SWZDI
Smart Work Zone Deployment Initiative

Development of Adjustment Factors for HCM Sixth Edition Freeway Work Zone Capacity Methodology

tech transfer summary

This project evaluates adjustment factors for the Highway Capacity Manual work zone capacity methodology based on locally collected field measurements to make it more applicable to Iowa freeways.

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RESEARCH PROJECT TITLE
Development of Adjustment Factors for HCM Sixth Edition Freeway Work Zone Capacity Methodology

SPONSORS
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Iowa, Kansas, Missouri, and Nebraska created the Midwest States Smart Work Zone Deployment Initiative (SWZDI) in 1999 and Wisconsin joined in 2001. Through this pooled-fund study, researchers investigate better ways of controlling traffic through work zones. Their goal is to improve the safety and efficiency of traffic operations and highway work. The mission of the Institute for Transportation (InTrans) and Center for Transportation Research and Education (CTRE) at Iowa State University is to develop and implement innovative methods, materials, and technologies for improving transportation efficiency, safety, reliability, and sustainability while improving the learning environment of students, faculty, and staff in transportation-related fields.

ctre
Center for Transportation Research and Education

Iowa State University
Institute for Transportation

Objectives

The objectives of this project were to validate the Highway Capacity Manual (HCM) Sixth Edition work zone capacity methodology for urban and rural freeways in Iowa and to provide recommendations for a more accurate work zone capacity estimate for Iowa and other Smart Work Zone Deployment Initiative states.

Background and Problem Statement

The 2016 HCM introduced a new methodology to estimate freeway work zone capacity, defined as the prebreakdown flow rate, based on data from 12 work zone sties in six states. However, it was expected that capacity in work zones in the Smart Work Zone Deployment Initiative states, including Iowa, may be significantly different from that in the six states used to develop the methodology.

Thus, it was crucial to validate the methodology using locally collected data and provide adjustment factors as necessary.

Project Description

The researchers collected work zone activity data and the corresponding traffic data from 16 work zone sites across Iowa during the 2018 and 2019 construction seasons. The data included flow rate, speed, and work zone active times and configurations to estimate work zone capacity, discharge flow rate, and free flow speed (FFS). Traffic conditions were collected from the Iowa Department of Transportation's (DOT's) permanent sensors and through the temporary sensors deployed by the DOT's Traffic Critical Projects program.

The team used their observed field measurements to evaluate the HCM work zone capacity methodology.

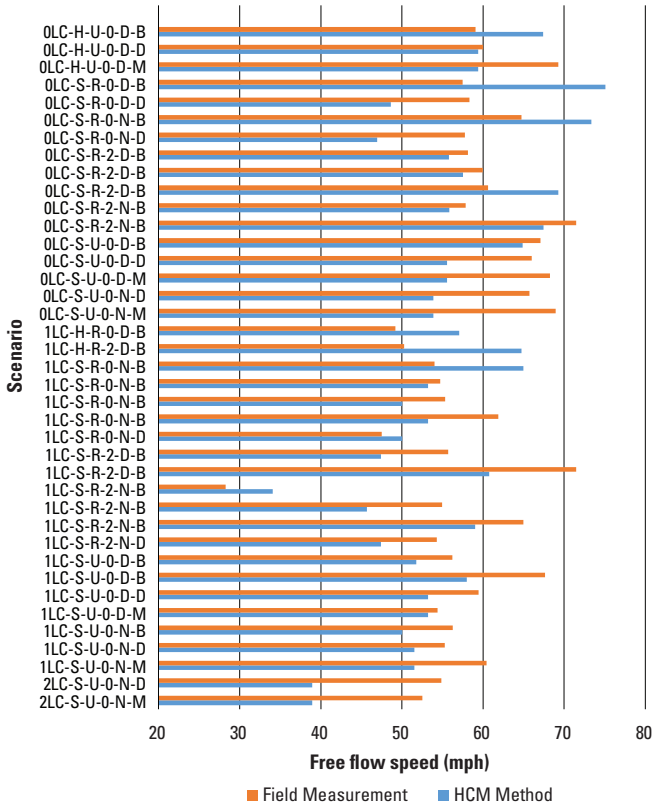
Traffic breakdown at a work zone site included in this project

Key Findings

- FFSs estimated using the HCM method had a greater variance than the team's field-measured values. Iowans generally drove around the work zone speed limits under free flowing conditions, while the HCM method predicted a wide range of FFSs.
- The field-measured prebreakdown capacities and queue discharge rates (QDRs) were significantly lower than the values computed using the HCM method, indicating that traffic breakdown could happen at a much lower flow level than the capacity predicted using the HCM method.
- The HCM work zone capacity method does not account for the effects of complex work zone configurations, such as narrow lanes, lane shifts, and crossovers; thus, the observed FFS and prebreakdown capacity can be significantly lower than that for typical work zones.

Implementation Readiness and Benefits

After comparing the results from the HCM work zone capacity method with locally collected field measurements, the project team recommended adjustments to make the methodology more applicable for Iowa's urban and rural freeways.



Free flow speed comparison: HCM method vs. field measurement

Implementation Recommendations

- When possible, work zone QDR and capacity should be estimated using field data to account for the unique features of the work zone.
- If the HCM method estimates a free flow speed that is significantly lower or higher than the posted work zone speed limit, consider adjusting the estimated value unless the special configuration of the work zone can justify the discrepancy.
- Recognizing that traffic breakdown might occur at a flow level lower than the HCM estimated capacity, the traffic control target should be set lower than the estimated capacity to avoid slowdowns in work zones.
- The Iowa DOT Lane Closure Planning Tool can use the field-measured capacity in this study as the thresholds for three work types—TC-402: Shoulder closure with cones, TC-40x: Shoulder closure with TBR, and TC-418: Lane closure.

Queue discharge rate and prebreakdown capacity comparison: HCM method vs. field measurement

Scenario	# of breakdowns	HCM method (pc/hr/ln)		Field data (pc/hr/ln)		
		QDR	Capacity	QDR	Capacity	α_{wz}
0LC-H-U-0-D-D	2	2,042	2,358	1,496	1,519	1.5%
1LC-H-U-0-D-D	1	2,042	2,358	1,582	1,678	5.8%
0LC-H-U-0-D-M	7	1,784	2,059	1,096	1,821	39.8%
0LC-S-U-0-D-M	2	1,848	2,134	893	1,657	46.1%
0LC-S-R-0-D-B	3	1,725	1,991	1,171	1,737	32.6%
1LC-S-R-2-D-B	15	1,378	1,591	1,032	1,482	30.3%

Note: The scenarios are designated by the number of lanes closed (LC), barrier type (i.e., soft versus hard), area type (i.e., urban versus rural), lateral distance in feet from the edge of the travel lane adjacent to the work zone to the barrier, time of day when work occurred (i.e., day versus night), and segment type (i.e., diverge, merge, or basic). The α_{wz} is the percentage drop in prebreakdown capacity at the work zone due to queuing condition. The data for the HCM method and field data are given in passenger cars per hour per lane (pc/hr/ln).