

**State of Wisconsin/Department of Transportation/Midwest Regional University
Transportation Center
RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: December 31, 2008**

Program:	Part
Project Title: Guidelines for Implementing the Bridge Health Index	Project ID: MRUTC 08-07 (0092-07-14)
Administrative Contact: Jason Bittner	Sponsor: MRUTC
WisDOT Technical Contact: Scot Becker/Travis McDaniel	Approved Starting Date: July 01, 2007
Approved by COR/Steering Committee: \$50,329	
Project Investigator (Agency & Contact): University of Wisconsin-Madison, Teresa M. Adams	Approved Ending Date: December 31, 2008; requested June 30, 2009

Description: The goals of this research are to identify/develop tools for using the bridge Health Index (HI) in a comprehensive bridge management system and specifically for decision-making in the context of a bridge preventive maintenance (PM) program. Specific outcomes are (1) demonstration and definition of the bridge HI on Midwest bridges (2) guidelines for integrating the HI with PM criteria (3) planning models that forecast bridge HI for different maintenance scenarios (4), and recommendations for integrating the HI into the overall bridge management decision-making process.

Total study budget	Current FFY budget	Expenditure for current quarter	Total Expenditure to Date	Percent Complete
\$ 50,329	\$50,329	\$18,439	\$46,206	92%

Progress This Quarter

Task 1: Health Index Definition

Task 1 was complete and the final report is being prepared.

Task 2: Health Index (HI) Implementation Guidelines

The survey was resent to State Pontis user representatives. The information we wish to obtain: 1) how the states use smart flags for calculating HI 2) the non-CoRe elements the states are currently using 3) the element Failure Cost (FC) or Weight Factor (WF) with element replacement cost when they calculate bridge HI.

28 surveys have been returned. We received two responses each from Kansas and Utah and three anonymous responses. 14 respondents indicate their state is using HI for their bridge management system. The survey results show most of the contacted States are calculating bridge HI using WF with element replacement costs rather than element failure costs (FC). Table 1 shows the list of states that are currently using HI and indicates how they weight values for computing HI.

Each state is being contacted individually. The research team is attempting to state specific failure costs or replacement costs.

Table 1 Bridge Health Index Usage in State DOTs

State	Agency Contact	Use Smart Flag for cal. HI?	Weight Value		Information delivered?
			Failure Cost	WF with Replacement Cost	
Delaware	Douglas Finney	No	-	Pontis default	Yes
Florida	Richard Kerr	No	State-specific	-	Yes
Hawaii	James Fu	No response	-	Pontis default	
Kansas	Deb Kossler	Yes	-	State-specific	Yes
Massachusetts	Mohammed Nabulsi	No	-	Pontis default	
Montana	Paul Jensen	Yes ¹	-	State-specific	
Oregon	Bruce Novakovich	No	-	Pontis default	Yes
Utah	Chris Potter	Yes	-	Pontis default	Yes
Wyoming	Paul Cortez	No	-	State-specific ²	

¹ Montana has Modified HI including smart flag.

² Wyoming is developing in house Bridge Index.

Task 3 and 4: Sensitivity Analysis of Failure Cost and Element Condition on Bridge HI

The research team investigated the sensitivity of HI to variations in element FC. For this study, the element failure costs developed by Adel Al-Wazeer, (from Science Applications International Corporation (SAIC), working at FHWA’s Turner-Fairbank Highway Research Center) and available on the Transportation Asset Management Today website were used.

(<http://assetmanagement.transportation.org/tam/aashto.nsf/docs/E5D2A9F05323691185256B3A004E0632?opendocument&CurrentCategory=c.%20Management%20Systems>)

The range of the element FC is not known for Wisconsin bridges. For the simulation analysis, the research team varied the element FCs, from 50% to 150% of the estimated FC from Al-Wazeer. The simulation analysis used the commercial software @Risk.

From the analysis, the research team found that bridge HI is more sensitive to element FC when the deterministic HI is low (the bridge is in bad condition). In other word, bridges in worse condition have more uncertainty in the range of HI. Figures 1 and 2 illustrate this finding.

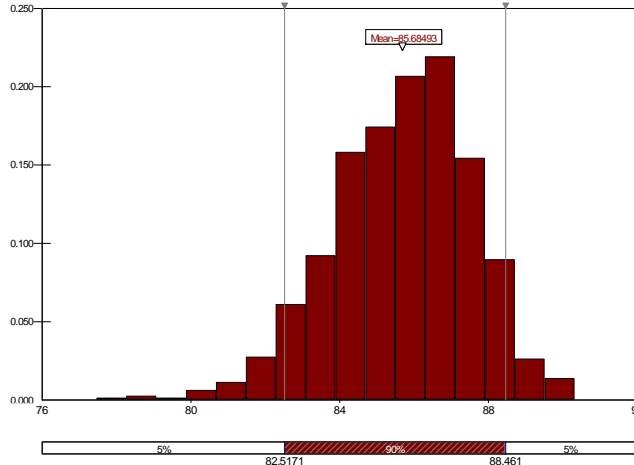


Figure 1 Uncertainty in Bridge Health Index due to Variation in Element FC when deterministic HI = 85.78 (B130112 inspected 2004)

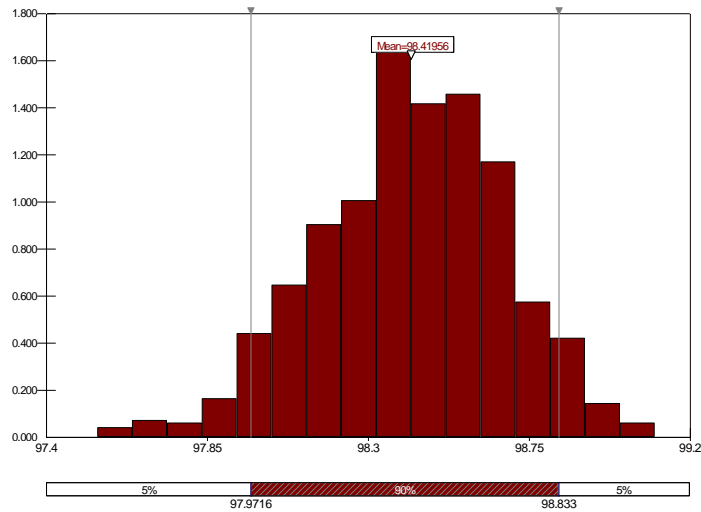


Figure 2 Uncertainty in Bridge Health Index due to Variation in Element FC when deterministic HI = 98.44 (B130112 inspected 2006)

Both figures are for bridge B130112 inspected in 2004 and 2006, respectively and both figures use the same range of possible element FCs. In Figure 1, when the deterministic HI=85.78, 90% of calculated HIs are between 82.52 and 88.46 (range of 5.94), while in Figure 2, when the deterministic HI=98.44, 90% of the simulated values are between 97.97 and 98.83 (range is 0.86). This indicates that HI is more uncertain as the bridge condition worsens.

Work Next Quarter

1. Obtain the element failure cost from Caltrans. The research team will continue the simulation analysis of bridge HI. In calculating HI, bridge condition and the element failure cost are the input variables.
2. Sensitivity of HI to variations in element Failure Cost: The feasible region of bridge HI (95% HI confident range) will be plotted versus the deterministic bridge HI for a range of element failure

costs. Element condition will be fixed. The FC will be randomly selected by normal distribution. This sensitivity analysis will be conducted for multiple bridges of the same type of bridges. And the same analysis will be also tried for multiple bridges of different types of bridges.

- 3.** Sensitivity of HI to variations in Element Condition: The feasible region of bridge HI (95% HI confident range) will be plotted versus the deterministic bridge HI for a range of element conditions. For this analysis, element failure costs are fixed. The quantity of each element in each condition state can be perturbed by randomly sampling on a Triangle distribution. The quantities of the element in each state are then proportionally corrected, so that the total sum of the quantity of the element is preserved.

Gantt chart (Modified work plan)

Task	% complete		2008						2009					
			Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1. Health Index Definition	100%	Proposed												
		Actual												
2. HI Implementation Guidelines	80%	Proposed												
		Actual												
3. Sensitivity Analysis of Failure Cost on Bridge HI	60%	Proposed												
		Actual												
4. Sensitivity Analysis of Bridge Condition on Bridge HI	20%	Proposed												
		Actual												
5. Final Report	10%	Proposed												
		Actual												