Highway Attachment 7 – Severe Duty Crash Cushions Web Conference

HWY18FH011

(44 pages)

U.S.Department of Transportation
Federal Highway Administration

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TIG
AASHTO TECHNOLOGY IMPLEMENTATION GROUP

Severe Duty Crash Cushions
Experiences of California, Kansas & Nevada

NHI Innovations Web Conference
January 17, 2013

Moderated by Mr. Joe Horton, Office Chief, Caltrans Office of Safety Innovation and Cooperative Research

Technology Implementation Group (TIG) Program

- Identifies and champions nationwide use of new, high-payoff, ready-to-use technologies

- Severe-Duty Crash Cushions
  - TIG wants to showcase the relatively new but growing suite of available severe duty crash cushions.
  - Severe duty crash cushions are shown to be particularly useful for high-incident locations, by offering either superior cost effectiveness, improved safety for the traveling public and repair workers, or both.

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Driving Innovation for Transportation
TIG
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Disclaimer

FHWA, AASHTO, Caltrans, Nevada DOT, and Kansas DOT do not endorse any particular products or companies that may be portrayed. Product names appear in this report only because they are considered essential to the objective of the webinar and serve a safety enhancement awareness purpose only.

California Department of Transportation (Caltrans)

Use and Implementation of Severe Duty Crash Cushion Systems

Tony Tavares – Chief, Caltrans Division of Maintenance

- Technological & Implementation Champion for Caltrans

- Asset manager of:
  - 6,000 employees
  - $1.45 Billion Annual Budget
  - 12,899 Bridges
  - 50,460 Lane Miles

“Need” for Severe Duty Crash Cushions

Tony Tavares, Chief, Caltrans Division of Maintenance

- Reduce worker exposure.
- Protection for the traveling public.
- Reduces traffic delays
- Caltrans, targeting high hit locations.
  - Approximately 190 locations will be upgraded to Severe Duty Crash Cushions by Fall of 2013
  - After Fall 2013, these cushions will total 35% of our total Crash Cushion inventory of 2,215 cushions Statewide.
- Determine life cycle costs for budget & replacement guidance

Caltrans

Caltrans Speakers

Rick Aaron

- Caltrans Superintendent ,HQ Coordinator for Traffic Guidance and Safety Devices.
  - 32+ years Caltrans Maintenance experience

Troy Bucko

- Transportation Engineer, Division of Traffic Operations – District 11– San Diego.
  - Route Manager / Traffic Safety Investigator
  - Statewide Traffic Safety Systems Instructor
  - 17 years with Caltrans

Caltrans Criteria for Crash Cushion Maintainability

- Caltrans currently has no classification criteria for Crash Cushions.

- Consideration for approval for use in California currently requires an Acceptance Letter from FHWA or been evaluated by FHWA and meeting Report 350 or the AASHTO Manual for Assessing Safety Hardware (MASH) requirements, and approval from the Department's Highway Safety Features New Products Committee.

- Caltrans currently has four devices approved that could be quantified as Severe Duty Crash Cushions. These are the REACT 350; Compressor; SMART SCI100; and the Quad Guard Elite and LMC systems.

Caltrans Criteria for Crash Cushion Maintainability

- Caltrans has approved over 30 Crash Cushions for use on our Highway System.

- Caltrans is studying the feasibility and need to further quantify these devices into classifications: sacrificial, re-usable and Low Maintenance and/or Self-Restoring Crash Cushions.

- Caltrans Maintenance would prefer that all Attenuators used on our highways be the ***Low Maintenance and/or Self-Restoring Crash Cushions.***

Caltrans Suggested Criteria for Low Maintenance and/or Self-Restoring

- History or expectation of multiple impacts per year.
- Systems that recover or can be easily pulled/reset to their original shape, position, and capabilities after being impacted with minimal need for additional parts.
- Sites that require short repair time limitations or are difficult to access.
- Repair cost parameters and thresholds for repair time may be considered.

Caltrans Suggested Crash Cushion Maintainability Criteria

- Criteria may be based on frontal and side impacts approximating the severity of crash test impacts.
- Reporting of repair cost and repair time results from installed systems.
- Use of Crash Cushion types in current use that have proven to provide either quick reset times or low repair costs.
- Consideration of new systems as they become available that may fall within the severe duty category.

REACT 350

- Caltrans average repair time 15 min*. for simple reset up to 60 min. if minor system repairs are needed.
- Typically requires a lane closure(s) to reset or repair.
- Average cost for parts < $700 per impact.
- Ideal for locations that cannot be attended to shortly after impact by maintenance.
- Frequent device side impacts may require more in depth field maintenance.
- Some potential for rebound effect after impact, so special consideration should be given when placing near mainline traffic.
- Caltrans has approximately 390 units installed statewide.
- * Not including traffic control setup/takedown.

Caltrans

REACT 350 PHOTOS

Managed Lanes
Separation Barrier Protection

Offset Barrier Protection

Caltrans

SMART SCI100GM

- Test Level 3 – 24" wide by 21.5’ long.
- Caltrans repair time experience is 15-30 minutes*. Some resets have been conducted with a traffic break from CHP.
- Caltrans has 232+ units installed statewide
- Average repair cost for parts per impact is less than $50.
- Average repair cost per impact for high impact locations is less than $100.
- Has preformed well in areas that will have multiple side impacts within a one year period.
- Length of system advantageous in short gore areas.

* Not including traffic control setup/takedown.

SMART CUSHION PHOTOS

Post Head-On Impact

Barrier Protection
Freeway Off-Ramp

Caltrans

QUADGUARD FAMILY

- Currently used in high impact areas (Elite) moderate impact areas for LMC
- Average reset time 30-60 minutes, from1-2 hours if minor system repairs needed*
- Average part costs per incident $900
- Cylinders have proven reusable after most impacts
- Approximately 190 Quad Guard Family crash cushions statewide.

* not including traffic control

Caltrans

QUADGUARD ELITE / LMC PHOTO

COMPRESSOR

- Fairly new system for Caltrans.
- Repair time per impact 15-30 minutes.* Some resets have been done in 5-10 minutes with a traffic break.
- Average parts cost per incident $700
- Shorter system length good for short gore areas.
- Repeated impacts with minimal or no repairs.
- Redirects side impacts with minimal system damage.
- Caltrans has 39 units installed statewide.

* not including traffic control

COMPRESSOR PHOTOS

Caltrans Severe Duty Lifecycle Cost Estimate

Please Enter Data in the Green Boxes	*SMART SCI100*	*REACT 350*	*COMPRESSOR*	*GuadGuard LMC*
Installation				
Initial Cost of System (Material Only)	$ 34,336	$ 45,550	$ 50,507	$ 46,323
Freight	$ 1,000	$ 1,000	$ 1,000	$ 1,000
Landed Initial Cost of System (excludes tax)	$ 35,336	$ 46,550	$ 51,507	$ 47,323
Installation Material & Equipment Cost	$ 1,000	$ 1,000	$ 1,000	$ 1,000
Traffic Control Cost/Installation	$ 1,000	$ 1,000	$ 1,000	$ 1,000
Required Installation Time (Man Hours)	3.00	3.00	3.00	3.00
Labor Cost (Per Man Hour)	$ 60	$ 60	$ 60	$ 60
Total Installation Cost:	$ 2,180	$ 2,180	$ 2,180	$ 2,180
Total Installed Cost:	**$ 37,516**	**$ 48,730**	**$ 53,687**	**$ 49,503**
Repair				
Required Repair Time (Man Hours)	0.50	1.00	1.00	1.00
Recommended man hours for a 3 man crew:				
Disposable (Redirective) 6 hours				
Partially Reusable 4.5 hours				
Reusable 3 hours				
Traffic Control Cost per Repair	$ 560	$ 560	$ 560	$ 560
Anticipated # of Impacts Requiring Repair/Year	3.00	3.00	3.00	3.00
Reusability Percentage of System	99%	98%	98%	95%
Recommended:				
Disposable 5%				
Partially Reusable 65%				
Totally Reusable 90%				
Labor Cost/Repair	$ 90	$ 180	$ 180	$ 180
Material Cost/Repair	$ 40	$ 677	$ 695	$ 911
Total Cost/Repair	*$ 690*	*$ 1,416*	*$ 1,435*	*$ 1,651*
	SMART SCI100	**REACT 350**	**COMPRESSOR**	**GuadGuard LMC**
Total Cost				
5 years	*$ 47,864*	*$ 69,976*	*$ 75,212*	*$ 74,268*
10 years	*$ 58,213*	*$ 91,221*	*$ 96,737*	*$ 99,033*
15 years	*$ 106,077*	*$ 161,197*	*$ 171,949*	*$ 173,301*

***REUSABLE SYSTEMS WILL MOST LIKELY NEED TO BE REPLACED AFTER TEN YEARS**

Caltrans

Kansas Department of Transportation

The KANSAS DOT Perspective On Severe Duty Crash Cushions

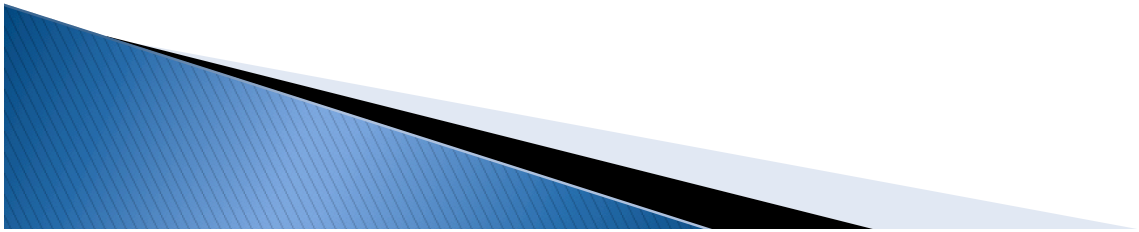
By Rod Lacy, PE

Rod Lacy, P.E.

- Engineering Manager for State Road Office
  20 Years experience with KDOT
  - Road Designer, Project Manager, and currently Engineering Manager for all State Highway Projects
  - Construction and Maintenance experience as the Topeka Metro Engineer
  - Serve on the AASHTO Technical Committee for Roadside Safety
    - Produce the AAHSTO Roadside Design Guide
  - Panel member on several NCHRP Roadside Safety Research Projects
  - Member of AASHTO Subcommittee on Design

Crash Cushions in KS

- History with numerous devices over the last several decades
  - HexFoam
  - Great
  - Trend
  - Sand Barrels
  - Quadguard Family
  - TRACC
  - SCI
  - REACT in several test locations



Development of Severe Duty Crash Cushion Criteria

- KDOT recognized a need for systems to provide improved performance in Severe Duty Locations
  - Robust design – Avoid complicated systems with parts that break easily
  - System survivability
  - Reliable confidence in repair parts and efforts to make repair
  - Reduce need to stock numerous parts
  - Acceptable In-Service Performance
  - Avoid systems with excessive rebound

Public Interest Finding Analysis Conducted

- Analyzed repair costs on different crash cushions in KC Metro
- Evaluated Crash test results
- Reviewed FHWA Acceptance Letters
- Conducted Cost Effective Analysis
  - AADT
  - 10 Year Life Cycle Cost

Severe Duty Criteria for KDOT

- Crash prone locations such as gore areas
- Locations where historical crash rate exceeds one hit every ten years
- High speed, high volume roadways with directional traffic more than 6,000 vehicles per day per lane

Crash Cushion Selection

Temporary	Permanent		
	TL-2	TL-3	Severe Duty
Absorb 350			
ACZ-350			
QuadGuard	QuadGuard	QuadGuard	
QuadGuard II	QuadGuard II	QuadGuard II	
SCI	SCI	SCI	SCI
Tau-II	Tau-II	Tau-II	

SCI Crash Cushions

SB US-69 at the I-435 Split

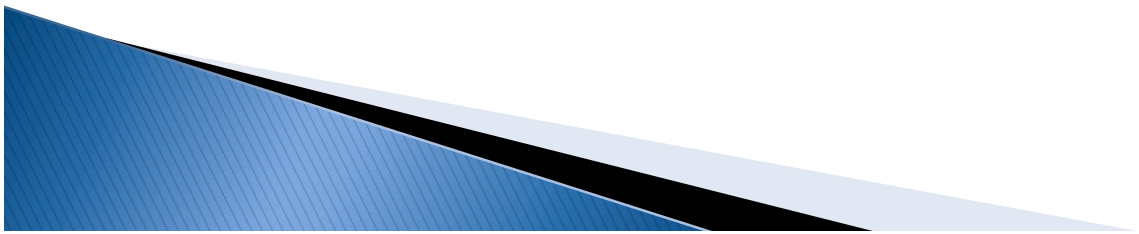
On Ramp to NB US-69

Future Severe Duty Devices in KS

- Devices that exhibit acceptable crash performance
- Devices that have reliable/consistent repair characteristics
- Devices that provide acceptable life cycle cost
- Devices that are uncomplicated to repair and provide safe operation after repair

Lessons Learned

- Avoid wide transition units
- Select units that expedite maintenance and reduce exposure to motorists
- Select units that are uncomplicated to inspect and make repairs
  - All steel products such as SCI are easy to inspect in the field. Determination of re-use or acceptable service life of composite components is more difficult.
- Develop maintenance guidelines for existing systems.
- Understand amount of damage to device during crash testing and subsequent in-service performance

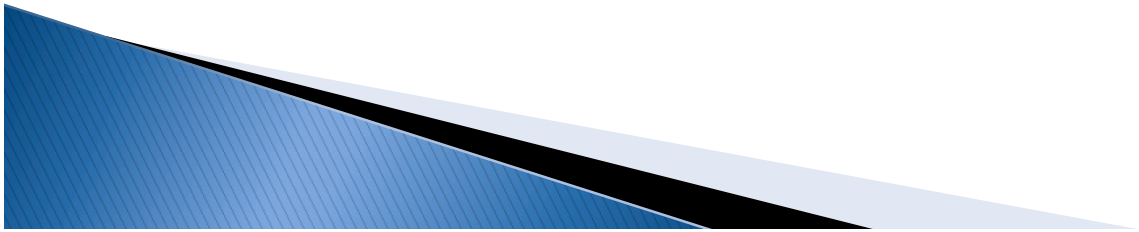


The Use and Implementation of Severe Duty Crash Cushion Systems

By Kevin Killian
Highway Maintenance Supervisor II, Las Vegas

Kevin Killian

- Highway Maintenance Supervisor II, District 1 Las Vegas
- Responsible for night time Maintenance activities
- 14 years experience working with various crash cushion systems at NDOT.
- Started with NDOT as a maintainer April 1999
- Promoted through the ranks to current position as a Supervisor II about two years ago and tasked with overseeing amongst other things the repair and maintenance of several crash cushion systems in our inventory.
- Directly Responsible for 38 Highway maintenance workers working on Nevada roads at night.

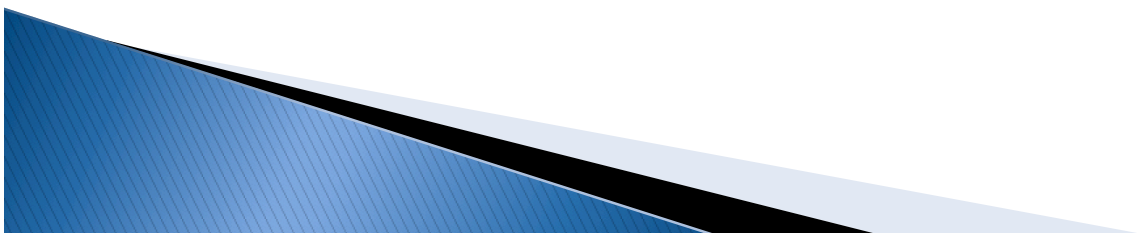


NDOT considerations

- NDOT owns and maintains several hundred crash cushions that are in use on Nevada roads.
- Survivability and Lifetime Cost are our main factors we use to determine the type of system we need to install.
- Life cycle cost is the preferred way.
- Main consideration is getting crews in and out as quickly and as safely as possible when resetting or repairing a system.

What should we think about?

- System survivability
- Ease of repair or reset
- Repair parts availability and cost
- Training of personal to accomplish the inspection and repair.
- Life cycle cost
- Impact on the driver that use the system
- Time exposed to traffic during repairs



NDOT crash cushion inventory

Standard duty crash cushions

- Quad guard
- GREAT
- Tau II
- ADIEM
- React

Severe duty crash cushions

- Smart TL-3

So what does NDOT use in Las Vegas?

- Currently only Smart Cushion Innovations (SCI) is installed in the Las Vegas area.
- Since no other severe duty systems are currently installed in Las Vegas, data on repair and performance is not available.
- NDOT continues to evaluate new systems as they are introduced to the market and consider them for placement on our qualified products list and possible inclusion in the severe duty classification.

NDOT guidelines we currently use for severe duty locations

- Locations on high speed, high volume roadways where the posted speed limit (or 85th percentile speed) is greater than or equal to 55 mph per hour and directional traffic volume meets 25,000 AADT in District 1 and District 2 and 12,500 AADT in District 3;

  and

- History or expectation of multiple impacts each year; sites with repair time limitations, locations with 10' (or less) of the traveled way, sites requiring night repairs, and gore locations;

  or

- New construction or alterations where there is no crash history to base a decision on, analyze a site with similar geometry or conditions as locations meeting the above criteria.

Why is SCI the predominant crash cushion in Las Vegas?

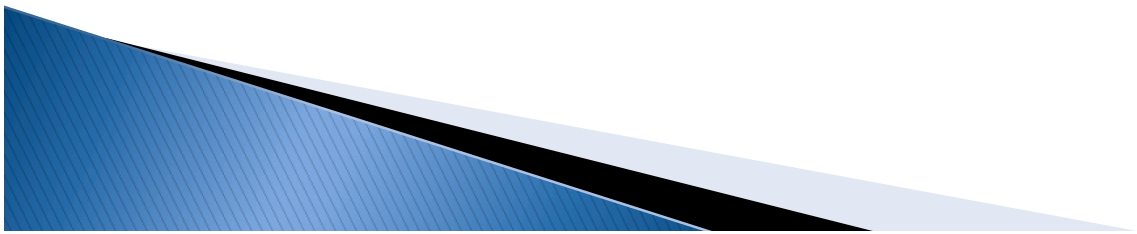
- We need a system made from components that can survive the harsh environmental conditions in Las Vegas.
- One system reduces the confusion.
- Simplified training
- Ease of repair
- Tool kit in supervisors trucks
- Ability to repair or reset during the initial accident call.
- Reduced system down time
- Minimal out of service time to the traveling public equals safer highway system.
- 15-30 minute repair or reset time reduces the exposure of the people working on the system to hazardous high speed traffic.
- Lifetime cost especially in locations that see high hit counts.

Our experience

- The SCI system has proven to provide an extremely safe easy to work on and relativity inexpensive system to reset.
- Our goal is to reset damaged SCI systems prior to the accident being cleaned up. This is accomplished 90% of the time if crews are on duty and we are notified.
- If there is a trained Supervisor on duty during our after hours calls it is often quicker to repair the system than it is to barricade or place a crash truck at the location.

Cost of System

- $18,500 initial cost of system
- System can be reset numerous times with proper inspections and maintenance.
- We have had SCI systems that have been reset 20 times without any major repairs before they show signs of needing to be replaced.
- Maintenance forces have installed about 80 TL-3 systems in the last 5 years mostly to replace older systems that have been removed from our Qualified products list.
- Contractors have installed and additional 50 or so in the Las Vegas valley on various projects over the same amount of time.
- We average at least three resets or repairs a week in Las Vegas.
- Over the last 4 years we have had to replace 7 units because they were damaged beyond repair.

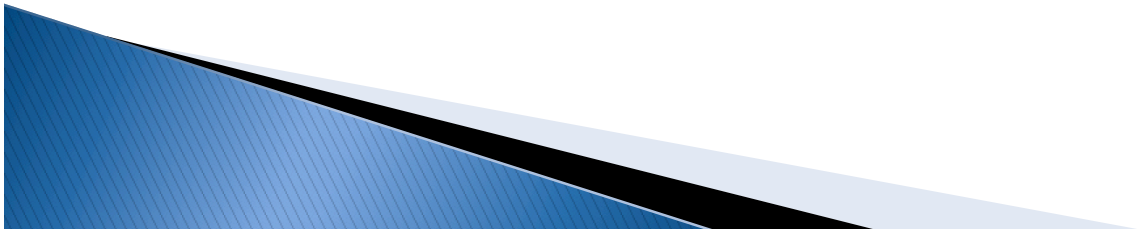


Cost of Repair

- We have found it to be less expensive to reset the system in most cases than it is to drive to a maintenance yard to retrieve barricades and return to the accident seen, when trained employees are available to effect the reset.
  - Typical repair time is 20 minutes for two workers.
  - The repair parts most commonly needed are sheer bolts which cost $3
  - Approximately 50% of the time we would need to replace a nose plate which cost $100.
  - Major repairs about 10% of the time:
    - Fender Panel – Approx 30 to date
    - Cable Replacement – 8 in 5 years
    - Hydraulic Cylinder Replacement – No failures to date

Cost of Repair (Continued)

- A 10 impact cost history of one location shows the total cost to the tax payer of $28,705 for the life of the system.
- The average repair cost was $1,070 this includes parts equipment labor w/ benefits traffic control, time to and from the shop.
- The average parts cost was $123 we had a couple of side panels that needed to be replaced.
- This location received 10 hits in 4 months if we used any other system the parts cost alone would have been over $60,000 not including labor.
- This system is still in place and working as designed.



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Question and Answer Session

Moderated by Joe Horton