TEXAS TRANSPORTATION INSTITUTE

TEXAS HIGHWAY DEPARTMENT

COOPERATIVE RESEARCH

MEDIAN BARRIERS
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MEDIAN BARRIERS

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1. "Anti-glare median barrier", Roads & Road Construction 42: n 495, March 1964, p 42.

   Night-driving safety experiment on Schuylkill Expressway in Pennsylvania to test effectiveness of expanded-metal mesh fencing.

2. Ayre, R.S., J. I. Abrams and M. A. Hilger, "Dynamics of vehicle impact against highway guardrails; laboratory experiments", John Hopkins Univ--Dept of Civ Eng--Tech Rept n 5, Dec 1955, 112p.

   Cable type guardrail discussed and laboratory methods and apparatus described; guardrail parameters; maximum dynamic increment of cable tension; final speed and direction of vehicle; analysis of energy losses; investigations on beam type guardrail.

3. Beaton, John L. and Robert N. Field, "Dynamic full-scale tests of median barriers", Nat'l Research Council--Highway Research Board Bul 266, 1960, p 78-91.

   Full-scale dynamic tests were made of 15 proposed designs of traffic barriers for use in median areas. Of these, two proved to be worthy of trial installations.
   This report describes the procedure used in testing median barriers by oblique, high-speed collisions with passenger vehicles and a 17,000-lb bus, and outlines the extensive instrumentation used in this test series.
   Specific recommendations are made for use of a flexible type barrier in wide medians and a semi-rigid type in narrow medians.

4. Beaton, J. L., R. N. Field and K. Moskowitz, "Median barriers: one year's experience and further controlled full-scale tests", Nat'l Research Council--Highway Research Board Proc 41: 1962, p 433-468.

   Development of two types of barriers for use in the medians of California freeways was reported at the 39th Annual Meeting. As outlined in that report, it was planned to continue studying these two barriers under actual operating conditions.

This report covers one year of operation and additional full-scale collision tests of cable-chain link barriers. The before-and-after operational studies indicate that (a) the barriers were successful but need some improvement; (b) the total accidents increased when the barriers were installed, but the head-on fatalities were virtually eliminated; and (c) the maintenance cost of the cable-chain link barrier was more than the metal beam barrier, but this was offset by the higher first cost of the metal beam barrier. Controlled collision tests resulted in an improved design of the cable-chain link barrier.

5. Billion, C.E., A. Taragin and E. C. Cross, Jr., "Effect of parkway medians on driver behavior--Westchester County parkways", Nat'l Research Council--Highway Research Board Bul 308, 1962, p 36-63.

The purpose of the study was to evaluate by means of a day and night study of traffic performance the effectiveness of (a) the guide rail median on the 40-ft wide Cross County Parkway as compared to the surface paint line divider, and (b) the 4-ft wide raised and curbed grass compared with the 4-ft wide raised and curbed paved and the 4-ft wide raised and curbed grass with guide rail types of medians on the Hutchinson River Parkway. The effects to be ascertained would be those manifested in drivers' actions such as speeds, lateral placement and lane use, and in accident experience.

6. Cichowski, William G., Paul C. Skeels and William R. Hawkins, "Appraisal of guardrail installations by car impact and laboratory tests", Nat'l Research Council--Highway Research Board Proc 40: 1961, p 137-178.

This paper describes the guardrail tests conducted at the General Motors Proving Ground since the previous paper, "Full-Scale Appraisals of Guardrail Installations by Car Impact Tests," was presented in January 1959 (HRB Proc 38: 353). Approximately 105 tests have been conducted since that time, including tests of improved end sections, chain link fence and cable type barriers, rail mounting and spacing from post, post strength, beam strength, special posts and mounting on superelevated curves.

7. Franck, R. J., "Design and shape analysis of cast steel guardrail posts", Nat'l Research Council--Highway Research Board Proc 40: 1961, p 125-136.

The increasing number of fatal accidents resulting from failure of bridge guardrail post systems has focused attention on a serious highway design problem. With ever-increasing traffic on highways, particularly expressways, this problem requires immediate attention to developing a fail-safe guardrail system. This is no small task as there are many points to be considered. The nature of the problem was brought out early in discussions of the Bridge Castings Task Force Committee of the Steel Founders' Society, which is concerned with problems regarding use of steel castings in bridges. This group gathered as much information and known data as possible as a foundation on which to begin work, but surprisingly little was available at the onset of the investigation due to the fact that guardrails apparently had been designed from a decorative rather than protective standpoint. However, thanks to the cooperation of other groups, the basic problems involving guardrail failures were defined.

8. Heitmann, "Die Stahlplanke als Verkehrssicherung", Strasse u Autobahn 11: n 4, Apr 1960, p 149-57.

Steel guard rail as traffic safeguard; description of various types of guard rails used in European countries and United States; factors of force at impact; steel rails provide good compromise solution between required elasticity and stiffness; several examples of steel rail deformations.

9. Henault, G.G., "Highway guide rails", AGM 63-CIV-C. 77th Annual General Mtg. paper, Engineering Institute of Canada, Quebec, May 22-24, 1963, Eng J 46: n 4, p 59, April 1963.

Highway safety depends directly on such factors as vehicle speed, traffic density and vehicle loading. In the face of a growing number of accidents, the question arose whether the guide rails on the elevated section of the Metropolitan Boulevard in Montreal were providing the necessary protection. The Minister of Highways of Quebec initiated a study on this question and, in August 1962, eight (8) different types of guide rails were tested under simulated service conditions. This paper deals with the selection of the test method

and the choice of other important test conditions: the technique for launching the test vehicle, the launching speed and the speed and angle of impact, etc. A film will be shown of tests in progress, and the use of this film in interpreting the results of the tests will be described. Finally, conclusions drawn from thirteen (13) tests of eight (8) different kinds of guide rails, of steel, aluminium and concrete, will be discussed.

10. Ives, Howard S., "Cable-cahin link median barrier performance record in Connecticut", American Highways 41: n 2, pp 10, 23-25, April 1962.

"The Cross Median Accident Problem and Coorective Meaaures in Connecticut" is the title of an article which appeared in the October 1960, issue of American Highways. One of the various median crossing deterrents discussed therein is the cable-chain link barrier. At that time, a lack of accident experience of the only experimental installation had to be admitted.

Approximately one year later, seven collisions at the first and one at a second installation have been recorded. It might validly be said that this accident experience is too limited to form a sound basis for a performance evaluation. When the more extensive accident experience at similar cable-chain link median barriers reported by California is taken into account, however, this criticism is no longer valid.

Thus, the presentation of information on even a short term performance history of this new median barrier at two locations in Connecticut would seem wholly justified.

The test section of median barrier, as completed on June 3, 1960, consists of 888 feet of cable-chain link light barrier, with vertical wood slats, west of the Frenchtown Road bridge and 736 feet of cable-chain link barrier east of this bridge. All trees and bushes were removed from the median within the limits of construction.

The seven collisions with the median barrier recorded up to October 17, 1961 involved four eastbound and three westbound motorists, all seven occurring west of the Frenchtown Road bridge. The tabulation of these accidents differs somewhat from the previous one. The most significant difference is that the column "Fatalities" could be omitted.

Considering all accidents at both locations, or eight in all, the cable-chain link median barrier has performed in a highly satisfactory manner. In regard to meeting the essential functions of a median barrier, as established by California in its median barrier tests, it may be rated as follows: (1) Positiveness in preventing median crossings: 100%. (2) Minimizing reflection of vehicle back into traffic: 50%. (3) Minimizing injury to occupants of offending vehicle: 100% minus.

It should be noted that the eight accidents involved the cable-chain link light barrier. In this type, the light barrier median, whether wood slats or aluminum strips, tends to prevent a colliding vehicle from becoming readily enmeshed in the chain link fabric. This may well account for the fact that in four accidents out of eight the vehicle was not wholly retained in the median.

11. Johnson, Roger T. and Thomas N. Tamburri, "Freeway guardrail: installation made where genuine hazard exists", California Highways and Public Works 42: n 3-4, pp 58-60, March-April 1963.

In recent years the public has shown considerable interest in the subject of guardrail on freeways where private improvements are located immediately adjacent to the freeway right-of-way.

Investigations were made in the Los Angeles and San Francisco areas to determine the magnitude of any such problems.

In the San Francisco area a field survey was made of all freeway locations without guardrailing, meeting both of the following conditions: (1) embankment 10 ft or more in height and (2) improved property immediately adjacent to the freeway right-of-way without an intervening ramp or frontage road.

A summary of the data gathered discloses the following: (1) there are no points of concentration of accidents involving cars running off the roadway and damaging private property; (2) there have been 0.48 offshoulder accidents per mile per year in the Los Angeles area and 2.07 offshoulder accidents per mile per year in the San Francisco area at locations where improved property is immediately adjacent to freeway lanes; (3) in four years there were 25 offshoulder accidents in the San Francisco area. Nine of thes caused right-of-way fence damage; (4) in two years there were 29 offshoulder accidents in the Los Angeles area and two caused damage to private property; (5) no fatalities or personal injuries have occurred on private property; and (6) there has been very little damage to private property.

In conclusion, the incidence of offshoulder accidents is so small, scattered and unpredictable that no blanket policy of installing guardrail where improved properties exist immediately adjacent to freeway lanes is warranted. However, guardrailing should be installed at locations where concentrations do develop and at locations where the combination of superelevation, curvature, embankment height, slopes and type of improvements is such as to indicate a potentially hazardous situation.

Among the 25 offshoulder accidents: (1) no fatalities occurred: (2) no one on private property was injured; and (3) no private property was damaged.

12. Moskowitz, Karl and William E. Schaefer, "Barrier report, performance of beam, cable types analyzed", California Highways & Public Works 40: n 9-10, Sept-Oct 1961, p 18-24.

In the summer of 1959, two types of median barriers were developed and tested for use on California freeways. These were the cable-chain-link fence barrier, hereafter referred to as "cable", and the double-blocket-out metal beam barrier, hereafter referred to as "beam".

Details of the barriers, and tests leading to their adoption, were reported in "California Highways & Public Works" in July-August 1959. The photographs on this page show typical installations of both types.

...In order to compare the performance of the two types of barrier, the first contracts were split, with some of each type in each contract. These are referred to as test sections. One test section was on the Santa Ana Freeway in Los Angeles County where 3.17 miles of cable barrier were erected end-to-end with 2.57 miles of beam barrier; the other test section was on the Minitz Freeway in Alameda County where 3.87 miles of cable barrier were erected end-to-end with 2.87 miles of beam barrier. Before-and-after accident records on these test sections have been examined. The results of the study are given in this report.

13. Moskowitz, K. and W. E. Schaefer, "California median study: 1958", Nat'l Research Council--Highway Research Board Bul 266, 1960, p 34-62.

This study concerns the relative safety of the various types of median design, including the positive barrier median, on divided highways carrying traffic volumes in excess of 15,000 vehicles per day, and the development of tentative criteria for the installation of positive median barriers. A report covering a previous median study of divided highways which carried volumes up to 25,000 vehicles per day was presented at the HRB Thirty-Second Annual Meeting.

An analysis was made of the approximately 8,000 accidents which occurred in 1956 and 1957 on some 265 mi of divided highway with deterring and nontraversable median designs. Operating conditions, as measured by the average daily traffic (ADT) volume, apparently influenced the relative safety of the deterring and nontraversable medians. In the volume range of up to 130,000 vehicles per day, the deterring-type median had the lower accident and injury rate. In the volume range of 130,000 or more vehicles per day, the advantage shifted to the nontraversable medians which had the lower accident and injury rate.

To emphasize the cross-median fatal head-on-type accident, the 407 fatal accidents which occurred on freeways in 1956, 1957 and 1958 were then analyzed.

During this period, the cross-median collisions accounted for 19 percent of the fatalities on freeways. Freeways carrying more than 60,000 vehicles per day accounted for one-fifth the mileage and two-thirds of the fatal cross-median collisions. Therefore, in order to make a significant attack on the cross-median fatal accident problem, it would be necessary to reach down to the 60,000 ADT level with the installation of median barriers. Past experience indicates that barriers may convert cross-median accidents to other types. However, newly-developed barrier designs may reduce the severity of collisions with the barriers and result in fewer casualties even though the accident rate may rise.

14. "Put logic into locating guardrail", Western Construction 37: n 11, pp 86,88, November 1962.

Highways in the mountainous areas of the West have more need for adequate installations of guardrail than similar mileage in Eastern States. Concerned with the obvious lack of standards for these installations, O. L. Grunerud, assistant traffic engineer of the Idaho Department of Highways, conducted a critical study of the problem and developed a table of values as the first step in standardizing such

installations.
The reader is referred to an accompanying table which represents the formula.
The use of the suggested formula with consistent evaluation of the factors will provide a logical approach to guardrail installation based on the establishment of a minimum figure on the hazard profile by the individual engineer. This procedure begins to establish a rational approach to guardrail installation, with sufficient flexibility for the individual enginee r and for modifications over a period of time.

15. Severy, D.M., J. H. Mathewson and A. W. Siegel, "Barrier collisions, IV. An evaluation of motorist force and injury control systems", Nat'l Research Council--Highway Research Board Proc 40: 1961, p 541-556.

Two barrier collisions were conducted under identical experimental conditions, except for impact speeds which were 35 mph in the first experiment and 28 mph in the second.
In these automobile collision experiments, a fixed barrier was used to control the influence of the opposing forces of impact in order to obtain a realistic means of evaluating the effects that variations in impact speed and type restraint may have on efforts to control motorist force and injury exposures.
Collision force systems were quantified for two configurations of motorist restraints. Additionally, one of these restraints was evaluated for three positions of car occupancy; the other restraint, a shoulder-loop device, included an inertia reel. Inferred injury diagnoses and other forms of advanced collision research methodology are briefly described.

16. Stonex, K. A., "Roadside design for safety", Nat'l Research Council--Highway Research Board Proc 39: 1960, p 120-156.

A safety engineering study at the General Motors Proving Ground revealed that off-the-road accidents were the most prevalent type and concluded that this was the greatest potential hazard in the operation. Comparison with accident statistics and the physical characteristics of roadsides on public highways leads to the same conclusions.
Between 30 and 35 percent of highway fatalities occur in off-the-road accidents, year after year. An objective

look at many public highway roadsides shows that they offer few safeguards in the event of vehicle malfunction or human malfunction; in the eyes of the industrial safety engineer, much of the roadside is deficient in this respect. The objective of this study is to develop criteria for roadside design which would remove these deficiencies.

The severity of operation through roadside and median ditches as a function of speed and cross-section detail is measured in terms of accelerations along the principal axes as a test car is driven through the ditch. Measured values are correlated with severity as gauged by the driver. Cross-section design criteria are developed such that the severity of accidents at legal road speeds can be kept within the tolerable range.

Guardrails are recognized as a feature which must be resorted to on occasions, and thus must be considered as a part of roadside design. Full-scale test results of guardrail installations, emphasizing modified end treatments, are given. The hazards of striking standard traffic signs and light poles are indicated and practical solutions are suggested.

Analysis and measurement of ground surface reaction "coefficient" relates passenger car stability factors to roadside slope values such that criteria can be developed for significant design factors. The comparative costs of roadsides designed for safety are developed for specific examples of roads passing through both level and wooded hilly terrain.

17. Takahashi, N., "Experiments to determine impacts given to several road guard rails", Japan Soc Civ Engrs--J 45: n 3, 1960, p 21-8.

Different types of buffers for protection of traffic accidents were tested by humping cars against them; tests revealed that particular guard rails used for tests prevented cars from going beyond them and gave just mild shock to car on collision so that passengers were safe and cars were almost free from damage.

18. Wilson, John O., "Porcelain enameled guardrail tested", Public Works 93: n 11, p 100, November 1962.

In an effort to reduce maintenance costs on guard rails in medians, Connecticut is experimenting with porcelain enamel beam. The first step to reduce maintenance cost was adoption of galvanized beam type rail in place of the painted rail previously used.

In installation, care is needed to avoid chipping of the enamel, The first installation consisted of 30 panels of standard length (12.5 ft between posts) 12-gage steel beams at the easterly end of a median barrier installed by contract on Route 15, Wethersfield, just south of the Hartford city line. The entire panel has one grip coat and, on the face, an additional finish coat of porcelain enamel. A yellow finish coat was selected for this installation.

Since this experimental railing was installed early in July 1962 no conclusions are possible at this time. The surface is much smoother than either painted or galvanized surfaces. It is possible that this smooth surface will be self-cleaning, or at least will not accumulate dirt as rapidly as the rougher surfaces of the painted or galvanized beam. Night observations on two occasions left the impression that reflectivity was considerably less than the adjacent galvanized beam.

The second test installation was on Route 15, Manchester, a few hundred ft east of the Hockanum River. This railing is similar to that already described except that the finished surface of the beams is white instead of yellow and they are mounted on wood posts.

Initial cost of the porecelain enameled beam will be higher than painted or galvanized beam. It may be some time before sufficient information is available to determine whether or not the use of porcelain enameled beam elements can be economically justified.

19. Wutzler, H., "Verkehrssicherheit durch DAV-Stahlbetonleitplanken", Strasse u Autobahn 11: n 4, Apr 1960, p 161-4.

Traffic safety through DAV steel concrete guard rails; DAV stands for "Danish car protection" (Dansk Auto-Vaern); such rails are used at dangerous road sections; in case of impact, rail affects tires and has strong braking and guiding effect on them; rail yields without breaking; photographs show examples of impact and deformations.