Improving Safety and Mobility with Modern Work Zone Traffic Control

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Introduction

Construction work zones are growing in number around the world. The natural aging of existing roadway infrastructure ensures that more and more maintenance and rehabilitation will be required. Work zones, by their very definition, create two major problems that must be addressed in some way: safety and mobility. In the United States, highway work zones are responsible for almost 25% of all non-recurring congestion and 10% of overall congestion[1]. Vehicle accidents are more common in work zones, and traffic congestion through work zones on urban arterials and freeways is often considered to be "unavoidable." Fortunately, technology is providing new solutions to these problems at an accelerated rate. By combining the best of these new technologies, agencies can effectively reduce injury accidents and mitigate traffic congestion through construction work zones.

Background: Traditional Work Zone Practices and Problems

In a construction work zone, there must be a balance between the number of lanes that are available for motorists and the space requirements of the contractor. Typically, this is addressed in one of three scenarios:

1. First, to give the maximum number of lanes to traffic, the size of the work zone must be reduced. In this scenario, congestion is minimized, but the work zone is confined and inefficient. This creates a work zone environment that is prone to accidents, and it extends the construction schedule.

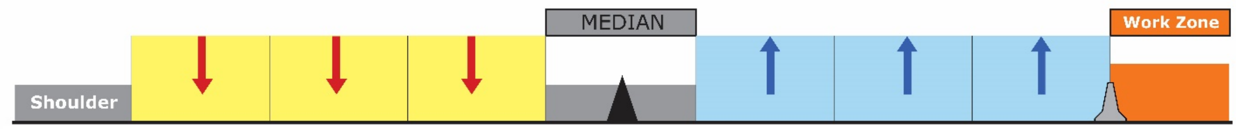

Figure 1. Traffic is not impacted, but the work zone is confined and inefficient.

2. In the second scenario, the work zone is expanded. This allows for larger, more efficient equipment to accelerate the construction schedule, and more space means a safer work zone. The impact on traffic is seen as the number of vehicle lanes is now minimized, creating congestion and potentially increasing vehicle accident rates.

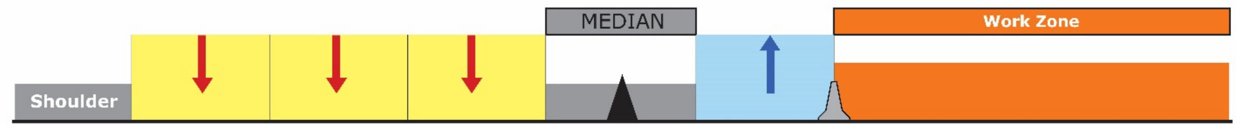

Figure 2. The work zone is safe and efficient, but severe congestion and user delay costs will result.

In these first two scenarios, the static, inflexible work zone is optimized for either the motoring public or the contractor, but it cannot be optimized for both. Fortunately, in either of these scenarios we can increase safety by separating vehicles and workers from each other with either steel or concrete barrier. This positive protection virtually eliminates vehicle encroachments into the work zone, which account for a large percentage of work zone fatalities. Positive barrier protection is a critical safety element, and agencies are often willing to sacrifice mobility and work zone efficiency for the safety of barrier separation.

3. The third scenario is the most efficient use of the roadway. In this case, the maximum number of lanes is made available to motorists during peak traffic hours, and the road is reconfigured to increase the size of the work zone during off-peak traffic hours. This allows the contractor to create dedicated haul lanes, use larger equipment, accelerate the construction schedule, and create a safer working environment, while maximizing mobility and vehicle throughput for traffic.

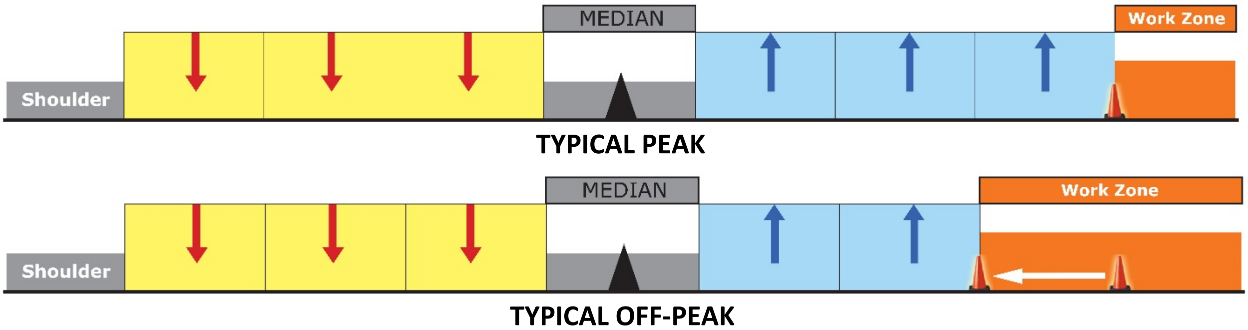

Figure 3. The work zone is efficient and traffic is not impacted, but encroachment accidents will still occur.

Unfortunately, implementing a flexible divider between vehicle traffic and the construction work zone is traditionally accomplished by using plastic cones, barrels, and flexible delineators that offer no positive protection. Historically, road delineation that can be reconfigured quickly enough to respond to the needs of peak traffic conditions must by definition lack the crashworthy physical attributes of positive protection. This is the essential conflict between safety and mobility: work zone intrusion accidents must be eliminated if safety and mobility are to be optimized together.

Safely Separating Workers from Traffic While Mitigating Traffic Congestion

Both long-term and short-term construction work zones can cause traffic congestion and put workers and motorists at risk[2]. Agencies and contractors must decide which of the modern work zone solutions are best when considering the duration of the work zone. For smaller, shorter duration work zones, protection must be portable, crashworthy, and able to mobilize quickly. The MBT-1 from Mobile Barriers is a modern work zone technology that provides all of these benefits.

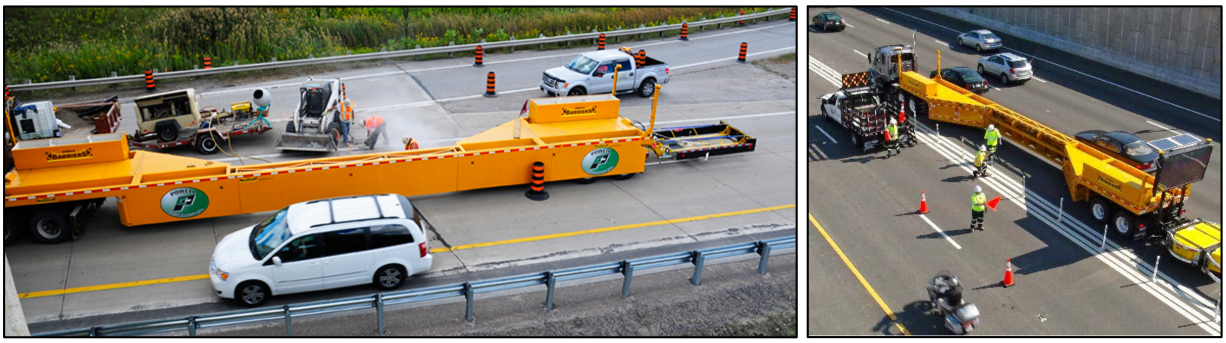

Figure 4. The MBT-1 from Mobile Barriers provides highly portable positive protection for work zones

The MBT-1 has proven to be particularly efficient for work zones where protection has not been historically practical, and where set up and break down of lane closures and work zone delineation takes longer than the work itself. The MBT-1 can be outfitted with power, lighting, sign boards and TMAs. Even cranes and scissor lifts can be mounted to create a fully functional and integrated mobile work zone. The MBT-1 has excellent deflection characteristics when impacted, and the impact on traffic is often greatly reduced as the unit is able to quickly move between work areas.

Long-term and larger work zones provide a greater challenge to enhance safety while mitigating traffic congestion. When arterial or freeway lanes are taken for construction, user delay costs to motorists can easily climb to millions of dollars. Additionally, the longer the work zone is in place, the more likely that there will be an intrusion accident, or accidents related to changes in the road configuration. One solution that meets both challenges is moveable concrete barrier. Moveable barrier technology mitigates traffic congestion by quickly reconfiguring the roadway under traffic, and the positive protection of concrete barrier provides the safety that is not available with plastic delineation. This creates a crashworthy lane separator that provides more lanes for peak traffic and expands the work zone to accelerate the construction process. Vehicle mobility is maximized without compromising the safety of positive protection.

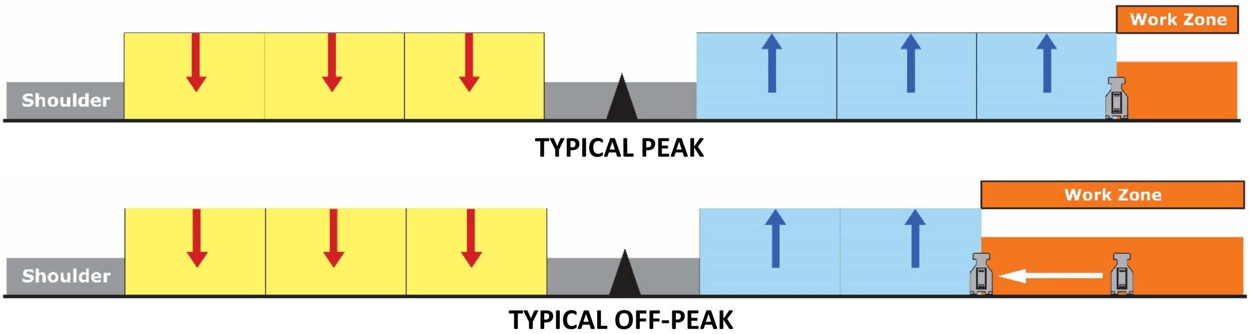

Figure 5. Moveable barrier reconfigures the roadway in real time with positive barrier protection.

Figure 6. Moveable barrier is used to expand the work zone and/or provide more lanes for peak traffic.

<u>Shoulder / Median Work</u>
For shoulder and median work, the barrier can be stored at the edge of the road and moved out during off-peak traffic periods to increase the size of the work zone. The barrier is returned to the stored position during peak traffic periods to give the maximum number of lanes to traffic. The barrier can be moved many times per day to meet the needs of both construction crews and motorists.

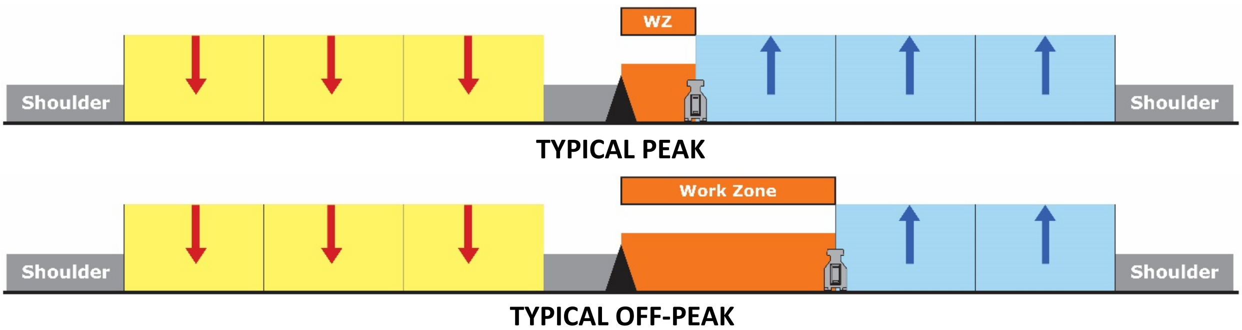

Figure 7. Moveable barrier expands the work zone during off peak traffic hours.

Figure 8. The lane taken to expand the median work zone is returned to peak

Partial Closures

During partial closure construction, one side of the road is completely shut down for construction and all traffic is diverted to the other side. Moveable barrier is used as a “moveable median,” shifting multiple times per day to reconfigure the road and give more lanes to the peak traffic direction.

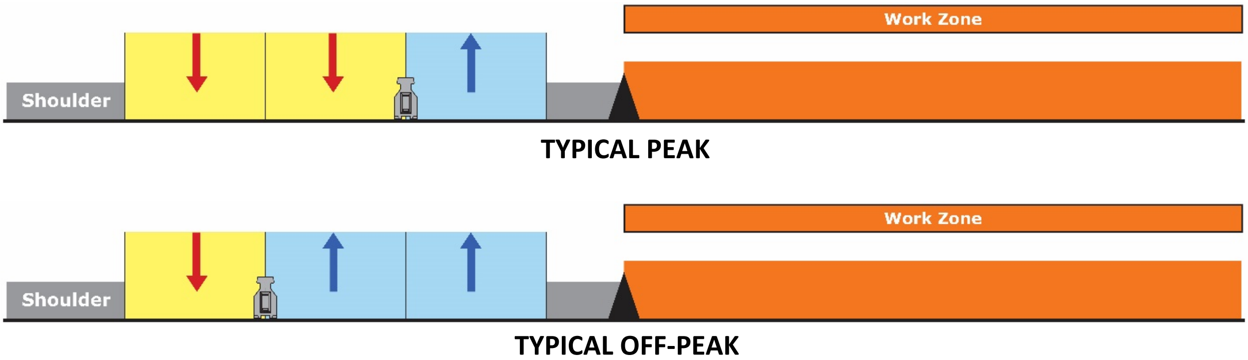

Figure 9. One side of the road is completely closed for construction while traffic is managed on the other side.

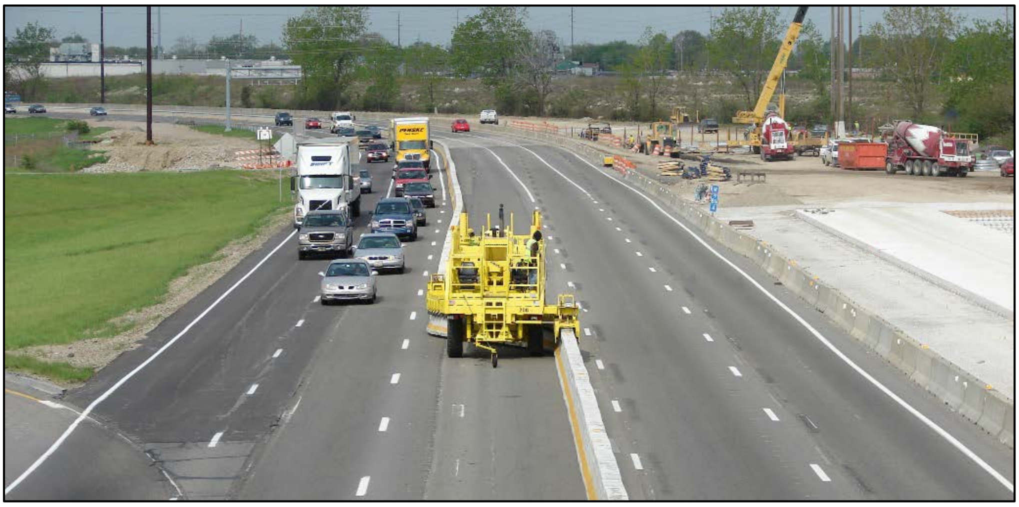

Figure 10. Traffic lanes are reconfigured under traffic in real time during a partial closure.

Moveable Barrier for Construction: Case Study

The following case study explain the concepts and the benefits derived from using moveable barrier in a real world situation.

3500 South, Salt Lake City, UT USA (Shoulder / Median Work)

3500 South is a busy arterial in Salt Lake City, Utah. The first phase of the reconstruction called for two traffic lanes to be open for traffic in each direction, and plastic barrels were used to separate directional traffic and to delineate the work zone. The work zone area was confined and restricted, and it lacked positive protection, which created dangerous conditions as confused motorists occasionally turned into the work zone. For the second phase of the project, it was decided that a moveable barrier system would be used to create a larger work zone, while minimizing the impact on traffic and limiting left-hand turns.

It was determined that moveable barrier could keep two lanes open to traffic in the peak direction by using a total of only three lanes. This would give the contractor an extra lane to expand the work zone, keeping workers safe and accelerating construction. The barrier was moved multiple times daily to create a 1/2, 2/1 traffic pattern.

- Project was completed seven months early & saved one construction season[3]
- Savings from early completion were estimated at US $1.3 to $1.4 million
- Reduced user delay costs
- US $1 million in accident cost reductions
- Total moveable barrier benefits estimated at US $2.4 million
- Moveable barrier benefit/cost ratio estimated between 4:1 and 10:1

Figure 11. Moveable barrier has major benefits on both highways and arterials.

Automated Lane Closure Systems

While workers and motorists benefit from flexible positive protection throughout the work zone, there are more opportunities to improve safety and mobility. Lane closure signage and tapers provide the first level of safety during the motorist's approach to the work zone, and by definition there is very little or no protection for workers who deploy the lane closure. For long-term work zones, new automated lane closure systems like the SwiftGate from Canadian manufacturer Versilis neutralize the danger and exposure to workers during the lane closure process.

Figure 12. The SwiftGate system from Versilis is an automated lane closure system that operates by remote control.

The SwiftGate system consists of a number of high-density polyethylene gates that are tapered in length to close a lane of traffic next to the shoulder or median, while full length gates maintain the closure over any distance. The gates pivot from a stored position to the fully deployed lane closure configuration. Each gate is connected to a control box that receives a high-frequency radio signal from one of several possible sources. A handheld remote control can open or close the system from a distance of up to 800 meters, and for offsite control the deployment or retraction signal can be sent from a cell phone, pager, or computer. Each gate and control box is powered by a lightweight solar panel that can tilt and rotate for optimum sunlight exposure.

Motorists who are approaching the SwiftGate system will see signage as required by local traffic control standards. These signs, mounted to SwiftSign units, operate in the same manner as the SwiftGates and deploy just prior to the deployment of the SwiftGate system. This dynamic signage is only visible to motorists during the lane closure, and the signs are retracted with the rest of the system when the lane closure is ended.

Figure 13. SwiftSign deployed

Figure 14. SwiftGates illuminated at night

Traffic Control Optimization Based On Real-Time Traffic Data

In much the same way that automated lane closure systems can increase safety in a long-term construction work zone, automated decisions regarding when to change the lane patterns can decrease congestion to a greater degree than reconfiguring the road based solely on a structured time schedule. Data collection systems from companies such as Inrix gather cellphone data that can be used to analyze vehicle counts in a work zone. Microwave radar systems from companies such as Mobile Traffic Solutions can count and analyze data in real time over a predetermined section of roadway and transmit the collected data to a central control system. Once this data is analyzed against historical patterns or site-specific algorithms, changes can be made to the road in real time. Now, instead of changing a moveable barrier lane configuration based on assumed peak commute times, the real-time lane configuration changes can respond to any external factors, including the daily ebb and flow of traffic, special events and road incidents. This technology was used recently in the UK on two trial projects, the M25 Dartford Widening and the M27 Crawler Lane project. With the ability to adjust traffic lanes based on immediate traffic data, it was estimated that these projects saved 6 months and 3 months respectively while maintaining positive protection between workers and motorists[4]. These types of systems are likely to be used on larger road works in major urban areas, but that is where the congestion is greatest and the cost benefit justifies the initial expense of implementing the system.

Figure 15. Real time traffic data transferred to a cell phone from a microwave radar station.

Conclusion

Modern work zone traffic control must succeed on several levels to be truly effective. First and foremost, traffic control through a work zone must provide obvious visual delineation for motorists who encounter a change in lane configuration or shoulder accessibility due to construction. Beyond this basic tenant, there are a number of additional characteristics that increase the effective performance of a traffic control system. Work zones create and contribute to traffic congestion on arterials and highways, and the severity of the congestion is directly related to lane reductions due to construction and the time of day, as work zones that operate during peak traffic periods will cause more congestion than work zones which operate only during off-peak hours. Because of this, a work zone traffic control system that can be reconfigured in real time throughout the day to give more lanes to peak traffic will be much more effective, and it must provide the safety of positive barrier protection. One method of reaching these goals is to use moveable barrier.

To reduce worker exposure, moveable barrier installations can be combined with automated traffic control technology. At the push of a button, traffic advisory signs and lane closure gates can be activated to channel road users into the current lane configuration. These automated control systems can be operated onsite or remotely, or they can be combined with real-time intelligent traffic data that can analyze traffic patterns to determine the best times to reconfigure the roadway. Data from the cloud is sent to the automated traffic control as well as the moveable barrier system operators to keep traffic congestion and road closure confusion to a true minimum through the work zone. Together, these new technologies will create safer, less congested work zone environments for motorists and provide a new level of safety for workers by decreasing exposure to vehicles and removing confusion from lane configuration changes.

References

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2. Texas Transportation Institute. 2012 Urban Mobility Report. 2012.

3. D. Anderson, D. Eixenberger, K. Berg. Evaluation of Movable Barrier in Construction Work Zones. March, 2010.

4. ITS International. Beating the DRUM for Faster Roadworks. January, 2014.