SECTION 540.00 – PAVEMENT STRUCTURE ANALYSIS

540.01 General

540.01.01 An engineering report covering life cycle cost analysis of the pavement structure shall be made for each project that involves new construction, reconstruction, or rehabilitation of pavement. Refer to Section 540.03.01.

540.01.02 The engineering report will be incorporated as an attachment to the Phase 1 materials report and, subsequently, to the concept report.

540.01.03 The engineering report will address the pavement type and will be reviewed and updated as needed as part of the Phase II report and again reviewed prior to advertising for bids if the report is more than 2 years old.

540.01.04 A report will not be required on projects where the primary work is other than paving.

540.01.05 The overall design concept should start with current design standards to provide a basis for comparing alternates.

540.01.06 The report should address the need and estimated cost for additional right-of-way, excavation, borrow, structures, and cross drain extension and/or replacement. These costs should be used to help describe the project. The costs are not to be included in the life cycle cost analysis.

540.01.07 Review the roadway beyond the project limits.

540.01.08 Pavement structure designs tend to be overly conservative for low- volume roadways with the surface basically intact. Roadways under 250 truck ADT are considered low-volume; from 250 to 1000 truck ADT are medium-volume; and above 1000 truck ADT are high-volume.

540.01.09 On low-volume, older roads with the surface basically intact, the maximum overlay will be 90 mm (0.3 foot) or less, even if the 20-year pavement structure design calls for a greater depth.

540.01.10 On rehabilitation projects, new construction such as shoulder widening will be fully ballasted even if the interior road surface overlay is governed by the maximum 90 mm (0.3 foot) requirement.

540.01.11 When appropriate, address the historical performance of applicable design alternatives.

540.02 Engineering Evaluation.

540.02.01 Determine the history of construction and maintenance for the project under consideration, including typical section and summary of soils profile.

540.02.02 Complete a field review.

540.02.03 Request a pavement overlay design (POD) run.

540.02.04 Request traffic data including truck loadings.

540.02.05 Evaluate the POD run and take samples at each side of break points for R-value testing. Determine the existing layer thickness of each structural component at these points.

540.02.06 Using R-values and traffic data, calculate overlay thickness, new plant mix, and Concrete surface requirement based on a 20-year design period.

540.02.07 An engineering evaluation shall be made of the extent and effect of low R-value soils found at depth during the breakpoint testing.

540.02.08 Deflection readings from a POD run indicate uniformity of support and should be used to locate test sites for R-value and as a guide for engineering judgment. In addition, the deflection data should be used to develop an independent overlay thickness for comparison.

540.02.09 Select appropriate alternates for consideration from Standard Rehabilitation Reconstruction Alternatives (see Section 541). For new construction, evaluate at least one plant mix and one concrete alternate over a 36-year cycle

540.02.10 When structural requirements call for an overlay on only part of a rehab project, the Segments shall be evaluated as separate projects, i.e., W.B.L. and E.B.L. of an interstate section.

540.02.11 Prepare a life cycle cost analysis (see Section 541.03).

540.02.12 Prepare engineering Phase I report.

540.03 Analysis/Selection.

540.03.01 On rehabilitation projects, lean toward the least cost alternative.

540.03.02 On reconstruct projects, lean toward full design standards for the pavement structure.

540.03.03 Normally short, weak areas will be corrected by excavation and backfill or application of a thicker overlay to the area to provide uniform support throughout the project.

540.03.04 The gravel equivalent for intact road mix pavement shall be in accordance with the table in Section 510.06.

540.03.05 The gravel equivalent used for plant mix pavement scheduled for rehabilitation shall be in accordance with Section 530.02.01.02, except pavement greater than 180 mm (0.6 foot) thick that exhibits no stripping will be considered new for calculation purposes.

540.03.06 When the evaluation calls for reconstruction, schedule the work far enough in the future to receive maximum practical benefit from the existing surface.

540.03.07 On high-volume roads carrying over 1,000 trucks per day, the normal design shall provide for 20-year pavement structure design.

540.03.08 The minimum structural overlay shall be 50 mm (0.15 foot).

540.03.09 For designs requiring 30 mm (0.1 foot) overlay or less, engineering analysis and judgment shall determine whether or not to place the overlay.

540.03.10 When the pavement structure design for a high-volume road indicates need for an overlay greater than 30 mm (0.1 foot) but the overlay will not correct a widespread problem such as frost heaving, engineering analysis and judgment shall determine the course of action.

540.03.11 On those projects where the primary work is not paving, such as railroad crossings, the paving and widening required to meet new grades and widths shall, as a minimum, provide a pavement structure equal to the existing street or highway.

540.03.12 Underdrains shall not be installed in flat terrain with a roadway grade of 0.5 percent or flatter.

540.03.13 Dowels shall be used in concrete alternates carrying over 250 trucks per day.

540.03.14 On concrete pavement that has received the design axle loading, the practicality of performing rehabilitation will be based on a study of the rate of deterioration, engineering analysis, and judgment.

540.04 Cost Analysis.

540.04.01 On rehabilitation projects, always run an analysis of reconstruction alternates for comparison. Each alternative shall be described on a separate page beginning with a brief narrative of the work included. The costs included shall follow Sections 541.04 and 541.05.

540.04.02 Always address the next major work (rehabilitation or reconstruction) in evaluating alternatives.

540.04.03 All pavement costs comparisons shall be based on a 20-year pavement structure design, even though the next rehabilitation is estimated to occur 12 years from the current design year.

540.04.04 Pavement structure designs for less than 20 years should be used only as a guide for engineering judgment.

540.04.05 When the cost of a concrete alternate is substantially higher than plant mix, the concrete alternate may be chosen based on engineering judgment for such things as steep grades predicted to exhibit chain and stud wear, stripping, and heavy traffic movement such as city streets.

540.05 Engineering Report.

540.05.01 The introduction shall briefly cover the history and current condition of the roadway and its relation to the roadway adjacent to the project, along with a typical section and summary of the investigation. This should include an analysis of existing drainage and the causes of distress in the existing pavement.

540.05.02 The engineering evaluation shall include a comparison of the EUAC of the alternatives, a discussion of risks involved, and a test for reasonableness.

540.05.03 Include a brief summary of conclusions and recommendations.

540.05.04 Attachments shall include an outline and time line with EUAC and years to equal annual cost figures, as needed.

540.05.05 Engineering analysis reports for rehabilitation/reconstruction projects should be able to
withstand the test of time and distance and lead the reader to the same conclusion as the writer.

540.06 Report Format.

540.06.01 Introduction. Include project data such as key number, project number, location, length, current pavement condition, section thicknesses, summary of previous projects, and past pavement experience in the vicinity and on adjacent roadway sections.

Describe scope of proposed project: widening, reconstruction, realignment, new alignment, height of cuts and/or fills, long-term settlement expectations, etc.

Include traffic data.

540.06.02 Design Criteria. Include data used as basis for design alternates: subgrade support, climatic factor, layer properties and substitution ratios, design traffic, materials availability, and construction considerations.

540.06.03 Alternatives. Describe alternatives selected for analysis. For rehabilitation projects, include reconstruction alternatives for comparison.

540.06.04 Conclusions. Based on the life cycle cost analyses of alternatives, historical performance, weather, visibility, and foundation or materials availability considerations, present conclusions regarding the recommended alternate(s).

540.06.05 Appendix. Cost data, life cycle cost analysis, and time lines.

SECTION 541.00 – STANDARD REHABILITATION/ RECONSTRUCTION ALTERNATIVES

541.00.01 The list of standard rehabilitation/reconstruction alternatives (Section 541.01) should be used in the life cycle cost analysis.

541.00.02 The list is not intended to be all inclusive.

541.00.03 Use of the list of standard alternatives is intended to form the basis of comparison for treatment of the roadway surface.

541.00.04 The specifics of such things as widening, handling of soft spots, and alignment changes would normally be kept separate from the pavement structure analysis as they generally affect all options on a one-time basis and should be considered in the overall economic analysis in the project concept.

541.01 Rehabilitation/Reconstruction Alternatives List.

- 2-Lane Roadway
  - Recycle, inlay, and seal coat
  - Recycle, inlay/overlay, and seal coat
  - Leveling course, overlay, and seal coat
  - Mill, overlay, and seal coat
  - Reconstruct with asphalt concrete pavement
  - Reconstruct with jointed plain concrete pavement (JPCP)
  - Reconstruct with doweled concrete pavement (JRCP)
  - Reconstruct with continuously reinforced concrete pavement (CRCP)
- 4-Lane Roadway
  - Recycle-inlay travel lanes and seal coat
  - Recycle-inlay passing lanes and seal coat
  - Recycle-inlay travel lanes, overlay, and seal coat
  - Recycle-inlay passing lanes, overlay, and seal coat
  - Reconstruct with asphalt concrete pavement
  - Grind and subseal PCC travel lanes, seal joints
  - Grind and subseal PCC passing lanes, seal joints

  - Subseal PCC travel and passing lanes, level, fabric, AC overlay
  - Crack and seat PCC, AC overlay
  - Reconstruct with jointed plain concrete pavement (JPCP)
  - Reconstruct with doweled concrete pavement (JRCP)
  - Reconstruct with continuously reinforced concrete pavement (CRCP)
- Selected Menus
  - Edge drains
  - Fabric layer

541.02 Standard Costs.

541.02.01 The list of standard costs should be used in the life cycle cost analysis.

541.02.02 The standard costs are intended for use at the concept stage and should not be used for final estimating purposes.

541.02.03 The standard costs are based on recent bid prices that have been multiplied by 1.3 to cover engineering and contingencies, traffic control, and mobilization.

541.02.04 The standard total cost for rehabilitation, as indicated in the examples titled "Reconstruct Plant Mix Pavement" (Section 541.04) and "Reconstruct Concrete Pavement" (Section 541.05), shall be used in the time line for new construction and reconstruction.

Description	Cost per Kilometer (mile)	Cost per Unit	Units per Meter (foot)
Seal Coat [23 m (76 ft.) wide]	19,900 (32,000)	0.86 (0.72)	S.M. (S.Y.)
SAMI Seal Coat [23 m (76 ft.) wide]	72,000 (115,800)	3.11 (2.60)	S.M. (S.Y.)
Plant Mix Seal [19 mm (0.75 in.) × 23 m (76 ft.) wide]	38,600 (62,070)	49.60 (45.00)	Metric Ton (ton)
Seal Joints (concrete to asphalt) (4 joints)	13,200 (21,200)	3.28 (1.00)	L.M. (L.F.)
Seal Joints (concrete) [107 m (352 ft.) × 15 m (48 ft.) transverse]	18,400 (29,568)	5.74 (1.75)	L.M. (L.F.)
Seal Joints (concrete) (2 longitudinal)	11,453 (18,432)	5.74 (1.75)	L.M. (L.F.)
Subseal [3.5 m (12 ft.) lane]	19,900 (32,000)	5.44 (4.55)	S.M. (S.Y.)

Description	Cost per Kilometer (mile)	Cost per Unit	Units per Meter (foot)
Grind [3.5 m (12 ft.) lane]	19,900 (32,000)	5.44 (4.55)	S.M. (S.Y.)
Rotomill [15 m (50 ft.) wide 45 mm (0.15 ft.) depth]	13,100 (21,000)	18.72 (0.53)	C.M. (C.F.)
Overlay-Inlay [8 m (25 ft.) wide 45 mm (0.15 ft.) depth] (no milling included)	27,400 (44,170)	34.38 (31.20)	Metric Ton (ton)
Excavation [8 m (25 ft.) wide × 300 mm (1 ft.) depth]	17,400 (28,000)	7.49 (5.73)	C.M. (C.Y.)
Borrow [8 m (25 ft.) wide × 300 mm (1 ft.) depth]	19,800 (31,800)	8.50 (6.50)	C.M. (C.Y.)
Base Aggregates [150 mm (0.5 ft.) × 23 m (76 ft.)]	47,300 (76,100)	8.88 (8.06)	Metric Ton (ton)
Rock Cap [300 mm (1 ft.) × 23 m (76 ft.)]	67,500 (108,600)	6.34 (5.75)	Metric Ton (ton)
Rock Cap [300 mm (1 ft.) × 23 m (76 ft.)] - South Idaho	108,700 (174,900)	10.21 (9.26)	Metric Ton (ton)
Add Haul [$0.14/metric ton km ($0.20/ton mile)] [150 mm (0.5 ft.) × 23 m (76 ft.)]	2,400 (3,800)	0.18 (0.26)	Metric Ton km (ton mile)
Plant Mix/Rubber [top 60 mm (0.20 ft.) only] [60 mm (0.20 ft.) × 23 m (76 ft.)]	204,400 (328,950)	63.20 (57.33)	Metric Ton (ton)
Plant Mix/AC-20R [top 60 mm (0.20 ft.) only] [60 mm (0.20 ft.) × 23 m (76 ft.)]	138,600 (223,000)	42.83 (38.86)	Metric Ton (ton)
Furnish Dowelled and CRC Concrete Urban Commercial [300 mm (12 in.) × 23 m (76 ft.)]	600,200 (966,000)	85.00 (65.00)	C.M. (C.Y.)
Place and Finish CRC Pavement [23 m (76 ft.) wide]	457,300 (735,900)	19.73 (16.50)	S.M. (S.Y.)
Furnish Dowelled and CRC Concrete [300 mm (12 in.) × 23 m (76 ft.)]	515,000 (828,800)	72.94 (55.77)	C.M. (C.Y.)
Place and Finish Dowelled Pavement [23 m (76 ft.) wide]	171,200 (275,500)	7.39 (6.18)	S.M. (S.Y.)
Soft Spot Excavation and Backfill [23 m (76 ft.) wide/km (mile)]	179,000 (288,000)	10.46 (8.00)	C.M. (C.Y.)
Recycle			
Overlay-Inlay [8 m (25 ft.) wide 45 mm (0.15 ft.) depth] (no milling included)	21,700 (35,000)	26.70 (24.72)	Metric Ton (ton)
Cold In-Place Emulsified Asphalt [45 mm (0.15 ft.) × 17 m (56 ft.)]	38,800 (62,400)	2.27 (1.90)	S.M. (S.Y.)
Free Draining (ATPB) [100 mm (4 in.) × 23 m (76 ft.)]	122,400	29.29	Metric

Description	Cost per Kilometer (mile)	Cost per Unit	Units per Meter (foot)
	(197,000)	(26.57)	Ton (ton)
Lean Concrete Base [100 mm (4 in.) × 17 m (56 ft.)]	133,600 (215,000)	0.08 (1.64)	S.M./mm (S.Y./In.)
Hot In-Place Recycled [50 mm (2 in.) ×16 m (50 ft.)]	41,400 (66,900)	4.00 (3.35)	S.M. (S.Y.)
Hot In-Place Virgin Addition [27 kg/S.M. (50 lb./S.Y.)]	16,400 (26,400)	1.08 (0.90)	S.M. (S.Y.)
Crack and Seat Concrete [450 mm (18 in.) OC both ways at $3.14/S.M. ($2.63/S.Y.)] (no work on stabilized base)	8,100 (13,000)	3.14 (2.63)	S.M. (S.Y.)
Rubblized Concrete [$2.55/S.M. ($2.13/S.Y. @ 7 m (24 ft.) wide] (no work on stabilized base)	18,600 (30,000)	2.55 (2.13)	S.M. (S.Y.)
Polystyrene Insulate Installed [$11.09/S.M. ($1.03/S.F.) @ 8 m (25 ft.) wide]	84,500 (136,000)	11.09 (1.03)	S.M. (S.F.)
Edge Drains (2 each)	36,000 (58,000)	18.00 (5.49)	L.M./Dr. (L.F./Dr.)
2% Slab Replace [$63.36/S.M. ($53 S.Y.) @ 230 mm (9 in.) × 3.5 m (12 ft.) lane]	7,612 (12,250)	4.10 (87.00)	S.M./mm (S.Y./In.)
Route and Seal Random Cracks (asphalt pavement)	22,400 (36,000)	3.28 (1.00)	L.M./Jt. (L.F./Jt.)
Fabric Full Width [$1.43/S.M. ($1.20/S.Y.) @ 7 m (24 ft.) wide]	10,600 (17,000)	1.45 (1.21)	S.M. (S.Y.)
Remove 300 mm (12 in.) Concrete 15 m (48 ft.)	51,200 (82,500)	3.20 (2.93)	S.M. (S.Y.)
Pulverized Base Stabilization [150 m (0.5 ft.) × 15 m (48 ft.)]	64,400 (103,600)	4.02 (3.68)	S.M. (S.Y.)
Cross Over @ 250,000 for 2		150,000	Ea.
Footnote Transverse Joints [5 m (15 ft.) = 200 per km (352 per mile)]			

541.03 Life Cycle Cost Analysis.

541.03.01 Choose the appropriate alternates from the list of standard rehabilitation/ reconstruction alternates (Section 541.01).

541.03.02 Complete the life cycle cost analysis for reconstruction with rigid and flexible pavements, using standard costs and a 36-year time line. Outline each alternate on a separate page. See examples in Sections 541.04.01 and 541.05.01.

541.03.03 Select the appropriate standard remaining life, i.e., 24 years or 12 years for flexible, or 18 years for rigid.

541.03.04 Only one standard remaining life will be used per project.

541.03.05 Construct a 36-year time line for each rehabilitation alternate (see Figures 541.03.05-1 and 541.03.05-2).

541.03.06 Start with the rehab cost at year zero and extend the time line to cover the selected standard remaining life.

541.03.07 At the end of the standard remaining life (year 24 or year 12 for flexible, or year 18 for rigid), insert the appropriate reconstruct time line from Section 541.03.02.

541.03.08 Cut off the reconstruct time line insert at year 36 of the rehab time line.

541.03.09 Calculate the salvage value for the portion of the reconstruct time line not used in the 36-year rehab time line (see Figure 541.03.09-1).

541.03.10 The salvage value for the standard 24-year remaining life shall be 80 percent of the initial flexible reconstruct cost.

541.03.11 The salvage value for the standard 12-year remaining life shall be 40 percent of the initial flexible reconstruct cost.

541.03.12 The salvage value for the standard 18-year remaining life shall be 60 percent of the initial rigid reconstruct cost.

541.03.13 The salvage value is always a positive number; all other costs are negative. This convention must be followed in making the net present value calculations.

541.03.14 Calculate the net present worth using the table of present worth and capital recovery factors (Figure 541.03.14-1) for the years 1 through 36 at 4 percent compounded interest.

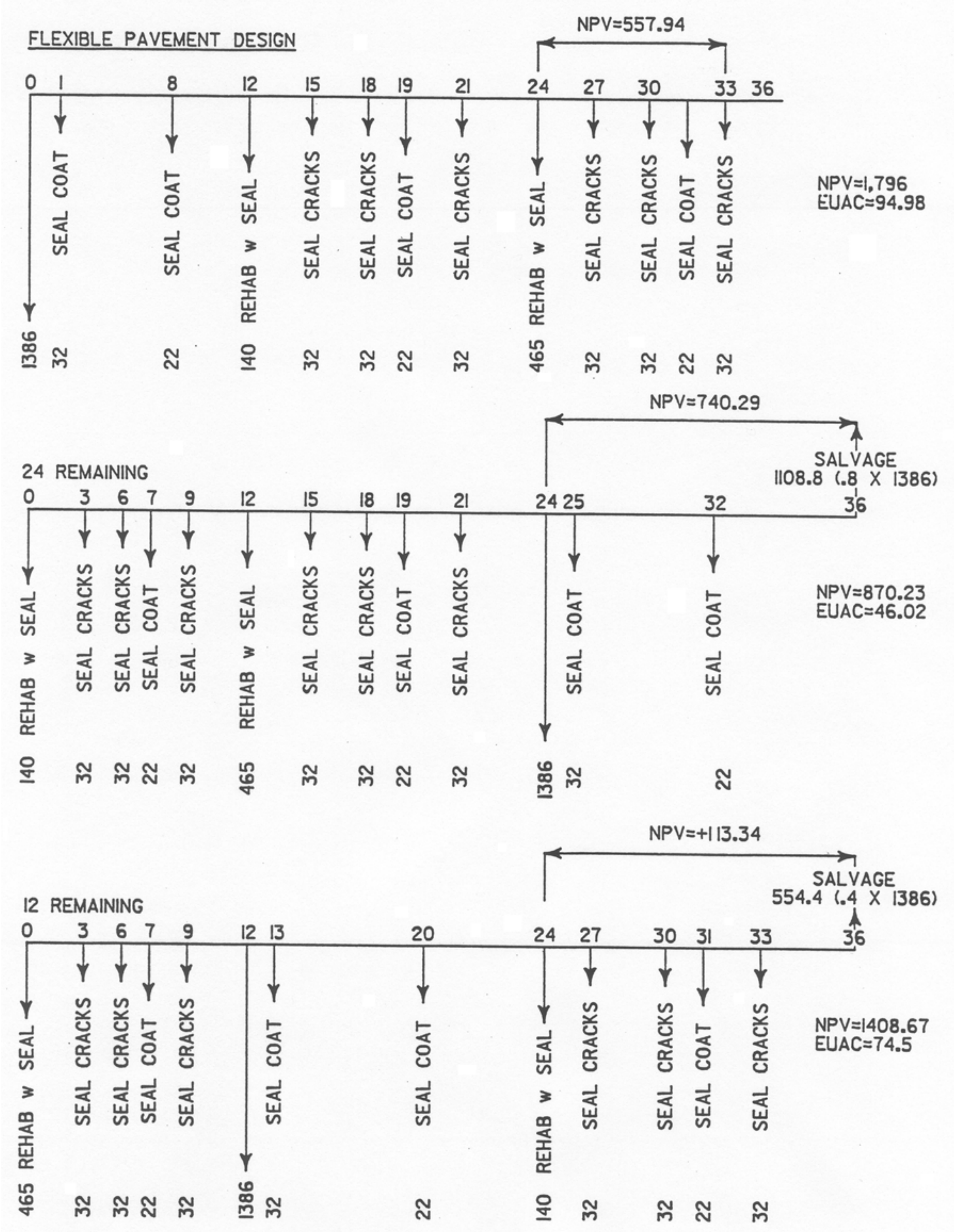


FIGURE 541.03.05-1. STANDARD TIME LINES

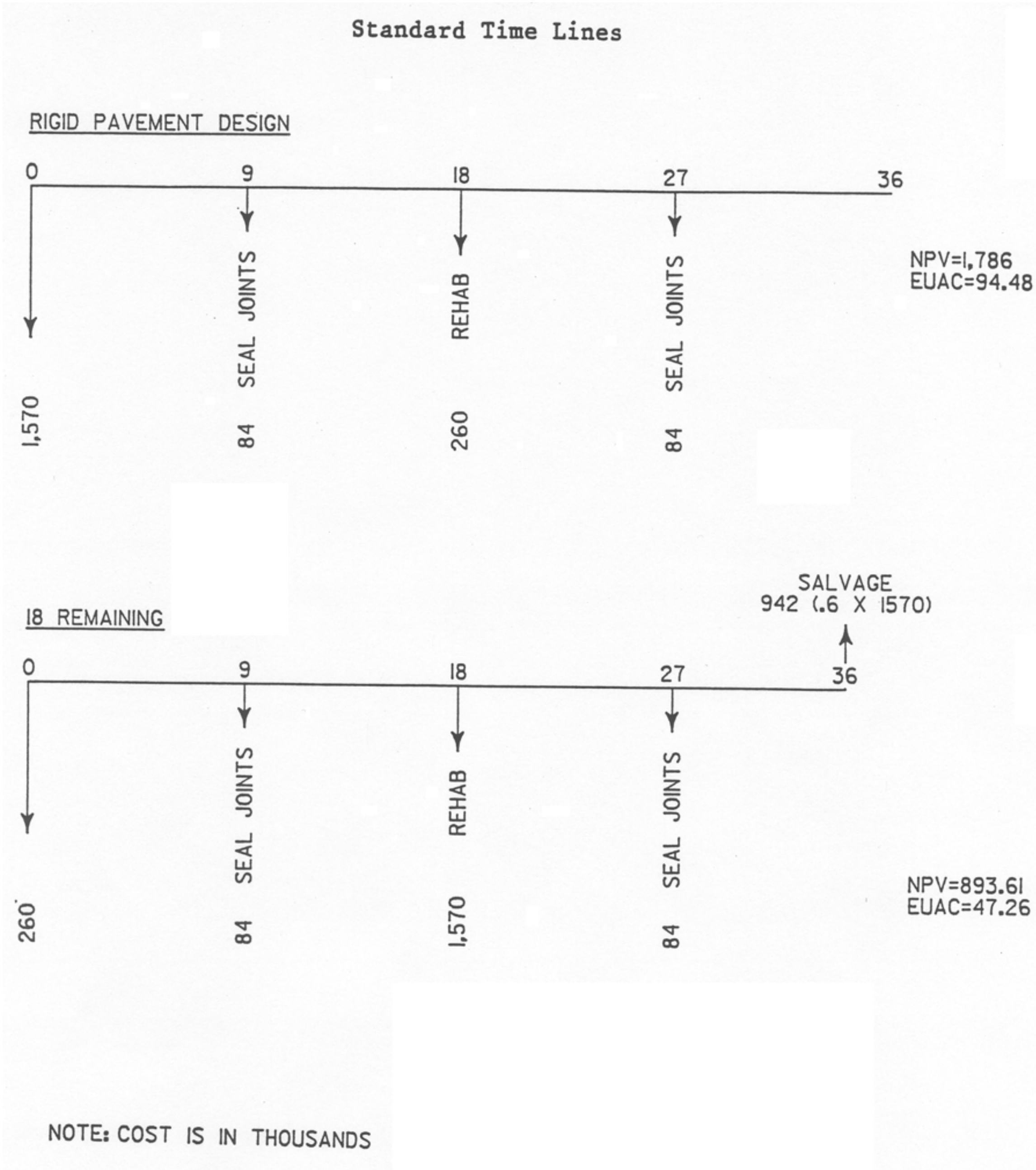
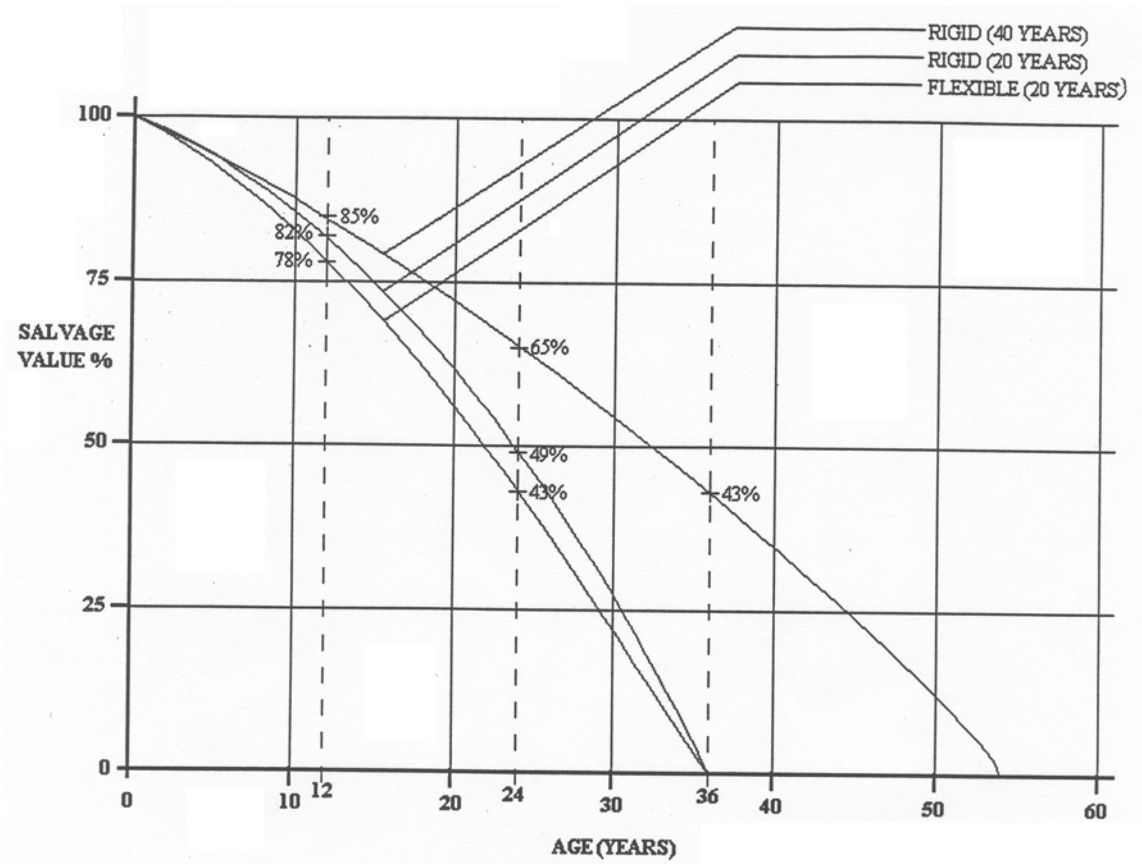


FIGURE 541.03.05-2. STANDARD TIME LINES



CURVES BASED ON WSDOT GENERAL PERFORMANCE CURVE EQUATION (SV=100-B(A6E)X

RIGID (40 YEARS) $100-.65(AGE)^{1.25}$

RIGID (20 YEARS) $100-.95(AGE)^{1.25}$ (MODIFIED BEYOND 24 YRS. TO FIT 36 YR. ANAL.)

FLEXIBLE: $100-.66(AGE)^{1.4}$ PRESUMES REHAB @ 12 &24 YEARS.

FIGURE 541.03.09-1. APPROXIMATE SALVAGE VALUES FOR USE IN LIFE CYCLE COST ANALYSES OF NEW OR RECONSTRUCTED PAVEMENT

Year	Present Worth Factor (PWF)*	Capital Recovery Factor (CRF)**
0	1.0000	N/A
1	0.9615	1.0400
2	0.9246	0.5203
3	0.8890	0.3603
4	0.8548	0.2755
5	0.8219	0.2246
6	0.7903	0.1908
7	0.7599	0.1666
8	0.7307	0.1485
9	0.7026	0.1345
10	0.6756	0.1233
11	0.6496	0.1141
12	0.6246	0.1066
13	0.6006	0.1001
14	0.5775	0.0947
15	0.5553	0.0899
16	0.5339	0.0858
17	0.5134	0.0822
18	0.4936	0.0790
19	0.4746	0.0761
20	0.4564	0.0736
21	0.4388	0.0713
22	0.4220	0.0692
23	0.4057	0.0673
24	0.3901	0.0656
25	0.3751	0.0640
26	0.3607	0.0626
27	0.3468	0.0612
28	0.3335	0.0600
29	0.3207	0.0589
30	0.3083	0.0578
31	0.2965	0.0569
32	0.2851	0.0559
33	0.2741	0.0551
34	0.2636	0.0543
35	0.2534	0.0536
36	0.2444	0.0529

*Given single future value (FV),, find present value (PV),, PV = FV × PWF.
**Given present value (PV),, find uniform payments (PMT),, PMT = PV × CRF.

FIGURE 541.03.14-1. PRESENT WORTH AND CAPITAL RECOVERY COST FACTOR TABLE 4% COMPOUNDED INTEREST RATE (for use with life cycle cost analysis)

541.03.15 Find the EUAC by multiplying the net present worth times the capital recovery factor for time represented by the time line. A procedure using the HP12C calculator is described in Figure 541.03.15-1.

541.03.16 A "feel" for the validity of a rehabilitation alternate can be gained by dividing the EUAC of the higher cost alternate by the net present worth of the lower cost alternate. Using an interest table, find the nearest year represented by this capital recovery factor. This indicates how long the rehabilitation must last to equal the annual cost of the compared alternative.

541.03.17 The life cycle cost analysis provides a standard of comparison for the pavement structure on projects involving new construction, reconstruction, or rehabilitation.

541.03.18 Calculation of the life cycle cost for reconstruction provides an "experience benchmark" for comparison purposes and is to be performed even if there is no intent to reconstruct the section.

541.03.19 The long-range 4R schedule will indicate a time in the life cycle of the pavement for reconstruction. At that point, life cycle cost comparisons for other than reconstruct alternates will not be required.

541.03.20 A 36-year life cycle has been chosen for comparison purposes. This cycle is within practical budget constraints and close to the theoretical life of concrete pavement using 100-percent of design flexural stress.

541.03.21 The 4 percent interest rate has been chosen, as it is close to the deterioration rate for streets and highways.

541.03.22 The cost of traffic disruption is not normally warranted in the economic analysis of Idaho highways.

541.03.23 Due to the inaccuracies in estimating the life and cost of an alternative, the life cycle cost analysis should not be used as a sole deciding factor but one of the many tools used in the selection process.

Calculation of Equivalent Uniform Annual Cost (EUAC) using HP12C financial calculator. The procedure first calculates Net Present Value (NPV), then calculates the annual payments (EUAC).

The number of entries for flexible pavement is limited to 20; therefore, on the 36-year time line, it is necessary to first calculate the NPV of a portion of the time line. The example calculates the NPV for years 24 through 36 as a separate calculation. This operation is not necessary for concrete time line.

PLANT MIX TIME LINE PROCEDURE (24-YEAR REMAINING LIFE)		
f clear REG	f clear REG	32 CHS g CFJ
1479 CHS g CFO*	140 CHS g CFO	0 g CFJ
32 CHS g CFJ	0 g CFJ	2 g NJ
0 g CFJ	2 g NJ	32 CHS g CFJ
6 g NJ**	32 CHS g CFJ	22 CHS g CFJ
22 CHS g CFJ	0 g CFJ	0 g CFJ
0 g CFJ	2 g NJ	32 CHS g CFJ
3 g NJ	32 CHS g CFJ	0 g CFJ
1183.2 g CFJ*	22 CHS g CFJ	2 g NJ
4 i***	0 g CFJ	786.82 CHS g CFJ
f NPV	32 CHS g CFJ	4 i
DISPLAY -786.82	0 g CFJ	f NPV
	2 g NJ	DISPLAY -888.38
	465 CHS g CFJ	36 n
	0 g CFJ	PMT
	2 g NJ	DISPLAY 46.98

*All costs are negative; salvage is positive; this convention must be followed.

**When consecutive years of zero cost occur, enter zero once, then key the number of zero cost years into the NJ register.

***EUAC is determined using 4 percent interest.

FIGURE 541.03.15-1

541.04 Reconstruct Plant Mix Pavement (36-Year).

541.04.01 Example.

LIFE CYCLE COST ANALYSIS
MOUNTAIN HOME – HAMMETT
PROJECT IR-84-2(29)105
KEY NO. 3823
WA = I863340
ALTERNATE NO. 1 (36 YEARS)

Reconstruct with plant mix 170 mm (0.55 ft.) by 23 meters (76 ft.) on 90 mm (0.30 ft.) of Asphalt-Treated Permeable Base (ATPB) with 90 to 140 mm (0.30 to 0.45 ft.) of 19 mm (3/4 in.) base. Subgrade will be improved as required to provide a minimum R value of 60. Edge drains will be provided full-length (two each). Existing grade will be maintained unless isolated areas are raised to provide minimum slope for underdrains. The existing base and surfacing will be removed. Traffic crossovers will be provided at 8-km (5-mile) intervals.

Cost Per Mile Summary:	
Traffic Crossovers	38,000
Additional Excavation	129,000
Additional Borrow	20,000
Plant Mix [170 mm (0.55 ft.) × 25 m (82.6 ft.)]	780,400
Permeable Base [90 mm (0.30 ft.) × 23 m 76 ft.)]	214,200
Aggregate Base [90 mm (0.30 ft.) × 31 m 101 ft.)]	177,100
Edge Drains (2 each)	27,000
Total Initial	1,385,700
Seal Coat Full Width	32,100
Seal Coat Driving Lanes	21,100
Seal Cracks [2 long + 160 × 23 m (76 ft.)]	32,300
Rehabilitation at 12 Years:	
Rotomill Travel Lanes [60 mm (0.20 ft.) × 7.6 m (25 ft.)]	29,000
Plant Mix Inlay (Recycle) [60 mm (0.20 ft.) × 7.6 m (25 ft.)]	46,700
Seal Cracks	32,300
Seal Coat Full Width	32,100
Total for 12-Year Rehabilitation	140,100
Rehabilitation at 24 Years:	
Rotomill Travel Lanes [60 mm (0.20 ft.) × 15.2 m (50 ft.)]	58,100
Plant Mix Inlay (Recycle) [60 mm (0.20 ft.) × 15.2 m (50 ft.)]	93,300
Fabric Membrane	53,900
Plant Mix Overlay [60 mm (0.20 ft.) × 23 m (76 ft.)]	194,600
Seal Cracks	32,300
Seal Coat Full Width	32,100
Total for 24-Year Rehabilitation	464,300
Total 36-Year Cost (from time line chart)	2,279,300
Equivalent Uniform Annual Cost (EUAC)	94,700

541.04.02 Example.

LIFE CYCLE COST ANALYSIS
MOUNTAIN HOME – HAMMETT
PROJECT IR-84-2(29)105
KEY NO. 3823
WA = I863340

STANDARD TIME LINES
36-YEAR LIFE CYCLE
UNIFORM COST PER KM (MILE)

Flexible Pavement **Alternate No. 1 New Construction**

Work	Cost	Present Worth Factor	Capital Recovery Factor	Equivalent Uniform Annual Cost
0}--- Initial Cost	$1,385,700	1.00000	0.05289	$73,300
}--- Seal Coat	32,100	0.96150	0.05289	1,600
}				
}				
}				
5}				
}				
}				
}---Seal Coat	21,100	0.75990	0.05289	800
}				
10}				
}				
}--- Rehab Seal Cracks	140,100	0.62460	0.05289	4,600
}				
}				
15}--- Seal Cracks	32,300	0.55530	0.05289	900
}				
}				
}--- Seal Cracks	32,300	0.49360	0.05289	800
}--- Seal Coat	21,100	0.47460	0.05289	500
20}				
}--- Seal Cracks	32,300	0.43880	0.05289	700
}				
}				
}--- Rehab Seal Cracks	464,300	0.39010	0.05289	9,600
25}				
}				
}--- Seal Cracks	32,300	0.34680	0.05289	600
}				
}				
30}--- Seal Cracks	32,300	0.30830	0.05289	500
}--- Seal Coat	21,100	0.29650	0.05289	300
}				
}--- Seal Cracks	32,300	0.27410	0.05289	500
}				
35}				
}--- End Life				
Total Flexible Pavement	$2,279,300	EUAC---		$94,700

541.05 Reconstruct Concrete Pavement (36-Year).

541.05.01 Example.

LIFE CYCLE COST ANALYSIS
MOUNTAIN HOME –
HAMMETT
PROJECT IR-84-2(29)105
KEY NO. 3823
WA = I863340
ALTERNATE NO. 2 (36 YEARS)

Reconstruct with 290 mm (11.5 in.) by 23 meters (76 ft.) doweled concrete pavement on a 90 mm (0.30 ft.) by 23 meters (76 ft.) Asphalt-Treated Permeable Base (ATPB) with 80 mm (0.25 ft.) of 19 mm (3/4 in.) aggregate base (choker). Subgrade will be improved as required to provide a minimum R value of 60. Edge drains will be provided full length (two each). Existing grade will be maintained unless isolated areas are raised to provide minimum slope for underdrains. The existing base and surfacing will be removed. Traffic crossovers will be provided at 8-km (5-mile) intervals.

Cost Per Mile Summary:	
Traffic Crossovers	38,000
Additional Excavation	129,000
Additional Borrow	20,000
Doweled Concrete [0.29 m (11.5 in.) × 23 m (76 ft.)]	915,900
Permeable Base [0.09 m (0.30 ft.) × 23 m (76 ft.)]	214,200
Aggregate Base [0.08 m (0.25 ft.) × 33 m (109 ft.)]	225,900
Edge Drains (2 each)	27,000
Total Initial	1,570,000
Rehabilitation at 9 Years:	
Seal Longitudinal Joints (4)	37,000
Seal Transverse Joints (352 jts. ×)	46,800
Total for 9-Year Rehabilitation	83,800
Rehabilitation at 18 Years:	
Slab Replacement at 2%	49,000
Grinding Driving Lanes	128,100
Seal Longitudinal Joints (4)	37,000
Seal Transfer Joints (352 jts. ×)	46,800
Total for 18-Year Rehabilitation	260,900
Total 36-Year Cost (from time line chart)	1,998,500
Equivalent Uniform Annual Cost (EUAC)	94,400

541.05.02 Example.

LIFE CYCLE COST ANALYSIS
MOUNTAIN HOME – HAMMETT
PROJECT IR-84-2(29)105
KEY NO. 3823
WA = I863340

STANDARD TIME LINES
36-YEAR LIFE CYCLE
UNIFORM COST PER KM (MILE)

Flexible Pavement **Alternate No. 1 New Construction**

Work	Cost	Present Worth Factor	Capital Recovery Factor	Equivalent Uniform Annual Cost
0}--- Initial Cost	$975,300	1.00000	0.05289	$51,600
}				
}				
}				
}				
5}				
}				
}				
}				
}---Seal Joints	51,600	0.70260	0.05289	1,900
10}				
}				
}				
}				
}				
15}				
}				
}				
}---Rehab Seal Joints	162,100	0.49360	0.05289	4,200
}				
20}				
}				
}				
}				
}				
25}				
}				
}--- Seal Joints	52,000	0.34680	0.05289	950
}				
}				
30}				
}				
}				
}				
}				
35}				
}--- End Life				
Total Concrete Pavement	$1,241,500	EUAC---		$58,600