MICHIGAN CONCRETE ASSOCIATION

Simplified Life Cycle Cost Analysis

LCCA for Local Agencies

Steve Waalkes, PE

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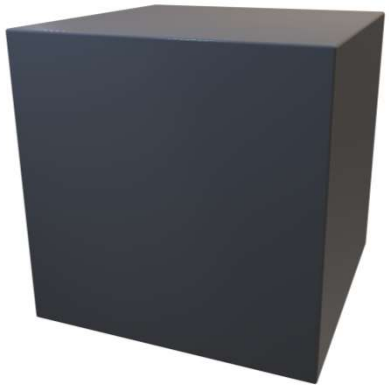
Life-Cycle Cost Analysis

What is it ?

- Economic procedure
  - That uses Engineering inputs
- Compares competing alternates over their life
  - by considering all significant costs (and benefits)
    - Construction, Maintenance, Rehabilitation
    - User
    - Performance
- Expressed in equivalent dollars.

What it isn't:

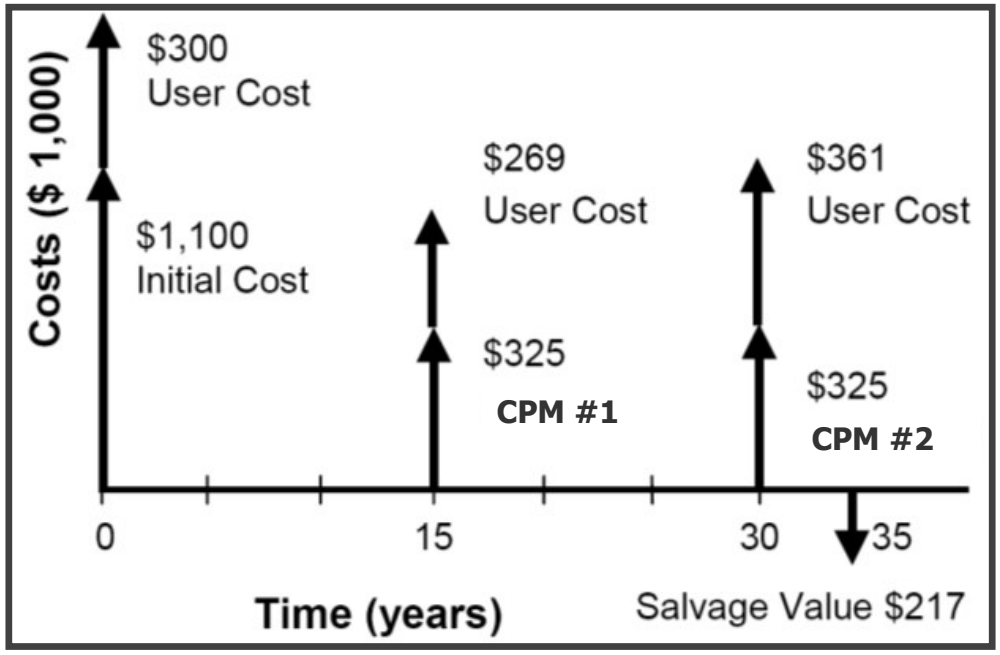


LCCA: What is it?

"A life cycle cost analysis calculates the cost of a system or product over its entire life span."

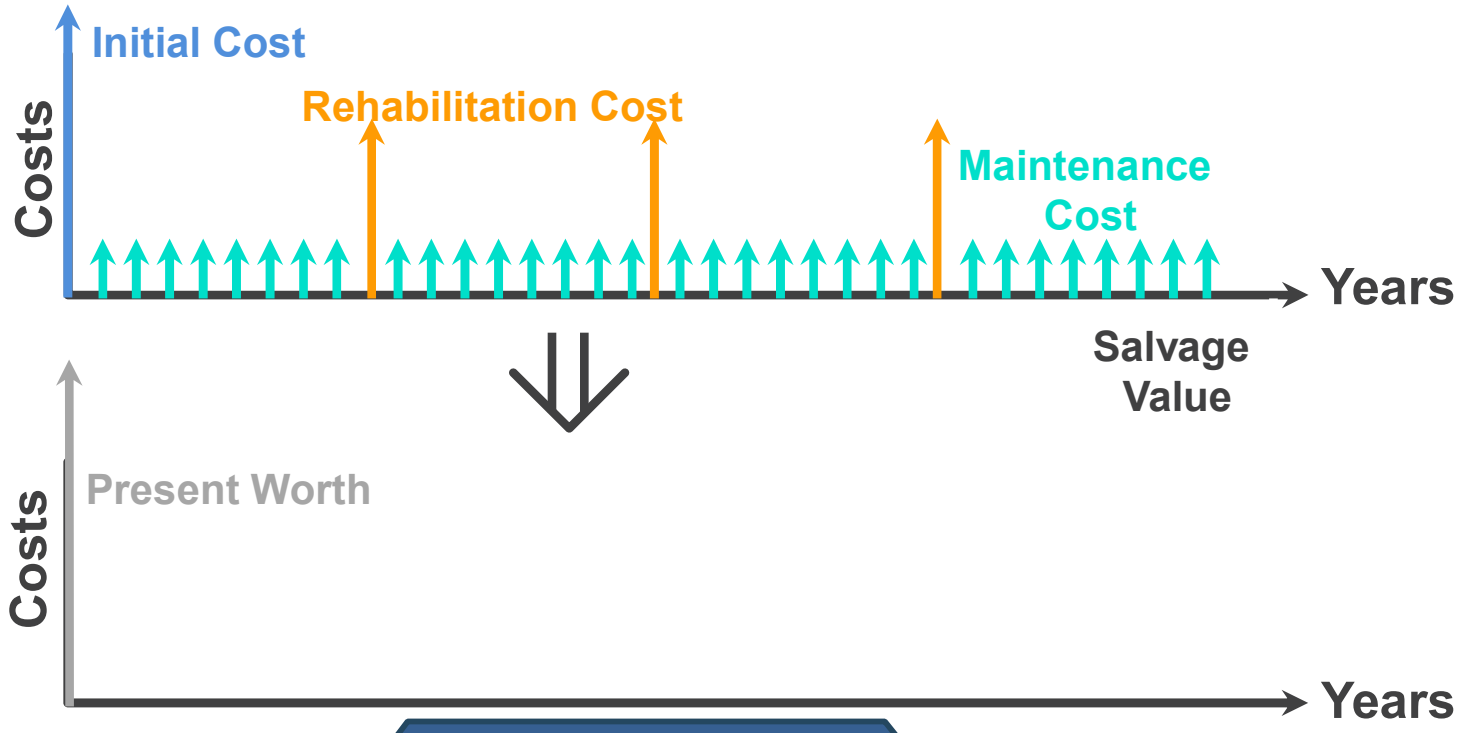
For pavements, can include :

- Initial Construction Costs
- Maintenance Costs
- User Delay Costs
- Salvage/Remaining Life Value



Life-Cycle Cost Analysis

Present Worth Analysis:



Life-Cycle Cost Analysis

Present Worth Analysis:

$$PW = IC + \sum_{t=0}^{t=n} pwf\,[MC+UC+FRC] - pwf(S)$$

IC	= Initial Cost
MC	= Maintenance Cost
UC	= User Cost
FRC	= Rehabilitation Cost
S	= Salvage (Recycling value)
pwf	= Present Worth Factor

Life-Cycle Cost Analysis

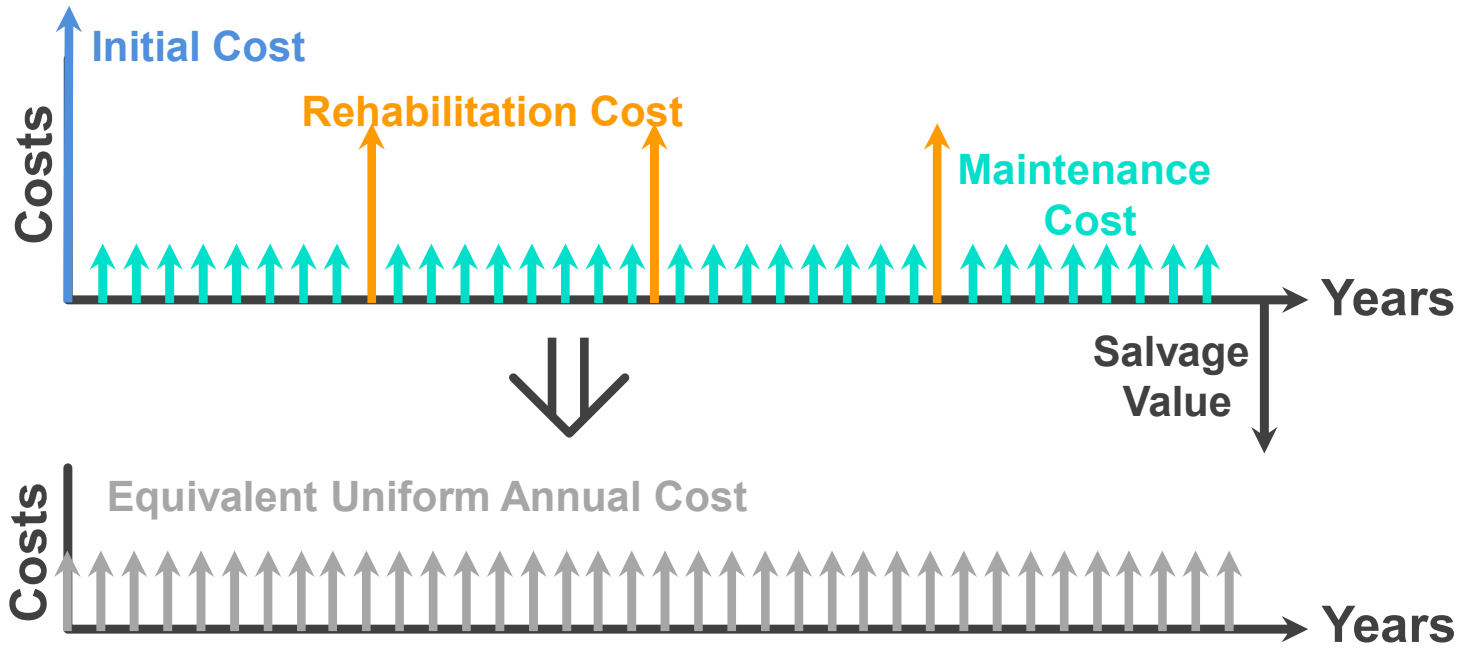
Present Worth Factor:

$$pwf = \frac{1}{(1 + i)^n}$$

pwf = Present Worth Factor for discount rate i and year n
i = Discount rate
n = Number of years when cost (benefit) will occur

Life-Cycle Cost Analysis

Equivalent Uniform Annual Cost:



Life-Cycle Cost Analysis

Equivalent Uniform Annual Cost:

$$EUAC = crf\,(IC) + AM + AUC + \left[crf \sum_{t=0}^{t=n} pwf(FRC) \right] - crf(S)$$

IC	= Initial Cost
AM	= Annual Maintenance Cost
AUC	= Annual Users Cost
FRC	= Future Rehabilitation Cost(s)
S	= Salvage Value
crf	= Capital Recovery Factor
pwf	= Present Worth Factor

Life-Cycle Cost Analysis

Capital Recovery Factor:

$$crf = \frac{i\,(1+i)^n}{(1+i)^n - 1}$$

crf	= Capital Recovery Factor for discount rate i and year n
i	= Discount rate
n	= Number of years when cost (benefit) will occur

Life-Cycle Cost Analysis

Discount Rate:

$$DR = \frac{\text{Interest - Inflation}}{1 + \text{Inflation}}$$

Discount Rate = *Real Interest Rate*

Interest - The return of an investment that raises the future value of a dollar
Inflation - The erosion of a dollar's value that raises the cost of future expenses

LCCA: Simple spreadsheet (Initial Costs)

PAVEMENT TYPE COMPARISON

Lake Township, MI

Concrete vs. Asphalt

Equivalent Designs - using 6" Concrete as starting point

Project Size = 20,000 syd

Asphalt								Back-of-the-envelope comparison	
Item	Description	Thickness		Price	Unit	Quantity	Cost	layer coeff	SN
Top	HMA, 5EL	3.25	in.	$90.00	ton	3575	$321,750.00	0.44	1.43
Leveling	HMA, 4EL	3.25	in.	$80.00	ton	3575	$286,000.00	0.44	1.43
Agg Base	21AA	8	in.	$12.00	syd	20000	$240,000.00	0.14	1.12
						TOTAL	$847,750.00	S SN	3.98
Concrete									
Concrete	Conc Pavt, Nonreinf, 6 inch	6	in.	$40.00	syd	20000	$800,000.00	0.55	3.3
Agg Base	21AA	6	in.	$10.00	syd	20000	$200,000.00	0.14	0.84
							$1,000,000.00	S SN	4.14
						% diff. =	17.96%		

LCCA: Simple spreadsheet (Maint/Rehab Costs)

Maintenance/Rehab Costs

	Interest Rate	3.0%			Conc. Transverse Joint Spacing	12	ft
	Inflation Rate	2.5%			Service Life	30	yrs
	Discount Rate	0.49%					

Asphalt

Year	Action	Quantity		Unit Cost	Extended	pwf	Present Cost
6	Crack sealing	4,000	ft	$2.00	$8,000.00	0.971225	$7,769.80
10	HMA Patching	1500	syd	$20.00	$30,000.00	0.952503	$28,575.09
12	Mill & Overlay 1.5"	20,000	syd	$7.00	$140,000.00	0.943278	$132,058.91
15	Crack sealing	5,000	ft	$2.00	$10,000.00	0.929607	$9,296.07
20	Chip seal	20,000	syd	$2.50	$50,000.00	0.907262	$45,363.11
17	HMA Patching	3000	syd	$20.00	$60,000.00	0.920604	$55,236.24
25	Crack sealing	5,000	ft	$2.00	$10,000.00	0.885454	$8,854.54
						TOTAL	$287,153.78

Concrete

Year	Action	Quantity		Unit Cost	Extended	pwf	Present Cost
15	Conc Patching	500	syd	$100.00	$50,000.00	0.929607	$46,480.37
25	Conc Patching	600	syd	$100.00	$60,000.00	0.885454	$53,127.24
						TOTAL	$99,607.62

Total Life Cycle Cost (Net Present Cost)

Asphalt	Concrete
$1,134,903.78	$1,099,607.62

% diff. = -3.11%

Requires:

- Estimated amounts of future maintenance & rehab

Benefits:

- Can use today's prices

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Summary

- Life cycle cost analysis (LCCA) can be used to compare pavement alternatives that have different initial costs
- LCCA doesn't have to be difficult
- Can be done with a simple spreadsheet
- Be careful with inputs that can sway results

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QUESTIONS?

Steve Waalkes, P.E.
616-633-9629
steve@miconcrete.org