Alternative Methods of Temporary Traffic Control on Rural Highways

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• Researchers
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  o Jacqueline Jenkins (CSU)
  o Graduate students
  o Undergraduate students

• Sponsors
Rural One-Lane, Two-Way Operations

• Must alternate one-way movement of two lanes
• Flaggers typically used to control traffic flow
• Advantages
  o Typically available
  o Least amount of setup/removal time
• Disadvantages
  o Vehicle-flagger conflicts
  o Flagger fatigue and stress
  o Additional trained personnel for rotation
  o Cannot work if flaggers unavailable
Identify and evaluate cost effective and safer alternatives to current temporary traffic control (TTC) methods used by state agency maintenance forces without significantly increasing motorist delay.
TTC Alternatives Evaluated

Automated Flagger Assistance Devices (AFADs)

Pilot Vehicle (PV)

Portable Traffic Signals (PTSs)
How Do Red/Yellow AFADs work?

Stop

Proceed

Transition
How Do Stop/Slow AFADs work?

Stop

Proceed
AFADs

• Flagger must operate and not leave unattended

• Advantages
  o Flaggers located off roadway
  o One flagger can operate
  o Easier to setup and deploy than PTSs

• Disadvantages
  o More expensive if two flaggers retained
  o May result in increased intrusions
  o Potential for device malfunction
  o Device maintenance
  o Training in setup/operation
 PTSs

• Replace flaggers

• Advantages
  o Vehicle-flagger conflicts removed
  o Reduces flagger stress
  o Removes need for flagger rotation
  o Flaggers can preform other work duties
  o Less potential to be obscured by vehicles
  o Clearer signal indications
• Disadvantages
  o More expensive
  o Work zone length limited to $\leq 1$ mile
  o May result in increased intrusions
  o Longer setup time
  o Potential for device malfunction
  o Device maintenance
  o Training and expertise in setup/operation
  o May increase motorist delay
Pilot Vehicle with PTSS

- Advantages
  - Control operating speeds within work zone
  - Provide positive guidance regarding open travel lane

- 2009 MUTCD
  - Allows for a pilot vehicle to be used with PTS
  - Requires a flagger on each approach when a pilot vehicle is used
## Overview of Field Studies

<table>
<thead>
<tr>
<th>TTC</th>
<th>State</th>
<th>Sites</th>
<th>AADT (vpd)</th>
<th>Speed Limit (mph)</th>
<th>Lane Closure Length (ft)</th>
<th># of Stop Periods</th>
<th># of Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flagger</td>
<td>Ohio</td>
<td>6</td>
<td>2390–5120</td>
<td>55</td>
<td>830–3430</td>
<td>913</td>
<td>3206</td>
</tr>
<tr>
<td></td>
<td>Texas</td>
<td>8</td>
<td>220–3650</td>
<td>45–70</td>
<td>460–2570</td>
<td>294</td>
<td></td>
</tr>
<tr>
<td>AFADs</td>
<td>Ohio</td>
<td>6</td>
<td>520–1140</td>
<td>55</td>
<td>700–1490</td>
<td>733</td>
<td>1442</td>
</tr>
<tr>
<td></td>
<td>Texas</td>
<td>16</td>
<td>220–5100</td>
<td>35–70</td>
<td>300–5280</td>
<td>1414</td>
<td></td>
</tr>
<tr>
<td>PTSs PV</td>
<td>Ohio</td>
<td>3</td>
<td>7180–9230</td>
<td>55</td>
<td>1020–1630</td>
<td>497</td>
<td>5772</td>
</tr>
<tr>
<td></td>
<td>Texas</td>
<td>8</td>
<td>470–2800</td>
<td>55–70</td>
<td>2160–7480</td>
<td>661</td>
<td>3822</td>
</tr>
</tbody>
</table>

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What We Did

• Observational data
  o Stop phase onset time
  o Arrival time of first vehicle
  o Proceed phase onset time
  o Total number of vehicles in queue
  o Whether or not the queue cleared
  o Total number of violations
  o Total number of vehicles through

• Documented site characteristics
• Surveyed ODOT & TxDOT personnel
• Motorist surveys in Texas only
Performance Measures

- Violation rates
- ODOT & TxDOT personnel opinions
- Implementation and use considerations
- Benefit-cost
- Motorist delay (simulation)
- Motorist comprehension
Motorist Surveys Main Findings

• Stop/slow AFADs
  o Current signs not well understood
  o Experimental symbol sign best understood
  o Need to require gate arm

• Red/yellow lens AFADs
  o Participants understood stop and proceed phases
  o Most participants did not understand difference between flashing and steady yellow signals
  o Gate arm critical to understanding
# Texas Violation Rates

<table>
<thead>
<tr>
<th>TTC</th>
<th>Supplemental Sign(s)</th>
<th>Gate Arm</th>
<th>Violations Per 100 Stop Cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flagger</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>0.0</td>
</tr>
<tr>
<td>Red/Yellow Lens AFAD</td>
<td></td>
<td>Yes</td>
<td>2.2</td>
</tr>
<tr>
<td>Stop/Slow AFAD</td>
<td></td>
<td>No</td>
<td>6.7*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yes</td>
<td>3.8</td>
</tr>
</tbody>
</table>
## Ohio Violation Rates

<table>
<thead>
<tr>
<th>TTC</th>
<th>Violations Per 100 Stop Cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Flaggers</td>
<td>0.1</td>
</tr>
<tr>
<td>2 Flaggers with 2 Red/Yellow Lens AFADs</td>
<td>0.0</td>
</tr>
<tr>
<td>1 Flagger with 2 Red/Yellow Lens AFADs</td>
<td>0.5</td>
</tr>
</tbody>
</table>

*Significantly different from flagging operation.*
## More Texas Violation Data

<table>
<thead>
<tr>
<th>TTC</th>
<th>Violations Per 100 Stop Cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Followed Queue</td>
</tr>
<tr>
<td>PTSs With Flagger</td>
<td></td>
</tr>
<tr>
<td>PTSs Without Flagger</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>

*No significant difference between scenarios.*
## More Texas Violation Data

<table>
<thead>
<tr>
<th>TTC</th>
<th>Violations Per 100 Stop Cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Followed Queue</td>
</tr>
<tr>
<td>PTSs With Flagger</td>
<td>14.6</td>
</tr>
<tr>
<td>PTSs Without Flagger</td>
<td>11.6</td>
</tr>
<tr>
<td>Total</td>
<td>13.0</td>
</tr>
</tbody>
</table>

*No significant difference between scenarios.*
AFAD Lessons Learned

• Slight signal delay from remote to device
• Slower response to arriving vehicles
  o Adjusted minimum red times
  o May need shorter minimum green times
  o Leave direction 1 “green” if no traffic in direction 2
• STOP HERE ON RED signs mounted at 5 ft
  o Sometimes hard to setup due to terrain
  o Can block view of AFAD
  o Crew preferred sign on AFAD
PTS Lessons Learned

• Shoulder width and terrain limit locations where PTSs can be used
• May need to adjust green and/or red times in field
  - Requires training and some expertise
Pilot Vehicle Lessons Learned

- Need to select adequate green time to ensure all vehicles in queue clear
- Researchers developed quick and easy tool
Device Recommendations

• Use red/yellow lens AFADs and PTSs, when appropriate for conditions
  o Improves flagger safety
  o Increases work crew productivity
  o Does not significantly increase motorist delay

• Pilot vehicles with PTSs should be allowed
  o No need for flagger

• Traditional flagging should still be used where these devices are not suitable
Device Recommendations, cont.

- AFADs best suited for...
  - Short-term stationary operations lasting a few hours to 1 day
  - Narrow roadways with limited to no shoulders

- PTSs best suited for...
  - Activities that last at least half a day
  - Nighttime only work
  - Multiple day work
  - Higher volume roadway with shoulders and relatively flat side slopes
Report Information

- TxDOT Project 0-6407 (Flaggers & AFADs)
  - TRB Journal No. 2337, pp. 1-8
- TxDOT Project 9-1001-14 (PTSs & PVs)
- ODOT Project 134846 (Flaggers, AFADs, & PTSs)
  - http://www.dot.state.oh.us/Divisions/Planning/SPR/Research/reportsandplans/Pages/MaintenanceReports.aspx
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