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Progress Report on Median Barrier Test Program

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F.N. Hveem

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16. ABSTRACT

This is a progress report to outline the test results performed to date on various highway guard systems suggested as median barriers along with a partial analysis of the findings. Attached are 11 sheets, which outline the brief pertinent facts of each test.

All of these tests except one were of a steel beam system. The one exception is Test No. 10 of concrete posts. This latter test is reported but not included in the preliminary analysis below. Deceleration will be noted on only a few of the attached reports. This information must be taken from the film and is a slow, tedious process that must be completely checked before it can be reported. This information will probably not be ready until the time of the final report.

When considering only metal beam guard rail systems, it appears that the most economical yet efficient median barrier would be corrugated beam (W Section) steel rails, mounted back-to-back on 8" x 8" pressure creosoted Douglas fir posts, 6 feet long, and placed at 6' 3" centers. The over-all height of the rail above the ground should be 30", the creosote being recommended rather than salt treatment. This would result in an effective life of the barrier equivalent to the anticipated life of the highways. Such posts could not be painted.

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November 14, 1958

To: F. N. Hveem

From: J. L. Beaton

Subject: Progress Report on Median Barrier Test Program

This is a progress report to outline the test results performed to date on various highway guard systems suggested as median barriers along with a partial analysis of the findings. Attached are 11 sheets, which outline the brief pertinent facts of each test.

All of these tests except one were of a steel beam system. The one exception is Test No. 10 of concrete posts. This latter test is reported but not included in the preliminary analysis below. Deceleration will be noted on only a few of the attached reports. This information must be taken from the film and is a slow, tedious process that must be completely checked before it can be reported. This information will probably not be ready until the time of the final report.

When considering only metal beam guard rail systems, it appears that the most economical yet efficient median barrier would be corrugated beam (W Section) steel rails, mounted back-to-back on 8" x 8" pressure creosoted Douglas fir posts, 6 feet long, and placed at 6' 3" centers. The over-all height of the rail above the ground should be 30", the creosote being recommended rather than salt treatment. This would result in an effective life of the barrier equivalent to the anticipated life of the highways. Such posts could not be painted.

The major drawback to this type of barrier system is the height of beam. A passenger car wheel can enter under the rail resulting in the car either tripping over or hanging up on the posts. To alleviate this action it is necessary either to place a rigid rail (such as a steel channel) below the top beam, or to block the top beam out far enough so that the automobile frame cannot contact the posts. Unfortunately, to do an efficient job when subjected to high angles (30° ± and above) of collision, the projection of the rail would have to be as much as 18" out from the posts. This distance would require an expensive structural support for the rail. The rail could, however, be blocked out about 8" rather inexpensively by the use of 8" x 8" x 14" creosoted DF blocks. At the lower angles of collision (20° ± and lower, where most of the accidents occur, such 8 x 8 blocking would be effective. Even when subjected to only a moderate collision, the above design still will result in "pocketing" and therefore will cause reflection of the car into the traffic stream. Major high angle collisions with this type of rail probably will result in the car "hanging up" on the rail posts with the rear end swinging around into the traffic lanes.

The least the above steel beam median barrier could cost in place is approximately \$9.00 a lineal foot, but if it is decided to add a lower rail, then the price would be in excess of \$10.00 per lineal foot. In my opinion the lower rail should be used.

Evidence accumulated during this series of tests and an earlier series of tests of reinforced concrete bridge rails, indicates that collision with a solid concrete wall will result in approximately the same automobile contact damage (except the crash loading will be better distributed). There is no danger of the car becoming trapped and less danger of the car rolling. Furthermore, the reflection angle tends to be much flatter off a solid concrete wall rail than off any of the steel rail systems so far tested.

Our past consideration of concrete rail has been colored by excessive costs for such a design. Recently, however, the Bridge Department has revised their design assumptions and have prepared a preliminary design of a reinforced concrete wall rail that is competitive in first cost with any competent steel rail system and will probably result in an advantage insofar as maintenance cost is concerned.

It is probable that the barrier efficiency of such a wall could be improved by adding a 12 to 18" projection on both sides out from the top of the wall. The projection should be designed to have a horizontal top surface, 6" vertical faces, and the under surface to slope back at a 1:1 ratio to contact with the wall. It is doubtful, however, that the additional benefit of such a projection could justify its additional cost.

It is my suggestion that a concrete wall be tested, the design of the wall to be similar to Study 3 on the plan accompanying Mr. Elliott's letter to Mr. Hveem dated September 26, 1958.

The following remarks are made concerning specific details of metal beam type barrier systems:

<u>Beam Type</u>:

It is typical of all forms of steel guard rail systems that during a collision they form a pocket. The more rigid the post and mounting systems, the shallower this pocket appears to be, and vice versa. A shallow pocket tends to reflect the car off the rail into the lanes of traffic, whereas the deeper pockets tend to trap and trip the car either into rolling over the rail or parallel with the rail. For instance, during all collisions of the test car with the Tuthill type of beam guard rail (which is our standard curve beam rail mounted on springs) at the 30° angle of approach, the car ended up either astraddle the rail or on the opposite side of the barrier.

In one test at a 20° angle of approach the side thrust of the car was insufficient to cause a deep pocket in this type of rail. This resulted in a flat reflection angle, and the car remaining upright on the collision side of the barrier.

On the other hand the use of the corrugated beam (W Section) type of rail in all cases resulted in the vehicle remaining on the collision side of the barrier. The only test in which there may be a question about whether or not chance played a part in the car not passing over the corrugated beam rail was when such rail was mounted 25" high on timber posts at 12' 6" centers. This resulted in a system that gave results not much different than the Tuthill system. In general it appears that the prevention of a deep pocket is a desirable feature for a median barrier.

Post Type:

In this series of tests three types of posts have been used: 8" x 8" Douglas fir timber posts tamped in earth (both 5' 4" in length and 6' in length), 6" x 15.5# steel H beams set in concrete, and spring steel posts bolted to a concrete anchor block. The results using the 6' long 8 x 8 timber posts and the 6" H beams were about the same. Both were sufficiently rigid to support the rail in position throughout collision. The timber post seemed to absorb energy somewhat better than did the steel posts. While about the same number of posts were destroyed during similar collisions, there were usually more timber posts loosened than there were steel. This, however, was a minor problem in that the posts could be tamped back into position easily. It was found to be easier to replace a tamped-in-place wood post than it was a steel post with a poured in place concrete footing. Static cantilever tests of 8 x 8 DF posts and 6" x 15.5# H posts show them to be of equal strength with the timber post having a greater deflection. This correlates with the better performance of the timber post under dynamic loading.

The 5' 4" timber post is insufficient in length to support the height of rail needed in a barrier system.

The spring steel post tended to collapse under loading and resulted in the car passing directly over the barrier. The spring offered only sufficient resistance so as to form the rail into a ramp causing the car to travel through the air about 40 feet before striking the ground on the other side of the rail.

Spacing of Posts:

Three spacings of posts were used: 12' 6", 10', and 6' 3". Little significance could be observed between the 12' 6" spacing and the 10' spacing, primarily because no direct comparison was possible since the two spacings were not tested by comparable railings. It did appear, however, that the corrugated beam mounted on timber posts at 12' 6" centers resulted in a guard rail system approximately as flexible as the Tuthill type mounted on posts at 10' centers.

In general it appears that the closer the post spacing the more rigid the over-all barrier system. As was illustrated, however, by Test No. 9, care must be used in the over-all design. The lack of distribution of loading to many posts is one of the results of a rigid system, so the beam in a rigid system must be stronger than with flexible posts so as to resist the concentration of loading that occurs due to the relatively short span in which the loading is absorbed. This loading is a tensile load rather than a beam load and tends to snap the rail at the joint.

Height of Rail:

Four heights of rail have so far been used in this series of tests. They are: 25", 30", 34", and 36". The latter height of 36" was attained by Tests No. 6 and No. 7 where a back-to-back railing was mounted at a 30" height above and in back of a six inch high curb. In over-all effect, this railing can be considered as 36" in height because after the car passed over the curb, there was no perceptible change in elevation of the frame of the car. All of the 6" raise in height was taken up in change of elevation of the wheel only.

We will have an opportunity a little later to also check the 27" height. This will be when a mounting of corrugated beam rail is made to simulate the typical metal bridge railing installation.

Evidence to date indicates the 30" height to be as low as a metal rail should be built so as to be effective as a barrier. Any additional height above this level is only significant as a factor of safety. Even this significance appears to fade at the 36" height.

If extension above this height were desired for headlight screening, then it could be done with some lighter type of material.

It was interesting that a 6" high curb had little effect on elevating the car frame. As the automobile went over the curb, all of the movement was taken up in front wheel movement. This was discussed with automobile manufacturers who felt that this action would be true for most cars in that this much movement would be taken up in the springing systems. It should be kept in mind that this is no longer true when the curb attains 8" or greater in height. At these greater heights, the travel of the wheel exceeds the springing system and the push against the car is directly against the framing members causing an after effect or delayed jump of the car behind the 8" and higher curbs. So, rails behind curbs 8" and higher must be constructed at a greater height than the 30".

Spring Mounting Brackets:

At the high speed and 30° angle of collision of these tests, it appears that the standard Tuthill spring mounting is probably somewhat of a detriment rather than a help. It appears to permit a greater pocketing of the vehicle, at least more than does the corrugated beam rail without the spring mounting. A 20° angle of approach was used on a Tuthill rail mounted without spring brackets on posts at 6' 3" centers for Test No. 7. Probably because of the 20° angle of approach, there was little pocketing during this collision. However, it is also considered that the effect of the lack of springs was significant.

After witnessing the several tests, both of ours and those performed by General Motors at their Proving Ground, it is my general feeling that, while a spring mounting will serve to better distribute the tension load over a greater number of posts and will probably result in fewer posts being greatly disturbed during a collision, the hazard of deep pocketing resulting from such flexibility is of greater concern than the value of additional distribution obtained by such springs.

One interesting test was made by the General Motors people, in which they collided with a corrugated beam rail mounted on a Tuthill spring fixed with a wood block cut to the shape of the corrugations in front and the Tuthill spring in back. The rail thus was blocked out from the wooden post not only the normal 6 1/2" of the Tuthill spring but an additional 1 1/2" of the block.

This collision was at a speed of 35 mph and an impact angle of 18.5°. The damage to both the rail and the car was relatively minor. There was a tendency by some of the General Motors people to attribute this minor damage to the spring mounting and to a degree this is probably true. However, I think that it was significant that no part of the car caught on any of the posts. I think that this was a result of the additional blocking out of the rail (combined with the flat angle of collision) and that this factor was more significant than the flexibility of the spring.

It therefore appears to me that since the majority of collisions resulting in property damage are between 15 and 20° that it would be well worthwhile to block out a median barrier rail system with at least the before-mentioned 8" blocks of creosoted Douglas fir.

It is emphasized that the above analysis is merely a preliminary discussion and a progress report of the median barrier test to date.

It is strongly urged that additional tests be authorized of the new reinforced concrete median barrier proposed by the Bridge Department and further that at least two more tests be authorized on energy absorbing types of median barriers such as the previously proposed baled straw barrier and the use of roof joists mounted in a horizontal plane. It is estimated that about $15,000.00 should be provided for additional testing.

Since writing the above, Test No. 12 has been performed but not analyzed. This unit is a 3 foot high chain link fence on standard steel H posts with two 3/4" anchored cables serving as snubbers.

Based on observations in the field, this test resulted in snubbing of the car into the system at a deceleration tolerable to human occupants and at minor damage to the vehicle. The collision was at the standard 30° angle of approach at a speed of 60 mph.

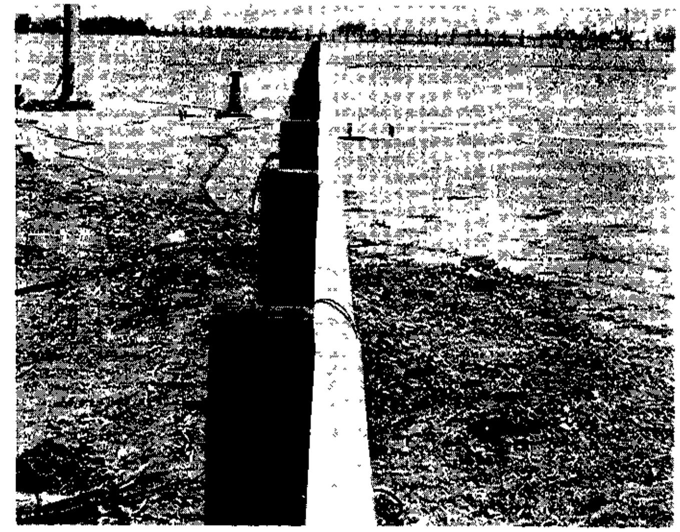
Further study must be made to be sure that all factors are considered, but at this time it appears that this cable and chain link fence barrier system is one of the more promising barriers tested to date.

These results in no way change my above recommendation for additional tests.

John L. Beaton
J. L. Beaton
Supervising Highway Engineer

JLB:mw
Attach.
cc: Members of Median Barrier Committee
JWTrask
FEBaxter
MHarris

POST IMPACT



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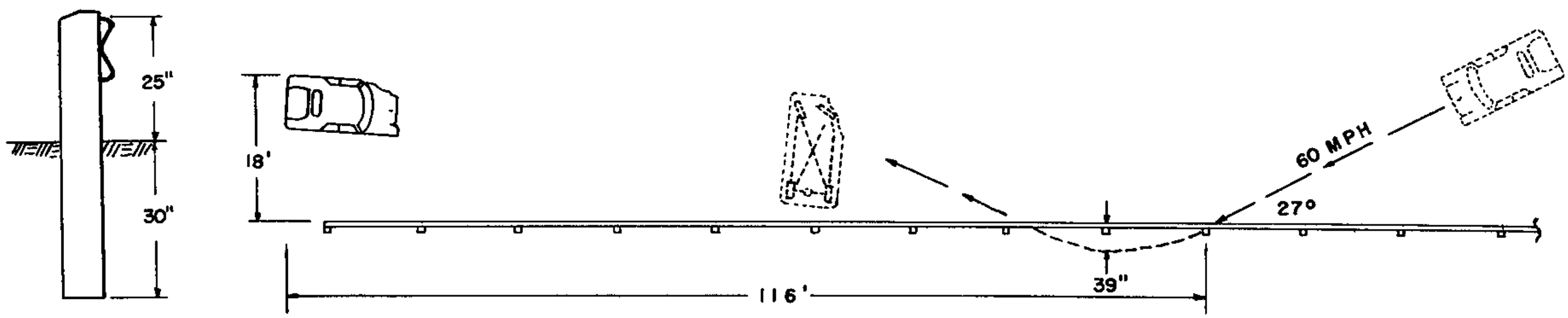


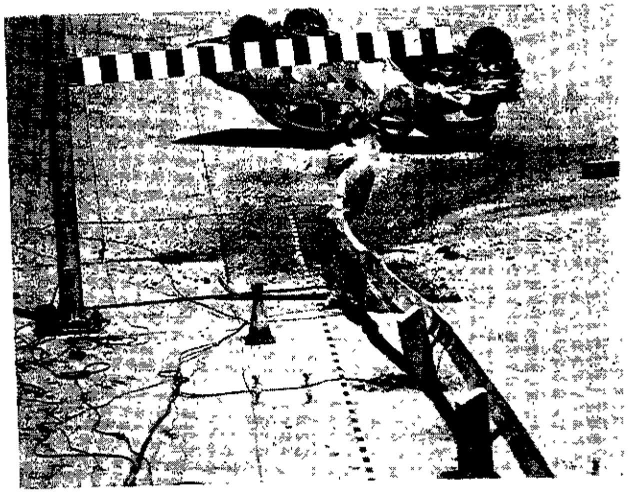
GUARDRAIL	W Section
BRACKET	None
POST	8x8 D.F.
POST SPACING	12'-6" O.C.
LENGTH OF INSTALLATION	212.5'
GROUND CONDITION	Dry

DUMMY INJURY	Multiple scalp lacerations.
GUARDRAIL DAMAGE	3 Sections damaged beyond repair.
POST DAMAGE	2 Posts damaged beyond repair. 12 Posts out of alignment.
VEHICLE DAMAGE	Total loss
MAX. DYNAMIC DEFLECTION OF RAIL	48"
VEHICLE DECELERATION (PEAK)	Long. .... Transv.

TEST NO.	1
DATE	7-10-58
VEHICLE	Chev. 52 Sedan
SPEED	60 MPH
IMPACT ANGLE	27°
VEHICLE WEIGHT (W/DUMMY & INSTRUMENTATION)	3980

STATE OF CALIFORNIA   DIVISION OF HIGHWAYS   MATERIALS & RESEARCH DEPT.

1958 MEDIAN BARRIER & BRIDGE RAIL IMPACT TESTS



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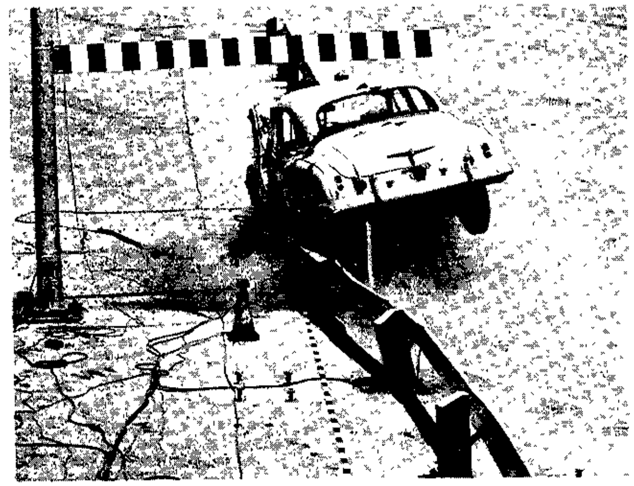

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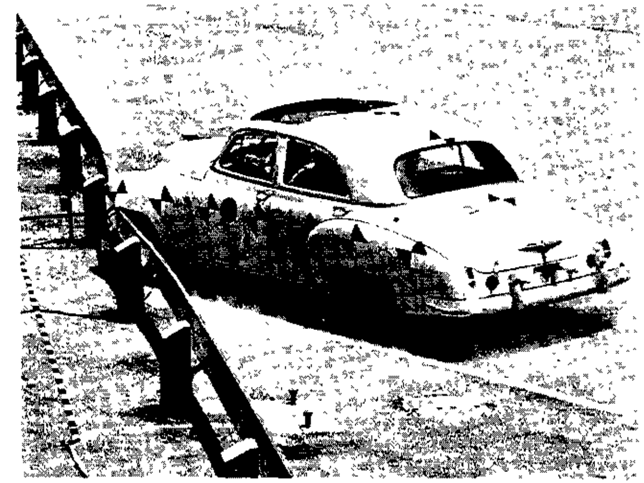

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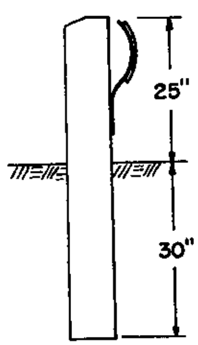

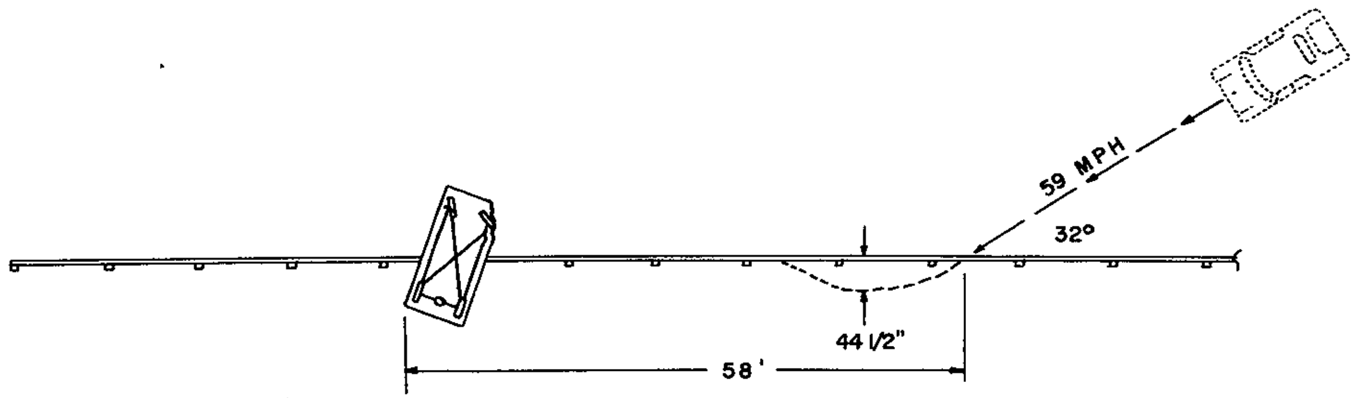

GUARDRAIL .... Tuthill
BRACKET HG15N
POST .... 8x8 D.F.
POST SPACING .... 10' O.C.
LENGTH OF INSTALLATION ... 200'
GROUND CONDITION .... Dry

DUMMY INJURY .... Severe scalp lacerations. Possible minor concussion.
GUARDRAIL DAMAGE .... 4 Sections damaged beyond repair.
POST DAMAGE .... 5 Posts damaged beyond repair.
10 Posts out of alignment.
VEHICLE DAMAGE .... Total loss
MAX. DYNAMIC DEFLECTION OF RAIL ... 55 1/2"
VEHICLE DECELERATION (PEAK) ...... Long. ... Transv.

TEST NO. 2
DATE 7-23-58
VEHICLE .... Chev. 50 Sedan
SPEED .... 59 MPH
IMPACT ANGLE ..... 32°
VEHICLE WEIGHT 3980
(W/DUMMY & INSTRUMENTATION)

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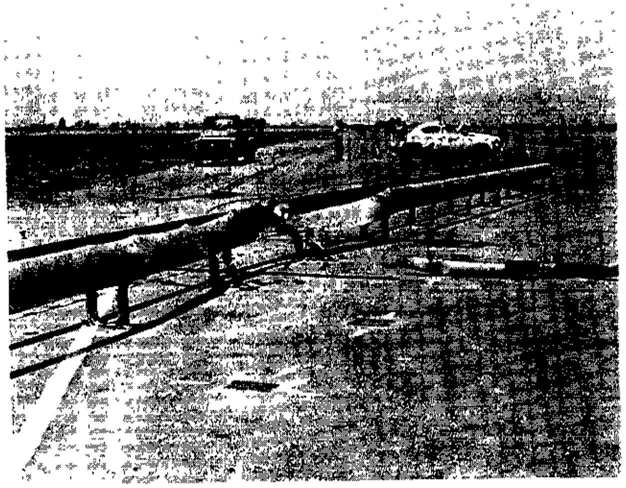
1958 MEDIAN BARRIER & BRIDGE RAIL IMPACT TESTS



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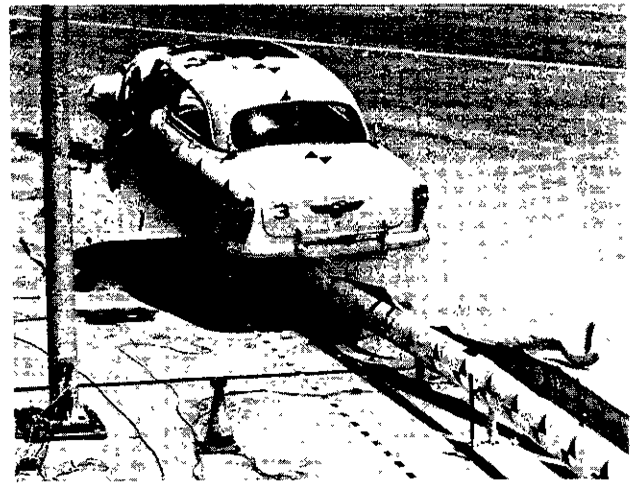

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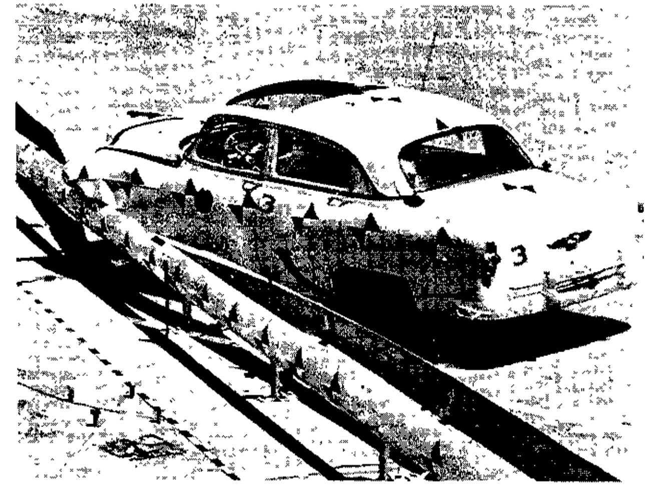

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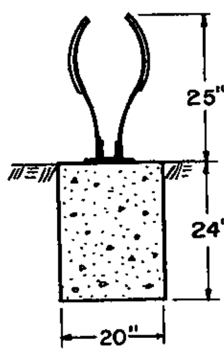
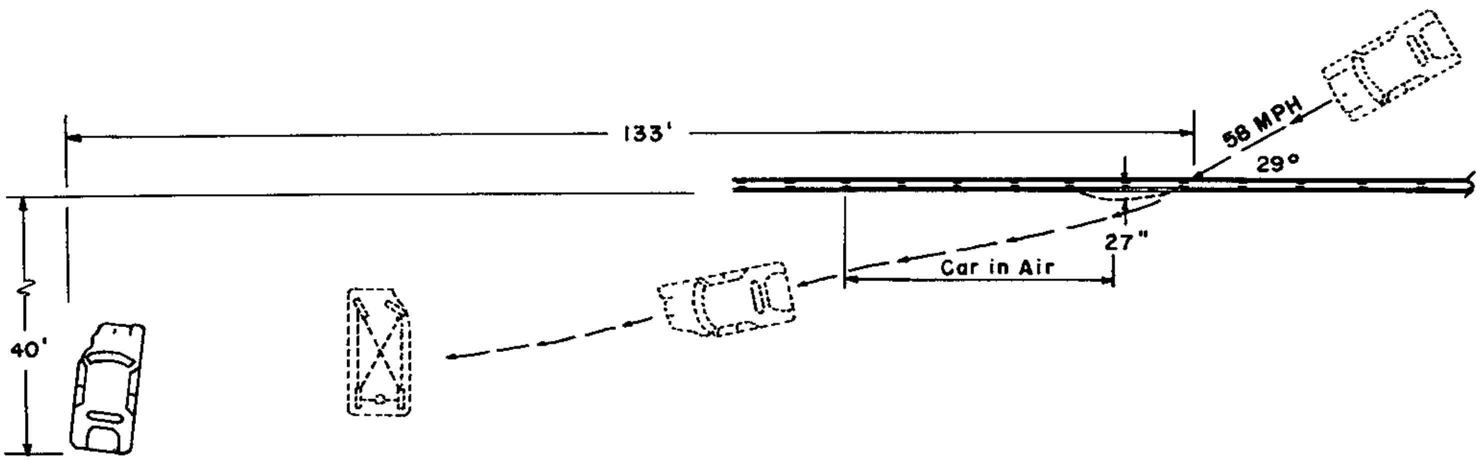




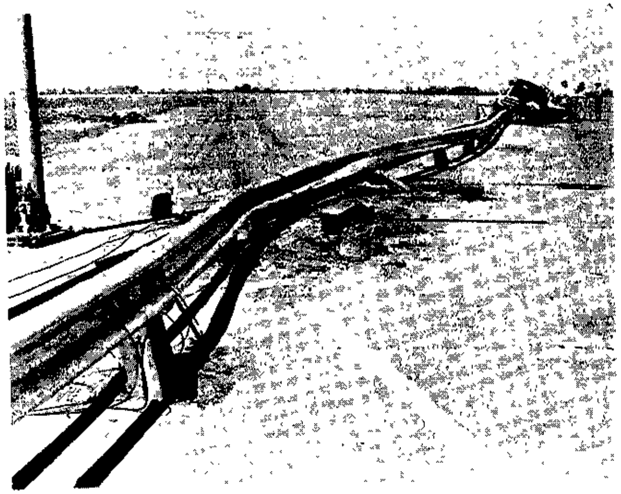
GUARDRAIL ....Tuthill
BRACKET ....HG 26 N
POST ....HG26 N
POST SPACING ....6'-3" O.C.
LENGTH OF INSTALLATION... 100'
GROUND CONDITION ....Dry

DUMMY INJURY ....Multiple scalp lacerations. Possible minor concussion.
GUARDRAIL DAMAGE ....4 Sections damaged beyond repair. Inside rail failed.
POST DAMAGE ....6 Brackets damaged beyond repair.
VEHICLE DAMAGE ....Total loss
MAX. DYNAMIC DEFLECTION OF RAIL... 27" Before failure.
VEHICLE DECELERATION (PEAK) ......Long. ... Transv.

TEST NO. 3
DATE 8-6-58
VEHICLE ....Chev. 53 Sedan
SPEED ....58 MPH
IMPACT ANGLE .....29°
VEHICLE WEIGHT... 3980
(W/DUMMY & INSTRUMENTATION)

STATE OF CALIFORNIA DIVISION OF HIGHWAYS MATERIALS & RESEARCH DEPT.

1958 MEDIAN BARRIER & BRIDGE RAIL IMPACT TESTS



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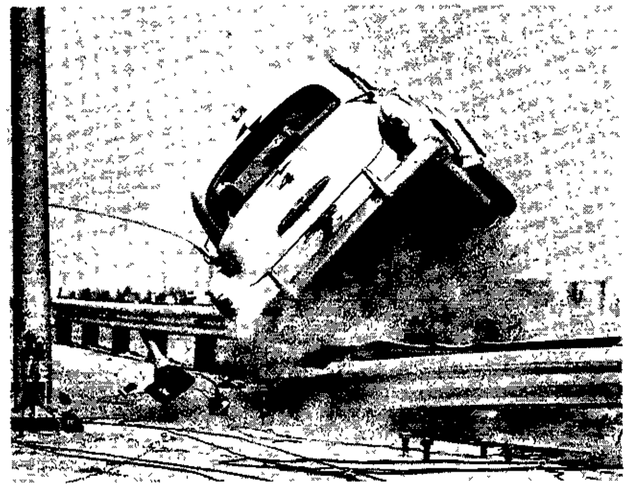

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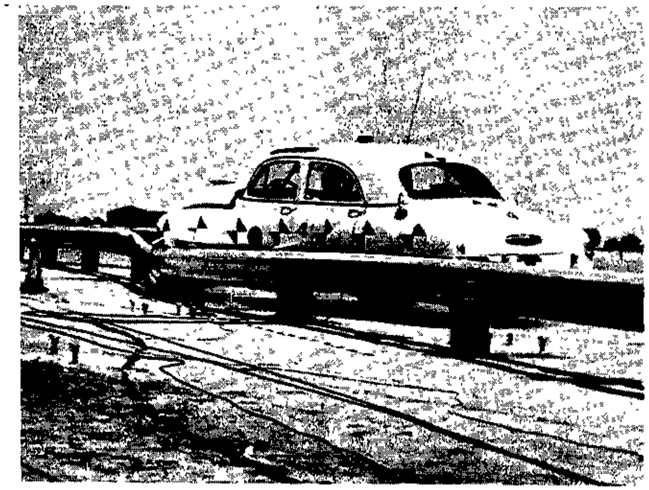

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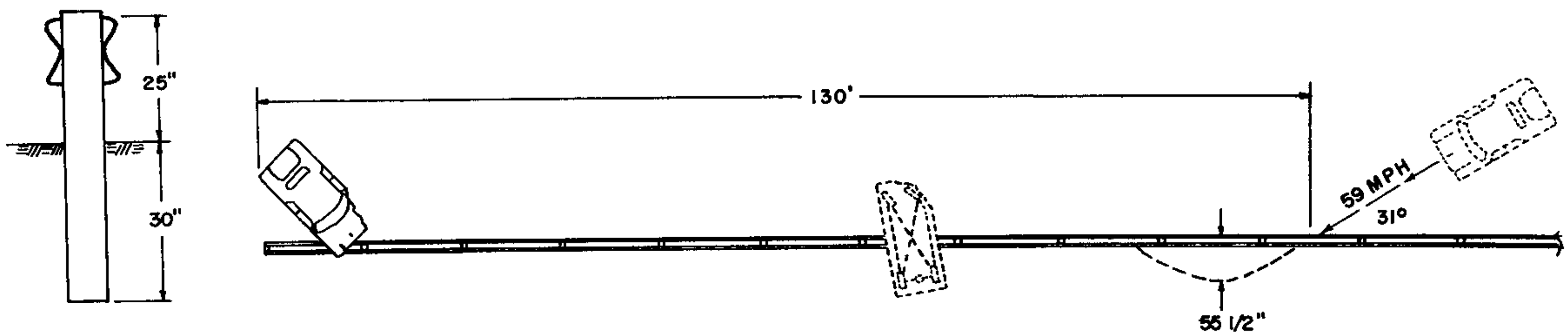


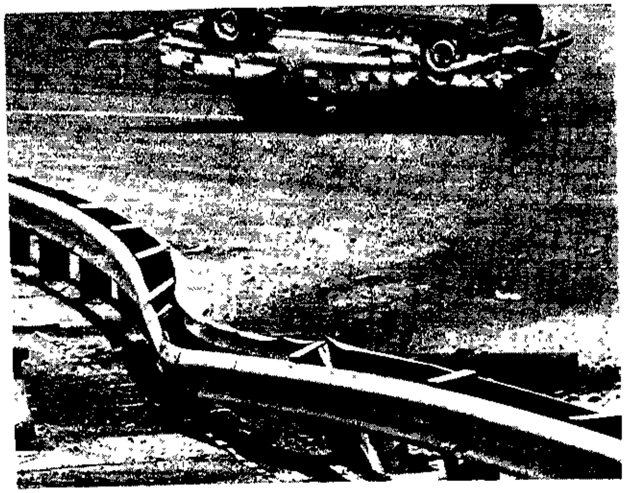
GUARDRAIL .... W Section
BRACKET .... None
POST .... 8x8 D.F.
POST SPACING .... 12'-6" O.C.
LENGTH OF INSTALLATION ... 200'
GROUND CONDITION ......: Dry

DUMMY INJURY .... Minor scalp abrasions. Possible concussion.
GUARDRAIL DAMAGE .... 3 Sections damaged beyond repair.
POST DAMAGE .... 1 Post damaged beyond repair.
7 Posts out of alignment.
VEHICLE DAMAGE .... Total loss.
MAX. DYNAMIC DEFLECTION OF RAIL ... 60"
VEHICLE DECELERATION (PEAK) ...... Long. ... Transv.

TEST NO. 4
DATE 8-20-58
VEHICLE .... Chev. 51 Sedan
SPEED .... 59 MPH
IMPACT ANGLE ..... 31°
VEHICLE WEIGHT ... 3980
(W/DUMMY & INSTRUMENTATION)

STATE OF CALIFORNIA DIVISION OF HIGHWAYS MATERIALS & RESEARCH DEPT.

1958 MEDIAN BARRIER & BRIDGE RAIL IMPACT TESTS



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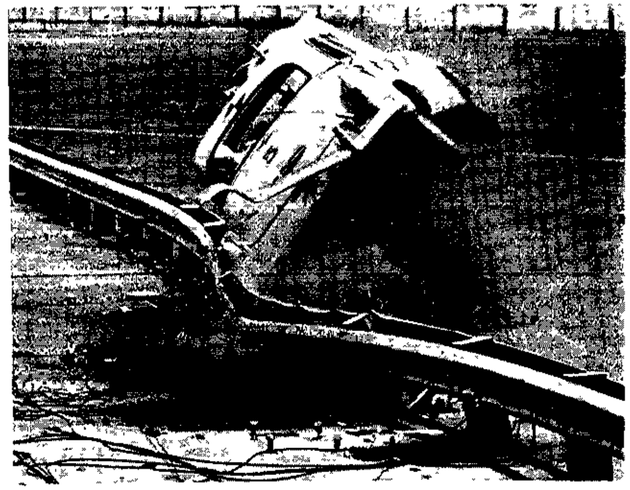

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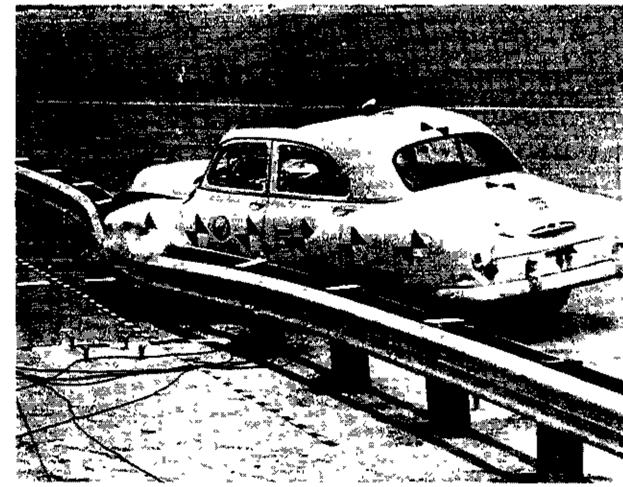

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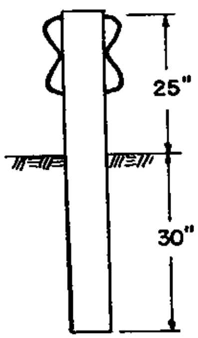
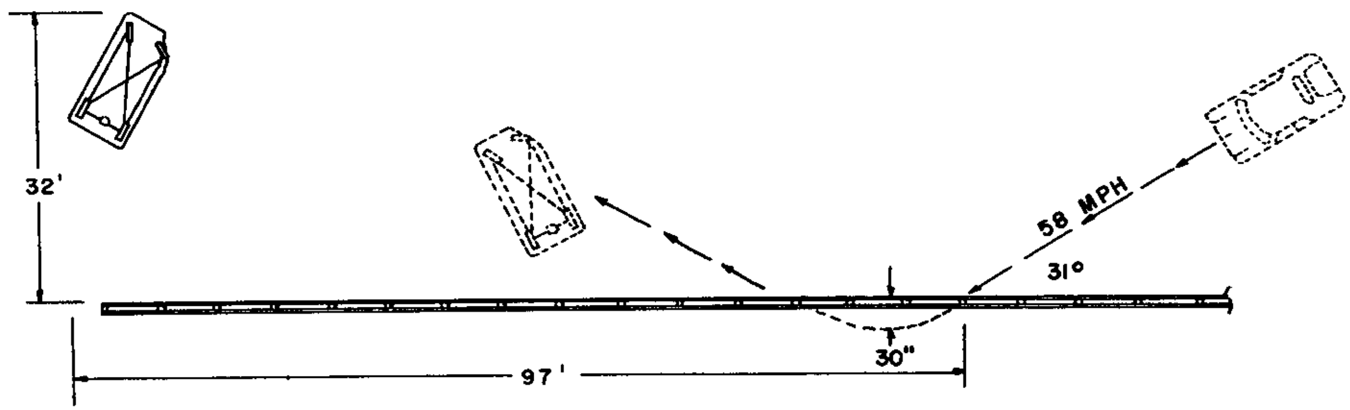




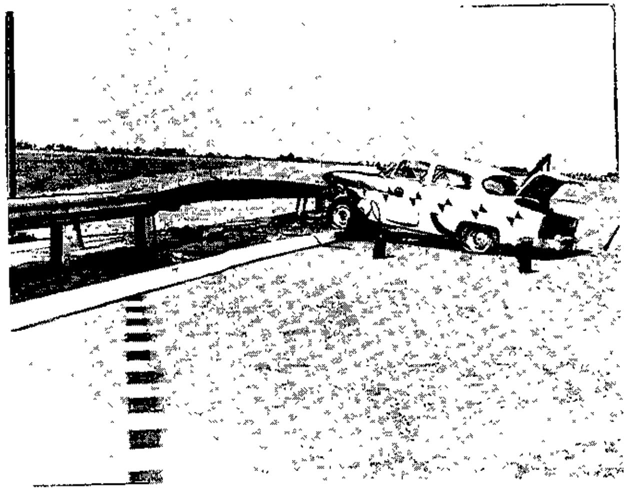
GUARDRAIL	W Section
BRACKET	None
POST	8x8 D.F.
POST SPACING	6'-3" O.C.
LENGTH OF INSTALLATION	200'
GROUND CONDITION	Dry

DUMMY INJURY	Scalp lacerations. Possible concussion
GUARDRAIL DAMAGE	2 Sections damaged beyond repair.
POST DAMAGE	3 Posts damaged beyond repair. 5 Posts out of alignment.
VEHICLE DAMAGE	Total loss.
MAX. DYNAMIC DEFLECTION OF RAIL	40.5"
VEHICLE DECELERATION (PEAK)	Long. ... Transv.

TEST NO.	5
DATE	8-27-58
VEHICLE	Chev. 51 Sedan
SPEED	58 MPH
IMPACT ANGLE	31°
VEHICLE WEIGHT	3980 (W/DUMMY & INSTRUMENTATION)

STATE OF CALIFORNIA DIVISION OF HIGHWAYS MATERIALS & RESEARCH DEPT.

1958 MEDIAN BARRIER & BRIDGE RAIL IMPACT TESTS



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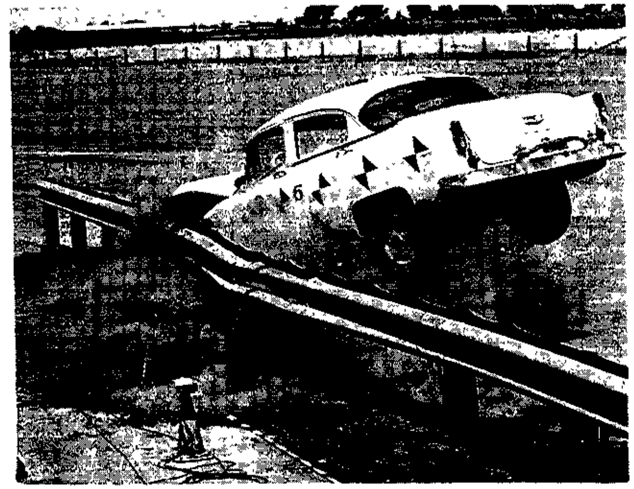

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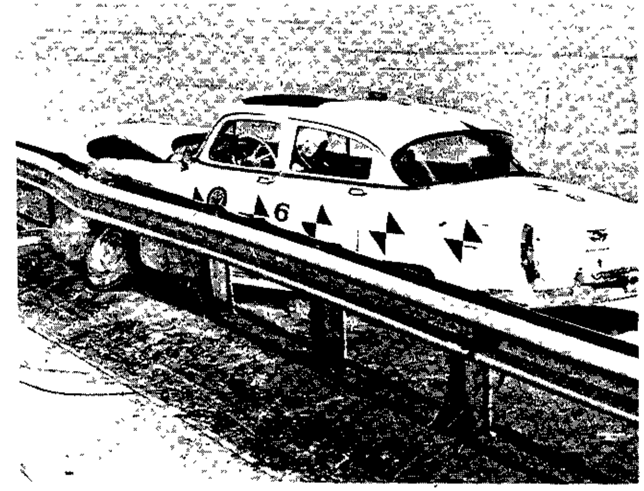

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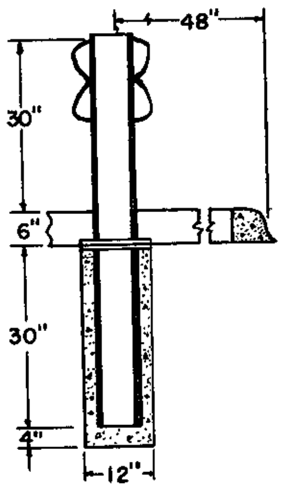
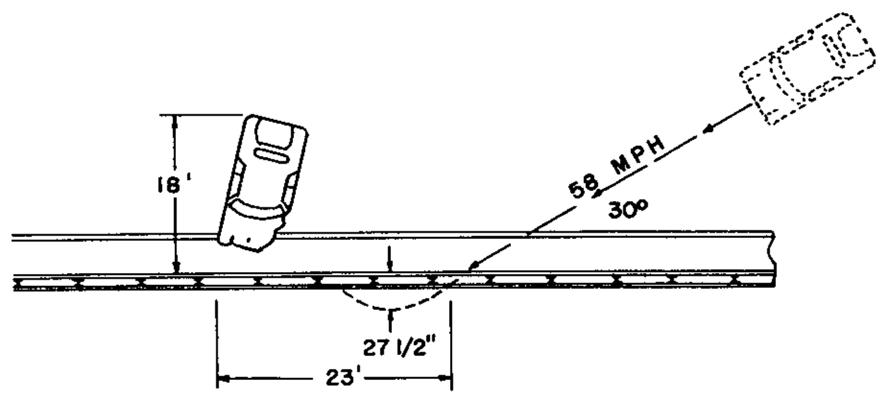




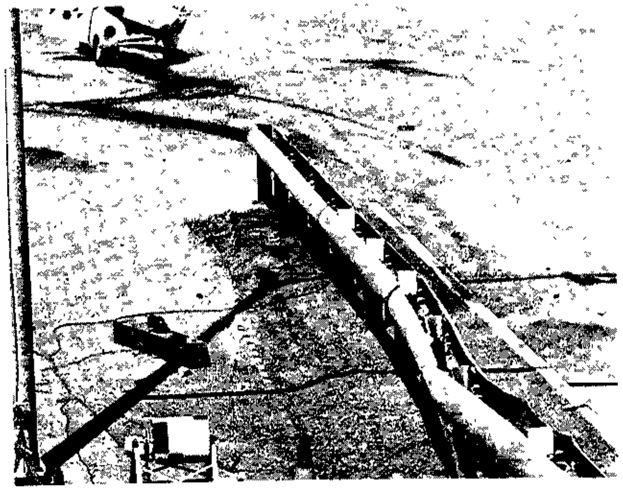
GUARDRAIL .... W Section
BRACKET .... None
POST .... 6" WF Beam
POST SPACING............. 6'-3" O.C.
LENGTH OF INSTALLATION... 100'
GROUND CONDITION .... Dry

DUMMY INJURY .... Possible neck injury & concussion.
GUARDRAIL DAMAGE .... 4 Sections damaged beyond repair.
POST DAMAGE .... 3 Posts knocked out.
2 Posts out of alignment.
VEHICLE DAMAGE .... Total loss.
MAX. DYNAMIC DEFLECTION OF RAIL ... 36"
VEHICLE DECELERATION (PEAK) ...... Long. ... Transv.

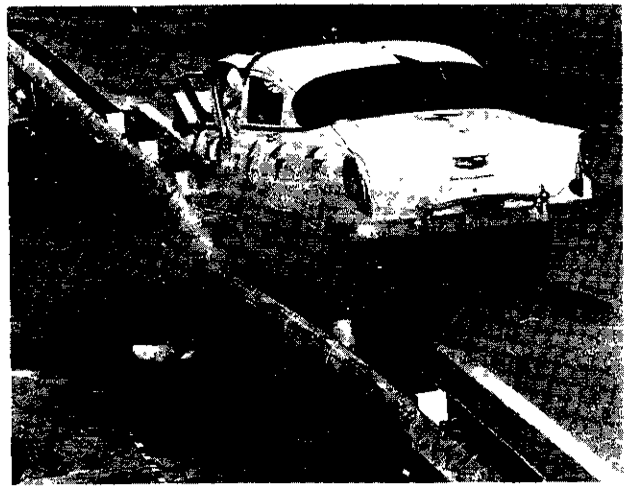
TEST NO. 6
DATE 9-10-58
VEHICLE .... Chev. 54 Sedan
SPEED............... 58 M P H
IMPACT ANGLE...... 30°
VEHICLE WEIGHT.... 4000
(W/DUMMY & INSTRUMENTATION)

STATE OF CALIFORNIA DIVISION OF HIGHWAYS MATERIALS & RESEARCH DEPT.

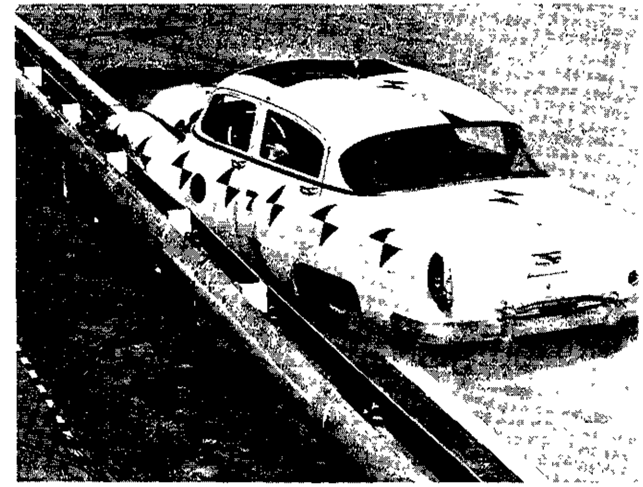
1958 MEDIAN BARRIER & BRIDGE RAIL IMPACT TESTS



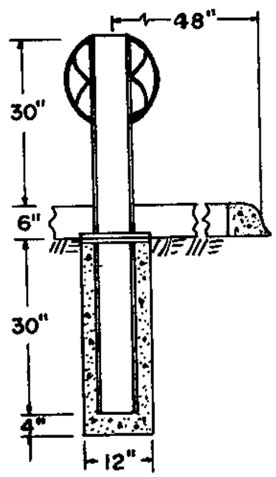
POST IMPACT

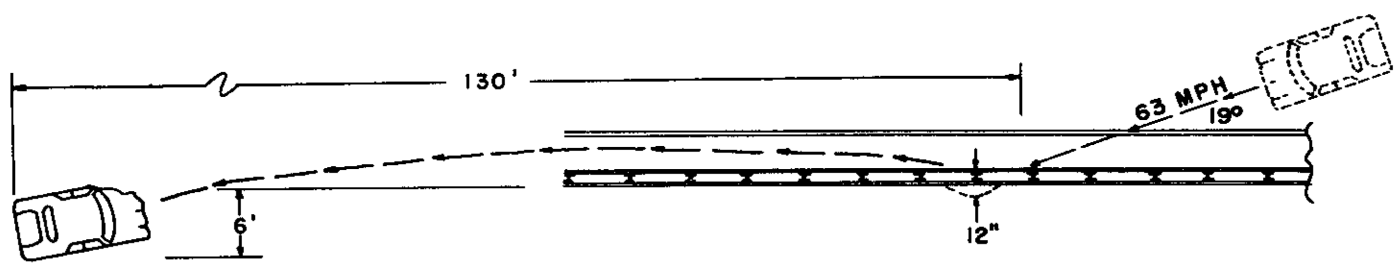


IMPACT +350 M SEC.



IMPACT + 50 M SEC.





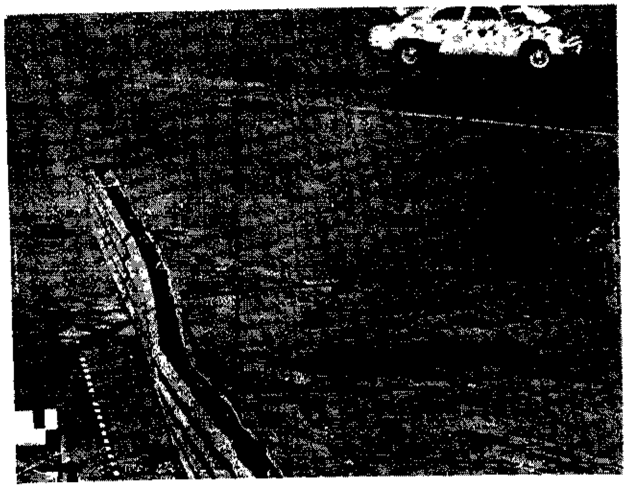
GUARDRAIL................Tuthill
BRACKET.................HG 32 N
POST ....6" WF Beam
POST SPACING ....6'-3" O.C.
LENGTH OF INSTALLATION...100'
GROUND CONDITION.........Dry

DUMMY INJURY.......................Multiple scalp lacerations. Possible internal injury.
GUARDRAIL DAMAGE...............2 Sections damaged beyond repair.
POST DAMAGE.....................2 Posts damaged beyond repair.
2 Posts out of alignment.
VEHICLE DAMAGE ....Total loss.
MAX. DYNAMIC DEFLECTION OF RAIL...19"
VEHICLE DECELERATION (PEAK).....Long. ....Transv.

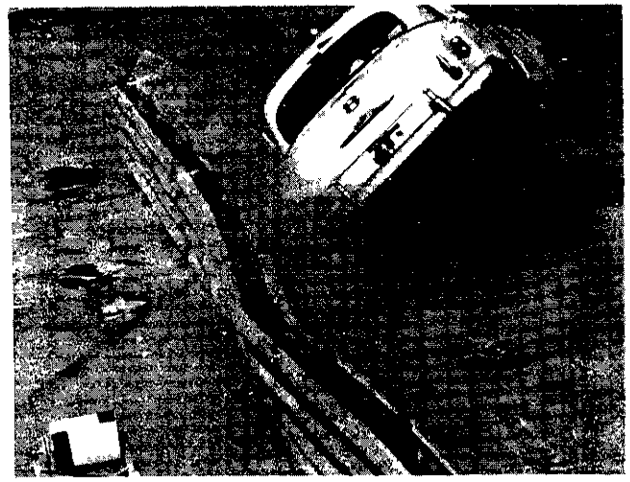
TEST NO.............7
DATE..............9-18-58
VEHICLE..........Chev. 54 Sedan
SPEED ....63 MPH
IMPACT ANGLE......19°
VEHICLE WEIGHT....4050
(W/DUMMY & INSTRUMENTATION)

STATE OF CALIFORNIA DIVISION OF HIGHWAYS MATERIALS & RESEARCH DEPT.

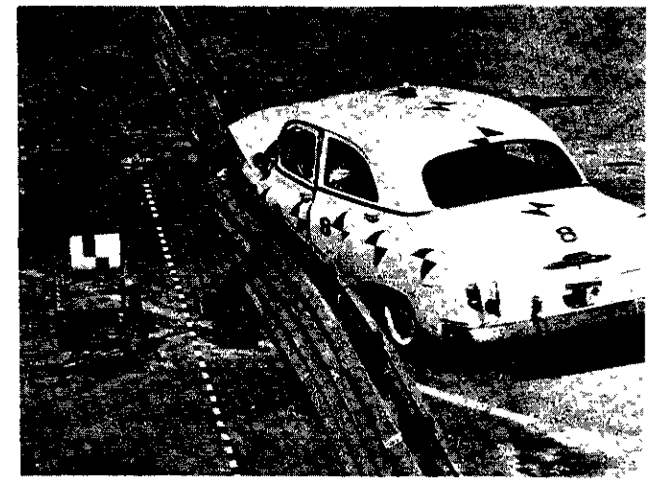
1958 MEDIAN BARRIER & BRIDGE RAIL IMPACT TESTS



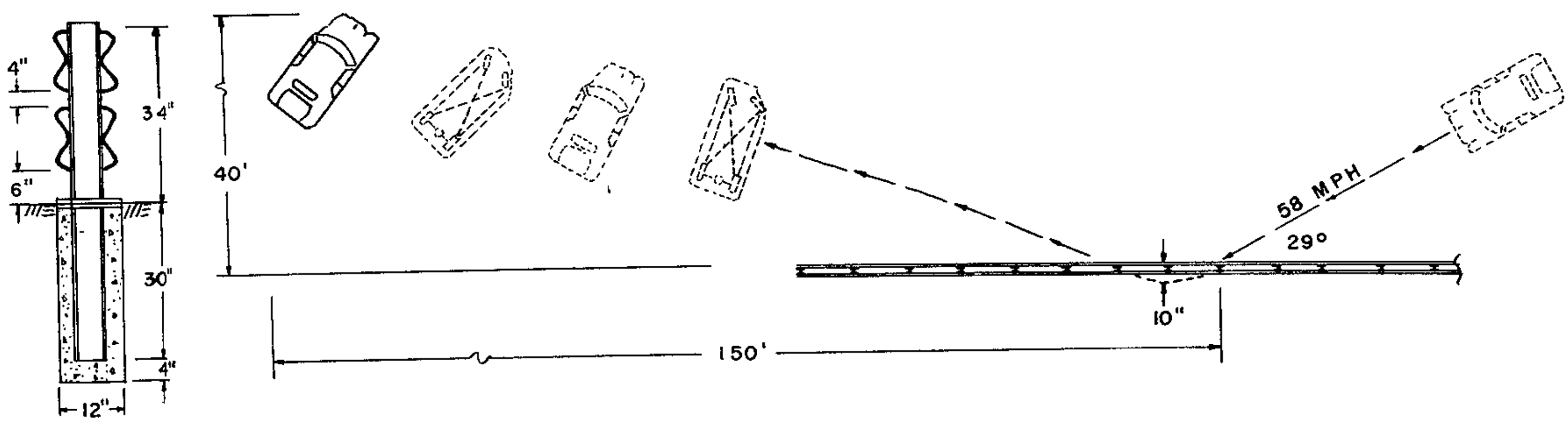
POST IMPACT



IMPACT + 500 M SEC.



IMPACT + 100 M SEC.



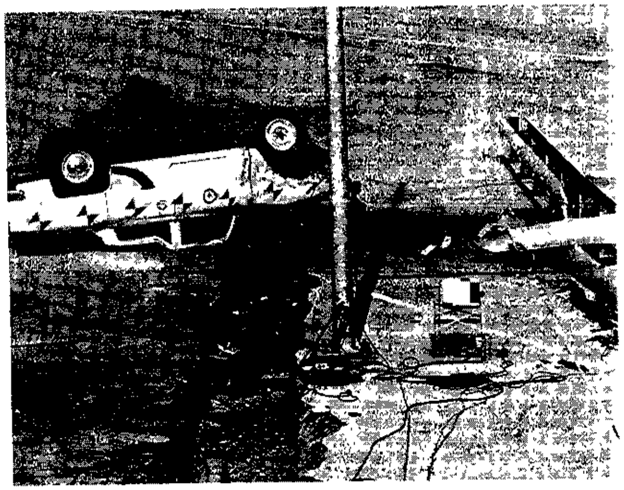
GUARDRAIL	W Section
BRACKET	None
POST	6" WF Beam
POST SPACING	6'-3" O.C.
LENGTH OF INSTALLATION	100'
GROUND CONDITION	Dry

DUMMY INJURY	Scalp lacerations. Possible concussion.
GUARDRAIL DAMAGE	2 Sections damaged beyond repair.
POST DAMAGE	All can be repaired. 5 Posts out of alignment.
VEHICLE DAMAGE	Total loss.
MAX. DYNAMIC DEFLECTION OF RAIL	15"
VEHICLE DECELERATION (PEAK)	Long. .... Transv.

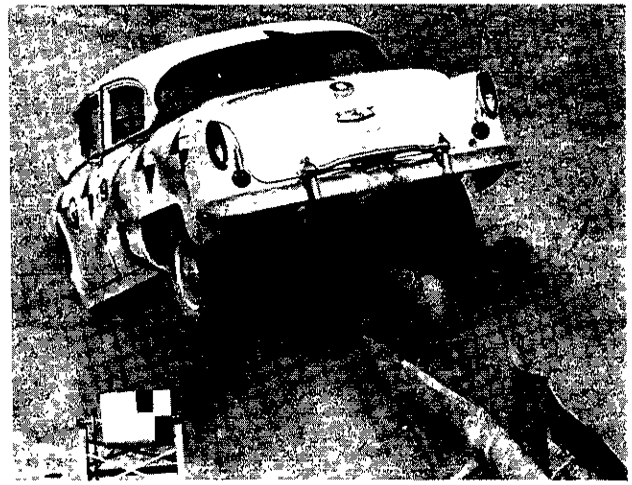
TEST NO	8
DATE	10-2-58
VEHICLE	Chev. 52 Sedan
SPEED	58 M.P.H
IMPACT ANGLE	29°
VEHICLE WEIGHT	4050 (W/DUMMY & INSTRUMENTATION)

STATE OF CALIFORNIA DIVISION OF HIGHWAYS MATERIALS & RESEARCH DEPT.

1958 MEDIAN BARRIER & BRIDGE RAIL IMPACT TESTS



POST IMPACT



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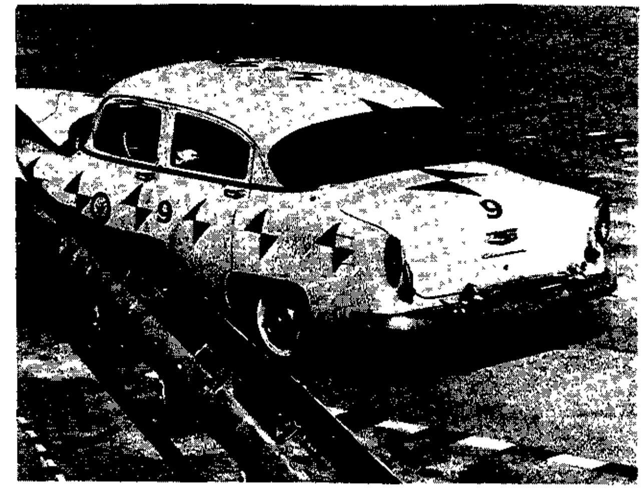
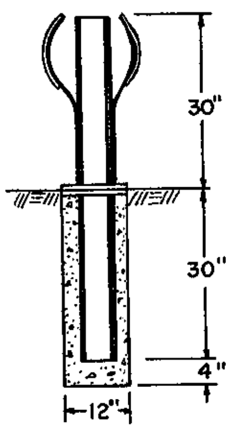
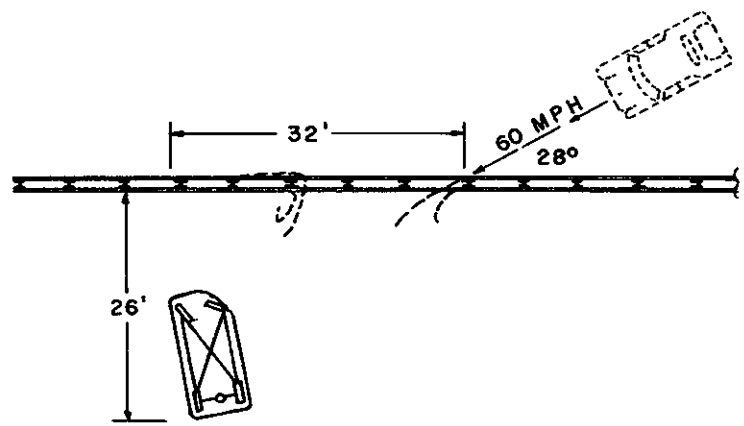


IMPACT + 100 M SEC.





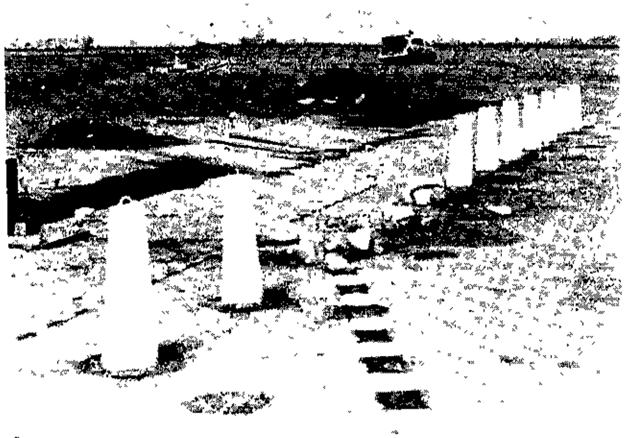
GUARDRAIL ....Tuthill
BRACKET HG15N
POST ....6" WF Beam
POST SPACING ....6'-3" O.C.
LENGTH OF INSTALLATION...100'
GROUND CONDITION ....Dry

DUMMY INJURY .... Possible chest and internal injuries.
GUARDRAIL DAMAGE .... 4 Sections damaged beyond repair. Both rails failed.
POST DAMAGE .... 2 Posts damaged beyond repair. 2 Posts out of alignment.
VEHICLE DAMAGE .... Total loss.
MAX. DYNAMIC DEFLECTION OF RAIL... 15" Before failure.
VEHICLE DECELERATION (PEAK)..... Long. ...Transv.

TEST NO. 9
DATE 10-15-58
VEHICLE ....Chev. 54 Sedan
SPEED ....60 MPH
IMPACT ANGLE.....28°
VEHICLE WEIGHT...3970
(W/DUMMY & INSTRUMENTATION)

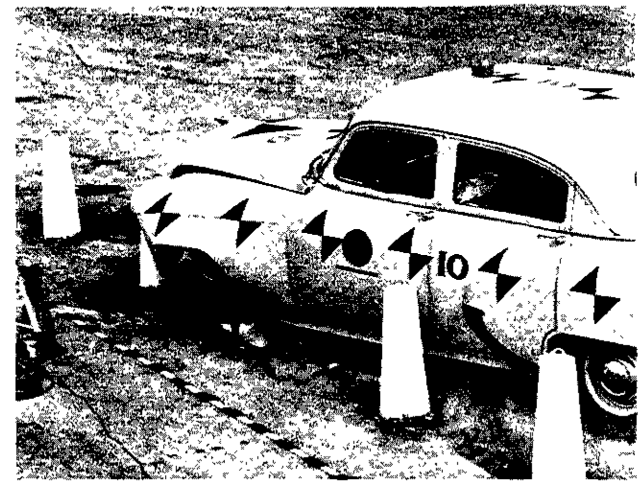
STATE OF CALIFORNIA DIVISION OF HIGHWAYS MATERIALS & RESEARCH DEPT.

1958 MEDIAN BARRIER & BRIDGE RAIL IMPACT TESTS



POST IMPACT

IMPACT + 500 M SEC.



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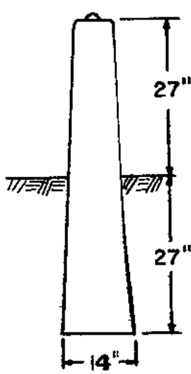
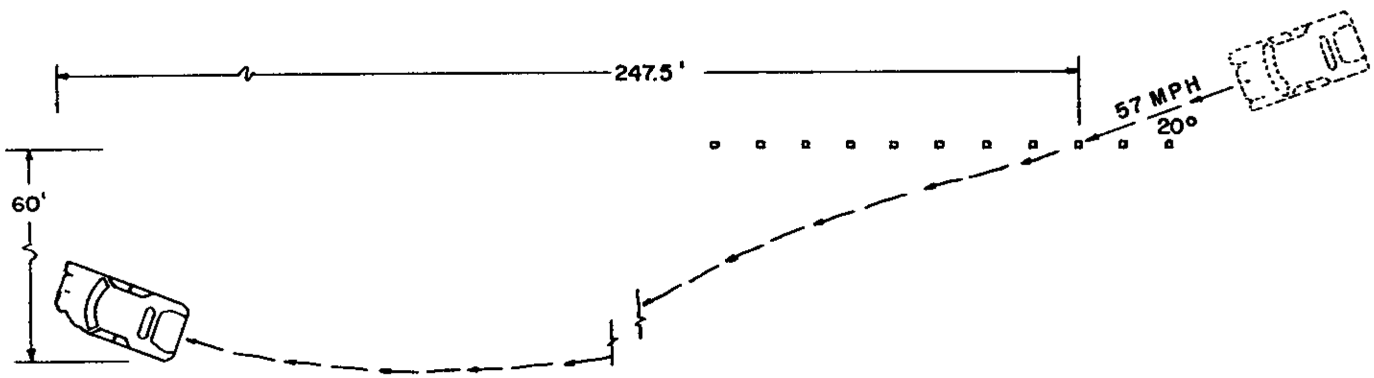




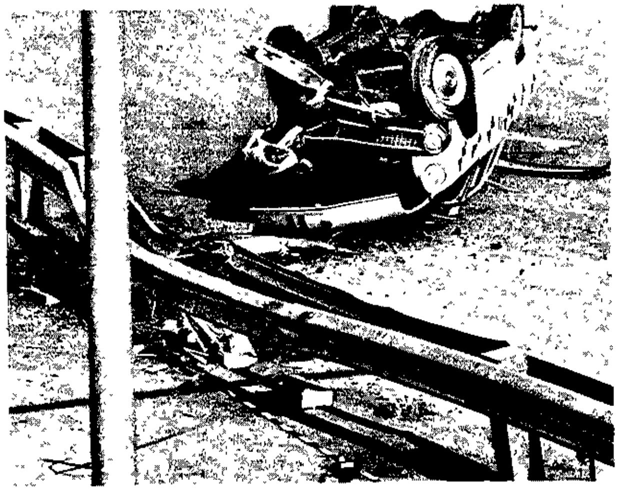
GUARDRAIL ....None
BRACKET ....None
POST ..................P.C.C.
POST SPACING ....5' O.C.
LENGTH OF INSTALLATION...60'
GROUND CONDITION.......Dry

DUMMY INJURY ....No apparent injuries.
GUARDRAIL DAMAGE ....No rail.
POST DAMAGE ....3 Posts demolished.
1 Post out of alignment.
VEHICLE DAMAGE ....Est. $ 200.
MAX. DYNAMIC DEFLECTION OF RAIL...No rail.
VEHICLE DECELERATION (PEAK).... Long. ....Transv.

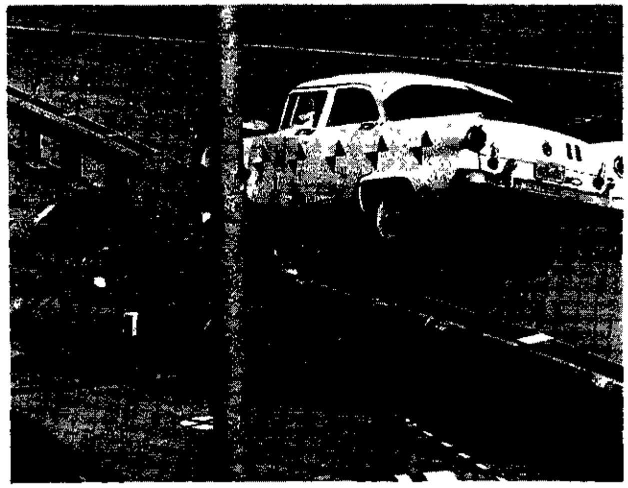
TEST NO. 10
DATE 10-23-58
VEHICLE ....Chev. 53 Sedan
SPEED ....57 MPH
IMPACT ANGLE .... 20°
VEHICLE WEIGHT...3970
(W/DUMMY & INSTRUMENTATION)

STATE OF CALIFORNIA DIVISION OF HIGHWAYS MATERIALS & RESEARCH DEPT.

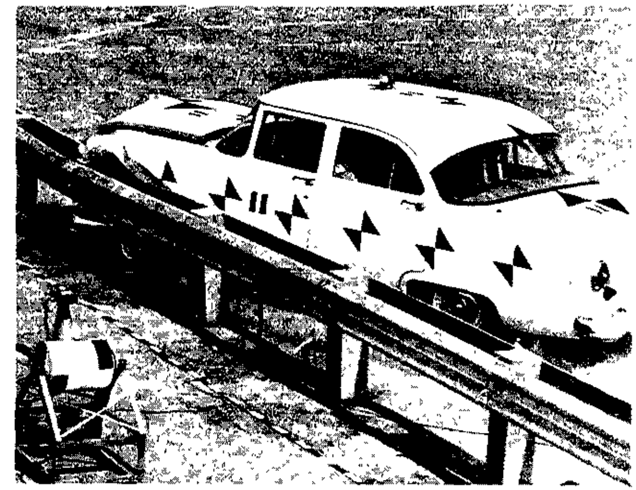
1958 MEDIAN BARRIER & BRIDGE RAIL IMPACT TESTS



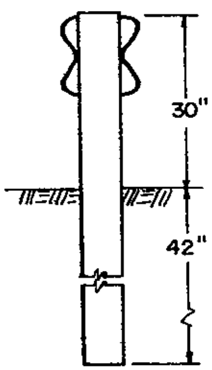
POST IMPACT

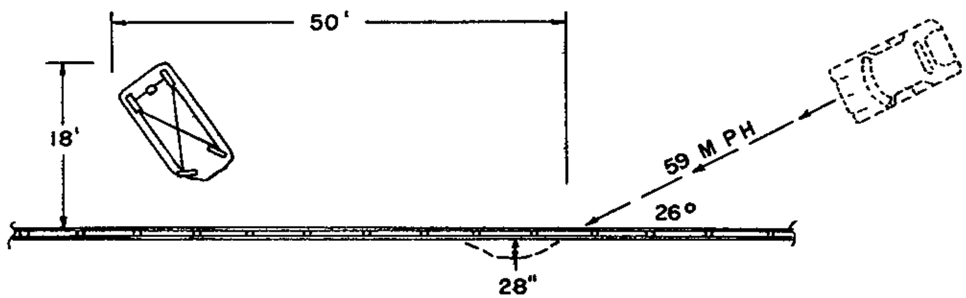


IMPACT + 450 M SEC.



IMPACT + 50 M SEC.





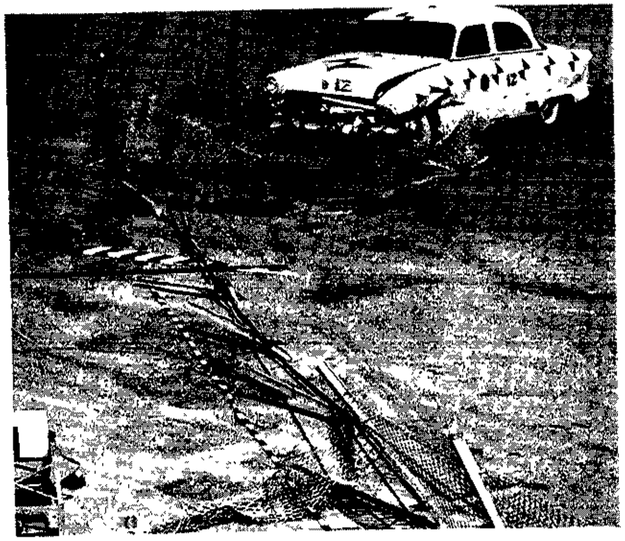
GUARDRAIL .... W Section
BRACKET .... None
POST .... 8x8 D.F.
POST SPACING .... 6'-3" O.C.
LENGTH OF INSTALLATION... 200'
GROUND CONDITION .... Dry

DUMMY INJURY .... Scalp lacerations. Possible internal injuries.
GUARDRAIL DAMAGE .... 6 Sections damaged beyond repair.
POST DAMAGE .... 3 Posts damaged beyond repair.
3 Posts out of alignment.
VEHICLE DAMAGE .... Total loss.
MAX. DYNAMIC DEFLECTION OF RAIL... 40"
VEHICLE DECELERATION (PEAK) .... Long. ... Transv.

TEST NO. 11
DATE 10-30-58
VEHICLE .... Ford 55 Sedan
SPEED .... 59 MPH
IMPACT ANGLE ..... 26°
VEHICLE WEIGHT ... 4050
(W/DUMMY & INSTRUMENTATION)

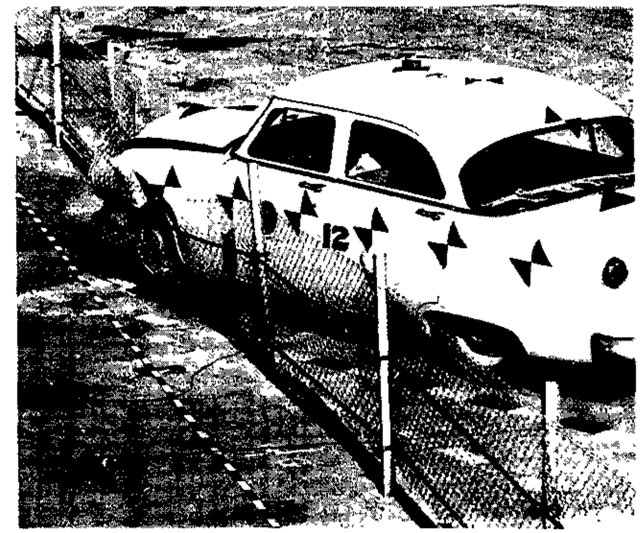
STATE OF CALIFORNIA DIVISION OF HIGHWAYS MATERIALS & RESEARCH DEPT.

1958 MEDIAN BARRIER & BRIDGE RAIL IMPACT TESTS

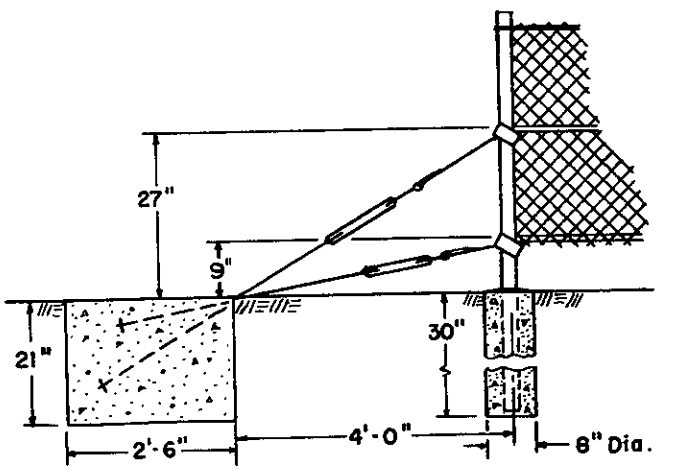


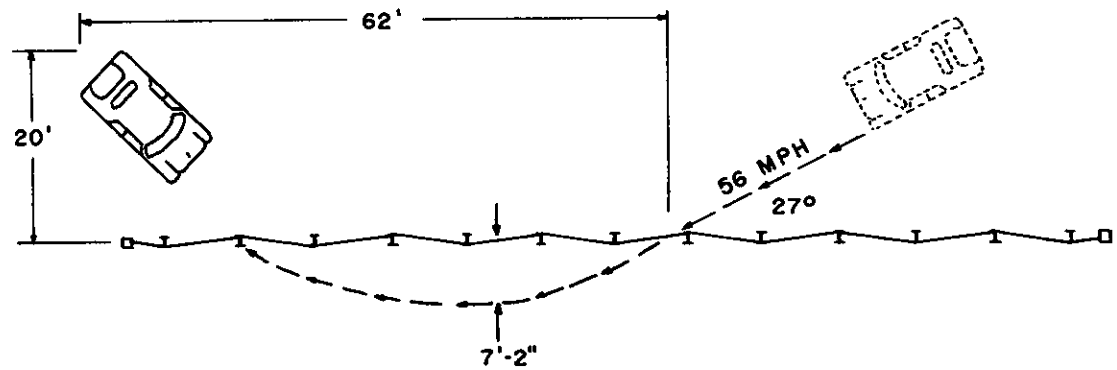
POST IMPACT

IMPACT +500 M SEC.



IMPACT + 50 M SEC.





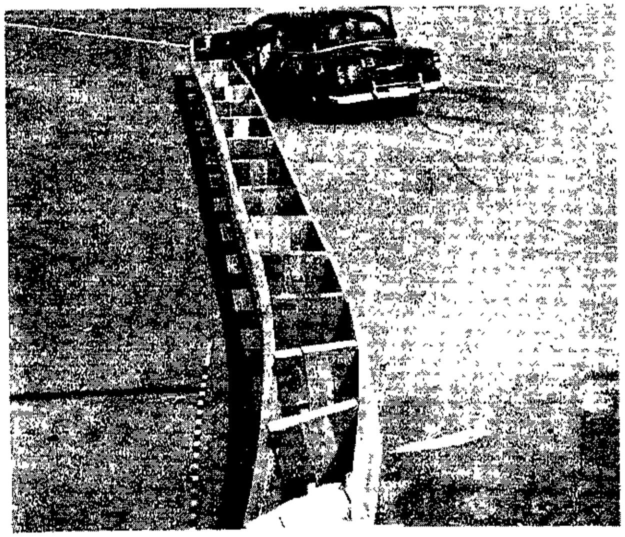
GUARDRAIL .... 36" Chain Link
Fence w/ 3/4" cables 9" & 27" above Pvmt.
POST .... 2 1/4"-4.1 #
H Section Fence Post.
POST SPACING .... 8' O.C.
LENGTH OF INSTALLATION... 96'
GROUND CONDITION .... Dry

DUMMY INJURY .... No Visable Injury.
GUARDRAIL DAMAGE .... 50' of Fence knocked out. No damage to Cable.
POST DAMAGE .... 7 Posts damaged beyond repair. 6 Posts Bent.
VEHICLE DAMAGE .... $400.
MAX. DYNAMIC DEFLECTION OF RAIL . . 7'-2"
VEHICLE DECELERATION (PEAK)..... Long. ...Transv.

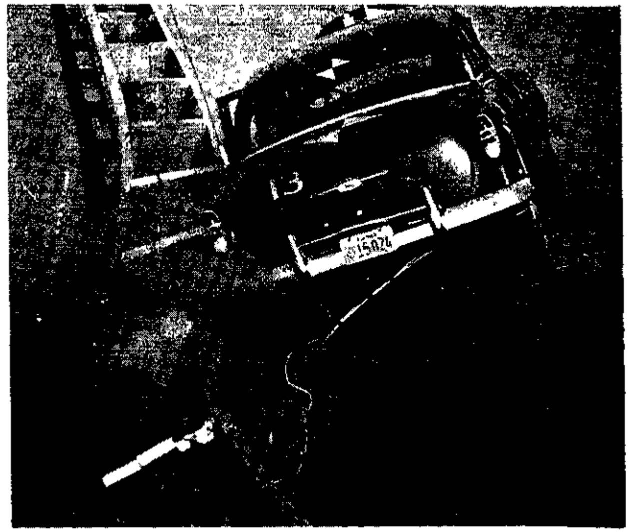
TEST NO. 12
DATE 11-13-58
VEHICLE .... Ford 52 Sedan
SPEED .... 56 MPH
IMPACT ANGLE .... 27°
VEHICLE WEIGHT ... 4002
(W/DUMMY & INSTRUMENTATION)

STATE OF CALIFORNIA DIVISION OF HIGHWAYS MATERIALS & RESEARCH DEPT.

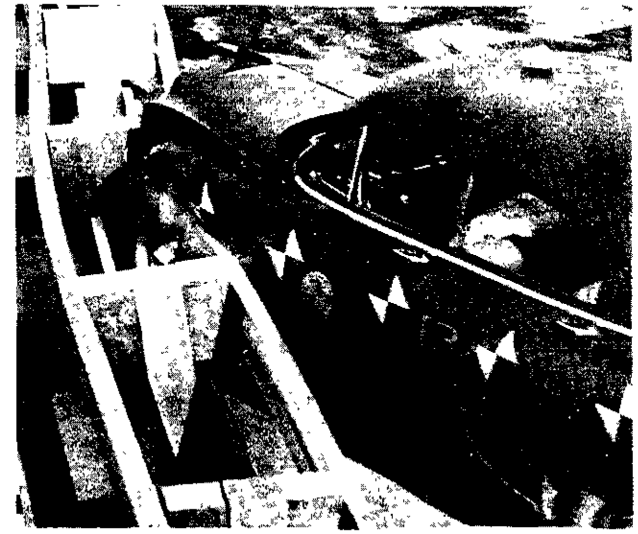
1958 MEDIAN BARRIER & BRIDGE RAIL IMPACT TESTS



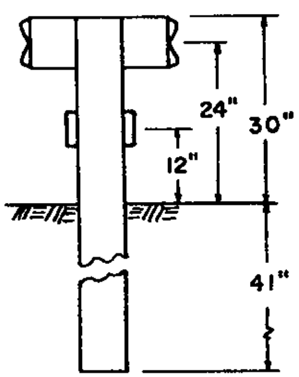
POST IMPACT

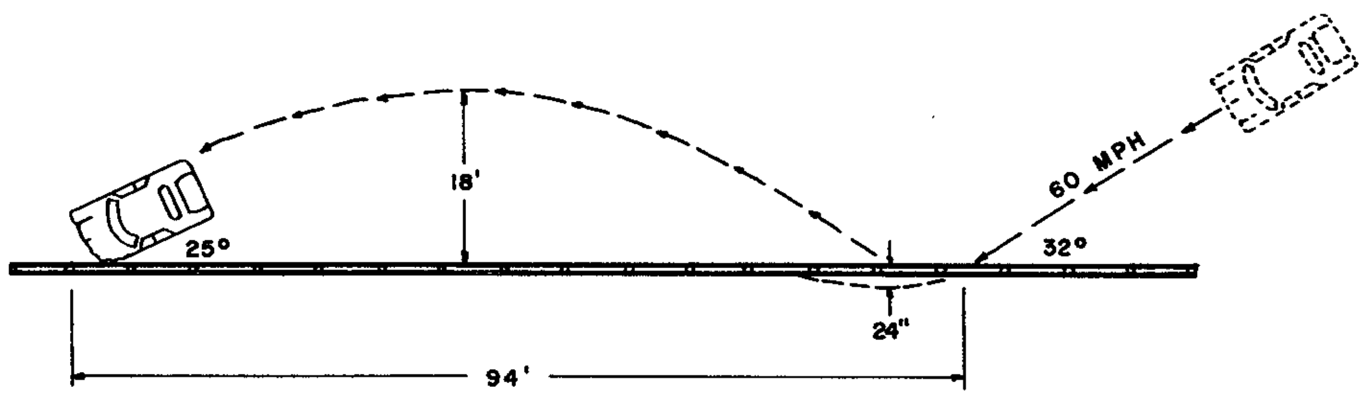


IMPACT + 500 M SEC.



IMPACT + 100 M SEC.





GUARDRAIL	W Section	DUMMY INJURY	Minor head injury.	TEST NO.	13
CHANNEL	6" ⊓ 8.2 #	GUARDRAIL DAMAGE	4 Sections damaged beyond repair.	DATE	12-18-58
BRACKET	8x8x12 D.F Block	CHANNEL DAMAGE	4 Sections damaged beyond repair.	VEHICLE	Chev. 53 Sedan
POST	8x8 D.F.	POST DAMAGE	3 Posts damaged beyond repair.	SPEED	60 MPH
POST SPACING	6'-3" O.C.			IMPACT ANGLE	32°
LENGTH OF INSTALLATION ...	125'	VEHICLE DAMAGE	Total Loss	VEHICLE WEIGHT ...	4000
GROUND CONDITION	Dry	MAX. DYNAMIC DEFLECTION OF RAIL ...	37"	(W/DUMMY & INSTRUMENTATION)	
		VEHICLE DECELERATION (PEAK)	Long. ...Transv.		

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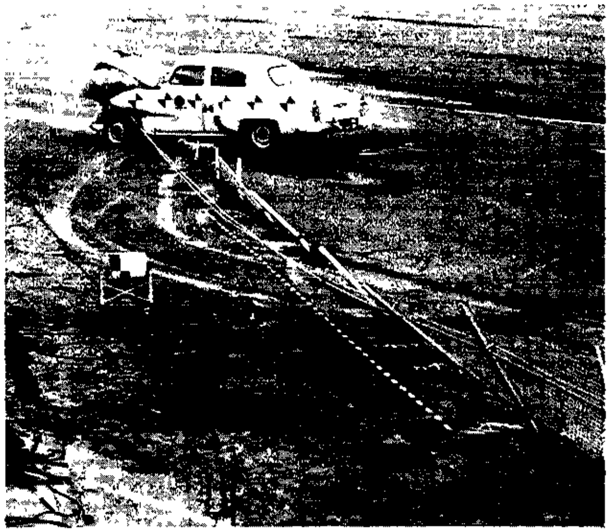
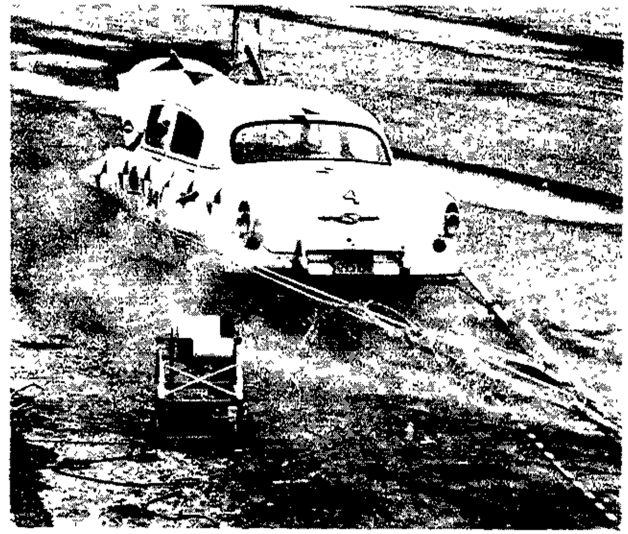
1958 MEDIAN BARRIER & BRIDGE RAIL IMPACT TESTS

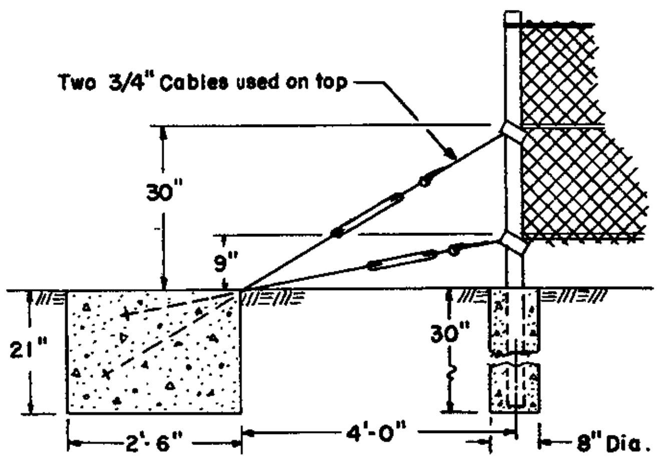


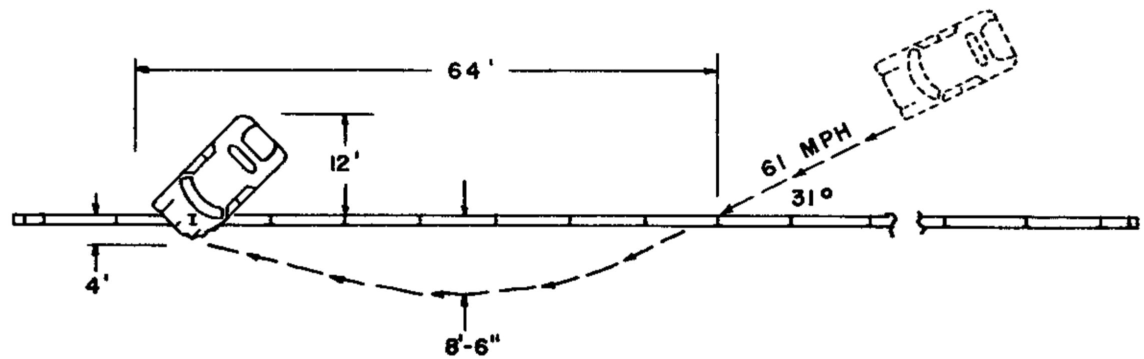
POST IMPACT



IMPACT + 400 M SEC.

IMPACT + 150 M SEC.





GUARDRAIL .... 36" Chain Link
Fence w/ 3/4" cables 9" & 30" above Pvmt.
POST .... 2 1/4"-4.1 #
H Section Fence Post.
POST SPACING .... 8' O.C.
LENGTH OF INSTALLATION ... 192'
GROUND CONDITION .... Dry

DUMMY INJURY .... Minor Bruises
GUARDRAIL DAMAGE .... 80' of Fence knocked out. No damage to Cables.
POST DAMAGE .... 11 Posts damaged beyond repair.

VEHICLE DAMAGE .... $400.
MAX. DYNAMIC DEFLECTION OF RAIL ... 8'-6"
VEHICLE DECELERATION PEAK .... Long. ...Transv.

TEST NO. 14
DATE 12-26-58
VEHICLE .... Chev. 53 Sedan
SPEED .... 61 MPH
IMPACT ANGLE .... 31°
VEHICLE WEIGHT ... 4000
(W/DUMMY & INSTRUMENTATION)

STATE OF CALIFORNIA DIVISION OF HIGHWAYS MATERIALS & RESEARCH DEPT.

1958 MEDIAN BARRIER & BRIDGE RAIL IMPACT TESTS