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Life cycle cost analysis for decision making of rehabilitation of arch bridge in India: A case study

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ABSTRACT

In India there is need of rehabilitation of old arch bridges. But decision making for rehabilitation of any old arch bridge is not so simple when we consider cultural and aesthetical value of that bridge. Considering better option for rehabilitation of arch bridge may costs higher initially, but in due course of time it could prove economical if we perform bridge life cycle cost analysis. This paper shows how arch bridge rehabilitated using lithely arch technology proved economical over other rehabilitation technique by performing life cycle cost analysis using case study in Satara, Maharashtra, India.

Keywords— *Arch bridges, Rehabilitation, Life cycle cost analysis*

1. INTRODUCTION

Old arch bridges in India are on the edge of rehabilitation due to many reasons like deterioration, changed traffic conditions, etc. But it is necessary to consider their cultural values and architectural values while decision making for rehabilitation of arch bridges. But in India most of the arch bridges have rehabilitated by doing some retrofitting or by constructing new parallel reinforced cement concrete beam bridge to existing old arch bridge. But these traditional options of rehabilitation are not aesthetically and economically feasible if we consider life cycle cost of these bridges. In this paper one case study has considered where actual rehabilitation of old arch bridge constructed over Tilganga River near Koregaon in Satara district in Maharashtra was to be carried out either by retrofitting by cantilever widening and strengthening by jacketing of piers or by constructing new parallel bridge to existing bridge. So this paper shows how new bridge constructed using Lithely Arch technology parallel to existing bridge proved economical over retrofitting by performing bridge Life cycle cost analysis.

1.1 Cost comparison of two alternatives of rehabilitation by bridge life cycle cost analysis

Alternatives for rehabilitation of Arch Bridge

Case I: Rehabilitation by widening (cantilevering) and strengthening by Jacketing of piers of old existing bridge (Life Duration-50 years). And same rehabilitation or construction of new R.C.C. Beam Bridge after 50 years (Assumed for calculation Purpose). Annual maintenance is considered.
Initial Cost- Rs. 2, 00, 00,000

Case II: Rehabilitation by constructing new Arch Bridge parallel to the existing bridge using lithely arch method. Annual maintenance is considered. (Design life of new bridge is actually 120 years for safety purpose it has taken 100 years)
Initial Cost- Rs. 2, 11, 41,295.

1.2 Assumptions made for calculations

Table 1: Calculations Assumptions

Analysis Period	100 years (Design life of new bridge is actually 120 years for safety purpose it has taken 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 are made after discussions with technical persons from P.W.D. Satara Division and Modern Arch Infra, Pvt. Ltd, Nagpur, Maharashtra.

1.2.1 Formula utilized for comparison

Present worth method:

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= Uniform series of equal payments in future
i= Interest rate, *n*= Periods

1.2.2 Calculations

Table 2: Case-I

Activities	P (in Rs.)	Year	Expenditure (in Rs.)
Initial cost	2,00,00,000	0	2,00,00,000
Annual maintenance cost	2,76,014	50	20,000
Repeated rehabilitation or new R.C.C. beam bridge construction	2,00,00,000	50	58,91,40,501
Annual maintenance cost (for repeated rehabilitation)	2,76,014	50	20,000
Salvage value	0	50	0
Sum of P	**4,05,52,028**		

Table 3: Case-II

Activities	P (in Rs.)	Year	Expenditure (in Rs.)
Initial cost	2,11,41,295	0	2,11,41,295
Annual maintenance cost	3,01,666	100	21,141
Special maintenance cost (one time)	33,947	50	10,00,000
Salvage value	0	100	0
Sum of P	**2,14,76,908**		

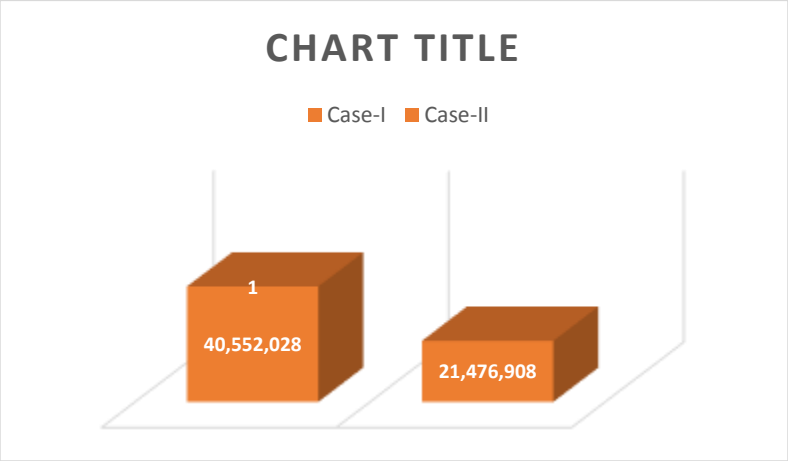

Fig. 1: Chart showing sum of P (in rupees) in Case-I and Case-II

2. CONCLUSION

Following are the conclusions drawn from the study:

- 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 arch bridge carried out by Lithely arch method 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 with lithely arch method is more economical than rehabilitation carried out by replacing bridge with R.C.C. beam bridge method.

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