PAVEMENT TYPE SELECTION MANUAL

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FLORIDA DEPARTMENT OF TRANSPORTATION
PAVEMENT MANAGEMENT SECTION
OFFICE OF ROADWAY DESIGN
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UPDATES TO THIS MANUAL WILL BE ANNOUNCED ON PAVEMENT MANAGEMENT WEB SITE.

ADDRESS:http://www.dot.state.fl.us/pavementmanagement

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State Pavement Design Engineer

PAVEMENT TYPE SELECTION MANUAL

CHAPTER 1

INTRODUCTION

1.1 PURPOSE

The objective of this manual is to provide a Pavement Design Engineer with sufficient information so that the necessary input data can be developed and proper engineering principles applied to develop a Pavement Type Selection Report. This manual addresses methods to properly develop an analysis and the computations necessary for the selection process.

1.2 AUTHORITY

Sections 20.23(3) (a) and 334.048(3), Florida Statutes

1.3 SCOPE

The principle users of this manual are the District Pavement Design Engineers and District Design Engineers.

1.4 GENERAL

Chapter 334 of the Florida Statues, known as the Florida Transportation Code, establishes the responsibilities of the state, counties, and municipalities for the planning and development of the transportation systems serving the people of the State of Florida, with the objective of assuring development of an integrated, balanced statewide system.

The Code's purpose is to protect the safety and general welfare of the people of the State and to preserve and improve all transportation facilities in Florida.

Under Section 334.048(3), the Code sets forth the powers and duties of the Department of Transportation to develop and adopt uniform minimum standards and criteria for the design, construction, maintenance, and operation of public roads.

Pavement type selection is primarily a matter of sound application of acceptable engineering criteria and standards. While the standards contained in this manual provide a basis for uniform practice for typical pavement type selection situations, precise rules which would apply to all possible situations are impossible to give.

1.5 STIMULATION OF COMPETITION

It is desirable that monopoly situations are avoided, and that improvement in products and methods be encouraged through continued and healthy competition among industries involved in the production of paving materials.

1.6 PAVEMENT TYPE SELECTION MANUAL ORGANIZATION AND REVISIONS

1.6.1 BACKGROUND

The manual is published as a revision to the January 1, 1999 manual.

1.6.2 REFERENCES

The design procedures incorporated in this document are based on the 1993 American Association of State Highway and Transportation Officials (AASHTO) Guide for Design of Pavement Structures plus numerous National Council on Highway Research Projects (NCHRP), Transportation Research Board (TRB), and Federal Highway Administration (FHWA) publications.

The specifics addressed in this manual have been tailored to Florida conditions, materials, and policy.

1.6.3 FLORIDA CONDITIONS

A number of coefficients and variables are specified in this manual. They should be considered as standard values for typical Florida projects. There may be instances where a variance from the values would be appropriate. In these instances, the Pavement Design Engineer will stay within the bounds established by the basic AASHTO Design Guide, justify the variance, and document the actions in the Pavement Type Selection File. Some variables are still under study and revised values will be published from time to time.

1.6.4 APPENDICES

Included with this manual are 3 appendices:

Appendix	Contents
A	Pavement Type Selection Quality Control Plan
B	1993 AASHTO Guide For Design Of Pavement Structures, Appendix B, Pavement Type Selection
C	Pavement Type Selection Report Example and Discussion
D	Example of Life Cycle Cost Analysis Using RealCost Spreadsheet
E	Life Cycle Cost Analysis Spreadsheet Example

1.7 DISTRIBUTION

This document is distributed through the Maps and Publications Section.

Manuals may be purchased from:

Florida Department of Transportation
Map and Publication Sales
Mail Station 12
605 Suwannee Street

Tallahassee, FL 32399-0450
Telephone (850) 414-4050
FAX (850) 414-4915
http//www.dot.state.fl.us/mapsandpublications

Contact the above office for latest price information. Authorized Florida Department Of Transportation personnel may obtain the manual from the above office at no charge with the appropriate cost center information.

1.8 PROCEDURE FOR REVISIONS AND UPDATES

Comments and suggestions for changes to the manual are solicited and can be submitted by writing to the address below:

Florida Department Of Transportation
Pavement Management Section
605 Suwannee Street, M.S. 32
Tallahassee, Florida
32399-0450

Each idea or suggestion received will be reviewed by appropriate Pavement Design staff in a timely manner. Items warranting immediate change will be made with the approval of the State Pavement Design Engineer in the form of a Pavement Design Bulletin.

Proposed revisions are distributed in draft form to the District Pavement Design Engineers and District Design Engineers. The District Pavement Design Engineer coordinates the review of the proposed revisions with other affected district offices. The goal is to obtain a majority opinion before revisions are made.

All revisions and updates will be coordinated with the Organization and Procedures Office prior to implementation to ensure conformance with and incorporation into the Departments standard operating system.

The final revisions and addenda will be distributed to District Pavement Design Engineers and copies provided to Maps and Publications. The date of the latest revision will be posted on the Pavement Management Office Internet Web Page with information on ordering copies from Maps and Publications.

http//www.dot.state.fl.us/mapsandpublications

TRAINING AND FORMS

None required.

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CHAPTER 2

GENERAL INFORMATION

2.1 FEDERAL POLICY

The Federal Highway Administrations rule on Pavement Management Systems requires the Florida Department of Transportation to design pavements in a cost effective manner with engineering and economic considerations given to alternative base and surface materials.

The Department has adopted the AASHTO Pavement Type Selection Guidelines published as Appendix B, of the 1993 AASHTO Guide For The Design Of Pavement Structures.

2.2 CANDIDATE PROJECTS

This procedure is to be used to develop analysis for the pavement type selection of new construction projects and reconstruction projects where work includes a modification to the base or subbase materials.

A Pavement Type Selection (PTS) analysis should be prepared for resurfacing projects where there is a history of poor performing pavement and the design ESALs are greater than ten (10) million. Poor performing pavement, for the purpose of this direction, is defined as pavement becoming deficient in less than ten (10) years for flexible pavement or less than fifteen years for rigid pavements. However, if the deficiency is only due to raveling of the friction course, a PTS analysis is not required.

When a two lane road is to be converted to four lanes plus a median, the project will be treated as new construction.

2.3 PAVEMENT TYPE SELECTION REPORT EXCEPTIONS

Where a lane is to be tied to an existing roadway and the same pavement type is to be used, a memo to the file documenting the decision will be satisfactory and will serve as the analysis and report. Any projects less than half a mile will also not require pavement type selection documentation.

By Executive Committee decision on July 16th, 2003, new weigh stations, rest areas and welcome stations are to use concrete paving for both access to and internal traffic flow and parking, so pavement type selection reports are not required.

2.4 REPORTS

All reports will be developed using information provided by the Flexible Pavement Design Manual (Document No. 625-010-002) and the Rigid Pavement Design Manual (Document No. 625-010-006).

A district wide Pavement Type Selection Report will be prepared and updated at least annually by the District Design Office on each applicable major typical section type and significant cost differential area in the district.

The major typical section types should be by pavement system, i.e. Interstate, FIHS and non-FIHS.
The individual project pavement type selection decisions will be made by the District Design Engineer, or as otherwise assigned by the District Secretary. The decision can be based on the annual report or by a project specific report, if appropriate.

A careful review of each applicable project should be made to determine if the annual district wide Pavement Type Selection Report is adequate for that project.
A reference to the appropriate report will be made a part of applicable project files.

2.5 REVIEWS

Copies of all PTS and annual PTS shall be sent to the Central Office Pavement Management Section for a Quality Assurance review. See Section A.6 for information on Quality Assurance Reviews.

The annual analysis and any project specific reports should be reviewed by the District Construction Engineer.

The Pavement Type Selection decision will again be reviewed by Design at the time the pavement is to be designed to determine if any overriding factors have changed sufficiently to warrant reconsideration. A letter to the Project Design File documenting this review is adequate.

CHAPTER 3

SUPPLEMENTARY CONSIDERATIONS

3.1 MINIMUM REQUIREMENTS

The report will address, as a minimum, all of the Principal Factors given in Appendix B of the 1993 AASHTO Guide plus the following Supplementary Considerations.

A copy of the report will be made a part of or referenced by each applicable project file.

3.2 PRINCIPLE FACTORS

The following supplementary considerations to the 1993 AASHTO Design Guide, Appendix B include the following Principle Factors.

3.2.1 EMBANKMENT CHARACTERISTICS

Asphalt Base or Treated Permeable Base Option **is** generally the preferred subdrainage design. These bases options, uses standard materials and construction methods and provides lateral drainage. Illustration of typical sections are shown in standard index 505 with more detail provided in standard index 287.

If the special select soils embankment option is analyzed, the availability of permeable Special Select Soils as required by Standard Index 505 should be reflected in the cost estimate for rigid pavements as well as any special drainage requirements that may be dictated by available materials for any type of pavement. The District Materials Engineer should be consulted in this analysis.

3.2.2 WEATHER

No special considerations have been noted in Florida except for concern of high rainfall conditions.

3.2.3 CONSTRUCTION CONSIDERATIONS

Special consideration should be given to features such as a high water table and shallow ditches.

3.2.4 RECYCLING

The Department has successfully recycled both flexible and rigid pavements.

3.2.5 COST COMPARISON

An analysis period of 40 years will be used with the Present Worth method.

3.3 SECONDARY FACTORS

Care must be taken to insure that there is a high degree of similarity in soils, pavement structure, drainage, traffic, etc. and not just a superficial similarity.

Secondary factors should be considered. Refer to Appendix B.3 for information on secondary factors.

3.3.1 PERFORMANCE OF SIMILAR PAVEMENTS IN THE AREA

Care must be taken to insure that there is a high degree of similarity in soils, pavement structure, drainage, traffic, etc. and not just a superficial similarity.

CHAPTER 4

ECONOMIC ANALYSIS

4.1 PAVEMENT SYSTEM

This portion of the pavement type selection analysis will be performed in accordance with the procedures published in the Life Cycle Analysis for Transportation Projects developed by the Value Engineering Section.

4.2 BASE DATA

The following base data can be used unless the district chooses to select and thoroughly document an alternative scenario.

4.2.1 TIME PERIODS

The following time periods will be used as a basis of computations: The Analysis Period will be 40 years.

The Initial Pavement Design will be 20 years for new construction. This is based on using standard design techniques and the best available data for soils, traffic, material properties, etc. The same design reliability level will be used for each pavement type design.

4.2.2 REHABILITATION STRATEGIES

For cost analysis, use the future rehabilitation strategies for concrete and asphalt shown in Table 4.1. The district may want to thoroughly study and document another scenario.

The costs for Maintenance of Traffic (MOT), design, and Construction Engineering Inspection (CEI) should be included with the rehabilitation strategies.

These scenarios are not intended to indicate the exact future rehabilitation designs, but rather to reflect reasonable strategies and quantities for estimating life cycle cost.

The rehabilitation time intervals are based on the Florida Pavement databases, with engineering consideration given to pavement design methods and materials.

TABLE 4.1 - Future Rehabilitation Strategies

Concrete			
Rehab Period	**Urban Arterial**	**Rural Arterial**	**Limited Access**
20 year	CPR (3% Slab Replacement)	CPR (3% Slab Replacement)	CPR (3% Slab Replacement)
30 year	CPR (5% Slab Replacement)	Crack, Seat and Overlay ARMI, 4″ Str. AC and FC	Crack, Seat and Overlay ARMI, 4″ Str. AC and OGFC
Asphalt Pavement			
Rehab Period	**Urban Arterial**	**Rural Arterial**	**Limited Access**
14 year	Mill 2″, Resf. 1″ Str. AC and DGFC	Mill 2″, Resf. 3″ Str. AC and FC	Mill 3″, Resf. 4″ Str. AC and OGFC
28 year	Mill 2″, Resf. 1″ Str. AC and DGFC	Mill 2″, Resf. 3″ Str. AC and FC	Mill 3″, Resf. 4″ Str. AC and OGFC

Where:

CPR - Concrete Pavement Rehabilitation

ARMI - Asphalt Rubber Membrane Interlayer

Str. AC - Structural Asphaltic Concrete

DGFC - Dense Graded Friction Course

OGFC - Open Graded Friction Course

FC - Friction Course (appropriate for facility)

4.2.3 DESIGN AND COST ASSUMPTIONS

The following design and cost assumptions apply when calculating agency and user costs for these or any other rehabilitation strategies:

- Agency costs include the initial cost of construction and the rehabilitation costs for each rehabilitation effort within the assumed life cycle.
- The user costs include motorist delay time and vehicle operating costs due to work zone activity during the initial construction and rehabilitation efforts within the assumed life cycle.

4.2.3.1 AGENCY COSTS

Agency construction costs for each alternative

- A discount rate of 4% will be used.
- The cost of shoulder construction and rehabilitation will be considered in the economic analysis.

Salvage value, remaining life and maintenance costs do not have to be considered.

- Costs should be summarized by project mile.

4.2.3.2 USER COSTS

User costs, as described above, should be calculated using the deterministic method provided in FHWA's RealCost spreadsheet. Crash costs should not be considered as there is insufficient research to quantify crash rates in work zones.

- A discount rate of 4% will be used.
- The recommended 2007 value of time for passenger cars is:

  Local Travel = $12.70/hr.

  Inter City Travel = $13.50/hr.
- The recommended 2007 value of time for trucks is:

  Single Unit = $18.50/hr.

  Combination = $18.50/hr.

The 2007 Transportation Component of the Consumer Price Index (CPI) = 190. The value of the time costs should be inflated to the current year by the CPI when the analysis is made. The current CPI is available at: http://www.bls.gov/cpi/. (Go to 'Get Detailed CPI Statistics', then to 'Consumer Price Index Detailed Report'.

- The following traffic capacities should be used:

  Work Zone Capacity (vphpl) = 1,450

  Free Flow Capacity (vphpl) = 1,900

  Queue Dissipation Capacity (vphpl) = 1,800

Table 4.2 - Maximum AADT for Limited Access (total for both directions)

Lanes	Urbanized	Transition Areas	Rural
4	75,600	69,100	63,000
6	117,800	106,700	97,200
8	160,000	144,400	131,400
10	202,000	182,000	n/a

*Values are taken from the FDOT Planning tables titled 'Generalized Annual Average Daily Volumes'. Values for arterials are available at: http://www.dot.state.fl.us/planning/systems/sm/los/default.htm.

- Some project specific inputs needed include:

1. Construction year AADT
2. Percent single unit trucks
3. Percent combination trucks
4. Annual traffic growth rate
5. Speed limit
6. Hourly traffic distribution (from Project Traffic Report or use default values)
7. Number of lanes in each direction
8. Work zone duration (see Appendix D for sample calculations and Tables 4.3 and 4.4 for estimates of lane closure days by facility type)

Table 4.3 – Estimated Lane Closure Days for Asphalt Pavements

Rehab. Period	No. of Lanes	Urban Arterial	Rural Arterial	Limited Access
14 Year	2	4 days / mile	5 days / mile	N/A
	4	8 days / mile	11 days / mile	16 days / mile
	6	11 days / mile	16 days / mile	19 days / mile
28 Year	2	4 days / mile	5 days / mile	N/A
	4	8 days / mile	11 days / mile	16 days / mile
	6	11 days / mile	16 days / mile	19 days / mile

Table 4.4 – Estimated Lane Closure Days for Concrete Pavements

Rehab. Period	No. of Lanes	Urban Arterial	Rural Arterial	Limited Access
20 Year	2	10 days / mile	10 days / mile	N/A
	4	19 days / mile	19 days / mile	19 days / mile
	6	27 days / mile	27 days / mile	27 days / mile
30 Year	2	12 days / mile	7 days / mile	N/A
	4	20 days / mile	17 days / mile	17 days / mile
	6	29 days / mile	25 days / mile	25 days / mile

9. Time of day of lane closures (typically night time work for Interstate)
10. Work zone length (2 miles maximum for Interstate)
11. Work zone speed limit (typically 10 mph below the Speed Limit)

Estimated lane closure days are based on the typical future rehabilitation scenarios in table 4.1 and typical production rates. Districts may adjust these times based on local conditions and experience.

An example life cycle cost analysis using the RealCost spreadsheet is presented in Appendix D.

4.2.4 FLEXIBLE PAVEMENT ASSUMPTIONS

The following flexible pavement assumptions apply when using these or any other rehabilitation strategies.

- Milling will remove cracked pavement and an ARMI will not be required.

4.2.5 RIGID PAVEMENT ASSUMPTIONS

The following rigid pavement assumptions apply when using these or any other rehabilitation strategies. Concrete Pavement Rehabilitation will include the following:

- Slab Replacement
- Cleaning and Resealing the Joints
- Routing and Sealing Random Cracks
- Grinding

4.3. EXCEPTIONS

When the design engineer deviates from the future rehabilitation strategies provided, an adequate data base must be provided from the District Pavement Management Section.
A pavement history of both types of pavements (flexible and rigid) must be provided in the appendix of the report. This report should be based on system type roads (i.e., Interstate history only for an Interstate Pavement analysis).
The PTS cost analysis should involve the District Estimate Engineer, and when there is not sufficient cost data in the district, the State Estimate Engineer should be consulted for assistance.
Engineering considerations must also be given for improvements in design procedures and specifications from the historical pavements (i.e. for example, improvements in rut resistance for flexible pavements and good drainage, reduced joint spacing, for rigid pavements).

APPENDIX A

PAVEMENT TYPE SELECTION QUALITY CONTROL PLAN

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A.1 QUALITY CONTROL PLAN

All Pavement Type Selection Reports will be reviewed independently for accuracy and correctness. The following quality control plan is provided as a guideline.

A.2 DEFINITIONS

The following definitions are used throughout this section.

Quality

Conformance to policies, procedures, standards, guidelines and above all, good engineering practice.

Quality Assurance

Consists of all planned and systematic actions necessary to provide adequate confidence that a design, structure, system, or component will perform satisfactorily and conform to project requirements.

Quality assurance involves establishing project related policies, procedures, standards, training, guidelines, and systems necessary to produce quality.

Quality Control

This is the checking and review of designs and plans for compliance with policies, procedures, standards, guidelines and good engineering practice.

A.3 RESPONSIBILITY

The district offices are responsible for Quality Control. Quality Assurance is the role of the Central Office.

A.4 PAVEMENT TYPE SELECTION REPORTS

Pavement Type Selection Reports will be developed in accordance with the Pavement Type Selection Manual (Document No. 625-010-005). Supporting data will be included in the report file.

A.4.1 MINIMUM REQUIREMENTS

The Pavement Type Selection Report as a minimum will include the following items:

- Typical section types and geographical cost locations if different than the district boundary.
- Unit price and quantities per centerline mile used in estimates.
- Summary
- Information Sources

A.4.2 DISTRIBUTION

In addition to retaining the original documentation in the District Design Office, copies of the approved project level Pavement Type Selection and annual Pavement Type Selection Reports with supporting documentation will be transmitted to the State Pavement Design Engineer each year.

Central Office approval of the Pavement Type Selection Report is not required. Pavement Type Selection Reports will be monitored and reviewed, in detail, for quality assurance and for purposes of identifying and improving design policies, procedures, standards and guidelines.

For Federal Aid Projects not covered by Certification Acceptance, two copies of the current approved Pavement Type Selection Report and one copy of the supporting documentation, will be forwarded directly to the appropriate Federal Highway Administration (FHWA) District Engineer for FHWA concurrence.

The District will deal directly with the FHWA to resolve any questions. Central Office Pavement Management will be available for assistance if requested by the District or FHWA. The FHWA will return directly to the District one copy of the summary sheet with signature denoting concurrence. This copy will be filed in the District Project Design file.

A.4.3 REVISIONS

Changes made subsequent to formal distribution will require that a revision letter to the report be prepared, a copy of which shall be signed and sealed, distributed, and filed for permanent record in the report file.

Minor changes may be noted in type or ink on the original Pavement Type Selection Report with the responsible Professional Engineer's initials and the date of change. A copy of the revised original should then be signed, dated, sealed and filed for permanent record.

Major changes may require that a complete new Pavement Type Selection Report be prepared and processed, in which case it shall note that it supersedes a previous report.

A.4.4 DOCUMENTATION

The rational for selection should be clearly documented in the Pavement Type Selection Report.

The reports do not need to be lengthy or overly verbose. Rather, they should focus on reasonable cost estimates and a concise presentation of the analysis.

On projects where the policy is deviated from (i.e. Research projects), the reasons should be clearly documented in the Pavement Design Package.

A.5 DISTRICT QUALITY CONTROL

The quality control process will include three activities:

- The checking and review of annual Pavement Type Selection Reports for compliance with policies, procedures, standards, guidelines and good engineering practice.

- The checking and review of individual project determinations of annual report applicability.

- Documentation of the Quality Control Process.

The Quality Control Process will be carried out by an independent qualified Professional Engineer. As a minimum, the documentation will consist of a copy of the Quality Control Checklist filed with the Annual Pavement Type Selection Report, or a Pavement Type Selection Applicability Quality Control File maintained by project number order consisting of:

- A copy of a memo referencing the annual report that it is applicable to this project or a copy of the signed and sealed project specific Pavement Type Selection Report.

- A copy of the Quality Control Checklist signed by the Quality Control Engineer.

A sample checklist is attached.

A.6 QUALITY ASSURANCE REVIEWS

The State Pavement Design Engineer will be responsible for conducting and/or coordinating all pavement related Quality Assurance activities within each District. A Quality Assurance review of District Pavement Type Selection activities will be conducted annually.

A.7 PAVEMENT TYPE SELECTION

QUALITY CONTROL CHECKLIST

	~~Satisfactory Yes/No~~
Project Description..................	________
Finan. Proj. ID / Annual Report......	________
State Rd. No.........................	________
County...............................	________
Project Length.......................	________
Transportation System................	________

Flexible Pavement Design

ESAL.................................	________
Level of Reliability.................	________
Initial Design Period................	________
Structural Number....................	________
Friction Course......................	________
Structural Thickness.................	________
Base Thickness.......................	________
Number of through Lanes..............	________
Lane Width...........................	________
Shoulder Width.......................	________

Rigid Pavement Design

ESAL..................................._________

Level of Reliability......................_________

Initial Design Period......................_________

Thickness..................................._________

Base Thickness.............................._________

Base Type...................................._________

Number of through Lanes...................._________

Lane Width…............................... _________

Shoulder Width............................ _________

Design Method (1993 or 1998 Supplement)... _________

Project Mile Estimates

Initial

Mainline quantities.........................._________

Shoulder quantities.........................._________

Unit prices reasonable......................_________

Rehabilitation

Mainline quantities.........................._________

Shoulder quantities.........................._________

Unit prices reasonable......................_________

Life Cycle Cost Analysis

Analysis Period.............................________

Discount Rate...............................________

Agency Costs............................... ________

User Costs...............................   ________

Present Worth Calculations correct..........________

Rehabilitation intervals shown..............________

Rehabilitation intervals shown documentation ________

Principal and Secondary factors addressed....________

Traffic control and other construction considerations...............................________

Conclusion listed...........................________

Approval of District Design Engineer.........________

Comments

QC by________________________________ Date ____________

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APPENDIX B

1993 AASHTO GUIDE FOR THE DESIGN OF PAVEMENT STRUCTURES, APPENDIX B, PAVEMENT TYPE SELECTION

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THIS APPENDIX HAS BEEN PRINTED WITH THE PERMISSION OF THE AMERICAN ASSOCIATION OF STATE HIGHWAY TRANSPORTATION OFFICIALS (AASHTO)

APPENDIX B
PAVEMENT TYPE SELECTION GUIDELINES

B.1 GENERAL

The highway engineer or administrator does not have at his disposal an absolute or undisputable method for determining the type of pavement which should be selected for a given set of conditions. However, the selection of pavement type should be an integral part of any pavement management program.

The selection of pavement type is not an exact science, but one in which the highway engineer or administrator must make a judgment on many varying factors such as traffic, soils, weather, materials, construction, maintenance, and environment. The pavement type selection may be dictated by an overriding consideration for one or more of these factors.

The selection process may be facilitated by comparison of alternate structural designs for one or more pavement types using theoretical or empirically derived methods. However, such methods are not so precise as to guarantee a certain level of performance from any one alternate or comparable service for all alternates.

Also, comparative cost estimates can be applied to alternate pavement designs to aid in the decision making process. The cost for the service of the pavement would include not only the initial cost but also subsequent cost to maintain the service level desired. It should be recognized that such procedures are not precise since reliable data for maintenance, subsequent stages for construction, or corrective work and salvage value are not always available, and it is usually necessary to project costs to some future point in time. Also, economic analyses are generally altruistic in that they do not consider the present or future financial capabilities of the contracting agency.

Even if structural design and cost comparative procedures were perfected, they would not by their nature encompass all factors which should be considered in pavement type determination. Such a determination should properly be one of professional engineering judgment based on the consideration and evaluation of all factors applicable to a given highway section.

The factors which may have some influence in the decision making process are discussed below. They are generally applicable to both new and reconstructed pavements.

One group includes those factors which may have major influence and may dictate the pavement type in some instances. Some of the major factors are also incorporated in the basic design procedures and influence the structural requirements of the pavement design or subgrade and embankment treatments. In such cases they are assigned an economic value for comparative purposes.

The second group includes those factors which have a lesser influence and are usually taken into account when there are no overriding considerations or one type is not clearly superior from an economic standpoint. A flow chart of pavement selection procedure incorporating the major and secondary factors is shown in Figure B.1.

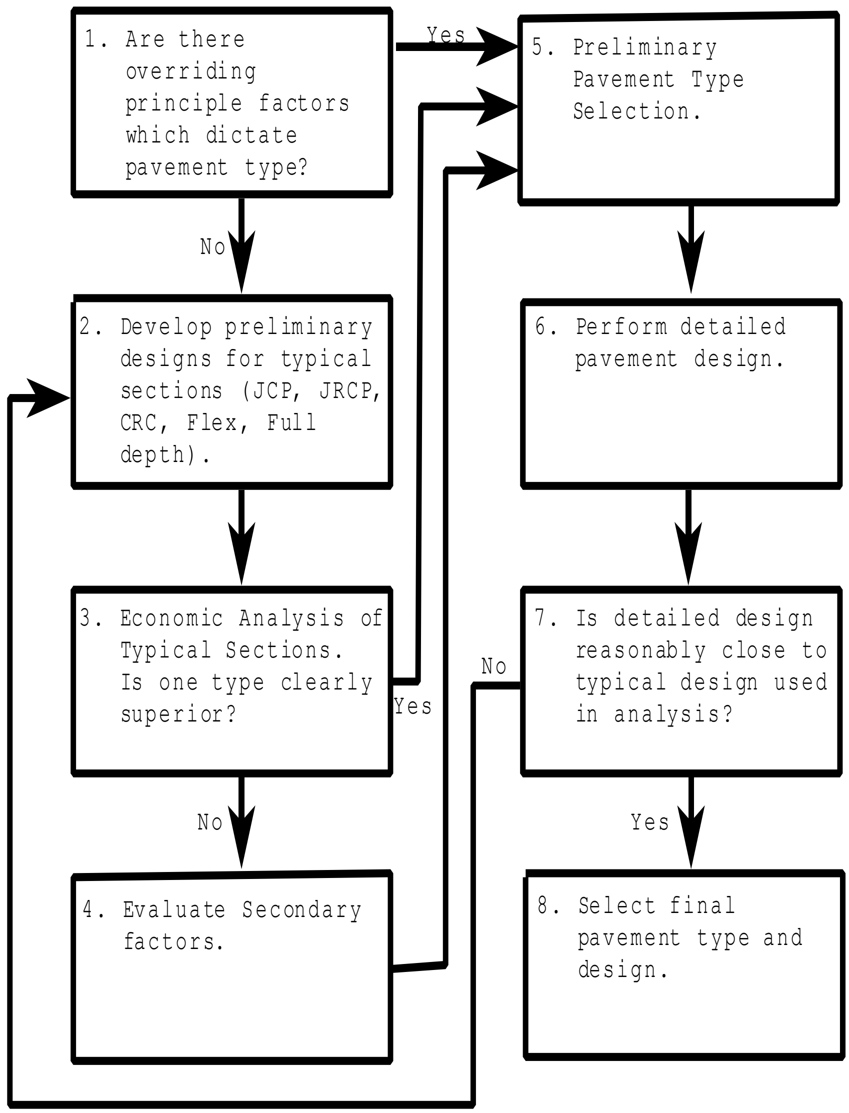
B.2 PRINCIPAL FACTORS

B.2.1 TRAFFIC

While the total volume of traffic affects the geometric requirements of the highway, the percentage of commercial traffic and frequency of heavy load applications generally have the major effect on the structural design of the pavement.

Traffic forecasts for design purposes have generally projected normal growth in the immediate corridor with an appropriate allowance for changes in land use and potential commercial and industrial development. However, experience over the past several decades has shown that the construction of new major highway facilities diverts large amounts of heavy traffic form other routes in a broad traffic corridor.

FIGURE B.1
PAVEMENT TYPE SELECTION PROCESS



This, coupled with a decline the quantity of railroad services, has resulted in a considerable underestimation of traffic growth, particularly commercial traffic. Also, the future availability and cost of motor fuels could result in increased legal loads to which pavement structures could be subjected during their design period.

For these reasons, pavement designs for major facilities should incorporate an appropriate margin of safety in the traffic factor. Agencies may choose to establish minimum structural requirements for all alternate pavement types to ensure adequate performance and service life for major facilities. Alternate strategies, or combinations of initial design, rehabilitation and maintenance, can be developed to provide equivalent service over a given period of time although the initial designs are not equivalent.

For heavily traveled facilities in congested locations, the need to minimize the disruptions and hazards to traffic may dictate the selection of those strategies having long initial service life with little maintenance or rehabilitation regardless of relative economics.

B.2.2 SOILS CHARACTERISTICS

The load-carrying capability of a native soil, which forms the subgrade for the pavement structure, is of paramount importance in pavement performance. Even in given limited areas the inherent qualities of such native soils are far from uniform, and they are further subjected to variations by the influence of weather.
The characteristics of native soils not only directly affect the pavement structure design but may, in certain cases, dictate the type of pavement economically justified for a given location. As an example, problem soils that change volume with time frequently require stage construction to provide an acceptable riding surface.

B.2.3 WEATHER

Weather affects subgrade as well as the pavement wearing course. The amount of rainfall, snow and ice, and frost penetration will seasonally influence the bearing capacity of subgrade materials.

Moisture, freezing and thawing and winter clearing operations will affect pavement wearing surfaces as to performance and maintenance costs. The surfaces, in turn, will have some effect on the ease of winter clearing operations due to differences in thermal absorption or to the ability of the pavement to resist damage from snow and ice control equipment or materials.

In drawing upon the performances record of pavements elsewhere, it is most important to take into consideration the conditions pertaining to the particular climatic belt.

B.2.4 CONSTRUCTION CONSIDERATIONS

Stage construction of the pavement structure may dictate the type of pavement selected. Other considerations such as speed of construction, accommodating traffic during construction, ease of replacement, anticipated future widening, seasons of the year when construction must be accomplished, and perhaps others may have a strong influence on paving type selections in specific cases.

B.2.5 RECYCLING

The opportunity to recycle material from an existing pavement structure or other sources may dictate the use of one pavement type. Future recycling opportunities may also be considered.

B.2.6 COST COMPARISON

Where there are no overriding factors and several alternate pavement types would serve satisfactorily, cost comparison can be used to assist in determining pavement type.

Unavoidably, there will be instances where financial circumstances are such as to make first costs the dominate factor in selection, even though higher maintenance or repair costs may be involved at a later date. Where circumstances permit, a more realistic measure is cost on the basis of service life or service rendered by a pavement structure. Such costs should include the initial construction cost, the cost of subsequent stages or corrective work, anticipated life, maintenance costs, and salvage value.

Costs to road users during periods of reconstruction or maintenance operations are also appropriate for consideration. Although pavement structures are based on an initial design period, few are abandoned at the end of that period and continue to serve as part of future pavement structure. For this reason, the analysis period should be of sufficient duration to include a representative reconstruction of all pavement types.

B.3 SECONDARY FACTORS

B.3. PERFORMANCE OF SIMILAR PAVEMENTS IN THE AREA

To a large degree, the experience and judgment of the highway engineer is based on the performance of pavements in the immediate area of his jurisdiction. Past performance is a valuable guide, provided there is good correlation between conditions and service requirements between the reference pavements and the designs under study.

Caution must be urged against reliance on short term performance records, and on those long term records of pavements which may have been subjected too much lighter loadings for a large portion of their present life. The need for periodic reanalysis of performance is apparent.

B.3.2 ADJACENT EXISTING PAVEMENTS

Provided there is no radical change in conditions, the choice of paving type on highway may be influenced by adjacent existing sections which have given adequate service. The resultant continuity of pavement type will also simplify maintenance operations.

B.3.3 CONSERVATION OF MATERIALS AND ENERGY

Pavement selection may be influenced by the pavement type which contains less of a scarce critical material or the type whose material production, transportation, and placement requires less energy consumption.

B.3.4 AVAILABILITY OF LOCAL MATERIALS OR CONTRACTOR CAPABILITIES

The availability and adaptability of local material may influence the selection of pavement type. Also, the availability of commercially produced mixes and the equipment capabilities of area contractors may influence the selection of pavement type, particularly on small projects.

B.3.5 TRAFFIC SAFETY

The particular characteristics of wearing course surface, the need for delineation through pavement and shoulder contrast, reflectivity under highway lighting, and the maintenance of a nonskid surface as affected by the available materials may each influence the paving type selection in specific locations.

B.3.6 INCORPORATION OF EXPERIMENTAL FEATURES

In some instances, the performance of material or design concepts must be determined by field testing under actual construction, environmental, or traffic conditions. Where the material or concept is adaptable to only one paving type, the incorporation of such experimental features may dictate pavement type selection.

B.3.7 STIMULATION OF COMPETITION

It is desirable that monopoly situations are avoided, and that improvement in products and methods be encouraged through continued and healthy competition among industries involved in the production of paving materials.

Where alternative pavement designs have comparable initial cost, including the attendant costs of earthwork, drainage facilities, and other appurtenances, and provide comparable service life of life-cycle cost, the highway agency may elect to take alternate bids to stimulate competition and obtain lower prices. If this procedure is used, it is essential that good engineering practices and product improvement are not abandoned for the purpose of making cost more competitive.

Where several materials will adequately serve as a component within the pavement structure, such as a subbase or base course, contractors should be permitted the option of using any of the approved materials.

B.3.8 MUNICIPAL PREFERENCE, PARTICIPATING LOCAL GOVERNMENT PREFERENCE AND RECOGNITION OF LOCAL INDUSTRY

While these considerations seem outside the realm of the highway engineer they cannot always be ignored by the highway administrator, especially if all other factors involved are indecisive as to the pavement type.

B.4 CONCLUSION

In the foregoing, there have been listed and discussed those factors and considerations which influence, to various degrees, the determination of paving types. This has brought to the fore the need, in certain areas, for the development of basic information that is not available at present. It has also served to point out, in general, that conditions are so variable and influences sufficiently different from locality to necessitate a study of individual projects in most instances.

APPENDIX C

PAVEMENT TYPE SELECTION REPORT EXAMPLE AND DISCUSSION

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SAMPLE MEMORANDUM (and discussion)

From: Preparer

To: District Design Engineer

Subject: Pavement Type Selection
Project or Typical Section Description

The following information has been developed in order to evaluate the type of pavement most appropriate for this typical section and area or project. The report follows the outline given in Appendix B of the 1993 AASHTO Guide for the Design of Pavement Structures.

Principal Factors

Traffic: Most of the time this will not be a determining factor. But, if this is a heavily trafficked project and a long initial service life is desired, for instance an urban freeway, and there has been good experience with one pavement type or the other, this could be an overriding factor. Otherwise, the memo would state that either type of pavement could be constructed satisfactorily.

Soils: Because of the requirement to place select materials beneath all pavement types, soil is normally not an overall determining factor. However, the availability of permeable special select soils is important for the selection of the type of embankment and drainage typical section for rigid pavements and should be evaluated with input from the District Materials Engineer. This could be a determining factor, but it probably is more properly reflected in the economic analysis.

Weather: This will probably not be an overriding factor in Florida. The memo should say that either pavement type could be constructed satisfactorily.

Construction: An overriding factor could occur here. If stage construction (pavement thickness or number of lanes) is planned due to funding or some other constraint, it may dictate that one or the other pavement type may be selected. Maintenance of traffic, now and in the future and constructability may or may not justify being considered an overriding factor, but also could indicate a preference.

Recycling: Florida has successfully recycled both AC and PCC. This in itself will probably not be a determining factor, but could be reflected in the economic analysis. For instance a reconstruction project could in itself be a potential source of construction material. If recycling is a part of the plan, there should be reasonable assurance that the materials will meet the applicable specifications.

Cost: Most pavement type selection reports will include an economic analysis. It is highly recommended that the standard, FHWA approved procedures be followed. The economic analysis should be an attachment and a summary of the results included in the memo report at this point.

If a conclusion has been reached based on the Principal Factors, a recommendation on pavement type can be made at this point. If necessary, a discussion of Secondary Factors can also be made.

Secondary Factors

Performance of Similar Pavements: In some instances this could almost be an overriding factor, especially if the experience has been bad for some reason that can not be overcome through proper design.

Adjacent Pavements: In order to avoid a checkerboard of pavement types, or to minimize future maintenance difficulties, a preference for a particular pavement type may be warranted. This could occur where you have a project between existing roadways or where you are adding lanes, for instance, going from two lanes to four lanes and median.

The next several factors; conservation of materials and energy, local materials, contractors capabilities, can be discussed, but are probably just as well reflected in the economic analysis. It is not necessary to discuss every secondary factor.

Traffic Safety: This could be a factor at some specific sites where time or space is limited or some unique condition exists.

Experimental Features: This could be an overriding factor, especially if the entire project is an experiment. In this case a Pavement Type Selection Report is probably unnecessary. A brief memo to the file describing the project and recommendation for research, with signature approval by the District Design Engineer should be sufficient.
Stimulation of Competition: This is a policy issue that could be addressed by a District Secretary. If it is desirable, it could be an overriding factor.

Local Preference: This could be an overriding issue if the FDOT is going to turn the road over to a local government following construction.

Recommendation: Based on the above, it is recommended that (concrete/asphalt) be used in the construction of this project. The economic analysis will be reviewed again after the pavement design is completed.

Approved: District Design Engineer, PE   Date:_______

PAVEMENT TYPE SELECTION ECONOMIC ANALYSIS

COMPUTATION SHEET

COST PER PROJECT MILE

Analysis Period = 40 years

Discount Rate = 4%

	COST		P/F		PRESENT WORTH
Rigid Pavement					
Initial	____________	*	(1.00000)	=	____________
20 yr.	____________	*	(0.45639)	=	____________
30 yr.	____________	*	(0.30832)	=	____________
Total Agency Costs				=	____________
User Costs				=	____________
Total Present Worth Life- Cycle Costs				=	____________

Costs should be calculated in present day dollars

Flexible Pavement

Initial ____________ * (1.00000) = ____________

14 yr. ____________ * (0.57748) = ____________

28 yr. ____________ * (0.33348) = ____________

Total Agency Costs = ______________________

User Costs = ______________________

Total Present Worth
Life- Cycle Costs = ______________________

Costs should be calculated in present day dollars.

PAVEMENT TYPE SELECTION ECONOMIC ANALYSIS

COMPUTATION SHEET

COST PER PROJECT MILE

Analysis Period = 40 years

Discount Rate = 4%

	COST		P/F		PRESENT WORTH
Rigid Pavement					
Initial	____________	*	(1.00000)	=	____________
___ yr.	____________	*	( )	=	____________
___ yr.	____________	*	( )	=	____________

Total Agency Costs = ______________________

User Costs = ______________________

Total Present Worth Life- Cycle Costs = ______________________

Costs should be calculated in present day dollars

Flexible Pavement

Initial ____________ * (1.00000) = ____________

___ yr. ____________ * (   ) = ____________

___ yr. ____________ * (   ) = ____________

___ yr. ____________ * (   ) = ____________

Total Agency Costs = ______________________
User Costs = ______________________

Total Present Worth
Life- Cycle Costs = ______________________

Costs should be calculated in present day dollars.

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APPENDIX D

EXAMPLE OF A LIFE CYCLE COST ANALYSIS USING THE REALCOST SPREADSHEET

Whenever vehicles are required to slow down or stop due to a lane closure there are related user costs. The RealCost spreadsheet calculates these costs for the initial construction and each rehabilitation effort within the assumed life cycle of the project. A lane closure under free flow conditions experiences costs due to a speed reduction. These costs include speed change delay, speed change vehicle operating and reduced speed delay. A lane closure under forced flow or queue conditions experiences costs due to stopping and creeping. These costs include stopping delay, stopping vehicle operating, queue delay and idling vehicle operating. Based on inputs, the RealCost spreadsheet determines for each hour of the day what the operating conditions are during a lane closure, and calculates the appropriate delay costs.

EXAMPLE: a 12.5 mile section of I-95 in Brevard County is being widened from 4 lanes to 6 lanes and a 40 year life cycle cost analysis is to be conducted. The asphalt alternative includes initially adding lanes and resurfacing, then milling and resurfacing every 14 years. The concrete alternative includes adding lanes milling with a concrete overlay, then a 3% slab replacement in year 20, and a crack and seat with asphalt overlay in year 30. The pavement design and construction costs are given. The following data is available from PD&E and initial engineering efforts:

1. Construction year AADT (both directions) = 61, 560
2. Percent single unit trucks = 2
3. Percent combination trucks = 20
4. Speed limit = 70 mph
5. Number of lanes in each direction = 3
6. Time of day of lane closures: typically, Interstate construction takes place at night. This project will be constructed at night between the hours of 9 pm and 6 am.
7. Work zone length = 2 miles
8. Work zone speed limit = 60 mph
9. The Annual Growth Rate can be calculated using the equation:

   $I = [(F/P)^{1/n} - 1] \times 100$ where;

   F = design year AADT = 102,800

   P = construction year AADT = 61,560

   N = initial design period = 20 years

   $I = [(102{,}800/61{,}560)^{1/20} - 1] \times 100 = 2.6\%$

Hourly traffic distribution: The table from the Design Traffic Report is shown below.

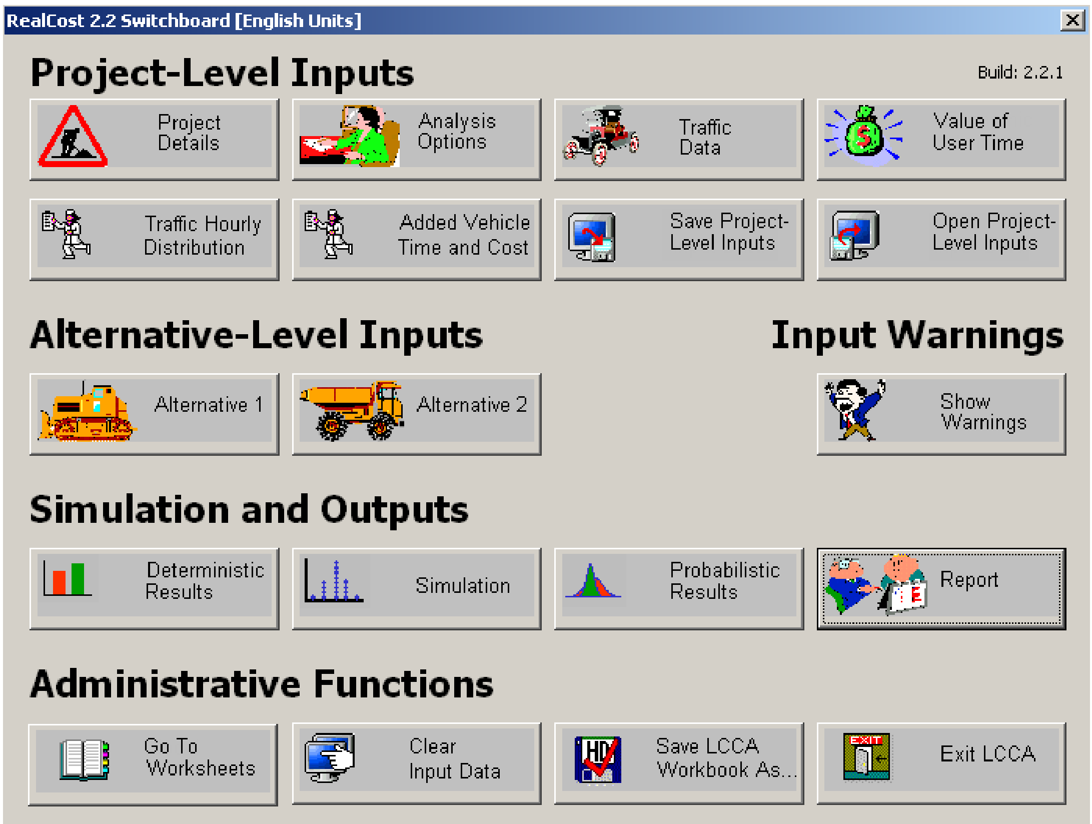
LOCATION: US 192 West of I-95

HOUR END AT	HOURLY VOLUME DIRECTION (SB or EB)	HOURLY VOLUME DIRECTION (NB or WB)	TOTAL VOLUME BOTH DIRECTIONS	DISTRIBUTION PERCENT DIRECTION (SB or EB)	DISTRIBUTION PERCENT DIRECTION (NB or WB)	TOTAL PERCENT BOTH DIRECTIONS
1:00	33	25	59	1.0535%	0.8333%	0.9458%
2:00	41	30	71	1.3064%	0.9759%	1.1446%
3:00	28	21	50	0.8955%	0.7018%	0.8007%
4:00	47	23	70	1.4960%	0.7456%	1.1285%
5:00	48	37	85	1.5171%	1.2281%	1.3757%
6:00	86	99	185	2.7181%	3.2566%	2.9824%
7:00	169	187	356	5.3308%	6.1513%	5.7338%
8:00	179	160	339	5.6469%	5.2632%	5.4597%
9:00	165	175	340	5.2044%	5.7566%	5.4758%
10:00	164	163	327	5.1833%	5.3618%	5.2716%
11:00	192	174	367	6.0788%	5.7346%	5.9111%
NOON	222	179	401	7.0164%	5.8882%	6.4646%
1:00	195	178	373	6.1631%	5.8443%	6.0078%
2:00	195	178	373	6.1631%	5.8553%	6.0132%
3:00	183	194	377	5.7838%	6.3816%	6.0777%
4:00	180	209	389	5.6995%	6.8640%	6.2712%
5:00	258	229	488	8.1648%	7.5439%	7.8618%
6:00	212	238	450	6.6898%	7.8289%	7.2492%
7:00	179	174	353	5.6469%	5.7237%	5.6854%
8:00	133	106	239	4.1930%	3.4868%	3.8476%
9:00	88	88	176	2.7918%	2.8947%	2.8427%
10:00	69	90	159	2.1808%	2.9605%	2.5633%
11:00	52	44	96	1.6540%	1.4364%	1.5476%
MIDNIGHT	45	39	83	1.4117%	1.2719%	1.3434%
TOTALS	3,164	3,040	6,203	99.9895%	100.0000%	100.0000%

Work zone duration is the number of days that a lane closure will be in place. This must be calculated for the initial construction and each rehabilitation effort. The calculations will be presented later when the alternatives are discussed.

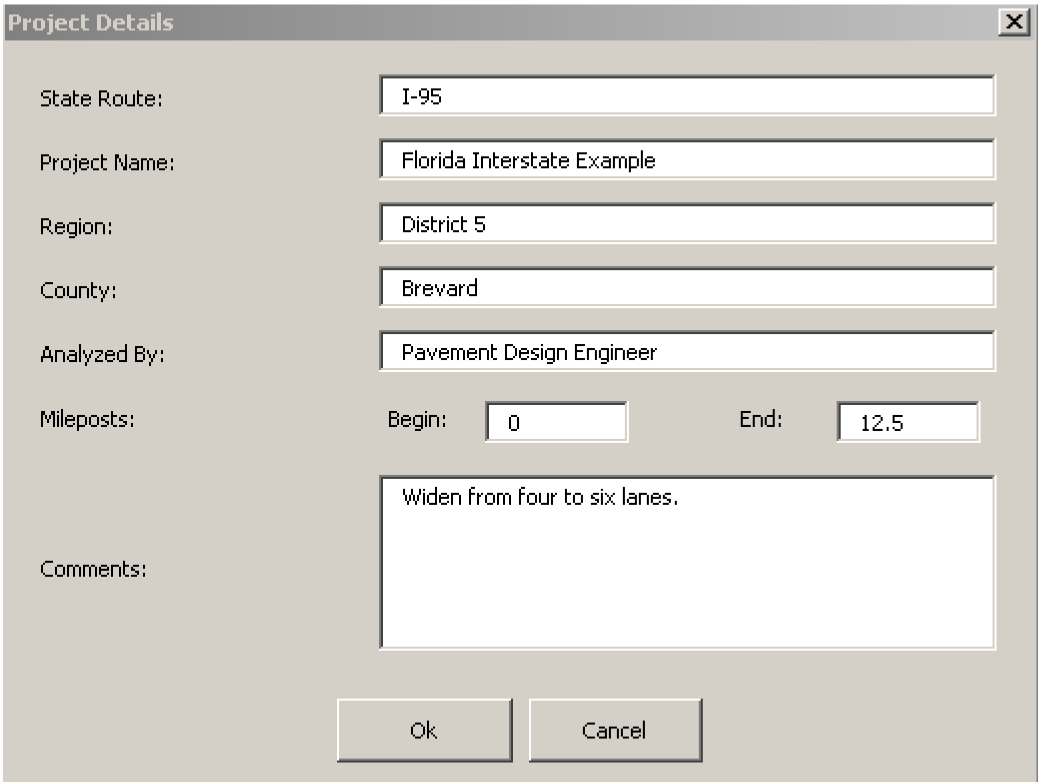
The main menu for the spreadsheet is shown in Figure D-1. The two main categories of inputs are Project-Level Inputs and Alternative Level Inputs. The Project –Level Inputs will be covered first, followed by the Alternative-Level Inputs.

Figure D - 1



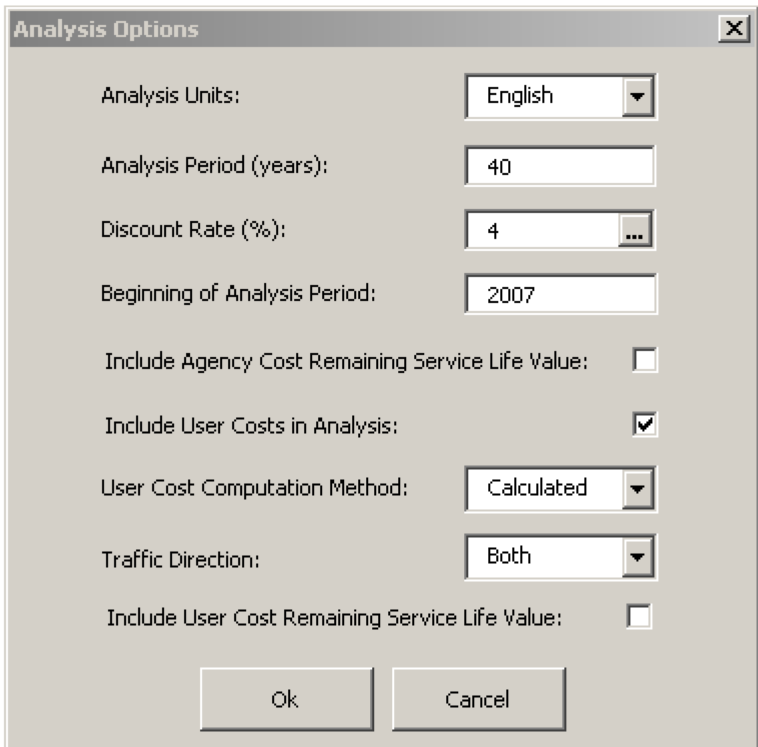
The Project Details input screen contains some generic project information as shown in Figure D - 2.

Figure D - 2



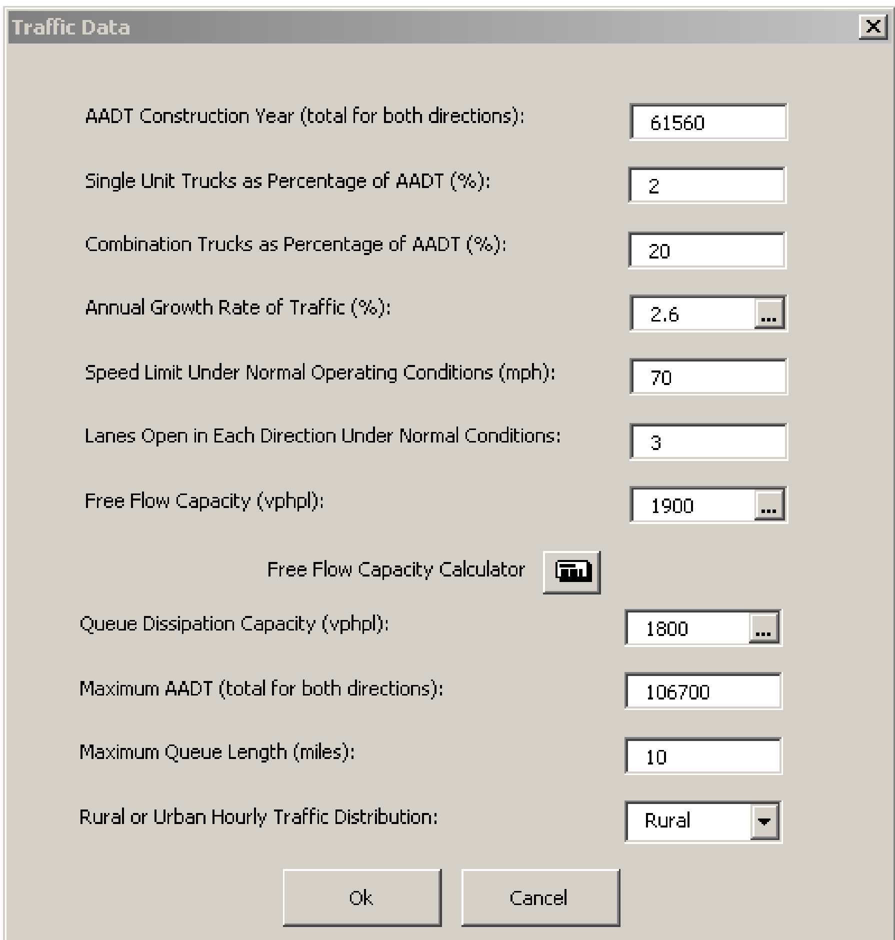
The Analysis Options input screen is shown in Figure D - 3. The analysis Period will be 40 years and the Discount Rate will be 4%. The Agency Cost Remaining Service Life Value will not be included. The User Costs will be included and by choosing the 'calculated' method, the spreadsheet will calculate the delay costs using the inputs provided.

Figure D - 3



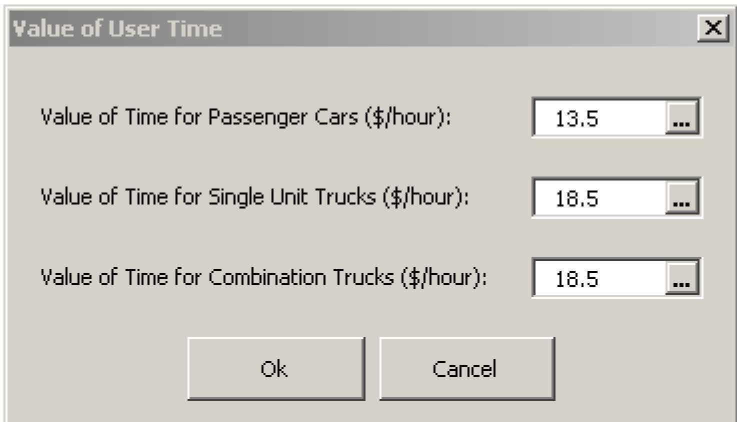
The Traffic Data input screen is shown in Figure D - 4. The maximum queue length is somewhat arbitrary. In an isolated area a longer queue length should be used to reflect the unavailability of alternate routes. In urban areas a shorter queue length would be more appropriate. Ten miles is used in this case. The default values for 'urban' or 'rural' traffic distribution will be over ridden by the values input in the Traffic Hourly Distribution screen in Figure D-5; therefore, selection is irrelevant in this case. The statewide traffic values are found in Section 4.2.3 of this manual.

Figure D - 4



The Values of User Time input screen is shown in Figure D – 5. The value for intercity travel will be used in this case as the project is outside an urban area. The Value of Time for trucks is $18.50 as per Section 4.2.2.2 of this manual.

Figure D - 5



The Hourly Traffic Distribution screen is shown in Figure D – 6. These values are provided in the Traffic Report and input manually.

Figure D - 6

Traffic Hourly Distribution

Hour	AADT Rural (%)	Inbound Rural (%)	Outbound Rural (%)	AADT Urban (%)	Inbound Urban (%)	Outbound Urban (%)
0 - 1	0.95	42	58	1.2	47	53
1 - 2	1.14	42	58	0.8	43	57
2 - 3	0.8	42	58	0.7	46	54
3 - 4	1.13	33	67	0.5	48	52
4 - 5	1.38	44	56	0.7	57	43
5 - 6	2.98	54	46	1.7	58	42
6 - 7	5.73	53	47	5.1	63	37
7 - 8	5.46	47	53	7.8	60	40
8 - 9	5.48	51	49	6.3	59	41
9 - 10	5.27	50	50	5.2	55	45
10 - 11	5.91	47	53	4.7	46	54
11 - 12	6.46	45	55	5.3	49	51
12 - 13	6.01	48	52	5.6	50	50
13 - 14	6.01	48	52	5.7	50	50
14 - 15	6.08	51	49	5.9	49	51
15 - 16	6.27	54	46	6.5	46	54
16 - 17	7.86	47	53	7.9	45	55
17 - 18	7.25	53	47	8.5	40	60
18 - 19	5.69	49	51	5.9	46	54
19 - 20	3.85	44	56	3.9	48	52
20 - 21	2.84	50	50	3.3	47	53
21 - 22	2.56	57	43	2.8	47	53
22 - 23	1.55	46	54	2.3	48	52
23 - 24	1.34	47	53	1.7	45	55
Total	99.99999			100		

Restore Defaults | Ok

The Added Time and Vehicle Stopping Costs input screen is shown in Figure D – 7. These are default values derived from research studies. The operator only needs to enter the Current Transportation Component CPI and year for the Current Year, and escalate the values.

Figure D – 7


Added Time and Vehicle Stopping Costs

Initial Speed (mph)	Added Time per 1,000 Stops (Hours): Passenger Cars	Added Time: Single Unit Trucks	Added Time: Combination Trucks	Added Cost per 1,000 Stops ($): Passenger Cars	Added Cost: Single Unit Trucks	Added Cost: Combination Trucks
0	0	0	0	0	0	0
5	1.02	0.73	1.1	3.591	12.3025	44.7146
10	1.51	1.47	2.27	11.7439	27.5576	103.0617
15	2	2.2	3.48	20.1628	45.0737	172.8601
20	2.49	2.93	4.76	28.9142	64.372	252.7798
25	2.98	3.67	6.1	38.1311	85.0801	341.1982
30	3.46	4.4	7.56	48.013	106.7059	436.5193
35	3.94	5.13	9.19	58.5998	128.8504	537.1072
40	4.42	5.87	11.09	70.091	151.5801	641.3393
45	4.9	6.6	13.39	82.5531	173.0064	747.6462
50	5.37	7.33	16.37	96.1723	194.1268	854.4053
55	5.84	8.07	20.72	111.0151	213.9837	959.9541
60	6.31	8.8	27.94	127.281	238.0434	1062.6567
65	6.78	9.53	31.605	144.9966	260.4672	1130.0212
70	7.25	10.27	39.48	164.4013	278.0498	1224.9699
75	7.71	11	47.9	185.5749	299.0771	1319.9186
80	8.17	11.73	57.68	208.6105	320.1044	1414.8806
Idling Cost per Veh-Hr ($):				0.9213	1.0216	1.097

Cost Escalation

Base Transp. Component CPI:	190
Base Year:	2007
Current Transp. Component CPI:	190
Current Year:	2007
Escalation Factor:	1.00

Escalate

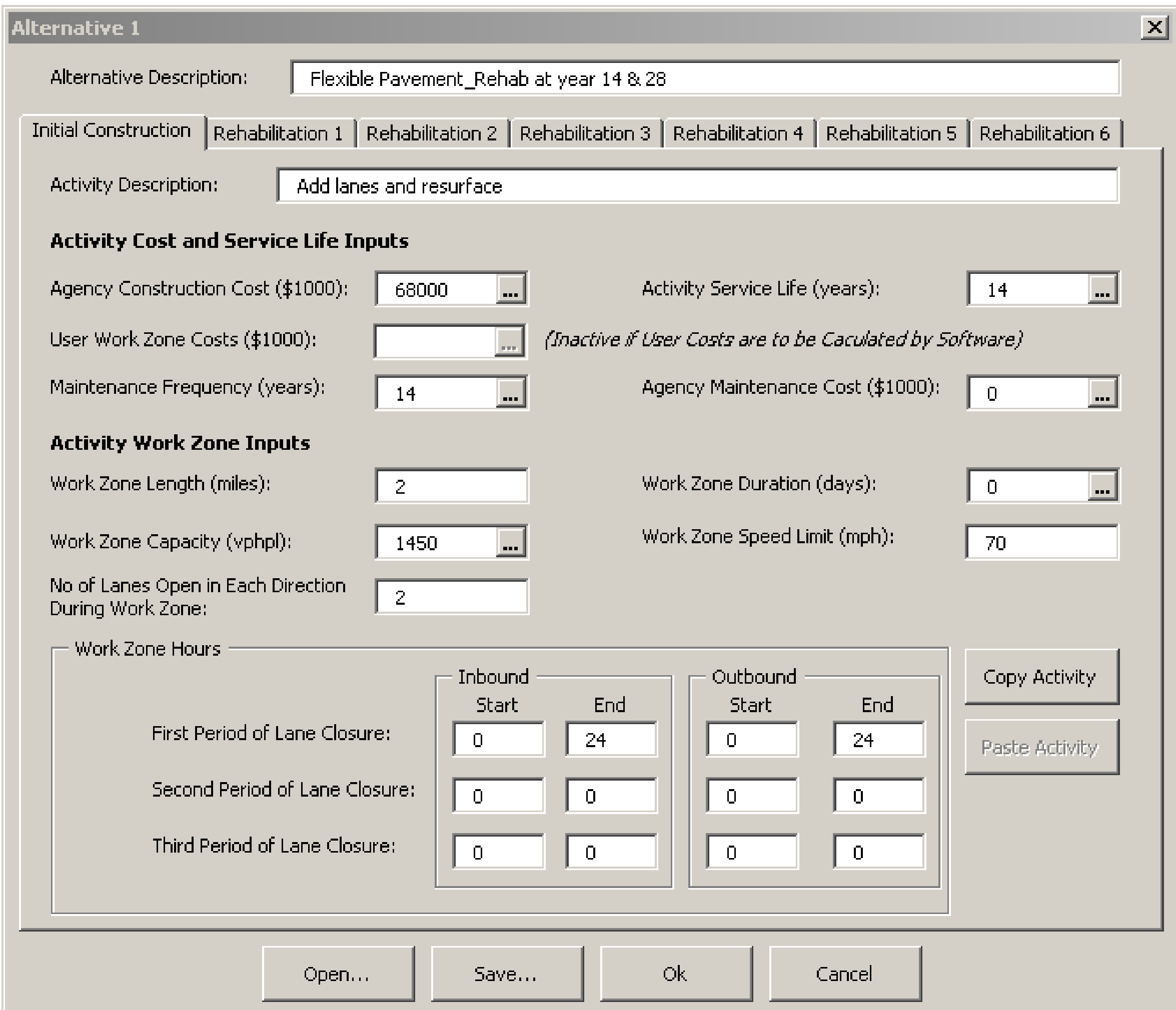
Restore Defaults | Ok

Alternative-Level Inputs will be covered next. The Initial Construction input screen is shown in Figure D - 8. The flexible pavement alternative will be Alternative 1. Input a description for the alternative and the initial construction activity. The Activity Cost and Service Life Inputs are given. The Activity Work Zone Inputs will be coded using the traffic control conceptual plan for the initial construction. This project will be constructed using two temporary lanes and diverting traffic to the opposite side of the roadway. Therefore, the initial construction will have no lane closures and no speed reduction, resulting in no delay. This is reflected by coding:

No. of Lanes Open In Each Direction During Work Zone = 2

1. Work Zone Duration (days) = 0
2. Work Zone Speed Limit = 70

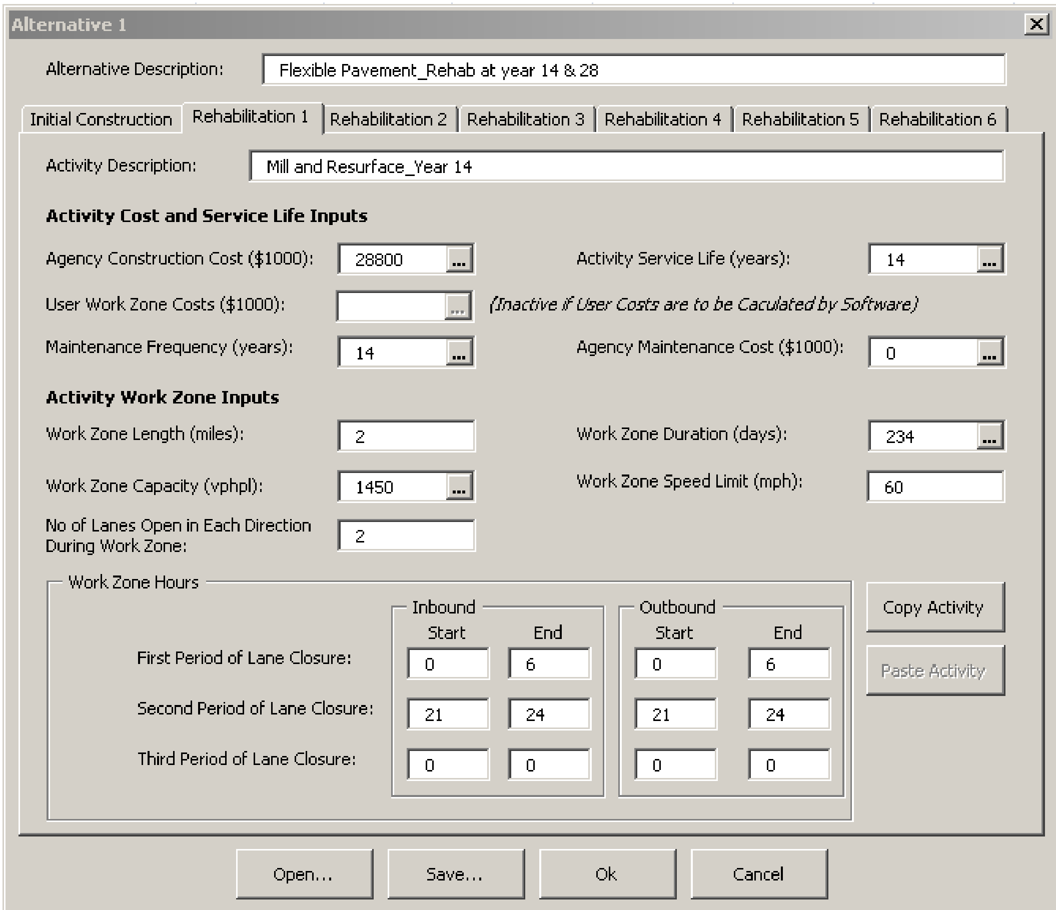
Figure D – 8



The Work Zone Hours are coded as a 24 hour work zone.

The Rehabilitation 1 input screen is shown in Figure D - 9.

Figure D - 9



The Activity Cost and Service Life Inputs are given. The Activity Work Zone Inputs will be coded using an assumed traffic control conceptual plan for a six-lane Interstate section. It is assumed that night work will apply and a single lane will be closed, leaving 2 lanes open in each direction. The reduced work zone speed will be 10 mph below the posted speed, or 60 mph. The Work Zone Duration (days) is the number of lane closure days for the project.

In order to determine work zone duration, production rates for each controlling item of work must be established. The construction office will usually be able to supply the controlling items and production rates based on the type, size and location of the project. The production rate may also vary from rural to urban settings.

The total square yards of the project are:

Area = (12.5 miles)(5,280 ft./mile)(72 ft.) / 9 ft^2./SY = 528,000 SY

The asphalt rehabilitation includes milling 3″ of asphalt and resurfacing with 4″ of structural asphaltic concrete and open graded friction course. The following items and production rates were used for asphalt rehabilitation:

1. Milling (3" one pass) @ 6,800 SY per day

   Area = 528,000 = @ 6,800 SY per day = <u>78 days</u>.

   With this milling sequence, the first lift of 1 ½″ of Type SP should be placed on the same day of milling to avoid any treatment criteria per standard index 600.

2. Resurface @ 885 Tons per day

The structural AC will be 4" thick @ 110 lb. per SY-inch.

Tons = (528,000 SY) x (110 lb / 2000 lb / ton) x (4") = 116,160 tons @ 885 tons per day = 131 days.

The friction course, FC – 5, will be ¾" thick @ 110 lb. per SY-inch.

Tons = (528,000 SY) x (110 lb / 2000 lb / ton) x (3/4") = 21,780 tons @ 885 tons per day = 25 days.

The total lane closure days = (132 + 131 + 25) = 234.

Referring to Figure D – 9, the user will notice that there are six Rehabilitation input screens. For the asphalt alternative each rehabilitation will be identical; therefore, the user should use the 'copy – paste' command buttons provided in the Rehabilitation screen to copy the Rehabilitation 1 screen to Rehabilitation screens 2 – 6. The spreadsheet requires that all Rehabilitation screens are filled in even though all Rehabilitation screens beyond the life cycle time frame will not be considered.

The Work Zone Hours apply to each day from midnight (hour 0) to midnight (hour 24). The lane closure for this project will be from 9 pm to 6 am; therefore, in any given day there are two lane closures time periods:

1. Midnight to 6 am (hour 0 to hour 6), and
2. 9 pm to midnight (hour 21 to hour 24)

Alternative 1 is now complete.

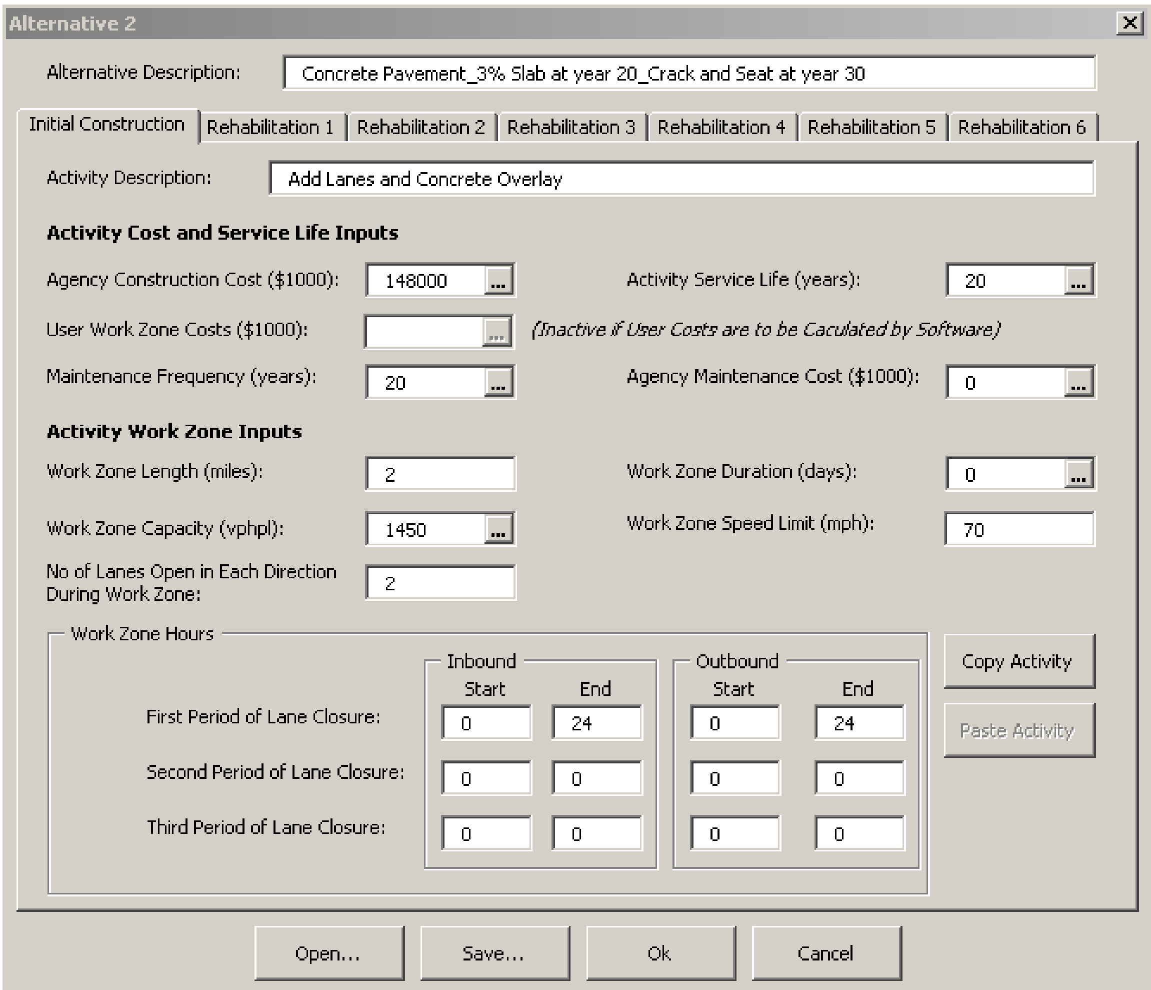
The concrete pavement alternative will be Alternative 2. The Initial Construction input screen is shown in Figure D - 10. Input a description for the alternative and the initial construction activity. The Activity Cost and Service Life Inputs are given. The Activity Work Zone Inputs will be coded using the traffic control conceptual plan for the initial construction. This project will be constructed using two temporary lanes and diverting traffic to the opposite side of the roadway. Therefore, the initial construction will have no lane closures and no speed reduction, resulting in no delay. This is reflected by coding:

1. No. of Lanes Open In Each Direction During Work Zone = 2

2. Work Zone Duration (days) = 0

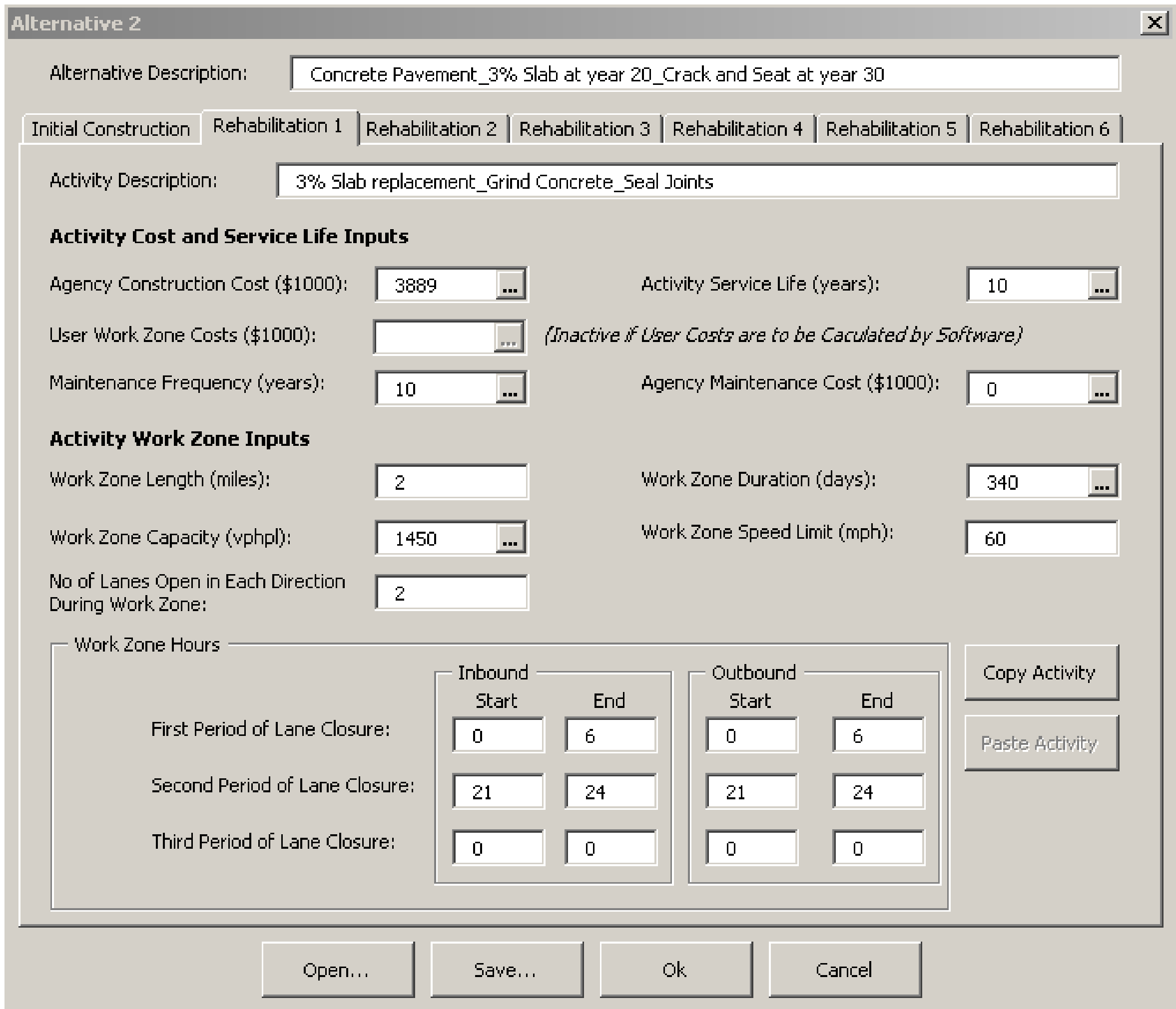
3. Work Zone Speed Limit = 70

Figure D – 10



The Work Zone Hours are coded as a 24 hour work zone. The Rehabilitation 1 input screen is shown in Figure D - 11.

Figure D - 11



The Activity Cost and Service Life Inputs are given. The Activity Work Zone Inputs will be coded using an assumed traffic control conceptual plan for a six-lane Interstate section. It is assumed that night work will apply and a single lane will be closed, leaving 2 lanes open in each direction. The reduced work zone speed will be 10 mph below the posted speed, or 60 mph. The Work Zone Duration (days) is the number of lane closure days for the project.

The concrete rehabilitation includes replacing 3% of the slabs in the outside lanes, grinding the entire pavement area and sealing the joints. The following items and production rates were used for the first concrete rehabilitation:

1. Slab Replacement @ 9 Slabs per day

   No. of Slabs = 2 x 12.5 miles x 5,280 ft/mile / 15 ft / Slab x 0.03 = 264 Slabs @ 9 Slabs per day = <u>30 days</u>.

2 Grinding @ 2,200 SY per day

   Area = 2 x 38 ft x 12.5 miles x 5,280 ft / mile / 9 ft^2 / SY = 557,300 SY @ 2,200 SY per day = <u>253 days</u>.

3 Joint Sealing @ 10,500 ft. per day

   Length of Transverse Joints = (12.5 miles x 5,280 ft / mile / 15) x 38 ft x 2 = 334,400 ft.

   Length of Longitudinal Joints = 12.5 miles x 5,280 ft x 4 = 264,000 ft.

   Total Length of Joints = 334,400 + 264,000 = 598,400 ft. @ 10,560 ft. per day = <u>57 days</u>.

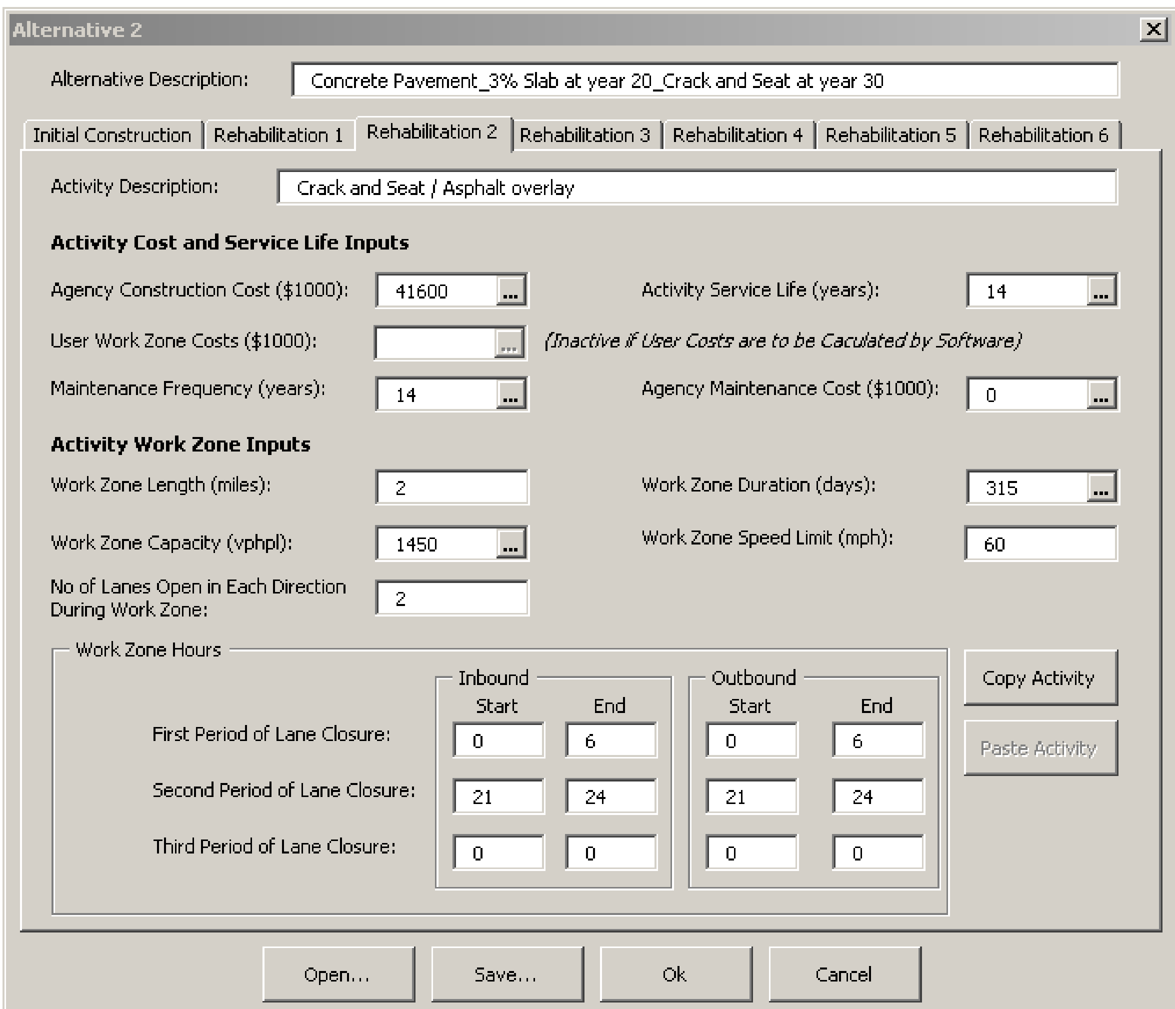
The total lane closure days = (30 + 253 + 57) = <u>340 days</u>.

The Work Zone Hours apply to each day from midnight (hour 0) to midnight (hour 24). The lane closure for this project will be from 9 pm to 6 am; therefore, in any given day there are two lane closures time periods:

1. Midnight to 6 am (hour 0 to hour 6), and
2. 9 pm to midnight (hour 21 to hour 24)

Alternative 2 – Rehabilitation 1 is now complete. The Rehabilitation 2 input screen is shown in Figure D -12.

Figure D – 12



Rehabilitation 2 includes Crack and Seat the concrete with an Asphalt Overlay. All inputs will be the same as Rehabilitation 1 except for the Construction Activity Service Life and the Work Zone Duration. The Activity Service Life will be 14 years. The following items and production rates were used for the second concrete rehabilitation:

1. Crack and Seat Concrete @ ½ Lane-Mile per day.

   12.5 miles x 6 Lanes = 75 Lane-Miles @ ½ Lane-Mile per day = 150 days.

2. Resurface with Super Pave @ 885 Tons per day

   Area = (12.5 miles)(5,280 ft./mile)(76 ft.) / 9 ft^2./SY = 557,300 SY

   The Super Pave will be 4" thick @ 110 lb. per SY-inch.

   Tons = (557,300 SY) x (110 lb / 2000 lb / ton) x (4") = 122,600 tons @ 885 tons per day = 139 days.

   The friction course, FC – 5, will be ¾" thick @ 110 lb. per SY-inch.

   Tons = (557,300 SY) x (110 lb / 2000 lb / ton) x (3/4") = 23,000 tons @ 885 tons per day = 26 days.

The total lane closure days = (150 + 139 + 26) = 315 days.

The subsequent Rehabilitations will be milling and resurfacing, identical to Alternative 1, Rehabilitation 1; therefore, the user should set up Rehabilitation 3 appropriately, then use the 'copy – paste' command buttons provided in the Rehabilitation screen to copy the Rehabilitation 3 screen to Rehabilitation screens 4 – 6.

Alternative 2 is now complete.

The results of the user cost analysis can be viewed by selecting the Deterministic Results command button on the main RealCost Switchboard screen. The results are displayed in Figure D-13.

Figure D-13

Total Cost	**Alternative 1: Flexible Pavement_Rehab at year 14 & 28**		**Alternative 2: Concrete Pavement_3% Slab at year**	
	Agency Cost ($1000)	User Cost ($1000)	Agency Cost ($1000)	User Cost ($1000)
Undiscounted Sum	*$125,600.00*	*$1,287.73*	*$193,489.00*	*$1,753.59*
Present Value	**$94,235.43**	**$587.87**	**$162,600.95**	**$673.07**
EUAC	$4,761.10	$29.70	$8,215.17	$34.01
Lowest Present Value Agency Cost	**Alternative 1: Flexible Pavement_Rehab at year 14 & 28**			
Lowest Present Value User Cost	**Alternative 1: Flexible Pavement_Rehab at year 14 & 28**			

Cost data are from district cost estimate for this project.

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APPENDIX E

PAVEMENT TYPE SELECTION
LIFE CYCLE COST ANALYSIS SPREADSHEET
EXAMPLE

Figure E-1, PROJECT BASIC INPUTS INFORMATION SHEET

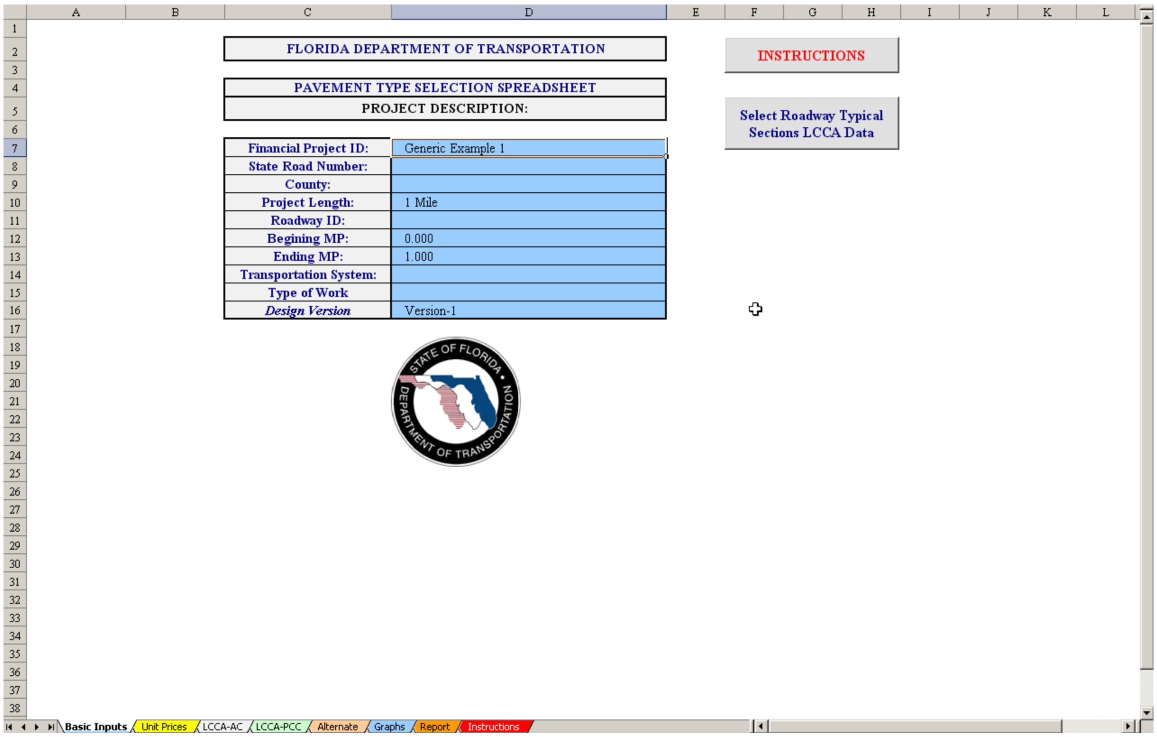


Figure E-2, SELECT ROADWAY TYPICAL SECTION DATA

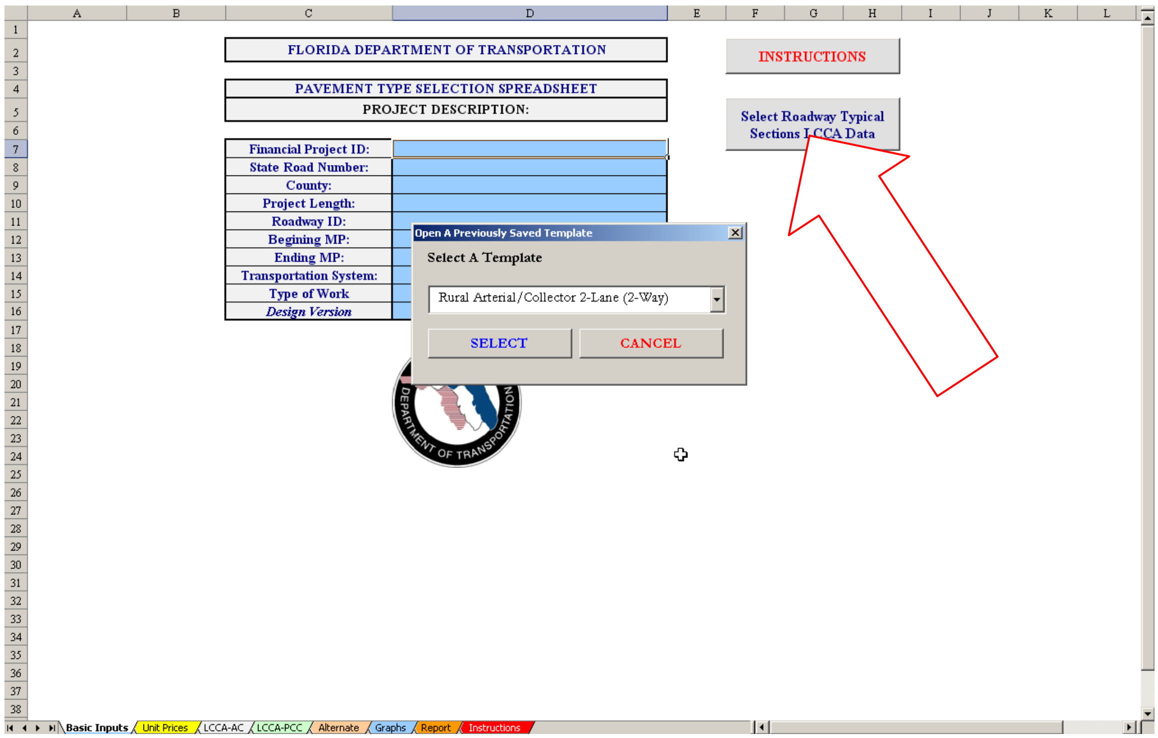
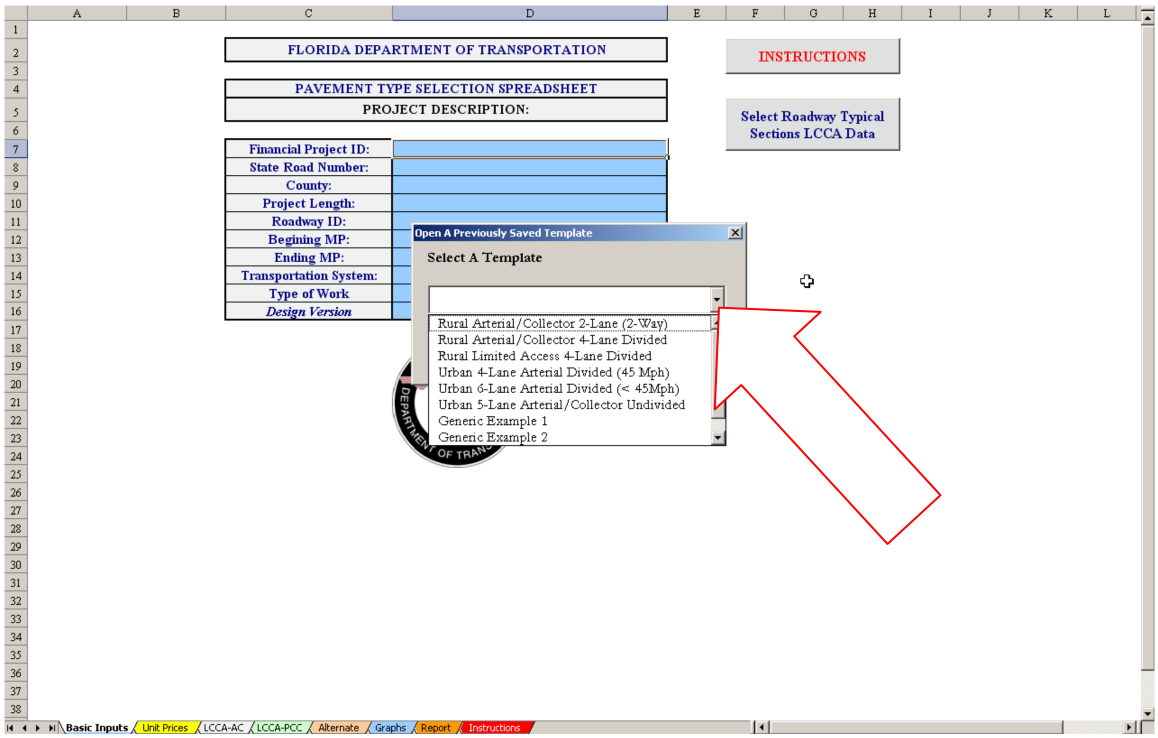


Figure E-3, SELECT A TEMPLATE FROM DROP DOWN MENU



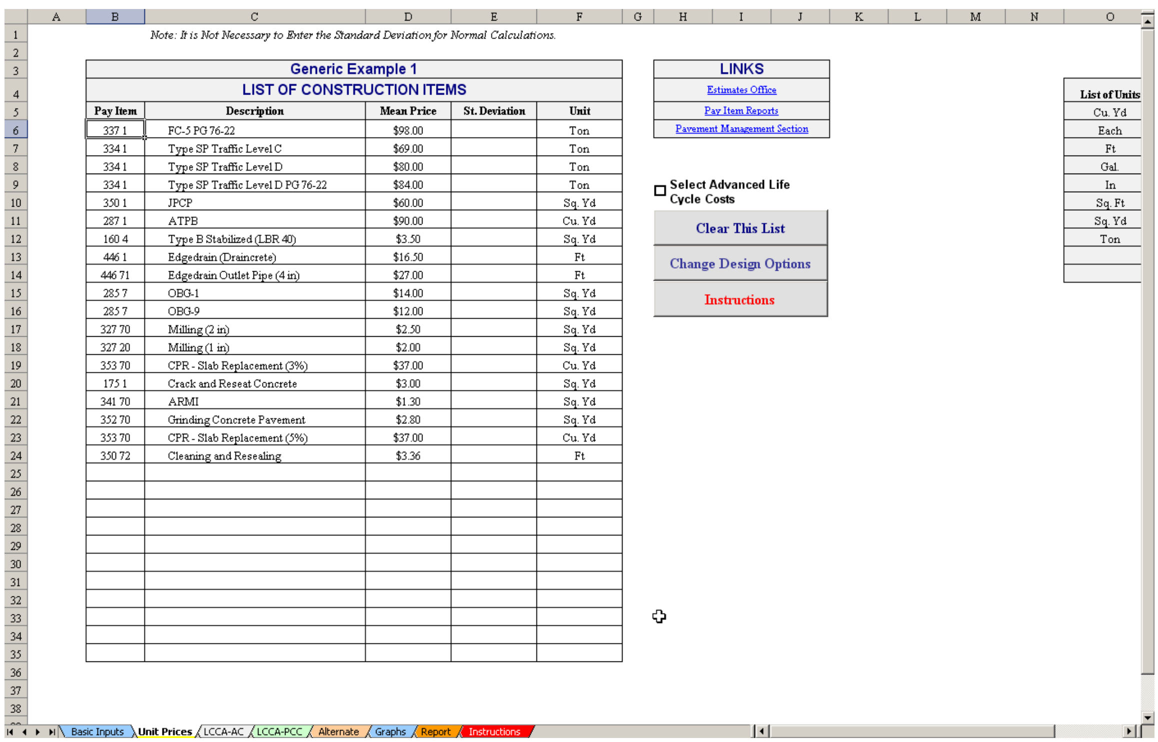
UNIT PRICES FOR CONSTRUCTION ITEMS SHEET

Based on a typical pavement design, the various construction items associated with it are loaded to this sheet.

Enter unit prices by Pay Items in the table for new construction and rehabilitation items and select the appropriate measurement unit from the drop down box.

Once these costs are entered, select any of the LCC sheets. The cost prices are automatically updated.

Figure E-4, CONSTRUCTION ITEMS SHEET



Note: It is Not Necessary to Enter the Standard Deviation for Normal Calculations.

Generic Example 1

LIST OF CONSTRUCTION ITEMS

Pay Item	Description	Mean Price	St. Deviation	Unit
337 1	FC-5 PG 76-22	$98.00		Ton
334 1	Type SP Traffic Level C	$69.00		Ton
334 1	Type SP Traffic Level D	$80.00		Ton
334 1	Type SP Traffic Level D PG 76-22	$84.00		Ton
350 1	JPCP	$60.00		Sq. Yd
287 1	ATPB	$90.00		Cu. Yd
160 4	Type B Stabilized (LBR 40)	$3.50		Sq. Yd
446 1	Edgedrain (Draincrete)	$16.50		Ft
446 71	Edgedrain Outlet Pipe (4 in)	$27.00		Ft
285 7	OBG-1	$14.00		Sq. Yd
285 7	OBG-9	$12.00		Sq. Yd
327 70	Milling (2 in)	$2.50		Sq. Yd
327 20	Milling (1 in)	$2.00		Sq. Yd
353 70	CPR - Slab Replacement (3%)	$37.00		Cu. Yd
175 1	Crack and Reseat Concrete	$3.00		Sq. Yd
341 70	ARMI	$1.30		Sq. Yd
352 70	Grinding Concrete Pavement	$2.80		Sq. Yd
353 70	CPR - Slab Replacement (5%)	$37.00		Cu. Yd
350 72	Cleaning and Resealing	$3.36		Ft

LINKS

Estimates Office

Pay Item Reports

Pavement Management Section

Select Advanced Life Cycle Costs

Clear This List

Change Design Options

Instructions

List of Units
Cu. Yd
Each
Ft
Gal.
In
Sq. Ft
Sq. Yd
Ton

Basic Inputs | Unit Prices | LCCA-AC | LCCA-PCC | Alternate | Graphs | Report | Instructions

FOR FIGURES E-5, E-6 AND E-7

1. Each LCC sheet has the following input cells that define the pavement section under consideration

    i. Length of section - Typically 1-mile for analysis purposes (5280 Ft.)

    ii. Passing lane width - (Inside lane/s) - Typically 12 ft.

    iii. Travel lane width - (Outer lane/s) - Typically 14 ft. for rigid pavements.

    iv. Inside and Outside Shoulder width - Enter width in Ft.

    v. Analysis Period - 40 Years

    vi. Discount rate - 4%

    vii. Initial year of construction - 2006.

    viii. Number of Passing lanes - Number of passing lanes in EACH direction

    ix. Number of Travel lanes - Number of travel lanes in EACH direction

    x. Number of Travel Directions - Typically 2. Therefore, for a 2 lane highway, the number of passing lanes is 0, number of travel lanes is 1, and number of travel directions is 2

2. Note: for rigid pavements, the slab dimensions will determine the total length of longitudinal and transverse joints. Change the dimensions if necessary in the Change Design Options Form.

3. Double check the number of travel and passing lanes, widths for travel, passing lanes, inside and outside shoulders. Usually, the number of travel directions is 2. In special cases, a one-direction roadway may be considered such as an experimental section of a road, toll plaza, rest area or a weighing station.

4. Enter the appropriate layer thickness in Inches. For pay items based on pavement area, ex.. Milling, Enter '1' as thickness. A thickness is required to invoke the VBA code to enter the appropriate formula for quantity calculation.

The analysis period is fixed at 40 Years and the Discount rate is fixed at 4%.
Design, CEI and MOT costs

Enter these costs as a percentage in the cell. Ex. Enter 10 for 10% MOT cost.

Figure E-5, **ASPHALT CONCRETE PAVEMENT**

LIFE CYCLE COST ANALYSIS

ASPHALT CONCRETE PAVEMENT DESIGN (FLEXIBLE PAVEMENT)

Financial Project ID:Generic Example 1, SR No.-, County:

Project Length: 1 Mile, Roadway ID:

Begining MP: 0.000, Ending MP: 1.000

Definitions:

Length of Section:	5,280	Ft		Analysis Period:	40
Passing Lane Width:	12	Ft		Discount Rate:	4.0
Travel Lane Width:	12	Ft	*Note:*	Initial Year of Construction:	2006
Inside Shoulder Width:	4	Ft	*This is the Shoulder Pavement Width*	No. of Passing Lanes:	1
Outside Shoulder Width	10	Ft	*This is the Shoulder Pavement Width*	No. of Travel Lanes:	1
Total Pavement Area:	253,440	Sq. Ft	*This is the Total Full Depth Pavement Area*	No. of Travel Directions:	2
Total Shoulder Area:	147,840	Sq. Ft	*This is the Shoulder Pavement Area*		

CONSTRUCTION ITEMS	THK.	QTY.	UNIT	UNIT PRICE	ST DEV	COST	PRESENT WORTH
INITIAL CONSTRUCTION IN YEAR:	**0**						
MAINLINE:							
FC-5 PG 76-22	0.75	1,069.2	Ton	$98.00	$0.00	$104,782	$104,782
Type SP Traffic Level D PG 76-22	1.5	2,296.8	Ton	$84.00	$0.00	$192,931	$192,931
Type SP Traffic Level D	2.5	3,828.0	Ton	$80.00	$0.00	$306,240	$306,240
OBG-9	10	28,160.0	Sq. Yd	$12.00	$0.00	$337,920	$337,920
Type B Stabilized (LBR 40)	12	28,160.0	Sq. Yd	$3.50	$0.00	$98,560	$98,560
SHOULDER:							
FC-5 PG 76-22	0.75	623.7	Ton	$98.00	$0.00	$61,123	$61,123
Type SP Traffic Level D PG 76-22	1.5	1,339.8	Ton	$84.00	$0.00	$112,543	$112,543
OBG-1	4	16,426.7	Sq. Yd	$14.00	$0.00	$229,973	$229,973
Type B Stabilized (LBR 40)	12	16,426.7	Sq. Yd	$3.50	$0.00	$57,493	$57,493
DESIGN COSTS:	10		Subtotal	$1,501,565		$150,157	$150,157
MOT COSTS:	10		Subtotal	$1,501,565		$150,157	$150,157
CEI COSTS:	10		Subtotal	$1,501,565		$150,157	$150,157
REHABILITATION IN YEAR:	**14**						
MAINLINE:							
Milling (2 in)	2	28,160.0	Sq. Yd	$2.50	$0.00	$70,400	$40,654
FC-5 PG 76-22	0.75	1,069.2	Ton	$98.00	$0.00	$104,782	$60,509
Type SP Traffic Level D	1.5	2,296.8	Ton	$80.00	$0.00	$183,744	$106,108

Basic Inputs / Unit Prices / LCCA-AC / LCCA-PCC / Alternate / Graphs / Report / Instructions

CONSTRUCTION ITEMS	THK.	QTY.	UNIT	UNIT PRICE	ST DEV	COST	PRESENT WORTH
REHABILITATION IN YEAR:	**28**						
MAINLINE:							
Milling (2 in)	2	28,160.0	Sq. Yd	$2.50	$0.00	$70,400	$23,477
FC-5 PG 76-22	0.75	1,069.2	Ton	$98.00	$0.00	$104,782	$34,942
Type SP Traffic Level D	1.5	2,296.8	Ton	$80.00	$0.00	$183,744	$61,274
Type SP Traffic Level D PG 76-22	1.5	2,296.8	Ton	$84.00	$0.00	$192,931	$64,338
SHOULDER:							
Milling (1 in)	1	16,426.7	Sq. Yd	$2.00	$0.00	$32,853	$10,956
Type SP Traffic Level D PG 76-22	1.5	1,339.8	Ton	$84.00	$0.00	$112,543	$37,531
FC-5 PG 76-22	0.75	623.7	Ton	$98.00	$0.00	$61,123	$20,383
DESIGN COSTS:	10		Subtotal	$758,376		$75,838	$25,290
MOT COSTS:	10		Subtotal	$758,376		$75,838	$25,290
CEI COSTS:	10		Subtotal	$758,376		$75,838	$25,290
REHABILITATION IN YEAR:							
MAINLINE:							
SHOULDER:							
DESIGN COSTS:			Subtotal				
MOT COSTS:			Subtotal				
CEI COSTS:			Subtotal				

TOTAL INITIAL CONSTRUCTION COST (YEAR 2006):	$1,952,035
TOTAL PRESENT WORTH REHABILITATION COST:	$898,098
PRESENT WORTH:	$2,850,133

Basic Inputs / Unit Prices / LCCA-AC / LCCA-PCC / Alternate / Graphs / Report / Instructions

TOOL BOX

☑ Highlight Data Entry Cells

Clear This Sheet

Change Design Options

Save Data

Retrieve Data

MESSAGE BOX

Design Options	
Superpave Structural Course Density	145
Friction Course Density	135
Tack Coat Spread Rate	0.5
Limerock Density	120
Subbase Density	110

Figure E-6, **JOINT PLAIN CONCRETE PAVEMENT (JPCP)**

LIFE CYCLE COST ANALYSIS

JOINTED PLAIN CONCRETE PAVEMENT DESIGN (RIGID PAVEMENT)

Financial Project ID:Generic Example 1, SR No.-, County:

Project Length: 1 Mile, Roadway ID:

Begining MP: 0.000, Ending MP: 1.000

Definitions:

Length of Section:	5,280	Ft		Analysis Period:	40
Passing Lane Width:	12	Ft		Discount Rate:	4.0
Travel Lane Width:	14	Ft	*Note:*	Initial Year of Construction:	2006
Inside Shoulder Width:	4	Ft	*This is the Shoulder Pavement Width*	No. of Passing Lanes:	1
Outside Shoulder Width	10	Ft	*This is the Shoulder Pavement Width*	No. of Travel Lanes:	1
Total Pavement Area:	274,560	Sq. Ft	*This is the Total Full Depth Pavement Area*	No. of Travel Directions:	2
Total Shoulder Area:	147,840	Sq. Ft	31,680 Long. Concrete Joints (Ft)	18,304	Trans. Concrete Joints (Ft)

TOOL BOX

☑ Highlight Data Entry Cells

Clear This Sheet

Change Design Options

Save Data

Retrieve Data

MESSAGE BOX

Design Options	
Superpave Structural Course Density	145
Friction Course Density	135
Slab Length	15
Slab Width	10
Base Course Density	120
CTPB Density	120

CONSTRUCTION ITEMS	THK.	QTY.	UNIT	UNIT PRICE	ST DEV	COST	PRESENT WORTH
INITIAL CONSTRUCTION IN YEAR:	**0**						
MAINLINE:							
JPCP	12.5	30,506.7	Sq. Yd	$60.00	$0.00	$1,830,400	$1,830,400
ATPB	4	3,389.6	Cu. Yd	$90.00	$0.00	$305,067	$305,067
Type SP Traffic Level C	1	1,658.8	Ton	$69.00	$0.00	$114,457	$114,457
Type B Stabilized (LBR 40)	12	30,506.7	Sq. Yd	$3.50	$0.00	$106,773	$106,773
Edgedrain (Draincrete)	10560	10,560.0	Ft	$16.50	$0.00	$174,240	$174,240
Edgedrain Outlet Pipe (4 in)	3168	3,168.0	Ft	$27.00	$0.00	$85,536	$85,536
SHOULDER:							
Type SP Traffic Level D PG 76-22	1.5	1,339.8	Ton	$84.00	$0.00	$112,543	$112,543
OBG-1	4	16,426.7	Sq. Yd	$14.00	$0.00	$229,973	$229,973
Type B Stabilized (LBR 40)	12	16,426.7	Sq. Yd	$3.50	$0.00	$57,493	$57,493
DESIGN COSTS:	10		Subtotal	$3,016,483		$301,648	$301,648
MOT COSTS:	10		Subtotal	$3,016,483		$301,648	$301,648
CEI COSTS:	10		Subtotal	$3,016,483		$301,648	$301,648
REHABILITATION IN YEAR:	**20**						
MAINLINE:							
CPR - Slab Replacement (3%)	3	171.1	Cu. Yd	$37.00	$0.00	$6,331	$2,889
Grinding Concrete Pavement	1	30,506.7	Sq. Yd	$2.80	$0.00	$85,419	$38,984
Cleaning and Resealing	48576	48,576.0	Ft	$3.36	$0.00	$163,215	$74,489
DESIGN COSTS:	10		Subtotal	$461,484		$46,148	$21,062
MOT COSTS:	10		Subtotal	$461,484		$46,148	$21,062
CEI COSTS:	10		Subtotal	$461,484		$46,148	$21,062
REHABILITATION IN YEAR:	**30**						
MAINLINE:							
CPR - Slab Replacement (5%)	5	285.2	Cu. Yd	$37.00	$0.00	$10,552	$3,254
Grinding Concrete Pavement	1	30,506.7	Sq. Yd	$2.80	$0.00	$85,419	$26,336
Cleaning and Resealing	48576	48,576.0	Ft	$3.36	$0.00	$163,215	$50,322
SHOULDER:							
Milling (1 in)	1	16,426.7	Sq. Yd	$2.00	$0.00	$32,853	$10,129
Type SP Traffic Level D PG 76-22	1.5	1,339.8	Ton	$84.00	$0.00	$112,543	$34,699
FC-5 PG 76-22	0.75	623.7	Ton	$98.00	$0.00	$61,123	$18,845
DESIGN COSTS:	10		Subtotal	$465,706		$46,571	$14,359
MOT COSTS:	10		Subtotal	$465,706		$46,571	$14,359
CEI COSTS:	10		Subtotal	$465,706		$46,571	$14,359
REHABILITATION IN YEAR:							
MAINLINE:							
SHOULDER:							
DESIGN COSTS:			Subtotal				
MOT COSTS:			Subtotal				
CEI COSTS:			Subtotal				

TOTAL INITIAL CONSTRUCTION COST (YEAR 2006):	$3,921,428
TOTAL PRESENT WORTH REHABILITATION COST:	$460,461
PRESENT WORTH:	$4,381,889

Figure E-7, **COMPOSITE PAVEMENT**

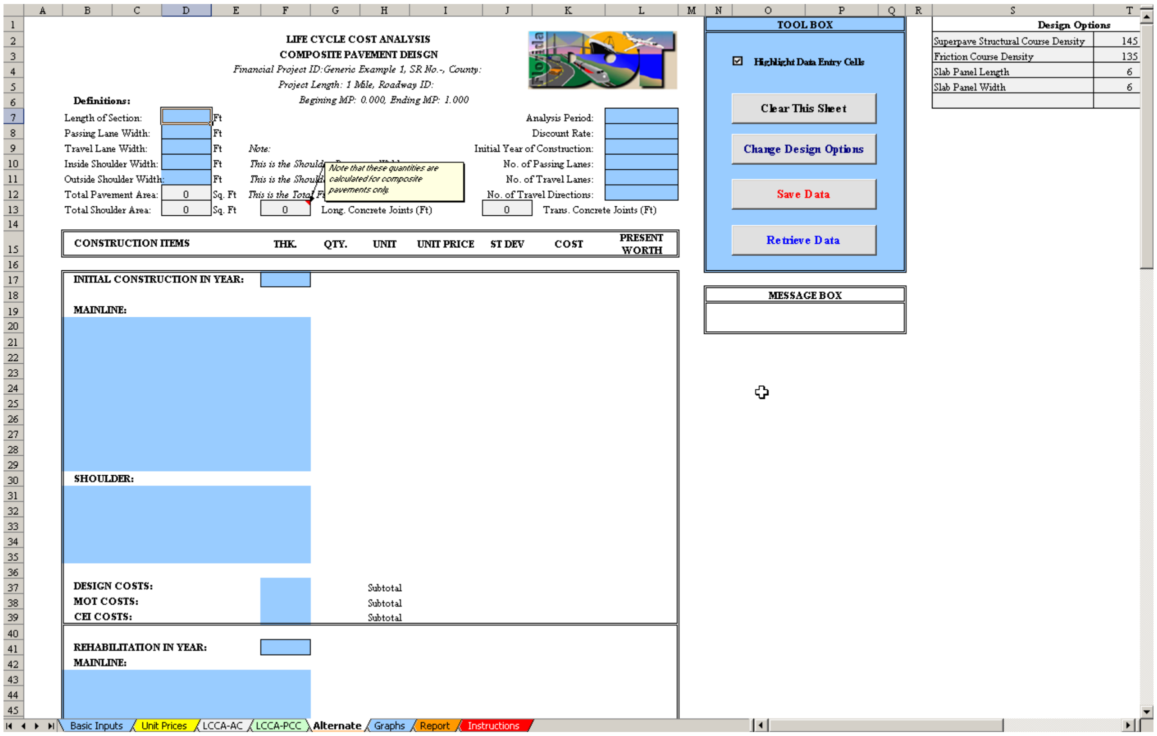
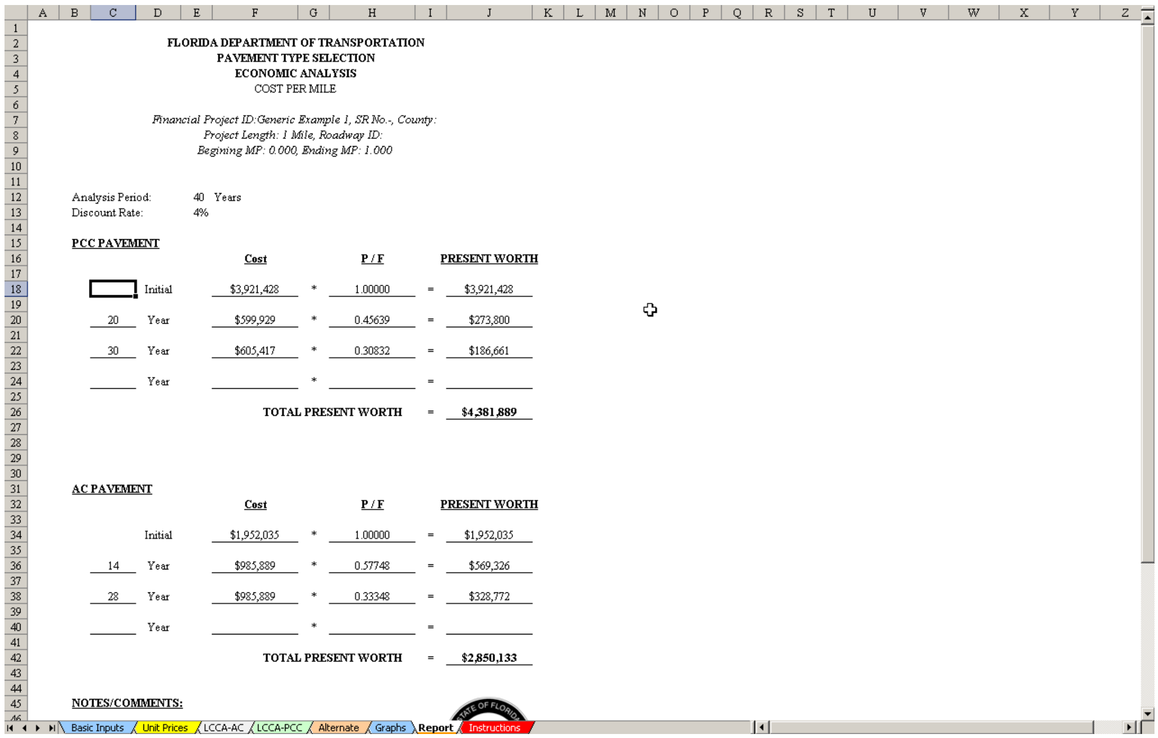


Figure E-8, **REPORT SUMMARY SHEET**



FLORIDA DEPARTMENT OF TRANSPORTATION
PAVEMENT TYPE SELECTION
ECONOMIC ANALYSIS
COST PER MILE

Financial Project ID:Generic Example 1, SR No.-, County:
Project Length: 1 Mile, Roadway ID:
Begining MP: 0.000, Ending MP: 1.000

Analysis Period: 40 Years
Discount Rate: 4%

PCC PAVEMENT

		Cost		P / F		PRESENT WORTH
	Initial	$3,921,428	*	1.00000	=	$3,921,428
20	Year	$599,929	*	0.45639	=	$273,800
30	Year	$605,417	*	0.30832	=	$186,661
	Year		*		=	
		TOTAL PRESENT WORTH			=	**$4,381,889**

AC PAVEMENT

		Cost		P / F		PRESENT WORTH
	Initial	$1,952,035	*	1.00000	=	$1,952,035
14	Year	$985,889	*	0.57748	=	$569,326
28	Year	$985,889	*	0.33348	=	$328,772
	Year		*		=	
		TOTAL PRESENT WORTH			=	**$2,850,133**

NOTES/COMMENTS:

SAVING AND RETRIEVING DATA

1. Another useful tool included with this spreadsheet is a tool for storing and retrieving previously stored data. This data is stored in the current file in a Database.

2. As part of the original spreadsheet, 6 typical roadway design templates and 2 examples are provided.

3. Please note that the examples are for information purpose only. All the costs have been completely assumed! Do not use these examples to continue your work.

4. Select a type of roadway design from the drop down box from the 'Retrieve Data' form.

5. As explained earlier, typical pay items, roadway design options, initial construction items and rehabilitation items will be loaded into LCC sheets.

6. Overwrite the information in the Basic Inputs sheet to match your current project.

7. It is highly recommended that the User perform random checks to verify quantity and cost calculations.

8. After all the data is entered and the spreadsheet checked for calculations, click the Save Data' button. All data that is in blue cells, will be saved to the database.

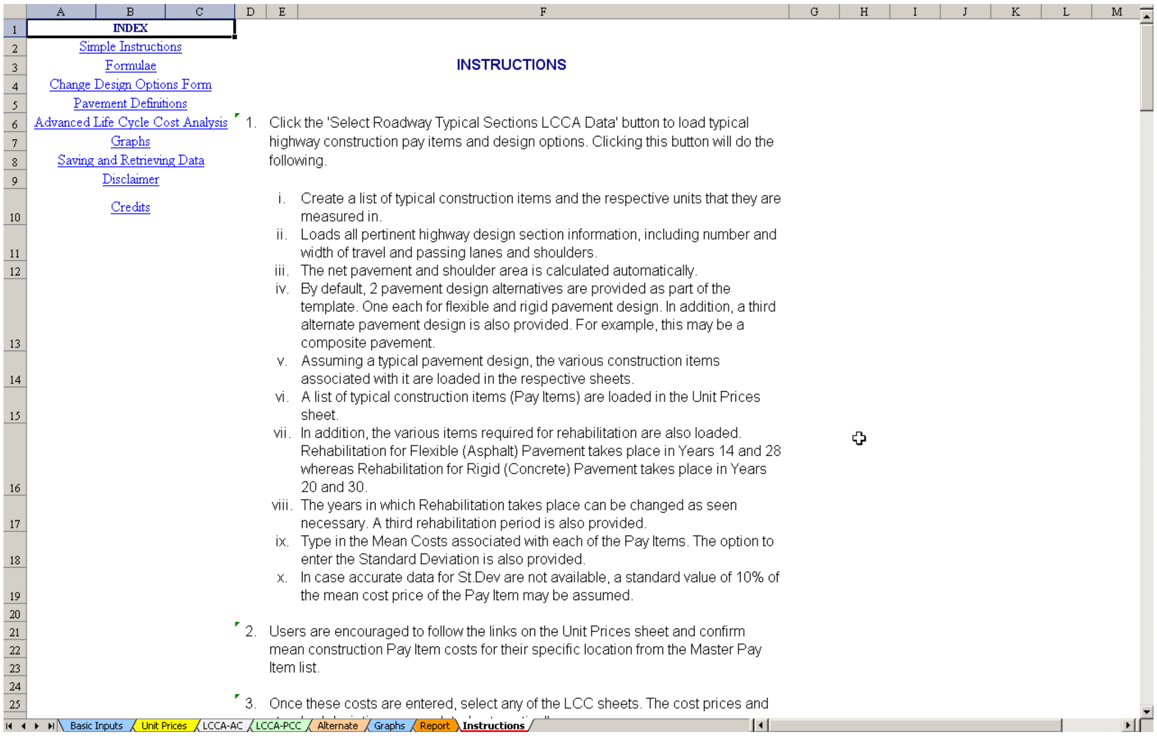
9. Your data will be stored with a unique identifier. This Unique Identifier is a combination of "FIN project ID -and- SR number -and- Design Version.

10. The code has been written to check the database if this combination already exists and will warn if you an identical match is found.

11. If an identical match is found, change your design version (in the Basic Inputs Sheet) say for example, from Version-1 to Version-2

12. Please do not over-write any of the previously stored templates!

Figure E-9, **SPREADSHEET INSTRUCTIONS**



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INSTRUCTIONS

1. Click the 'Select Roadway Typical Sections LCCA Data' button to load typical highway construction pay items and design options. Clicking this button will do the following.

   i. Create a list of typical construction items and the respective units that they are measured in.
   ii. Loads all pertinent highway design section information, including number and width of travel and passing lanes and shoulders.
   iii. The net pavement and shoulder area is calculated automatically.
   iv. By default, 2 pavement design alternatives are provided as part of the template. One each for flexible and rigid pavement design. In addition, a third alternate pavement design is also provided. For example, this may be a composite pavement.
   v. Assuming a typical pavement design, the various construction items associated with it are loaded in the respective sheets.
   vi. A list of typical construction items (Pay Items) are loaded in the Unit Prices sheet.
   vii. In addition, the various items required for rehabilitation are also loaded. Rehabilitation for Flexible (Asphalt) Pavement takes place in Years 14 and 28 whereas Rehabilitation for Rigid (Concrete) Pavement takes place in Years 20 and 30.
   viii. The years in which Rehabilitation takes place can be changed as seen necessary. A third rehabilitation period is also provided.
   ix. Type in the Mean Costs associated with each of the Pay Items. The option to enter the Standard Deviation is also provided.
   x. In case accurate data for St.Dev are not available, a standard value of 10% of the mean cost price of the Pay Item may be assumed.

2. Users are encouraged to follow the links on the Unit Prices sheet and confirm mean construction Pay Item costs for their specific location from the Master Pay Item list.

3. Once these costs are entered, select any of the LCC sheets. The cost prices and

Basic Inputs | Unit Prices | LCCA-AC | LCCA-PCC | Alternate | Graphs | Report | Instructions