

Study of Box-Beam Median Barrier Accidents

JOSEPH V. GALATI, Bureau of Traffic Engineering,
 Pennsylvania Department of Highways

This study was performed to evaluate the effectiveness of a newly installed box-beam median barrier with respect to its ability to sustain vehicle damages and prevent median crossings. Approximately 9.4 miles of box-beam median barrier was inspected monthly for a 12-month period, and damages were classified and recorded. Of the 204 damages recorded, 153 (75 percent) were classified as minor, 41 (20 percent) medium, and 10 (5 percent) major, one of which was a breakthrough. The damages sustained by the box-beam barrier reflect its design concept, i. e., strong rail and weak posts. Eighty-four percent of all the box-beam damages were not reported to the police, indicating that motorists who hit the box-beam barrier were able to maintain control of their vehicles and continue on their trips.

•THE OBJECTIVE of this study was to determine how well a newly installed box-beam median barrier functions as an integral highway element of vehicle control with respect to sustaining vehicle damages and preventing median crossings. The study was conducted on I-83 and the Harrisburg Expressway, the major route connecting Harrisburg and York, 30 miles to the south, and Harrisburg and communities on the west side of the Susquehanna River.

The box-beam median barrier was installed on 4-ft wide inclined concrete median separating two 12-ft lanes in each direction. The top of the rail was 27 in. above the height of pavement (Fig. 1). Two sections of rail were spliced with two external splice

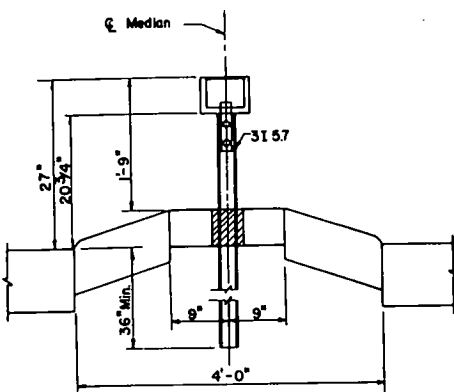


Figure 1. Installation of box-beam barrier in 4-ft median.

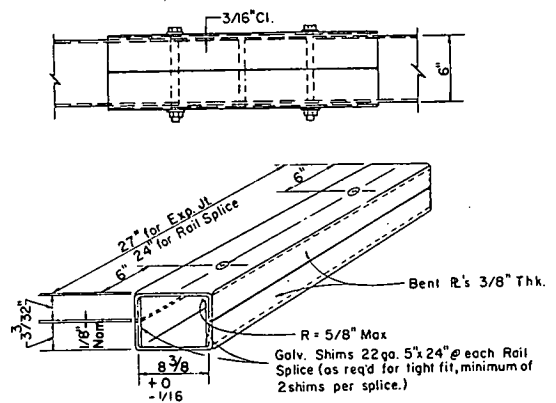


Figure 2. Plates for splicing two rail sections.

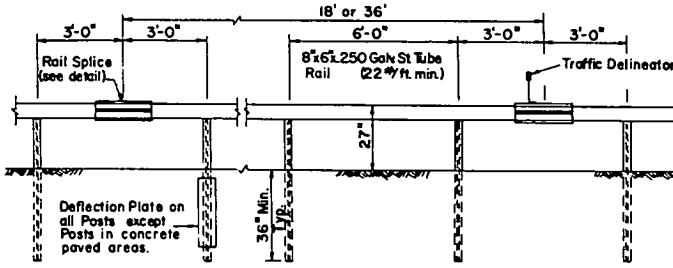


Figure 3. Rail-splice and post spacing.

plates 24 in. in length bolted at two places (Fig. 2). The post spacing was 6 ft, and rail splices were made midpoint between posts every 18 ft and, at some locations, 36 ft (Fig. 3). The 9.4 miles of box-beam median barrier was installed during 1966-1967 at a contract price of \$448,907. Approximately 48,300 ft of standard installation and 3,500 ft of anchor post installation were included in the contract.

A technician walked the length of the box beam each month in both directions and recorded damages to the rail. Data were collected on location of damages, direction, and severity. After it was recorded, each damage was spray painted. A different paint color was used for each month of the study period to avoid the possibility of recording a barrier damage more than once.

From May 1, 1965, to April 30, 1966, a one-year period before the box-beam barrier was installed, the average daily traffic (ADT) was 44,000. During a one-year period after it was installed, from May 1, 1967, to April 30, 1968, the ADT was 46,000. Data on accidents reported by the police were also obtained for these two time periods.

DAMAGES TO THE BOX-BEAM MEDIAN BARRIER

One of the prime considerations in evaluating the effectiveness of any median barrier is how many times has it been hit and how much damage has occurred. An initial inventory was taken of the barrier damages at the start of the 1967-1968 study period so that these would not be included in the data recorded during the 12 months. The number of damages observed during this initial inspection and during the study period are given in Table 1 by severity classification. These classifications are as follows:

Minor

- Scratch minor—scratch less than $\frac{1}{2}$ in. high, less than 8 ft long.
- Scrape minor—scrape more than $\frac{1}{2}$ in. high, less than 8 ft long.
- Scratch major—scratch less than $\frac{1}{2}$ in. high, more than 8 ft long.
- Scrape major—scrape more than $\frac{1}{2}$ in. high, more than 8 ft long.
- Dent—bent reflector or dented box beam.

Medium

- Tilted post—one or more tilted posts.
- 1 twisted post—twisted or bent post.
- 2 twisted posts—2 twisted or bent posts.
- 3 twisted posts—3 twisted or bent posts.
- 4 twisted posts—4 twisted or bent posts.
- 5+ twisted posts—more than 4 twisted or bent posts.

Major

- Post ripped away—post ripped away from rail or road.
- Plus twisted post—post ripped away from rail and as many as 3 twisted or bent posts.

TABLE 1
 NUMBER AND SEVERITY OF DAMAGES TO MEDIAN BARRIER RECORDED AT THE TIME OF INVENTORY AND DURING 1967-1968 STUDY PERIOD

Severity	1967-1968 Study Period													Inventory
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	Total	
Minor														
Scratch minor	11	3	4	3	6						3	3	33	24
Scrape minor	12	6	13	6	2	18	3		2	2	8	2	74	41
Scratch major	8	1	1									1	11	13
Scrape major	6	2	1	6	3	1	3	1	2	1	1	3	30	11
Dent	1			1					3				5	6
Medium														
Tilted post						1	1	1	3	2		1	9	12
1 twisted post	4				1		3	4	2	1		1	16	20
2 twisted posts		3		1		2	1			1	1	1	10	4
3 twisted posts		1				1			1		1		4	
4 twisted posts													0	3
5+ twisted posts		1				1							2	1
Major														
Post ripped away			1										1	4
Plus twisted post	1												1	1
2+ ripped posts			1		1	1		1			1		5	1
Bent rail		1				1							2	1
Break-through										1			1	
Total	43	18	21	17	13	26	11	7	13	8	15	12	204	142

2+ ripped posts—more than one post ripped away from rail or road.
 Bent rail—bent box beam.
 Breakthrough—box beam separated.

Table 2 gives the number and percentage of damages classified as minor, medium, or major for both the inventory and study periods. The percentages show a similarity for both periods. The minor damages included 41 scratches or scrapes more than 8 ft in length and 5 dents in the box beam. If these are added to the 51 medium and major damages, there were a total of 97 vehicle encroachments on the rail. At least 63

posts were bent, twisted, or torn away (not including post damages in the bent-rail and breakthrough categories). The box beam was bent twice, and separated once.

TABLE 2
 COMPARISON OF DAMAGE SEVERITY RECORDED AT THE TIME OF INVENTORY AND DURING 1967-1968 STUDY PERIOD

Severity	1967-1968 Study Period		Inventory	
	Number	Percent	Number	Percent
Minor	153	75	95	67
Medium	41	20	40	28
Major	10	5	7	5
Total	204	100	142	100

ACCIDENTS

Accident data were obtained from the files of the Pennsylvania State Police and from those of the police departments of the city of Harrisburg, the boroughs of Lemoyne and Camp Hill, and the townships of Swatara, Hampden, and Lower Allen.

TABLE 3
ACCIDENT SEVERITY DURING BEFORE AND
AFTER STUDY PERIODS

ADT and Severity	Before (1965-1966)	After (1967-1968)	Percent Difference
Average daily volume	44,000	46,000	+ 4.5
Total accidents	81	93	+14
Fatal accidents	2	2	0
Injury accidents	39	31	-20
Property damage accidents	40	60	+50
Total killed	2	2	0
Total injured	43	52	+21

Accidents were analyzed for a one-year period May 1, 1965, to April 30, 1966, before the box-beam median barrier was installed, and police reports of accidents were analyzed for a one-year period, May 1, 1967, to April 30, 1968, after it was installed. The first year, 1965-1966, will be referred to as the "before" period, and the second year, 1967-1968, as the "after" period.

There were a total of 81 accidents reported by the police in the before period, and the ADT was 44,000. In the after period the police reported 93 accidents, and the ADT was 46,000. Volume increased 4.5 percent, whereas accidents increased 14 percent. The severity of these accidents is given in Table 3. The increase in the number of accidents and the reduction in the number of injury accidents are reflected in a 50 percent increase in property damage accidents. The number of persons injured increased 21 percent, though injury accidents were reduced 20 percent.

Data given in Table 4 indicate a 120 percent increase in median accidents. In the before period there were 10 crossover accidents and 5 accidents wherein the median was involved but not crossed. In the after period, only 1 crossover accident occurred. This was caused by a tractor-trailer traveling westbound that had passed under a bridge and was struck by a gust of wind. The wind blew the tractor-trailer to the left on snow-covered pavement, and in the process of adjustment the tractor struck the box beam and broke through. The trailer's dolly wheels caught on the beam, and the trailer remained lodged thereon. The tractor, which rested in the opposing directional lanes, was struck by another vehicle.

The box-beam median barrier was involved in 33 accidents during the after period. Fatal accidents involving the median were eliminated, but injury accidents and the number of persons injured increased. As would be expected, accidents involving the median increased during the after period, and the number of crossover accidents decreased.

TABLE 4
SEVERITY OF ACCIDENTS INVOLVING MEDIAN
BARRIER DURING BEFORE AND
AFTER STUDY PERIODS

Severity	Before (1965-1966)	After (1967-1968)	Percent Difference
Total accidents	15	33	+120
Box beam	—	33	
Crossover	10	1 ^a	
Median encroachments	5	—	
Fatal accidents	1	0	-100
Injury accidents	10	14	+ 40
Property damage accidents	4	19	+360
Total killed	1	0	-100
Total injured	22	25	14

^aTractor-trailer broke through box-beam median barrier.

TABLE 5
NUMBER OF ACCIDENTS OCCURRING EACH MONTH DURING BEFORE AND
AFTER STUDY PERIODS

Month	Before (1965-1966)	After (1967-1968)	Month	Before (1965-1966)	After (1967-1968)
May	7	6	December	2	6
June	4	7	January	12	11
July	6	9	February	11	5
August	8	6	March	5	9
September	5	5	April	7	10
October	7	12		—	—
November	7	7	Total	81	93

TABLE 6
TOTAL ACCIDENTS AND ACCIDENTS INVOLVING MEDIAN BARRIER BY
COLLISION TYPE DURING BEFORE AND AFTER STUDY PERIODS

Collision Type	Total Accidents		Median Barrier Accidents	
	Before (1965-1966)	After (1967-1968)	Before (1965-1966)	After (1967-1968)
Head on	3	1 ^a	3	0
Rear end	31	37	3	4
Angle	7	4	0	0
Sideswipe	19	10	5	1 ^b
Hit fixed object	13	40	2	28 ^c
Other	8	1	2	0
Total	81	93	15	33

^aWrong-way driver.

^bSame direction sideswipe.

^cIncludes box-beam median barrier breakthrough accident caused by tractor-trailer.

Table 5 gives a comparison of the number of accidents that occurred each month during both study periods. The variation in the number of accidents per month is indicative of the reporting by police of investigated accidents. For many reasons, such as the availability of manpower, attention of available manpower to other responsibilities, and lack of notification by motorists and others, persons conducting studies that include accident data based on police reports must be careful in using them to forecast trends.

Table 6 gives a summary of the type of collision for total accidents and those that involved the median during both periods of study. The collision types were based on the first event that occurred regardless of the severity of the various events that occurred in an accident. The head-on accident during the after period was caused by a wrong-way driver, and the sideswipe accident involving the median was a same-direction accident. Crossover head-on accidents and crossover sideswipe accidents were eliminated. It should be recalled that one breakthrough accident involving vehicles in the opposing lanes did occur though it was not classified as a head-on or sideswipe accident.

There was an increase in hit-fixed-object accidents, and these accidents were further analyzed. Of the 40 hit-fixed-object accidents during the after period, in 23 of them the box-beam median barrier was the first object hit (Table 7). Of the 33 accidents involving the median barrier during the after period, the 23 that involved the box beam as the first thing hit constituted 70 percent of the box-beam damages. Table 8 gives the severity of these accidents.

There was a reduction in the number of injury accidents, an increase in the number of property damage accidents, and an increase in the number of persons injured. An analysis of the increase in the number of persons injured indicates a small reduction in serious injuries and a threefold increase in the complaints of injury (Table 9).

TABLE 7
FIRST THING HIT IN HIT-FIXED-OBJECT
ACCIDENTS DURING BEFORE AND
AFTER STUDY PERIODS

Fixed Object	Before (1965-1966)	After (1967-1968)
Box beam	0	23
Guardrail	5	6
Embankment	2	2
Bridge abutment	2	1
Curb	0	3
Traffic sign	2	1
Other	2	4
Total	13	40

TABLE 8
ACCIDENT SEVERITY WHEN BARRIER WAS
FIRST THING HIT DURING AFTER
STUDY PERIODS

Severity	After (1967-1968)
Fatal	0
Injury	9
Property damage	14
Total	23

TABLE 9
SEVERITY OF PERSONAL-INJURY ACCIDENTS DURING
BEFORE AND AFTER STUDY PERIODS

Severity	Before (1965-1966)	After (1967-1968)
Total accidents	81	93
Noninjury	40	60
Injury and fatal	41	33
Total injured	43	52
Serious injury	24	21
Visible injury (less severe)	14	15
Complaints of injury	5	16
Total killed	2	2

BOX-BEAM MEDIAN BARRIER DAMAGES AND ACCIDENTS

How many times have vehicles been prevented from crossing the median due to the installation of the box-beam median barrier? How many crossover accidents have been prevented? No scientific attempt has been made to answer these questions based on collected data. The data collected, however, do provide some insights.

During the before period, there were 10 crossover accidents, and during the after period only 1. Had the box-beam

median barrier not been installed, presumably 10 crossover accidents would have occurred in the after period, if not more, because traffic volume increased 4.5 percent.

Of the 93 accidents reported by police during the after period, 33 involved the median barrier. These 33 reported accidents were matched with field data pertaining to damages to the box beam according to type of accidents, speeds, locations of rail damages, and size of damages to determine what degree the vehicles encroached on or crossed the median. It is estimated that, of the 204 damages to the box beam, approximately 44 were so minor and of such a nature that, had the box-beam median barrier not been installed, the vehicles would not have encroached on the existing median divisor to a degree to result in accidents. For the remaining 160 box-beam damages, if it is assumed that the 10 crossover accidents occurring during the before period would occur similarly during the after period, approximately 150 vehicles would have encroached on or crossed the median and would not have been involved in any accident (1). Because crossover accidents occur as a matter of chance depending on many variables, the figure of 150 vehicles also represents that number of vehicles that incurred relatively minor vehicle damage and that thereby avoided the possibility of serious accidents because of the installation of the box-beam median barrier.

The box beam was hit $6\frac{1}{2}$ times more often than reported by the police. In effect, 84 percent of the box-beam damages were minimal to the extent that the police were not notified, and apparently the motorists who hit the box-beam median barrier were able to maintain control of their vehicles and continue on their trips.

SUMMARY

There were 204 encroachments on the box-beam median barrier during the 12-month study period following the installation of the box beam. Of these damages, 75 percent were classified as minor, 20 percent as medium, and 5 percent as major. Included in the major accidents was one median barrier breakthrough. Within the limits of the study area, the police investigated 93 accidents during the after period, of which 33 involved the box-beam median barrier. During the before period the police reported 81 accidents, of which 10 involved median crossover.

Traffic volume increased between the before and after periods by 4.5 percent, and accidents increased by 14 percent. The largest increase in accidents was related to the installation of the box-beam median barrier. From a comparison of the 33 police-reported accidents involving the box-beam median barrier with the 204 field-recorded box-beam damages, it is estimated that 150 vehicles, which incurred relatively minor vehicle damages by hitting the barrier, could have crossed the median had the box beam not been installed. Because of the 4.5-percent increase in traffic volume, it is possible that these 150 vehicles could have been involved in crossover accidents.

The box-beam median barrier reduced the number of crossover accidents from 10 to 1 and prevented an estimated 150 other vehicles from encroaching on or crossing the median and possibly becoming involved in crossover accidents. The amount of damage to the box beam and to the vehicles was relatively small according to the number

of accidents investigated by the police in relationship to the relatively large number of observed box-beam median barrier damages.

ACKNOWLEDGMENTS

This study was conducted by the Division of Research and Studies, Traffic Engineering Bureau, Pennsylvania Department of Highways, and was initiated by E. R. Ricker. Lee C. Shepley, a technician in the Bureau, deserves special mention for the laborious task of walking the necessary 18 miles each month in all kinds of weather to mark and record the various damages to the box beam.

REFERENCE

1. Galati, Joseph V. Median Barrier Photographic Study. Highway Research Record 170, 1967, pp. 70-81.