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LIFE CYCLE COST ANALYSIS OF FLEXIBLE AND RIGID PAVEMTN MATRERIAL

Nitish Kumar K[1]

[1]*Department of Civil Engineering & New Horizon College of E gineering,nitish.sit@gmail.com*

Abstract*— In the developing country the infrastructure development give way for the development of country. On the same time the investment to the project development requires more cost and efficient maintenance. where we are having restricted amount for investment, then the alternative methods of material and construction methodology has to adopt for best output. Infrastructure basically consists highway, airports, seaports, bridges etc. The road sector is very necessary because more than 60% of the passengers and goods are trawling through road. Hence good connectivity will ensure faster movement of traffic if the pavement is in good condition. For ensuring good condition construction and maintaining of pavement has to carried out based on type of pavement. Life Cycle Cost Analysis of Pavement (LCCA) is one tool to study of transportation project relating pavements starting from its design phase to its entire service life. It determine the total cost and value of item over the entire life cycle of pavement. The cost of road construction includes design expenses, material extraction, construction equipment, rehabilitation and maintenance strategies. In the present study a stretch of 24km National Highway of Butwal, Nepal was considered and various data like pavement performance, material, traffic, climatic condition and economic data were collected and integrated. Comparative life cycle cost for flexible pavement and rigid pavement are carried out by designing a pavement for 30year life. In this flexible pavement was designed for design period of 10 year with maintenance of 15 years and rigid pavement for 30 years to finalize optimum performing pavement based on construction and maintenance. Based on above study we conclude that construction cost of rigid pavement are 28% more than flexible pavement. Total quantity of material in case of flexible pavement is 8% greater than that of rigid pavement.

***Keywords*— Life cycle cost analysis (LCCA), Rigid pavement and Flexible pavement**

I. INTRODUCTION

Due to the lack of fund and limited budget transportation office choose the most cost effective project alternatively. Choosing the most cost effective type and design pavement which provide high quality of service to travelling public is one of the most important decision of LCCA. It is an economic evaluation tool that provides valuable guidance to transportation official in this process. The use of LCCA method may optimise the project construction and maintenance cost. Infrastructure basically consists highway, airports, seaports, bridges etc. The road sector is very necessary because more than 60% of the passengers and goods are trawling through road. Hence good connectivity will ensure faster movement of traffic if the pavement is in good condition. For ensuring good condition construction and maintaining of pavement has to carried out based on type of pavement. Mr. Siddesh kashinath pai et al, suggested maintenance cost of rigid pavement is 19% less as compared to flexible pavement and Life cycle cost of rigid pavement is 20 - 25% less than flexible pavement. Mr. Peyman Babashamsi et al, suggested Life cycle cost analysis research will become more robust if improvements are made, facilitating private industries and government agencies to accomplish their economic aims. Mr. Zeynep Guven suggested survey results showed Life cycle cost analysis is used widely among transportation agencies and it varied at different project condition. In the present study for a stretch of 24Km are considered for Life cycle cost analysis of pavement. Comparative life cycle cost for flexible pavement and rigid pavement are carried out by designing a pavement for 30year life. In this flexible pavement was designed for design period of 10 year with maintenance of 15 years and rigid pavement for 30 years to finalize optimum performing pavement based on construction and maintenance.

II. METHODOLOGY

A. Collection of site date

B. Design of Flexible and Rigid pavement

C. Construction Cost of pavement and its quantity comparison

D. Comparison of construction cost and maintenance cost

III. RESULT AND DISCUSSION

Project are started with collection of required data, analyse, design and comparison.

A. Collection of site data

Data required for project are collected along a length of 24Km for two lane divided road.. The data collected are CBR data, Traffic data, Topography, Rainfall data, Terrain, Longitudinal, Cross section, Material cost & Maintenance cost.

B. Design of Flexible and Rigid pavement

The design of Flexible pavement and Rigid pavement were down by IRC:37-2012 and IRC:58-2015 as per Indian standards.

1. Flexible pavement design

a) CBR = 6% (90% Reliable CBR value along the stretch of road)

b) Lane Distribution Factor, D = 75%

c) Vehicle Damage Factor, V = 4.5 (Calculated as per available traffic data)

d)Design life, n = 15 years

e) Annual growth rate, r = 5%

f) Initial traffic, A = 4543

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

N = 120msa

For a CBR of 6% and Cumulative no. of standard axle of 120msa pavement thickness proposed are tabulated below.

TABLE I

Total Flexible pavement thickness and cost

Sl. No.	Description	Thickness, m	Length, m	Width, m	Volume, Cum	Rate/Cum, Rs	Total, Rs
1	Granular sub base course	0.260	24000	14	87360	2050	179088000
2	Granular base course	0.25	24000	14	84000	2040	171360000
3	Dense bituminous macadam	0.13	24000	14	43680	11384	497253120
4	Semi dense bituminous macadam	0.05	24000	14	16800	13090	219912000
						Total	**1067613120**

2. Rigid pavement design

a) Modulus of subgrade reaction, K = 50.3MPa

b) Design life, n = 30 years

c) Annual growth rate, r = 5%

d) Cumulative no. of vehicle during the design period.

C= 365*A((1+r)^n -1)/r

C = 180msa

Pavement are designed by considering trial thickness of 0.25m then after Fatigue damage analysis we conclude thickness of pavement 0.29m.

TABLE III

Total Rigid pavement thickness and cost

Sl. No.	Description	Thickness, m	Length, m	Width, m	Volume, Cum	Rate/Cum, Rs	Total, Rs
1	Subgrade borrow soil	0.50	24000	14	168000	3125	525000000
2	Granular sub base course	0.15	24000	14	50400	2040	102816000
3	Dry lean concrete	0.15	24000	14	50400	4153	209336400
4	Pavement quality concrete	0.29	24000	14	97400	9185	894986400
						Total	**1732138800**

C. Construction Cost of pavement and its quantity comparison

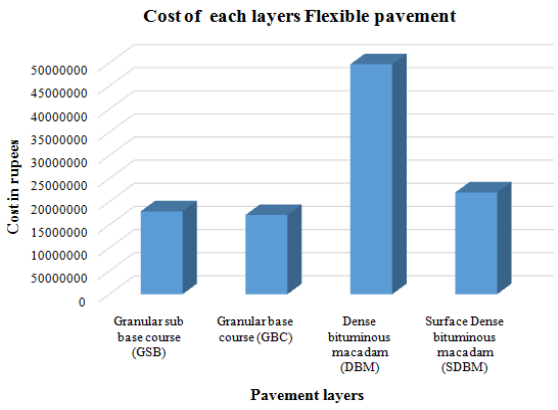

Fig. 1 Graphical representation of thickness of flexible pavement

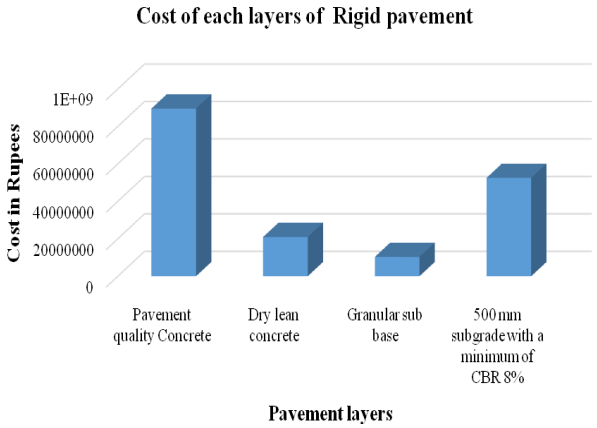

Fig. 2 Graphical representation of thickness of Rigid pavement

From the above graph we can see that variation of thickness of different layer based on the material we used in and load carrying capacity of material. Quantity of material required in rigid pavement is 8% less than flexible pavement.

D. Comparison of construction cost and maintenance cost

TABLE IIIII

Maintenance in Rigid pavement and Flexible pavement

Sl. No.	Maintenance cost of pavement				
	Flexible Pavement	**Rate, %**	**Cost, Rs**	**Rigid Pavement**	**Cost, Rs**
1	Semi Dense Bituminous Macadam (Every 5year after design life)	-	219912000	Subgrade borrow soil	525000000
2	Asphalt Concrete Surface	0.2	43982	Granular sub base course	102816000
3	Surface Dressing	0.75	1649340	Dry lean concrete	209336400
4	Penetration Macadam	0.3	659736	Pavement quality concrete	894986400
Total			222265058	Total cost of Rigid pavement for 30 year	**1732138800**
Total Cost of Flexible Pavement			**1067613120**		
After 15 year for every 5 year maintenance			1067613120 + (3x222265058) = **1734408294**		

From the above table III we can see that flexible pavement initial construction cost is less compared with rigid pavement. After construction of Rigid pavement there is less maintenance cost for design period of 30 years, we can say that is negligible. But in case of flexible pavement it is maintained for next 15years with addition to initial cost of construction. If we compare maintenance cost of flexible pavement with rigid pavement till 30 years we can see flexible pavement is more than rigid pavement.

IV. CONCLUSIONS

The comparison between Flexible and Rigid pavements by using method of life cycle costing gives the initial cost of rigid pavement is 28% higher than the initial cost of flexible pavement. Rigid pavements are high on initial costs but these costs get balanced during the entire life of 30 years since more durability and serviceability is provided by the pavement. The total quantity of materials in flexible pavement is 8% more than that of rigid pavements. Life cycle cost analysis of Flexible pavement was found to be 20% higher than that of rigid pavement.

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