
COLORADO DEPARTMENT OF TRANSPORTATION

# Research Newsletter

Spring 2009

## Electromagnetic Wildlife Detection System

CDOT's Strategic Plan for Improving Roadway Safety states that motor vehicle crashes involving wildlife are the third leading cause for crashes in Colorado. Wildlife-vehicle crashes can have serious consequences, particularly when elk and deer are involved. In an effort to mitigate these crashes, CDOT is funding a study to determine the reliability and effectiveness of an electromagnetic animal detection and driver warning system (ADS-DWS) along U.S. 160 east of Durango. The research team, consisting of researchers from the Western Transportation Institute, SWCA Environmental Consultants, and Colorado State University, will be testing the system in several ways. Reliability testing will determine how reliable the ADS-DWS is at detecting elk and deer and whether environmental conditions influence the reliability of the ADS-DWS (e.g., does it activate when the ground is wet or frozen). Effectiveness testing will determine whether the ADS-DWS reduces vehicle speed when activated and whether it results in fewer, less severe collisions with elk and mule deer.

The study will focus primarily on conducting snow tracking surveys during the winter and remotely-triggered camera surveys during the summer to determine whether the system accurately records large animals crossing over a buried electromagnetic cable, which parallels a one-mile stretch of U.S. 160. Each wildlife crossing event of the buried cable activates a wildlife warning sign, alerting drivers to the presence of animals along the highway shoulder. Radar detectors will record vehicle speeds, which will be compared to times when the wildlife warning signs are both active and inactive. Animal-vehicle collision information will also be collected to determine if road kill rates vary along portions of U.S. 160 where the system is installed compared to portions where it is not. This three-year study will allow CDOT to determine whether the system is a useful mitigation tool to reduce wildlife-vehicle conflicts along Colorado roadways.

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*Deer crossing U.S. 160 next to wildlife warning sign*

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CDOT's first simple made continuous steel bridge, completed in 2006, crosses Box Elder Creek on U.S. 36

## Innovative Steel Bridge Design

Federal requirements mandate accurate bidding of both steel and concrete during the initial bidding process for design and construction of bridges, but prestressed concrete bridges have dominated the bridge type selection processes in Colorado. This can be attributed to a lack of steel mills, combined with a strong presence of precast fabricators in the region. In addition, a lack of readily available economical procedures to design and construct steel bridges has hindered the industry. To address this issue, the CDOT Research Branch funded a study that resulted in a report titled "Development of Steel Design Details and Selection Criteria for Cost-Effective and Innovative Steel Bridges in Colorado."

The research study focused on investigating the use of compact rolled sections in the application of a simple made continuous design and construction approach to steel bridge design. Design elements include steel beams placed and designed as simply supported for self weight and wet concrete, termed dead load I; the beams designed as continuous and composite (designed to carry railings, wearing surface, etc.), termed dead load II; and the composite continuous section designed to carry live load.

During the study, a software package was created at Colorado State University that takes user inputted data such as span lengths, out to out width, number of girders, and overhang along with various other inputs and outputs the lightest wide flange shape that will satisfy the loading. The girders were designed using appropriate provisions from the AASHTO LRFD Bridge Design Specifications, 2007.

Design charts and design tables were created for several one, two, and three span steel bridges. Each span arrangement for the design charts and tables was made using full widths of 39 ft, 44 ft, and 60 ft. The charts and tables show how the structural steel weight per square foot changes as the number of girders increases, as well as providing the lightest wide flange shape required to support the deck and traffic loads. These charts and tables also illustrate how the amount of structural steel needed changes when different spans are used. The design charts will aid the bridge type selection process by giving designers an accurate measurement of minimum steel requirements for numerous one, two and three span steel bridges.

Finally, steel fabrication and erection costs were gathered from regional steel fabricators and bridge contractors. The cost information gives an accurate measurement of the cost per square foot for the structural steel of a bridge to be built in the state of Colorado. This research has provided CDOT and others who will use the software or design charts a tool that will facilitate the construction of innovative steel girder bridges. See the final report for design details of a simple made continuous steel bridge girder system and a user's guide for the design software: *http://www.dot.state.co.us/Publications/PDFFiles/steelbridges.pdf*

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# High Tension Cable Barriers

High Tension Cable Barriers (HTCBs) have many advantages over other types of barriers. They are less costly to install and maintain; they do not act as snow fences; they provide a softer barrier than steel or concrete, reducing the damage to vehicles and injury to their occupants; and they are often able to retain their functionality after an impact because the tension keeps the cables near the system design height even with posts bent or broken off.

CDOT installed 40 miles of HTCB in the median of I-25 north of Denver, beginning in July 2004. CDOT traffic accident records for this segment of I-25 were examined for the before and after periods, and the findings are summarized in the table below. The "Pre Const" column summarizes data for crashes that would likely have involved the median barrier, had one been present. The "Post Const" column shows the crashes that involved vehicle collisions with the HTCB, with three exceptions where there was no median barrier of any kind.

There have been five crossover crashes – all injury only – since the installation of the HTCB. The single head on and two of the sideswipe opposite crashes occurred where there was no median barrier; the other two sideswipe opposite crashes were penetrations of the cable barrier. The crash costs are based on National Safety Council figures: $1.15M per fatal crash, $52.9K per injury crash, and $7.5K per property-damage-only crash. Maintenance costs include labor, materials, and equipment used to maintain and repair the HTCB. Millions of Vehicle Miles Traveled (MVMT) were calculated from CDOT traffic counts.

The large number of property damage only crashes is made up of vehicles that might have crossed into oncoming traffic and vehicles that might have recovered in the median with no crash if the HTCB had not been there. There have been many vehicles hit the HTCB, recover, and drive away without a crash report being made. Their costs are included in the maintenance costs.

| Pre Const (**4.5 yrs**) | | Post Const (**2 yrs**) |
|---|---|---|
| 1/1/00 to 7/12/04 | | 1/1/05 to 12/31/06 |
| 40 | Head On | 1 |
| 6 | Sideswipe Op. Direction | 4 |
| 0 | Median Barrier | 239 |
| 9 | FATAL | 0 |
| 30 | INJURY | 13 |
| 8 | Property Damage Only | 229 |
| 3351.30 | Million Vehicle Miles Traveled (MVMT) | 3329.34 |
| 0.0119 | HO / MVMT | 0.0003 |
| 0.0027 | FAT / MVMT | 0.0000 |
| 0.0090 | INJ / MVMT | 0.0039 |
| 0.0024 | PDO / MVMT | 0.0688 |
| **$ 3,580** | **Crash costs / MVMT** | **$ 707** |
| $ 11,997,000 | Total Crash Cost | $ 2,352,300 |
| | Total Maint. Cost 1/1/05 - 12/31/06 | $ 235,188 |
| | Crash cost + Maint. / MVMT | $ 777 |

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## Staff Changes

Patricia Martinek, the Research Branch's Environmental Specialist, retired at the end of February: The Queen of Green is recycling her career. We wish her the best of luck with her new endeavors. Roberto DeDios will be handling Pat's projects until a replacement can be hired. Roberto may be reached at 303.757.9975 roberto.dedios@dot.state.co.us

## Cutting Loose the Chains

The CDOT Research Branch is currently involved in the evaluation of the in-service performance of AutoSocks for Trucks ™, an alternative (to chains) traction device that received probationary approval last May for use during the winter season. The Research Branch was instrumental in developing an approval process and criteria so that alternative traction devices can be evaluated and approved. Colorado chain law requires that to be accepted as an alternative a device must demonstrate traction equal to or better than chains. AutoSocks' manufacturer submitted results of tests conducted by third parties which demonstrated that AutoSocks for Trucks can outperform traditional chains in terms of starting traction, hill climbing traction, braking traction, and lateral acceleration. Comparison was also made to chains in terms of durability in snow and on dry roads, as well as ease of installation. AutoSocks for Trucks demonstrated durability sufficient to traverse I-70 from the east side of Floyd Hill to the west side of Vail Pass under snow conditions. They could also go that far on dry pavement (which chains can't) if driven under 25 MPH. Installation is a snap – the 4 AutoSocks for trucks required for a typical tractor (outboard drive wheels, as shown in the photo) can be installed in a couple minutes without prior instruction, whereas chains take about 30 minutes to install even for those who have practiced.

Unfortunately there has not been a lot of market penetration so far. The AutoSocks for Trucks are almost twice as expensive as a good set of chains, and truck drivers traveling through other mountainous states would probably still have to have chains. CDOT maintenance employees working on I-70 report that there has been a high usage rate for AutoSocks for Trucks among fuel haulers. The consequences of a broken or thrown chain for a gasoline tanker are obvious. There were no reports of fuel tankers having any trouble climbing or descending the grades on I-70 or Loveland Pass. It's a bit too soon to pass judgment on this first season of AutoSocks for Trucks, but the preliminary results are encouraging. If more trucks use the AutoSocks (or other alternate traction devices) we can expect decreased congestion at chain-up/chain-down locations, less risk to truck drivers during installation and removal, less pavement damage from chains, and less broken chain parts causing damage to vehicles.

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