A PROCESS FOR SYSTEMATIC REVIEW OF BRIDGE DETERIORATION RATES

Robert Kelley
Bridge Management Systems Engineer
Design Division
Michigan Department of Transportation

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PURPOSE

The purpose of this report is to establish a process through which trends in bridge deterioration rates can be evaluated at regular intervals. These periodic reviews will show whether preventive maintenance and other small actions taken on bridges are becoming more or less effective over time. This process is fairly simple, can be thoroughly documented, and is easily replicated.

BACKGROUND

Bridge condition is reported to the Federal Highway Administration (FHWA) using two rating methods- the National Bridge Inspection (NBI) Condition Ratings and the National Bridge Element (NBE) ratings. Since NBE data is only in its second year of collection, there is insufficient data at this time to use NBE data to either compute deterioration rates or evaluate trends in these rates and therefore the NBI condition ratings (deck, superstructure, and substructure ratings for bridges; culvert rating for culverts) were used in this report.

When a bridge condition rating is compared to the rating of the same component a year later, there are only three possibilities: Either the rating increased, stayed the same, or the rating decreased due to deterioration. Those with a rating increase are assumed to have received rehabilitation or replacement actions. Since the purpose of the report is to study the effectiveness of maintenance actions, those with rating increases are ignored in the calculations.

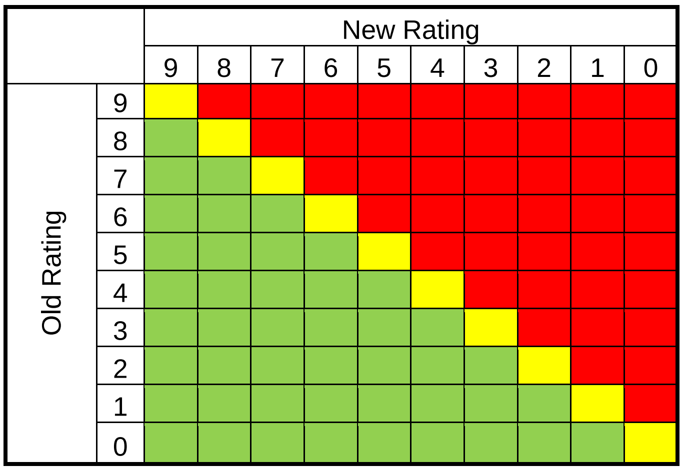
The changes that occurred in these ratings in a given year were aggregated in five year bands and the deterioration curves for each of these five year periods were computed using the Markov deterioration modeling method.

It should be noted that the quantity of data is quite limited for culvert structures and that deterioration curves and trends of these curves will be significantly less accurate than those for decks, superstructures, and substructures.

	Number of Data Points			
	2000-04	2005-09	2010-14	Total
Deck	20,974	20,494	20,417	61,885
Superstructure	20,998	20,536	20,474	62,008
Substructure	21,162	20,546	20,465	62,173
Culvert	572	896	1,030	2,498

METHODOLOGY

The Michigan structure database was queried to generate a matrix of bridge condition ratings in each year compared to the ratings in the previous year. This 10 x 10 matrix represents counts of bridges for every combination of new rating and old rating. The matrix can be visualized as shown below:



The yellow cells are those bridges that remained in the same condition rating for that year. The red cells above the diagonal are those bridges that deteriorated at least one rating while the green cells are those bridges that improved by at least one rating. The green cells are ignored in the analysis, they are assumed to have received rehab or replacement actions during that year and their change in condition is not the result of deterioration. We can compute the probability of survival at any condition rating n as per the equation below:

$$P = Survival\ Probability\ State\ n = \frac{Number\ of\ Bridges\ Remaining\ In\ State\ n}{\sum_{i=0}^{n} Number\ of\ Bridges\ With\ New\ Rating\ i}$$

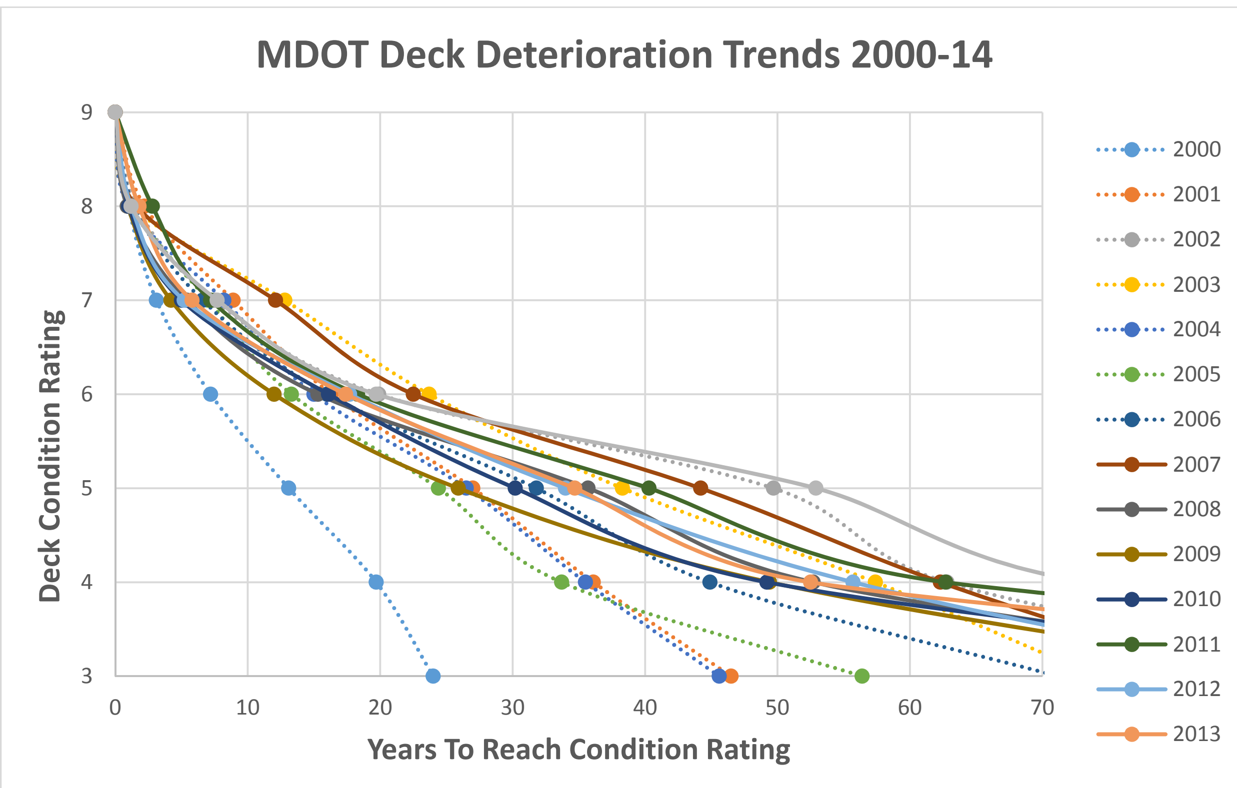
The survival probability P is converted to median transition years y by this equation:

$$y = Median\ Transition\ Years = \frac{\log(0.5)}{Log\ P}$$

To construct a deterioration curve from a starting point of rating = 9 in year 0, simply add these transition years together as per the following equation:

$$\text{Time To Reach Condition Rating } X = \sum_{Z=X+1}^{9} \text{Median Transition Years State } Z$$

It may not be obvious why the data is grouped in five year bands rather than showing the data for each individual year. With each new inspection year there are staffing changes, assignment changes, and changes in inspection technique. Each year may bring new emphasis on particular facets of the inspection and criteria may change. Additionally, most bridges are inspected every other year, and the bridge populations in the odd and even year inspection years may have slight variations in material and/or design resulting in different deterioration rates for those years. Plotting a deterioration curve for each year results in a lot of "noise" in the results and trends are much harder to observe, as seen below for decks:



ILLUSTRATIVE EXAMPLE

As an example of how the method outlined above is used, consider deck rating changes in the years 2000, 2001, 2002, 2003, and 2004. For the year 2000, take the latest inspection prior to 01/01/00 and compare that to the latest inspection prior to 01/01/01. Sum these for all decks and combine the results with those of queries done for the other four years. The result is the 10 x 10 matrix shown below:

2000-2004		New Deck Rating									
		9	8	7	6	5	4	3	2	1	0
Old Deck Rating	9	306	171	28	9	2	0	0	0	0	0
	8	15	1799	252	23	9	2	0	0	0	0
	7	6	31	4860	439	62	9	6	0	0	0
	6	25	14	137	6245	351	47	18	0	0	0
	5	51	40	36	213	2978	182	39	0	0	0
	4	58	42	10	25	70	1180	92	0	0	0
	3	60	40	7	13	27	43	875	5	0	0
	2	3	0	0	0	0	0	4	15	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0

Compute the survival probabilities and transition times as shown below:

2000-2004		Remain Same	Deteriorated	Survival Probability	Median Trans. Yrs.	Time to Reach
Deck Rating	9	306	210	0.59302	1.3	0.0
	8	1799	286	0.86283	4.7	1.3
	7	4860	516	0.90402	6.9	6.0
	6	6245	416	0.93755	10.7	12.9
	5	2978	221	0.93092	9.7	23.6
	4	1180	92	0.92767	9.2	33.3
	3	875	5	0.99432	121.6	42.5
	2	15	0	1.00000	N/A	164.1
	1	0	0	N/A	N/A	N/A
	0	0	N/A	N/A	N/A	N/A

As an example, consider the deck rating of 6.

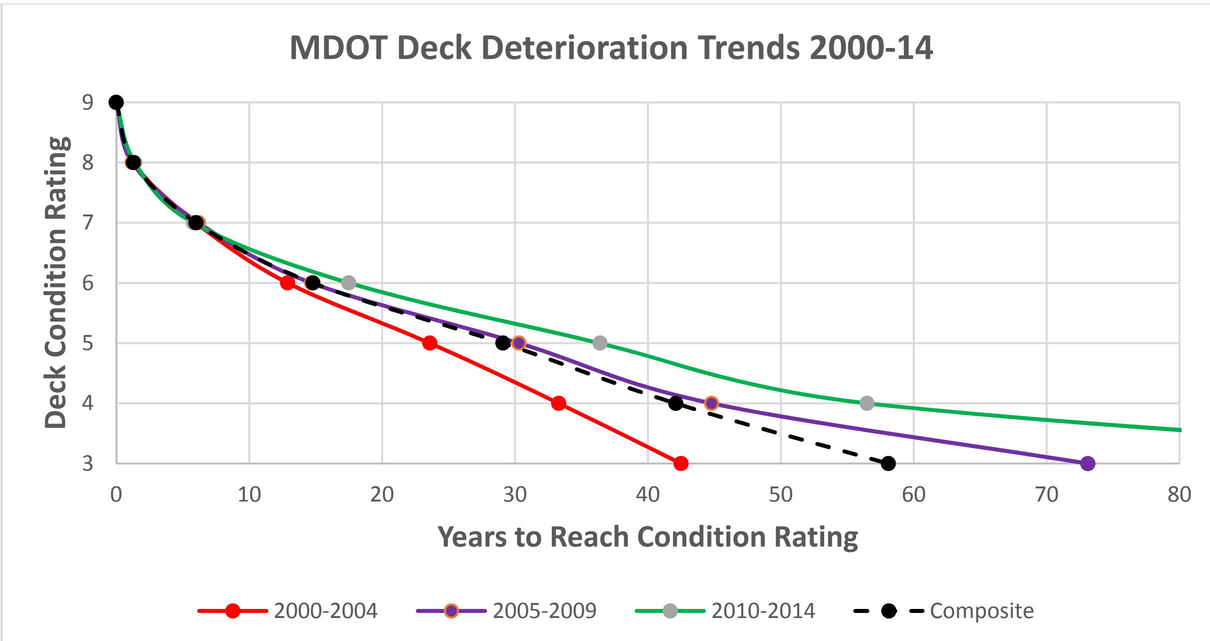
$$Survival\ Probability = \frac{6245}{6245+351+47+18} = 0.93755$$

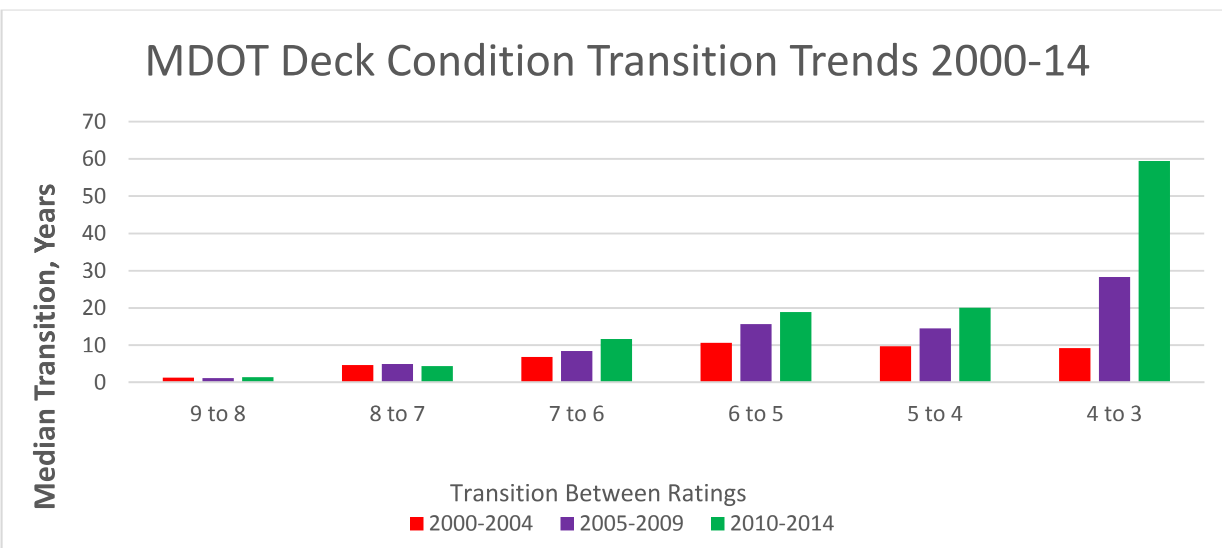
$$Median\ Transition\ Years = \frac{Log\ 0.5}{\log 0.93755} = 10.7 \text{ years}$$

Time to reach rating of 6 = 0.0 + 1.3 + 4.7 + 6.9 = 12.9 years

RESULTS AND ANALYSIS

DECKS

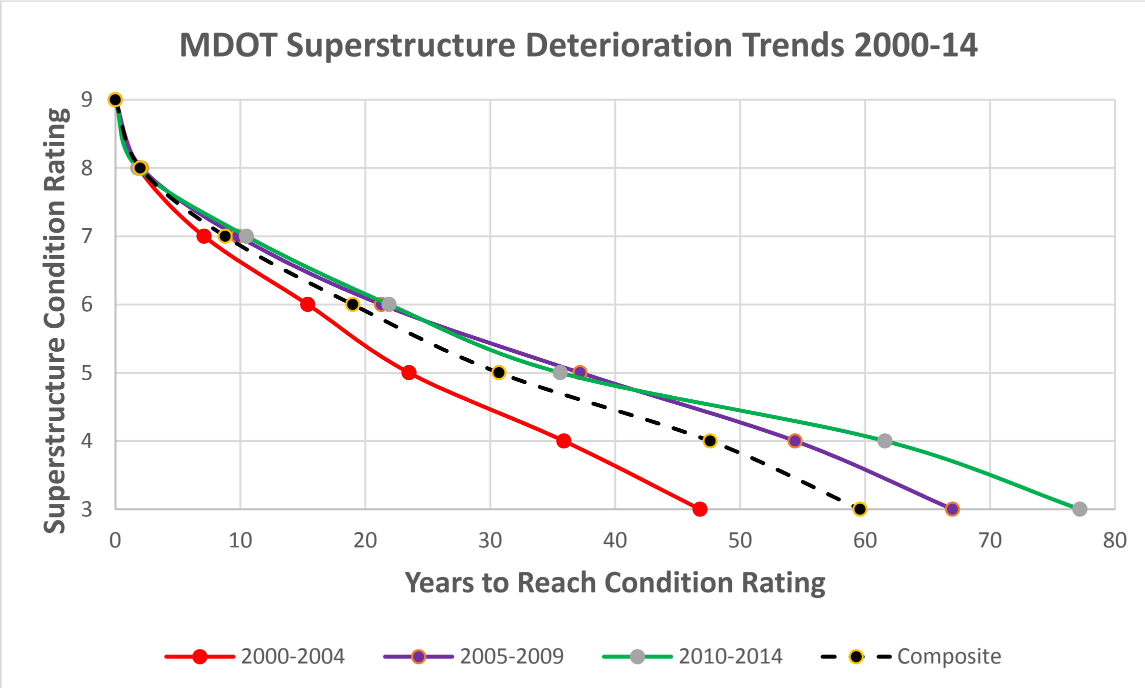


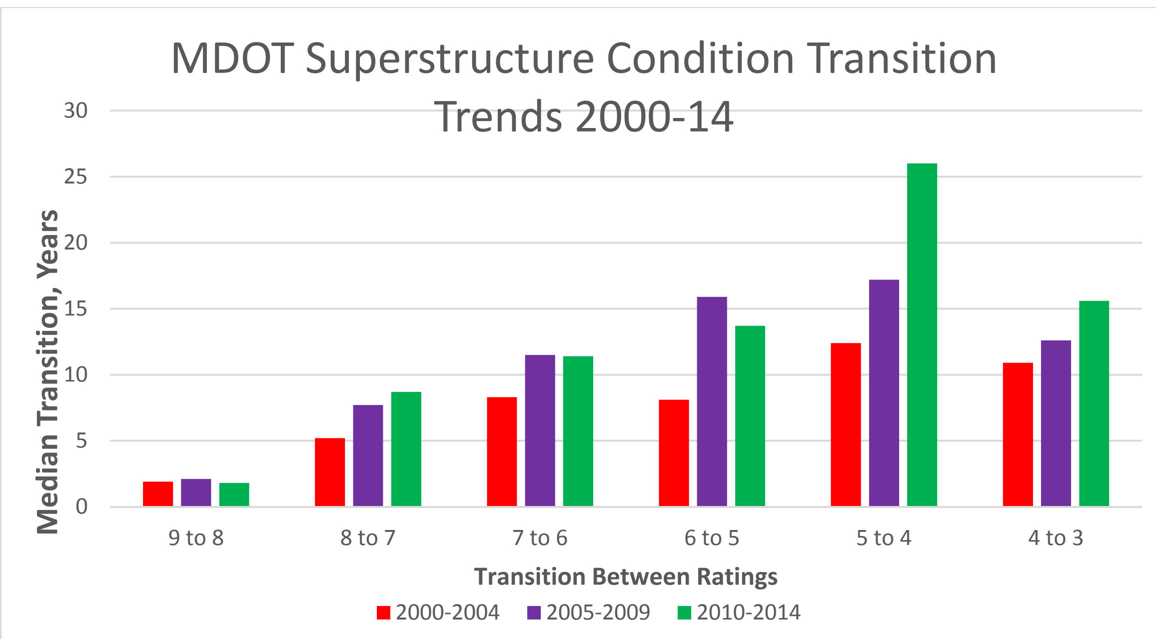


ANALYSIS

The deck results show a clear trend of slowing deterioration between ratings of 7 and 3. The deterioration curve from 9 to 7 is virtually unchanged over time, which is to be expected since few maintenance actions are done on these bridges. Transitions from 7 to 6, 6 to 5, and 5 to 4 all show significant increases in time, indicating that maintenance actions are having a more positive effect on deterioration over time.

SUPERSTRUCTURE

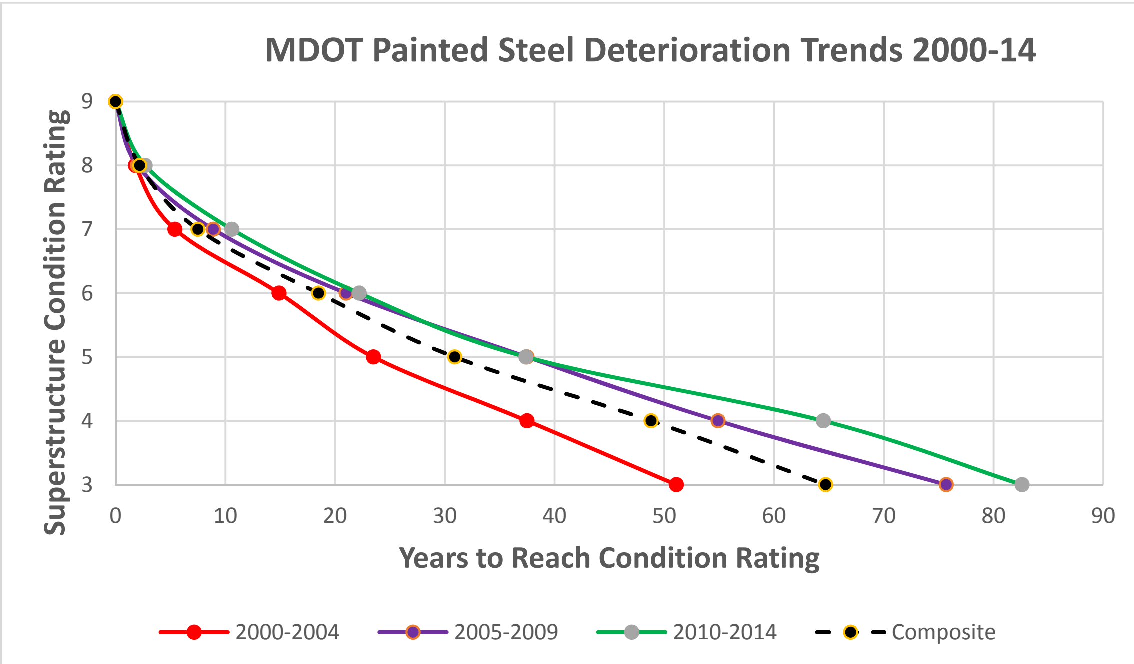


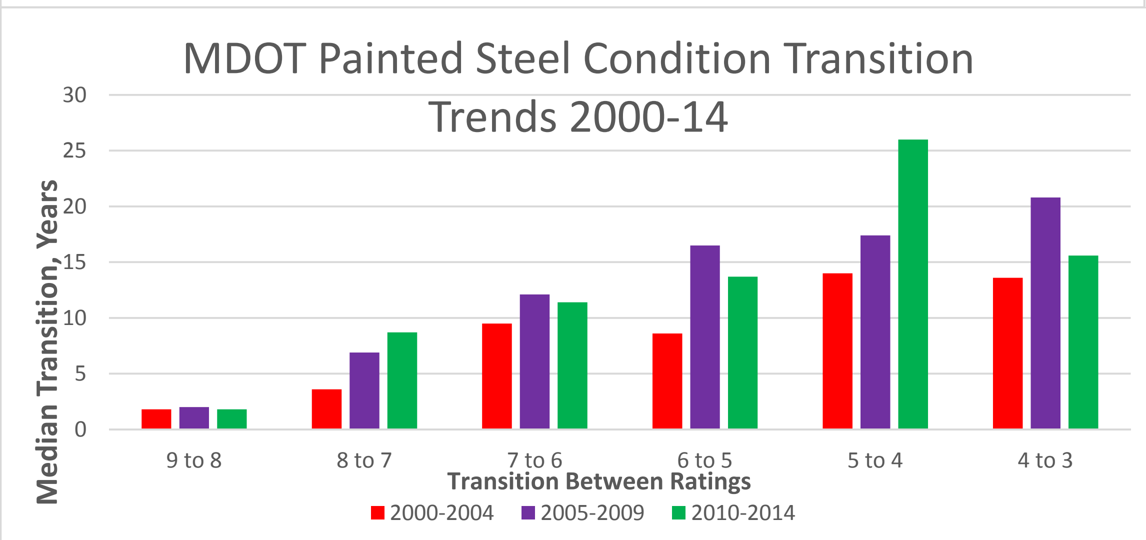


ANALYSIS

After the 2000-04 period, the deterioration from 7 to 4 slowed dramatically. The curve for 2005-09 is nearly identical to that from 2010-14,   It should be noted that the transition time from a rating of 5 to 4 has doubled from the first time range to the last, this has significantly reduced the number of bridges falling into the Structurally Deficient classification. The superstructure analysis may be further refined by looking at the superstructures by main material type separately.

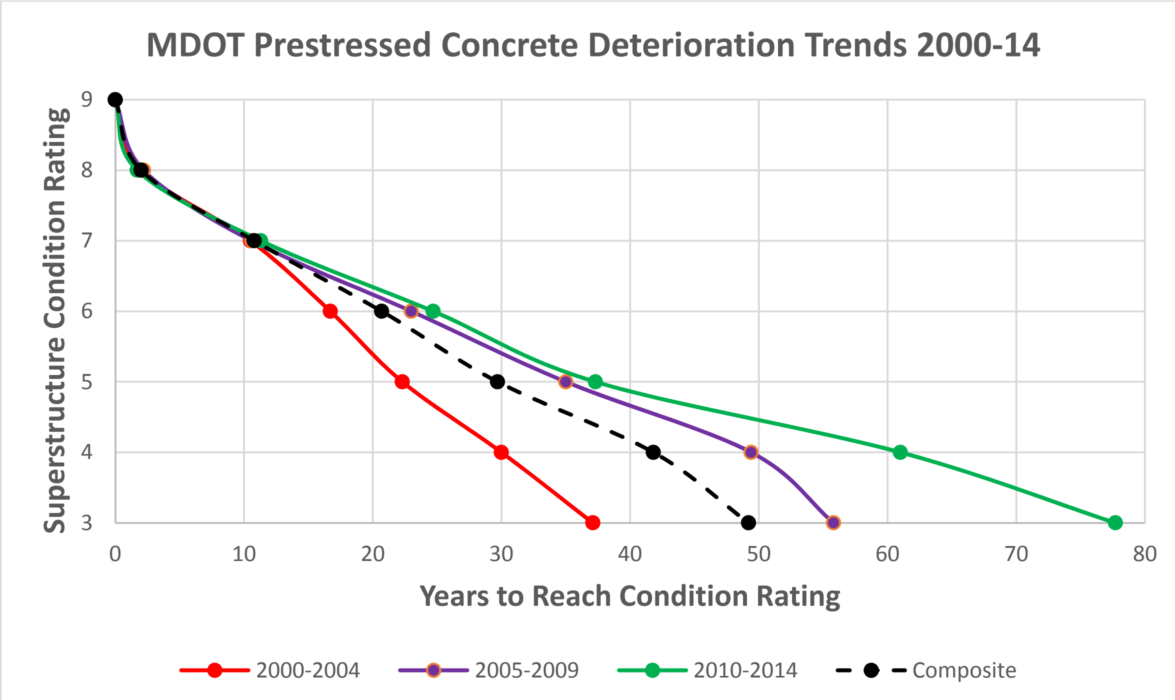
PAINTED STEEL SUPERSTRUCTURES

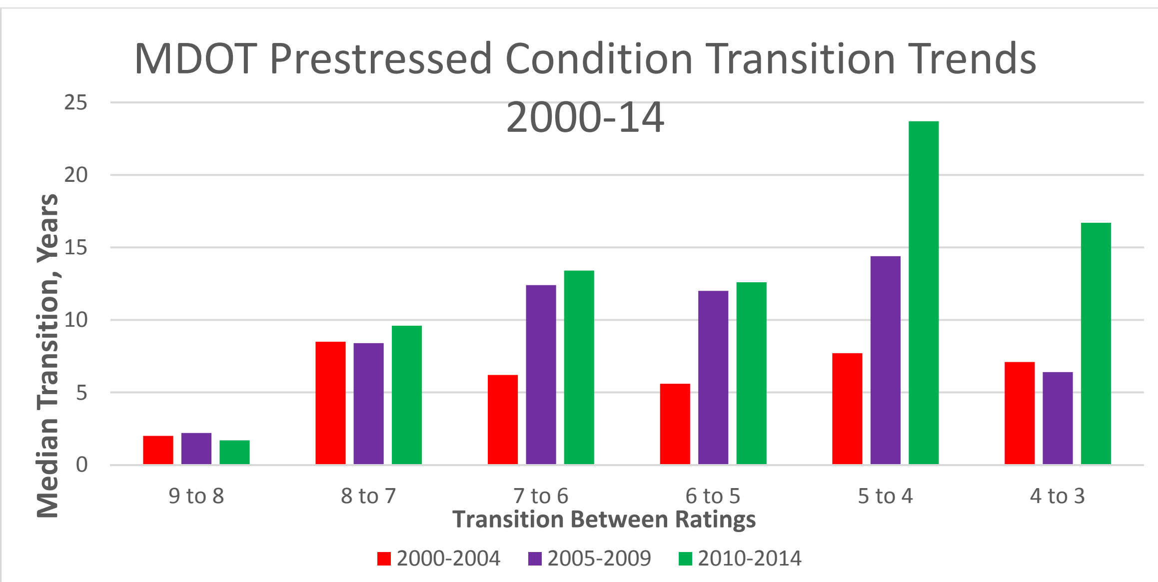




ANALYSIS
The transition from 6 to 4 has slowed greatly after the initial 2000-04 period. In particular, the transition from 5 to 4 has slowed dramatically in the latest five year interval, reducing the number of bridges falling into the structurally deficient classification.

PRESTRESSED CONCRETE SUPERSTRUCTURES



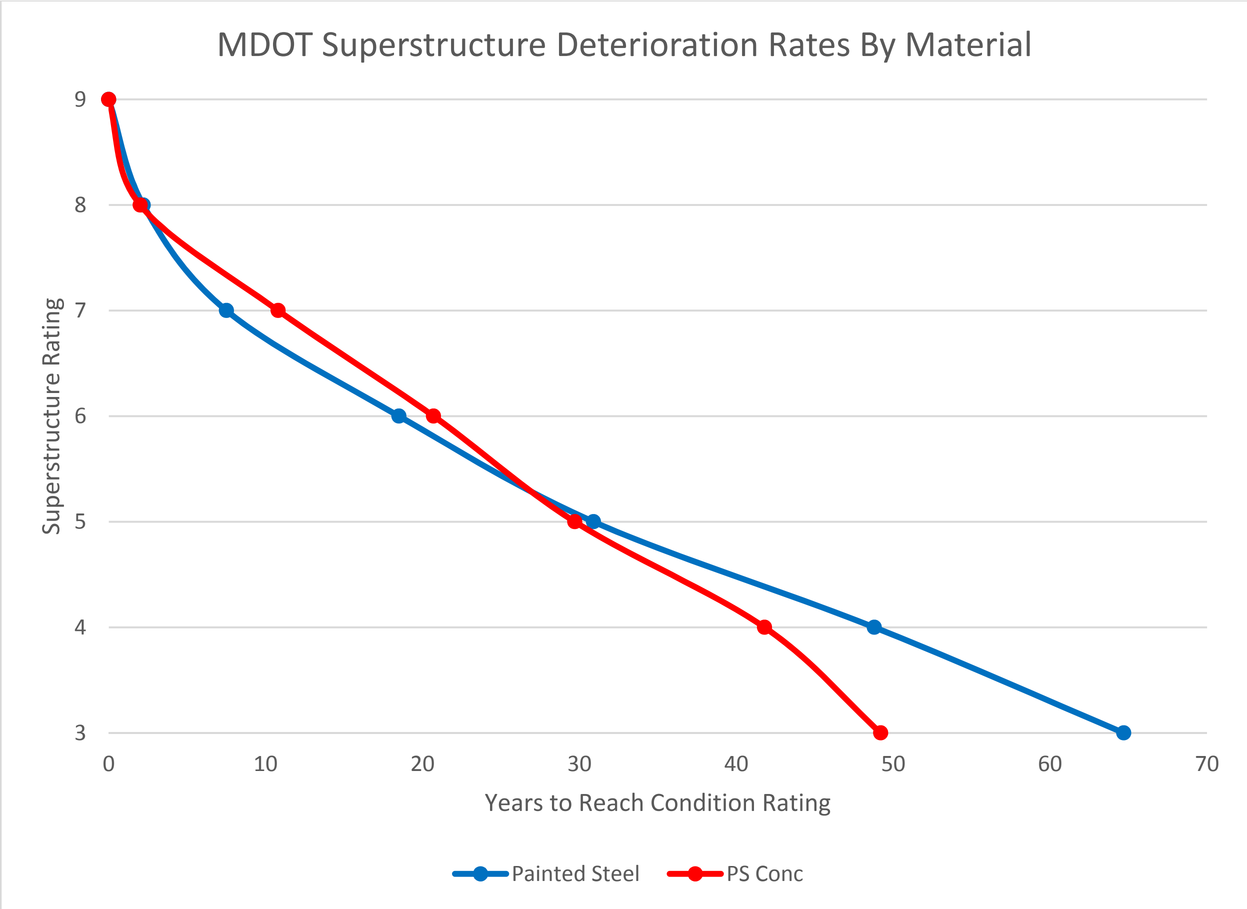


ANALYSIS

The time to reach a rating of 7 was virtually unchanged over time. The transition from 7 to 4 was much faster in the 2000-04 period than in later years. It should be noted that transitions from state 5 and below have a fairly small sample size and these transition times may not be as accurate as they are for steel bridges.

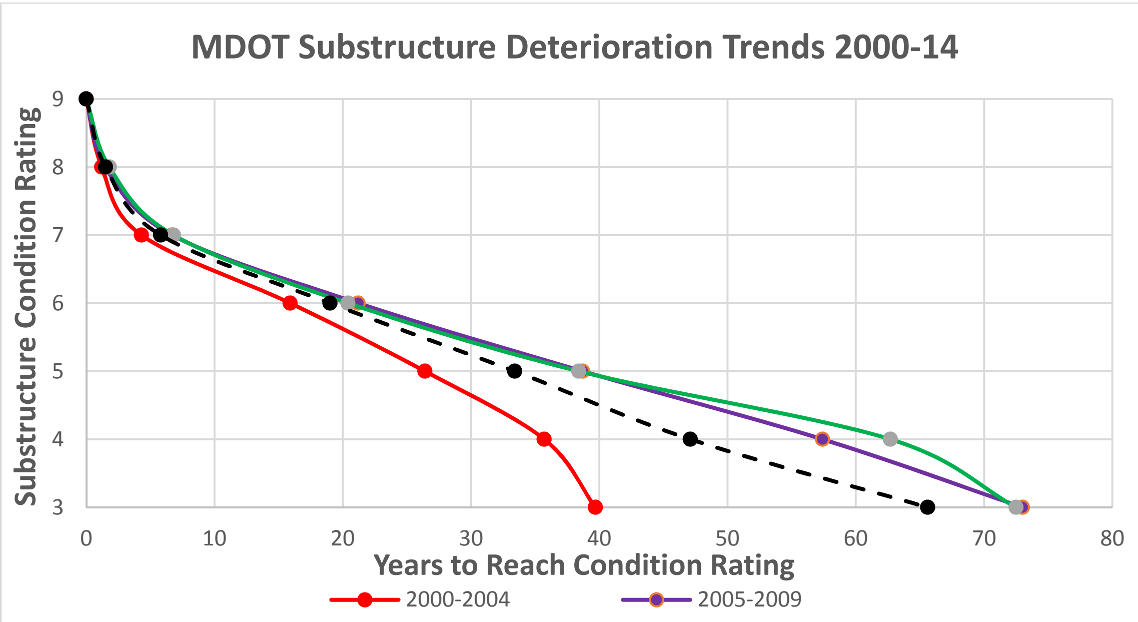
PAINTED STEEL VS. PRESTRESSED CONCRETE SUPERSTRUCTURES

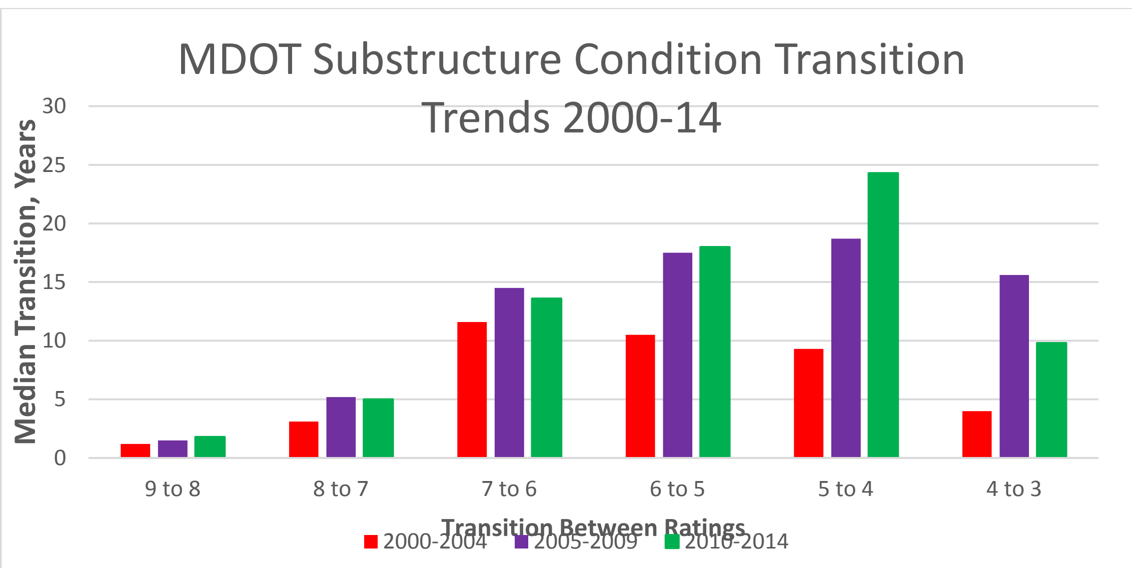
If we plot the composite 15 year average deterioration curve for painted steel and prestressed concrete superstructures together we get this:



ANALYSIS
The prestressed concrete deterioration curve is very nearly linear, as is the painted steel curve once it gets to a rating of 7. They both reach a rating of 5 in about the same time, and the prestressed concrete deterioration begins to accelerate at that point. This may be due to the fact that there are fewer preventive maintenance actions typically done on fair prestressed members while steel members often are repaired and/or repainted, slowing their further deterioration.

SUBSTRUCTURE

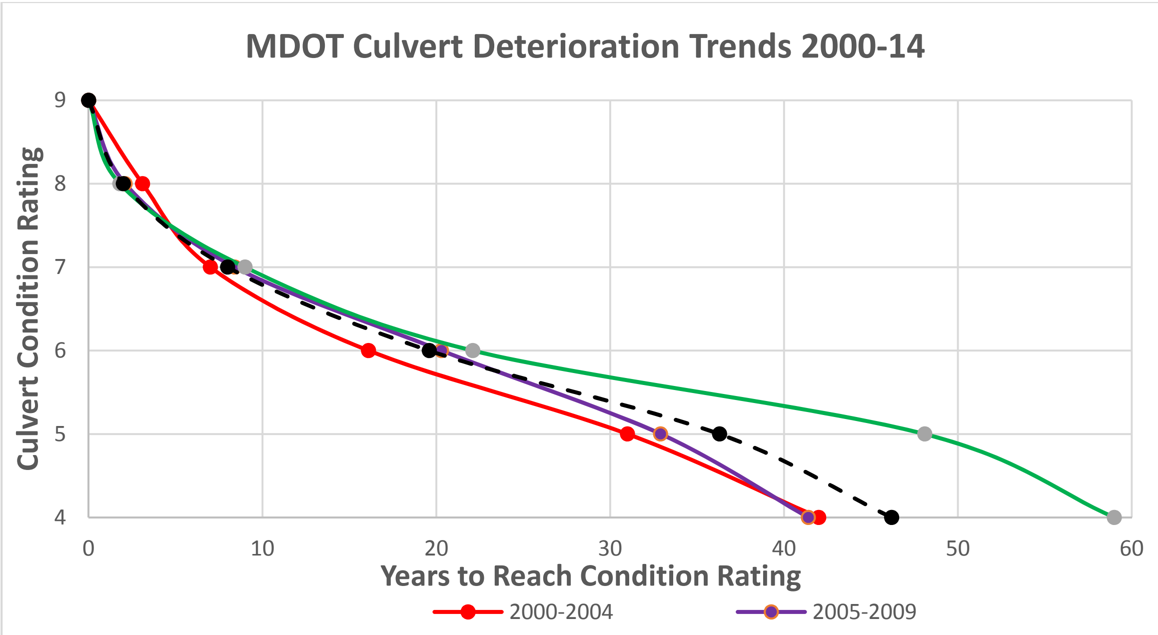


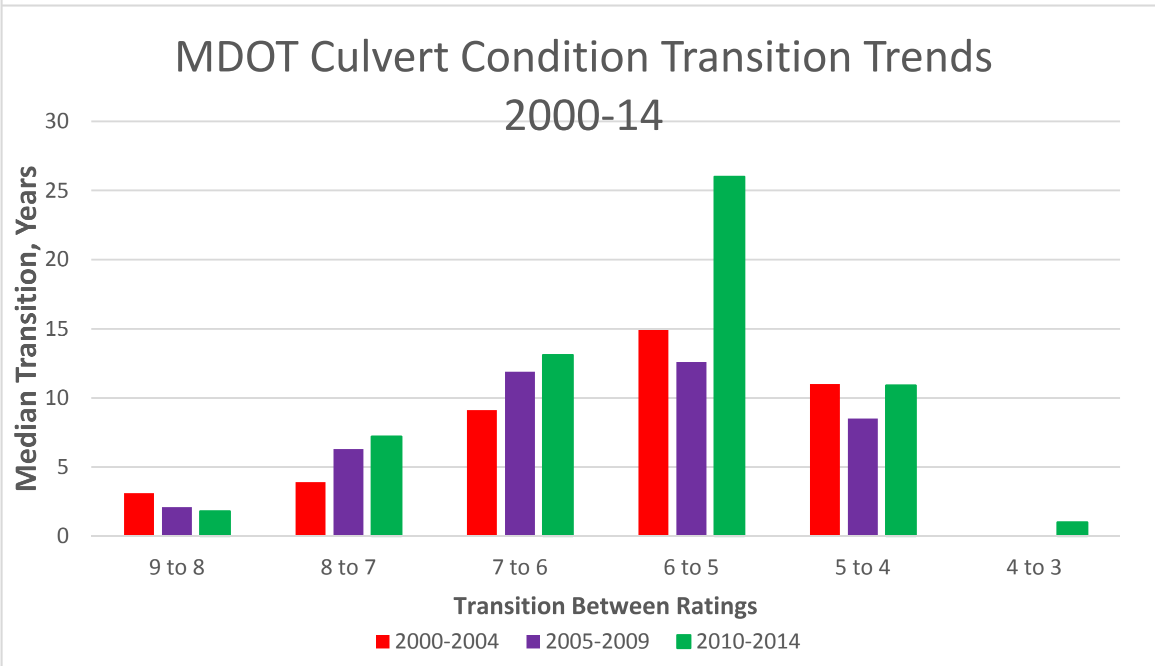


ANALYSIS

The substructure results were very similar to the superstructure results. The 2004-09 curve is nearly identical to the 2010-14 curve, and there was significant change in the transition time from 5 to 4, greatly reducing the number of Structurally Deficient bridges over the past decade.

CULVERTS

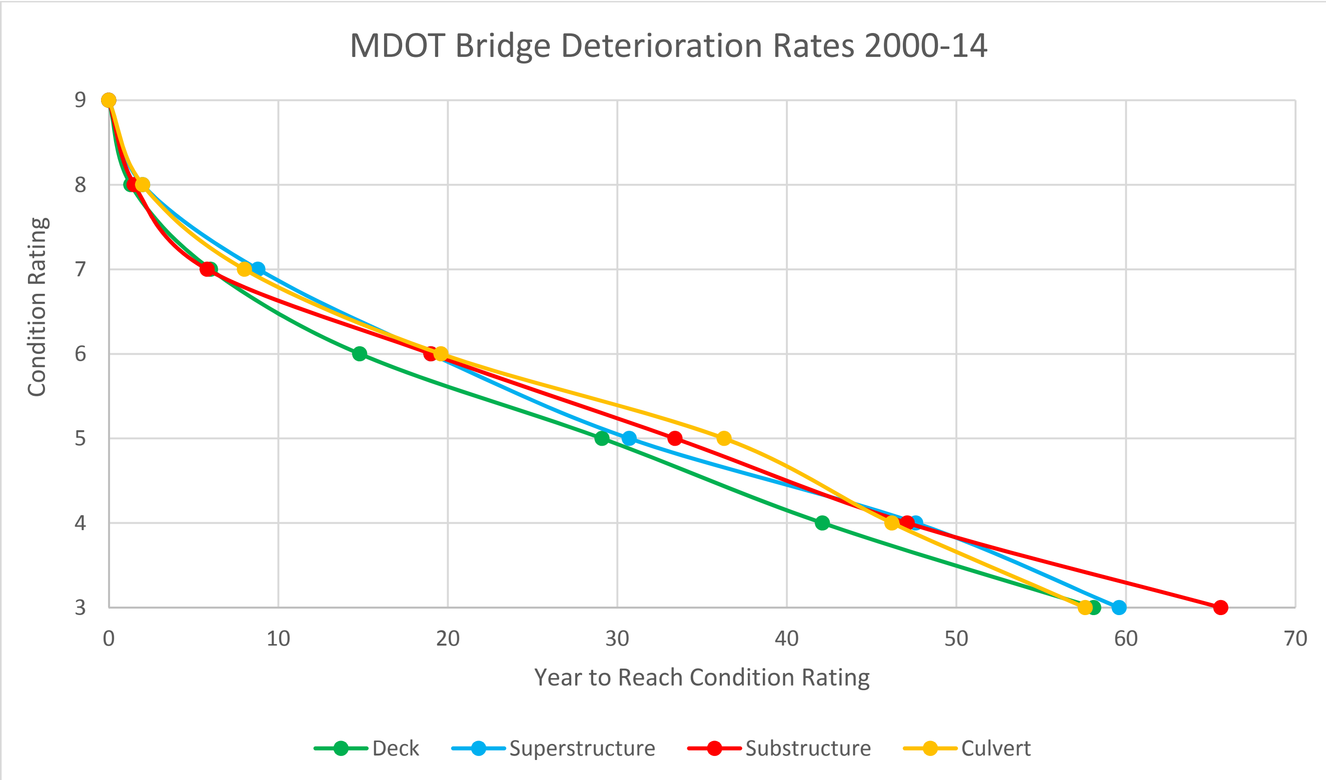




ANALYSIS

The deterioration curves have changed little over the years. This may be due to the limited opportunities for preventive maintenance that culverts present. The large spike in the 6 to 5 transition may be an outlier. There is insufficient data to extend the curves to a rating of 3. As noted earlier, there are far fewer data points available for culverts and much less confidence should be placed in these results.

ALL COMPONENTS



Each of the major NBI components has a similar deterioration curve. It may be that in the absence of preventive maintenance work that decks and superstructures would significantly faster than substructures and culverts. The deterioration curves give credibility to the conventional wisdom that bridge service life is around 50 years.

NEXT STEPS

The process presented here can be easily replicated in 2020 to compare the 2015-19 period to the three previous five year periods.

A similar study using NBE data rather than NBI data will not be possible for several more years as NBE data collection has just now finished its first cycle. The NBE data will allow opportunity to see deterioration trends for each specific bridge element (prestressed beams vs. steel beams, etc.) but also present challenges in how to present this wealth of data in a manner that is not overwhelming with detail.

The effect of preventive maintenance work actions could be demonstrated more positively if the data for these actions, particularly those of agency crew work, was more readily available. As the bridge management system becomes more robust, the value of preventive maintenance will be more readily documented.

APPENDIX

Data Grouped In Five Year Bands

2000-04		New Deck Rating									
		9	8	7	6	5	4	3	2	1	0
Old Deck Rating	9	306	171	28	9	2	0	0	0	0	0
	8	15	1799	252	23	9	2	0	0	0	0
	7	6	31	4860	439	62	9	6	0	0	0
	6	25	14	137	6245	351	47	18	0	0	0
	5	51	40	36	213	2978	182	39	0	0	0
	4	58	42	10	25	70	1180	92	0	0	0
	3	60	40	7	13	27	43	875	5	0	0
	2	3	0	0	0	0	0	4	15	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0

2005-09		New Deck Rating									
		9	8	7	6	5	4	3	2	1	0
Old Deck Rating	9	268	184	21	3	1	0	0	0	0	0
	8	10	2431	341	22	2	0	0	0	0	0
	7	5	72	4812	379	26	5	0	0	0	0
	6	26	32	303	6394	251	37	2	0	0	0
	5	26	21	69	229	2512	121	2	0	0	0
	4	58	37	22	44	72	1047	26	0	0	0
	3	45	19	13	5	6	22	459	0	0	0
	2	0	1	0	0	0	0	0	11	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0

2010-14		New Deck Rating									
		9	8	7	6	5	4	3	2	1	0
Old Deck Rating	9	291	139	37	3	0	0	0	0	0	0
	8	3	2109	312	41	3	0	0	0	0	0
	7	11	57	6444	381	12	2	0	0	0	0
	6	17	27	259	6514	223	20	0	0	0	0
	5	37	24	44	176	2169	74	2	0	0	0
	4	64	35	15	23	30	596	7	0	0	0
	3	35	8	4	2	3	4	156	0	0	0
	2	2	0	0	0	0	0	0	2	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0

2000-04		New Superstructure Rating									
		9	8	7	6	5	4	3	2	1	0
Old Superstructure Rating	9	402	145	24	2	1	1	0	0	0	0
	8	20	3360	427	42	8	6	0	0	1	0
	7	15	63	6146	435	84	12	3	1	0	0
	6	20	28	148	4514	343	42	16	1	0	0
	5	44	39	60	144	2611	115	35	0	0	0
	4	56	22	38	38	60	945	61	1	0	0
	3	24	13	10	14	16	20	292	3	0	0
	2	3	1	0	1	2	1	5	12	0	0
	1	0	0	0	1	0	0	0	0	0	0
	0	0	0	0	1	0	0	0	0	0	0

2005-09		New Superstructure Rating									
		9	8	7	6	5	4	3	2	1	0
Old Superstructure Rating	9	382	136	10	0	0	0	0	0	0	0
	8	19	3259	285	18	5	1	0	0	0	0
	7	7	49	6574	345	59	3	3	0	0	0
	6	19	27	212	4863	191	17	9	0	0	0
	5	29	21	104	136	2555	83	22	0	0	0
	4	22	17	43	40	55	549	31	0	0	0
	3	25	9	24	16	33	13	213	2	0	0
	2	1	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0

2010-14		New Superstructure Rating									
		9	8	7	6	5	4	3	2	1	0
Old Superstructure Rating	9	385	154	21	0	0	0	0	0	0	0
	8	9	3144	242	16	2	0	0	0	0	0
	7	13	80	7033	391	41	4	6	0	0	0
	6	17	39	148	5021	243	16	2	0	0	0
	5	33	30	61	82	2663	65	4	3	0	0
	4	28	8	14	8	17	308	13	1	0	0
	3	15	7	6	3	4	2	72	0	0	0
	2	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0

2000-04		New Substructure Rating									
		9	8	7	6	5	4	3	2	1	0
Old Substructure Rating	9	184	117	18	5	0	0	0	0	0	0
	8	16	1096	264	6	2	5	1	0	0	0
	7	5	41	8485	462	51	9	2	0	0	0
	6	18	15	218	5033	288	38	17	0	0	0
	5	32	20	124	127	2456	159	29	1	0	0
	4	27	19	65	44	55	960	52	1	0	0
	3	12	12	33	25	12	26	396	8	0	1
	2	2	1	5	4	1	1	3	36	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0	1	9	3	3	1	0	0	0	0

2005-09		New Substructure Rating									
		9	8	7	6	5	4	3	2	1	0
Old Substructure Rating	9	148	78	8	0	0	0	0	0	0	0
	8	6	1419	193	10	1	0	0	0	0	0
	7	16	56	9342	414	39	3	0	0	0	0
	6	9	32	326	4948	185	12	2	0	0	1
	5	19	25	176	85	1828	66	3	0	0	0
	4	22	14	62	44	19	655	10	0	0	0
	3	7	5	28	22	3	5	191	1	0	0
	2	1	0	2	0	0	0	1	1	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0	1	0	1	0	0	0	0	0	1

2010-14		New Substructure Rating									
		9	8	7	6	5	4	3	2	1	0
Old Substructure Rating	9	210	87	9	0	1	0	0	0	0	0
	8	5	1425	199	9	3	0	0	0	0	0
	7	9	98	10097	491	27	8	2	0	0	0
	6	22	46	277	5033	182	12	4	0	0	0
	5	18	19	103	61	1520	41	0	3	0	0
	4	17	17	47	11	10	272	8	1	0	0
	3	3	4	15	2	0	2	33	0	0	0
	2	0	0	0	0	0	1	0	1	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0

2000-04		New Culvert Rating									
		9	8	7	6	5	4	3	2	1	0
Old Culvert Rating	9	12	3	0	0	0	0	0	0	0	0
	8	1	83	13	2	1	0	0	0	0	0
	7	0	6	151	11	1	0	0	0	0	0
	6	0	0	10	189	7	1	1	0	0	0
	5	0	0	0	6	46	3	0	0	0	0
	4	2	2	0	1	1	17	0	0	0	0
	3	0	0	0	0	0	0	1	0	0	0
	2	0	0	0	0	0	0	0	1	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0

2005-09		New Culvert Rating									
		9	8	7	6	5	4	3	2	1	0
Old Culvert Rating	9	38	15	0	0	0	0	0	0	0	0
	8	1	155	17	1	0	0	0	0	0	0
	7	0	3	299	17	1	0	0	0	0	0
	6	3	3	14	213	10	2	0	0	0	0
	5	2	1	1	5	59	5	0	0	0	0
	4	1	2	0	0	0	21	2	0	0	0
	3	1	1	0	0	0	0	3	0	0	0
	2	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0

2010-14		New Culvert Rating									
		9	8	7	6	5	4	3	2	1	0
Old Culvert Rating	9	44	18	2	0	0	0	0	0	0	0
	8	1	227	21	2	0	0	0	0	0	0
	7	1	3	331	18	0	0	0	0	0	0
	6	2	0	3	259	6	1	0	0	0	0
	5	0	0	1	3	61	2	2	0	0	0
	4	3	0	1	0	1	10	1	0	0	0
	3	1	1	0	0	0	0	4	0	0	0
	2	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0

SQL

The script below can be modified by anyone reasonably familiar with SQL and the data structure to give results for any single year which can later be aggregated as desired.

```
//  Rating Pairs October 2015
//  Robert Kelley
// This will produce 100 columns of data that can be copied to a 10x10 matrix
// Can use for deck, superstructure, substructure, or culvert ratings

// To go from deck rating to superstructure rating
// Replace all 'dkrating' with 'suprrating'
// Also replace all 'deck' with 'super'

// To go from deck rating to substructure rating
// Replace all 'dkrating' with 'subrrating'
// Also replace all 'deck' with 'sub'

// To go from deck rating to culvert rating
// Replace all 'dkrating' with 'culvrrating'
// Also replace all 'deck' with 'culv'

// Need to change dates for each year of desired data
// For example:  If you want to see the data for calendar year 2010
// Scroll to the Where Statement and change these items:
// to_char(c2.inspdate,'yyyy')<'2010')
// to_char(d2.inspdate,'yyyy')<'2011')
// Table c is the ''earlier' inspection date, the first clause will return the latest date prior to 2010
// Table d is the 'later' inspection date, the second clause will return the latest date prior to 2011

// The results will be one one line in this format:
// 9 to 9, 9 to 8, 9 to 7,... 9 to 0, 8 to 9, 8 to 8, 8 to 7.... 8 to 0, 7 to 9, 7 to 8, 7 to 7, 7 to 6, ... 7 to 0.... 0 to 0
// This can be copied and pasted in Excel and then the data can be shuffled to form a 10x10 matrix
// in this format
// 9 to 9, 9 to 8, 9 to 7, 9 to 6, 9 to 5.... 9 to 0
// 8 to 9, 8 to 8, 8 to 7, 8 to 6, 8 to 5... 8 to 0
// and so on down to
// 0 to 9, 0 to 8, 0 to 7, 0 to 6, ... 0 to 0

select
sum
(case when NVL(c.dkrating,'X')='9' and NVL(d.dkrating,'X')='9'
then 1 else 0 end) as deck99,
sum
(case when NVL(c.dkrating,'X')='9' and NVL(d.dkrating,'X')='8'
then 1 else 0 end) as deck98,
sum
(case when NVL(c.dkrating,'X')='9' and NVL(d.dkrating,'X')='7'
then 1 else 0 end) as deck97,
sum
(case when NVL(c.dkrating,'X')='9' and NVL(d.dkrating,'X')='6'
then 1 else 0 end) as deck96,
sum
(case when NVL(c.dkrating,'X')='9' and NVL(d.dkrating,'X')='5'
then 1 else 0 end) as deck95,
sum
(case when NVL(c.dkrating,'X')='9' and NVL(d.dkrating,'X')='4'
then 1 else 0 end) as deck94,
sum
(case when NVL(c.dkrating,'X')='9' and NVL(d.dkrating,'X')='3'
then 1 else 0 end) as deck93,
sum
(case when NVL(c.dkrating,'X')='9' and NVL(d.dkrating,'X')='2'
then 1 else 0 end) as deck92,
sum
(case when NVL(c.dkrating,'X')='9' and NVL(d.dkrating,'X')='1'
then 1 else 0 end) as deck91,
sum
(case when NVL(c.dkrating,'X')='9' and NVL(d.dkrating,'X')='0'
then 1 else 0 end) as deck90,
sum
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(case when NVL(c.dkrating,'X')='8' and NVL(d.dkrating,'X')='9'
then 1 else 0 end) as deck89,
sum
(case when NVL(c.dkrating,'X')='8' and NVL(d.dkrating,'X')='8'
then 1 else 0 end) as deck88,
sum
(case when NVL(c.dkrating,'X')='8' and NVL(d.dkrating,'X')='7'
then 1 else 0 end) as deck87,
sum
(case when NVL(c.dkrating,'X')='8' and NVL(d.dkrating,'X')='6'
then 1 else 0 end) as deck86,
sum
(case when NVL(c.dkrating,'X')='8' and NVL(d.dkrating,'X')='5'
then 1 else 0 end) as deck85,
sum
(case when NVL(c.dkrating,'X')='8' and NVL(d.dkrating,'X')='4'
then 1 else 0 end) as deck84,
sum
(case when NVL(c.dkrating,'X')='8' and NVL(d.dkrating,'X')='3'
then 1 else 0 end) as deck83,
sum
(case when NVL(c.dkrating,'X')='8' and NVL(d.dkrating,'X')='2'
then 1 else 0 end) as deck82,
sum
(case when NVL(c.dkrating,'X')='8' and NVL(d.dkrating,'X')='1'
then 1 else 0 end) as deck81,
sum
(case when NVL(c.dkrating,'X')='8' and NVL(d.dkrating,'X')='0'
then 1 else 0 end) as deck80,
sum
(case when NVL(c.dkrating,'X')='7' and NVL(d.dkrating,'X')='9'
then 1 else 0 end) as deck79,
sum
(case when NVL(c.dkrating,'X')='7' and NVL(d.dkrating,'X')='8'
then 1 else 0 end) as deck78,
sum
(case when NVL(c.dkrating,'X')='7' and NVL(d.dkrating,'X')='7'
then 1 else 0 end) as deck77,
sum
(case when NVL(c.dkrating,'X')='7' and NVL(d.dkrating,'X')='6'
then 1 else 0 end) as deck76,
sum
(case when NVL(c.dkrating,'X')='7' and NVL(d.dkrating,'X')='5'
then 1 else 0 end) as deck75,
sum
(case when NVL(c.dkrating,'X')='7' and NVL(d.dkrating,'X')='4'
then 1 else 0 end) as deck74,
sum
(case when NVL(c.dkrating,'X')='7' and NVL(d.dkrating,'X')='3'
then 1 else 0 end) as deck73,
sum
(case when NVL(c.dkrating,'X')='7' and NVL(d.dkrating,'X')='2'
then 1 else 0 end) as deck72,
sum
(case when NVL(c.dkrating,'X')='7' and NVL(d.dkrating,'X')='1'
then 1 else 0 end) as deck71,
sum
(case when NVL(c.dkrating,'X')='7' and NVL(d.dkrating,'X')='0'
then 1 else 0 end) as deck70,
sum
(case when NVL(c.dkrating,'X')='6' and NVL(d.dkrating,'X')='9'
then 1 else 0 end) as deck69,
sum
(case when NVL(c.dkrating,'X')='6' and NVL(d.dkrating,'X')='8'
then 1 else 0 end) as deck68,
sum
(case when NVL(c.dkrating,'X')='6' and NVL(d.dkrating,'X')='7'
then 1 else 0 end) as deck67,
sum
(case when NVL(c.dkrating,'X')='6' and NVL(d.dkrating,'X')='6'
then 1 else 0 end) as deck66,
sum
(case when NVL(c.dkrating,'X')='6' and NVL(d.dkrating,'X')='5'
then 1 else 0 end) as deck65,
sum

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(case when NVL(c.dkrating,'X')='6' and NVL(d.dkrating,'X')='4'
then 1 else 0 end) as deck64,
sum
(case when NVL(c.dkrating,'X')='6' and NVL(d.dkrating,'X')='3'
then 1 else 0 end) as deck63,
sum
(case when NVL(c.dkrating,'X')='6' and NVL(d.dkrating,'X')='2'
then 1 else 0 end) as deck62,
sum
(case when NVL(c.dkrating,'X')='6' and NVL(d.dkrating,'X')='1'
then 1 else 0 end) as deck61,
sum
(case when NVL(c.dkrating,'X')='6' and NVL(d.dkrating,'X')='0'
then 1 else 0 end) as deck60,
sum
(case when NVL(c.dkrating,'X')='5' and NVL(d.dkrating,'X')='9'
then 1 else 0 end) as deck59,
sum
(case when NVL(c.dkrating,'X')='5' and NVL(d.dkrating,'X')='8'
then 1 else 0 end) as deck58,
sum
(case when NVL(c.dkrating,'X')='5' and NVL(d.dkrating,'X')='7'
then 1 else 0 end) as deck57,
sum
(case when NVL(c.dkrating,'X')='5' and NVL(d.dkrating,'X')='6'
then 1 else 0 end) as deck56,
sum
(case when NVL(c.dkrating,'X')='5' and NVL(d.dkrating,'X')='5'
then 1 else 0 end) as deck55,
sum
(case when NVL(c.dkrating,'X')='5' and NVL(d.dkrating,'X')='4'
then 1 else 0 end) as deck54,
sum
(case when NVL(c.dkrating,'X')='5' and NVL(d.dkrating,'X')='3'
then 1 else 0 end) as deck53,
sum
(case when NVL(c.dkrating,'X')='5' and NVL(d.dkrating,'X')='2'
then 1 else 0 end) as deck52,
sum
(case when NVL(c.dkrating,'X')='5' and NVL(d.dkrating,'X')='1'
then 1 else 0 end) as deck51,
sum
(case when NVL(c.dkrating,'X')='5' and NVL(d.dkrating,'X')='0'
then 1 else 0 end) as deck50,
sum
(case when NVL(c.dkrating,'X')='4' and NVL(d.dkrating,'X')='9'
then 1 else 0 end) as deck49,
sum
(case when NVL(c.dkrating,'X')='4' and NVL(d.dkrating,'X')='8'
then 1 else 0 end) as deck48,
sum
(case when NVL(c.dkrating,'X')='4' and NVL(d.dkrating,'X')='7'
then 1 else 0 end) as deck47,
sum
(case when NVL(c.dkrating,'X')='4' and NVL(d.dkrating,'X')='6'
then 1 else 0 end) as deck46,
sum
(case when NVL(c.dkrating,'X')='4' and NVL(d.dkrating,'X')='5'
then 1 else 0 end) as deck45,
sum
(case when NVL(c.dkrating,'X')='4' and NVL(d.dkrating,'X')='4'
then 1 else 0 end) as deck44,
sum
(case when NVL(c.dkrating,'X')='4' and NVL(d.dkrating,'X')='3'
then 1 else 0 end) as deck43,
sum
(case when NVL(c.dkrating,'X')='4' and NVL(d.dkrating,'X')='2'
then 1 else 0 end) as deck42,
sum
(case when NVL(c.dkrating,'X')='4' and NVL(d.dkrating,'X')='1'
then 1 else 0 end) as deck41,
sum
(case when NVL(c.dkrating,'X')='4' and NVL(d.dkrating,'X')='0'
then 1 else 0 end) as deck40,
sum
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```
(case when NVL(c.dkrating,'X')='3' and NVL(d.dkrating,'X')='9'
then 1 else 0 end) as deck39,
sum
(case when NVL(c.dkrating,'X')='3' and NVL(d.dkrating,'X')='8'
then 1 else 0 end) as deck38,
sum
(case when NVL(c.dkrating,'X')='3' and NVL(d.dkrating,'X')='7'
then 1 else 0 end) as deck37,
sum
(case when NVL(c.dkrating,'X')='3' and NVL(d.dkrating,'X')='6'
then 1 else 0 end) as deck36,
sum
(case when NVL(c.dkrating,'X')='3' and NVL(d.dkrating,'X')='5'
then 1 else 0 end) as deck35,
sum
(case when NVL(c.dkrating,'X')='3' and NVL(d.dkrating,'X')='4'
then 1 else 0 end) as deck34,
sum
(case when NVL(c.dkrating,'X')='3' and NVL(d.dkrating,'X')='3'
then 1 else 0 end) as deck33,
sum
(case when NVL(c.dkrating,'X')='3' and NVL(d.dkrating,'X')='2'
then 1 else 0 end) as deck32,
sum
(case when NVL(c.dkrating,'X')='3' and NVL(d.dkrating,'X')='1'
then 1 else 0 end) as deck31,
sum
(case when NVL(c.dkrating,'X')='3' and NVL(d.dkrating,'X')='0'
then 1 else 0 end) as deck30,
sum
(case when NVL(c.dkrating,'X')='2' and NVL(d.dkrating,'X')='9'
then 1 else 0 end) as deck29,
sum
(case when NVL(c.dkrating,'X')='2' and NVL(d.dkrating,'X')='8'
then 1 else 0 end) as deck28,
sum
(case when NVL(c.dkrating,'X')='2' and NVL(d.dkrating,'X')='7'
then 1 else 0 end) as deck27,
sum
(case when NVL(c.dkrating,'X')='2' and NVL(d.dkrating,'X')='6'
then 1 else 0 end) as deck26,
sum
(case when NVL(c.dkrating,'X')='2' and NVL(d.dkrating,'X')='5'
then 1 else 0 end) as deck25,
sum
(case when NVL(c.dkrating,'X')='2' and NVL(d.dkrating,'X')='4'
then 1 else 0 end) as deck24,
sum
(case when NVL(c.dkrating,'X')='2' and NVL(d.dkrating,'X')='3'
then 1 else 0 end) as deck23,
sum
(case when NVL(c.dkrating,'X')='2' and NVL(d.dkrating,'X')='2'
then 1 else 0 end) as deck22,
sum
(case when NVL(c.dkrating,'X')='2' and NVL(d.dkrating,'X')='1'
then 1 else 0 end) as deck21,
sum
(case when NVL(c.dkrating,'X')='2' and NVL(d.dkrating,'X')='0'
then 1 else 0 end) as deck20,
sum
(case when NVL(c.dkrating,'X')='1' and NVL(d.dkrating,'X')='9'
then 1 else 0 end) as deck19,
sum
(case when NVL(c.dkrating,'X')='1' and NVL(d.dkrating,'X')='8'
then 1 else 0 end) as deck18,
sum
(case when NVL(c.dkrating,'X')='1' and NVL(d.dkrating,'X')='7'
then 1 else 0 end) as deck17,
sum
(case when NVL(c.dkrating,'X')='1' and NVL(d.dkrating,'X')='6'
then 1 else 0 end) as deck16,
sum
(case when NVL(c.dkrating,'X')='1' and NVL(d.dkrating,'X')='5'
then 1 else 0 end) as deck15,
sum
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```
(case when NVL(c.dkrating,'X')='1' and NVL(d.dkrating,'X')='4'
then 1 else 0 end) as deck14,
sum
(case when NVL(c.dkrating,'X')='1' and NVL(d.dkrating,'X')='3'
then 1 else 0 end) as deck13,
sum
(case when NVL(c.dkrating,'X')='1' and NVL(d.dkrating,'X')='2'
then 1 else 0 end) as deck12,
sum
(case when NVL(c.dkrating,'X')='1' and NVL(d.dkrating,'X')='1'
then 1 else 0 end) as deck11,
sum
(case when NVL(c.dkrating,'X')='1' and NVL(d.dkrating,'X')='0'
then 1 else 0 end) as deck10,
sum
(case when NVL(c.dkrating,'X')='0' and NVL(d.dkrating,'X')='9'
then 1 else 0 end) as deck09,
sum
(case when NVL(c.dkrating,'X')='0' and NVL(d.dkrating,'X')='8'
then 1 else 0 end) as deck08,
sum
(case when NVL(c.dkrating,'X')='0' and NVL(d.dkrating,'X')='7'
then 1 else 0 end) as deck07,
sum
(case when NVL(c.dkrating,'X')='0' and NVL(d.dkrating,'X')='6'
then 1 else 0 end) as deck06,
sum
(case when NVL(c.dkrating,'X')='0' and NVL(d.dkrating,'X')='5'
then 1 else 0 end) as deck05,
sum
(case when NVL(c.dkrating,'X')='0' and NVL(d.dkrating,'X')='4'
then 1 else 0 end) as deck04,
sum
(case when NVL(c.dkrating,'X')='0' and NVL(d.dkrating,'X')='3'
then 1 else 0 end) as deck03,
sum
(case when NVL(c.dkrating,'X')='0' and NVL(d.dkrating,'X')='2'
then 1 else 0 end) as deck02,
sum
(case when NVL(c.dkrating,'X')='0' and NVL(d.dkrating,'X')='1'
then 1 else 0 end) as deck01,
sum
(case when NVL(c.dkrating,'X')='0' and NVL(d.dkrating,'X')='0'
then 1 else 0 end) as deck00


from bridge a, userbrdg b, inspevnt c, inspevnt d

where
a.brkey=b.brkey
and a.brkey=c.brkey
and a.brkey=d.brkey

// NOTE:  In this section, change the date criteria as noted above
// Table C is the EARLIER date
// Table D is the LATER date

and c.nbinspdone='1' and c.inspdate=(select max(inspdate) from inspevnt c2
where c.brkey=c2.brkey and to_char(c2.inspdate,'yyyy')<'2013')
and d.nbinspdone='1' and d.inspdate=(select max(inspdate) from inspevnt d2
where d.brkey=d2.brkey and to_char(d2.inspdate,'yyyy')<'2014')

and b.legal_cd='1'
and a.servtypon in ('1','4','5','6','7','8')
and a.nbislen='Y'
and c.oppostcl not in ('S','G')
```