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Civil & Environmental Engineering Department



# LIFE CYCLE COST ANALYSIS OF PRECAST CONCRETE PAVEMENT

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*2017 Project Management Symposium*



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# INTRODUCTION



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- Two priorities of construction projects are time and cost consideration.
- Traditional methods causes inconvenience.
- Precast concrete panels (PCP) are fabricated offsite, transported to site, and installed on prepared subbase at site.
- PCP are also used for retrofitting pavements, maintenance of pavements, construction of new pavements, urban street rehabilitation, isolated repair, intersections and ramp rehabilitation.



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# ADVANTAGES OF PRECAST CONCRETE PAVEMENT



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- Faster construction.
- Thinner slabs.
- Durability.
- Longer construction season throughout the year.
- Reduces the project duration.



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# LCCA METHODOLOGY



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- LCCA provides an approach for computing the cost of a product or its serviceability
- It is used to compare design alternatives over its life of each alternative considering cost and benefit parameter
- Two types of cost: User cost and Agency cost
- Agency costs are cost paid by department of transportation
- User costs are cost which are associated with public motorists





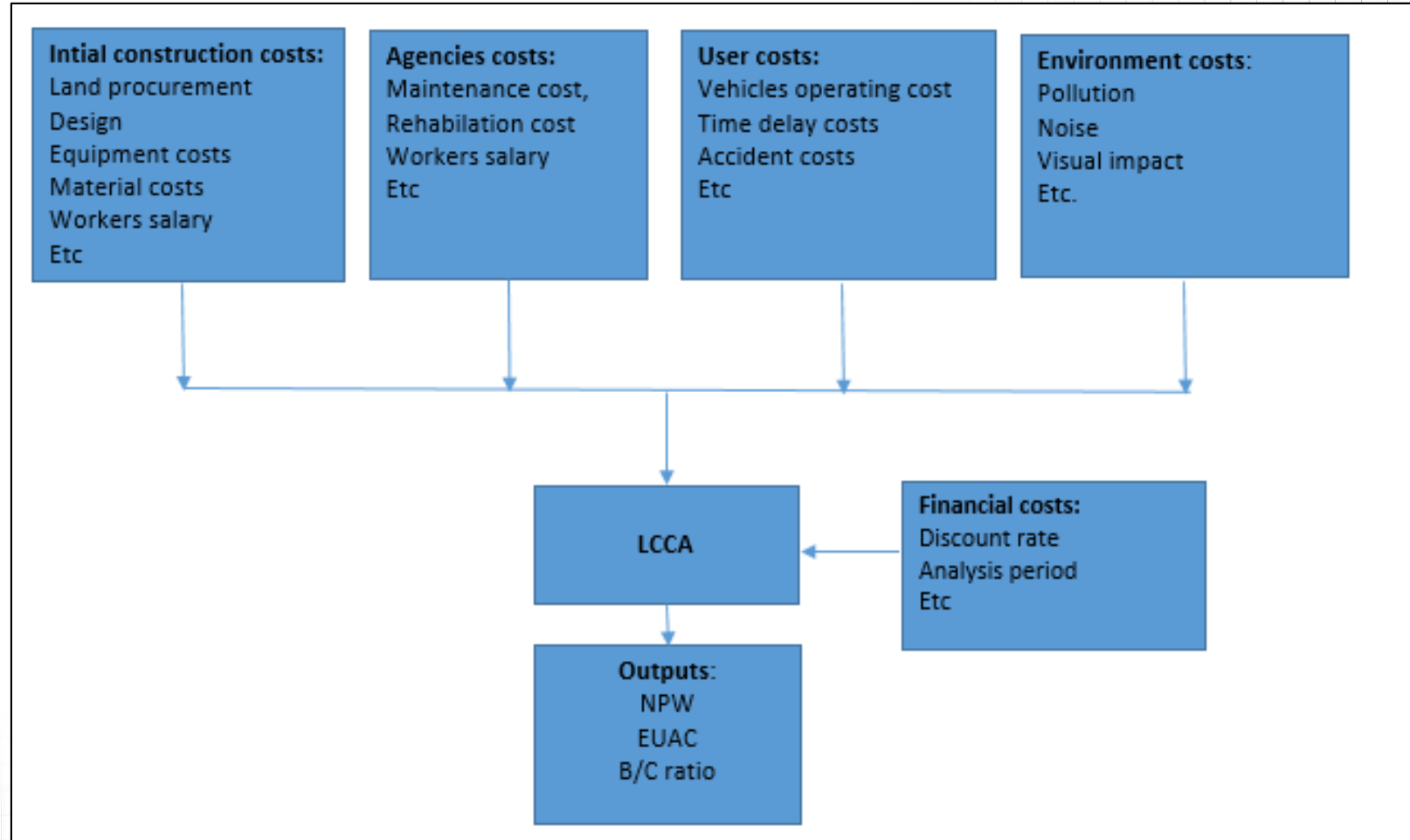
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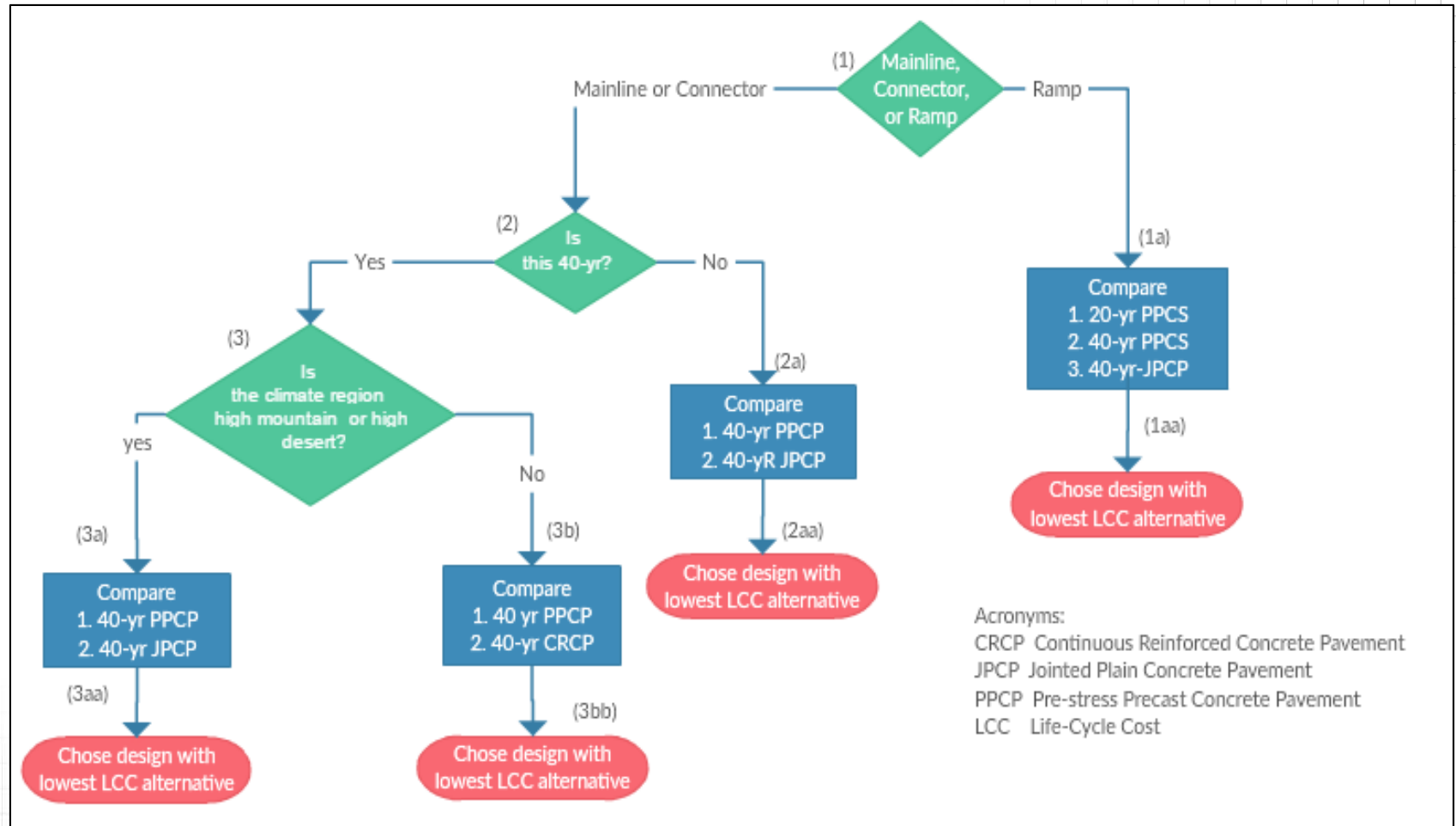
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## Elements to perform LCCA:

- Set up alternative design strategies
- Establish activity timings
- Evaluation of agency costs
- Estimation of user costs
- Determine the life cycle cost



**A flowchart describing LCCA process for  
pavement selection Scheving, A. G. (2011).**



**A flowchart describing selection of Pavement Alternative.**



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## Economic analysis components

1. Evaluation methods
2. Analysis period
3. Discount rate
4. Sensitivity analysis

### Costs Factors

- Agency cost:
  1. Initial construction cost,
  2. Maintenance and rehabilitation cost
- User cost:
  1. Vehicle operating cost,
  2. User delay cost,
  3. Crash cost

### Salvage Value



## Evaluation methods:

- Economic Analysis techniques
- Net Present Worth (NPW) method
- The Internal Rate of Return method (IRR)
- Benefit-Cost Ratio (B/C)
- Equivalent Uniform Annual Cost (EUAC)
- Net Present Worth is also called Net Present Value (NPV).

$$NPW = C_0 + \sum_{n=1}^N \frac{M_n + O_n + U_n}{(1+i)^n} - \frac{S}{(1+i)^N}$$

Where,  $C_0$  = Initial construction cost;  $n$  = specific year of expenditure;  $i$  = discount rate;  $M_n$  = maintenance cost in year  $n$ ;  $O_n$  = operating cost in year  $n$ ;  $U_n$  = user cost in year  $n$ ;  $S$  = Salvage value;  $N$  = Total analysis period (Scheving, A. G., 2011).



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# LCCA MODEL



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$$LCCA = (I + M\&N + U + O + S)$$

where:

I= Initial construction cost,

M&N= present value of maintenance and rehabilitation cost,

U= present value of user cost,

O= present value of operating cost,

S= present salvage value.



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# CASE STUDY





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- In this model, hypothetical dimensions of pavements are considered.
- The quantity calculations are carried for the length of a one-mile road
- the comparison is done between different pavement alternative design models such as Precast Prestressed Concrete Pavement (PPCS), Joint Plain Precast Concrete Pavement (JPPCP), Jointed Plain Concrete Pavement (JPCP) and Continuous Reinforced Concrete Pavement (CRCP).
- The dimensions for the prefabricated precast panel are 40ft x 8ft x 1ft.
- The model considered an overall discount rate of 4%.
- The salvage value was not taken into consideration for this model.
- All the future costs were converted to present value with the help of the NPW equation.



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# RESULT AND ANALYSIS



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## Cost calculation

Activity	PPCP	JPCP	JPPCP	CRCP
Initial Construction Cost (\$)	2,741,715.57	1,931,412.01	2,623,804.82	2,018,207.43
Maintenance and Rehabilitation Cost (\$)	379,493.99	872,140.29	379,493.99	872,140.29
User costs (\$)	1,037,382.55	2,652,537.02	1,037,382.55	2,652,537.02
Life Cycle Cost (\$)	4,158,592.11	5,456,089.32	4,040,681.36	5,542,884.74



# Construction duration calculation

Activity	Precast (Days)	Onsite (Days)
Aggregate	6	13
LCB	10	10
Concrete Slab	19	55
Total Duration	35	88

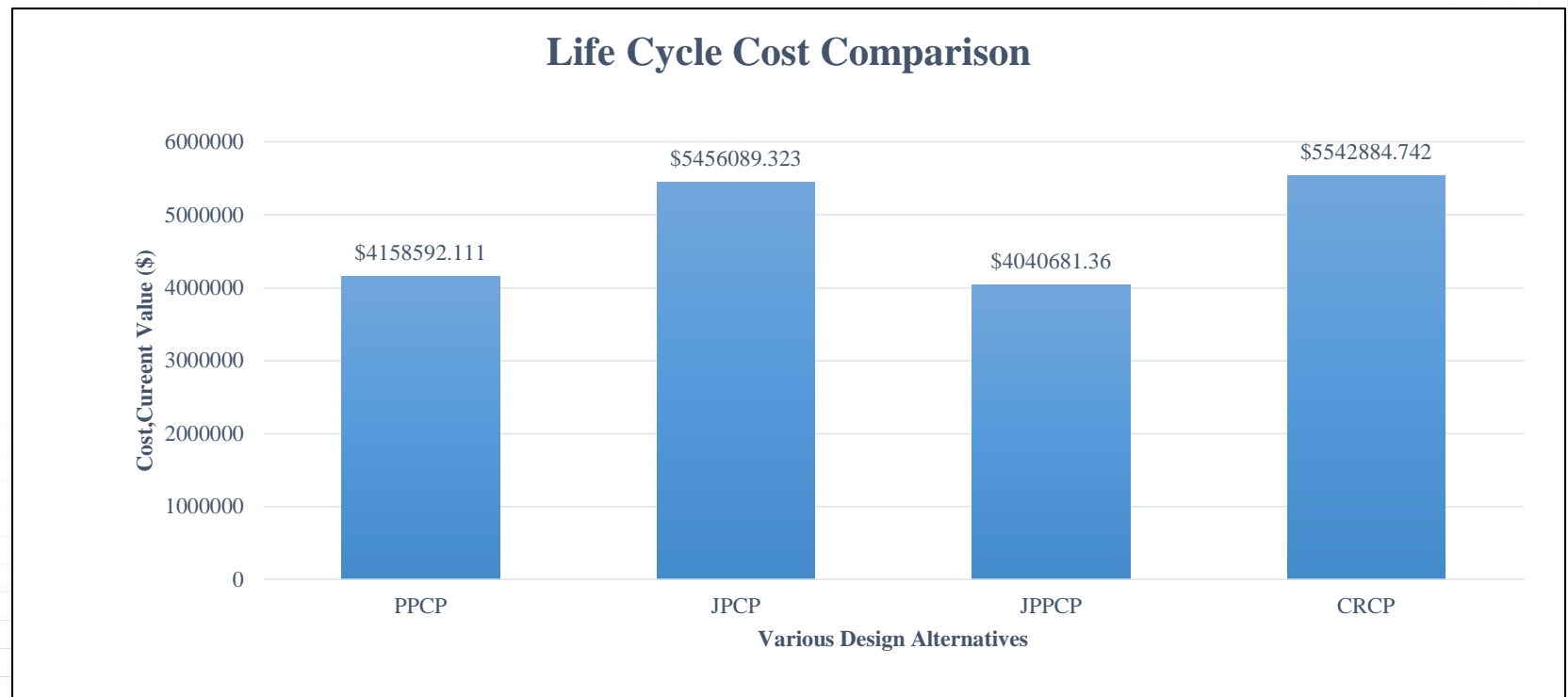


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## Analysis



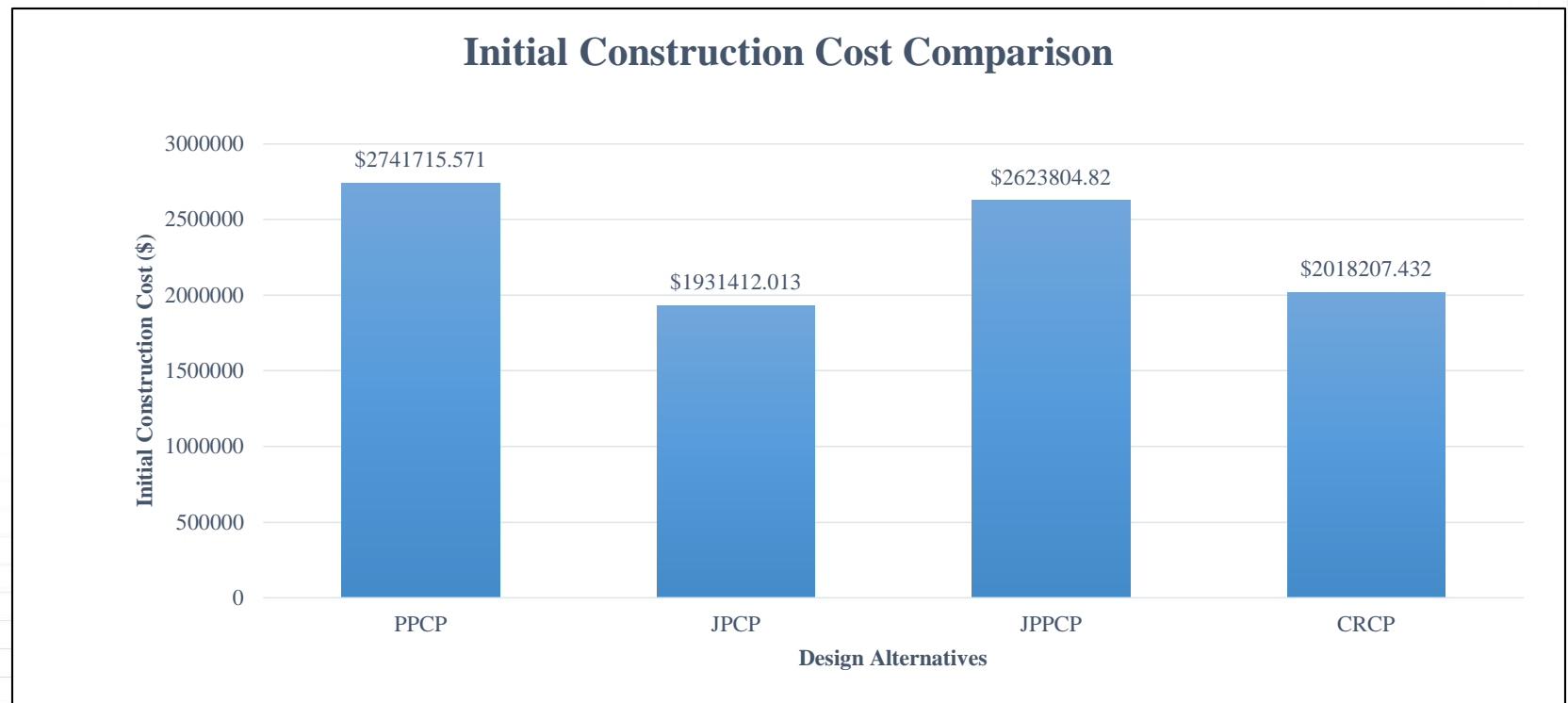


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## Analysis





# Analysis

- Life Cycle Cost of precast concrete pavement for both alternatives are less than the traditional method.
- Duration for onsite casting is 88 days which is way higher than the precast concrete which is 35 days.



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# QUESTIONS