Montana Department of Transportation
Research Programs
December 2018

FINAL REPORT

SMART CUSHION INNOVATIONS (SCI) 100GM CRASH ATTENUATOR

Location:	Interstate 90 (C000090): Approximate reference point 6-7, Mineral County; Missoula District
Project Name:	Taft-West
Project Number:	IM-90-1(84)0
FHWA Project Number:	MT-11-04
Project Type:	Crash Attenuator
Principal Investigator:	Craig Abernathy, Experimental Project Manager (ExPM)
Date of Installation:	August 2012
Date of Inspections:	April 2013, February 2014, March 2015 & 2016, June 2017 & April 2018

Objective

Determine the effectiveness of the SCI100GM in a mainline application. The SCI100GM is a fully redirective, speed-dependent, non-gating, bi-directional crash attenuator with a reverse-tapered design to eliminate side panel stress during a collapse. In addition, it has a low angle of exit on side impacts (<1°) to keep vehicles from rebounding back into traffic.

The hydraulic porting of the attenuator is designed that the proper resistance is applied to stop the vehicle before it reaches the end of the cushion's usable length. Per the manufactures information, this device, based on a frontal impact, may be reset and back in service under an hour with minimum cost.

Goals:
-Document all processes pertaining to the installation procedures.
-Install the device at strategic locations with high impact rates in an effort to:
-Determine performance during an impact,

-Repair procedures following impacts,
-The cost of repair and time required to fully repair product,
-Maintenance feedback following the repairs,
-Any adverse effects of sanding and anti-icing agents on the cables, cylinder system, side guides, or front rollers.

Evaluation Procedures

The purpose of an experimental features report is to document the phases and events of any given project to gain the reader an understanding of the general activities required to install or incorporate the research element into an active construction or maintenance project. This report also establishes a baseline for defining performance for any given feature under actual service conditions to determine its relative merits.

Research will document the installation process and schedule site visits biannually to record the physical condition of the five (5) installed devices.

If or when the attenuators have been involved in an active traffic event (collapse by vehicle impact), Research will document the condition of the unit and all steps involved to put back in service. Cost of repair and time required will be included.

Post Documentation: Will entail annual inspections of the SCI crash attenuator units.

Construction Documentation: will include information specific to the installation procedures of the attenuator.

Initial Remarks and Issues

The contractor reported no issues with the installation of the five SCI crash cushion units which may affect operating performance.

The following images represent the activities regarding the installation of the SCI units at the I-90 project crossover and documentation of the annual site inspections.

April 2013 Site Inspection

All five SCI installations appear in good shape. No impacts to the units have occurred. Some road sanding material has accumulated in and around the SCI components. The manufacturer's representative has previously stated that this will not reduce the effectiveness of the ride down function of the SCI; however, to note that excessive material build-up around the sheave and hydraulic components may reduce the effectiveness of the unit and regular maintenance is suggested.

The April 2013 information begins on page fourteen (14).

February 2014 Site Inspection

This inspection was scheduled to document the SCI units under winter conditions. No impacts to the units have occurred. Road sanding material has accumulated in and around the SCI components as documented in the 2013 site visit. Hard-pack snow and ice has collected to a depth of 3-4" over the cylinder and cable/sheave assembly on the four SCI units located at the crossover sites. Most noticeable is the northbound SCI unit at exit 5 (Reference point 6). The accumulation of snow and ice has almost completely filled the body of the attenuator to a density that you are able to walk on top without depressing the mass.

Per the manufacturer, attenuators of the type used on this project was developed and tested under the guidelines of NCHRP 350. The condition the crash cushion is in during the timeframe of this report is not applicable to NCHRP 350 performance criteria therefore it would be difficult to ascertain if this condition will affect optimum performance to any lesser degree.

Representative images of the February 2014 site inspection begin on page eighteen (18).

March 2015 Site Inspection

No impacts to the SCI units have occurred since installation. Conditions were dry and as reported in the 2014 inspection sanding debris and particulates have coated, at various levels, the cable sheaves and hydraulic porting.

Damaged side panels were noticed on the east end crossover unit near reference point 7 located on the north side of the SCI. The side panels affected was the lower tier and involved two panels. What hit the panels or how this will affect the efficacy of the cable hydraulic porting unit is unknown.

Representative images of the March 2015 site inspection and damaged panels begins on page twenty (20).

March 2016 Site Inspection

No impacts to the SCI units have occurred since installation. Conditions were dry and as reported in the 2015 inspection sanding debris and particulates have coated, at various levels, the cable sheaves and hydraulic porting.

At this time the accumulation of material around the porting mechanism is not considered a detriment to the function of the SCI unit.

Representative images of the March 2016 site inspection begin on page Twenty-two (22).

June 2017 Site Inspection

Units are in basically same condition as noted in the 2016 inspection; with exception to one of the crossover SCI's has suffered an impact with damage to one of the side panels (for more details, see pages 23 & 25).

The SCI is located at approximate reference point 7.8 and is the west end unit. The vehicle strike came from the eastbound passing lane. It is unsure if the damaged side panel will inhibit the functional use of the attenuator.

April 2018 – Final Site Inspection

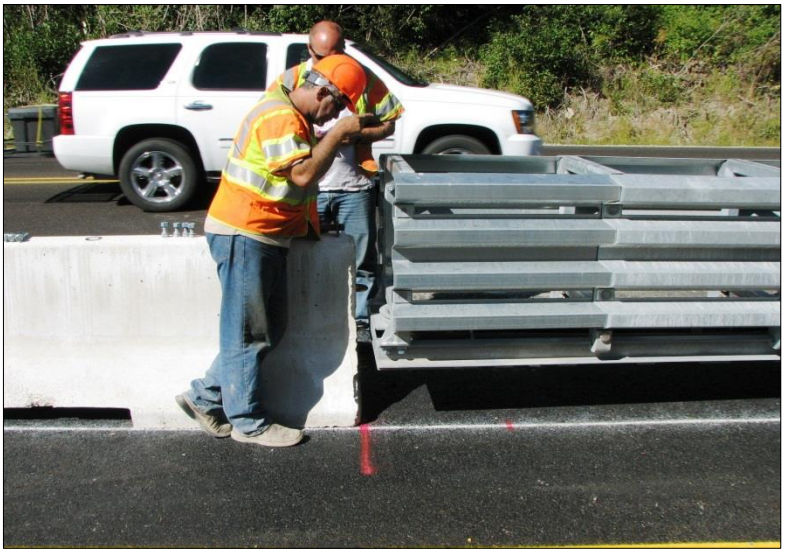
All units are in service; no additional information on performance is relevant. As stated, if any of the units are activated (actual impact and under conditions the unit will be able to be put back into service as advertised) Research will document the process at that time (page 24).

August 2012: SCI Crash Attenuator Installation

🡐 The SCI crash attenuator arrives on site fully assembled and ready for installation.

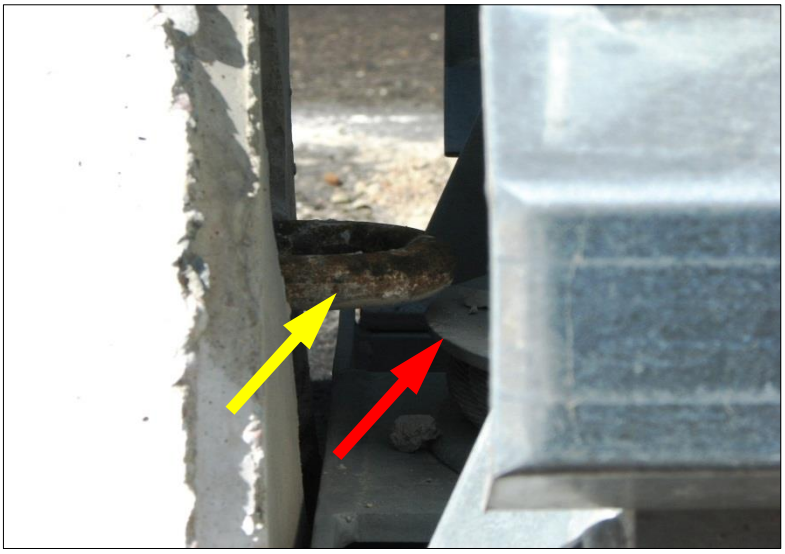
🡐 The attenuator is unloaded using a fork lift.

🡐 The fork lift places the unit at the end of the barrier; paint has been sprayed on the pavement to delineate proper alignment to the concrete barrier and pavement.

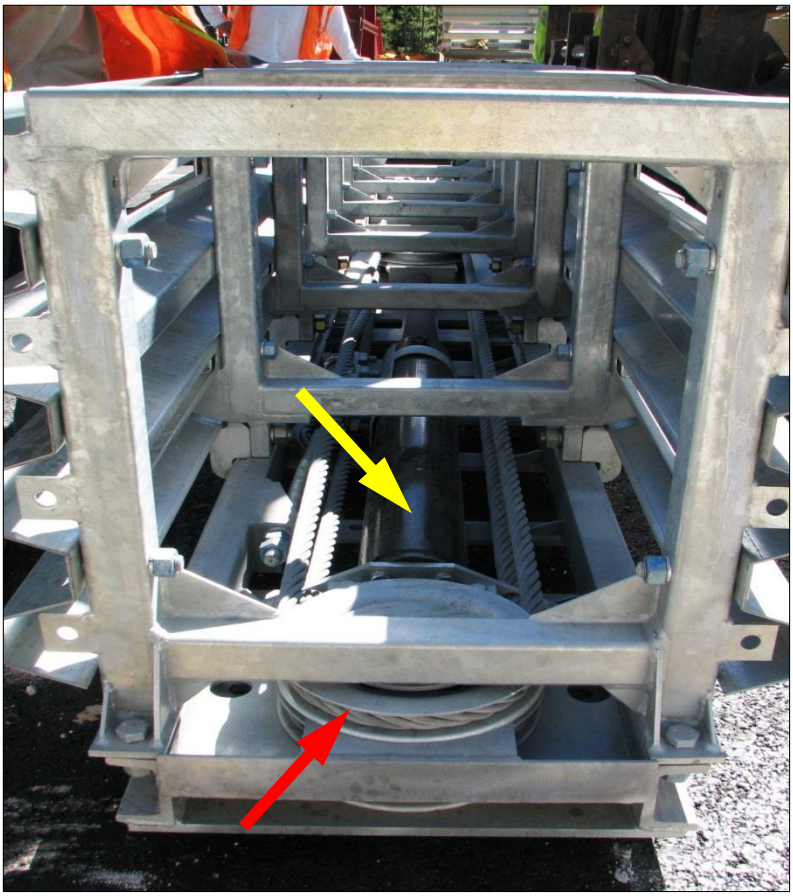


🡐 A workman guides the fork lift operator to correct placement of the crash barrier.

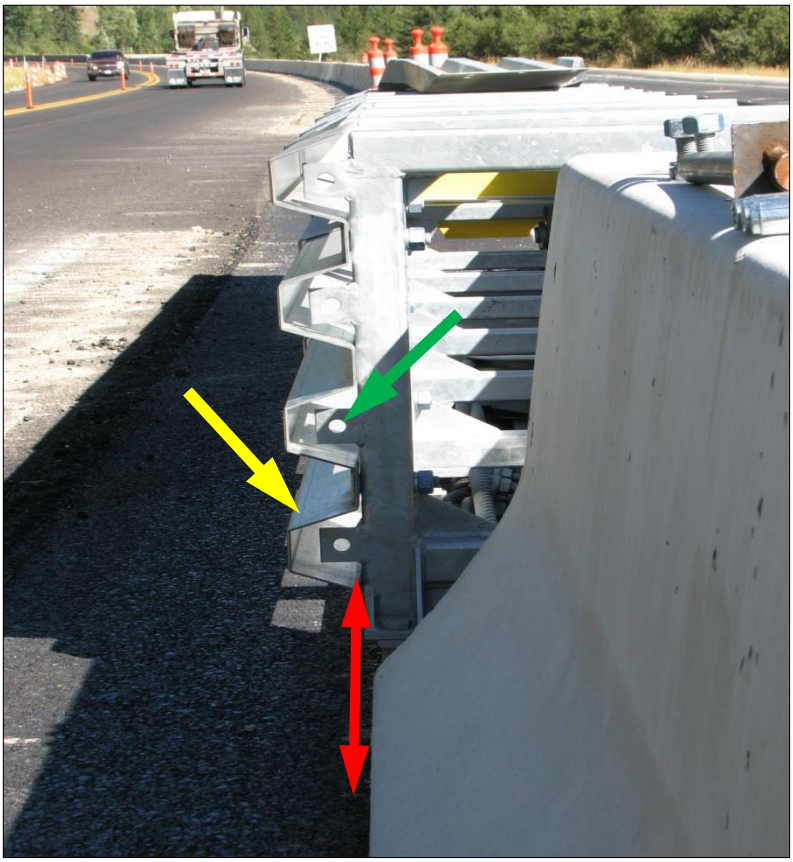
🡐 The fork lift, at the front of the attenuator, uses its fork blade to finish the alignment.



🡐 Although difficult to see in this image, the lower loop of the concrete jersey barrier (yellow arrow) must not interfere with the attenuators cable sheave cover (red arrow).



🡸 Image shows the rear of the attenuator (prior to placing against the jersey barrier). Here you can see the rear sheave cable assembly (red arrow) and the hydraulic cylinder (yellow arrow).



🡸 This image details how the rear panel of the attenuator (yellow arrow) must not be obstructed by the (F shape) jersey barrier (red arrow).

The green arrow points to the bolt holes which the transition panel will attach to.

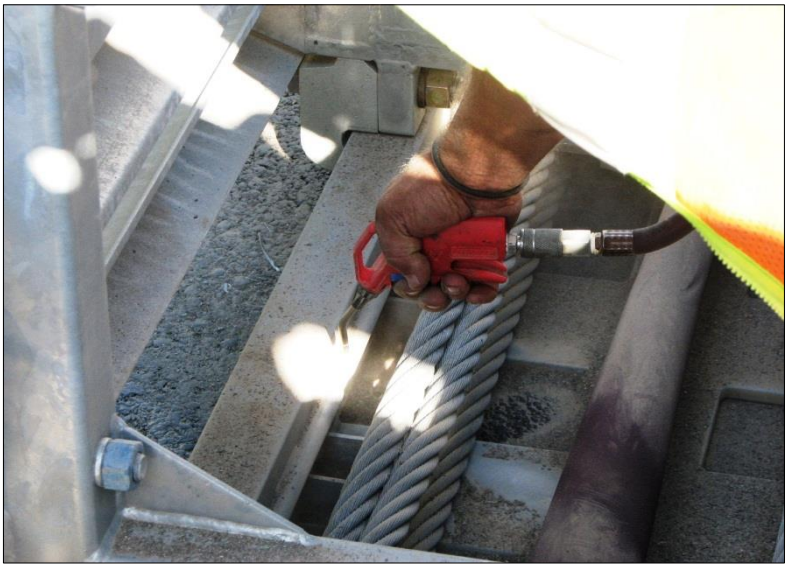
🡐 Once the attenuator is in its proper position the workmen begin to assemble the threaded anchor bolts and nuts which will be used to secure the unit base to the pavement. These bolts are 3/4"x18" in size.

Approximately fifty (50) bolts are required for this unit.

🡐 Workmen begin drilling the holes for the bolt insertion phase.

Using the holes in the attenuator base as a template a 7/8" hole is drilled to an approximate depth of 17.5". The drill bit is taped for a visual reference when the proper depth is reached.

The pavement type is an asphalt overlay on portland cement concrete pavement (PCCP).



🡐 Compressed air is used to blow all dust and debris out of the drilled holes.

The manufacturer stresses the need for a competent cleaning of these holes to insure a proper epoxy adhesion.

🡸 The product Red Head Epcon A7 Adhesive is the acrylic epoxy used to adhere the bolt to the surrounding pavement foundation.

A special attachment to the glue gun is a static mixing nozzle which mixes the acrylic resin and hardener agent internally before it exits the tube end.

🡸 The acrylic adhesive is inserted (as much as possible) at an angle to prevent air pockets from forming. The drilled hole is filled approximately to a level at 70%.

🡸 As the bolted nut (with washer) is inserted into the hole it is turned continually to insure a complete coating of the bolt threads and the walls of the drilled hole; also, to insure the bolt is vertically plumb.

🡸 The workman uses one of the bolts to help seat the inserted bolt fully into the hole.

If the bolt does not fully seat a hammer was used to pound it down to an acceptable depth.

🡸 Here the bolts are placed correctly and will be tightened once the epoxy has fully cured.

The epoxy will be ready for bolt tightening after 30 minutes at 80 degrees (27° C). The ambient air temperature onsite was about 55 degrees. The contractor waited for about 1 hour before tightening.

🡐 The transition panel is being positioned for attachment to the jersey barrier and attenuator frame.

🡐 Here the workman is drilling the holes and using concrete compression bolts to fix the panel to the jersey barrier.

🡐View of completed transition panel for the F type jersey barrier.

🡅 This image details the scalloped side panel which allows the beveled edges to overlap each other during a collapse on impact.

🡇 Close-up of the side guides (yellow arrow) and front rollers (red arrow) on the side panel rails which produces a smooth aligned collapse during impact.

🡅 Completed installation at crossover.

April 2013 Site Inspection

🡅🡇 SCI crossover installation at approximately mile point seven (7), view west.

🡸🡹 SCI crossover installation at approximately mile point eight (8), view west.

🡅🡇 SCI installation at exit 5; approximately mile point six (6), view west.

🡸 Representative view of SCI front sled cable assembly.

🡸 Representative view of SCI rear mobile sheave assembly and hydraulic cylinder.

🡸 Representative view of side guides and front rollers.

February 2014 Site Inspection

🡸 SCI crossover installation at approximately mile point eight (8), view east.

🡸 SCI crossover installation at approximately mile point eight (8), view west.

Image shows minor accumulation of snow and ice in the interior of the SCI unit.

🡸🡻 Northbound I-90 at reference point 6. Exit 5 location of SCI unit.

Note the level of snow and ice inside and in front of the attenuator.

As stated earlier it is uncertain how this condition would affect the performance of the cushion if struck by a vehicle.

March 2015 Site Inspection

🡸🡻 Westbound I-90 at approximate reference point 6. Exit 5 location of SCI unit.

These images represent the general condition of all of the SCI units on the project.

As documented in earlier inspections sand and grit accumulates in and around the cable, guides and cylinders systems.

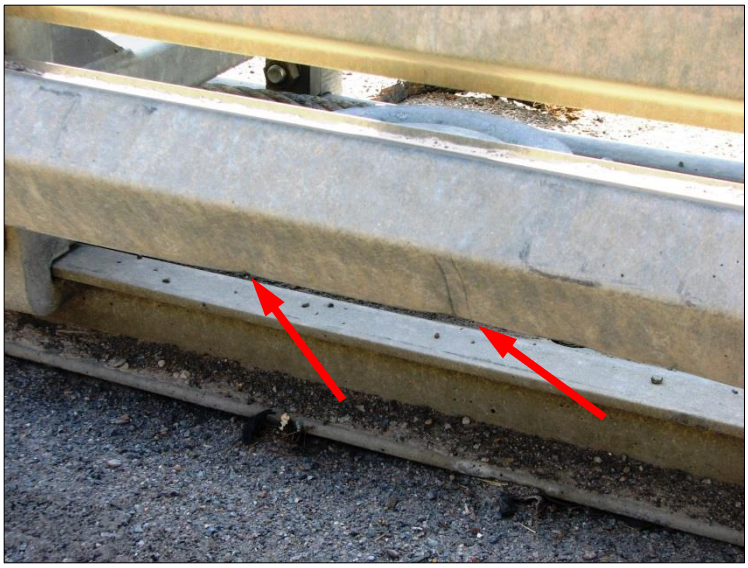
If this effects the hydraulic porting during impact is unknown at this time.

Damaged SCI Unit: Crossover Installation near Reference Point 7

🡸🡻 Westbound lane I-90 at approximate reference point 7: East end unit, north side.

Noticeable damage to a section of the bottom side panels (delineated by the red arrows).

🡸 Close-up of panel damage.



🡸 Arrows show strike dents on the lower panel. It is difficult to determine if this type of damage will affect the performance of the unit.

March 2016 Site Inspection

🡸🡻 Representative images of the SCI units at the three locations between references post 6-7.

As noted in previous inspections sanding grit accumulates in and around the hydraulic porting mechanism.

No information to date suggests the accumulated material will affect the unit's ridedown function.

June 2017 Site Inspection

🡸🡻 Representative images of the SCI unit located at Exit 5.

As noted in previous inspections sanding grit accumulates in and around the hydraulic porting mechanism.

No information to date suggests the accumulated material will affect the unit's ridedown function.

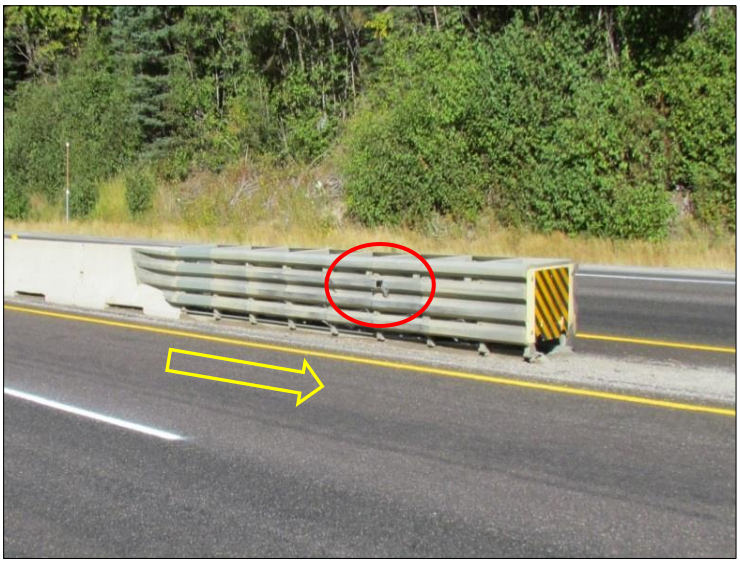
The other SCI units were in similar condition; one unit has suffered a side swipe with damage to the side panel as detailed in the supplement.

April 2018 Site Inspection

🡸🡻 Representative images of the SCI unit located at Exit 5.

No issues to report. SCI Units are in same condition as reported in 2017.

Supplemental: Damaged side panel by vehicle impact – 2017



🡸 Damaged SCI located at first set of crossover units (going westbound) at approximate RF 7.8.

Unit seen is the westbound SCI; red circle is the area of damaged side panel.

Damage occurred apparently by a side swipe from an eastbound vehicle (yellow arrow denotes direction of travel).

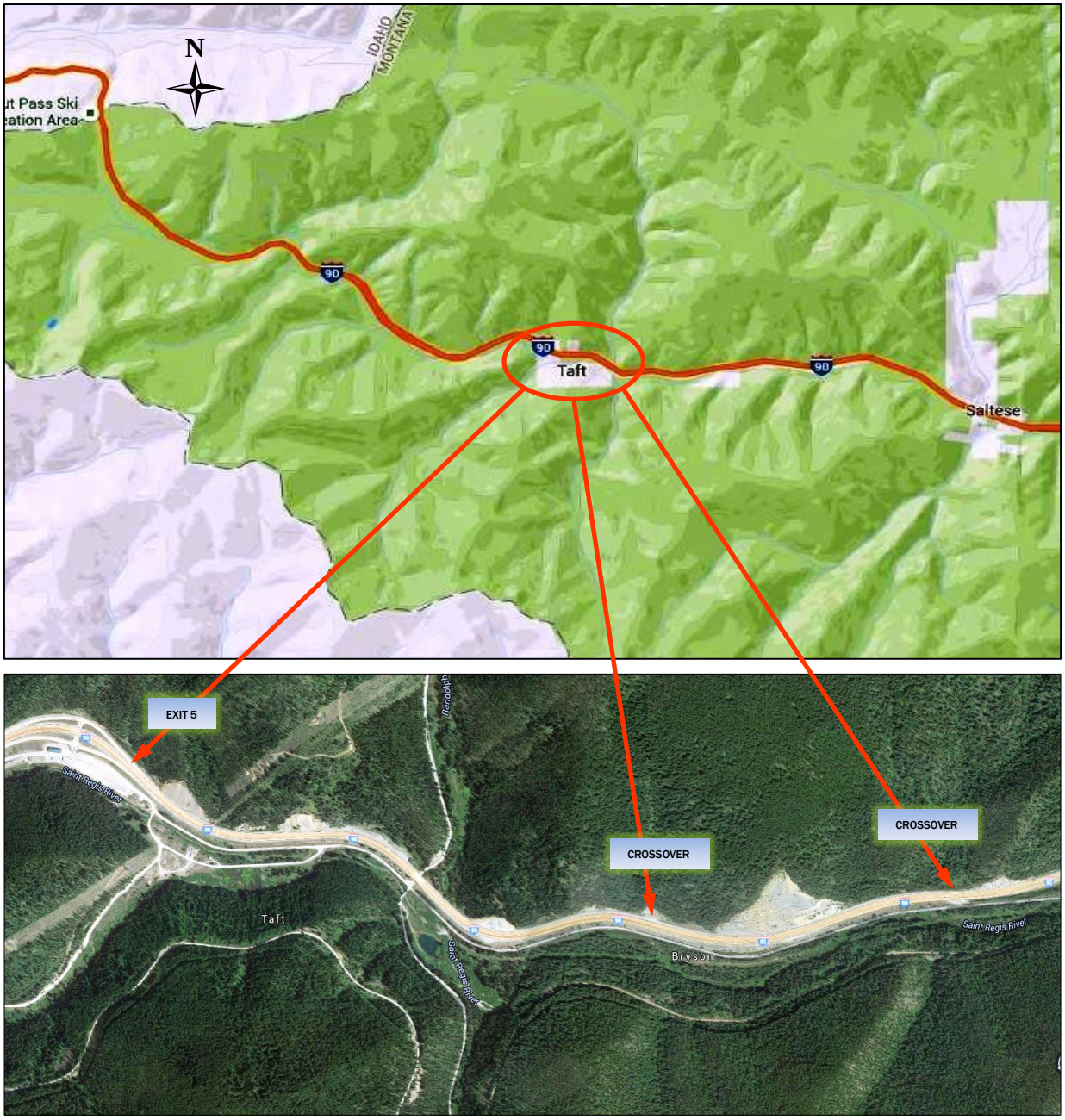
🡸 Level of damage to SCI side panel.

It is unsure if the damaged panel will affect the ride-down function of the attenuator upon impact.

🡸 The red arrow shows a piece of vehicle plastic wedged between a section of the scalloped side panel.

Project Location: Montana Interstate 90 (C000090): Approximate reference point 6-7, Mineral County; Missoula District.

Five SCI units in place at two crossover locations and westbound exit 5.



*Locations are approximate; not to scale.

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