MIDWEST SMART WORK ZONE DEPLOYMENT INITIATIVE

MwSWZDI

FHWA POOLED FUND STUDY

Report Title

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Brown Real-Time CMS Control and Iteris Wireless Detection

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Supplemental Funding Agency Name and Address (if applicable)

Supplemental Notes

Abstract

Chapter 4

REAL-TIME CMS CONTROL

Description

Real-Time CMS Control (RTCMSC) is an enroute traveler information system whereby real-time traffic-responsive information is provided to drivers by means of a changeable message sign (CMS) strategically placed in advance of a diversion point upstream of the work zone. The objective of the system is to advise drivers of a work zone ahead and encourage them to divert to an alternate route when there is congestion in the work zone.

The RTCMSC system studied was comprised of a video detection system and a portable CMS. Communication between the video detection system and the CMS was provided by NDOR radio. The video detection was used to measure the speed of vehicles entering the work zone. The message normally displayed on the CMS was the following two-phase message:

Phase 1	Phase 2
RIGHT LANE CLOSED	2 MILES AHEAD

However, when congestion was detected in the work zone, the following message was displayed:

DELAYS ! !
CONSIDER
ALT. RTE

The logic used by the RTCMSC to select the appropriate messages is shown in Figure 4-1. As long as the speeds of no more than two consecutive vehicles entering the work zone were below 20 mph, the two-phase message advising drivers of the lane closure 2 miles ahead was displayed. However, when the speeds of three or more consecutive vehicles entering the work zone were below 20 mph, the message advising drivers to consider an alternate route was displayed for 13 minutes. At the end of 13 minutes, the two-phase message was displayed again until the speed of three consecutive vehicles were found to be less than 20 mph.

The system was developed specifically for the MwSWZDI by Brown Traffic Products, Inc., 736 Federal Street, Davenport, Iowa 52808; PH: 319-323-0009; FX: 319-323-8256.

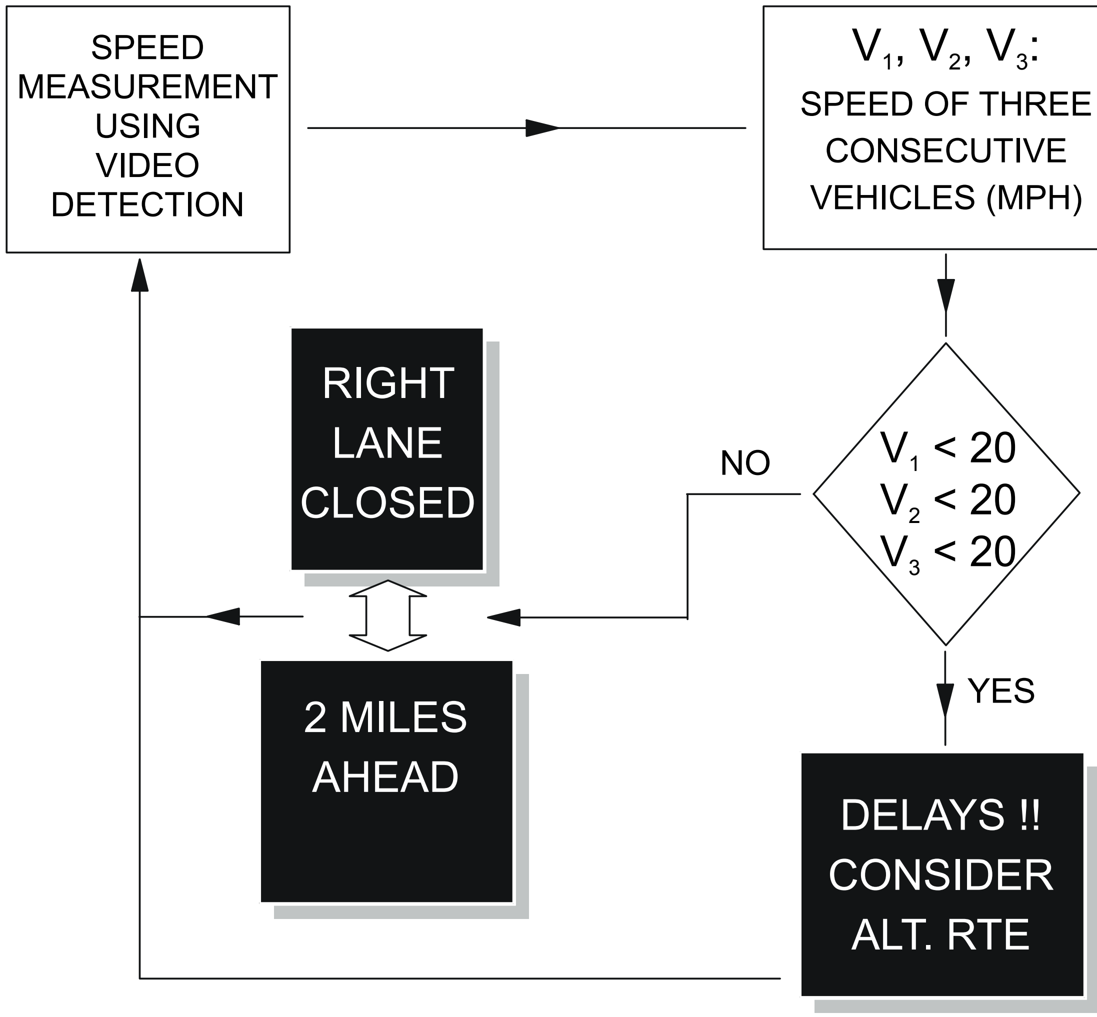

FIGURE 4-1 RTCMSC VMS message selection.

Study Site

The technology was deployed along an approximately 2.7-mile section of eastbound I-80 within two work zones near Lincoln, Nebraska. The section operated as a 4-lane divided interstate highway. It was located between two relatively long sections of the interstate with head-to-head operation (i.e., one roadway was closed for reconstruction and the other operated as a two-lane, two-way roadway). The location of the study area is shown in Figure 4-2.

The average daily traffic volume on this section of I-80 was approximately 38,000 vehicles per day, of which 22 percent was commuting traffic. The truck percentage was 21 percent. The normal speed limit on I-80 is 75 mph, but the speed limit in the study area was 55 mph, because it was located between two work zones. The two work zones were for an interstate reconstruction project.

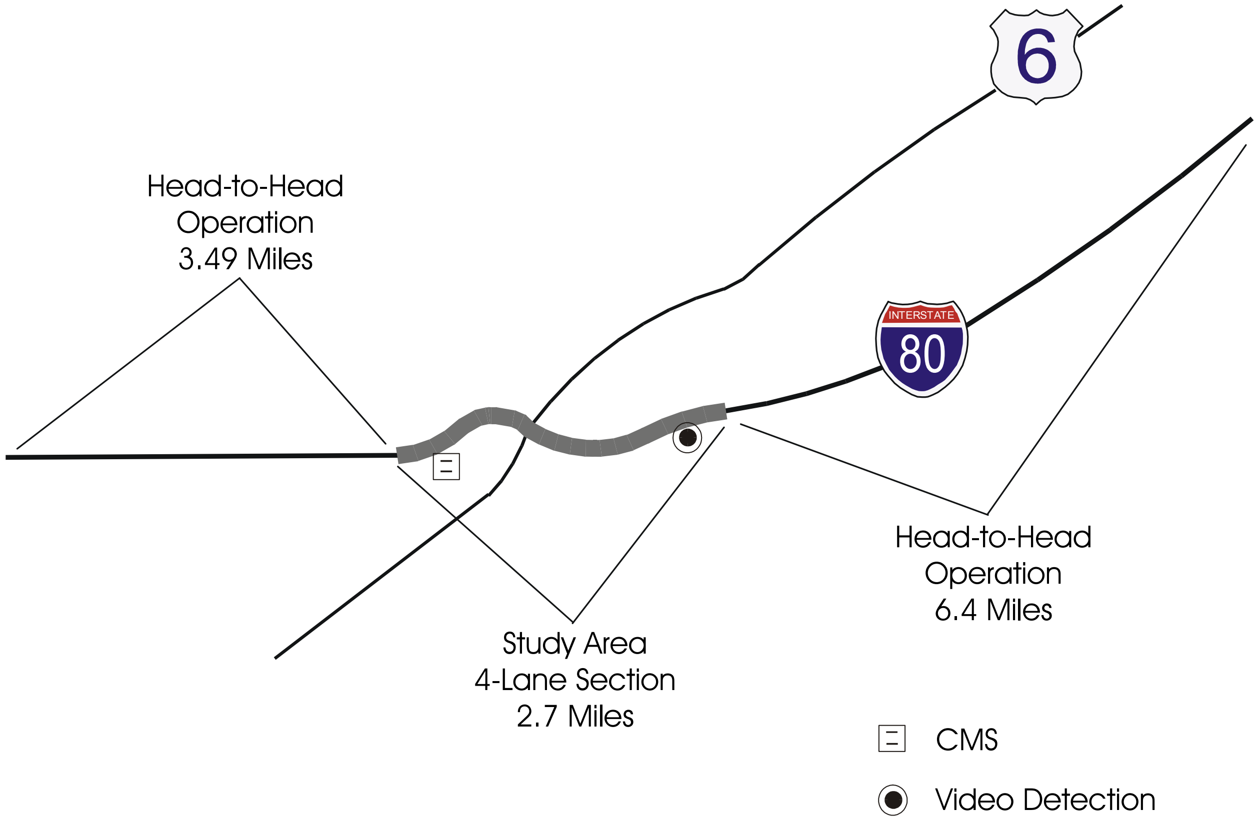

FIGURE 4-2 Location of work zone where technologies evaluated in Nebraska were deployed.

The traffic control plan within the study area is shown in Figure 4-3. The following sequence of signs was located on each side of the roadway:

1. SPEED LIMIT 55 sign with FINES DOUBLE sign plate about 13,000 ft before the lane closure taper;
2. SPEED LIMIT 55 sign with FINES DOUBLE sign plate about 9,000 ft before the lane closure taper;
3. LEFT LANE CLOSED AHEAD sign about 5,500 ft before the lane closure taper;
4. SPEED LIMIT 55 sign with FINES DOUBLE sign plate about 3,000 ft before the lane closure taper;
5. RIGHT LANE CLOSED ½ MILE sign about 2,750 ft before the lane closure taper;
6. Symbolic "lane reduction on the left" transition sign about 1,100 ft before the lane closure taper; and
7. SPEED LIMIT 55 sign with FINES DOUBLE sign plate about 625 ft before the lane closure taper.

In addition to the signs, there were two flashing arrow panels on the right shoulder. One arrow panel was located about 3,100 ft in advance of the lane closure taper, and the other arrow panel was located at the beginning of the lane closure taper. The lane closure taper was 900 ft long. It was delineated by reflectorized plastic drums spaced at 50-ft intervals and monodirectional yellow raised pavement markers at 5-ft centers.

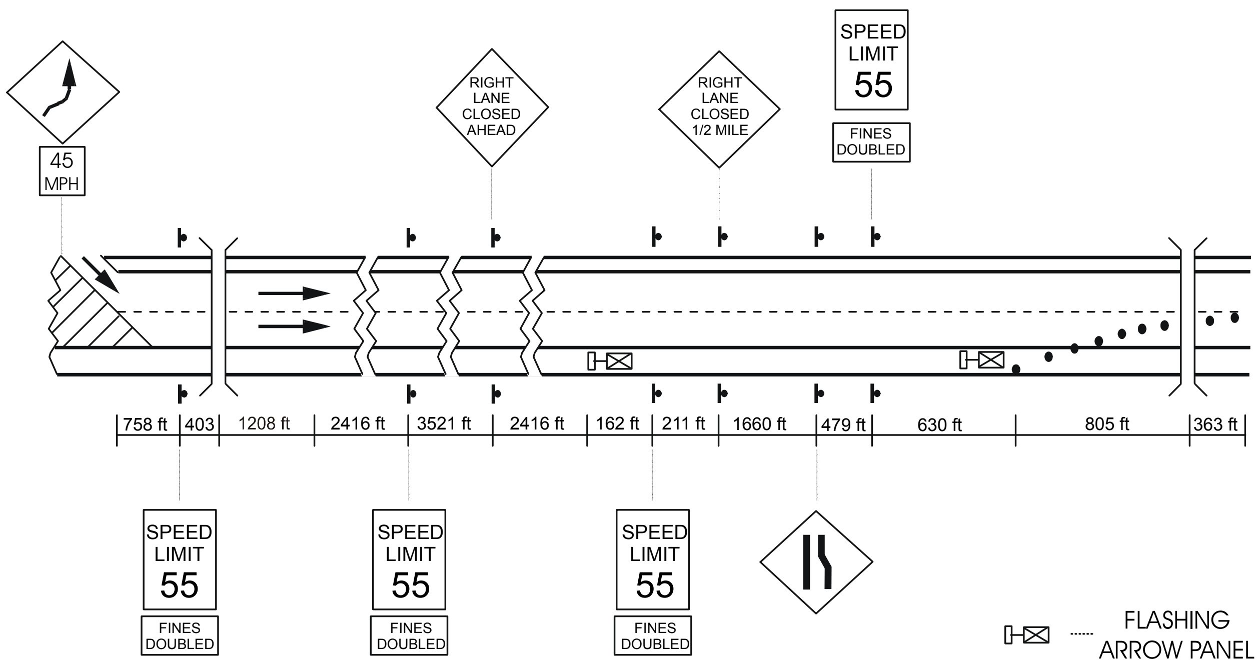

FIGURE 4-3 Traffic Control Plan at the Study Site.

The study site for the evaluation of the RTCMSC was the eastbound approach to the work zone east of the Highway 6 interchange as shown in Figure 4-2. On this approach, the right lane was closed, reducing the two eastbound lanes of I-80 to one lane in advance of the median crossover and head-to-head traffic operation through the work zone.

The video detection camera of the RTCMSC was mounted on the mast arm of a pole located on the roadside. The camera was focused on the single open lane following the lane closure taper and in advance of the median crossover and head-to-head traffic. The camera installation is shown in Figure 4-4.

The portable CMS was located on the median of eastbound I-80 about one mile before the Highway 6 interchange. Highway 6 connects with Highway 31 which returns to I-80, providing an alternate route around the work zone. The placement of the portable CMS is shown in Figure 4-5.

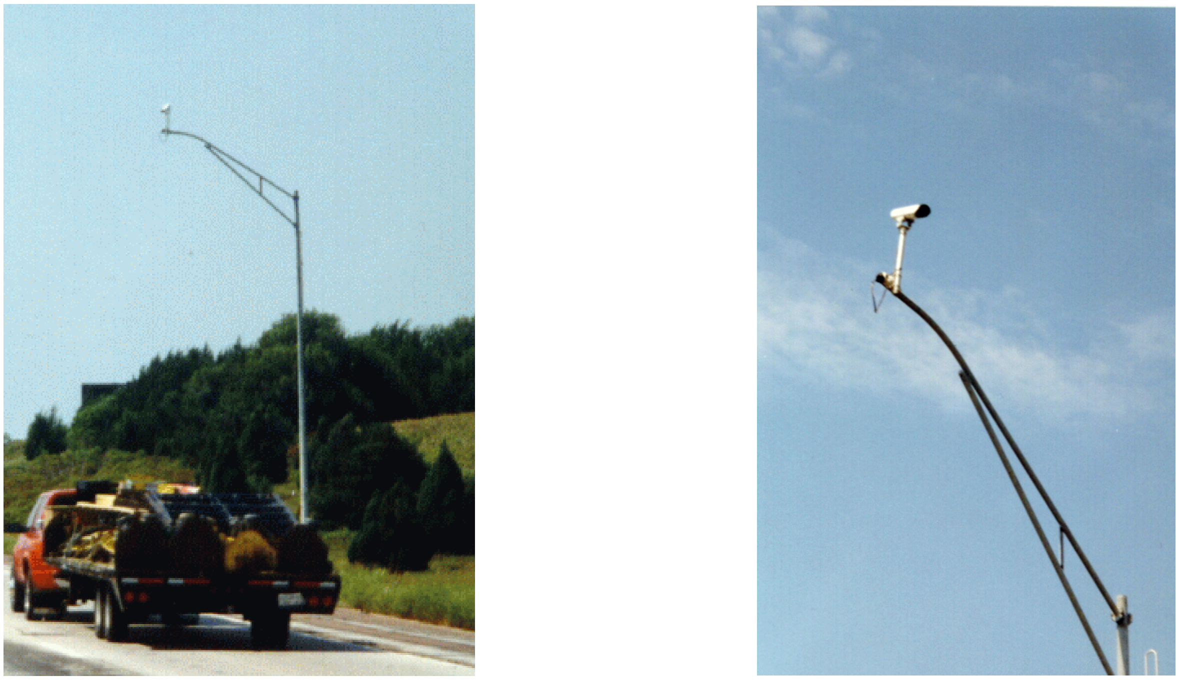

FIGURE 4-4 Video camera installation.

FIGURE 4-5 CMS placement.

Data Collection

The primary objective of the RTCMSC is to encourage drivers to divert to an alternate route when there is congestion in the work zone. Based on the findings of former studies (*1*), it is not expected to affect vehicle speeds, lane distribution or other traffic characteristics in advance of the lane closure taper. Therefore, the RTCMSC was evaluated simply based on its effectiveness in diverting traffic during congested periods. The percentage of I-80 eastbound traffic exiting at the Highway 6 interchange was used as the measure of effectiveness. To determine the percent of exiting vehicles traffic counts were taken at three points as shown in Figure 4-6.

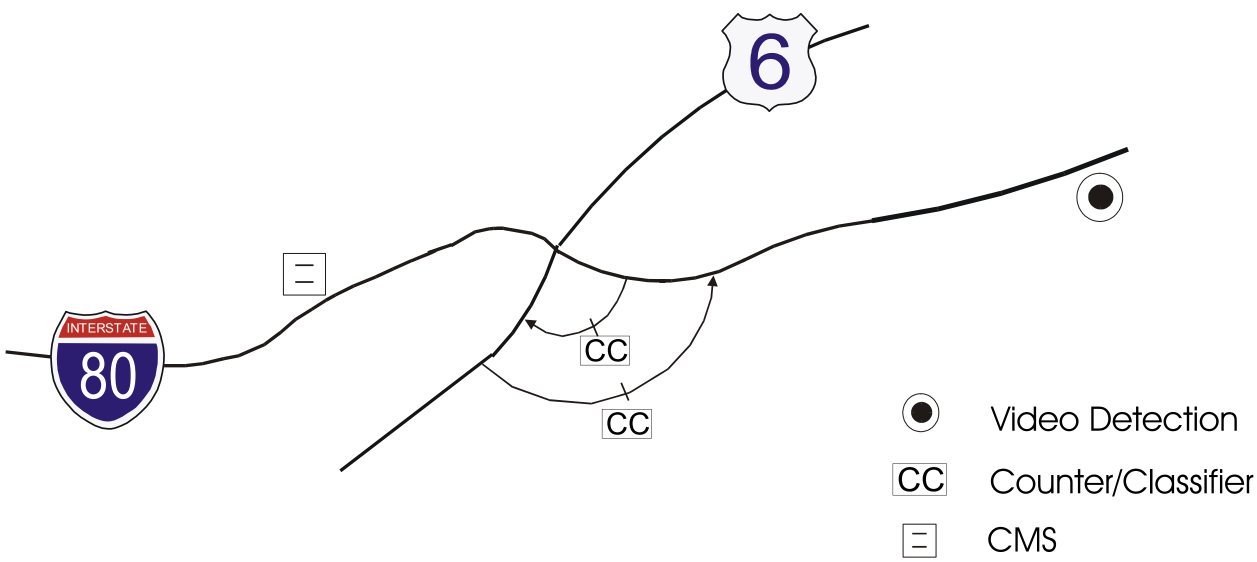

Figure 4-6 Data Collection Points

Traffic counts on the entry and exit ramps were taken using two traffic counter/classifier units deployed and operated by the NDOR. The traffic on I-80 eastbound was monitored using the video camera of the RTCMSC at the beginning of the lane closure taper, approximately one mile downstream of the diversion point at the Highway 6 interchange. Volume data at this location were determined by Brown Traffic's video image processing system, and stored in a log file. Because of limited storage capacity of the controller unit, the log files were downloaded daily as shown in Figure 4-7. Traffic volume data were collected over a 12-day period, from June 1 through June 12, 2000.

FIGURE 4-7 Retrieval at the Camera Location on I-80 Eastbound.

Data Analysis

Volume data on I-80 at the camera location, and on the exit and entry ramps were determined for 20-minute time intervals. Then the percent of traffic exiting to Highway 6 at the diversion point was calculated as:

$$\% \, EXIT = \frac{V_{EXIT\ RAMP}}{V_{I-80}} = \frac{V_{EXIT\ RAMP}}{V_{CAMERA} - V_{ENTRY\ RAMP} + V_{EXIT\ RAMP}}$$

where $\% \, EXIT$ = percent of exiting traffic from I-80 eastbound to Highway-6,
V_{I-80} = 20-minute volume on I-80 upstream the diversion point,
$V_{EXIT\ RAMP}$ = 20-minute volume on the exit ramp,
$V_{ENTRY\ RAMP}$ = 20-minute volume on the entry ramp,
V_{CAMERA} = 20-minute volume on I-80 at the camera location downstream the diversion point.

The log files downloaded from the controller unit at the camera location were reviewed to determine the time intervals when the normal two-phase message and the one-phase diversion message were displayed. The 20-minute percentages of exiting traffic was determined separately for the time periods of normal and diversion messages. An analysis of covariance was conducted to determine the statistical significance of the effects of CMS message and traffic volume on the 20-

minute percentages of traffic on the mainline and exit ramp. The t test was used to determine the statistical significance of the differences between the mean mainline and exit ramp percentages of the two messages.

Results

The results of the analysis of covariance are shown in Table 4-1. They indicate that the message displayed on the CMS had a statistically significant effect (α=0.05) on the percentage of traffic on the exit ramp. However, the effect of traffic volume was not statistically significant. The means of the 20-minute volume percentages on the mainline and exit ramp for each CMS message are shown in Table 4-2. The diversion message was found to increase the percentage of traffic on the exit ramp and decrease the percentage of traffic on the mainline by 4 percentage points, which was statistically significant (α=0.05). This reduction in the mainline volume percentage of 89 points corresponds to a 4.5 percent diversion (*i.e.*, 4 percent divided by 89 percent) of traffic which would normally stay on I-80. Thus, the diversion message accounted for a 4.5-percent diversion of mainline traffic to avoid delays in the work zone.

TABLE 4-1 Analysis of covariance of effects of VMS diversion message and traffic volume.

Source	Sum of Squares	Degrees of Freedom	Mean Square	F-Ratio	p-Value
Volume	4.4729	1	4.4729	0.23	0.6357
VMS	224.611	1	224.611	11.30	0.0009
Residual	4233.31	213	19.8747		
Total	4470.63	215			

TABLE 4-2 Mainline and exit ramp volume distribution.

Variable	Message		
	ROAD WORK AHEAD	PLEASE USE CAUTION	DELAYS!! USE ALT ROUTE
Mainline (%)	89		85
Exit Ramp (%)	11		15
Sample Size [a]	197		20

[a] Number of 20-minute volumes.

(shaded) Difference between messages is significant (α = 0.05).

Conclusion

The RTCMSC was effective in encouraging some drivers to divert to an alternate route when congestion was detected in the work zone. Although its effectiveness was limited to about 4.5 percent diversion, the diversion message displayed on the CMS had a statistically significant effect (α=0.05) on the percentage of traffic on the exit ramp. The effect of traffic volume during the study period was not statistically significant.

A previous study (*1*) suggests that the system's effectiveness could be improved if the diversion message DELAYS!! CONSIDER ALT RTE specified which alternate route drivers should take.

REFERENCES

1. P.T. McCoy and G. Pesti, *Midwest Smart Work Zone Deployment Initiative: Technology Evaluations - Year One,* Chapter 5, Mid-America Transportation Center, University of Nebraska-Lincoln, Lincoln, Nebraska, May, 2000.