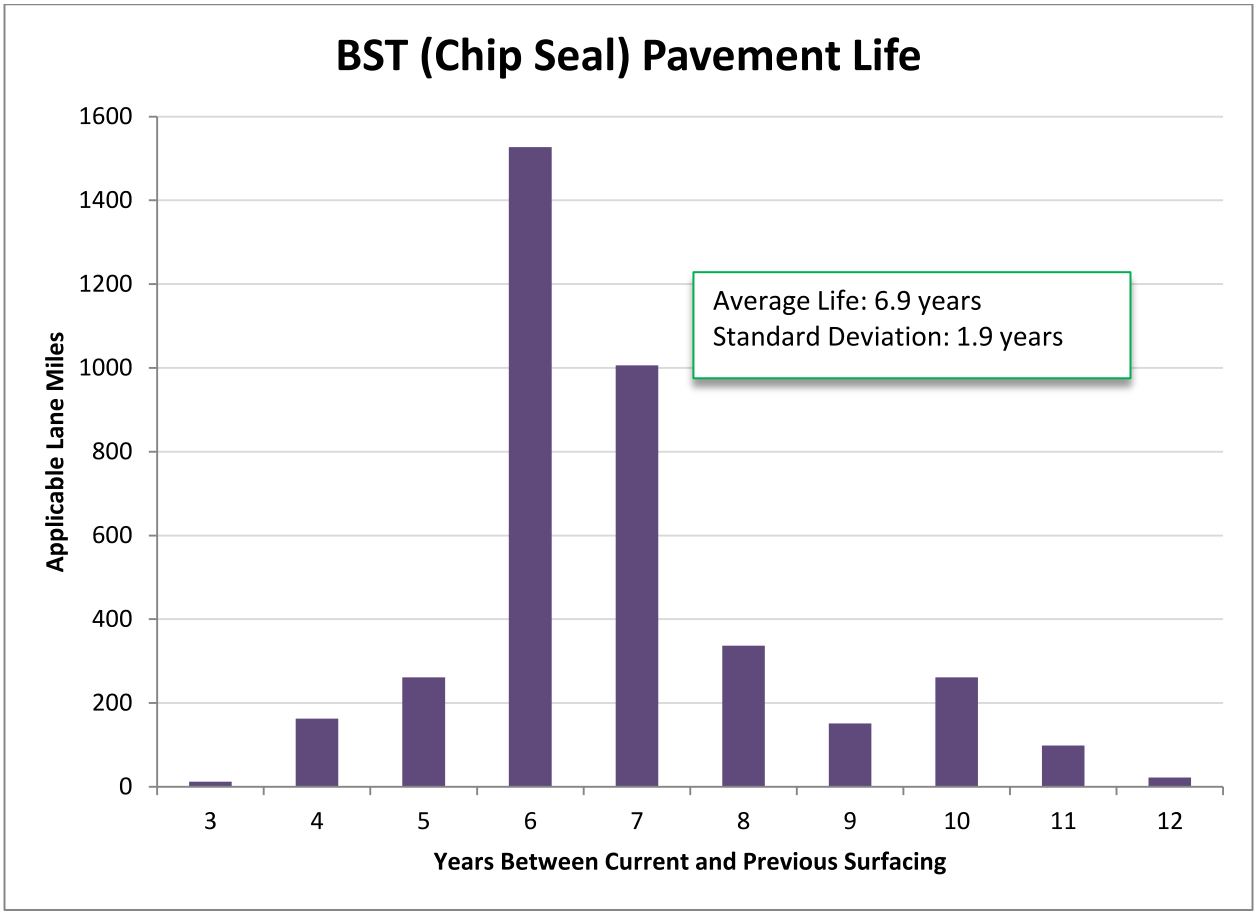
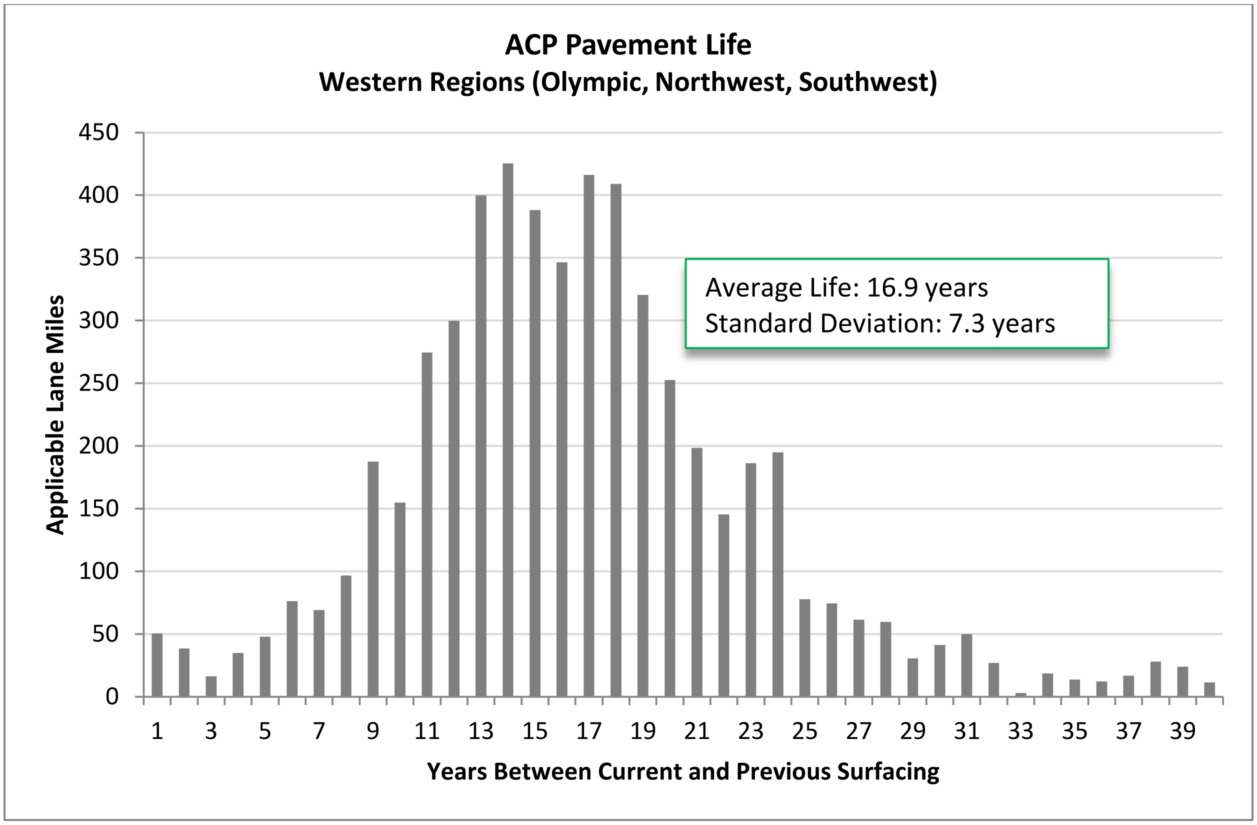
AVERAGE PAVEMENT LIFE IN WASHINGTON STATE

2015 Update, Produced 2/11/2016

The following charts illustrate the average pavement life for state-maintained roads. For flexible pavements, pavement life is defined as the number of years between resurfacings. There are two main types of flexible pavements, Chip Seals, also called Bituminous Surface Treatments (BST), and Asphalt Concrete Pavements (ACP). Chip seal surfaces are thin and cost effective, but have a relatively short life. They are used primarily on roadways with lower volumes of traffic.



For Asphalt Concrete Pavement (ACP), pavement life is different on the West and East side of the state. This is because of the harsher climate on the East side of the state, greatly reducing the life of the pavement relative to the West side of the state.


ACP Pavement Life
Western Regions (Olympic, Northwest, Southwest)
Average Life: 16.9 years
Standard Deviation: 7.3 years
Applicable Lane Miles
Years Between Current and Previous Surfacing
0
50
100
150
200
250
300
350
400
450
1
3
5
7
9
11
13
15
17
19
21
23
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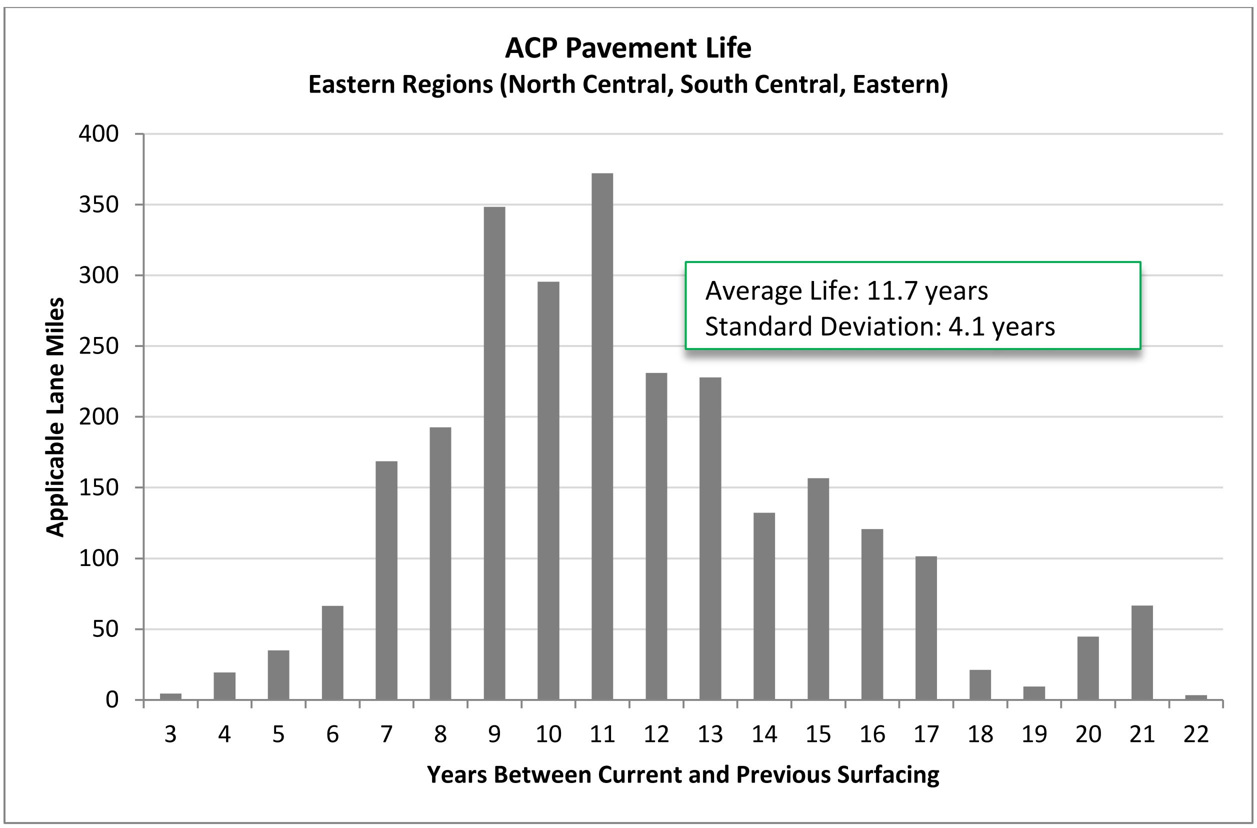
ACP Pavement Life
Eastern Regions (North Central, South Central, Eastern)
Average Life: 11.7 years
Standard Deviation: 4.1 years
Applicable Lane Miles
Years Between Current and Previous Surfacing
0
50
100
150
200
250
300
350
400
3
4
5
6
7
8
9
10
11
12
13
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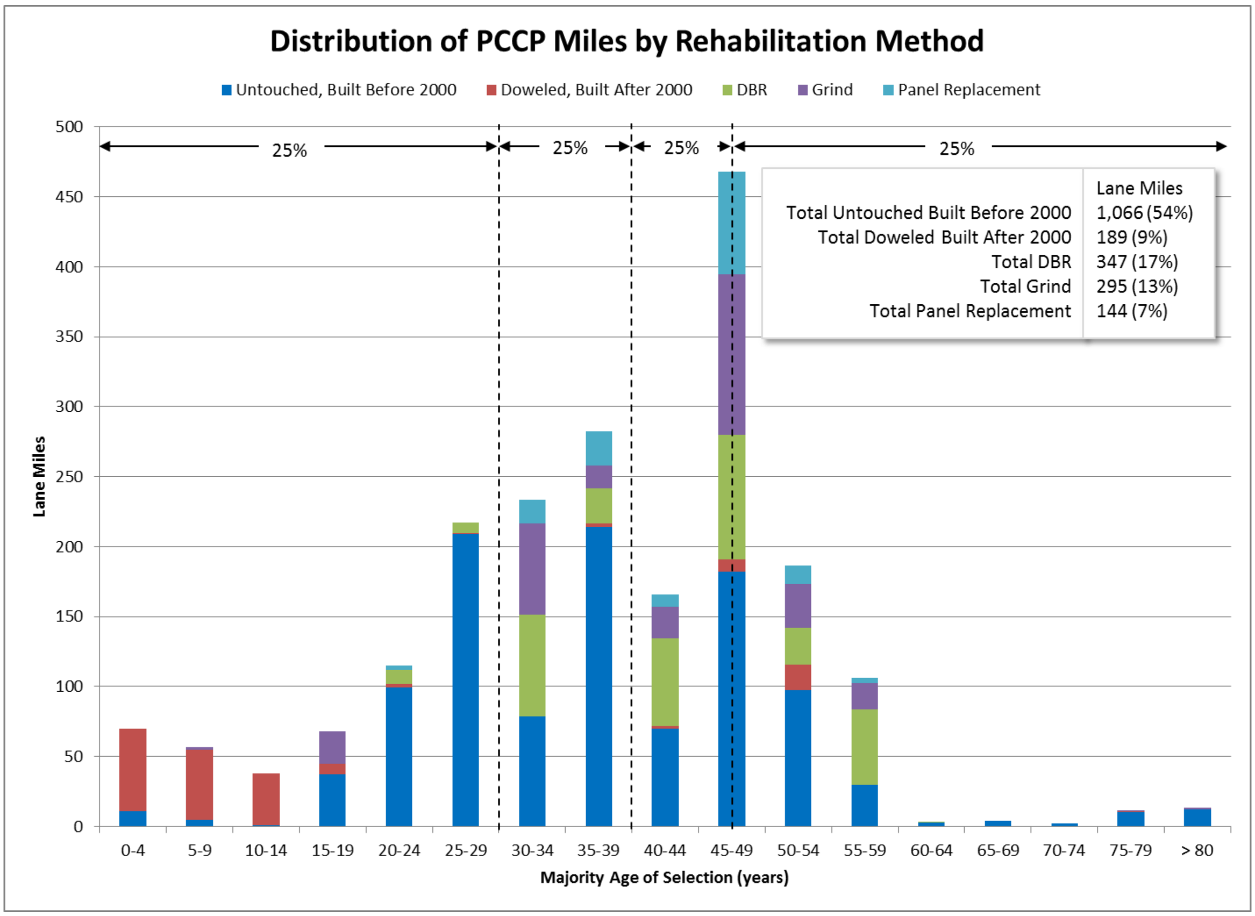
The rigid pavement type used in Washington State, Portland Cement Concrete Pavement (PCCP), needs more explanation. The majority of these pavements were constructed during the late 1950s and 1960s as part of the interstate highway program. At that time, the pavement design life for these roadways was estimated to be about 20 years. These pavements have far exceeded their original design lives and carried many times the traffic load originally anticipated. Therefore, there is not a sufficient amount of PCCP in Washington State that has been replaced to accurately quantify a pavement life. However, WSDOT currently uses a 60 year model with treatments for grinding in year 20 and grinding and panel replacement in year 40. This model considers the age of PCCP throughout the state, along with the miles that have been rehabilitated with grinding, Dowel Bar Retrofit (DBR), or selective panel replacement, gives a good understanding PCCP life.



EXTENDING PAVEMENT LIFE SAVES MILLIONS OF DOLLARS

WSDOT has been making deliberate changes in the way it manages its pavements in order to maximize service life and the minimum cost. This strategy is referred to Lowest Life Cycle Cost. Strategies to reduce life cycle costs that have been implemented by WSDOT in the last decade include:

- Use chip seal surfacing where feasible, which corresponds to roadways with traffic levels up to 10,000 vehicles per day. Using chip seal surfacing compared to asphalt surfacing, where appropriate, is approximately one-third the cost.

- Implement practical design concepts including milling and overlaying roadways for only those lanes requiring rehabilitation, eliminating "curb to curb" fixes within city limits, providing "surgical" repairs to only a portion of a given section of pavement that requires rehabilitation, and considering lower cost solutions for ramps.
- Extend pavement life with properly timed maintenance.
- Prioritize projects to allocate funds strategically, making sure the most cost-effective projects receive the highest priority.

More in-depth explanation of these strategies can be found in the Gray Notebook #56.

These changes can take several years to affect average pavement life for an entire network of roadways. However, the overall averages from these pavement life summaries are showing an increase in pavement life for asphalt and chip seal roadways.

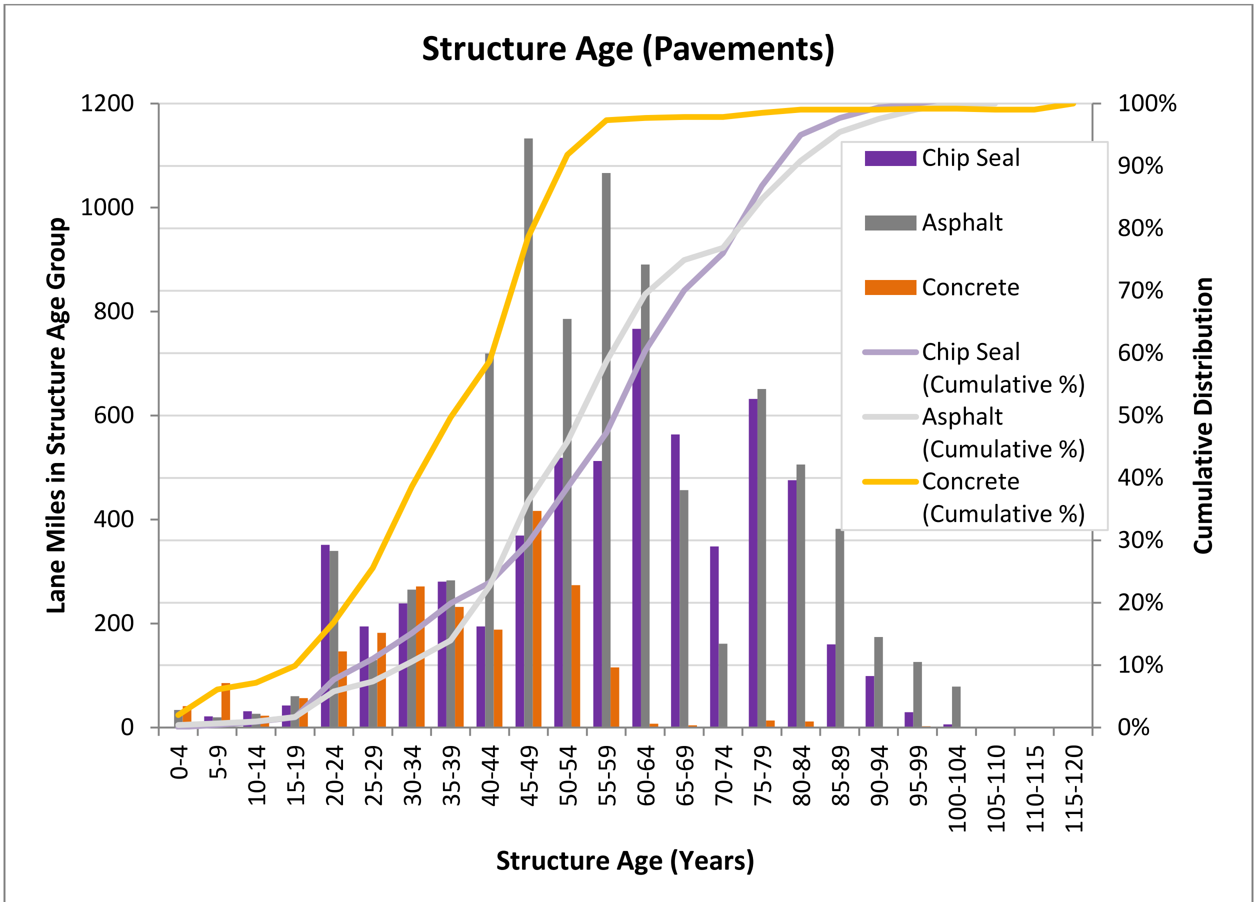
Year	BST	ACP-West	ACP-East
2011	6.5	16.7	10.9
2012	6.6	16.8	10.7
2013	6.7	16.9	11
2014	6.9	16.9	11.6
2015	6.9	16.9	11.7

By using the overall number of lane miles of each of these types and average resurfacing costs, the annual savings from these life extensions can be estimated. For example, at 6,000 total chip seal lane miles, a 6.5 year average life and $40,000 per lane mile resurfacing cost, the average annual cost to maintain chip seals would be (6,000 x $40,000 / 6.5) = $36.9 million. At a 6.9 year average life, this lowers to (6,000 x $40,000 / 6.9) = $34.8 million, or an annual savings of $2.1 million. For West Asphalt, the total lane miles are 6,777 and average resurfacing costs of $250,000, making the change in life between 16.7 and 16.9 years correspond to an annual savings of $1.2 million. For East Asphalt, the total lane miles are 3,470 and average resurfacing costs are $200,000, making the change in life between 10.9 and 11.7 years correspond to an annual savings of $4.4 million. In total, the life extension of flexible pavements is saving $7.7 million annually.

Surface Life, Structure Life and Perpetual Pavements

At the beginning of this document, pavement life was defined as the number of years between resurfacings. Therefore, this is just a measure of life for a pavement surface. What about the rest, and majority, of the pavement structure? In general, WSDOT *designs* pavement structures using a 50 year design life. This means that the estimated life for new pavement structures is fifty (50) years before needing FULL replacement. While fifty years is a long time, the ramifications of having to reconstruct 1/50th of our pavement network each year would have a substantial fiscal impact.

When looking at the in-place pavement life, over 50% of asphalt and chip seal pavements are lasting longer than the 50 year design life and a substantial amount are 70 years old or older. Moreover, with properly timed resurfacings, WSDOT is not planning for a significant amount of these pavements to need reconstruction in the foreseeable future.



When a pavement structure lasts indefinitely with properly timed resurfacing, it is referred to as *perpetual pavement.* Perpetual pavement is extremely cost efficient, as may be expected intuitively. WSDOT primarily attributes the perpetual behavior of flexible pavements to a fundamental change in how its pavements deteriorated. The standard model for cracking involves cracking starting at the bottom of the pavement structure and propagating upwards toward the surface, or "bottom-up" cracking. However, the majority of WSDOT pavements have deteriorated in a way previously unexpected; cracking starts at the top and propagates downward, also called "top-down" cracking. The major ramification of this is that the majority of the pavement structure is relatively unchanged when cracking becomes an issue at the surface, making properly timed resurfacings a critical piece of its perpetual behavior. It should also be noted that the converse is true if the failure mechanism is bottom-up cracking; cracking at the surface would indicate cracking throughout the entire pavement structure.

WSDOT has noted that the thickness of the pavement structure relative to overall traffic loading is the primary factor in crack propagation. If a pavement structure is relatively thick, (assume a six inch thickness near the minimal amount), then cracking tends to initiate at the surface. If the pavement structure does not meet this thickness, then the cracking tends to be bottom-up. Additional factors may include overall aggregate strength and construction quality. The precise mechanism and contributing factors related to top-down cracking have not been as well researched for several reasons including top-down cracking only becoming well known within the last twenty years and the lack of other pavement networks (i.e. non-WSDOT) with sufficient structure to behave similarly.

In summary, the perpetual nature of WSDOT pavements contributes a substantial annual savings and is an investment well worth protecting for both economic and material conservation purposes. It also allows WSDOT to focus primarily on surface life when tracking overall pavement life. Finally, it stresses the importance of not waiting too long to properly maintain a roadway.