AIJREAS VOLUME 2, ISSUE 3 (2017, MARCH) (ISSN-2455-6300) ONLINE
ANVESHANA'S INTERNATIONAL JOURNAL OF RESEARCH IN ENGINEERING AND APPLIED SCIENCES

A GENERAL STUDY ON LIFE CYCLE COST ANALYSIS FOR ROADS

VEMULA BHAVANI,
M.Tech, Transportation Engineering, Priyadarshini Institute of Technology and Science for Women.

K.KIRAN KUMAR,
Associate Professor, Priyadarshini Institute of Technology and Science for Women.

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.

Keywords: *Life cycle cost analysis, Optimization model, „C" language program, Maintenance, Rehabilitation, IRI.*

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 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.

As the past studies like Bangasan (2006), Lamptey (2005), are more focused on case specific cost analysis it is much needed that a general form of such analysis will prove much more useful in future. In this study an effort to generalize the LCCA of roads is attempted.

LITERATURE REVIEW

Jain et al. (2004) presented that the flexible maintenance strategies after an analysis period of twenty years can save more than thirty three percent highway agency cost than that of scheduled maintenance strategies. They compared their adopted model with predefined models on selected pavement sections. As the fund granted for maintenance management is only 60percent of the fund required, they prepared an optimized and prioritized work process for 60 percent budget availability. They showed us that the average roughness value of the highway network increases with reduction in budget levels, which in turn can lead to a very high road user cost values.

Zhang (2009) developed a new life cycle optimization model for pavement asset management system. He evaluated three potential overlay systems. One of these is a concrete overlay system. He observed the application of dynamic programming as an optimization tool in life cycle optimization of pavement overlay systems, which obtain outputs considerably faster and more accurately compared to conventional methods. His results demonstrate the importance of including user costs and roughness effects in pavement management accounting.

Whiteley-Lagace et al. (2011) attempted to show us the challenges and successes of implementing a pavement management system for roads. Their project team developed a 5 and a 10 year budget plans for road network and developed a number of recommendations to improve the level of detailed data to be added to the system to refine the models. They collected data for four years. They collected performance based data, which included the distress data for asphalt and concrete, gravel and native roads. They calibrated decision trees and cost models forall pavement types. They translated distress rating scores into individual distress index scores and then combined both to create a single surface condition rating.

Jhonson (2008) discussed about current issues facing roads managers. They discussed new methods to stabilize dirt and gravel roads, reclamation process for full depth of the roads. They provided information to support decision making of when to upgrade gravel roads. They also discussed cost safety improvements, farm to market road issues, best practices and resources in pavement design methods for roads.

Zhang et al. (2013) described about the development of a new pavement network management system that helps analysis and optimization. This LCCA optimization was implemented to regulate the optimum conservation scheme for a .pavement network and to reduce supportability metrics within a given analysis period. They discussed about .pavement deterioration, which is a main aspect to focus future pavement conservation procedures and is extremely difficult to focus faultlessly.

Pradhan Mantri Gram Sadak Yojona (2006) presented the choice of the appropriate economical and advantageous pavement type, was made by carrying out life cycle cost analysis, which takes into account the initial cost and the maintenance cost. They also presented the cost of construction for both rigid and flexible pavements. They also estimated an economical cost analysis, which showed us that the life cycle cost of concrete pavement is about twenty to twenty five percent lower than bituminous pavement.

Omkar et al. (2001) developed relationship between international roughness index (IRI) and present serviceability rating (PSR) for rigid, flexible and composite pavement types. PSR is defined as mean user panel rating for ride ability on the conventional 0 to 5 scale.

Empirical study and analysis

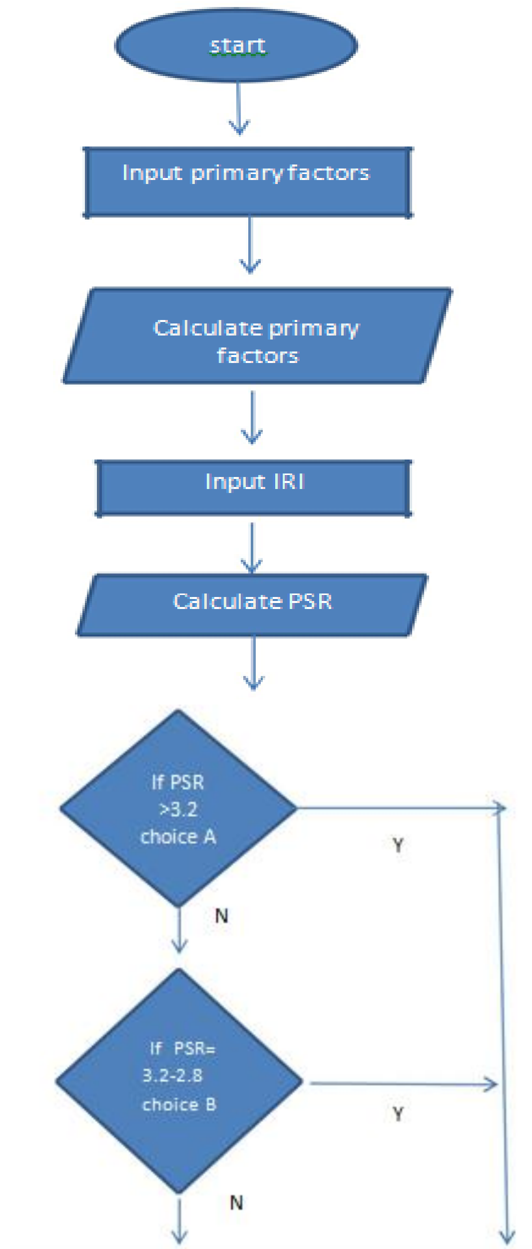
As the study is not case specific, from the past studies, assumptions were made to develop the optimization model. The elements considered are

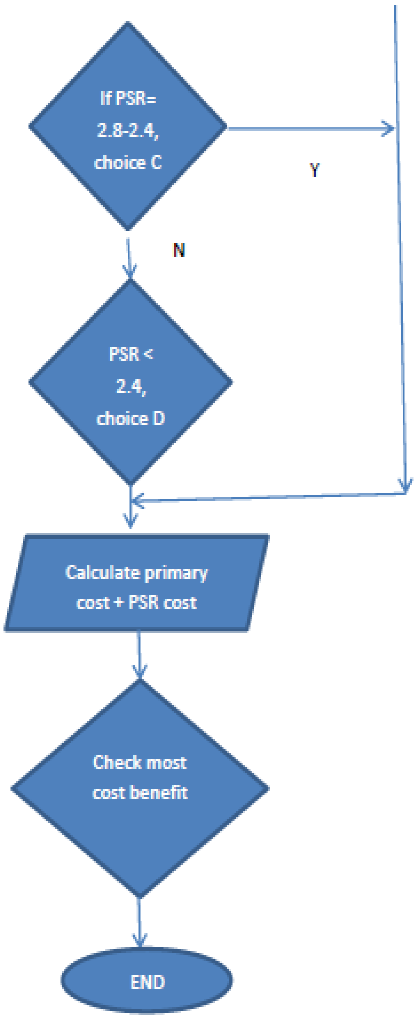
- Traffic growth: Traffic growth denotes the increment or growth of traffic volume in the given road section over past years. In this study traffic is represented as the axle load of vehicles. It showed the growth of traffic in percentage with a gap of five years.
- Climate: Climate is a measure of the average pattern of variation in temperature, wind, precipitation and other factors. Rainfall or precipitation is the main factor for pavement deterioration. And assumptions were also made to present the climatic condition as a factor.
- Other factors: In this study urbanization and development of the area were considered as the other factors in percentage. These factors have huge impact on pavement life.
- Environment: Environment is the surroundings of a physical system that may interact with the system by exchanging mass, energy, or other properties. This environmental factor which is presented in percentage is more or less same throughout the life period of a pavement.

By considering the factors traffic growth, climate, external features and environment a graph was developed as shown below.

By slope analysis and regression model criteria an equation was developed.

Flow Chart





Algorithm of C language programing

- Input primary factor and calculate the cost.
- Input IRI values and calculate corresponding PSR values.
- Divide the PSR values in four categories.
- Choose the action of maintenance.
- Calculate the total cost.

RESULTS AND DISCUSSION

It is evident from the table and the C programming output results that, (B)b is having the least value, whenever any kind of maintenance is needed. For major maintenance (C)a is having the least value among all major maintenances. So it can be said that, when the PSR values are between, 3.125 to 2.900 the cost incurred for maintenance seems to be least.

Z1(min) = 0.412Xa + 0.5Xb + 5Xc + Xd + PSR (B)b

Z2(min) = 0.412Xa + 0.5Xb + 5Xc + Xd + PSR (C)a

The equation contains Z1 is the most generalized form of life cycle cost analysis for general roads which needs minor maintenance.

The equation contains Z2 is the most generalized form of LCCA for general roads which needs major maintenance.

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.

SCOPE OF FUTURE WORK

Further studies may determine the most generalized life cycle cost equation for any type of roads at any given condition.

In future this study and the past studies can be combined to get the most generalized and economical LCCA equation. Time, traffic load, road roughness parameters, weather condition, user comfort these factors can be combined to get a relationship, which can be used to develop the most generalized equation, among them.

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