Visual Analysis of Pavement Performance and Related Factors

Final Report
July 2018

Sponsored by
Midwest Transportation Center
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16. Abstract

The purpose of this research project was to develop visualizations that display pavement performance data and information in a visually clear and insightful way. The data used to generate these interactive visuals were provided by the Iowa Department of Transportation and covered the period from 2013 to 2015. This data set contains numerous indicators of pavement performance by road segment, county, and district. Tableau 10.3 was used conduct the visual analysis.

This work focused on identifying information about the different types of cracks, relationships between them, relationships between condition and distress data, and performance in Iowa districts and counties. Counties were divided into five county types based on their size and proximity to major cities, as described by U.S. Census data from 1970 to 2010. These five county types included central city metropolitan, outlying metropolitan, regional center, small urban, and rural.

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Principal Investigator
Cynthia Corritore, Professor
Department of Business Intelligence & Analytics, Heider College of Business
Creighton University

Co-Principal Investigator
Nalini Govindarajulu, Associate Professor
Department of Business Intelligence & Analytics, Heider College of Business
Creighton University

Authors
Cynthia Corritore and Nalini Govindarajulu

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A report from
Institute for Transportation
Iowa State University
2711 South Loop Drive, Suite 4700
Ames, IA 50010-8664
Phone: 515-294-8103 / Fax: 515-294-0467
www.intrans.iastate.edu

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ACKNOWLEDGMENTS

The authors would like to thank the Midwest Transportation Center and U.S. Department of Transportation Office of the Assistant Secretary for Research and Technology for sponsoring this research.

OVERVIEW

Visual Analytics and Visualization of Iowa Department of Transportation Pavement Performance Data

The data were explored visually with a focus on three questions, in light of which all of the visuals were conceived and organized.

1. Are there relationships between condition, distress, and traffic variables?
2. Are there relationships between condition, distress, and traffic variables with respect to the age of road segments and different types of cracks?
3. What is the state of counties and county types (on a rural-urban continuum) and districts with respect to condition and distress data?

Question 1: Are There Relationships between Condition, Distress, and Traffic Variables?

The first set of visualizations are dashboards that show the crack index for each county by year (2013, 2014, or both), sorted low to high (see Figures 1, 2, and 3). The user can click on one or more counties to display the drilldown values for these cracks (see Table 1 for a summary). The purpose of this dashboard is to be able to explore some of the important condition and distress data by county ID. Note that all figures show both 2013 and 2014 data as chosen by the user.

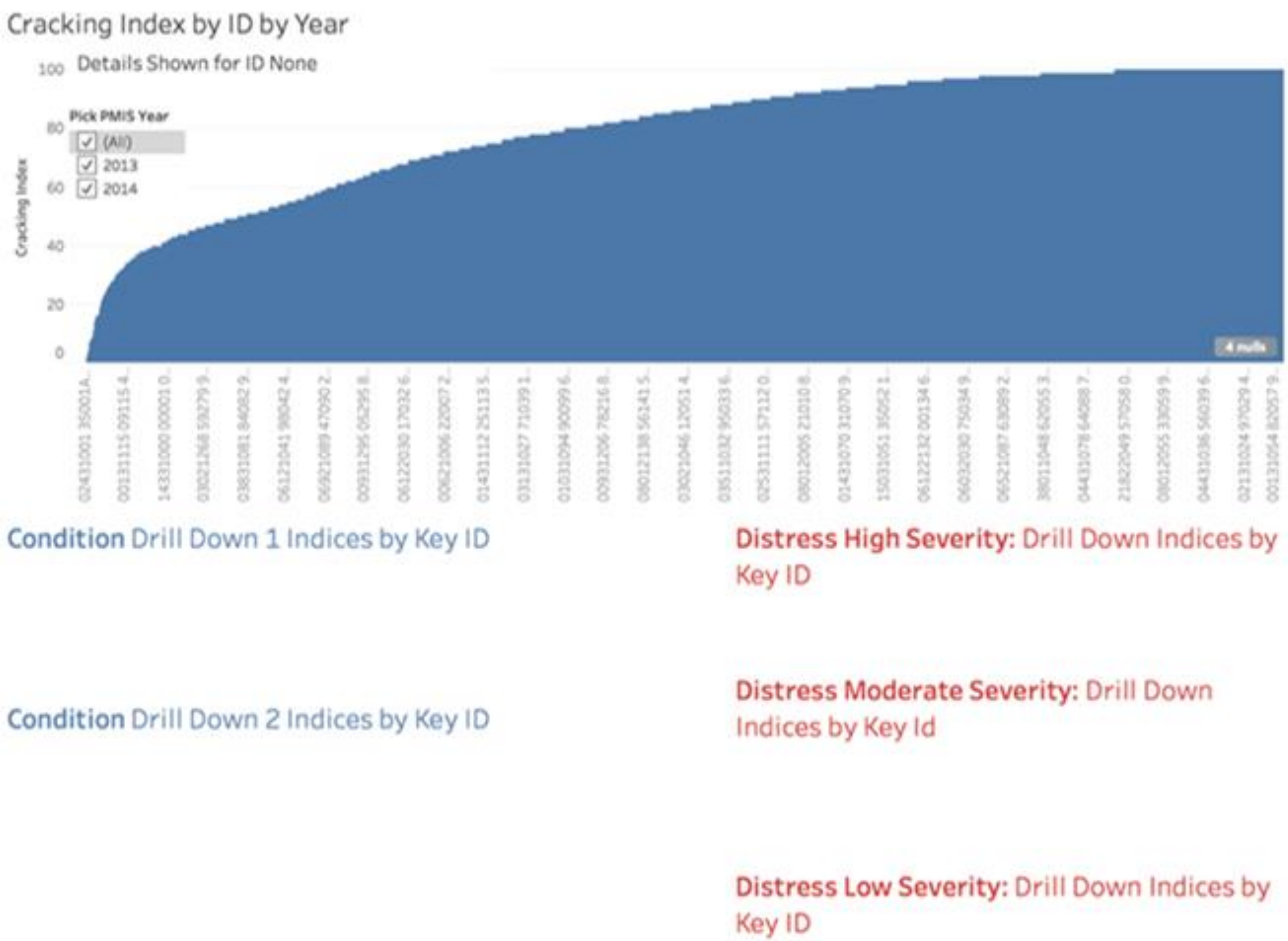


Figure 1. Initial view of cracking index by county ID and year

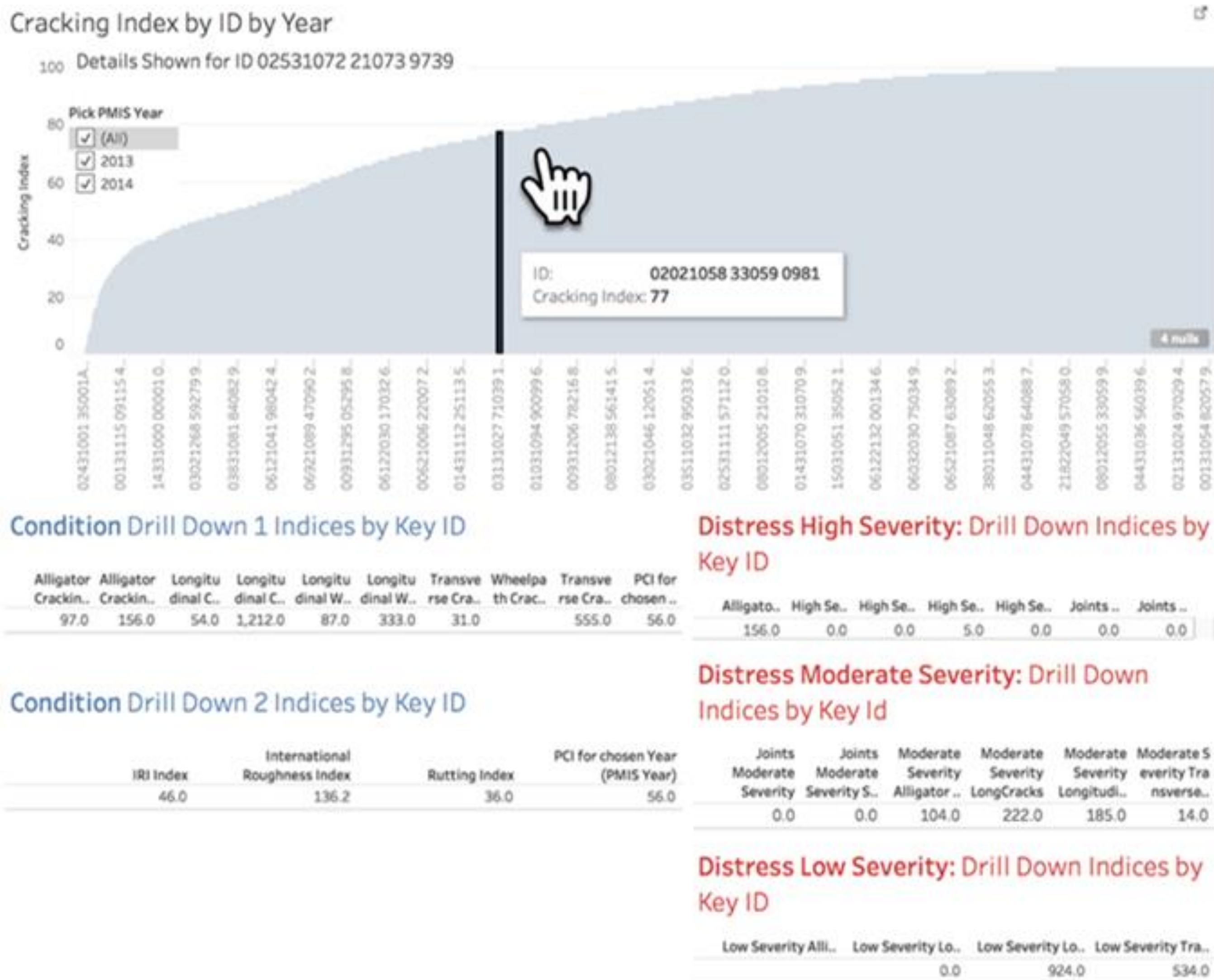


Figure 2. Cracking index by ID and year for a selected county showing condition and distress data

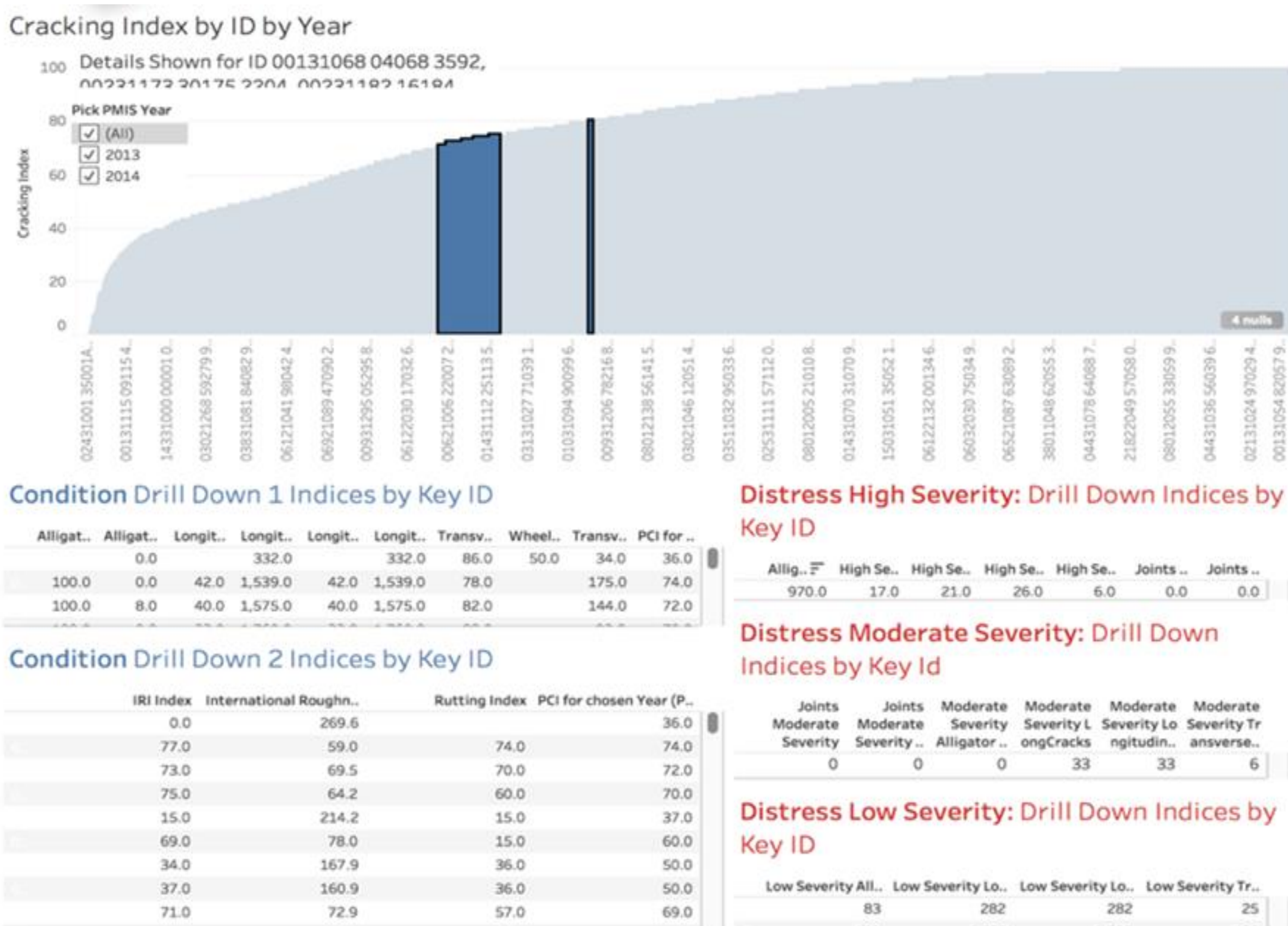


Figure 3. Cracking index by ID and year for multiple county selections showing condition data

Table 1. Drilldown condition and distress variables for dashboards

Conditions Set 1	Distress: High Severity
Alligator cracking index	Alligator cracking combined
Alligator cracking combined index	High severity alligator
Longitudinal cracking index	High severity long cracks
Longitudinal wheelpath cracking index	High severity longitudinal cracks
Longitudinal wheelpath combined index	High severity transverse cracks
Transverse cracking index	Joints, high severity
Wheelpath cracking index	Joints, high severity spalling
Conditions Set 2	**Distress: Moderate Severity**
IRI index	Joints, moderate severity
International roughness index (IRI)	Joints, moderate severity spalling
Rutting index	Moderate severity alligator
Pavement condition index (PCI)	Moderate severity long cracks
	Moderate severity longitudinal cracks
	Moderate severity transverse cracks
	Distress: Low Severity
	Low severity alligator
	Low severity long cracks
	Low severity longitudinal cracks
	Low severity transverse cracks

The second set of visualizations shows the crack index for each district by year (2013, 2014, or both), sorted low to high. The user can click on one or more counties to display the drilldown values for these cracks (see Table 1 and Figures 4, 5, and 6). The purpose of this dashboard is just to be able to explore some of the important condition and distress data by district. Note that all figures show both 2013 and 2014 data as chosen by the user.

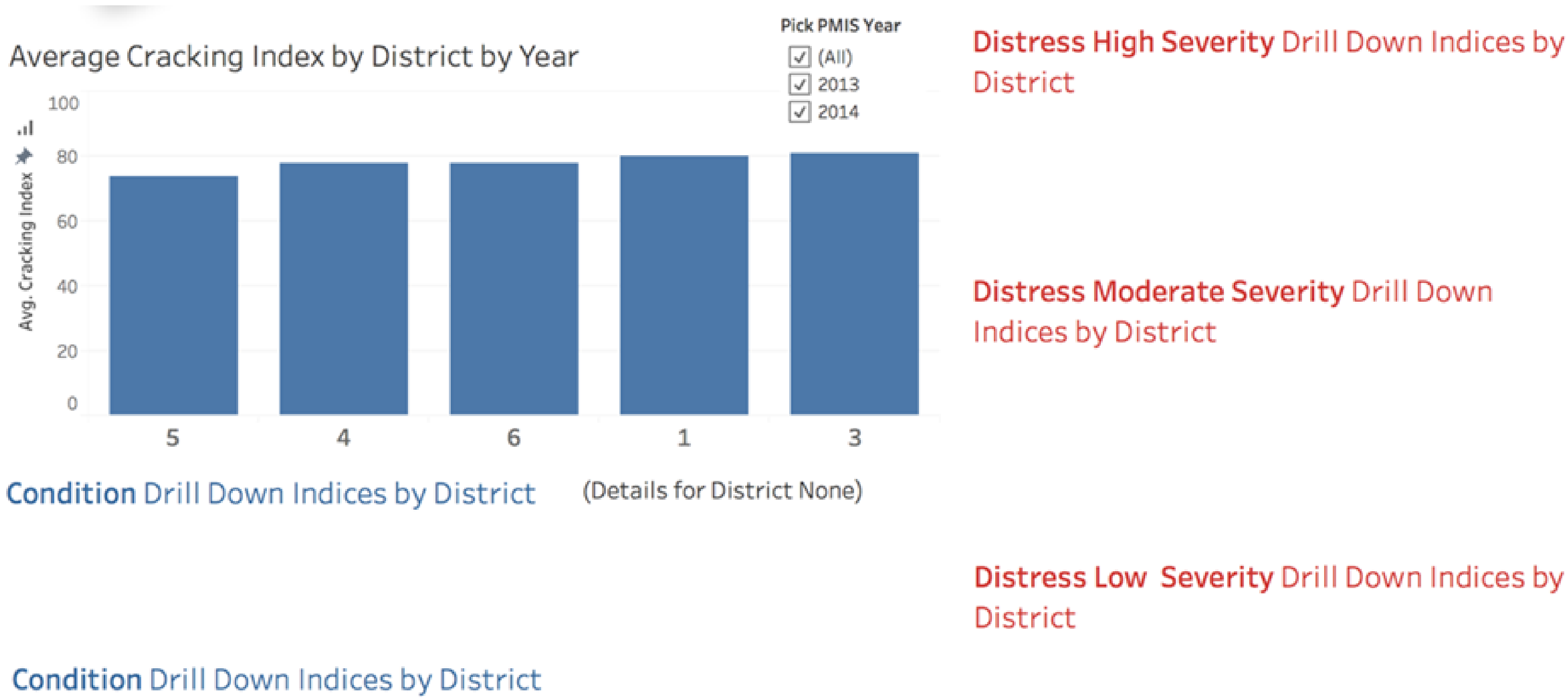
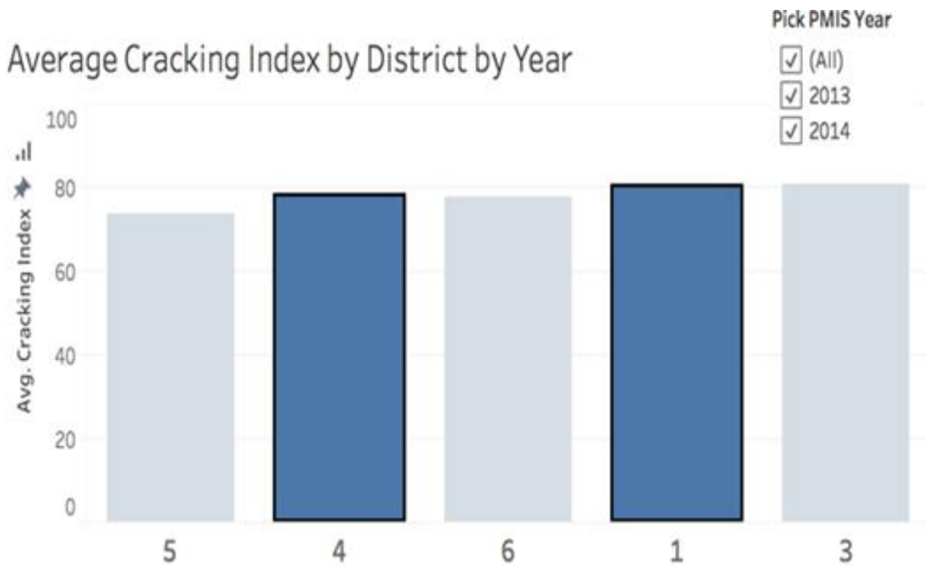


Figure 4. Initial view of cracking index by district and year

Figure 5. Cracking index by ID and year for a selected district showing condition and distress data



Condition Drill Down Indices by District

(Details for District 1 & 4)

Alligator Cracking Index	Alligator Cracking Combined ..	Longitudinal Cracking Index	Longitudinal Wheelpath Combi..	Longitudinal Wheelpath Crack..	Transverse Cracking Combined ..	Transverse Cracking Index	Wheelpath Cracking Index	PCI for chosen Year (PMI..
37,974	104,223	22,529	462,695	27,142	106,940	49,940	21,452	44,020
39,625	125,746	20,683	518,950	27,983	109,709	39,143	10,483	36,154

Condition Drill Down Indices by District

Faulting index	IRI Index	International Roughness Index	Rutting Index	PCI for chosen Year (PMIS Year)
14,632	36,908	76,111	24,751	44,020
7,511	30,983	62,736	25,257	36,154

Distress High Severity Drill Down Indices by District

High Severity Alligator Crack	High Severity LongCracks	High Severity Longitudinal Crack	High Severity Transverse Crack	Joints High Severity	Joints High Severity Spalling
368.0	4,071.0	9,067.0	1,145.0	3,760.0	1,609.0
95.0	2,779.0	8,450.0	1,013.0	2,944.0	751.0

Distress Moderate Severity Drill Down Indices by District

Joints High Severity Spalling	Joints Moderate Severity	Moderate Severity Alligator Crack	Moderate Severity LongCracks	Moderate Severity Longitudinal Crack	Moderate Severity Transverse Crack
$1,609.0	$3,106.0	$68,955.0	$83,976.0	$118,261.0	$17,325.0
$751.0	$2,059.0	$83,654.0	$90,297.0	$156,382.0	$19,190.0

Distress Low Severity Drill Down Indices by District

Low Severity Alligator Crack	Low Severity LongCracks	Low Severity Longitudinal Crack	Low Severity Transverse Crack
45,518.0	328,488.0	465,829.0	78,533.0
189,469.0	377,854.0	554,353.0	78,785.0

Figure 6. Cracking index by ID and year for multiple district selections showing condition and distress data

The third set of graphs show that there are relatively consistent patterns in the data over individual road segments for the cracking, alligator, longitudinal, longitudinal wheelpath, and, to a lesser extent, the transverse cracking indices. Of interest here is that the alligator and longitudinal cracking indices appear to be at the top of their respective ranges, while the longitudinal wheelpath cracking index tends to have two groupings at the higher and lower ranges of value. The transverse cracking index did not show a definite pattern, while the cracking index tended to cluster around the middle of the values. These patterns are relatively consistent across each. The graph can be viewed over all five variables for a specific district, group of districts, or all districts (see Figures 7, 8, and 9).

Figure 7. Initial view of selected cracking indices by road segment, district, and year

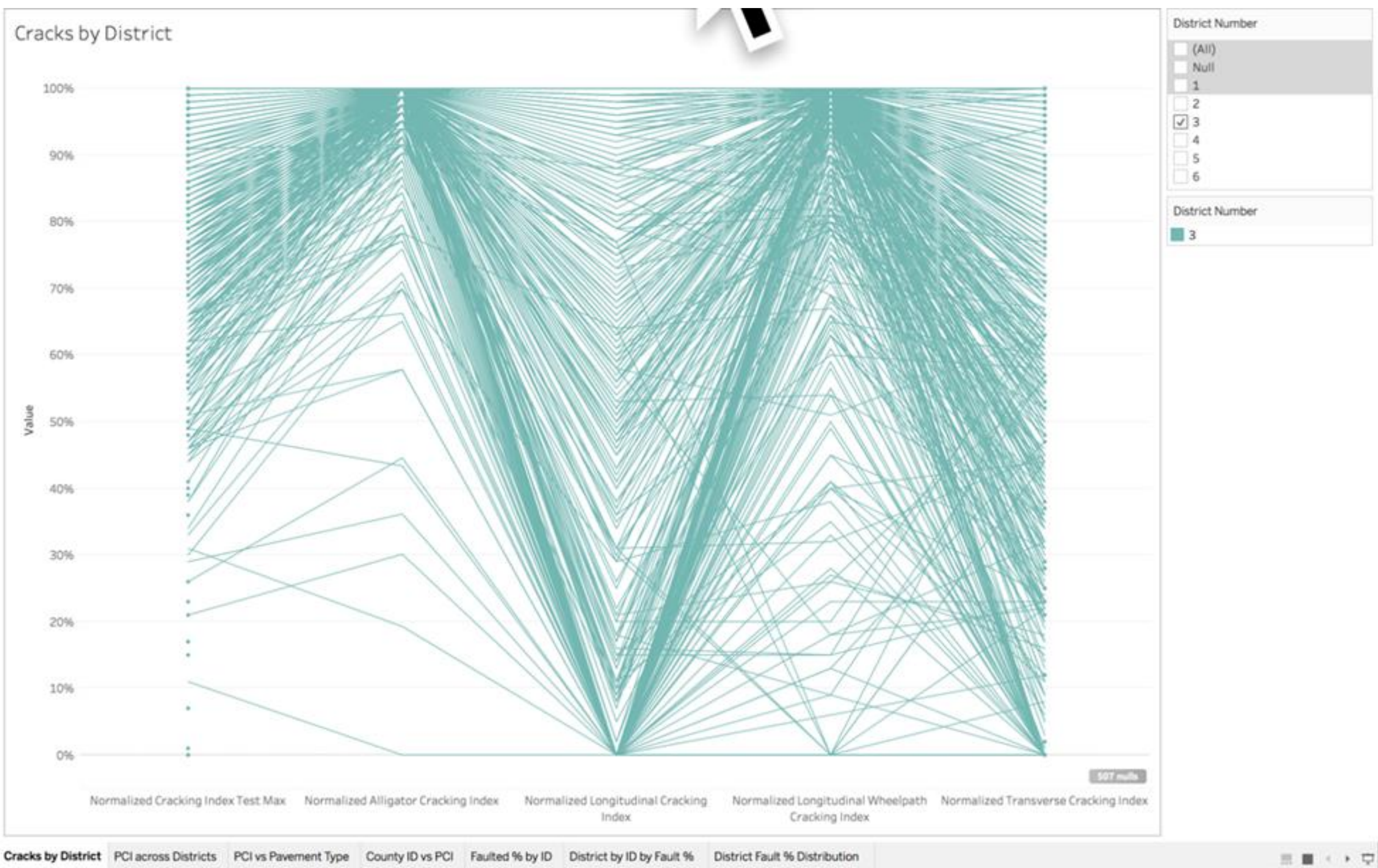


Figure 8. Selected crack indices by road segment and year for a selected district

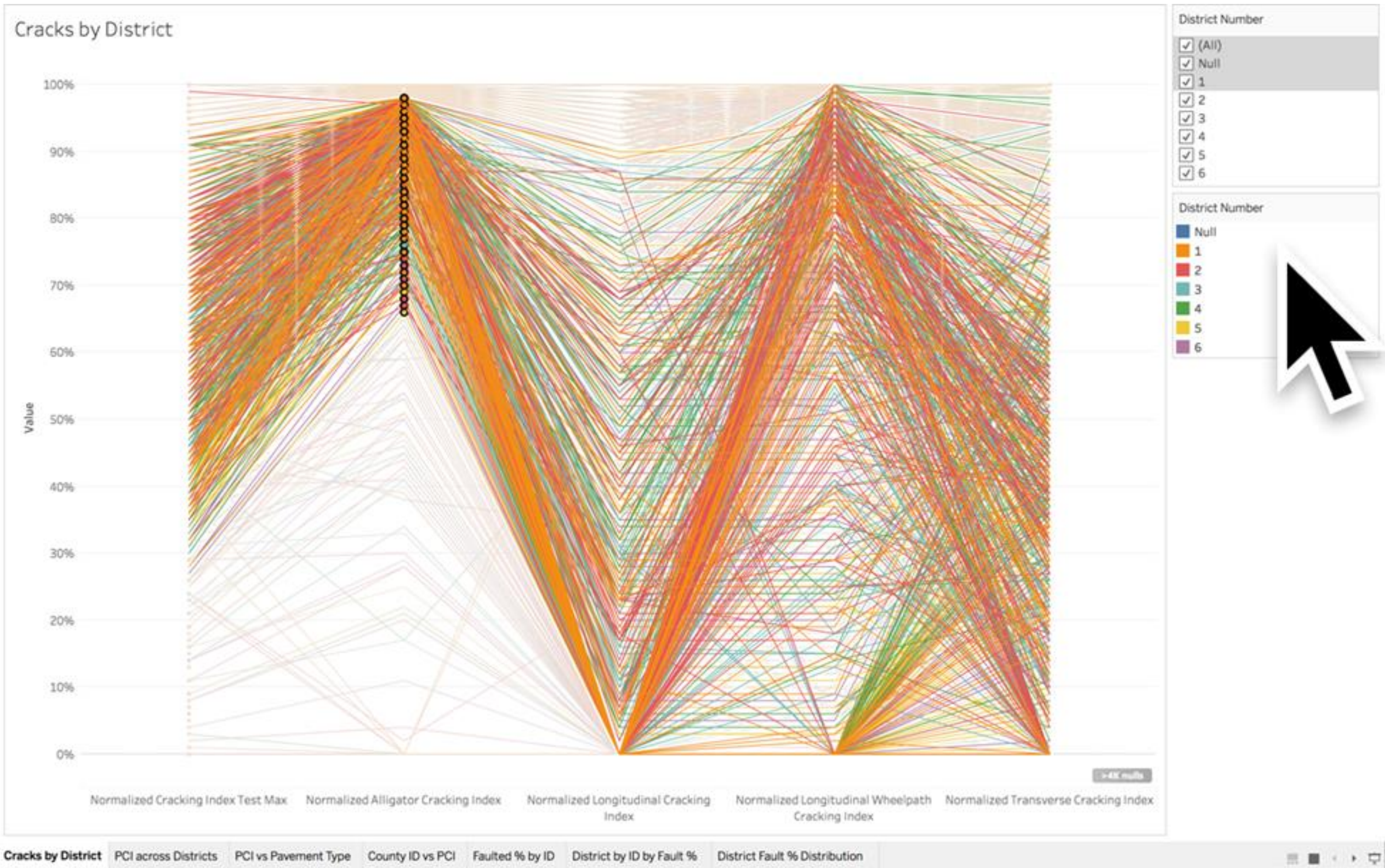


Figure 9. Selected crack indices by road segment, year, and district for brushed high values of alligator cracking index

The following shows that the PCI from 2013 to 2015 has a consistent pattern over time by district. It also shows that District 5 has the highest PCI values, while District 4 has the lowest (see Figure 10).

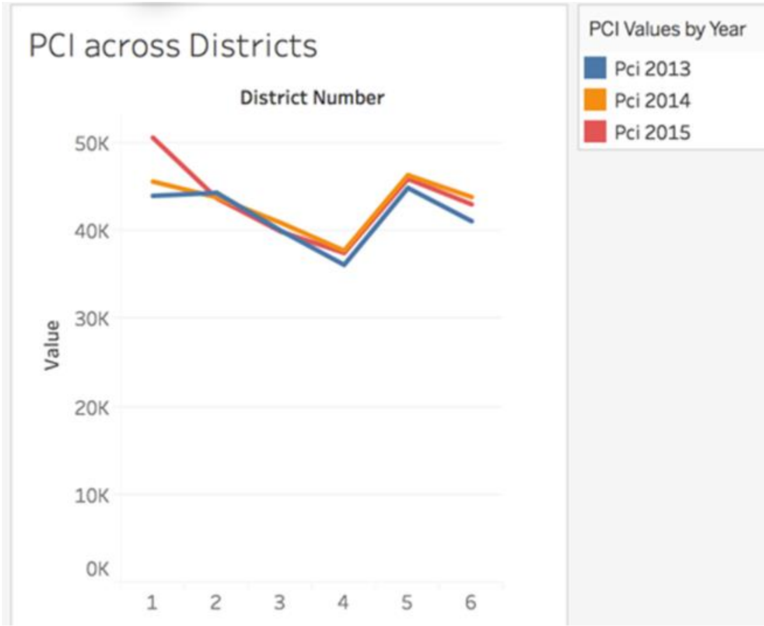


Figure 10. PCI from 2013 to 2015 by district

The following shows PCI from 2013 to 2015 for the different pavement types (1 to 4). The consistency of the pattern over time is notable. The highest PCI values were seen in Pavement Type 3, followed by 1, and to a lesser extent 4 (see Figure 11).

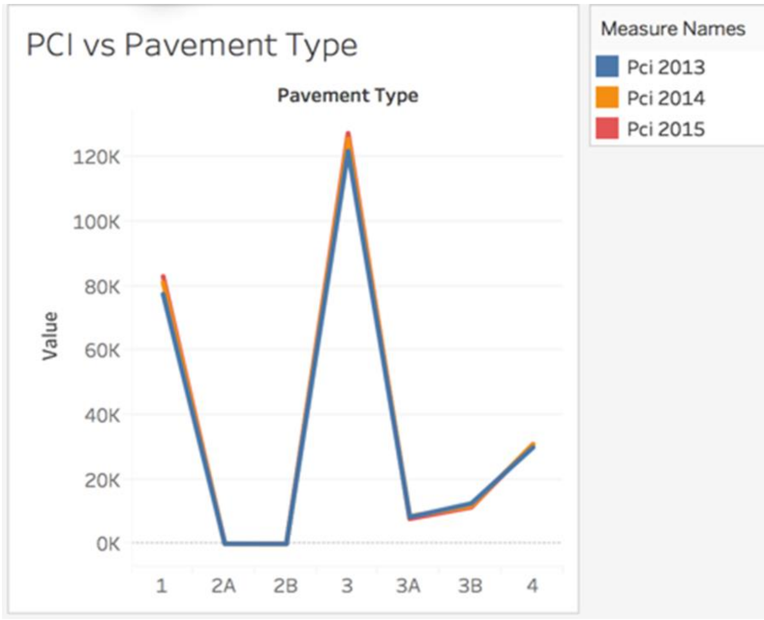


Figure 11. PCI from 2013 to 2015 by pavement type

The following shows PCI from 2013 to 2015 for each county. The consistency of the pattern over time is notable, with the single, clear exception of Story County, which saw a higher PCI in 2015 than in 2013 or 2014 (see Figure 12).

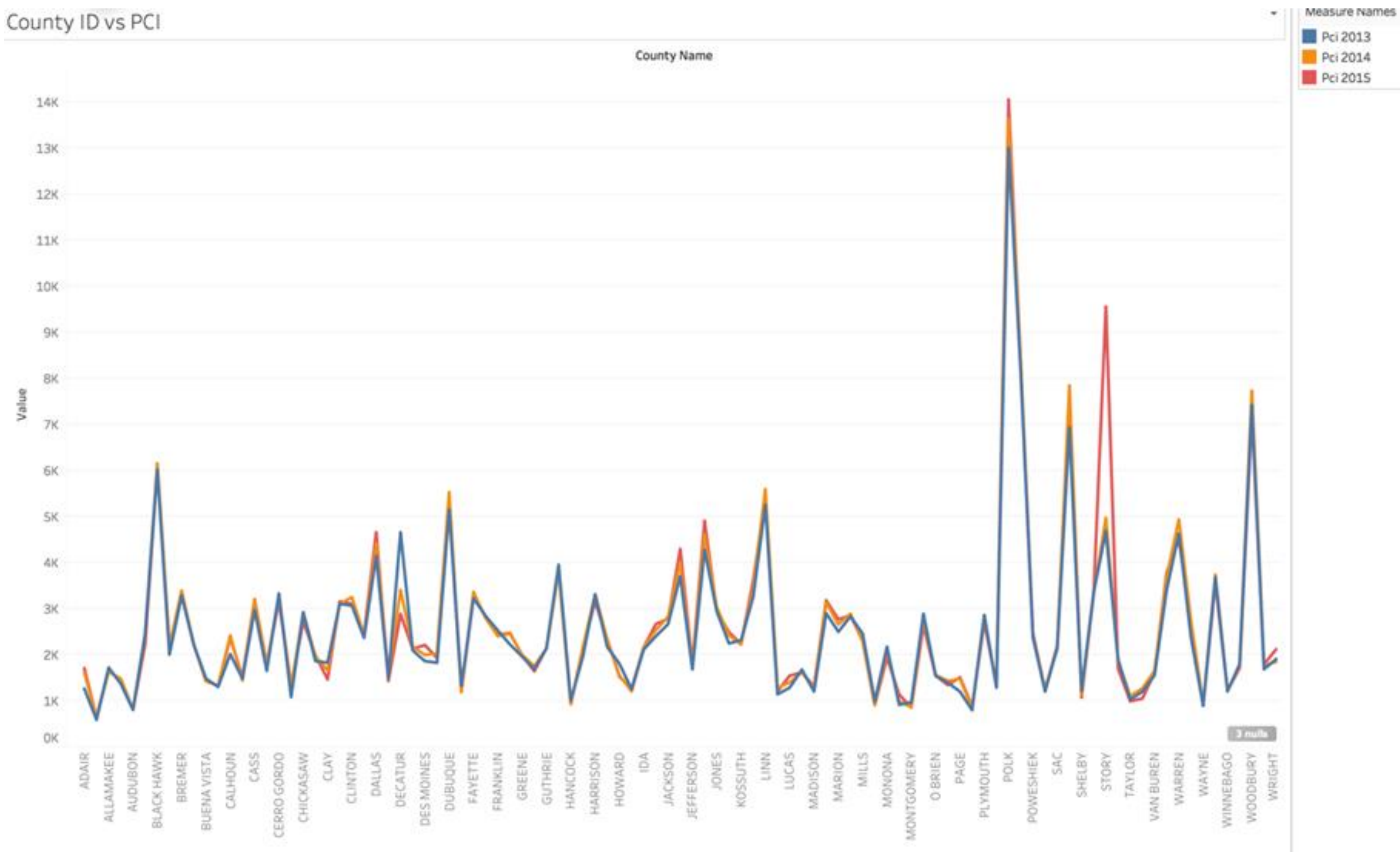


Figure 12. PCI from 2013 to 2015 by county

The following shows the faulted percentage by road segment. The chart has been sorted so that the highest percentages are first (see Figures 13 and 14). The user can hover over any spot on the line to see the actual figures for a given road segment.

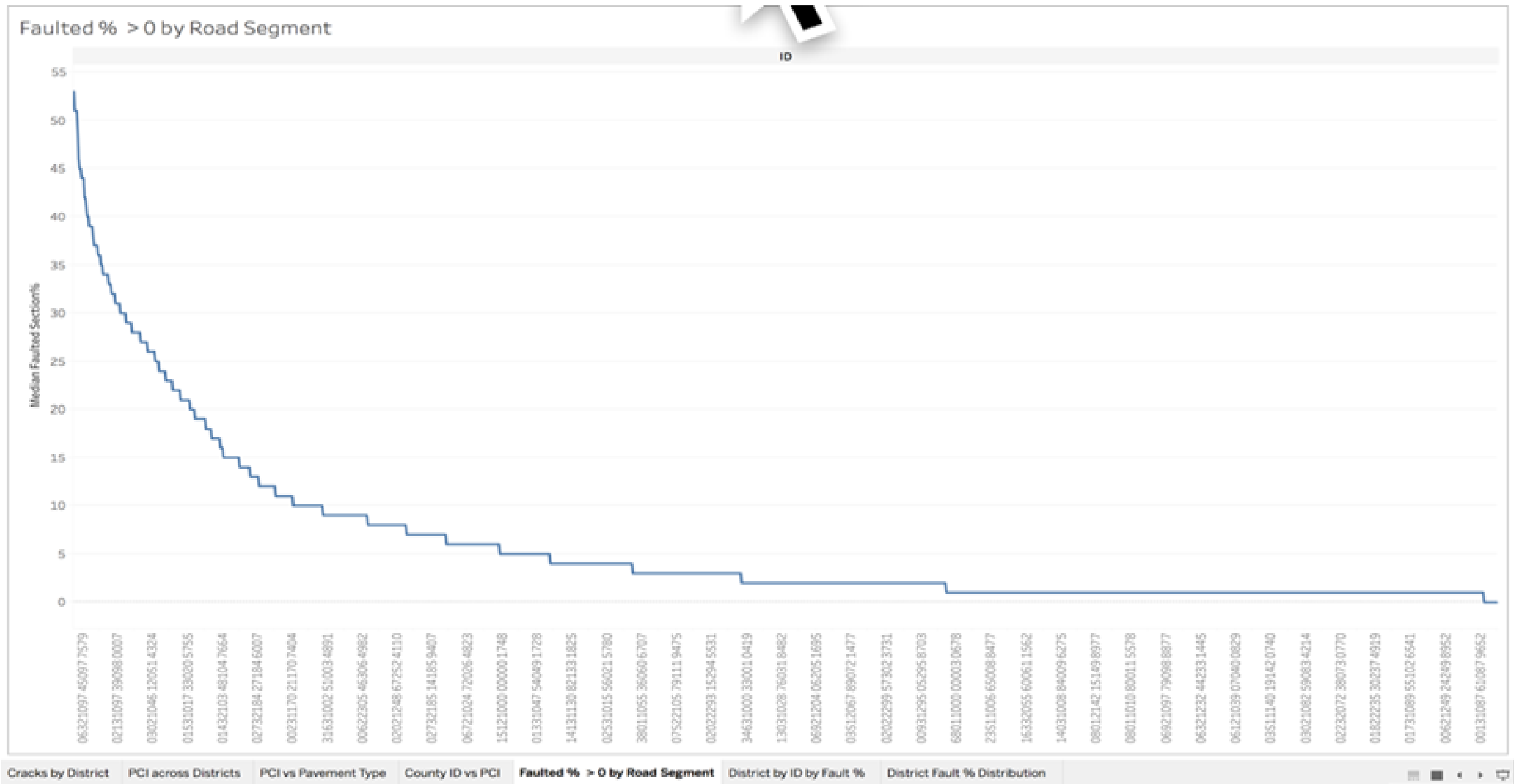


Figure 13. Faulted percentage by road segment for all segments

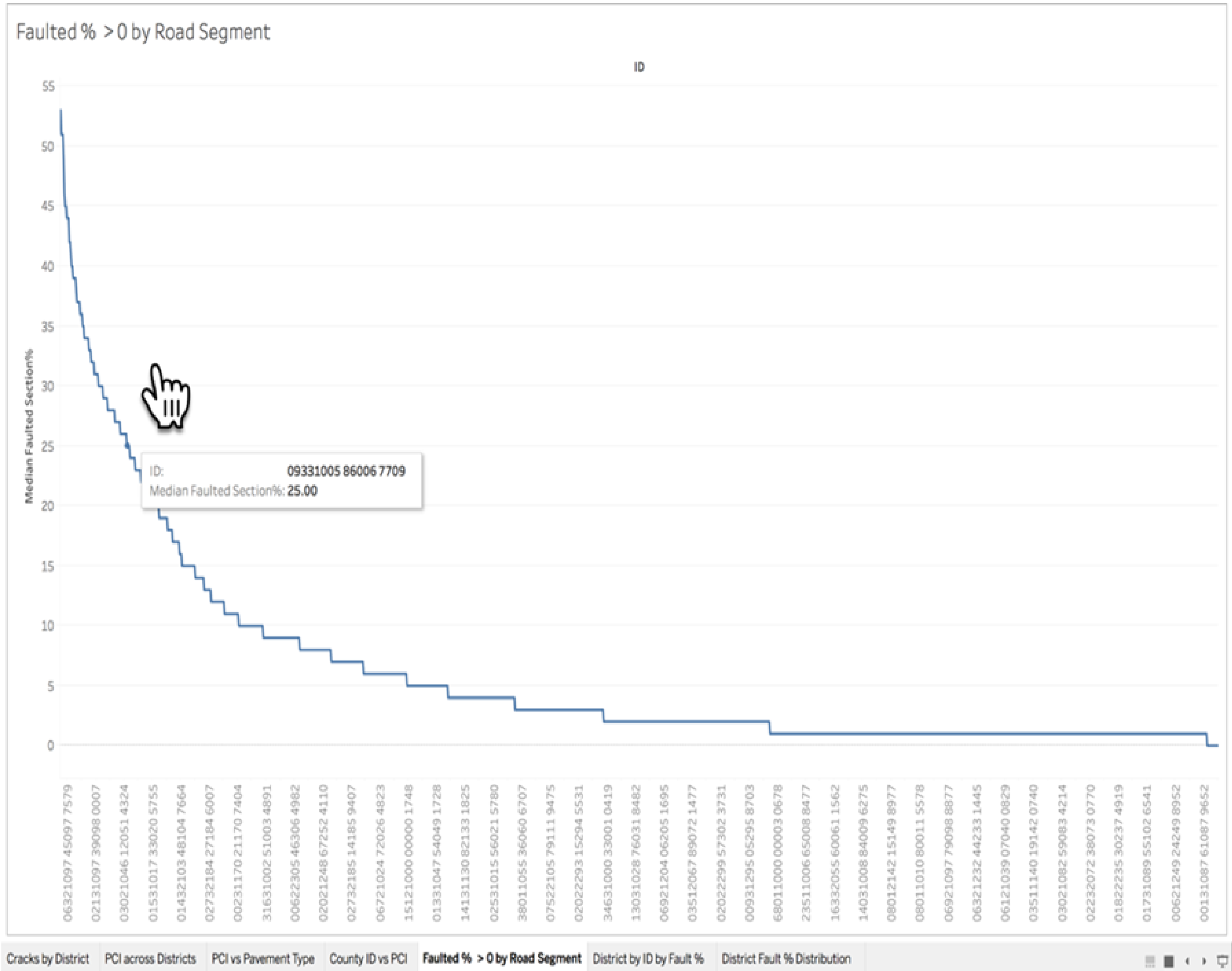


Figure 14. Faulted percentage by road segment showing ability to hover over specific segment for additional details

The following shows road segment by faulted percentage by district. All districts are shown on the initial graph (see Figure 15), while the user can also view selected district(s) only. In Figure 16, only District 6 is being displayed in the context of the entire set of districts.

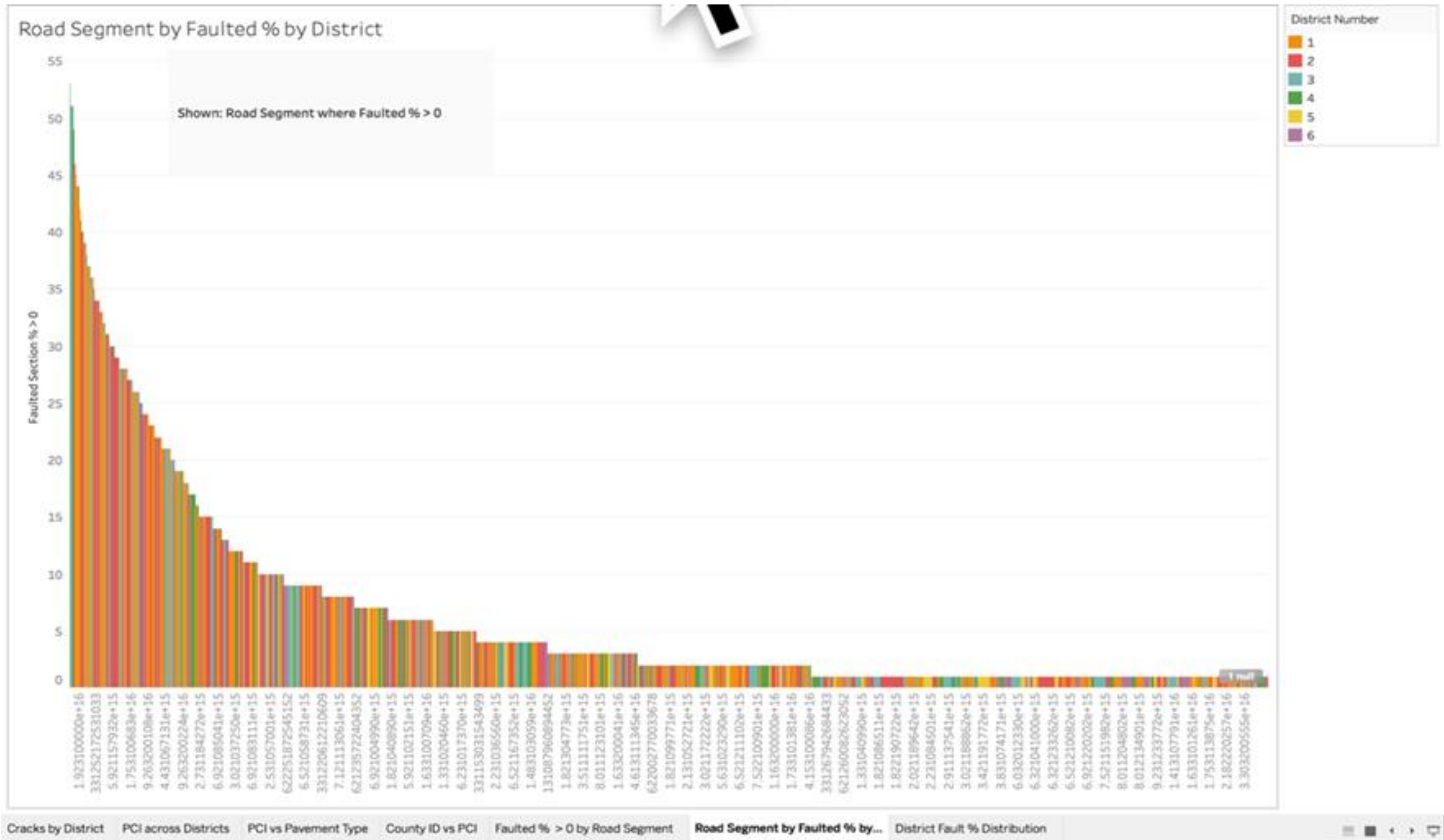


Figure 15. Road segment by faulted percentage by district for all districts

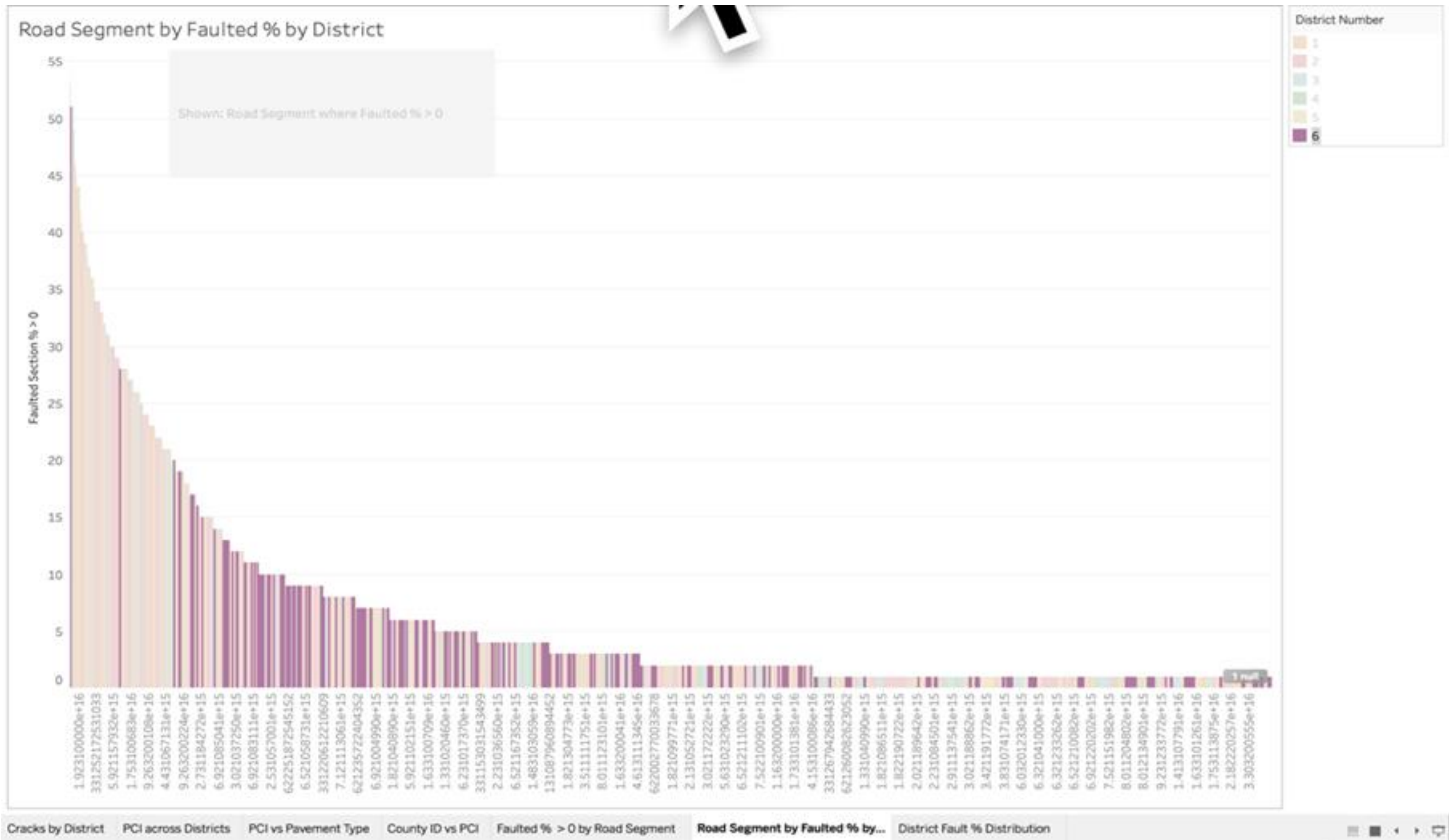


Figure 16. Road segment by faulted percentage by district for District 6 only

The following shows the distribution of faulted section percentage by district for all road segments with a faulted section percentage greater than zero (see Figure 17). The mean faulted section percentage of these segments is relatively consistent across all districts at 2% to 3%. Districts 5 and 6 have the tightest distributions, while District 4 has the widest distribution with many outliers. Most of the values are below 40%, with some outliers in Districts 3, 4, and 6 having some values greater than 50% but less than 55%.

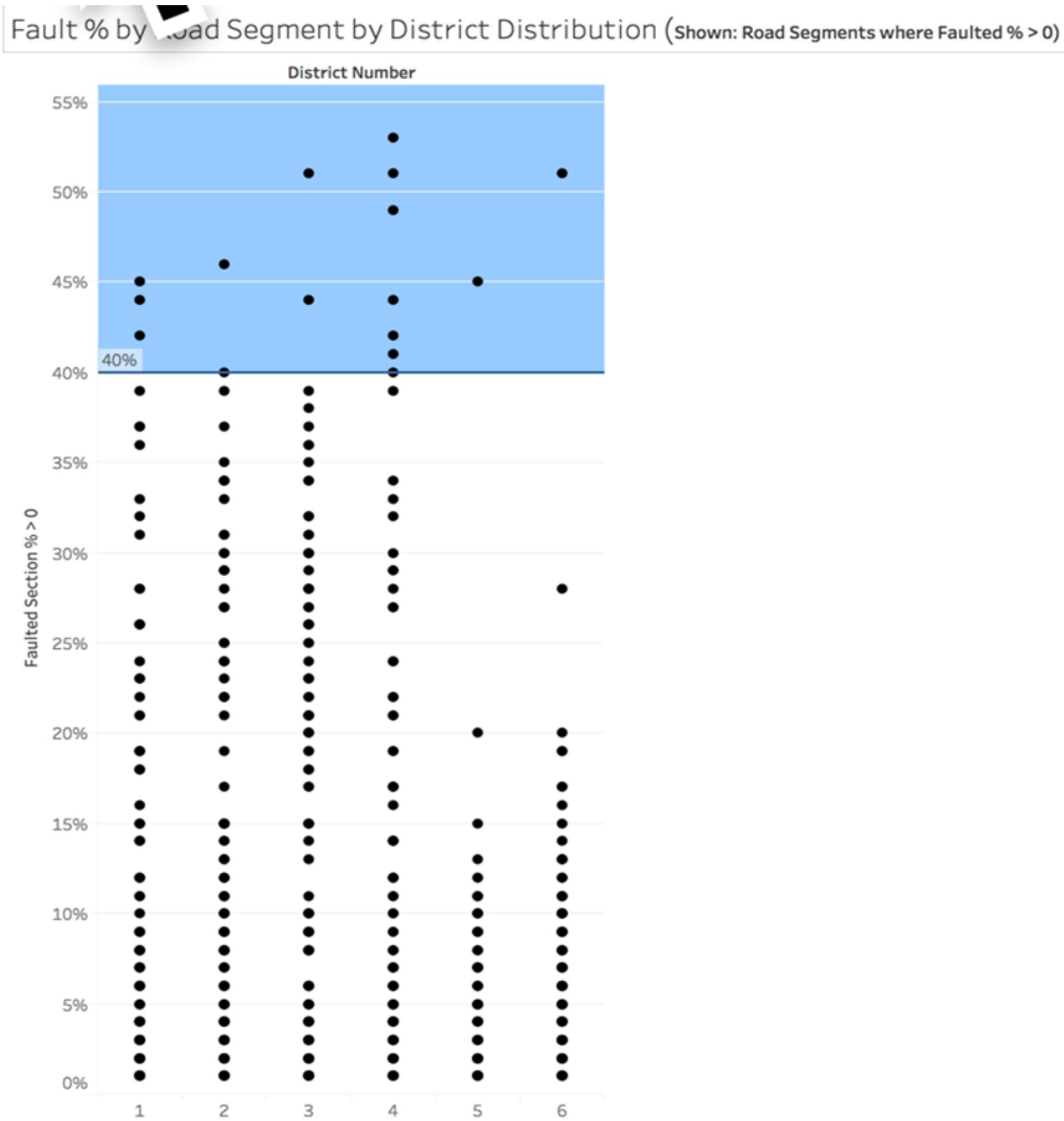


Figure 17. Faulted section percentage by district (for segments with a faulted section percentage greater than zero)

Question 2: Are There Relationships between Condition, Distress, and Traffic Variables with Respect to the Age of Road Segments and Different Types of Cracks?

As a note, the age of a road segment was calculated as the most recent resurface/construction year.

The first dashboard displays the relationships between road segment age and four types of cracks (see Figure 18). Note that the y-axis is logarithmic so that behaviors at small crack values can be observed more clearly.

Figure 18 shows charts for four types of cracks:

- Top left: High, moderate, and low severity alligator cracks
- Top right: High, moderate, and low severity long cracks
- Bottom left: High, moderate, and low severity longitudinal cracks
- Bottom right: High, moderate, and low severity transverse cracks

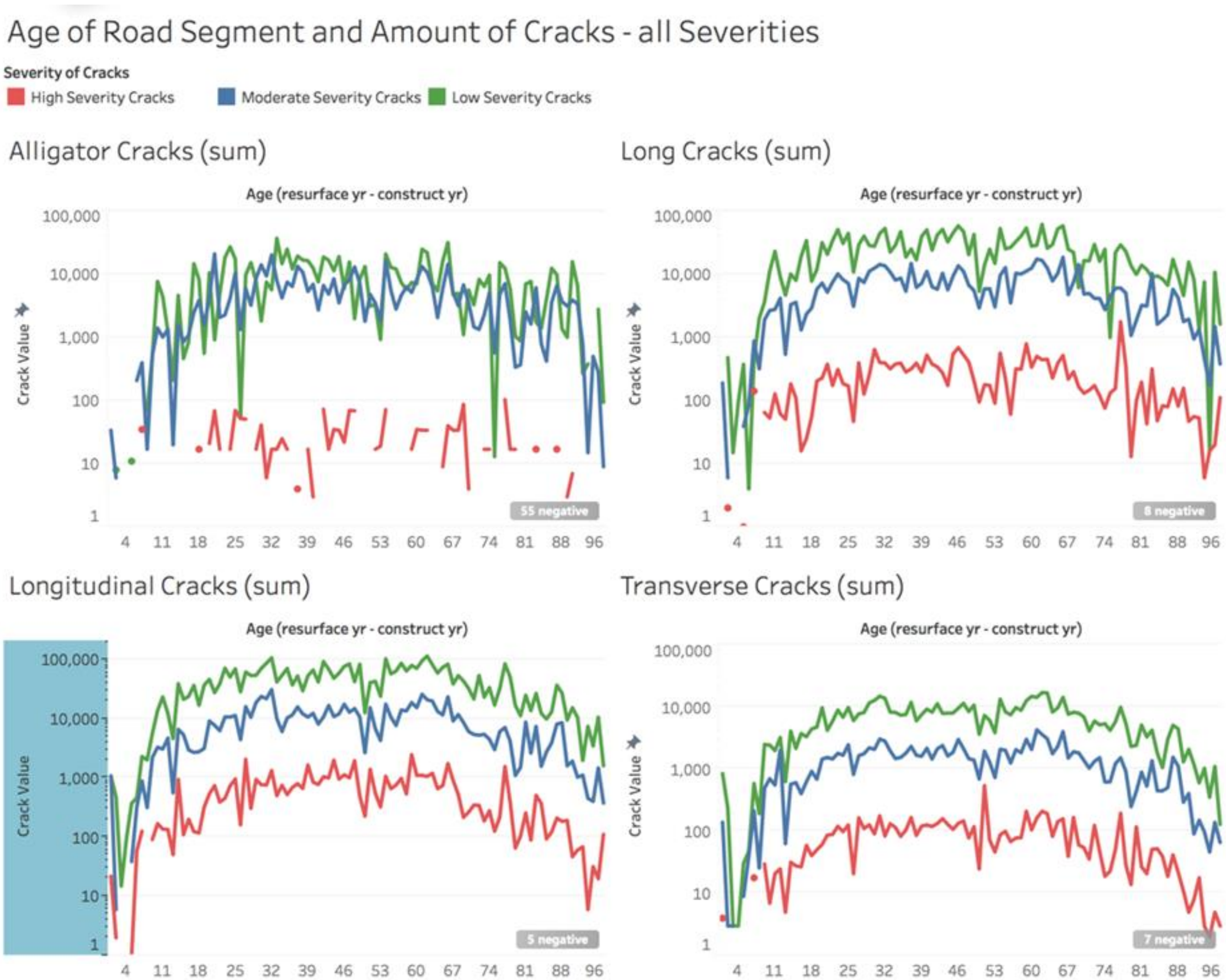


Figure 18. Crack types and severity by age of road segment

Several observations are of interest in this dashboard. First, for all crack types, cracks of low severity were most common, followed by cracks of moderate severity. The amount of severe cracking was typically very low compared to moderate and low severity cracks.

All of the crack types displayed a similar pattern of values over the age of the road segments. The amount of cracking was lower in low-age (i.e., newer) road segments, gradually rose to around 25 years, and plateaued from 25 to 80 or 90 years, at which time it declined again.

The following shows road segment age by cracking index (see Figure 19). In this chart, the cracking index declined steadily as the pavement aged (for all pavement types), with the exception that at 75 years the crack index increased by 10 points.

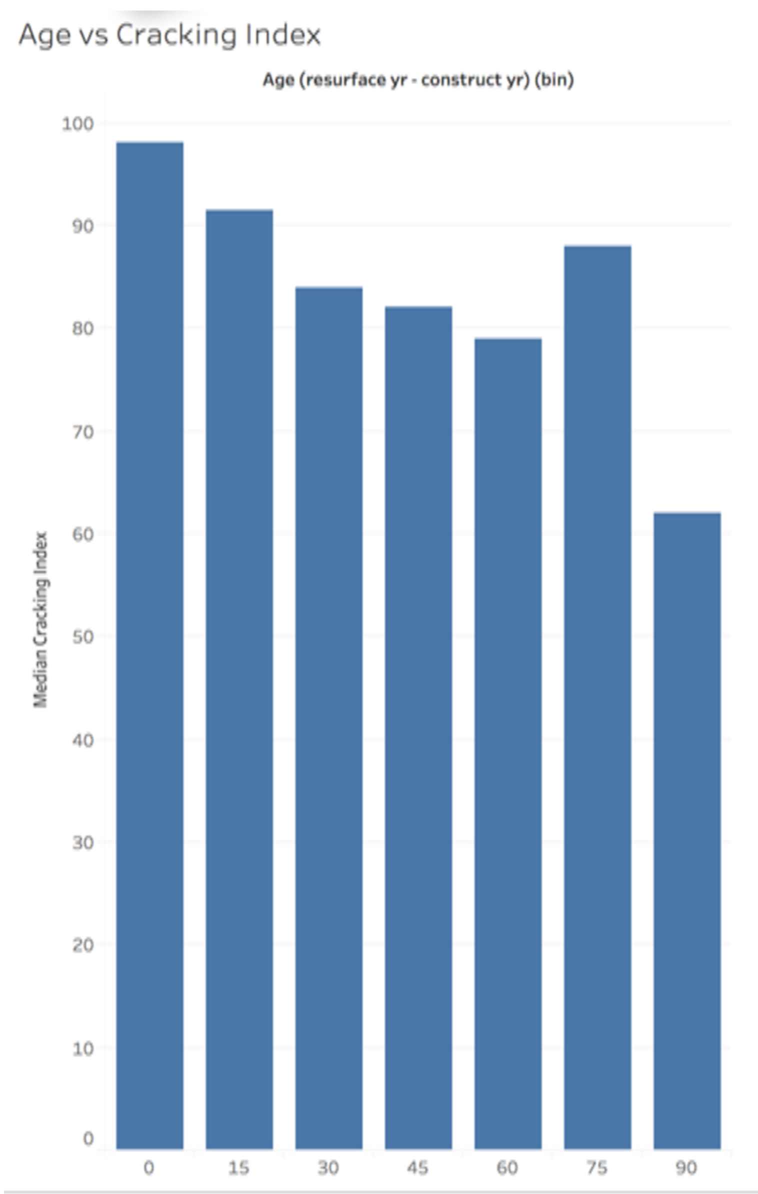


Figure 19. Age by crack index

The following shows road segment age by base thickness (see Figure 20). In this chart, base thickness declined steadily as age increased, with the exception that at a pavement age of 15 years the base thickness was higher by 1.

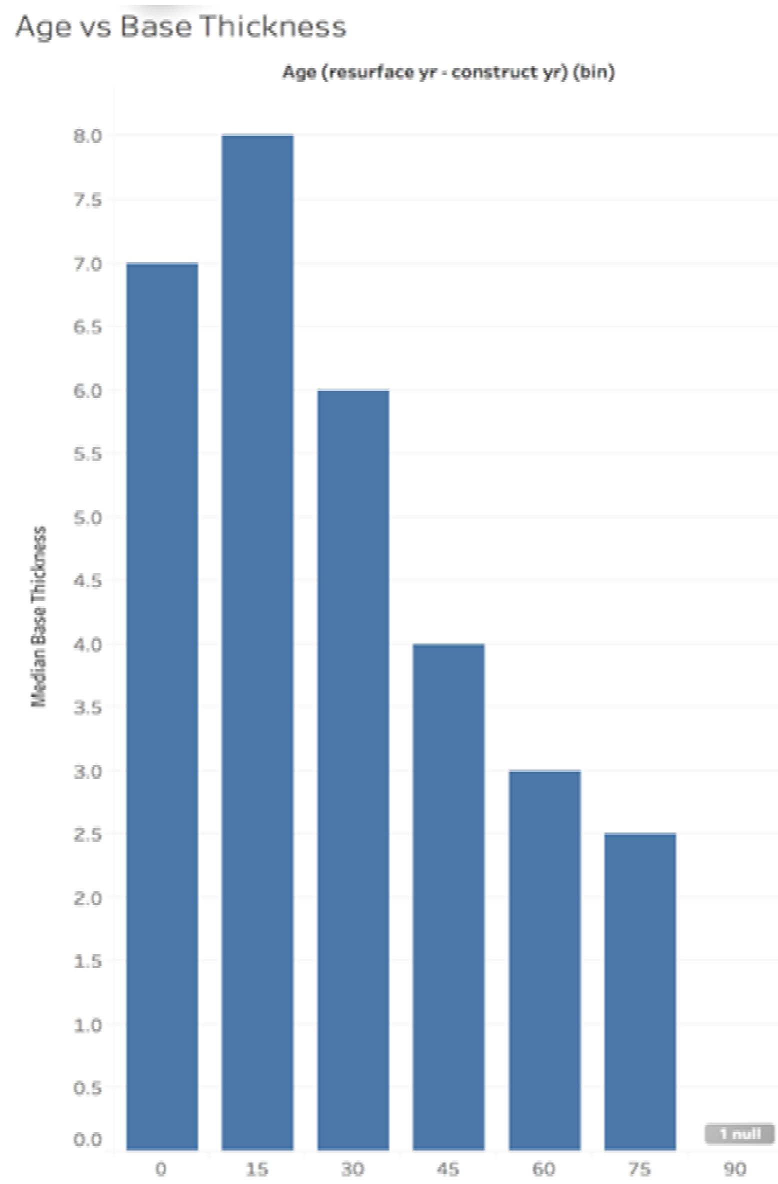


Figure 20. Age by base thickness

The following shows road segment age by pavement thickness (see Figure 21). In this chart, pavement thickness increased steadily as age increased, with the exception that at pavement ages of 30 and 45 years and 60 and 75 years thickness did not increase or decrease.

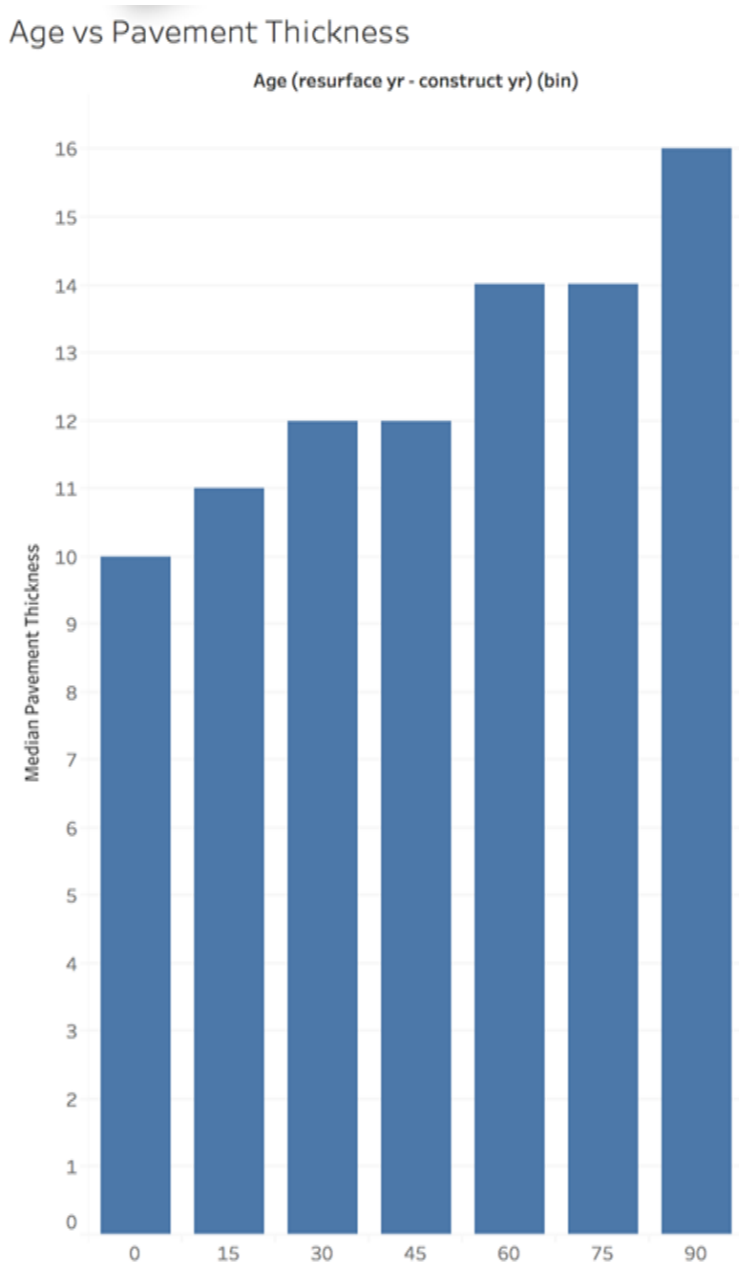


Figure 21. Age by pavement thickness

The following set of graphs shows age versus total asphalt depth and age versus total portland cement concrete (PCC) depth (see Figure 22). In both pavement types, the depth started low at a low age, rose, and then started falling around an age of 62 years. Also notable is that there were consistent, large variations throughout the age values in both pavement types. Total PCC depth exhibited this pattern more strongly than asphalt depth over the age of 63 years.

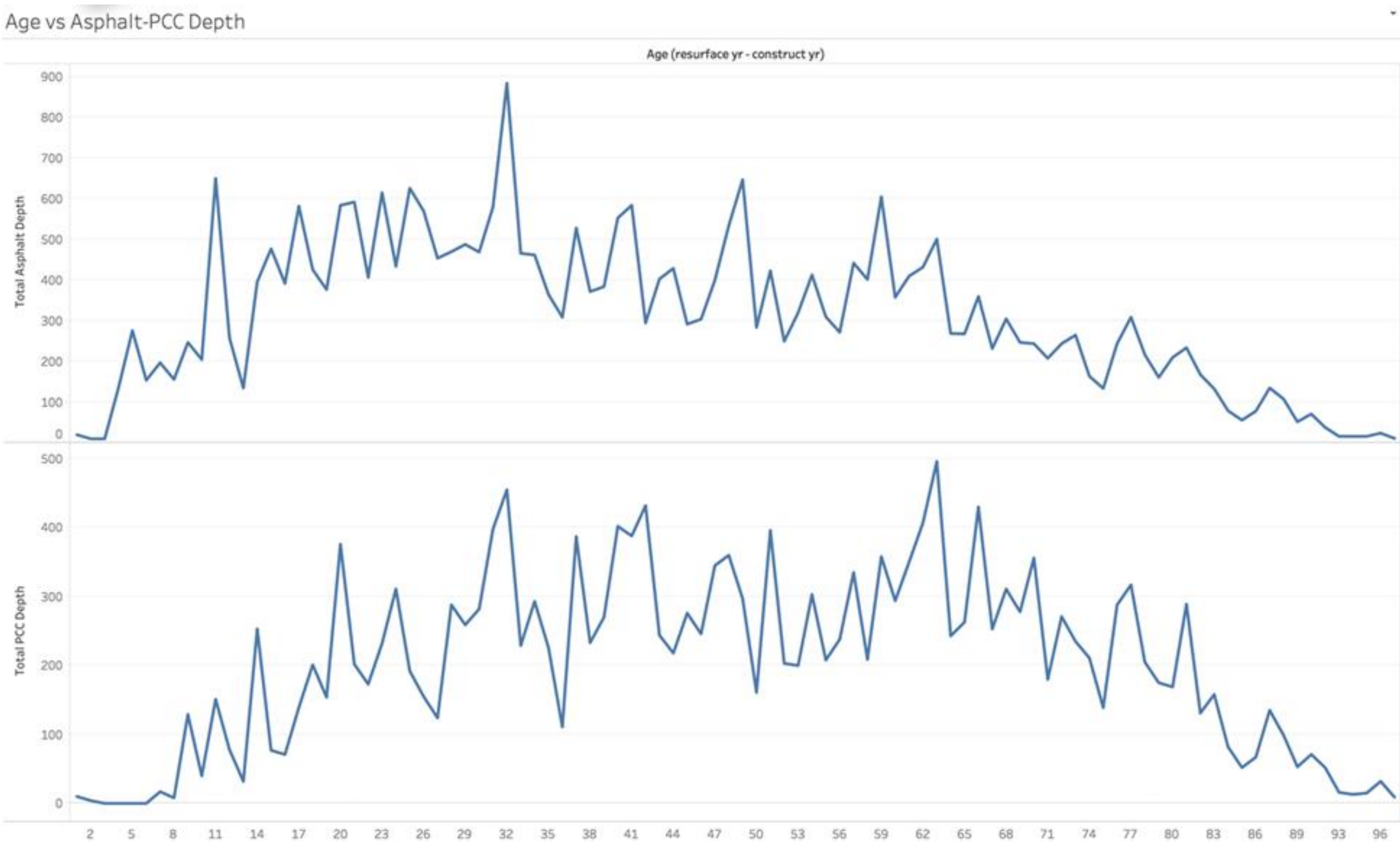


Figure 22. Age versus asphalt and PCC depth

The following shows age versus the number of road segments with the following four types of cracks at high, moderate, and low severity: alligator, long, longitudinal, and transverse (see Figure 23). It is notable that the low severity cracks tended to have the highest counts (i.e., were most common), particularly for longitudinal and transverse cracks, which spiked at an age of 32 years. High severity alligator cracks were the least common high severity crack type.

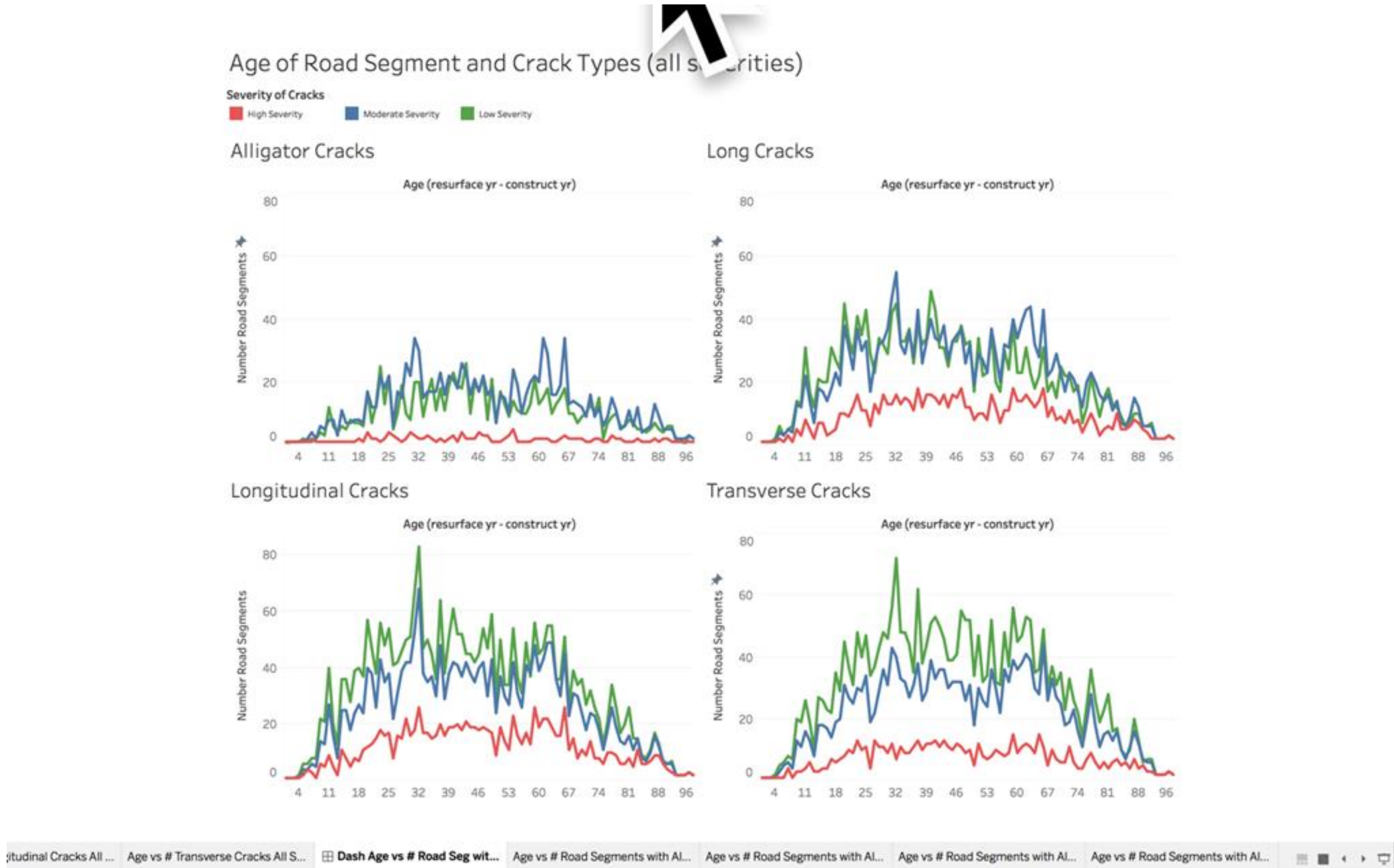


Figure 23. Age versus crack counts by severity for alligator, long, longitudinal, and transverse cracks

The following shows age versus rutting index (see Figure 24). There was no significant relationship between these two measures (R^2 = .02).

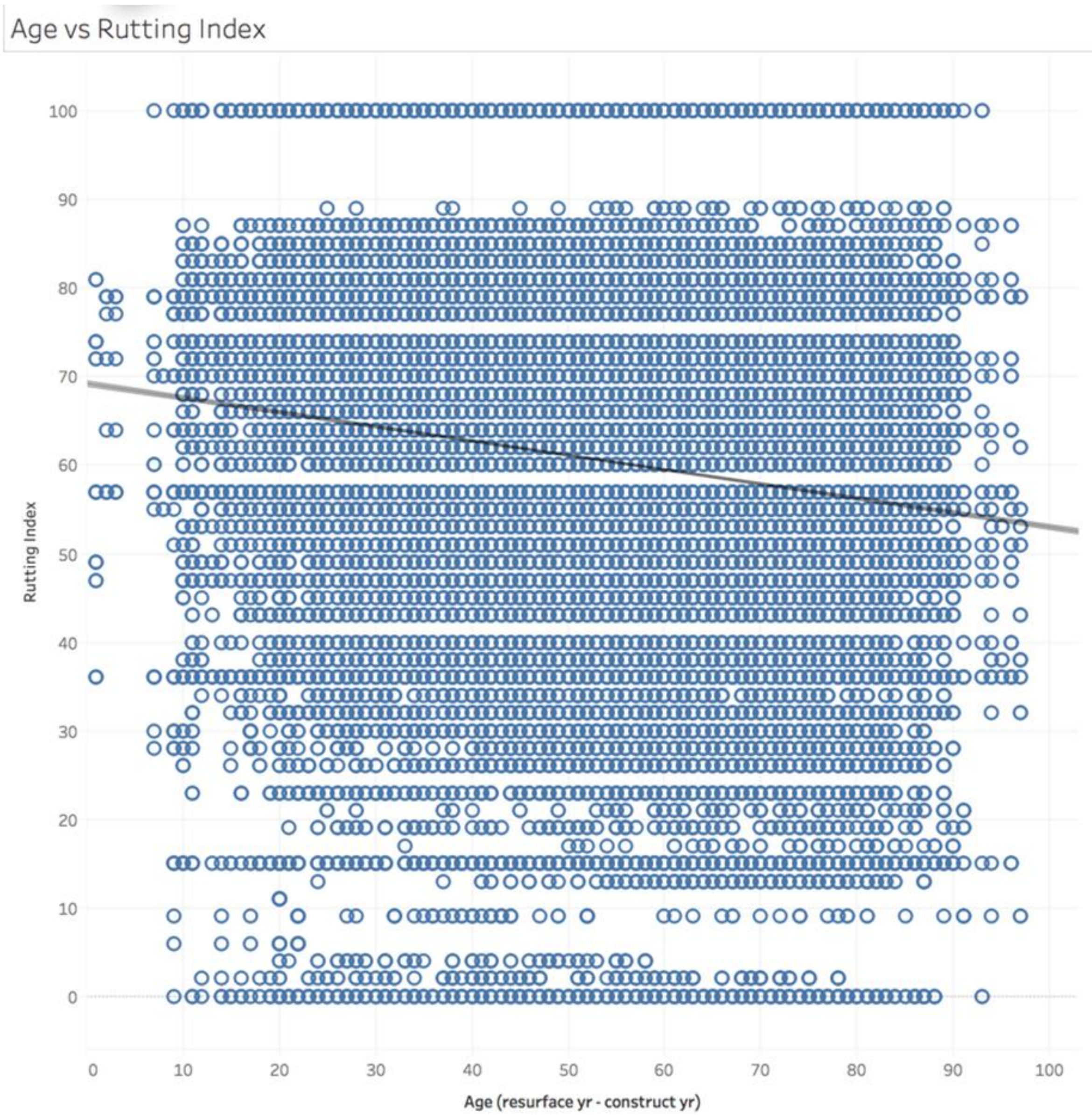


Figure 24. Age versus rutting index for all road segments with trend line

The following graph shows the average age of road segments by county (see Figure 25). There were 45 counties with road segments over the age of 50 years.

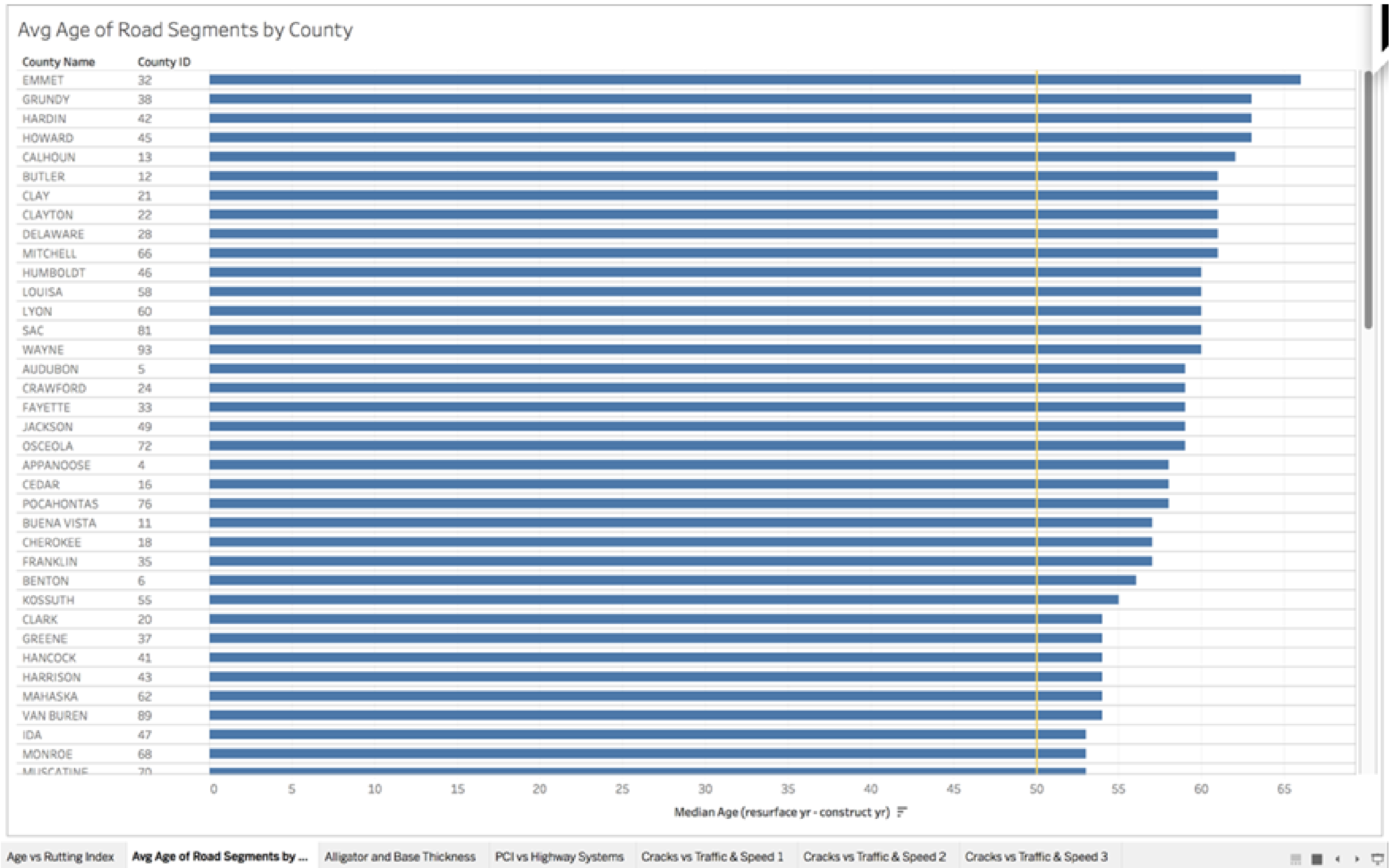


Figure 25. Average age of road segments by county

Other graphs (not included here) showed no correlation between variables:

- Alligator versus base thickness (R^2 = .0007)
- Average daily traffic versus
  - International roughness index
  - Alligator cracking index
  - Cracking index
  - Wheelpath cracking index (R^2 values < .22)
- Speed limit versus
  - International roughness index
  - Alligator cracking index
  - Cracking index
  - Wheelpath cracking index (R^2 values < .22)
- Average daily traffic versus
  - Longitudinal cracking index
  - Longitudinal wheelpath cracking index
  - Transverse cracking index (R^2 values < .06)
- Average daily trucks versus
  - Longitudinal cracking index
  - Longitudinal wheelpath cracking index
  - Transverse cracking index (R^2 values < .06)
- Speed limit versus
  - Longitudinal cracking index
  - Longitudinal wheelpath cracking index
  - Transverse cracking index (R^2 values < .04)
- Speed limit versus
  - Reconstruct 18 kips
  - Number of patches
  - Rutting index
  - Rut depth (R^2 values < .08)
- Average daily traffic versus
  - Reconstruct 18 kips
  - Number of patches
  - Rutting index
  - Rut depth (R^2 values < .48)

The following examines correlations between several variables: reconstruct 18 kips, number of patches, rutting index, rut depth versus speed limit, average daily traffic, and average daily trucks (Figure 26). None of the correlations (R^2) were greater than .50 (50%) except average daily truck versus reconstruct 18 kips, which had an R^2 of .94 (see lower left quadrant of Figure 26).

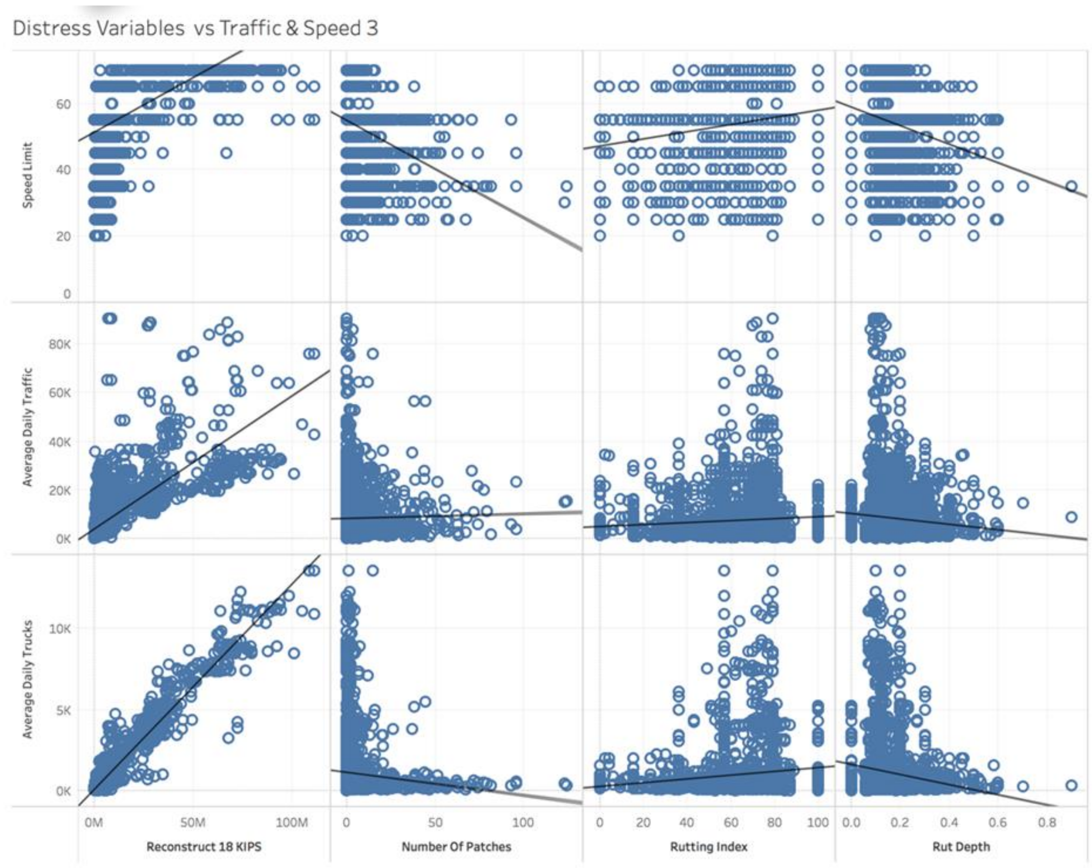


Figure 26. Correlations between reconstruct 18 kips, number of patches, rutting index versus speed limit, average daily traffic, and average daily trucks

The following shows PCI for 2013, 2014, and 2015 by highway system (see Figure 27). The PCI for each system was consistent over the three years, but between systems it varied. PCI vales were lowest for Highway System C and highest for Highway System Y.

Figure 27. PCI for highway systems C, N, and Y from 2013 to 2015

The following shows the districts that are responsible for 80% of selected crack indices (see Figures 28 and 29). Table 2 summarizes the findings.

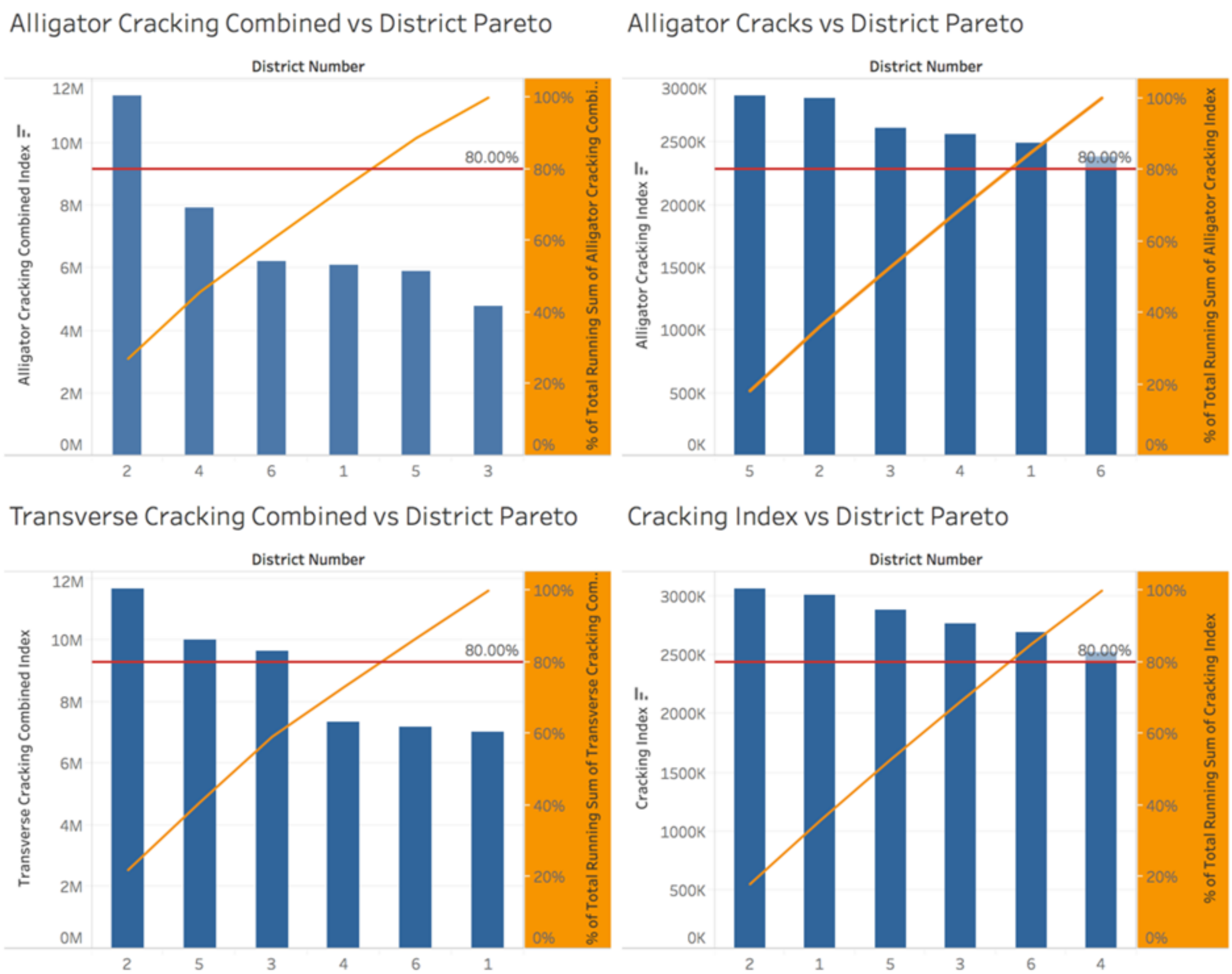


Figure 28. Districts responsible for 80% of alligator, alligator combined, transverse combined, and cracking indices

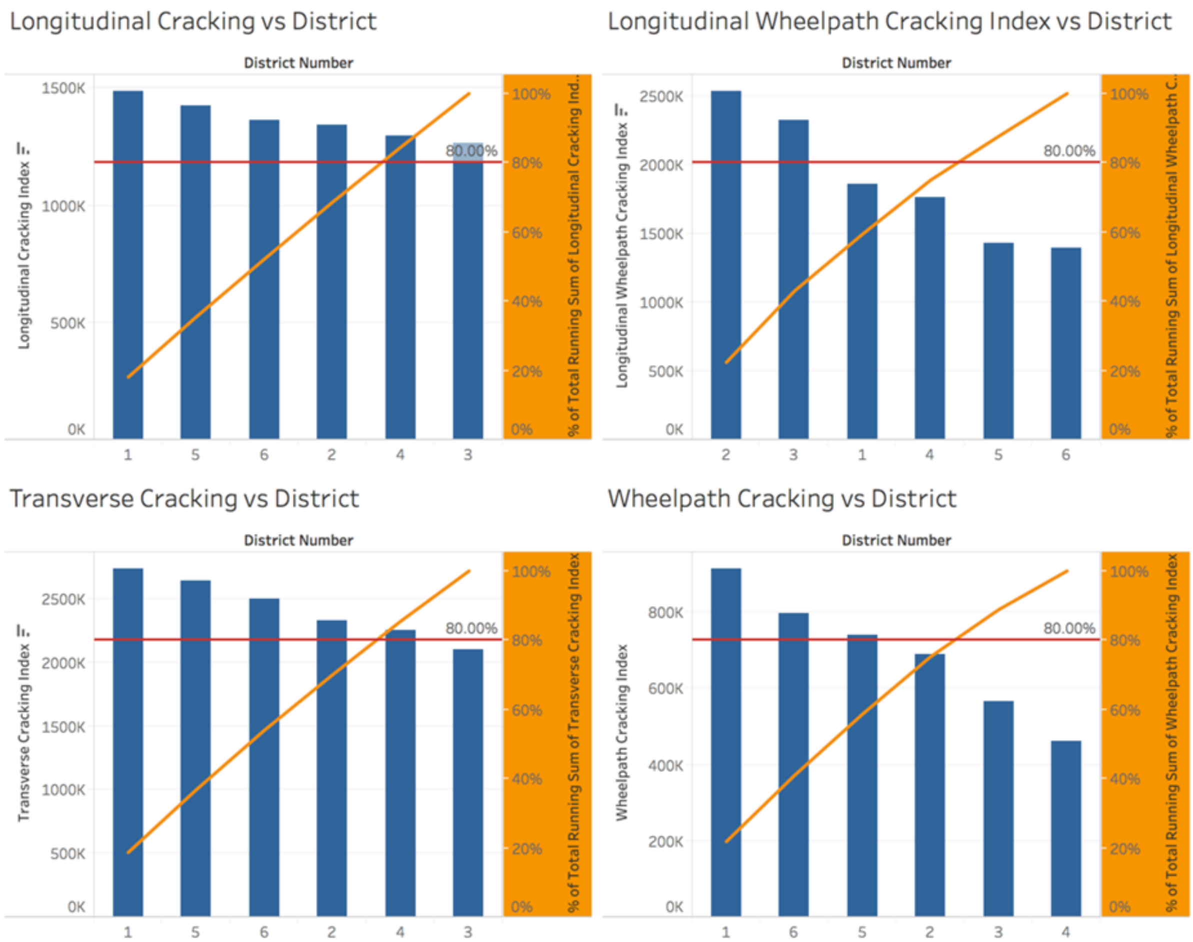


Figure 29. Districts responsible for 80% of longitudinal, longitudinal wheelpath, transverse, and wheelpath cracking indices

Table 2. Districts responsible for 80% of crack index

Crack Index	Counties Responsible for 80% of Index (Ordered by Descending Contribution)
Alligator cracking index	5, 2, 3, 4
Alligator cracking combined index	2, 4, 6, 1
Cracking index	2, 1, 5, 3
Longitudinal cracking index	1, 5, 6, 2
Longitudinal wheelpath cracking index	2, 3, 1, 4
Transverse cracking index	1, 5, 6, 2
Transverse cracking combined index	2, 5, 3, 4
Wheelpath cracking index	1, 6, 5, 2

The following shows the districts that are responsible for 80% of high severity crack indices (see Figure 30). Table 3 summarizes the findings.

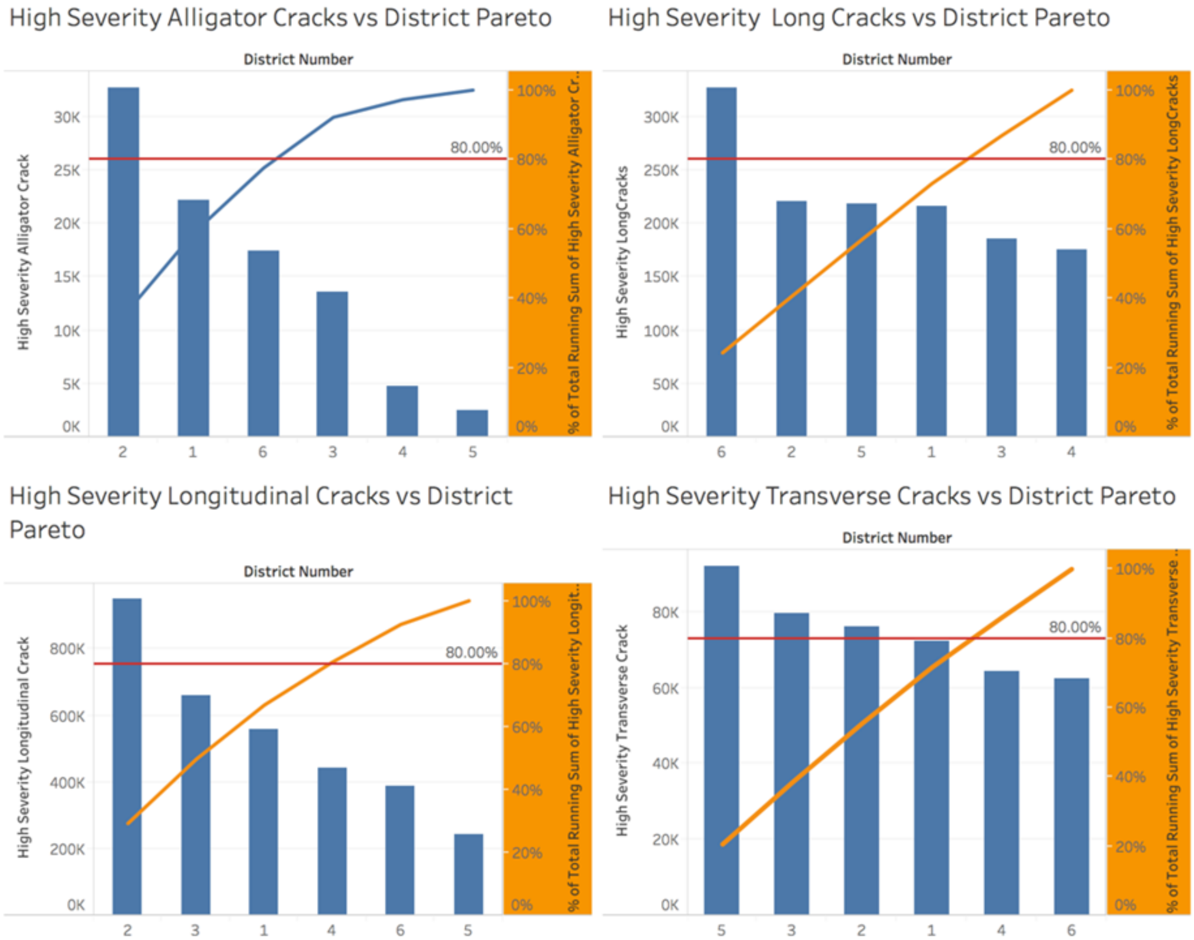


Figure 30. Districts responsible for 80% of high severity cracks

Table 3. Districts responsible for 80% of selected high severity cracks

High Severity Crack Index	**Counties Responsible for 80% of Index (Ordered by Descending Contribution)**
Alligator cracks	2, 1, 6
Long cracks	6, 2, 5, 1
Longitudinal cracks	2, 3, 1, 4 (note: 80% reached in first part of District 4)
Transverse cracks	5, 3, 2, 1

The following shows the number of districts responsible for 80% of each of the four types of moderate severity cracks (see Figure 31). Table 4 summarizes the findings.

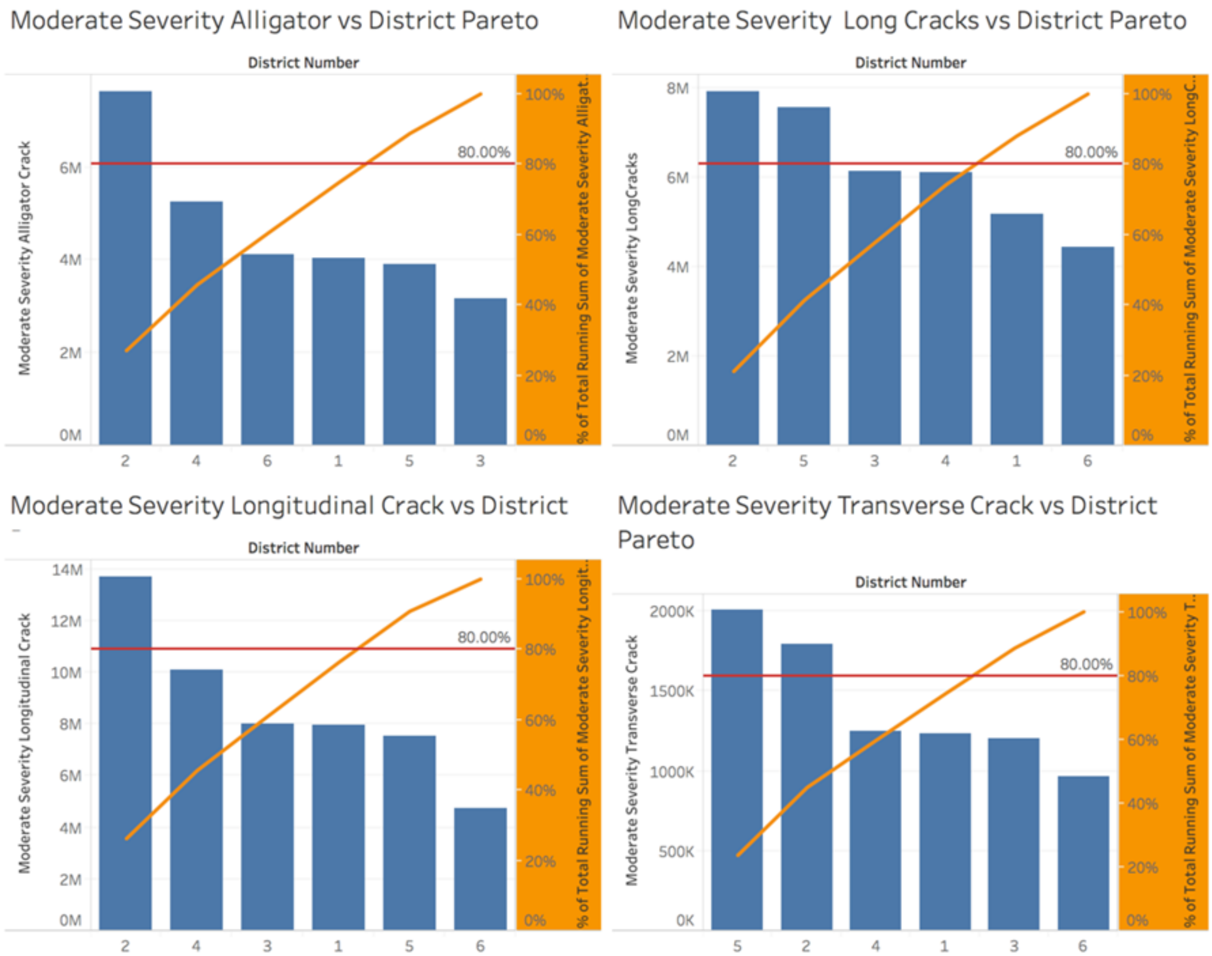


Figure 31. Districts responsible for 80% of moderate severity cracks

Table 4. Districts responsible for 80% of moderate severity cracks

Moderate Severity Crack Index	Counties Responsible for 80% of Index (Ordered by Descending Contribution)
Alligator cracks	2, 4, 6, 1
Long cracks	2, 5, 3, 4
Longitudinal cracks	2, 4, 3, and most of 1
Transverse cracks	5, 2, 4, 1

The following shows the number of districts responsible for 80% of each of the four types of low severity cracks (see Figure 32). Table 5 summarizes the findings.

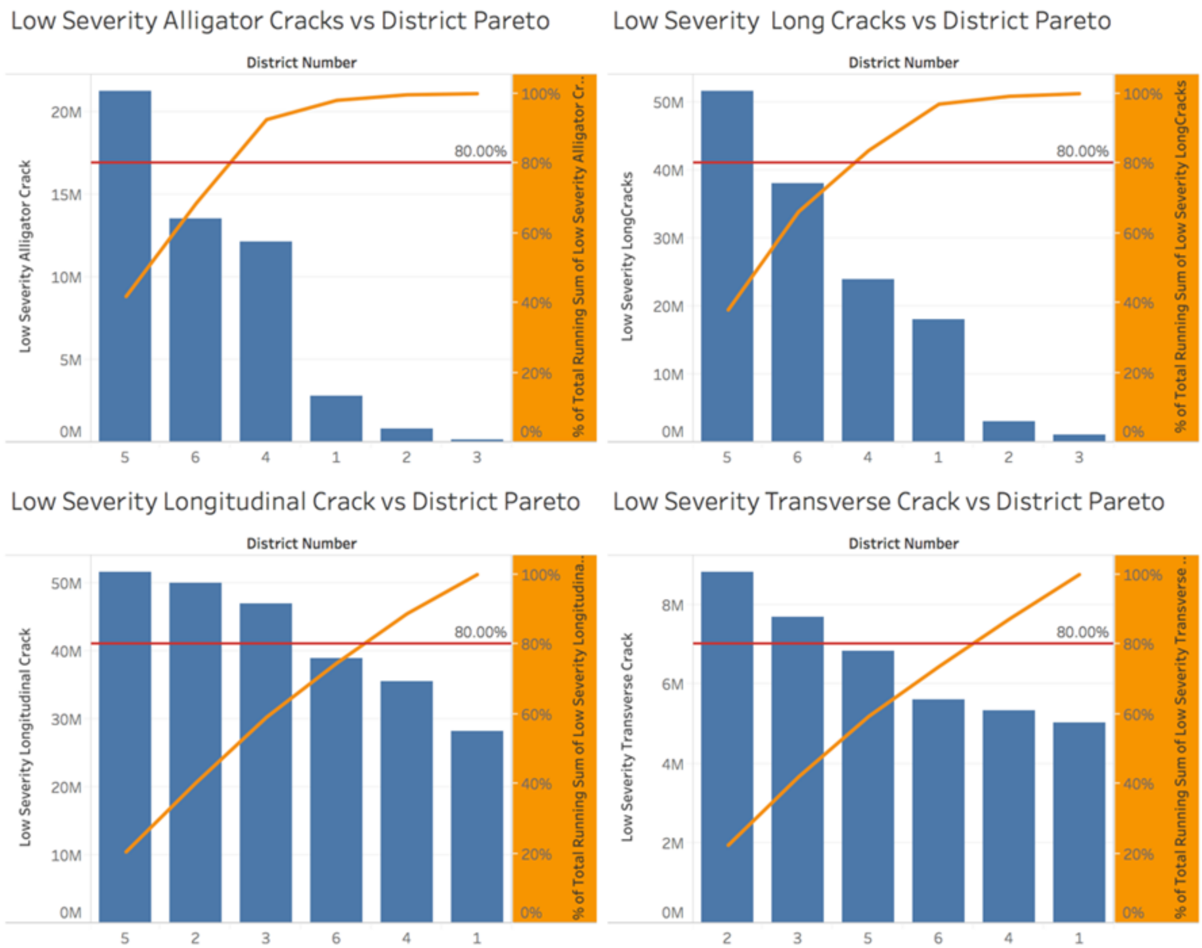


Figure 32. Districts responsible for 80% of low severity cracks

Table 5. Districts responsible for 80% of low severity cracks

Low Severity Crack Index	Counties Responsible for 80% of Index (Ordered by Descending Contribution)
Alligator cracks	5 and 6
Long cracks	5, 6, and part of 4
Longitudinal cracks	5, 2, 3, 6
Transverse cracks	2, 3, 5, 6

The following represents a visual analysis of various traffic data measures, including accumulated kips since resurfacing, annual 18 kips, average daily traffic, average daily trucks, and reconstruct 18 kips, versus several indices (see Figure 33 for representative reconstruct 18 kips versus selected indices). No relationships were supported, with R^2 values less than 0.14.

Figure 33. Relationships between traffic data measures and selected indices

The following shows two relationships (see Figure 34). The first plot shows a relationship between average daily trucks and reconstruct 18 kips, which is significant, with an R^2 value of .94. The second shows no significant relationship between rutting index and reconstruct 18 kips.

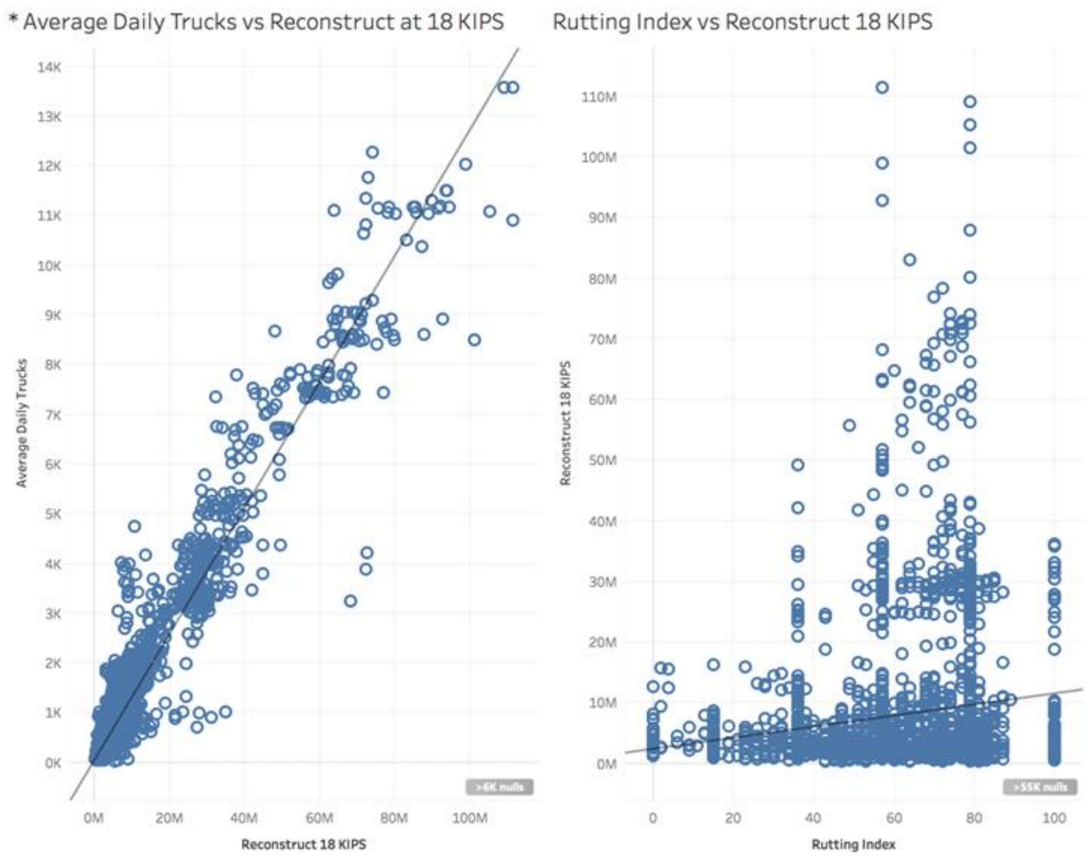


Figure 34. Relationship between traffic data measures and selected indices

The following shows the relationship between high severity and low severity cracks versus county (see Figure 35). Note that the y-axis scale is not the same for each crack type. The reference lines for each graph show the graph's average. As can be seen, there were counties that appear to have many above-average crack counts. However, it should be noted that because the y-axis range is different for each graph, comparisons between them are not valid.

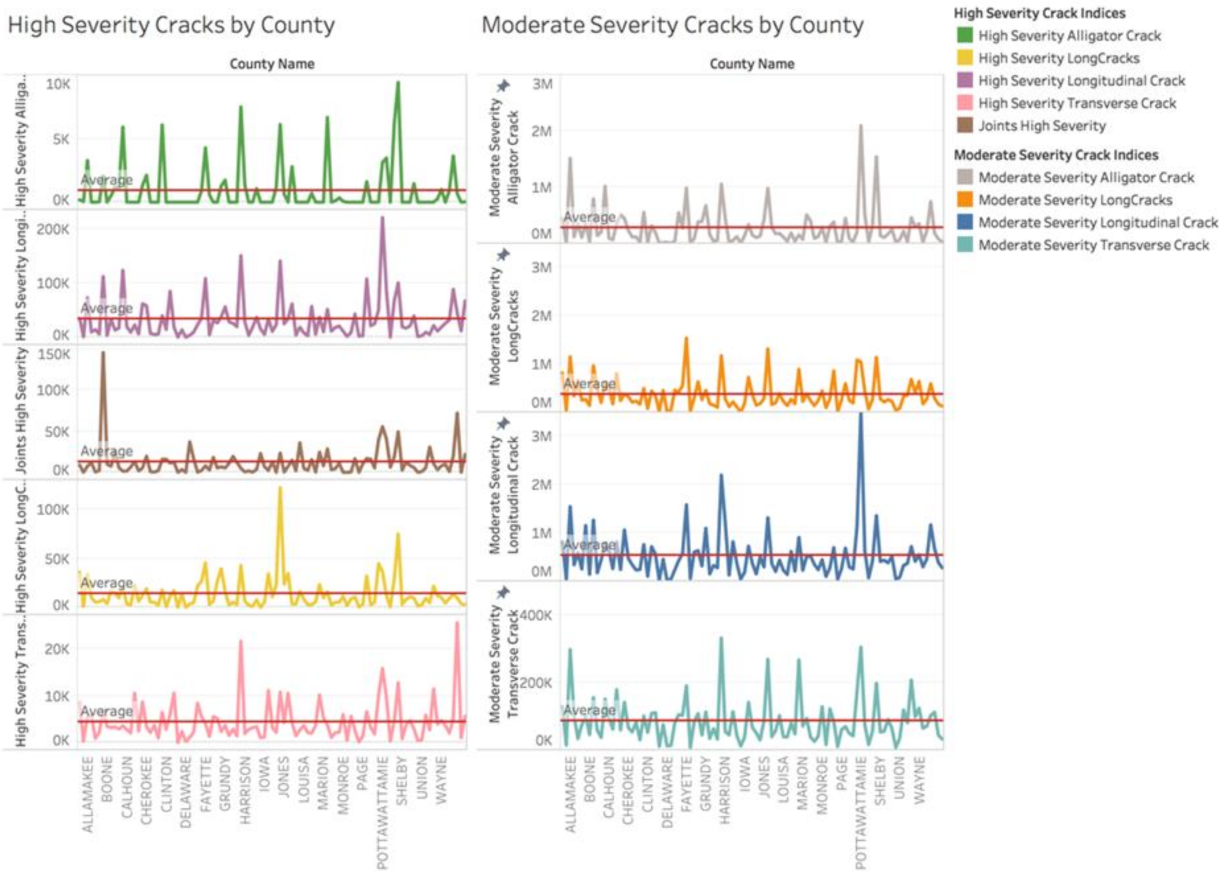


Figure 35. Relationship between moderate and high severity cracks by county

Question 3: What is the State of Counties and County Types and Districts, with Respect to Condition and Distress Data?

The condition and distress data were visually explored for ways in which they varied by county, county type (urban or rural), and district. The Iowa counties were grouped into five types (based on their size and proximity to large cities) using a typology developed by the Iowa Legislature and U.S. Census data from 1970 to 2010 (Iowa Legislature 2017).

The five types include the following:

1. Central city metropolitan (9 counties): These counties are defined by the federal Office of Management and Budget (OMB) as metropolitan. They contain an urban core population of at least 50,000 people.
2. Outlying metropolitan (11 counties): These counties are defined by the OMB as metropolitan, but they are adjacent to, but do not contain, the urban core. They have a high degree of social and economic integration with the core, as measured by commuting patterns.

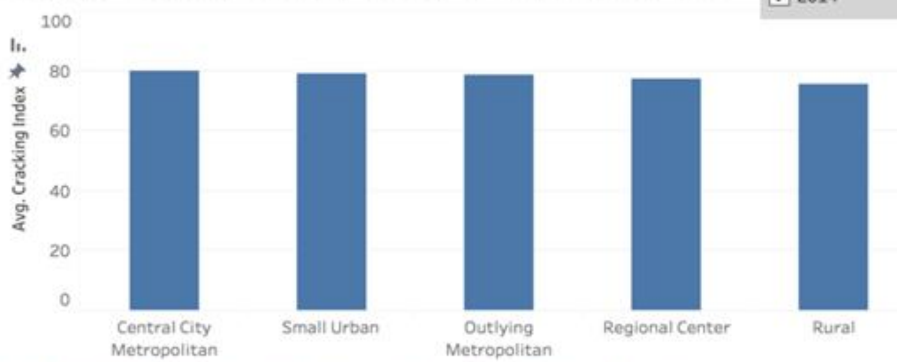
3. Regional centers (17 counties): These counties are defined by the OMB as micropolitan areas. They contain an urban core of at least 10,000 and fewer than 50,000 people or are adjacent to the urban core and have a high degree of social and economic integration with it.
4. Small urban (24 counties): These counties are non-metropolitan/micropolitan areas whose largest town has at least 5,000 and fewer than 10,000 residents.
5. Rural (38 counties): These counties are non-metropolitan/micropolitan areas whose largest town has fewer than 5,000 residents.

The following charts show the condition and distress measures by county type for a chosen pavement management information system (PMIS) year, with drilldown into specific counties that represent a given county type (see Figure 36). Drilldown data are shown for specific condition indices and distress data (see Figure 37). Condition indices shown include average, alligator, alligator compound, longitudinal, longitudinal wheelpath, transverse, and transverse combined cracking, as well as PCI. Distress indices (high, moderate, and low severities) include alligator cracking, long cracking, longitudinal cracking, transverse cracking, joints, and joint spalling.

Condition & Distress by County Type

Pick PMIS Year
(All)
2013
2014

Average Cracking Index by County Urban/Rural by Year



Condition Drill Down Indices by County Urban/Rural

	Alligator Cr..	Alligator Cr..	Longitudin..	Longitudin..	Longitudin..	Transverse ..	Transverse ..	Wheelpath ..	PCI for cho..
Central City ..	52,855	131,785	29,211	676,776	36,793	145,643	73,698	31,779	60,848
Outlying Met..	31,655	85,506	17,470	404,256	22,481	97,735	32,545	10,901	30,654
Regional Cen..	39,746	67,020	21,000	532,248	28,115	142,848	46,374	20,077	43,445
Rural	74,623	225,648	37,415	904,972	54,640	266,192	61,996	15,791	64,907
Small Urban	52,929	158,127	28,553	575,288	39,799	174,857	52,358	18,193	50,747

Condition Drill Down Indices by County Urban/Rural

	Faulting index	IRI Index	International Ro..	Rutting Index	PCI for chosen Y..
Central City Metropolitan	21,122	48,139	122,900	33,377	60,848
Outlying Metropolitan	7,394	26,374	52,167	19,663	30,654
Regional Center	14,656	36,252	80,827	25,168	43,445
Rural	12,434	56,565	109,130	47,966	64,907
Small Urban	12,287	42,533	90,050	33,617	50,747

Distress High Severity Drill Down Indices by County Urban/Rural

	High Severity Alligator ..	High Severity LongCracks	High Severity Longitudi..	High Severity Transverse..	Joints High Severity	Joints High Severity Spalling
Central City ..	315.0	6,134.0	13,646.0	1,862.0	9,824.0	2,077.0
Outlying Met..	64.0	2,062.0	4,119.0	761.0	1,501.0	527.0
Regional Cen..	172.0	2,423.0	5,341.0	1,098.0	4,204.0	1,343.0
Rural	476.0	6,839.0	17,762.0	2,067.0	5,304.0	1,367.0
Small Urban	458.0	4,818.0	13,835.0	1,748.0	4,714.0	1,822.0

Distress Moderate Severity Drill Down Indices by County Urban/Rural

	Joints High Severity Spalling	Joints Moderate Severity	Moderate Severity Alligator Crack	Moderate Severity LongCracks	Moderate Severity Longitudinal Crack	Moderate Severity Transverse Crack
Central City ..	$2,077.0	$5,368.0	$87,385.0	$88,328.0	$161,042.0	$21,037.0
Outlying Met..	$527.0	$1,622.0	$56,882.0	$66,267.0	$100,241.0	$15,416.0
Regional Cen..	$1,343.0	$1,924.0	$44,415.0	$78,144.0	$100,101.0	$20,639.0
Rural	$1,367.0	$3,111.0	$149,708.0	$208,128.0	$269,063.0	$44,359.0
Small Urban	$1,822.0	$3,514.0	$104,750.0	$139,803.0	$182,666.0	$28,760.0

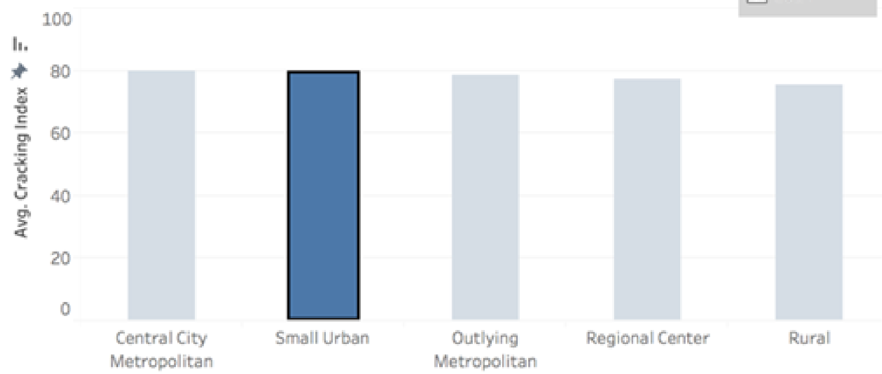
Distress Low Severity Drill Down Indices by County Urban/Rural

	Low Severity Alligator Crack	Low Severity LongCracks	Low Severity Longitudinal Crack	Low Severity Transverse Crack
Central City Met..	126,666.0	531,881.0	760,592.0	110,189.0
Outlying Metrop..	111,890.0	300,661.0	463,157.0	72,996.0
Regional Center	96,871.0	410,086.0	691,306.0	109,563.0
Rural	285,638.0	578,927.0	1,263,266.0	195,310.0
Small Urban	164,003.0	355,830.0	800,994.0	128,086.0

Figure 36. Condition and distress data for county types by PMIS year

Condition & Distress by County Type

Average Cracking Index by County Urban/Rural by Year



Pick PMIS Year
- ☑ (All)
- ☑ 2013
- ☑ 2014

Condition Drill Down Indices by County Urban/Rural

	Alligator Cracking Index	Alligator Cracking Combined I..	Longitudinal Cracking Index	Longitudinal Wheelpath Combined I..	Longitudinal Wheelpath Cracking In..	Transverse Cracking Combined I..	Transverse Cracking Index	Wheelpath Cracking Index	PCI for chosen Year (PMIS Year)
Small Urban	52,929	158,127	28,553	575,288	39,799	174,857	52,358	18,193	50,747

Condition Drill Down Indices by County Urban/Rural

	Faulting Index	IRI Index	International Roughness Index	Rutting Index	PCI for chosen Year (PMIS Year)
Small Urban	12,287	42,533	90,050	33,617	50,747

Distress High Severity Drill Down Indices by County Urban/Rural

	High Severity Alligator ..	High Severity LongCracks	High Severity Longitudi..	High Severity Transverse..	Joints High Severity	Joints High Severity Spalling
Small Urban	458.0	4,818.0	13,835.0	1,748.0	4,714.0	1,822.0

Distress Moderate Severity Drill Down Indices by County Urban/Rural

	Joints High Severity Spalling	Joints Moderate Severity	Moderate Severity Alligator Crack	Moderate Severity LongCracks	Moderate Severity Longitudinal Crack	Moderate Severity Transverse Crack
Small Urban	$1,822.0	$3,514.0	$104,750.0	$139,803.0	$182,666.0	$28,760.0

Distress Low Severity Drill Down Indices by County Urban/Rural

	Low Severity Alligator Crack	Low Severity LongCracks	Low Severity Longitudinal Crack	Low Severity Transverse Crack
Small Urban	164,003.0	355,830.0	800,994.0	128,086.0

Figure 37. Drilldown on condition and distress data for small urban/rural counties by PMIS year

The following shows visual charts for condition and distress data for county types by chosen PMIS year (see Figure 38). Drilldown shows details on the selected condition indices and high, moderate, and low severity distress data (see Figure 39).

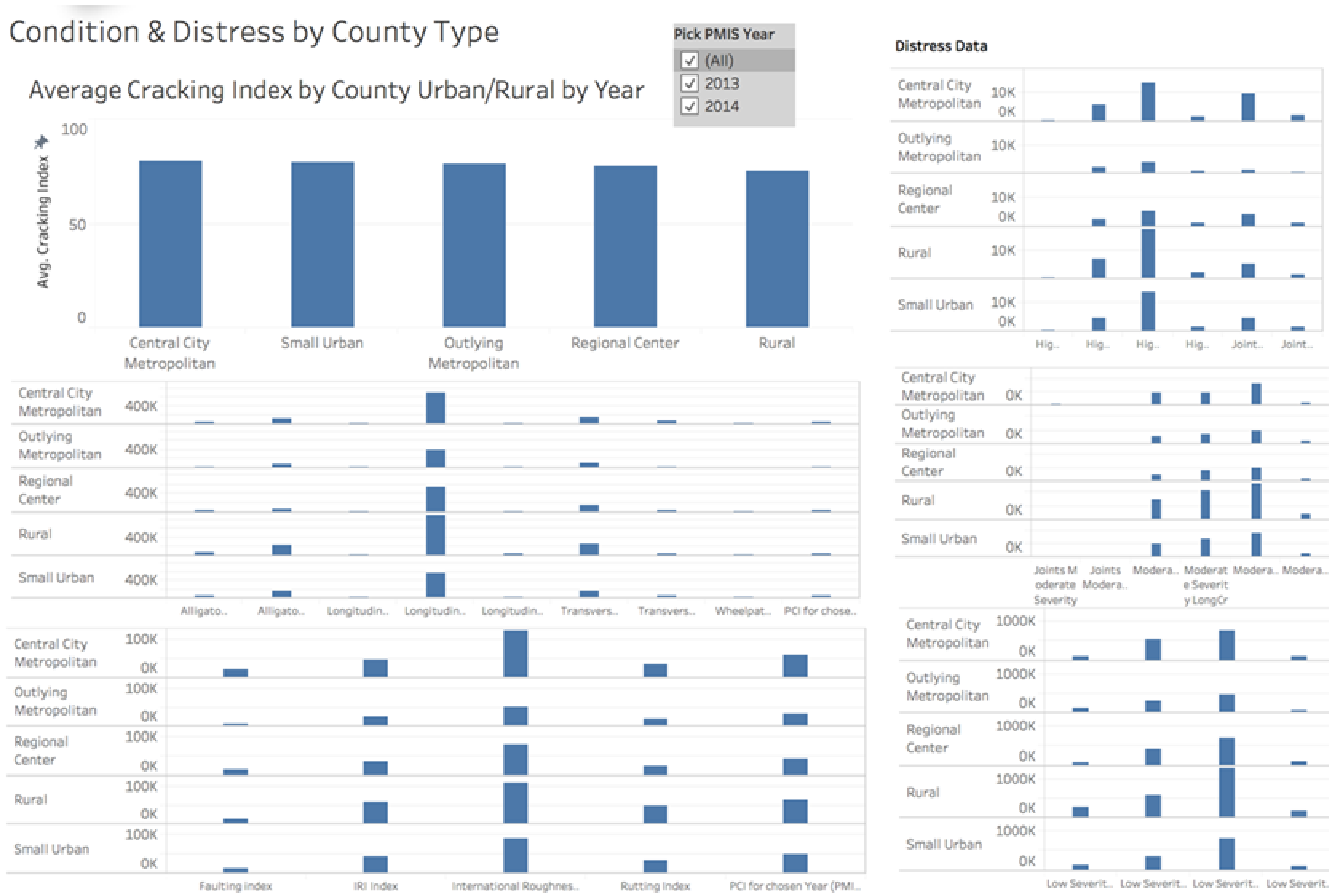


Figure 38. Visible condition and distress data for county types by PMIS year

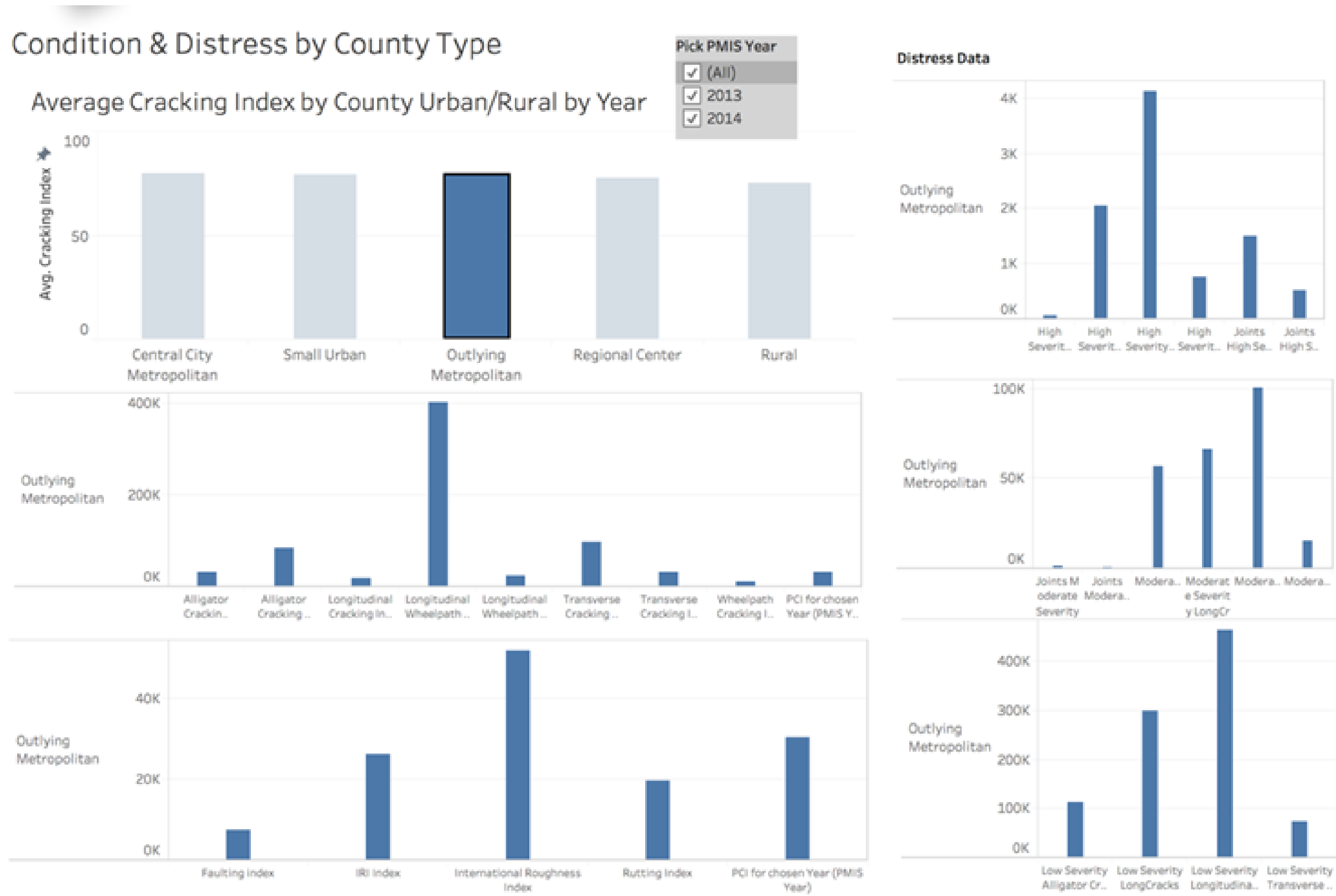


Figure 39. Drilldown on visible condition and distress data for small urban/rural counties by PMIS year

Several trends can be seen when drilling down on each county type (see Figures 40 through 44). Findings are summarized in Table 6.

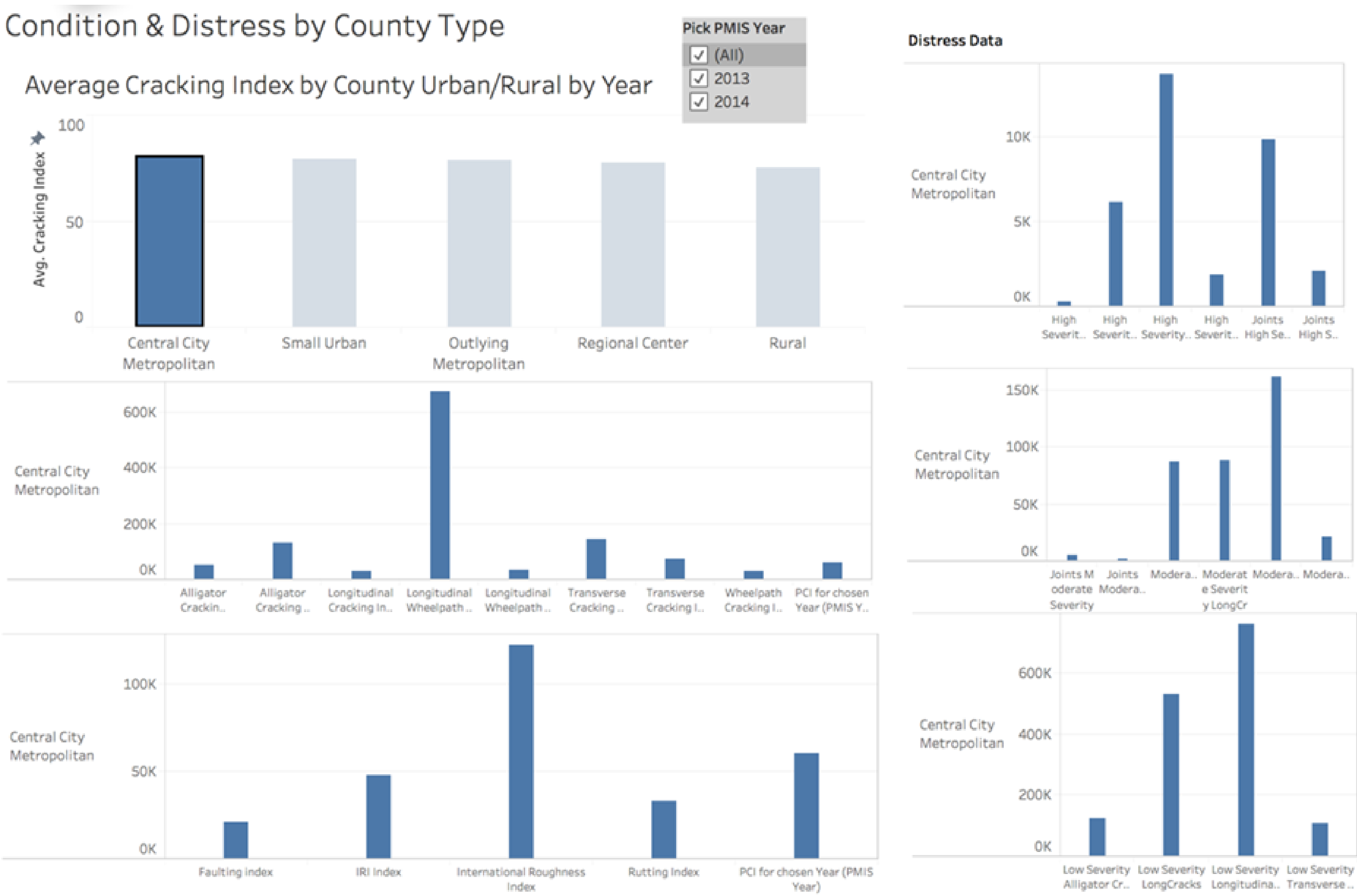


Figure 40. Drilldown on visible condition and distress data for central city metropolitan counties

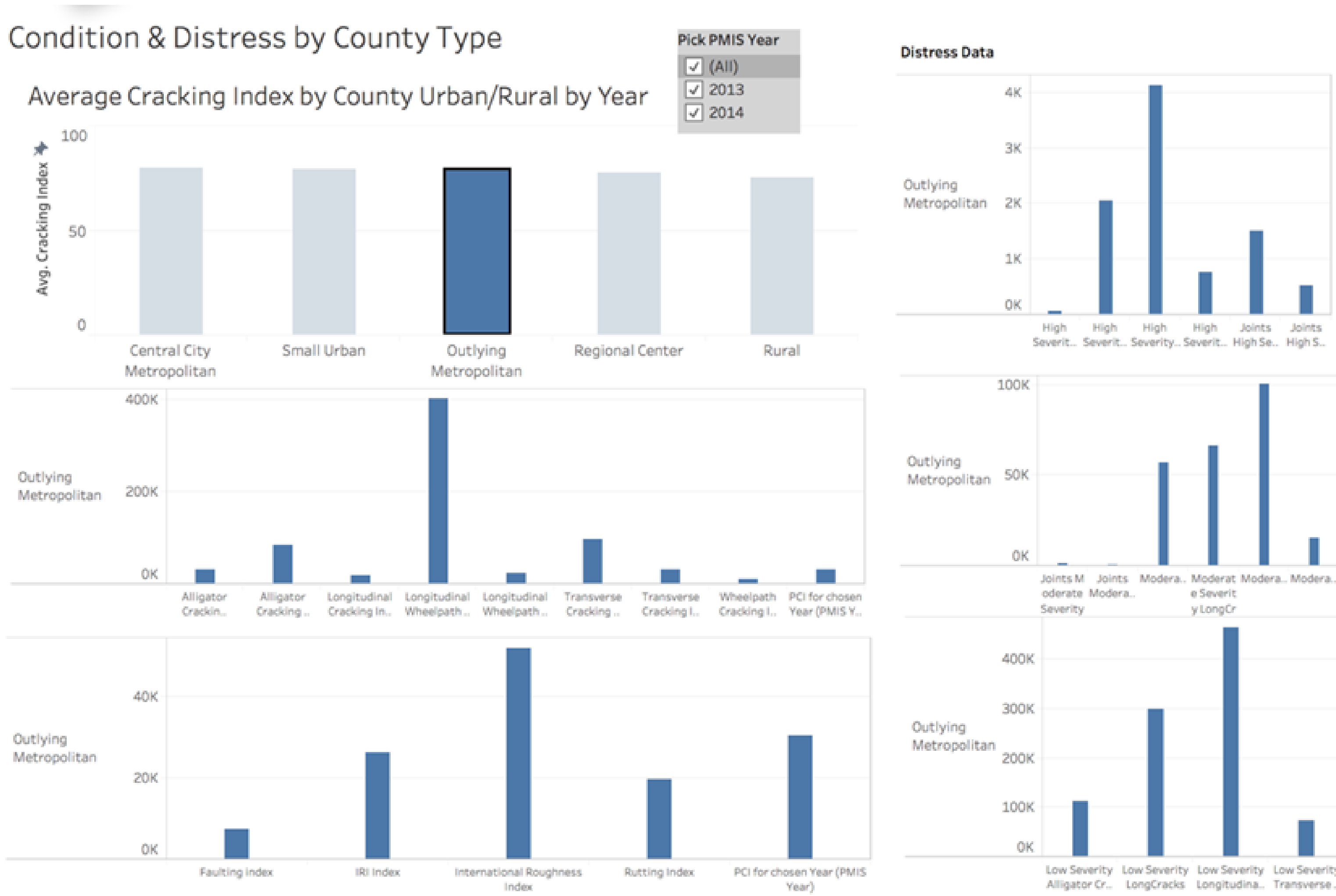


Figure 41. Drilldown on visible condition and distress data for outlying metropolitan counties

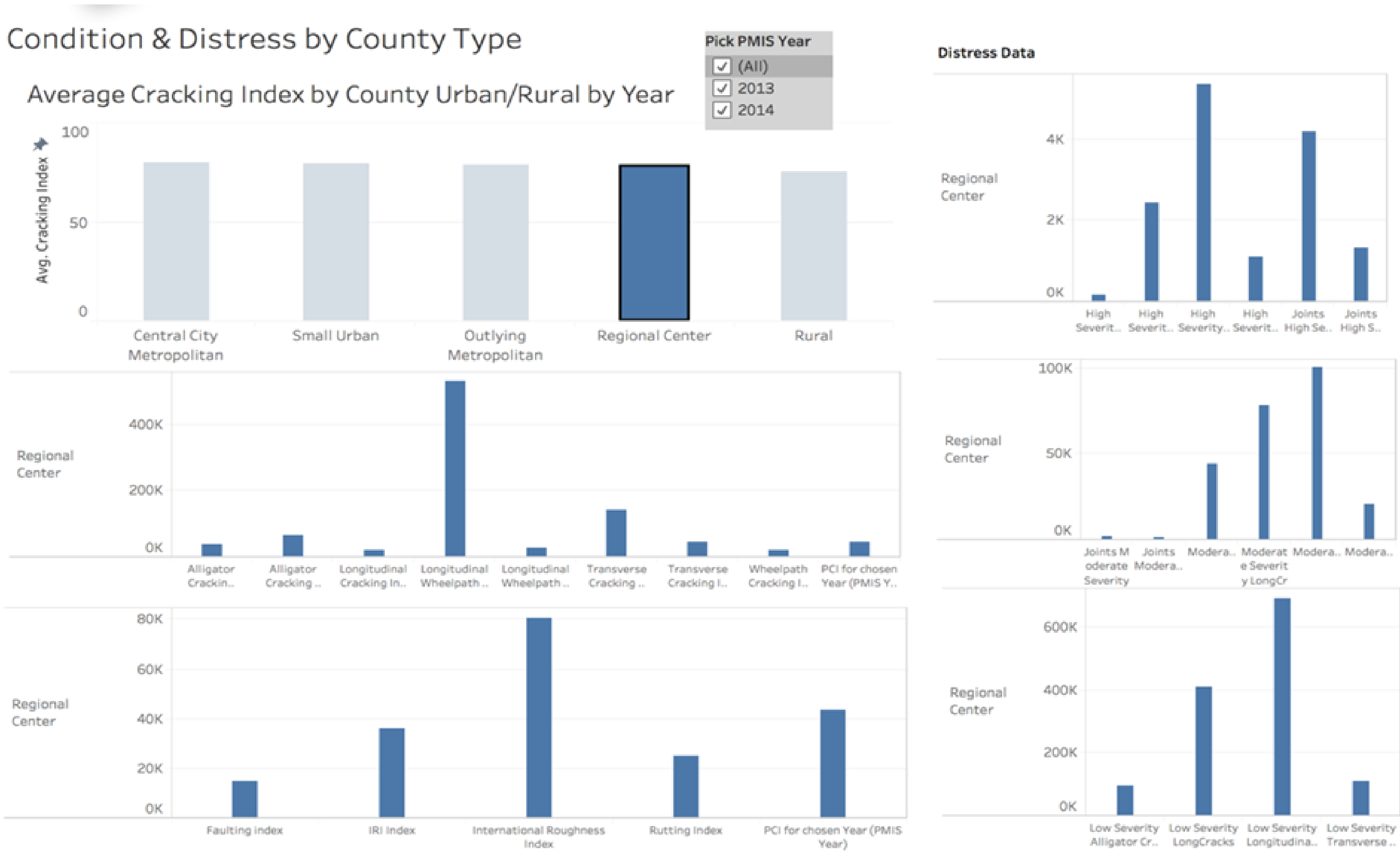


Figure 42. Drilldown on visible condition and distress data for regional center counties

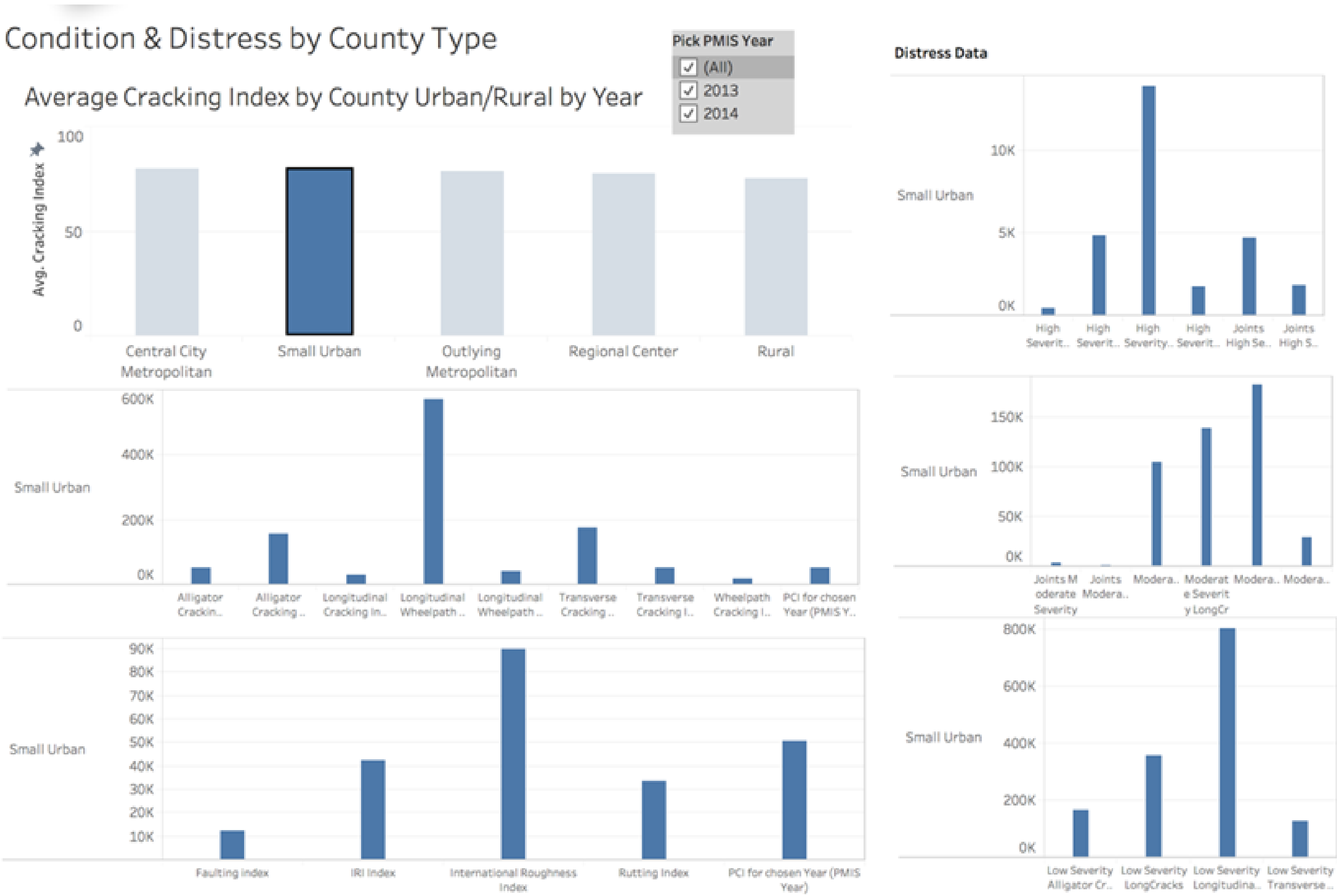


Figure 43. Drilldown on visible condition and distress data for small urban counties

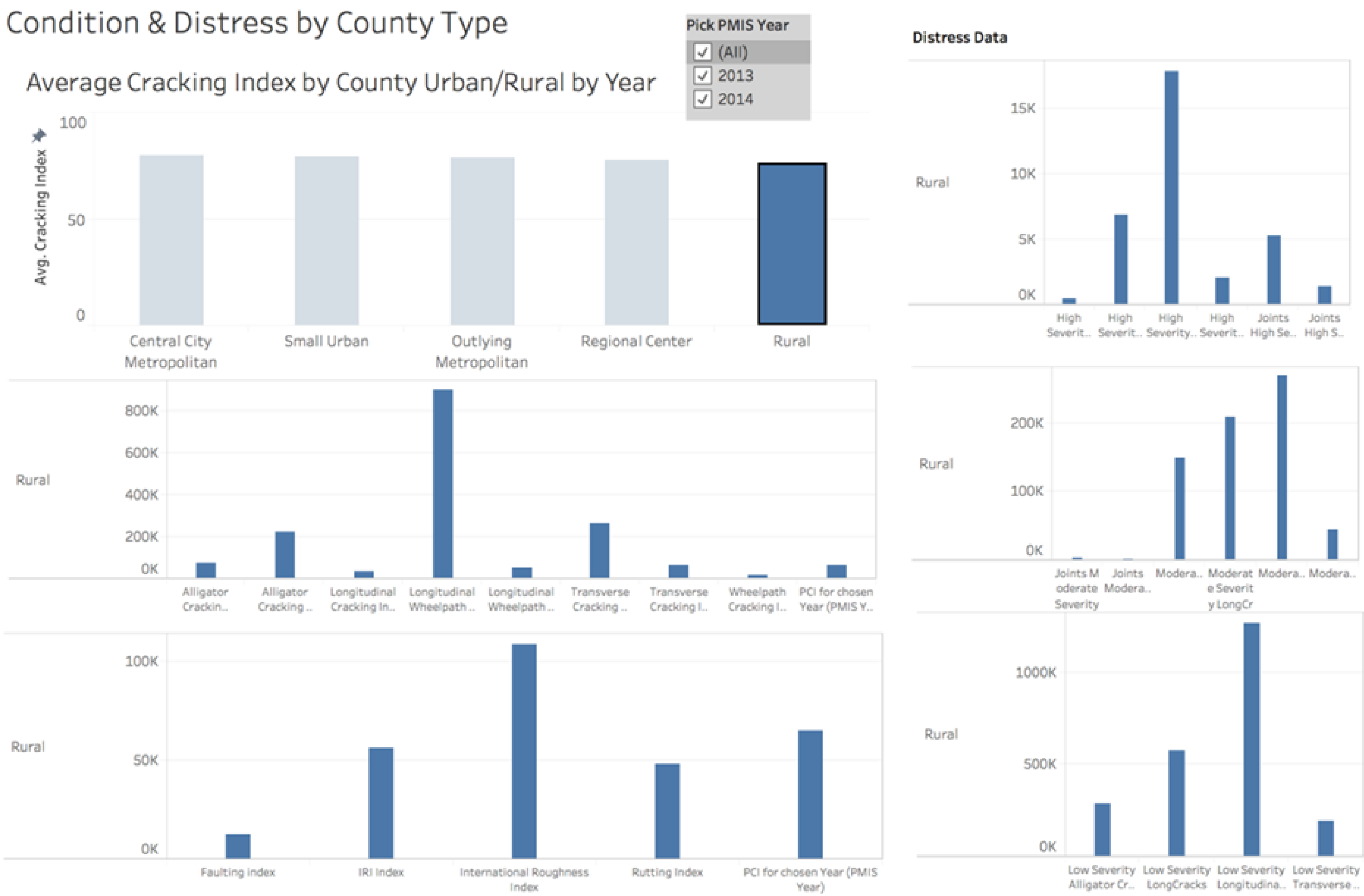


Figure 44. Drilldown on visible condition and distress data for rural counties

Table 6. Trends in condition indices and distress cracks by PMIS year for all county types

County Type	Trends Illustrated in Drilldown on the Dashboard by County Type (Figure 38)
Central city metropolitan (Figure 40)	**Condition** • Longitudinal wheelpath index (600K) is much higher than other indices • Transverse cracking (143K) and alligator cracking (131K) indices are next largest • In the next chart, the IRI (122K) is by far the highest index • PCI (60K) and the IRI index (48K) are the next largest **Distress** • High severity longitudinal cracks (13K) are the largest index • High severity joints (9K) is next largest, with long cracks (6K) after that • Moderate severity longitudinal cracks (161K) are the largest • Moderate severity alligator cracks (88K) and long cracks (87K) are next with close values • Low severity longitudinal cracks (760K) are the largest • Low severity long cracks (531K) are the next largest
Outlying metropolitan (Figure 41)	**Condition** • Longitudinal wheelpath index (404K) is by far the highest index • In the next chart, IRI (52K) is the largest index • PCI (31K) and the IRI index (26K) are the next largest **Distress** • High severity longitudinal cracks (over 4K) are the largest • High severity long cracks (2K) and joints (1.5K) are the next largest with close values • Moderate severity longitudinal cracks (100K) are the largest by far • Moderate severity long cracks (66K) and alligator cracks (57K) are the next largest • Low severity longitudinal cracks (463K) are the highest • Low severity long cracks (361K) are the next highest
Regional center (Figure 42)	**Condition** • Longitudinal wheelpath index (532K) is by far the largest • In the chart, the IRI (81K) is by far the largest index • PCI index (43K) and IRI index (36K) are the next largest indices **Distress** • High severity longitudinal cracks are the largest • High severity joints (4.2K) are the next largest, followed by long cracks (2.4K) • Moderate severity longitudinal cracks (75K) are the highest • Moderate severity long cracks (78K) and alligator cracks (44K) are the next highest • Low severity longitudinal crack (691K) are the largest • Low severity long crack (410K) are the next largest

County Type	Trends Illustrated in Drilldown on the Dashboard by County Type (Figure 38)
Small urban (Figure 43)	**Condition** • Longitudinal wheelpath crack index (575K) is by far the largest • Transverse cracking combined index (174K) and alligator cracking combined index (158K) are both similar and next largest • In the next chart, the IRI (90K) is the largest • PCI (51K) and the IRI Index (43K) are similar and are the next largest **Distress** • High severity longitudinal cracks (14K) are the largest • High severity long cracks (4.8K) and joints (4.7K) are similar and the next largest • Moderate severity longitudinal cracks (183K) are the largest • Moderate severity long cracks (140K) and alligator cracks (105K) are the next largest • Low severity longitudinal cracks (801K) are the largest • Low severity long cracks (356) are the next largest
Rural (Figure 44)	**Condition** • Longitudinal wheelpath combined index is by far the largest index • In the next chart, the IRI (109K) is the largest • PCI (65K), the IRI index (57K), and the rutting index (48K) are all similar and are the next largest **Distress** • High severity longitudinal cracks (18K) are the largest by far • High severity long cracks (6.9K) and joints (5.3K) are the next largest • Moderate severity longitudinal cracks (269K) are the largest • Moderate severity long cracks (208K) and alligator cracks (150K) are the next largest • Low severity longitudinal cracks (1.2M) are the largest • Low severity long cracks (79K) are the next largest

The following shows the median age and PCI by county type. All five county types were evaluated. In the first graph, it is seen that the median age of roads in rural counties is much higher, while the median ages of roads in the other four county types are similar (see Figure 45). In contrast, the median PCI value for rural counties is the lowest, with the values for the other four county types being similar and greater than the median PCI of the rural counties (see Figure 46).

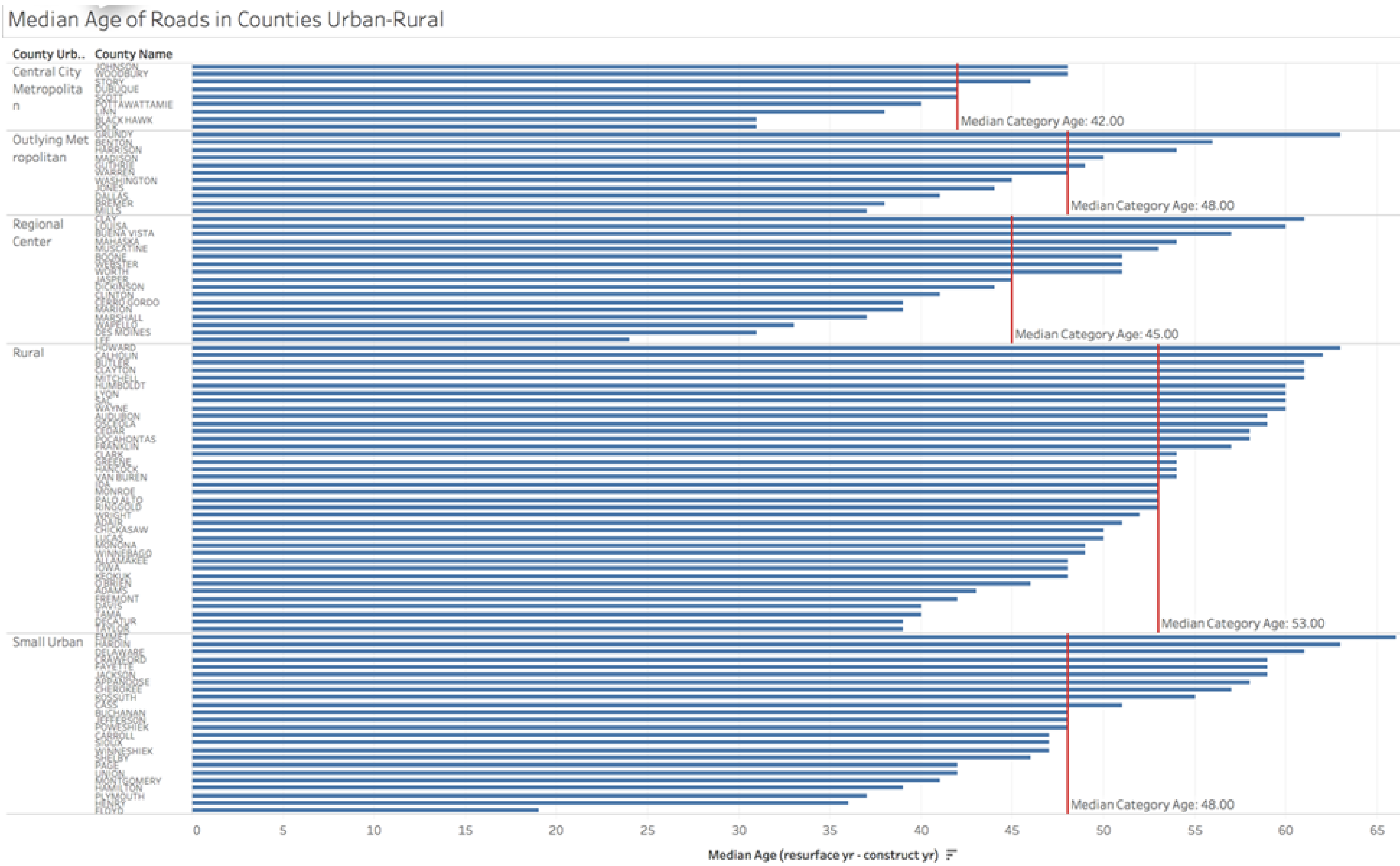


Figure 45. Median age by county type

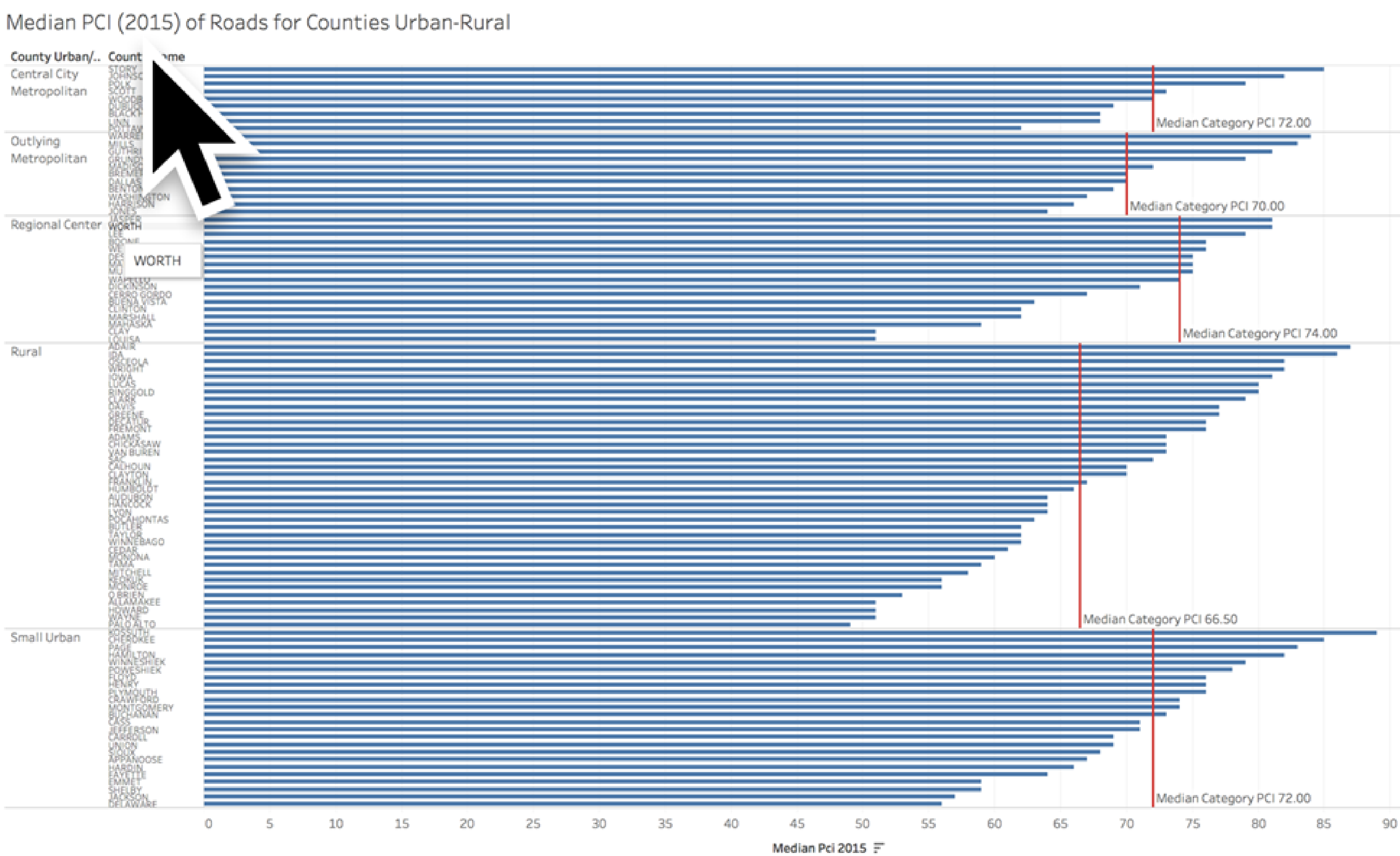


Figure 46. Median PCI value by county type

The following shows the county type(s) that account for 80% of a given distress crack (e.g., alligator or longitudinal wheelpath cracking). Two groups were apparent. The first group (Figure 47) showed that the same three county types (rural, small urban, and central city metropolitan) accounted for 80% of the alligator, alligator combined, longitudinal, and longitudinal wheelpath cracks. Of these, the rural county type was the greatest contributor.

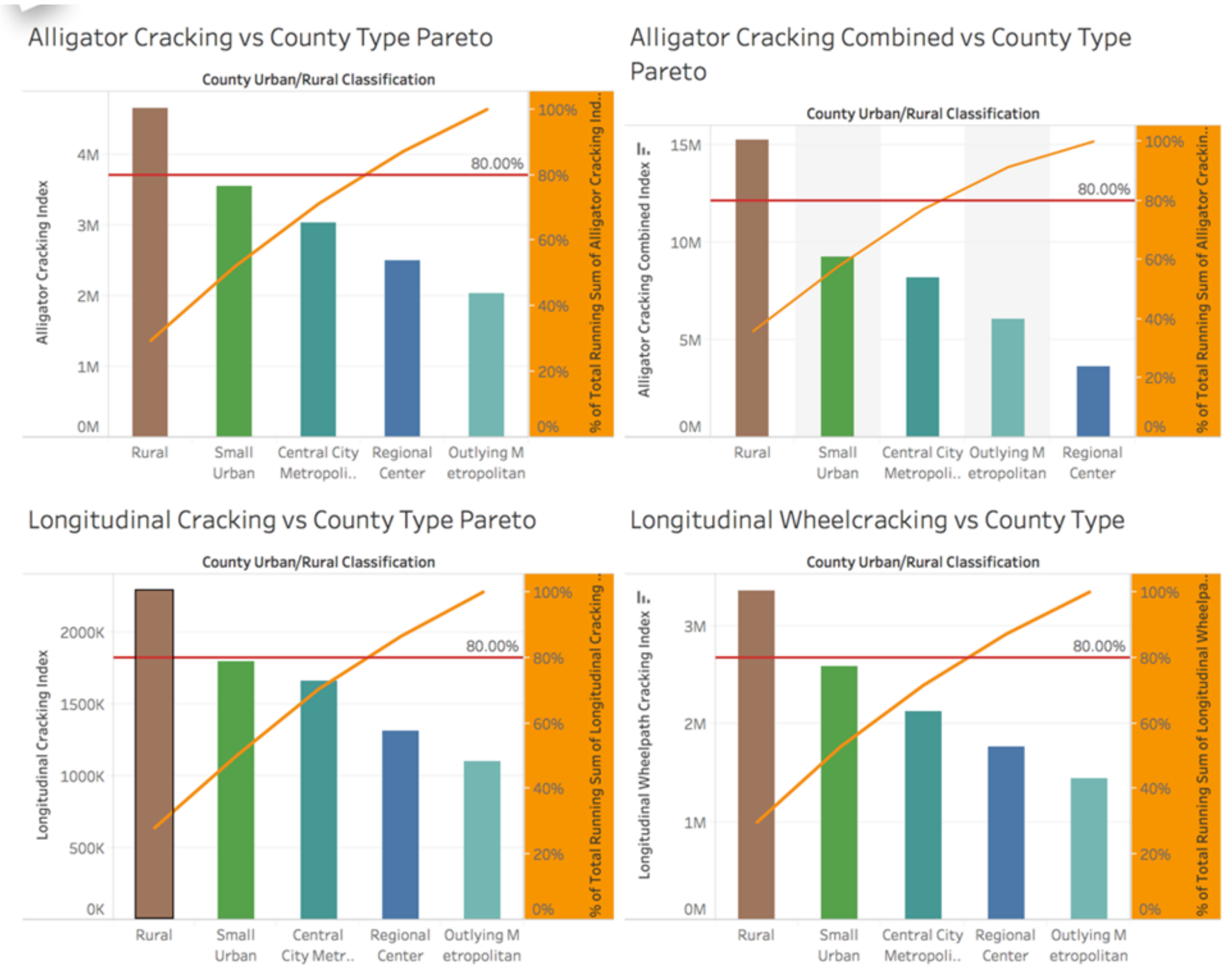


Figure 47. Counties accounting for 80% of alligator, alligator combined, longitudinal, and longitudinal wheelpath cracks

The next group (Figure 48) showed somewhat less consistency across the crack types. Three of the county types (rural, small urban, and central city metropolitan) accounted for 80% of the longitudinal and transverse cracks. These county types showed high levels of transverse cracks, especially in the central city metropolitan, rural, and small urban counties (in that order). Eighty percent of wheelpath cracking is contributed by the central city metropolitan, small urban, and regional center county types. Wheelpath and transverse cracks are the only crack types for which rural counties were not the largest contributor.

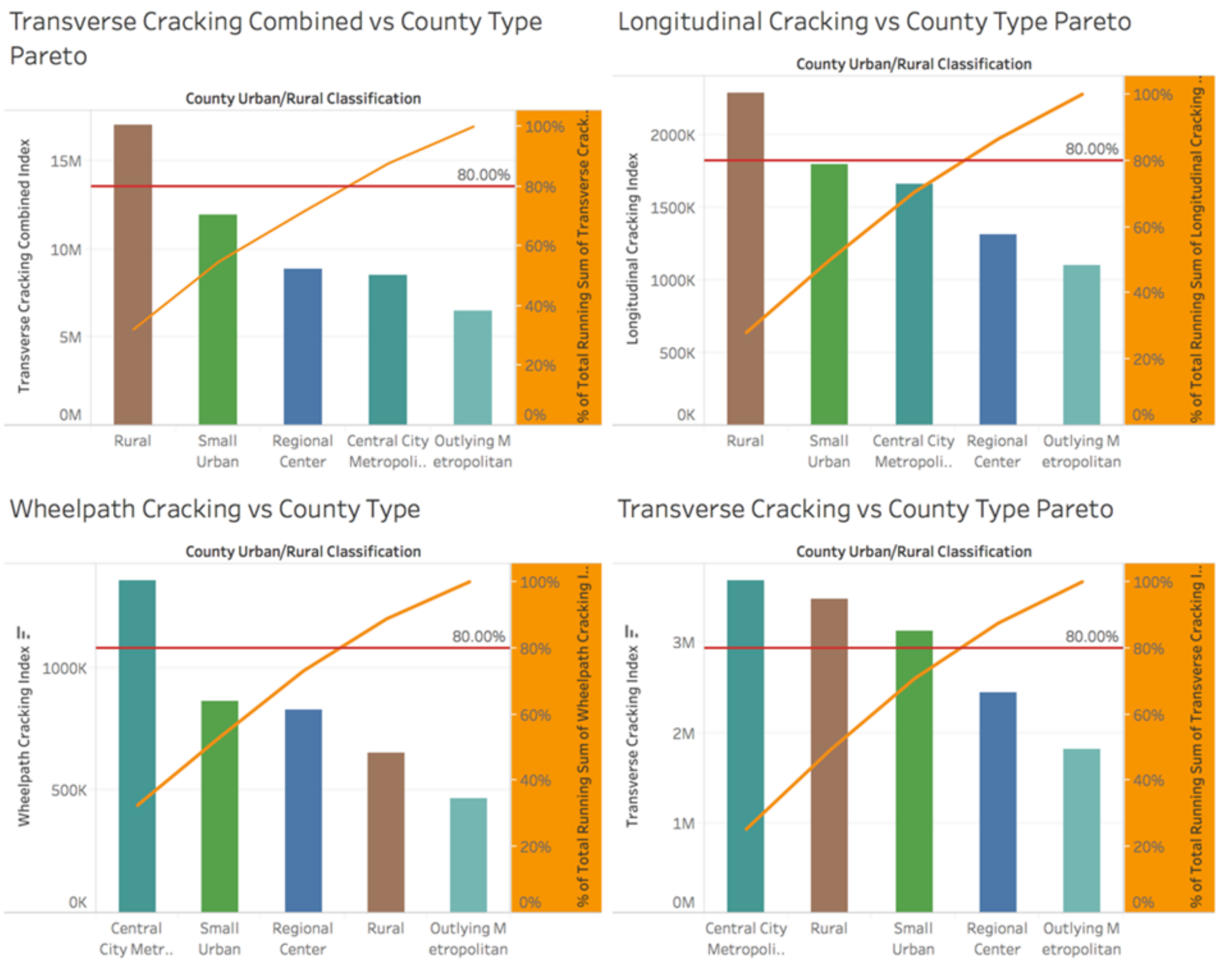


Figure 48. Counties accounting for 80% of transverse combined, longitudinal, wheelpath, and transverse cracks

The following group shows the county types that contributed 80% of four high severity crack types (Figure 49). In all cases, rural counties had the highest number of high severity cracks. In all four cases, 80% of the cracks were seen in less than three counties. For high severity alligator, transverse, long, and longitudinal cracks, the following county types contributed the same numbers of cracks: rural, small urban, and central city metropolitan.

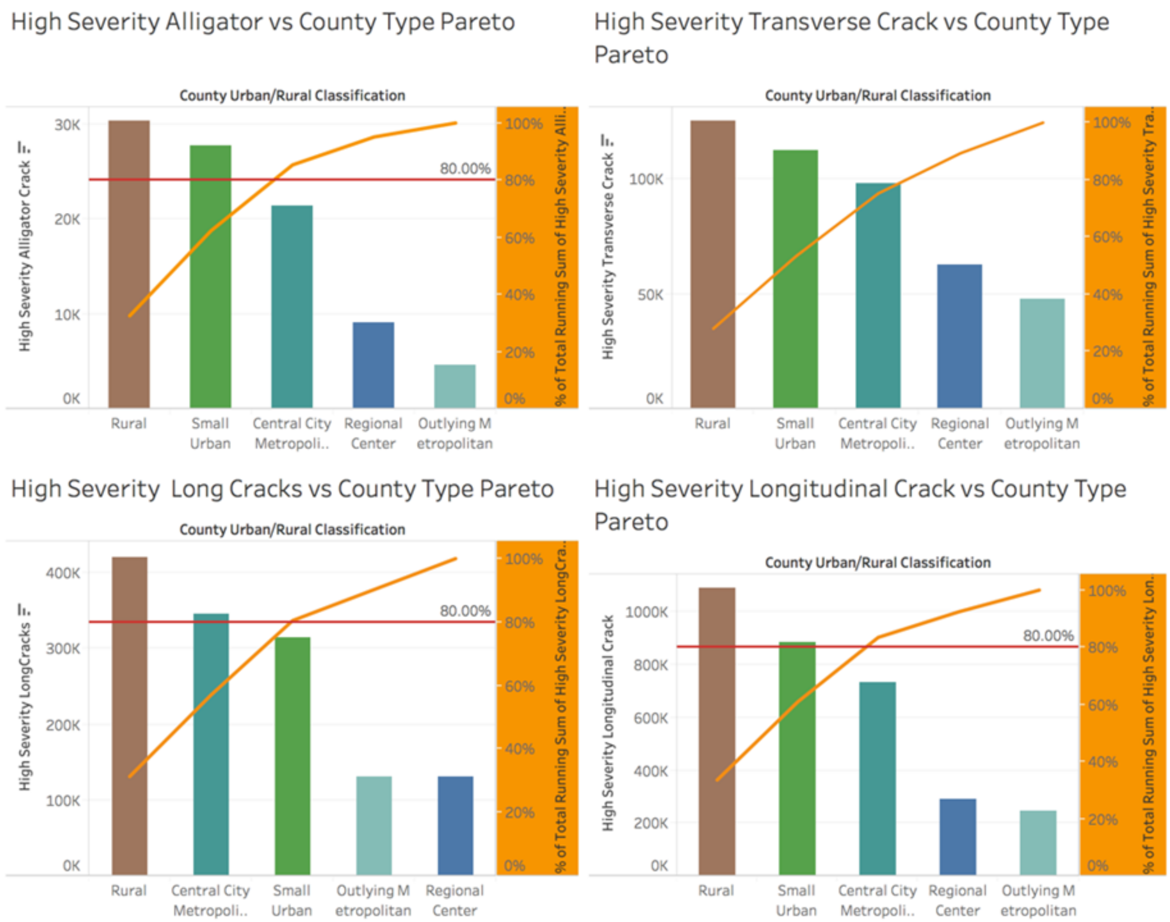


Figure 49. Counties accounting for 80% of high severity crack types

The following shows the county types that contributed 80% of four moderate severity crack types (Figure 50). In all cases, rural counties had the highest number of moderate severity cracks, followed by small urban counties. For moderate severity alligator, long, and longitudinal cracks, 80% of these cracks were contributed by rural, small urban, and central city metropolitan county types (in that order). In the fourth chart, for moderate transverse cracks, the regional center type was the third county type that was part of the 80%.

Figure 50. Counties accounting for 80% of moderate severity crack types

The following shows the county types that contributed 80% of four low severity crack types (Figure 51). In all cases, rural counties had the highest number of each type of low severity crack. For alligator, longitudinal, and transverse cracks, the small urban county type was the second largest contributor, followed by central city metropolitan. In the case of transverse cracks, the second largest contributor was central city metropolitan, followed by small urban. With less than three counties exhibiting long cracks, long cracks had the fewest county types making up 80% of total cracks.

Figure 51. Counties accounting for 80% of low severity crack types

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Iowa Legislature. 2017. *Part 1: Statewide Population Trends*. www.legis.iowa.gov/docs/publications/SD/16442.pdf. Last accessed February 2018.

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