9th International Conference on MANAGING PAVEMENT ASSETS (ICMPA9)

Validation of Default Sample Condition Standard Deviation in ASTM D5340

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WORLD ROAD ASSOCIATION MONDIALE DE LA ROUTE 1909-2009

VDOT Virginia Department of Transportation

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Overview

- **Introduction**
- **Comparison to defaults**
- **Comparison among different pavement categories**

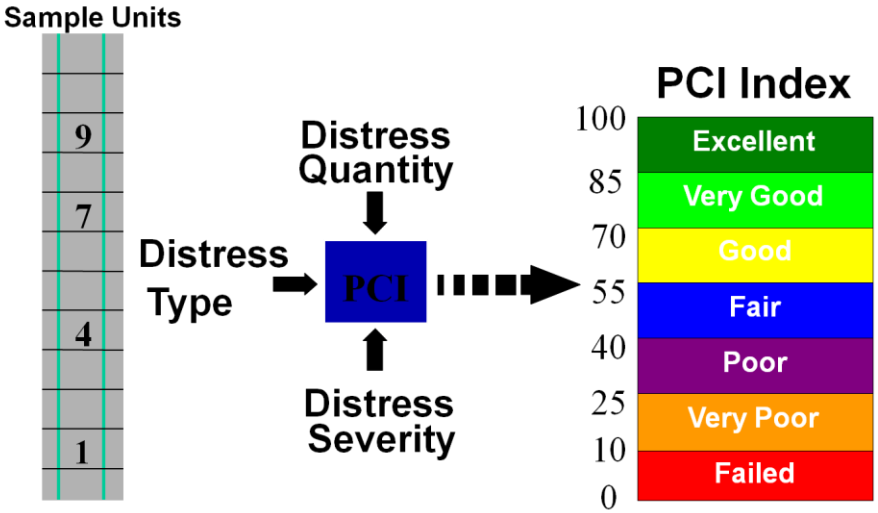
Acknowledgements

- **Data provided courtesy of the United States Air Force**
- **POC: Mr. George Vansteenburg, AFCEC/COSC**

INTRODUCTION

Pavement Condition Index

- **PCI**
  - Commonly used measure of pavement condition
  - ASTM D5340 for airfields

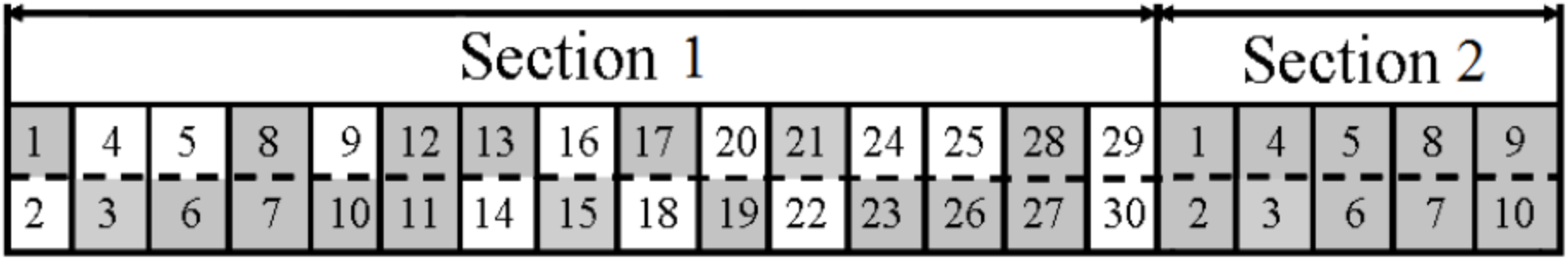


Sample Units

- **Developed to reduce inspection effort**
  - 5,000±2,000ft² (AC)
  - 10±8 slabs (PCC)
- **Survey enough for confidence interval of 95%±5 points.**

$$n = \frac{N(s^2)}{\left(\frac{e^2}{4}\right)(N-1) + s^2}$$

Sampling


Section 1
Section 2
1 4 5 8 9 12 13 16 17 20 21 24 25 28 29
2 3 6 7 10 11 14 15 18 19 22 23 26 27 30
1 4 5 8 9
2 3 6 7 10

Sampling

- **Need s to determine appropriate number of samples**
- **Defaults given:**
  - AC: 10
  - PCC: 15

Data Set

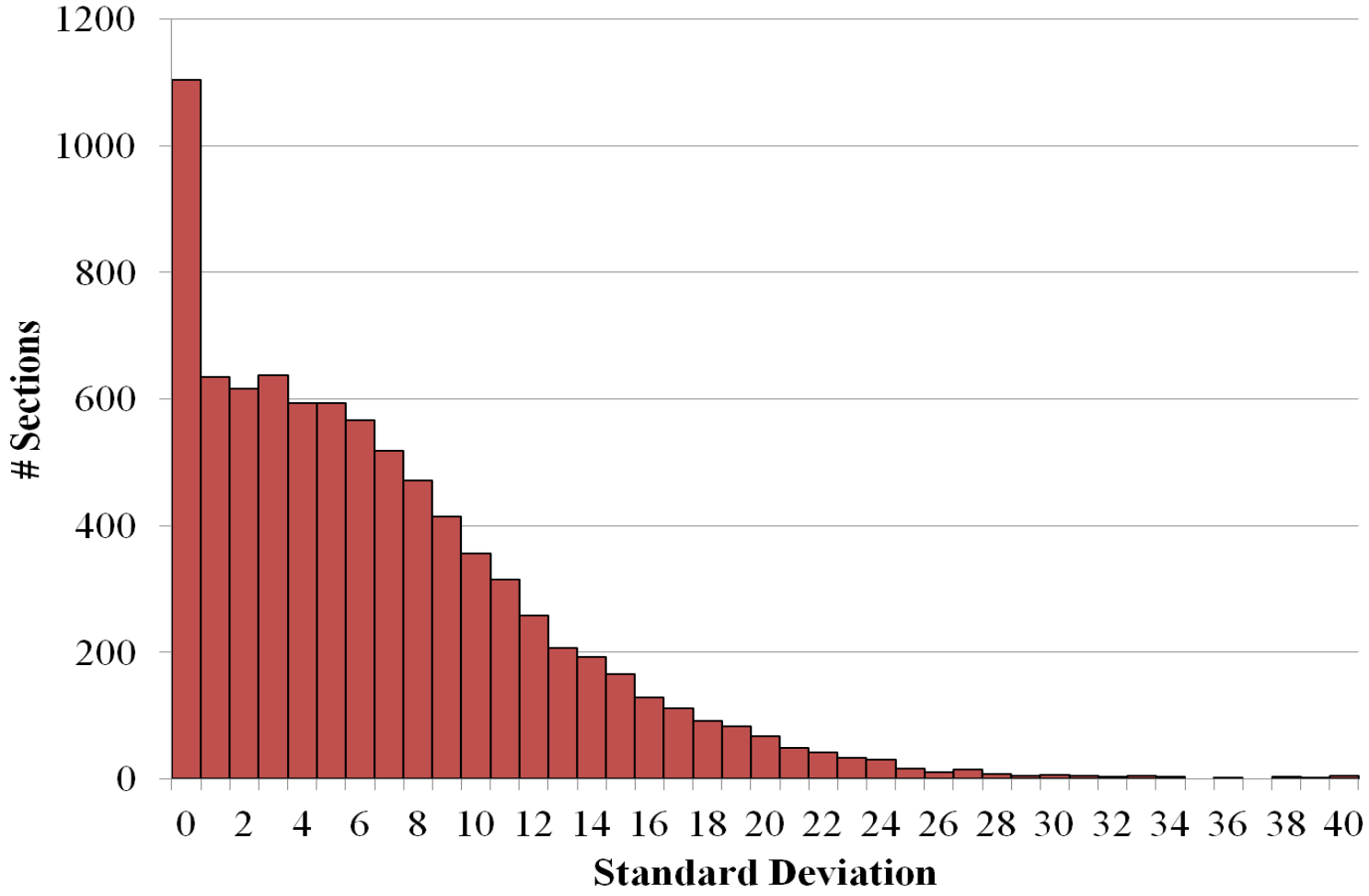
- **United States Air Force**
- **Approximately 10000 data points**
- **8364 useable**
- **Worldwide**
- **Oldest inspection 1984 with most data after 1996**
- **80% PCC**
- **20% AC**

Why Is This Important?

- **If s is higher than default, we are under-sampling and our results are not as accurate as expected**
- **If s is lower than default, we are over-sampling, wasting time and money**

COMPARISON TO DEFAULTS

Standard Deviation for all Data Points



Descriptive Statistics

Category	Count	Mean	Median	Maximum	95th %-ile	% Rank 10	% Rank 15
All data	8364	7.17	6.01	45.15	18.74	0.73	0.89
Non-PCC Surface	1712	6.10	4.37	41.10	18.12	0.77	0.90
PCC Surface	6652	7.45	6.30	45.15	18.85	0.73	0.89
Aprons	3380	8.22	7.13	43.76	20.40	0.67	0.85
Runways	1871	5.59	4.43	31.94	15.24	0.83	0.95
Taxiways	2856	7.18	6.13	45.15	18.19	0.74	0.90
Primary	5411	6.94	5.91	38.64	17.82	0.75	0.91
Secondary	2579	7.52	6.06	45.15	20.31	0.71	0.88
Tertiary	374	8.23	6.94	42.51	20.73	0.67	0.83
Population *s*	3891	6.96	5.53	45.15	18.85	0.74	0.89
Sample *s*	4473	7.36	6.34	41.10	18.55	0.73	0.90
Slab Size $\leq$ 15 ft	1306	6.78	5.58	39.95	17.81	0.76	0.91
15 ft< Slab Size $\leq$ 20 ft	2380	6.21	4.99	45.15	16.37	0.80	0.93
15 ft< Slab Size $\leq$ 20 ft	2859	8.87	7.93	43.76	20.43	0.64	0.85
Slab Size > 25 ft	120	5.62	4.20	25.44	17.42	0.86	0.91

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Primary							
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Tertiary							
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15 ft< Sl							
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Runways						0.83	0.95
Taxiways						0.74	0.90
Primary						0.75	0.91
Secondary						0.71	0.88
Ter						0.67	0.83
Pop						0.74	0.89
San						0.73	0.90
Slab						0.76	0.91
15 f						0.80	0.93
15 f						0.64	0.85
Slab Size > 25 ft	120	5.62	4.20	25.44	17.42	0.86	0.91

	95th %-ile	% Rank 10	% Rank 15
All	18.74	0.73	0.89
AC	18.12	0.77	0.90
PCC	18.85	0.73	0.89

Conclusion 1

- **AC pavements are under-sampled approximately 23% of the time**
- **PCC pavements are under-sampled approximately 11% of the time**

Actual Confidence Interval

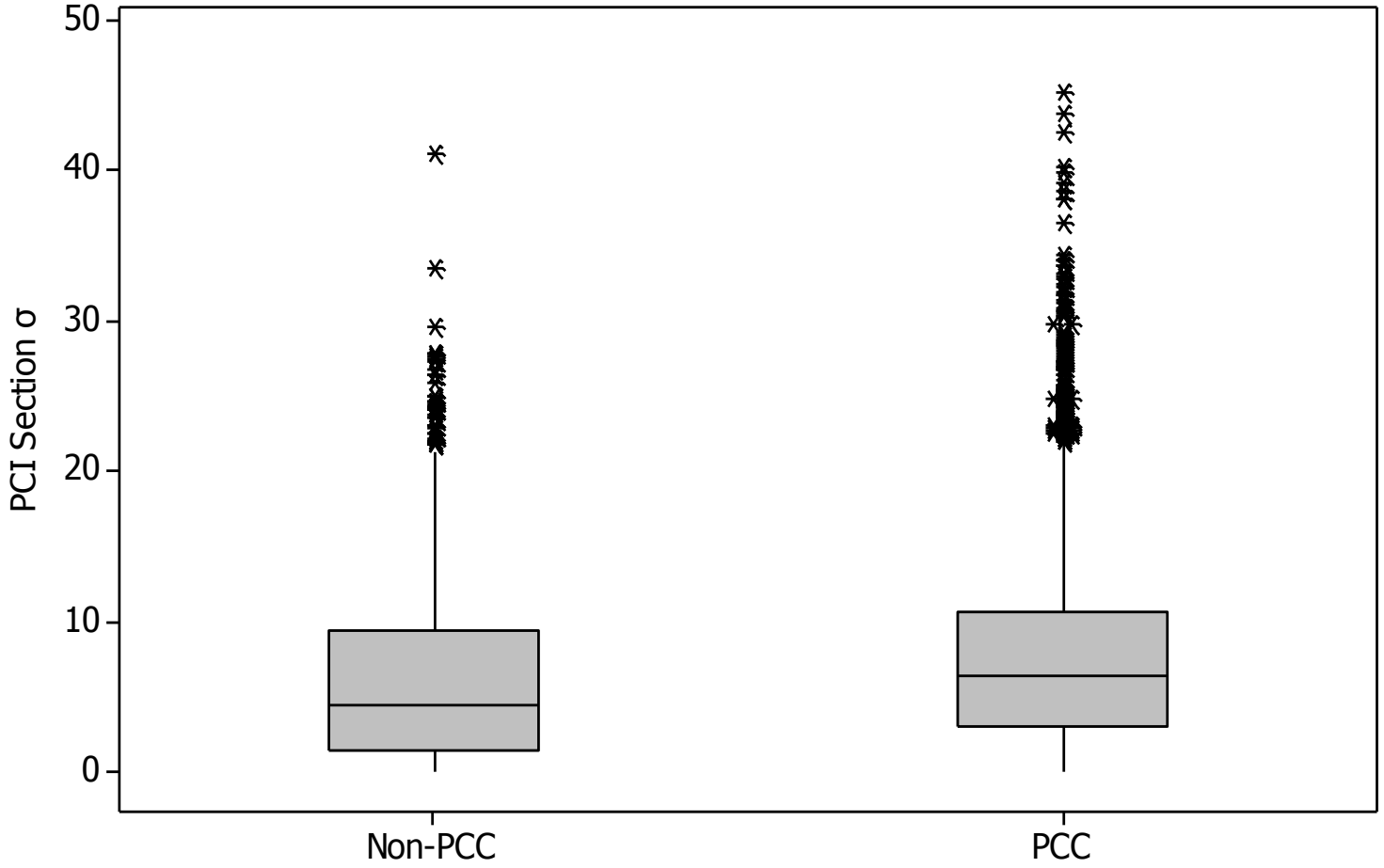
- **Based on quantile function of standard normal distribution**

$$n = \frac{(z_{(1-\alpha)})^2 s^2}{e^2}$$

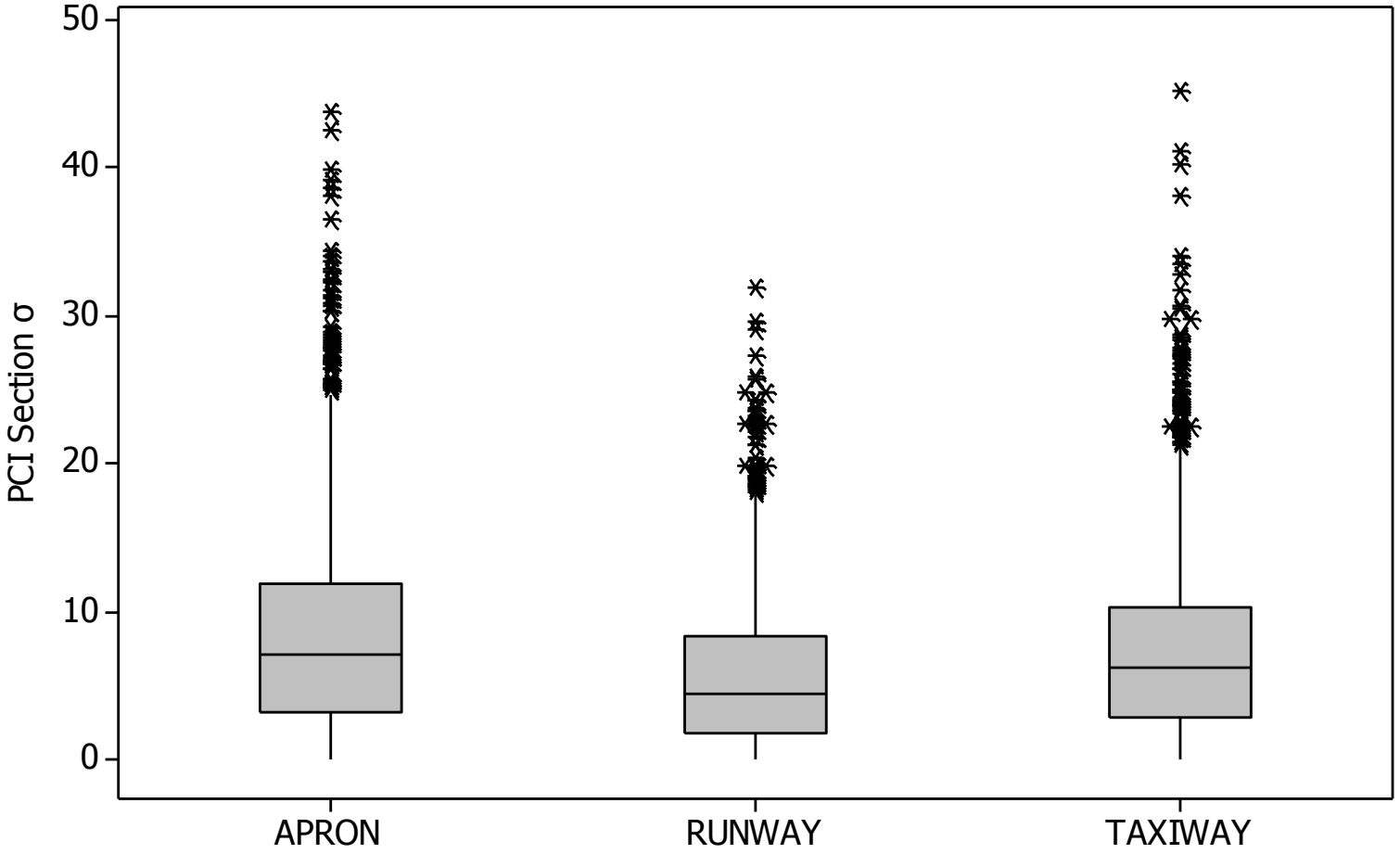
Surface	*e* for 95% CI	CI for *e*=5
AC	95%±9.0	86.7%±5
PCC	95%±6.3	94.3%±5

COMPARISON AMONG PAVEMENT CATEGORIES

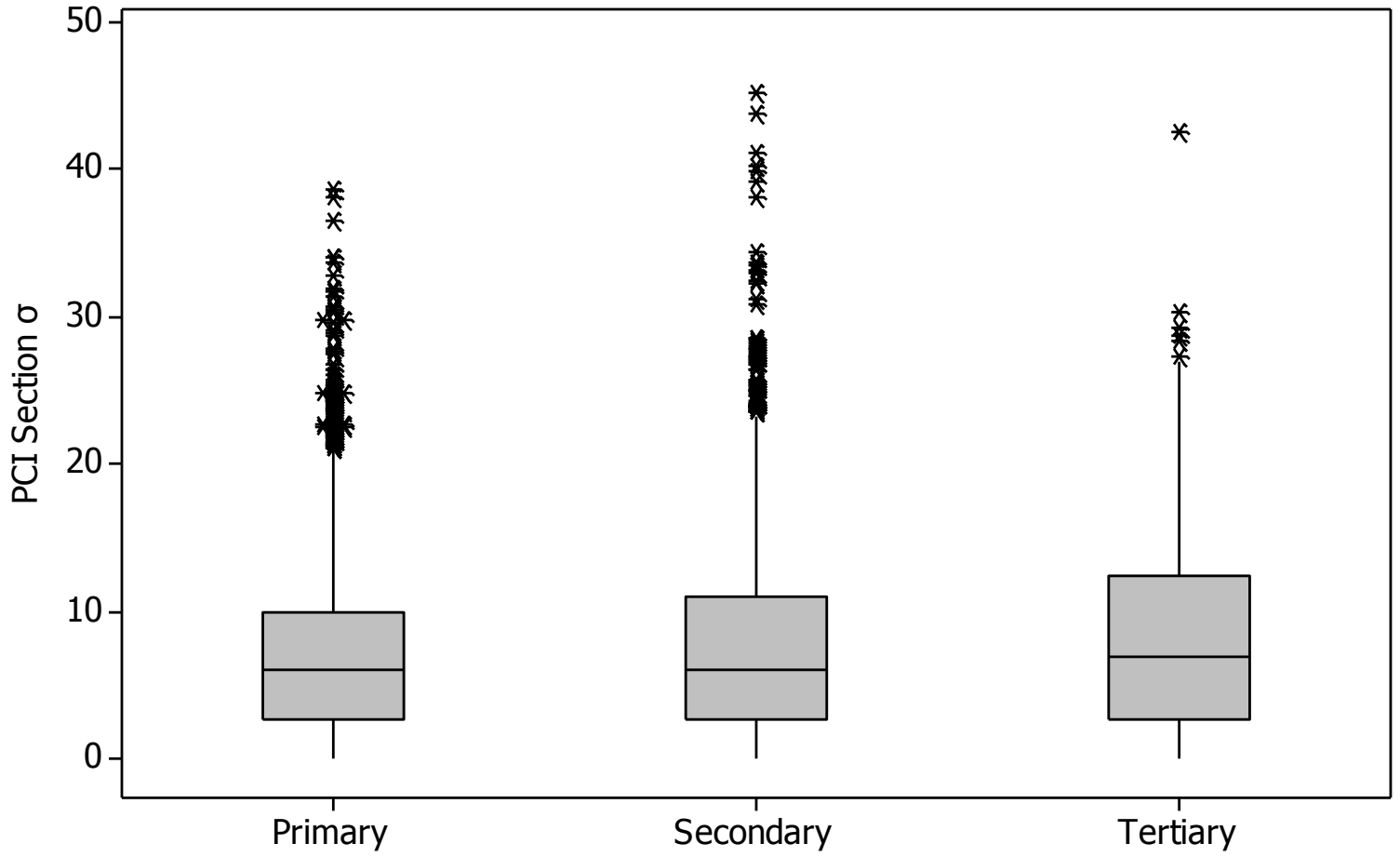
Pavement Type



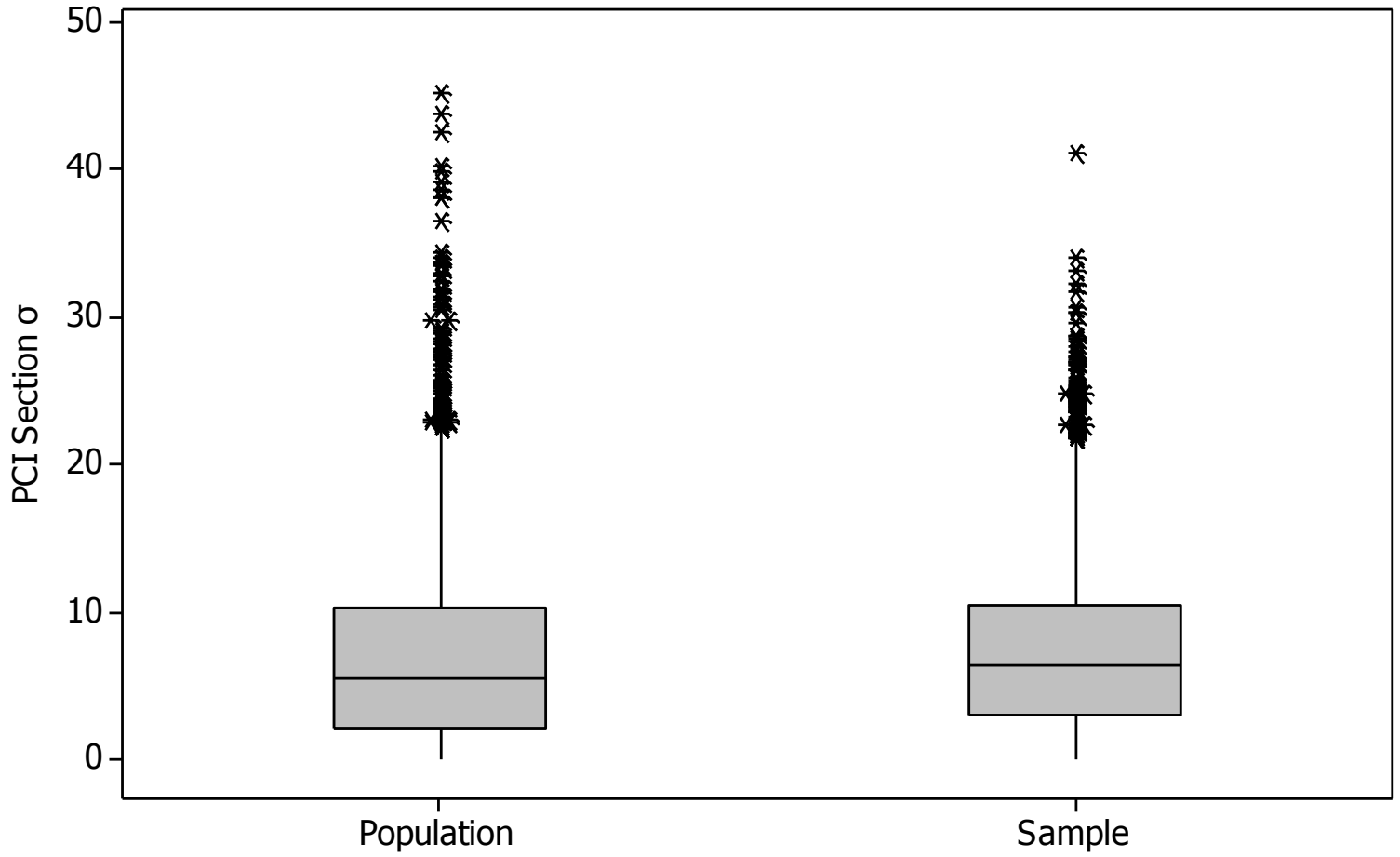
Pavement Use



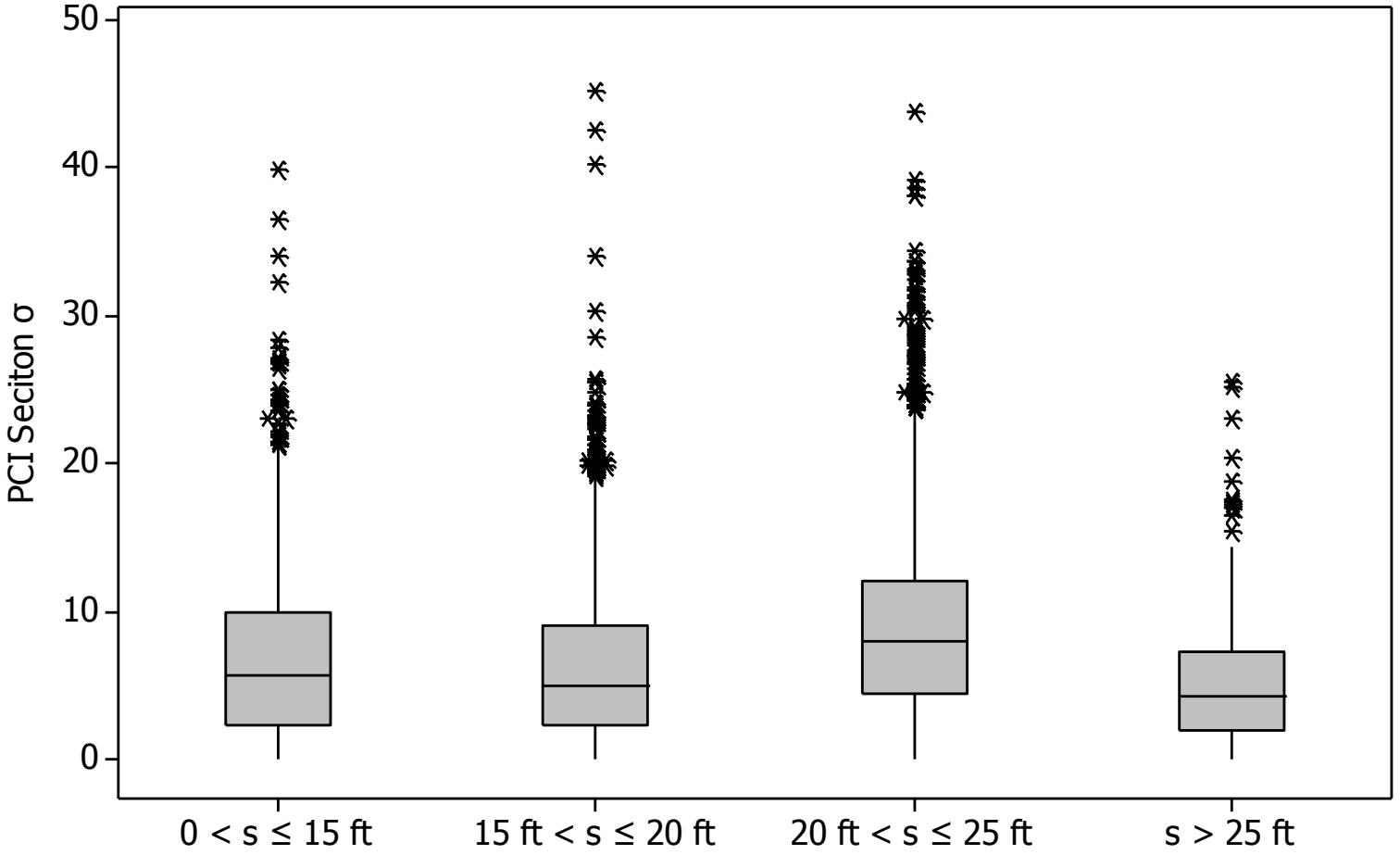
Pavement Rank



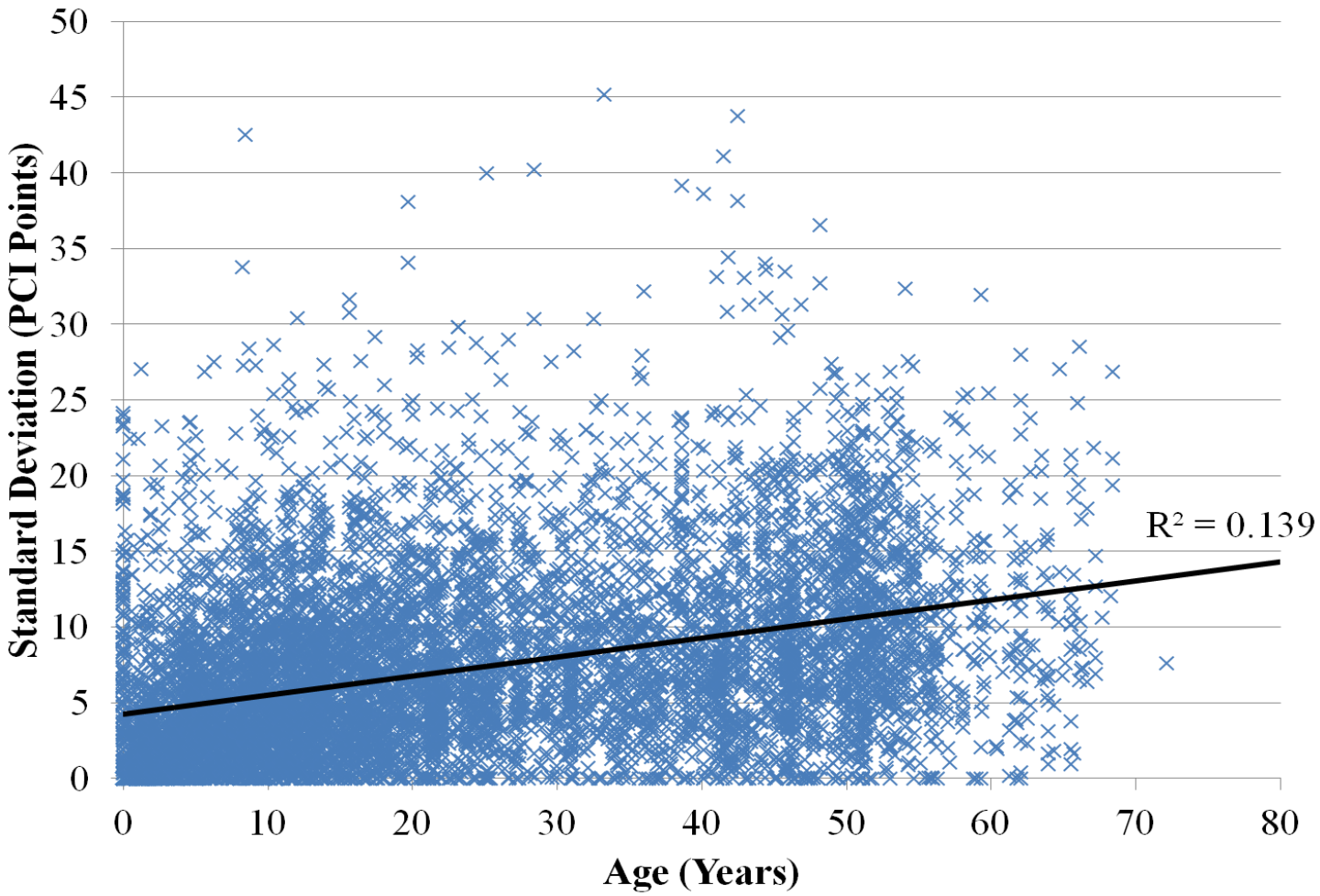
Surveying 100%



Slab Size


PCI Seciton σ
50
40
30
20
10
0
0 < s ≤ 15 ft
15 ft < s ≤ 20 ft
20 ft < s ≤ 25 ft
s > 25 ft

Pavement Age



Conclusion 2

- **Runways appear to have lower s**
- **Slight positive correlation between s and pavement age**
- **Appears to be no significant return on surveying more than recommended number of samples**
- **Large slabs (>20 ft) appear to have greater variability in condition**

Summary of Conclusions

- **Measured standard deviations are higher than the default values provided in ASTM D5340**
- **Standard deviation appears to be affected by:**
  - Surface type
  - Use (runway or non-runway)
  - Slab size (for PCC)
  - Pavement age (to a lesser extent)