

Dynamic Work Zone Traffic Management

**CONSTRUCTION ACTIVITY
IN HIGHWAY WORK ZONES
CREATES CONSTANTLY
CHANGING TRAFFIC
CONDITIONS THAT REQUIRE
REAL-TIME TRAFFIC
INFORMATION TO KEEP
MOTORISTS INFORMED OF
THE CONDITIONS AHEAD.
SMART WORK ZONES NOT
ONLY HELP INCREASE SAFETY
AND MINIMIZE DELAYS, BUT
THE COLLECTION OF TRAFFIC
DATA CAN BE USED BY
CONSTRUCTION PERSONNEL
TO MAKE INFORMED
DECISIONS.**

BY JEREMY JACKSON, E.I.T.

INTRODUCTION

Smart work zone technology has long been an important part of work zone management, providing motorists with real-time information through variable message signs or through Web sites designed to aid travelers before they ever leave their house. The technology is constantly evolving, enabling engineers and construction personnel to actively monitor work zone operations and make important, real-time and near-real-time decisions in the field.

As part of the Oregon Transportation Investment Act (OTIA) III State Bridge Delivery Program, the Oregon Bridge Delivery Partners (OBDP), in conjunction with the Oregon Department of Transportation (ODOT), have been evaluating the use of traffic data gathered using smart work zone technology and its potential applications during a project's design and construction phases. OBDP is a joint venture between HDR Engineering and the Fluor Corporation and is managing the repair or replacement of hundreds of bridges throughout the state of Oregon, USA, over the span of eight years.

In response to the overwhelming number of highway work zones as a result of bridge construction, ODOT has adopted a proactive policy in dealing with work zone mobility statewide. New mobility standards require that work zone traffic analysis be performed for every project that involves potential impacts to traffic flow. Work zone traffic analysis is performed at the planning stage of every project and is continually revisited throughout design and the end of construction. The use of smart work zone technology to manage mobility is an integral part of ODOT's mission to keep freight and traffic moving through an unprecedented amount of bridge construction on Oregon's highways.

WORK ZONE TRAFFIC ANALYSIS

Work zone traffic analysis is a tool that identifies the acceptable hours of the day during which traffic lanes can be closed for construction or maintenance activities while maintaining stable and efficient traffic operations. This analysis is critical because lane closure restrictions can preserve highway safety, alleviate costly staging strategies and reduce lengthy travel delays. The lane closure restriction hours identified during a work zone traffic analysis are written into the project specifications for a construction project.

Preserving highway safety is the single most important goal of work zone traffic analysis. A recent report on determining the major causes of highway work zone accidents in Kansas, USA, published by the Kansas Department of Transportation and the University of Kansas Center for Research, found that 68 percent of work zone accidents were multi-vehicle crashes. These crashes included head-on, sideswipe and rear-end collisions, where 40 percent of them were caused by heavy trucks. Of these three accident types, the number of rear-end collisions in work zones can be reduced or eliminated through effective work zone traffic analysis.

Determining acceptable windows of time in which a traffic lane can be safely closed requires an estimation of traffic volumes throughout construction and a threshold for maintaining stable and efficient traffic operations. Traditional work zone traffic analysis uses up to seven manual traffic counts for day-to-day and hour-to-hour differences and seasonal adjustment factors to account for month-to-month variations in traffic. An example of a week-day, Monday through Thursday, lane closure chart used to determine lane closure restriction hours is shown in Figure 1.

The resulting 24-hour, 12-month estimation of traffic volumes are compared to a free-flow threshold that represents the maximum sustainable volume that yields

I-5 Fairgrounds Interchange - Roseburg
Southbound - Weekday

Year of Analysis	Closure Type	Hwy #	Milepost	Region	Roadway Type	Terrain Type	Speed Limit	# Existing Lanes (Per Direction)	% Trucks	PCE Factor	PCE Limit	Linear Growth Rate	Analysis ADT	Nearby ATR	ATR Hwy #	ATR MP	Date Issued																																																																																																																																																																																																																																																																																																																																					
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December	287	189	143	179	324	540	1067	1268	1164	984	1529	1559	1725	1845	2277	2449	2478	1868	1795	1365	1102	764	626	413																																																																																																																																																																																																																																																																																																																														
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Figure 2. Segment 4-C—Grants Pass to California state line.

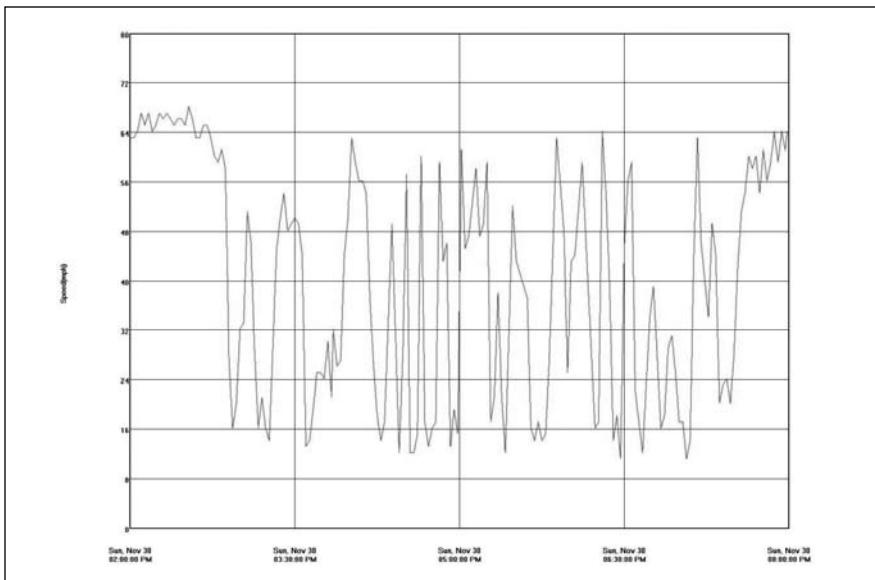


Figure 3. Averages within a traffic queue.

travel times through highway construction zones using side-fire radar. The estimated travel time as a result of construction is then displayed on variable message signs warning motorists of expected delays. Research has indicated that smart work zones can improve both safety and mobility on highway construction projects.

Side-fire radar is widely used across the country for various applications and settings. Many distributors are available that carry different technology with unique

algorithms, software and hardware used to gather data. The technology of side-fire radar works by taking real-time measurements of vehicles that pass within the radar's field of view. The radar unit is mounted in such a way that it allows the radar to measure traffic volumes and vehicle speeds at any given point that is being monitored by the system. In order to collect travel time information, multiple units are used to monitor traffic at several points on a roadway segment.

Using vehicle speeds measured at each location and the distances between units, reasonable assumptions can be made to extrapolate the travel time and delays for traffic within that segment. The accuracy and reliability of this system, however, is dependent on the number and placement of the monitoring devices.

USING THE DATA

Smart work zones not only increase safety and provide important information for motorists, but the applications of historic and real-time traffic data collection go beyond the traveling public. During the design process, historic traffic data can aid in the development of lane closure charts. Data collection devices can be deployed prior to construction to obtain the necessary traffic data, or the data collected from similar projects can be used. Work zone traffic analysis provides an estimation of traffic volumes that are used to determine acceptable hours of the day when a lane of traffic can be closed, having a direct impact on the movement of freight and the traveling public. Having access to historic traffic volumes will produce more accurate results for determining lane closure restrictions and construction staging.

Historic traffic data can also be of value in managing work zone construction activities. Depending on the length of construction, frequent reviews of work zone delays and mobility goals can provide a clear measure of the effectiveness of traffic management strategies chosen for a project. When delays outside of acceptable limits are identified, an investigation can lead to changes in traffic control strategies and improvements in practice for future projects. When considering a new project, the historic data can provide a benchmark for determining suitable strategies.

In addition to measuring travel times through a work zone, the placement of side-fire radar units leading up to a work zone can be used for queue detection. Multiple devices strategically placed upstream of a work zone will monitor vehicle speeds approaching a lane closure. If a traffic queue begins to form, measured speeds at each radar device will decrease as the length of the queue increases. A plot of vehicle speeds collected upstream of a work zone lane closure is shown in Figure 3.

Speed data can be used to identify when a traffic queue formed and how long it lasted. Fluctuations in vehicle speed within a traffic queue can also be observed, indicating the importance of advance warning to motorists in order to avoid rear-end collisions.

Real-time and near-real-time traffic data collected using smart work zone technology can be used by construction and management personnel to monitor the status and performance of a work zone. The collection of traffic volume data can be used to modify the construction specifications if a contractor determines that a particular construction activity will require a lane closure outside of the contractual lane closure restriction hours. If a contractor requests that a lane be closed two hours early, for example, near-real-time traffic volume data can be used to assess current volume conditions and compare them to the lane closure charts developed during design. Monitoring traffic volumes during construction can add potential cost savings to a project if traffic volumes indicate that a traffic lane can be safely closed earlier than expected.

An added benefit of using smart work zone technology to monitor construction activities is the ability to view or download real-time and historic traffic data from a Web-based reporting system. Many intelligent transportation systems (ITS) devices use global positioning system (GPS) technology to display their location on an interactive map interface, as shown in Figure 4.

Having access to real-time and near-real-time traffic data via the Web allows for quick verification that traffic flow is being maintained and delays are within acceptable standards. In order to monitor work zone operations, threshold speed and travel time limits can be set for each work zone. If the threshold is exceeded, an automated notification message can be sent by e-mail to inform someone that traffic queues are forming or delays are beyond acceptable limits. This gives construction and management personnel the opportunity to respond to situations as they occur in the field and make immediate changes to improve operations.

CONCLUSION

When deployed in a highway construction zone, smart work zone tech-

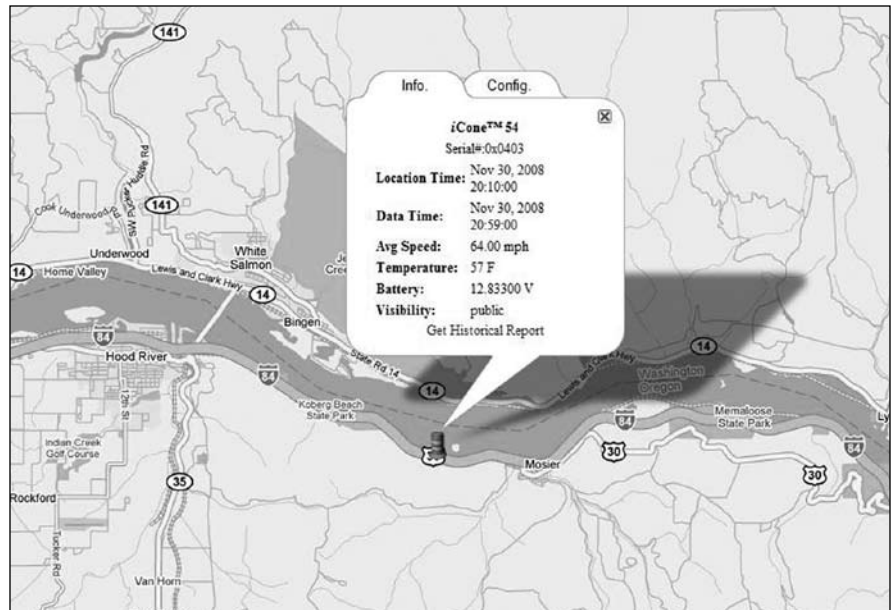


Figure 4. Sample Web-based reporting system for work zone monitoring.

nology not only helps increase safety and provide motorists with important information regarding delays and travel times, but the collection of historic and real-time traffic data can be used for both design and construction. During the design process, historic traffic data can be used in work zone traffic analysis to provide more accurate lane closure restrictions that are included in a project's construction specifications. Additionally, historic traffic data can be used during construction to evaluate mobility goals and measure the effectiveness of traffic management strategies.

Real-time and near-real-time traffic data collected using smart work zone technology can be used by construction and management personnel to make informed decisions that affect construction and the overall operations of a work zone. Speed and volume data can be used to detect traffic queues and modify contractor work hours if necessary. Monitoring construction activities via a Web-based reporting system allows for quick assessments of work zone performance and the opportunity to evaluate and respond to situations as they occur in the field. ■

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