



Notes from a Demonstration of the Balsi Beam and ArmorGuard Positive Protection Systems

The demonstration described here occurred on Tuesday, December 11, 2007, on Interstate 80 at post mile 33, in Colfax, California, about 50 miles east of downtown Sacramento.

Source — These are primarily notes taken at the morning demonstration by Mary Ortolano Arico and Robert Bosler of AHMCT. Additional notes were taken at an afternoon session by Duane Bennet and George Burkett of AHMCT. They are not meant to be a definitive record of the event. These notes reflect what the contributors saw and heard at the event, not opinions or research performed by the contributors. These notes are not intended to critique present practices or define best practices.

Morning Session: 8:00 am to 1:00 pm

Attendees for Morning Session Demonstrations (9:30 - 1:00)

California Department of Finance

Jim Parks, responsible for Capital Outlay / Department of Transportation and for California Transportation Commission, <Jim.Parks@dof.ca.gov>
Mark Tollefson, responsible for Department of Transportation <Mark.Tollefson@dof.ca.gov>

Caltrans Finance and Budgets

Cindy Mckim, Chief Financial Officer and Deputy Director Finance, <Cindy.Mckim@dot.ca.gov>
Norma Ortega, Chief, Division of Budgets, <Norma.Ortega@dot.ca.gov>
Jared Ingram, Budget Policy and Development Office, <Jared.Ingram@dot.ca.gov>

Caltrans District 3

Wayne Brazelton, Superintendent
Bridge Maintenance
Dan Delle, Supervisor
Crew: Rob Rexun, Curtis Scribner, Dave Manley, Mike Stamdefer, Dean Patton, Hank Wisner, Mark Lawson
Auburn Maintenance
Shelley Pangan, Supervisor
Crew: John Salazar, Wendy Davis, Cathy Bohannon, Mike Alexander

Caltrans Video and Photography

Jeff Shumaker, Ed Andersen, Larry Moore, Dave Bengal

Caltrans Research and Innovation

Kamal Sah

North Texas Tollway Authority

Eric Hemphill, Infrastructure Engineer, <EHemphill@NTTA.org>
William Little, Senior Project Manager for Jacobs Civil Inc (Florida), a contractor for the North Texas Tollway Authority, <bill.little@jacobs.com>

Barrier Systems

James Keaton, Vice President, <jkeaton@barriersystemsinc.com>
Ron Keener, Sales Manager (NoCal), <Ron.Keener@barriersystemsinc.com>
Dwight Cook, Field Service Technician, <Dwight.Cook@barriersystemsinc.com>
Byron West, Regional Manager, <Byron.West@barriersystemsinc.com>
Bryan Fisk -- McPherson Crane and Rigging



Advanced Highway Maintenance and Construction Technology Research Center (AHMCT) at UC Davis

Mary Ortolano Arico, <mcortolano@ucdavis.edu>
Robert Bosler, <rhbosler@ucdavis.edu>

Description of Demonstration

Products: ArmorGuard and Balsi Beam

The Balsi Beam consists of two, rotatable, telescoping beams configured as a trailer. It can provide 30 feet of NCHRP Test Level 2, positive barrier protection for work zones.

The ArmorGuard System consists of lengths of 28 foot steel beams that can be folded for transport and unloaded from a trailer with a crane. After unloading, the lengths or "sticks" are rolled and linked in place by two to three workers. The ArmorGuard System can provide either NCHRP Test Level 2 or Level 3 positive barrier protection for work zones, depending on the number of links used.

Task: Median Wall Repair

Balsi Beam — Task: setup a work zone and then protect workers as they performed a median wall repair. Vehicle: Tractor and Balsi Beam trailer.

ArmorGuard — Task: setup a work zone. Vehicles: One-ton truck for crash cushions and a Tractor truck and trailer with barrier bundles on trailer and crane on tractor.

Per standard Caltrans procedures, an Attenuator vehicle protected each work zone. To perform the repair in the Balsi Beam work zone, a Tender truck for tools was also used.

Notes on the Situation and Systems

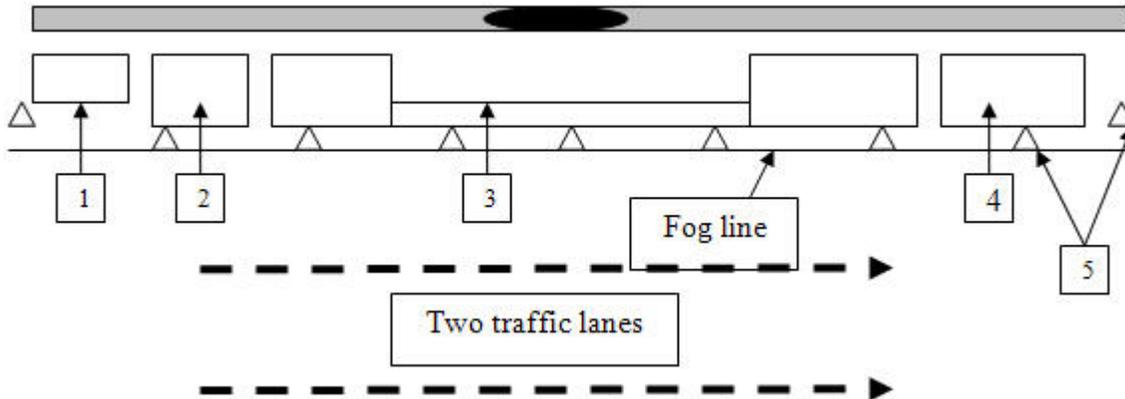
Based upon what we were told in our briefings and interviews and based upon what we saw, here's a quick overview of the general situation and of the two systems.

Weather	Weather was clear and cold with no wind. The pavement was dry.
Traffic	Traffic was light in terms of count, but dangerous in terms of heavily loaded tractor-trailers traveling at high speed through the work zones. There was a constant, heavy, acrid smell of truck brakes.
Work zone	The Balsi Beam was set on west-bound 80 (the down-hill side). The ArmorGuard system was set on east-bound 80.
Setup crews	Signage and traffic cones for both zones were set by a Caltrans Auburn maintenance crew. The Balsi Beam was set by a Caltrans bridge maintenance crew. The ArmorGuard was set by a Barrier Systems crew.
Work and observation areas	Caltrans work rules forbid work on both sides of a roadway (such as both a shoulder and a median.) The rules do permit work on both sides of a median. This meant that the observation area had to be well off the roadway. However, the observation area was located immediately opposite the median repair site and allowed clear, unobstructed views of both demonstrations.
Lane closure requirements	The ArmorGuard system required a shoulder plus a full lane closure because of the space requirements of the setup crane and the need to provide room for support vehicles. The Balsi Beam did not require a lane closure.

Purpose of the systems	<p>The ArmorGuard system is meant for closures lasting more than 72 hours and for work areas longer than 140 feet.</p> <p>The Balsi Beam system is meant for closures lasting 6 hours or less and for work areas of 30 feet.</p> <p>Note: at present, Caltrans uses no barriers for work lasting less than 45 minutes.</p>
Transport requirements	<p>The ArmorGuard system requires two separate transport vehicles for a crane, barrier sections and crash cushions. The Balsi Beam system requires no separate transport vehicles: the barrier is its own transport vehicle and crash cushion.</p>
Worker exposure during setup	<p>During the deployment, the ArmorGuard system required setup personnel to graze or enter live traffic lanes. The Balsi Beam system is deployed without workers leaving a vehicle.</p>
Actual protection was not within the scope of this demonstration	<p>The most important factor in comparing the two systems is whether they actually provide positive protection in the event of an actual impact by an errant vehicle.</p> <p>Since this factor is so important, we make the following notes based upon observer comments, although we understand that this event was intended only to demonstrate setup procedures and to show resulting work areas.</p> <p>As background, it was stated that Caltrans recommends that workers be kept 6 feet from moving traffic. But, it was clear from crew comments that this is sometimes neither realistic or meaningful for many maintenance tasks (particularly bridge maintenance tasks.)</p> <p>For example, if cones are used to define a work zone, workers can be kept 6 feet back for at least some portions of some tasks, but since there is no positive separation the distance makes no meaningful difference to either a worker or to an errant vehicle.</p> <p>The key factors that determine actual positive separation are barrier distortion (how much it bends upon impact) and barrier displacement (how much it slides towards the workers upon impact).</p> <p>Some crew members felt that since the ArmorGuard consists of simple steel barriers placed directly on the ground, it distorts and displaces more than the Balsi Beam, which consists of square beams anchored by 12 tires that provide a high coefficient of friction. However, although observers and crew raised this issue, they did not resolve it or present any hard data related to this issue.</p>

Work Zone Sketches

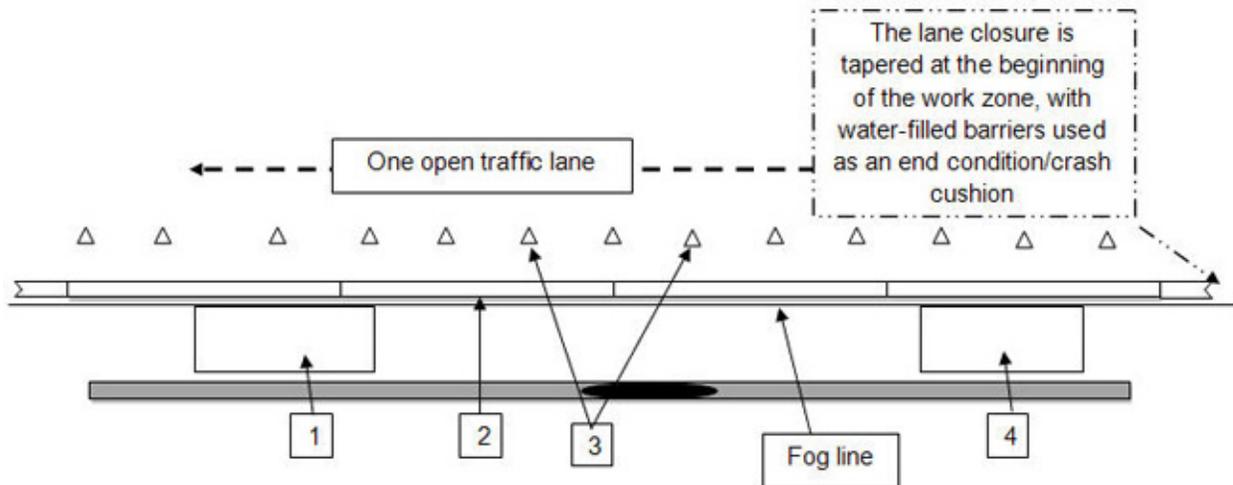
Sketch of Balsi Beam (east bound) Work Zone (*not to scale*)



KEY:

1. Cone Truck
2. Truck with arrow board and TMA
3. Balsi Beam
4. Tender truck
5. Cones used for shoulder closure

Sketch of ArmorGuard (west bound) Work Zone (*not to scale*)



KEY:

1. Work truck
2. ArmorGuard
3. Cones used for lane closure
4. Work truck

Setup Times

The following setup times do not include the time required to implement signage and set warning cones, activities which occurred outside the viewing area. For a full lane closure, as required by the ArmorGuard system, the District Superintendent stated that those activities would typically take 15 to 20 minutes. No estimate was available for closure preparation for the Balsi Beam zone, which was both shorter in length and which did not take a lane.

Balsi Beam Setup Times

10:07 Tender truck arrives.
10:09 Balsi Beam arrives and immediately lowers rear attenuator.
10:10 Balsi Beam tractor extends, moves back on pin.
10:11 Balsi Beam lowers legs and begins rotating its beams.
10:12 Balsi Beam repeats rotation of beams for benefit of photographers.
10:13 Balsi Beam barrier in place.
10:14 Work crew enters work area and begins work;
TOTAL ELAPSED TIME: 7 minutes.

ArmorGuard Setup Times

10:19 Tractor-trailer arrives with barriers. There are 8 bundles, each 3700 lbs.
10:21 Truck arrives with crash cushions for end protection. There are 5 water-filled cushions, each 500 lbs.
10:29 Crane ready. Crane begins lifting crash cushions into place.
10:32 Crash cushion 1 down.
10:45 Crash cushions 2-5 down.
10:50 Crane secure. Truck moves 300 feet uphill.
11:02 Crane is setup, straps are undone. Barrier Section 1 on ground.
11:08 Barrier Section 1 rolled into place.
11:20 Barrier Section 1 in place and linked to crash cushions. [There were problems lifting a 500 lb cushion in order to tuck Barrier Section 1 under it.]
11:53 Barrier Sections 2-8 moved into place and linked with one another.
11:57 Crane secure and setup done.
TOTAL ELAPSED TIME: 1 hour and 46 minutes

Balsi Beam Takedown Times (one person, one truck)

1:52 Balsi begins retraction process by swinging beam over to other side
1:53 Balsi Beam tractor moves forward to disengage "V" support.
1:55 Truck Mounted Attenuator folds-up on trailer.
1:56 Backing truck to fold telescoping beams to locked position.
1:57 Balsi Beam and tender trucks leave workzone.
TOTAL ELAPSED TIME: 6 minutes.

ArmorGuard Takedown Times (three people, two trucks)

2:19 Tractor-trailer w/crane and flatbed trucks arrive.
2:25 Water cushions are disconnected from end barrier section and barred over to center wall.
2:23 End barrier, barrier 1 rolling toward crane.
2:39 Barrier 1 lifted on truck.
2:50 Barrier 2 lifted on truck.
2:56 The truck moves 150 feet uphill and the last barrier in line, barrier eight is rolled to the crane.
2:57 Barrier 8 lifted on truck.
3:05 Barrier 7 lifted on truck.
3:10 Barrier 6 lifted on truck

3:18 Barrier 5 lifted on truck.
3:20 Barrier 4 free and rolled to truck.
3:26 With 6 barriers on truck, 3 wide and 2 high, load is strapped down.
3:40 Barrier 3 is lifted on the truck.
3:46 Barrier joint covers are collected and packed onto crane truck trailer.
4:00 With all 8 barriers on-board, 3 rows high, additional load straps are placed.
4:06 First water cushion is lifted onto flatbed truck.
4:15 All water cushions lifted onto flatbed truck.
4:17 Water cushions strapped down on flatbed truck.
4:25 Tractor-trailer w/crane and flatbed trucks leave.
TOTAL ELAPSED TIME: 2 hour and 33 minutes

Caltrans Removes Lane Closure (three people, two trucks)

4:26 Caltrans begins process of removing lane closure. (cones, signs and arrowboard trailer)
4:45 All lanes open.

Procedural Observations During Takedown

- Both setup and takedown of the ArmorGuard definitely required three people.
- During takedown of the ArmorGuard, there were many times when the crew was not positively protected while moving the barriers to the trailer; the crew entered areas without positive protection in order to strap barrier bundles to the trailer; crew members loaded the trailer while not facing traffic; and a crew member had to climb to the top of the trailer to place stack spacers.
- In brief, during the four hours and 19 minutes of ArmorGuard setup and takedown, the crew were not behind a positive barrier for approximately 1/3 of the time or about 1 1/2 hours.
- Once the ArmorGuard system was packed and stowed, a temporary full road closure was put in place to allow the transport vehicle to get on the road.

Some Quotes

Barrier Systems — Comments from Participants

- **Ron Keener** — "We are comparing apples and oranges. There are lots of products that provide positive separation, and lots of niches for these products. The Balsi Beam and ArmorGuard System are intended for different niches. The ArmorGuard niche is closures longer than 300 feet that last more than 72 hours. At any one time, NYDOT uses ArmorGuard on 50 to 100 jobs. The advantages are the ability to push a barrier into place, once it has been unloaded and linked, and the ability to create any length of closure."

"Here's some news. We have been working with MD DOT for over a year and are about to announce our PaveGuard System for rolling paving operations. The system consists of a tractor that tows 300 feet of barrier sections. The barrier sections have large rubber wheels that both provide mobility on hot, soft asphalt and feature a high coefficient of friction when the barrier is impacted from the side. The tow vehicle pulls from inside and alongside the barrier, so it is protected. Paving equipment and workers move along inside the rolling area of protection."

- **Byron West** — "This will be a fair demonstration and comparison. We are pleased with it and happy to be here."
- **Unattributed** —
"Positive protection is coming. There is legislation in the works for the requirement of positive protection."

"After it is deployed, the ArmorGuard system can be towed down the road to a new site at 2-3 mph."

Crew Comments

- **Mark Lawson, Crew Member, District 3, Bridge Maintenance** — "I love the Balsi Beam. It makes me feel a whole lot safer than just cones. Now, I'm used to having it. I get nervous without it, when I have to work next to 80 mph traffic with just cones for protection."
- **Curtis Scribner, Crew Member, District 3, Bridge Maintenance** — "More Caltrans workers are killed than law enforcement officers, but there are no laws to protect us or any meaningful safety devices."
- **Wayne Brazelton, Superintendent, District 3** — "With the Balsi Beam, I think I could repaint the diamond lanes in our District in a single night with a succession of 5 minute zones. Without it, the job takes weeks of taking lanes and setting and breaking work zones."

"One disadvantage of the ArmorGuard is that you need a whole crew to deploy it."

"We lose a lot more people than CHP, this is dangerous work out here."

"You could theoretically remove the lane closure once the ArmorGuard was fully deployed if it was only set up as a shoulder closure, but then support vehicles would not fit within the protected area."

North Texas Tollway Authority — Participant Comments

- **Eric Hemphill** — "Why don't they put a TMA (Truck Mounted Attenuator) at the end to avoid the whole crash cushion placement, that would save 30 minutes."

Unattributed Comments from Participants from the Department of Finance and from the Caltrans Finance

- "The Balsi Beam would (may) be a good option in urban areas where you can't have a lane closure. But in places like LA, you'd have to have a lane closure anyway because they have absorbed all the shoulders."
- Comment made while standing inside the BB protected area — "Actually, you feel pretty safe in here."
- "You could theoretically remove the lane closure once the ArmorGuard was fully deployed if it was only set up as a shoulder closure, but then the vehicles would not fit within the protected area."
- "In the end, it comes down to cost."
- "The crew is familiar with the Balsi Beam. They verify that there are good and bad situations for using it. The Balsi Beam doesn't afford equipment mobility."
- "A good thing about the Balsi Beam is that you can still keep both lanes open and traffic is minimally affected."
- "It certainly took less time to set up the Balsi Beam, and there was no lane closure needed. It is quite obvious that the ArmorGuard is more of a hassle to setup and take down."
- "The large crane truck would be necessary to bring in/deploy the ArmorGuard. What is the cost the truck with the crane vs. the Balsi Beam?"

General Discussion

- Many observers gasped audibly when it became clear that during deployment of the ArmorGuard system workers were entering the live traffic lane at various times, especially when linking sections, and were grazing the edge of the live lane while pushing barrier links into place.
- There was discussion about the inclusion of the cost of the crane required to deploy the ArmorGuard system. This seemed to be a cloudy subject – Was it included in the cost estimate? Should it be? Would this be up to maintenance to figure out? The DOF people were particularly surprised the costs of the tractor/crane, barrier transport trailer, and crash cushion truck were not included in the cost estimate for the ArmorGuard system (just the barriers themselves.) These are additional vehicles that Caltrans would have to deploy to the work zone.
- There was a discussion of other ways to unload the ArmorGuard rather than using the crane – there was talk of using a tilt trailer.