Crash Reduction Strategies for Work Zones

Tracy Scriba, FHWA

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Presentation Outline

- Work Zone Safety and Mobility Challenges
- Work Zone Crash Reduction Strategies
  - ITS
  - Effective TMPs
  - Performance Monitoring
WZ Safety & Mobility Challenges

- Congestion
  - End-of-queue crashes
- Delay
- Dissatisfied motorists (private & commercial)
- Difficulty in emergency vehicle access and response
- Delayed contractor vehicle access (reduced efficiency)
Causes of Congestion

- Work Zones: 10.0%
- Bottlenecks: 40.0%
- Traffic Incidents: 25.0%
- Poor Signal Timing: 5.0%
- Weather (Snow, Ice, Fog): 15.0%
- Other Non-Recurring (e.g. Special Events): 5.0%

Source: “Traffic Congestion and Reliability;” FHWA (September, 2005)
WZ Safety & Mobility Challenges

- **Speeding/Speed Management**
  - Setting speed limits
  - Compliance with speed limits
  - Limited areas for law enforcement officer stationing
  - Limited areas to pullover speeders

- **Crashes**
  - Timely incident detection and response
  - Secondary crashes
  - Congestion
  - Intrusions
  - Work vehicle access/egress
**WZ Crashes – A Few Facts**

**Rear-end Crashes**

- **Rear-end crashes are over-represented**
  - Crashes with rear-end impacts increased 7.1 to 83 % in work zones vs non-work zones (depending on study cited and location)

- **2001 study of WZ crashes in Illinois:**
  - More rear-end crashes during periods of work activity than during inactivity
  - Many rear-end crashes were severe - often the case when traffic traveling at high speeds crashes into back of a vehicle moving slowly in a queue
  - Likely a result of creation of queues and congestion during work activities:
    - Closure of a traffic lane
    - Construction equipment moving into and out of the work area

- **Can reduce rear-end crashes by avoiding the creation of traffic queues**
WZ Crashes – A Few Facts

Day work – Night work

The risk of a crash for an individual driver encountering roadwork activity at night may go up more percentage-wise than during the day.

However, lower traffic demands at night can lead to fewer additional crashes in total over the duration of a project than would otherwise occur if the work were performed during the day.
WZ Safety & Mobility Challenges

- Performance Monitoring
  - Lack of data
  - Limited personnel to gather data
  - Difficulty in assessing impacts and estimating performance
  - Unknowns about appropriate work windows
  - Unknown effectiveness of WZ strategies
Which work zone will I get?
Context for WZ Crash Reduction

Part of overall WZ management

Effective work zone management requires:

- Understanding the likely impacts of a WZ
  - Safety and Mobility Impacts
- A combination of strategies
- Strategies should be chosen to solve specific problems
WZ Crash Reduction Strategies

- WZ crash reduction strategies include:
  - ITS
  - Effective Transportation Management Plans (TMPs)
  - Monitoring WZ Performance

- Not all-inclusive – there are many others
How ITS Can Help
Potential Benefits

- Improved mobility and traffic management
- More informed public
- Quicker incident response
- Greater safety of workers and travelers
- Better PR and relationships with stakeholders
- Enhanced speed management
- Better understanding of traffic conditions
- One study showed a benefit-cost ratio of 2:1, another showed a B-C ratio of 6:1
How ITS Can Help

Applications

- Traffic monitoring/management
- Traveler information
- Incident management
- Worker safety/protection
- Performance monitoring
- Setting allowable work hours
- Speed management/enforcement
- Tracking and evaluation of contract incentive/disincentives
How ITS Can Help

- Congestion
  - End-of-queue crashes
  - Delay
- Dissatisfied motorists (private & commercial)
- Difficulty in emergency vehicle access and response
- Delayed contractor vehicle access (reduced efficiency)
- Speed detection and warning systems
- Traveler information systems, active diversion
- Data on best times to work and for deliveries
Example - Speed Detection and Warning Systems

- Alerts drivers to slowed or stopped traffic ahead
- Can reduce rear-end crashes and secondary crashes
- Use sensors to detect queues/slow speeds and signal the message board to activate
Example - ConnDOT Interactive Project Map

http://www.dotdata.ct.gov/iti/master_iti.html
ConnDOT Work Zone Information

- Road project info
- Incident info
- Near real-time streaming video
How ITS Can Help

- Speeding/Speed Management
  - Setting speed limits
  - Compliance with speed limits
  - Limited areas for law enforcement officer stationing
  - Limited areas to pullover speeders

- Speed monitoring systems
- Variable speed limit systems
- Automated enforcement systems
Example - VDOT VSL System

- I-495/I-95 Telegraph Road Interchange Redesign of Woodrow Wilson Bridge Project
  - Work expected 2008 to 2013
  - Traffic reduced from 8 lanes to 6 long-term (further short-term lane closures at night)

- System
  - Speed limits can vary from 55mph to 35 mph
  - As congestion builds, speed limit decreases to try to maintain smooth flow and avoid stop-and-go traffic
  - Operators monitor system - can override speed limits, messages
  - Active enforcement used to increase compliance
Roll your mouse over the following images on the map to view real time information.

- Changeable Message Signs
- Variable Speed Limits
- Cameras

I-495 WB before Bridge
50
How ITS Can Help

- Crashes
  - Timeliness of incident detection and response
  - Secondary crashes
- Congestion
- Intrusions
- Work vehicle access/egress

- Cameras and queue detection systems
- Intrusion alarms
- Signs warning of trucks entering/leaving roadway
How ITS Can Help

A study of successful deployments showed that:

- 50-85% of drivers surveyed said they changed their route in response to WZ ITS info (*lower exposure*)
- Queue length reductions of 56-60% are possible
- Speed monitoring displays reduced speeds by 4-6 mph
- One study found a 20-40% reduction in vehicles traveling ≥ 10 mph over the speed limit when SMDs are used
FHWA ITS Effectiveness Study
Results - 2008

- **Reductions in aggressive maneuvers at WZ lane drops**
  - MI: Forced merges were 7 times less frequent, and dangerous merges were 3 times less frequent when the ITS system was on (flashers on)

- **Significant traffic diversion during congestion, and enhanced ability to manage WZ traffic and incidents**
  - TX: Average of 10% diversion (range of 1 to 28%)
  - DC: Average of 52% (range of 3 to 90%) lower mainline volume

- **Improved ability to react to stopped or slow traffic**
  - AR: 82% of surveyed drivers felt ITS system improved their ability to react to stopped or slow traffic

- **Driver perception of improved WZ safety**
  - AR: 49% of surveyed drivers said ITS messages made them feel safer, 17% were neutral, 32% disagreed, 2% did not answer
How TMPs Can Help

- Set of coordinated strategies implemented to manage the work zone impacts of a project
- Required for all Federal Aid highway projects by the Work Zone Safety and Mobility Rule
How TMPs Can Help

- Work zone management is increasingly complex
  - Increasing traffic volumes using the same roads that agencies need to maintain and rehabilitate
  - Need traffic management efforts beyond temporary traffic control plans
- Has affects on:
  - Safety
  - Mobility
  - Constructability
- TMPs = more comprehensive approach to managing WZ impacts
TMP Components

- Must always include a Temporary Traffic Control Plan (TTC)
- For significant projects, TMPs must also contain:
  - Traffic operations (TO) component
  - Public information and outreach (PI) component
- A TMP may be a single document, or several documents/plans compiled together

Simply stated, a significant project is a project that the agency expects will cause a relatively high level of disruption.
### TMP Strategies to Manage WZ Impacts

<table>
<thead>
<tr>
<th>Temporary Traffic Control (TTC) Strategies</th>
<th>Public Information (PI) Strategies</th>
<th>Transportation Operations (TO) Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>-Traffic control/design approaches</td>
<td>-Public awareness</td>
<td>-Demand management</td>
</tr>
<tr>
<td>-Traffic control devices</td>
<td>-Motorist information</td>
<td>-Corridor/network management</td>
</tr>
<tr>
<td>-Project coordination, contracting, and innovative construction</td>
<td></td>
<td>-WZ safety management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Traffic/incident management &amp; enforcement</td>
</tr>
</tbody>
</table>

Designers are encouraged to consider these strategies early on in the process for all projects, even if they aren’t included in the TMP.
TMPs Need to Be…

- Well-thought out
- Started early in project development
- Coordinated with other projects nearby
- Contain a combination of strategies
- Fit the expected level of WZ impacts
- Funded
- Updated as needed after project award
- Implemented!
- Monitored – and adjusted as needed
Identification of TMP Strategies

Should be based on:
- project constraints
- type of work zone
- anticipated WZ impacts
- construction phasing/staging plan

Some agencies use strict lane closure policies/strategies or permissible lane closure times that must be followed

Agencies may use analysis tools to predict delays, queues, and impacts of detours and compare these for various strategies
Example - MI DOT TMP Template

Table of Contents:
- Executive Summary
- Temporary Traffic Control Plan (TTCP)
- Transportation Operations Plan (TOP)
- Public Information Plan (PIP)
- Delay Calculation Details
- Alternative Traffic Control
- Vicinity Map or Location Diagram
MI DOT TMP Executive Summary

- Basic description - Location, work type
- Specific Project Data:
  - Letting Date
  - Anticipated Project Duration \((\text{Construction Start Date and Completion Date})\)
  - Existing Lane Widths
  - Existing Paved Shoulder Widths
  - Existing Aggregate Shoulder Widths
  - Threshold Criteria
    - Which criteria were exceeded?
    - How was delay calculated?
    - What is the source of traffic volumes?
- Facility Details (e.g., ADT, lanes)
- Crash Analysis and Safety Review
How Monitoring WZ Performance Can Help

- Gather data and use it!
  - Understand how work zones are performing
  - Identify issues and correct them
  - Make improvements to enhance performance

- Current work zones
  - Identify issues and address them now!

- Sample of work zones
  - Looks for trends
  - Assess effectiveness of strategies
  - Adjust design standards and WZ policies
Sources of Performance Data

- Lane closure, queue data from project personnel
- Crash reports
- Volume/occupancy data, speed data from existing sensors
- Installing temporary ITS during a project
- TMC data
- Sampling
  - Student interns doing travel time runs, observing queues
  - Rotating trailers with sensors to gather speed data
WZ Performance Measurement Examples

- **Current Work Zones**
  - New Mexico – incident response, maneuverability issues
  - Queue detection and management
- **Sample of Work Zones**
  - Ohio – merge areas, ramp back-ups, shoulder widths
Example - New Mexico

- Deployed a WZ ITS system at Big I reconstruct
- System included cameras to:
  - Help identify and quickly clear incidents
  - Monitor flow of traffic and driver behavior

- Incident response and clearance time reduced from 45 minutes to 25 minutes – secondary crashes avoided

- Saw areas where drivers had difficulty navigating the work zone. Made configuration changes to improve traffic flow (e.g., re-aligned a temporary ramp) - likely crashes avoided
Example - Queue Detection and Management

- Monitor performance
- Identify queues that weren’t expected
- May lead to some changes in TMP:
  - Providing more info to the public (reduce volumes, alert motorists)
  - Moving advance warning signs further upstream
  - Adding a CMS to alert drivers
  - Adjusting lane closure schedule/work hours
  - Changing law enforcement deployment/positioning
Example - Ohio

- 3 Categories of WZ performance monitoring data in Ohio:
  - Historic Data (primarily crash)
  - Near Real-time (also crash)
  - Real-time (mobility/speed)
# WZ Crash Data in Ohio - Historic

Used by ODOT to assess how it is doing with WZ safety

### Construction Cost Awarded by ODOT vs. WZ Total Crashes

<table>
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<tr>
<th>Year</th>
<th>Awarded Amount</th>
<th># Work Zone Crashes</th>
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<td>2001</td>
<td>$800</td>
<td>6808</td>
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<tr>
<td>2002</td>
<td>$1,400</td>
<td>7409</td>
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<td>2003</td>
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<td>6389</td>
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<td>2004</td>
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<td>5854</td>
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<td>2005</td>
<td>$3,000</td>
<td>5772</td>
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### Crash Rate = Accidents/Million Vehicle Miles

<table>
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<th>Year</th>
<th>Crash Rate Before Work Zone</th>
<th>Crash Rate With Work Zone</th>
<th>Change</th>
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<tr>
<td>2002</td>
<td>1.04</td>
<td>1.68</td>
<td>62%</td>
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<tr>
<td>2003</td>
<td>1.19</td>
<td>2.02</td>
<td>69%</td>
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<tr>
<td>2004</td>
<td>1.34</td>
<td>1.71</td>
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<tr>
<td>2005</td>
<td>1.29</td>
<td>1.23</td>
<td>-5%</td>
</tr>
<tr>
<td>2006</td>
<td>1.51</td>
<td>1.51</td>
<td>0%</td>
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</table>

Legend:
- Orange Bar: Before Work Zone
- Yellow Bar: With Work Zone
- Green Line: LPA projects
- Red Triangle: WZ Crashes

**Note:** The crash rate is calculated as the number of accidents divided by the million vehicle miles.
### ODOT’s Historical WZ Crash Analysis

#### Work Zone Crash Summary - 2003

<table>
<thead>
<tr>
<th>County</th>
<th>Route</th>
<th>Project</th>
<th>Begin SLM</th>
<th>End SLM</th>
<th>Length</th>
<th>Begin Month</th>
<th>End Month</th>
<th>Time Period (Days)</th>
<th>2003 Average ACT</th>
<th>Work Zone Crashes</th>
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<td>9.73</td>
<td>13.58</td>
<td>3.85</td>
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<td>AVG</td>
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<td>01</td>
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#### Free Flow Comparable

<table>
<thead>
<tr>
<th>Comp. Crashes</th>
<th>Comp. Year</th>
<th>Comp. ACT</th>
<th>Comp. Rate</th>
<th>Percent Difference</th>
<th>Free Flow Cost</th>
<th>Test</th>
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<td>211</td>
<td>#211</td>
<td>211</td>
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</table>

Average Difference $532,488

- **WZ Crash Rate** = 2.02
- **NON WZ Crash Rate** = 1.19
ODOT’s Historical WZ Crash Analysis

- Drilled deeper into data
- Logged and analyzed hundreds of WZ crashes - looked for “abnormally” high concentrations of crashes
- Analysis showed need for new/revised specifications & processes
Results –

Geometrics - The “abnormally” high concentrations of crashes showed there were major geometric contributing factors to Ohio’s work zone crashes:

(a) Inadequate ramp merges
(b) Inadequate off-ramp capacity
(c) Insufficient paved shoulders
ODOT’s Historical WZ Crash Analysis

- **Ramp Merges** – Created new standards for WZ on-ramp merges. Merges are now required to be detailed in plans. (now explicitly looked at in MOTAA)

- **Paved shoulders** – Created “desired/minimum” cross section that requires a 2’ paved shoulder (now used in MOTAA and detailed design)

- **Off-Ramp-Capacity** – Now explicitly looked for in Maintenance of Traffic Alternative Analysis (MOTAA)
ODOT’s Historical WZ Crash Analysis
- Plans -

- Plan to perform historical WZ crash analysis every 2 years seeking additional “lessons learned”

- Policies/standards/specifications will be changed as necessary to keep problems from happening again
For more information on work zone management strategies

www.fhwa.dot.gov/workzones