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Life Cycle Cost Analysis for a Bridge Rehabilitation Project

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Abstract - *In India rehabilitation of old bridges is important. When we consider cultural and aesthetical value of that bridge, the decision making for rehabilitation of any old bridge is not so simple. By considering best option for rehabilitation of bridge may costs higher in initial stage, but in due course of your time it could prove economical, if we perform bridge life cycle analysis. This paper shows bridge rehabilitated proved economical over other rehabilitation technique by performing life cycle cost analysis using case study in Ratnagiri, Maharashtra, India.*

Key Words: Life Cycle Cost (LCC), Life Cycle Cost Analysis(LCCA), Bridge Rehabilitation, Net Present Value(NPV).....

1. INTRODUCTION

Old bridges in India are need of rehabilitation due to many reasons like deterioration, changed traffic conditions, etc. But it's crucial to believe their cultural values and architectural values while deciding for rehabilitation of arch bridges. By performing some retrofitting or by constructing new parallel reinforced cement concrete beam bridge to existing old arch bridge, most of the arch bridges have rehabilitated in India. But if we consider life cycle cost of those bridges, these traditional options of rehabilitation aren't aesthetically and economically feasible. In this paper one case study has considered where actual rehabilitation of old bridge constructed on Bhom posare, Donavali, Gangrai, Maldoli Road in Ratagiri district in Maharashtra was to be handled either by widening and strengthening by jacketing of piers or by constructing new parallel bridge to existing bridge. So this paper shows how new bridge constructed parallel to existing bridge proved economical over widening of bridge by performing bridge Life cycle analysis.

1.1 LITERATURE SURVEY

The paper focuses on provident construction of civil engineering works islands. Islands involve high investment costs, but, because of their estimated service life (100 times), significant operating costs are incurred associated with the conservation and addition of individual structural rudiments. The trend in extending not only considers the investment cost quantities, but also takes into account the anticipated operating costs of completed structures. The Life Cycle Going Styles for islands are still under development and need farther enhancement so that the affair data correspond to reality as much as possible. The paper summarizes the being procedures and presents the rearmost inventions in modelling the life cycle costs of islands built last Time. These particularly relate to the cost base update, but also revaluation of relief cycles of individual structural rudiments, which is grounded on the rearmost specialized knowledge performing from real conditions of serviced islands. (Daniel Maceka, Vaclav Snizekb, Science Direct, 2017).

The proposed work evolves from the examination records of New York City islands and their factors. Factual and recommended periodic expenditures are examined." Full conservation"is defined in terms of fifteen distinct conservation tasks with known costs. The matching benefit are expressed in terms of ground life extension. Indispensable conservation strategies are compared with and without blinking, pointing to a distinction between structurally and economically permissible bones. (BojidarS. Yanev, 2020).

The paper presents a methodology of life cycle cost analysis (LCCA), which is used for the stylish profitable design for both structural integrity and continuity, comparison of indispensable design approaches, Comparison of indispensable strategies, Identification of cost effective enhancement, Project's budget cum profitable viability assessment and Long term fiscal planning. Structural deterioration increases with the age of the ground structure due to concrete spalling, rebar rusting, erosion, fatigue, wear and tear and other styles of material deterioration. Business volume, vehicles number and legal cargo limits increases with time in future. When the geriatric ground structures are subordinated to these kinds of inordinate loads, also the structural capability of it reduces. Thus, LCCA system is best suited to maintain the ground in good condition indicator, for the ever- adding loads and business on deteriorated ground. (Satish Chandra, 2020).

1.2 SLELECTED BRIDGE DESCRIPTION

The selected bridge for life cycle cost analysis is a minor Bridge on Bhom Posare Donavali Gangrai Maldoli Road MDR-29 at km 4/850 in Tal.Chiplun ,Dist.Ranagiri. The traffic intensity of this road is 4266.68 MT/day i.e. 2243.07 PCU/day with average rainfall of 4000 mm/ year. The average road width is 7.0 m with an average height of embankment 1.20 m. This road passes through murum and hilly terrain with adjoining paddy fields and cultivated land. This road connects to SH 136 which is declared as NH 166E and ends at MDR 25 in Maldoli village and caters for heavy vehicle traffic for transportation of grains/ agro products/

tourisms. The existing road is BT surface, having average width of carriageway ranging from 3.75 m with hard murum side shoulder of 1.50 m width both sides. The Bridge under consideration is not been constructed from 15 to 20 years and presently having accident spot so the local residents and drivers of automobile owners are continuously requesting for widening the bridge.

1.3 COST COMPARISON OF TWO ALTERNATIVES OF REHABILITATION BY BRIDGE LIFE CYCLE COST ANALYSIS ALTERNATIVES FOR REHABILITATION OF BRIDGE

Case I: Rehabilitation of old existing bridge (Life Duration-50 years) and same rehabilitation or construction of R.C.C. Beam Bridge after 50 years (Assumed for calculation Purpose). Annual maintenance is considered.

Initial Cost- Rs. 59, 21,000.

Case II: Rehabilitation by constructing new bridge parallel to the prevailing bridge. Annual maintenance is considered. (Design life of new bridge is actually 120 years for safety purpose it has taken 100 years).

Initial Cost- Rs. 62,40,000.

1.4 ASSUMPTIONS MADE FOR CALCULATIONS

Table 1: Calculations Assumptions

Analysis Period	100 years
Service life	Case-I- 50 years +50 years Case-II- 100 years
Annual Maintenance cost	0.1% of initial cost
Interest Rate	7%
Inflation Rate	7%
User cost	No user cost (Rural area with very less traffic) No traffic Delay

*Assumptions according to discussions with technical from P.W.D. Ratnagiri Division.

1.4.1 FORMULA UTILIZED FOR COMPARISON

Present worth method:

Net present value method considers all the cash flows till the end of the life and considers time value of money. Therefore most of time NPV method is used for LCCA. Not only net present value considers different discount rates but also takes into account the cost of capital. But if the alternatives have different life length then NPV cannot be used.

1. $P=F/(1+i)^n$
2. $P=A(((1+i)^n-1)/i(1+i)^n)$

Where,

P= Present worth of money

F= Future sum of money

A= Equal payments in future in uniform series

i= Interest rate

n= Periods

1.4.2 CALCULATIONS

Table 2: case I

Activities	P (in Rs.)	Year	Expenditure (in Rs.)
Initial cost	5921000.00	0	5921000.00
Annual maintenance cost	81714.21	50	5921
Repeated rehabilitation or new R.C.C. beam bridge construction	5921000.00	50	174415045.40
Annual maintenance cost (for repeated rehabilitation)	81714.21	50	5921
Salvage value	- 20100.46	50	-592100.00
Sum of P	11985327.96		

Table 3: Case-II

Activities	P (in Rs.)	Year	Expenditure (in Rs.)
Initial cost	6240000.00	0	6240000.00
Annual maintenance cost	89040.12	100	6240.00
Special maintenance cost (one time)	33947.00	50	1000000.00
Salvage value	-719.12	100	-624000.00
Sum of P	6362268.12		

2. CONCLUSION

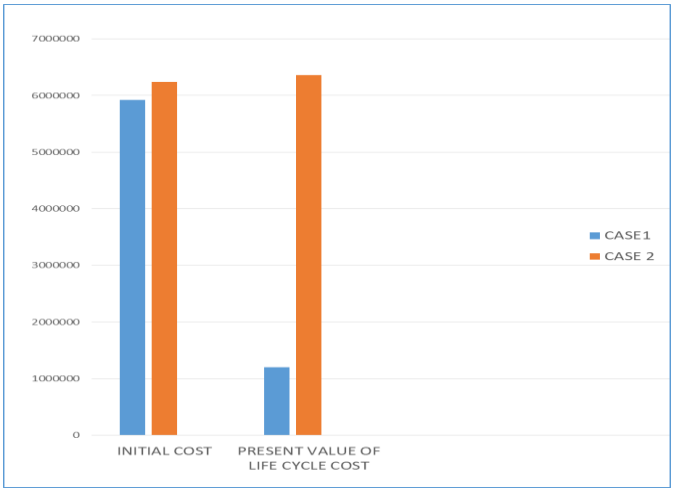

Fig. 1: Comparision between two alternatives

The following conclusions are drawn from study:

1. Life cycle cost analysis is carried out for two cases i.e. one for rehabilitation of old bridge and other one for new parallel R.C.C. bridge. After life cycle cost analysis it is found that initial cost for rehabilitation is Rs.5921000/- and initial cost for new bridge is Rs.6240000/-. Present value of annual maintenance cost for rehabilitated bridge is Rs. 81714/- and for new bridge Rs.89040.12/-.Repeated rehabilitation cost for bridge is Rs.5921000/- and present value of annual maintenance cost for the same is Rs.81714/-. Present value of special maintenance cost for new parallel bridge is Rs.33947/-.
2. Life cycle cost analysis is done for the selected bridge and both alternatives are compared with each other. After comparing both the alternatives it is found that construction of new parallel bridge to the existing bridge is more economical than the rehabilitation of the bridge. Rehabilitation of bridge is initially economical than the construction of the new parallel bridge but it is found that after calculating whole life cycle cost of bridge construction of new bridge is more economical than the widening of a bridge.
3. From calculation it is proved that sum of present worth in Case-I is more than that of sum of present worth in Case-II. So Case- II is economical than case-I. So rehabilitation of bridge carried out is initially feel costlier than other type of rehabilitations but after performing life cycle cost study it proved economical. Rehabilitation of arch bridges carried out by replacing bridge is more economical than rehabilitation carried out by replacing bridge with R.C.C. beam bridge method.

3. LIMITATIONS

Life cycle cost analysis is a time consuming process. It takes lots of time to data collection for the analysis. The analysis process is also time consuming process.
Data collected for the analysis is estimated data so the results obtained from this method are not precise. This method does not gives the exact values of cost.
Life cycle cost analysis sometimes may be costly. In the analysis process accuracy of data collected is doubted because it is roughly collected.
Life cycle cost analysis is can be done only when two alternatives have same timeline.
Life cycle cost analysis would become time consuming process when project comes with more than two alternatives.

4. FURTHER SCOPE

Life cycle cost analysis for bridges become very important to choose one best alternative out of two alternatives. But when project comes with more than two alternatives life cycle cost analysis becomes time consuming. So there is need to avoid time consumption for analysis process which can be further achieved by the software. In India very little study is carried on life cycle cost analysis of bridges so there is scope to do life cycle cost analysis for old bridges which analysis data can be useful for the other bridges which are nearly same in physical condition of that bridge.

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