Purpose

The purpose of this interview is to gain insight into the following Michigan Department of Transportation practices:

- Pavement type selection
- Engineer's estimate and life cycle cost analysis
- Other items that affect cost

Agency Interviewed

Michigan Department of Transportation
Construction and Technology
8885 Ricks Road
Lansing, MI 48909

Person(s) Interviewed

Name	Title	Phone	Email
Curtis Bleech	Pavement Engineer	517-322-1237	bleechc@mdot.state.mi.us
Kevin Kennedy	Capital Preventive Maintenance Engineer		

1. Do you have a documented pavement type selection procedure for:

New Construction: Yes
Reconstruction: Yes
Rehabilitation: Unbonded overlays, break & seat

2. How long have you used the current type selection procedure?

3 years

3. Changes made over the last 5 years:

Developed to meet the requirements of State legislation passed in 1979. Public Act 79, states that "the department shall develop and implement a life cycle cost analysis for each project for which total pavement costs exceed one million dollars funded in whole, or in part, with state funds. The department design and award paving projects utilizing material having the lowest life cycle costs." The legislation also states "life cycle costs shall also compare equivalent designs and shall be based upon Michigan's actual historic project maintenance, repair and resurfacing schedules and shall include estimates of user costs throughout the entire pavement life."

Note: Because of the wording of the legislation, rehabilitation schedules and costs must be based on the past performance of pavements in Michigan. This does not allow modification based on design improvements. For example, asphalt mixtures are now based on Superpave and PCC

design has been change from JRCP to JPCP. However, performance must be based on the old designs

What prompted the change? Legislation

4. Have you used alternative bidding as a means of making a pavement type selection during the past 5 years? If yes describe the process. Was alternate bidding used on a Federal-aid project? If so, what was the basis of FHWA's approval?

Two projects under SEP 14. No additional projects currently planned, but the State hasn't ruled out future projects.

5. Importance and extent of industry involvement in the development of type selection process?

Participated in an ad hoc committee, where consensus on the new procedure was developed.

6. How was the selection process implemented within the agency?

Issued in a revised pavement design manual by the Chief Operations Officer

7. How is the type selection process related to the overall project selection, budgeting, planning process used by the agency?

It isn't

8. Pavement types used for new construction or reconstruction over the last 5 years

Pavement Type	Approximate lane miles, Interstate & other 4 Lane	Performance (Good Fair Poor)
Full depth ACP		
Deep Strgth ACP	*5%*	
ACP(less than 6") agg base		
Jointed Plain (JPCP) & JRCP	*95%*	
Jointed Reinforced (JRCP)		
Continuously Reinf. (CRCP)		

9. Thickness design procedure used and design life (if AASHTO which version)

ACP: AASHTO 93
PCCP: AASHTO 93

10. What analysis period used for each pavement type?

20 Years for both types

11. Are there different foundation/base requirements for AC and PCC?

Yes – Flexible requires 18-inch sand subbase and 6-inch aggregate base, PCC requires 12-inch sand subbase and 4-inch open-graded base.

12. For those agencies that use smoothness as criteria do they use the same initial serviceability in design?

Yes-Currently based on Ride Quality Index measured with either profilograph or profilometer. Will be going to IRI.

13. Typical costs and method of contract measurement

ACP in place $/25.40 to 45.39/ton sy cy other $28 to $50 metric ton
JPCP (slab only) $/10.25" 22.21sy cy other 260mm $26/m2,
JRCP (slab only) $/10.25" 27.21 sy cy other 260mm $32.55/m2,
CRCP (slab only) $/_____sy cy other

14. How important is first cost versus future costs?

Same importance, evaluated in LCCA

15. Is life cycle cost analysis used?

Yes Based on Equivalent Uniform Annual Cost

16. Analysis period

Varies depending on the design.

17. Discount Rate (how established)

OMB A94

Engineering and Construction Considerations

Factors used, scoring system, primary factors secondary factors, weights, importance, etc

Factor	Considered	Primary or Secondary	Importance (0 to 5)	Comments
1. Roadway/lane geometrics (lane widths, cross slopes, ability to provide drainage)	NO			
2. Highway functional class	NO			
3. Traffic	NO			
4. Roadway peripheral features (overhead clearance, weigh-in-motion, guardrails, etc)	NO			
5. Construction considerations	NO			
a. Staging	NO			
b. Clearance for equipment	NO			
c. Construction operations	NO			
d. Traffic operations during construction	NO			
e. Construction seasons	NO			

Factor	Considered	Primary or Secondary	Importance (0 to 5)	Comments
6. Consideration of future maintenance operations (maintenance of traffic, ease of maintenance)	NO			
7. Performance of similar pavements in the area	NO			
8. Availability of local materials, contractor's capabilities, and experienced agency personnel.	NO			
9. Pavement Continuity	NO			
a. Adjacent sections	NO			
b. Adjacent lanes	NO			
10. Noise issues	NO			
11. Subgrade soils	NO			
12. Climate	NO			
13. District or local preference	NO			
14. Ease of maintenance	NO			
15. Recycling	NO			
16. Conservation of materials and energy	NO			
17. Stimulation of Competition	NO			
18. Safety considerations (rutting, friction, lighting, etc)	NO			
19. Smoothness	NO			

18. Initial Costs – Estimating procedure

Only costs that differ between alternatives are considered. Include cost items such as mainline pavement, shoulders, joints, subbase, base, underdrains, and traffic control. Unit prices are determined from past MDOT projects and are based on the weighted average of low bid data.

19. How does agency determine unit cost to include in the cost analysis (standardized or project by project)? Is the size of the project used in the database considered (economy of scale)? Age of the price data. How often updated.

Prices are updated on a semiannual basis based on low bid data from the previous 18 months. They are developed following procedures set forth in the Pavement Design Manual.

20. Are price adjustment factors used for any materials, and if so are they used in the life cycle cost analysis.

Not used

21. Actual cost versus estimated cost (are completed projects evaluated for overruns etc.)

No

22. Routine maintenance (how estimated, operations included)

Not

23. Rehabilitation (how is timing estimated, techniques used, etc.)

Based on MDOT maintenance data (contract work only). Historical contract data and pavement condition data for the pavement management system are used to develop maintenance cost schedules.

Salvage Value (remaining life): None – Analysis period goes to the end of life
Residual value (recycling): No
Construction traffic control (crossovers, added lanes, barriers, detours, etc.): Rehab only. Considered same for initial
Engineering and administration: Included in future costs only.

24. How are users costs weighted in relation to agency costs?

Not weighted, user delay included n LCCA

25. Vehicle operating costs

26. User Delay

Speed delay and lane closure delay costs are calculated using a University of Michigan program.

27. Description of the analysis process

28. Routine maintenance

Reactive

29. Preventive maintenance

Contract

30. What are the states standard routine and preventive maintenance operation and schedule by pavement type?

Not stated

31. Allocation of resources between maintenance, rehab, new and reconstruction

32. Do you have a formal system to track pavement condition, cost, and survivability?

Yes, serves as basis for the rehabilitation schedules.

33. Do you allow old concrete to be recycled? If so into what products? Percentage limits?

Yes. Contractors become owners and generally do not use in project but rather use it in their private work. The following are the Michigan specifications for recycling of PCC:

> **902.03 Coarse Aggregates for Portland Cement Concrete.** Use Michigan Class 4AA, 6AAA, 6AA, 6A, 17A, and 26A coarse aggregate produced from natural aggregate, iron blast furnace slag, or reverberatory furnace slag sources. Michigan Class 6A, 17A and 26A may be produced by crushing Portland cement concrete, but only for uses stipulated by this specification. The bulk dry specific gravity must be within the limits established by freeze-thaw testing. Aggregates must conform to the grading requirements in Table 902-1, the physical requirements in Table 902-2, and the following.
> A. **Slag Coarse Aggregate.** Iron blast furnace slag or reverberatory furnace slag conforming to the grading specified for the concrete mixture must have a dry (loose measure) unit weight of not less than 70 pounds per cubic foot as determined by MTM 123.
> B. **Crushed Concrete Coarse Aggregate.** Use only crushed concrete coarse aggregate originating from concrete sources owned by the Department as part of the contracted project. Crushed concrete coarse aggregate may be used in concrete mixtures for curb and gutter, valley gutter, sidewalk, concrete barriers, driveways, temporary pavement, interchange ramps with commercial ADT below 250, and concrete shoulders. Crushed concrete coarse aggregate may not be used in mainline pavements or ramps with commercial ADT equal to or greater than 250, concrete base

course, bridges, box or slab culverts, head walls, retaining walls, prestressed concrete, or other heavily reinforced concrete. 693

902.03

Process crushed concrete coarse aggregate in a manner that avoids contamination with any non-concrete materials including joint sealants, HMA patching, and base layer aggregate or soil. Contamination particles retained on the-inch sieve are limited to 3.0 percent maximum by particle count of the total aggregate particles. The aggregate stockpile will be rejected totally when there is any evidence of contamination from non-Department sources such as building brick, wood, or plaster. Pieces of steel reinforcement are allowable in the stockpile provided they pass the maximum grading sieve size without hand manipulation. The fine aggregate portion of the gradation must not exceed a liquid limit of 25.0 percent or a plasticity index of 4.0. Crushed concrete coarse aggregate will be tested for freeze-thaw durability for each project. This testing requires a minimum of three months after samples of the produced aggregate are received in the laboratory. Use equipment and methods to crush concrete that will maintain uniformity in aggregate properties: specific gravity □0.05 and absorption □0.40, with no apparent segregation. This requirement includes separating crushed concrete aggregate according to its original coarse aggregate type, except for the following situations: 1. Different aggregate types may exist in the same stockpile if the quantities by weight of each aggregate type retained on the No. 4 sieve do not differ by more than □10 percent from the average quantity obtained from at least three representative samples. 2. When aggregate is produced from concrete pavement with only one aggregate type that has been repaired with concrete patches with a different aggregate type.

902.04 Coarse Aggregates for HMA Mixtures. Use natural aggregate, iron blast furnace slag, reverberatory furnace slag, steel furnace slag, or crushed concrete meeting the grading and physical requirements in the contract documents.

34. Do you allow HMA materials to be recycled? If so into what products? Percentage limits?

Yes). Contractors become owners and generally do not use in project but rather use it in their private work. The following is the Michigan Special Provision for recycling:

03SP501(G)
MICHIGAN
DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION
FOR
RECYCLED HOT MIX ASPHALT MIXTURE
C&T:GMM 1 of 1 C&T:APPR:JAR:MF:12-19-01
FHWA:APPR:08-06-02

Add the following subsection to Section 501.02.A.2 of the standard specifications.

c. Reclaimed Asphalt Pavement (RAP) Percentages and Binder Grade Selection. The method for determining the binder grade in hot mix asphalt (HMA) mixtures incorporating RAP is divided into three categories designated Tier 1, Tier 2 and Tier 3. Each tier has a range of percentages that represent the contribution of the RAP binder toward the total binder, by weight. The tiers identified below apply to both Superpave and Marshall mixtures with the following exception: **Superpave mixture types E3, E3 High Stress and E10 used as leveling or top course shall be limited to a maximum of 17% RAP binder by weight of the total binder in the mixture. Superpave Mixture types E10 High Stress, and all E30 and E50 mixtures used as leveling or top course shall be limited to a maximum of 14% RAP binder by weight of the total binder in the mixture.**

Tier 1 (0% to 17% RAP binder by weight of the total binder in the mixture) No binder grade adjustment is made to compensate for the stiffness of the asphalt binder in the RAP.

Tier 2 (18% to 27% RAP binder by weight of the total binder in the mixture) The selected binder grade for the asphalt binder is one grade lower for the high temperature than the binder grade required for the specified project mixture type. For example, if the specified binder grade for the mixture type is PG58-28, the required grade for the binder in the recycled mixture would be a PG52-28. The asphalt binder grade can also be selected using a blending chart for high and low temperatures. The Contractor shall supply the blending chart and the RAP test data used in determining the binder selection.

Tier 3 (A 28% RAP binder by weight of the total binder in the mixture)
The binder grade for the asphalt binder is selected using a blending chart for high and low temperatures. The Contractor shall supply the blending chart and the RAP test data used in determining the binder selection.

Have difficulty meeting Superpave specifications

Notes

Most PCC is 11 to 12 inches thick, ACP bound layers are 12 to 15 inches

Generally when BSEAL's are above 10 million, the LCCA favors PCC.

Purpose

The purpose of this interview is to gain insight into the following Minnesota Department of Transportation practices:

- Pavement type selection
- Engineer's estimate and life cycle cost analysis
- Other items that affect cost

Agency Interviewed

Minnesota Department of Transportation
1400 Gervais Ave.
Maplewood, MN 55109-2044

Person(s) Interviewed

Name	Title	Phone	Email
Dave Van Deusen	Pavement Design/Grading and Base Engineer	651-779-5564	Dave.VanDuesen@dot.state.mn.us
Dave Janisch	Pavement Management Engineer	651-779-5567	Dave.janisch@dot.state.mn.us

1. Do you have a documented pavement type selection procedure for:

New Construction: Yes
Reconstruction: Yes
Rehabilitation: Unbonded overlays

2. How long have you used the current type selection procedure?

Issued in 1997 and modified in 2001

3. Changes made over the last 5 years:

Modified in 2001 to increase the BESAL's from 7 million to 10 million before pavement automatically went PCC. Process is currently being further modified.

What prompted the change? Request of the HMA industry

4. Have you used alternative bidding as a means of making a pavement type selection during the past 5 years? If yes describe the process. Was alternate bidding used on a Federal-aid project? If so, what was the basis of FHWA's approval?

No

5. Importance and extent of industry involvement in the development of type selection process?

Both industries serve as non-voting members on committee responsible for recommending changes.

6. How was the selection process implemented within the agency?

Commissioner issues policy

7. How is the type selection process related to the overall project selection, budgeting, planning process used by the agency?

No

8. Pavement types used for new construction or reconstruction over the last 5 years

Pavement Type	Approximate lane miles		Performance (Good Fair Poor)
	Interstate	Other 4 lane	
Full depth ACP			
Deep Strgth ACP	X*	X	Generally good, thermal cracking and stripping have been prob.
ACP(less than 6") agg base			
Jointed Plain (JPCP)	X*	X	Generally good now. Using a premium design on high volume routes. Low w/c concrete and stainless steel clad dowels
Jointed Reinforced (JRCP)			
Continuously Reinf. (CRCP)			

*Mileage data not readily available, but most Interstate reconstruction goes concrete because design traffic exceeds 10 million BESAL's

9. Thickness design procedure used and design life (if AASHTO which version)

ACP: Modified AASHTO
PCCP: AASHTO 86

10. What *design life* used for each pavement type?

Flexible – 20 years
Rigid – 35 years

11. Are there different foundation/base requirements for AC and PCC?

Flexible design requires subbase and minimum 30-inch total pavement thickness
Rigid 12 inches select material and 4-inch granular base

12. For those agencies that use smoothness as criteria do they use the same initial serviceability in design?

Use same smoothness criteria based on profilograph. Plan to change to and IRI specification. Modified flexible procedure does not directly consider initial serviceability

13. Typical costs and method of contract measurement

ACP in place $/____43____/ton sy cy other
JPCP (slab only) $/_____*____sy cy other
JRCP (slab only) $/_____sy cy other
CRCP (slab only) $/_____sy cy other

* Concrete pavements are paid for based on a combination of surface area of concrete pavement specified and the volume based on planned thickness and the computed area of pavement. Typical for 13-inch pavement was $19/sy plus $58.10/cy

14. How important is first cost versus future costs?

Straight LCCA

15. Is life cycle cost analysis used?

Yes – Agency costs only

16. Analysis period

35 years currently, going to 50 years

17. Discount Rate (how established)

Current 4.5 %, but going to OMB A94

18. Initial Costs – Estimating procedure

Not bid unit cost based. Do cost estimates based materials costs at project site. Process looks at factors such as aggregate costs, haul, and construction costs.

Additional costs for premium enhance designs are not included in the initial analysis. These features are included after pavement type has been selected.

Engineering and Construction Considerations

Factors used, scoring system, primary factors secondary factors, weights, importance, etc

Factor	Considered	Primary or Secondary	Importance (0 to 5)	Comments
1. Roadway/lane geometrics (lane widths, cross slopes, ability to provide drainage)	N			
2. Highway functional class	N			
3. Traffic	Y	P	%	
4. Roadway peripheral features (overhead clearance, weigh-in-motion, guardrails, etc)	N			
5. Construction considerations	N			
a. Staging	N			
b. Clearance for equipment	N			
c. Construction operations	N			
d. Traffic operations during construction	N			
e. Construction seasons	N			

Factor	Considered	Primary or Secondary	Importance (0 to 5)	Comments
6. Consideration of future maintenance operations (maintenance of traffic, ease of maintenance)	N			
7. Performance of similar pavements in the area	N			
8. Availability of local materials, contractor's capabilities, and experienced agency personnel.	N			
9. Pavement Continuity	N			
a. Adjacent sections	N			
b. Adjacent lanes	N			
10. Noise issues	N			
11. Subgrade soils	N			
12. Climate	N			
13. District or local preference	N			
14. Ease of maintenance	N			
15. Recycling	N			
16. Conservation of materials and energy	N			
17. Stimulation of Competition	N			
18. Safety considerations (rutting, friction, lighting, etc)	N			
19. Smoothness	N			

19. How does agency determine unit cost to include in the cost analysis (standardized or project by project)? Is the size of the project used in the database considered (economy of scale)? Age of the price data. How often updated.

Project based.

20. Are price adjustment factors used for any materials, and if so are they used in the life cycle cost analysis.

No

21. Actual cost versus estimated cost (are completed projects evaluated for overruns etc.)

No

22. Routine maintenance (how estimated, operations included)

Rout and seal cracks, Joint reseal, minor CPR are included. Based on estimates by District Engineers

23. Rehabilitation (how is timing estimated, techniques used, etc.)

Mill and Overlay, Major CPR, Some full depth and Grinding. Based on estimates by District Engineers and performance history in PMS database.

Salvage Value (remaining life): New System will consider for PCC high performance design. None for HMA.
Residual value (recycling): No
Construction traffic control (crossovers, added lanes, barriers, detours, etc.): Consider for original construction
Engineering and administration: No

24. How are users costs weighted in relation to agency costs?

Not considered now. Plan to look at for future up date.

25. Vehicle operating costs

26. User Delay

27. Description of the analysis process

28. Routine maintenance

Reactive

29. Preventive maintenance

Crack and joint sealing, minor CPR other than full depth patching, surface treatments, overlays less than 2 inches

30. What are the states standard routine and preventive maintenance operation and schedule by pavement type?

31. Allocation of resources between maintenance, rehab, new and reconstruction

Districts allocate as needed. However, $40 million is allocated statewide to preventive maintenance.

32. Do you have a formal system to track pavement condition, cost, and survivability?

Yes. Have targets for percent pavements in good category and percent with a remaining life of 12 years.

33. Do you allow old concrete to be recycled? If so into what products? Percentage limits?

Yes into aggregate base, and subbase. Contractors can't meet the w/c ratio requirements if used in PCC

34. Do you allow HMA materials to be recycled? If so into what products? Percentage limits?

30% max in wearing course
50% max on wearing course mixes

However, mixes must meet mix design specification requirements

Purpose

The purpose of this interview is to gain insight into the following State of New York Department of Transportation practices:

- Pavement type selection
- Engineer's estimate and life cycle cost analysis
- Other items that affect cost

Agency Interviewed

State of New York, Department of Transportation
1220 Washington Avenue
Albany, NY 12232-0861

Person(s) Interviewed

Name	Title	Phone	Email
Russell Thielke, P.E.	Head, Materials Bureau	518-457-4582	rthielke@dot.state.ny.us
Brad Allen, P.E.	Engineer, Materials Bureau	518-457-4582	ballen@dot.state.ny.us
Mike Brinkman	Engineer, Materials Bureau	518-457-4582	mbrinkman@dot.state.ny.us

1. Do you have a documented pavement type selection procedure for:

New Construction: Yes. For new construction, consult Chapters 3 and 5 of the New York Comprehensive Pavement Design Manual. Available on the web.
Reconstruction: Yes. For reconstruction, consult Chapters 3 and 5 of the New York Comprehensive Pavement Design Manual. Available on the web.
Rehabilitation: Yes, there are two manuals. DKH provided with copies. They are also included as chapters in the Comprehensive Pavement Design Manual.

2. How long have you used the current type selection procedure?

Rehabilitation has been in effect since 1989. The Comprehensive Pavement Design Manual was published in 2000. The manual brought together all of the designer's tools into one comprehensive document.

3. Changes made over the last 5 years:

On-going minor changes but nothing significant.

What prompted the change? Treatment selection hasn't changed much but will in 2004.

4. Have you used alternative bidding as a means of making a pavement type selection during the past 5 years? If yes describe the process. Was alternate bidding used on a Federal-aid project? If so, what was the basis of FHWA's approval?

No. Alternative bidding has not been used.

5. Importance and extent of industry involvement in the development of type selection process?

Industry doesn't have much involvement in pavement type selection. The industry tends to partner with the DOT in the review of new technology, specifications changes, etc. The industry has not generally questioned the State's decisions on pavement type selection.

6. How was the selection process implemented within the agency?

NY DOT started with the suggestions provided in the AASHTO 1993 Guide and modified them for NY State conditions. LCCA is used and at least 2 alternatives are evaluated for each project.

7. How is the type selection process related to the overall project selection, budgeting, planning process used by the agency?

Project by project selection. The initial costs usually drive the selection process. The designs are done at the regional level and they are each provided with a pot of money. The central office reviews designs but generally in a cursory way. The regions have the autonomy to choose pavement type and to pay higher initial costs in favor of lower future maintenance if desired.

8. Pavement types used for new construction or reconstruction over the last 5 years

Pavement Type	Approximate lane miles		Performance (Good Fair Poor)
	Interstate	Other 4 lane	
Full depth ACP	90 percent		Good
Deep Strgth ACP	0		
ACP(less than 6") agg base	0		
Jointed Plain (JPCP)	10 %		Good
Jointed Reinforced (JRCP)	0		
Continuously Reinf. (CRCP)	0		

9. Thickness design procedure used and design life (if AASHTO which version)

ACP – AASHTO 1993 as modified for New York State. Included in the Comprehensive Pavement Design Manual.
PCCP – AASHTO 1993 as modified for New York State. Included in the Comprehensive Pavement Design Manual.

http://www.dot.state.ny.us/cmb/consult/cpdmfiles/cpdm.html

10. What analysis period used for each pavement type?

50 years for new construction
30 years for rehabilitation

11. Are there different foundation/base requirements for AC and PCC?

They are treated the same.

12. For those agencies that use smoothness as criteria do they use the same initial serviceability in design?
Initial serviceability is not directly considered in the modified procedure.

Smoothness specifications for PCC require the use of the California Profilograph with a 5 mm blanking band to measure smoothness. There are no smoothness requirements for flexible pavements. They are working on an IRI based acceptance criteria for flexible pavements and may use this for rigid pavements as well although they are sensitive to the issues of using a light weight profiler on tined concrete surfaces.

13. Typical costs and method of contract measurement

Varies widely and depends on local conditions. Typically, HMA is $ 30 - $ 80 /metric tonne and concrete is $ 140 to $ 250 per cubic metre. All designs and payment, etc. in New York is done in metric.

ACP in place $/_____/ton sy cy other
JPCP (slab only) $/_____sy cy other
JRCP (slab only) $/_____sy cy other
CRCP (slab only) $/_____sy cy other

14. How important is first cost versus future costs?

Initial cost has about a 95 percent importance level. They are currently revising their pavement selection process to include probabilistic modeling and user costs so this may change. The expected date of implementation is summer 2004.

15. Is life cycle cost analysis used?

Yes

16. Analysis period

50 years for all new construction and reconstruction
30 years for all rehabilitation

Engineering and Construction Considerations

Factors used, scoring system, primary factors secondary factors, weights, importance, etc

Factor	Considered	Primary or Secondary	Importance (0 to 5)	Comments
1. Roadway/lane geometrics (lane widths, cross slopes, ability to provide drainage)	Y	P	5	
2. Highway functional class	Y	P	5	
3. Traffic	Y	P	5	
4. Roadway peripheral features (overhead clearance, weigh-in-motion, guardrails, etc)	Y	S	5	
5. Construction considerations				
a. Staging	Y	S	3	
b. Clearance for equipment	N			
c. Construction operations	Y	S	3	
d. Traffic operations during construction	Y	S	5	
e. Construction seasons	Y	S	3	

Factor	Considered	Primary or Secondary	Importance (0 to 5)	Comments
6. Consideration of future maintenance operations (maintenance of traffic, ease of maintenance)	Y	S	3	If the Region wants to sacrifice some of their initial cost funds to save future maintenance costs, they can do that.
7. Performance of similar pavements in the area	Y	S	4	Only if traffic warrants a change. They will tend to build pavements similar to others in a particular area.
8. Availability of local materials, contractor's capabilities, and experienced agency personnel.	Y	S	2	Regional preference.
9. Pavement Continuity				
a. Adjacent sections	Y	S	4	
b. Adjacent lanes	Y	P	4	Very high importance. They would not build differing adjacent lanes
10. Noise issues	Y	S	1	They are not very worried about noise. They have longitudinal tined sections as experiments and like the results. They also have used turf drag instead of tining but FHWA doesn't approve.
11. Subgrade soils	Y	S	2	
12. Climate	N			
13. District or local preference	Y	S	4	Regions can have local preference.
14. Ease of maintenance	N			
15. Recycling	N			
16. Conservation of materials and energy	N			
17. Stimulation of Competition	N			
18. Safety considerations (rutting, friction, lighting, etc)	Y	P	5	Very cognizant of safety.
19. Smoothness	N			

502-3.16 Profilograph. This section applies to profilographed projects and nonprofilographed projects when a full-width finishing pan or triple transverse screed paving operation is not employed, as discussed in §502-2.04B2, Paving Equipment.

Use equipment meeting §502-2.04G, Profilograph. Provide traffic control and survey stationing for referencing measurements. The Engineer will divide the pavement into 160 m long reporting segments, but may group segments shorter than 160 m with previous or subsequent placements. The reporting segment width is the placement width. Develop a profile trace and determine an initial profile index (PI) for each travel lane of each reporting segment. Obtain the trace along the longitudinal center of the travel lane in accordance with Materials Method 24, PCC Pavement Profilograph Operations. Develop a referencing system that allows the Engineer to readily associate a trace and an initial PI to the actual corresponding reporting segment travel lane. Give the traces and initial PIs to the Engineer.

The Engineer will identify bumps exceeding 10 mm in 7.6 m on each profile trace. Locate and diamond grind these bumps, if any, to 10 mm or less in 7.6 m. If no grinding is required for a given reporting segment, the initial PI may be used to determine the payable Quality Units of Smoothness Quality Adjustment per reporting segment, as discussed in §502-4.04, Smoothness Quality Adjustment. Then, up to 10% of any reporting segment's surface area may be ground to increase the amount of Quality Units payable. This 10% includes areas ground to remove bumps exceeding 10 mm in 7.6 m. Whether diamond grinding was required through profile trace analysis, or performed as a Contractor option, reprofilograph the pavement and determine a final PI for each travel lane of each reporting segment. Give the Engineer the final profile traces and final PI determined by using both the 5 mm and zero blanking bands.

The Engineer will report the final PI and payable Quality Units, if any, for each segment as discussed in §502-4.04, Smoothness Quality Adjustment. No Quality Units will be paid for a reporting segment if more than 10% of the segment's surface area requires diamond grinding to achieve the minimum acceptable PI. If more than 20% of a reporting segment's surface area requires diamond grinding to achieve the minimum acceptable PI, production grind the entire segment such that the minimum PI is achieved for the segment.

502-4.04 Smoothness Quality Adjustment (Profilographed Items Only). Quality Units of Smoothness Quality Adjustment, if any, payable for each reporting segment determined by the following:

Quality Units (Per Segment) = (SAF - 1.00) x PCC Cubic Meters (Per Segment)

The Smoothness Adjustment Factor (SAF) from Table 502-5, Smoothness Adjustment Factors, is based on the final PI obtained for each reporting segment in accordance with §502-3.16, Profilograph. Refer to §502-3.16, Profilograph, for diamond grinding limits on Quality Unit determination. No Quality Units are computed for pavements originally specified as nonprofilographed as discussed in §502-2.04B2, Paving Equipment.

TABLE 502-5 SMOOTHNESS ADJUSTMENT FACTORS		
Final Profile Index (mm/km.)	**Level 1 SAF**	**Level 2 SAF**
0.0 - 16.0	1.05	1.05
16.1 - 32.0	1.04	1.04
32.1 - 48.0	1.03	1.03
48.1 - 64.0	1.02	1.02
64.1 - 79.9	1.01	1.01
80	1	1
80.0 +	Grind	1
190.0 +	Not Applicable	Grind

17. Discount Rate (how established)

They use the OMB rate of 4 percent. This will be reviewed with the revised pavement selection methodology.

18. Initial Costs – Estimating procedure

They have a unit price bid book which is updated at 6 month intervals. It contains bid prices for all contract bidders in all regions. The LCCA staff person can call up this information and decide to use averages, filtered values, etc.

19. How does agency determine unit cost to include in the cost analysis (standardized or project by project)? Is the size of the project used in the database considered (economy of scale)? Age of the price data. How often updated.

They have a unit price bid book which is updated at 6 month intervals. It contains bid prices for all contract bidders in all regions. The LCCA staff person can call up this information and decide to use averages, filtered values, etc.

http://www.dot.state.ny.us/cmb/consult/awbpbp/awbpbp.html

20. Are price adjustment factors used for any materials, and if so are they used in the life cycle cost analysis.

Price adjustments are applied to HMA items only. They are not included in the LCCA.

21. Actual cost versus estimated cost (are completed projects evaluated for overruns etc.)

No this is not done.

22. Routine maintenance (how estimated, operations included)

Best guess based on local experience.

23. Rehabilitation (how is timing estimated, techniques used, etc.)

Best guess based on local experience.

Salvage Value (remaining life): Included.
Residual value (recycling): Not included.
Construction traffic control (crossovers, added lanes, barriers, detours, etc.): Not included.
Engineering and administration: Not really considered in initial design as it is assumed that these costs would be similar for all alternatives. They do add a 27 percent overhead cost for future maintenance and rehabilitation treatments.

24. How are users costs weighted in relation to agency costs?

None used. This will change with the expected implementation of the probabilistic approach next year.

25. Vehicle operating costs

None used. This will change with the expected implementation of the probabilistic approach next year.

26. User Delay

None used. This will change with the expected implementation of the probabilistic approach next year.

27. Description of the analysis process

Probabilistic will be used next year. Deterministic is currently being used.

28. Routine maintenance

They use the term "corrective." This includes spall repairs, pothole filling, grass cutting, sign repairs, etc.

29. Preventive maintenance

See Chapter 10 of the Comprehensive Pavement Design Manual. Includes thin surface seals, crack sealing, etc.

30. Rehabilitation

Includes all major items, mill and fill, unbonded overlay, rubblization, etc.

31. What are the state's standard routine and preventive maintenance operation and schedule by pavement type?

Best guess for each project type. No real standard.

Allocation of resources between maintenance, rehab, new and reconstruction— 90 percent focus on rehabilitation, 10 percent on maintenance. Not much in the way of any new construction

32. Do you have a formal system to track pavement condition, cost, and survivability?

Yes. A formal pavement management system is in place.

33. Do you allow old concrete to be recycled? If so into what products? Percentage limits?

Yes, standard specifications allow for recycling of both asphalt and concrete. In HMA, asphalt can be recycled up to 20 percent in surface and intermediate courses and 30 percent in base courses. Concrete can be recycled into base/subbase.

http://www.dot.state.ny.us/specs/2002specbook.html

34. Do you allow HMA materials to be recycled? If so into what products? Percentage limits?

Yes, standard specifications allow for recycling of both asphalt and concrete. In HMA, asphalt can be recycled up to 20 percent in surface and intermediate courses and 30 percent in base courses. Concrete can be recycled into base/subbase.

http://www.dot.state.ny.us/specs/2002specbook.html

401-2.05 Reclaimed Asphalt Pavement. Reclaimed Asphalt Pavement (RAP) will meet the requirements as written in MM 5.16.

304-2.02 Material Requirements. Provide suitable material conforming to the requirements of Section 203 and to the requirements contained herein.

Provide a subbase material which meets the specification material requirements and is within the Contractor's capabilities to place and fine grade to the required tolerances. Should the subbase course become unstable at any time prior to the placement of the overlying course, correct the unstable condition to the satisfaction of the Engineer at no additional cost to the State. Perform any required modification prior to placing the material on the grade.

If used, glass shall conform to the applicable paragraph of Section 203.

If RCA is used and it comes from other than a Department of Transportation project, provide documentation showing that the material obtained is from a NYSDEC registered or permitted construction and demolition (C&D) debris processing facility as specified in Section 360-16.1 of 6NYCRR Part 360, "Solid Waste Management Facilities".

If Blast Furnace Slag is to be used, provide documentation showing that it has undergone a NYSDEC beneficial use determination (BUD) prior to its use as specified in 6NYCRR Part 360-1.15, "Solid Waste Management Facilities".

For Types 1, 3 and 4 furnish materials consisting of approved Blast Furnace Slag, Stone, Sand, and Gravel, or blends of these materials with not more than 30 percent by weight of glass. Alternately, the following materials are also acceptable under these types as a replacement for the materials mentioned above:

- Alternate A. At least 95 percent, by weight, of RCA, and free from organic and other deleterious material. This material may contain up to 5% by weight asphalt and/or brick.
- Alternate B. A mixture of RCA conforming to Alternate A above mixed with stone, sand, gravel or blast furnace slag. This material may contain up to 5% by weight asphalt and/or brick.
- Alternate C. Bituminous material that is reclaimed from bituminous pavement and/or shoulders (Reclaimed Asphalt Pavement, or RAP) on a project constructed by the Department of Transportation and is well-graded from coarse to fine and free from organic or other deleterious material, including tar. This material is at least 95 percent, by weight, reclaimed bituminous material and has a maximum top size, at time of placement, of 50 mm. The gradation requirements for the different Types listed below do not apply when the material consists of RAP. No soundness or Plasticity Index testing will be required for this Alternate.

For Type 2, furnish materials consisting of approved Blast Furnace Slag or of Stone which is the product of crushing or blasting ledge rock, or a blend of Blast Furnace Slag and of Stone.

If, in the opinion of the Regional Geotechnical Engineer, this material becomes unstable during construction, it may be necessary to add a mixture of natural suitable material to the RAP. Acceptance of the final product shall be based on an evaluation by the Regional Geotechnical Engineer.

Provide written documentation that the reclaimed bituminous material originated on a Department of Transportation project. Include an identifier, such as State Highway, Construction Contract or Departmental Project Identification Number (PIN).

Purpose

The purpose of this interview is to gain insight into the following Ontario Ministry of Transportation practices:

- Pavement type selection
- Engineer's estimate and life cycle cost analysis
- Other items that affect cost

Agency Interviewed

Ontario Ministry of Transportation
1201 Wilson Avenue
Central Building, Room 232
Toronto, Ontario M3M 1J8
CANADA

Person(s) Interviewed

Name	Title	Phone	Email
Tom Kazmierowski	Manager, Pavements and Foundation Section	416-235-3512	Tom.Kazmierowski@mto.gov.on.ca

1. Do you have a documented pavement type selection procedure for:

New Construction: Yes – ERES Report
Reconstruction: Yes – ERES Report
Rehabilitation: Yes – for major rehabilitation - ERES

2. How long have you used the current type selection procedure?

1998 but other processes before that to the early 1970s.

3. Changes made over the last 5 years:

A Geokom document spells out the need for pavement alternative selection for all projects.

What prompted the change? The change was prompted by changes in technology and the desire to go to alternative bidding.

4. Have you used alternative bidding as a means of making a pavement type selection during the past 5 years? If yes describe the process. Was alternate bidding used on a Federal-aid project? If so, what was the basis of FHWA's approval?

Yes. Alternative bidding was used for one project to date. All current projects that are at least 10 km in length and have at least 1 million ESALs in the design lane or are likely to have 1 millions ESALs in the design lane in the next 5 years are serious considered for alternative bid.

5. Importance and extent of industry involvement in the development of type selection process?

This is very important to MTO. The industry (Cement Association of Canada) and the Ontario Hot Mix Producers Association has been extensively involved in the pavement type selection process and sit on the evaluation committee. This is an on-going process and the committee met this week in Toronto to discuss developments including the expected inclusion of user costs. They are also consulted on new technology developments and specification changes.

6. How was the selection process implemented within the agency?

It is done early in the process and is an integral part of the design process. It generally follows the schematic outlined in AASHTO 1993. Industry and consultant teams are involved in the implementation.

7. How is the type selection process related to the overall project selection, budgeting, planning process used by the agency?

It is done early in the process and is an integral part of the design process. It generally follows the schematic outlined in AASHTO 1993.

8. Pavement types used for new construction or reconstruction over the last 5 years

Pavement Type	Approximate lane miles		Performance (Good Fair Poor)
	Interstate	Other 4 lane	
Full depth ACP	< 1 %		Fair
Deep Strgth ACP	95 %		Good
ACP(less than 6") agg base	0		
Jointed Plain (JPCP)	<5 %		Good
Jointed Reinforced (JRCP)	0		There are old JRCP but they are all now composite as they have been overlaid with HMA.
Continuously Reinf. (CRCP)	0		

9. Thickness design procedure used and design life (if AASHTO which version)

ACP:
AASHTO 1993 Modified for Ontario Conditions
Ontario Pavement Analysis of Costs
MTO Routine Method for low volume roads
PCCP:
AASHTO 1993 Modified for Ontario Conditions
Ontario Pavement Analysis of Costs
Portland Cement Association

10. What analysis period used for each pavement type?

50 years for high volume freeways
30 years for secondary highways and rehabilitation

11. Are there different foundation/base requirements for AC and PCC?

No.

12. For those agencies that use smoothness as criteria do they use the same initial serviceability in design?

Yes.

13. Typical costs and method of contract measurement

Difficult to determine. It is regional and contract specific.

ACP in place $/_____/ton sy cy other
JPCP (slab only) $/_____sy cy other
JRCP (slab only) $/_____sy cy other
CRCP (slab only) $/_____sy cy other

14. How important is first cost versus future costs?

They are weighted the same and used in the LCCA. The LCC dominates the decision process.

15. Is life cycle cost analysis used?

Yes

16. Analysis period

50 years new and reconstruction
30 years rehabilitation

17. Discount Rate (how established)

Ministry of Finance (similar to OMB) social discount rate for infrastructure. The current rate is 5.3 percent and they suggest a 2 percent sensitivity level.

Engineering and Construction Considerations

Factors used, scoring system, primary factors secondary factors, weights, importance, etc

Factor	Considered	Primary or Secondary	Importance (0 to 5)	Comments
1. Roadway/lane geometrics (lane widths, cross slopes, ability to provide drainage)	Y	P	5	Is a given with all designs.
2. Highway functional class	Y	P	3	
3. Traffic	Y	P	5	
4. Roadway peripheral features (overhead clearance, weigh-in-motion, guardrails, etc)	Y	S	3	
5. Construction considerations				
a. Staging	Y	S	3	Is considered but minimal impact.
b. Clearance for equipment	N			
c. Construction operations	Y	S	2	
d. Traffic operations during construction	Y	S	3	
e. Construction seasons	Y	S	2	Scheduled to prevent late season paving.

Factor	Considered	Primary or Secondary	Importance (0 to 5)	Comments
6. Consideration of future maintenance operations (maintenance of traffic, ease of maintenance)	Y	S	3	
7. Performance of similar pavements in the area	Y	P	4	Tend to keep similar pavement types together.
8. Availability of local materials, contractor's capabilities, and experienced agency personnel.	Y	P	5	If materials or expertise is not available, it will drive up costs.
9. Pavement Continuity				
a. Adjacent sections	Y	P	4	
b. Adjacent lanes	Y	P	5	Would not put significantly differing materials in adjacent lanes.
10. Noise issues	Y	P	3	MTO has a policy on noise and pavement type.
11. Subgrade soils	Y	P	5	
12. Climate	Y	S	4	
13. District or local preference	Y	S	2	Regions can exercise local preference on a project by project basis
14. Ease of maintenance	Y	S	2	
15. Recycling	Y	P	3	
16. Conservation of materials and energy	Y	P	3	
17. Stimulation of Competition	Y	P	3	
18. Safety considerations (rutting, friction, lighting, etc)	Y	P	5	
19. Smoothness	Y	P	3	

18. Initial Costs – Estimating procedure

HiCo (Highway Cost) database is used. Contains an average of 3 lowest bids on recent projects in each regional area. Designer has the ability to review the prices to see what are reasonable for the project area.

19. How does agency determine unit cost to include in the cost analysis (standardized or project by project)? Is the size of the project used in the database considered (economy of scale)? Age of the price data. How often updated.

HiCo (Highway Cost) database is used. Contains an average of 3 lowest bids on recent projects in each regional area. Designer has the ability to review the prices to see what are reasonable for the project area. The costs are updated electronically continuously and are kept for the past 10 + years.

20. Are price adjustment factors used for any materials, and if so are they used in the life cycle cost analysis.

Yes. Most materials and placement have price adjustment. They are not included in the LCCA.

21. Actual cost versus estimated cost (are completed projects evaluated for overruns etc.)

Only bid costs are used.

22. Routine maintenance (how estimated, operations included)

Includes items such as ditching, grass cutting, etc. These are considered similar for all options and are not included in the LCCA.

23. Rehabilitation (how is timing estimated, techniques used, etc.)

Based on LCCA models developed by a consultant (ERES) in conjunction with MTO and industry representatives. Based on serviceability levels, trigger values and performance measures.

Salvage Value (remaining life): Included.
Residual value (recycling): Not included. Considered equal for all pavements.
Construction traffic control (crossovers, added lanes, barriers, detours, etc.): Not included. Part of normal design, not LCCA.
Engineering and administration: Not included in LCCA. Assume that everything outside of the pavement section is the same. Not include in initial or future costs.

24. How are users costs weighted in relation to agency costs?

Not used currently. Will likely be in 2004.

25. Vehicle operating costs

Not used currently. Will likely be in 2004.

26. User Delay

Not used currently. Will likely be in 2004.

27. Description of the analysis process

28. Routine maintenance

Shoulder grading, ditch cleanout, pothole filling, spall repairs, etc.

29. Preventive maintenance

Crack sealing, surface seals, selective resurfacing (area patching), thin lift resurfacing, hot in-place recycling, micro-surfacing, NovaChip, Dynapatch, slurry seals, etc.

30. What are the state's standard routine and preventive maintenance operation and schedule by pavement type?

See ERES Benefits of New Technology Report

31. Allocation of resources between maintenance, rehab, new and reconstruction

Current focus is on rehabilitation and preventive maintenance. Not much new construction.

32. Do you have a formal system to track pavement condition, cost, and survivability?

Yes. Detailed pavement management system.

33. Do you allow old concrete to be recycled? If so into what products? Percentage limits?

Yes. 100 percent can be recycled into base/subbase.

34. Do you allow HMA materials to be recycled? If so into what products? Percentage limits?

Yes. 30 percent can be recycled into base/subbase. Percentage in HMA varies from about 10 to 30 percent depending on the type of mix.

Purpose

The purpose of this interview is to gain insight into the following Pennsylvania Department of Transportation practices:

- Pavement type selection
- Engineer's estimate and life cycle cost analysis
- Other items that affect cost

Agency Interviewed

Pennsylvania Department of Transportation
400 North Street
Sixth Floor
Harrisburg, PA 17101-1900

Person(s) Interviewed

Name	Title	Phone	Email
Mr. Dan Dawood	Chief, Pavement Analysis & Design Section	(717) 787-4246	ddawood@state.pa.us

Overview of Procedure and General Notes:

The life cycle cost procedure is documented in a manual from the Pavement Design Analysis Section. The life cycle cost analysis procedure is in the form of an excel spreadsheet and is performed on all interstate project exceeding $1M and all other projects exceeding $10M, regardless of the funding source. A deterministic approach is used, and the inputs represent the median values, rather than the average values. The software can be obtained from PennDOT from their website.

The procedure has been recently updated and can be downloaded from the Pennsylvania DOT website. FHWA is currently reviewing the updated procedure. The current update was prepared to answer questions and issues that had been raised by industry related to pavement type selection. The Department is considering adding a probabilistic approach to the procedure, but that has yet to be completed.

The district determines the options to be considered. However, a field view or oversight committee that consists of district and central personnel and FHWA personnel is established that overviews the type of alternates that are considered for each project. Industry is not represented on this field view committee. The only external agency involved in the procedure is FHWA. A minimum of two alternates are considered for each project --- one PCC surfacing and one HMA surfacing option. The types of options that are considered consist of a decision between pavement preservation and reconstruction unless it is a new alignment project. The options for reconstruction are listed below.

- Jointed plain concrete pavements with a 4-inch open-graded drainage layer stabilized with asphalt or cement. If 10 percent patching is required, this is considered total reconstruction.
- Full-depth hot-mix asphalt concrete pavements – a drainage layer is not required for the HMA pavement. If there are severe distresses (rutting and cracking), this is considered total reconstruction.

Rubblization is not used that much in Pennsylvania. However, crack and seat is used quite extensively. The crack and seat includes sawing the PCC slabs and cutting the steel.

In some cases, the LCCA can be waived depending on the structure of adjacent lanes or adjoining sections with the same type of surface. Chapter 11-1 in the Pavement Design Analysis Manual gives a summary of when the rules can be bent or waived. Composite pavements are not considered and there is no bin with the LCCA for considering this type of pavement structure.

The LCCA procedure is used to calculate the present worth costs for each alternate. Equivalent annual costs have been used on very few projects. If the cost between the two alternatives has a difference of greater than 10 percent, the alternative with the lowest costs is selected, unless the district has some reason for selecting the other alternative, which does not happen very often. If the cost between the two alternatives is less than 10 percent, the district selects the option based on other factors. The district executive reviews the recommendation and approves or rejects the recommendation. In most cases the district executive approves the recommendation. The final recommendation then goes to the central office for review and concurrence.

User costs for initial construction are not considered as part of the LCCA because it is assumed that they will be equal for all alternatives. This assumption is dependent on the type and number of structures that occur along the project length.

1. Do you have a documented pavement type selection procedure for:

New Construction – Yes and it is documented in Chapter 11 of the Life Cycle Cost Analysis Procedure of the Pavement Design Analysis Manual.
Reconstruction – Yes and it is documented in Chapter 11 of the Life Cycle Cost Analysis Procedure of the Pavement Design Analysis Manual.
Rehabilitation – Yes and it is documented in Chapter 11 of the Life Cycle Cost Analysis Procedure of the Pavement Design Analysis Manual.

The following types of design strategies, new construction and rehabilitation by surface type are considered as part of the LCCA:

Bituminous Pavements:	HMA or bituminous overlay
	HMA overlay – crack-n-seat
	HMA Reconstruction – Rubblization
	HMA Reconstruction – Remove & replace

PCC Pavements:	Concrete pavement rehabilitation Bonded & Unbounded PCC overlays PCC overlays – Unbounded; crack-n-seat PCC Reconstruction – Rubblization PCC Reconstruction – Remove & replace

2. How long have you used the current type selection procedure?

The procedure was developed around 1985. It is about 18 years old. The current procedure has been automated and the software is available for use from the PennDOT website. However, there is no periodic review of the procedure.

3. Changes made over the last 5 years:

The maintenance schedules and initial service lives are routinely updated from data that has been collected through or for their pavement management system. In addition, the difference in costs between two alternatives of 5 percent was increased to 10 percent during the last update.

> **What prompted the change?** New data had been collected for their pavement management system and to answer questions or concerns that the asphalt industry had on the procedure regarding the comparison of different alternatives

4. Have you used alternative bidding as a means of making a pavement type selection during the past 5 years? If yes describe the process. Was alternate bidding used on a Federal-aid project? If so, what was the basis of FHWA's approval?

The Pennsylvania DOT does not plan to use the alternative bidding process in the future. The Department has used the alternative bidding process once, which is on-going. This is a federal aid project, but has yet to be reviewed and approved by FHWA. This project has two alternatives which have a 3 percent cost difference between the two alternatives, based on the engineers estimate. This first project is considered to be a pilot project. However, the Department has no intentions to continue or implement this process in the future.

5. Importance and extent of industry involvement in the development of type selection process?

Industry was not involved in the development of the life cycle cost analysis procedure. Industry is only involved when they ask to be involved. FHWA is the only external agency involved in the process. The Department wants two strong industries in Pennsylvania from a competitive standpoint.

6. How was the selection process implemented within the agency?

The Department developed the process or procedure in-house without involving industry. The LCCA is completed at the district level. The district engineer recommends the pavement type to be considered from the LCCA. The recommendation is forwarded to the district executive. The district executive recommends the selection to the central office for review. The central office evaluates the recommendation and forwards the recommendation to the FHWA for concurrence.

7. How is the type selection process related to the overall project selection, budgeting, planning process used by the agency?

There is no interrelationship between project selection, budgeting and planning within the pavement type selection process. The budget is predetermined for each project. The Department assumes that both or all alternatives considered within the LCCA procedure provide the same benefit to the DOT. The winning bid for the construction project must be within 10 percent of the engineers estimate. If the bid is greater than 10 percent of the engineers estimate, then the project is pulled, evaluated and re-advertised. However, the pavement type selection will not change once established for a particular project.

8. Pavement types used for new construction or reconstruction over the last 5 years

Pavement Type	Approximate lane miles		Performance (Good Fair Poor)
	Interstate	Other 4 lane	
Full depth ACP			This group really falls under ACP with 6-inch or less aggregate base.
Deep Strgth ACP			Does not use asphalt treated base layers.
ACP(less than 6") agg base	75 – 125	225 – 250	Within the last 2 to 3 years. Rated between good to fair. The Department has had some problems with Superpave mixes in the past.
Jointed Plain (JPCP)	450 – 500	225 – 275	Rated between good to fair. The Department has had some problems on a few projects with mid-slab cracking.
Jointed Reinforced (JRCP)			Does not use this type of pavement.
Continuously Reinf. (CRCP)			Does not consider this type of pavement.

9. Thickness design procedure used and design life (if AASHTO which version)

A 20-year design period is used for both ACP and PCCP.

ACP: The 1993 AASHTO Design Guide is used. In addition, the Department uses a frost factor for designing ACP. This frost factor is separate from the DARWin program. The increase in pavement structural thickness is applied to the HMA base thickness. The Department does not like to use more than 12 inches of an unbound aggregate base material for any design or roadway. The standard deviation used in design is 0.45. Moisture coefficients are also used in the design and are dependent on the type of material. The following table summarizes the layer coefficients that are used in the procedure.

Layer	Material Type	Structural Layer Coefficient
Wearing & Binder Layers	Superpave	0.44
	ID-2, ID-3	0.44
	FB-1, FB-2	0.20
	FJ-1, FJ-1C, FJ-4	0.35
Base Layer	Superpave	0.40
	Bituminous Concrete Base	0.40
	Crushed Aggregate	0.14
	Crushed Aggregate, Type DG	0.18
	Bituminous Base	0.30
	Aggregate Cement Base	0.40
	Aggregate Lime Base	0.40
Subbase Layer	Open-Graded	0.11
	No. 2 Subbase	0.11
	Asphalt Treated Permeable Base	0.20
	Cement Treated Permeable Base	0.20
	Rubblized PCC	0.20

PCCP: The 1993 AASHTO Design Guide is used. The frost factor used or considered in the design of ACP is not used or considered in PCCP designs. The average 28-day flexural strength used in design is 631 psi, and the modulus of elasticity is 4,000,000 psi. However, the District can use other values based on their experience and data. A loss of support is used in design --- values of 0.5 and 1.0 are used and depend on the material. The standard deviation used is 0.35.

10. What analysis period used for each pavement type?

A 40-year analysis period is used for both ACP and PCCP.

11. Are there different foundation/base requirements for AC and PCC?

Yes, as noted below.

- Subgrade preparation is the same for all alternatives. Lime or lime-fly ash stabilization is considered for both ACP and PCCP. This subgrade stabilization process is being used more routinely in Pennsylvania. The stabilization process has provided good performance in areas with frost susceptible or very weak soils. The Department has over-excavated frost susceptible soils for both pavement types. This is the other process that is being used to improve the subgrade foundation for both pavement types. The subgrade improvement process used is the same for both or all alternatives of a project or LCCA procedure.
- The ACP alternative, however, always includes a 6 to 8-inch dense- graded aggregate base for thick HMA bases (greater than 7 inches), but not for PCCP.
- The PCCP alternative always includes a 4 to 6-inch asphalt or portland cement open-graded drainage layer under PCCP, but not under ACP.

12. For those agencies that use smoothness as criteria do they use the same initial serviceability in design?

No. The following summarizes the values used in design for ACP and PCCP.

PSI-Value for LCCA and Design	Roadway Type	PCCP	ACP
Initial Value	Interstate or Limited Access Roadways	4.5	4.2
	All Other Roadways	4.5	4.2
Terminal Value	Interstate or Limited Access Roadways	3.0	3.0
	All other 4-lane Roadways	2.5	2.5
	Local Roadwdays	2.0	2.0
NOTE: However, the department uses a lower IRI-value for ACP in accepting pavement construction as part of their acceptance program. The IRI-value for PCCP is higher because of the tinning requirements.			

The above values are given in Chapter 6-12 of the Pavement Design Analysis Manual.

13. Typical costs and method of contract measurement

ACP in place $/___See below___/~~ton~~ sy ~~cy other~~

HMA Thickness, inches	Layer Type	In-Place Costs, $/sy
1.5	Wearing Surface	4.5 to 5.5
2	Binder Layer	6.25 to 6.8
5 to 7	Base Layer	About 7.0
NOTE: The Department pays for the binder separately. The binder costs is not included in the in place cost tabulated above. The cost for the liquid asphalt includes a price adjustment factor for HMA. The costs noted above have been reasonably stable over the past years.		

JPCP (slab only) $/___65 to 75___sy ~~cy other~~
Price adjustment factors for PCCP are not used.
JRCP (slab only) $/___NA___sy cy other
CRCP (slab only) $/___NA___sy cy other

14. How important is first cost versus future costs?

The Pennsylvania DOT does not use any kind of scoring system in selecting the pavement surface type. It is based on the total life cycle costs for each alternate or option. Present Worth cost is what matters and used in selecting the type of pavement. First costs and future costs is an issue, but not considered --- not open for discussion.

15. Is life cycle cost analysis used?

Yes. As noted above, the total life cycle costs for each alternate or option to select the type of design strategy or type of pavement surface.

16. Analysis period

The analysis period is 40 years for both types of pavements or for each design strategy considered in the LCCA.

17. Discount Rate (how established)

A discount rate of 6 percent is used. Industry has complained with the value, but has not been changed since the procedure was developed. This value is considered fixed but could be up for future consideration.

18. Initial Costs – Estimating procedure

The Department does not have an estimating procedure. The unit costs for each cost item are collected from the bid items. The median value for each cost item is used in the LCCA.

19. How does agency determine unit cost to include in the cost analysis (standardized or project by project)? Is the size of the project used in the database considered (economy of scale)? Age of the price data. How often updated.

The unit costs are complied for every bid item on a state wide basis and stored in the Contract Management System (CMS) database. These costs can be broken down by district, quantities, high and low bids, averages of all winning bids.

The age of the price data is updated after every letting.

20. Are price adjustment factors used for any materials, and if so are they used in the life cycle cost analysis.

For ACP, price adjustment factors are used. For PCCP, price adjustment factors are only considered for the HMA permeable base layers. The price adjustment factors are not used directly in the LCCA, but are indirectly included in the cost computations.

Engineering and Construction Considerations

Factors used, scoring system, primary factors secondary factors, weights, importance, etc

Factor	Considered	Primary or Secondary	Importance (0 to 5)	Comments
1. Roadway/lane geometrics (lane widths, cross slopes, ability to provide drainage)	Yes	S	2	Steep grades can be a factor if the difference in cost between the two alternatives in less than 10 percent.
2. Highway functional class	No			Generally defines that a LCCA should be done; i.e.; interstate and limited access roadways.
3. Traffic; Truck Overall Traffic	Yes Yes	P S	3 3	These items or factors are considered when there is less than a 10 percent difference between the costs.
4. Roadway peripheral features (overhead clearance, weigh-in-motion, guardrails, etc)	Yes	S	3	
5. Construction considerations				
a. Staging	Yes	P	3	
b. Clearance for equipment	No			
c. Construction operations	No			This factor maybe considered in the future based on comments or complaints from industry.
d. Traffic operations during construction	Yes	S	3	A factor that is considered, but most traffic control and delay costs are assumed to be equal between each alternate or option for initial construction.
e. Construction seasons	No			
6. Consideration of future maintenance operations (maintenance of traffic, ease of maintenance)	Yes	P	5	Definitely has an effect on the user or delay costs for the maintenance cycling and cost of the maintenance.
7. Performance of similar pavements in the area	Yes	P	4	Considered on a project by project bases. This factor is implemented on a system wide analysis and will change the maintenance cycles, and can have a significant effect on the LCCA. These are updated on a 4 to 5 year basis.

Engineering and Construction Considerations

Factors used, scoring system, primary factors secondary factors, weights, importance, etc

Factor	Considered	Primary or Secondary	Importance (0 to 5)	Comments
8. Availability of local materials, contractor's capabilities, and experienced agency personnel.	*No*			
9. Pavement Continuity				*Pavement continuity factors do have an effect but only when the cost difference between the two options are less than 10 percent.*
a. Adjacent sections	*Yes*	*S*	*2*	
b. Adjacent lanes	*Yes*	*S*	*2*	
10. Noise issues	*Yes*	*S*	*2*	
11. Subgrade soils	*Yes*	*S*	*2*	*The foundation for all pavement designs or options must have a good foundation, which is considered in design.*
12. Climate	*No*			
13. District or local preference	*Yes*	*S*	*4*	*When the costs difference is less than 10 percent.*
14. Ease of maintenance	*Yes*	*S*	*4*	*When the costs difference is less than 10 percent.*
15. Recycling	*No*			*However, this factor could have an effect on the rehabilitation strategy selection.*
16. Conservation of materials and energy	*No*			
17. Stimulation of Competition	*Yes*	*S*	*5*	*[More than just those projects where the difference in costs is less than 10 percent.]*
18. Safety considerations (rutting, friction, lighting, etc)	*Yes*	*S*	*4*	*When the costs difference is less than 10 percent.*
19. Smoothness	*Yes*	*S*	*4*	*When the cost difference is less than 10 percent.*

21. Actual cost versus estimated cost (are completed projects evaluated for overruns etc.)

Not during the LCCA process or within the LCCA procedure. Overruns are evaluated from a CMS construction management systems approach.

22. Routine maintenance (how estimated, operations included)

Routine maintenance if included from a pavement surface type. The type and timing of the routine maintenance applications if obtained from the maintenance department. This information and data are included in the Maintenance Operations Reporting Information System (MORIS). The following lists the annual maintenance costs for each surface type. The maintenance and rehabilitation activity time lines are included as figure 1.

Pavement Surface Type	Annual Maintenance Cost, $/Lane Mile
PCCP	825
ACP	1,825

23. Rehabilitation (how is timing estimated, techniques used, etc.)

The type and timing of the rehabilitation activities for a pavement surface type is determined though the data included in the pavement management system database. The median values are included in the LCCA. This information is input initially from the county managers. The resurfacing schedule can be shortened but not extended on high-volume heavy truck routes based on the district's experience. Currently the type of approach is solely based on the PMS data. The following lists the time to first resurfacing and the interval between resurfacings.

Pavement Surface Type	Time to First Resurfacing, yrs.	Interval of Resurfacing, yrs.
PCCP	30	10
ACP	10	10

Salvage Value (remaining life): No, none is used or considered in the LCCA.
Residual value (recycling): No, none is used or considered in the LCCA.
Construction traffic control (crossovers, added lanes, barriers, detours, etc.): The traffic control costs during construction are considered to be equal between the different options or alternatives.
Engineering and administration: No, none is used or considered in the LCCA.

24. How are users costs weighted in relation to agency costs?

No; Agency costs are not considered.

25. Vehicle operating costs

Yes the vehicle operating costs are a part of the user delay costs. Idling costs, stopping costs, and time value costs are determined by vehicle type. An inflation factor is determined by vehicle class and multiplied by the time value costs. This is described and discussed in the appendix and Chapter 11.6 of the Pavement Design Analysis Manual.

26. User Delay

User delay costs are not considered for initial construction, but are included for the maintenance cycling and rehabilitation times.

27. Description of the analysis process

A detailed analysis of the maintenance cycles are done and related to traffic control, user patterns, etc.

28. Routine maintenance

Refer to figure 1 as summarized in the Pavement Design Analysis Manual.

29. Preventive maintenance

Refer to figure 1. Basically mill and fill; more rehabilitation type activities are noted in the manual and in figure 1.

30. What are the states standard routine and preventive maintenance operation and schedule by pavement type?

See figure 1 (next page). These are defined by the central office from the database.

31. Allocation of resources between maintenance, rehab, new and reconstruction

No; built into the maintenance cycles.

32. Do you have a formal system to track pavement condition, cost, and survivability?

The PMS database is used for performance. The RMOIS is used for the maintenance cycles and costs.

33. Do you allow old concrete to be recycled? If so into what products? Percentage limits?

Yes, as an aggregate base, but only used as backfill for structures. Recycled PCC is not used or allowed in the PCC mixtures.

34. Do you allow HMA materials to be recycled? If so into what products? Percentage limits?

Yes, 15 percent is allowed in HMA mixtures. This material is used heavily is shoulders and widening projects and as unbound aggregate base materials.

Pavement Type	Activity and Time in years of Activity						
New Bituminous, Bit. Reconstruction & Bit. Overlay	5	10	15	20		30	35
	Seal coat Shoulders or do nothing as defined by mix type.	1.5 – 2.0 in. mill & fill; full-depth patches over 2% of area; saw & seal joints; seal coat shoulders; maintenance. & protection of traffic; user delay.	Seal coat shoulders depending on mix type.	Full-depth patches over 2% of area; HMA leveling course; saw & seal joints; adjust rails & drainage features; Type 7 paved shoulders; maintenance & protection of traffic; user delay.		Same as for 10 years.	Seal coat shoulders.
New PCCP, reconstruction, & Unbounded concrete overlays	5	10	15	20		30	35
		Clean & seal 25% of longitudinal joints & 5% of transverse joints; seal coat type 1 paved shoulders.		Concrete patch 2% of area; diamond grind 50% of area; clean & seal all longitudinal & transverse joints; maintenance & protection of traffic; user delay.		Concrete patch 5% of area; clean & seal all joints; HMA leveling course; 3.5-4 inch HMA overlay; saw & seal joints in overlay; type 7 paved shoulders; adjust rails & drainage features; maintenance & protection of traffic; user delay.	Seal coat shoulders.
PCCP Bonded Concrete Overlay	5	10	15	20	25	30	35
	Clean & seal 25% of longitudinal joints & 5% of transverse joints.	Concrete patch over 5% of area; spall repair over 5% of transverse joints; diamond grind 10% of area; clean & seal 25% of longitudinal joints & 10% of transverse joints; seal coat shoulders (Type 6 or 7); maintenance & protection of traffic; user delay.	Clean & seal 25% of longitudinal joints & 10% of transverse joints; seal coat shoulders.	Concrete patch over 10% of area; spall repair 10% of transverse joints; slab stabilization of 25% of transverse joints; diamond grind 100% of area; clean & seal all joints; type 6 shoulders; maintenance & protection of traffic; user delay.	Clean & seal 25% of longitudinal joints & 10% of transverse joints; seal coat type 6 shoulders.	Concrete patch 2% of area; clean & seal all joints; HMA leveling course; 3.5-4 inch HMA overlay; saw & seal joints in overlay; type 7 paved shoulders; adjust rail & drainage features; maintenance & protection of traffic; user delay.	Seal coat shoulders.
PCCP - Restoration	5	10		18	26	32	
	Seal coat shoulders; clean & seal 25% of all joints.	Concrete patch over 25% of initial quantity; slab stabilization of 25% of initial quantity; clean & seal all joints; HMA leveling course;3.5-4 inch HMA overlay; saw & seal joints in overlay; type 6 or 7 paved shoulders; adjust rail & drainage features; maintenance & protection of traffic; user delay.		Full-depth path over 1% of area; HMA leveling course; 1.5-2 inch HMA overlay; saw & seal joints in overlay; type 7 paved shoulders; adjust rail & drainage features; maintenance & protection of traffic & user delay.	1.5-2 inch mill & fill with HMA; full-depth patch over 3% of area; saw & seal joints; seal coat shoulders; maintenance & protection of traffic; user delay.	Same as year 18.	

Figure 1. Standard routine and preventive maintenance and rehabilitation schedules used in the LCCA.

Purpose

The purpose of this interview is to gain insight into the following Washington State Department of Transportation practices:

- Pavement type selection
- Engineer's estimate and life cycle cost analysis
- Other items that affect cost

Agency Interviewed

Washington State Department of Transportation
2655 South 2nd Avenue
Tumwater, WA 98512

Person(s) Interviewed

Name	Title	Phone	Email
Linda Pierce, PE	State Pavement Engineer	360 709-5470	piercel@wsdot.wa.gov

1. Do you have a documented pavement type selection procedure for:

New Construction - yes
Reconstruction - yes
Rehabilitation - no

2. How long have you used the current type selection procedure?

Approximately 15 years (current procedure is under revision)

3. Changes made over the last 5 years:

Probability analysis, focus on other factors (engineering, environmental, operational, and societal) and not only LCCA.

What prompted the change? Need to update 15 year old document.

4. Have you used alternative bidding as a means of making a pavement type selection during the past 5 years? If yes describe the process. Was alternate bidding used on a Federal-aid project? If so, what was the basis of FHWA's approval?

No

5. Importance and extent of industry involvement in the development of type selection process?

Both industries are currently reviewing and commenting on WSDOT Pavement Type Selection Protocol revision

6. How was the selection process implemented within the agency?

WSDOT Directive issued by DOT Secretary requires use of a pavement type selection process on new and reconstructed pavements.

7. How is the type selection process related to the overall project selection, budgeting, planning process used by the agency?

A new or reconstruction project is deemed necessary, during the design stage, the pavement type selection process is activated and incorporated into the final design recommendations.

8. Pavement types used for new construction or reconstruction over the last 5 years

Pavement Type	Approximate lane miles		Performance (Good Fair Poor)
	Interstate	Other 4 lane	
Full depth ACP			
Deep Strgth ACP			
ACP(less than 6") agg base			
Jointed Plain (JPCP)	243	36	Good performance, approximately 210 lane miles are pending construction due to funding limitations
Jointed Reinforced (JRCP)	N/A	N/A	
Continuously Reinf. (CRCP)	N/A	N/A	

9. Thickness design procedure used and design life (if AASHTO which version)

ACP – AASHTO 1993
PCCP – AASHTO 1993

10. What design life used for each pavement type?

40 years for high volume designs

11. Are there different foundation/base requirements for AC and PCC?

Require use of 2 to 4 inches of HMA beneath PCCP to minimize mitigation of fines beneath PCCP.

12. For those agencies that use smoothness as criteria do they use the same initial serviceability in design?

Smoothness for PCC based on profilograph. Working on a specification covering both pavement types based on IRI. Same initial serviceability used for both pavement types.

13. Typical costs and method of contract measurement

ACP in place $/__35__/ton sy cy other
JPCP (slab only) $/__74__sy cy* other
JRCP (slab only) $/_____sy cy other
CRCP (slab only) $/_____sy cy other
*Quantity is based on core thickness up to 0.5 inches over plan thickness

14. How important is first cost versus future costs?

Equated as the same importance.

15. Is life cycle cost analysis used?

Yes. Probabilistic

16. Analysis period

20 years on low volume and 60 years on high volume routes.

17. Discount Rate (how established)

4 percent, based on FHWA recommendation and OMB Circular A-94

18. Initial Costs – Estimating procedure

Conducted by Project Office based on past project bid items and costs. Performed in the district office on a project-by-project basis. Reviewed by headquarters pavement design office

19. How does agency determine unit cost to include in the cost analysis (standardized or project by project)? Is the size of the project used in the database considered (economy of scale)? Age of the price data. How often updated.

Analysis is conducted project by project using up-to-date cost information from the bid item summary. Since many projects have varying lane configurations, ramp tapers, acceleration-deceleration lanes, etc., Project Offices are requested to conduct analysis based on a typical one-mile section.

Engineering and Construction Considerations

Factors used, scoring system, primary factors secondary factors, weights, importance, etc

Factor	Considered	Primary or Secondary	Importance (0 to 5)	Comments
1. Roadway/lane geometrics (lane widths, cross slopes, ability to provide drainage)	X	S		
2. Highway functional class	X	S		
3. Traffic	X	S		
4. Roadway peripheral features (overhead clearance, weigh-in-motion, guardrails, etc)	X	S		
5. Construction considerations		S		
a. Staging	X	S		
b. Clearance for equipment	X	S		
c. Construction operations	X	S		
d. Traffic operations during construction	X	S		
e. Construction seasons	X	S		

Factor	Considered	Primary or Secondary	Importance (0 to 5)	Comments
6. Consideration of future maintenance operations (maintenance of traffic, ease of maintenance)	X	S		
7. Performance of similar pavements in the area	X	S		
8. Availability of local materials, contractor's capabilities, and experienced agency personnel.	X	S		
9. Pavement Continuity		S		
a. Adjacent sections	X	S		
b. Adjacent lanes	X	S		
10. Noise issues	X	S		
11. Subgrade soils	X	S		
12. Climate	X	S		
13. District or local preference		S		*Reasoning for preference must be quantified*
14. Ease of maintenance	X	S		
15. Recycling	X	S		
16. Conservation of materials and energy	X	S		
17. Stimulation of Competition		S		
18. Safety considerations (rutting, friction, lighting, etc)	X	S		
19. Smoothness				

20. Are price adjustment factors used for any materials, and if so are they used in the life cycle cost analysis.

No

21. Actual cost versus estimated cost (are completed projects evaluated for overruns etc.)

Currently investigating this issue on past projects.

22. Routine maintenance (how estimated, operations included)

Since routine maintenance is such a small item, it is typically excluded in the LCCA. WSDOT intends to collect this data in the future to confirm this assumption.

23. Rehabilitation (how is timing estimated, techniques used, etc.)

The Washington State Pavement Management System is utilized to determine typical pavement service life.

Adjustments have made based on improved performance as a result of the use of dowel (all existing pavements were undoweled). In addition, stainless steel clad dowels being used on premium pavements.

Performance of HMA is based on performance of adjacent projects. Currently the State does not require contractor QA/QC. Some Superpave. No much use of stone matrix mixes.

Salvage Value (remaining life): Used as a ratio of cost and anticipated remaining life.
Residual value (recycling): Not specifically included.
Construction traffic control (crossovers, added lanes, barriers, detours, etc.): Included in estimate.
Engineering and administration: Included in estimate. Flat rate for all projects. Same for HMA and PCC.

24. How are users costs weighted in relation to agency costs?

Currently weighted equally. However, the analysis is summarized to show results with and without user costs.

25. Vehicle operating costs

Not included.

26. User Delay

Included as a function of delay due to construction.