REPORT OF

ENGINEERING EVALUATION TESTS

ON

QUICKCHANGE™ MOVABLE MEDIAN BARRIER

SYDNEY, NEW SOUTH WALES, AUSTRALIA

FEBRUARY 27 & 28, 1984

By:

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Introduction

The Quickchange™ MMB (Movable Median Barrier) System is a segmented concrete barrier that can be manufactured to any of the "New Jersey" barrier shapes. Prototypes of the barrier have been made in both the California Type 50 and the improved Type F shapes. The segments are 1 meter (3.28 ft) in length and are joined together by a pin and link joint. Various joint configurations having different rigidities are under evaluation.

The MMB is moved from lane to lane by a transfer system (see Figure 1) that is towed by a two-ton tractor truck. The barrier limits its movement or deflection due to impact forces by friction forces between the base of the barrier and the pavement; by converting energy from the vehicle to work moving the barrier; and by transfering impact forces and energy to adjacent barrier segments through joint rigidity.

The Quickchange™ MMB System was invented by, and is being developed by, Quick-Steel Engineering Pty, Ltd of Botony, New South Wales, Australia. John P. Quittner, Managing Director of Quick-Steel, is the inventor. Carson Manufacturing Company of Sausalito, California is the North American licensee for the system. All research and development on the System is being paid by private funding. Quick-Steel is looking towards a worldwide application of this system, justifying the tremendous expenses of research and development.

Quickchange™ MMB System Testing & Evaluation

John Quittner, Managing Director of Quick-Steel, has been refining the Quickchange™ MMB System by developing a simple mechanical means to lock the joints between segments using a steel channel assembly. The locking joint system was demonstrated using a 1/5 scale model made up of about 20 barrier segments to which the newly developed locking device had been fitted. In the model, and the prototype as well, the locking device was made from rolled steel channels. Mr. Quittner stated that for final production the locking device would be of cast steel rather than rolled steel channels. This choice of material would reduce the cost while increasing the strength and precision of the locking joint system.

The locking system is a mechanism that is fitted into the base of the barrier section longitudinally (see Figure 2) and locks the segments against lateral movement when the barriers are set on the pavement. Lateral stress is transferred from one barrier segment to the next through steel channels fitted into the base of the barrier. Force is transmitted from the impacted barrier segment to adjacent segments by shear and bearing through a shoulder on the concrete barrier segment into the steel channel and distributed to the remainder of the segments in the string in the same manner. Thus, when the barrier segments are in position, they are locked together to form a rigid barrier of infinite length.

When the barrier is moved by the transfer vehicle, the action of the transfer vehicle lifting the barrier segment unlocks or disengages the channel mechanism from the base of the barrier; and the transfer is smoothly made, including the concrete barrier segments as well as the longitudinal steel channel locking devices. When the barrier is repositioned on the pavement the steel channel mechanism locks itself into a rigid longitudinal beam, in the base of the barrier, thus making the string of barrier segments again a single rigid beam to resist forces applied in the lateral direction.

On Monday and Tuesday, February 27 & 28, 1984, engineering evaluation crash testing of the Quickchange™ MMB was performed on a drag strip track near Sydney, Australia. The tests were conducted by Quick-Steel and Carson Manufacturing Company.

Testing was performed to develop data which will enable Quick-Steel and Carson to refine design elements of the system.

Three systems were tested:

1. A "loose" hinge joint with a simple link and pin connection.

2. A "tight" hinge joint using a minimum tolerance spherical joint for the bottom link connection.

3. A channel lock system.

A total of 50 segments (each one meter long) was prototyped and used for testing. Thirty segments were cast in the California Type 50 configuration and 20 were cast in the Type F configuration. Of the 30 Type 50 segments, 10 contained the spherical joint and 20 contained the loose joint.

The 20 Type F segments contained Quick-Steel's newly developed locked joint.

The 50 barrier segments were similar in the following respects:

1. All cast from 3000 psi concrete using a steel form.

2. All segments had the basic pair of steel links by which they could be hinged using a steel pin through the links.

3. All segments were cast one meter in length.

4. All segments have a longitudinal recess in the center of their base which would fit over raised pavement markers. The base of the barrier on either side of the recess has a polyurethane surface bonded to the concrete. This polyurethane surface serves to protect the concrete base from chipping and spalling in use and to increase the co-efficient of friction between the barrier base and the pavement surface.

The simplest and least expensive joint configuration to fabricate is the loose joint. It is a simple pair of links with the holes in the link bushed with a polyurethane bushing. A pin can be fitted through the links to connect the segments together in a continuous chain. The resiliency of the polyurethane bushing allows for vertical movements so that the segment can be lifted by the conveyor vehicle and for lateral rotation about the pin through hinge action so that the segments will articulate through the S-shaped conveyor.

The second type of joint contains a spherical or ball connection at the lower of the two links. This type of joint is somewhat more rigid that the bushed link and pin joint because the ball joint does not allow any play or give between the link and pin connections. It does, however, allow rotation in the vertical planes so that the segment can be lifted by the transfer vehicle for transporting to the new lane position.

The third type of joining system combines the bushed joint link-pin assembly along with the locking channel assembly. This mechanism allows free movement in both the horizontal and vertical planes while the barrier is being conveyed from one lane to another, and locks the barrier segments rigidly together when the barrier is deployed.

The transfer vehicle in its prototype form (see Figure 1) is fabricated from structural steel plate and tubing, and contains an S-shaped conveyor assembly. The vehicle is mounted on a two-axle traveler assembly and has a pair of idler caster wheels, full sized, between the front and rear axle for added stability during the transfer of the barrier from lane line to lane line. The transfer vehicle is towed by a two-ton truck during operation.

Approximately 12 transfer tests were performed at varying speeds on Monday, February 27, 1984. A transfer at 10 mph was smooth and efficient. The polyurethane wheels in the conveyor showed absolutely no wear to date. The vehicle's ability to handle barrier segments of one meter in length was very satisfactory. It is capable of transferring the barrier on various lane widths up to a maximum of 12 feet.

It is this writer's observation that any lane width within reason can be accomodated by this type of transfer vehicle. Since this vehicle is a prototype, it contains only the basic features, which included an adjustment for varied lane widths. Several additional features that will assist in starting the transfer much more smoothly and accurately have been designed, as well as a barrier straightening device so that the barrier rail can be quickly and easily realigned after impact. These will be incorporated into a second-generation prototype for testing at a later date.

It was learned during the crash testing that the barriers could be easily realigned by two people using 6-foot prybars, provided the barrier was not out of alignment more than 4"-6". Greater misalignment could still be straightened with prybars; however, it became somewhat of a time-consuming operation.

A total of six 3000-lb Holden and Valiant automobiles was prepared for crash testing. These automobiles are very similar to American-made mid-size automobiles of the late 1970's. The Valiant automobiles are very similar, if not identical in most respects, to the American Plymouth Valiant. The Holden is a General Motors automobile and very similar to mid-size Oldsmobiles, Pontiacs, and Buicks.

Guidance of the test cars was achieved by a unique system developed by John Quittner. The crash car's steering wheel was removed and a universal joint was attached to the steering rod. To this in turn was attached a 10-foot length of square tubing which extended out the back window opening. Mounted on top of the push truck was a support through which a larger piece of square tubing extended. A steering wheel was attached to one end of th larger tubing and the other end slipped over the smaller tubing attached to the steering column of the crash vehicle. The desired test speed was achieved through pushing with a push truck. The driver of the test vehicle then positioned himself in the bed of the push truck and guided the car ahead with the steering wheel that was attached to a rack on top of the cab of the push truck.

At a predetermined distance from the impact, the push truck would slowly apply its brakes allowing the crash car to proceed to the crash point unattached and free of the push truck. The system worked remarkably well, impacting within 6'± of the desired point on 16 of 17 tests.

The driver of the push truck was accompanied by an observer who would call out the speed at which the crash car was being pushed, to assure and verify that the prescribed test speed had been reached by the test car prior to impact. The push truck's speedometer had been calibrated by test runs over measured distances.

A total of 17 test runs was made. Crash tests were performed at various speeds and impact angles into the three different types of barrier segments.

Crash speeds were run at 25, 35, 45, and 55 mph, and at 7½° and 15° impact angles (see Figures 3,4, & 5.). The barrier performed excellently at all speeds at the 7½° angle.

When the angle was increased to 15° significantly more deflection occured upon impact, but still very good results were obtained.

Two tests were run with the barrier at 15° and the vehicle ballasted to 4400 lbs. At 45 mph the deflection was 16", and at 55 mph the deflection was 11½". The writer believes that the difference in deflection tends to indicate that in the case of the 16" deflection the impact occured on a joint between two segments, while the 11½" deflection at a higher speed occured when the center of the barrier was impacted.

In all crashes the vehicles were well controlled after the crash by the safety shape of the barrier. There was no vehicle vaulting or bouncing back into the traffic lane. In most cases where sufficient length of the barrier extended beyond the point of initial impact, the vehicle came to a controlled stop while being retained against the barrier by the barrier shape. The vehicles suffered very little sheetmetal damage during any of the impact tests. In every case the impact occured by tire contact with the barrier face, not by bumper or fender contact. As the vehicle climbed the barrier face, tire contact remained, preventing major sheetmetal contact from taking place.

At higher speeds of impact the outboard front tire, which was apparently taking a large force against the pavement, blew out. At the very highest of speeds the impact tire blew out as well (see Figure 3).

In summary, recognizing that the barrier development is in its first stage of full-size prototype testing, the writer believes that with further research, development and refinement of the existing link-pin hinge assembly, along with a refined locking channel assembly, a satisfactory barrier can be developed that will withstand the impact of automobiles weighing up to 4500 lbs and at angles of at least 15°, with the amount of deflection upon impact being limited to 6" or less. Further testing is needed to determine the system's performance at a 25° impact angle.

Thus, the writer believes that this barrier can successfully be used when its development is finally completed, on roads and bridges where an MMB would provide the safety of a fixed barrier and the flexibility of allocating traffic lanes to accommodate peak traffic by utilizing off-peak traffic lanes of the opposing direction.

It must be recognized, however, that a considerable amount of research time, research money, and testing will have to be expended before this movable median barrier system can be put into production for use. Quick-Steel and Carson state that they will continue to further develop and refine this barrier into a viable movable median barrier that will have many applications throughout the world where a movable barrier is needed for traffic safety.

In attendance at the tests were:

John Quittner, Quick-Steel Engineering Pty, Ltd

John W. Duckett, Carson Manufacturing Co.

Warner Odenthal, consultant to Carson Manufacturing Co.

Approximately 5 engineers from New South Wales Department of Main Roads.

Bob Field, former employee of CalTrans who has worked on crash tests in that capacity; now retired in Australia and consultant to Department of Main Roads

In attendance at the tests:

C. Paul Bettini, Director, Golden Gate Bridge, Highway and Transportation District

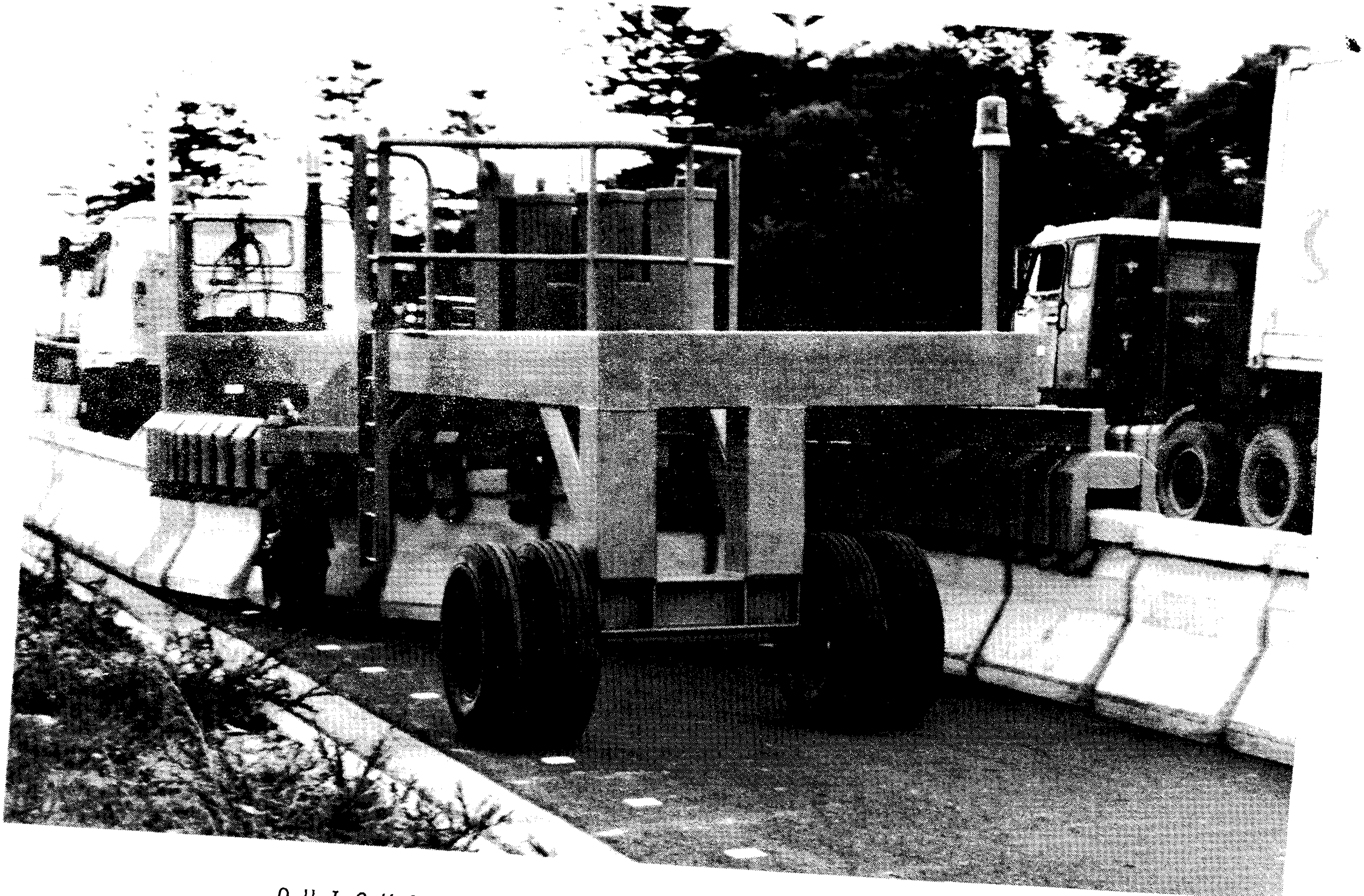
D.E. Mohn, PE, Chief Engineer, Golden Gate Bridge, Highway and Transportation District

All testing was recorded on videofilm.

DEM/db
March 30, 1984
retyped January 8, 1985

FIGURES AND TABLES

FIGURE 1



QUICKCHANGE™ MOVEABLE BARRIER

Details on Reverse

FIGURE 2

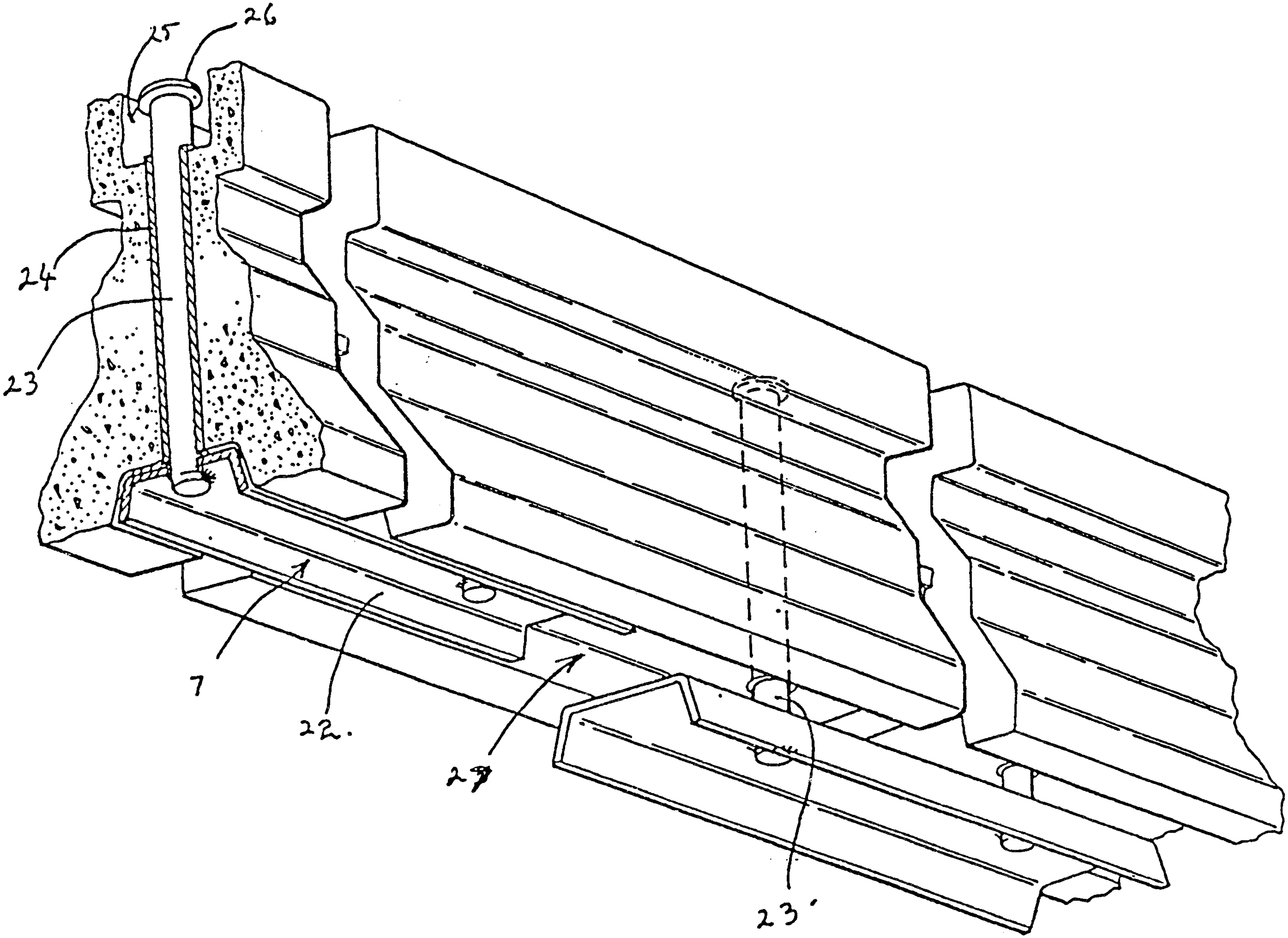


FIGURE 3

CRASH TEST RESULTS
QUICKCHANGE MOVEABLE MEDIAN BARRIER (MMB)
February 27 & 28, 1984

Test No.	Vehicle Weight (pounds)	Barrier Angle (°)	Speed (mph)	Barrier System Impacted	Lateral Displacement (inches)	Damage to vehicle Other Observations
0	3000	7½	25	NA	NA	Vehicle missed barrier
1	3000	7½	25	C.L.	0	1 2
2	3000	7½	25	L.J.	4½	1 2
3	3000	7½	25	NA	NA	Vehicle missed barrier
4	3000	7½	25	S.B.J.	1½	1 2
5	3000	7½	35	C.L.	1	3 2
6	3000	7½	35	L.J.	3½	1 2
7	3000	7½	35	C.L.	2	1 2
8	3000	7½	35	S.B.J.	2-3/4	1 2
9	4400	7½	35	C.L.	2¼	1 2
10	3000	7½	45	C.L.	2½	3 2
11	3000	7½	45	L.J.	7½	4 2
12	3000	7½	55	C.L.	2¼	3 2
13	3000	15	35	C.L.	5-3/4	3 2
14	3000	15	45	C.L.	12¼	4 2
15	3000	15	55	C.L.	14½	4 2 5
16	4400	15	45	C.L.	16	4 2 5
17	4400	15	55	C.L.	11½	4 2 -

NA - not applicable

C.L. - Channel Lock Joint

L.J. - Loose Joint

S.B.J. - Spherical Ball Joint

1 - No damage

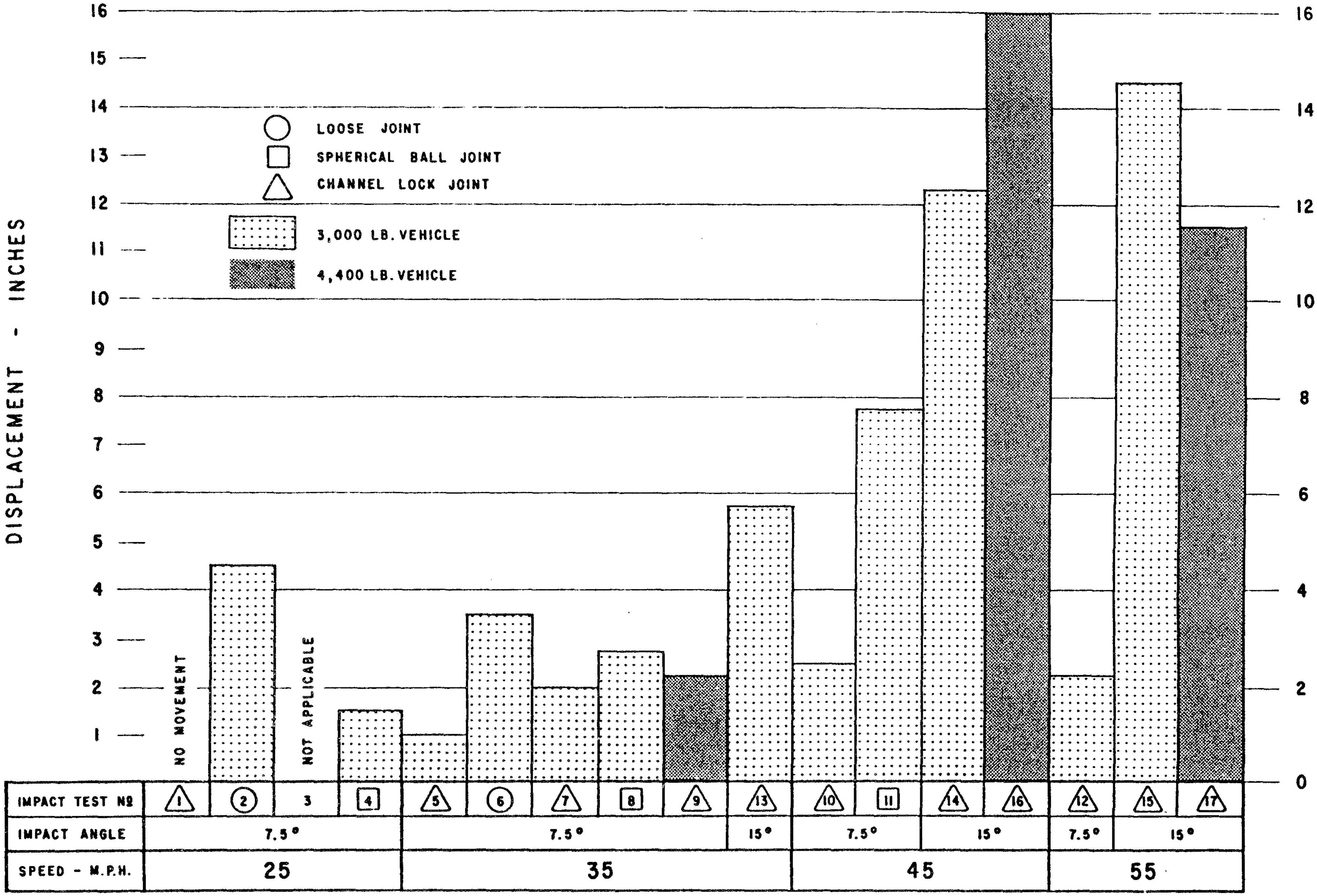
2 - Car clung to barrier

3 - Minor Damage

4 - Tire(s) blew and/or minor front end body damage.

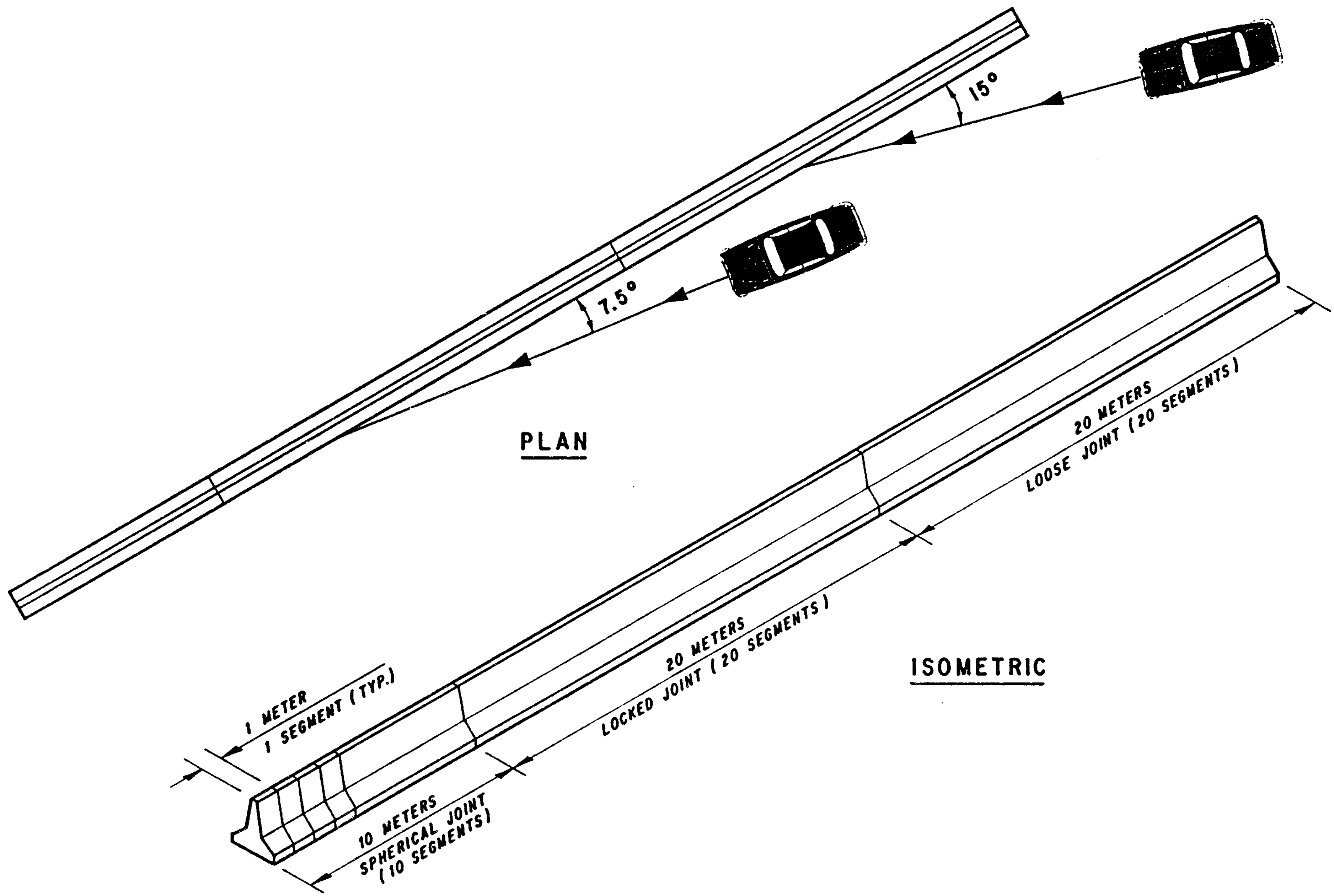
5 - Modules climbed up lock-channel incline allowing rotation. No damage done to lock channel or modules.

FIGURE 4



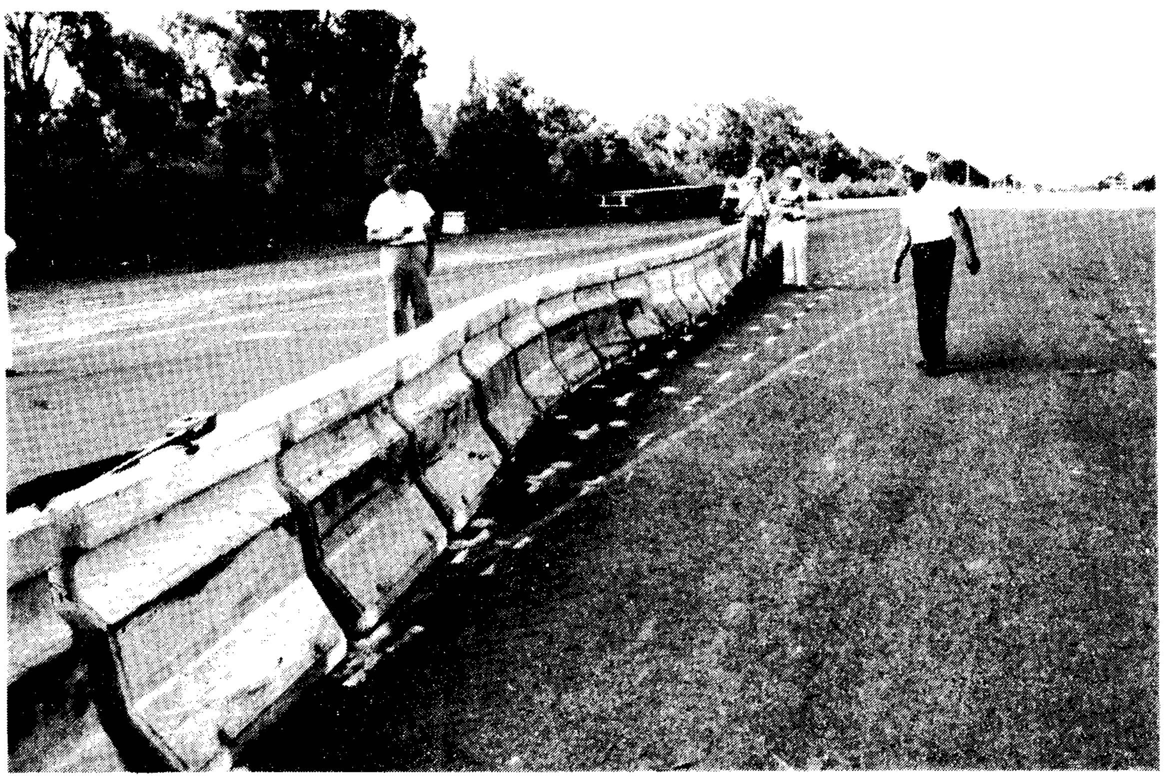
BARRIER DEFLECTION UNDER VEHICLE IMPACT

FIGURE 5



BARRIER LAYOUT - VEHICLE IMPACT ANGLES

TEST #15 55 MPH, 15° IMPACT ANGLE, 3000-LB CAR
LOCKED JOINT BARRIER



TEST #15 14½" DISPLACEMENT

FIGURE 6

Techniques Spéciales de Sécurité

Rue Ampère - Z.I. du Pâtis - B.P. 26
78511 RAMBOUILLET Cedex
Tél. : (3) 059.80.66 - 059.82.71
Télex : 698812 TSSRAM

INTRODUCING :

- To increase Traffic flow
- To protect drivers
- To increase Work area protection
- To optimise available road capacity
- To Postpone the necessity of new Road Construction :

MOVABLE TRAFFIC CONTROL EQUIPMENT

A1 Highway DDE Seine-Saint-Denis Paris - France (1984)

- Easy and Speedy Transfer (8 To 20 miles/Hour)

PATENTS PENDING EUROPE AND OTHER COUNTRIES

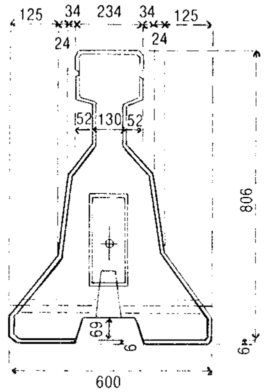
SPECIFICATIONS :

Transfer Machine : Length : 9 meters   Width : 2,50 meters   Weight : 6 Tons
Powered by a 200 HP Diesel engine - Hydraulic drive and steering

- Width of transfer : from 2,1 to 5 meters
- Self propelled - totaly reversible

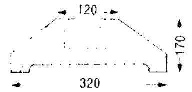
The transfer is achieved through a "S" shaped conveyor.

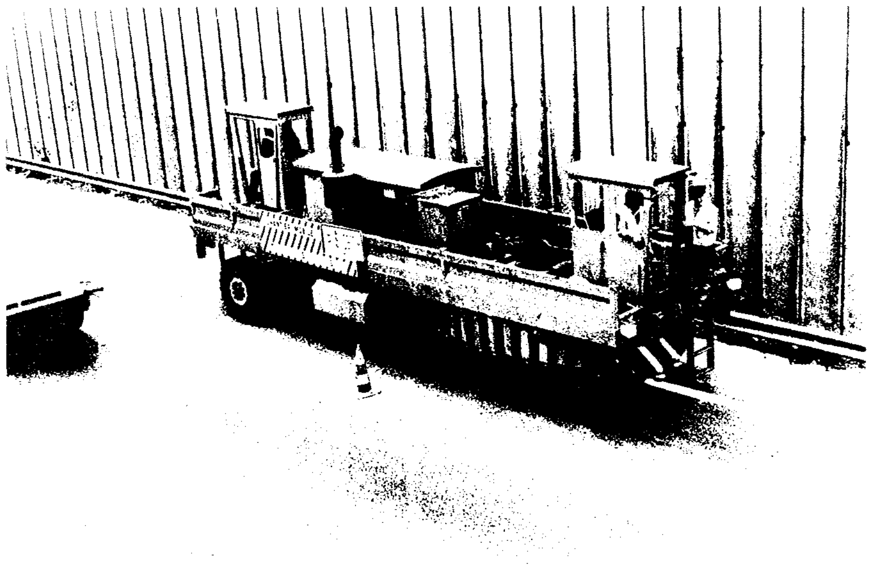
TYPE
800 SERIES
concrete or steel



TYPE 500 SERIES
concrete or steel
same profile H = 500 l = 500

TYPE
200 SERIES
steel





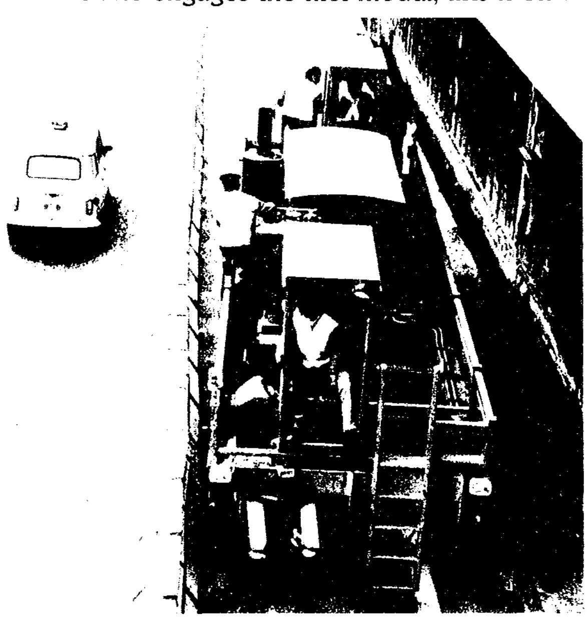
A1 Highway DDE Seine-Saint-Denis Paris - France (1984)

THREE TYPES OF MODULES

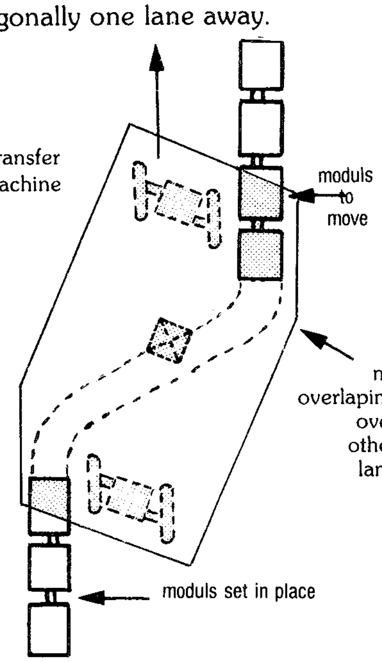
- 800 SERIES : concrete or steel - new jersey section - weight 650 Kg/meter - connected by a pin fitted into lugs length 1,1 meter - width 0,6 meter - height 0,8 meter
- 500 SERIES : mini new jersey - weight 250 Kg/meters - width 0,5 meter - height 0,5 meter
- 200 SERIES : cast iron or steel - 70 Kg/meter - width 0,32 meter - length 0,6 meter - height 0,17 meter
  Connected by a male-femable pin
  These elements may be equiped with reflective poles.

PRINCIPLE :

1) Installation of the moduls
2) The machine engages the first modul, lifts it off the ground and transfer diagonally one lane away.



A1 Highway DDE Seine-Saint-Denis Paris - France (1984)



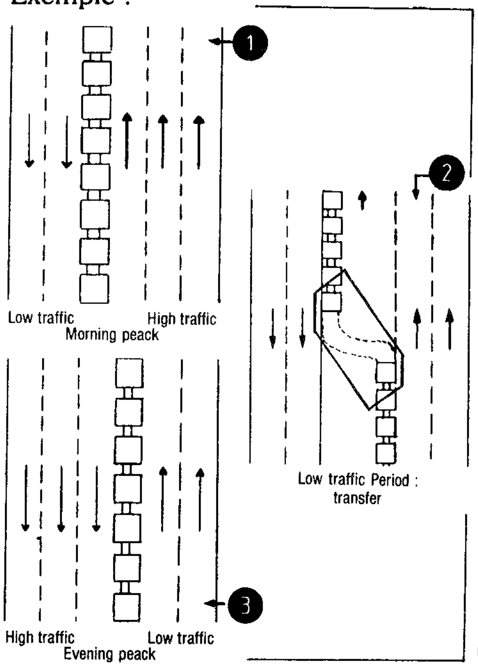
3) The transfer and depositing of the moduls is smooth an continuous
4) The transfer speed is 8 mph for 800 and 500 series and 20 mph for 200 series.
5) After transfer the machine is adjusted back to road width and travel unhindered in the traffic.

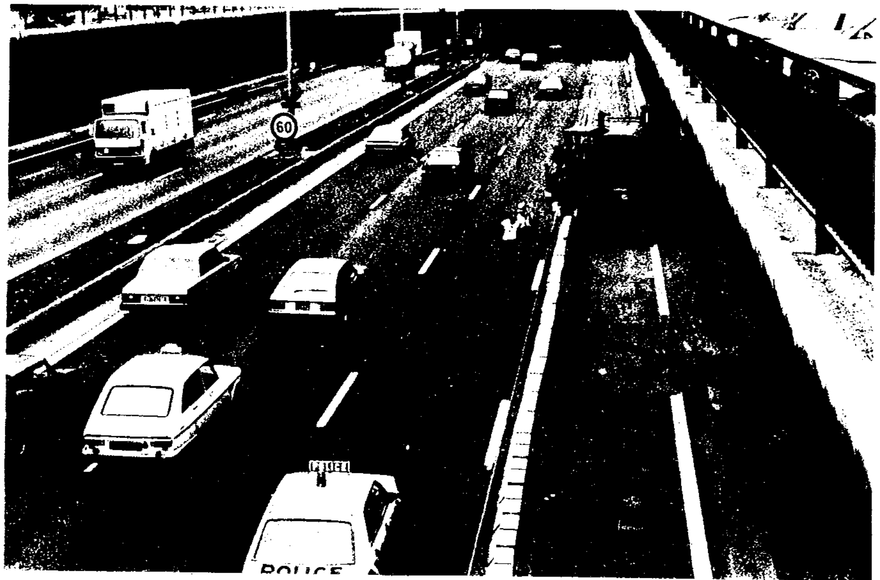
UTILISATION :

1) CONTROL OF TRAFFIC FLOW

When you plan for peack traffic flow in one way, you might increase the number of lanes by moving the barrier one lane away.

Exemple :





A1 highway July-August 1984 Paris

At each end of the barrier a moveable median may be installed (remote controlled).

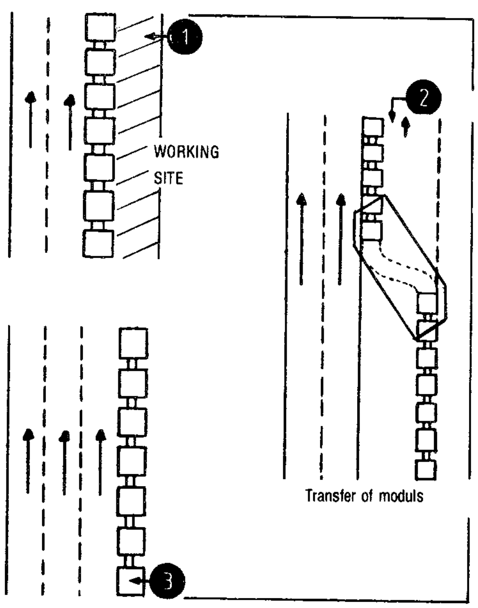
WORKING SITE PROTECTION :

To protect a job site you can use this tranferable barrier.

With 800 series moduls you protect :

- on the traffic side : drivers against hazards of roadworking machinery, materials, etc...
- on the other side : workers and machines at work.
- you have a positive separation of the work area.
- at end of day you transfer back the barrier, opening the full road to traffic.

A1 highway July-August 1984 Paris



MOVEABLE MEDIANS :

DESCRIPTION

- Made of galvanized steel
  3 meter long - 600 mm wide - 150 mm height
  They can be coupled into length up to 80 meters (under certain conditions the length of the medians can exceed 80 meters).
- The first modul is anchored, the end modul is equipped with electric or hydraulic driven wheels.
- Each modul have 4 spring loaded wheels.

UTILISATION :

- It is possible to open or to close one or more lanes at a speed of 15 to 20 seconds per lane to divert traffic.
- It is possible to close an exit and to deviate into a curve.
- It is even possible to create à "S" shape by using two separate driving moduls.

DRIVING :

- May be actuated by an operator on the driving modul or cable control, or radio control from traffic remote control.

COMPLEMENTARY EQUIPMENT :

The moveable median can be equiped with : flashing lights, reflective lenses, extended sides - delineators - etc...

POSITION 1

POSITION 2

- 15 seconds after