



INNOVATION EXPO 2020

Large-Scale Evaluation of Pavement Performance Models Utilizing the Concept of Deterioration Rate and Automated Pavement Condition Survey Data

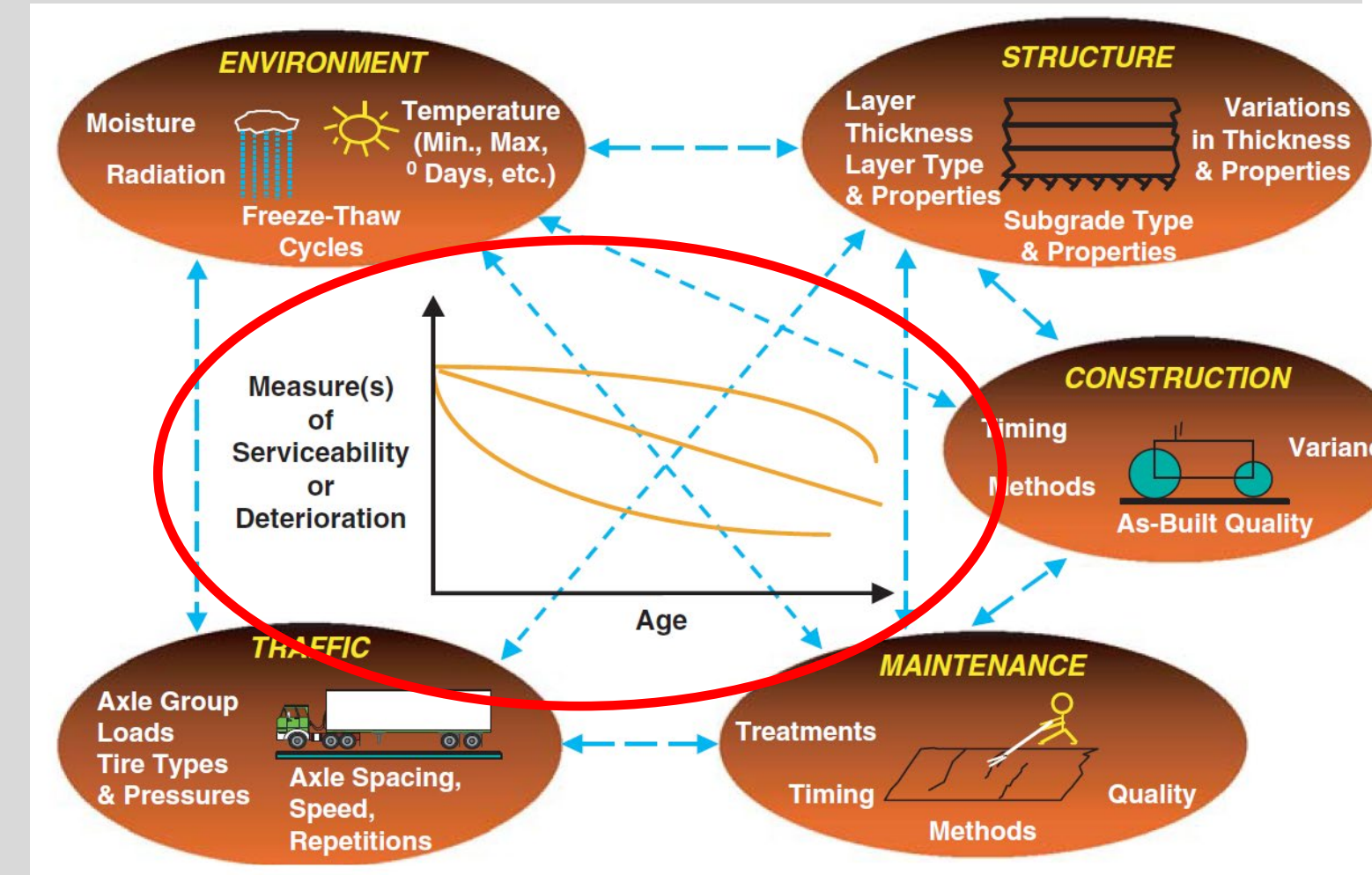


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BACKGROUND

Pavement Performance Models

- An essential component of Pavement Management System (PMS)
- Crucial for future pavement condition prediction
- Important for budget allocating for M&R projects
- Performance models in Pavem
 - 180 models for asphalt pavements (3 distresses × 10 treatments × 3 traffic levels × 2 climates)
 - 60 models for concrete pavements (2 distresses × 5 treatments × 3 traffic levels × 2 climates)



Deterioration Rate of Pavements

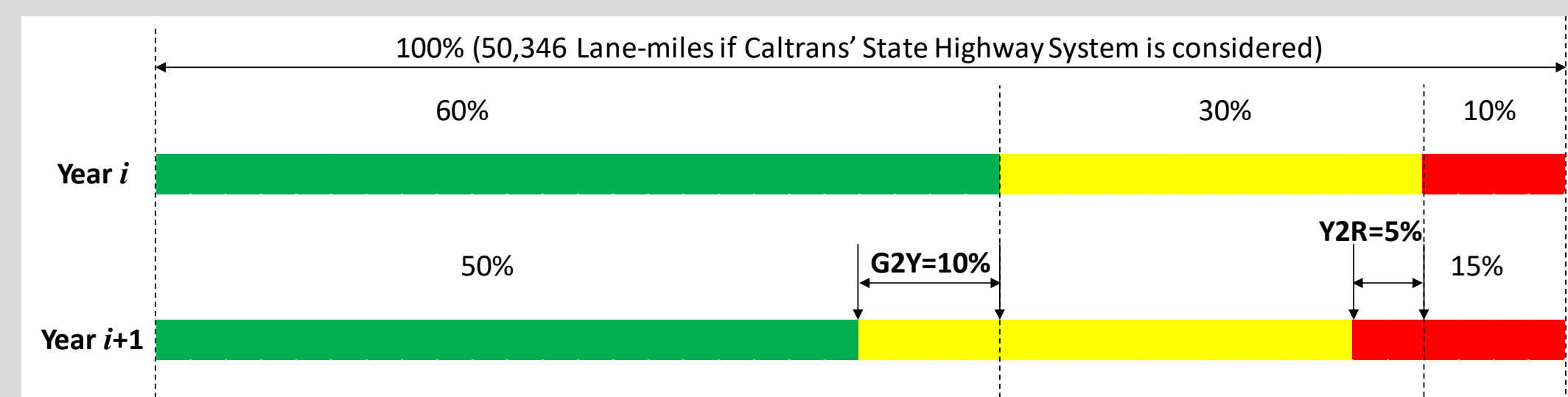
- The rate at which pavements deteriorate with time
- A simple performance indicator for state DOT executives and legislature
- Lack of consensus in its definition and calculations

OBJECTIVES

- Utilize the concept of deterioration rate and APCS data to evaluate pavement performance models in Pavem
- Define deterioration rate according to pavement performance measures
 - Propose a method for calculating deterioration rate
- Selectively evaluate specific pavement performance models

METHODOLOGY

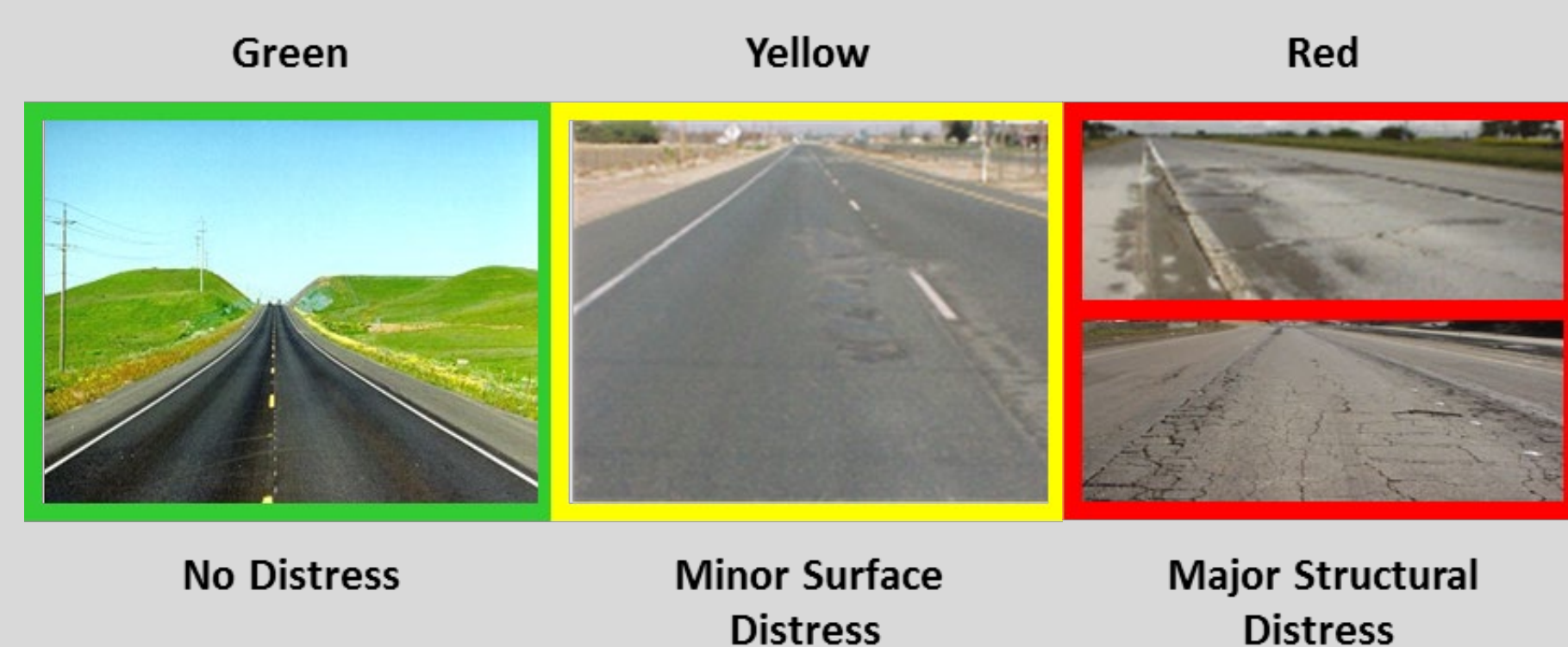
Concept of Deterioration Rate



- G2Y = green-to-yellow
- Y2R = yellow-to-red
- G2F = good-to-fair
- F2P = fair-to-poor

- G2Y and Y2R are defined according to the Caltrans traditional pavement performance measures.
- Similarly, G2F and F2P are defined according to the MAP-21 performance measures.

Traditional Caltrans' Color-Based Performance Measures



Calculation of Actual Deterioration Rate

- 2016 and 2018 APCS data were compared to identify pavement condition deterioration.
- Effects of M&R projects were eliminated to focus on natural deterioration only
- Average annual deterioration rates were obtained by dividing the total deterioration by the number of years between APCS data collections.

Prediction of Deterioration Rate and Pavement Distress Using Pavem

- Pavem was used to predict pavement condition and deterioration.
- 2016 APCS data were used as the pavement condition baseline for the prediction.
- No M&R budget given to focus on pavement condition deterioration
- Pavement distresses/conditions were predicted each year after 2016.
- Deterioration rates were calculated by comparing conditions year by year.

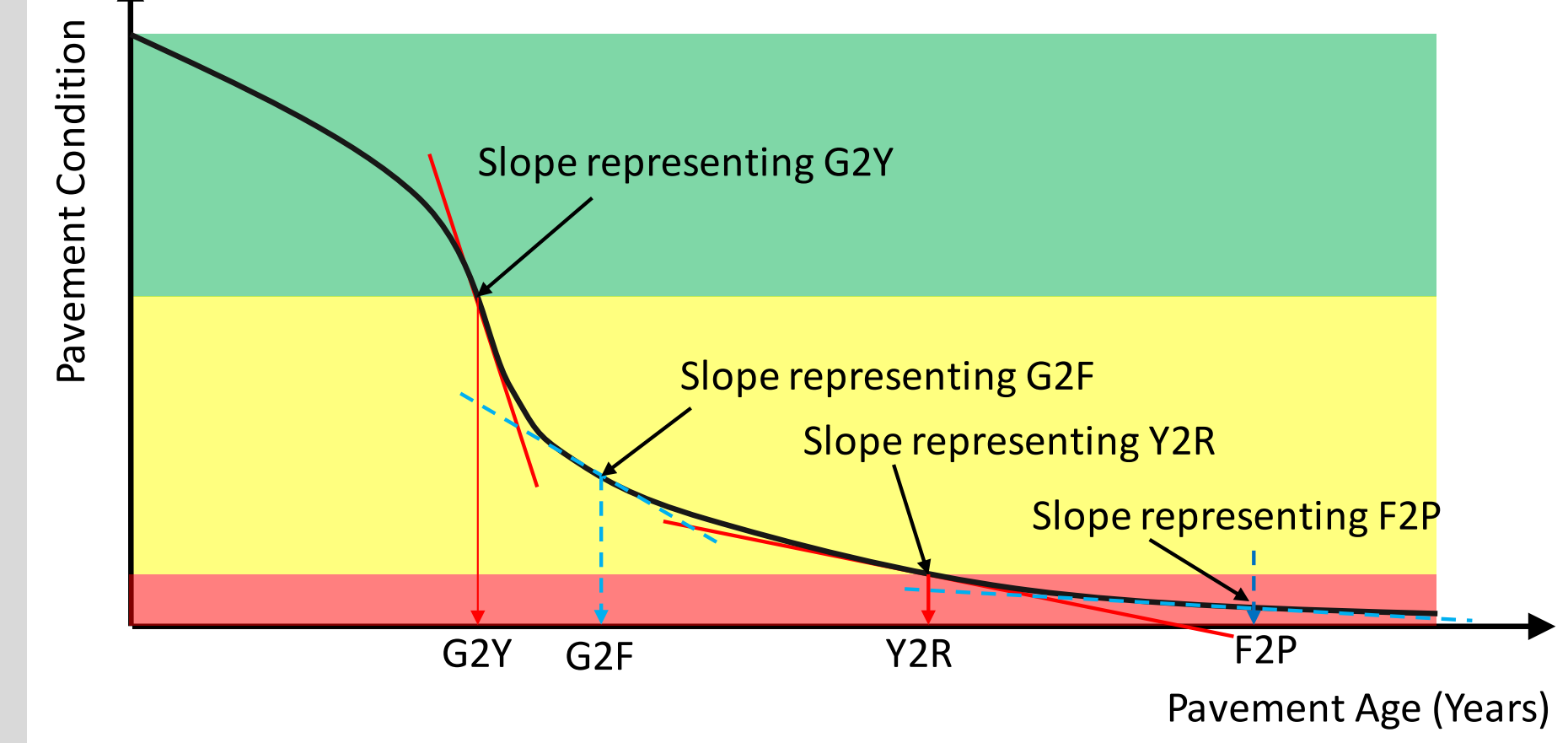
RESULTS AND DISCUSSION

Network Wide Deterioration Rates

Predicted G2Y			Measured G2Y	Difference in G2Y	Predicted Y2R			Measured Y2R	Difference in Y2R
2016-2017	2017-2018	Average			2016-2017	2017-2018	Average		
9.4%	13.9%	11.7%	5.3%	6.3%	1.9%	2.3%	2.1%	2.1%	0.0%

Predicted G2F			Measured G2F	Difference in G2F	Predicted F2P			Measured F2P	Difference in F2P
2016-2017	2017-2018	Average			2016-2017	2017-2018	Average		
3.0%	3.7%	3.3%	2.6%	0.7%	0.2%	0.2%	0.2%	0.2%	0.0%

Schematic Illustration of Deterioration Rates



Deterioration Rates by Pavement Class

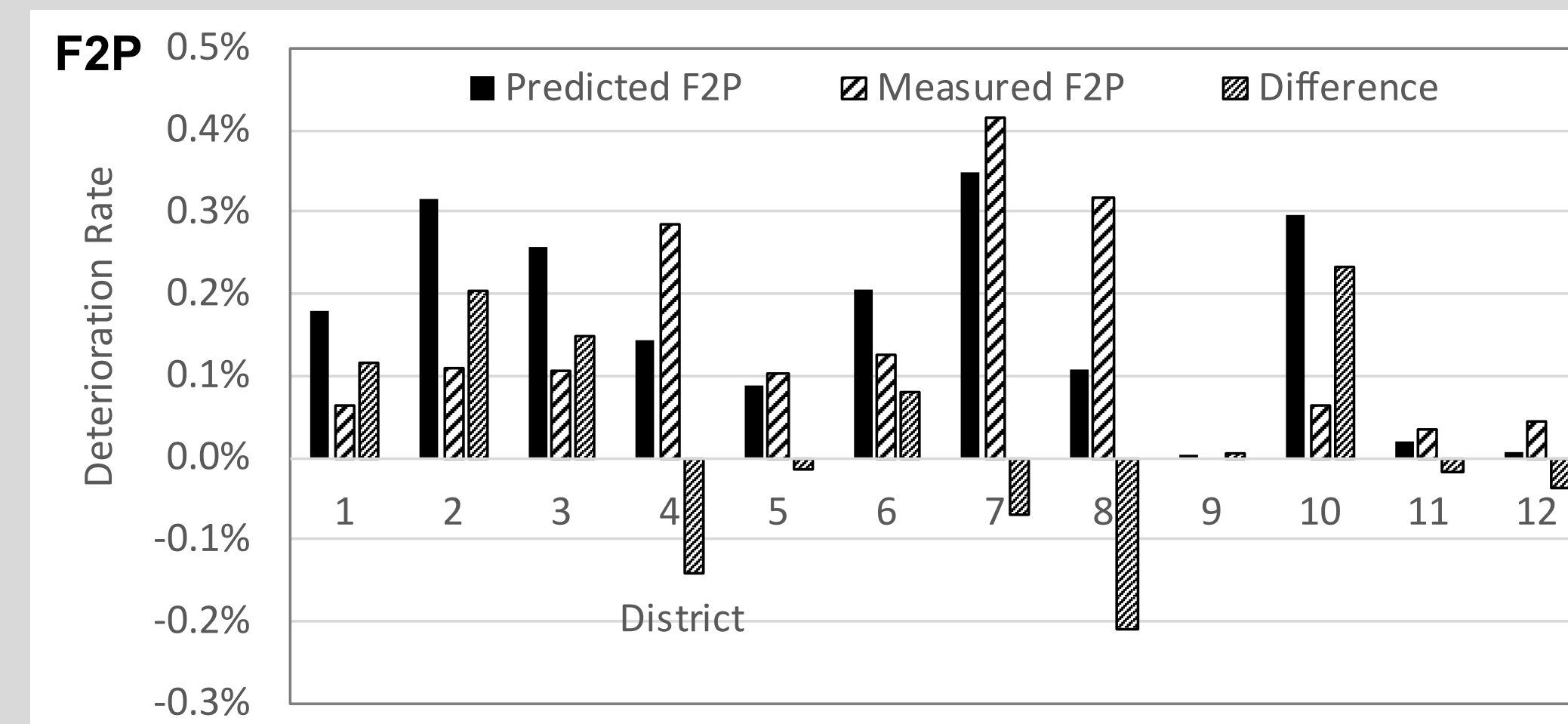
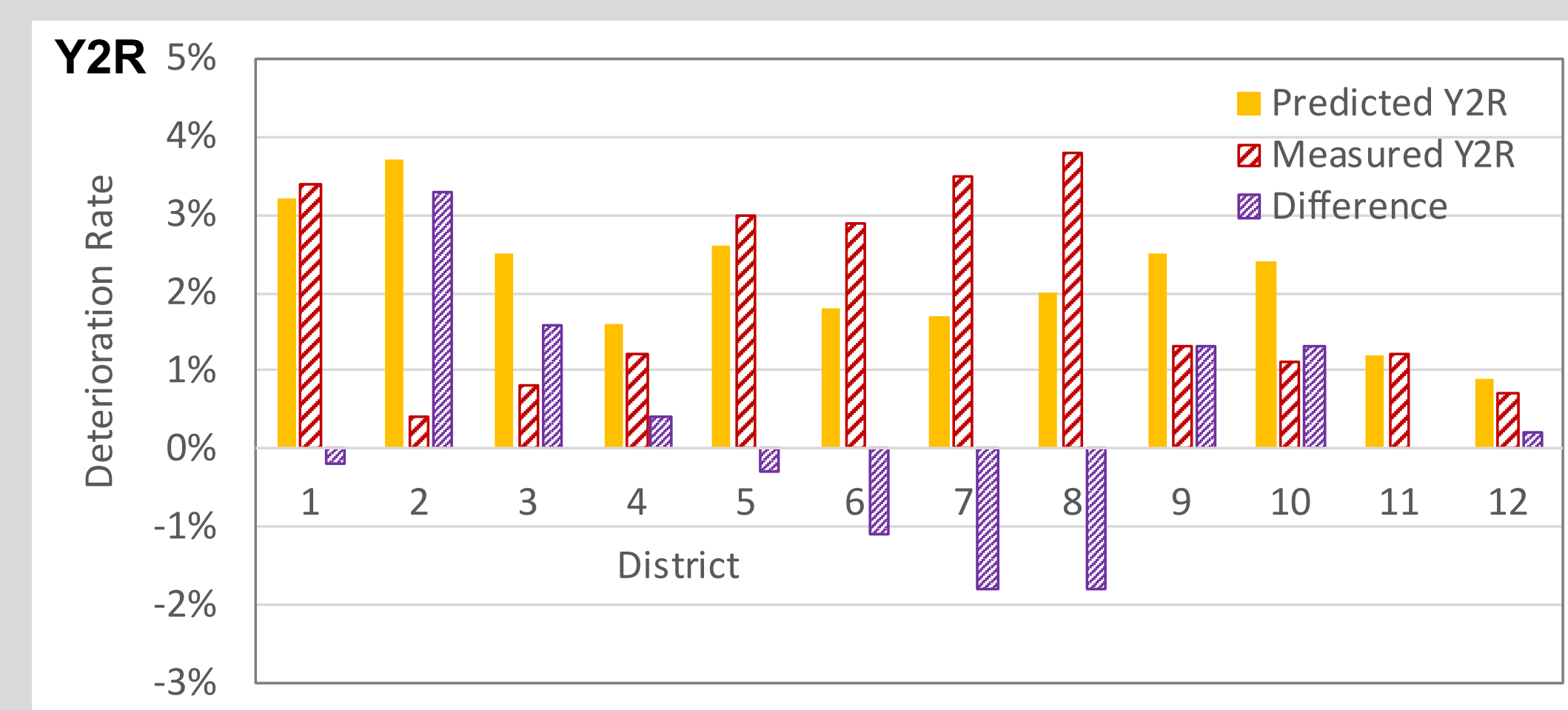
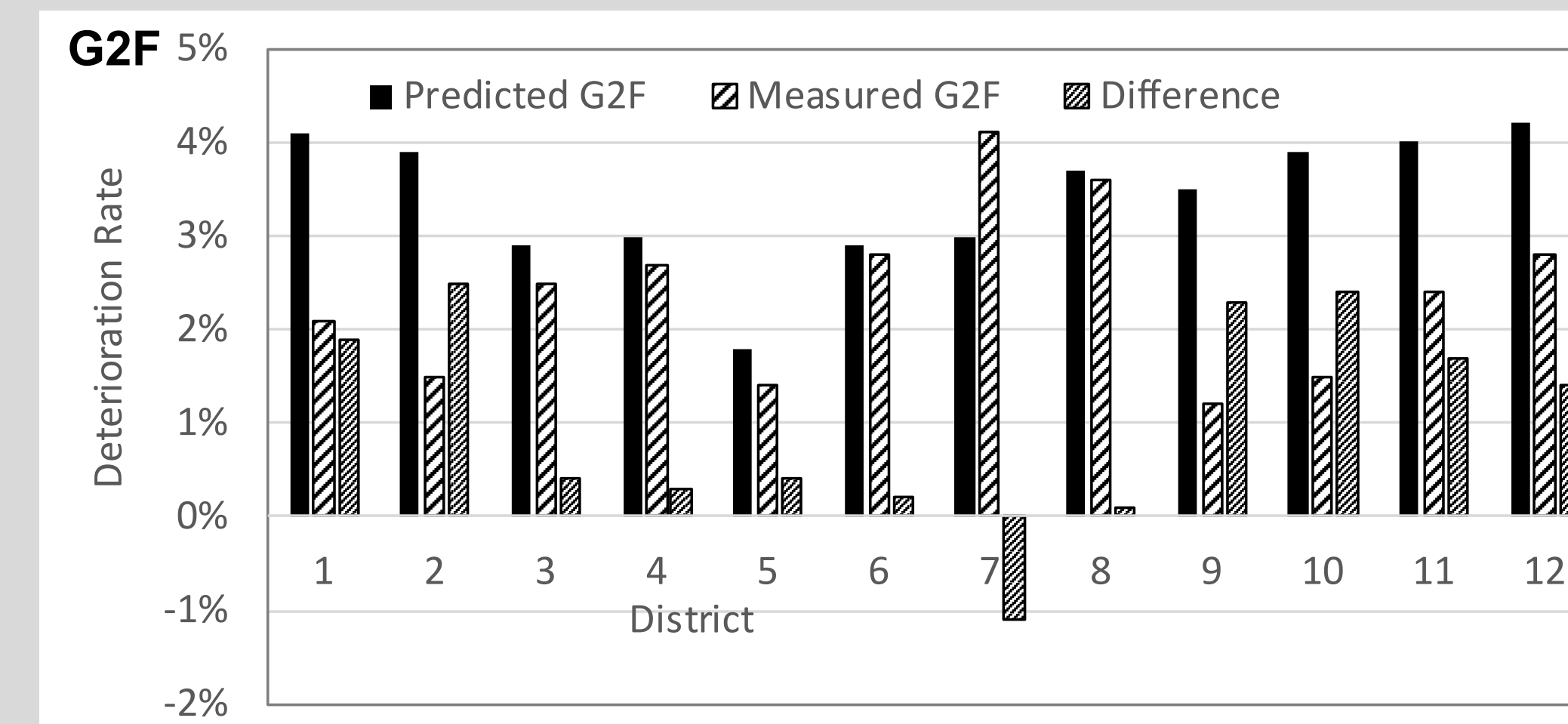
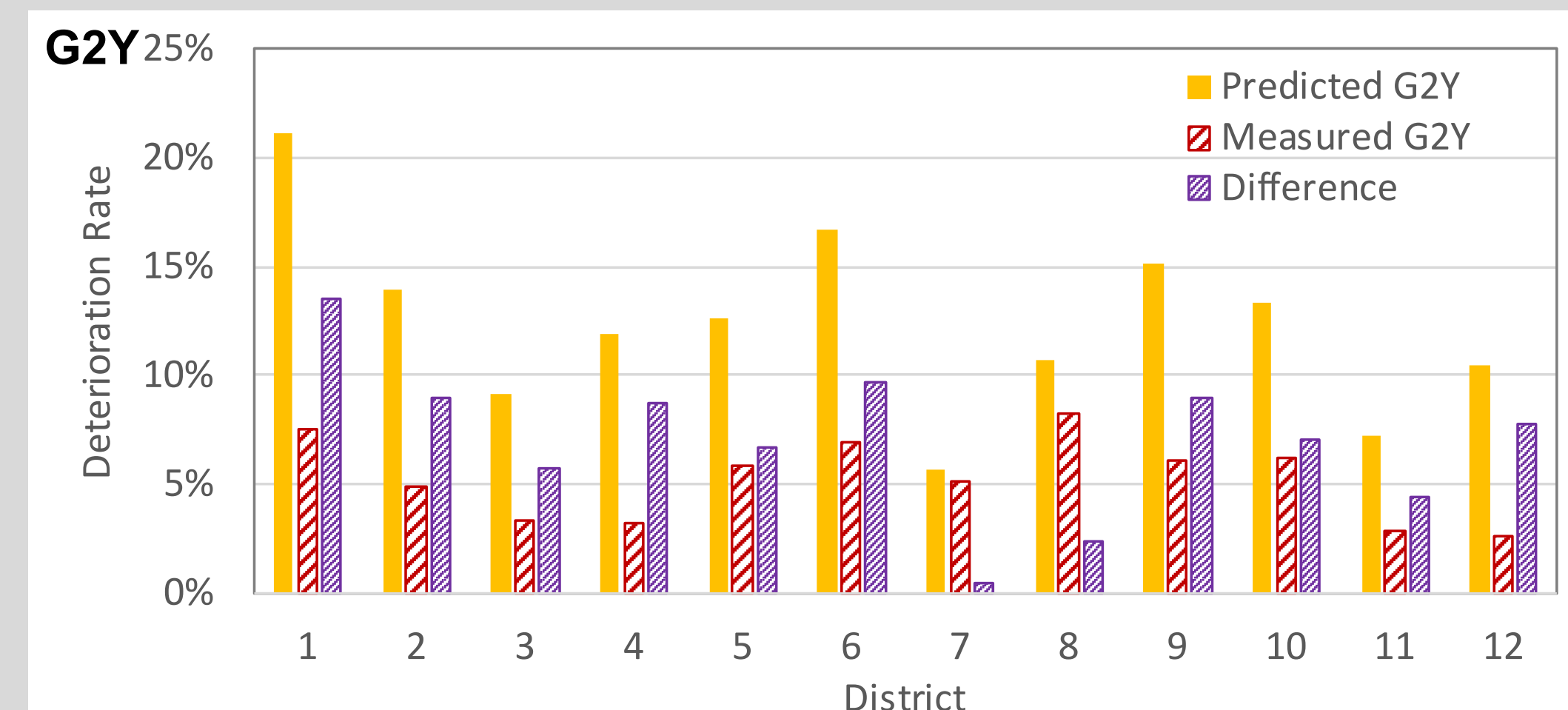
Class	Predicted G2Y			Measured G2Y	Difference in G2Y	Predicted Y2R			Measured Y2R	Difference in Y2R
	2016-2017	2017-2018	Average			2016-2017	2017-2018	Average		
1	7.6%	14.1%	10.9%	4.8%	6.1%	1.2%	1.5%	1.4%	1.9%	-0.6%
2	11.0%	13.7%	12.3%	6.0%	6.3%	2.7%	3.2%	3.0%	2.3%	0.6%
3	12.6%	13.8%	13.2%	5.7%	7.5%	2.9%	3.1%	3.0%	2.2%	0.8%

Class	Predicted G2F			Measured G2F	Difference in G2F	Predicted F2P			Measured F2P	Difference in F2P
	2016-2017	2017-2018	Average			2016-2017	2017-2018	Average		
1	3.3%	4.2%	3.7%	3.2%	0.5%	0.2%	0.2%	0.2%	0.2%	-0.1%
2	3.1%	3.3%	3.2%	2.1%	1.2%	0.2%	0.2%	0.2%	0.1%	0.1%
3	1.8%	2.3%	2.1%	1.4%	0.7%	0.3%	0.3%	0.3%	0.1%	0.1%

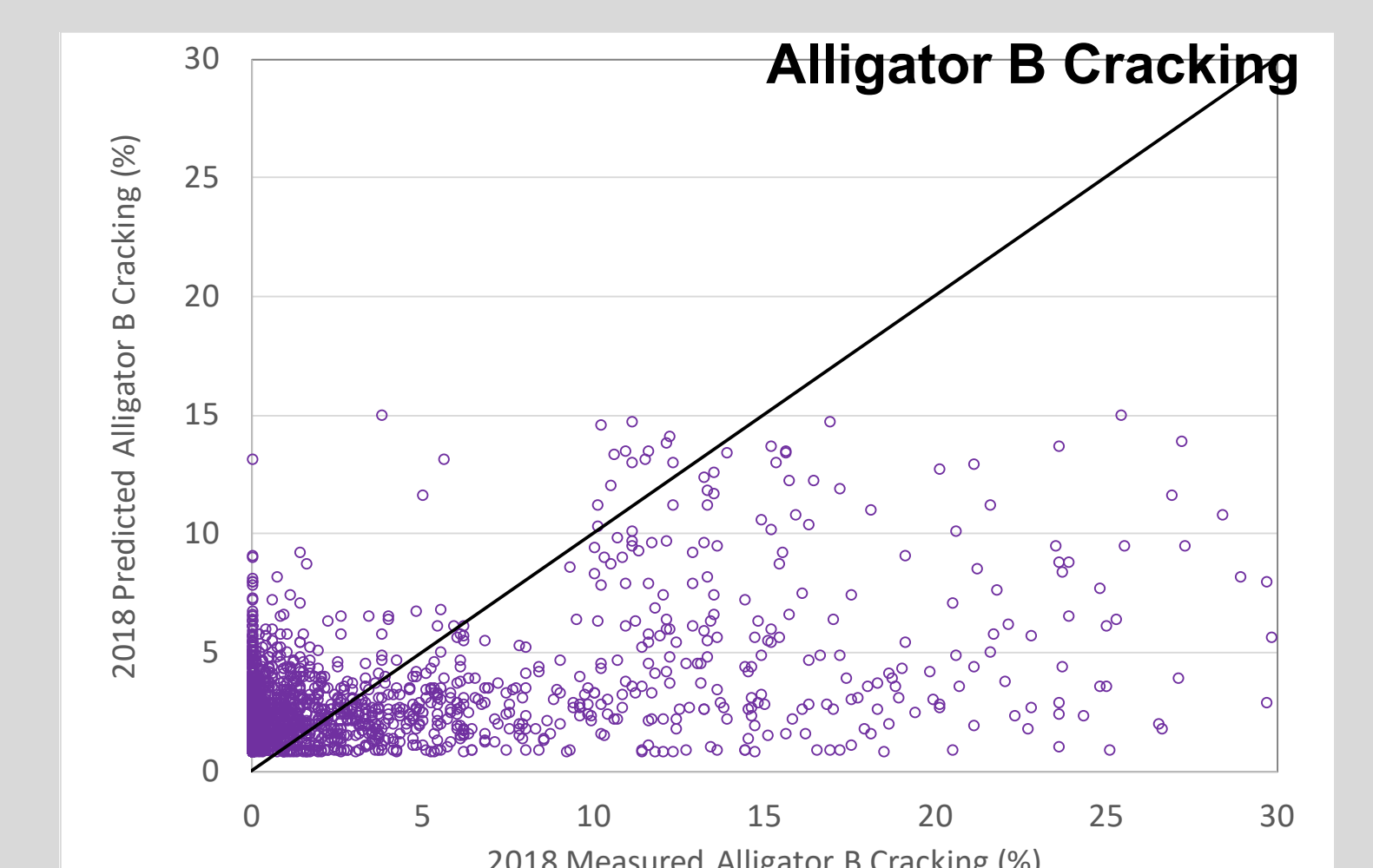
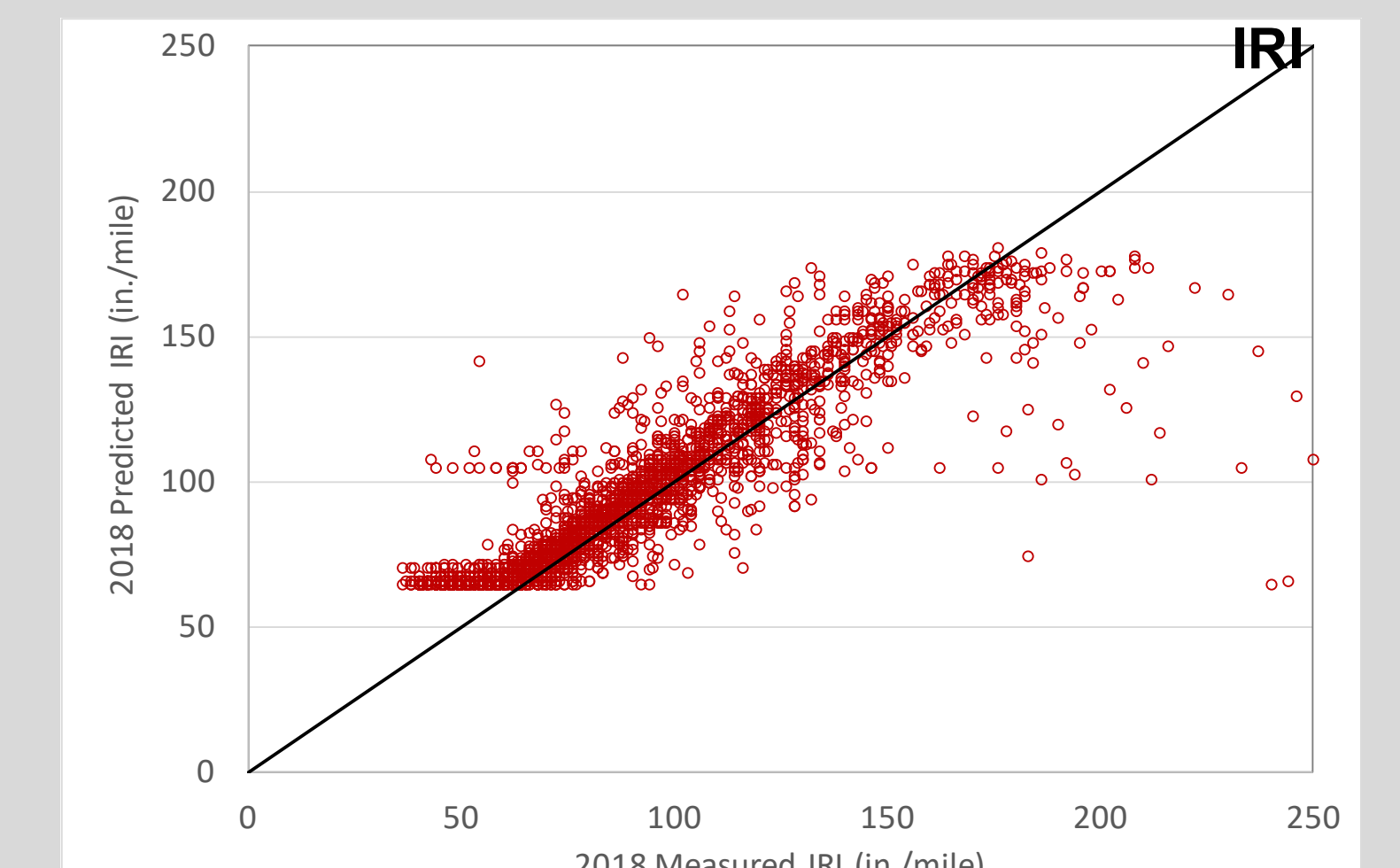
Major observations:

- Network level: Predicted G2Y & G2F > Measured G2Y & G2F, Predicted Y2R & F2P ≈ Measured Y2R & F2P, G2Y > G2F, Y2R > F2P
- District level: Deterioration rate varies from district to district.
- Pavement class: Deterioration rate varies by pavement class, but overall relatively close.
- Pavement type: Deterioration rate varies by pavement type. Higher predicted than measured deterioration rates for asphalt pavements.
- IRI models gave a more accurate prediction than Alligator B cracking models for asphalt pavement thin overlay treatment.

Deterioration Rates by District



Predicted vs. Measured Distress/Ride Quality



CONCLUSIONS AND RECOMMENDATIONS

- Deterioration rates reflect the specific change rates at the threshold points on the performance curves.
- Deterioration rates reflect the overall performance of the models adopted in Pavem.
- Predicted G2Y > Measured G2Y, indicating models over-predicted deterioration at early pavement ages.
- Predicted G2Y > Measured G2Y also indicates the threshold for green-to-yellow change might be harsh.
- Predicted Y2R ≈ Measured Y2R, indicating models performed fairly well at later pavement ages.
- G2F and F2P showed trends similar to those of G2Y and Y2R, but to a lesser extent.
- IRI models performed better than Alligator B Cracking models for asphalt pavement thin overlay treatment.
- Inaccurate models caused either over-prediction or under-prediction of pavement deterioration, resulting in inaccurate optimal timing for M&R projects and possibly driving pavement M&R cost higher.
- Model adjustment will be needed in future studies to improve the accuracy of pavement condition prediction.