I. System Preservation Program

Pavement

WSDOT owns and maintains approximately 20,083 lane miles of highway, including mainline, spur, couplet, reversible, alternate, grade-separated HOV, ramps, collectors, and special use lanes (slow vehicle, two-way turn, chain up, transit, climbing, bike, holding, weaving/speed change, and HOV lanes).

Basically, all hard surfaced pavement types can be categorized into two groups, flexible and rigid.

Flexible Pavements

Flexible pavements are those that are surfaced with bituminous (or asphalt) materials (Figure 1). These can be either in the form of a chip seal, which is generally found on lower volume (lower traffic) roads or hot mix asphalt pavements which are typically used on medium to high volume roadways.

Bituminous Surface Treatment (BST) or Chip Seal

Chip seal is generally used on lower volume local roadways (Photo 1) and has an expected life of 6 to 8 years.

Hot Mix Asphalt (HMA)

Hot mix asphalt pavement is typically designed for 20 to 50 years of life with routine overlays every 10 to 15 years (Photo 2). An average statewide pavement life cycle is 15 years.

Photo 1. Bituminous Surface Treatment (BST) or Chip Seal

Photo 2. Hot Mix Asphalt (HMA) Pavement

Rigid Pavements

Rigid pavements are composed of a Portland Cement Concrete surface course (Figure 1). Portland Cement Concrete Pavement (PCCP) generally serves 30 to 50 years with minimal maintenance (Photo 3).

Figure 1. Hard Surfaced Pavement Types

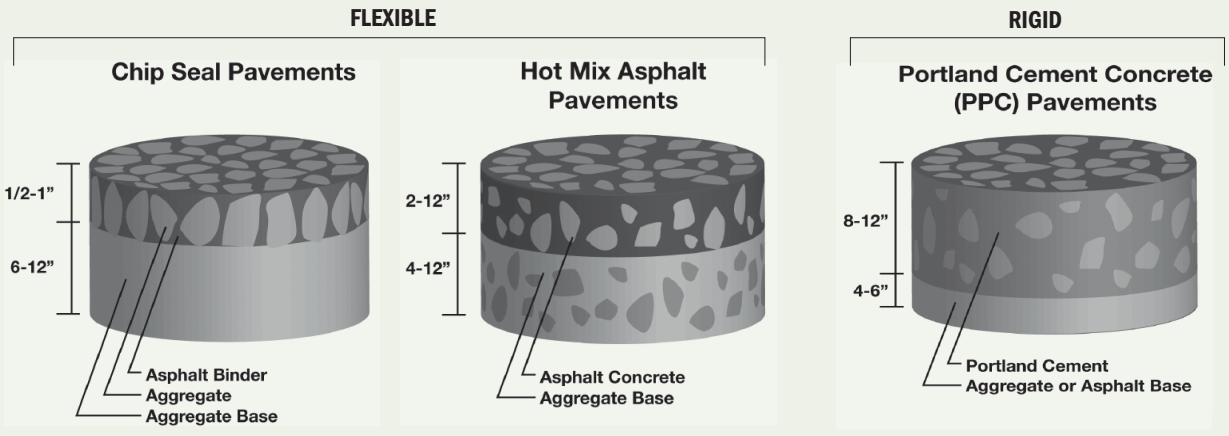


Photo 3. Portland Cement Concrete Pavement (PCCP)

Pavement type selection is based on pavement design criteria (materials, traffic, etc.), life cycle cost analysis and engineering evaluation.

Currently, the state highway pavement network is composed of approximately 87 percent of flexible pavements and 13 percent rigid pavements (Table 1, Figures 2 and 3).

Roadways require periodic rehabilitation to keep the driving surface smooth and safe and to prevent failure of the underlying substructure. Identifying the optimal time for rehabilitation is crucial to efficient pavement management. If rehabilitation is done too early, pavement life is wasted. Rehabilitation that is done too late requires additional costly repair work and increases the risk of subsurface structural failure.

Table 1. Annual Vehicle Miles in 2005 (in Billions)

Pavement Type	Lane Miles	Lane Miles (Percent)	Traveled Miles Annually	Traveled Miles Annually (Percent)
Chip Seal (Flexible)	4,332	21.6	1.1	3.5
Hot Mix Asphalt (Flexible)	13,214	65.8	21.7	68.7
Portland Cement Concrete (Rigid)	2,537	12.6	8.8	27.8

Needs

There is no more fundamental transportation capital investment than system preservation—keeping the physical infrastructure in good condition. As transportation facilities age and are used, a regular schedule of maintenance, rehabilitation, reconstruction, and replacement is needed to keep the system usable. Timing is important: if preservation investment

Figure 2. Statewide Pavement Inventory

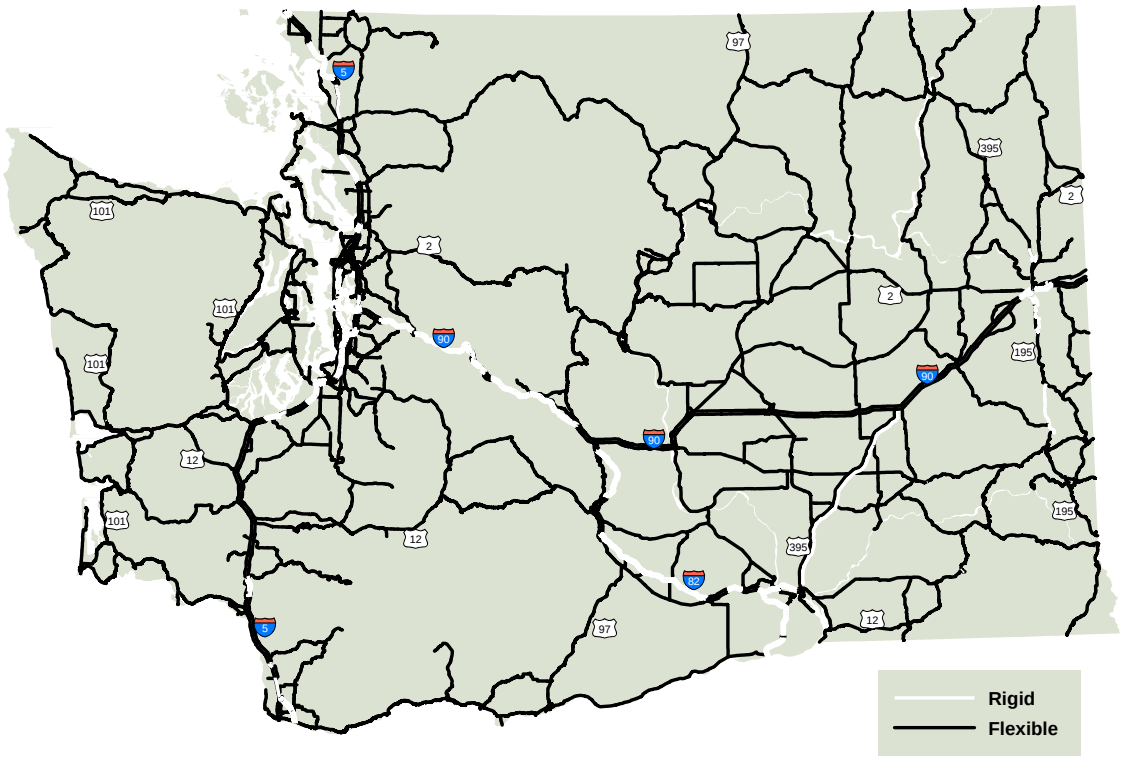
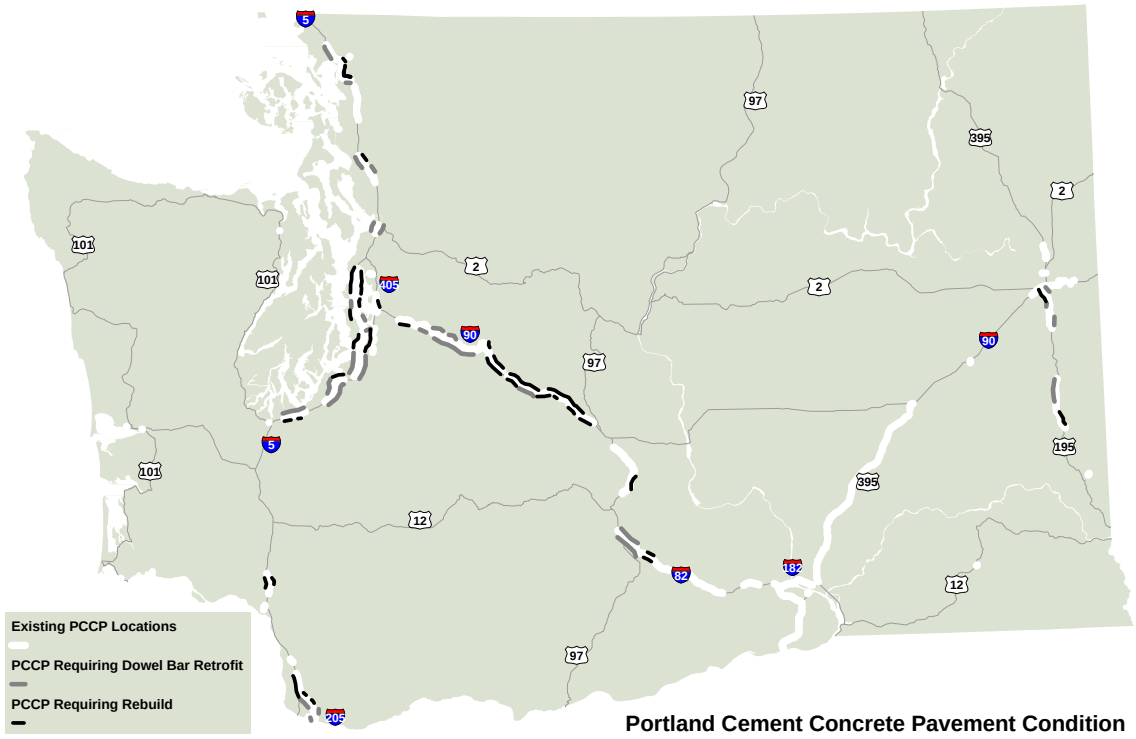


Figure 3. Portland Cement Concrete Pavement Condition



is deferred, costs increase dramatically, leading to the saying "pay me now, or pay me more—lots more—later" (Figure 4).

WSDOT's objective is to preserve roadways at the lowest cost per year of pavement life. Heavy traffic (especially slow, such as stoppings and turnings), studded tires, and extreme weather create wear and tear on pavement surfaces leading to its deterioration. Regular roadway preservation benefits traveling public safety as it prevents hydroplaning in wet weather, minimizes rough drive, and offers resistance to skipping and skidding. Roadway preservation includes restoration of worn-out basic safety features such as signing, striping, and gaurdrails.

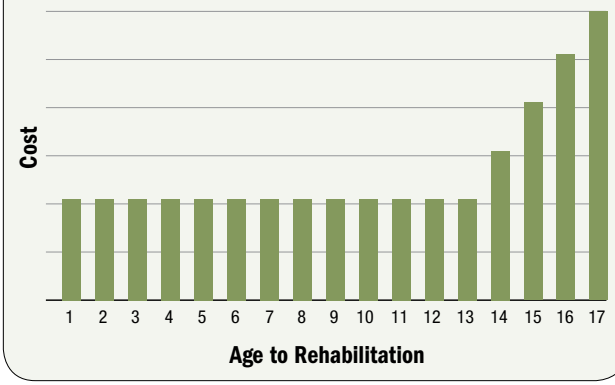
The Department uses a process to identify needs to preserve the existing state highway system, which gives considerations to lowest life cycle costing (RCW 47.05.051 (1)).

The legislature placed additional emphasis on preservation of asphalt pavements using lowest life cycle cost principles by inserting the following language in recent budget bills:

> *"The department of transportation shall continue to implement the lowest life cycle cost planning approach to pavement management throughout the state to encourage the most effective and efficient use of pavement preservation funds. Emphasis should be placed on increasing the number of roads addressed on time and reducing the number of roads past due."*

Figure 4. Cost of Asphalt Pavement Rehabilitation on State Highways

"Pay me now, or pay me more – lots more – later."



WSDOT Headquarter's Pavements Management Division uses three types of measures to evaluate pavement condition at the network level for rehabilitation scheduling. These include surface distresses (cracking, patching etc.), rut depth and roughness as characterized by international roughness index (IRI). An automated pavement condition survey vehicle, traveling at highway speeds, collects high-resolution digital images (for subsequent distress rating), profile (for roughness) and rutting data annually on all state highways. Trained technicians play back the digital images on special workstations at slow speeds and identify surface distresses. Quality Assurance/Quality Control processes are applied throughout the rating process to verify and validate the accuracy of the distress data. The surface distress, roughness and ride data are then added to the Washington State Pavement Management System (WSPMS) historical database.

Strategies for Preserving Highway Pavements

WSDOT places emphasis on highway pavements preservation by maintaining, preserving, and extending the life of existing system – accomplishing one of the essential transportation system policy goals established by legislature. Department also continuously improves the quality, effectiveness, and efficiency of the pavement system preservation achieving another important policy goal of stewardship. The strategies to preserving highway pavements described in this sub-chapter are instrumental in a fulfilling commitment to these policies.

Washington uses a lowest life cycle methodology to carefully evaluate the state highways surfaced with flexible pavements, and to develop a roadway rehabilitation schedule. WSDOT incorporates this methodology into the pavement management system to develop a list of roadways that are due for rehabilitation, or will be due at some point in the future. Field investigations confirm these assessments. This methodology is not as accurate for predicting PCCP rehabilitation cycles.

Each segment of state highway is assigned a year where the projected cost will be at the lowest cost for rehabilitation. This is known as the "**due year**." If the highway segment is not rehabilitated during its due year it becomes "**past due**." The Department uses the WSPMS information to determine when the roadway pavement sections have reached the "due" year and need to be rehabilitated to prevent additional deterioration which may result in either increased maintenance costs or added rehabilitation costs. Some roadway segments may actually be in the "past due" category for a few years without accruing significantly higher rehabilitation costs, but other segments may experience higher costs within one to two years, depending on climate and traffic volumes.

The Washington State Pavement Management System (WSPMS) plays a pivotal role in identification and prioritization of roadway preservation needs and projects. As part of this process, annually WSDOT collects, rates and analyzes pavement surface condition data for the entire state highway system. The three types of condition measures used for evaluation are shown below.

Photo 4. Pavement Structural Condition (PSC). This measure is based on cracking, patching, etc. A roadway should be considered for rehabilitation when PSC is between 40 and 60.

Photo 5. Rutting is caused by heavy traffic or studded tire use. Ruts greater than 1/3 inch deep require rehabilitation.

Photo 6. Roughness is characterized by international roughness index (IRI). A roadway should be rehabilitated when IRI is between 170 and 220 inches per mile.

The **chip seal pavements** are maintained at the lowest life cycle cost in the pavement preservation program. These pavements generally require rehabilitation every 6 to 8 years and provide a very durable surface for low volume roadways (typically less than 4,000 vehicles per day with less than 15 percent truck traffic) where adequate sub-base exists.

For **hot mix asphalt pavements**, a range in pavement life of 8 to 18 years is typical in Washington State. On average, western Washington hot mix asphalt pavement life is 16.5 years, eastern Washington life is 11.3 years, and the statewide average is 14.7 years. The range in pavement life between eastern and western Washington is primarily due to the severe winter cold and extreme summer heat experienced in eastern Washington. Hot mix asphalt pavement is susceptible to aging, cracking and rutting caused by temperature extremes.

High volume intersections with stop and go traffic provide a different challenge. Typically stop and go conditions, extreme weather, heavy traffic, and downhill grade cause severe damage to the hot mix asphalt pavements on those intersections. Usage of **PCCP in high volume intersections** has shown to be cost effective over the pavements life, as well as eliminating the need for periodic overlays.

Ramps and auxiliary lanes are similar to the HMA intersections but these have longer life.

There is an enormous task at hand with PCCP. Originally, PCCP was designed for only a 20-year life. To date, approximately 80 percent of the concrete pavement in Washington State is more than 20 years old (Figure 5 and Table 2). In addition, PCCP has carried much more traffic (two to five times more) than its original design anticipated.

Over the last 40 or more years, a number of PCCP design and performance issues have been evaluated. WSDOT believes that with today's technology it is possible to construct a PCCP that will perform for 50 or more years with minimal rehabilitation. We envision that future rehabilitation will be required to repair the damage caused by studded tires. Banning studded tires would not only lengthen pavement life, improve pavement ride and reduce pavement noise but would also reduce costs and future traffic disruptions due to pavement rehabilitation.

Another complication with PCCP is that the majority of this pavement is on the more heavily traveled areas of the interstate highway system. Pavement rehabilitation work inconveniences the traveling public and creates high traffic management costs while construction is underway. A PCCP that is faulted, but not cracked, can more than likely be rehabilitated by dowel bar retrofit and diamond grinding.

Figure 5. Concrete Pavement by Year Built

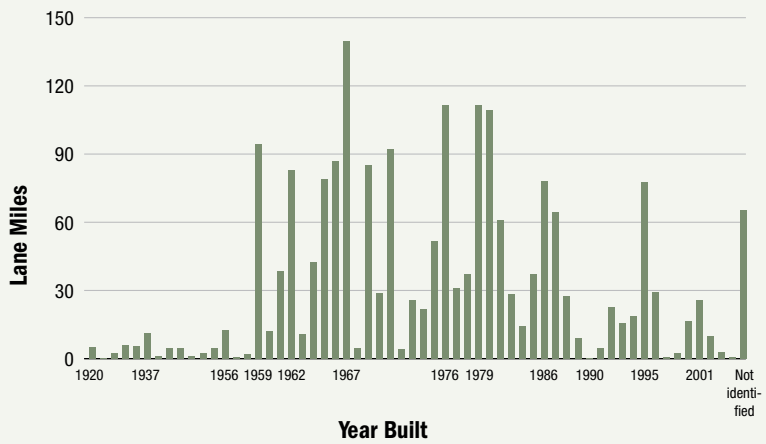


Table 2. Statewide PCCP Age*

Age (yrs)	Total Lane Miles
0-10	87.51
11-20	318.91
21-30	541.19
31-40	540.37
41-50	375.91
51-60	12.35
61 or more	36.07
Not identified	65.39
Total	**1,977.69**

**Note: The PCCP lane miles total does not include special use, grade-separated HOV, PCCP intersections, or ramps.*

Due to the high cost for the rehabilitation of concrete pavement, selective panel replacement combined with overlay will be required due to limited funds. Additionally, for PCCP rehabilitation projects WSDOT policy is not to include retrofitting of existing environmental needs such as fish passages, storm water, or noise.

On the opposite end of the scale, pavement that is severely cracked may be beyond simple rehabilitation and may require complete reconstruction. WSDOT has not needed to rehabilitate major sections of PCCP over the last 20 to 30 years. Unfortunately, that luxury no longer exists. It will take time and a considerable dedicated funding source to bring the PCCP to the same level of service that WSDOT strives to obtain for our other roadways.

Over the past three years an improved pavement management methodology was implemented. It is more efficient, cost-effective and consistent with the Revised Code of Washington, passed by the 2003 Legislature that emphasized the lowest life cycle cost principles. Pavement Management has been supported by years of experience and research as well as collaboration with national and international professional technical organizations such as the University of Washington, AASHTO, World Bank, and FHWA. The strategies discussed in the following pages of this section came about as a result of this intensive coordination and collaboration. Two key goals emerged as a result of this work for new flexible pavement methodology:

- Reducing the annualized cost of a pavement by optimizing the pavement design.
- Applying BST on some roadways traditionally paved with HMA by alternating cycles of chip seals followed by HMA surfacing. This does not affect WSDOT's policy regarding paving within city/town limits as city and town streets will be continued to be paved with the HMA.

A few critical areas requiring further research include:

- Refining the selection criteria for cost-effective methodologies using BST and HMA in alternating paving cycles.
- Predicting the life of concrete pavement including the development/refinement of the concrete performance curve will enable WSDOT to estimate the number of lane miles of concrete pavement needing replacement in the next 20 years.

As funds become tighter, WSDOT continues to the search and analyze better, more cost-effective pavement management methodologies consistent with current legislation.

If there are not enough funds to rehabilitate all the required lane miles according to the lowest life cycle cost averages, rehabilitation needs are ranked in the following order to minimize additional deterioration and potential future cost increases:

- Construction in progress
- Chip seal
- Emergent concrete (based on HQ WSDOT Materials Lab approval)
- Due HMA
- Pave due HMA miles with chip seal on identified sections. Apply savings to:
  - Past due HMA
  - Ramps and/or concrete (based in HQ WSDOT Materials Lab approval)
  - Intersections
- Concrete (non emergent) replacement/ rehabilitation

Chip seals are prioritized first because of their low cost per mile to pave when "due," compared to a rehabilitation project when "past due." The additive cost of deferring chip seal "past due" pavement can be very high as it may exceed ten times the cost of the project when it is due.

There is an emerging need for rehabilitation/reconstruction of PCCP – these pavements are disproportionately represented in future poor pavement miles. The current funding allocations are adequate to cover asphalt and chip seal repaving needs, but fall far short of funding PCCP rehabilitation/reconstruction needs.

Therefore, it is WSDOT's intent to evaluate each heavily traveled intersection and determine the appropriateness and life cycle cost to reconstruct these intersections with concrete. WSDOT has estimated that approximately 130 intersections may0p8.64be appropriate for PCCP at an estimated cost of $500,000 per intersection.

How Will Performance Improve?

In the next 20 years, the WSDOT Pavement Management will be focused on three main categories, i.e.:

- Asphalt pavement preservation
- Pavement strengthening
- PCCP rehabilitation

It will include the following improvements:

- Eliminate backlog of past-due asphalt pavements and maintain a lowest life-cycle cost0p8.64schedule for those pavements.
- Maintain chip seal paving at lowest life-cycle cost.
- Strengthen pavement structure where warranted, due to heavy truck loads, including intersections.
- Rehabilitate high priority interstate PCCP sections.
- Rehabilitate high priority non-interstate highway PCCP.

In the long term, the costs of pavement preservation in the state will be reduced and the traveling public will benefit from smoother rides and shorter travel times as there will be less closures due to maintenance.

Maintenance and Operation

As inventory of paved lane miles, ramps, and other paved surfaces are added to the highway system through the construction program, they will need to be maintained in order to keep them in good, working condition. This typically includes patching potholes, digging out and patching area of distressed pavement, and sealing pavement cracks.

Certain maintenance treatments on pavements will help hold the road together between preservation treatments and reconstruction projects. Some maintenance treatments will be more focused on immediate traveler safety (i.e. patching potholes) while others focus on extension of the pavement life (i.e. crack sealing). Through improved information management and decision making, the selection and timing of maintenance treatments is becoming better coordinated with the pavement preservation program.