WESTERN BRIDGE ENGINEERS SEMINAR

SERVICE LIFE OF BRIDGE DECK REPAIRS IN ALBERTA

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Overview

- Introduction to Deck Deterioration
- Alberta Deck Rehabilitation History
- Service Life
- Data Used in Study
- Results of Data Analysis
- Conclusion and Comments

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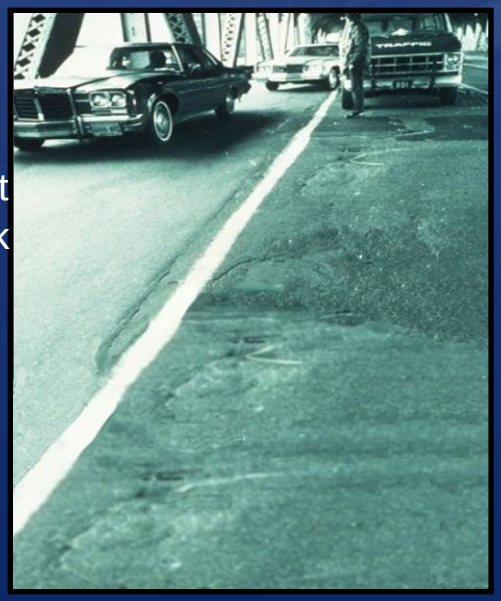
Bridge Deck Deterioration in Alberta

- Deck deterioration rates depend on:
  - Geographic location,
  - Traffic volumes,
  - Drainage (deck grade and crown),
  - Roadway de-icing policies and practice
  - Quality of designed deck protection systems

1960 Asphalt Covered Deck



Wearing Surface Provided Little Protection

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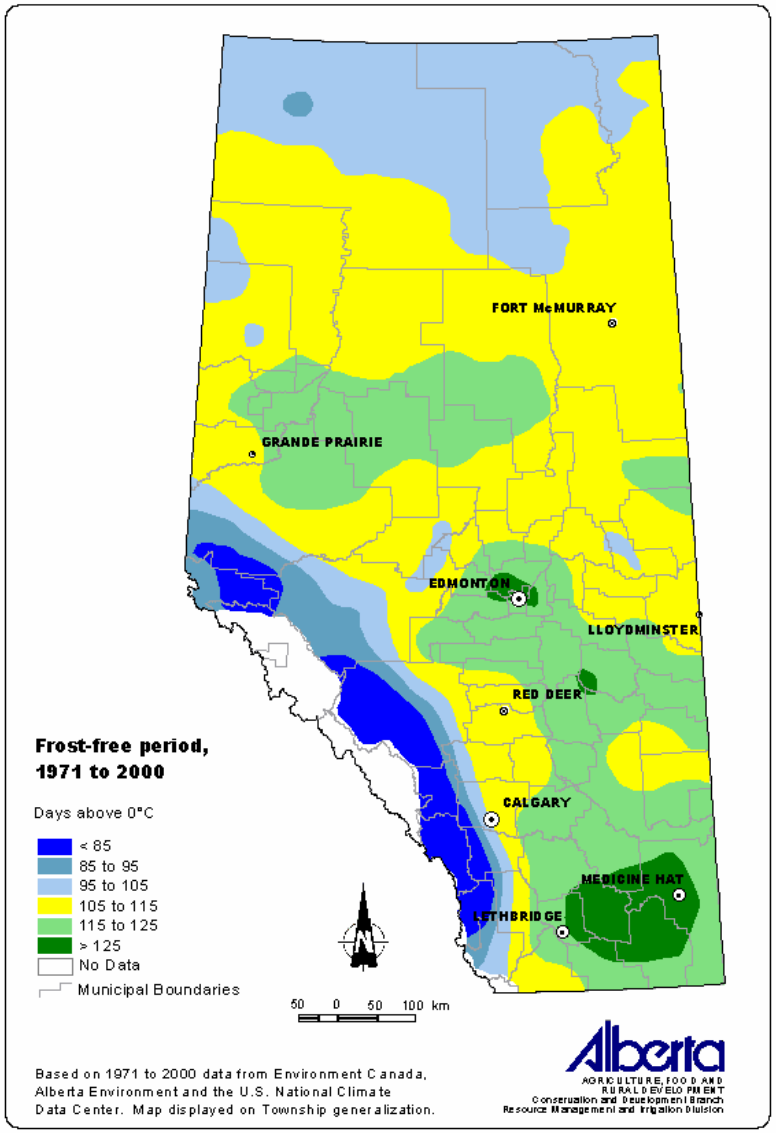
Bridge Deck Deterioration in Alberta

- Alberta Geographic conditions vary substantially
  - Snow/de-icing for up to 6 months
  - Mountain areas have ~ 140 annual free-thaw cycles
  - Heavy industrial truck routes
  - Urban areas have highest traffic volumes and greatest need for aggressive de-icing chemicals
  - Annual days w/o frost
    - less than 85 in Rockies
    - 85 – 95 in foothills
    - 95 – 105 far north



History of Concrete Bridge Deck Overlays on Alberta Highways

First Alberta Steel Fibre Overlays were placed in 1984

Overlay Type	Years Placed	Approx Total
Deep Conventionally Reinforced (COL)	1973 - present	80
Iowa 'High Density' (HDOL)	1977 - 1985	150
Class D w/Steel Fibre	1984 - 1986	10
HPC-Silica Fume, Steel Fibre (FRSF)	1987 - present	150
HPC-Pyrament, Steel Fibre (FRPOL)	1989 - 1991	20
HPC-Silica Fume (SFOL)	1994 - present	30
HPC-Silica Fume, Fly Ash	2000 - present	10
	Total	450

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Bridge Deck Overlay Stage 1:
Remove Existing Wearing Surface

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Bridge Deck Overlay Stage 2:

Prepare Surface (for Typical 2-3 Inch Overlay)

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Bridge Deck Overlay Stage 3:

Set Screed Rails - Conventionally Reinf Deep Overlay

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Overlay Stage 4:
Place Bond Slurry

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Overlay Stage 5:
Place Concrete Mix

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Overlay Stage 6:
7 Day Wet Curing for HPC Overlays

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Overlay Issues:
Prevent Cracks - overlays often placed at night

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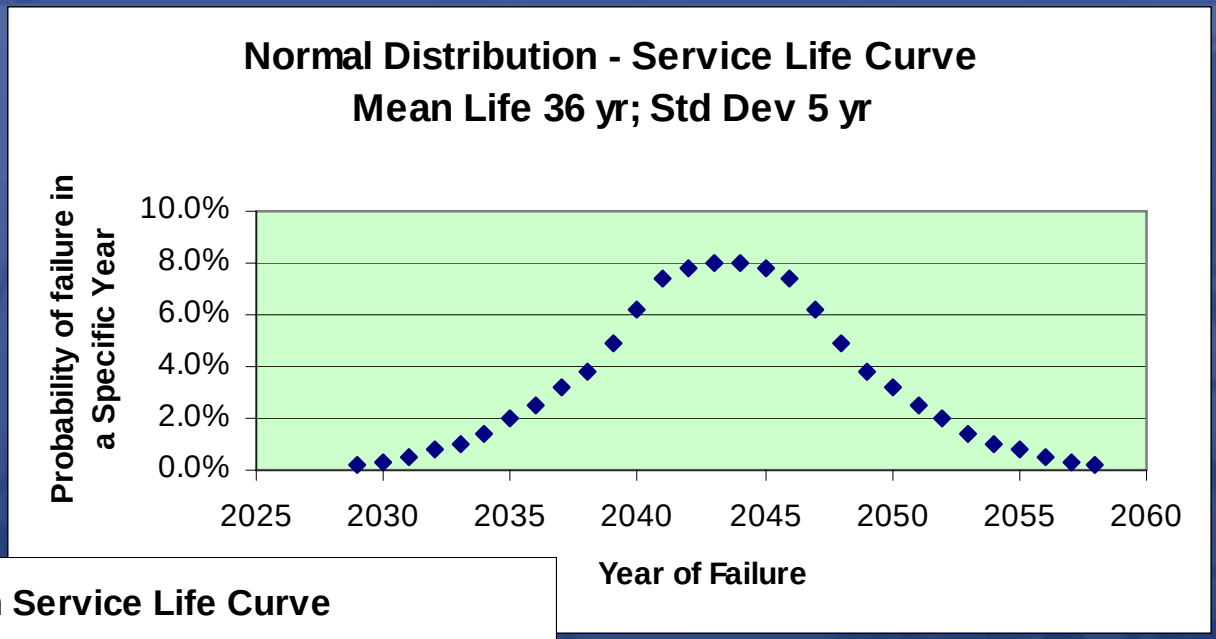
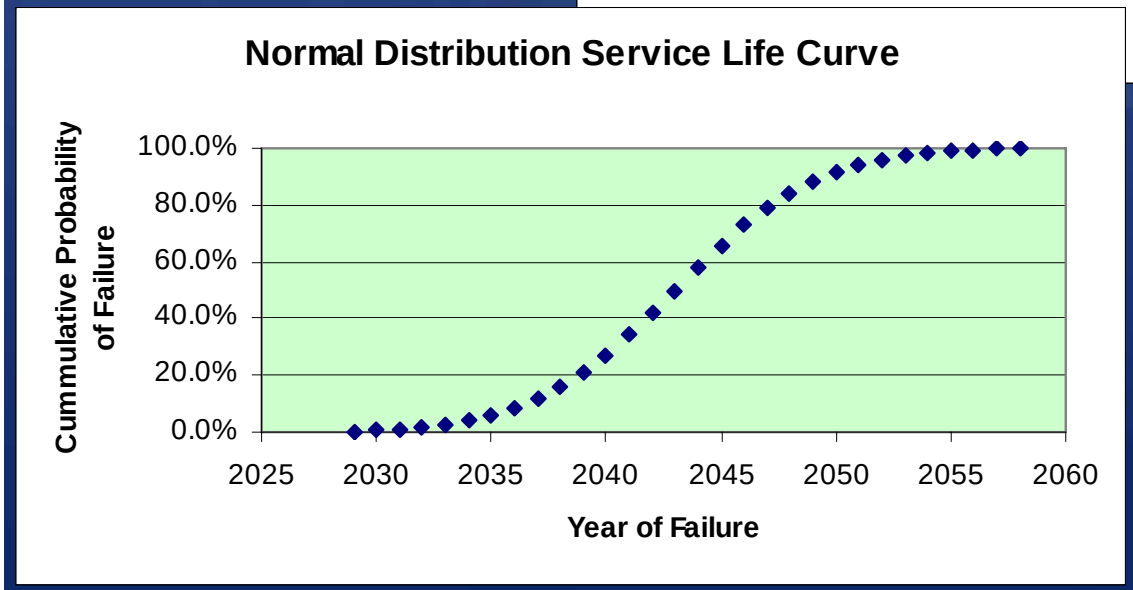
Service Life of Deck Repairs

- Definition: Service life of deck repairs = (The year of overlay, deck, or bridge replacement) – (The year of installation).
- Life is usually governed by safety issues.
- Failure mechanism – typically, pot'holes' result from impact disintegration, following crack propagation from corrosion (delamination) and overlay debonding.
- Many bridges carry traffic at speeds of 65 to 80 mph, and potholes threaten public safety.

Can We Measure Service Life from Non-Failed Repairs by using probability?





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DATA OVERVIEW

Description	Sub-category	Number of Sites	Ave Age @ Repair
All bridges	All with data	785	36.7
Replaced Deck or Bridge	No protection	84	35.0
1st Time Deck Repair	All with data	448	23.6
	Concrete Overlay	303	
	Surface Membrane	56	
	Membrane and Asphalt	89	
2nd Time Deck Repair	All with data	100	30.4
	Surface Membrane	83	
	HPC Concrete Overlay	17	
New Decks since 1978	Constructed w/Protection System	148	
	Membrane/Asphalt	42	
	High Density Overlay	106	

DATA - First Time Deck Repairs

- Existing Deck Repair Sites (448 of 785 – 57%)
- Concrete Overlays (303 of 448; 68%)
  - high performance steel fiber reinforcing (153), high density (93), high performance no fibre(29), Pyrament w steel fiber (7), steel reinforced (12), Class C (5), latex modified (2), impressed cathodic protection (2)
- Surface Membranes (56 of 448; 13%)
  - thin broom and seed epoxy overlays (53), polymer modified asphalt (PMA - 8), latex modified asphalt (4), screeded methyl-methacrylate overlays (3)
- Membranes and asphalt (90 of 448; 20%)
  - multi-layer polymer (76), hot applied rubberized (2) single layer polymer (1)

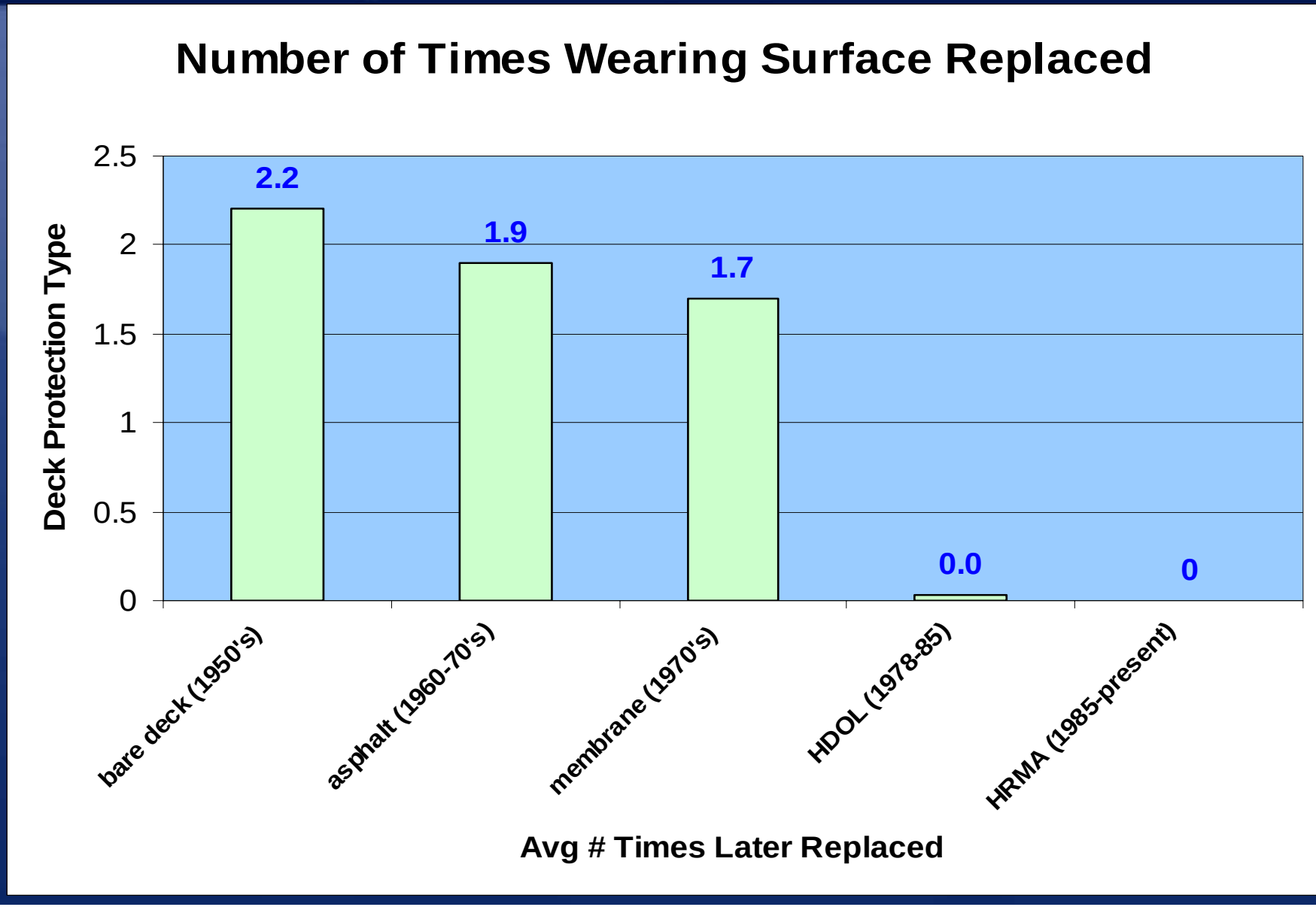
Conclusion: Cannot determine service life of most types, when so few repairs have failed

Type Repair	Number of Repairs	% Failed	Ave Age of Failure	Avg Age of Repairs Remaining in Service
FRSF	171	4%	11.7	12.4
EPOL	129	11%	15.4	15.9
HDOL	93	9%	21.5	25.3
MPM	74	19%	146	18.0
SFOL	29	0%	n/a	11.5
RCOL	13	0%	n/a	11.8
PMA	10	0%	n/a	11.1
FRPOL	8	0%	n/a	16.6
MMOL	6	0%	n/a	11.7
COL	5	40%	20.0	20.0
LMA	4	50%	19.0	21.0
LMOL	3	0%	n/a	21.0
Cathodic Protection	2	0%	n/a	17.0
HRMA	2	0%	n/a	3.5
1PM	1	0%	n/a	20.0

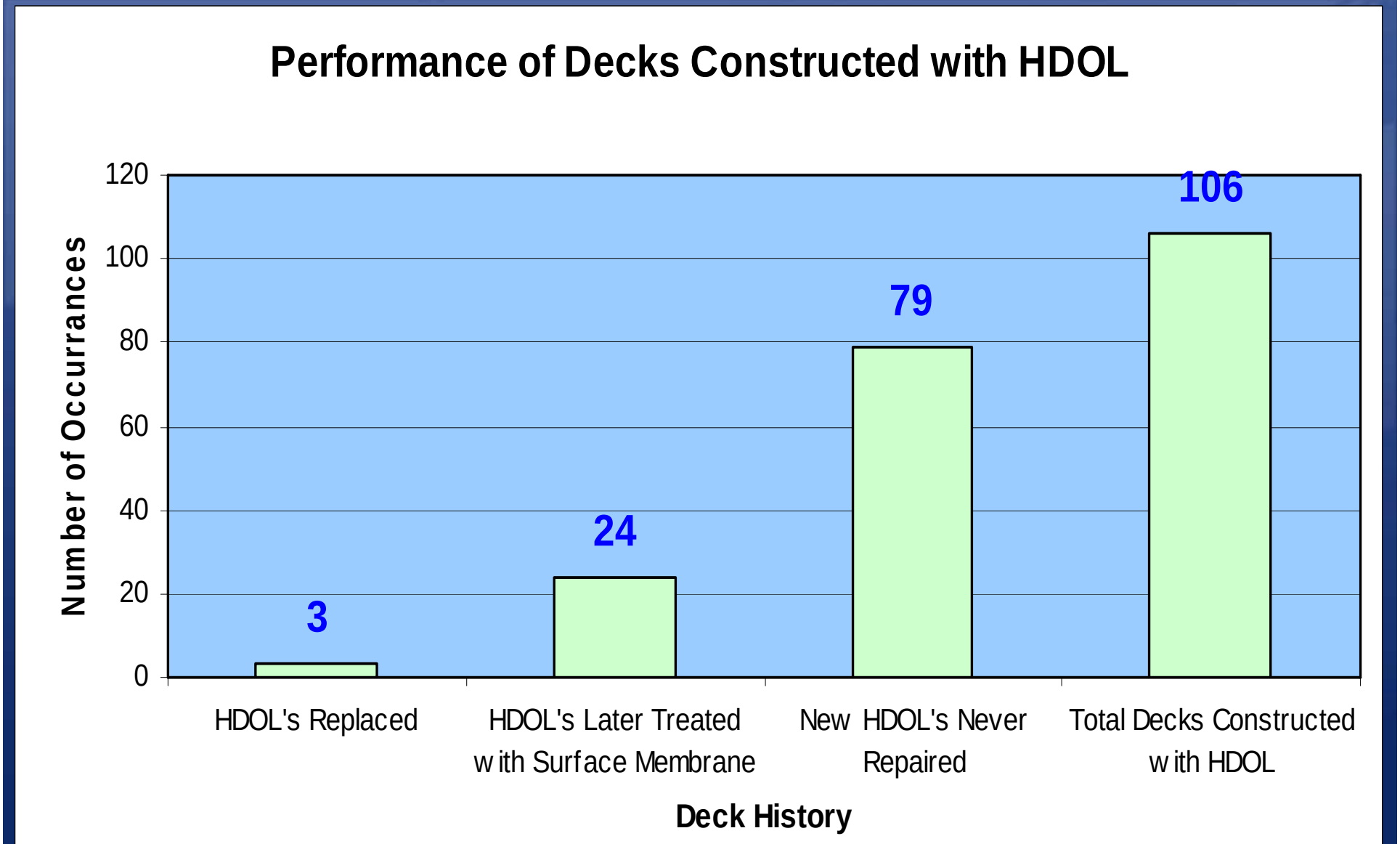
Repair Performance Summary
(1st, 2nd, or 3rd time repairs)

Type Repair	Total	% Failed	Ave Age of Failure (years)	Avg Age of Repairs Remaining in Service (years)
Concrete Overlay	322	5%	6.9	16.1
Surface Membrane	135	10%	15.4	15.7
Membrane/ asphalt	91	18%	11.5	16.8

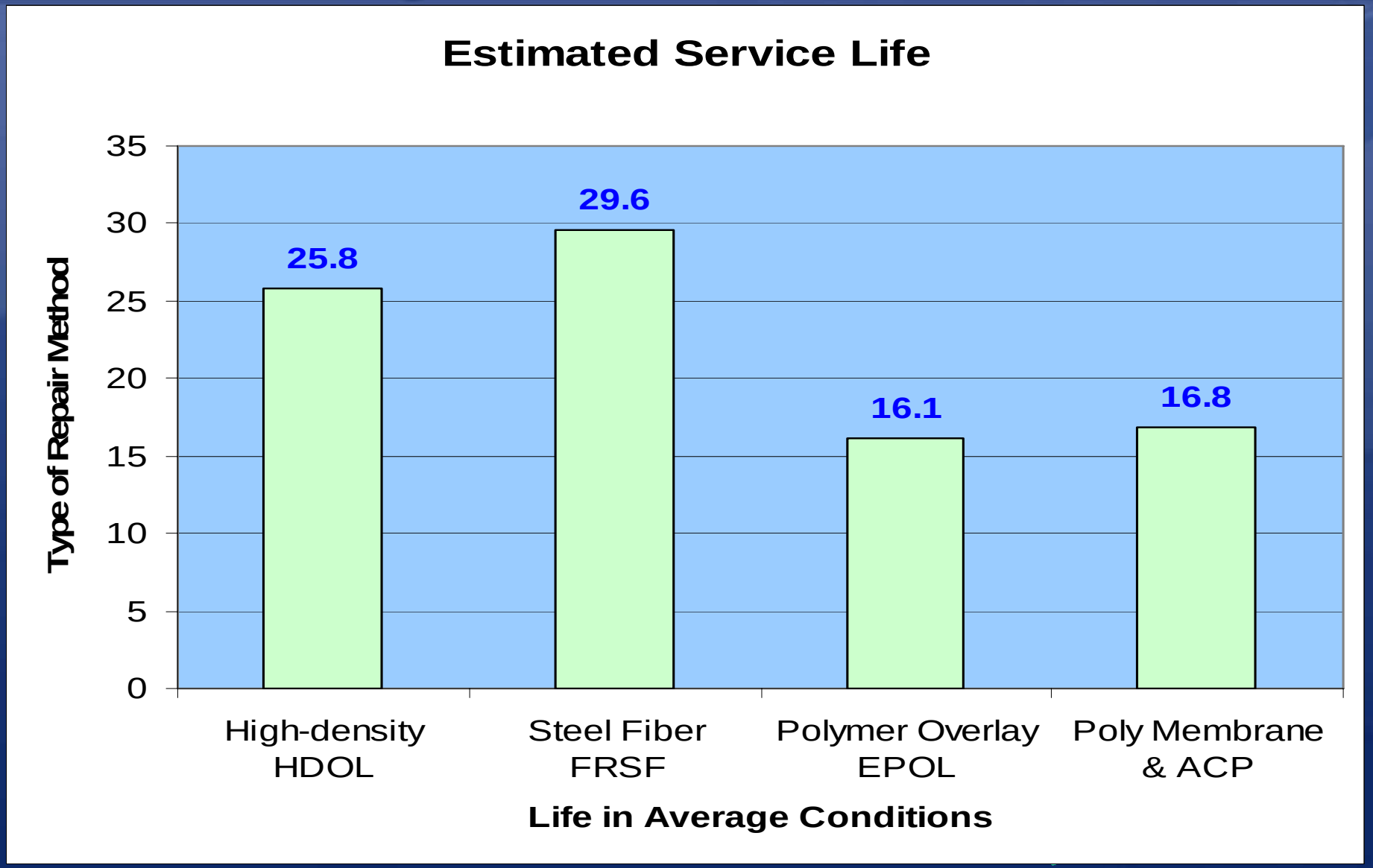
Service Life of Wearing Surfaces



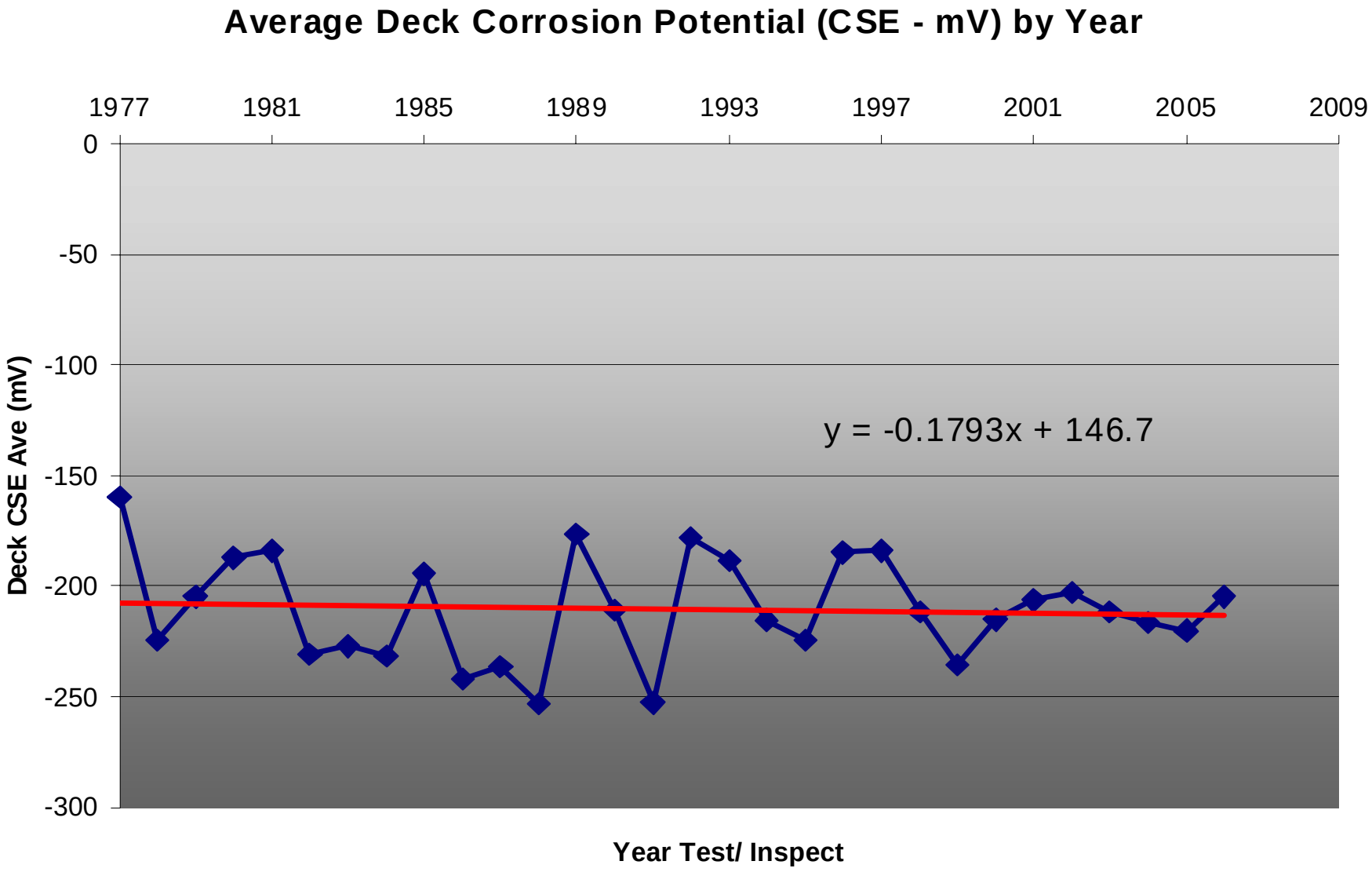
Data Analysis - Results:
Avg 2007 Age of New HDOL's = 26.1 years



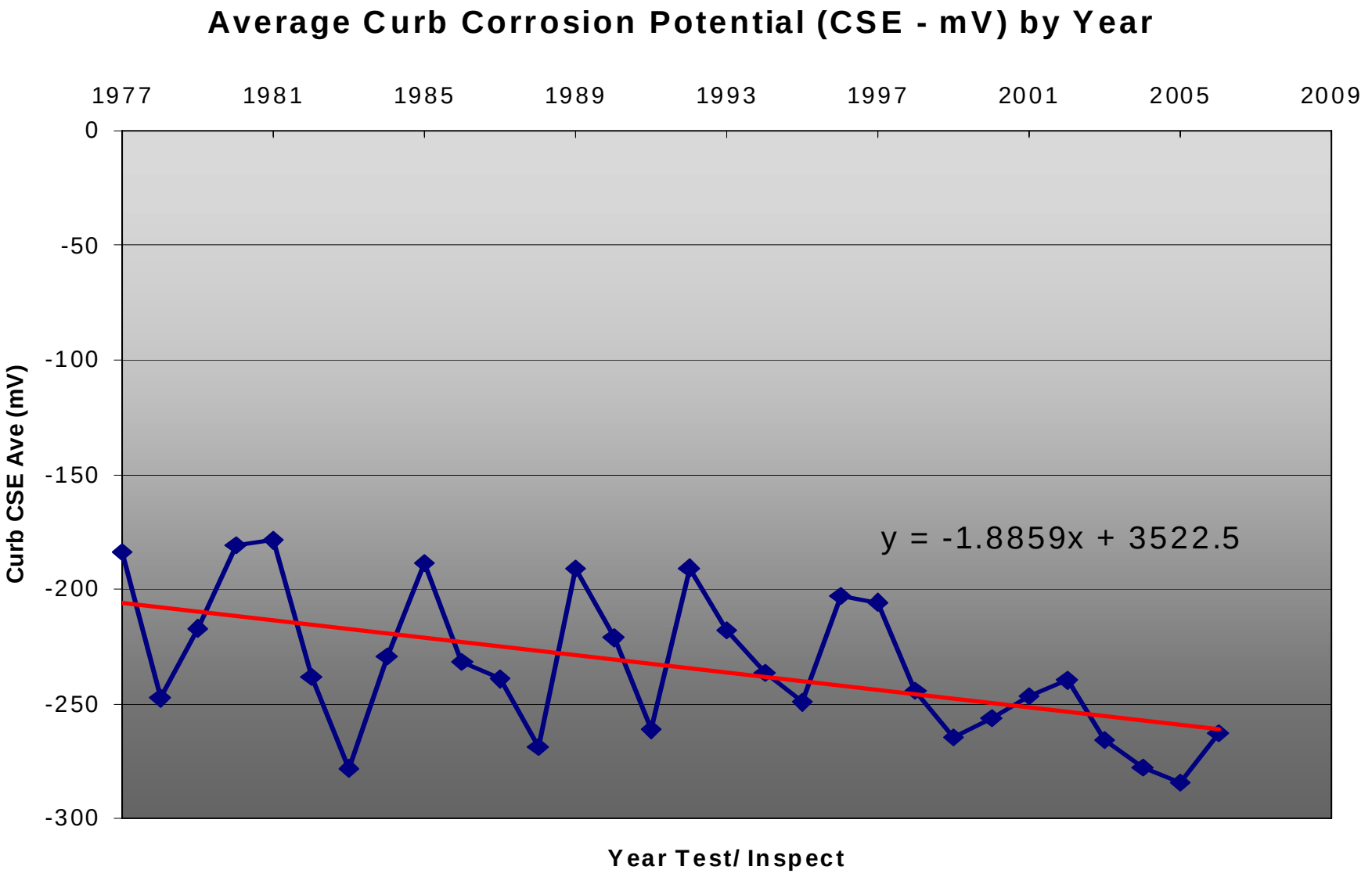
Expert Opinion Survey on Rehab Life
(10 Provincial Experts – Life in Typical Conditions)



Long-Term Monitoring of Alberta Bridge Deck Corrosion Potentials (ave 100 decks/year since 1977)



Long-Term Monitoring of Alberta Bridge Curb Top Corrosion Potentials (since 1977)



Conclusions and Comments:
Concrete Overlays

- When HDOLs were started in 1977, it was hoped they would achieve a 20 year extension of the overlay/deck service life.
- HDOL repairs were done to 1950-60's bridges. Only 9 of 93 (10%) HDOL repairs have failed. Data suggests HDOL repairs will typically yield 30+ years service life.
- Overlays perform better when done at the right time, i.e. when the deck is newer/ better condition.
- Today's HPC overlays have less cracks and lower permeability to chloride ions than HDOLs.
- Although the exposure conditions have increased, we expect typical 35+ year service life extensions for HPC overlays placed at the right time.

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Conclusions and Comments:
Membrane and Asphalt Repairs

- In the evolution of repair methods, the polymer membrane was an early prototype.
- Membranes provide better crack protection than concrete overlays, but when used for repair, they often trap chlorides and cover up on-going corrosion
- Membranes work best when applied to new decks or decks with very low chloride contents
- Polymer modified asphalt (PMA) has proved to be an efficient repair method when done to appropriate decks
- Hot rubberized membranes have been effective in protecting new decks, but have not been used much for repairs.

Conclusions: Future Repairs
Repair of Bridges Constructed since 1978

- 1978 – 1985 bridges constructed with high density overlays (HDOLs) will likely be replaced with HPC overlays.
- Maintenance of newer decks constructed with membranes will be faster and less expensive than older bridges.
- 1985 – present decks constructed with hot rubberized membranes and asphalt (HRMA) will likely be maintained by replacing asphalt and membranes.
- Some bridges constructed in the City of Calgary with polymer modified asphalt (PMA) will likely be maintained by replacing the PMA.

Acknowledgements

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THANK YOU

For Your Attention

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