十五、Selection of the Preferred 4R Alternatives

參考資料：

1. Darter, M. I. “ Techniques for Pavement Rehabilitation,” Training Course, FHWA, 1987. (Module 7A)

◎ Introduction

1. Costs for maintenance and rehabilitation at different points in time
2. Life Cycle Cost (LCC): (Figure 1)
   Present worth (PW)
   Equivalent Uniform Annual Cost (EUAC)
3. “Preferred Alternative” = the one that meet all of the engineering criteria (e.g., traffic control, initial funding) and is cost-effective

◎Development of Alternatives

※Major Design Alternatives:

1. Asphalt Overlay with extensive patching
2. Asphalt Overlay with little or no patching
3. Concrete Overlay with minor repairs
4. Recycle one or more layers plus overlay
5. Restore the existing pavement through extensive patching, grinding, etc. (without an overlay)

※Recommended Approach: (Figure 2 Rehabilitation Alternative Design Process)

1. Obtain available project information
2. Establish existing condition of pavement
3. Determine the causes of distress
4. Develop feasible alternatives: (Figure 3, 4)
    a. Restoration b. Recycling
    c. Resurfacing d. Reconstruction
5. Conduct engineering and economic analysis
6. Select the preferred rehabilitation alternatives
7. Design the rehabilitation alternative
8. Make follow-up reviews of pavement performance

※Value Engineering (VE)

1. Appointment of a design review committee: including planning, design, construction, traffic operations, standards, maintenance, and purchasing
2. Solicitation of intra-department or inter-department suggestions
3. Solicitations for ideas from contractors, material suppliers, etc.
4. Brainstorming by either individuals or committees
5. Review of previous studies and ideas from other highway agencies

※Greatest Obstacle: “Habitual Thinking”

◎Selection of the Preferred Alternative Design

※Overriding Factors: traffic, soils, climatic, traffic control, lane closures, available materials and equipment, overall pavement management considerations

※Life-Cycle Costs:

1. Costs to the highway agency
2. Costs to the highway user

Figure 6 - Various Cost Components for Example Design Strategy B

Figure 7 - Cost Components for Five Example Design Strategies

Figure 8 - Life-Cycle Cost Computation Example

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

$$EUAC = PW(CRF)$$

$$PW = EUAC\left(\frac{1}{CRF}\right) = EUAC\left(\frac{(1+i)^n - 1}{i(1+i)^n}\right)$$

$$= EUAC\left(\frac{1-(1+i)^{-n}}{i}\right)$$

※LCC Computations:

1. Analysis Period
2. 4R Alternative Performance Period
3. Future Maintenance and Rehabilitation Costs
4. Salvage Values

5. Discount Rate
    a. Commonly called an interest rate in business investments
    b. Opportunity cost of capital
    c. NCHRP Syntheis:
        “There is general agreement that the discount rate or real discount rate should be the difference between the market interest rate and inflation using constant dollars.”

[Figure 10 Preliminary Example LCC analysis]
[Table 3.4 Illustration of EUAC computation]

$$PW = C_i \frac{(1+\text{inf})^{\text{n}}}{(1+\text{int})^n} \approx C_i \frac{1}{(1+i)^n}$$

$$\textit{discount rate},\ i = \text{int} - \text{inf}$$

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

※Evaluate Overall Important Decision Factors
※Detailed Design for Selected Alternative

◎ **工程經濟分析**(**表二**~7)

$$S = P(1+i)^n = P[spcaf(i,n)]$$

$$S = R\frac{(1+i)^n - 1}{i} = R[uscaf(i,n)]$$

$$P = R\frac{(1+i)^n - 1}{i(1+i)^n} = R[uspwf(i,n)]$$

P = **投資現額**

S, F = n **期後之總額**

R = **連續每期償付或收回之固定金額**

(i = **每期最低報酬率**，n = **期數**)

spcaf = **一次償付複利因子**(single-payment compound-amount factor)

sppwf = **一次償付現值因子**(single-payment present-worth factor) = 1/spcaf

uscaf = **定額複利因子**(uniform-series compound-amount factor)

sfdf = **基金儲存因子**(sinking-fund deposit factor) = 1/uscaf

uspwf = **定額現值因子**(uniform-series present-worth factor)

crf = **資金還原因子**(capital recovery factor) = 1/uspwf

[**將分析期間所發生之任何成本**(C)**或利益**(B)**均換算成等額之年值或現值，再比較選擇經濟可行之方案**]