Guidelines

on Use of Exposure Control Measures

This document describes considerations and implementations of exposure control measures in a work zone. The document offers recommended practices and describes effective strategies and techniques that can be employed during the planning and construction phases to help mitigate safety and production concerns. The use of exposure control measures should be considered in the context of the overall transportation management plan for a project.

This document is organized into the following sections:

- **Examples of Exposure Control Measures**
  - Full Road Closures
  - Diversions
  - Median Crossovers
  - Ramp Closures
  - Rolling Roadblocks
  - Working During Nighttime Hours
  - Accelerated Construction Techniques
- **Selecting and Implementing Exposure Control Measures**
  - Table of Benefits and Implementation Factors for Various Measures
  - Examples: Minnesota, Oklahoma, Iowa, Florida, Washington

Refer to http://www.workzonesafety.org for a copy of this document.

Guidelines on Use of Exposure Control Measures

As defined in the federal regulation 23 CFR 630 Subpart K, exposure control measures are traffic management strategies used to avoid work zone crashes involving workers and motorized traffic by eliminating or reducing traffic through work zones. Exposure control can be achieved by diverting traffic away from the work space, reducing the duration of work zones, and/or reducing the number of work zones that motorists encounter.

Implementation of one or more exposure control measures in a work zone should be considered where appropriate, but with adequate thought given to the potential impacts of such measures on traveler mobility. Excessive delays or queues created upstream or on other roadways due to the use of an exposure control measure in a work zone can lead to rear-end and other types of traffic crashes that more than offset the reduction in crashes in the work zone itself. Thus, the use of exposure control measures should be considered in the context of the overall transportation management plan for a project.

Examples of Exposure Control Measures

There are three main approaches to reducing work zone exposure. The first approach is to reduce the number of work zones by using longer lasting materials and performing quality work to increase the period between when work is needed. The second approach is to reduce the duration that the work zones are needed. The third approach is to reduce or remove traffic from the work area.

This guide focuses on the latter two approaches. Reducing the duration of work zones and the amount of interaction between workers and traffic can be achieved through several strategies:

- full road closures;
- diversions;
- median crossovers;
- ramp closures;
- rolling roadblocks;
- working during nighttime hours; and
- accelerated construction techniques.

In addition to reducing work zone exposure, these strategies often make it easier for work crews to complete tasks safely, which can result in improved productivity rates and higher quality products.

Full Road Closures

Description

A full road closure is the removal or suspension of traffic operations either directionally or bi-directionally from a segment of roadway for the purpose of reconstruction and/or maintenance activities. During a full road closure, traffic is detoured usually for a predetermined amount of time, allowing contractors full access to roadway facilities. All traffic normally using the facility must use alternative routes or modes in the corridor. Full road closures can be implemented for a single night or weekend, for a few weeks or can last a year or more.

Benefits

A full roadway closure allows the construction or maintenance crew to have access to the entire facility. As a result, conflicts (and ultimately, crashes) between work activities and traffic are eliminated. The strategy can also significantly reduce project completion time, and potentially improve work quality. The strategy creates the opportunity to complete multiple work tasks during a single closure.

Implementation Considerations

This strategy requires a significant amount of lead time to incorporate the necessary planning, outreach, and other traffic management preparatory work required in the corridor before it is implemented. Because full road closures require the availability of adequate alternative routes and modes for motorists to use, the involvement of city and county agency personnel in the planning process is critical. To maintain credibility, it is critical that the project meet the deadline established and publicized for reopening the road.

Diversions

Description

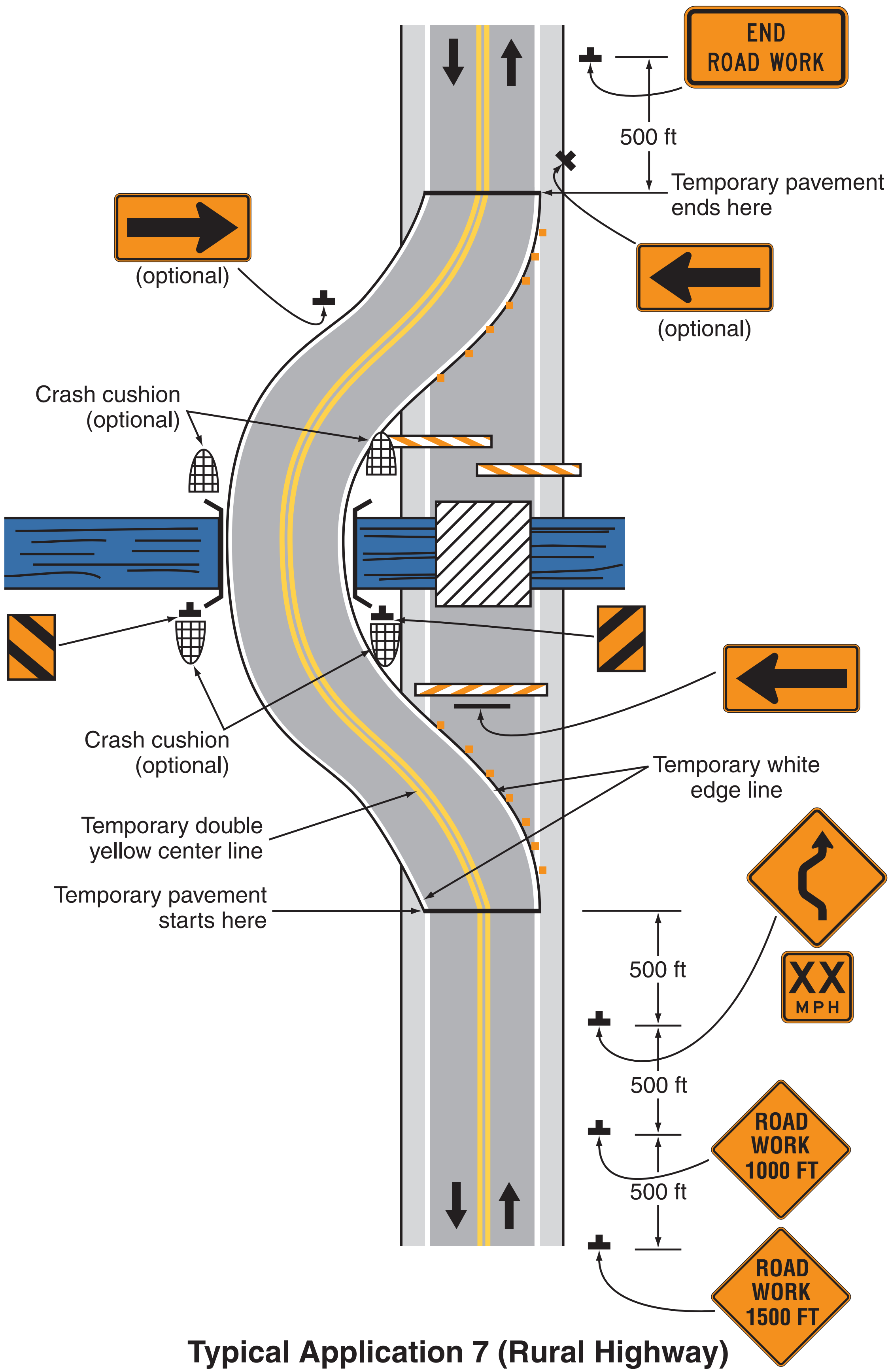
According to the national *Manual on Uniform Traffic Control Devices* (MUTCD), a diversion is a temporary rerouting of road users onto a temporary highway or alignment placed around the work area. A full diversion involves the complete closure of all lanes of a roadway, as shown in the illustration. In contrast, a partial diversion is where one or more lanes are left open through the work zone and the diversion is provided to offset the loss of capacity and to service some of the traffic. (See the Typical Application 7 on page 3.)

Benefits

One of the main advantages of using a diversion is that traffic flow is maintained within the agency's right-of-way, reducing the impacts to nearby alternative routes. As a result, the amount of analysis of those routes and efforts to upgrade them to handle additional traffic is reduced.

Implementation Considerations

A diversion does require the construction of temporary pavement and possibly channelization, lighting, and other devices, potentially increasing the time and cost of the project. Consequently, the strategy is probably best suited to bridge projects or other work zones that are limited in both length and duration.



Typical Application 7 (Rural Highway)

Median Crossovers

Description

A median crossover is used to close entirely one side at a time of a divided multi-lane highway, and move all traffic to the other side as a two-way operation (often with a median barrier separating opposing traffic flows to prevent head-on collisions). This strategy allows work activities to occur on the closed side, separated from traffic by a significant distance. In some instances, crossovers will need to make full use of all existing pavement on the other side, including existing shoulders, in order to maximize traffic capacity provided. (See the Typical Application 39 on page 5.)

Benefits

Similar to the diversion strategy, a median crossover maintains traffic flow within the agency's right-of-way, reducing the impacts on nearby alternative routes.

Implementation Considerations

It is important to first verify that a median crossover strategy can provide adequate traffic capacity. Temporary pavement must be constructed in the median of the roadway at both ends of the project, adding to the overall cost of the project. Lengthy crossover sections can create challenges in maintaining ramp access to cross streets. An appropriate design speed should be used for the temporary crossover. Care must be taken to ensure that newly-created roadside hazards are adequately protected, and that the work area access points near and in the crossovers are adequately designed and delineated.

Ramp Closures

Description

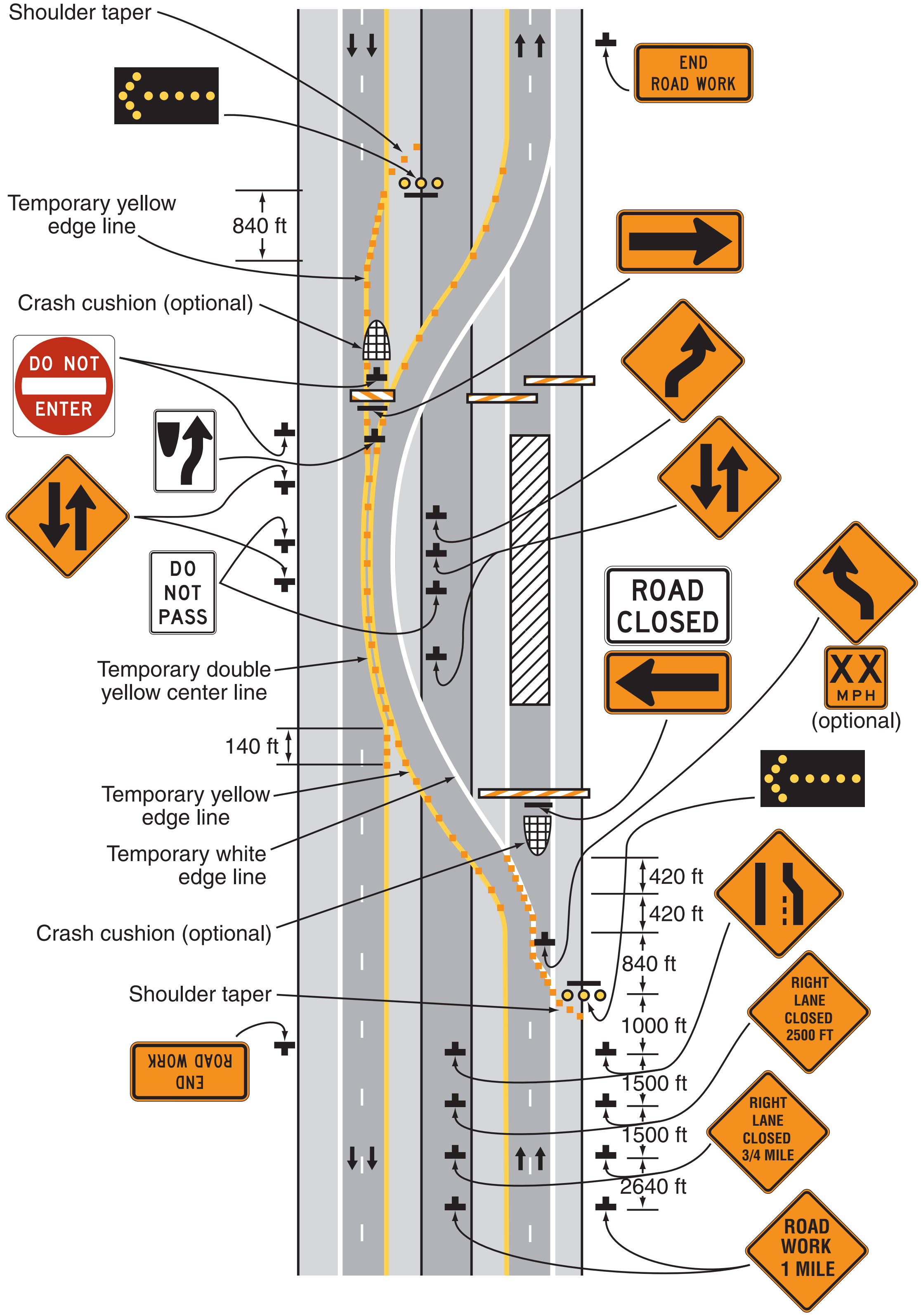
Another technique successfully used by some agencies to reduce vehicle exposure to work zones is to close temporarily the entrance and exit ramps upstream and within the limits of a work zone on an access-controlled facility. Ramp closures can be long-term over the duration of a project or project phase, or implemented during peak periods only on a daily basis.

Benefits

Ramp closures reduce exposure by causing drivers to seek out alternative routes. In addition, temporary ramp closures can also eliminate the need for complex traffic control to accommodate traffic entering and exiting the facility. Furthermore, ramps can be restricted to high-occupancy vehicle (HOV) use only, providing an incentive for carpooling/vanpooling and transit use through the work zone.

Implementation Considerations

Ramp closures require consideration of the effects of detoured traffic on nearby local streets, emergency vehicle routes, and local businesses and residents. Adequate signing regarding alternate entrances and exits must also be provided. In some cases, trailblazing signs to the alternate ramps may be required. Failure to properly notify motorists of an exit ramp closure may actually increase work zone exposure by causing drivers who were planning to exit to instead travel through the work zone before exiting at the next downstream ramp.



Typical Application 39 Median Crossover on a 70 mph Freeway

Rolling Roadblocks

Description

Many highway agencies and contractors use rolling roadblocks, also referred to as traffic pacing. Typically, law enforcement vehicles with lights flashing enter the roadway upstream of the work zone, and move at a fairly slow pace to create a blockage across all travel lanes. This creates a gap between the law enforcement vehicles and the vehicles in front of the blockade. Rolling roadblocks are used when it is important that no traffic be in the vicinity of a particular work activity for a short period of time (such as during the lifting and placing of a bridge beam over an interstate).

Benefits

This concept can also be applied during temporary traffic control set up and removal activities, allowing workers to finish the installation or removal process without having to interact with traffic constantly approaching and passing the temporary traffic control (TTC) crew. Given that TTC set up and removal activities tend to be overrepresented in work zone crash statistics, this technique can have substantial safety benefits for both workers and motorists.

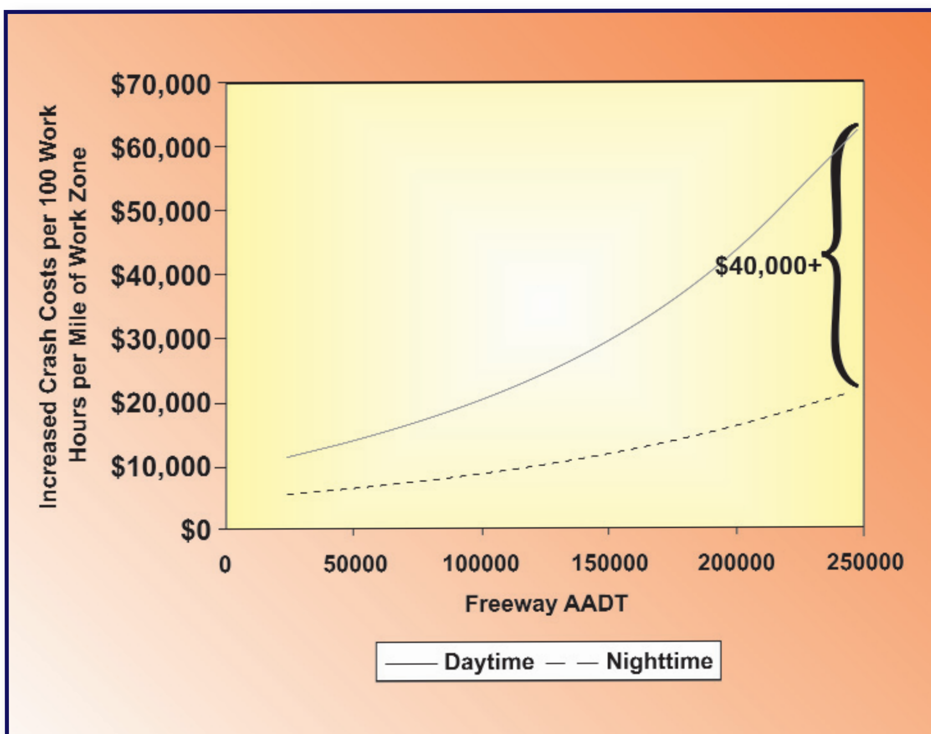
Implementation Considerations

Rolling roadblocks require advance planning to determine the duration of gap required and a high level of coordination and communication between law enforcement and the work crew to time the work activity with the gap in traffic. Using signs to warn approaching traffic of the slowdown is also important.

Night Work

Description

Another technique for reducing vehicular exposure to work zone activities is to perform those activities at night (or on weekends) when traffic volumes are lower.



Benefits

Many agencies already limit temporary lane closures on high-volume roadways to nighttime hours in order to minimize the delays and queues that can develop during the day. Evidence suggests that this technique also has a significant safety benefit as well. As shown in the figure on the right, the dramatic reduction in traffic exposure at night results in lower crash costs per hour of work activity than working during the day, and apparently more than offsets the perceived higher risks of impaired driving and reduced visibility commonly associated with working at night.

Implementation Considerations

Not all work activities can be accomplished at night. In those cases, other strategies to reduce traffic volumes through work zones should be considered to reduce traffic volumes (e.g., public outreach campaigns, travel demand management techniques, etc.).

Working at night requires high-quality signing, advance notification to warn motorists, adequate lighting for workers, and measures to ensure safe traffic flows through the work zone. Agencies should pay special attention to avoid creating work zone lighting glare problems for approaching motorists. In addition, working at night places increased stress on workers, supervisors, and inspectors. It is important to encourage these individuals to take adequate rest breaks to ensure that they are fully alert (and remain so) when at work.

Accelerated Construction Techniques

Description

Techniques and strategies that encourage faster completion of construction and maintenance efforts by the highway contractor can reduce motorist and worker exposure in work zones. A number of techniques and technologies exist which can reduce the time it takes to rehabilitate or reconstruct a roadway, or at least reduce the amount of time that construction activities adversely impact travelers. Some examples of such technologies include the use of:

- precast modular concrete road panels and bridge elements;
- high early-strength concrete;
- self-propelled modular transports (SPMTs) to move bridges fabricated completely off-site quickly into place on the roadway once the existing bridge is removed;
- full road closures to allow the contractor complete access to the entire roadway; and
- hot in-place asphalt recycling.

Financial incentives can also be created for contractors to be innovative and aggressive when developing project schedules, or can be used as financial disincentive if a proposed completion schedule is not met. Each hour that a project is reduced in duration results in potential crash savings to motorists and workers.

Common contract acceleration techniques include:

- design-build contracts;
- cost + time (A+B) bidding;
- incentive/disincentive clauses; and
- liquidated damages clauses.

When incentives are provided, contractors may be encouraged to utilize accelerated construction techniques that are more costly.

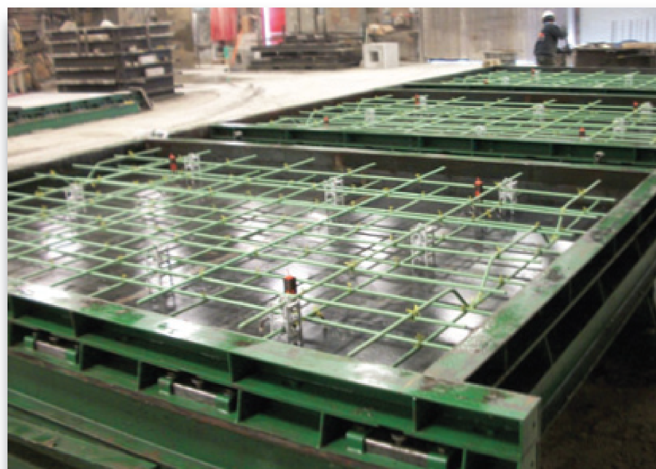
Benefits

Accelerated construction can improve safety, work productivity, and work quality while simultaneously minimizing the impacts of construction on traffic and the environment. Worker and traveler safety are improved because the duration of the work (and thus traffic exposure) is reduced, and because fewer iterations of temporary traffic control set up and removal are needed (workers are often more vulnerable during these activities). Experience suggests that construction acceleration techniques can often reduce project durations by 10 percent or more.

Accelerated construction techniques that allow work to be completed in off-peak time segments reduce the potential for queues to develop and thus for rear-end crashes to occur. Furthermore, those techniques that allow construction to occur off-site away from traffic (such as the use of precast modular panels or the self-propelled modular transport of newly-constructed bridges) or which allow the roadway to be completely closed to traffic so that the contractor has full use of the entire roadway result in higher quality products, lower exposure for workers and drivers, and less public inconvenience.

Implementation Considerations

It is important that the values for incentives and for penalties established for the contract be properly balanced. Furthermore, it is important that agencies be able to accurately estimate reasonable completion dates and critical milestones for the project. Finally, it is also important that the work be carefully planned, with appropriate safety precautions incorporated, to ensure production pressures do not lead to shortcuts that reduce safety or increase risk to workers.



Selecting and Implementing Exposure Control Measures

The table on page 9 provides some practical guidance on the implementation of the various exposure control measures available. Determination of which measures or combinations of measures is most appropriate for a given work zone must be made on a project-by-project basis, considering construction phase sequencing, impact on overall project costs, effects on residents and businesses, and other factors in addition to safety. Initial screening of possible approaches should occur during the maintenance of traffic alternatives analysis. Those strategies that are not deemed feasible can be excluded. For example, a lack of available nearby alternative routes may preclude the use of a full road closure strategy. In all cases, judgment must be applied to compare the project and societal costs of the strategies.

Benefits and Implementation Factors for Various Exposure Control Measures

Measure	Benefits	Implementation Factors to Consider
Full road closures	• Contractor has full access to roadway • Multiple tasks can be completed simultaneously • Can reduce total project time	• Availability of adequate alternative routes • Coordination with local agencies and other stakeholders • Adequate advance notification of all affected parties • Improvement costs on detour or nearby local roads to handle additional traffic during closure
Diversions	• Traffic flow is maintained within roadway right-of-way • Limited effect on nearby roadways	• Diversion roadway costs (temporary pavement, channelization modifications, lighting, etc.)
Median crossovers	• Traffic flow is maintained within roadway right-of-way	• Adequate capacity on temporary two-way operation roadway • Ramp access to and from two-way roadway • Adequate protection of newly-created roadside hazards (i.e., previously downstream ends of bridges or culverts, creation of two-way traffic operation, etc.) • Use of adequate design speed for temporary crossover • Costs of temporary crossover
Ramp closures	• Encourages drivers to seek out alternative routes • Can eliminate the need for complex traffic control to accommodate traffic entering and exiting the facility • Can be restricted to HOVs only and provide an incentive for carpooling /vanpooling and transit use through the work zone	• Adequate advance notification of local residents and businesses • Adequate capacity on local street system • Potential for providing an access incentive to high-occupancy vehicles (HOVs) • Effects of ramp closure on upstream and downstream ramps and cross-street intersections
Rolling roadblocks	• Effective for very short-duration work tasks that require a full closure • Can be used for traffic control set up and removal activities if desired	• Adequate advance notification of rolling roadblock operation • Adequate advance signing of slow traffic ahead • Sequence of enforcement or work vehicles onto and off of the roadway • Adequate rolling roadblock distance to create adequate gap in traffic
Working at night	• Traffic congestion is lower than if the work were conducted during the day • Total crash costs are reduced • Fewer driver complaints	• Adequate advance notification and signing • Adequate lighting of work operation and flagger stations • Avoidance of glare issues for approaching motorists (in both directions) • Provision of adequate rest time for workers and supervisors/inspectors
Accelerated construction	• Project duration can be significantly reduced • Construction innovation is encouraged and rewarded • Reduced exposure • Less inconvenience for drivers	• Adequate balance between dollar values for incentives and penalties • Ability to accurately estimate a reasonable completion date for project or critical milestone • Steps needed to ensure that safety is not compromised by increased production pressure

Examples

Full Road Closure, TH-36, St. Paul, Minnesota

The Minnesota Department of Transportation (DOT) implemented a full road closure to rebuild a two-mile section of trunk Highway 36, a primary commuter route in St. Paul. A number of innovative construction techniques and traffic management strategies were employed, as well as contract incentives. The project was highly successful in many ways. Construction time was reduced from 19 months (for traditional construction methods) to only 6.5 months during the full road closure, which resulted in less traffic impact than would have otherwise occurred. No worker injuries or traffic incidents were reported during the project. A strong public information campaign generated positive support for the strategy. A total of 90 percent of residents and commuters gave the project positive ratings and 83 percent of the local businesses were pleased with the approach.

Oklahoma DOT Ramp Closure Policy

The Oklahoma DOT instituted a formal policy that allows existing ramps to be closed during rehabilitation projects based on the potential for congestion or safety problems. To implement the policy, the DOT is required to conduct a public hearing for the surrounding neighborhoods to notify the public of the upcoming ramp closure(s) and to address concerns expressed by the public. Initially, this hearing was conducted just prior to closing the ramp(s). However, the DOT is working to conduct hearings earlier in the planning and design phase to ensure that all local concerns are addressed and no economic hardship is created for the local economy by closing the ramp(s).

The Oklahoma DOT has indicated that the policy generally allows for construction to be accelerated more than would be possible if the ramp(s) were left open. In addition, the DOT believes that the public awareness of the project and of work zones in general will increase due to the ramp closure(s) and has generated useful suggestions on how to further reduce traffic impacts.

Median Crossover Design Guidance, Iowa DOT

The Iowa DOT established specific design and implementation guidance regarding the use of median crossovers on four-lane divided highways. The guidance specifies that the crossover should be designed for the posted speed of traffic prior to construction, but can be reduced by up to 10 miles per hour if necessary. The crossovers are also to be located so as to minimize horizontal and vertical curvature sight restrictions approaching the crossover. In addition, no access points are to exist in the crossover area so that drivers can fully attend to negotiating the crossover without concern for entering or exiting traffic.

Florida DOT Traffic Pacing (Rolling Roadblock) Guide

The Florida DOT developed a design standard that specifically addresses the use of traffic pacing (or rolling roadblock) operations. The standard includes the following sections:

- general notes;
- traffic control plans and technical specifications;
- mainlane pacing details; and
- pacing operation design details.

The required project-specific traffic control plan, which should be developed prior to initiating any traffic pacing operation, is outlined in the traffic control plan and technical specifications sections. Establishing fail-safe "stop points" at exit ramps, in the event that a construction problem creates a condition that can-not be immediately cleared, and pacing operations to divert all traffic to the exit ramp are required. The main-lane pacing details a four-step process for getting traffic control officers onto the travel lanes to initiate a traffic pacing operation and for getting them off of the roadway at the conclusion of an operation. Finally, the pacing operation design details identify the calculations needed to determine how long the pacing operation must be to allow the desired work activity to occur.

Washington DOT Use of SPMT

A full-depth, precast concrete deck replacement was completed in 2004 for Lewis and Clark Bridge on SR 433 crossing the Columbia River between Oregon and Washington. SPMTs with a specially designed lifting and transporting frame were used to install 103 full-depth, full-width, prefabricated, precast, lightweight concrete deck panels supported by longitudinal steel beams. One panel was replaced per night within a 6-hour period. Time constraints allowed full closures from 9:30 p.m. until 5:30 a.m. Monday through Thursday. The deck replacement was completed in only 124 nights plus three weekend closures. Conventional deck replacement would have required replacing the deck lane by lane over a 4-year period, closure for several months, or closure every weekend for 6 months. Perhaps more importantly, the use of SPMTs allowed the bridge to remain open for normal weekday operation.

How Can I Locate More Information Regarding This Topic?

Full Road Closure for Work Zone Operations: A Cross-Cutting Study. Report No. FHWA-OP-04-009. FHWA, U.S. Department of Transportation, Washington, DC. August 2003. Available at http://ops.fhwa.dot.gov/wz/resources/publications/FullClosure/CrossCutting/its.htm

Flick, G., E.T. Cackler, S. Trost, and L. Vanzler. Time-Related Incentive and Disincentive Provisions in Highway Construction Contracts. NCHRP Report No. 652. TRB, National Research Council, Washington, DC. 2010. Accessed at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_652.pdf

Ullman, G.L., M.D. Finley, J.E. Bryden, R. Srinivasan, and F.M. Council. Traffic Safety Evaluation of Nighttime and Daytime Work Zones. NCHRP Report No. 627. TRB, National Research Council, Washington, DC. 2008. Accessed at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_627.pdf

Use of Police Traffic Services in Work Zones. Maryland State Highway Administration, Office of Traffic Safety. August 2005. http://www.marylandroads.com/OOTS/01Police.pdf

Barnard, R.K. A Mix of Innovations Succeeds in Minnesota. In Public Roads, Vol. 72, No. 6, May/June 2009. Accessible at http://www.fhwa.dot.gov/publications/publicroads/09june/02.cfm

Median Crossovers. Design Manual, Chapter 3, Cross-Section. Iowa Department of Transportation, Iowa City, IA. Revised May 2007. Accessible at http://www.iowadot.gov/design/dmanual/03e-03.pdf

Traffic Pacing. Design Standard Index 655. Florida Department of Transportation, Tallahassee, FL. July 2009. Accessible at http://www.dot.state.fl.us/rddesign/rd/rtds/10/655.pdf

Bryden, J.E., and D. Mace. Guidelines for Design and Operation of Nighttime Traffic Control for Highway Maintenance and Construction. NCHRP Report No. 476. TRB, National Research Council, Washington, DC. 2002.

Accelerated Construction. Office of Operations, FHWA, U.S. Department of Transportation. Accessible at http://ops.fhwa.dot.gov/wz/construction/accelerated/index.htm

Manual on the Use of Self-Propelled Modular Transporters to Remove and Replace Bridges. Report No. FHWA-HIF-07-022. FHWA, U.S. Department of Transportation, Washington, DC. June 2007. Accessible at http://www.fhwa.dot.gov/bridge/pubs/07022/

Developed By:

The Roadway Safety Consortium

202-628-5465
www.workzonesafety.org

Laborers' International Union of North America
Laborers' Health and Safety Fund of North America
LIUNA Training and Education Fund
American Road and Transportation Builders Association
National Asphalt Pavement Association
International Union of Operating Engineers
American Association of State Highway and Transportation Officials
Texas Transportation Institute
FOF Communications

U.S. Department of Transportation
Federal Highway Administration

This material is based upon work supported by the Federal Highway Administration under Grant Agreement No. DTFH61-06-G-00007.

Any opinions, findings and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the Federal Highway Administration. This publication does not constitute a national standard, specification or regulation.