Highlighted Project

Improving the Safety of Flaggers on Rural One-Lane, Two-Way Highways by Melisa Finley

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ODOT State Job Number	134846
Project Title	Evaluation of Alternative Methods of Temporary Traffic Control on Rural One-Lane, Two-Way Highways
Project Duration	16 months
Total Funding	$294,221.00

When a lane is closed on a two-lane, two-way road for maintenance activities, provisions must be made to alternate one-way movement of the two original travel lanes through the work area. In Ohio, flaggers are typically positioned at each end of the lane closure to control the flow of traffic. Unfortunately, crashes involving flaggers can result in serious injury or death to the flagger, since they are positioned on the edge of high speed roads in the transition area where traffic is moved out of its normal path. In addition, when there are not an adequate number of trained personnel available to be flaggers, maintenance work activities cannot be completed. With these issues in mind, the Ohio Department of Transportation (ODOT) sponsored a research project to identify cost effective and safer alternatives to the current procedures and methods used by ODOT for rural one-lane, two-way temporary traffic control in maintenance operations, without significantly increasing motorist delay. The research team was led by staff from the Texas A&M Transportation Institute (TTI) and supported by faculty and students from Cleveland State University (CSU).

In order to assess the state-of-the-practice and identify temporary traffic control alternatives, researchers performed a literature review, reviewed applicable ODOT standards, and conducted telephone discussions with key ODOT maintenance personnel. Researchers then developed a matrix of temporary traffic control methods available for rural one-lane, two-way maintenance operations. This matrix compared and contrasted traditional flagging, automated flagger assistance devices (AFADs), portable traffic signals (PTSs), and pilot vehicles. AFADs are designed to be remotely operated by a flagger positioned off the roadway, thereby reducing the flagger's exposure to traffic. PTSs can actually replace flaggers, allowing them to perform other work duties. Pilot vehicles can be used to direct traffic through the work zone, as well as regulate the speed of vehicles. Based on identified needs, an assessment of each alternative temporary traffic control method, the project budget, and input from the ODOT technical panel, the research team recommended that red/yellow lens AFADs and PTSs be studied in the field.

In the summer of 2014, researchers conducted field studies at 15 maintenance operations requiring lane closures on rural two-lane, two-way roadways in Carrollton County. Researchers evaluated the following temporary traffic control methods:

- A flagger with a stop/slow paddle at both ends of the lane closure (Figure 1a).

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a) Flagger.

b) Red/Yellow Lens AFAD.

c) PTS.

Figure 1. Field Study Temporary Traffic Control Methods.

- A red/yellow lens AFAD at both ends of the lane closure. Each AFAD was controlled by a flagger located near the device (Figure 1b).
- A red/yellow lens AFAD at both ends of the lane closure. Both AFADs were controlled by one flagger located in the middle of the zone near the work space.
- A PTS at both ends of the lane closure (Figure 1c).

At each site, researchers measured driver compliance and collected data to assess the driver delay incurred. Researchers also documented the site characteristics, temporary traffic control setup and removal processes, implementation issues, and device malfunctions. ODOT personnel provided their opinions about the methods throughout the field studies and via a survey. Overall, researchers collected data for approximately 114 staff hours of work activity. During this time, researchers observed 2143 stop periods and 10,420 vehicles for both directions of travel.

In addition to the field studies, researchers reviewed relative agency costs and benefits of flaggers, AFADs, and PTSs. The benefit/cost analysis primarily focused on initial and ongoing agency costs for labor and equipment and productivity savings. While safety impacts could not be quantified, AFADs and PTSs both remove the potential for flagger-vehicle conflicts and thus improve the safety of the flaggers. Researchers also conducted a delay analysis to determine the impact of the PTS method on mobility compared to the flagging method.

Table 2 contains the vehicle violation rate for each treatment. The violation rate for the red/yellow lens AFADs was comparable to the violation rate for the traditional flagging method. In contrast, the violation rate for the PTSs was significantly higher than the violation rate for the traditional flagging method. However, these devices were used on higher volume roadways resulting in an average vehicle queue lengths five to ten times longer than the other methods studied. Even though the green time was altered in the field, many times throughout the day queues would form that could not be cleared within one cycle. This scenario resulted in many drivers deciding to follow the queue into the one-lane section after the PTS changed to a steady circular red indication (i.e., drivers did not want to wait for the next cycle to proceed). Researchers believe that further use of PTSs and training will increase the work

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crew's familiarity with the devices and the fixed-time settings and thus improve operations and reduce end-of-green violations.

While ODOT personnel acknowledged some disadvantages associated with using AFADs and PTSs, their overall opinion was that these devices improved worker safety and work crew productivity. Considering initial and ongoing agency costs for labor and equipment and productivity savings, AFADs operated by a single flagger would need to be used 28 days each year in order to obtain a return on investment in 10 years. Assuming limited use of PTSs, a return on investment would be realized in about 9 years. Increasing the number of days the devices are used in a year will reduce the time it takes to achieve a return on investment. These estimates do not account for the worker safety savings that would also be accrued during this time.

The delay analysis showed that under most conditions studied a PTS system does not result in significant motorist delay compared to the flagging method when an adequate green duration to prevent cycle failure (i.e., when the minimum green time is insufficient to clear a queue within one cycle) is used. Both the traffic volume and the work zone length should be considered when determining the fixed-time settings. Once in the field, the operation of the PTS should be observed and the minimum green time increased as needed to prevent cycle failure. This will help reduce the number of violations that occur at the end of the green phase and minimize the impact of PTSs on motorist delay.

Based on the findings of this research, the research team recommended that ODOT utilize red/yellow lens AFADs and PTSs, when appropriate, to control traffic approaching the one-lane section of a two-lane highway. AFADs are most suitable for short-term stationary operations that last a few hours up to one day. Due to their smaller size, AFADs are best suited for narrow roadways with limited to no shoulders. As the work duration increases, PTSs become a viable option. Due to the additional time it takes to deploy and setup PTSs, the work activity should last at least a half a day. In addition, PTSs are preferable to flaggers for work activities that include nighttime work or work that will take multiple days. Due to their larger size, PTSs are best suited for higher volume roadways with shoulders and relatively flat side slopes. Traditional flagging procedures should still be used at maintenance operations where these devices are not suitable due to work duration or other site/work characteristics.

Contact the researchers with any questions on the project.

Table 2. Field Study Violation Rate Statistics.

Treatment	Hours of Study	Stop Cycles	Vehicle Violations	Violations per 100 Stop Cycles[a]
2 Flaggers	42.4	913	1	0.1
2 Red/Yellow Lens AFADs with 2 Flaggers	11.8	156	0	0.0
2 Red/Yellow Lens AFADs with 1 Flagger	36.3	577	3	0.5
2 PTSs	23.0	497	234	47.1[b]

[a] Rate computed as violations/stop cycles x 100.
[b] Significantly different from the standard flagging operation.