Montana Department of Transportation
Research Programs
June 2016

EXPERIMENTAL PROJECTS CONSTRUCTION AND 2014 SITE INSPECTION FINAL REPORT

EVALUATION OF THE BREAK-OUT SQUARE POST BREAKAWAY SYSTEM

Location: Montana & Central Ave Jct. – Billings: Yellowstone County

Project Name: Break-Out Square Post

Exp. Project Number: MT-12-08

Project Type: Sign Post Breakaway Trial

Principal Investigator: Craig Abernathy, Experimental Project Manager (ExPM)

Installation Date: August 28, 2012

Evaluation Dates: April 2013, April/ May 2014, October 2014

Objective

Determine the effectiveness of the Break-Out Square (BOS) Post coupler as a possible alternative to other breakaway devices. This product is designed to (upon impact) break flush with grade with no damage apparent to base or anchor and offer a quick turnaround to get the sign back in service.

Evaluation Procedures

When the break-away device has been involved in an active traffic event (sheared off by a vehicle impact), Research will document the condition of the unit and all steps involved to put in back in service. Cost of repair and time required may be included.

Construction Documentation: Will include information specific to the installation procedures of the break-out device.

Annual Evaluation: Document condition of the break-out units and to report on any instance of repair or replacement of BOS units.

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 overall 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.

The information in this report reflects the installation of the BOS post for this particular project.

Initial Installation and Issues - 08/28/2012

The installation of the Break-Out device took about forty (40) minutes. It was found when the drilling of the three (3) inch hole for the anchor adapter that the thickness of the concrete foundation was less than 2.5".

Normally in circumstances where the foundation has less than four (4) inches an extension would be attached to the base of the anchor adapter to aid in sign support. An extension was not available without delay in the installation. It was decided to install the adapter as is with the expectation it may not affect performance of the breakaway unit.

Pages 5-14 details the installation.

April 2013 Site Inspection

During this inspection it was found that the sign was leaning northwards about five degrees (5°) and leaning forward (easterly) about ten to fifteen degrees (10-15°).

Several of the top coupler attachments (lower socket cap nut and corner hex screw) were loose. The anchor adaptor has depressed into the 3" drilled hole about ¼".

As stated above in the initial remarks, the concrete base thickness was less than 2.5" which to date, appears proven inadequate to support the anchor with sign; however the installation went ahead. In retrospect with the thickness of the base as it was, an anchor extension (which attaches to the anchor adaptor) may have kept the anchor to base a stable installation. These extensions range from twelve inches (12") to twenty-six inches (26"). Another option with the thinness of the PCCP base would have been to apply concrete (or mortar) to the interior in and around the hole to make a solid connection.

A current assumption is that wind-generated vibration has caused the above conditions but that is only speculation.

See pages 15-17 details the site inspection.

April 2014 Site Inspection

Condition of the sign is the same as reported on April 2013. The tilt and lean was more pronounced. See page 18.

May 2014 Site Inspection and Subsequent Sign Hit

The District notified Research in early May that the sign unit had taken a vehicle hit and was down. Upon a site visit it was found the breakaway unit had performed exactly as designed snapping flush with the median surface with all sign components intact. See page for more details.

October 2014 Site inspection – Sign Reinstallation

The existing median was prepped for a new breakaway system by adding additional depth of concrete to support the anchor wedge unit. The sign and post were reinstalled in the original sign location of the median (page 20).

Lockwood/Roundup (Exit 452) Overpass Installation

This installation was outside the scope of this report and Research was informed on September 2013 that the BOS post had been (assumed) snapped due to high winds (excess of 70mph) with a sign area of 3'X3' and 1'x3'.

The sign and post were still intact and undamaged. Reinstallation of the unit took approximately 30 minutes to put the sign back in service. The following image is the completed repair.

October 2014 Site inspection – Documentation of New BOS Sign Units

Based on current performance of existing installations the District elected to install 12 additional units during the fall of 2014 on a project encompassing various locations on Montana Avenue and Billings/Laurel Rd.

BOS posts were place in a variety of ground conditions including concrete, asphalt, grass and gravel. Eight units had a base diameter of 2.5" and four had a diameter of 2".

As with the other BOS installations the District will inform Research if a unit has been struck and how the repair was facilitated to be documented in this report.

Pages 21-23 are representative images of the new units.

Analysis to Date: June 2016

An inspection was conducted in the spring of 2016 with no additional information to add from the 2014 site visit.

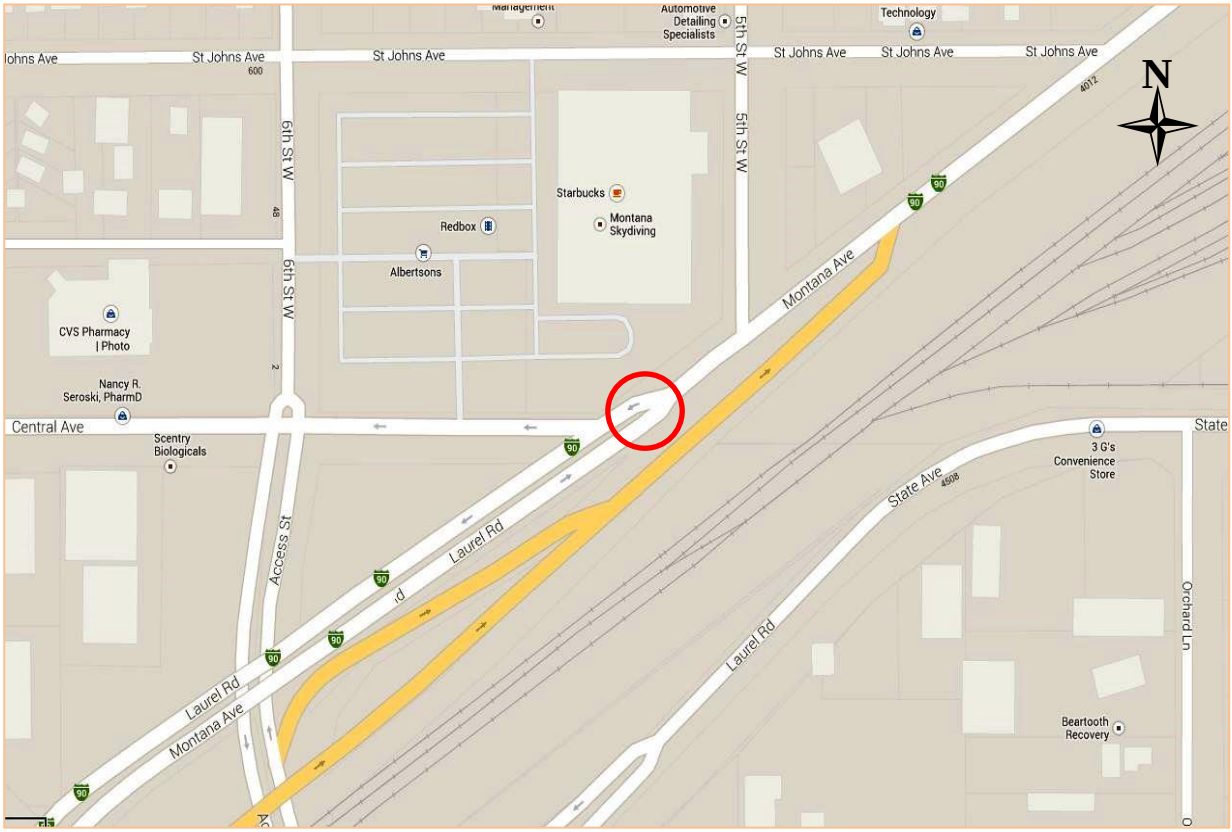
Based on reported performance the BOS breakaway bases are effective upon impact to shear the base flush with the surface with minimum or no damage to the sign sheeting or post (exceptions will be noted). The integrity of the anchor wedge remains intact to allow another coupler and wedge-lock to be reinserted to put the sign back in service with minimum delay. No special tools are required for the repair.

District personnel involve with the installation of the units, and subsequent repairs have reported satisfactory results.

This report and other information may be found at:
http://www.mdt.mt.gov/research/projects/break_out.shtml

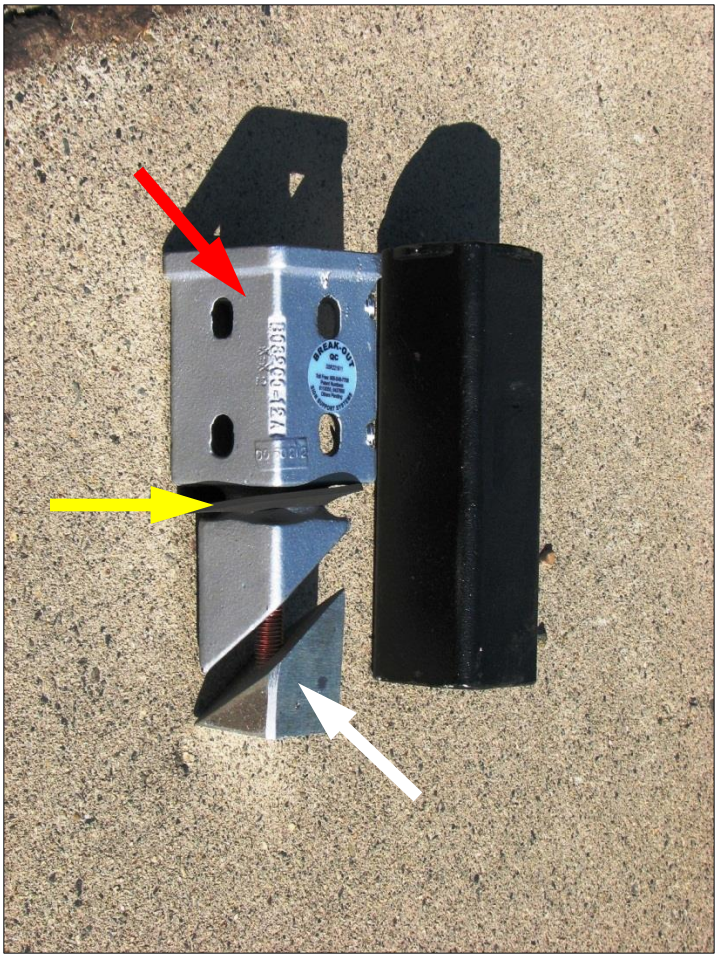
The following are representative images of the project installation with post-installation documentation at various locations.

Map View of Sign location: Junction of Montana Ave. and Central Ave.



August 2012: Billings MT – Junction of Montana Ave. and Central Ave.

⬆⬇ Condition of the lane divider after two sign impacts. Location of the original sign placement (yellow arrow). Yellow circle will approximate location of new sign base.



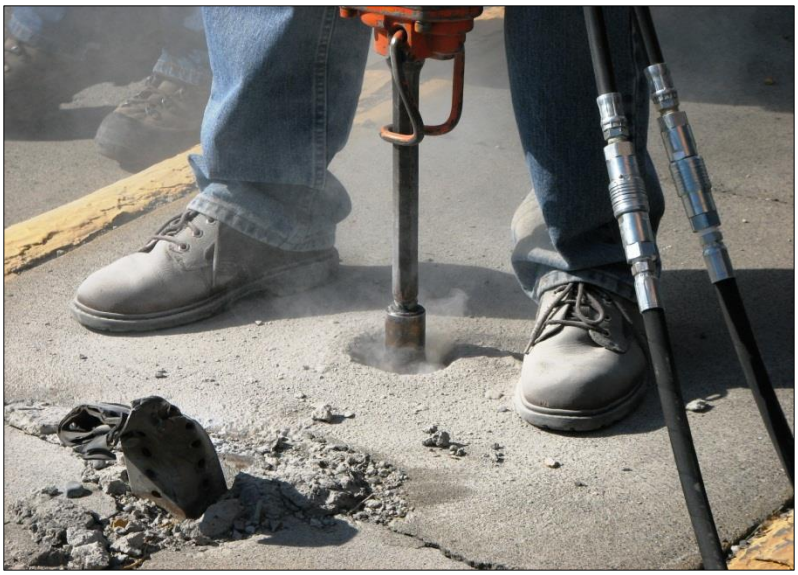
⬅ Main components of the Break-out. The top coupler (red arrow) is set above grade and the receptacle for the sign post base.

Although difficult to see with the black washer in place (yellow arrow), this is the 360 degree separation point that breaks flush with grade.

The wedge-lock (white arrow), when fully tightened, firmly secures the coupler into the anchor adapter.

⬇ Close-up of the anchor adapter which will be inserted into the drilled hole flush to the surface of the median.

🡸 Using a rock drill with a 3" bit the workman begins to bore into the median surface with an emphasis to keep the drill as vertically plumb as possible.



🡸 Continuing to bore with a good vertical drilling.

🡸 Boring completed. It was found the depth of the concrete was approximately 2.5" (6.4 cm).

Normally for slabs less than 4" thick an extension is added to the anchor adapter for added base support.

Since an extension was not supplied it was decided to use only the adaptor with this installation.

🡸 A drive cap, designed to fit and place the anchor adaptor for insertion into the bore hole, is attached to the jackhammer.

🡸 A conventional post leveler is attached to the anchor adapter to act as a visual guide in assuring a proper vertical seat.

The anchor is wedged shape and almost impossible to remove if not placed correctly without damaging the surrounding foundation.

🡸 The adapter is hammered flush and in correct alignment (as indicated by the diagram) for the sign to face towards oncoming traffic.

🡸 The coupler base is placed in the anchor adapter first, followed by the top coupler wedge.

🡸 The Break-Out in place ready for the tension bolt.

🡸 The fastener is the type that relies on tension rather than friction in keeping the wedge lock secure in anchor adapter.

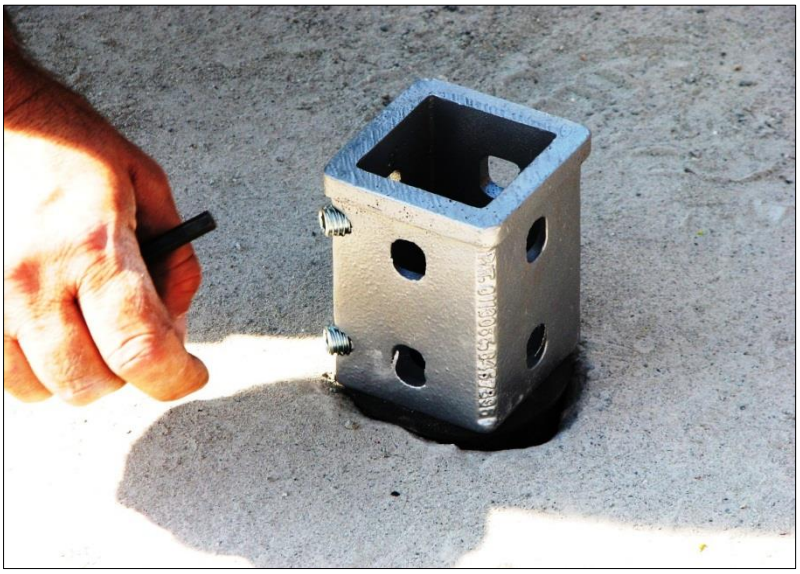
Tension bolts (Inclined cams on the inside and radial teeth/ridges on the opposite sides) are less susceptible to vibration caused by wind-generated post movement.

The bolt plays no part in the break-away function.

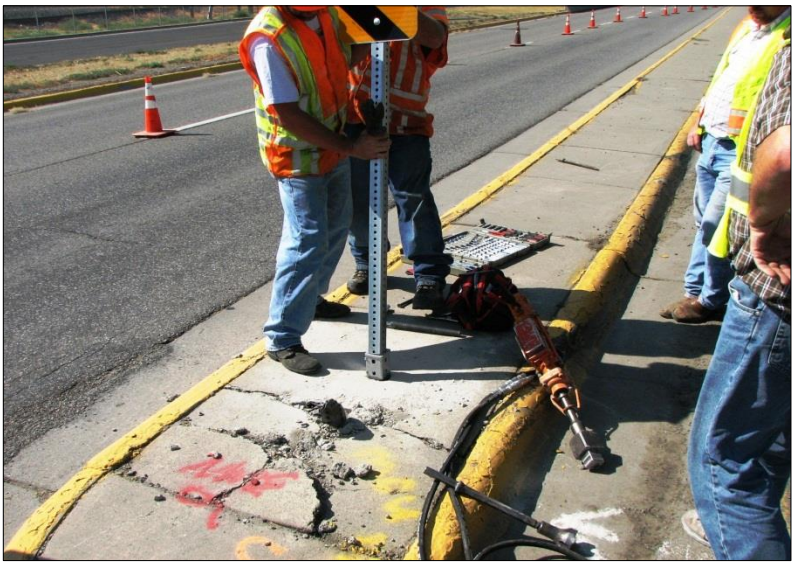
← The tension bolt is first hand tightened into the coupler wedge lock.

← The tightening is finished off using a conventional socket wrench and cheater bar.

The vendor stated no torque requirement is specified, only to tighten the bolt until it no longer moves.



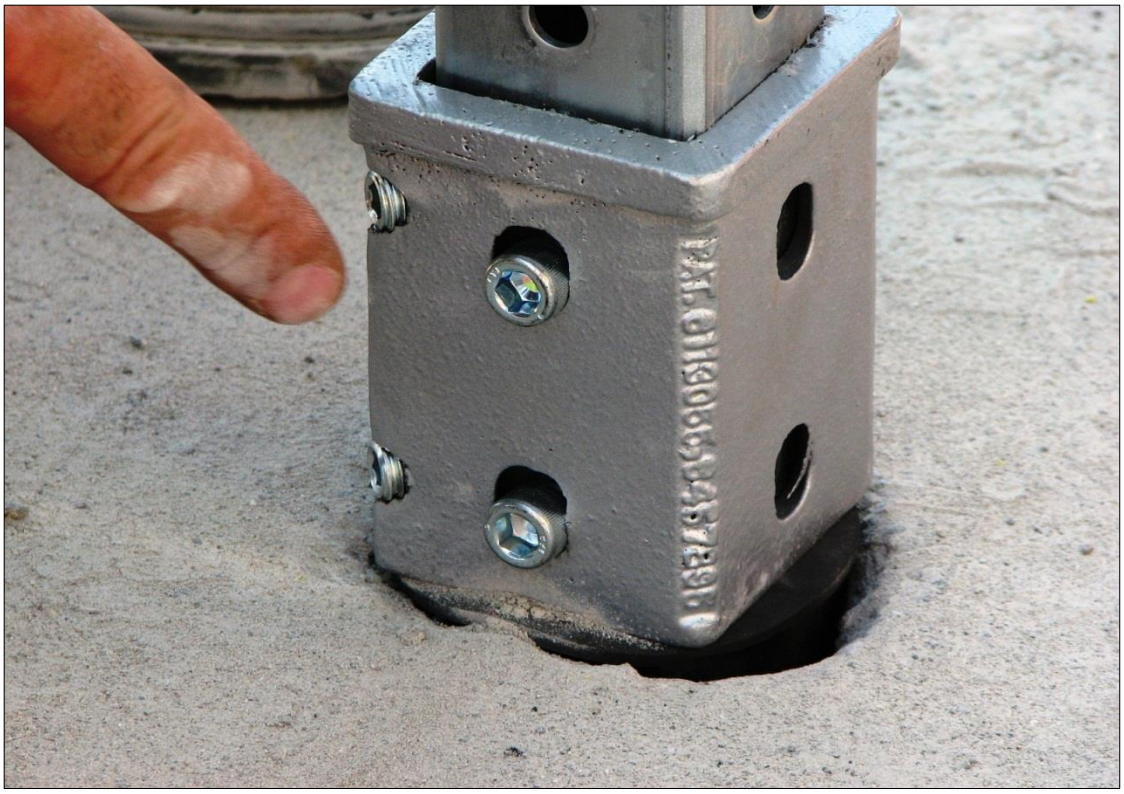
← The Break-Out Square Post Breakaway is ready to receive the sign base.



🡸 The sign post is inserted into the Break-Out receiver.

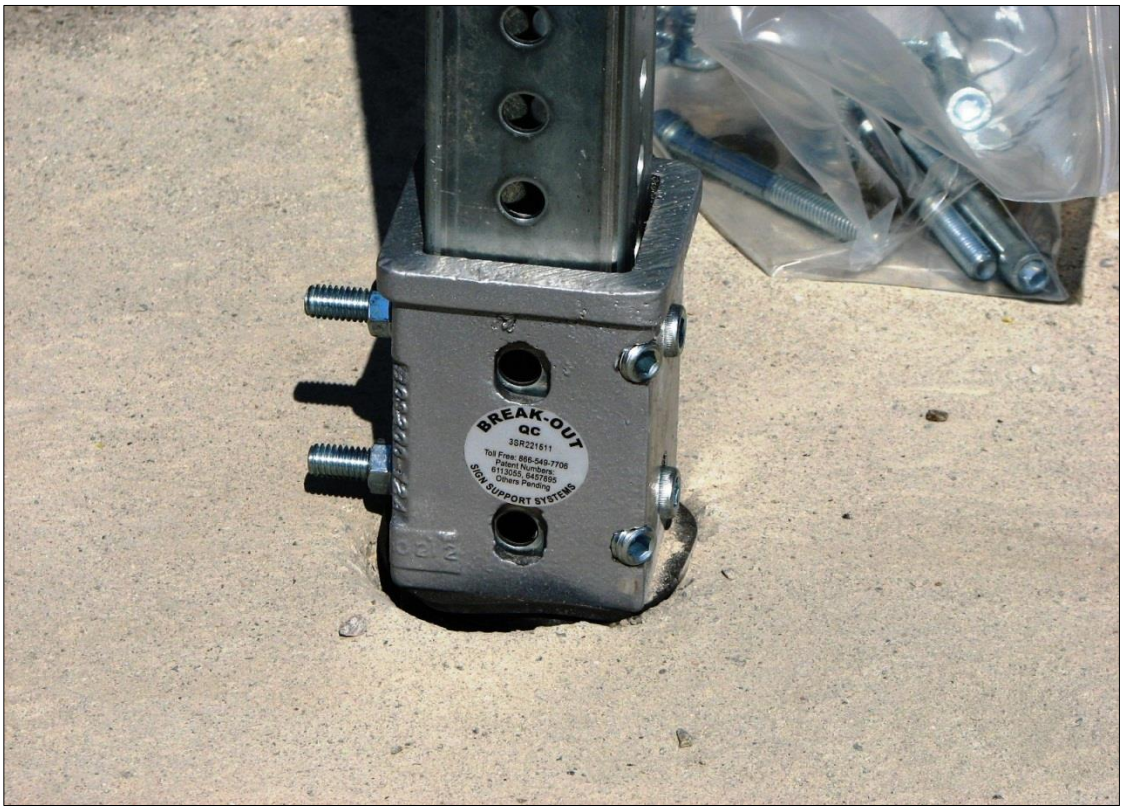
🡸 Corner hex screws are tightened first.

🡸 Round head socket cap screws are set parallel through the sign base and Break-Out and tightened firmly.



⬆ Note that the round cap screws are compressed against the sign pole square tube and not the coupler.

⬇ Completed sign base to coupler attachment.

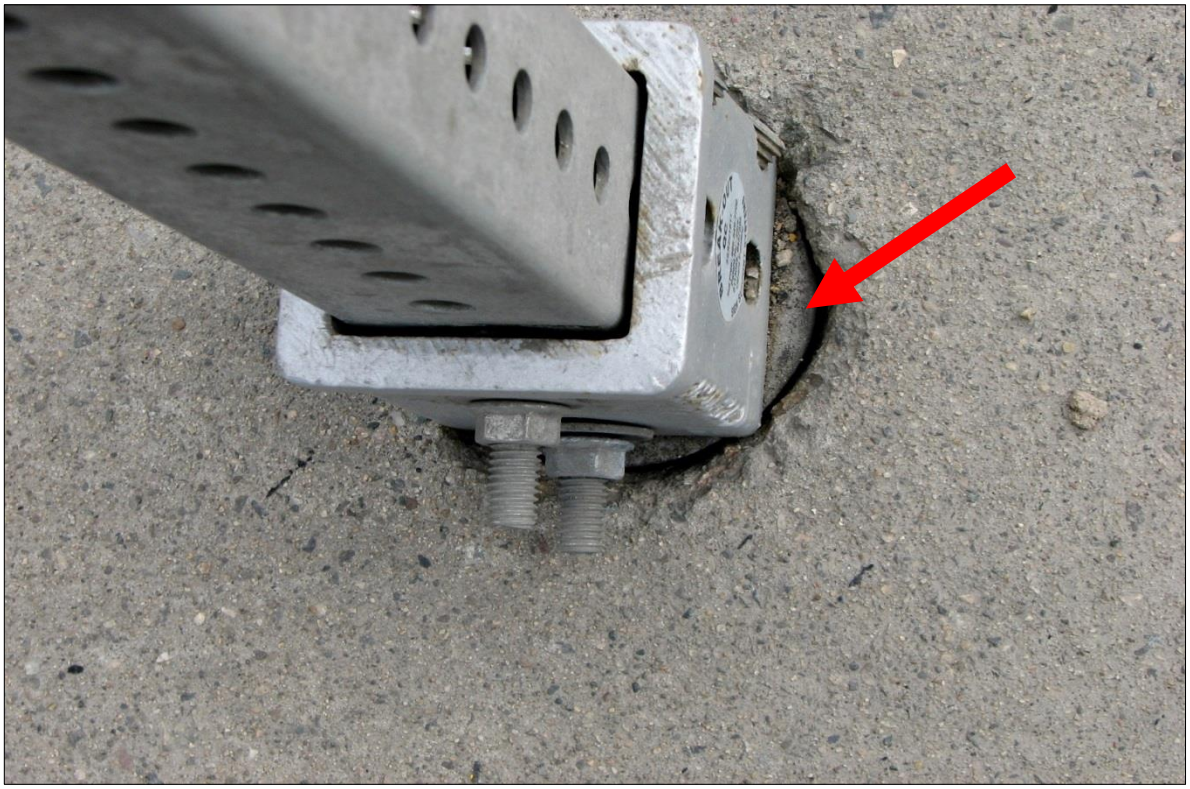


Completed installation of the Break-Out Square Post coupler (view west).

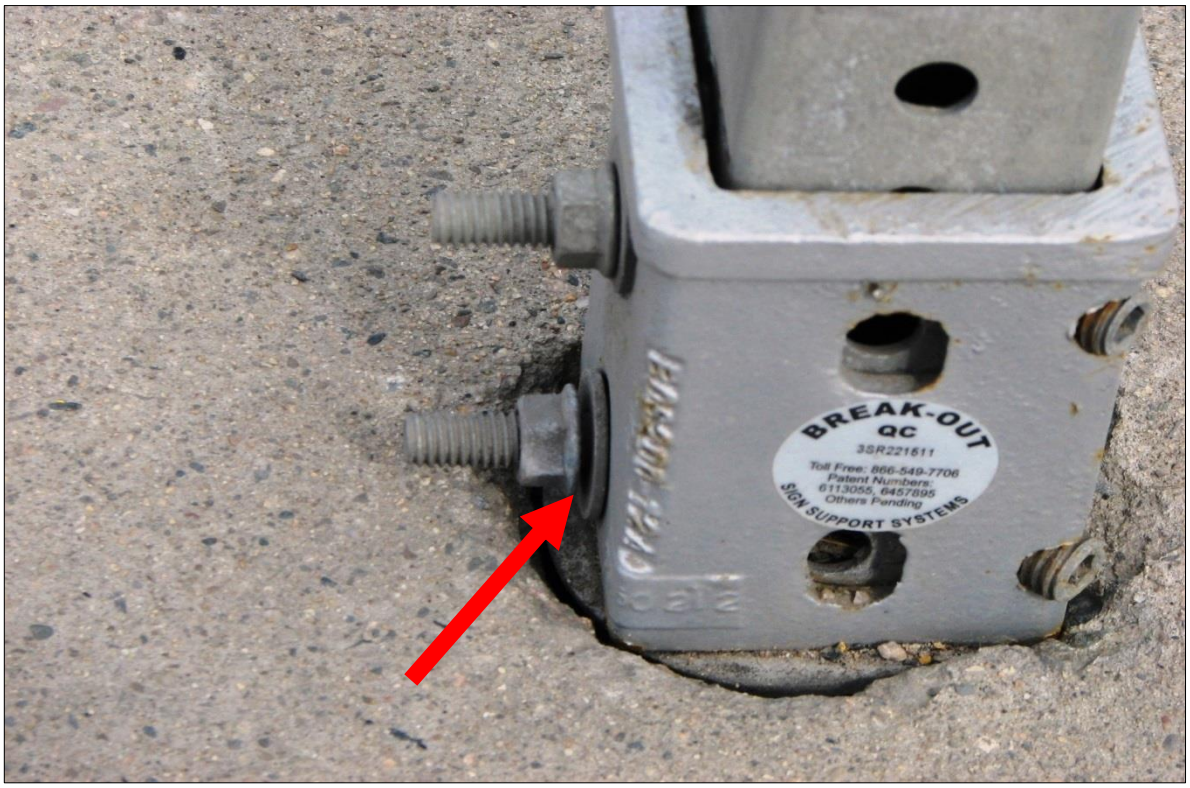
April 2013 Site Inspection

🡸 Upon inspection it was noticed that the sign post had a northern tilt as seen from the rear (view east).

🡸From a side view (looking north) the sign post had a substantial forward lean.

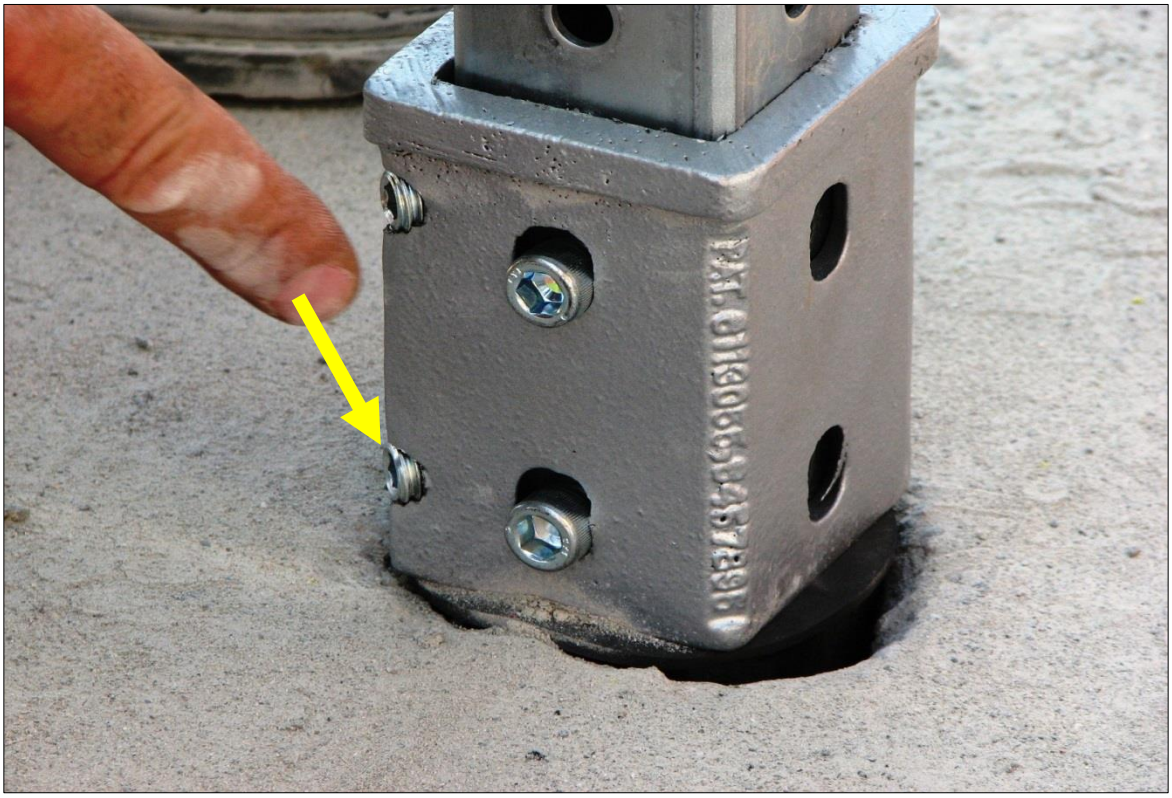


- The top coupler and wedge-lock unit appeared to be tight in the anchor base; however the anchor base was moveable in the drilled concrete.
- The rear lower base nut to socket cap attachment was loose. It could not be determined if the other socket cap nut attachment was tight or not.



🡸🡻 In comparing the lower image taken in 2012 of the completed BOS unit, and the upper image taken during the April 2013 inspection, shows that the anchor (wedge) adaptor has recessed almost a half inch (½") into the concrete base.

Also note the corner hex screws (yellow arrows) appear to have reversed out of the top coupler hex attachment.

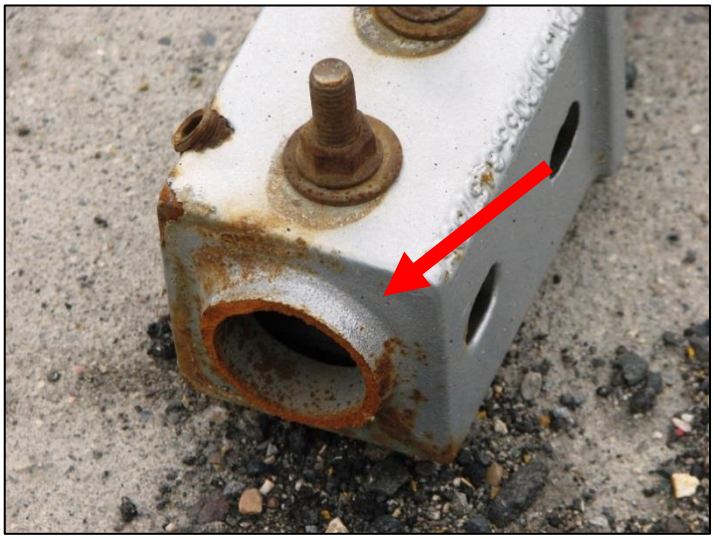


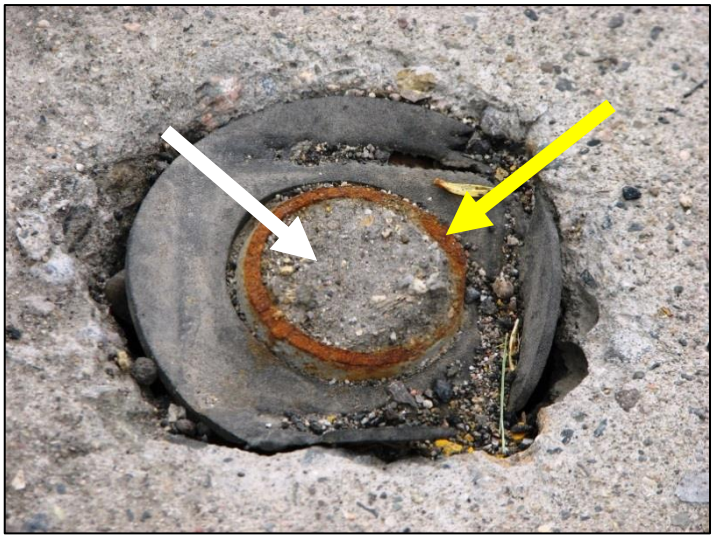
April 2014 Site Inspection

⬅⬇ As compared to the image taken in April 2014 the sign incline has increased. Even at this severe angle and in shallow placement, the anchor adapter has held.

⬇ Close-up of top coupler and anchor base.

May 2014 Site Inspection: Sign Impact by Vehicle





↙↓ The District notified Research that the Montana and Central Ave. Jct. sign unit had taken a vehicle hit in early May.

As these images show (even at the severe tilt of the base) the top coupler (red arrow) sheared cleanly from the 360° wedge-lock base insert (yellow arrow).

Note at the image at the bottom of the page, the round black deformed object is the seal washer (refer to page 7).

The impact did not affect the placement of the anchor base.

Conventionally, this design allows the wedge-lock to be removed from the anchor base by releasing and removing the tension bolt (in which sanding debris has covered – white arrow) to allow a new break-out unit to be reinserted into the anchor (refer to page 9).

Since the current median may be replaced or repaired the existing anchor can be removed and may be used again.

October 2014 Site Inspection: Sign Base Repair

← The existing median (which during the initial installation of the break-out unit, was found to be just over 2" in thickness – page 6), was repaired by concrete patch to an appropriate depth and mass for the reinstallation of the anchor adapter and coupler wedge.

The sign was installed in the original position within the lane divider median.

← New installation close-up of breakaway base.

Not confirmed; but it is assumed the original anchor adapter was reused.

Conventional hex bolts were used to affix the sign base to the break-out unit other than socket caps used in the original installation.

Fall 2014: Montana Ave. – BOS Post New Installations - Representative Images

⬅ Location: Montana Ave, near St. Johns Ave.

BOS unit, standard 2" base breakaway.

⬅ Close-up of 2" diameter, square post unit in concrete base.

🡸 Location: Montana Ave, near Cook Ave.

BOS unit, standard 2.5" base breakaway.

🡸 Close-up of 2.5" diameter, square post unit in concrete base.

⬅ Location: Montana Ave. and North 18th.

⬇ Location: North 18th and 1st Ave North.

Spring 2016: Site Inspections

🡸🡻 Location: Montana Ave. and North 18th. & Central Ave.

General examples of numerous installations around the city of Billings.

🡸 Some bases were observed developing rust or corrosion.

Disclaimer

The use of a product and/or procedure in the course of an evaluation does not constitute an endorsement by the Department nor does it imply a commitment to purchase, recommend, or specify the product or procedure in the future.

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