A Review On Life Cycle Cost Analysis For Roads

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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.

LITERATURE SURVEY

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 for all 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.

PROBLEM STATEMENT

In this study the motive was to develop a model for the following cases

Low traffic growth

Moderate weather in term of rainfall

Stable area development

In this study an optimization model was developed, with respect to the above conditions. The pavement can be considered as a general pavement. For the chosen pavement a low traffic growth had been considered. The weather condition was taken as moderate condition. That means the impact of rainfall on that area is average. Urbanization and development of the area were also considered as average.

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

Climate

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

Table 3.1 Primary factors for cost analysis & their values (adopted from report of annual conference of transportation association of Canada, 2001)

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.

$$Z_1(min) = 0.412Xa + 0.5Xb + 5Xc + Xd + PSR (B)_b$$

$$Z_2(min) = 0.412Xa + 0.5Xb + 5Xc + Xd + PSR (C)_a$$

The equation contains Z_1 is the most generalized form of life cycle cost analysis for general roads which needs minor maintenance.

The equation contains Z_2 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.

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