Chapter 1: Cable Median Barrier trends and performance

What is a crossover and what is WSDOT doing to reduce them?

Crossover collisions are incidents where a vehicle crosses the centerline or the median and collides with a vehicle or object in the opposing lanes on both divided and undivided highways. Crossover collisions on high-speed highways frequently result in serious injuries or death. Approximately 36 percent of all Washington state highway fatalities resulted from crossover collisions in 2007. It's not possible to prevent all crossover collisions. Our primary objective for placing barriers on the roadside or in the median is to reduce the risk of high-severity collisions.

For this report, we used a more stringent definition of a "crossover" that includes 32 collisions where a vehicle struck cable median barrier, continued across the median and reached the opposing lanes but did not make contact with a vehicle or object. This is in addition to the vehicles that crossed into or beyond the opposing lanes and made contact with another vehicle or object.

We use barriers to reduce the risk that vehicles that leave the roadway may strike hard objects, steep slopes, oncoming traffic, or bodies of water. We place barrier systems where other countermeasures are deemed impractical. Median barriers reduce the risk of crossover collisions, vehicles dropping off steep median slopes, and collisions with hard objects. WSDOT changed it's guidance on where to place median barriers to include locations not addressed by national criteria in order to help reach our goal of no highway fatalities.

While median barriers are effective at reducing the frequency of cars driving into oncoming traffic, none of the approved barriers we choose is 100 percent effective. Well-designed median barriers not only reduce the risk of crossover collisions, they also assist in minimizing the force of impact on people in vehicles that hit the barrier, redirect vehicles in a controlled manner, and bring vehicles to a controlled stop. Even though there is still a risk of crossover collisions after median barrier has been installed, these highways are reasonably safe for ordinary travel. The cable barrier program has effectively reduced crossover collisions on Washington's highways.

More detailed discussion on the types of barriers, including beam guardrail, cable barrier, and concrete barrier can be found in the June 2007 report to the Governor, "Cable Median Barrier, Reassessment and Recommendations," which is available online at: *www.wsdot.wa.gov/Projects/CableBarrier/Report2007*

What is included in our review of median collisions?

WSDOT analyzed nearly 2,550 collisions along 177 miles of cable barrier from the earliest installation in 1995 through 2007 for this report. The "before" period includes all reported collisions in the median for a period of five years before cable median barrier was installed. The "after" period is an accounting of all reported collisions in the median up to the end of December 2007. An exception is that collisions occurring during construction of the cable barrier are not normally included, since the traffic control used during construction presents unique traffic conditions that do not offer a fair comparison. Except for a few well-documented exceptions, the collision reports do not indicate whether the cable barrier installation was complete if the collision occurred during construction.

How collision reports are generated

Written collision reports are required by law when a collision results in injury or death, or results in personal property damage equal to or exceeding $700.

Collision reports are written by law enforcement personnel who investigate a collision. When law enforcement personnel do not investigate a collision, the driver of a vehicle involved in the collision is responsible for filing a collision report. These collision reports are processed by the WSDOT's Transportation Data Office (TDO). The TDO reviews the reports, accurately locates the collision on the highway, and enters the records into a database. That database is the source of collision data used in this study.

There are instances where drivers did not report a collision. Unreported collisions are not included in this study. Our review of maintenance repair records and a comparison with reported collisions reveals that there may be substantial numbers of unreported collisions involving cable barrier. For 2007, we have a record of 482 cable repair reports and 370 reported collisions. Of the 482 repairs, we are able to match about 61 percent (295 records) with collision reports. We estimate that 20 to 40 percent of collisions with cable barrier are unreported. It is reasonable to conclude that none of these involved serious injury. For this reason, we believe that the rates presented in this report conservatively overstate the average severity of collisions involving cable barrier.

Cross-median incidents in the "before" period are believed to have occurred more frequently than reported in this study. Cross-median collisions included in the before period include only collisions where the vehicle's initial point of impact was across the median. This would include collisions where a driver lost control and was then involved in a collision across the median. It would not account for instances such as a same-direction sideswipe where a vehicle is rebounded across the median, or events where a vehicle crossed the median without hitting anything. Because the original trooper's reports are no longer available for collisions prior to 2000, that information could not be retrieved. There was additional scrutiny of fatal and serious-injury collisions since 2000, in an attempt to identify additional cross-median events with the most severe injuries.

Adjustments and corrections made to previous year's data

In the process of updating the information in the report, there were adjustments made to approximately one percent of the collisions records presented in the July 2007 Cable Median Barrier report. This means that some of the collision counts in this report will not match the records presented in 2007. This one percent variation did not have a significant impact on the results of the 2007 report. Those adjustments are attributed to the following circumstances:

- One segment was found to be longer—collision records were added
- Records not identified in the 2007 report
- Corrections made to resolve reporting errors in direction of travel, or impact location
- Records incorrectly identified as cross-median
- More information was obtained
- Collision record with the wrong highway identifier
- Better information on construction project dates
- Crossover collision incorrectly identified as "redirected" (in Marysville)

This report also incorporates a change in terminology describing injury severity. For many years, WSDOT has used the term "disabling injury" to describe injuries that were severe enough that the injured party required assistance to leave the scene. This term was often misinterpreted to mean a permanent disability. Injuries that were described as "disabling" in the June 2007 report are referred to as "serious" injuries in this report. This change is being incorporated in all other documents and data sources within WSDOT.

Miles of cable median barrier installed

Figure 1.1

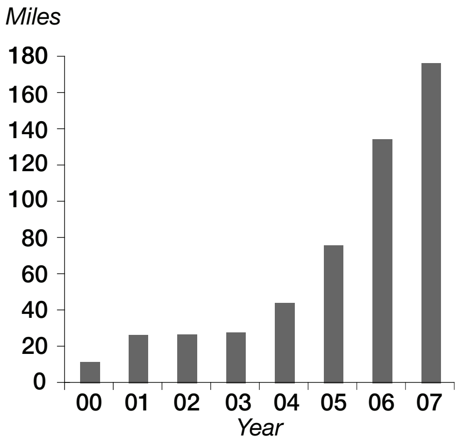


Figure 1.2

Median and cross-median fatal and serious-injury collisions

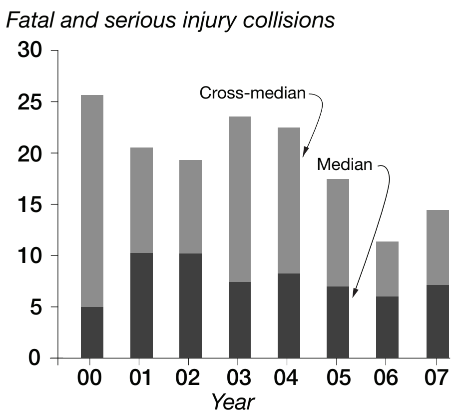
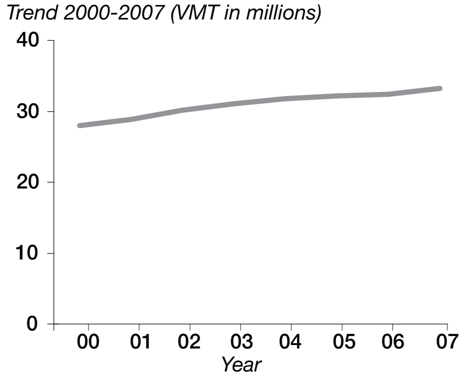


Figure 1.3

Vehicle Miles Traveled (VMT)

Within the Segments Where Cable Median Barriers Were Installed*



*177.36 miles of segments where cable barriers were installed as of December 31, 2007

How much cable barrier has been placed on Washington's highways?

By the end of 2007, there were 177 miles of cable median barrier in place and another 3.5 miles were under contract for installation. This analysis is an update to the "Cable Median Barrier, Reassessment and Recommendations" report published in June 2007 and focuses on a performance review of those 177 miles.

Figure 1.1 provides a year-by-year breakdown of the 177 miles of cable barrier installed between 2000 and 2007. Approximately 43 miles of new cable median barrier was completed in 2007.

High-severity collisions are on a downward trend

Between 2000 and 2007 there was a 44 percent decrease in fatal and serious-injury collisions within or across the median. Figure 1.2 illustrates the number of fatal and serious-injury collisions occurring within or across the median in locations where 177 miles of cable barrier has been installed. This graph does not differentiate between collisions that occurred before the cable barrier was installed and those that occurred after the cable was in place. Similarly, this graph does not differentiate between those collisions where cable barrier was struck and those where a vehicle ended up in the median, but did not strike the barrier.

Figure 1.2 illustrates a general downward trend in high-severity collisions. This corresponds to the increase in miles of barrier placed, as illustrated in Figure 1.1. While the general trend in fatal and serious-injury collisions is downward, the frequency of those collisions shows an increase from 2006 to 2007. The total for 2007 includes two cross-median collisions that occurred prior to installing cable barrier and two that occurred in the median, but did not contact the barrier. This downward trend in median collisions is significant considering the growth in traffic volumes that has occurred. From 2000 to 2007, the overall traffic volume increased 13 percent for the 177 miles of highway where cable median barrier was installed. Figure 1.3 illustrates the growth in traffic volume from 2000 through 2007.

With the addition of another year of collision data, we noted the reduction in annual cross-median collisions appears to be less dramatic than reported in 2007. This change is heavily influenced by the Puyallup segment where a single cross-median fatal collision in a short time period is skewing the annual rate. No other significant changes were noted. As cable installations within the 177 miles of freeway with medians of 50 feet or narrower are nearing completion, the reduction in collisions that can be expected by installing barrier has been realized and is starting to level off.

Calculating collision rates for highway segments

Collision counts can be linked with traffic volumes to calculate collision rates. A collision rate is calculated by determining the number of crashes in a particular category and dividing by the average yearly traffic volume in the study area and the length of the study area.

This report presents information on collision rates, expressing the number of collisions for each 100 million vehicle miles of travel (MVMT). If, for example, the collision rate on a particular one-mile-long road segment is 1.00 collision/100 MVMT, it means that on average one crash occurs for every 100 million vehicles that pass through the segment. In other words, an individual's average risk of being involved in a crash in this segment is one in 100 million. Reporting crash statistics in this way allows data from different sites with different traffic volumes and lengths of barriers to be compared directly to each other.

If cable barriers are put in to reduce crossover collisions, why do median collisions increase after barriers are installed?

Reportable collisions in the median routinely increase after the installation of any barrier system. Median barriers reduce the distance a vehicle can travel into the median without striking an object. Where an errant vehicle may have been able to travel 30 or 40 feet into an open median prior to barrier placement, it may only be able to travel 15 to 20 feet before it strikes a barrier placed in that same median. In the 177 miles studied, there were 223 collisions reported annually prior to barrier placement and 561 after barrier was placed in these locations. That amounts to an increase of 152 percent. Figure 1.4 summarizes this data.

Median barriers reduce the risk of serious crossover collisions but also create new risks for drivers who run off the road, since the barriers are objects that can be struck and may redirect vehicles back into traffic. This creates a dilemma for WSDOT engineers as they try to determine how to balance the benefits of barriers and the risks they present.

Fatality and serious-injury collision rates have dropped despite an increase in the number of collisions

Before cable barrier was installed in the 177 miles represented in this analysis, these locations averaged 7.64 collisions for every 100 million miles traveled on these segments. After cable barrier was installed, the number of collisions increased to 14.66 per 100 million miles traveled. After accounting for the over the 350 million vehicle mile increase in traffic in the sections, we calculated a 92 percent increase in the collision rate. Despite the overall increase in collisions, the number of fatal and serious-injury collisions occurring in or across the median was cut significantly.

There were 24.8 fatal and serious-injury collisions annually prior to cable barrier installation. That number dropped to 9.5 after cable barrier was installed. The average annual fatal median collisions dropped from 8.2 per year to 4.4 per year. Using the same methods, the rate of serious-injury collisions was reduced by 62 percent and the rate of fatal collisions was reduced by 56 percent. Collision rate data is presented in Figure 1.4.

Collision rate data “before” and “after” cable barrier installation

Figure 1.4

	Before	After	Percent change
Annual median collisions	223	561	+152%
Median collision rate (per 100 million vehicle miles of travel)	7.64	14.66	+92%
Annual serious-injury median collisions	16.6	5.2	-69%
Annual fatal median collisions	8.2	4.4	-47%
Serious-injury median collision rate (per 100 million vehicle miles of travel)	0.57	0.22	-62%
Fatal median collision rate (per 100 million vehicle miles of travel)	0.28	0.12	-56%

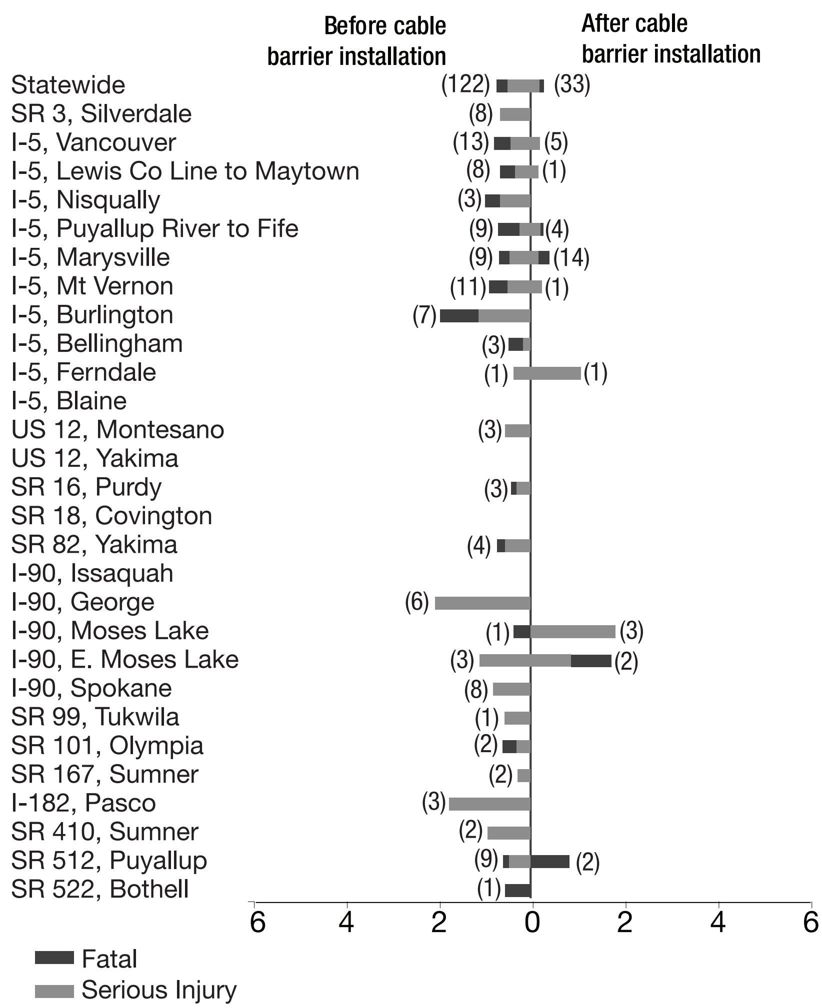
Rates for individual segments have greater variation than statewide rates

When examining the rate of collisions for an individual segment, one will see much more variation than when looking at what is happening in the state as a whole. This is because when we are dealing in numbers as small as 1 in 100 million, the occurrence of even one collision will change the rate significantly. In Puyallup, the number of annual fatal collisions in the period after cable barrier was installed is heavily influenced by two fatal collisions that occurred there in an eight-month period in 2007. This segment has 2.84 annual fatal collisions. Short time periods present opportunities for collision rates to be skewed by individual events. Omitting the Puyallup segment reduces the annual fatal collisions from 4.4 to 1.5, which corresponds with an 81 percent reduction.

The rate of fatal and serious-injury median collisions for individual segments is presented in Figure 1.5. This graph presents a comparison of the periods before and after cable barrier was installed.

Rates* of median collision per 100 million VMT before and after cable barrier installation

Figure 1.5



Source: WSDOT Transportation Data Office
The numbers in parenthesis indicate the number of collisions in the calculation.

* Collision rates are based on vehicle miles traveled (VMT) in the “before” and “after” periods. The “before” period represents a 5 year period and the “after” period varies based on the length of time cable has been installed. Therefore, one or more collisions within a short period of time “after installation” will produce a higher rate (longer bar) than an equivalent number of collisions in a “before” installation.

Cable median barrier has reduced cross-median collisions

Figure 1.6 illustrates cable median barrier's effect on cross-median collisions. Prior to cable barrier installation, there were 54.4 cross-median incidents per year in the 177 miles we studied. That number was reduced to 14.9 incidents per year after cable barrier was installed. The number of annual cross-median fatal and serious injury collisions dropped from 13.6 to 3.6 after cable barrier was installed. The short time period for the Puyallup SR 512 segment has skewed the annual fatal collision count where one cross-median fatality in this segment in eight months equates to 1.42 annual fatal collisions in the period after cable barrier was installed. Omitting this section yields an 85 percent reduction in the annual fatal collisions for the remainder of the cable barrier installation sites.

Figure 1.6

	Before	After	Percent change
Annual cross-median incidents	54.4	14.9	-73%
Cross-median collision rate (per 100 million vehicle miles of travel)	1.85	0.58	-69%
Annual serious-injury cross-median collisions	8.6	1.5	-83%
Annual fatal cross-median collision	5.0	2.2	-57%

Comparing low- and high-tension cable median barriers

Low-tension cable barrier installation

Low-tension cable median barriers have been used since the 1980s. They are based in part on the system developed in New York. Cables are mounted with J-bolts to posts placed 16 feet apart, and secured to concrete anchors buried every 2,000 feet. At the anchors, the cables are attached to springs and tightened. The springs are designed to expand and contract with temperature changes.

Low-tension cable barrier anchor

The cables tighten and flex as they bring the vehicle to a stop without redirecting it back into traffic or allowing it to cross the median. In standard crash tests, at over 60 mph and an impact angle of 25 degrees, the cables flex as much as 12 feet. If a vehicle hits the end of the barrier where the cables are anchored, the cables are designed to release from the anchor, lessening the force of impact transferred to people inside the vehicle.

High-tension cable barrier installation

During the last seven years, private manufacturing companies have developed high-tension systems that reduce deflection. This means cables don't flex laterally as far as their lower-tension predecessors, so they can be used in narrower spaces.

High-tension cable barrier anchor

Much like low-tension systems, high-tension cable median barriers typically involve three strands of steel cable-mounted on posts. The high-tension barriers used in Washington State string the cable through slots in the middle of the posts, typically spaced 16 feet apart. The anchors for this type of system have been placed as much as three miles apart, although other obstacles such as bridges, other barrier systems, or highway hardware often make that length impractical. Each cable is attached to its own anchor post and is designed to break free when struck by a vehicle.

Every 1,000 feet, cables are tightened at turnbuckles, applying more than 5,000 pounds of tension to the cable. Low-tension systems have about a third of that pressure. When a vehicle strikes the high-tension cable median barrier, the posts are designed to bend down, allowing the cables to slip out of their slots to catch the vehicle. In crash tests, the higher-tension cable flexed up to 10 feet, which is two feet less than the low-tension system.

High-tension systems have dominated Washington's cable median barrier installations since 2004. At the end of 2007, there were 43 miles of generic low-tension barrier in place and 134 miles of high-tension barrier. Washington has not installed any generic low-tension cable barrier since 2005.

A comparison of low-tension and high-tension cable barrier systems reveals a higher incidence of vehicles being redirected back into traffic lanes with high-tension cable barrier than with low-tension barrier (see Figure 1.7). The data show that the percentage of cross-median collisions is lower with the high-tension cable barrier installations. However, there is no clear indication whether the high-tension systems are actually performing better or whether changes in cable barrier placement are having a significant influence on the reduction in cross-median collisions.

Figure 1.7
Comparison of low-tension and high-tension cable barrier system performance

Barrier type	Barrier performance	Reported collisions	Not stated	No injury	Possible injury	Evident injury	Serious injury	Fatal
Low-tension	Contained in median	640 (87.0%)	16 (2.2%)	507 (68.9%)	62 (8.4%)	47 (6.4%)	6 (0.8%)	2 (0.3%)
	Redirected	52 (7.2%)	3 (0.4%)	40 (5.4%)	5 (0.7%)	3 (0.4%)	1 (0.1%)	0
	Cross-median	43 (5.8%)	0	14 (1.9%)	8 (1.1%)	10 (1.4%)	6 (0.8%)	5 (0.7%)
High-tension	Contained in median	316 (74.9%)	2 (0.5%)	254 (60.2%)	33 (7.8%)	24 (5.7%)	2 (0.5%)	1 (0.2%)
	Redirected	91 (21.8%)	4 (0.9%)	68 (16.1%)	12 (2.8%)	7 (1.7%)	1 (0.2%)	0
	Cross-median	14 (3.3%)	0	6 (1.4%)	2 (0.5%)	3 (0.7%)	1 (0.2%)	2 (0.5%)

Comparing cable barrier with other types of median barrier systems

Figure 1.8 shows a comparison of three barrier systems commonly used in the median on Washington's highways. This table presents collision data for all collisions with cable barrier through the end of 2007 and collisions with beam guardrail and concrete barrier from 2002 to 2006. The data in this table indicates that the experience with cable barrier in Marysville is an anomaly. When looking at the 167 miles of cable barrier installed in other locations, these data show that cable median barrier is more effective at reducing the risk of death and injury. For locations other than Marysville, the percentage of serious-injury and fatal collisions is lowest for cable barrier systems. These data show that 21 percent of collisions involving cable median barrier result in injury or death. Collisions with beam guardrail result in injury or death 38 percent of the time. Collisions with concrete barriers result in injury or death 39 percent of the time.

Figure 1.8

Comparison of three barrier systems commonly used in the median

Barrier type	Reported collisions	Not stated	No injury	Possible injury	Evident injury	Serious injury	Fatal
Cable barrier	1,158	25 (2.2%)	890 (76.9%)	122 (10.5%)	94 (8.1%)	17 (1.5%)	10 (0.9%)
Cable barrier (without Marysville)	865	21 (2.4%)	672 (77.7%)	87 (10.1%)	69 (8.0%)	13 (1.5%)	3 (0.3%)
Beam guardrail	2,204	55 (2.5%)	1,317 (59.8%)	493 (22.4%)	284 (12.9%)	40 (1.8%)	15 (0.7%)
Concrete barrier	7,004	156 (2.2%)	4,106 (58.6%)	1,772 (25.3%)	837 (12.0%)	96 (1.4%)	37 (0.5%)
Total	**10,366**	**236 (2.3%)**	**6,311 (60.9%)**	**2,387 (23.0%)**	**1,215 (11.7%)**	**153 (1.5%)**	**62 (0.6%)**

Cable barrier is more effective at stopping vehicles in the median than concrete barrier

Engineers analyzed 58 miles of concrete barrier installations and compared them to 177 miles of cable barrier. The concrete barrier segments were selected because they had some characteristics that were similar to highway locations with cable median barrier. Keeping vehicles in the median is an important measurement of median barrier performance. Vehicles that cross the median or are redirected back into traffic have a greater probability of involving additional vehicles. Multi-vehicle collisions result in higher numbers of injuries. For cable barrier, there is a slight shift (upward) in the percentage of vehicles that were redirected for 2007 compared to 2006. Through 2006, 10 percent of the vehicles were redirected and that increased to 12.4 with the addition of the 2007 collision data. In addition, 82.7 percent of the cable barrier collisions were contained in the median compared with 38 percent for concrete median barrier (Figure 1.9).

Figure 1.9

Comparison of cable barrier and concrete barrier performance

Barrier performance	Cable barrier	Concrete barrier
Contained in median*	956 (82.6%)	355 (38.0%)
Redirected**	145 (12.5%)	556 (59.6%)
Cross-median***	57 (4.9%)	22 (2.4%)
Total	**1,158**	**933**

* Contained in median: The vehicle hit the barrier and did not re-enter any lanes of traffic.

** Redirected: The vehicle hit the barrier and rebounded into the lanes of traffic.

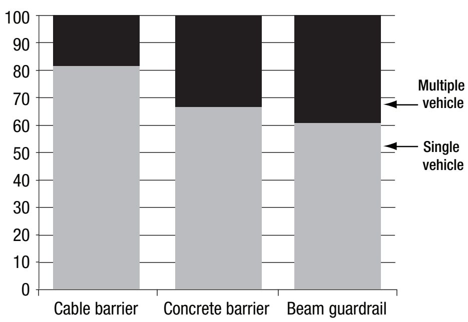
*** Cross-median: The vehicle hit the barrier, went across the median, and entered the opposing lanes. To be conservative, WSDOT considered any incident as a cross-median incident whether or not there was a collision with opposing traffic. In our analysis, there were 32 cross-median incidents involving cable barrier where there was not a collision with opposing traffic: 56 percent of the total.

Figure 1.10

Percentage of single- and multi-vehicle collisions with barrier types

2002-2006*

Percent



*Time period analyzed for concrete barrier and beam guardrail collisions.

Fewer multi-vehicle collisions occur with cable barrier use

Figure 1.10 illustrates the percentage of collisions with various barrier types in a comparison of single-vehicle and multi-vehicle collisions. Cable barrier collisions involve multiple vehicles 18 percent of the time. That number increases to 33 percent with concrete barrier and 39 percent with beam guardrail.

Figure 1.11

Number of injuries per collision

Collisions	Cable barrier	Concrete barrier	Beam guardrail
Single-vehicle collisions	0.19	0.45	0.46
Multiple-vehicle collisions	1.00	0.69	0.70
All collisions	0.33	0.53	0.55

Figure 1.11 illustrates the number of injuries per collision event with the various barrier types, with single-vehicle and multi-vehicle collisions. Cable barrier collisions result in lower numbers of injuries per collision than other barrier types.

Figure 1.12

Concrete barrier shows a slightly lower percentage of cross-median collisions

	Low-tension cable barrier (43 miles) 1995-2007	High-tension cable barrier (134 miles) 2004-2007	Concrete barrier (58 miles) 2002-2006
Cross-median incidents	43 (5.8%)	14 (3.3%)	22 (2.4%)
Cross-median rate (per 100 million vehicle miles of travel)	0.62	0.50	0.28
Fatal crashes where barrier was impacted	7 (0.9%)	3 (0.7%)	7 (0.8%)
Deaths from collisions where barrier was impacted	11	4	10
Fatal crash rate (per 100 million vehicle miles of travel)	0.10	0.14	0.13

Concrete barrier collisions indicate a slightly lower frequency of cross-median collisions, but high-tension cable barrier systems are approaching the effectiveness of concrete barrier

- 97.6 percent of the collisions with concrete barrier did not reach the opposing lanes
- 96.7 percent of the collisions with high-tension cable did not reach the opposing lanes
- 94.2 percent of collisions with low-tension cable barrier did not reach the opposing lanes

An analysis of 58 miles of concrete median barrier reveals that in 2.4 percent of the collisions with concrete barrier, the vehicle traveled over or through the barrier and reached the opposing traffic lanes. For high-tension cable barriers, which amount to 80 percent of the cable barrier mileage, 3.3 percent of the collisions crossed the median and reached the opposing traffic lanes. Of those 3.3 percent, 19 percent impacted an opposing vehicle—or 0.9 percent of all collisions. For low-tension cable barrier, 5.8 percent of the collisions crossed the median and reached the opposing traffic lanes. Of those 5.8 percent, 48 percent impacted an opposing vehicle or 2.8 percent of all collisions.

Cable barrier is effective in reducing rollover collisions in the median, although it may not contain a vehicle that is already rolling

Reducing rollover collisions is significant because injury severity increases when vehicles overturn. Vehicle occupants are subjected to a wider range of forces and more frequent impacts with vehicle components. Figure 1.13 illustrates an overall reduction of 37 percent for all rollover collisions in the median. For serious-injury collisions, the reduction is 69 percent, and for fatal collisions, a reduction of 74 percent was found.

Figure 1.13

Cable barrier is effective in reducing rollover collisions in the median

	Before	After	Percent change
Annual median rollover collisions	83.4	52.1	-37%
Median rollover collision rate (per 100 million vehicle miles of travel)	2.86	1.45	-49%
Annual serious-injury median rollover collisions	8.4	2.6	-69%
Annual fatal median rollover collisions	2.8	0.7	-74%

No barrier can completely reduce the risk of injury and death for drivers who leave the road

Many factors contribute to the survivability of a crash and no barrier can protect vehicle occupants in every situation. Weather and roadway conditions; speed and size of the vehicle; impact angle; influence of drugs and alcohol; attentiveness of the driver; use of seat belts; and driving tactics and strategies can all play a role in the outcome of an incident. Good driving and vehicle maintenance practices are effective ways to reduce crossover collisions.

In 2007, there were five collisions reported in the median that resulted in six fatalities where cable median barrier is installed. Not all of these collisions involved the cable median barrier, and not all cross-median collisions resulted in a fatality. Below are summaries of the factors involved in some of the most highly publicized collisions:

Summary of fatal cross-median collisions in 2007

I-5, Milepost 200, Marysville – Feb. 13, 2007: The driver of an Infinity QXR sport utility vehicle entered I-5 southbound at 88th Street and traveled across three traffic lanes, drove over one cable median barrier, crossed the median, traveled through a second cable median barrier, and hit a northbound bus. The Infinity driver was killed. Detailed information about this crash can be found in the June 2007 report.

I-5, Milepost 138, Fife - July 22, 2007: The driver of an Acura Integra was traveling southbound at a high rate of speed (reported between 80 and 100 mph) and was passing vehicles in all lanes. The driver lost control of the vehicle, entered the median and went under the cable barrier. The Acura collided with two vehicles in the northbound lanes. Toxicology tests revealed that the driver of the Acura was under the influence of methamphetamines. The driver of the Acura was killed. The other drivers suffered non-life-threatening injuries.

SR 512, Milepost 4, Tacoma – Nov. 19, 2007: The driver of a Volkswagen Golf was traveling westbound at a high rate of speed (reported in excess of 90 mph) and lost control. The Volkswagen entered the median, engaged the cable barrier, and went under the barrier into the eastbound lanes, hitting a semi-trailer truck in the eastbound lanes. The driver of the Volkswagen was killed. The driver of the truck did not suffer any injuries.

Summary of serious-injury median collisions in 2007

I-5, Milepost 85, north of Centralia – Nov. 7, 2007: The driver of a Honda Civic traveling northbound at approximately the 70 mph speed limit lost control and entered the median. The vehicle went under the cable barrier and entered the southbound lanes where it hit a pickup truck. The Honda Civic had an after-market suspension installed that could have lowered the vehicle up to three inches. The driver of the Honda suffered serious injuries and the driver of the pickup suffered minor injuries. The driver of the Honda was not wearing a seat belt.

I-5, Milepost 138, Fife – Aug. 25, 2007: The driver of a Lincoln Towncar was traveling northbound, lost control of the vehicle, and entered the median. The vehicle drove up the slope in the median, engaging the cable barrier with the rear undercarriage of the vehicle. The vehicle entered the southbound lanes and struck another vehicle, which started a chain reaction collision with six other vehicles. A total of seven people were transported to local hospitals with injuries, the most severe being an unbelted passenger who was in the backseat of the Towncar and ejected from the vehicle.

Summary of other fatal median collisions in 2007

I-90, Milepost 186, Moses Lake – Feb. 19, 2007: The driver of a Toyota Corolla was traveling eastbound, lost control of the vehicle, and entered the median. The vehicle rolled over several times but did not contact the cable barrier. The driver was killed.

SR 512, Milepost 11 – June 26, 2007: The driver of a Scion TC was traveling eastbound in the outside lane. The driver made a sudden lane change and was hit on the driver's side by a semi trailer truck, also traveling eastbound. The Scion entered the median and hit the cable barrier. A passenger was ejected from the car. The driver of the Scion, who did not use a seat belt, and the ejected passenger suffered fatal injuries. The driver of the truck was not injured.

WSDOT's evaluation of motorcycle collisions

- **Motorcyclists have concerns about cable median barrier**

  As noted in the June 2007 report, many motorcyclists have expressed concerns about cable barrier and motorcycle safety. There is a perception among motorcyclists that cable barrier isn't designed to protect them and would potentially cause harm if they hit it.

- **International studies have been conducted on this topic**

  The perception that cable barrier is a hazard to motorcyclists has been studied in several other countries. In 2006 Transit New Zealand sponsored a review of international research and practices on the use of cable barriers and published a position paper. This paper cited several European reports and concluded that "…whilst WRSBs [wire rope safety barriers] have the potential to cause serious injury to errant riders, so do all road safety barriers." They went on to say that "there is no reliable evidence to indicate that WRSBs present a greater risk or less risk than other barrier types, or indeed, no barrier at all."

  In January 2008 a meeting of the International Research Activities subcommittee of the Transportation Research Board's Roadside Safety Design committee was dedicated to addressing motorcycle issues. This meeting included presentations from representatives from Australia, Sweden, the United Kingdom, Italy, Spain, Germany, France, and the United States. At this meeting it was noted that while barrier impacts by motorcyclists are more severe than collisions with other hazards, there is no clear proof that cable barriers are a greater hazard for motorcyclists.

- **Washington's experience with motorcycle collisions**

  WSDOT will continue to analyze collisions involving motorcycles hitting median barrier. We have found no significant difference in injury severity regardless of what type of median barrier motorcyclists struck. In any collision, motorcyclists are relatively unprotected because they don't have many of the safety features found in cars, such as seat belts and airbags. Consequently, the injury rate when motorcycles hit barrier is much higher than the rate when automobiles hit barrier.

  We reviewed motorcycle collision data from 2003 through 2007, examining reported collisions involving motorcycles for the period after cable was installed. We found 48 reported collisions involving motorcycles (of all types) within the limits of the cable barrier installations. Of these 48, only four (eight percent) actually involved the cable barrier. By contrast, a similar look at all other vehicles shows that 24 percent (997 of 4200) of the reported collisions involved a vehicle striking the cable barrier.

- **Collisions involving motorcycles and cable barrier**

  Through the end of 2007, there have been four collisions involving motorcycles and cable median barrier in Washington State:

  I-5, Milepost 253, Bellingham – Oct. 25, 2007: A motorcycle was traveling in the left lane of northbound I-5 in Bellingham when a bolt on the rear of the motorcycle sheared off, causing the rear tire to lock up. The motorcycle veered off the road to the left into the median and struck two posts of the low-tension cable barrier. There were no injuries in this collision.

I-5, Milepost 222, Mt. Vernon – Oct. 23, 2007: A motorcycle traveling on northbound I-5 in the Mt. Vernon area was weaving through traffic at a high rate of speed when it struck the rear of a vehicle in the right lane. The driver was ejected, and the motorcycle slid across the two left lanes into the high-tension cable median barrier. The driver ended up on the pavement in the left lane, suffering serious injuries (severe head trauma). The driver was found to be under the influence of alcohol.

SR 512, Milepost 9, Puyallup – July 25, 2007: A motorcycle traveling in the left lane of eastbound SR 512 near Meridian Street ran off the roadway to the left and struck the high-tension cable barrier. The driver was apparently on the motorcycle when it contacted the barrier. The driver received evident injuries (arm abrasions).

I-5, Milepost 9, Clark County – Aug. 8, 2004: A motorcycle was traveling in the left lane of northbound I-5 near SR 502 when the front tire blew out. The motorcycle overturned in the lanes, ejecting the driver and a passenger. It is unclear whether either of the riders contacted the low-tension cable barrier. Both riders received evident injuries (contusions and lacerations).

- **Motorcycle-vehicle collisions**

  In addition, we identified two collisions where a vehicle crossed a median and struck a motorcyclist. Both of these collisions resulted in fatal injuries:

  I-90, Milepost 13, east of Bellevue – July 27, 2006: The driver of a vehicle traveling on westbound I-90 apparently blacked out from a medical condition and crossed the median. The vehicle struck a motorcycle traveling in the eastbound direction. The driver of the motorcycle was killed. The median at this location is approximately 70 feet wide and does not meet the WSDOT criteria for median barrier.

  SR 18, Milepost 19, Tiger Mountain – April 23, 2005: The driver of a vehicle traveling on westbound SR 18 lost control and entered the median. The vehicle began to spin as it crossed the median and entered the eastbound lanes where it struck a motorcycle. The driver and passenger on the motorcycle were killed. This section of highway has since been reconstructed and a beam guardrail median barrier installed.

- **Planned research on motorcycle safety**

  WSDOT proposed national research on crashes between motorcycles and barrier. This research, entitled "Identification of Factors Related to Serious Injuries in Crashes of Motorcyclists into Traffic Barriers," was selected for funding as part of the National Cooperative Highway Research Program (NCHRP).

  This study will identify characteristics involved in serious-injury and fatal collisions involving motorcycles and traffic barriers. We will investigate characteristics related to the drivers involved, the collision types, the barrier types, the roadway geometry and conditions, the vehicle types, and the environmental conditions. We will also identify specific characteristics that could be studied further to develop potential ways of improving motorcycle safety.

  This study will begin in 2009 and the results should be available in 2012.