Improving Work Zone Safety:
Why you should consider Longitudinal Channelizing Devices (LCDs)

A WHITE PAPER PREPARED BY THE WATER BARRIER MANUFACTURERS ASSOCIATION

The purpose of this paper is to educate transportation departments, consulting engineers, and others on the availability of new, cost effective, and safe alternatives to drums and temporary concrete barrier for work zone traffic channelization.

Our highway infrastructure is aging and the need for rehabilitation and reconstruction is growing. Much of this reconstruction work is occurring while at the same time traffic is maintained on the roadway under repair. Approximately 20% of the National Highway System (NHS) is under construction during the peak construction season. More than 3000 work zones are expected to be present on the NHS during the peak season. Approximately 12 billion vehicle miles of travel a year will be through active work zones. Motorists can expect to encounter an active work zone 1 out of every 100 miles drive on the NHS. Over the last ten years, work zone fatalities increased 45%, up to 1,010 in 2006. More than 40,000 people are injured each year as a result of crashes in work zones.

Improvements in our highway infrastructure will benefit all Americans by creating safer roadways, providing jobs, and alleviating congestion, in turn saving time and energy otherwise spent commuting. Throughout these infrastructure improvements, more attention must be given to safety and the prevention of work zone accidents, which take the lives of construction workers, motorists, and pedestrians. Our nation needs to build better roads, bridges, and transit systems *without sacrificing the safety* of motorists, pedestrians, and workers.

The *Manual on Uniform Traffic Control Devices* (MUTCD), approved by the Federal Highway Administrator as the National Standard, contains the basic principles of design and use of all accepted traffic control devices for all streets and highways which are thought to provide a safe work zone environment for construction workers and motorists.

Longitudinal channelizing devices (LCDs) were first introduced in the 2003 Manual on Uniform Traffic Control Devices (MUTCD), at the time referred to as longitudinal channelizing barricades (LCBs). Per the current version of the MUTCD, LCDs are described as lightweight, deformable devices that can be connected together to delineate or channelize vehicles or pedestrians. LCD's are much safer in use than temporary concrete barrier, which, when impacted by a wayward motorists, create high G forces that can cause serious injury and death to the driver and occupants of the vehicle. LCD's are designed to give way and allow the vehicle to pass through the device, in turn keeping the G Forces from impact low and tolerable to the human body.

The Federal Highway Administration (FHWA) has accepted the use of several LCDs on the National Highway System from various manufacturers. While all of the accepted LCDs are considered crashworthy, as with all accepted traffic control devices, the test level for which each device is accepted varies. A review of the FHWA acceptance letter for the LCD being considered would let an engineer know what speed level the particular LCD has been tested to and the conditions under which the LCDs were tested (i.e., crash test level, evaluation criteria, with or without ballast, etc.) prior to adopting it for use in a particular situation.

"Although continuous line applications of LCDs may appear to form a solid wall, they do not meet the vehicle redirection requirements for temporary traffic barriers. Thus, while LCDs must be crashworthy, they do not provide positive protection for obstacles, pedestrians or workers. Since LCDs look very similar to water-filled barriers, the two devices are often confused with each other. To help reduce this confusion, Task Force 13, which serves the American Association of State Highway & Transportation Officials (AASHTO), Associated General Contractors of America (AGC) and the American Road & Transportation Builders Association (ARTBA) Joint Subcommittee on New Highway Materials and Technologies, has addressed this matter through the development of warning label guidelines that will provide users with sufficient information to discern between LCDs and barriers. It is anticipated that these guidelines will educate users about the performance of the different devices in order to avoid the unintentional use of LCDs at sites where actual barriers are intended. Task Force 13 and the American Traffic Safety Services Association (ATSSA) have approved the guidelines, and the FHWA has endorsed them. Task Force 13 is currently developing a website to disseminate the guidelines. The FHWA plans to include a link to the guidelines on its Crashworthy Work Zone Traffic Control Devices website."[1]

Unfortunately, LCDs have only been used to delineate pedestrian travel paths in work zones. As such, LCDs have ensured that the temporary pedestrian travel path meets the MUTCD accessibility requirements for persons with disabilities. Although LCD's are exceptional at meeting this requirement, there are other uses where LCD's are accepted by the FHWA, but are rarely considered. For instance, LCD's can be used in place of concrete barriers to close roadways to vehicular traffic. Closing roads using concrete barrier exposes motorists to extremely hazardous high angle impacts. Using LCD's to close roadways instead of concrete barrier mitigates this hazard. LCDs can be used to denote the edge of the pavement or separate the active travel lanes from the work area, where positive protection is not required. Again, using LCD's in this manner greatly reduces the risk to motorists and their passengers of an impact with concrete barrier.

"The limited application of LCDs in the traveled way is not surprising, since guidance regarding the work-zone configurations and conditions where LCDs should be considered in lieu of other channelizing devices has not been developed.

In contrast to traditional channelizing devices (e.g., cones, drums, etc.) that have some open space between devices, LCDs can be connected together to form a solid line. Thus LCDs can prevent drivers and pedestrians from going between devices and entering the work area (whether inadvertent or deliberate). A solid line of LCDs also provides continuous delineation of the travel path, which may be beneficial at major decision points in work zones, such as lane closures, exit ramps, business access points (i.e., driveways) and temporary diversions (i.e., crossovers).

Of course, LCDs also could be used in a more traditional fashion. For example, in lane closures, single LCDs acting as Type 2 barricades (i.e., oriented 90° toward oncoming traffic) could be used in lieu of drums to form the merging taper. While the LCDs would not be used in a continuous line (i.e., there would be some open space between devices), due to their larger size the LCDs may still appear to form a solid wall to drivers approaching the lane closure in the closed lane. LCDs also are considered to be highly visible and have good target value, thus LCDs might increase the sight distance to the lane closure. In addition, the larger size of the LCDs may allow for increased spacing of the devices (i.e., more than one times the speed limit in mph); thus fewer devices would be needed."[2]

When deciding on the correct and safe choice for temporary traffic control in a work zone, an evaluation of devices should place a particular emphasis on balancing the protection of construction and maintenance workers

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[1] Source: *Roads & Bridges* February 2010 Volume: 98 Number: 2 Copyright © 2010 Scranton Gillette Communications by Melisa Finley, P.E. *Finley is an associate research engineer with the Texas Transportation Institute.*

[2] Ibid

with the safety of road users traveling through work zones. According to the Bureau of Labor Statistics, there were 101 fatal occupational injuries at road construction sites in 2008 alone. In 2007, 831 workers and motorists were killed in highway work zones and more than 40,000 were injured. Eighty-five percent of those killed in work zones are drivers or their passengers.[3] According to an exhaustive report on 2008 traffic fatalities released by the Illinois Department of Transportation[4], there were 31 fatal crashes in work zones in which 31 people were killed. Only two of the persons killed were road construction workers, more than 93% of fatal injuries where to drivers and their passengers. Four out of five of the people who die in work zone crashes are motorists, not highway workers according to the Virginia Department of Transportation.[5]

The current mindset set of the safety community is geared toward using "positive protection" to protect maintenance workers in roadway work zones. As a result, concrete barrier has become the temporary traffic control device most commonly used in highway work zones. In fact, a recent survey of practices confirmed that temporary concrete barrier is the option most frequently used by state transportation agencies.[6] This has occurred even though the data from work zone accident fatalities overwhelmingly indicate that maintenance workers are in the minority of those killed in work zone.

As stated in Part 6 of the MUTCD, "the primary function of temporary traffic control is to provide for the safe and efficient movement of vehicles, bicyclists, and pedestrians through or around temporary traffic control zones while reasonably protecting workers and equipment". Traffic engineers expect these devices to improve safety for the motorists and reasonably protect workers when they are installed and maintained properly. However, the widespread use of concrete barrier, much of it for channelization and not positive protection, has been because the emphasis on safety has been on positive protection for workers, while 85% of fatalities are drivers and their passengers. These motorists and their passengers can be subject to average forces of 9.55 g's and as high as 23.5 g's (See table 1)[7] when impacting at 25 degree angles when traveling in standard size pickups.

The same vehicle when impacting water-filled longitudinal channelizing devices at 25 degrees measured average ride-down accelerations of 5.05 g's with the highest measurement at 7.4 g's, (See table 2)[8]. Keep in mind these angles are low and motorists can expect much higher forces when striking barriers that have been located perpendicular to traffic flow to close lanes. It is clear, when the crash test data is reviewed, that plastic water-filled longitudinal channelizing devices create more positive outcomes in the event of an accident than the use of traditional concrete barrier due to the high G's that motorists are subjected to when impacting concrete barrier.

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[3] **FHWA-HRT-09-011,** http://www.tfhrc.gov/focus/mar09/03.htm

[4] http://www.dot.il.gov/travelstats/2008cfweb.pdf

[5] http://virginiadot.org/programs/WorkZoneSafetynewsroom.asp

[6] Work Zone Positive Protection Tool Box, ATSSA, p.5.

[7] Results of NCHRP-350 Test 3-11 from FHWA

[8] Ibid

The Roadside Design Guide urges temporary **concrete barrier be placed only parallel to traffic**.[9] **Most catastrophic accidents involving vehicles moving through the work zone and temporary concrete barrier occur when the barrier is struck at a high angle. Deploying temporary concrete barrier in work zones to close roads or to act as channelizing/delineating devices exposes vehicles and occupants to the possibility of engaging a massive object that can cause substantial injury and death. In this case, Longitudinal Channelizing Devices, which are designed to channel traffic without the risk associated with impacting a temporary concrete barrier, should be used.**

Table 1 [4] summarizes most of the full-scale NCHRP-350 crash tests carried out on concrete barriers.

TABLE 1

Acceptance Code	Test Level	Material	Deflection (meters)	Deflection (feet)	Acceleration (g's)
B-149	3	concrete	1.90	6.23	8.60
B-134A	3	steel	0.70	2.30	23.50
B-134	3	steel	2.10	6.89	5.30
B-131	4	steel	1.50	4.92	13.30
B-122	3	concrete	0.29	0.94	10.98
B-117		steel	0.31	1.03	12.36
B-102	3	concrete	2.29	7.50	10.10
B-98	3	concrete	1.54	5.05	7.70
B-94	3	concrete	1.27	4.17	8.90
B-93	3	concrete	1.67	5.48	7.20
B-90	3	concrete	0.75	2.46	12.20
B-86	3	concrete	0.76	2.50	18.20
B-86	3	concrete	0.81	2.67	
B-84	3	concrete	1.60	5.25	10.40
B-79	3	concrete	2.56	8.38	9.50
B-70	3	concrete	1.10	3.61	11.70
B-69B (concrete)	3	concrete	0.61	2.00	12.30
B-67	3	concrete	1.93	6.33	
B-63	3	concrete	1.35	4.42	5.40
B-62	3	concrete	0.42	1.38	4.50
B-61	3	concrete	0.26	0.85	17.62
B-54	3	concrete	1.83	6.00	12.40
B-52A	3	concrete	1.30	4.27	
B-52	3	concrete	1.30	4.27	5.70
B-42		concrete	0.20	0.66	10.06
B-41	3	concrete	1.14	3.74	10.50
		Avg. Deflecti	**1.21**	**Average G's**	**9.55**

TABLE 2

[9] Ibid, p.9-10.

Acceptance Code	Test Level	Material	Acceleration (g's)
WZ-214	3	Plastic	3.00
WZ-255	3	Plastic	5.60
WZ-191	2	Plastic	7.40
WZ-279	2	Plastic	4.19
			5.05

If 85% of work zone accidents fatalities are drivers and their passengers, and water-filled longitudinal channelizing devices provide a higher degree of safety for the motorists passing through work zones, it would seem logical that water filled devices would be the traffic control device of choice. But these devices are rarely if ever used. In road construction work zones, resistance to change to use of water-filled longitudinal channelizing devices (as with many devices new to the transportation infrastructure environment) slows industry-wide adoption of water ballast devices. There is an enduring familiarity with concrete and a tendency to rely on concrete barrier for every use, even when it is not the safest or most appropriate device for the job. Because there is no requirement or incentive for change, engineers simply continue to specify temporary concrete barrier for all traffic control jobs, in spite of the innovation of safer and more effective mechanisms. Findings show that deployment of new devices face roadblocks because (*a*) transportation projects are complex, multifaceted, and interjurisdictional with many players having different interests; (*b*) multiple layers of decision making sometimes lack logic; (*c*) public-sector procurement is driven by competitive, multiple low-bid processes that often infringe on intellectual property rights; (*d*) public agencies resist change; and (*e*) risk-averse executives hesitate to implement new innovations.[10] This research underlines the need for improved communication among researchers, developers, operators, and decision makers.

In addition to the institutional factors contributing to the lack of innovation listed above, there is no funding for innovative practices. If better safety costs more money, it must be funded. FHWA's rule on Temporary Traffic Control (a.k.a. Subpart K) states:

> "Payment for work zone traffic control features and operations shall not be incidental to the contract, or included in payment for other items of work not related to traffic control and safety; as a minimum, separate pay items shall be provided for major categories of traffic control devices, safety features, and work zone safety activities, including but not limited to positive protection devices, and uniformed law enforcement activities when funded through the project."

To comply with this rule states create itemized lists of work zone devices. Unfortunately, innovative devices are rarely if ever listed. For example, the Longitudinal Channelizing Device, a traffic control device listed in the MUTCD for several years, is not listed in any of the itemized lists published by any State DOT's. As it is, the state views a **lower cost job** as the bid winner. The contractor wants to increase his profit on the job, the state wants a lower cost job (especially now). It is no wonder that many work zones have little or no traffic control.

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[10] Overcoming Roadblocks to Innovation: Three Case Studies at the California Department of Transportation
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Imagine if the government made it "profitable" for the contractor to try innovative traffic control techniques by offsetting any additional costs. At this point the contractor is a willing participant.

It is important to recognize that utilizing the full array of work zone traffic control devices available, and deploying suitable traffic control devices for each specific job, can prevent many accidental injuries and deaths in work zones. The continued reliance on temporary concrete barrier for every work zone application is extremely hazardous to the motoring public.

Although no consensus on specific warrants exist, barriers are usually justified for bridge widening, shielding of roadside structures, roadway widening with edge drop off, and to separate two-lane, two-way traffic on one roadway of a normally divided roadway.[11] Temporary concrete barriers are appropriate in work zones when needed for positive protection, **but can create hazards in themselves if used simply for channelization.** The Roadside Design Guide calls for concrete barriers to be used:

1) To protect traffic from entering work areas such as excavations or material storage sites
2) To provide positive protection for workers
3) To separate two-way traffic
4) To protect construction such as falsework for bridges and other exposed objects
5) To separate pedestrians and vehicular traffic

In addition, temporary concrete barriers also cause unnecessary work zone congestion while they are unloaded and set into position by cranes requiring the closure of a traffic lane for the installation. Manually unloading lightweight plastic LCD's, positioning them by hand, and adding a very small volume of ballast is much more affordable and does not require an additional lane for a flat bed and crane.

For applications outside these specific operational requirements, temporary concrete barrier should not be used, and alternative traffic control devices that do not pose a hazard to the motoring public should be evaluated for best practice. Where guidance emphasis will suffice, a Longitudinal Channelizing Device is ideal. Longitudinal Channelizing Devices are lightweight, plastic, water-fill able devices that form bright, visually-compelling, continuous walls in the manner of concrete but without the lethal potential to impacting vehicles. The Federal Highway Administration recognizes the need for Longitudinal Channelizing Devices and the Manual on Uniform Traffic Control Devices (MUTCD) has been updated to reflect the useful and effective deployment of Longitudinal Channelizing Devices as an alternative traffic control device. See Section 6F.66 MUTCD.

Insubstantial traffic control devices such as folding Type I or Type II barricades, delineator posts, reflective panels and cones can be used in these applications as well, but are regularly ignored by aggressive drivers as the size of these devices is not formidable and the spacing between devices permits intrusion by vehicles. If drivers do not respect traffic devices, they may accidentally or even intentionally enter a work zone, causing injury to their passengers and/or workers. Longitudinal Channelizing Devices create a large and commanding traffic

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[11] Roadside Design Guide, AASHTO, 1996, p. 9-1.

control device, compelling drivers to exercise more care in avoiding impact. Without this boundary, drivers may not realize until too late that insubstantial delineator posts were actually marking the edge of a very hazardous drop-off. The posts can also be confusing to drivers who often have difficulty determining their intended travel path through the widely spaced array of markers. This risk is increased when visibility is inhibited by weather conditions of heavy rain, fog, or other precipitation. Lastly, delineator posts, panels and other lightweight safety devices are often knocked over by passing vehicles, weather and the air backwash of heavy vehicles. An unbroken, interconnected array of Longitudinal Channelizing Devices provides a clear, unambiguous travel path, particularly where there may be directional path changes within a work-zone. In addition, LCDs connected together can also reduce the potential for missing devices as ballasted LCDs are more resistant to becoming misaligned by passing vehicles and weather.

For decades, road transportation departments, consulting engineers, and others who specify safety equipment in roadway construction projects have had few choices in traffic control devices. Historically, engineers have specified temporary concrete barriers as a "one solution fits all" solution, and a culture has developed leaving temporary concrete barrier as the default option for channelizing delineation. In order to reduce the number of work zone fatalities, these transportation professionals are urged to examine and consider new products offering vehicle occupants a safer environment. Preventing accidents and protecting workers, pedestrians, and motorists is a national concern. The way to ensure elimination of these tragedies is to encourage and require the use of the safest product for each specific job instead of relying on the most familiar traffic control devices or those devices already on hand for the project.

Only when road transportation departments and practitioners begin to look beyond the familiar traffic control products will work zone safety be improved. The individuals most often overlooked when making traffic control decisions are the occupants of vehicles traveling through work zones. They are frequently exposed to the dangerous practice of utilizing temporary concrete barrier as a delineator or to close a road, elevating exposure to high angle impacts or required to drive through a confusing array of delineators, risking head-on collision. Those vehicle drivers and occupants could be your family or mine, so we must ask ourselves if we are really considering all of the available traffic control devices and how the proper deployment of these devices can create safe work zones, preventing injuries and perhaps saving lives. Surely, it is worth consideration.

For more information on non-traditional traffic control devices, visit the water barrier manufacturers association at www.waterbarriers.org or contact us at 423 South 600 West, Salt Lake City, UT 84101
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