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Life Cycle Cost Analysis Of Roads

Kapil. C (P6815PTN04)

PG Student, Prist University, Thanjavur

Abstract

Life cycle cost analysis of existing road is becoming more significant to determine the proper time of maintenance and the proper action, which should be taken for maintenance. An efficient maintenance policy is essential for a cost-effective, comfortable and safe transportation system. But, the decision to maintain the road facilities, consider a number of possible ways from routine maintenance action to reconstruction of the road network. Moreover, an economic analysis of a road network is dependent upon a number of factors, which are responsible for deciding road serviceability level. Optimization model is an analytical model, which helps to make a cost benefit analysis and compare that with various possible alternatives to give out the best possible activity within the allocated budget, before being carried out in field work.

In the present study, the aim was to develop a general optimization model to give the most cost-effective activity. The choice of maintenance action is divided in four groups from no action to rehabilitation. Various factors like traffic growth, environmental conditions are taken into account, along with the International Roughness Index (IRI). „C" language program is used to formulate the model.

Introduction

Road authorities of all around the world are finding and innovating ways to cope with the high cost of road network maintenance, the increasing demands of road users and the changing traffic type and volume. The road network plays a vital role in contributing to the economic, social, cultural and environmental development of the country. A well-maintained road is needed to make the network sustainable for future generations. Improving road maintenance management has become a key factor in developing nations like India.

As per a student paper submitted on 2006 at Atlantic International University, Life cycle cost analysis (LCCA) is a financial analysis instrument which is valuable in deciding the execution of a roadway. The instrument thinks about and examines the relative monetary alternatives of diverse constructional and recovery plans for a roadway. It decides the execution data by analysis of pavement administration information and verifiable experience to assess the pavement condition.

As per Bangasan (2006), Life-Cycle Cost Analysis is a process for evaluating the total economic worth of a usable project segment

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by analyzing initial costs and discounted future costs, such as maintenance, user, reconstruction, rehabilitation, restoring, and resurfacing costs, over the life of the project segment.

Life Cycle Cost Analysis

Life cycle cost analysis (LCCA) has become an essential component of infrastructure design and asset management programs. It has long been realized that maintenance and rehabilitation costs, not just the immediate initial construction costs should be considered when evaluating pavement alternatives. In order to assist owners and practitioners in comparing pavement whole life costs, a spreadsheet model for life cycle cost procedures was developed to compare flexible, rigid, and interlocking concrete pavements for low traffic volume pavements. The tools and procedures can be used to document the life cycle cost benefits of interlocking concrete pavements (ICP) compared to flexible and rigid pavements.

The U.S. Federal Highway Administration [Walls, et al, 1998] describes LCCA as "an analysis technique that builds on the well founded principles of economic analysis to evaluate the overall long term economic efficiency between competing alternative investment options". Comparing life cycle costs has become standard for selecting among different pavement types, but also to evaluate different, feasible rehabilitation plans over the service life of pavement alternatives. Pavement service life is defined as the time between initial construction and the time when the pavement reaches a minimum acceptable service level. Actual service life with required rehabilitation treatment depends on a variety of factors. These can include the traffic/wheel loads, timeliness of maintenance treatments, and environmental factors such as temperature and precipitation. In order to develop comparative cost estimates over the pavement life, the timing, type and quantities of repairs and the corresponding "activity" service life must be known or estimated with reasonable accuracy. Life cycle costing quantifies initial construction and activity costs such as maintenance and rehabilitation for a pavement over an "analysis period", typically between 25 and 50 years. . Future costs are discounted to today's dollars by selecting a discount rate i.e., the difference between bank financing rates and inflation rates. The discount rate is a key factor in determining the net present value of future costs. Lower discount rates tend to favor pavements with long service lives and higher initial costs such as interlocking concrete pavement.

Objective

The main objective of this study is to review few literatures on life cycle cost analysis of roads and apply some of them to develop a model as a general form to analyze life cycle cost analysis of roads in general. Development of an optimization model can be more useful if along with reduction of maintenance cost, the road condition also improves and being serviceable for a longer duration during the design period.

Primary factors for cost analysis

Year	Traffic growth	Impact Climatic condition	Impact of External features	Impact of Environmental condition
5	9.693%	20	8.0	20
10	9.932%	25	8.5	20
15	5.806%	30	9.0	20
20	2.118%	35	9.5	20
25	1.128%	40	10.0	20
30	0.925%	45	10.5	20

Programming

According to Virginia research council report (2002), LCCA is an economic method to compare among alternatives that satisfy a need in order to determine the lowest cost option. According to Chapter 3 of the AASHTO Guide for Design of Pavement Structures2, life cycle costs "refer to all costs which are involved in the provision of a pavement during its complete life cycle." These costs borne by the agency include the costs associated with initial construction and future maintenance and rehabilitation. In addition, costs are borne by the traveling public and overall economy in terms of user delay. The life cycle starts when the project is initiated and opened to traffic and ends when the initial pavement structure is no longer serviceable and reconstruction is necessary.

In this study no case study was taken into account. Hence, values were assumed from past studies. From that studies International roughness index (IRI) values were taken. And the IRI values vary between 80 inches per mile to 170 inches per mile.

In this study from IRI values helped to calculate present serviceability rating (PSR). Where, PSR is a parameter to indicate the road condition. It is used to estimate long term pavement rehabilitation needs. Generally PSR value ranges from 0 to 5 (very poor to very good).

From a past study of Al-Omari et al. (2005), following relationship was adopted for PSR values and IRI values. It was also observed that the IRI values for general roads varied from 80 to 200 inches per mile.

Respective IRI Values

IRI (inches/mile)	PSR=5e^(-0.0041*IRI)
80	3.601
85	3.529
90	3.457
95	3.387
100	3.318
105	3.251
110	3.185
115	3.120

Conclusions

In this study an attempt was made to determine the most general equation for any general road at moderate weather.

- By probabilistic analysis it was concluded that if the roads have roughness of 120 inches per mile to 130 inches per mile, then the road can serve twice its life time with minor maintenance at the end of its initial life period.

- In past studies the analysis which were done, were mainly dependent on time factor, in comparison of that this study is analyze with respect to road roughness parameter.

- This study tried to show that minor and major maintenance of any general road is more economical and give more benefit in term of serviceability than complete rehabilitation.

References

- *Ahmed.K, Abu-Lebdeh, and Lyles, R.W. (2006). „Prediction of .pavement .distress index with limited data on causal factors: An auto-.regression approach." International J. Pavement Engg. 7(1). 23–35.*

- *Application Of Low-Volume Road Maintenance Management Systems In New Zealand To The Philippines.*

- *Avro Tinni (2003), „Cautions with life cycle cost analysis for optimal pavement selection."*

- *Dr. Santosh A.Jalihal, Kayitha Ravinder, Dr.T.S. Reddy, (2005), „Traffic characteristics of India: Proceedings of the Eastern Asia society for transportation studies."*

- *Emblemsvåg, J. (2003). "Life cycle costing: using activity based costing and Monte Carlo methods to manage future costs and risks." John Wiley & Sons, Inc., USA, New Jersey*

- *Geoffery Lamptey, Muhammad.Z.Ahmed, Kumares.C.Sinha (2005), „Life Cycle Cost Analysis for INDOT Pavement Design Procedures."*

- *Jon.A.Epps and R.G.Hicks, „Life cycle costs for asphalt-rubber paving materials."*

- *Kathleen.T.Hall, Carlos.E.Correa, Samuel.H.Carpenter, Robert.P.Elliott, 2003 „Guidelines for Life-Cycle Cost Analysis of Pavement Rehabilitation Strategies."*

- *S.S.Jain, M.parida, Sanjiv Agarwal (2004). Development of pavement management system for Indian national highway network.*

- *Stantec Consulting Services Inc., FLH PMS Final Report – Volume I: Development and Implementation of FLH PMS, January 13, 2006 (unpublished).*

- *Stantec Consulting Services Inc., Report for United States Fish and Wildlife Service Pavement Management Analysis, January 28, 2011 (unpublished).*

- *US Fish and Wildlife Service, National Wildlife Refuge System Map, United States Department of Interior, Division of Realty, Washington, DC, September 20, 2008.*

- *V.Mandapaka, I.Basheer, K.Sahasi, P.Ullidtz, J.Harvey, N.Sivaneswaran, (2005), „Application of mechanistic-empirical and life-cycle cost analyses for optimizing flexible pavement maintenance and rehabilitation."*

- *William. G.Holland (2012), „Illinois department of transportation"s life-cycle cost analysis for road construction contracts."*