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ENGINEERING INSTRUCTION

NEW YORK STATE DEPARTMENT OF TRANSPORTATION

SUBJECT: Innovative Safety Barrier

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J.R. LAMBERT, Deputy Chief Engineer, Facilities Design Division

This Engineering Instruction issues procedures and administrative details for complying with the Innovative Safety Barrier requirements of Section 1058 of the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA). These procedures and administrative details will become effective immediately.

A list of innovative safety barriers, and a work plan for evaluating innovative safety barriers is attached to this instruction. The list of innovative barriers includes barrier features, advantages, disadvantages, warrants and/or guidelines for the use of the various barriers.

ISTEA REQUIREMENTS: Section 1058 of ISTEA requires each State to certify annually that a minimum of 2.5% of the mileage of new or replacement permanent median barriers included in awarded contracts along Federal-aid highways shall be innovative safety barriers. FHWA interprets this to apply only to awarded contracts on Federal-aid projects on the National Highway System (NHS). This requirement commenced with the calendar year of 1992.

DEFINITIONS:

Innovative Safety Barrier: (as defined by Federal Highway Administration (FHWA) in February 27, 1992 memorandum, H. Brown, FHWA Div. Administrator to Chief Engineer, NYSDOT)... "The 1991 ISTEA defines an innovative safety barrier as one which is considered experimental by the Federal Highway Administration (FHWA) or was classified as operational after January 1, 1985. However, the FHWA no longer classifies traffic barriers as experimental or operational but leaves this decision to each State highway agency once a barrier is deemed crashworthy." (passed NCHRP 230 testing)..."Therefore....an innovative median barrier is one which: (1) is considered experimental by a State; or (2) is not already in use (or is in limited use) by that State and differs significantly in material, size, shape, performance/test level, or operational characteristics from median barriers in common use elsewhere."

National Highway System: ISTEA provides for an interim Nation Highway System (NHS) through 1995. The interim NHS consists of all Interstate highways and all highways classified as principal arterials by the State. Sometime in 1994 or 1995, Congress will approve an official NHS that has been developed by the Secretary of Transportation.

PROGRAM OBJECTIVES: The objectives will be to (1) meet the ISTEA requirements, (2) develop knowledge and experience with new median barrier systems that could possibly become NYSDOT standards or find use in special applications, (3) evaluate the innovative barriers constructed on our projects for performance, cost, construction and maintenance.

PROGRAM IMPLEMENTATION: In order to implement and comply with the ISTEA requirements the Regions shall periodically provide the Design Quality Assurance Bureau (DQAB) with information concerning their proposed median barrier usage on Federal-aid projects on the NHS. The information will be requested each year for the following three calendar years based on the estimated award dates for the contracts. The data received from the Regions will be refined throughout the year by coordination between the Regions and DQAB.

The required information will consist of the following:

1. A list of all Federal-aid projects on the NHS that will contain standard median barrier and/or innovative safety barrier.

2. An estimate of the quantity of each barrier type to be incorporated into each project.

3. The anticipated PS&E, Letting and Award dates for the projects.

The Regional Design Engineer or his representative will coordinate with the program coordinator in the Design Quality Assurance Bureau (W.E. Hopkins) to insure that the program objectives are met. In the event it appears that the Department will have difficulty meeting the 2.5% requirement during any given year (January 1 to December 31), DQAB under the direction of the Deputy Chief Engineer, Facilities Design, will review with the Regional Design Engineers the projects most suited for the use of innovative safety barrier and select projects with the consensus of the Regional Design Engineers.

With the exception of cable median barrier and SERB (the Department has limited experience with these barriers) all of the innovative safety barriers are new to the Department. Therefore, the innovative safety barriers will have to be evaluated. The Regions will initially be responsible for conducting the evaluations and DQAB will coordinate the process so that there will be no duplication of effort.

PROGRAM OVERVIEW: P.J. Clark's September 11, 1992 memorandum to all Regional design engineers on the subject of innovative barrier included the following:

1. A list of median barrier systems that qualified as innovative safety barrier. Additional information was supplied on each barrier system.

2. A request for Region comments and for each Region to prepare a list of candidate projects for innovative safety barrier for the 1993, 1994 and 1995 construction seasons and send it to DQAB.

NYSDOT has complied with the ISTEA requirements for 1992 and has certified to FHWA that the 2.5% requirement has been met. Innovative barrier quantities in contracts to be awarded in 1993 appear sufficient to meet or exceed the 2.5% requirement.

To date, three innovative barrier systems have been selected by the Regions for use: (1) The single slope concrete barrier, (2) the movable concrete barrier, and (3) the truck barrier. DQAB has prepared specifications and details for the single sloped barrier and is preparing specs and details for the movable concrete barrier and truck barrier. Due to the time constraints associated with program start-up, the details, drawings and specs are transmitted to the requesting design groups as soon as possible. Formalized drawings, details and specs will be issued by Engineering Instruction to all parties as soon thereafter as our resources permit. An Engineering Instruction for the single slope concrete barrier containing additional details for transitions, bridge pier protection, half sections, etc. is nearly completed and will be issued shortly.

ADMINISTRATIVE DETAILS:

1 Program Coordinators:
Design Qual. Assurance Bureau: W. E. Hopkins (518) 457-6399

Regions: Regional Design Engineer or his representative.

2. Program: The DQAB coordinator will request from each Region design group their anticipated future use of standard and innovative safety median barrier on Federal-aid projects on the National Highway System. This information will be re-evaluated and updated several times a year by the DQAB coordinator to insure that a sufficient quantity of innovative safety barrier is programmed into our projects.

3. Contract Award Date: Innovative safety median barrier is credited to the year in which the contract is awarded.

4. 93 Prefix: Specifications for all innovative safety median barrier items used on Federal-aid NHS projects will include a 93 prefix for ease of tracking and identification. Innovative safety barrier items with the 93 prefix should not be used as a barrier on the right hand side of a highway where traffic will pass only on one side of the barrier. If you intend to use an innovative safety barrier to the right of traffic and not as a median barrier, it will be necessary to request a special item number for this work. Also, the use of innovative safety barrier is not limited to projects on the NHS. They may be used on any project where a barrier of that type is warranted.

5. Specifications & Drawings: DQAB will provide the necessary specifications, drawings and warrants for innovative safety barrier used on highways. Details and specifications for barrier carried across bridges will have to be obtained from the Structures Division.

6. Barrier Evaluations: Attached to this EI is a work plan for evaluating innovative safety barrier. The Regions will be responsible for conducting the evaluations. DQAB will coordinate the evaluation process so that efforts are not duplicated.

If you have any questions concerning this engineering instruction you may contact W. E. Hopkins at (518) 457-6399.

EVALUATION OF INNOVATIVE BARRIER SYSTEMS

I OBJECTIVE:

The objective is to perform overall evaluations for various innovative safety barrier systems to determine their effectiveness and acceptability as alternate or replacement systems for current standard designs. Based on these evaluations, the Department's current design criteria, policies, drawings, and specifications will be revised accordingly to incorporate systems acceptable for use in New York State.

II SCOPE:

The DOT Regional Offices will be responsible for conducting the general evaluation of innovative safety barrier systems on selected projects to assess design, construction and maintenance parameters. The Design Quality Assurance Bureau in conjunction with the Traffic and Safety Division will retrieve accident data and evaluate vehicle/barrier performance. The Design Quality Assurance Bureau will coordinate the selection of barrier systems and projects to be evaluated to prevent duplication of effort. It is anticipated that 2 to 3 projects will be selected for evaluation of each type of innovative safety barrier.

III WORK PLAN FOR INNOVATIVE SAFETY BARRIER

A. Site Information

1. Contract No.
2. Route No.
3. State Highway No.
4. County
5. Location of begin and end of barrier by milepost marker and sta.
6. Type of innovative safety barrier evaluated.

B. Design Phase

A brief report shall be prepared at the time of design covering the following areas.

1. Rationale for selecting the barrier.
2. List any design advantages, disadvantages or problems encountered during design.
3. Estimated unit costs and total cost.
4. Any design modification recommendations.

C. Construction Phase

A brief report shall be prepared at the time of construction covering at least the following areas.

1. The Engineer in Charge and the evaluator's name and assigned work unit.
2. Identify by station and milepost marker the beginning and end of barrier runs.
3. Procedures and techniques used to construct, install, and complete the work.
4. Construction problems, specification problems, and design problems encountered.
5. Contractor unit bid price and quantities installed.
6. Orders on Contract associated with barrier.
7. Make any recommendations to correct or improve the product or the work.

D. In-Service Evaluation

An in-service evaluation will be conducted for a period of (2) two years after completion of the barrier and it's exposure to traffic. If insufficient information is available at the end of the period, the period may or may not be extended based on information gathered from other similar evaluations of the same type of barrier. The in-service evaluation will consist of semi-annual field inspections, maintenance data and annual status reports. The in-service evaluation shall consist of at least the following:

1. Regional Responsibility:

    a) Inspect the barrier at least twice a year and document the following.
        1. Identify any problems that may compromise or defeat the barrier performance.
        2. Identify influence on other highway conditions that may affect highway operations and/or traffic.
        3. Is the barrier functioning as intended? Are design goals being met?
    b) Regional Maintenance shall document the following.
        1. Maintenance problems encountered.
        2. Repairability, extent of repairs when hit, frequency of repair.
        3. Estimated cost of repairs.
    c) Include info from (a) and (b) above in an Annual In-Service Status Report. Make recommendations.

2. Main Office Responsibility:
   a) DQAB will retrieve all police accident reports in the vicinity of the barrier from Traffic and Safety Division on an annual basis or at shorter intervals if warranted.
   b) DQAB will review the accident reports and retrieve and analyze the following information if it is present.
      1. Vehicle Type.
      2. Vehicle collisions prior to barrier contact.
      3. Vehicle trajectory and barrier impact angles.
      4. Vehicle speed.
      5. Vehicle redirection and resting place.
      6. Penetration of barrier by vehicle.
      7. Penetration or intrusion of vehicle by barrier
      8. Abnormal vehicle reaction after impacting barrier (rollover, vaulting,destabilization)
      9. Amount of vehicle damage.
      10. Personal injuries and fatalities.
      11. Driver and witness statements.
      12. Police comments.

E. Report Summary And Related Information

The following reports shall be submitted by the Region to the Design Quality Assurance Bureau: A brief design report, a construction report, 2 annual in-service status reports, and a final summary with conclusions. The reports should be brief and concise and can be in memo form.

The Region coordinator for innovative barrier should submit to the DQAB coordinator the following information at the time of PS&E or as soon thereafter as possible.

1. The approximate date the design report will be submitted.
2. The estimated completion date of the barrier installation.
3. The estimated date the construction report will be submitted.
4. The estimated dates that the annual in-service status reports will be submitted.
5. The estimated date for the final summary and conclusions.

INNOVATIVE SAFETY BARRIERS

The following is a list of barriers that presently qualify as innovative safety barriers:

Single Slope Concrete Median Barrier
Movable Concrete Barrier
Truck Barrier (Extra High)
Sand Filled Median Barrier
Cable Median Barrier
Self Restoring Median Barrier
Modified Thrie Beam Barrier

Single-Slope Concrete Median Barrier. The single-slope concrete median barrier may be used for any barrier applications that the standard N J barriers may be used for as the warrants for the two barriers are the same. The Single-Slope Concrete Median Barrier has been crash tested in accordance with the requirements of NCHRP Report 230. The report of the tests are published in Transportation Research Record 1302 (TRR1302). The Single-Slope Concrete Median Barrier has several advantages over the standard N J shape. The following is a partial list:

1. Increased safety, especially for the small car, because of lower roll angles.

2. The extra height and thickness of the barrier will increase its strength and mass. Therefore, it will better contain a large vehicle.

3. The extra height will lessen headlight glare without the use of glare screens.

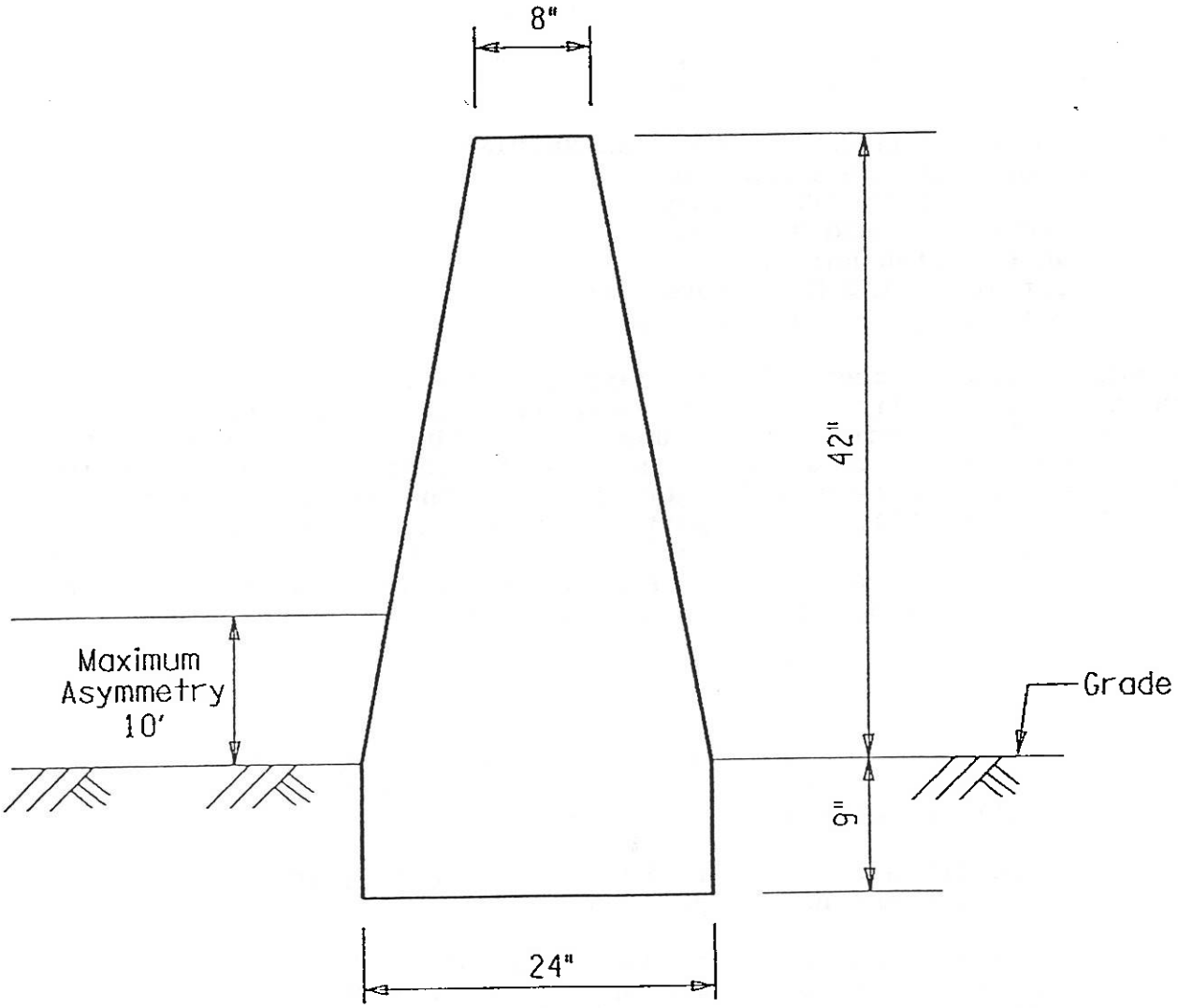
4. Resurfacing of the roadway adjacent to the barrier that changes the grade by more than 3" may be made as long as the resurfacing does not reduce the height of the barrier to less than 32".

5. The grade from one side of the barrier to the other can differ without the necessity of a complex asymmetrical barrier provided the height of the barrier on the high side is not less than 32".

6. The single slope barrier is easier to construct because of its simple shape.

Two disadvantages surfaced during our review of the research report. The first is that computer simulations indicate that the occupant risk of the single-slope concrete median barrier is slightly higher than the New Jersey barrier. However, the crash tests indicated that the occupant risk was within the limits of NCHRP Report 230. The second is that the extra height may reduce the sight distance of the operator of a vehicle in the lane immediately adjacent to the barrier.

SINGLE SLOPE CONCRETE MEDIAN BARRIER



Barrier Height 32" Min.; 42" Max.

Moveable Concrete Barrier. The moveable concrete barrier (MCB) may be used as a permanent installation on highways where traffic is heavy in one direction in the morning peak hours and heavy in the opposite direction in the afternoon peak hours to increase the capacity of the highway without adding additional lanes. The MCB has been crash tested and the results of the tests are published in Transportation Research Record 1258 TRR (1258). In addition to the crash test data in TRR 1258 NYSDOT Research Report 145 "Movable Concrete Median Barrier: Risk Analysis of Deflection Into Opposing Traffic" gives additional information.

The following is a partial list of identified advantages:

1. The roll angle of an impacting vehicle is lessened because of the special shape at the top of the barrier.

2. The cost of increased capacity using this barrier may be significantly less than adding an additional lane or lanes in urban or heavily populated areas.

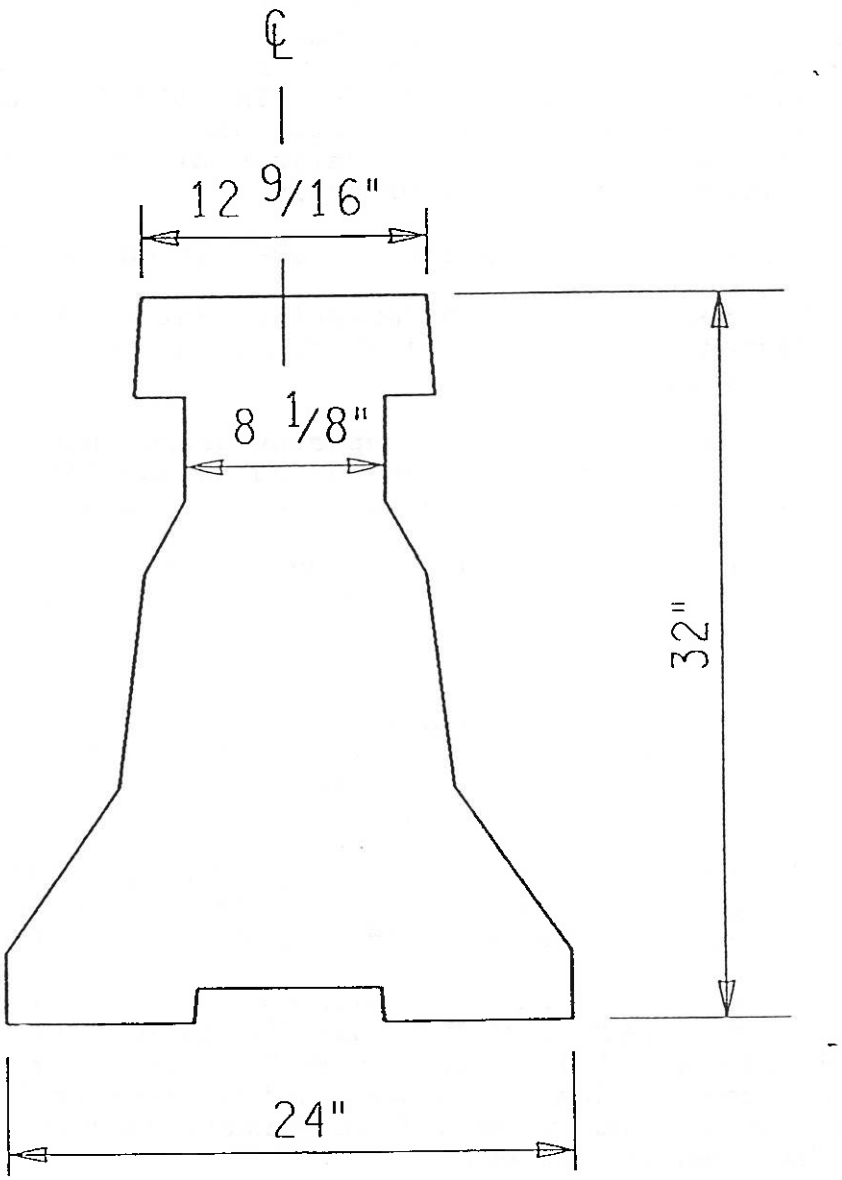
3. The barrier movement from one location to an other is relatively fast (up to 10 MPH [16 K/ph]) and may be performed with traffic running adjacent to the barrier.

4. After an impact the barrier may be rapidly realigned with the transfer vehicle without the need of placing workers on the ground to manually adjust the barrier.

5. The transfer vehicle can readily replace damaged units of the barrier thereby reducing maintenance crew effort and time required to repair the barrier.

A disadvantage that surfaced during our review of the research report was the fact that the barrier translated 3 3/4 feet when impacted with a 4,370 pound car at 59.3 mph at a 24 degree impact angle. However, we have been informed by Barrier Systems, Inc., the U S licensee, that a method to reduce lateral movement of the barrier has been developed.

MOVEABLE CONCRETE BARRIER



Nominal Barrier Height	32"
Maximum Dynamic Deflection	Approx. 4"

Truck barrier (Extra high). Truck barrier may be used on divided highways with heavy truck traffic (5% trucks with an AADT ≥ 50,000). This barrier is an "F" shape barrier that is 42" tall with a 12" thick stem. This barrier has been impacted with and contained an 80,000 pound vehicle in a crash test. The passenger car impacts were within the limits of NCHRP Report 230. The truck barrier has specialized advantages in areas where it can be justified. The following is a list of some of the advantages:

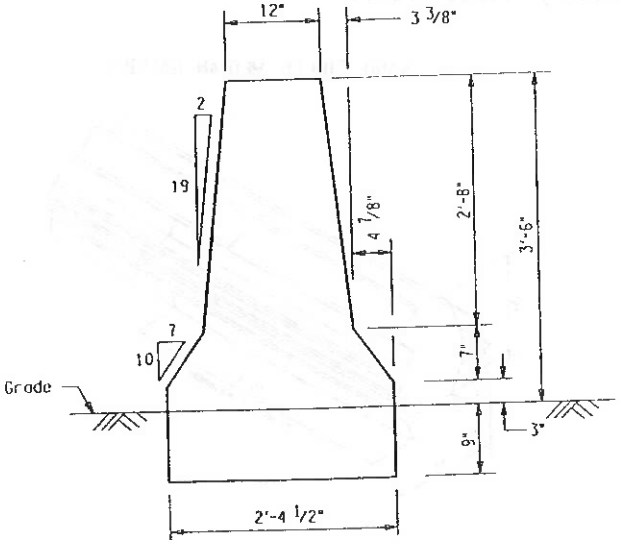
1. The "F" shape barrier will impart a lower roll angle to a heavy truck thereby increasing the vehicle's stability after an impact.

2. The extra 13" of barrier height better contains heavy trucks and helps to keep them from penetrating the line of barrier by rolling over the top of the barrier.

3. The extra mass of the truck barrier helps to contain heavy vehicles.

As with other barriers the truck barriers are not without disadvantages. The extra height may reduce the sight distance of the operator of a vehicle in the lane immediately adjacent to the barrier.

TRUCK BARRIER
(EXTRA HIGH)



Barrier Height: 3'-6"
Barrier Width: 2'-4 1/2"

We have received requests for the above innovative barriers and are now working on developing detail drawings and specifications for them. The specifications and details for the single-slope concrete barrier are nearly complete and should be issued in the next few weeks.

In addition to the three barriers listed above we have information on the following innovative safety barriers and will develop details and specifications for them upon request:

Sand Filled Median Barrier. The sand filled median barrier (IBC Barrier) consists of sand filled compartments with corrugated steel panels on either side of the barrier. This barrier is for use on divided highways where the barrier will sit on the level. The following is a list of advantages that we identified in our review of IBC's literature. Copies of this literature are available upon request:

1. The barrier is free standing with no connection to the median. It relies on its weight, approximately 1000 pounds per foot, to resist movement.

2. The IBC Barrier contained and redirected an 80,000 pound truck in testing.

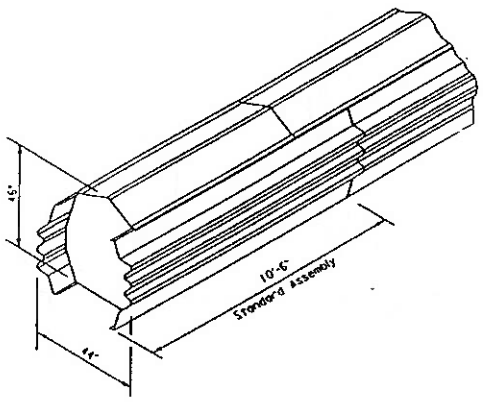
We have also noted the following disadvantages:

1. The barrier weight may preclude it from being placed on structures.

2. The IBC Barrier is 20 inches wider than the standard N J barrier and 16½ inches wider than the truck barrier.

3. The cost of constructing and maintaining IBC Barrier is substantially higher than other barriers that can contain heavy vehicles.

SAND FILLED MEDIAN BARRIER



Post Type and Spacing	N/A Barrier consists of a steel bin filled with sand and covered with a non-structural fill
Beam Type	4 corrugated panels, 3 mm gauge steel, two overlapped on each side
Nominal Barrier Height	42"

Cable Median Barrier. Cable median barrier is used to prevent crossover accidents on wide traversable medians (over 22 feet). This barrier is substantially the same as our standard cable guide rail except that the center cable is mounted on the opposite side of the post from the other two cables. The cable median barrier is presently in service on the Palisades Interstate Parkway. An in service field evaluation of this installation has been made by the Department and the results are published in Client Report 37 "Performance of Cable Median Barrier on the Palisades Interstate Parkway". The identified advantages of this barrier are:

1. It uses standard cable guide rail hardware.

2. The deflection characteristics are the same as the deflection characteristics of cable guide railing.

3. In terms of repair costs, the cable median barrier is economical. Even though longer sections must be repaired, the cables are rarely damaged, and the simple design of the system facilitates repairs.

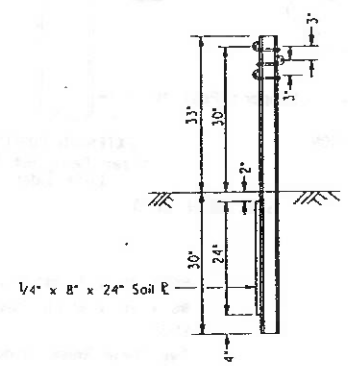
4. On projects where aesthetics are a factor the cable median barrier offers a very unobtrusive appearance, especially if weathering steel posts are used.

Disadvantages that we identified are as follows:

1. Damage to the barrier, placing it out of service, may be expected even with moderate impacts.

2. Cable barriers are basically "one hit" systems and impacts on damaged barrier may allow penetration. Therefore, cable median barrier will require maintenance after every impact and may require periodic inspections to ascertain if there is any damage from unreported impacts.

CABLE MEDIAN BARRIER



Post Type	S3 x 5.7 Steel
Post Spacing	16'
Beam Type	3/4" Diam. Steel Cable
Nominal Barrier Height	30"
Maximum Dynamic Deflection	11.5'

Self Restoring Median Barrier (SERB). The self restoring median barrier (SERB) is a staged system that is designed to restore itself after most impacts. The SERB is for use in narrow curved medians that experience a high number of impacts. The SERB should be considered as an alternate to Heavy Post Blocked-out Corrugated Beam Median barrier on narrow medians with a high likelihood of vehicular impacts. The following is a list of advantages a design engineer should consider:

1. During testing the SERB redirected a passenger car with only minimal damage to the vehicle and also restored itself to full service.

2. The SERB has the capacity of containing vehicles that weigh up to 40,000 pounds.

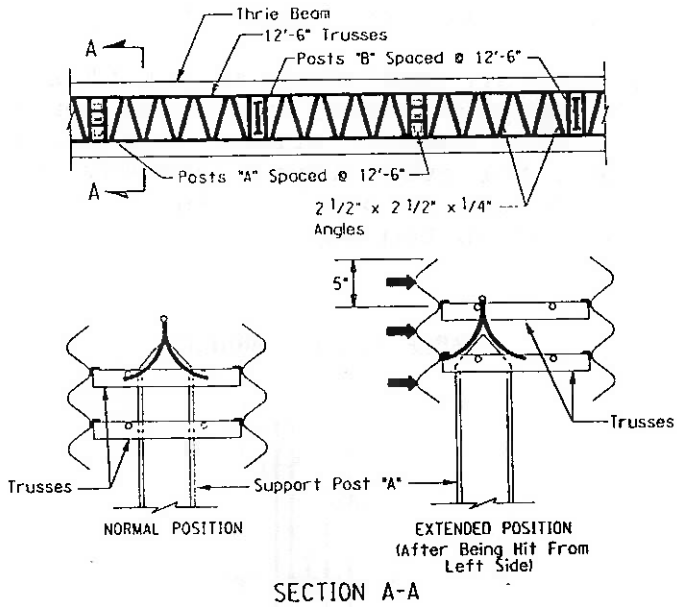
3. This system weighs only 52 pounds per foot. Therefore, its use on structures should be considered.

The following disadvantages should also be considered:

1. The SERB has high initial costs.

2. Maintenance must stock specialized hardware for repair.

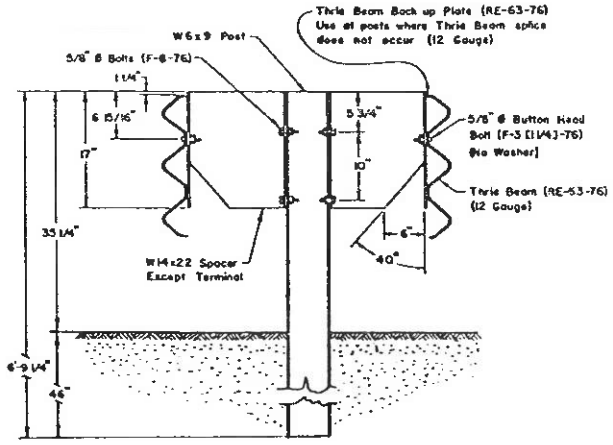
SELF RESTORING MEDIAN BARRIER



SECTION A-A

Post Type	W6 x 20 x 7' ("A" Posts); W6 x 20 x 8' ("B" Posts)
Post Spacing	6'-3"
Beam Type	Two Thrie Beams spaced @ 1'-8" by Two Steel Trusses
Mountings	Beam elements rest on steel caps of "A" Posts
Nominal Barrier Height	34"
Maximum Dynamic Deflection	2.4' (40,000 lb. bus @ 60 M.P.H. and 15°)

Modified Thrie-Beam Median Barrier. This barrier is a modification of the Thrie Beam Median Barrier (MB9). This barrier may be used as a median barrier in narrow medians on highways with heavy truck traffic. We have requested detailed information on this barrier from FHWA. Therefore, we have not included any guidelines for its use nor have we listed any advantages and disadvantages of this barrier. Once we have received this information we will send each Region information on its use and identified advantages and disadvantages.



AASHTO Designation	MB9 Modified
Post Type	W6 × 8.5*
Post Spacing	6′ 3″
Beam Type	Two Thrie Beams
Offset Brackets	M14″ × 17.2″ Steel
Mountings	5/8″ diam Steel Bolts
Nominal Barrier Hts.	32″
Max. Dynamic Deflection	approx. 3′

As new barriers are developed we will add them to the list of innovative safety barriers.