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Executive Summary Report

Development of Degradation Rates for Various Bridge Types in the State of Ohio

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Project Background

The Ohio Department of Transportation (ODOT) maintains a Bridge Management System (BMS) which is responsible for collecting and maintaining historical and longitudinal data by year for all the bridges in Ohio.BMS aids ODOT in tracking, design, planning maintenance requests on bridges and funds allocation for maintenance.

The historical data collected in the BMS can be used for analysis and modeling to understand the degradation rate of bridges across the state of Ohio. Degradation rate of bridges varies across the different districts in Ohio owing to changes in location, traffic, environmental factors, freeze thaw cycling, traffic wear and tear, use of salt since chloride ions causes corrosion, restricted inspection and maintenance due to lack of availability of funds.

Statistical analysis and modeling of the BMS data can provide good insight to the rate of degradation and maintenance requirement on bridges under different environmental, location and other factors. An understanding of the behavior of the existing bridges under the effect of different conditions and their future performance is essential for the BMS. A reliable bridge prediction and performance model would facilitate inspection scheduling, cost analysis and budget optimization.

Study Objectives

The main objective of this project is to apply statistical analysis and modeling of the BMS data to understand the degradation rate of bridges in the state of Ohio. The degradation rate thus obtained can be utilized for planning, maintenance and budget allocations.

Description of Work

Step 1: Database Creation

The BMS data made available in the form of excel spreadsheet was cleansed, formatted and uploaded to MySql database and data warehouse for different districts and material types were created.

Step 2: Age Reset and Markov Models

Domain for analysis was changed from year of inspection to bridge age domain where age = (year of inspection – year built). Using concept of age reset, bridges were resettled back to early ages (age 0) whenever a major maintenance happens on the bridge.

Markov models were then applied to the bridges for OPI forecasting and trending. Using Markov models predicted mean OPI rating for each bridge age was compared with the actual mean OPI rating obtained from the database.

Figure 1.1 shows the Markov modeling and OPI forecasting of GA OPI. The 'y' axis is the mean GA rating and the 'x' axis is the GA age.

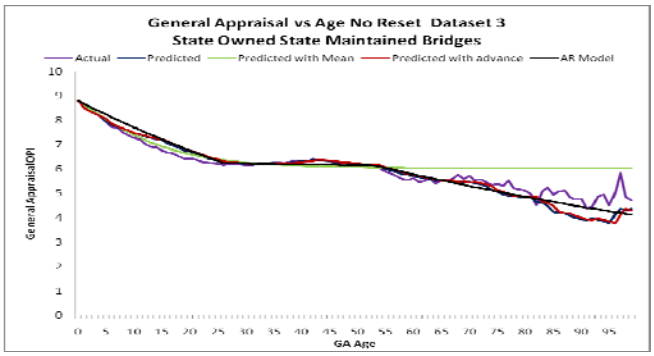

Figure1.1: GA OPI Forecasting

Step 3: Degradation Rate Modeling

The definition for degradation rates for each OPI was established using ODOT spreadsheet as reference. Markov models developed in Step 2 were utilized for degradation rate modeling. Two degradation rate models namely 5 year moving window and 2year moving window was introduced to model the rate of degradation and compared against the actual rate of degradation from the database.

Figure 1.2 shows the results of degradation rate modeling.

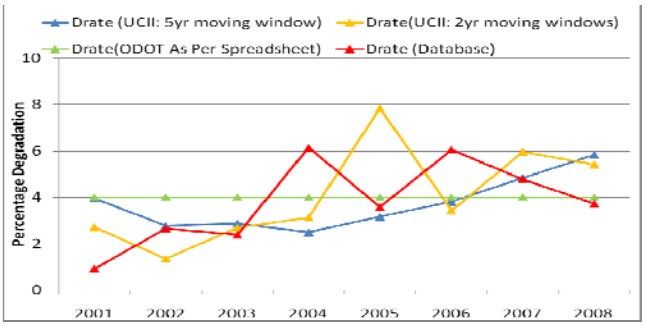

Figure1.2: GA Degradation rate

The actual degradation rate and maintenance rate for the different districts of Ohio were analyzed from the data in the database.

Figure 1.3 shows the degradation rate of bridges in different districts.

Year	Dist 1	Dist 2	Dist 3	Dist 4	Dist 5	Dist 6	Dist 7	Dist 8	Dist 9	Dist 10	Dist 11	Dist 12
2001	0.00	0.92	0.48	0.11	2.45	0.91	0.00	2.08	2.87	5.92	0.48	1.15
2002	3.48	1.73	0.31	0.00	9.48	0.00	0.16	1.19	3.75	5.01	4.05	7.86
2003	7.64	2.49	7.90	0.00	4.40	0.22	2.27	5.88	2.58	2.24	5.42	0.00
2004	0.00	0.00	5.64	25.94	1.58	2.08	1.38	0.00	0.42	7.26	6.81	0.25
2005	9.79	1.68	7.85	2.85	4.00	0.00	4.76	0.39	0.56	11.94	4.38	2.15
2006	0.00	0.00	6.95	13.31	9.04	17.01	6.21	3.36	8.15	0.95	5.87	0.00
2007	0.00	0.69	11.02	6.63	6.50	20.72	2.38	1.28	1.55	1.23	6.07	2.23
2008	0.00	3.86	2.91	0.63	10.73	9.44	1.41	13.61	1.25	1.92	2.60	3.90
AvgDrate	2.61	1.42	5.38	6.18	6.02	6.30	2.32	3.47	2.64	4.56	4.46	2.19

Figure 1.3: Degradation Rate of Districts.

Research Findings & Conclusions

The following are the findings of the project

1) Age resetting and Markov models were applied to the bridges. OPI forecasting using Markov models were validated against the actual values and the results were very positive.

2) Degradation rates are seldom constant and using a constant degradation rate will not capture changing trends in maintenance and policy changes.

3) Degradation rates for all four OPI's were modeled using Markov models and Table 1.1 below records the actual degradation rate for the 4 OPI's for the year 2008.

GA Degradation Rate(2008)	FC Degradation Rate(2008)	WS Degradation Rate(2008)	PCS Degradation Rate(2008)
3.7%	0.52%	1.85%	4.42%

Table1.1: Actual Degradation rates for 2008.

4) Actual degradation rate and maintenance rates for different districts were analyzed.

5) Degradation and maintenance rate of bridges across districts can be used to validate their performance. It also provided insights to the behavior of bridges at the district level and hence helps in better planning and funds allocation.

6) Statistical analysis and comparison of the degradation and maintenance rate of the districts, taking into account factors like district area and funds allocated can be used to evaluate the performance of the district DOT's and if necessary bring in corrective measures.

Implementation Recommendations

ODOT spreadsheet currently uses a fixed Degradation rate for all 4 OPI's. Keeping the degradation rates fixed will not capture the changing trends in maintenance and policy changes and hence not an efficient parameter for planning and budget allocation.

A solution to the above problem would be to update the degradation rates every year and hence capture the latest information on maintenance and policies. Manual update of degradation rates every year is a tedious process requiring many man hours and also less efficient in terms of accuracy.

Degradation models developed by UCII offer two main advantages

1) Updating degradation rate is completely automated, requiring very less time and no manual interventions.
2) Degradation rates obtained by UCII models are more accurate as compared to manual process as it involved advanced data analysis and statistical modeling of BMS data.

In addition to the points mentioned above, UCII models can provide good insights to the performance of the DOT's at the district level and aids in better planning and budgeting.