IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

OPTIMUM COST ANALYSIS FOR SELECTING BEST SUITED FLEXIBLE PAVEMENT ROAD TYPE FOR REDUCING DIRECT CONSTRUCTION COST OF ROAD PROJECT

[1]Omkar S.Patil, ,[2] Prof.Aniket V. Hankare

[1]Student M.Tech,[2]Asst.Professor,Department Of Civil Engg.,

Tatyasaheb Kore Institute Of Engineering and Technology,Warananagar ,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.

IndexTerms - Direct Construction Cost, Road Types, Traffic,CBRs and Proportions of Construction Cost.

I. 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 exist communication 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. 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. 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.

II. LITERATURE REVIEW

Badake Sanju Kumar et.al.[1] The study will be used by the R&B department's Design and Estimate of Flexible Pavement. Phase 1 of the "Devarakonda-paddavuru-miryalaguda-kodad"project has been delegated to the Government of Telangana. A lane road lane of 2 or road lane of4, paved shoulder-configured corridor of state and national highways with a tentative length of115 KM has been sanctioned in principle for designation as national highways. Designing flexible pavement in accordance with 'IRC 37-2015,'and planning road infrastructure in accordance with 'IRC SP 19-2001'. MX Road software is a powerful string-based modeling tool that makes it possible to quickly and accurately create all sorts of roads using MX Road. It is simple to create design options for the development of the optimum road system. With MX road modeling, further features that need to be added into the process once a design option has been verified, saving both time and money. The project estimate needs to be reasonable and should paint a clear picture of the financial commitment required. This is only achievable if the tasks, quantities, and rates are presented on a realistic basis and are calculated with an acceptable degree of precision using SSR in accordance with the 2016–17 revision of the T.S. standard data.

Chantal C. Cantarelli et.al.[2] This study investigates the relationships between three in dependent explanatory factors and cost overrun to determine whether Dutch infrastructure projects differ from those found globally. There are three types of variable factors, which are not dependent on each other. One of them is, actual time requirement to fulfill the project, other one is actual size of construction site based on expected expenses and last one is variants of project which include road infrastructure ,rail projects and other rigidly connected projects. The average increase in cost for dutch projects are different which are mainly depend on their significant factors. Based on studies it is going up to 18.5% for road infrastructure. For railways, stands upto 11% and 22% for firmly depended project. In another prospective, it is observed that smaller projects have higher increase in expenditure compare to it, larger projects have greater part of overall overrun. This makes a significant contribution to our understanding of cost overruns since it reduces the time frame during which projects are most likely to experience them.
Keywords: cost overruns, infrastructure, ex-post studies.

Ghulam Ibrahim Mahamid et.al.[3] In this paper, author collected a lots of data of various road project,which was constructed in west band and Palestine amidst 2007 to 2010.From this all types of collected data, he has examined the impact of different practical aspects on expenditure in their project. For that he has conducted data from road projects near about 74 roads. Regression models are created using these data. We should ascertain the influences of such specifications on expenditure on construction sites. He also made a questionnaire study. In the questionnaire survey, there were 25 consultants, 30 contractors, and 14 owners. Some of parameters that we have to consider such as the actual size of construction site, what will be the expected expenditures, the total length of roads and with their width as well as available load, different topographical conditions, soil bearing capacity of soil, piling work or piers construction, hard strata. After analyzing and studying, outcomes tell that the overall expenses of all construction projects has ups in costing and that ranges from 21% to 56%, with an average of 17%.It is looked at if there is a relationship amidst the expenditure changing in different construction projects such road line projects and building sites and the aforementioned factors.

V S Meganathan et.al.[4] The author of this paper explained how transportation has been crucial to the advancement of human civilization. For instance, the relationship between the development of human settlement and the closeness of transportation infrastructure is straight forward to see. Also, there is a direct link between the style of life and the quality of transportation infrastructure, therefore society has high expectations for these amenities. In our program, we will first use an auto level and leveling staff to gather longitudinal-section and cross-section levels, and then we will assess the California bearing ratio of relatable soil. As well as pavement thickness, in which layers is assessed for flexible pavement design based on CBR value. In the next part emphasis on calculations of estimated value of road projects, including the cost of flexible paving materials, machinery, labour, and earth work excavation (cutting and filling). On the basis of the data presented above, road design is completed for horizontal curves, vertical curves, cross-sectional components, transition curves, and pipe culverts to direct drainage water beneath.

III. PROPOSED WORK

3.1 Objectives

- 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.

3.2 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 Finding out parameters for cost reduction and cost escalation by optimum cost analysis method and cost variance method.
- Suggesting the best recommendations for formation of baseline for low budgeting direct cost of road construction, material and equipment.

IV. PHASE 1

4.1 Study Of Flexible Pavement Crust Type:

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

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

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

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

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

4.2 Computation of Design Traffic:

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:

$$N = 365 \times [(1 + r)n - 1/r] A \times D \times F$$

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.

$N = 365\times[(1 + r)n – 1/r]\times A\times D\times F$

$N = 21.5 \times 105$

$= 21.5$ msa.

4.3GENERAL CONDITIONS FOR THE PROVISION OF STANDARD DATA BOOK

The following is a explanatory of the fundamental procedure for creating the Standard Data Book for Road Works:

- Mechanical Means
- Overhead Charges
- Contractor revenue
- Plants and Machinery
- Materials requirement
- Labor requirement
- Transport of Materials

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V. PHASE 2

5.1 Compaction Test:

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

Water content determination by oven drying method

Table5.1.CBR standard load

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%

Sample calculation: Trial no 1

Water content = $[(W2 – W3) / (W3-W1)]\times 100$

$= [(40-38) / (38-26)]\times 100$

$=16.67\%$

Result:

OMC obtained from oven drying method = 20%

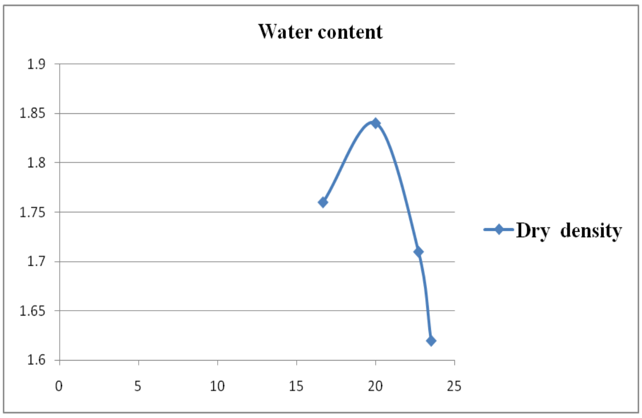

Fig.5.1 Water Content v/s Dry Density

5.2**. 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 a 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.

Table 5.2.1CBR standard load

Penetration of plunger (mm)	**Standard load (kg)**
02.5	01370
05.0	02055
07.5	02630
010.0	03180
012.5	03600

California Bearing Ratio Test:

Table No.5.2.2: Sample No.1

Penetration	**Load (KN)**
0.5	0.19
1.0	0.20
1.5	0.25
2.0	0.27
2.5	0.32
3.0	0.36
3.5	0.40
4.0	0.44
4.5	0.49
5.0	0.51
5.5	0.56
6.0	0.61
6.5	0.65
7.0	0.70
7.5	0.75
8.0	0.80

Calculation: for sample no.1

Table No.5.2.3: CBR value for sample no. 1

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

Calculation :for sample no.2

Table No.5.2.4: CBR value 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

Calculation: for sample no.3

Table No.5.2.5: CBR value 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

Result :

Table no 5.2.6.CBR value

Sample No	**CBR Value %**
1	2.52
2	1.33
3	2.26

The average CBR value obtained is 3%.

VI. CALCULATION OF ROAD COST

For Granular Base and Granular Sub base:
Given: CBR value: 3%
Traffic volume: 21.5msa

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

- Thickness:
  a) BC layer

Table no. 6.1. Thickness of BC layer

Traffic	**Thickness**
20.0	40
21.5	40
30.0	40

Hence, the thickness of the BC layer = 40 mm.

b) DBM layer:

Table no. 6.2. Thickness of DBM layer

Traffic	**Thickness**
20.0	120
21.5	X
30.0	140

By interpolation method

(21.5-20)	(x-120)
(30-20)	(140-120)

1.5	(x-120)
10.0	20

Hence, thickness of DBM layer = 123mm.

c) Granular Base:

Table no. 6.3.Thickness of Granular base

Traffic	**Thickness**
20.0	250
21.5	250
30.0	250

Hence, Thickness of Granular base = 250mm.

d) Granular Sub-base:

Table no. 6.4. Thickness of granular sub base

Traffic	Thickness
20.0	380
21.5	380
30.0	380

Hence, Thickness of Granular sub base = 380mm.

- **Width of single lane Road**:

a) Width for BC layer= 3.75m

b) Width for DBM layer = 3.75 + (2×0.04)
= 3.83m

c) Width for granular base layer =3.83 + (2×0.123)
=4.076m

d) Width for Granular sub-base =4.076 + (2×0.250)
=4.576m

- **Compacted volume per KM:**

a) BC layer :
Volume= L×B×D
=1000×3.75×0.04
V =150cumec.

b) DBM :
Volume= L×B×D
=1000×3.83×0.123
=471.09cumec.

c) Granular base layer:
Volume= L×B×D
=1000×4.08×0.25
= 1019 cumec.

d) Granular sub base layer:
Volume= L×B×D
=1000×4.58×0.3
=1738.8 8cumec.

6.1 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.

VII. RESULTS AND DISCUSSION

- 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.

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