International Journal of Modern Trends in Engineering and Research
www.ijmter.com
e-ISSN No.:2349-9745, Date: 2-4 July, 2015

Life Cycle Costing of Building Structure

Shweta S.Sawant[1],Prof.Dr.P.G.Gaikwad[2]
[1]*Department of Civil Engineering, NDMVPS's KBT, COE Nashik.sawantjaya92@gmail.com*
[2]*HOD,Department ofCivil Engineering, NDMVPS's KBT,COE.Nashik.pggiitr@gmail.com*

Abstract-Cost is the main criteria at the time of making choice between different systems or assets. Thus it has become essential to optimize it throughout their entire life cycle from initial stage to final stage.i.e. acquisition to the disposal of an asset.Life cycle costing is concerned with optimizing value of physical asset or system by considering all cost factors relating to asset during its operational life. An ability to determine the life cycle cost of building will help to evaluate the value of existing structure and make better decision for new structure or system and it also takes into account the time value of money, that is, the variation in the cost due to its timing. For the application of life cycle costing, bunglow is selected. From Life Cycle Cost analysis of bunglow it is found that acquisition cost constitutes only 23% of total life cycle cost of bunglow while service cost constitutes 77%.
Keywords-Life Cycle Cost(ing);cost optimization;Net Present Value; operational life; life cycle.

I. INTRODUCTION

Life Cycle Costing (LCC) was originally designed for investment purposes in the U.S. Department of Defence [10]. The importance of LCC for the U.S. Department of Defence was shown by the fact that the operational costs regarding to weapon systems, where 75% of the total life cycle costs. Later the LCCmethod was also applied in the automobile sector [11] and then in engineering sector.The need to apply whole life costing becomes even more important when considering sustainable buildings. This is because sustainability advocates having the buildings needed at the lowest, environmental, social, and economic cost to be able to "meet the needs of the present without compromising the ability of future generations to meet their own needs". Green buildings are designed to use resources efficiently (e.g., materials, energy), minimize impacts on the environment (e.g., emissions), and reduce long-term costs[2].

There is considerable evidence that many organisations make acquisition of asset simply on basis of purchase cost alone.[3]Usually the cost of operation and maintenance exceed all other costs many times over. Therefore, to overcome this problem of increasing cost budget, concept of LCC analysis is used to optimize cost.Life cycle costing (LCC) is used to evaluate the cost performance of a building throughoutits life cycle, including acquisition, construction, operation, repair, replacement and disposal.It allows comparison among the different systems. The analysis methodology of Life Cycle Costing (LCC) concerns the estimation of the cost, incurred in all phases of the life of an asset, i.e. construction, operation, maintenance and disposal / recovery. The ultimate aim is to calculate the combined costsassociated with each phase of the life cycle and attempting to minimize it, thus providingeconomic benefits to both the producer and the end user.

Life Cycle Cost analysis needs various cost inputs for calculating the life cycle cost of project. The cost variables are categorized into groups:

Acquisition cost-Acquisition cost is the initial cost. It is occur prior to putting assets or system in service. It includes site cost, temporary work, design cost, planning cost, and earthwork, commissioning fees etc.

Construction, Maintenance, operation and management cost-Maintenance, operation and management are necessary for ensuring that building function and operate properly throughout its life cycle. The costitems consider in this phase are Rates, Insurance, Energy cost, Water and sewage cost, facility management and cleaning, security and maintenance.LCC analysis helps engineers to justify equipment, system and process selection based on total costs rather than the initial purchase price alone.An attempt has been made in this work to determine the life cycle cost of bunglow by Net Present Value of discounting approach and attempting to find out cost effective areas hence more attention is given towards them to reduce total life cycle cost.

II. METHOD

Bunglow is selected for the analysis of life cycle costing for finding out cost associated with different phases of bunglow and summing up of them to find out Life Cycle Cost of bunglow. Due to change in time value of money project cost that occurs at different points in life cycle of building cannot be compared or summed up directly. Therefore they are discounted back to their present value through the appropriate equations. Costsare converted into their time-equivalent value at the base date before beingcombined to calculate the LCC of a project stage. This timeequivalentvalue is referred as the Present Value (PV) of the costs. The discountrate is the interest rate used to convert future expenditures to theirpresent value at the base date.To calculate the LCC first compute the present value of each cost to be incurred during the study period, using discount rate.Then summing up of these present values at base date subtracting positive cash flow i.e. residual cost,and that is formulated as follows.

$$TLCC = (I)+PV(E)+PV(W)+PV(REPL)+PV(OM\&R)-PV(RES\ )^{[5]}$$

Where,TLCC-Total Life cycle cost of building, PV-Present value, I -Investment Cost, E-Energy Cost, W-Water Cost, Repl=Replacement cost, OM &R=Operation, Maintenance and repair cost,Res =Residual value.

III. DATA COLLECTION &ANALYTICAL WORK

According to cost/cash data collected from architectural firm in different phases of life cycle of bunglow, analytical work is carried out. In this, at year 2007 land acquisition was takes place and that is considered as base date at which all costs are discounted back. Bunglow wasdesign for 50 years, hence the life of bunglow is 50 years i.e. from 2008 to 2058.

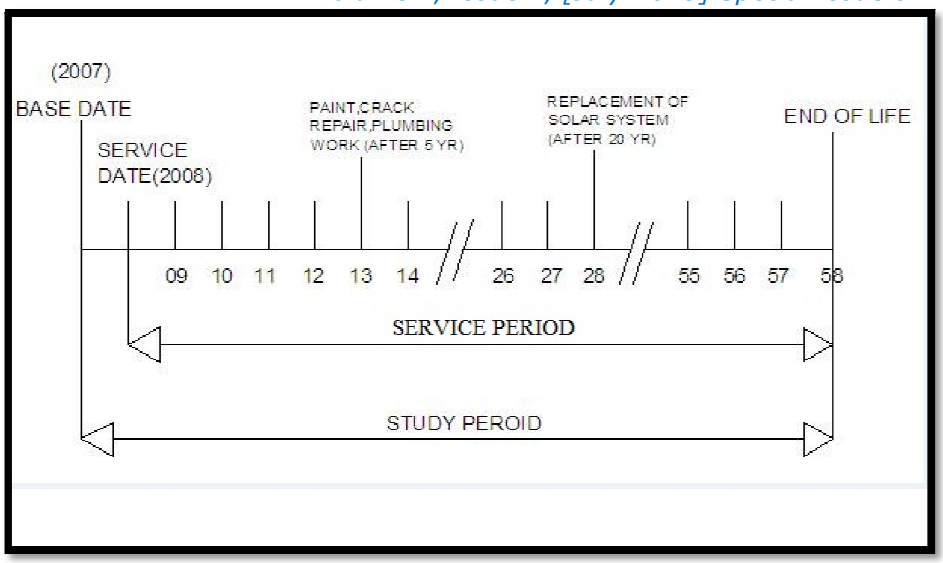

Figure 1 Cash Flow diagram for entire life cycle of bunglow

Study period is selected from base date and it includes both construction period and service period for the project. After construction, service period is start i.e. from 2008 to 2058.After every 5thyear paint, repair work, plumbing work is carried out. After 20thyear replacement of solar system is carried out. Total life cycle cost is calculated as follows considering discount rate, inflation rate using appropriate equations etc.

Table 1 Criteria For LCC Analysis

Criteria For LCC Analysis	Description
Evaluation Method	Life cycle cost analysis
Discounting Approach	Present value at the base date
Cost measurement basis	Constant Rs. At the base date
Cash flow Convention	End of year cash flow
Evaluation Criteria	Lowest life cycle cost
Basic requirement	Written record for every analysis

3.1 Calculation of LCC:

1) Life of Building =50 years
2) Discount Rate (i) =6%[Ref.International Monetary Fund]
3) Inflation Rate For fuel/light (e) =5.52%
4) Study Period=50 years
5) LCC OF building=

[Initial Cost of building +PV (Construction Cost) +PV (Operation Cost) +PV (Maintenance Cost) – PV (Residual/Disposal cost)]

3.1.1 Equations used in calculation of LCC[8]:

1. Simple Present Value (SPV)=$\frac{\mathbf{1}}{\mathbf{(1+i)^n}}$

   for non recurring cost like Construction Cost, Crack repair, Paint, Plumbing work, Replacement of solar, Residual cost etc.
2. UniformPresent Value (UPV)=$\frac{\mathbf{(1+i)^n-1}}{\mathbf{i(1+i)^n}}$

For recurring cost like Water cost, Cleaning cost etc.

3. Modified Uniform Present Value(UPV*)=$\frac{\mathbf{1-\{(1+e)/(1+i)\}}}{\mathbf{\{(1+i)/(1+i)\}-1}}$

For recurring cost having escalation rate like energy cost
Escalation rate for energy =5.52%, Discount rate =6%

3.2 Life Cycle Cost Calculations

Table 2 Total Life Cycle Cost Calculations

Type of cost	Year	Year from base date	Amount in Rs.	Discount factor	Present Value at base date
1)Land Acquisition Cost	2007	0	1500000	-	1500000/-
2)Construction Cost including interior	2008	1	2105845	0.9433	1986646/-
3)Maintenance Cost					
a)Crack repair	2013	6	30000	0.7049	211480/-
b)Paint	2013	6	100000	0.7049	704900/-
C)Plumbing Work	2013	6	35000	0.7049	246730/-
d)Replacement of solar system	2028	21	55000	0.2941	323557/-
4)Operation Cost					
a)NA Tax	Annually	-	400/yr	15.761	6304/-
b)Property Tax	Annually	-	1500/yr	15.761	23641/-
c)Energy Cost	Annually	-	30000/yr	44.626	1338785/-
d)Water Cost	Annually	-	5000/yr	15.761	78805/-
e)Cleaning	Annually	-	3000/yr	15.761	47283/-
5)Residual Cost	2058	51	210584	0.0542	11432/-
Total Life Cycle cost					**6469274/-**

IV. CONCLUSION

Every year numerous purchases of buildings and equipments are based on initial or acquisition cost alone. Lowest purchase price does not necessarily minimize total cost over the life of asset.Best balance among cost elements is achieved when the total LCC is minimized. Inadequate design, construction, inspection, and maintenance practices are identified as key factor for increasing LCC.

Therefore, to overcome this problem of increasing cost budget, concept of LCC analysis is used to optimize cost. LCC analysis is applied on selected bunglow. Cost data required for LCC is collected and Using Net Present Value approach, future costs are converted into their present value at base date. Result from the calculated life cycle cost of bunglow shows that acquisition cost is Rs.15,00,000 which constitute only up to 23% and construction, operation, maintenance cost is Rs.49,69,274 which constitutes about 77% of total life cycle cost Rs. 6469274.Hence more attention is required towards them for optimizing total life cycle cost and also at time of selecting alternative of optimum LCC.

REFERENCES

[1] ASTM International. Standard Classification for Life-Cycle Environmental Work Elements-Environmental Cost Element Structure. E 2150-02. West Conshohocken, PA: ASTM International. (2003)

[2] Brutland G. "Our common future: The world commission on environment and development" Oxford University Press(1987).

[3] David G. Woodward, "Life Cycle Costing: theory, information acquisition and application" International Journal of Project Management, Vol. 15 No. 6, p. 335-44. (1997)

[4] David Arditi, ASCE, and Hany Mounir Messiha,"Life Cycle Cost Analysis (Lcca) In Municipal Organizations" Journal of Infrastructure Systems, Vol. 5, No. 1. ASCE, ISSN 1076-0342/99/0001-0001–0010 Paper No. 16673. (1999)

[5] Life Cycle Costing Manual for the Federal Management Programme/National Institute of Standards and Technology.NIST Handbook 135 (1995)

[6] Mazen Farran and Tarek Zayed, "Comparative Analysis of Life-Cycle Costing for Rehabilitating Infrastructure Systems"Journal of Performance of Constructed Facilities, Vol. 23, No. 5, ASCE, ISSN 0887-3828/2009/5-320–326.(2009)

[7] M. H. Issa, M. Attalla, J. H. Rankin and A. J. Christian, "Detailed Analysis of the Construction, Operating, Maintenance, and Rehabilitation Costs of Green Toronto Schools" Journal of Architectural Engineering, Vol. 19, No. 1, ASCE, Pg no.1–11(2013).

[8] Society of Chartered Surveyors Ireland, Guide to Life Cycle Costing.

[9] Tamer E. El-Diraby and Igor Rasic "Framework for Managing Life-Cycle Cost of Smart Infrastructure Systems"Journal of Computing in Civil Engineering, Vol. 18, No. 2, ASCE, Pg.no.115-119.(2004)

[10] White G.E. and Ostwald P.F, "Life Cycle Costing" Management Accounting, Vol. 57 No. 7, p. 39-42. (1976)

[11] Witik,R.A., Gaille, F., Teuscher, R., Ringwald, H., Michaud, V. and Månson, J.A.E. "Economic and environmental assessment of alternative production methods for composite aircraft components". Journal of Cleaner Production, Vol. 29–30, Pages 91-102. (2012)

