for various traffic volumes and CBRs by using DSR for sample traffic and CBR of location.
- To obtain low costing best suited road among five road crust types given at IRC 37 for sample traffic and CBR of location by using optimum cost analysis method.
- To calculate the construction cost proportions of equipment cost, material cost with reference to direct construction cost so as to make baseline for budget.
- In case of change in road type due to change in scope, finding out cost escalation by calculating cost variance percentage for all five types of flexible pavements.

1.4. METHODOLOGY

The following methodology will be adopted -

- ❖ Collection of preliminary information through a literature survey.
- ❖ Manifesting of problem statement, objectives, IRC-37(2012) and analyzing types of flexible pavements.
- ❖ Study of MORTH specification and standards then collecting appropriate require data for our project

as well as study of general conditions given in standard data book published by NHAI.

- Calculation of material cost and direct construction cost for various flexible pavements given in IRC-37 such as,

  1. Granular Base and Granular Sub-base (GB and GSB).

  2. Cementitious Base and Cementitious Sub-base of aggregate interlayer for crack relief (CB and CSB).

  3. Cementitious base and sub-base with SAMI at the interface of base and the bituminous layer (CB and CSB with SAMI).

  4. Foamed bitumen/bitumen emulsion treated RAP or fresh aggregates over 250 mm Cementitious sub-base (RAP).

  5. Cementitious base and granular sub-base with crack relief layer of aggregate layer above the cementitious base (CB and GSB with crack relief layer).

- Finding out parameters for cost reduction and cost escalation by optimum cost analysismethod and cost variance method.

- Suggesting the best recommendations for formation of baseline for low budgeting direct cost of road construction, material and equipments.

2. TRAFFIC DATA STUDY AND ANALYSIS

The process of designing a highway takes into account the purpose of the road, the kind and amount of traffic, possible traffic hazards and safety, capital expenses, maintenance costs, vehicle operating costs, environmental implications, aesthetics, and the convenience of the road users. Road categorization, the horizontal alignment, vertical alignment, and the road cross-section are the key geometric elements for achieving these goals. The effectiveness of the pavement is crucial since it directly affects the economic returns. This chapter discusses the design process used for the new roadway's flexible and rigid pavement, as well as the reinforcement and restoration of the current carriageway. This chapter also discusses the project corridor's current state, the pavement option analysis, and the ideal alternative design. This chapter discusses the design process used for the new roadway's flexible and rigid pavement, as well as the reinforcement and restoration of the current carriageway. This chapter also discusses the project corridor's current state, the pavement option analysis, and the ideal alternative design.

2.1. COMPUTATION OF DESIGN TRAFFICC

Given equation must be used to calculate the total number of standard axles to be transported during the course of the road's design life:

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

Where

N = number of standard axles in terms of msa.

A = Initial traffic measured in commercial vehicles per day in the year at the end of construction (CVPD).

D = Lane distribution factor.

F = Vehicle Damage Factor (VDF).

n = years of design life.

The following formula is used to estimate traffic in the year of completion.

$$A = p(1+r)^n$$

Where,

p= Last counted number of commercial vehicles.

n= Years between the most recent count and the construction's completion year.

Kodoli - Borpadale road

r=annual growth rate=7.5%

F=vehicle damage factor (VDF) = 3.5

A=645 CVPD

n= Design period in years=15

D= lane distribution factor=1

N=no of standard axels for one lane in both directions.

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

$$N = 21.5 \times 10^6$$

= 21.5 msa.

2.2. COMPACTION TEST

Using a typical proctor compaction test, establish the optimum moisture content and maximum dry density of a soil.

2.1 Collection of soil sample:

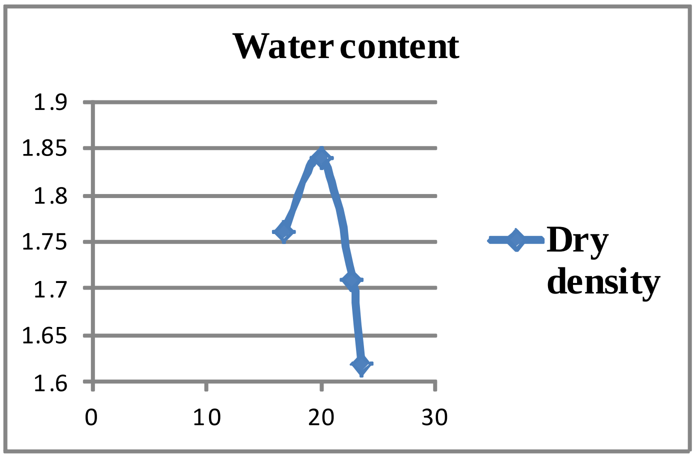
Along 1 km road soil samples at starting, center and the end point are taken.

For finding out CBR value of soil sample firstly required Optimum Moisture content of soil. This is why we carried out Standard compaction test (Heavy compaction test) on soil samples.

2.3. WATER CONTENT DETERMINATION BY OVEN DRYING METHOD:

Trial No	**1**	**2**	**3**	**4**
Empty weight of tin(W1)	26	24	24	27
Initial weight of tin + weight of sample (W2)	40	39	51	48
Weight of tin + dry sample (W3)	38	36.5	46	44
Water content (%)	16.67%	20%	22.72%	23.52%

Table no.1.CBR standard load



Graph no.1.Water Content v/s Dry Density

RESULT:

OMC obtained from oven drying method = 20%

3. CBR TEST:

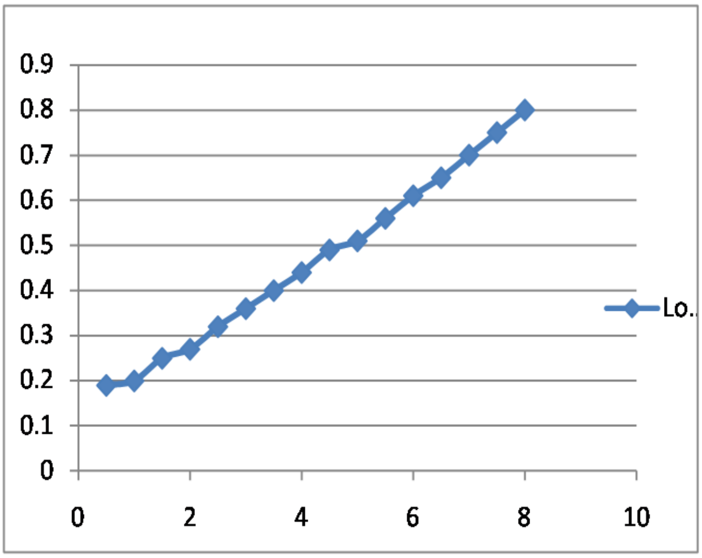
To carry out a load penetration test in the lab and estimate the California bearing ratio. The thickness values of a pavement employed in the IRC technique are read from the CBR values of the sub grade since it is based on a mechanistic empirical approach. From CBR value and Cumulative standard axle load the total pavement thickness could be read. Design procedure of pavement based on IRC: 37-2012.

3.1. CALIFORNIA BEARING RATIO TEST:

1. Calculation for sample no.1

Penetration	CBR Value
	Sample No. 1
At 250mm = (Cal Load/ 1370) $\times$ 100	2.38
At 500mm = (Cal Load/ 2055) $\times$ 100	2.52

Table no.2

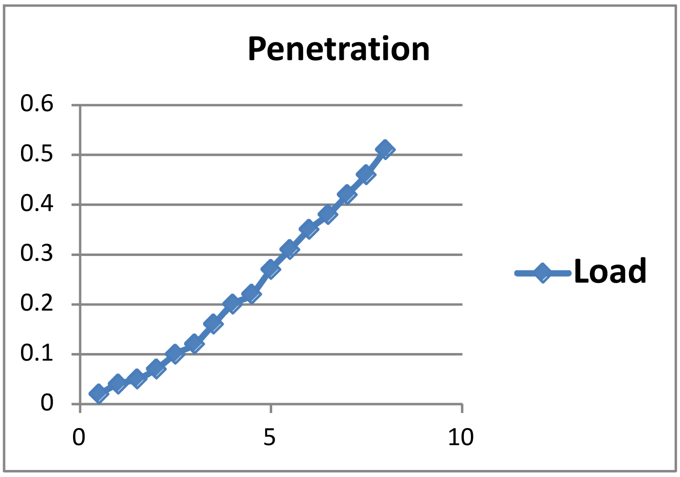


Graph no.2

2. Calculation for sample no.2

Penetration	CBR Value
	Sample No 2
At 250mm = (Cal Load/ 1370) × 100	0.74
At 500mm = (Cal Load/ 2055) × 100	1.33

Table no.3

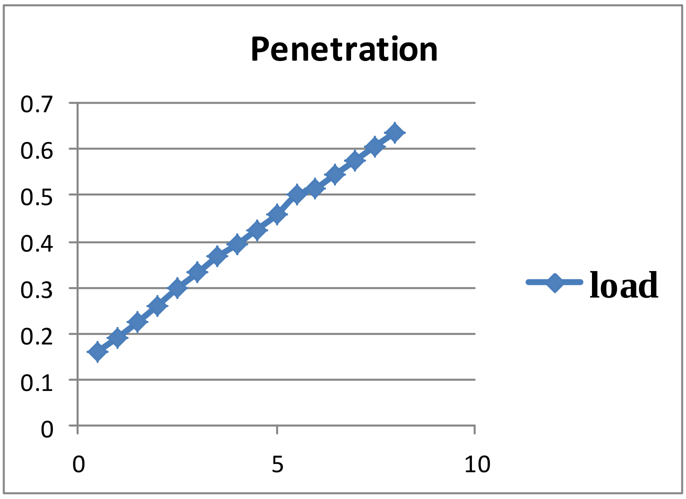


Graph no.3

3. calculation for sample no.3

Penetration	CBR Value
	Sample No. 3
At 250mm = (Cal Load/ 1370) × 100	2.21
At 500mm = (Cal Load/ 2055) × 100	2.26

Table no.4



Graph no.4

RESULT

SAMPLE NO	CBR VALUE %
1	2.52
2	1.33
3	2.26

Table no.5

The average CBR value obtained is 3%.

4. CALCULATION OF ROAD COST

Given:

CBR value: 3%

Traffic volume: 21.5msa

Solution:

By using IRC 37 -2012, the thickness of every layer is calculated.

4.1. Thickness

Layers of road	Thickness
BC layer	40
DBM layer	123
Granular Base	250
Granular Sub-base	380

Table no.6

4.2. Width of single lane Road:

Width for BC layer: 3.75m

Width for DBM layer:

= 3.75 + (2×0.04)

= 3.83m

Width for granular base layer:

=3.83 + (2×0.123)

=4.076m

Width for Granular sub-base:

= 4.076 + (2×0.250)

= 4.576m

4.3. Compacted volume per KM:

BC layer:

Volume= L×B×D

=1000×3.75×0.04

V =150cumec

DBM:

Volume=L×B×D

=1000×3.83×0.123

V =471.09cumec.

Granular base layer:

Volume =L×B×D

=1000×4.08×0.25

V =1019cumec

Granular sub base layer:

Volume =L×B×D

=1000×4.58×0.38

V =1738.8 8cumec.

4.4. Material cost & construction cost:

The material costs are obtained from DSR rates and MORTH specification. The construction cost are obtained from multiplication of compacted volume, construction cost obtained from standard data sheet and DSR rates.

CONCLUSION

The cheapest road crust type for the present traffic volume is cemented base and cemented sub base with SAMI layer and highest cost of road crust type is granular base and granular sub base layer.

Moreover, by changing the kind of flexible road crust at any time during construction, this research may be utilized to determine the impact on direct construction costs. This analysis can also be used in future when traffic volume increases to 30 to 50 msa.

This analysis can also be used in future when traffic volume increases to 30 to 50 msa.

REFERENCES

1) Harshavardhan N. Shinde (july2018),"Cost Deviation Approach to Obtain Direct Construction Cost Escalation or Savings for Different Flexible Pavements at Traffic Volume 50-150msa and Various CBR Conditions", International Research Journal of Engineering and Technology (IRJET), Volume: 05, Issue: 07.

2) Harshavardhan N. Shinde (June 2018),"Minimal Cost Approach for Selecting the flexible pavement type to Minimize the Construction Cost of Road", International Journal of Latest Technology in Engineering, Management & Applied Science, Volume VII, Issue VI.

3) Harshavardhan N. Shinde (Feb 2019)," Material & Construction Cost Deviation In Road Construction for Different Flexible Pavement Crust Types at Various Traffic & Subgrade CBR Conditions", Journal of Emerging Technologies and Innovative Research, Volume 6, Issue 2.

4) Badake Sanju Kumar, Malothu Narasimha (Nov 2017), "Design and estimation of flexible pavement on 2/4 lane carriageway with paved shoulder using mix road software", Anveshana's International Journal Of Research in Engineering And Applied Sciences, volume-2, issue 11.

5) Bent Flyvbjerg, Mette K.Skamris Holm and Søren L. Buhl (Jan 2014), "What Causes Cost Overrun in Transport Infrastructure Projects?" Transport Reviews, volume-24, no.1, pp. 3-18.

6) Chantal C. Cantarelli , Bert van Wee, Eric J. E. Molin, and Bent Flyvbjerg (April 2012), "Different Cost Performance: Different Determinants? The Case of Cost Overruns in Dutch Transportation Infrastructure Projects", Transport Policy, volume-22, 88–95.

7) Ghulam Abbas Niazi, Noel Painting (2017), "Significant Factors Causing Cost Overruns in the

Construction Industry in Afghanistan", International Journal of Scientific and Research Publications, Procedia Engineering 182, 510 – 517.

8) Ibrahim Mohamed (June-2013), "Effects of project's physical characteristics on cost deviation in road construction", Journal of King Saud University-Engineering Science 25, 81-88.

9) Mr. Peter Morris and Mr.William F. Willson (2006), "Measuring and Managing Cost Escalation", AACE International Transactions, CSC.06.

10) Rodrigo F. Herrera, Omar Sanchez, Karen Castaneda and Hernan Porras (August 2020), "Cost Overrun Causative Factors in Road Infrastructure Projects: A Frequency and Importance Analysis", Appl. Science, vol.10, 5506.

11) Salim S. Mulla, Ashish P. Waghmare (October 2015), "Influencing Factors caused for Time & Cost Overruns in Construction Projects in Pune-India & their Remedies", IJISET-International Journal of Innovative Science, Engineering & Technology, Volume-2, Issue 10.

12) Guidelines for the design of flexible pavements: IRC 37, July 2012.

13) Government of Maharashtra Public Works Department State e-DSR for year 2019-2020, w.e.f. 14/06/2019.

14) MORTH - Specifications for Road & Bridge Works (5th Revision) 1, 2013.