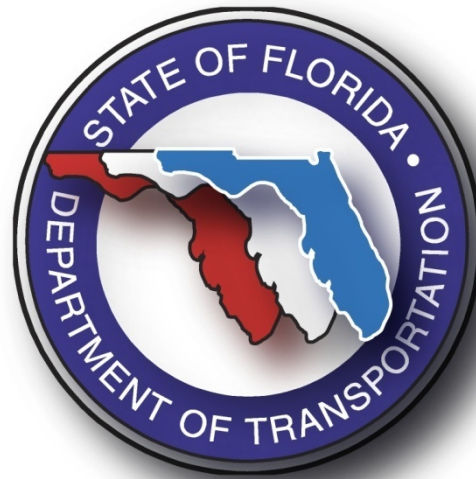


# High RAP Performance in Florida



Jim Musselman  
Florida Department of Transportation

# Background

- Used RAP routinely since 1980
- 50 Blow Marshall Mix Design until 1998
  - Average RAP content ~ 25%
- Superpave since 1998
- No RAP in friction/wearing courses
  - Issues with pavement friction



# Background

- Statewide average pavement life:
  - Approximately 14 – 15 years until deficient
  - Resurfacing cycle 17 – 18 years





# Pavement Performance

# Statewide Pavement Performance

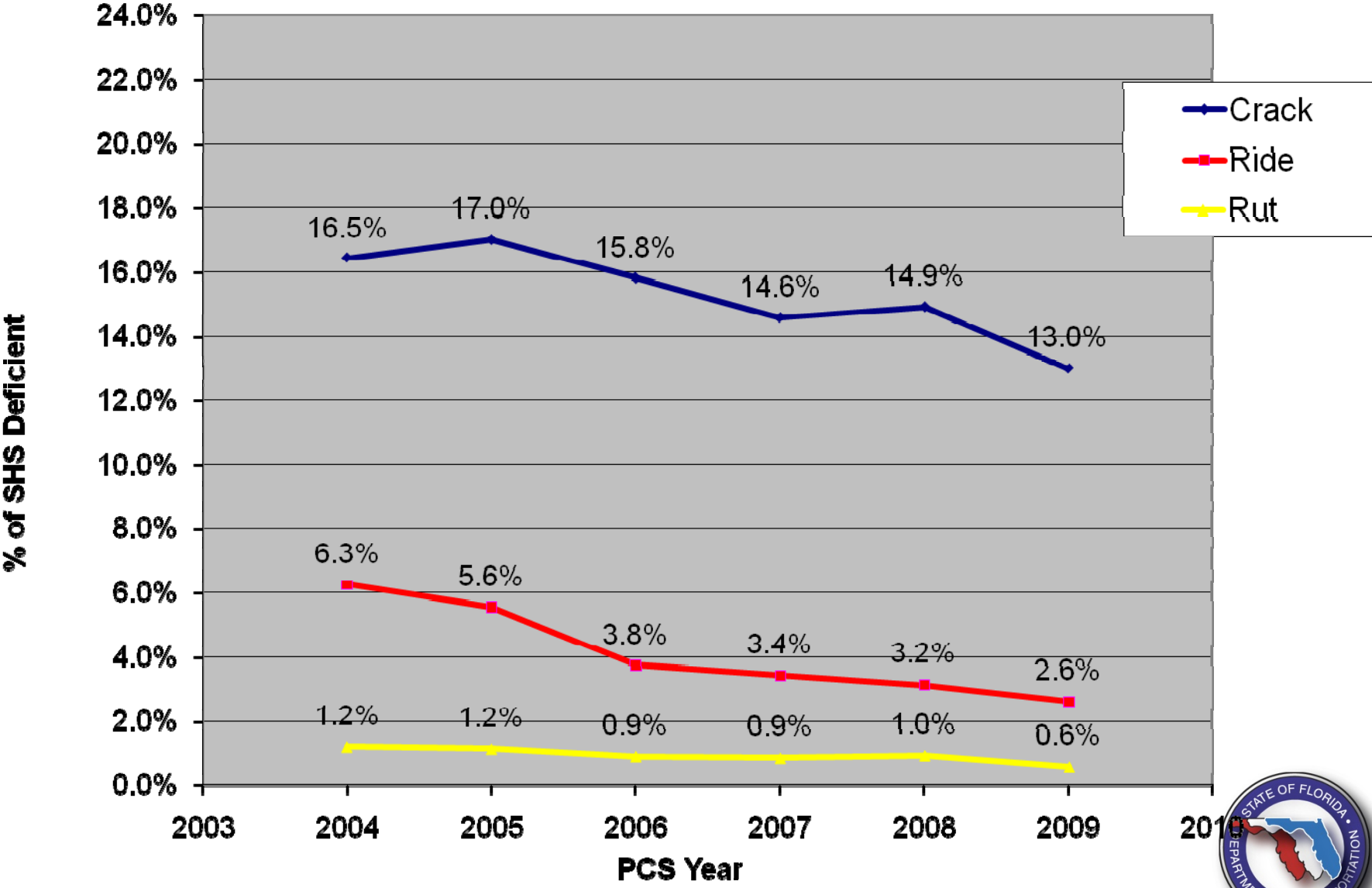


	Deficient Pavements (%)					
Criteria	2004	2005	2006	2007	2008	2009
Ride	6.3	5.6	3.8	3.5	3.2	2.6
Crack	16.5	17.0	15.8	14.6	14.9	13.0
Rut	1.2	1.2	0.9	0.9	1.0	0.6

Section 334.046 of Florida Statutes: “Ensuring that 80% of the pavement on the SHS meets Department Standards”



# Statewide Deficient Pavements



# Pavement Resurfacing Program

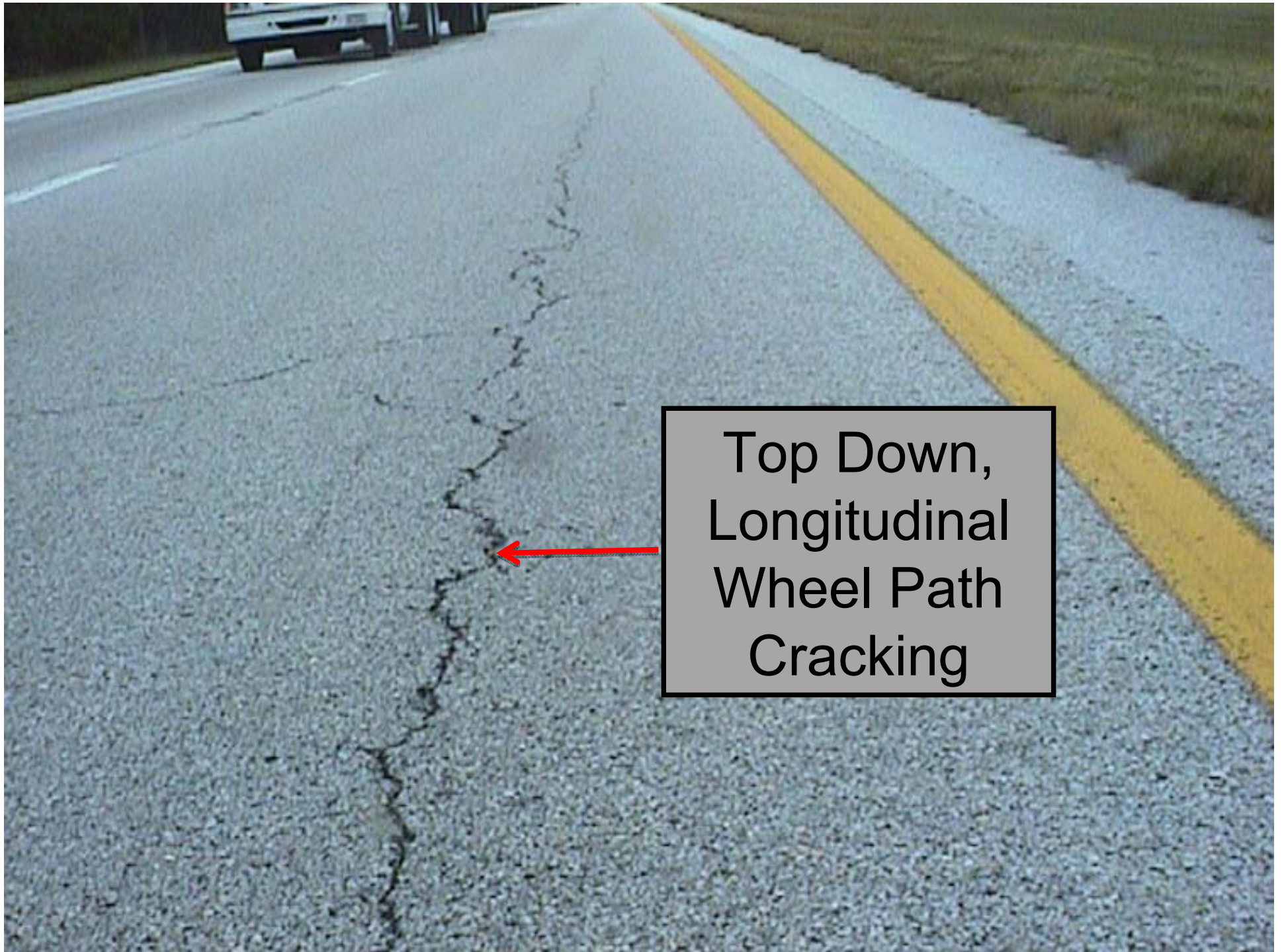
- FDOT Resurfacing Cycle = **18 years**  
– Matches deterioration rate

$$\frac{\text{System Size}}{\text{Cycle}} = \frac{42,082 \text{ lane miles}}{18}$$

1/18 or 5.6% of the system = ~2350 lane miles/year







Top Down,  
Longitudinal  
Wheel Path  
Cracking



# Sources of Data

- Multiple databases:
  - Mix Design
  - Construction Reporting
  - Financial Project Management
  - Pavement Management
- Older computer systems/databases - not really compatible
- “Manually automated” search



# D.R.I.P

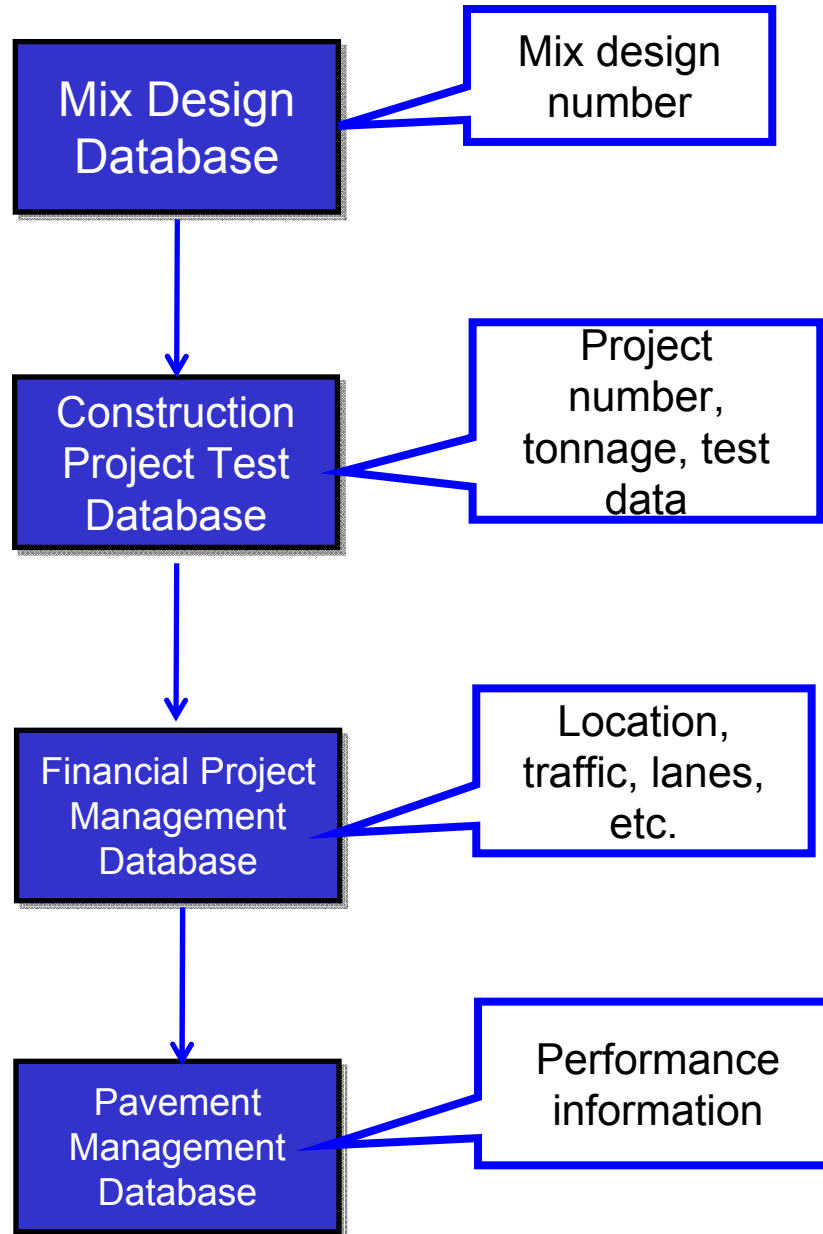
Data Rich....  
Information Poor



# Initial Search Criteria

- Random list of mix designs with  $\geq 30\%$  RAP
- Constructed 1991 – 1999
  - No construction data prior to 1991
- Age when pavement became deficient
- Cracking was the only distress considered
  - Most common mode of distress





**Mix Design used in: District 1**

**From : 01Jan1993**

**To : 31Dec1993**

MIX DESIGN #	# of PROJECTS	TONS PLACED	FROM DATE	TO DATE
<a href="#">QA-825522</a>	1	468.94	01JUL1993	01JUL1993
<a href="#">QA-88-3876</a>	1	162.84	09DEC1993	09DEC1993
<a href="#">QA-904570</a>	1	682.03	12JUL1993	27JUL1993
<a href="#">QA-92-5169</a>	1	7.13	25FEB1993	25FEB1993
<a href="#">QA-92-5522</a>	1	1020.12	20JAN1993	20JAN1993
<a href="#">QA-92-5526</a>	1	277.15	02SEP1993	03SEP1993
<a href="#">QA-92-5527</a>	1	840.95	08SEP1993	09SEP1993
<a href="#">QA-925169</a>	1	321.25	23FEB1993	23FEB1993
<a href="#">QA-925522</a>	1	4024.8	28JUN1993	27JUL1993
<a href="#">QA-925526</a>	1	84.31	18APR1993	18APR1993
<a href="#">QA-93-5806</a>	1	52.12	02SEP1993	07SEP1993
<a href="#">QA-93-5979</a>	1	58.78	01SEP1993	10SEP1993
<a href="#">QA-93-92-5527</a>	1	1010.1	07SEP1993	07SEP1993
<a href="#">QA-935806</a>	1	2782.27	07JUN1993	08JUN1993
<a href="#">QA-935923</a>	1	4158.78	08JUN1993	11JUN1993
<a href="#">QA5527</a>	1	850.85	14APR1993	14APR1993

**Search results for Mix Design Number: QA92-5522**

**\*\*Click the red MATL. link to view test results\*\***

MATL.	JOB	TONS PLACED	MIX DESIGN NUMBER	REPORT	SAMPLE	SAMPLE DATE	SOURCE
<a href="#">120A</a>	197494 -1 -52 -01	108.0900	QA92-5522	28402	L3012	02/04/1993	N/A
<a href="#">120A</a>	197494 -1 -52 -01	42.6600	QA92-5522	28402	S3013	02/05/1993	N/A





Financial Project Search



Florida Department of Transportation

# Financial Project Search

[Search](#) | [Help](#) | [Contact Us](#)

## Financial Project Number Search

Search for financial project numbers by location. A location can be selected to access more detailed information. If a location is blank when not known) and click the submit button. Items with roadway locations will be returned.

### Search Criteria:

- 1) Select a geographic district:
- 2) Select a county:
- 3) Select a status:
- 4) Select a phase:
- 5) Select a time period:

### Optional Input:

- Enter Begin and End Milepost:
- Enter a location:
- Enter a roadway id:
- Select a work type:

Submit

## Project Information

Enter a project number to bypass the search.

Financial Project Number:

## Work Program Item Segment

Enter a Work Program Item Segment number. Project numbers for the entered Work Program Item Segment will show all Financial Project numbers for the location.

Item Segment Number:

## Financial Project Detail

Fin. Proj. No: 210884-1-52-01

Description: Sr 55/us 19 from Dixie Co. to 1.5 Mi. S. Of Salem

District: Second

Major Work: Farp-pave Shoulders & Resurf.

Project Manager: Sw/da

Federal Project 1854 016 p

Transportation System: Intrastate State Highway

Contracts	
Active	Inactive
	<a href="#">18150</a>

### Work Program Status History

status	Date
Line Item Completed	9/8/1997
Under Construction	5/1/1993
Contract Executed	8/1/1992
Awarded	7/1/1992
Bids Received	6/1/1992
Advertised	5/1/1992
Plans&row In Talla.	3/1/1992
Pre-const underway	7/1/1991
Candidate Line Item	10/29/1989

### Additional Work Program Information

Version	AD (Adopted)
Current Status	Line Item Completed
Managing District	02
County	38 Taylor
Contract Class	1 To Be Let
Unit Of Measure	E -- English

1 Roadway Location was found.

Roadway Location	County
US 19 / US 27A / US 98 / SR 55	TAYLOR

Roadway ID: 38010000

Project Length (miles): 7.809

Beginning Sect. Pt: 0

Ending Sect Pt: 7.809

No. of Lanes: 4

No. of Lanes Added: 0

Type of Work: Farp-pave Shoulders & Resurf. mill And Resurface state Pave Shoulders & Resurf.

« Previous Next »

1

# Pavement Condition Survey

## For Levy County

Other Conditions: Critical Value=6.4, Section= 050, Subsect= 000

Click on the Begin Mile Point to plot the history and forecast years of crack, ride and rut ratings distribution for a roadway segment.

Click on the Roadway ID to plot the current year of crack, ride and rut ratings distribution for an entire roadway.

Roadway Segment							Tentatively Planned Project						PCS Survey Information				
SR	US	Begin Mile Point (History Link)	End Mile Point	Rdwy Side	Posted Speed	AADT	Item Segment	Begin Mile Point	End Mile Point	Rdwy Side	Fiscal Year	Work Mix	Current Pvmt age In Yrs	Cracking 2009	Ride 2009	Rutting 2009	Lane Miles
55	19	<a href="#">0.000</a>	9.831	L	65	5800	<a href="#">2103762</a>	0.000	9.831	C	2007	0012	34				19.662
55	19	<a href="#">0.000</a>	9.831	R	65	5800	<a href="#">2103762</a>	0.000	9.831	C	2007	0012	34				19.662
55	19	<a href="#">9.831</a>	24.026	L	65	3700	<a href="#">2103764</a>	9.831	24.026	C	2009	0012	15	3.5	7.7	9.0	28.390
55	19	<a href="#">9.831</a>	24.026	R	65	3700	<a href="#">2103764</a>	9.831	24.026	C	2009	0012	15	4.5	7.7	9.0	28.390
55	19	<a href="#">24.026</a>	35.060	L	65	2900	<a href="#">2103763</a>	24.026	35.028	C	2010	0012	15	4.5	7.6	7.0	22.068
55	19	<a href="#">24.026</a>	35.060	R	65	2900	<a href="#">2103763</a>	24.026	35.028	C	2010	0012	15	7.0	8.3	7.0	22.068
55	19	<a href="#">35.060</a>	35.637	L	45	3700	<a href="#">2103768</a>	35.028	36.547	C	2009	0012	15	4.5	7.2	9.0	1.154
55	19	<a href="#">35.060</a>	35.637	R	45	3700	<a href="#">2103768</a>	35.028	36.547	C	2009	0012	15	5.0	7.6	8.0	1.154
55	19	<a href="#">35.637</a>	36.137	C	30	7500	<a href="#">2103768</a>	35.028	36.547	C	2009	0012	15	5.0	6.4	8.0	2.000
55	19	<a href="#">36.137</a>	36.547	L	35	10500	<a href="#">2103768</a>	35.028	36.547	C	2009	0012	15	6.5	7.4	9.0	0.820
55	19	<a href="#">36.137</a>	36.547	R	35	10500	<a href="#">2103768</a>	35.028	36.547	C	2009	0012	15	6.5	6.5	9.0	0.820

Download Report Table to Excel

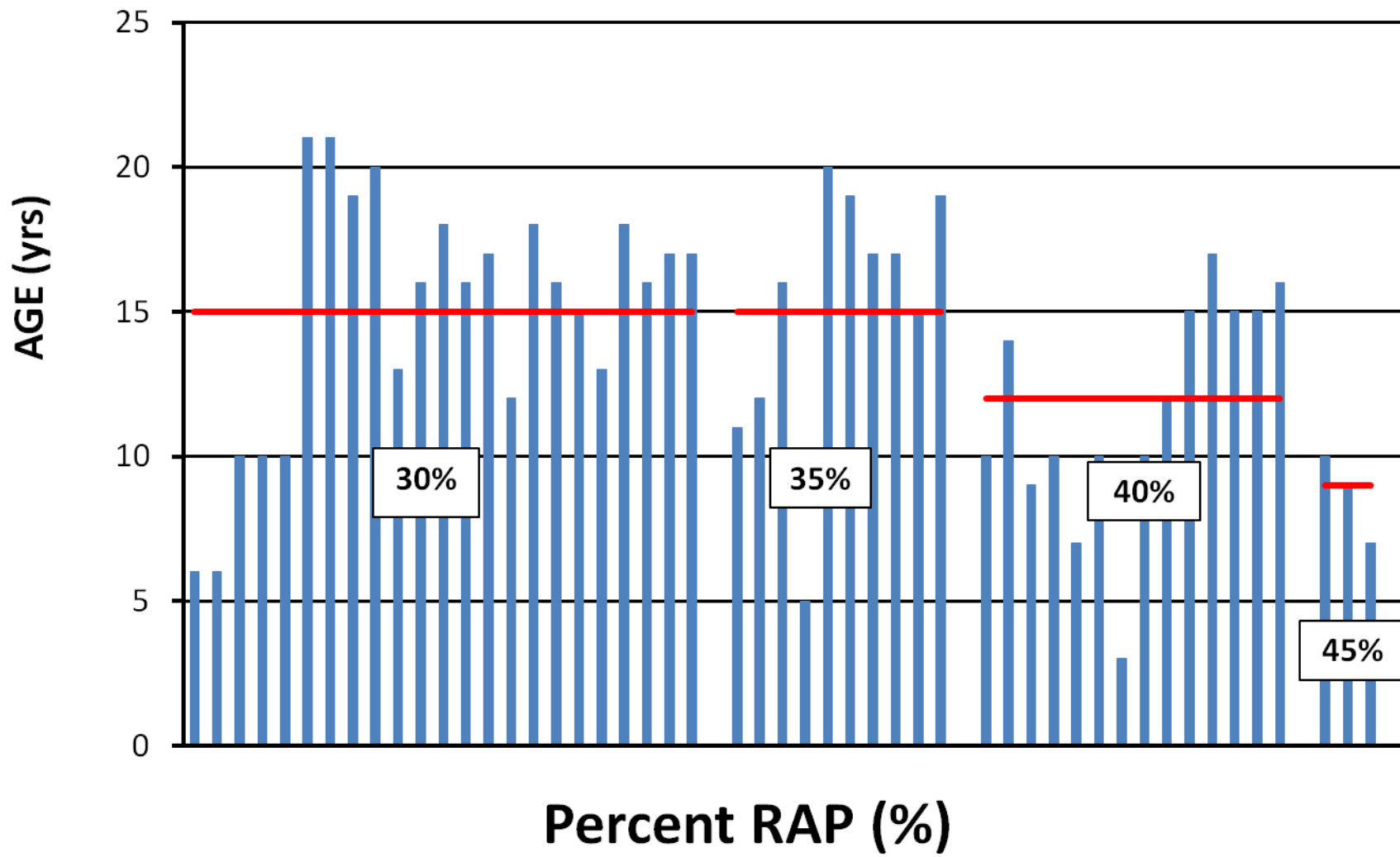
# Pavement Management Data

1994	L	25,674	29,148			
1994	R	25,674	29,148			
Year	Crack - R	Ride - R	Rut - R	Crack - L	Ride - L	Rut - L
1981	8.7	8.4	8	8.7	8.7	7
1982	8.7	8.3	8	7.7	8.7	7
1983	8.7	8.3	8	8.4	8.5	7
1984	.	.	.	.	.	.
1985	.	.	.	.	.	.
1986	8.4	8.3	9	9.4	8.3	9
1987	8.4	8.5	10	9.4	8.6	9
1988	8.4	8.5	9	9.4	8.7	9
1989	8.4	8.3	9	9.4	8.1	8
1990	8.4	8.3	9	9.4	8.4	8
1991	9	7.9		9	7.8	8
1992	10	8.1	10	10	8.5	10
1993	10	8.1	8	10	8.2	9
1994	10	8.4	9	10	8.9	9
1995	10	8.9	9	10	8.8	9
1996	10	8.4	9	10	8.6	9
1997	10	8.6	9	10	8.5	9
1998	10	8.9	9	10	9.1	9
1999	10	8.9	10	10	8.9	9
2000	10	8.8	10	10	8.9	9
2001	10	8.8	9	10	8.9	9
2002	10	8.9	9	9	8.9	9
2003	10	8.7	9	9	8.7	9
2004	10	8.2	9	7.5	8.2	9
2005	10	8.2	9	6	8	9
2006	9	8.1	9	6	8	8
2007	7.5	8.2	9	6	8	8
2008	7	8.2	9	4.5	7.7	8
2009	6.5	8.2	9	4.5	7.3	8
2010						
2011						
2012						
2013						
2014	6.5	8	9	3	7.3	8

1994	L	29,148	32,614			
1994	R	29,148	32,614			
Year	Crack - R	Ride - R	Rut - R	Crack - L	Ride - L	Rut - L
1993	10	8.9	9			
1994	10	7.8	10	9	8.3	10
1995	10	8.2	10	9	8.7	10
1996	10	8.2	10	9	8.4	10
1997	10	8.3	10	9	8.6	10
1998	10	8.8	10	9	9	9
1999	10	8.6	10	9	8.5	10
2000	10	8.8	10	9	8.5	10
2001	10	8.8	10	8.5	8.2	10
2002	10	8.9	10	7.5	8.3	10
2003	10	8.6	10	7.5	8.1	9
2004	9	8.4	9	6	7.9	9
2005	9	8.2	9	4.5	7.4	9
2006	8	8.2	9	4.5	7.1	9
2007	7.5	8.2	9	4.5	7.1	9
2008	7	8.1	9	4.5	6.9	9
2009	6.5	7.7	9	4.5	6.7	9
2010						
2011						
2012						
2013						
2014	6.5	7.7	9	2.5	6.3	8

Add lanes - Rehab Pavement

# Based on Age & RAP Content Alone

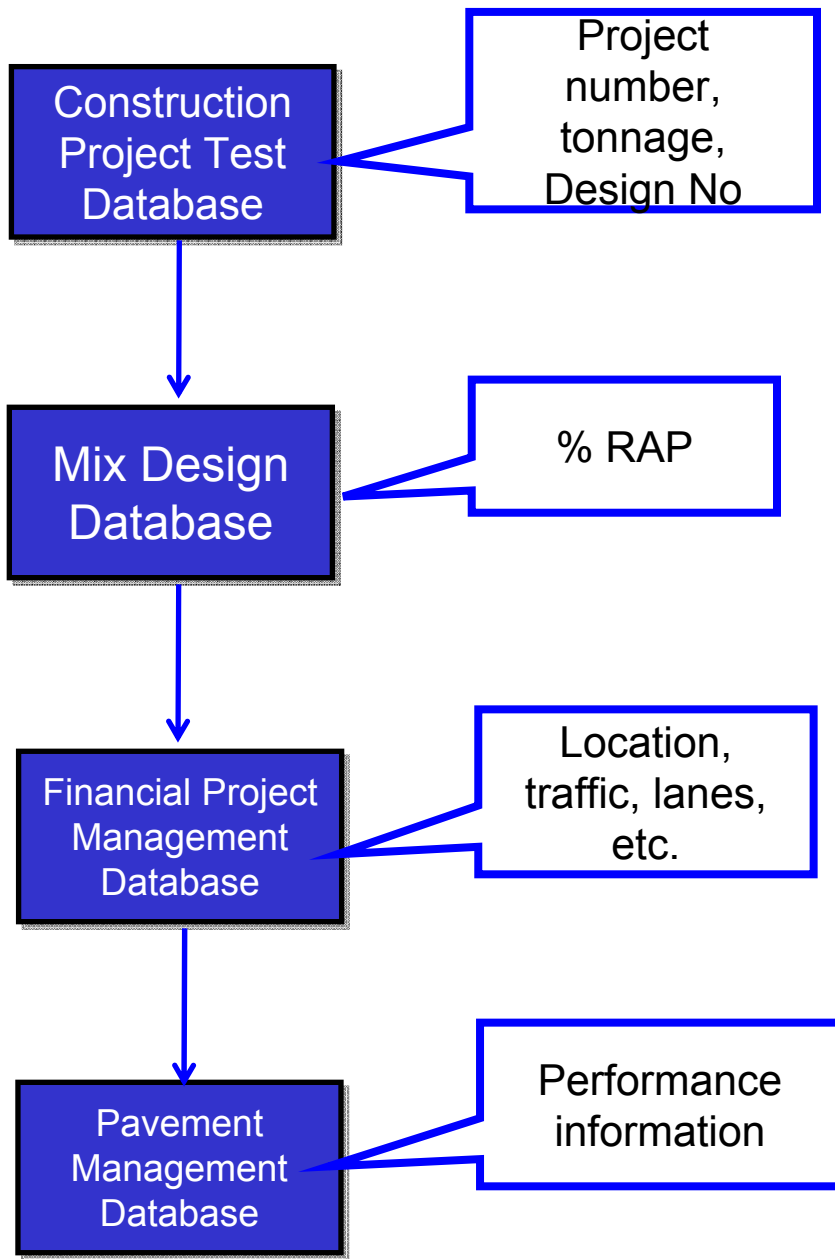


# New Search with Additional Criteria

- Minimum 5,000 tons w/30% RAP
  - Preferable 10,000 tons
- Factored in traffic
  - ESALs not available
  - Used AADTT (AADT x %Trucks)
- Considered friction course used
  - Open vs. dense graded
- Included virgin mixes as a benchmark



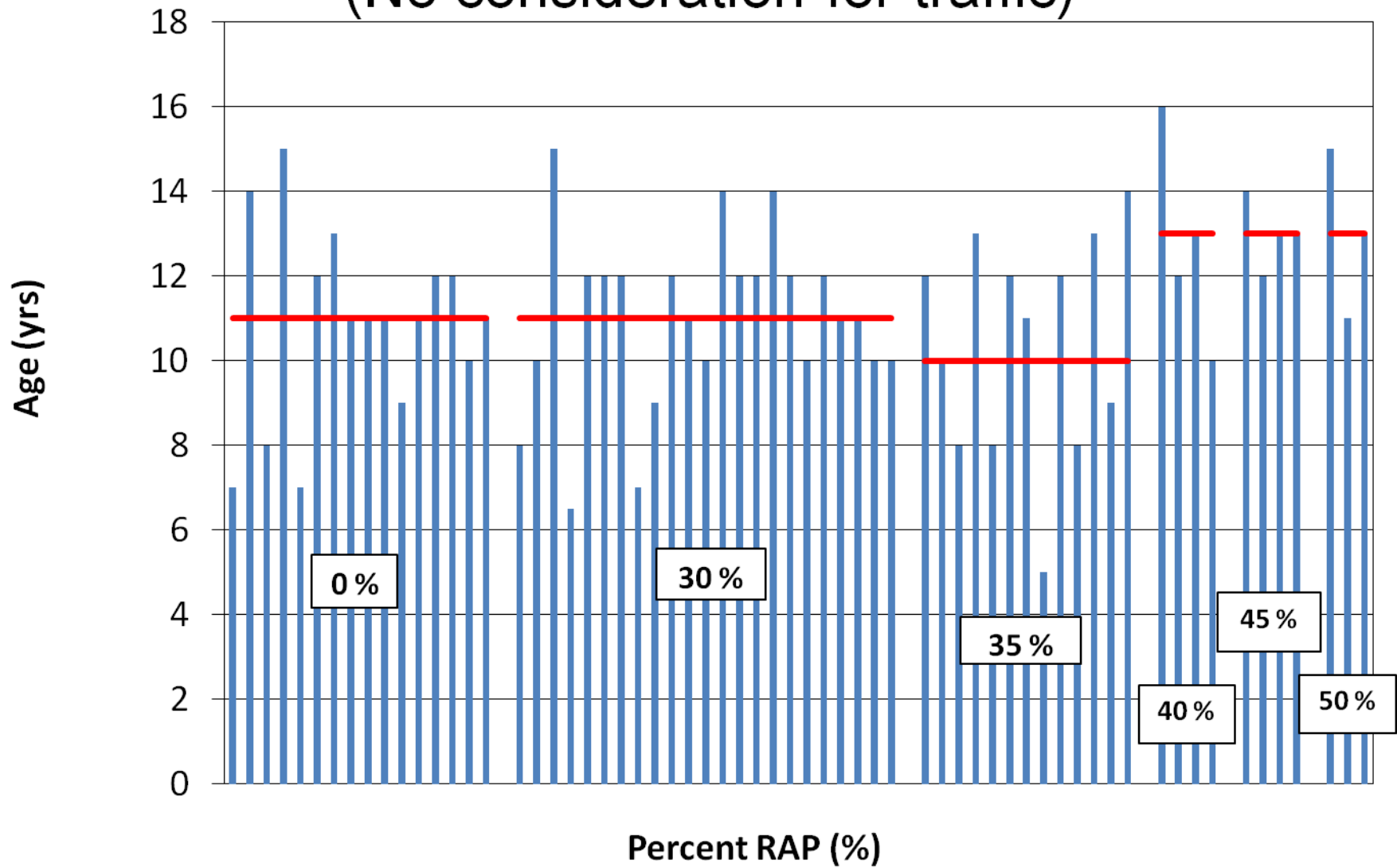




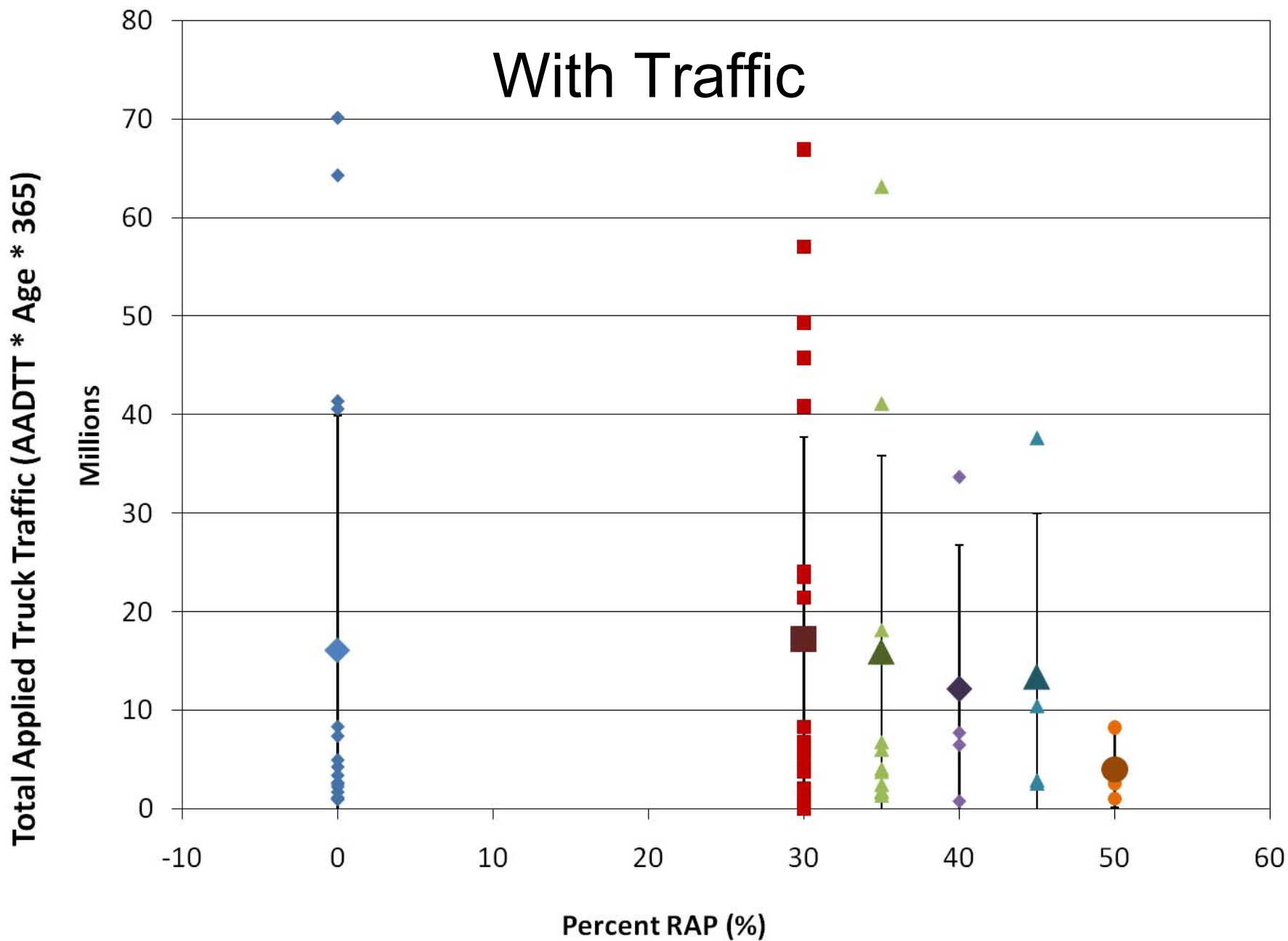
% RAP	MIX DESIGN #	PROJECT NUMBER	COUNTY	NAME	TONS PLACED	FROM DATE	TO DATE	PROJECT NUMBER	COUNTY	NAME	TONS PLACED	FROM DATE	TO DATE	PROJECT NUMBER
0	QA 94-6685	209266 -1 -52 -01	Duval	SR 13	7469.58	9-Dec-95	11-Dec-95	208202 -1 -52 -01	Clay	SR 15	4076.43	29-Aug-95	12-Sep-95	210217 -1 -52 -01
0	QA 93-6212	213003 -1 -52 -01	Baker	SR 8	6282.33	23-Oct-95	3-Nov-95	213007 -1 -52 -01	Baker	SR 8	357.75	25-Oct-95	31-Oct-95	213082 -1 -52 -01
0	QA 98-8767A	207794 -1 -52 -01	Alachua	SR 200	24372.9	3-Jan-00	23-Dec-99	208017 -1 -52 -01	Bradford	SR 200	7631.49	7-Sep-99	30-Sep-99	
0	QA 98-8610A	213435 -1 -52 -01	Madison	SR 8	6339.15	19-Nov-98	21-Dec-98	213434 -1 -52 -01	Madison	SR 8	4128.43	19-Nov-98	8-Dec-98	
0	QA 98-8811A	213076 -1 -52 -01	Columbia	SR 93	7455.74	22-Jun-98	7-Jul-98	213554 -1 -52 -01	Suwannee	SR 93	7143.45	22-Jun-98	7-Jul-98	213560 -1 -52 -01
0	QA 95-7401	213007 -1 -52 -01	Baker	SR 8	11055.2	3-Dec-95	17-Apr-96	213002 -1 -52 -01	Baker	SR 8	5541.75	3-Dec-95	23-Feb-96	213471 -1 -52 -01
0	QA 98-8826B	210800 -1 -52 -01	Suwannee	SR 10	11142.7	16-Apr-99	27-Apr-99	208367 -1 -52 -01	Columbia	SR 10	2799.35	4-Apr-00	13-Apr-00	208396 -1 -52 -01
0	QA 93-5885	210376 -1 -52 -01	Levy	SR 55	23194.7	17-Jun-93	1-Oct-93	210369 -1 -52 -01	Levy	SR 55	1101.68	28-Jan-94	3-Feb-94	
15	QA 99-9182A	207794 -1 -52 -01	Alachua	SR 200	15137	13-Jul-99	7-Sep-99							
20	QA 98-8899C	208391 -1 -52 -01	Columbia	SR 47	24288.4	24-Nov-98	29-Sep-99	208396 -1 -52 -01	Columbia	SR 10	22747.6	31-Jul-98	24-Apr-99	208410 -1 -52 -01
22	QA 95-7521	213081 -1 -52 -01												
23	QA 95-7378	213007 -1 -52 -01									5944.12	20-Oct-95	30-Mar-96	213471 -1 -52 -01
25	QA 93-6072	212951 -1 -52 -01												
25	QA 94-6537	213082 -1 -52 -01									39683.6	21-Apr-95	21-Dec-95	213081 -1 -52 -01
25	QA 97-8558A	208013 -1 -52 -01									14256.6	29-Apr-99	1-Nov-99	210020 -1 -52 -01
25	QA 95-7224	213082 -1 -52 -01									19475.1	23-Jun-96	16-Jan-96	213388 -1 -52 -01
25	QA 95-7224	213082 -1 -52 -01												
25	QA 92-5183	210001 -1 -52 -01	Putnam	SR 21	13952.3	16-Apr-92	28-May-92	210002 -1 -52 -01	Putnam	SR 26	13880.4	23-Mar-92	29-Apr-92	210000 -1 -52 -01
25	QA 93-6061	213084 -1 -52 -01	Columbia	SR 93	25214	25-May-95	25-May-95	213082 -1 -52 -01	Columbia	SR 93	496.14	25-May-95	25-May-95	
25	QA 99-9243B	207794 -1 -52 -01	Alachua	SR 200	17906.9	18-Jan-00	5-Dec-99							
25	QA 93-6107	212951 -1 -52 -01	Alachua	SR 93	17697.4	14-Oct-93	12-Feb-94							
25	QA 94-6539	212697 -1 -52 -01	Suwannee	CR 136	19891.2	24-Jul-97	29-May-98	213084 -1 -52 -01	Columbia	SR 93	4069.45	17-Oct-95	3-Jan-96	213082 -1 -52 -01
30	QA 95-7187	213002 -1 -52 -01	Baker	SR 8	19743	23-Jun-95	19-Sep-95	213003 -1 -52 -01	Baker	SR 8	33355	13-Jul-95	10-Aug-95	213007 -1 -52 -01
30	QA 95-7188	207992 -1 -52 -01	Bradford	SR 200	2646.09	21-Sep-95	28-Sep-95	213002 -1 -52 -01	Baker	SR 8	15358.4	13-Oct-95	17-Nov-95	213003 -1 -52 -01
30	QA 92-5644	208173 -1 -52 -01	Clay	SR 21	38392.5	12-Dec-95	2-Mar-98	208193 -1 -52 -01	Clay	SR 15	80.67	13-Jul-95	13-Jul-95	208202 -1 -52 -01
30	QA 96-7570	207667 -1 -52 -01	Alachua	SR 20	9278.3	15-May-99	9-Oct-99	207668 -1 -52 -01	QA 96-7570	SR 20	20441.4	14-Jan-97	9-Dec-98	208010 -1 -52 -01
30	QA 96-7571	213088 -1 -52 -01	Columbia	SR 93	44794.8	23-Mar-96	15-Oct-96							
30	QA 98-8723A	209296 -1 -52 -01	Duval	SR 9A	14865.6	24-Feb-00	5-Nov-99	210570 -1 -52 -01	Nassau	SR A1A	1639.41	14-Mar-00	15-Dec-99	
30	QA 92-5629	209442 -1 -52 -01	Duval	SR 5	28949.7	3-Sep-97	19-Oct-97	209528 -1 -52 -01	Duval	SR 228	8001.9	14-Jul-96	19-Nov-96	209532 -1 -52 -01
30	QA 92-5644E	209269 -1 -52 -01	Duval	SR A1A	8131.12	24-Nov-97	25-Nov-97	209401 -1 -52 -01	Duval	SR 5	51.54	14-May-98	17-May-98	210265 -1 -52 -01
35	QA 93-6217	212949 -1 -52 -01	Alachua	SR 93	3772.78	7-Dec-93	19-Feb-94	212936 -1 -52 -01	Alachua	SR 93	23638	1-Feb-93	7-Mar-94	
35	QA 93-5946	212936 -1 -52 -01	Alachua	SR 93	6507.04	28-Sep-93	14-Oct-93	212949 -1 -52 -01	Alachua	SR 93	28216.4	2-Jul-93	9-Aug-93	212959 -1 -52 -01
35	QA 94-6291	210889 -1 -52 -01	Taylor	SR 55	22511.9	30-Jan-94	14-Feb-95	213316 -1 -52 -01	Duval	SR 9	221.3	4-Apr-95	4-Apr-95	
35	QA 94-6425	207903 -1 -52 -01	Baker	SR 10	18993	25-Apr-97	19-Nov-98	209538 -1 -52 -01	Duval	SR 115	1086.62	19-Mar-97	20-Mar-97	213265 -1 -52 -01
35	QA 93-6073	212936 -1 -52 -01	Alachua	SR 93	2479.51	28-Oct-93	23-Nov-93	212949 -1 -52 -01	Alachua	SR 93	12175.1	27-Aug-93	27-Sep-93	212959 -1 -52 -01
35	QA 93-6219	212936 -1 -52 -01	Alachua	SR 93	17809.4	19-Jan-94	11-Apr-94							
35	QA 93-6110	212959 -1 -52 -01	Alachua	SR 93	13127.3	15-Oct-93	27-Oct-93	212936 -1 -52 -01	Alachua	SR 93	1775.87	15-Oct-93	27-Oct-93	
45	QA 92-5590	210884 -1 -52 -01	Taylor	SR 55	17716.7	3-Dec-92	9-Mar-93							
45	QA 92-5594	210884 -1 -52 -01	Taylor	SR 55	15261.1	4-Jan-93	9-Apr-93							

Took a random sampling of the data

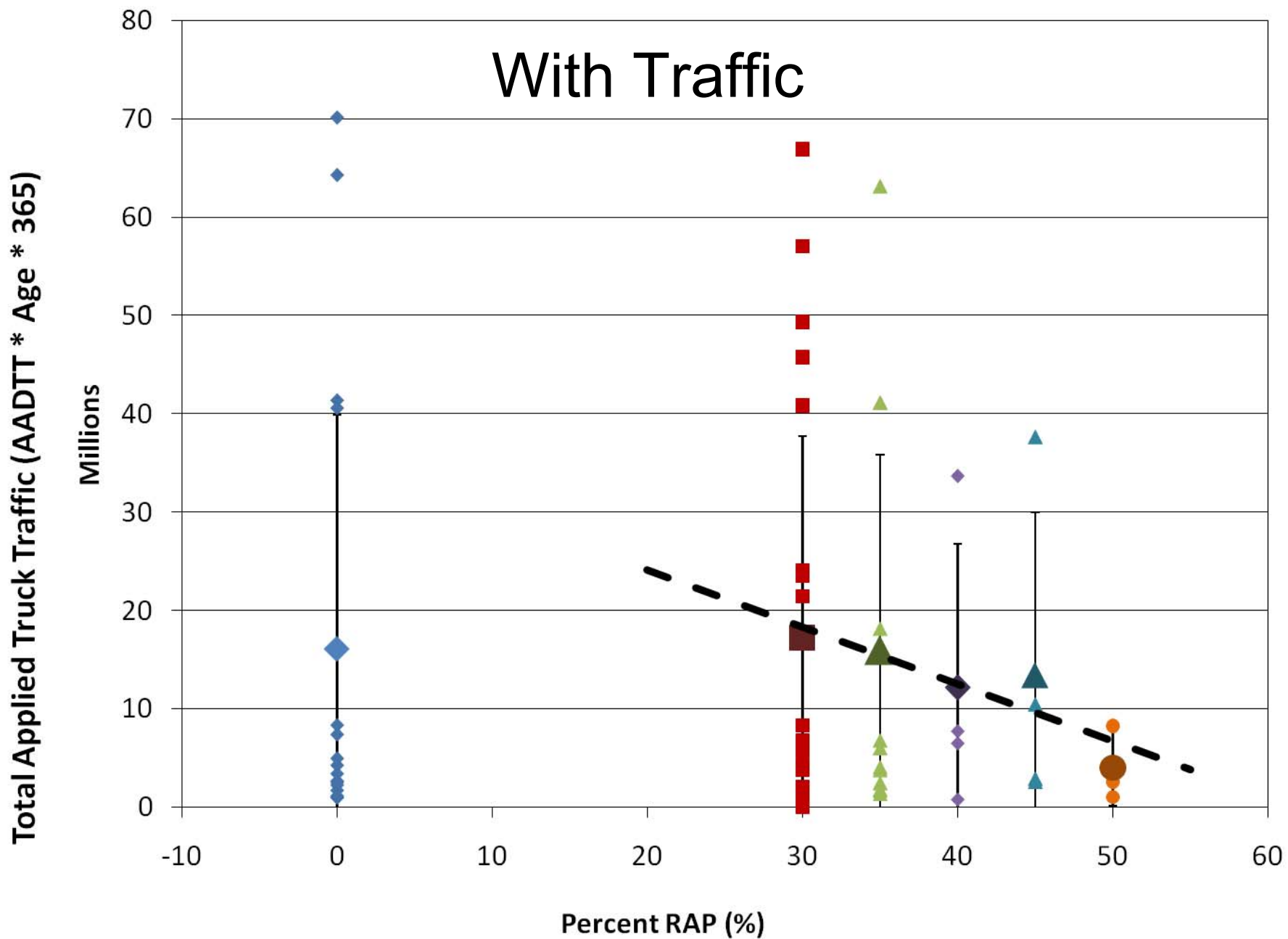
# Only Projects >5,000 tons (No consideration for traffic)



# With Traffic



# With Traffic





# Factored in Friction Course

- All projects have a friction course
- Friction courses are 100% virgin materials
- Open graded friction course – 1/2” thick
- Dense graded friction course – 1” thick

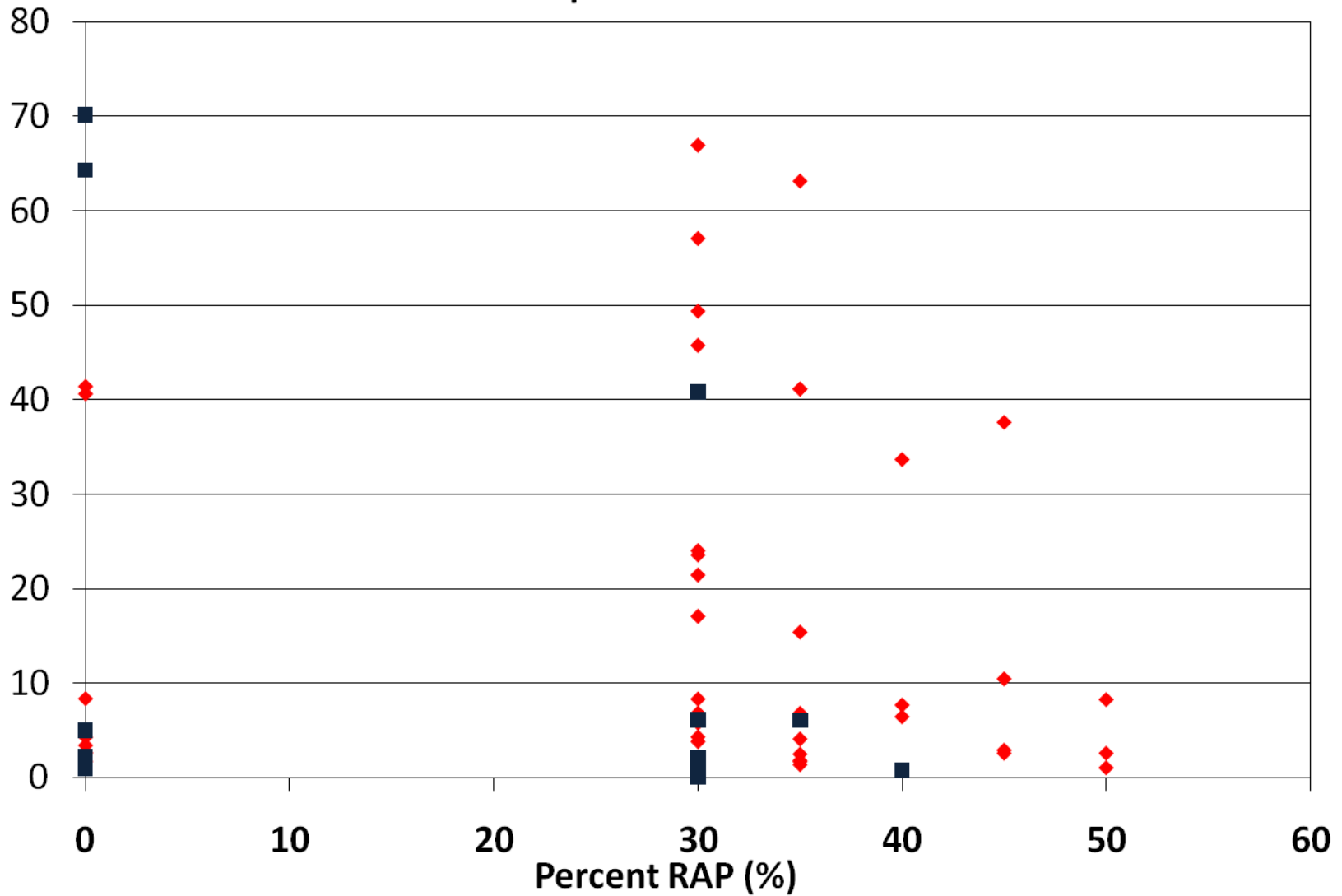


# Type of Friction Course

◆ Open ■ Dense

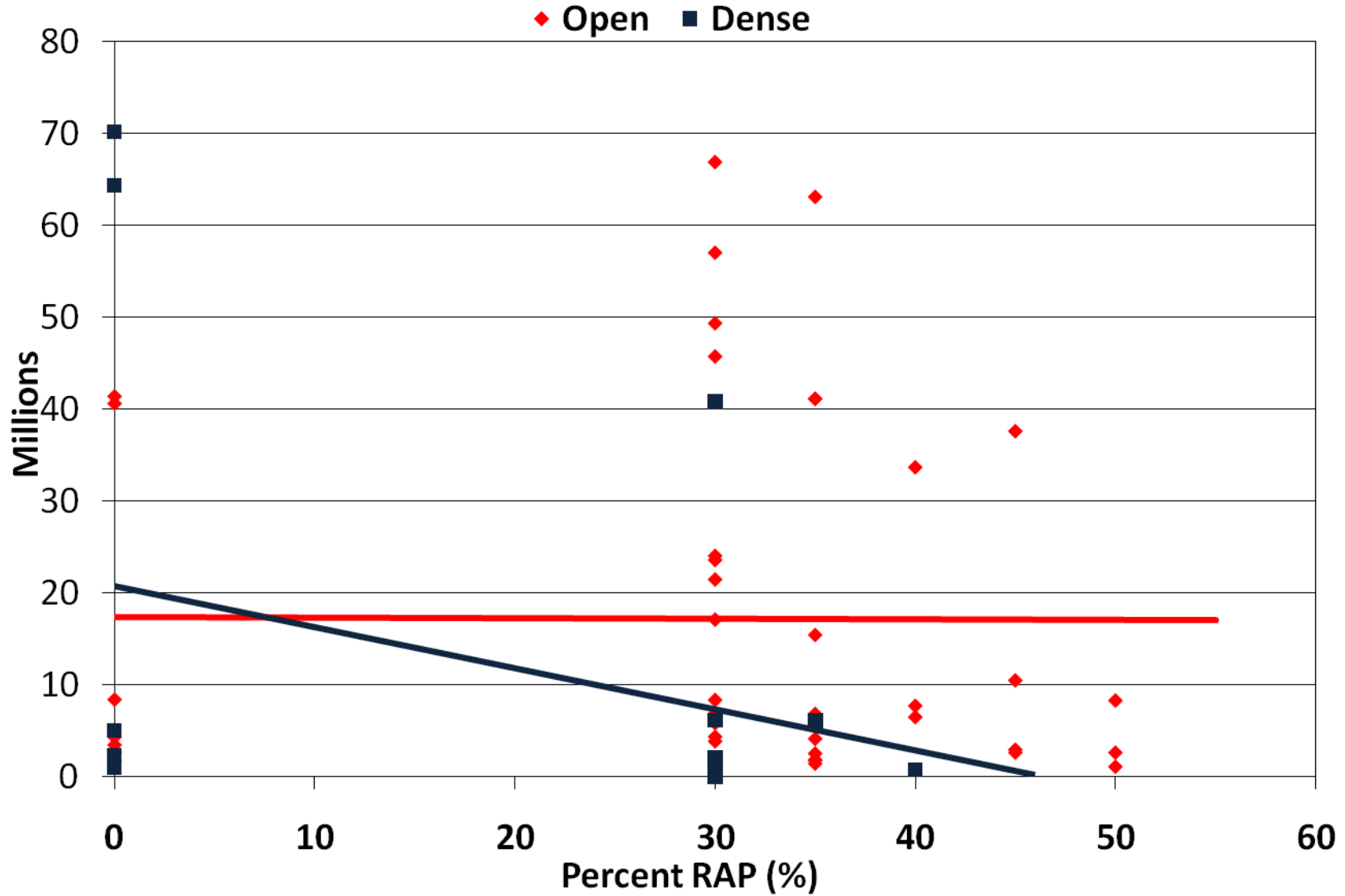
Total Applied Truck Traffic (AADTT \* Age \* 365)

Millions

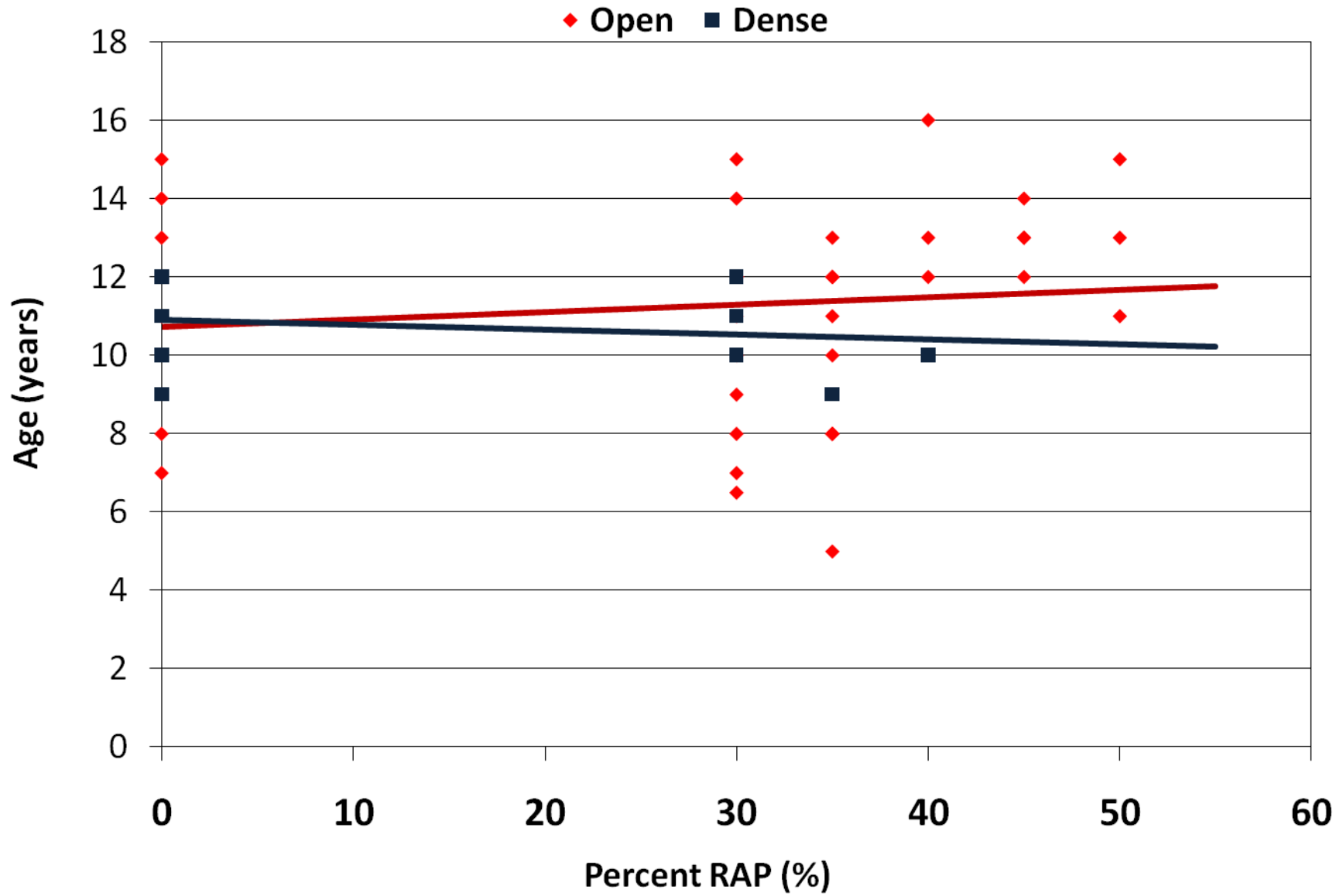


# Type of Friction Course

Total Applied Truck Traffic (AADTT \* Age \* 365)

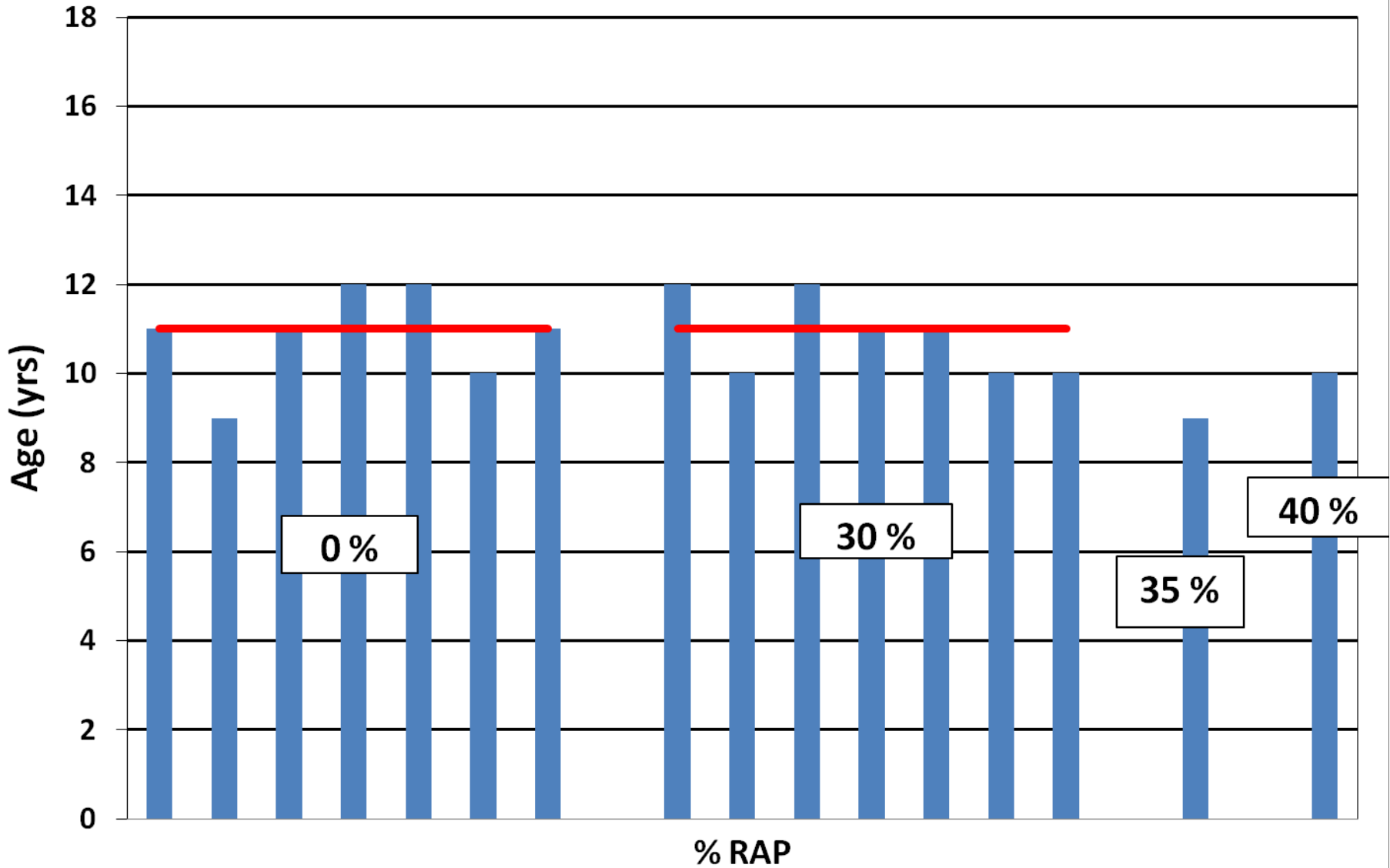


# Friction Course Related to Performance Age



Overall Average  
10.7 yrs

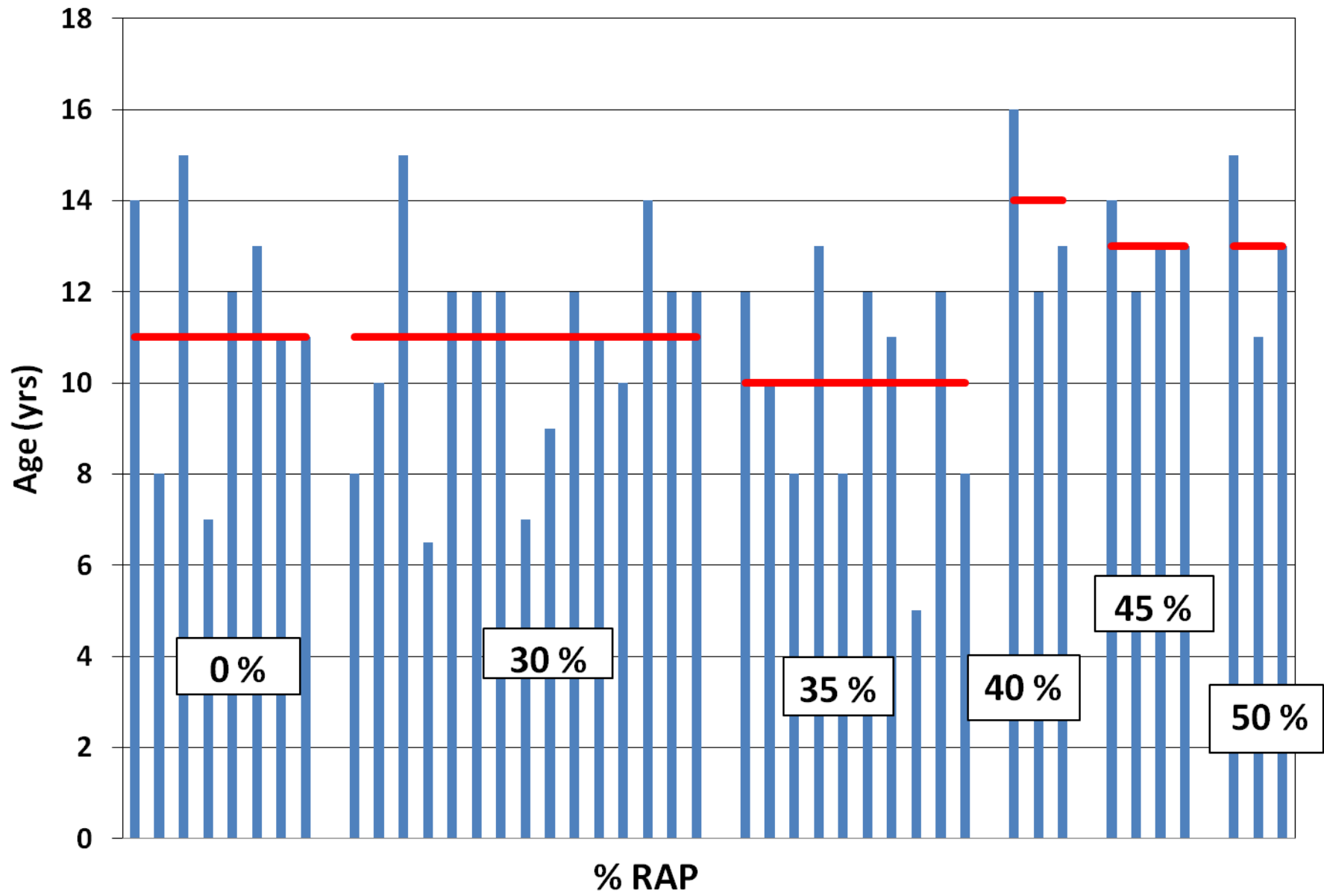
# Dense Graded





Overall Average  
11.2 yrs

# Open Graded



# Summary

- Data is somewhat questionable
  - Pavement life less than what is documented
  - Limitations on getting complete information
- Does not appear to be a significant difference between 0% and 30% RAP
  - >30% RAP appears to be a reduction in performance

