Chapter 3: The evolution of WSDOT's use of cable median barriers and current performance data on serious crashes averted

How does automotive design affect median barrier?

Automotive design evolves constantly. Sometimes these evolutions complement median barrier. Examples on modern vehicles include airbags, anti-lock brakes, crush zones and seatbelts. However, at times automotive design outpaces our ability to design and upgrade median barriers, which affects median barrier effectiveness. For example, taller vehicles will interact differently with barriers than those that are lower to the ground, heavier vehicles will interact differently than lighter ones, and more flexible vehicles will interact differently than more rigid ones. Adjusting median barriers to accommodate these trends takes creative engineering, time and money.

Like most technologies, cable barriers have improved over time and continue to improve.

Cable barriers have been used in Washington for more than 70 years to help protect drivers who have driven their cars off the road. Today's cable barriers differ significantly from their 1930s counterparts. Slack cables strung between concrete or wood posts have been replaced by high-tension cables laced through steel posts that give way in a crash.

Cable barrier improvements are the result of years of tests and studies. Washington state has been a national leader in adopting and contributing to evolving safety designs and policies. In 1977, cable barrier first was incorporated in national design guidelines for use in highway medians. The first modern three-cable median barrier system was introduced in national guidelines in 1988. In 1996, WSDOT sponsored the first crash tests of modern systems' crashworthiness. Two years later, the Federal Highway Administration implemented crashworthiness criteria for everything placed on the side of the highway, establishing requirements for more consistent crash testing nationwide.

No barrier can save lives in every crash, and waiting for a perfect system would do nothing to reduce the risk of injury and death to vehicle occupants. WSDOT will continue to use the latest information available to responsibly improve highway safety while keeping traffic moving.

Figure 3.1

Evolution of cable barrier design

1930s – 1960s:	Two-strand steel cables used as guardrails. Cables ¾-inch diameter, supported by 9-inch diameter concrete posts or 8-inch by 8-inch wood posts spaced 15-feet apart. Top cable 29 inches off the ground. Bottom cable 15 inches off the ground.
Early 1960s:	California uses two-cable system with ¾-inch cables, both 27 inches off the ground. The system has never been tested using modern crash test criteria.
Late 1960s:	Three ¾-inch cables supported by steel posts 16 feet apart. Cables evenly spaced. Top cable 27 inches off the ground. Bottom cable 21 inches off the ground. All cables mounted on the same side of supporting posts.
1990s:	Cable configuration changes for median use. Middle cable is mounted on opposite side of posts. Cables still ¾-inch diameter on posts 16 feet apart. Top cable 30 inches off the ground, bottom cable 21 inches off the ground. Cables evenly spaced from each other, 4 ½ inches apart.
2000s:	Private manufacturers develop high-tension cable systems that slow vehicles faster and with reduced deflection, meaning they flex less, decreasing lateral distance required to absorb crash. In 2004, WSDOT begins using high-tension cables in median.

First barriers

Cable barriers were used to keep people from driving off cliffs or into roadside obstacles such as trees or rocks as early as the 1920s.

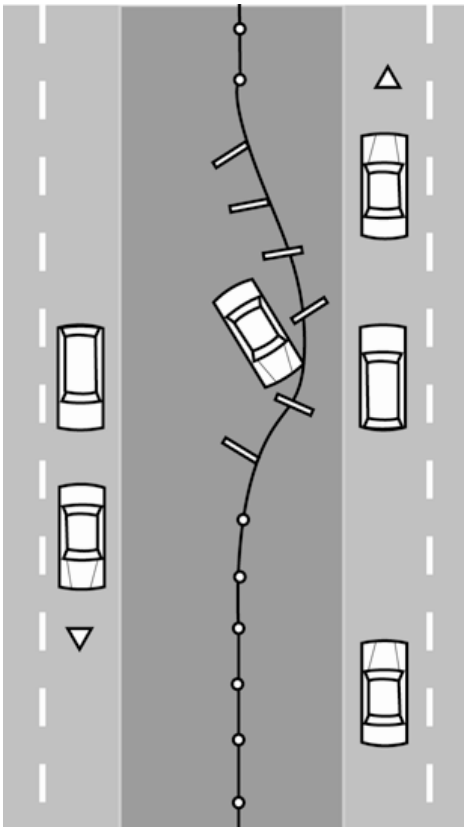
In its earliest uses, little attention was paid to the consequences of hitting the barrier itself. The cables effectively caught cars, but they directed them head-on into rigid concrete or wood anchoring posts. In some cases, drivers would have fared better without the barrier.

It wasn't until the 1960s that guidelines were developed for testing barriers intended to improve safety by crashing vehicles into them. In a one-page document, the Transportation Research Board, then the Highway Research Board, outlined guidelines for crash tests: Safety devices intended for roadside use should be tested by striking them at a 25-degree angle and at a 7-degree angle with a vehicle traveling 60 mph.

By the late 1960s, the New York State Department of Transportation had developed a three-strand cable system mounted on steel posts that was more forgiving than other roadside barriers. The posts were designed to flex and bend out of the way when a vehicle hit them or exerted enough force on the cables to push the posts down.

Figure 3.2

Cable barrier deflecting during impact



Cable barrier is designed to flex and absorb the force of impact when struck while keeping the vehicle striking it within the median.

Moving to medians

In the early 1980s, Missouri started using cable barriers between opposing lanes of traffic, in addition to using them along the side of the highway. To address the possibility of vehicles striking the barrier from both sides, the middle cable was mounted on the opposite side of the supporting posts.

WSDOT became interested in using cable barriers in medians in the early 1990s. In 1995, cable barrier was installed along two miles of I-5 median in Marysville, where previously there was no barrier, and where WSDOT identified a history of cross-median collisions during a routine traffic safety review. The median in that two-mile stretch was a grassy 40-foot wide ditch with 6H:1V slopes from the lane to the bottom of the ditch, meaning the ground drops 1 foot for every 6 feet of horizontal distance.

According to roadside crash test information, cars striking cable barriers would deflect, or flex the cable laterally, up to 12 feet, so WSDOT engineers were comfortable that the Marysville median allowed plenty of room.

The cable was placed 12 feet from northbound lanes, but when a southbound vehicle crashed into it, the cable stretched laterally more than expected, allowing the vehicle to edge into the opposing lane.

The crash prompted WSDOT officials to examine whether the cable median barrier flexed differently than cable roadside barrier. In 1996, WSDOT sponsored a study by the Texas Transportation Institute, at Texas A & M University. Researchers used a small car to conduct what may have been the first crash test for the three-cable median barrier. This test followed crash test criteria which had been formally adopted by the Federal Highway Administration in 1993.

WSDOT/WSP

The car deflected only 8 feet during the test, satisfying researchers that the crash that flexed the barrier more than 12 feet was an anomaly.

In 2000, WSDOT and the Federal Highway Administration commissioned further testing of cable median barriers, using a pickup truck to test how well the cables restrain heavier vehicles.

In both the car and pickup tests, the cable system stopped the vehicles, preventing them from crossing the median or bouncing back into traffic, and the impact on vehicle occupants was within acceptable limits outlined in national crash test standards.

WSDOT continued its methodical evaluation of cable median barrier effectiveness, publishing studies including:

- **Washington State Cable Median Barrier In-Service Study** – In this 2003 study, WSDOT researched the performance and costs of cable median barriers used in three places, along 24.4 miles of Washington highways, through 2002. Researchers found that through 2002, the number of crashes increased substantially because cars were hitting a barrier that wasn't there before, but the number of fatal or disabling crashes decreased substantially.
- **I-5 Marysville Cable Median Barrier** – In 2006, WSDOT carried out this study in response to concerns about crashes in Marysville that involved vehicles crossing the median into opposing traffic. The study reported that 171 crashes along I-5 in Marysville involved people driving off the road and hitting the cable median barrier. Eighteen of those vehicles crossed into opposing traffic. This was a significantly higher rate than elsewhere in the state.

Research reinforced previous state and national findings that cable barrier was the most effective tool available for restraining cars driven off the road in some locations.

In 2003 and 2005, the state Legislature dedicated millions of dollars toward improving roadside safety. Part of those efforts involved installing cable median barriers because volumes of research showed they would be most effective.

Eliminating old guardrail

Research and studies are a starting point for updating old systems. However, it is impractical – if not impossible – to change all existing barriers on highways statewide with every new piece of information. As WSDOT learns about the results of new research, it may revise designs or placement guidelines for new installations. The process of replacing older barriers can take years to fund and implement.

With the 2003 and 2005 gas tax increase construction programs, WSDOT focused on improving roadside safety. The Nickel package set aside $20 million to replace outdated guardrails, and the Transportation Partnership Account budgeted $47 million for low-cost improvements to areas with no barriers and an above-average number of deadly and disabling crashes involving cars driven off the road.

WSDOT will replace about 75 miles of old guardrail and improve 400 miles of highway with projects such as moving large rocks and telephone poles, flattening slopes or installing barriers.

Low- and high-tension cable median barriers

Low-tension

Low-tension cable median barriers have been used since the 1980s. They are based on the 1960s system developed in New York. The only difference is that the middle of three cables is mounted on the opposite side of flexible posts.

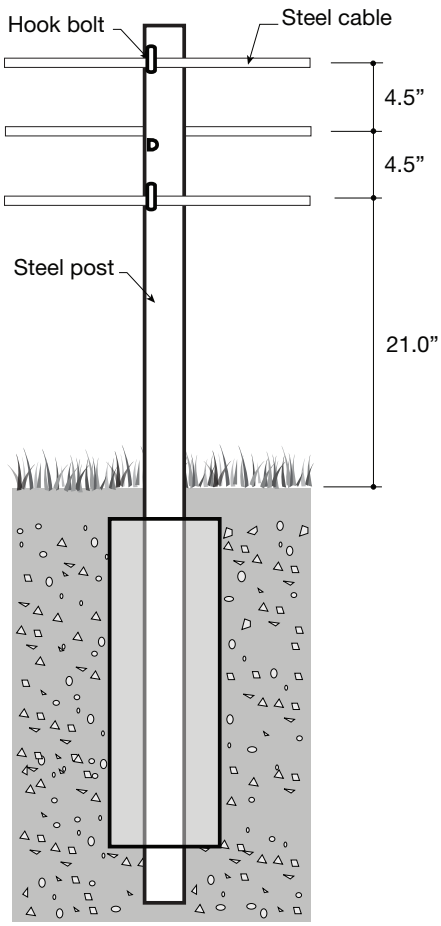
Cables are mounted with J-bolts to posts placed 16 feet apart, and secured to concrete anchors buried every 2,000 feet. At the anchors, the cables are attached to springs and tightened. The springs are designed to expand and contract with temperature changes.

The system is designed so that a vehicle hitting the barrier pulls the cables out of the J-bolts. The cables tighten and flex up to 12 feet laterally as they bring the vehicle to a stop without bouncing it into traffic or allowing it to cross the median. 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.

High-tension

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

Figure 3.3
Low-tension cable barrier



WSDOT began using these systems in 2004. In tests, high-tension cable barriers stopped vehicles faster than low-tension cables, while exerting less force on the vehicle occupants. Much like low-tension systems, high-tension cable median barriers 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, also 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 often make that 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. The higher tension allows them to flex up to 10 feet, two feet less than the low-tension system.

Median width requirements

Cable barriers are known to stop vehicles and cause less damage on average than other types of barriers. But like all barriers, they are not appropriate in all situations.

Their comparative elasticity absorbs the forces of impact, stopping the vehicle, while keeping it out of traffic and reducing the force exerted on people in the vehicle. But that elasticity requires space to work effectively. Also, research findings vary in terms of how narrow a median needs to be before it needs any type of barrier. National guidelines recommend barriers in medians that are 30 feet or narrower. Some states have expanded the use of median barrier to medians that are up to 75 feet wide.

In 2002, Washington adopted a more stringent policy to install some type of barrier in freeway medians that are 50 feet or narrower. In most locations, medians where WSDOT uses cable barrier are more than 30 feet wide.

Low-tension end

High-tension end

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Evolution of crash test criteria, and crashworthiness defined

The evolution of protective highway barrier design has been accompanied by, and often led to, new designs for barrier use and durability.

1960s – First crash test criteria

A one-page document by the Transportation Research Board, then the Highway Research Board, outlined the first crash test standards for barriers: Safety devices intended for roadside use should be tested by striking them at a 7-degree and a 25-degree angle with a vehicle traveling 60 mph. The current criteria, found in the National Cooperative Highway Research Program (NCHRP) Report 350, are about 132 pages long.

1977 – Cable median barriers included in national design standards

The American Association of State Highway and Transportation Officials included information on a two-cable median barrier in its 1977 Guide for Selecting, Locating, and Designing Traffic Barriers. In 1988, information on a three-cable median was included in its Roadside Design Guide. New York and Missouri already were using cable barriers in medians.

1988 – Crashworthy defined

The American Association of State Highway and Transportation Officials defined "crashworthy" in its Roadside Design Guide: "A feature that has been proven acceptable for use under specified conditions either through crash testing or in-service performance." According to national standards, a barrier is crashworthy if it successfully restrains a vehicle, doesn't allow it to roll over, doesn't bring the vehicle to a violently abrupt stop and doesn't puncture the vehicle striking it.

1993 – Federal government adopts crashworthiness procedures

The Federal Highway Administration adopted the NCHRP crashworthiness procedures and required that all new barriers in the National Highway System meet the crashworthiness criteria by 1998.

Barrier use on slopes

Federal research first addressed performance of guardrails and cable barriers on slopes in the 1970s. But information about the way barriers perform on slopes remains limited because most tests have been conducted on level ground.

Washington state's guidelines are based on available information. WSDOT recognizes that the information is evolving and that testing the outcome of every crash scenario would be impossible.

In 1978, both cable barriers and beam guardrails were tested on 6H:1V slopes, meaning for every 6 feet of horizontal distance, the ground drops 1 foot vertically. Tests indicate that when a vehicle goes off the road on a 6:1 slope, its bumper may be higher than normal because the car's full weight is not on the tires as it rides downhill. The bumper will remain high until the suspension compresses under the weight of the car.

Crash tests of vehicles striking guardrail placed on a 6:1 slope, 12 feet down from the top, found vehicles hit the rail higher than normal and went over the guardrail.

Crash tests showed cable barrier is appropriate on 6:1 or shallower slopes. Research indicates concrete barrier should be used only on even flatter surfaces – 10:1 or flatter.

Cable barrier use in ditches

National research conducted in April 2004 revealed that sedans could nose under and lift the cable barrier when the barrier is placed near the bottom of the ditch.

The tests, conducted by the Federal Highway Administration, used cable barriers installed in a ditch with 6:1 slopes that allowed the vehicle to drive over the bottom of the ditch before hitting the barrier on the opposite, uphill side. The barrier was effective when placed within a foot of the ditch bottom, but vehicles could nose under barriers placed 4 feet from the bottom.

Researchers found that vehicle suspension would compress, pulling the body of the car down toward the tires until the tires hit the bottom of the ditch. With barriers 4 feet uphill from the bottom of the ditch, the compression would allow the front bumper and hood of the car to push under the barrier before the suspension rebounded.

A month after the federal tests were conducted, WSDOT directed engineers to avoid placing cable barrier between 1 foot and 6 feet from the bottom of the ditch on new projects until a final recommendation was made. Since then, national roadside design guidelines, from the American Association of State Highway and Transportation Officials, advised designers that cable barriers are most effective outside 1 foot to 8 feet from the bottom of a sloping median ditch. WSDOT led the association's efforts to update the Roadside Design Guide.

Other states using cable barrier

Cable barriers have been used in medians for decades, but their use became widespread only since the 1990s.

The New York Department of Transportation developed the first crash-tested cable barriers for roadside use in the 1960s. It was the first state to install them in medians. New York also was the first to evaluate the performance of cable median barriers that already were in use.

Figure 3.4

From 2000, installation of cable median barrier on Washington state highways has grown more than 165 miles.

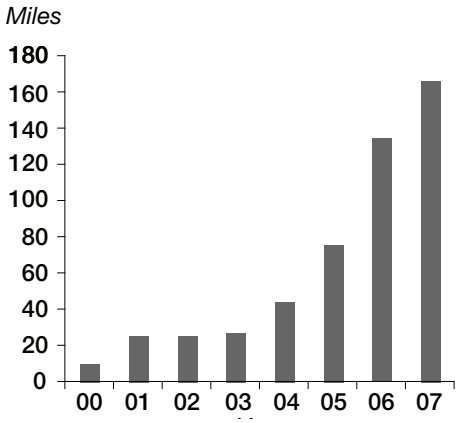


Figure 3.5

Median and cross-median fatal and disabling collisions

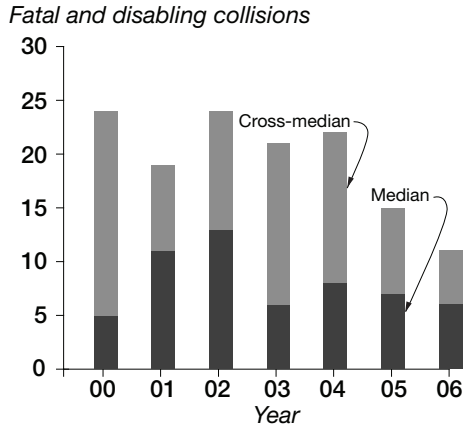
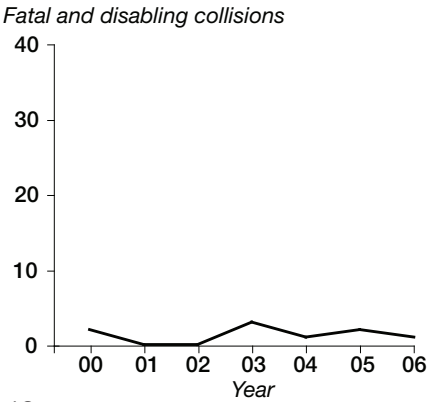


Figure 3.6

Where cable median barrier has been installed, the number of fatal and disabling collisions through cable median barrier has been very small.



In the 1980s, Missouri was next to experiment with cable median barrier. That state used a 33-inch tall low-tension cable system in areas where cross-median crashes occurred. Based on good performance results, Missouri installed more cable median barrier, and today the state has about 250 miles of it along highways.

North Carolina began installing test sections of cable median barrier in the mid-1990's, and as a result of studies following its installation, the state's policy now is to install some type of barrier in all medians 70 feet wide or narrower. Cable barrier accounts for about 600 miles of cross-median protection in North Carolina.

Currently, Washington state has more than 165 miles of cable median barrier installed and has plans to install another 20 miles by 2008.

(See Appendix B for detailed information about other states use of cable median barrier.)

Figure 3.7 States reporting cable median barriers

Year	No.	States reporting cable median barrier use
1997	4	North Carolina, Washington, South Dakota and Missouri.
2004	14	Alabama, Arizona, Iowa, Mississippi, Missouri, Nebraska, Nevada, New York, North Carolina, South Carolina, Washington, Wisconsin, New Jersey and Minnesota
2006	25	Maine, Pennsylvania, Virginia, North Carolina, Georgia, Florida, Alabama, Ohio, Indiana, Illinois, Wisconsin, Iowa, Missouri, Arkansas, Texas, Oklahoma, North Dakota, Montana, Idaho, Washington, Oregon, Nevada, Utah, Colorado, Arizona.

Looking ahead

Part of WSDOT's continued commitment to improving highway safety includes watching for innovations and improvements in technology and testing techniques.

Research is under way that should provide WSDOT with new information about barrier performance. This research includes a review of how different barriers perform when struck by larger trucks and SUVs that recently have gained popularity. The tests will consider how barriers might be improved to respond to vehicles with a higher center of gravity and higher bumpers.

Also, researchers are analyzing the use of all barriers on slopes. Cable median barrier has been researched more than any other type of barrier, and these tests should update information about the performance of other barriers to the same level.

WSDOT is aware of experimental technologies, monitors their progress and sometimes participates in their development.

Current performance data on serious crashes averted

WSDOT has installed more than 165 miles of cable median barrier along highways in Washington state. WSDOT engineers analyzed data for the locations where cable median barrier had been installed by the end of 2006. These locations totalled almost 135 miles. Much of the information in this chapter is based upon this analysis and indicates what effect the cable median barrier had on safety.

The number of cross-median crashes and the number of fatal and disabling median crashes has dropped. This is even more significant considering that the risk for crashes is higher because there are more vehicles on the road. With the exception of I-5 in Marysville, no one has died in a cross-median collision since the cable median barrier was installed.

Figure 3.8

Cable median barrier program, limited access highway

WSDOT engineers performed a more detailed review of each location where cable median barrier had been installed before the end of 2006. They compared collision and injury data for the five-year period before the cable median barrier was installed with data after it was installed. Here's what this research showed: Cable median barriers significantly reduce the number of cross-median collisions and fatal and disabling injury collisions.

Fatal and disabling injury median collisions dropped 71 percent after cable median barrier was installed: The average annual number of disabling and deadly median collisions decreased from 18.6 to 5.3 per year. The average annual fatal median collisions dropped from 7.2 per year to 0.8 per year, a reduction of 89 percent, with all of the fatal collisions after installation occurring in the Marysville section. Collision rate data can be found in figure 3.11. When factoring in the traffic volume, the rate of fatal and disabling median incidents dropped from 0.88 collisions per 100 million vehicle miles traveled to 0.33 collisions per 100 million vehicle miles traveled, a reduction of 63 percent.

Figure 3.9

Collision rates before and after cable median barrier installation, through 2006

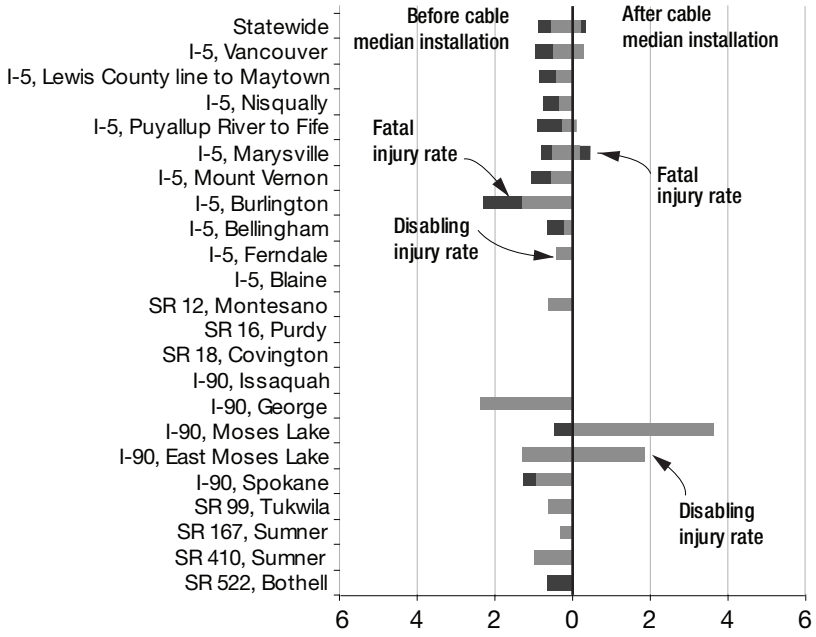
	Before	After	Percent change
Annual median collisions	168	444	+164
Median collision rate (per 100 million vehicle miles)	8.00	14.55	+82
Annual disabling median collisions	11.4	4.5	-61
Annual fatal median incidents	7.2	0.8*	-89
Disabling median collision rate (per 100 million vehicle miles)	0.54	0.22	-59
Fatal median collision rate (per 100 million vehicle miles)	0.30	0.10	-69

* Some cable barrier data includes all data available from the date when the barrier was installed, which in some locations occurred before 2002

The rate of fatal and disabling collisions for specific highway locations before and after cable median barrier was installed is shown in figure 3.9. While the rate of disabling collisions shows an increase for the I-90 sections in the Moses Lake area, the rate is distorted due to the short evaluation period and low traffic volumes in those locations.

Figure 3.10

Median collisions per 100 million vehicle miles traveled, before and after cable median barrier installation



Source: WSDOT Transportation Data Office

Cable median barriers significantly reduced the number of cars crossing the median: The number of cross-median collisions and cars crossing into oncoming traffic decreased 74 percent after cable median barrier was installed, from 42.4 per year to 11.2 per year. The rate of cross-median collisions dropped from 2.01 collisions per 100 million vehicle miles traveled to 0.61 collisions per 100 million vehicle miles traveled, a 70 percent reduction. These numbers suggest that in 10 years, 64 fatal collisions and 69 disabling collisions could be avoided in the sections where we have installed cable median barrier. With increases in traffic volume, that estimate could be even higher.

Figure 3.11

Cross-median collision rates before and after cable median barrier installation, through 2006

	Before	After	Percent change
Annual cross-median incidents	42.4	11.2	-74
Cross-median collision rate (per 100 million vehicle miles)	2.01	0.61	-70
Annual disabling cross-median collisions	5.2	1.5	-71
Annual fatal cross-median collisions	4.4	0.4*	-91

* All fatal collisions were in the Marysville section.

Cable median barriers increased the number of collisions reported: Installing cable median barrier increases the number of collisions reported because many of those collisions involve vehicles hitting a barrier that wasn't there before.

Previously, many drivers who entered the median may have stopped or regained control in the median without hitting anything. In the sections where cable median barrier was installed, the annual number of median collisions increased by 164 percent from 168 per year to 444 per year. The rate of median collisions increased from eight to 14.55 collisions for every 100 million vehicle miles, an increase of 82 percent. Most of these collisions only resulted in property damage.

How does cable median barrier perform compared with other barriers?

WSDOT engineers performed two studies, a systemwide study and a comparative section study, to assess the relative effectiveness of cable barrier, concrete barrier and guardrail.

The system-wide study reviewed nearly 10,000 median barrier collisions that occurred on Washington state highways during the last five years. For concrete barrier and beam guardrail, researchers analyzed collisions that occurred from 2002 through 2006 where a barrier was the first or second object struck by vehicles. This five-year period represents the most recent highway collision data available.

The comparative section study examined specific highway segments with cable median barrier and concrete barrier. WSDOT engineers compared 135 miles of highway with cable median barrier and 58 miles of highway with concrete median barrier. The engineers selected the concrete barrier locations because they had some characteristics that were similar to highway locations with cable median barrier and because they were locations that the public suggested were comparable to locations where WSDOT has installed cable median barrier.

To review results for specific highway locations, see Appendix A.

Figure 3.12

Median barrier effectiveness: Preventing injury, system-wide, 2002-2006*

Barrier type	Reported collisions	Not stated	No injury	Possible injury	Evident injury	Disabling injury	Fatal
Cable barrier	774	13 (1.7%)	599 (77.4%)	75 (9.7%)	70 (9.0%)	11(1.4%)	6 (0.8%)
Cable barrier (without Marysville)	510	9 (1.8%)	402 (78.8%)	46 (9.0%)	45 (8.8%)	8 (1.6%)	0
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 (59.8%)	1,772 (25.3%)	837 (12.0%)	96 (1.4%)	37 (0.5%)
Total	**9,982**	**224 (2.2%)**	**6,022 (60.3%)**	**2,340 (23.4%)**	**1,191 (11.9%)**	**147 (1.5%)**	**58 (0.6%)**

* Some cable barrier data includes all data available from the date when the barrier was installed, which in some locations occurred before 2002

Reducing the risk of death and injury: Cable barrier more effective than concrete; I-5 Marysville is an anomaly

The systemwide study revealed that 21 percent of crashes in medians where cable barrier is used resulted in injury or death. This is lower than the 39 percent of crashes that resulted in injuries or death where concrete barrier is used or 38 percent where guardrail is used. If I-5 in Marysville is excluded, crashes in medians with cable barrier result in the lowest percentage of disabling and fatal collisions at 1.6 percent. This is significantly lower than crashes in medians with concrete barrier at 1.9 percent and guardrail at 2.5 percent. I-5 in Marysville appears to be an anomaly because it is the only location with cable barrier where fatalities have occurred.

Cable barrier is more likely to stop vehicles in the median

Because concrete barriers are significantly more rigid than cable barriers, they perform differently in terms of restraining vehicles. Data from the comparative section study revealed that most vehicles that crashed into a concrete median barrier were directed back into lanes of traffic. Cable median barriers usually stopped vehicles within the median, preventing a second crash with another vehicle. Five percent of vehicles that struck cable median barrier went through the barrier and entered opposing lanes of traffic compared with 2 percent that went through concrete barrier.

Figure 3.13

Median barrier effectiveness: containing vehicles, comparative section study, 2002-2006*

Barrier performance	Cable barrier	Concrete barrier
Contained in median **	657 (85%)	355 (38%)
Redirected ***	76 (10%)	556 (60%)
Cross-median ****	41 (5%)	22 (2%)
Total	774	933

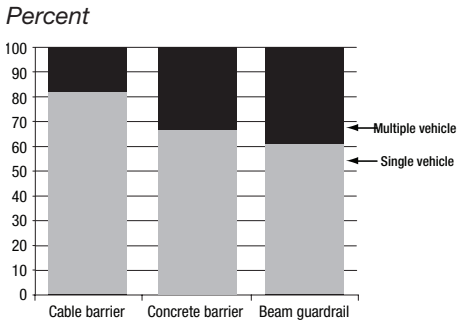
** **Contained in median:** The vehicle hit the barrier and did not re-enter any lanes of traffic.

*** **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.

Figure 3.14

Median barrier effectiveness comparison: number of vehicles involved in each incident, system-wide, 2002-2006*



Cable median barrier reduces the risk of multiple vehicle collisions

As Figure 3.14 shows, vehicles that hit cable barrier are significantly less likely to involve multiple vehicles than guardrail and concrete barrier.

Median barrier effectiveness: number of injuries per collision, system-wide, 2002-2006*

As Figure 3.15 shows, vehicles that hit cable barrier result in fewer injuries per collision than concrete barrier or guardrail.

Figure 3.15

	Cable barrier	Concrete barrier	Beam guardrail
Single vehicle collision	0.19	0.45	0.46
Multiple vehicle collisions	1.04	0.69	0.70
All collisions	**0.34**	**0.53**	**0.55**

Washington state highways

* Some cable barrier data includes all data available from the date when the barrier was installed, which in some locations occurred before 2002.

Concrete barrier more effective than cable at reducing the risk of cross-median collisions

As the comparative study in Figure 3.16 indicates, when compared with cable barrier, concrete barrier more effectively reduced the risk of cross-median collisions. However, crossing the median into oncoming traffic isn't the only concern for drivers. Because concrete barrier is more rigid than cable barrier, the overall risk of death is nearly equal to crossing into oncoming lanes because vehicles rebound off of the barrier into traffic, and they experience greater impact when crashing into the barrier. Five of the seven fatal concrete barrier crashes involved vehicles that were redirected into the lane of traffic. I-5 in Marysville appears to be an anomaly because it is the only location with cable median barrier where fatalities have occurred.

Figure 3.16

Median barrier effectiveness: cross-median and fatal crashes, systemwide, 2002-2006

	Cable barrier statewide (135 miles)	Cable barrier excluding I-5 Marysville (125 miles)	Concrete barrier (58 miles)
Cross-median incidents	41 (5%)	20 (5%)	22 (2%)
Cross-median rate (per 100 million vehicle miles traveled)	0.61	0.47	0.28
Fatal crashes	6 (0.8%)	0 (0%)	7 (0.8%)
Deaths	10	0	10
Fatal crash rate (per 100 million vehicle miles traveled)	0.10	0	0.09

What else did the data reveal about cable median barrier?

Cable median barrier significantly reduces the number of rollover collisions

Rollover collisions can occur when people drive off the road, sometimes in highway medians. WSDOT research revealed that cable median barrier significantly reduced the risk of rollover collisions, though when vehicles start to roll over before they hit the cable barrier it is unlikely to stop them. In eight incidents, a vehicle that rolled over crossed the median and entered the opposing lanes. Here's what WSDOT found regarding locations where cable barrier was installed in the median:

- The number of rollover collisions in the median decreased 43 percent, from 62.2 to 35.7 per year.
- The number of disabling and fatal rollover collisions decreased from 8.6 to 3.1 per year.
- The average annual fatal rollover collisions dropped from 2.4 per year to 0.3 per year, with all of the fatal rollover collisions on I-5 in Marysville.

When factoring in traffic volumes, the rate of rollover incidents dropped from 2.97 collisions per 100 million vehicle miles to 1.5 collisions per 100 million vehicle miles, a reduction of 50 percent, after cable median barrier was installed.

Figure 3.17 – Median rollover collisions for 135 miles of Washington state highway cable median barrier

	Before	After	Percent change
Annual median rollover collisions	62.2	35.7	- 43
Median rollover collision rate (per 100 million vehicle miles)	2.97	1.50	- 50
Annual disabling median rollover collisions	6.2	2.8	- 55
Annual fatal median rollover collisions	2.4	0.3*	- 88

* All fatal collisions were on I-5 in Marysville.

Little difference in performance between high-tension and low-tension cable median barrier

WSDOT compared high-tension cable barrier and low-tension cable barrier. With the exception of fatal collisions, which all occurred on I-5 in Marysville, there was not a significant difference in the overall injury severity. The percentage of cross-median collisions was less for the high-tension cable barrier (3.8 percent) compared with the low-tension cable barrier (5.6 percent). However, some of this difference may be due to the fact that the high-tension cable barrier has been installed more recently, after WSDOT revised guidance regarding placement on slopes.

Figure 3.18 – Injury severity by cable median barrier type

Barrier type		Reported collisions	Not stated	No injury	Possible injury	Evident injury	Disabling injury	Fatal
Low-tension	Contained in median	543 (87.9%)	12 (1.9%)	431 (69.7%)	50 (8.1%)	44 (7.1%)	4 (0.6%)	2 (0.3%)
	Redirected	40 (6.5%)	1 (0.2%)	30 (4.9%)	4 (0.6%)	3 (0.5%)	1 (0.2%)	1 (0.2%)
	Cross-median	35 (5.6%)	0	12 (1.9%)	7 (1.1%)	9 (1.5%)	4 (0.6%)	3 (0.5%)
High-tension	Contained in median	114 (73.1%)	0	97 (62.2%)	10 (6.4%)	7 (4.5%)	0	0
	Redirected	36 (23.1%)	0	28 (17.9%)	2 (1.3%)	5 (3.2%)	1 (0.6%)	0
	Cross-median	6 (3.8%)	0	1 (0.6%)	2 (1.3%)	2 (1.3%)	1 (0.6%)	0

WSDOT's analysis included an evaluation of variables to determine if any of these factors seemed to influence barrier performance:

Type of vehicle involved: The type of vehicle involved in the collision seems to have some influence on the outcome of the collision. It appears that passenger cars are more prone to cross-median collisions than other vehicle types (74 percent). Pickups, flatbed trucks, and vans appear to be more susceptible to rolling over in the median. While these vehicles were involved in 38 percent of median collisions, they account for 50 percent of the vehicles that rolled over.

Curves: Collision rates declined as the number of curves in the highway increased, however the difference in collision rates was not statistically significant.

Posted speed: The rate of collisions are statistically the same in locations where the posted speed limit is 70 mph compared with 60 mph. Fatal and disabling rates are greater at higher posted speeds.

Traffic volume: Sites with the lowest traffic volumes, less than 25,000 vehicles per day on average, exhibited the highest rate of median collisions and the highest rate of fatal and disabling collisions in both before and after a barrier was installed. This is to be expected since a single collision can have a significant affect on the rates in locations with lower traffic volumes. Rates for other traffic volumes were randomly dispersed.

Horizontal curve radius: The rate of median collisions does not appear to be influenced by the radius, or sharpness, of the horizontal curves.

Presence of shoulder rumble strips: The presence of shoulder rumble strips does not seem to influence barrier performance. Most locations with rumble strips were rural highways.