

I dare say the auto polish sign is equally effective on the motorist.

Mr. CONSTANDY. His sign probably will not be struck, will it?

Mr. PRISK. Not much chance.

Here is another installation of a sign that we are gradually beginning to think is just about an obsolete message: "Keep off the median."



You cannot talk about it without getting into the subject of messages. But this is at the same general locale as the speed sign that I mentioned in the previous slide. Here is the corner of that auto polish sign off here on the side and it gives you an idea of the dimensions we are talking about again, 2 feet away.

This installation is mounted on a couple of U-channels that are backed up and doubled. They measure as the tape shows 4 inches longitudinally along the road, and there are two of them. This is a pretty stiff installation. [Slide.]



To go back to this one just a moment, we find this in a number of cases. This sign, and on the "No U-turn" sign [several slides] and on other signs. The "No U-turn" sign, incidentally, cannot be enforced or is not enforced in that particular State.

Here is a Wells County sign, erected to show the political boundary. Again, this is questionable. This is an installation on an Interstate highway. How much information that provides that is really of benefit to the motorist is highly questionable in light of the other demands on his skills and on his capacity to operate safely.



This is a sign which I would say is not on a U-channel; it is on an I-beam.

Mr. CONSTANDY. It is kind of ironic, as we saw the guardrail on the median divider in the Indiana installation, 50 feet, you people questioned it; it was inadequate. Just in front of it you have two I-beams holding up a sign, which has dubious value. It could just as well be mounted on the bridge, could it not?

Mr. PRISK. Yes. It is not uncommon to find these on bridges. And it certainly would be a contribution of safety to put them there.

Here, now, in Missouri we find another installation of an Interstate marker, mounted on an I-beam also, I might say.



Here is the exit direction sign just in advance of an exit ramp leaving the main lines of the interstate project that we are looking at. Concrete bases again undesirably high, out of the ground, and close to the roadway.



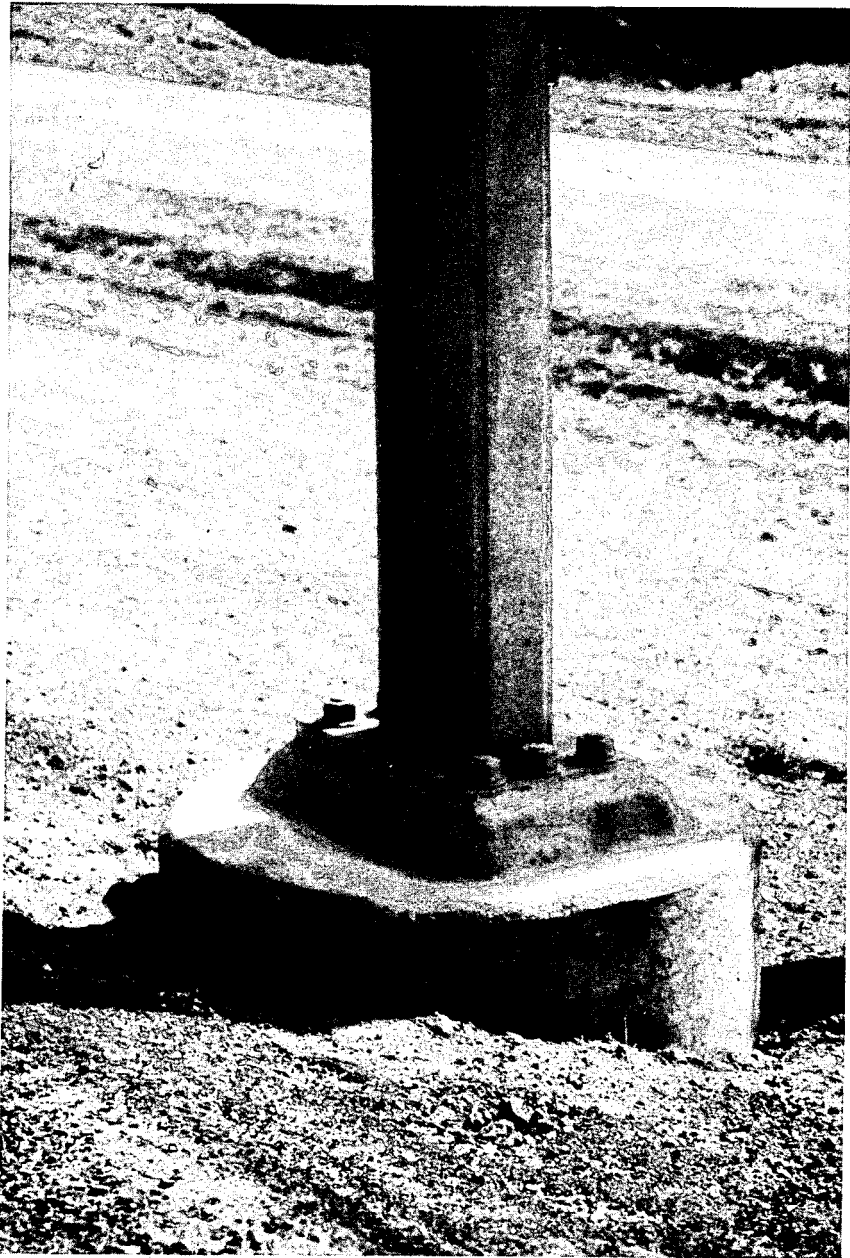
This is that base, close up.

Mr. ZION. Could these signs be put on breakaway posts, too, Mr. Prisk?

Mr. PRISK. Yes, sir.

Mr. ZION. They could be like the light poles?

Mr. PRISK. Yes, sir.



Mr. CONSTANDY. Congressman, we will, later in this presentation, show just briefly this concept of breakaway signs. Next week we would hope to develop that in greater detail through witnesses who will appear from Texas Transportation Institute. They have done research on the development of the breakaway signs. That is one form that is being used.



Mr. PRISK. We proceed. Here is another type sign that is useful in orienting the motorist in his distance to destinations. But it need not be up on concrete footings of that size and magnitude. This, again, is the old base problem of getting something in line with the slope.

Mr. RICKER. This illustrates something else. That sign does not have to be at any particular location, and by moving it longitudinally along the roadway it could have been placed behind that cut slope at a relatively safe place; even moving it out slightly and putting it beyond that cut slope would have been protecting it.

Mr. CONSTANDY. Thank you. Here we could have safety at no cost, no additional cost.

Mr. RICKER. Right.

Mr. PRISK. And it could be handled, of course, in another way by moving laterally, as the auto polish sign is located.

Mr. RICKER. The point I want to make is the longitudinal placement oftentimes provides the safety equally as well as laterally. And it can be done simply in the matter of staking out the proper location for the sign.

Mr. PRISK. It would not make a bit of difference if it was 3.5 miles to Kearney or 29 miles to Cameron, I am sure.

Mr. WILSON. Several years ago when we started putting these signs up on limited access highways we tied them fairly close.

If you will notice on this one, a truck merely driving along the shoulder—and they do this occasionally—will damage the sign; even though it will not strike the post or anything, it will damage the sign to the point where it has to be replaced. This, to us, became quite a maintenance problem. You know that the slope of a shoulder allows a truck to tilt over on about a 5-percent slope and maybe more in other

places and he will catch the corner of the sign and damage it completely so it has to be replaced. So just from the point of maintenance, it would be better to get this thing out of here.

Mr. CONSTANDY. It is another cost factor that should be borne in mind.

Mr. RICKER. Mr. Prisk, that sign does not meet present clearance standards, lateral clearance, 2 feet beyond the shoulder?

Mr. PRISK. I think it does. There are 2 feet here and the edge of the shoulder is out here somewhere. These were checked, practically all of them. I think you will find it does meet the standards as far as minimum clearance is concerned. But it is ironic that the standards are actually set up to read that the sign must clear the edge of the shoulder by at least 2 feet, and you find all the signs at 2 feet. Suggestion of a minimum is taken as a standard and fixed dimension, unfortunately.

Mr. CONSTANDY. Just adherence to the minimum standards, without judgment, really is a problem.

Mr. PRISK. That is true.

Mr. CONSTANDY. On that picture, there is oil where the shoulder ends, here at the beginning of the fore slope. They spray it with tar or oil. It gives the impression the shoulder is over farther.

It might also give the same impression to a driver. As that relates to the closeness to the sign, and could, in turn, create an additional problem.

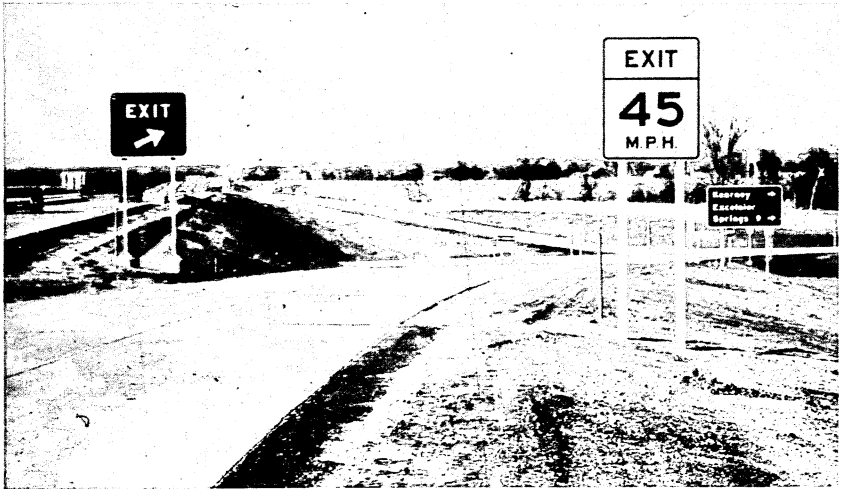
I might say this, we have many pictures of signs on these various projects and the problem is one of being able to pick a typical installation and not spend the entire day showing all of them. These signs are simply intended to be representative and they appear with great frequency on sections of the highway we looked at. The fact we show two or three slides for a given State should not suggest they were the only signs on the project.

Mr. PRISK. Moving on, here is another similar installation for another purpose, service sign, "Gas, Food" marking, with exposed footings.

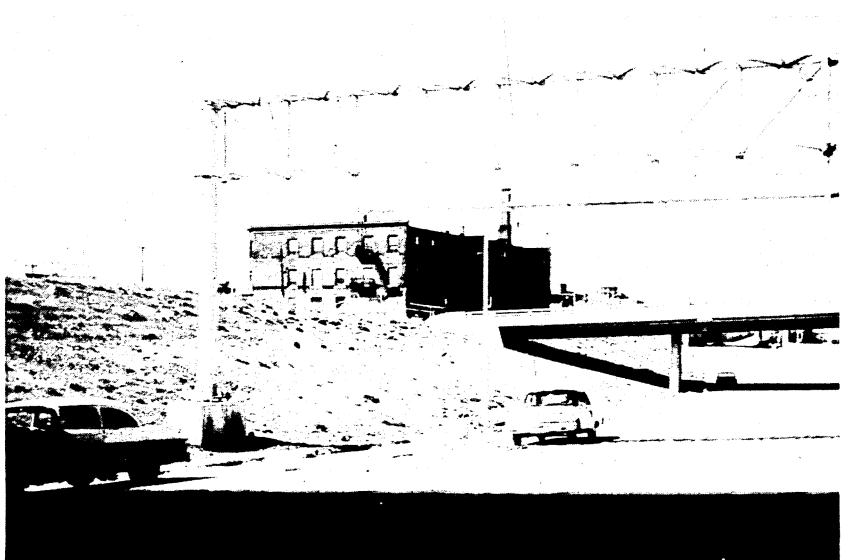


Here is an exit sign with exposed footings. Here is an exit sign, speed sign, on the right-hand side on I-beams. And in this case you will notice that the shoulder is paved to this point and then at this location you drop to a narrow shoulder. So that it would be possible, conceivably, to drive directly into it.

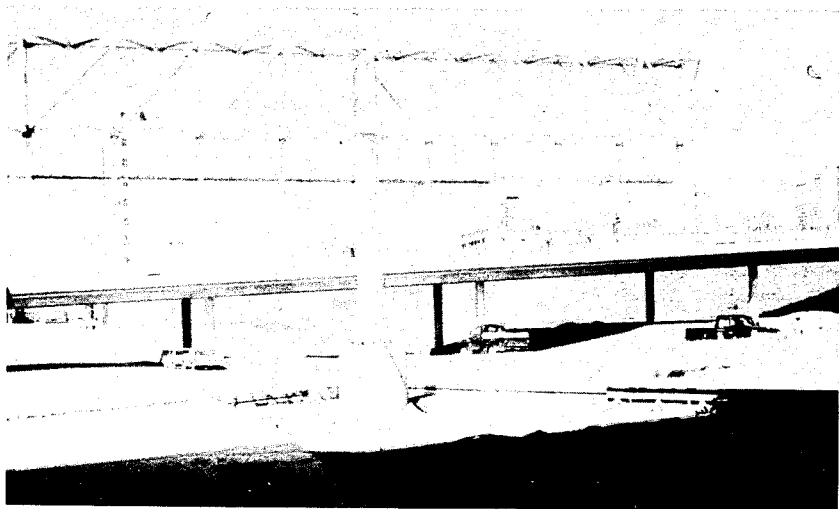
I would also call your attention to almost the forest of signposts down in this area. I cannot help but think that some improvement in this situation will be necessary.



Urban area, off the project, specifically in Kansas City, in the free-way sections that are being built there now. This installation was found with the concrete pedestal supporting one end of an overhead bridge sign.

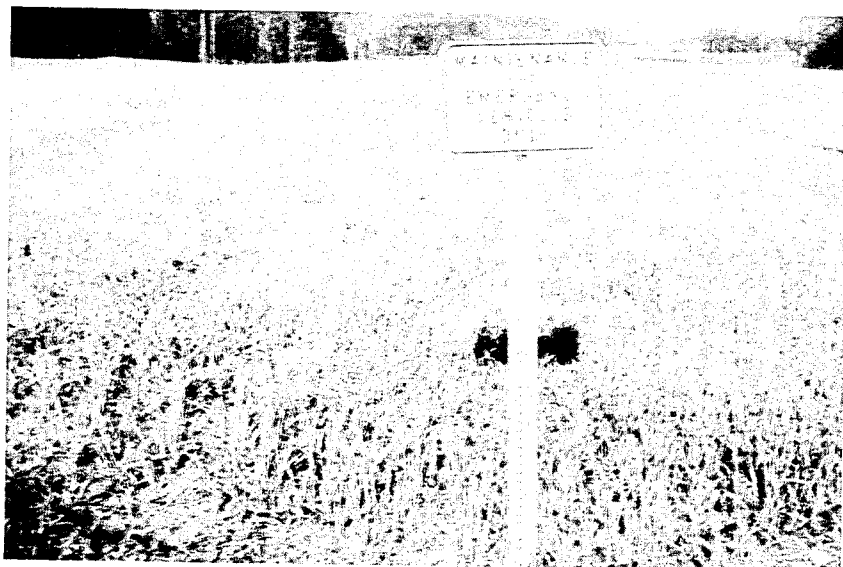


And this is the other end. You are looking here in the direction against traffic. So traffic comes down under this structure and must pass either side of this support. They really have themselves quite an obstacle there. Something like 8 feet from the front edge of this concrete pedestal to the curb that will outline it.



After some discussion on that job, incidentally, during the course of the visit, some additional negotiation and so on, this work is to be taken down and that hazard will be removed from the gore at that point.

This is another installation of a sign bridge where the pole is up on the wall instead of being in front of the wall, which is desirable. This bulge is in here and rather abruptly made. I daresay that some more feathering on this would have been desirable so as to make a more gradual transition at that point.



Moving now to Montana, again we find some pretty husky posts here, too. Here is an interstate route marker on a 4-inch I-beam.

Mr. CONSTANDY. Before you go on, perhaps the members would like to look and heft a piece of 4-inch I-beam—if you can lift it.



In that connection, earlier we had displayed, during a segment of the hearing dwelling on the roadside hazards of the Capital Beltway, pictures of routing signs similar to this one, route signs mounted on 4-inch I-beams. We thought it would be helpful to get a piece of one of those posts to give some idea how big they are.

We asked the Bureau of Public Roads to furnish a piece of the sign support and they did.

Actually, the signs in Maryland are mounted on two of these, each in a 3-foot concrete foundation. Very formidable.

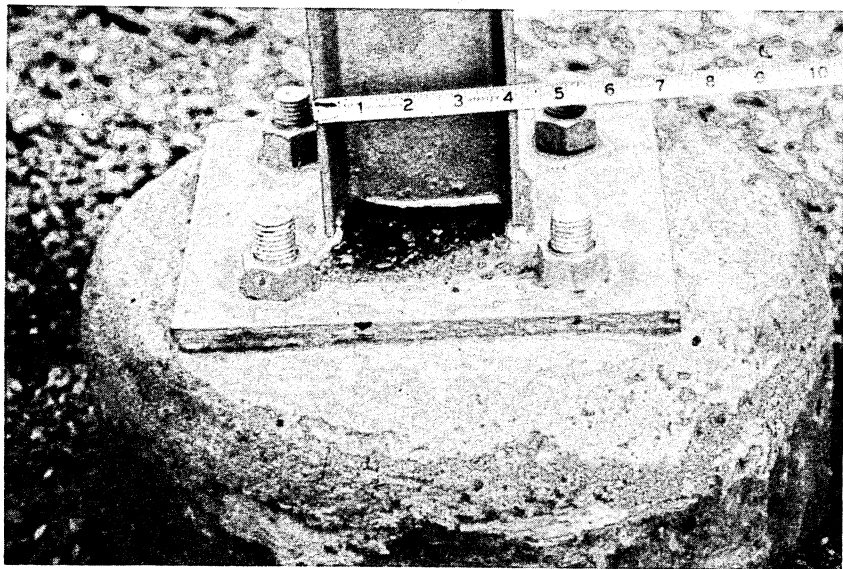
We recently asked the Bureau to furnish this size and one of the larger sizes. We got back this reply from the Bureau:

In compliance with the telephone request from the Washington office, we are delivering under separate cover two pieces of 4-inch galvanized steel I-beam. These pieces were cut from the sign support damaged in a highway accident. This size I-beam is used in the support for a great many of the signs on the Interstate System in Maryland. There is a larger size beam that is also used but the State did not have a damaged larger size available from which to cut pieces.

Kind of significant. They only had the 4-inch I-beam. The larger ones don't get damaged. So we were not able to produce the larger size to show you. I thought you might like to see just how heavy they are.

Mr. PRISK. Thank you.

That is exactly the same as the section that you have there on the table.



This merging traffic sign is also mounted on a 4-inch I-beam on the Montana project.



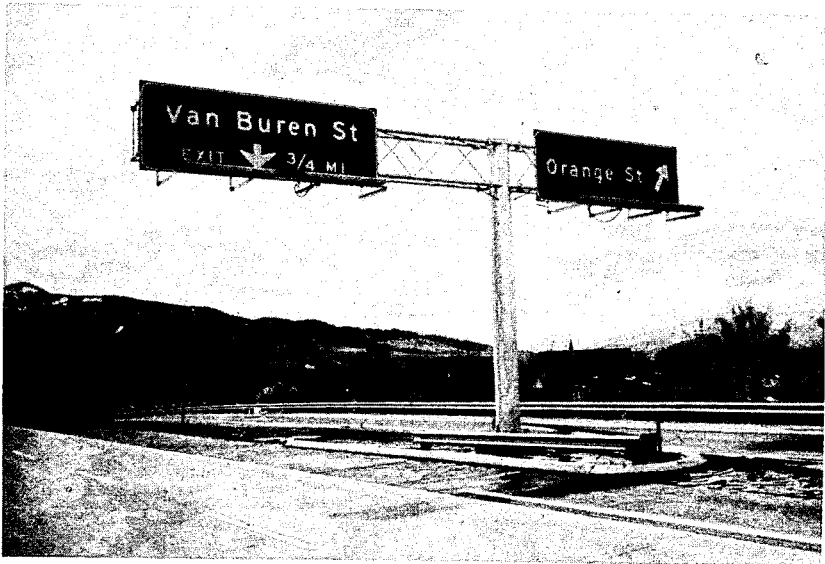
Here is the exit sign similarly mounted on I-beams.



Here is one of the very husky mountings that we saw on an exit from the main line here going into Orange Street.

Mr. CONSTANDY. Missoula?

Mr. PRISK. This is the west side of Missoula, Mont.; outskirts of Missoula. And that particular installation was extremely impressive. You see the gore condition where you have the approach roadways nicely divided, curbing outlines it, extremely short section of guard-



rail here, 12.5 feet either side. And then that pole in the middle. I would like to take some estimates of the audience as to how large that is.



I estimated it was 18 inches and when I measured it, I found it was 24 inches in diameter, and then measuring the base, I found that that base the pole is welded to is 32 inches by 32 inches by 3 inches thick. Those nuts that you see are 5 inches across.

This is a tremendous thing. And there it sits on a concrete base.

I don't know what it would take to move that.

Mr. CONSTANDY. It looks like a piece of locomotive.

Mr. PRISK. It is very large.

Mr. CONSTANDY. Mr. Ricker, would you care to say something?

Mr. RICKER. Yes. There is a different approach to this. On the AASHO safety tour last year, almost every time that an intersection, separation of roadways, was described as giving problems, it was noted that the signs were too far past the decision point. The type of mounting illustrated here presents exactly that case. The signs are over the roadway beyond the point of decision.

If the signs were brought out to the decision point or in advance of it, you could not use a cantilever of this type; it would have to be a full span across the highway.

So this is an unnecessary hazard in itself. Messages are in the wrong place.

Mr. CONSTANDY. Yes. Mr. Huff?

Mr. HUFF. I would like to ask the reason for the large signs. I have been told it was wind load; is that correct?

Mr. PRISK. That is what I understand, yes.

Mr. HUFF. What intensity of wind is used on such posts, Mr. Wilkes?

Mr. PRISK. The specifications call for loadings up to 100 miles per hour, 100-mile-per-hour velocity. I don't know what the pound loading is on that. Perhaps Mr. Wilkes does.

Mr. CONSTANDY. Mr. Prisk, before Mr. Wilkes answers that, is that 100 miles an hour directly on the face of the sign, 90° angle?

Mr. PRISK. Yes.

Mr. WILKES. The wind velocities for design purposes do go up to 100 miles an hour.

Mr. CONSTANDY. The wind does not but the sign design does.

Mr. WILKES. And also this is a type identified as a butterfly—one wing on each side of the roadway. In the design assumptions, you would apply the wind on one side to develop a torsion effect and that gives an unbalanced load which is greater than you would have in some cases to a balanced wind load on the two sides.

Mr. CONSTANDY. I realize it may be unfair in that you have no dimensions other than those Mr. Prisk gave you, but could you conceive the necessity for something this massive any place?

Mr. WILKES. Those were substantial cantilevers; they extended out over the roadway.

Mr. CONSTANDY. You know, in the nine States plus traveling considerably around the United States, that is the largest thing I have ever seen. And it may be they have very strong winds up in that part of the country. But the peculiar thing to me is Van Buren Street is perhaps the major street. Missoula has three interchanges into the city. Orange Street does go deep to the heart of downtown Missoula. But I just wondered why the sign in this gore is mounted on such massive support while Van Buren Street, at the preceding interchange, had more modest signs.

Mr. WILKES. I would not want to pass judgment on the size until I could review design calculation.

Mr. CONSTANDY. I appreciate that and I did not mean to put you in such a position. If I had to choose the most impressive thing we saw on the whole trip it would be this sign. Mr. Huff?

Mr. HUFF. I might add we have done a limited amount of wind tunnel testing to support sign post design. Now we found, through our limited research, that you could safely cut those loadings down to I believe about 80 percent, 75 or 80 percent. And as a result of that, we have begun cutting down on the sizes of our sign support.

Mr. CONSTANDY. Are you meeting the standard?

Mr. HUFF. Well, we are building them and getting paid for them.

Mr. CONSTANDY. That is one test. Actually, though, the standard, as you found it, is too high and results in more massive sign supports than are necessary; is that true?

Mr. HUFF. In our opinion, a 100-percent allowance for the 100-mile-per hour wind load is too high, yes, that is our opinion.

Mr. CONSTANDY. If they ever had the kind of a wind in Missoula which this is intended to withstand, it would be the only thing left standing in the city.

Mr. HUFF. I agree with you.

Mr. CONSTANDY. Mr. Wilkes?

Mr. WILKES. Mr. Constandy, the original specifications were developed for overhead sign bridges and experience will prove the ground-mounted signs could have a reduction in the wind load application and this 0.8 reduction is a standard for all ground-mounted signs. And that is permitted by the specification.

Mr. CONSTANDY. So it does allow for going below the 100-mile winds for such signs?

Mr. WILKES. For ground-mounted signs.

Mr. CONSTANDY. Is this a ground-mounted sign?

Mr. WILKES. No, this would be considered an overhead bridge, for which there would be no reduction in the wind velocity or wind pressures.

Mr. CONSTANDY. You probably would not have to worry about this one.

Mr. WILKES. I think I could safely say it is a safe——

Mr. CONSTANDY. Only from the standpoint of the wind.

Mr. WILKES. Only from the standpoint of the wind. [Laughter.]

Mr. CONSTANDY. Did you care to say something, Mr. Ricker?

Mr. RICKER. No.

Mr. CONSTANDY. I think at this point, with your permission, Mr. Chairman, we will recess.

(Whereupon, at 12:27 p.m., the subcommittee recessed to reconvene at 2 p.m., the same day.)

AFTERNOON SESSION

Present: Messrs. McEwen (presiding), and Schadeberg.

Staff present: Same as heretofore noted.

Mr. McEWEN. The committee hearings will resume. Mr. Constandy.

Mr. CONSTANDY. We might just as well begin where we left off, Mr. Prisk, if you will continue the slides of sign mountings and placements.

We had begun to show the slides on Montana, is that correct?

Mr. PRISK. Yes. This is Montana, Interstate 90, just outside of Missoula, west of Missoula, a project that was opened in December 1966.

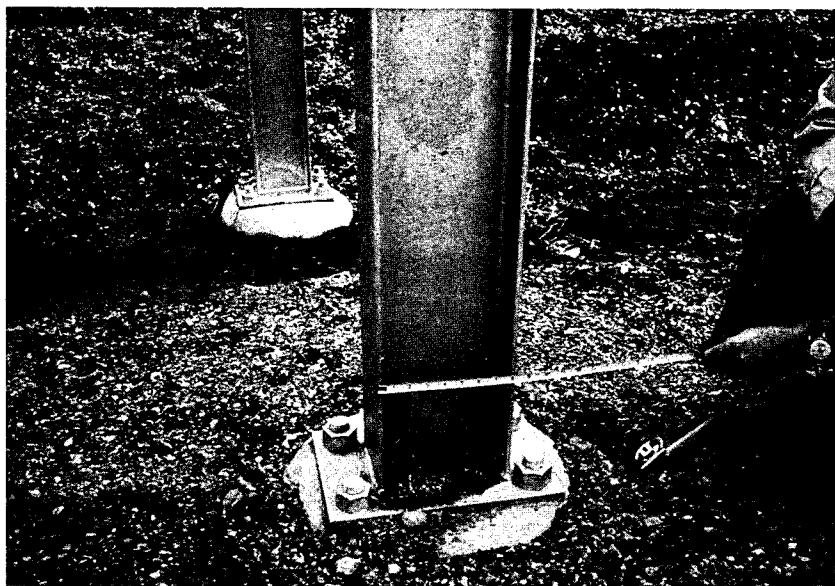
This particular sign structure, I recall, is one we photographed because of the very large column, 24-inch column, supporting the two cantilevered signs on this exit.

This column is supported on a steel base that measures 32 inches by 32 inches. It seems remarkable that those nuts are 5 inches across, but they are, from one side to the other. From here to here it is 5 inches.

It is very heavy construction and of course is on a concrete platform, raised above the roadway itself.

I think the best point that was made in summary of this situation is the fact that it need not be there at all and would better serve the motorists if it were mounted at a position a couple hundred feet upstream, back toward the camera, so the drivers would have that information somewhat earlier, and that this gore itself could actually be fully clear.

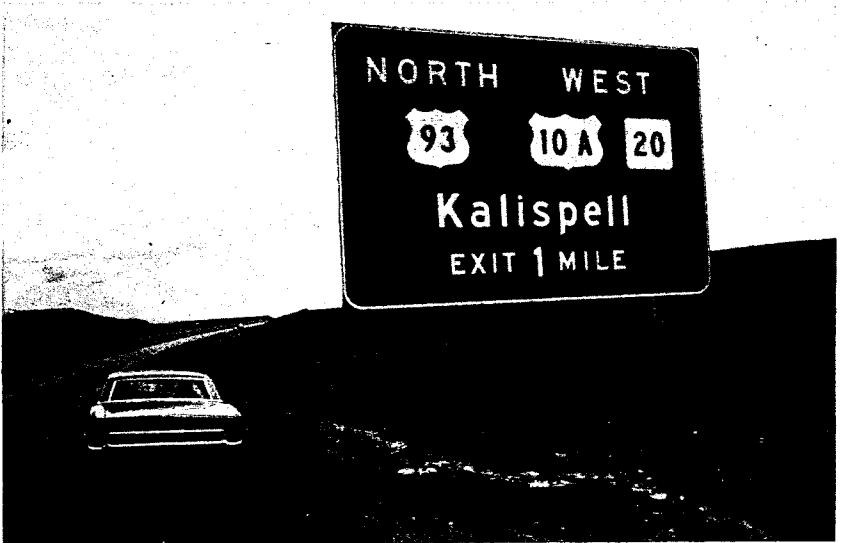
We move along on the Montana project, going west, getting into a more rural section. We find the exit sign for Reserve Street the next installation. This is mounted on two I-beams, as they are shown here.



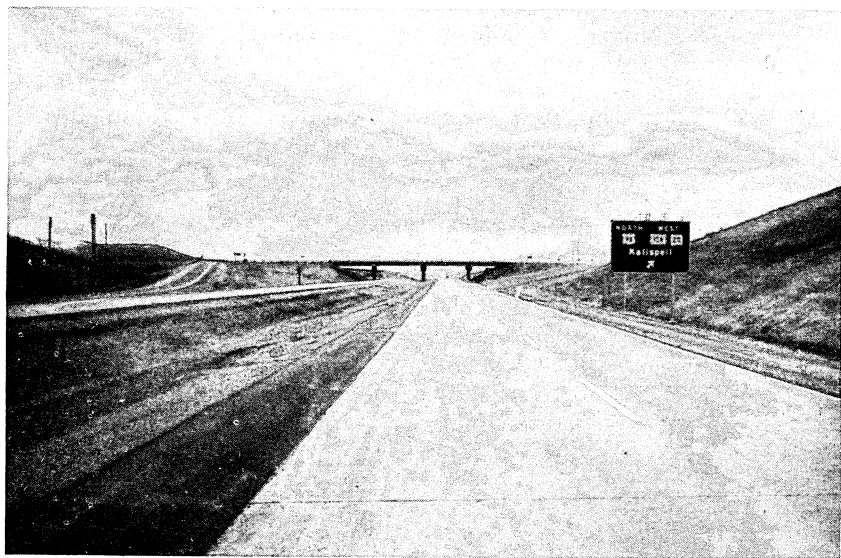
Here is the 2-mile exit sign for the next major interchange, the Kalispell Interchange; and this is mounted on three 10-inch I-beams.



Here is the 1-mile exit sign, the same design as the previous one, but mounted on three 10-inch I-beams, very heavy support.



Here then is the exit direction sign, just ahead of the interchange. You will notice a rather abrupt deceleration lane, perhaps too short, particularly in this kind of open country; but, in any event, this is the signing that we find there.



Then if you move off to the side road, you find this rather surprising sign which, after you have read Kalispell is 2 miles and 1 mile, you get on the side road and you find it is 114 miles. This is a bit of a surprise.



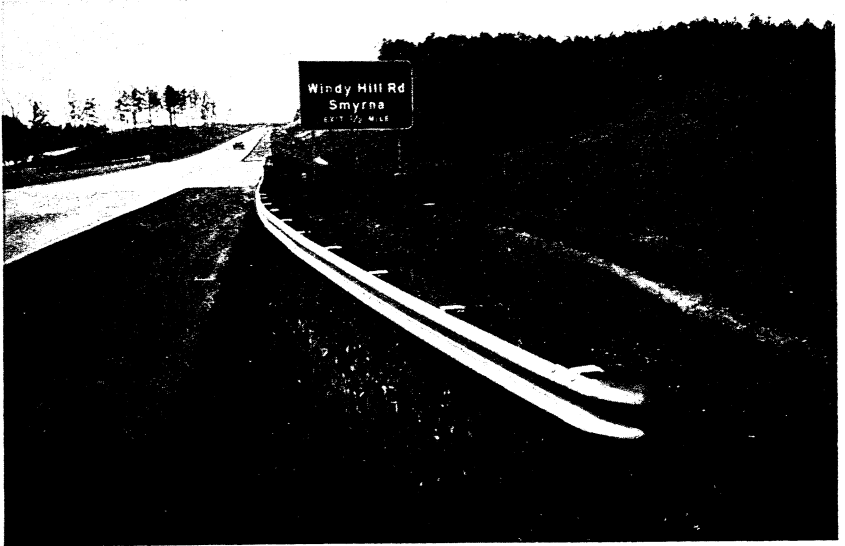
Mr. CONSTANDY. We were strangers in that area, and we thought we would go to Kalispell for cigarettes, coffee, film; so we were looking forward, as we began to see this sequence of signs, to stopping shortly.

I was about ready to pull off the road into Kalispell, and we were amazed to see we had 114 miles yet to go.

It is also interesting to point out that, on the side road, the sign telling where Kalispell is, is mounted on small posts.

Mr. PRISK. I think this ought to come under the heading of sign messages, which will be discussed at a later time.

Here you notice they do use wood posts on this side road mounting.



We move along now to the Georgia job, and this Windy Hill sign is also supported on three I-beam mounts. These measure 12 inches. This is a very light section beam, but is 12 inches. There are three of them.

Mr. CONSTANDY. I think we should note, Mr. Prisk, should we not, the guardrail installation as we saw them yesterday and the day before



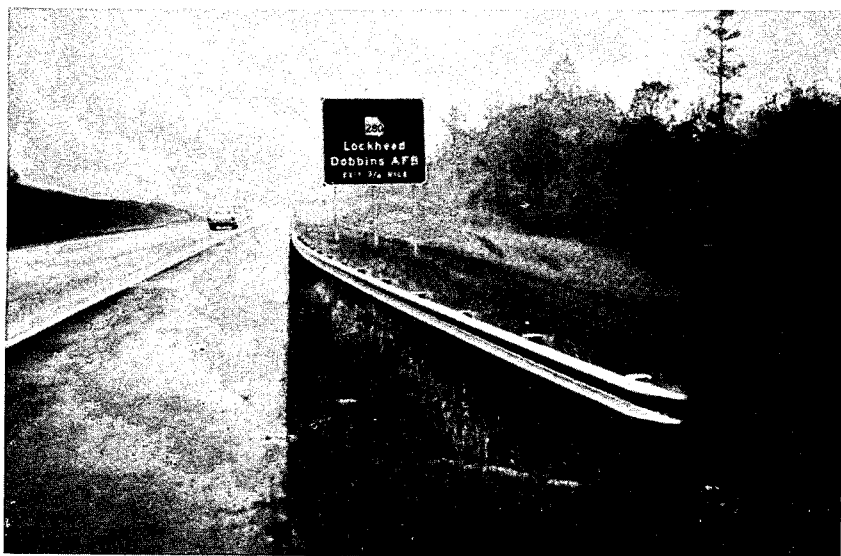
do afford some protection for these signs, unlike the ones that we saw in Montana.

Mr. PRISK. That is a fair statement.

The merging traffic sign used on the Georgia project mounted on a high pair of channels.



Here is an interesting set of photographs. Starting at this point, three-fourths of a mile from the Lockheed, Dobbins Air Force Base, let us drive down through that rainy road and see what you see.



Here next is the exit direction sign, just in advance of the grade separation, directing you to the right to the Dobbins Air Force Base and Lockheed plant.



Here is another view of the same thing.

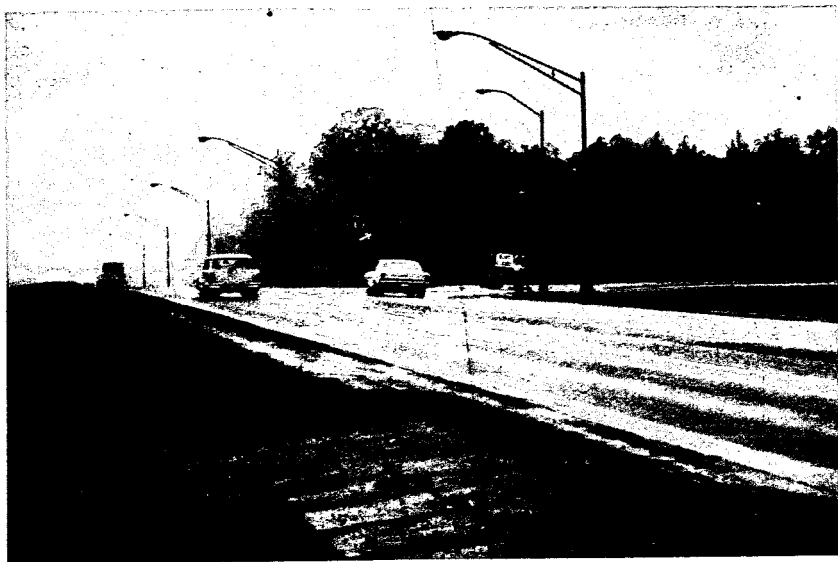




You reach the exit just beyond the structure, and you move into this situation, where you find the road is closed. So anybody who is bound for the base is a little surprised at that point.

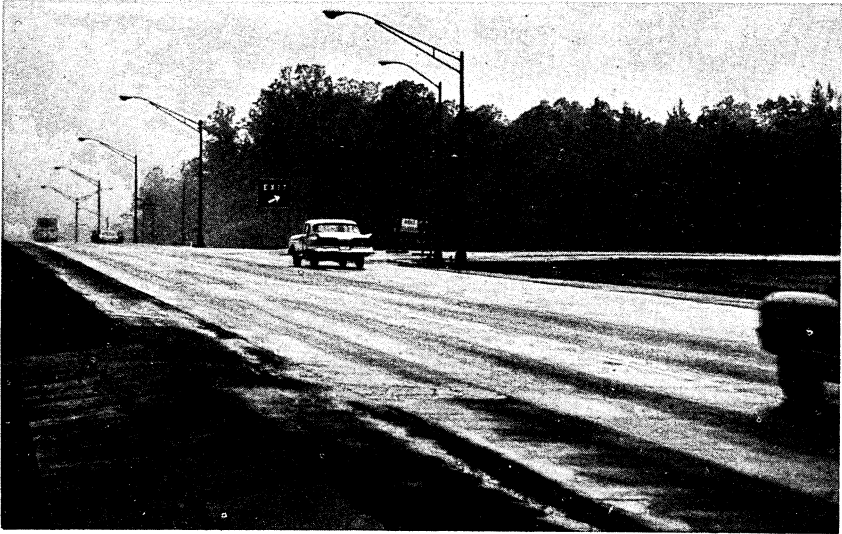


Here is one man who was surprised. He was starting into the exit, as you can see—and this is not Mr. Constandy; this was a Georgia native—and he recovered and pulled away. But, see, he is on the shoulder at that point.



Here is another car pulling into the exit.

Mr. CONSTANDY. Notice in that picture the distance between the two cars. If we can have the previous slide, you can see the second car is well back. This gives you an indication of how slowly the first car was traveling to find the exit.



You can see by this slide that the car that was far ahead is now alongside the other car.



In that same slide you will see a car off on the shoulder beyond it. That is one we did not get a picture of, but he did the same thing, except that he went beyond the exit ramp, pulled off on the shoulder, and then got out, clutching his map in his hand, looking around at the countryside.

Apparently he wanted to go there. He presented another hazard while he was in the exit ramp and afterward.

Mr. PRISK. Here is still another car. You can see by the application of brake lights he has the same intention of slowing down to make that entrance movement.

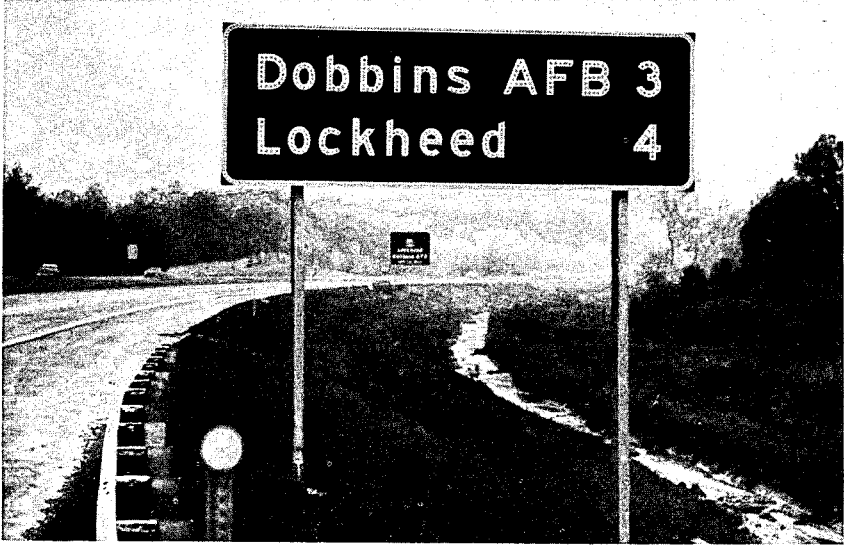


And still another one.

This whole series, I might say, of erratic actions around that exit point, were photographs selected from a number that we witnessed over about a 20-minute period.



Here is another interesting series, going the other way, going south. Dobbins Air Force Base here is labeled 3 miles, Lockheed 4 miles. It is a bit difficult to understand, because when you get up there, they appear to be across the street from each other.



You go from this sign to the sign you see, through the legs of this sign, in the background. That sign says a half mile. Instead of saying Dobbins and Lockheed, this says Lockheed and Dobbins. This violates the principle of good signing practice, which maintains continuity in signing messages.



Mr. CONSTANDY. I think it is worth pointing out, too, that the exit here is also closed, although none of the signs in advance have reflected that.

Mr. PRISK. That is true.

We move along here close to the terminal of the project. You see another series of signposts erected on the right-hand side, ready for installation. The truck is turning off on the ramp which in fact does carry the traffic from this point on farther north.



This treatment around the terminus of freeway projects and interstate projects in particular—the freeway ends—is quite an art by itself.

Evidently this is not altogether successful at this point, as witness the damage done to this exit sign just ahead of where you just saw the truck.

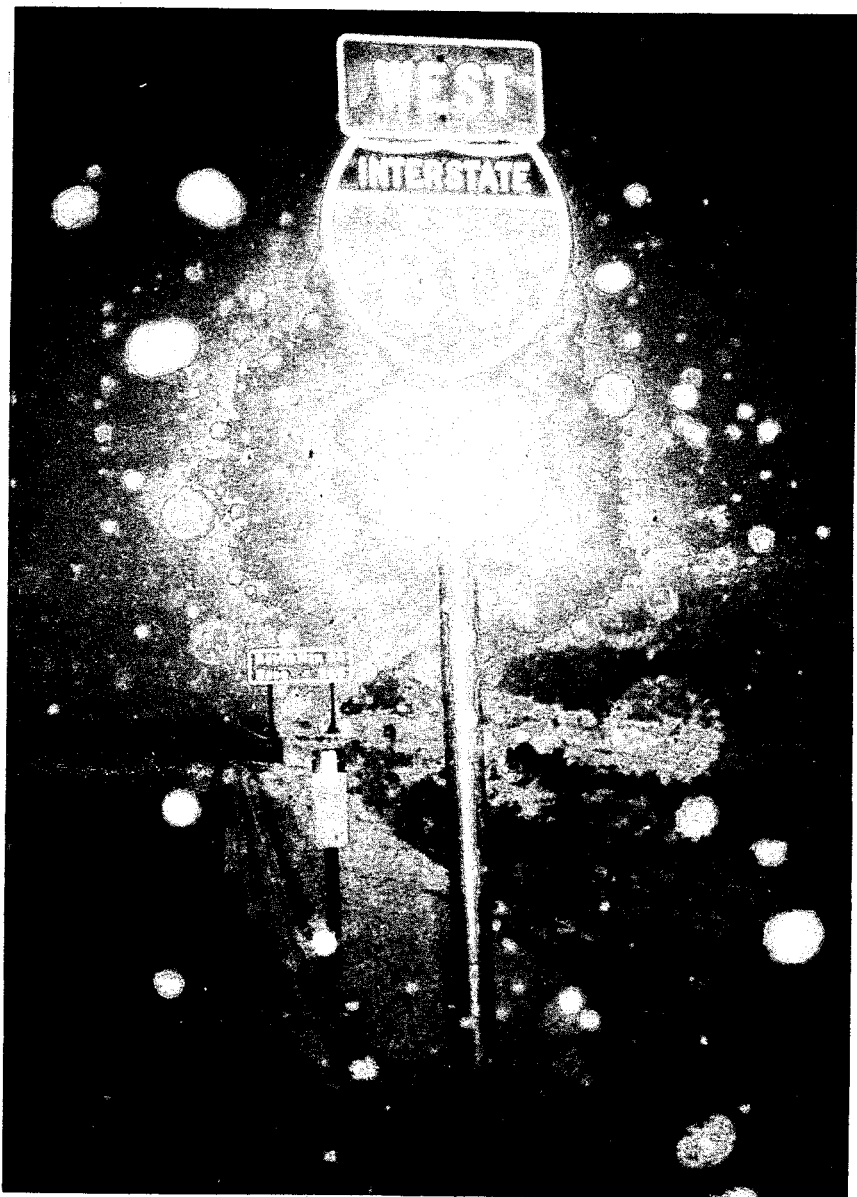


Moving now to Nevada, to take a look at a few of their signs, you have this Interstate marker which, in this case, is a round steel post on a concrete base. It is somewhat out of the ground—just a little bit out of the picture, too.



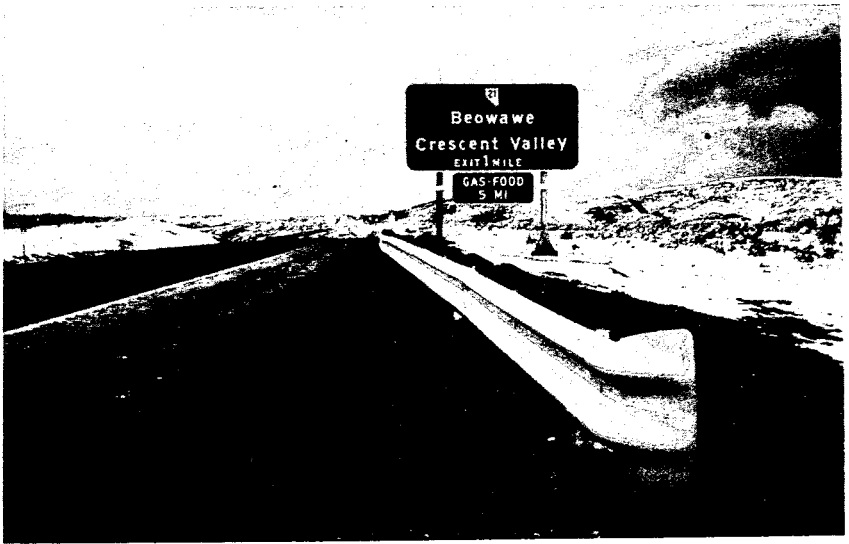
Here it is at night and in a snowstorm—essentially at night—taken with a flash photo. Here you can see the base out of the ground somewhat more than desirable, and the steel post. Both are very close by an asphalt curb.

Mr. CONSTANDY. Mr. Prisk, how does that round pipe compare with an I-beam in strength? Does it present as much of a hazard as the I-beam?

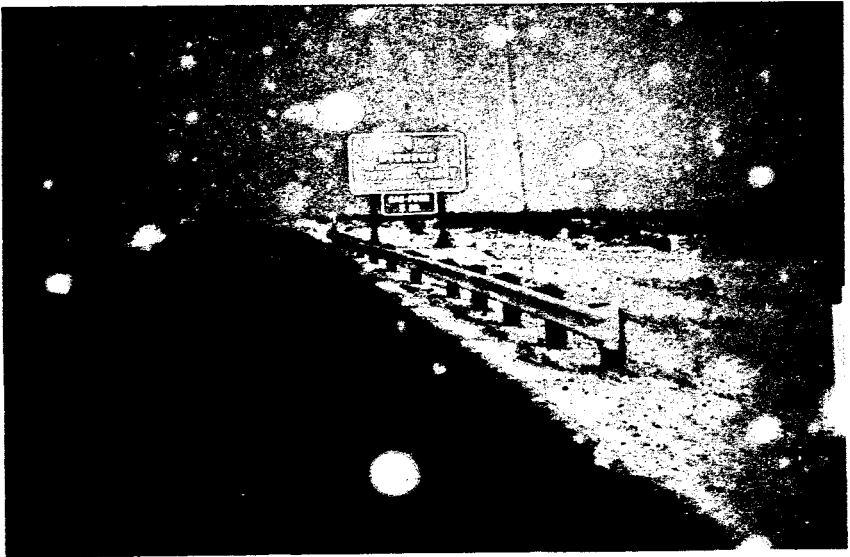


Mr. PRISK. I would say so. It would depend on sizes, of course, but relative to the ones that we have been looking at on that general structure, it would be equally hazardous.

Here is the installation just ahead of the one interchange that we had to look at in Nevada. This is the 1-mile sign. It is mounted on heavy supports, but in this case it is pretty well protected by the advance guardrail, as you see.



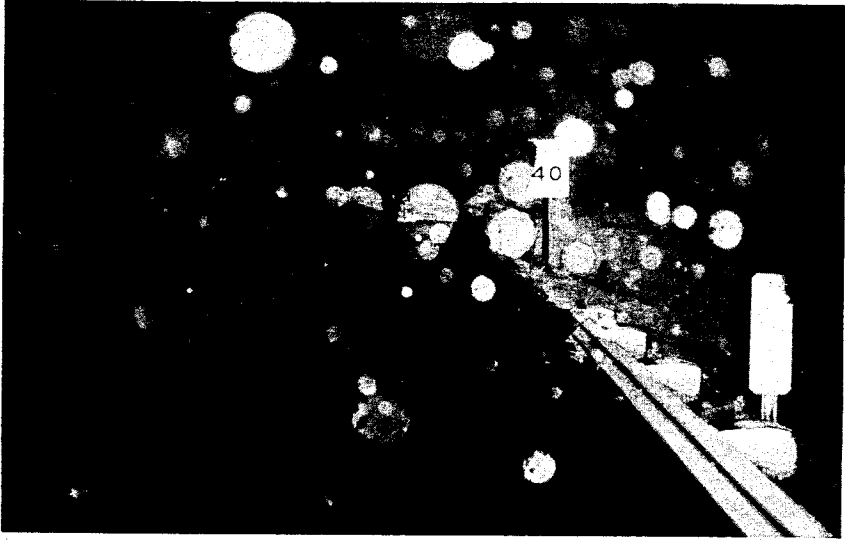
This is a snow shot, under adverse conditions, of the same location. I think you can visualize here the relative ease of viewing if this sign were moved out here quite some distance, even if you do not make an



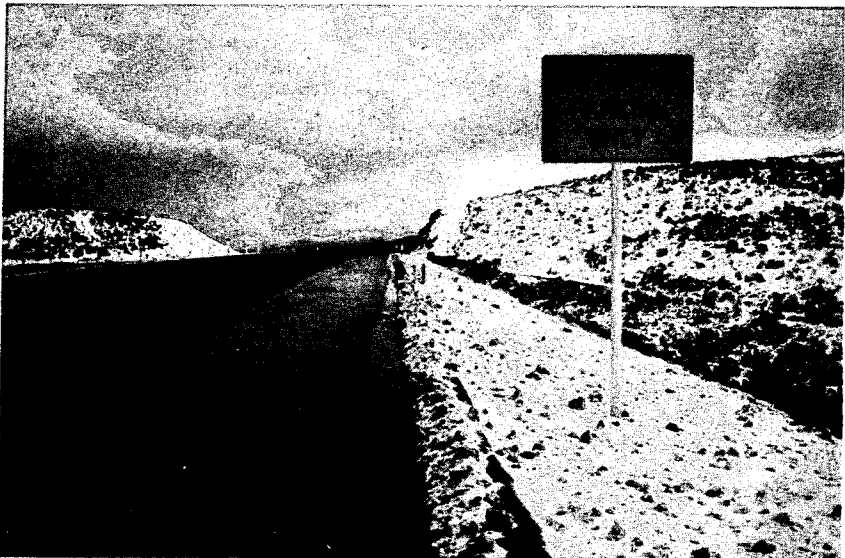
adjustment longitudinally, which many times is the more desirable thing to do; but this could be easily moved out here and be readily visible.

The driver's eyes are in clear focus for straight ahead vision about 5° either side of looking straight ahead, so within 5° —the 5-degree visual angle—there is no difficulty in getting the sign slightly away from the roadway.

Here is a shot of a smaller sign, also taken under adverse conditions, not protected.



Here is another sign, "Emergency parking only," perhaps of a class that ought to be looked at again in terms of its necessity.



We move now to Rhode Island. Here we find that the interstate marker is accommodated on a wood post, 4 by 4 instead of a 4-inch I-beam.



These posts would go down much more easily and with far less violent consequences as far as a collision is concerned. The same thing is used, doubled up, two of them, for speed limit signs.



The same thing there.

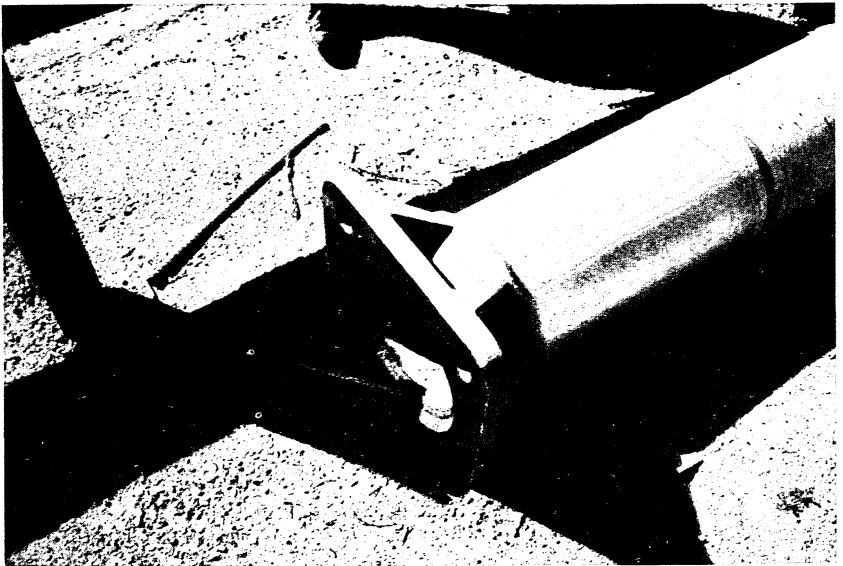


The same thing here. Merging traffic.





When we come to direction type signs, advance guide signs, there are mounted now, as you can see, two aluminum poles here. The third one remains to be placed on this base to back up the center of it. I think you tend to look at this and wonder if that would not be quite adequate without the third one, but in case you think that three may



be too much—here is one with four. Again I am not too sure whether this is not more support than that sign needs. It is an extremely large sign—no question about it.

Mr. HUFF. Mr. Prisk, what is the reason for all the blank space on the top of the sign?

Mr. PRISK. That will be a future message when other exits are open, so we were advised when visiting the project. This is not a completed sign, as far as the project is concerned, because some of the exits are not yet open.



Mr. CONSTANDY. Could you show that base in the last slide? (Slide.)

In speaking with the people from the department here, they mentioned that base is frangible and the pole is aluminum. It was their opinion that if struck it would not cause the car to stop violently. However, it is also very heavy. I was not able to lift up this end of the sign. Their opinion is that the post is not as lethal as it looks.

Mr. SKEELS. Again I would suggest they run a test on this. [Slide.]

Mr. WILSON. I would like to comment on Mr. Huff's observation here on the blank space on the sign. I believe that all the message that should be on the sign is there already, as far as readability from the standpoint of the motorist, and I would hesitate to add any more to that.

I believe that the Interstate regulations would restrict you to two lines of copy in this location.

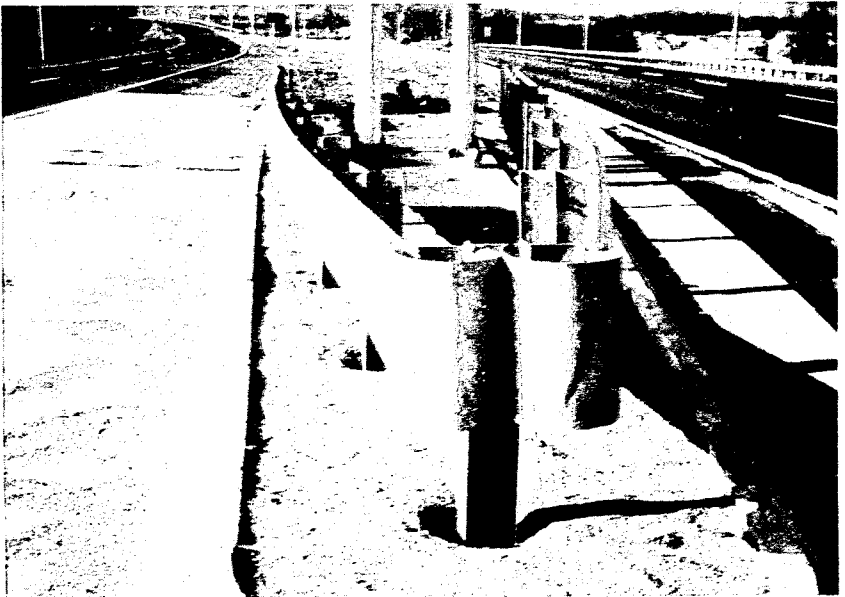
Mr. CONSTANDY. Thank you.

Mr. PRISK. Moving along, we come to the situation where there is a major division of roadways, and here again is another roadway at the left that is not yet fully signed.



It is covered with a sheet here so that the message only shows as the sheet flaps back and forth, showing the main route proceeding to the right.

This does have the advantage as you approach it of having this nice white concrete area in the gore, running down through the decision point, and by color at least you are adequately warned of the approach to an important decision point.



Signing does present a problem when you have as many as four signs with that much message copy to understand.

As you come in close at that point, this is the way the actual sign base looks in the gore area. There are two posts there, actually two bridges, if you remember, one over the right road and one over the left. This is to be replaced by a single structure, single support, which will cover the entire roadway.

Mr. CONSTANDY. As Mr. Marcello mentioned, they recognize the hazard that exists here themselves, and it was his intention to have both of those sign bridges taken down and one longer one put over both roadways, and the elimination of the sign structure and the guardrail in the gore.

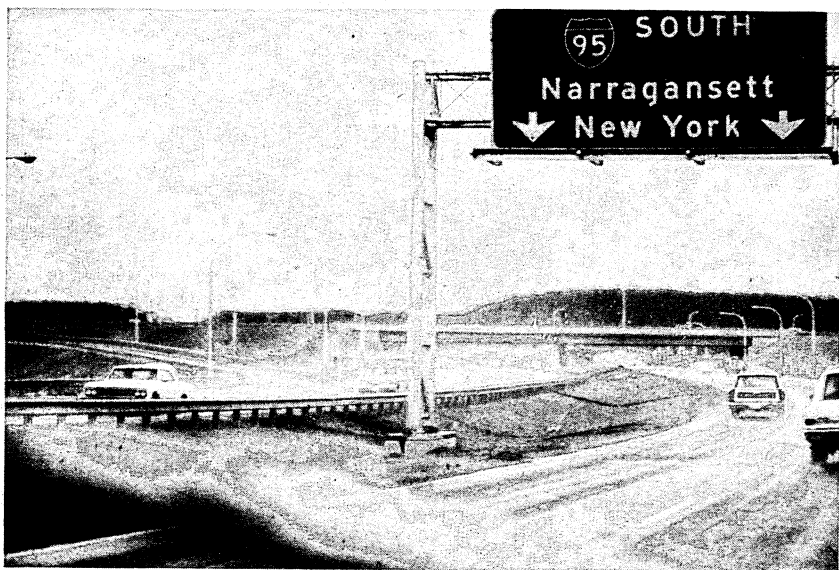
Mr. PRISK. At a point in advance of where it is now, which is in line with what Mr. Ricker mentioned this morning. Do you have a comment?

Mr. RICKER. I was going to ask you whether this sign was intended to separate those two streams of traffic, or make an additional separation beyond this point?

It looked to me as if they were beginning to follow a separation on each roadway.

Mr. PRISK. No. These were primarily for the two signs on each one.

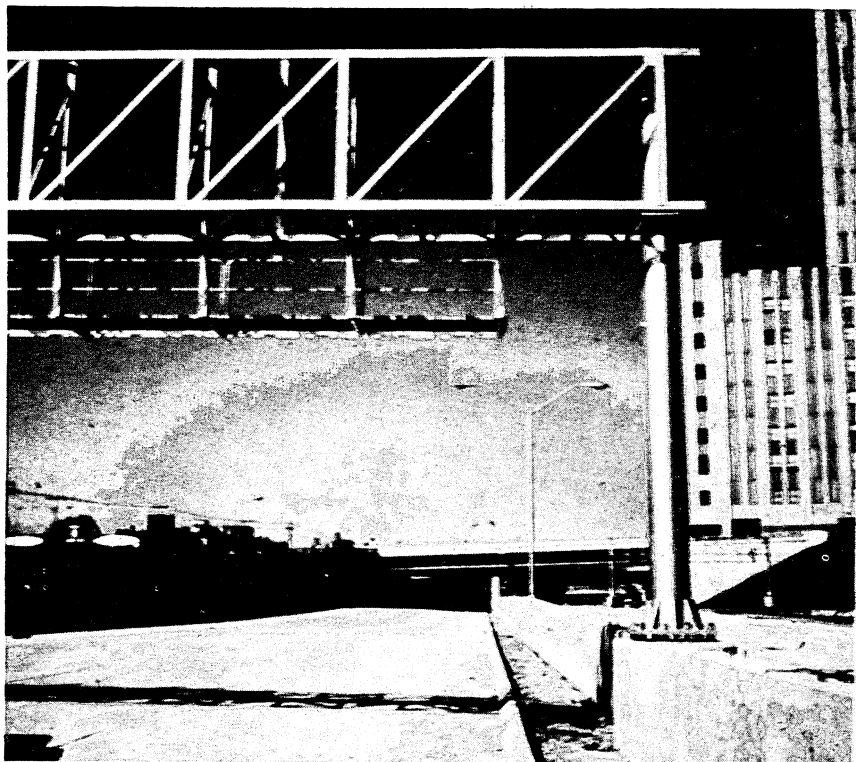
Moving now to the next one, south on 95, Narragansett-New York, we see an exposed sign structure support. This is in the median. I think I showed a picture rather similar to this yesterday, or day before yesterday, as we looked at the guardrail.



Now to Ohio. Only temporary signing was up on the Ohio project, 80-S, that we looked at. I think more frequently than not we found that only temporary signs were in place.



These are small signs used at crossovers, to indicate that only maintenance and emergency vehicles could use the crossover. There was a crossover paved just about where the camera shot was taken.

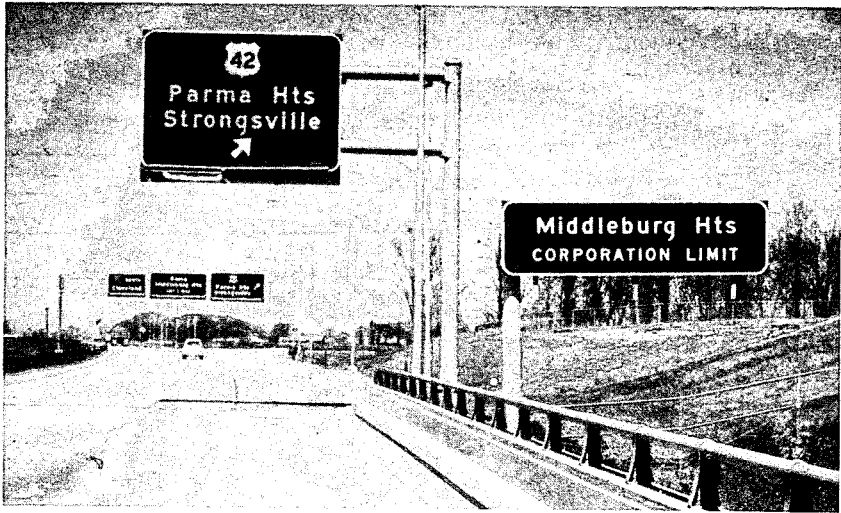


This is approaching the end of the project where it intersects with State Route 627. You will notice here that this is temporary signing. In fact, it is mounted on a U-channel. Actually there were a couple of channels driven into the ground, which probably extend above the ground 4 or 5 feet, and then these channels you see are bolted onto the lower ones, so it is a double channel through its height, where it would be hit if it were hit, 2 feet off the pavement.

The sign structure is serving a perfectly good purpose as it is.

On I-71, running back toward Cleveland Airport—and this is a recently opened one, though not the subject one we looked at in Ohio—we found this kind of installation. It is a desirable type of





cantilevered overhead sign, with a support well back here in a protected place beyond this bridge structure.

Here is another sign support which cantilevers out here to indicate you are at the corporate limits of Middleburg Heights.

Thinking again in terms of demands on the driver to find his way through some of these freeway situations, we have begun to question whether as much signing as is done of this type is in fact necessary.

You see, there is quite a bit to take your attention up ahead here.

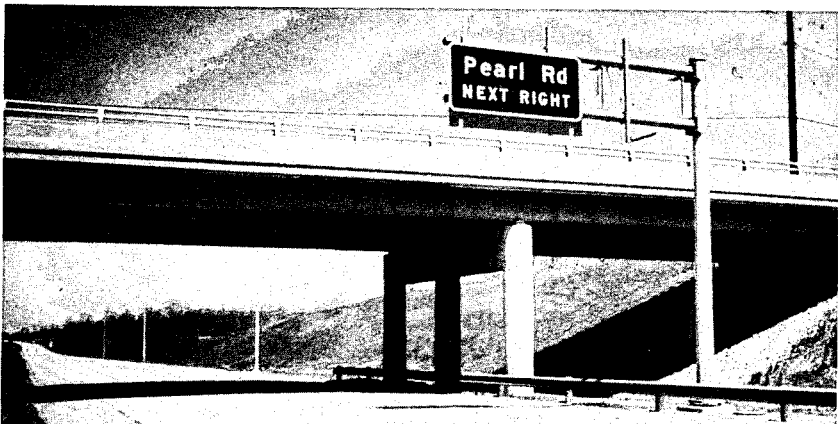
Mr. WILKES. I know we are not concerned with sign message, but on that sign you see the corporate limit sign, and then the following sign showing the Middleburg exit. This would be confusing to a stranger.

Mr. PRISK. Because of its position.

Mr. WILKES. Because of its position, which indicates it might be this exit.

Mr. PRISK. Good point. What I was attempting to suggest was we might do away with it entirely.

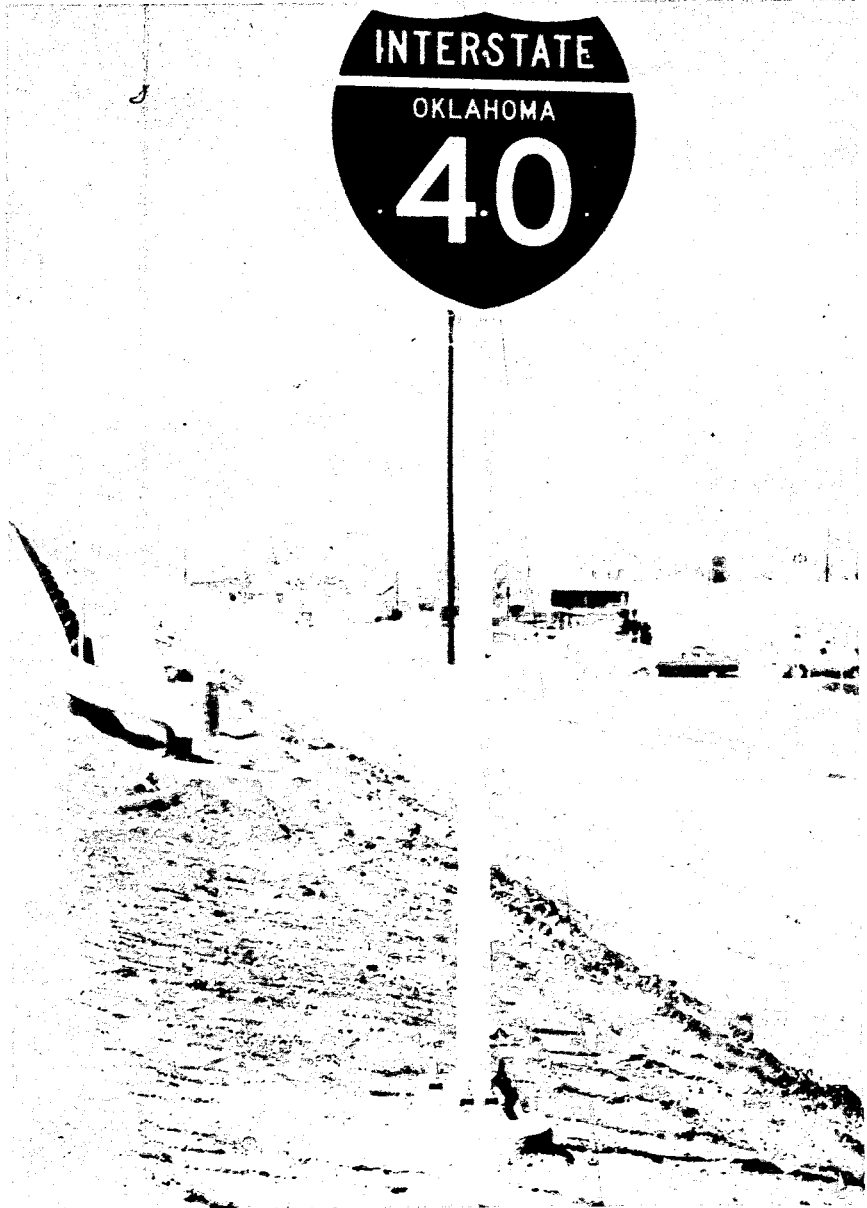
Here is an installation made almost at the structure, a cantilevered design, good design, behind the rail, nicely protected as far as that is



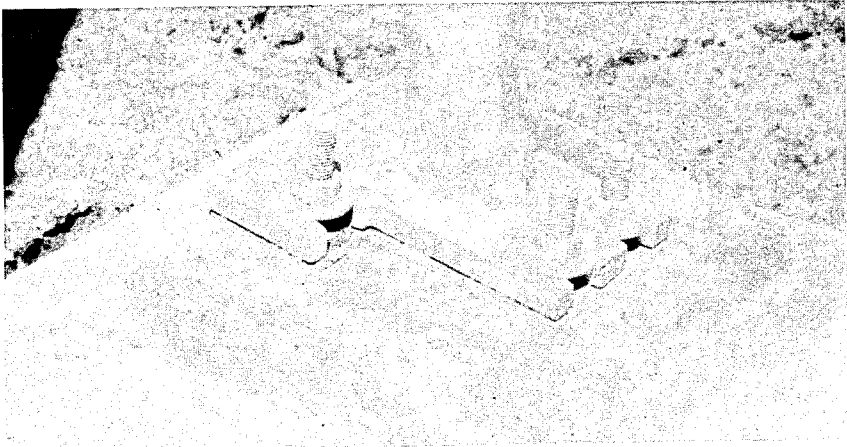
concerned, but you immediately seize on the thought here that that sign might be mounted on the surface of the structure itself, and that this installation and support could be done away with.

We saw a series of this in this same location on I-71.

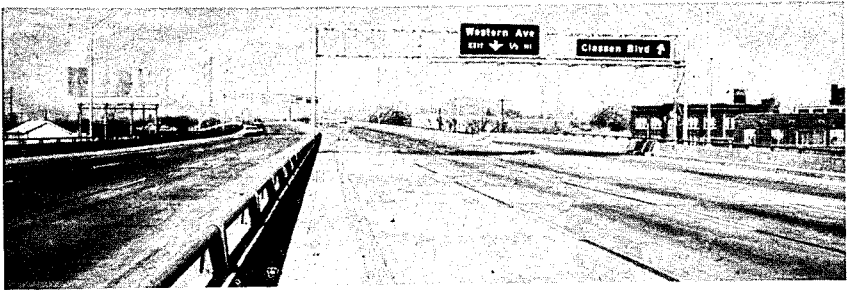
Moving to Interstate 40 in Oklahoma, this is the type of support that they use, again a steel pole on a concrete footing.



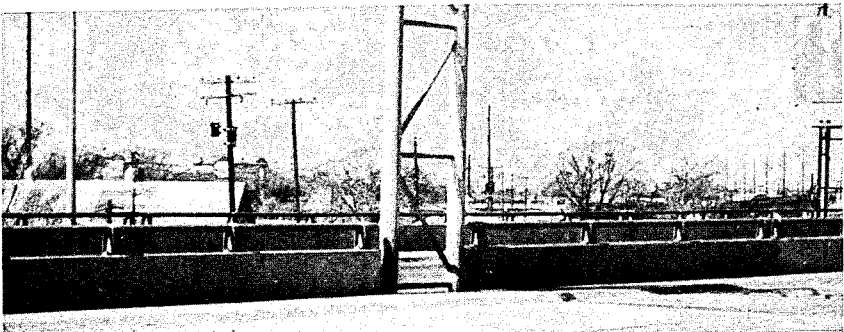
For the first time in our tour we found some breakaway support. This in fact is what your breakaway support looks like down at the base, slip base, this particular design that Oklahoma has adopted.



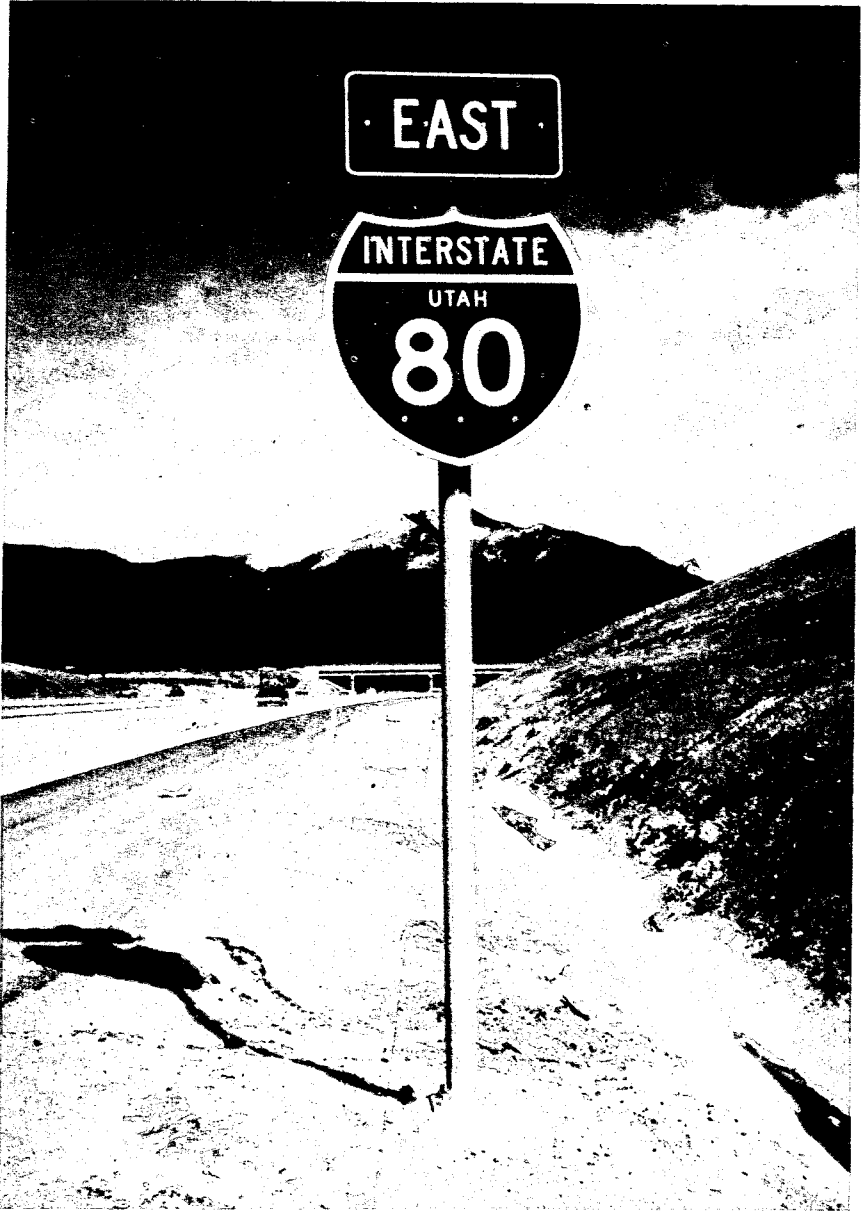
Here are some other supports on the Oklahoma project for the bridge. The uprights, as you see, have been put in line or behind the guardrail or bridge rail, or median rail that is already in place. This does provide a natural protection for this type of installation.



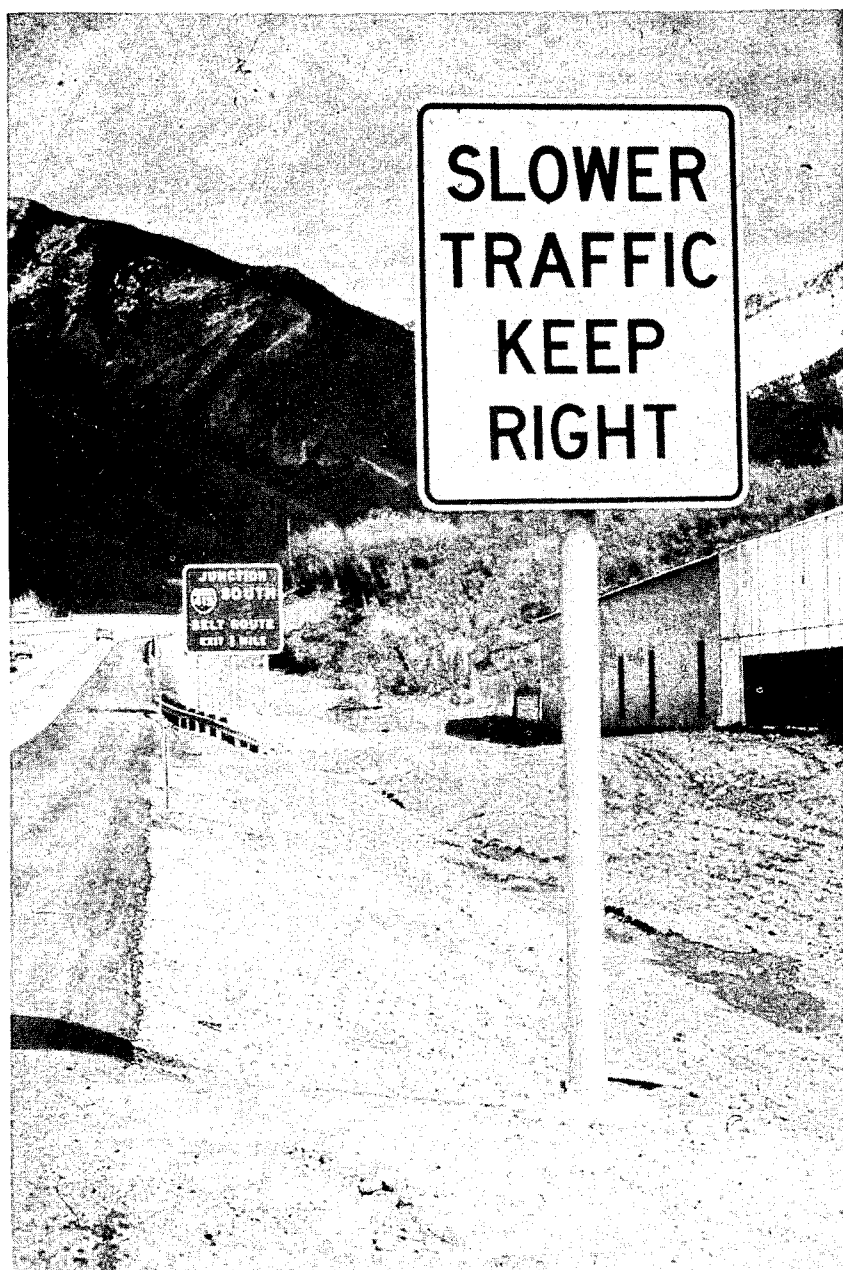
Here is a closeup showing how it is introduced in the median rail. There might possibly be some improvement on this, but this is at least lined up with the center barrier, and therefore offers much less hazard than it would if it were outside the barrier.



Here in Utah we also find a steel pole employed. This eastbound on Interstate 80 going into Salt Lake City. This is just the conventional steel base, no breakaway features here at all.



Here is another regulatory sign, same type of installation.



Here are speed signs mounted side by side, 45 miles minimum when conditions permit; 65-mile limit otherwise. These are real husky signs.

In some cases we found them mounted like this. This is not necessarily typical. You will notice over here these foundations are pretty well down, but in this installation—



They are up, indicating this is not uniformly controlled to keep these bases down to the ground level.



We were not surprised by that previous one; we were here, because here our cylinders are concrete, bigger than you can put in a barrel, extending above ground, and on the outside of a curve. There are signs of cars running off into this area, and this would not make anyone feel too easy about leaving that type of installation in place very long.



Mr. CONSTANDY. If the concrete was much higher, they would not need the pipe.

Mr. PRISK. That is true.

Mr. HUFF. Mr. Prisk, would you care to discuss the reason for building those high pedestals, or do you know?

Mr. PRISK. In some cases it is because of the necessity to meet a standard length of steel post on top of the footing. In other cases I expect it is a combination of construction practice.

Mr. HUFF. I have been involved in that recently. It is my understanding the sign message is supposed to be so high a vertical dimension above the roadway. The sign material, particularly the posts, are ordered before the exact slope and so forth of the roadway are known.

In our experience, what we are doing is to prevent the contractor from ordering his material until the final cross sections of the road have been determined.

Mr. CONSTANDY. We did hear that in one State the sign supports were ordered so much in advance that by the time they got them, the grade of the road was not what they expected it to be, they poured the concrete high enough so the sign came out to the right elevation.

It is a problem that possibly administrative processes could take care of.

Mr. HUFF. That can be remedied by a simple clause in the specification.

Mr. WILSON. I believe these two signs have the same message, have they not?

Mr. PRISK. Yes.

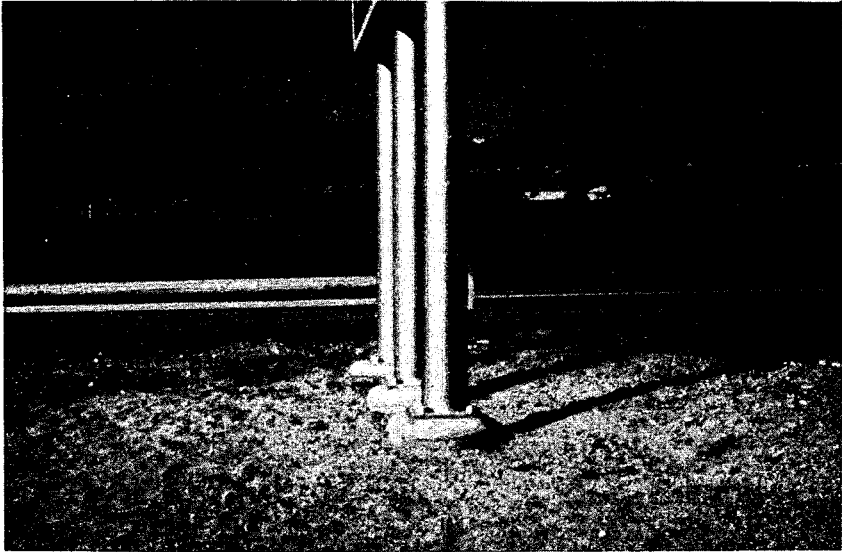
Mr. WILSON. Most States would combine these in one sign, located down the road about 100 feet, about where that car is, so it could be viewed from both the ramp and the mainline traffic. That is one solution of this problem.

Mr. PRISK. Thank you.

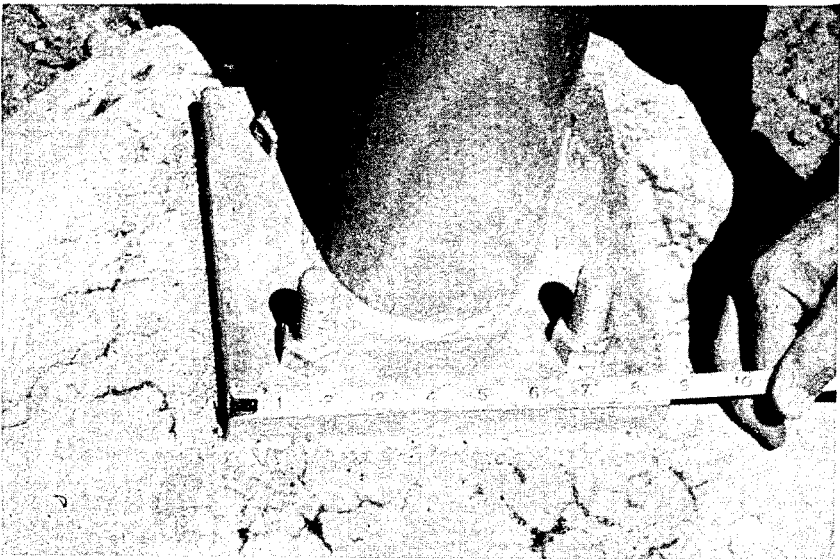


We proceed to another typical installation, the 23d Street East, where the exit sign is actually put on a sign island. I expect this is part of the solution, too, in some cases, to create an island in an appropriate place where the sign can be accommodated.

This gives you some idea of the size of these posts. These are 6-inch posts. There are three used for that installation.



On the 6-inch post you see an $8\frac{1}{2}$, $8\frac{3}{4}$ -inch plate at the base.



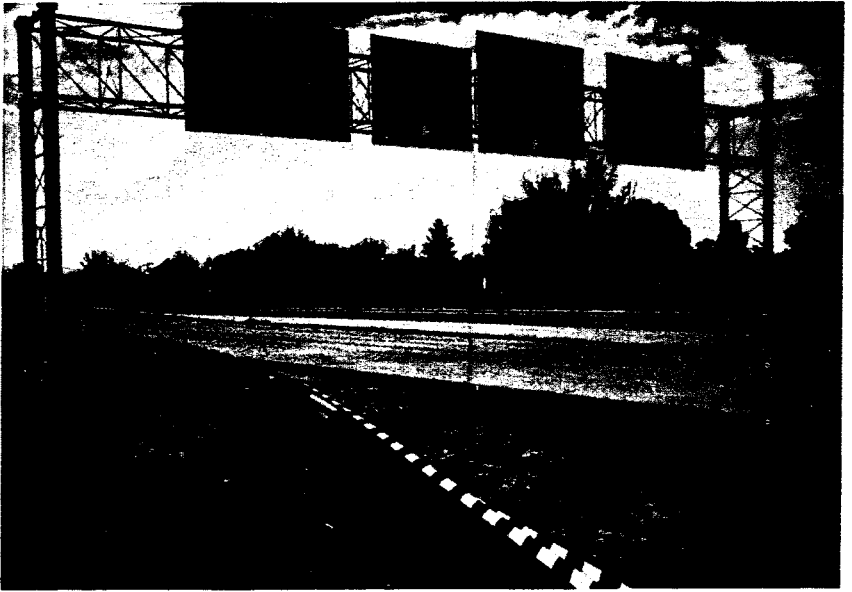
Again, not wanting to talk too much at this moment about the content of the sign, but you see here quite a lot of information to soak up: Los Angeles, Salt Lake City, Ogden, Pocatello, Provo, and various other places.

Along with this there is a repetition of Interstate 15, of 80, and then some U.S. route markers, two different ones over here, which seemed to me, as a first-time visitor, to be a rather complicated message in terms of the installation.

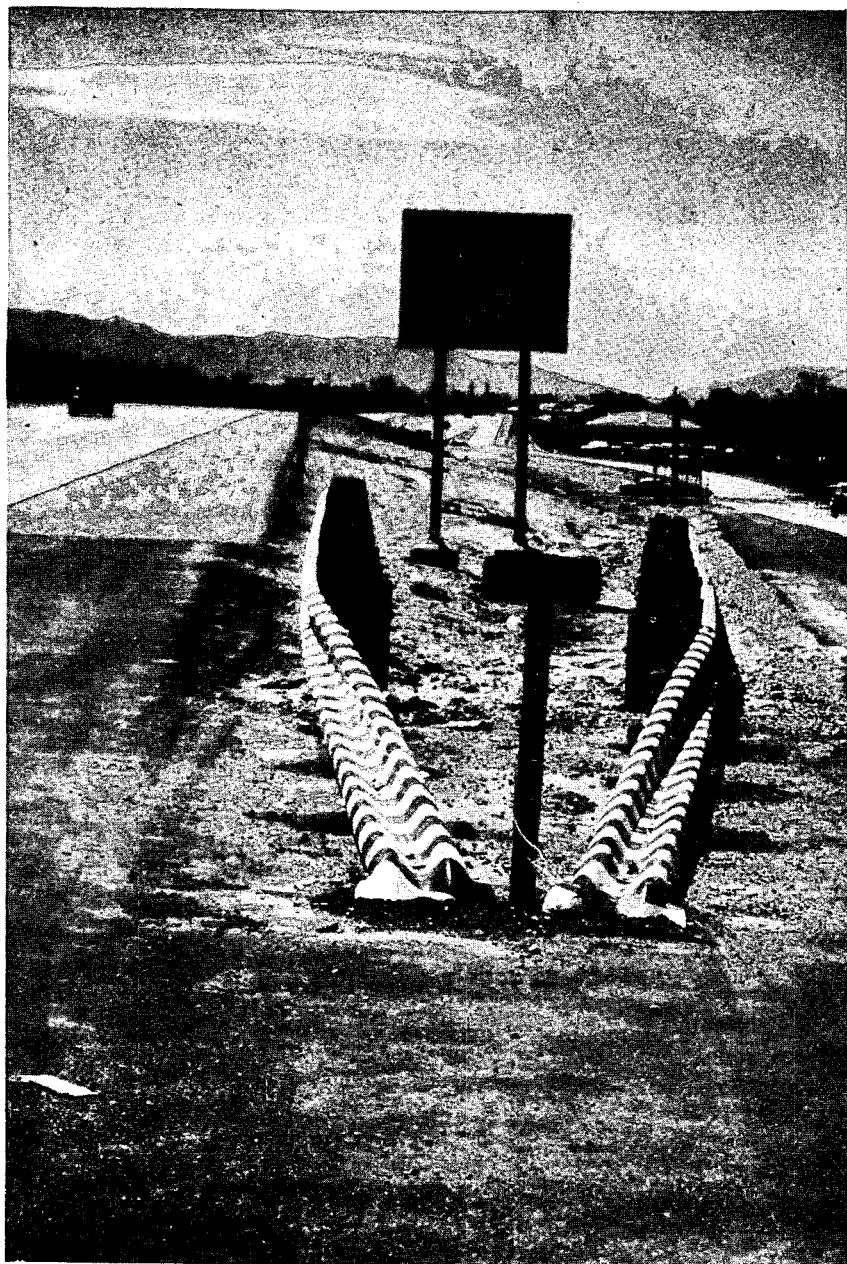
These are protected by this typical rail that we have seen on our look at Utah projects, which is a little bit too short.

Mr. CONSTANDY. Mr. Prisk, would you say the sign bridge is located sufficiently in advance of the gore of the exit ramp?

Mr. PRISK. This is not as far in advance of the gore as would be desirable. No, it is practically at the gore right here [indicating].



Continuing in Utah you see this situation, the typical exit sign installed at this point. Clearly this is the kind of place where the breakaway design has its best application. With the breakaway sign, I dare say the entire area could be cleared up of this hardware, as the British call it; namely, the guardrail, posts. All these could be taken out.

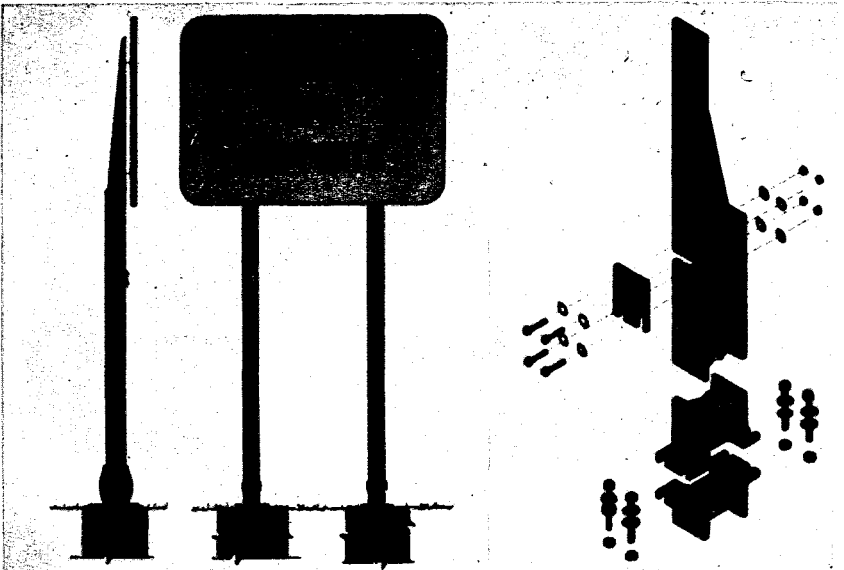


This is the back of that same installation, showing the concrete footings above ground.



For the benefit of those who are not too well acquainted with break-away sign supports, this is a drawing prepared at Texas Transportation Institute, illustrating the details of the joint at the base of the sign, right at this point which shears off.

The one up here is in fact a hinge arrangement on the traffic side of the I-beam, which causes the I-beam to break and break around the hinge just below the sign surface itself—you saw the pictures



this morning of how this performs when it is struck by a car. The pole goes over the top of the car.

Essentially this is the same kind of performance you get from this support. I think we have some pictures here. This happens to be in Ogden, Utah. This is the very first breakaway sign installation site in Utah.

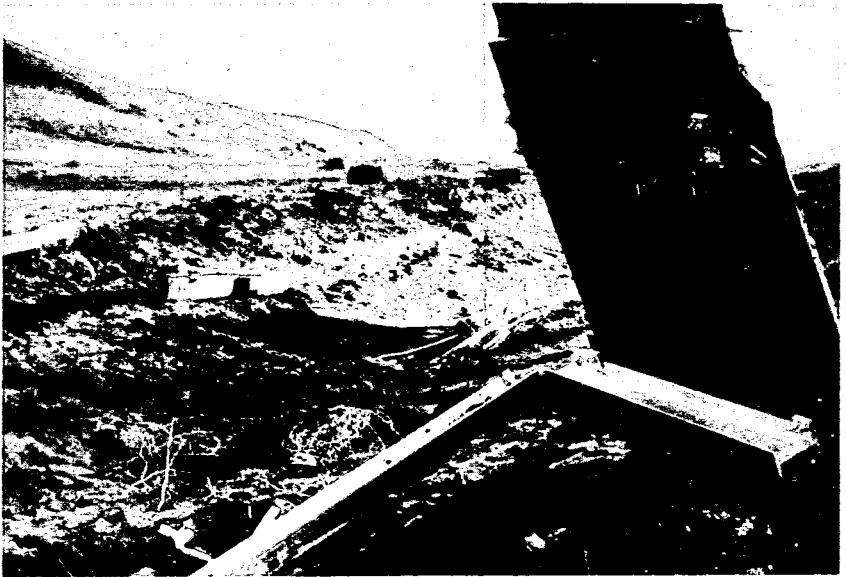
This sign was being put in at the time of our visit. We did not see this particular installation at that time, but it was about that time, 2 months ago now, that this sign was put in. We are looking from the gore back toward the approach.



This is the way it looked as you drove into it, and you can see the breakaway supports here.



Here it shows how this hinge joint actually operate when it is struck by a car. It lets loose, and the web of the I-beam is cut through, all except this flange here on the back, on the underneath side. You end up with that kind of situation.



It almost looks like a war scene. In this particular case the sign was struck, the driver went on his way, and there was no record of the accident filed. The newspaper in the area became a little bit curious, and with some little detective work finally located the car in a garage, found out there was very little damage to the car, talked to the driver. He was completely uninjured, and had no difficulty at all at this point,



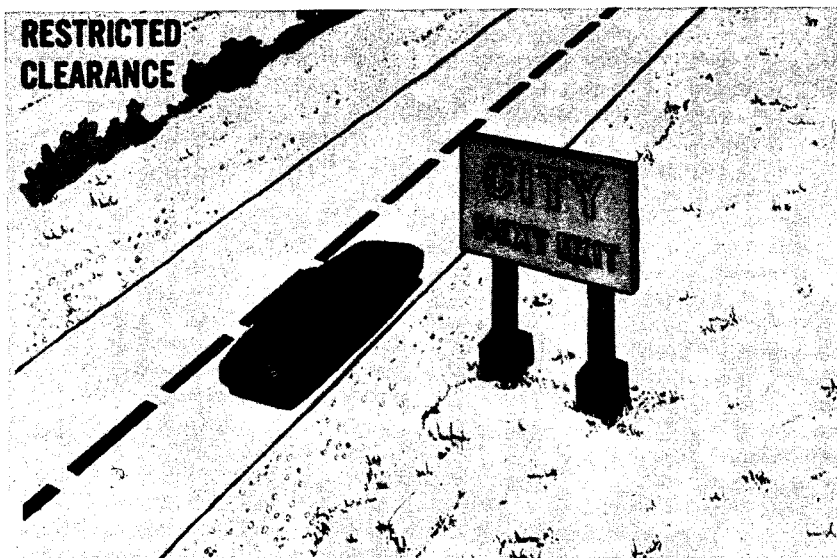
in spite of what appears to be a great deal of violence.

This performed in a very safe way.

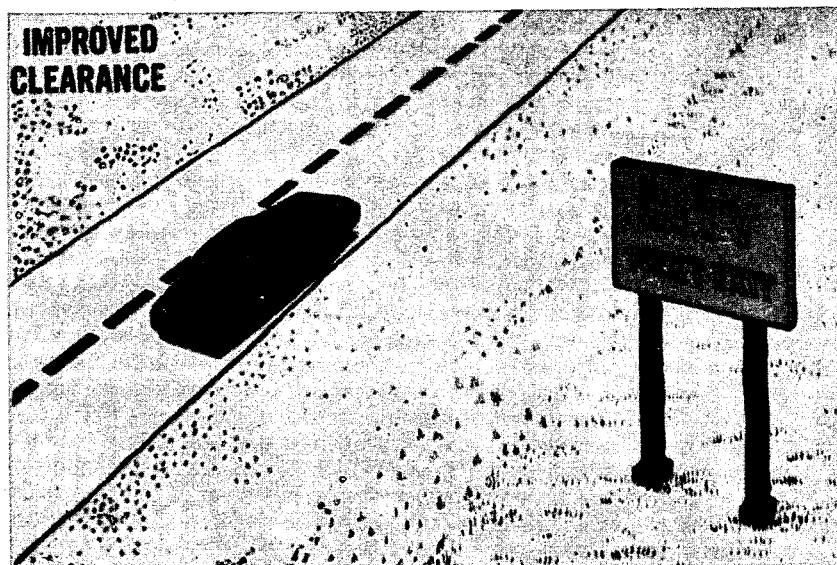
Mr. CONSTANDY. That is a very fine demonstration; is it not?

Mr. PRISK. Yes, it is.

Mr. CONSTANDY. We will have additional information relative to this type of breakaway sign mount, as I mentioned before, next week when the people from Texas Transportation Institute testify relative to this and some other work they have done.



Mr. PRISK. These are indicative of typical signs that exist all too often, some of which we have seen in actual photographs: heavy footings, whole installations in a restricted clearance area.



One easy way of course is simply to move these out. I think perhaps the most remarkable thing you might do sometime as you drive the Interstate System is to look at the signs that could be moved. We attempted to do this, and in a 30-mile section, out of 150 signs that were observed, it appeared that more than 100 of them could be moved 20 to 30 feet off the edge of the pavement without any loss of effectiveness.

There were quite a number of others, 20 or 25 others that did not need to be moved because they were already in a protected place.

So with some planning I am sure our sign installations can be put in safer locations.

Mr. CONSTANDY. Mr. Prisk, in the view you showed of the breakaway sign installation in Utah there was a guardrail in front of the sign at the gore. Might the removal of that guardrail be an additional safety feature?

Mr. PRISK. I am sure it would be, and I think this is the judgment of the Utah authorities, after seeing this performance, that it would be entirely adequate to delineate that gore with reflectorized units, so vehicles would be guided through there at night.

You would have a visual definition of the gore area, but not necessarily any physical outlining of the gore.

Mr. CONSTANDY. I wonder if the members of the panel would comment now on the sign photographs which we have seen on the nine projects. Perhaps we could begin at the other end this time. Mr. Ricker, would you care to comment?

Mr. RICKER. After seeing the last few slides of the steel breakaway posts, I am happy with our wooden ones we use in Pennsylvania, because they break much easier and without so much debris left afterward.

Mr. CONSTANDY. But the important thing is that the use of either of them is going to lessen the violence of the impact of automobiles.

Mr. RICKER. Yes. I think we all realize there is much to be done in proper location of signs, both longitudinally and laterally, to keep them from being struck.

The real point of concern, of course, is the gore area. There are more people apt to go off there, so that one should certainly have breakaway posts. There are some gores, particularly on elevated structures, where there has to be a parapet rail anyway, and in those cases we need protection by means of something other than breakaway posts.

Mr. CONSTANDY. Overall, are you satisfied or not, relative to the slides you saw on the nine projects?

Mr. RICKER. I have to say no.

Mr. CONSTANDY. Mr. Wilkes?

Mr. WILKES. I believe I have commented on the more obvious features before. I do not know that I can add anything, except the committee may be interested to know that the Committee on Bridges and Structures of the American Association of State Highway Officials is currently reviewing their standards for design of signs, and they are considering methods of reducing the windloads, or methods that will reduce the mass of the sign supports as a means of reducing the hazard to vehicles hitting the post support.

Mr. CONSTANDY. Overall, are you satisfied, Mr. Wilkes?

Mr. WILKES. From a structural engineer's viewpoint, I believe it would be safe to say most of the structures I saw were structurally adequate.

Mr. CONSTANDY. They are strong enough to hold up the sign?

Mr. WILKES. Yes.

Mr. CONSTANDY. But what we are really concerned with is from the standpoint of being hazards where they are placed and in the form in which they are placed.

Mr. WILKES. I think I would agree with the rest of the members of this panel, that most of these signs could be relocated to provide a more generous lateral clearance, and many of the signs could be eliminated.

Mr. CONSTANDY. I take it your answer then, is "No"?

Mr. WILKES. That is right.

Mr. CONSTANDY. Mr. Huff?

Mr. HUFF. I think the advantage of the breakaway sign has proven itself over and over. I know it has in my State. We have saved many, many lives by the installations we have. Whether it be wood or some other method I think is immaterial. We have not used wood, but we would have no objection to using it.

I might state here that I have thought for sometime the signposts themselves were overdesigned. I know that is argumentative.

I believe there would be some advantage in having them blow over once in a while rather than to build such a strong structure, even though it might break away.

We have begun coming down on the size of those by two methods. We have gotten approval from the Bureau of Public Roads to reduce the wind stresses some—I believe about 80 percent on the ground-mounted signs. On the ground-mounted signs and others, we are bringing it down some more by using high-strength steel. Of course the higher the strength steel, the less protection you need. I have no other comment.

Mr. CONSTANDY. That combined with your breakaway feature?

Mr. HUFF. Yes.

Mr. CONSTANDY. We will hear more on the experience Texas has had with those signs later. Mr. Skeels?

Mr. SKEELS. I cannot help but agree with the other members of the panel on the need for improvement. One item which might bear quite a lot of looking into is a better and safer support for the large overhead bridge type sign. The only solution we have so far is to make the bridge sign longer, to get the support farther away from the traveled way, or to protect the supports with guardrails or some other method.

I am not sure that a breakaway type of support could not be made for these, and perhaps even if one leg were knocked down, the whole bridge would still remain in the air.

I think this is a challenge for the structural people.

The breakaway sign mount, as we have seen here, is so well proven and so well engineered at this point that it certainly should, in my opinion, be made mandatory on all new signs, or accomplish an equivalent result.

I do not really care how it is accomplished, but we certainly have to eliminate the exceedingly strong sign support which in many cases appears to be designed not to be damaged by automobiles.

This would also imply that guardrails around the sign supports could then be eliminated. A breakaway sign or a sign mounted on breakaway post is safer than a sign protected by any type of guardrail I know of.

Also it is fairly obvious that many signs perhaps can be eliminated, or at least the supports, which are what we are concerned with, can be eliminated by mounting the signs on bridges, combining signs.

I noticed one in which we had two signposts adjacent to each other, one carrying one sign and one the other. This is not uncommon, and certainly needs to be looked at.

Mr. CONSTANDY. Overall, were you satisfied or not, Mr. Skeels?

Mr. SKEELS. I am satisfied that there is progress showing up. I particularly like the breakaway sign on the smaller Oklahoma sign we saw. There is progress in view. If this progress can be carried across the country, I am certain it would be still better.

I do know Michigan has gone to the breakaway sign, as well as Texas, and obviously many other States are moving in this direction rapidly. What we have done in the past, and we saw examples of, I am not satisfied with.

Mr. CONSTANDY. Mr. Wilson?

Mr. WILSON. I think this is one of the most fruitful areas that we can improve for the motorist, and not only in the structural problems we have been looking at here, but in sign messages as well, although I will not talk about sign messages now.

My office in Sacramento reviews message or sign guiding, and in that review we look at them very carefully to try to eliminate signs where possible, but where we find out the most good can be gained is the placement itself, particularly the lateral placement.

Due to heavy traffic volume and the fact that we put a lot of signs in the median, we found mounting signs back to back—in other words, putting a sign message in the median area, and having a sign face in both directions—eliminates one fixed object entirely. We think this is good.

I might recall on one modest-sized freeway project, after making our headquarters review of the guide signs, we found out we could eliminate about 45 supports that had been proposed by the district.

These are individual signposts. We did this by going to a back-to-back mounting, to structure mounting.

I would like to have Mr. Wilkes make a comment on what he thinks of mounting signs on structures. All in all we think this a pretty good area to improve safety for the motorist.

We have recently changed our wind loading specifications to the point where we are now getting 90 square feet of sign on wood posts. In years past we used wood on all signs having less than 60 square feet of area. That is a pretty good sized sign.

We have done extensive testing on structural timber, 4 by 6, 6 by 6, 6 by 8. We feel we can use a 6 by 8 post without causing too much damage to a vehicle striking it.

The exit signs that you saw in the gore area here we mount on a single 4-by-6 post.

One of the things that bothers traffic engineers is the number of signs we feel are not needed. You saw some of those here, particularly some of the rules of the road. I think there are enough freeways now constructed around the country that motorists should be aware of some of these regulations without having to be reminded of them every 3 or 4 miles.

The other area of needless signs is signs that are demanded by local groups. It is a difficult situation to try to tell someone that he should

not have a sign on the freeway, when it is just one more object you see. The proliferation of signs cannot only damage the motorist's ability to read them all, but adds to the safety problems as well.

Mr. CONSTANDY. Thank you, Mr. Wilson.

Mr. RICKER. Could we have Mr. Wilkes' comment on the problems, if any, involved in mounting signs directly on a roadway bridge?

Mr. CONSTANDY. I think it would be very fine.

Mr. Wilkes? So that we understand what the question is: The sign bridges which we have seen in the photographs sometimes appear not too far from a grade separation or other structure. The question is whether those sign messages can be mounted directly on the bridge structure and save the additional hazards of the support of the sign bridge and the cost of the sign bridge. How about that, Mr. Wilkes?

Mr. WILKES. Most of the problems of attaching signs to overhead bridge structure are in the minds of the designers who do not want to clutter up their bridges. I expect this is not a real problem, but it has to be a job of salesmanship to convince responsible people in the highway organizations that this is a desirable goal. Then it just remains to detail the connections, because the sign itself really is an insignificant part of the total load that would go on to the bridge.

It is a matter of detail more than anything else.

Mr. CONSTANDY. You believe, more frequently, they can be mounted on bridges?

Mr. WILKES. Yes; I do. We are encouraging that.

Mr. McEWEN. Mr. Wilkes, does the objection come from the esthetics standpoint? Someone is proud of a rather attractive bridge that he has designed, and he does not want it encumbered by a sign? Do you think this is a factor?

Mr. WILKES. Yes, Mr. Congressman, it definitely is. Bridge designers spend considerable time on trying to develop an esthetically pleasing structure, and then they resist any efforts to place signs on them. As I say, this is case for a little better salesmanship.

Mr. McEWEN. I have been impressed, as I know other members of the committee have, with seeing the massive concrete abutments on many of our bridge structures on Interstate and other high-speed highways, which follow the same pattern of being three- or four-tiered, and quite nicely designed esthetically.

I must confess having passed many of those on our Interstate express highways, traveling 60 to 65 miles an hour, and I don't believe I ever noticed the tiered effect of those concrete abutments until I had the benefit of looking at them in a stationary position here, as shown on the screen to the committee.

I just wonder how many of us are able to appreciate this, traveling at high speeds? We so seldom have an opportunity to notice a really fancy abutment.

Mr. WILKES. I think I will agree with you.

Mr. CONSTANDY. If they stop long enough to notice it, it is apt to be they are dead.

Another comment relative to esthetics of bridges, frequently the sign structure is built in advance of the bridge and I do not mean to impose my own taste on others; I am not a bridge engineer—but they look kind of ugly to me, and frequently you cannot see the bridge for the sign bridge structure.

I think perhaps the bridge would look better, and you could view the thing better if the sign were attached to it.

We will go into the subject of gores—this area we have heard so much about, being such a critical point from the standpoint of the motorist.

Mr. PRISK. Yes. This is, perhaps, certainly the most frequent place, where the motorist overruns his normal path and gets away. You are always faced with the decision to steer right or left, or to continue straight ahead, and it is at these places where people, particularly those not entirely familiar with the highway locations, or inattentive, because both of these things enter into it—you may be familiar with the location and still get in trouble in the gore. You may be unfamiliar and be in trouble as well.

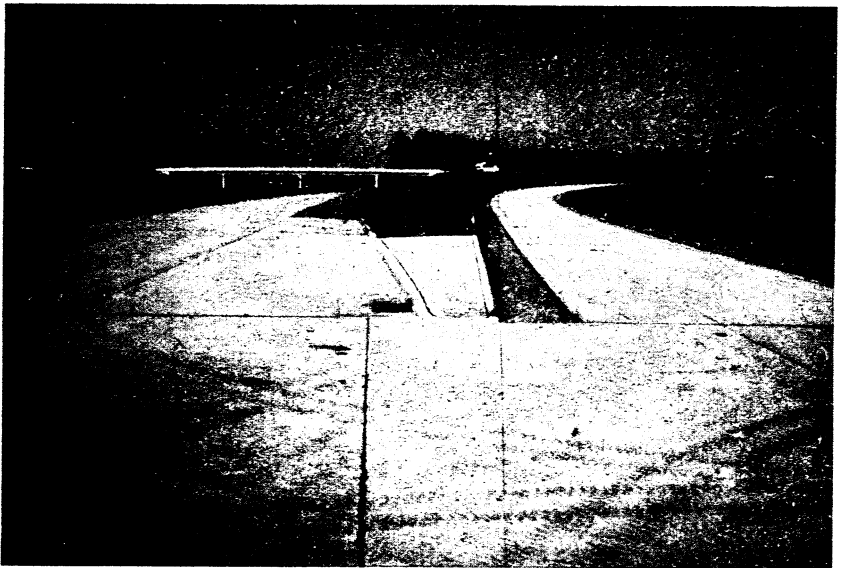
We do have a series of pictures taken on the nine Interstate projects that I would like next to show, which relate specifically to that problem, and what may be done about it.

I am going to start with a fairly good location. I would say this is one of the best gores we saw. This is on Ohio Interstate 80-S. You see out here that the curbing that is introduced in the gore is extremely moderate, coming down to as little as an inch at this point, rising up here to perhaps 3 inches, and this distance from here back to here is about 30 feet, which does stand out as a target area for dividing traffic that would leave by this roadway or the through traffic that would go down here.

It just so happens this particular section right in here is not yet in use. The Interstate project includes this but is operative only from this structure away from the camera.

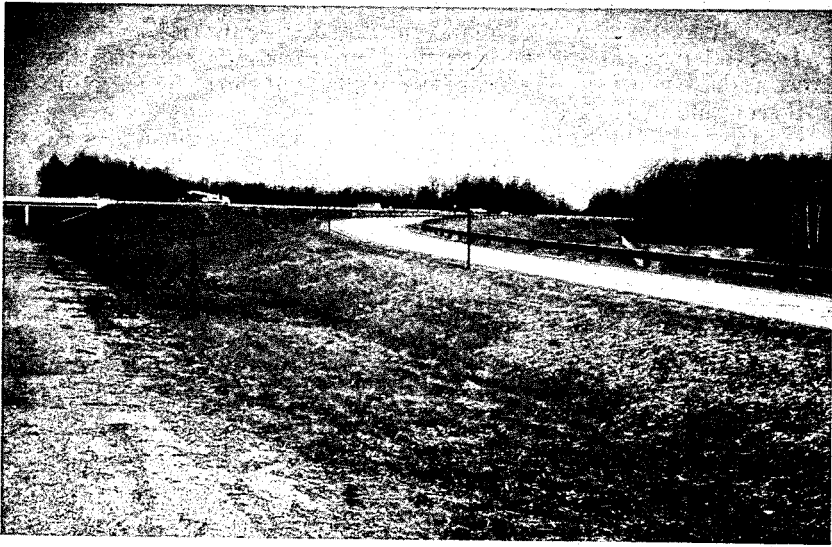
Mr. CONSTANDY. Mr. Ricker.

Mr. RICKER. Could I comment there? There have been suggestions that the exit sign be removed from the gore. I think this picture illustrates why it should not, particularly on the gore visibility condi-



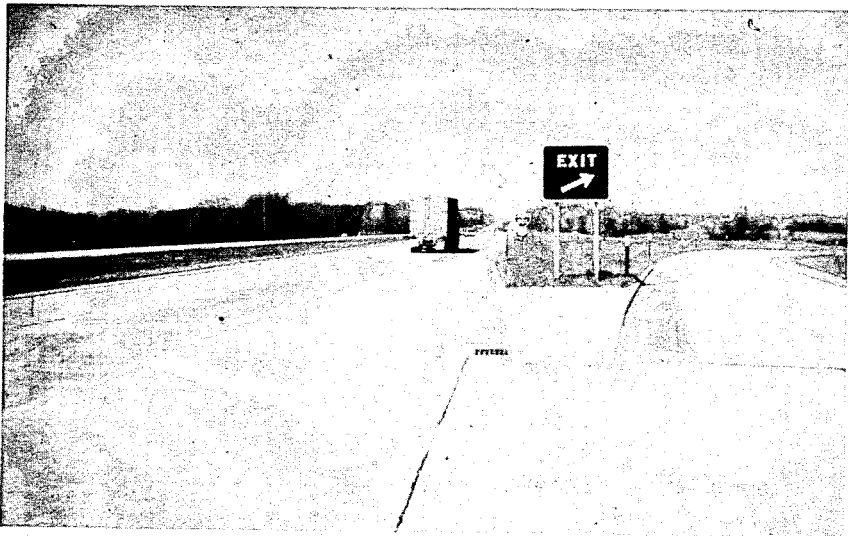
tions, snow on the ground, so on. You need a guiding point here, and the exit sign mounted on breakaway post provide that guide point that here you must turn off.

Mr. CONSTANDY. That is a good point. Thank you.



Mr. PRISK. Moving along to take a little closer look at that gore, this is the area that exists on beyond. You could certainly run through a breakaway exit sign and on into this area without any difficulty of upset. Slopes here are moderate. The terrain is relatively flat for several hundred feet.

This is a similar gore at the other end of the project where reflectorized paint has been applied to that same type of paved surface. You



have shoulders on either side. You might say either side of the exit ramp, and in the same general setup.

You have a flat area on beyond here. The difficult part about this is an exit sign on a 4-inch I-beam.

Mr. CONSTANDY. Mr. Prisk, would not a different colored shoulder area enhance the gore even more?

Mr. PRISK. Yes. I think this is one added feature that is desirable; that is, to have a colored and textured separation between the through lanes and the neutral area immediately ahead of the decision point. We will see some pictures of that later on in the slides.

Mr. HUFF. I would like to ask what purpose does the curb serve?



Mr. PRISK. The only purpose that I can think of that it serves would be to raise the area up slightly so as to get a little more projection and a little more conspicuity for this particular area here, cut off as it is by the grass, and defined in this fashion.

I think you begin to sense this is a decision point. I would not hold for that very much. I think if I had to choose between this and the sort of thing I believe Mr. Constandy was suggesting; namely, that you have a big paved triangular area, asphalt in the middle between these two concrete pavements, that diverging, that I would settle for the asphalt wedge.

Mr. WILSON. I would like to point out to the committee this was the sign I was referring to that we support on a single 4 by 6 wooden post, which incidentally I have seen hit. One particularly that I recall was when a small foreign car hit it with very little damage, and sheared it off.

Mr. CONSTANDY. So that is another form of breakaway sign?

Mr. WILSON. That is right. It is a form we have been using on all our 60-square-foot area signs, at least 60 square feet, or less, for a number of years, and we have now gone to 90 square feet.

Mr. PRISK. So this, then, on the Ohio project, is a fairly good gore, especially from the standpoint of the level terrain in between the roadways.

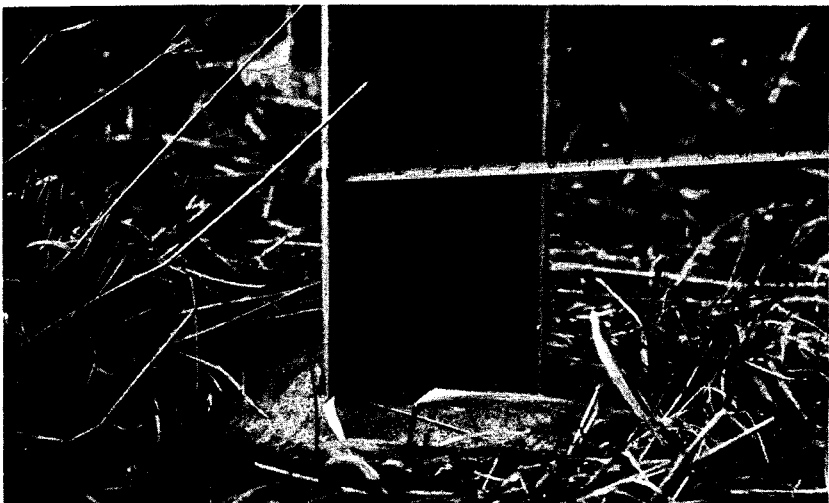
If you expect four times as many people to run off here as at other points, it does have good characteristics except for the signposts themselves.

Mr. WILKES. You may be pointing out later, Mr. Prisk, the desirability of the escape hatch to the left of the gore. There is a partial one here. It should be continued all the way through. It comes down to an abrupt end.

Mr. PRISK. That is true. We will see some later.

I said 4 inches. I was wrong. That is the sign you are looking at. There is the dimension, and it is a 6-inch I-beam. There are two of them, not just one.

What Mr. Wilson said, if I understood him correctly, is that he used a 4 by 6 wood post, one 4 by 6. Here you have two 6-inch I-beams made of steel.



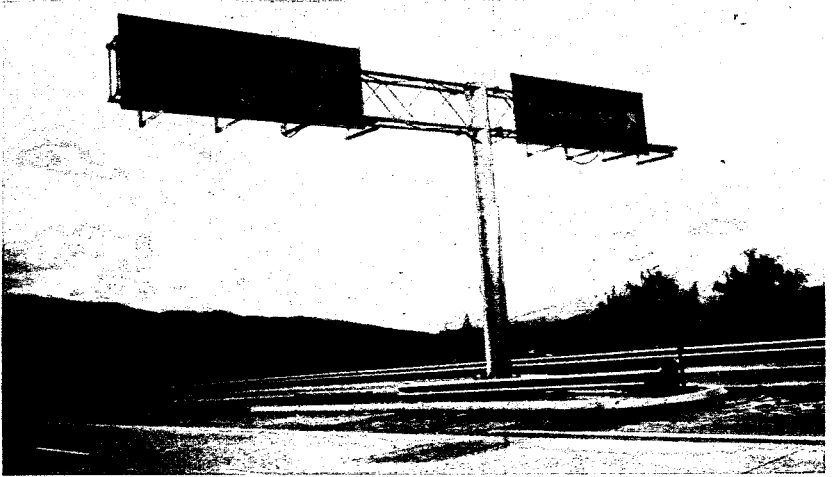
Did I understand you correctly?

Mr. WILSON. That is correct.

Mr. PRISK. So if your exit signs are standing up, I would say this is too heavy; no question about it.

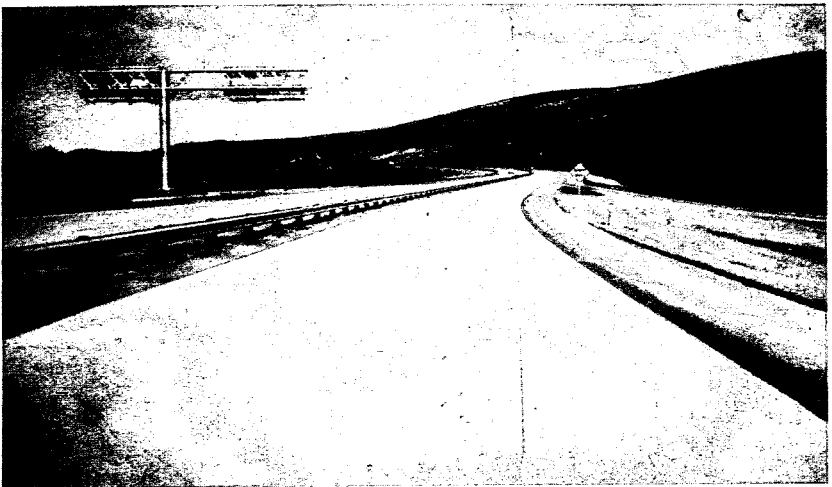
Mr. RICKER. The exit sign I believe has $27\frac{1}{2}$ square feet of area, so the wood post is perfectly adequate to hold it up.

Mr. PRISK. Moving back to our favorite sign, which you saw a moment ago, this gore I think speaks for itself, after what we have said about it previously.



There are not too many things in here that are necessary. It could be entirely cleared by an advance sign bridge 200 feet to the right of the picture, and the rest of the gore is fairly flat, negotiable, traversable by car.

This is a view from the back of the same sign, only to indicate that the gore is not any problem of itself.



Here is the opposite approach coming onto the Orange Street connection. You see the exit sign in the distance.



You move up on this one and you come on into the gore here. You have conditions in this gore that are tied up with what we were talking about earlier today, about where there are twin bridges.



So in the gore this presents really a double hazard.

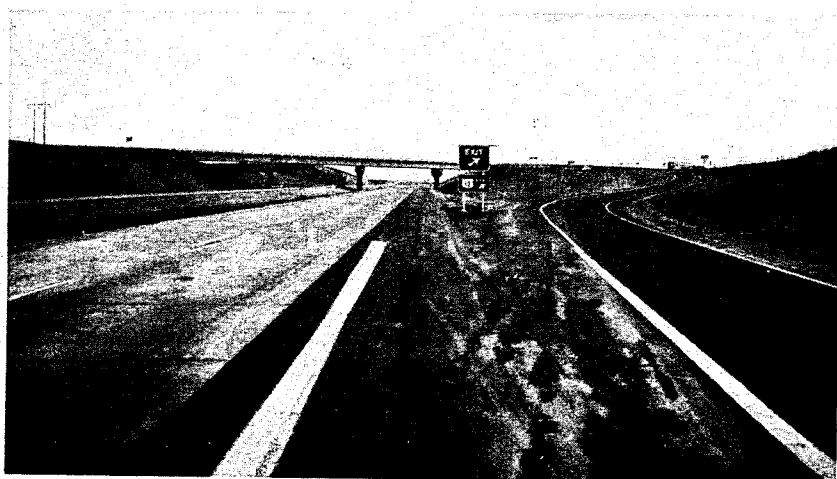
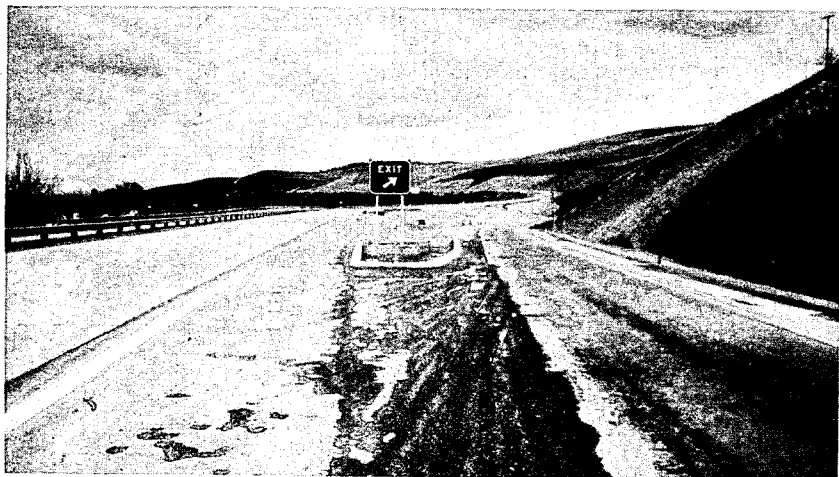
You have these two 6-inch I-beams on the exit sign. Following the practice in this State you also have the additional hazard of the hole between the bridges. This is in Montana, I should say.



Another gore with a non-break-away sign support, otherwise quite easily traversable up here for several hundred feet if you do run off.

This is the advance to still another one. I think many of these things have to be considered as a system, just as we regard the total traffic accident as a system of interrelationships between the highway, the vehicle and the driver. So, too, you have to consider the gore really as a function of the total design, and the abrupt departure of the deceleration ramp along this line puts more pressure on traffic to run into this gore.

More signing does the same thing, so these are all interrelated factors we are talking about.

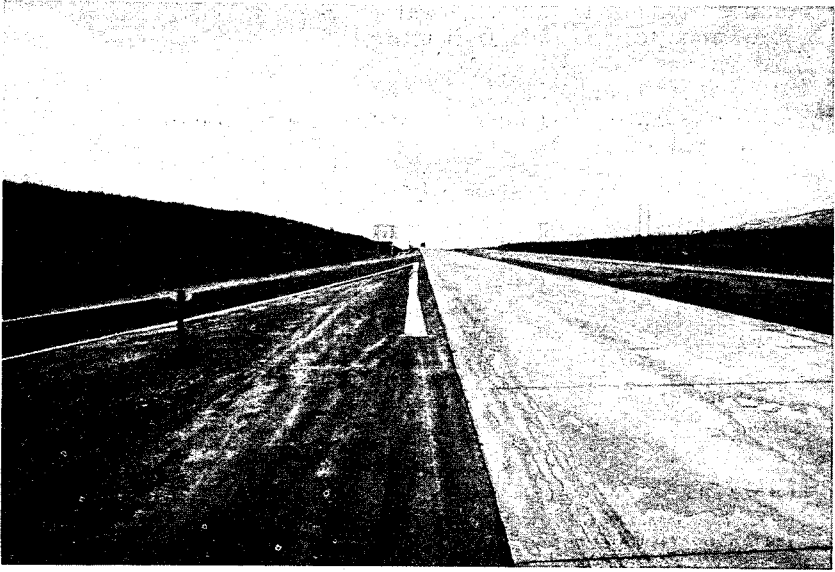


Moving up on the gore you begin to see the signing at that point, and the relatively flat area beyond it.

But very heavy signposts, I-beams, concrete footings which are necessarily heavy.



This is looking back on the approach. It gives you a little more idea of the abrupt departure and the alinement that is involved here would just make it more difficult to stay on either roadway.



Transferring ourselves to Nevada and the project there, this is the way the gore looks at that point. Here they have supported the exit sign on a single I-beam. This is outlined with a black and white curb to give better visibility both day and night, and this does seem to assist at that place.

You also have the advantage of these delineation units that run down through here, and I think you need to remember that these gore areas



need to be highly visible both at night as well as in the daytime, but the gore itself, with the removal of this obstruction, would not be an unreasonable place to run into.

Mr. SKEELS. I would like to point out, that guardrail in the background should also be ramped, because it is very apt to get hit.

Mr. PRISK. Right here? [Indicating.]

Mr. SKEELS. Yes.

Mr. PRISK. Thank you.

Mr. CONSTANDY. You were not advocating the use of the curb, were you, Mr. Prisk?



Mr. PRISK. No; I would not think this is the place where it is absolutely necessary. I rather generally object to the use of curbs.

This is a closeup of that exit sign giving you a little better idea of the fact that this is mounted on an I-beam support. As I say, in some cases States are using two 6-inch I-beams; in this case a single one. The variability in this practice is quite remarkable.

Mr. CONSTANDY. They are all supposed to hold up a sign of the same size?

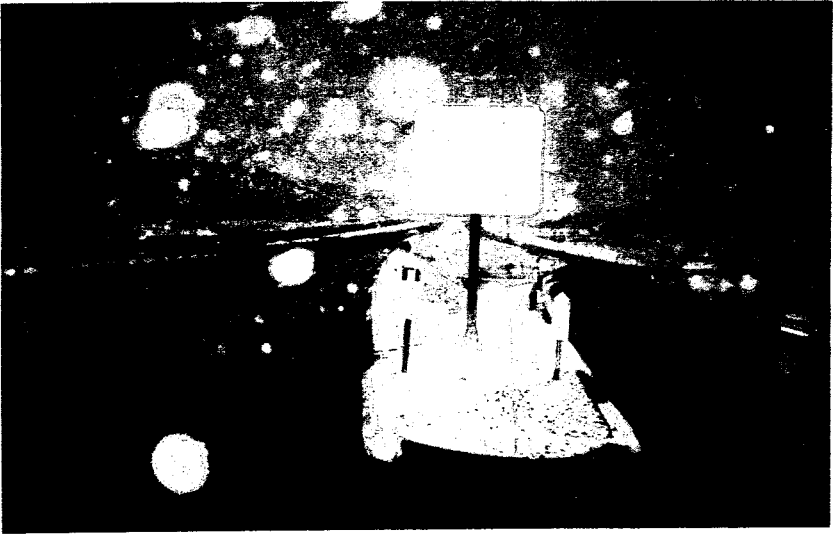


Mr. PRISK. I am sure that the signs are the same size. The sign is a standard one. There are literally thousands of them on the Interstate System and prescribed by the Interstate Sign Manual as a standard size.

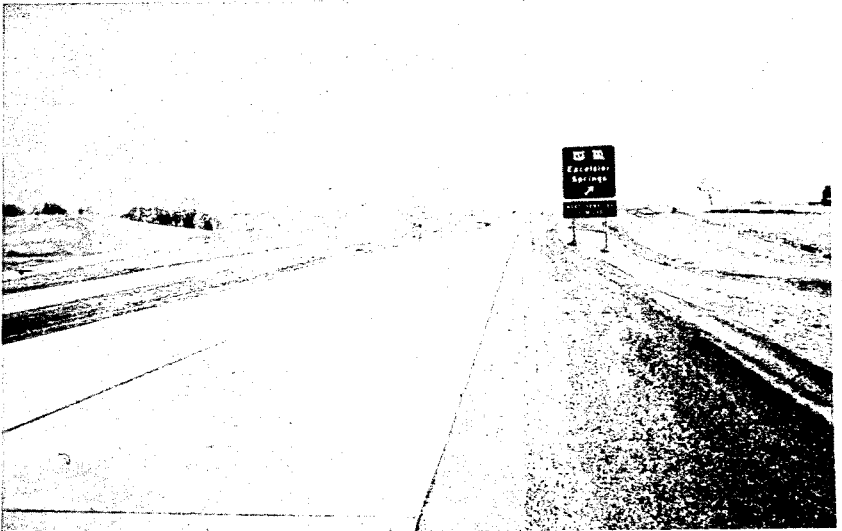
Mr. CONSTANDY. So in Ohio and Montana, they use two I-beams; in Nevada, they use one I-beam. Yet Mr. Ricker and Mr. Wilson, in their States, use one wooden post holding up the same size sign?

Mr. PRISK. That is right.

Here is the same thing under adverse weather conditions.

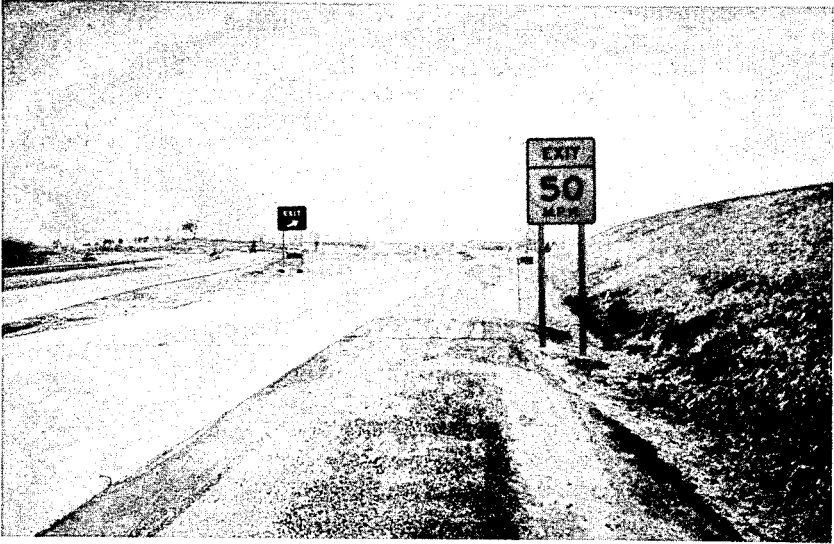


This is a long view of an approach to an exit gore, in Missouri. But by way of using this photograph a little bit more, you do have an entrance gore over on this side, too. This is a merging situation here.

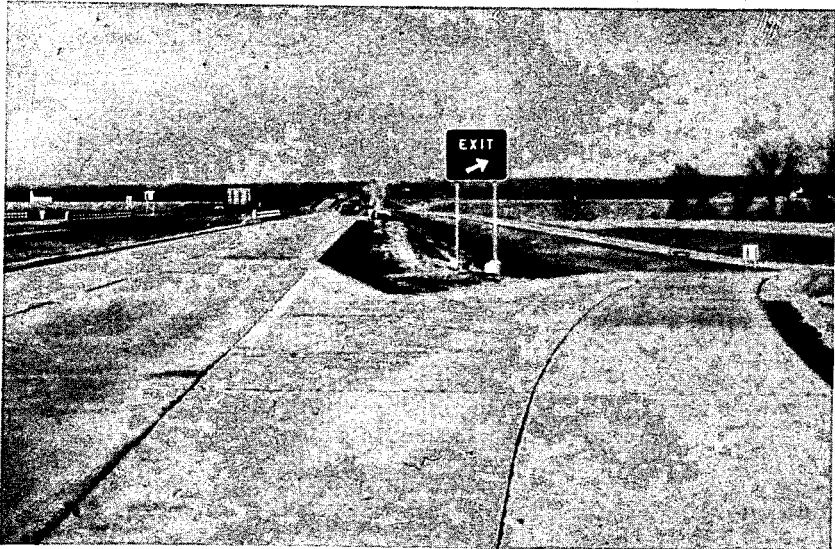


It is quite important this area be clear as far as visibility between the two roads is concerned. A driver coming down this roadway should be able to see traffic on this through lane as far back as possible in order to adjust his own speed and entry to the through lane.

To move on down to that gore, we find the exit sign here with rather heavy concrete footings sticking out of the ground.

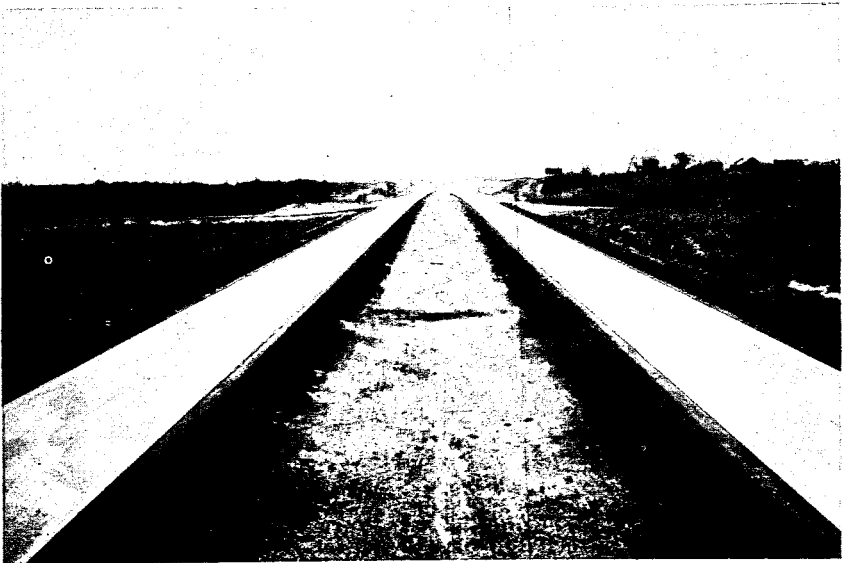


And here we are—again the place here where the grading of the interchange probably could not be accommodated to make this a real safe place to run into, but it does not look like you have too good a chance of getting in there with those footings in the way as they are.



Mr. CONSTANDY. Does that suggest, Mr. Prisk, that perhaps further consideration should have been given to the layout of the interchange so that there would be an area within the gore, to run into, if the car goes out of control?

Mr. PRISK. This is certainly one thing that should be considered. There are some efforts being made to develop impact attenuation barriers to use in just such situations as this. The Bureau of Public Roads has a mockup now of a barrier that will accept a reasonable amount of impact where you have to guard against collision with some fixed object that cannot possibly be removed, or against a situation of dropping into a hole, such as you have here. But I think your point is well taken, it is time to back up and take another look if that situation does exist.



Here is a gore coming toward you, on camera, in this area, again indicating relatively flat land that lays there. Oftentimes not too much consideration has been given to filling in places of this sort; but with some consideration of that in advance, it would be possible to provide a reasonable runoff area along in this section between the two roadways.

It might be of some interest to the committee to know that Road Research Laboratory in England has come up with a series of tests very recently that have shown that gravel, about three-fourths of an inch round, laid to a depth of 18 inches will stop a car within reasonable deceleration limits and actually will hold the car in there. So that still another possibility is to load this up with a gravel runoff track that would be used for that purpose.

As an aside to that comment, they told me that it is impossible to drive out of 18 inches of gravel when you get into it, so nobody is going to run into it just for the fun of it. If they do, they have to be towed out.

This we find in Oklahoma City, a version of what we saw in Ohio, except that the curb is higher here. In this case they use a pipe to support that same exit sign, although this is temporary here and probably a little bit smaller than the standard.

You see tracks of vehicles running across this gore indicating that the advance notice of that is not too good, or possibly the identification of it right at that point is not as good as it could be. Again, there is no differentiation in pavement color to help the driver identify the exact location of the gore.



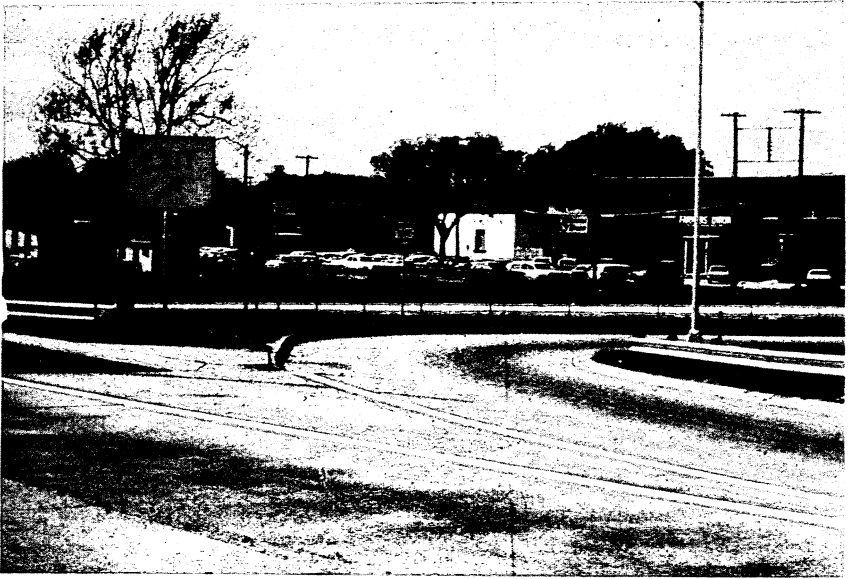
Here is a gore somewhat in the distance in this shot showing another place where it is relatively flat.



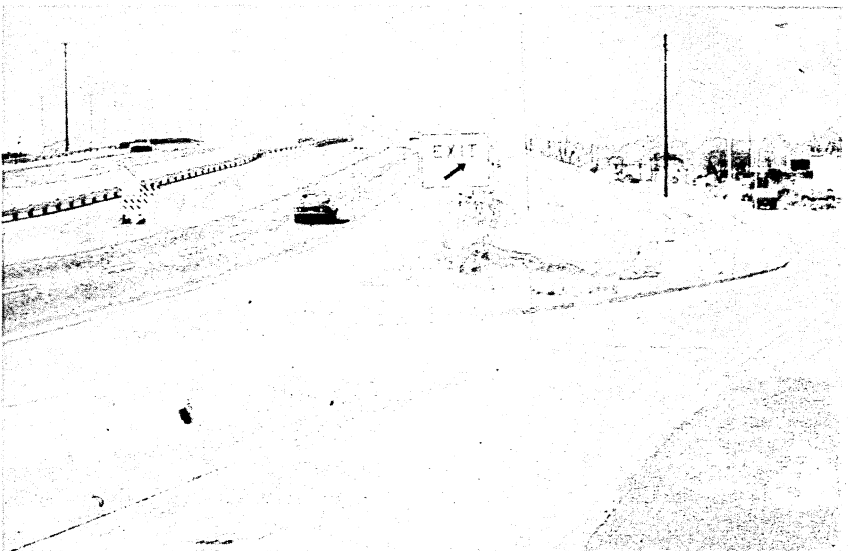
This is one that is undesirable from the standpoint of the curb and certainly the rail, not to mention the sign installation; that is temporary. The fear that I would have in looking at this would be that they would replace this with a 6-inch I-beam.

Mr. CONSTANDY. If they followed the practice on the exit sign that they have done with the other sign we saw, they would use a breakaway sign as developed in Texas; is that correct?

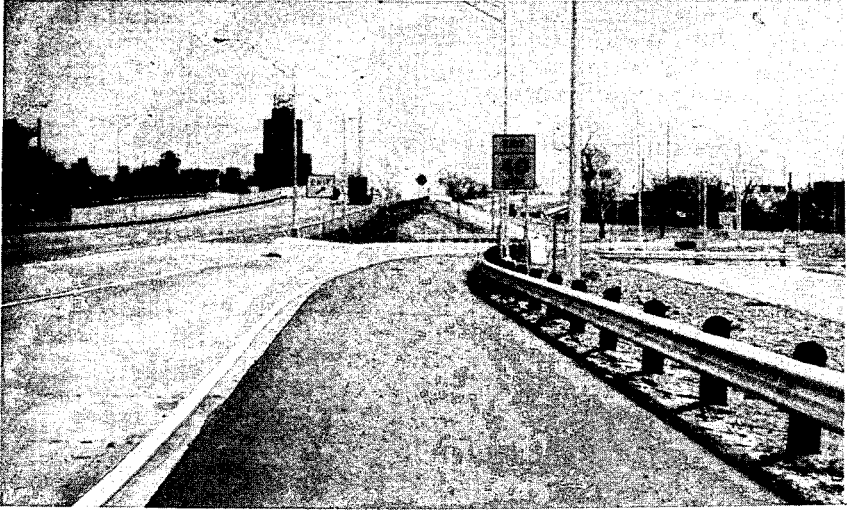
Mr. PRISK. That is right.



Here is another view of still another gore in this urban section where it would be possible to run on down in there without too much difficulty.



Still another one, the guardrail possibly being some hazard.



This is the entrance gore showing there is a degree, at least, of opportunity for someone here to look across the gore at the entrance and see the position and speed of cars in this main line.

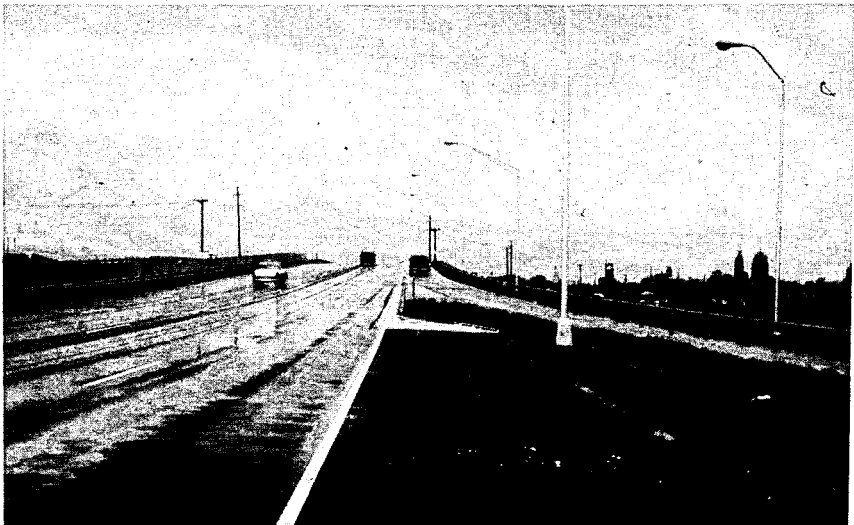
Do you have a comment, Mr. Ricker?

Mr. RICKER. On that previous one (slide), Mr. Prisk, are you going to comment on the desirability or undesirability of that shoulder disappearing?

Mr. PRISK. We have a series of slides on shoulders that would include that point, most certainly so.

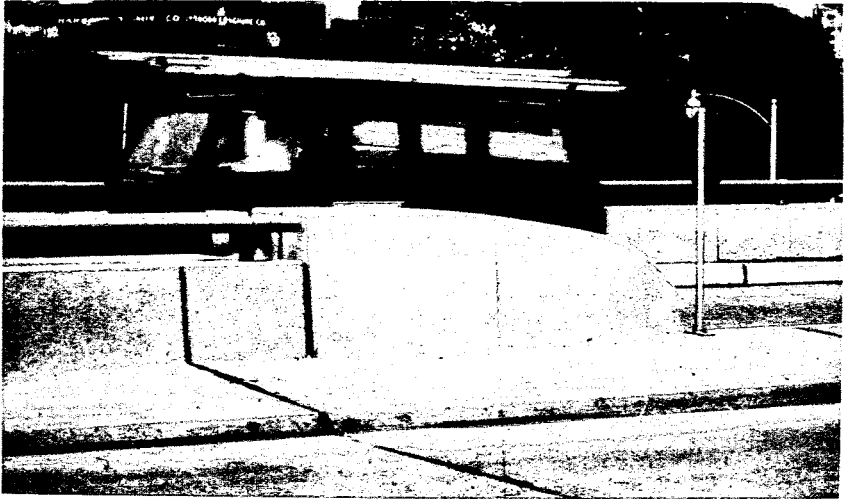
This is an abrupt shoulder. I think I showed a slide this forenoon, one that had a lamp post in this same location. These are not good. [Several slides.]

Mr. SKEELS. Could we go back?



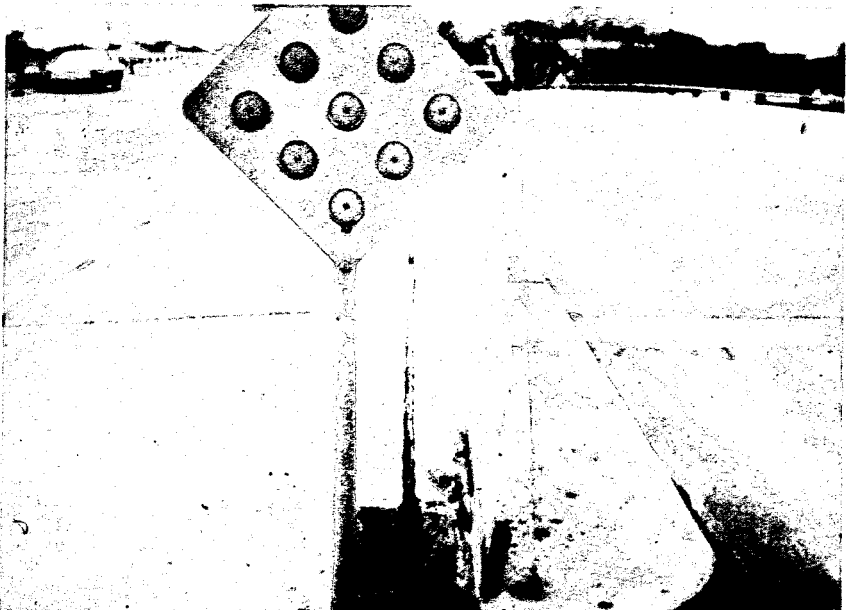
Mr. PRISK. Yes.

Mr. SKEELS. This is perhaps an example of the very serious gore problems, one on an elevated structure in which you have to have a railing behind it and you have to get into that railing in some manner. In this case the large block of concrete is pretty short and pretty vertical. I am sure Mr. Prisk will have more to say about this.



Mr. PRISK. There is another view of it here. This is about the way it looks. This is what I am sure is a hazard marker, and that, in fact, would be a very considerable hazard.

This is a prow-type design here, which does come on down close to the roadway level, but there is not very much streamline to it. And



because of it being on an elevated structure, it does create an unusual and especially difficult problem.

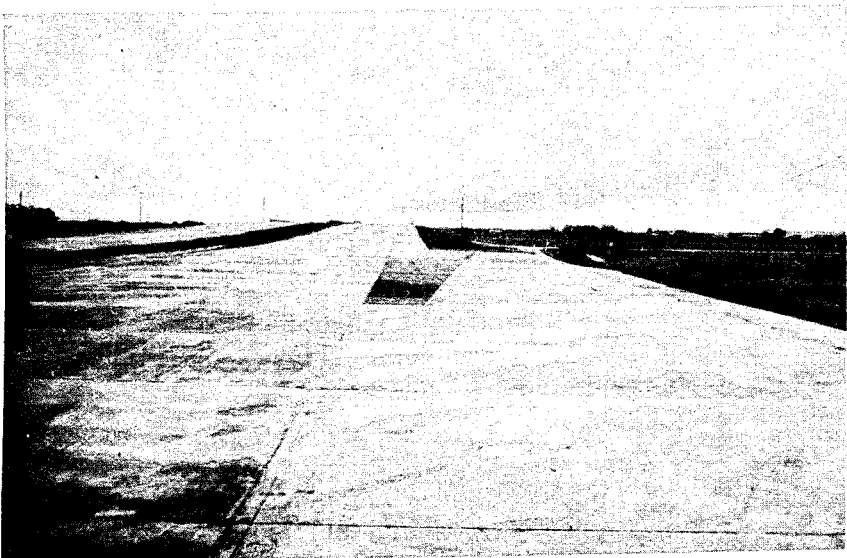
Many times walls in that position obscure the sight from one car to another, which is another serious handicap that concrete introduces.

Here is a view of another one at a somewhat greater distance. There is a little bit of advance notice out here in terms of some lane mark-



ings and a little island out in front. Otherwise you do not have much notice of that hazard.

Here is the portion that is just west of Oklahoma City. It is under construction and is contiguous with the projects we looked at, and here



on this gore they have attempted something a little different. You can see this darkened area.

If you move in close on it, you will see it is red brick. It is laid transversely across here.





I recall measuring this at about 80 feet, and at the end of that 80 feet is the usual curb such as we just saw on the urban project, and then, of course, your gore is beyond here.

I would only point out that 80 feet at 60 miles an hour would be traversed in less than a second and hardly is enough notice—or given at the proper time perhaps is a better way to put it.

If you could just transfer this whole thing a little farther in advance, it might do some good. At that point I fail to see this is going to help anybody very much.

Perhaps some members of the panel would like to comment about this treatment.

Many things have been tried to warn the motorist of the approach to the gore.

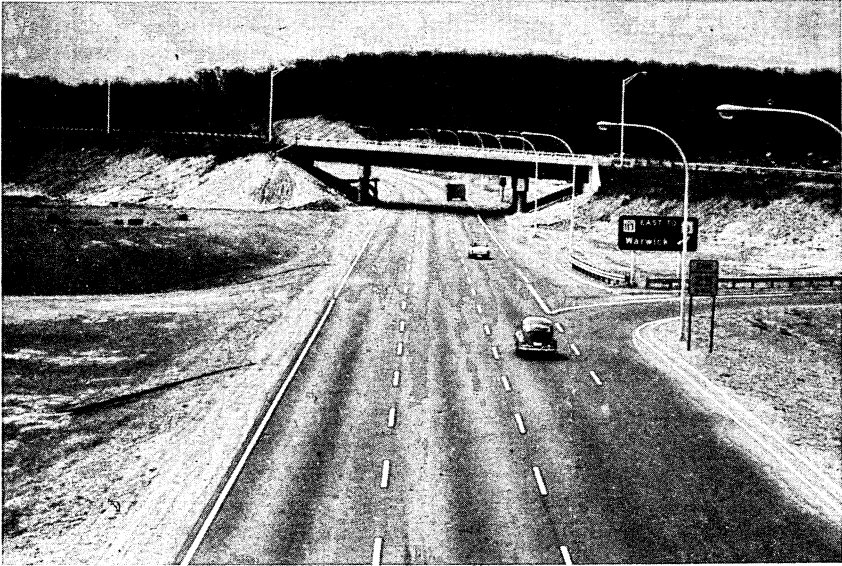
I think the big advantage, the one advantage it does have, perhaps shown here, is that it provides visual contrast in the pavement, and some indication visually of dividing roadways.

Here is an exit sign in Rhode Island and a gore beyond, which again is quite traversable. If you think of riding in there too far, you might concern yourself about that rail and get that down at the end.



Here is still another gore where there is a very abrupt takeoff, 25-mile-an-hour curve to enter that, and there is need for additional material to fill this depression if that gore is preserved.

Mr. CONSTANDY. Mr. Prisk, is there some rule which governs what the exit speed should be?



Mr. PRISK. Desirably, exit speed should be .7 or .8 of the design speed. And design speeds—I do not know that I fully understand the concept of design speed except it is something to govern the geometrics and superelevation, curvature, by. But beyond that its meaning is a little mystic to me.

If you figure that our sections through urban areas are designed for 50 miles an hour, as is required by the Interstate standards, .7 would, of course, permit you to have a 35-mile-an-hour exit at this point. This puts this a little bit low, a little bit sharp.

Mr. CONSTANDY. On this particular roadway, the speed limit I think is 60, am I correct? This should be up to 40 or 45?

Mr. PRISK. Desirably.

Mr. CONSTANDY. Of course, we are not suggesting they change the sign to 40 or 45 miles an hour, are we?

Mr. PRISK. No. Not at all.

Mr. CONSTANDY. The design of the ramp should be one that would accommodate a car going 40 to 45 miles an hour, is that the way it is?

Mr. PRISK. That is desirable, yes.

One think that has happened here is you have a skew crossing and this roadway is coming up closer to the camera here than it is down here [indicating]; and for that reason, without a considerable amount of right-of-way here, it would be hard to get a 40-mile-an-hour takeoff.

Mr. CONSTANDY. So they have to fit this into a smaller area?

Mr. PRISK. I expect the right-of-way was a consideration.

Mr. CONSTANDY. Mr. Huff.

Mr. HUFF. Of course, the design speed can be lowered by providing a long deceleration lane up the road. It appears they did not in this case; they used the shoulder as best I can tell.

Mr. PRISK. They did use the shoulder.

Mr. CONSTANDY. We are actually one lane too short here then, are we not?

Mr. HUFF. Yes.

Mr. CONSTANDY. The roadway is three lanes and there should be a 10-foot shoulder to the right of it?

Mr. HUFF. Yes.

Mr. CONSTANDY. We can either say there is not a shoulder here or there is no deceleration lane?

Mr. PRISK. You can take your pick. It is one or the other.

Mr. CONSTANDY. Mr. Ricker.

Mr. RICKER. There is another approach to this, or perhaps several. One is to redesign the sign so that it does not have so much message and, therefore, can be carried on a breakaway post and do away with the guardrail.

Another would be to put a sign on a cantilever mounted on the right side of the road.

Mr. CONSTANDY. More in advance of the exit?

Mr. PRISK. We cannot see all the geometry of the interchange, so we cannot suggest a specific answer to this one.

Mr. CONSTANDY. I see.

Mr. RICKER. But there are ways of getting a big sign out of the gore.

Mr. CONSTANDY. Mr. Wilkes.

Mr. WILKES. I would expect that that exit sign would obscure most of the message on the message sign because of its position.

Mr. CONSTANDY. It would seem to.

Mr. PRISK. From the decelerating lane. There is one advantage to bridges such as the one where this picture was taken; you can read the exit signs down below.

Mr. McEWEN. Mr. Prisk, in your answer to Mr. Constandy, the last part I did not understand.

Why is that exit ramp such a sharp curve? It appears in this picture it is out in the country, is it not, and not in a heavily built-up area?

Mr. PRISK. This is just a short way south of Providence. I suggested the degree of the sharpness of this curvature might very well have been restricted by reason of the right-of-way limitations that existed in here. [Indicating.]

Mr. McEWEN. The intersecting highways come in quite close proximity?

Mr. PRISK. Yes. This is coming over closer to us, coming up on this roadway. You get into a tight angle situation unless you have a very wide right-of-way on both roadways.

Mr. McEWEN. Would not it have been better in this case if the exit ramp had been located farther from the overhead structure? In other words at a point where the two highways were a greater distance apart?

Mr. PRISK. That would permit a flatter curve, yes. Sometimes that is possible; sometimes it is costly.

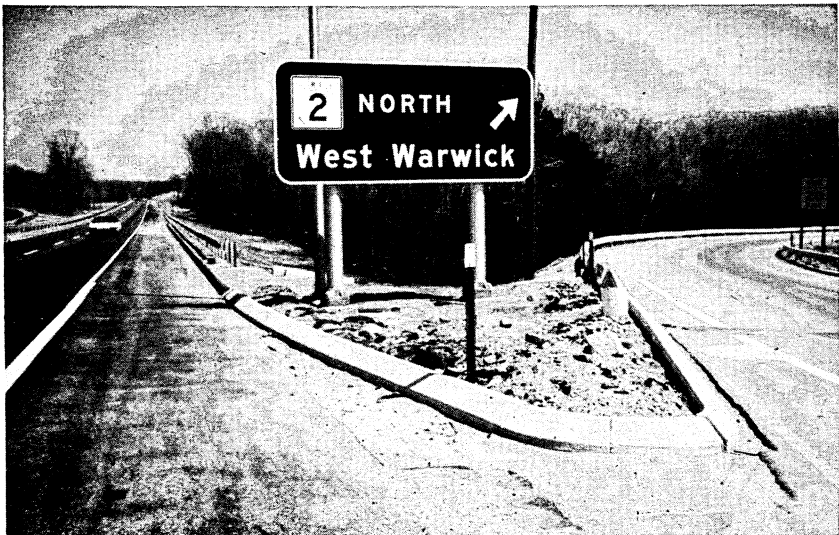
This is another gore situation which we saw where there is a curb here outlining the gore, and for the life of me I cannot see reasons for curbs in this kind of a situation.



The footings are high. These are concrete footings, these blocks you see, topped by aluminum poles, which will snap all right if you can get up to them. But possibly when the final grading is done here, as someone suggested this morning, this will be brought up to grade, so that you will not have anything except aluminum poles to contend with.

I think I still would feel a little more comfortable with a true break-away slip joint in there.

This is another view of a similar situation. We do have a guardrail difficultly in here. This job is still in the cleanup stage. But you can



see that it is not totally outside the range of possibility of running through here, taking the sign out and running through here and coming to rest down below without getting into any great difficulties.

We have some trees down there. There is always something you can hit, of course, if you go far enough.

Mr. CONSTANDY. Before that project is completed, it is probable that there will be more fill put in that gore; is that correct?

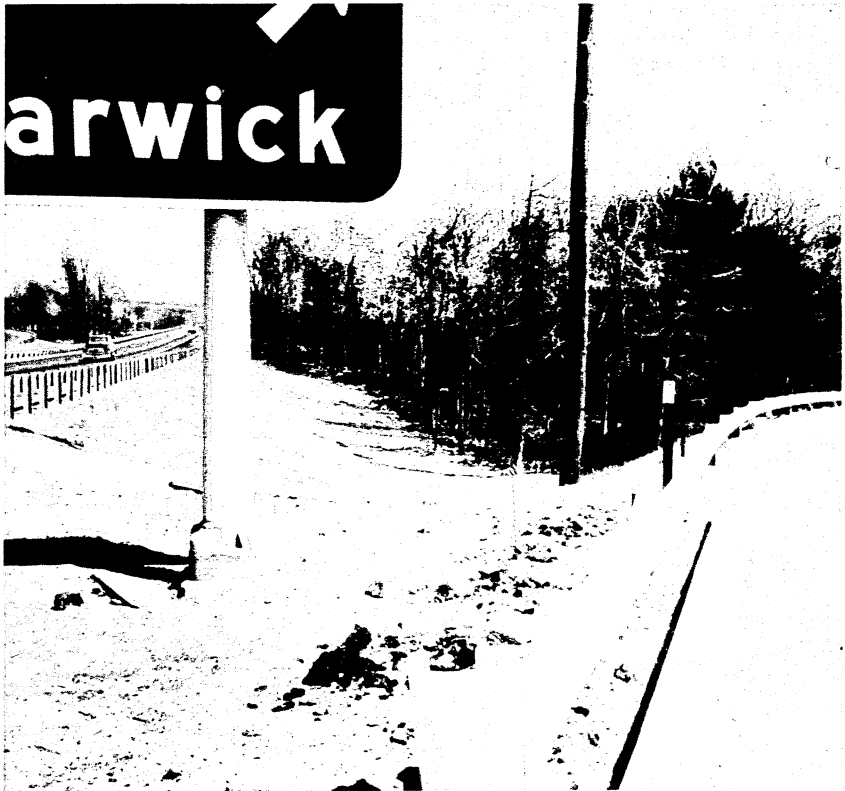
Mr. PRISK. Right there at the beginning; yes.

That previous shot (slide) this one here, of course, that will be filled to curb height, we expect, in front of the sign.

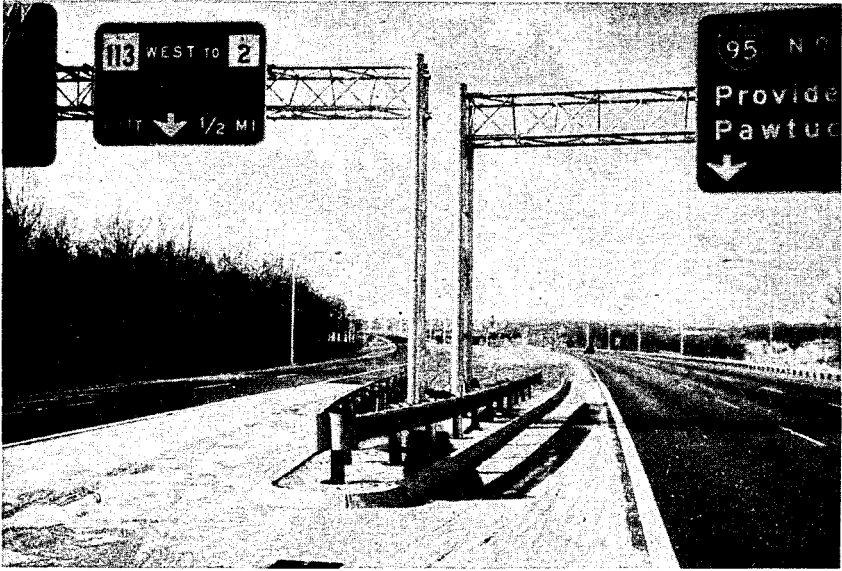
In back of the sign, shown by this next picture, I have no way of knowing if anything is going to be done there.

Mr. CONSTANDY. What I am wondering about, when that fill is added, in this particular one at least, it would seem that the concrete footings of the sign would then not project above the grade quite so much.

Mr. PRISK. I think that is true.



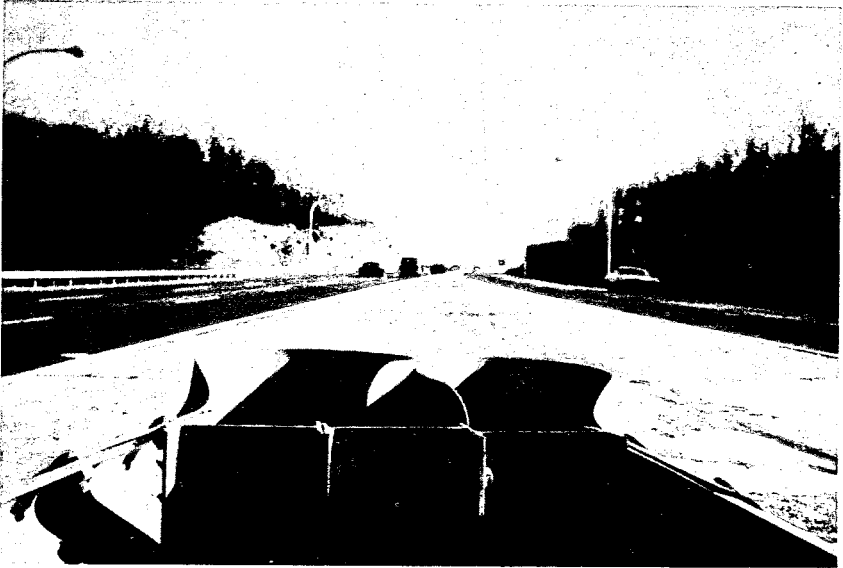
And here we have the gore that you saw as we were looking at signs in particular. This, again, could be relieved entirely by the plan that is now in mind, which is to replace these two structures, both of them having center supports in the gore, with the single structure moved back toward the camera a couple hundred feet.



This is a pretty formidable thing to run into.



That shows the long wedge of white concrete coming on up to that gore and does provide very good visual delineation between two roadways. That is an excellent feature, one that needs to be commended as much as the signs can be condemned.



There is another use of concrete wedge between two asphalt pavements. This is a rather rough gore, if you move on into it, because this is rock in here and, of course, rock in the vicinity in general.



The question rises again as to just how much of this you can remove.

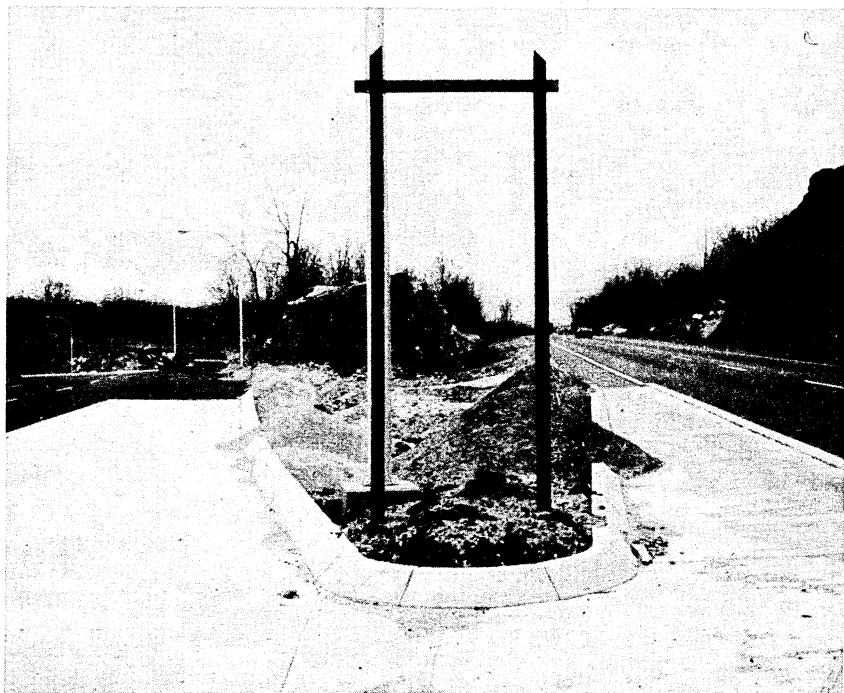
Mr. CONSTANDY. Would you just hold up one minute?

I just call your attention to the right-hand side of the road. We will be doing slopes a little bit later and we have another view of that rock cut. However, I do not think the one used shows the two different conditions. I think that rock was taken out in two different methods, the first part leaving a jagged portion that you see at the beginning, and then a different method was used, to result in that smooth sheer surface beyond it. The photograph we will use shows a good view of the smooth surface; it may not show the jagged part.

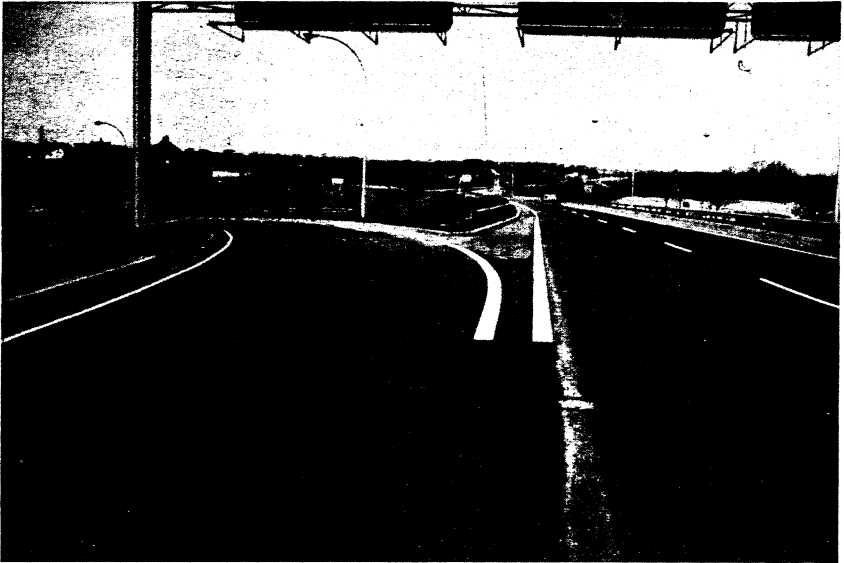
Why I mentioned it is because there was some comment made at the time this was done by those people who prefer the esthetics of rough rock projecting next to the road in preference to the smooth rock to the road.

The point I am making will be more apparent. I just want to direct your attention to the differences there.

Mr. PRISK. Moving up closer on this gore, there is a concrete footing in there to contend with along with the curb, which although it is not vertical, still is enough to bounce a car out of control if someone is not prepared to ride into it.



This gore has had its share of skid marks, and again in this location you have guardrails starting here and guardrails starting here [indicating], which are hazards of themselves and desirably should be down to ground level and anchored.

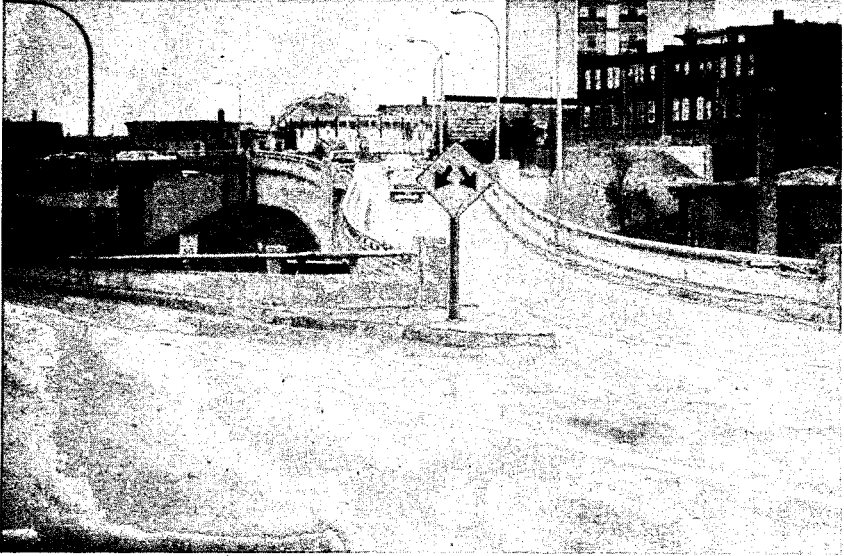


This is a section of gore. This is just off the project, but again a place where a guardrail has been applied similar to the last picture, and it has been struck as you can see.

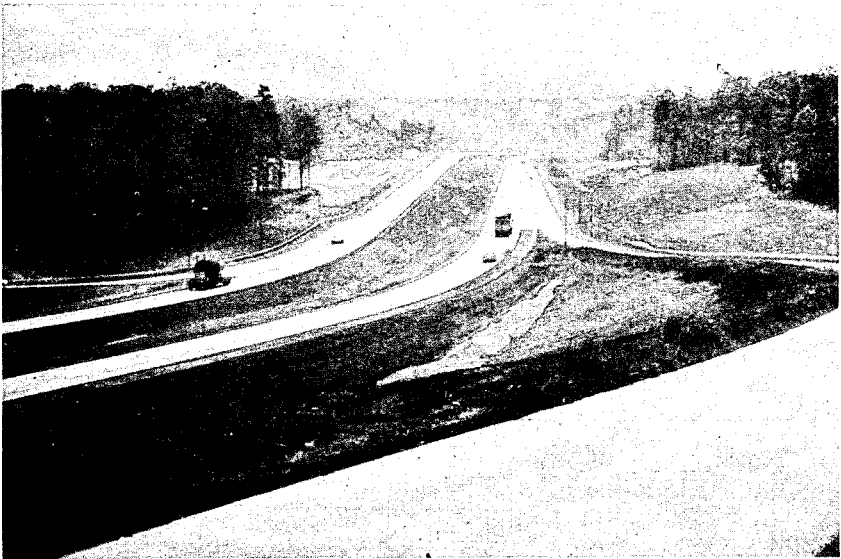
That is not too good delineation there, nor too good protection of the area.



Some of these are pictures now on the north side of Providence, also on I-95, showing some of the things you can get into in urban conditions where you have walls to contend with and vertical curbs are the rule of the day. This is overworked obviously. Still on our Interstate System.



Now we come back to conditions in Georgia, and the thing I wanted to illustrate here is the very good alignment, vertical and grading in between these two roadways. Excellent opportunity. The car at this elevated position has to see traffic on the main line in order to make its merge down at this point. [Indicating.]



Also it is worthy calling attention to that very excellent acceleration lane. It gives you plenty of opportunity.

Mr. CONSTANDY. Could you comment about the deceleration lane, Mr. Prisk? I notice that they are different. You come on the highway with a long tapering section.

Mr. PRISK. Yes. This is a marked contrast over here, because you have the abrupt widening here to a parallel deceleration lane. [Indicating.]

There are two schools of thought about deceleration lanes, as to whether or not they should be tapered like this entrance lane is tapered or whether or not they might start abruptly. This one does.

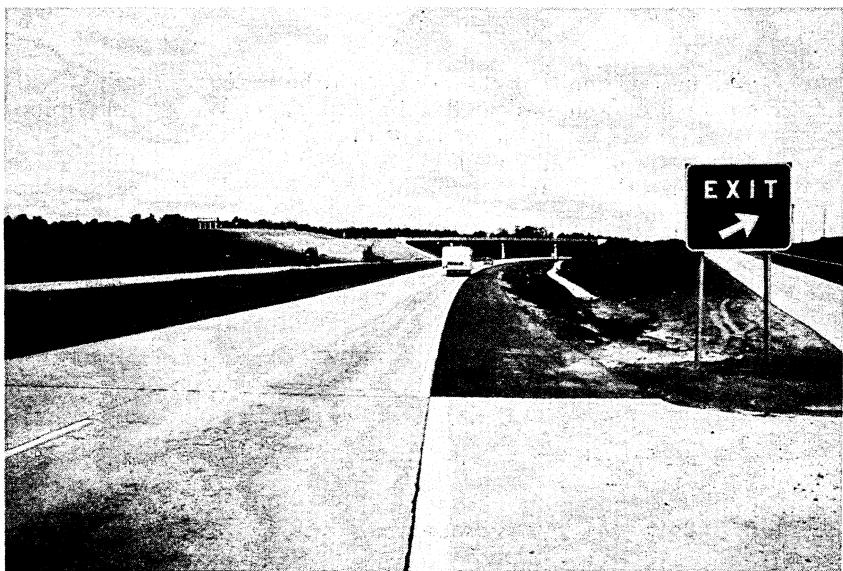
This is the choice in Georgia, and some other States use tapers.

This is the view over on that other side, again showing the start of the parallel decel lane, coming on up in here [indicating] and what it is you have to contend with here in the gore. In this case I suspect that the man who planned for this drainage ditch down through here did not think too much about people running in there.

Again, in total, the opportunity for coming through this kind of terrain is pretty good, coming through there without serious accident.

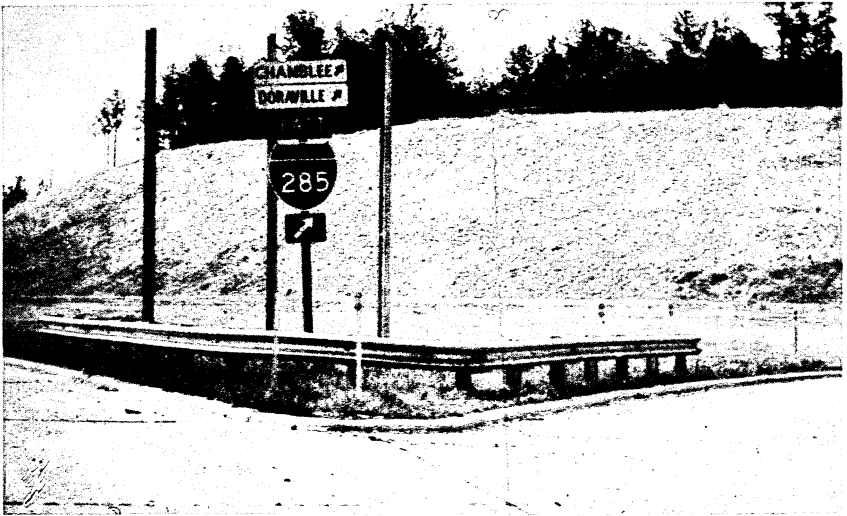


Two views, same place, head on.



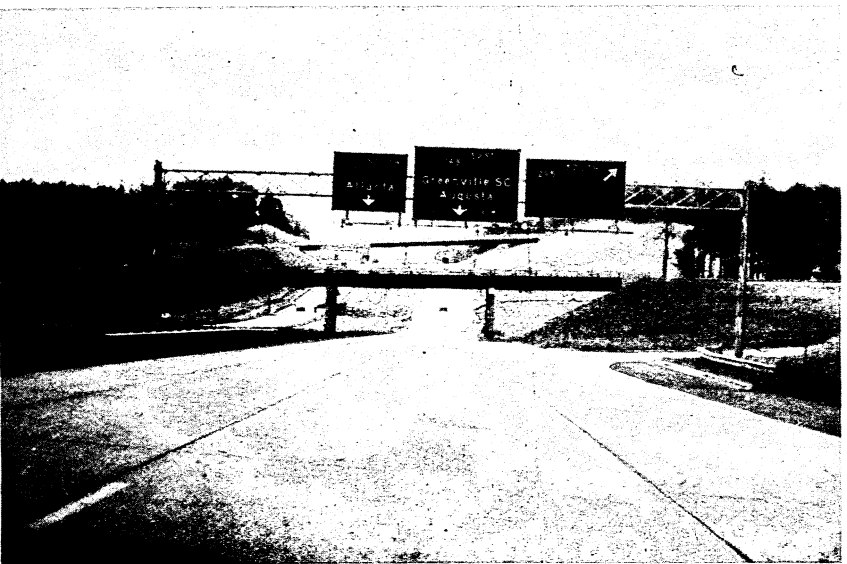
And here, then, at the end of the project, we have this kind of situation where they are getting ready to put up a three-masted sign to replace this Interstate 285 marking, which designates a beltway around the city. A guardrail has been put around the gore area, which constitutes a substantial obstruction.

There will be a large sign put up here without the breakaway design. It too will be a very substantial traffic hazard.



The gore here is one that contends with the bank and is about like Congressman McEwen indicated a little bit ago. We are in a place where the right-of-way is either tight or another condition exists.

You do have a slope here in this gore which in itself could prove to be a hazard. Unless these slopes are held to 4 to 1, desirably 6 to 1, it is pretty hard to negotiate.



This is the condition headed for the Atlanta Airport, where you have a heavy concrete base here, very short section of guardrail, with two ends to hit. Otherwise, as you can see, it is fairly free and level terrain between the two roadways.

With the removal of that sign, the upright posts, the guardrail, the erection of the bridge a couple hundred feet in advance, this gore problem would be entirely solved.



This is new work. I showed a similar picture to you before. I wondered, as I looked at this location, why this guardrail was put in here at all. I do not think I understand yet. It was being put in.



Mr. RICKER. I believe the picture you showed this morning showed there was a drainage structure in there.

Mr. PRISK. Perhaps that is what is there. In any event, it outlines the gore and would prevent you getting in there too far.

This gore in Salt Lake City is the kind of situation that also is met in some urban areas where walls exist. This is the prow design. I think someone mentioned this a day or so ago. This is shaped like the hull of a ship almost, upside down, and laid up here, and gradually increasing slope—little block of concrete that will stop you if you do not stop on that slope. Some of these work reasonably well. Under high speed they are not too effective.



The thing I would point out here, too, is the relationship to this system's concept that I mentioned earlier. You have South 15, East 80; North 15, and West 80. I do not know how that strikes most non-Utah residents, but it is a little difficult sometimes for drivers to distinguish between South 15 and North 15 when they are separated like this.

I have been puzzling over an alternate possibility. I think there probably are other solutions to that problem, but that is a signing problem.

This is in here principally to show you the gore problem and, as I say, when you are in an elevated section or up on a high embankment, these rails and walls cause serious difficulties in the gore.

Mr. SCHADEBERG (presiding). What would you say the structure costs to put the signs on?

Mr. PRISK. Overhead sign structure?

Mr. SCHADEBERG. Yes.

Mr. PRISK. I would say \$11,000 to \$12,000, something like that. Perhaps one of these gentlemen could make a better estimate, Jack?

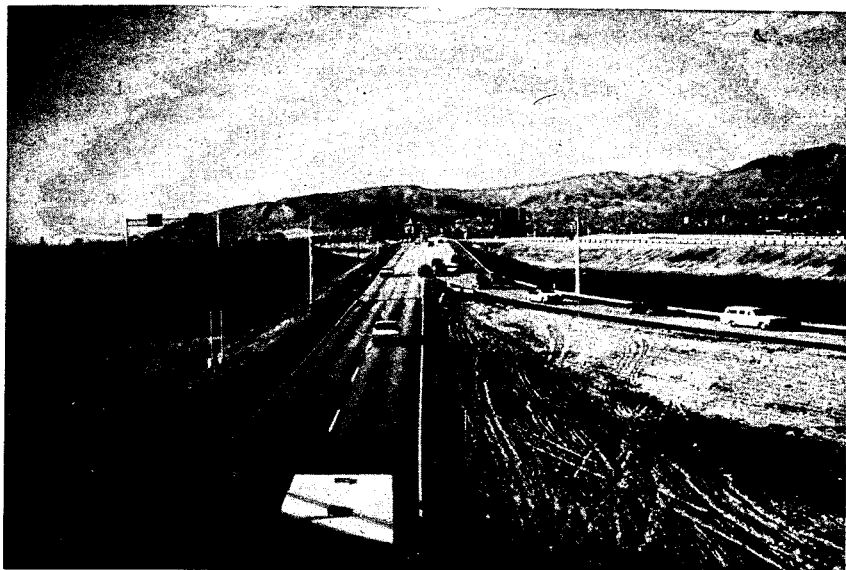
Mr. WILKES. I would guess \$10,000.

Mr. SCHADEBERG. Without the signs installed?

Mr. WILKES. Without the signs.

Mr. SCHADEBERG. Thank you.

Mr. PRISK. This is a gore, also in Salt Lake City, outlined with a very short section of guardrail, up to this point [indicating]. You can see the cars can traverse this. There are marks all over the place. And they not only can, they do. They run off here and run down through



here [indicating] no reason. There is nothing down there. So obviously these are just drivers who were approaching the camera position, missed the road on one side or another, and then corrected their action by crossing the gore in order to get back to the road where they wanted to run.

Mr. CONSTANDY. A policeman we spoke to knew this area and pointed this out as one of the most hazardous locations that they have, because of the existence of that guardrail. I believe he said that last year they had 24 accidents there.

You can see a car right here [indicating] that had been coming south on 15, now moving into 80 to go east. And we found this, we stayed there for awhile and took a series of photographs, and I think in half an hour we had a dozen or two photographs of automobiles whose drivers found themselves in this same situation, either being on this side wanting to go there or being on this side wanting to go down here [indicating], very narrowly missing the prow of that guardrail. Mr. Ricker?

Mr. RICKER. At the risk of being repetitious, that structure seems to be past the point of the gore rather than in advance of it.

Mr. CONSTANDY. It probably would be helpful if it were farther down the road away from it.

Mr. RICKER. Particularly the sign on the left, as the motorist sees it, is out of position.

Mr. CONSTANDY. There is a great deal of confusion at this point. It is noticeable. Mr. Prisk noticed it before the police brought it to our attention. But after talking to the policeman, we went back and spent a little time there, and it was amazing how frequently the cars almost hit the guardrail, or else they get pushed off on the shoulder.

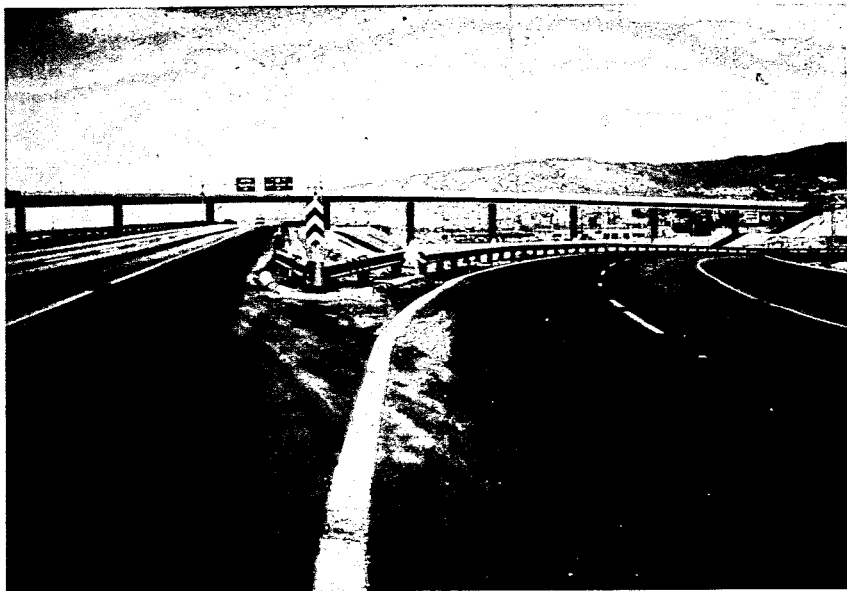
Mr. PRISK. The point Mr. Ricker makes is very valid and would save money, because as you move this structure back to the location back up in here [indicating], the number of lanes and the distance to be spanned is less.

Mr. CONSTANDY. So the bridge would be shorter?

Mr. PRISK. We would have a shorter span, yes. And with this guardrail out of here [indicating], it would be possible to run down in here without any difficulty at all.

This is a gore that also serves as a battleground. You can see here a number of very undesirable features—discontinuous rail here, very short sections, then another piece that starts up within just a few feet. There is a great deal of crossing and recrossing in front of this gore.

This again is I-15 here. The gore we were just looking at is over the hill. This turn takes you onto 80 going into Salt Lake City, so this is a juncture of two interstate routes.



Mr. CONSTANDY. I would like to ask you to keep this in mind, too; because as we approached this, it became apparent that many of the cars, a goodly percentage of them were going up this shoulder area believing it to be a lane. Of course, it is not; it is a shoulder. So we went up to the bridge, up where the arrow points and looked back this way [indicating], and took a series of pictures there. And again, not surprising, there were a number of cars that narrowly missed the guardrail, gore, but then continued on their way. And they have the duplication of the same problem at the narrow bridge right here at the crest of a hill. The shoulder is reduced for the bridge and it is not carried across the bridge full width, so you have another problem of the vehicles almost striking the bridge parapet.

This was pointed out; it is probably the most dangerous situation we saw.

Yes, Mr. Ricker.

Mr. RICKER. Perhaps this is the time to comment that it has been found useful to stripe that gore area; in other words, where the shoulder is beginning, to put diagonal paint marks about 2 feet wide across that entire area in which you see traffic out there. It does work. It keeps people out of there.

Mr. CONSTANDY. Yes. Mr. Prisk?

Mr. PRISK. Yes.

This is a closeup of the actual gore itself.

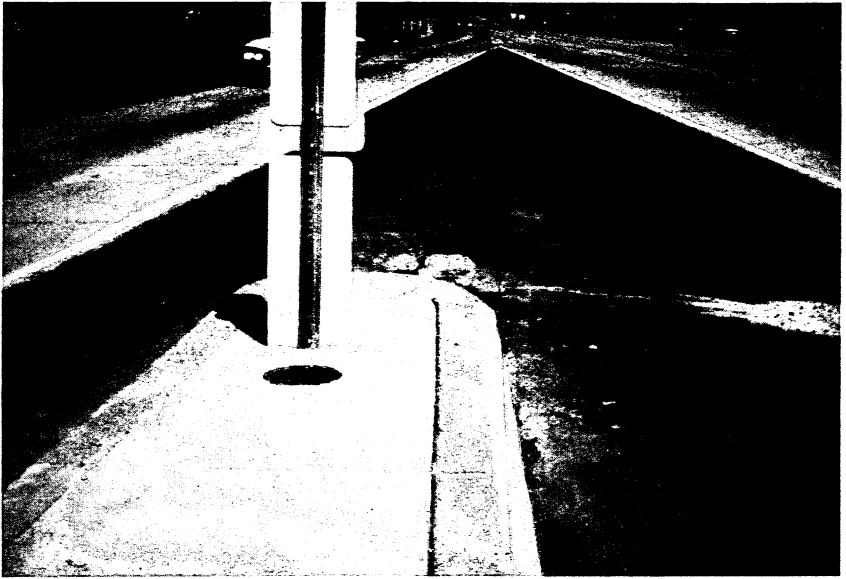


Here is still another one, another gore with a dual bridge just beyond. So again we contend with not only the hardware that is in the gore, but the possibility of dropping into a space between the two bridges.



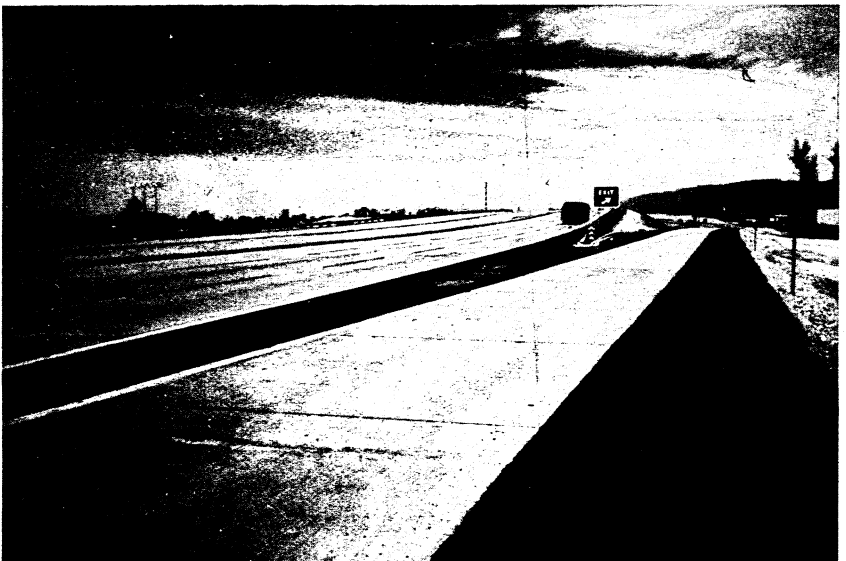
This is another one on the same Utah project and in this case that asphalt wedge is doing a very good job of keeping people away.

In the immediate foreground, however, you do have to contend with the curb, which is raised about 6 inches at that point, almost vertical; and if that is struck, you can be in trouble.



Here is a gore. As you get a little ways away from the city conditions where there is relatively easy terrain to follow, a little grading and treatment in that gore installation, breakaway sign for the exit marking, and removal of the guardrail would probably make it quite safe.

Again I call attention to the desirable contrast in pavements.



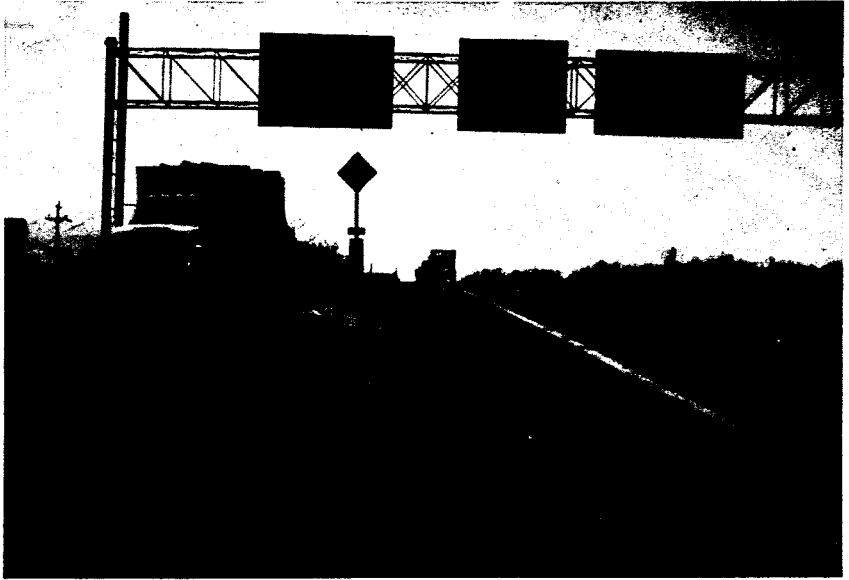
Here is a closeup of that same spot. One thing that was characteristic of their design there in Utah was this little platform out front, this little hemisphere of concrete. I am not quite sure what function that performs.



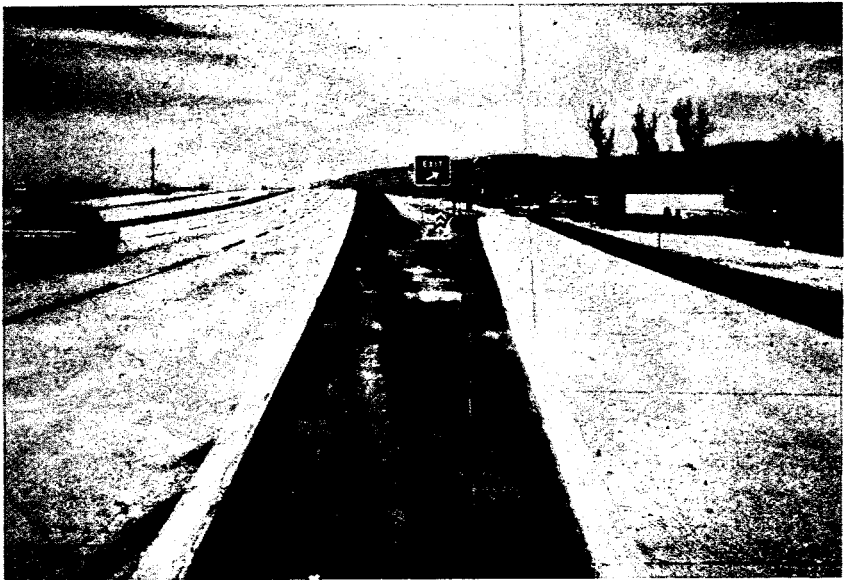
This is looking back at the same gore.



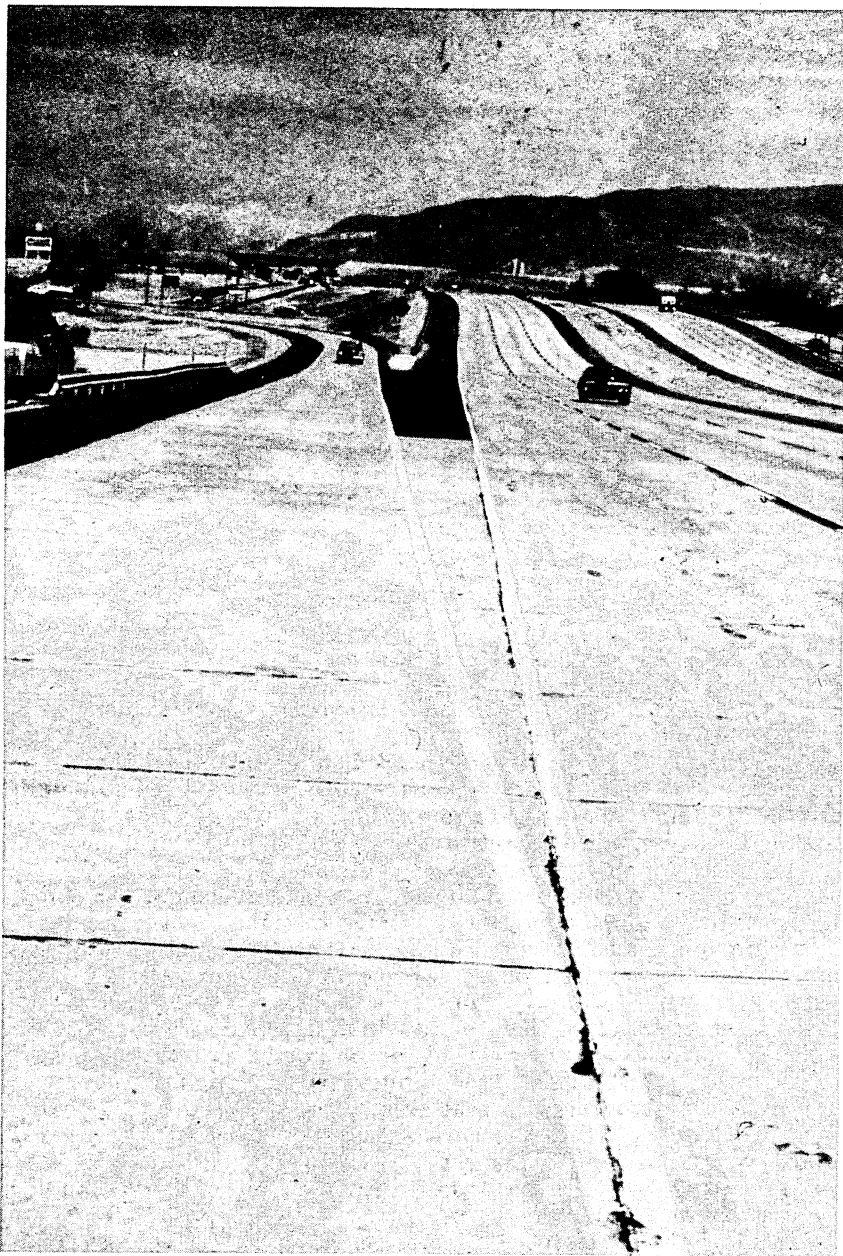
Here is one where the entire platform was raised up, again on a curb, a hazard marker up there, diamond marker, simply to reflectorize at night.



Still another traverseable gore.



And here is another entrance gore showing how flat this angle really is where the roadways are brought on.
This is on a section of I-15.



Here is a departure and this happens to be in Switzerland. This is a picture I took earlier this year showing the attention they give to the type of marking Mr. Ricker just mentioned, in advance of the gores in Switzerland.

Mr. CONSTANDY. I think that concludes the material on gores, does it not Mr. Prisk?

Mr. PRISK. Yes.



Mr. CONSTANDY. Perhaps, Mr. Wilson, you would make some comments relative to what you have seen?

Mr. WILSON. Yes. In connection with gores, I noticed that there are quite a few of the areas that have the basic fundamentals built into the grading to make a safe gore. I think that relative to this series of slides that we looked at, probably in more than half of them, with a very modest modification in hardware, you could make a safe gore out of it. Others, of course, would need a considerable amount of grading work to be done behind the gore area to make them safe.

It is my opinion that the only thing in that gore area should be the sign, exit sign, mounted on some type of breakaway structure or post.

The lighting standard that you saw in many of these areas could be logically moved back of or ahead of the gore area and put on the right-hand side and raised to a slightly greater height to give you the illumination you need in that area.

It is my opinion that the curb that you see here is not needed probably in 95 percent of the cases.

The drainage that has to be taken care of here could be handled properly perhaps in another type of way.

One thing that I might mention in connection with the gore treatment—it has not been brought up yet—is the use of reflective markers that are now on the market to delineate the V in the gore.

We think that quite a lot of the trouble develops at night, and particularly in unlighted areas. The use of reflective markers to outline the two white lines you saw in most of these picture is certainly helpful.

Mr. CONSTANDY. Thank you.

Mr. SCHADEBERG. On the drainage, was there any study that indicated whether in the accidents that happened in the gore area, it was because they did not see the division in the road? I mean, whether they hit it straight away or were they at the point and then wanted to cross over?

Mr. WILSON. Most of them, in my opinion, are due to indecision when they reach the point. However, the more advance notice you can give that there is a split in the path for the vehicle I think is better. These markers show up in your headlights.

As far as the experimentation is concerned, we found in our studies that a signpost mounted in the gore area is four times as susceptible to being struck by a vehicle than one mounted on the right-hand shoulder. For this reason, we think the gore area should be just as clean as possible.

Mr. SCHADEBERG. Give them something to aim at?

Mr. WILSON. Well, he has to have the exit sign. I think this is an essential part. But it should be something that could be struck and not cause a lot of damage.

Mr. SCHADEBERG. I just asked one of the gentlemen here whether there was any—this probably sounds fantastic, but were there any studies made in different kinds of signs, like hard rubber that would bend but not break? Something that would not damage the car?

Mr. WILSON. Well, of course, these signs that are used are rather lightweight. Most are aluminum and some are even a kind of paper composite with a very light gage aluminum face on them.

Mr. SCHADEBERG. Yes. They would not harm the car much.

Mr. CONSTANDY. Mr. Skeels?

Mr. SKEELS. I agree with Mr. Wilson in all he says.

In the early part of Mr. Prisk's presentation, we certainly saw some gores that were very good. Some of these had been spoiled by putting signs and other hardware in there, but the grading was very good and with very little additional attention, they would have been satisfactory.

Gore signs certainly need to be eliminated to the maximum extent possible, and those remaining should be mounted on an approved type of breakaway mount.

Now I am quite sure who is going to provide the approval, but we should have some specification for the type of signs that will be allowed in gores.

A proper breakaway mount for a small sign, such as the exit sign, mounted on a proper breakaway mount, will not damage the car or its occupants.

The painting of the V area immediately in front of the gore certainly is a plus factor and I would think should be encouraged.

The curbing we find around many gores certainly should be held to a very minimum height. I do not think I object to having a very low roll curbing there where the gore is a splitting device to

split traffic. It is not going to split quite all of it, and it should be an unfavorable area to drive on, but still not be a lethal area to drive on.

If you have a low roll curb there and maybe some gravel in there or rumble strips, this produces this effect.

One gore type which has not been solved is the one on the elevated structure, and perhaps this would get back into a real look at the design of the structure to provide room enough to get a proper gore in when you do have to have an elevated structure with the gore.

Mr. CONSTANDY. Thank you. Mr. Huff?

Mr. HUFF. I have been very interested in listening to the details of this subject. I would defer to Mr. Ricker on the subject of signs; if he thinks they should be in there, I am sure that he must be right, but I would urge him to get all of them out of there that he can. Perhaps only in isolated instances would he need a sign in a gore. As a matter of fact, I thoroughly agree with Mr. Wilson, the gore area should be as clean as possible.

I do not believe we can emphasize too strongly the matter of curbs on the approach to the gore, because the curb, anything more than $1\frac{1}{2}$ and 2 inches in slope—12 inches in my opinion is hazardous. It is also my opinion slopes of that kind will provide ample drainage.

Now, the gores on the elevated stretches do present a problem. I have not personally run into that problem. From what I have heard here, I certainly can agree it would be a problem.

One or two details that have not been mentioned: The angle of departure of an exit was touched upon. I do not know whether that is part of this subject or not, but I would like to talk about it just a moment.

An automobile going on a freeway is going, say, 80 miles an hour. That is almost 120 feet a second, which is pretty fast.

We are transitioning him in the gore area down to a city street or local road system, which may not be over 30 miles an hour. So he has to make a quick transition, we will say, from an operating speed of 80 miles an hour down to 30 miles an hour. That is a point of extreme turbulence. You can liken it to a water pipe; where you are turning water out of a pipe, you have extreme turbulence at that point.

Now, in order to accomplish this transition, you need as flat an angle of departure from the freeway as you can get.

I subscribe to the practices in Los Angeles, which I believe is about a 5-to-1 angle of departure, which is—oh, roughly speaking, that is about 2° , I suppose, something like that.

Is that correct, Mr. Wilson?

Mr. WILSON. No, it is 4° and 46 minutes, Mr. Huff.

Mr. HUFF. I was just half off. Anyhow it is a very flat angle. It is extremely necessary in order to transition him from the high speed to the low speed. And it is my opinion that our standards for this transition link probably are not enough—this is some operation—on the freeways.

Now, there is another thing that was not mentioned except he showed a picture of one, I do not believe he called attention to the dangers and hazards of left-hand exits. It is a place where traffic is unaccustomed to leaving the freeway. They are used to leaving it on the right. And in my opinion a left-hand exit should never be built.

Now, some of my colleagues may argue with that—I know some who are not here will—but in my opinion, they should not be built.

Now, another thing that was not mentioned; for night operations, it is my opinion that two or three light standards, luminaires around these so-called conflict points of both exit and entrance ramps does help night operations, particularly for people who may not be accustomed to the particular installation.

Mr. CONSTANDY. Very good. Thank you, Mr. Huff.

Two of the points you mentioned, the left-hand exit and the tapering of the ramps, will be part of the material to be presented some time later relative to the design features. There is a relationship. Mr. Wilkes?

Mr. WILKES. From what we have seen today, certainly more careful attention needs to be given to the location of the overhead sign bridges.

I would agree with the rest of the panel that we should clean up the gore area and have as maximum the simple exit sign.

The problem of the gore obstruction will be greatly reduced when we start building our structures with full width shoulders, because that removes this prow a considerable distance from the main lane of traffic. I think that will produce a considerable improvement.

Mr. CONSTANDY. Thank you, Mr. Wilkes. Mr. Ricker?

Mr. RICKER. I agree with what the other fellows have said.

I would point out that gores are a necessary item on the highway. Every place we have an exit ramp, there is a gore.

From looking at these pictures and others, it would seem to me that this is an area where we could go back on existing freeways and make corrections relatively cheaper and gain a lot of savings.

Mr. CONSTANDY. Yes. Thank you.

Mr. SCHADEBERG. Would you gentlemen suggest that safety could be enhanced if you had a longer approach to the point of decision?

What did you call that pavement, rumble pavement, Mr. Huff?

Mr. HUFF. Beg your pardon?

Mr. SCHADEBERG. Did you call this rumble pavement? Is that the pavement that makes a noise?

Mr. HUFF. Someone else may have mentioned it, but rumble pavement I believe is a common name given to it.

Mr. SCHADEBERG. This has nothing to do with the gore area, but maybe one of you might suggest, are there any indications of how many accidents involving cars that go off on the shoulder are the result of the driver going to sleep, or just losing control?

Mr. HUFF. We do not have any statistics on that, sir.

Mr. SCHADEBERG. The reason I asked is I wonder if it would be of any value safetywise to put some rumble pavement in the shoulder occasionally so it would at least warn the driver?

Mr. HUFF. We have used that on our bridges in our large metropolitan areas where we have large traffic volumes, on bridges particularly.

Mr. CONSTANDY. Thank you, Mr. Chairman.

I would like to continue with this, taking up as another element of the design which contributes to the roadside hazard problem, curbs and shoulders, if you are prepared to give that, Mr. Prisk.

Mr. PRISK. I think curbs and shoulders rather naturally associate themselves with urban and rural conditions. Either you have a shoulder provided outside the main travel lanes for disabled vehicles, or in some cases, as you approach the city street conditions, and particularly on ramps from expressways, you find curbs that are used to delineate ramps, delineate gores, control drainage, and so on.

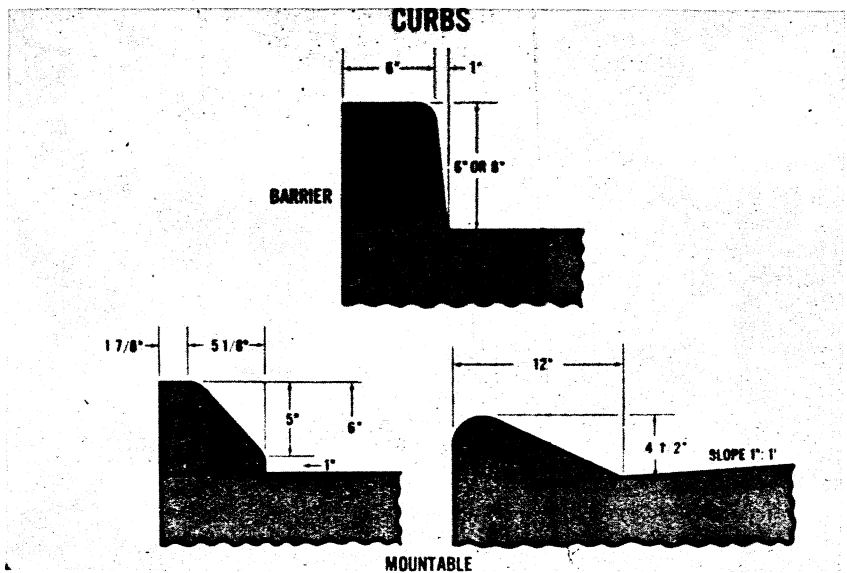
The matter of the unimpaired width on that involved lateral clearances, and how these are arranged in different design situations was of great interest as we looked at these nine projects.

We have a series of slides that relate to this area of interest, and if you will go ahead with those, we will begin to look at them.

Just to introduce you to very general considerations, this is known as a barrier curb, the top curb. Dimensions are not awfully important. This is only one typical type of barrier curb with a rise 6 to 8 inches, possibly to be laid back as much as 1 inch on that rise. This is what we mean when we call it a barrier curb; we intend essentially from the traffic side—traffic being out here [indicating] to restrain traffic from going over the top of the curb. It does not mean traffic will not go over the top, but it is intended to restrain it.

These two types at the bottom are mountable curbs. One is an extremely flat sloping curb on this section that you see. The other one is about a 45° angle curb. Both of these are very readily mountable. Many drivers will go off this type curb [indicating], however—that is, deliberately drive over this curb—that would not drive over this curb [indicating], and many will be restrained just by the sight of this curb [indicating] and would not even attempt to drive over it.

But this, in general, is what we mean by barrier and mountable curbs, the two general categories that exist. There are many variations of design of curbs, as you will see.



Mr. CONSTANDY. Mr. Prisk, how high would a curb of that top type have to be before it actually became an effective barrier?

Mr. PRISK. Well, in terms of effective barrier, if you think back to what we have seen on the structures, where this runs up in the median dividers, it runs up to 31 inches before you begin to get real control of the vehicle for certain.

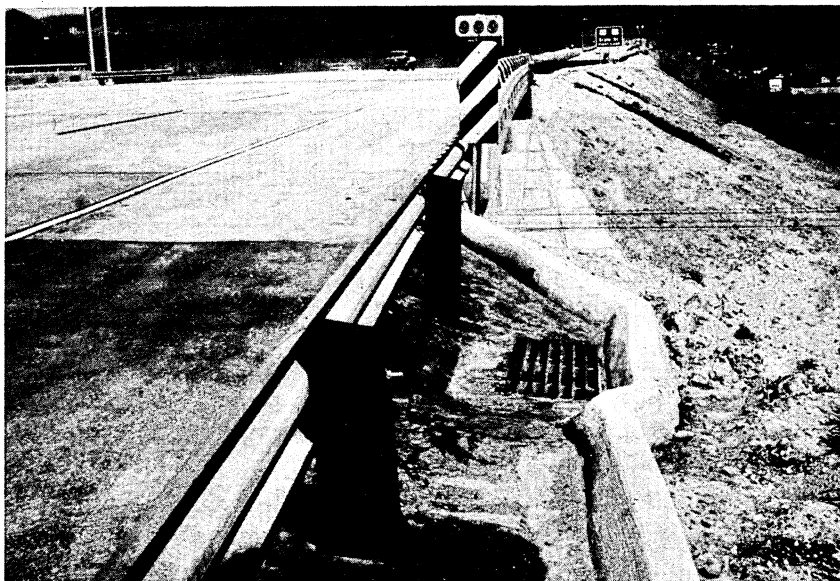
I think very commonly among designers—perhaps others on the panel would have a view on this—10 or 12 inches is regarded as a fairly effective height. You get to the point, Mr. Constandy, if you go too high with the curb and you are attempting to accommodate a vehicle next to it, a man cannot open his door when he pulls up alongside the curb.

Mr. CONSTANDY. Yes. What caused me to ask, I have a recollection of having read something about a 12-inch curb height as being non-mountable.

A vehicle could mount a 12-inch curb, could it not, depending on the angle and speed?

Mr. PRISK. It is entirely possible, yes. Probably not under city operating conditions, but in other conditions, yes. Let's go ahead and look at some of the curb applications that we found.

Here in Salt Lake City, I am very pleased to see the curb was put in this case behind the guardrail. This is serving the drainage function. This, of course, is an erodable soil out here. And this drainage was a necessary part of the design of the embankment situation.



A longer look at this. You can get an idea of that construction. The travelway out here was supplemented by a paved shoulder, and then the rounding of the embankment carried over here also was paved when this shoulder was built. At that point drainage was entirely accommodated off the traveled way.

The curb in no sense was a traffic hazard in this instance.



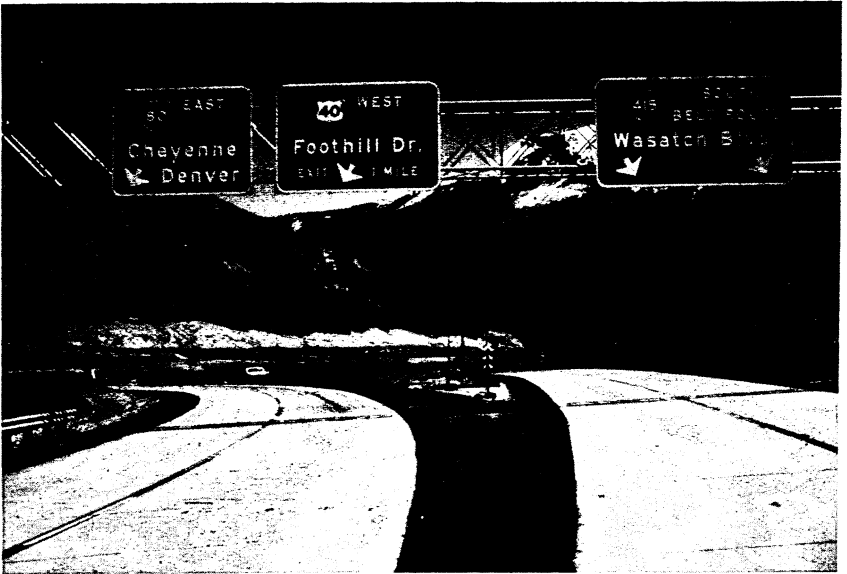
Here the curb is in front of the rail. This also is in the Salt Lake City project. I am disappointed this is not out here [indicating]. In this case I do not know. This is on an approach to a structure. There may be some reason for it.



Here again is the use of a curb in a gore where it serves as a place to put this marker board. I am not sure what else it does, but it at least serves for that.



Here is a curb down here used to outline this area, the same sort of thing. The marker board is here, indicating you may go either way.



This is another curb use, in this case cutting off the shoulder that existed back here near where the camera was, taking it out to within a foot or so of the true traffic lane.

This curb does outline the entrance gore and provides a measure of shielding for the traffic that enters here, protection for that traffic.



Here we find the curb outside the guardrail, in there, of course for a drainage function.

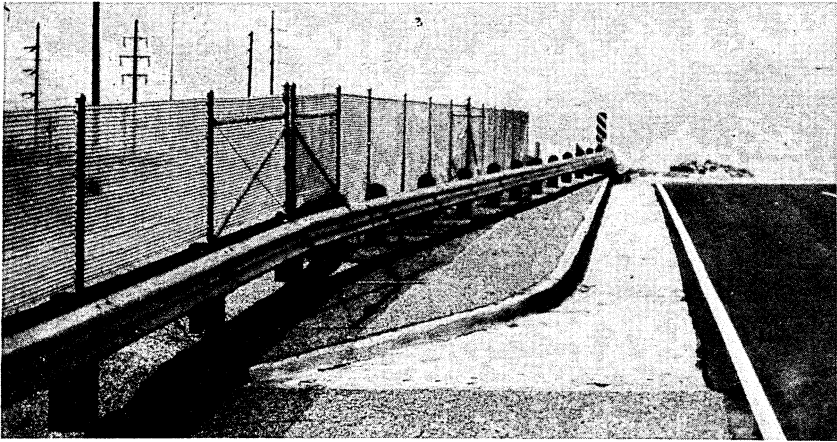
Mr. CONSTANDY. This is in Oklahoma, Mr. Prisk?

Mr. PRISK. This is in Oklahoma, excuse me—I-80.

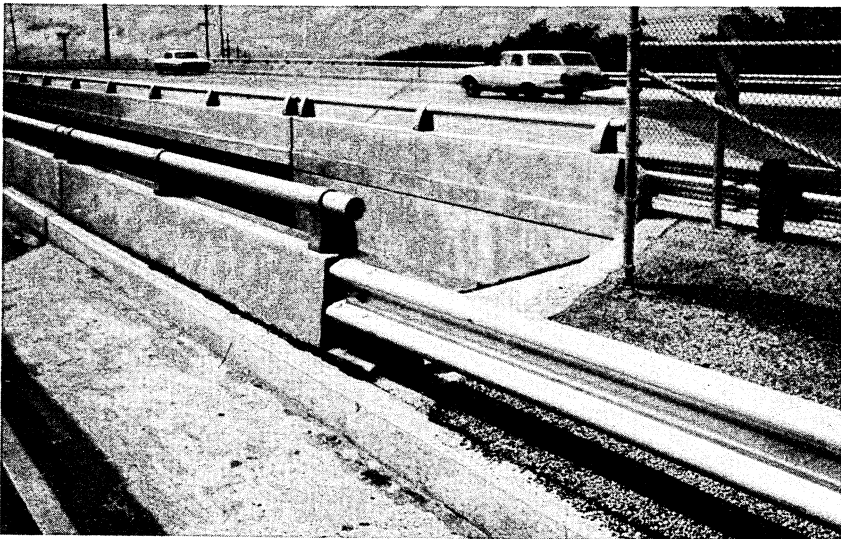
And desirably this curb would be better if it were like the Utah situation—behind the rail, or at least back in line with the face of the rail. This entire area could be flat.

Mr. CONSTANDY. I cannot help thinking, looking at this, that we are really beginning now to figure how we could improve something that is there. But actually the real improvement would have been to pave between bridges and avoid the whole problem.

Mr. PRISK. It would have been, yes. The dual bridges are up here [indicating].



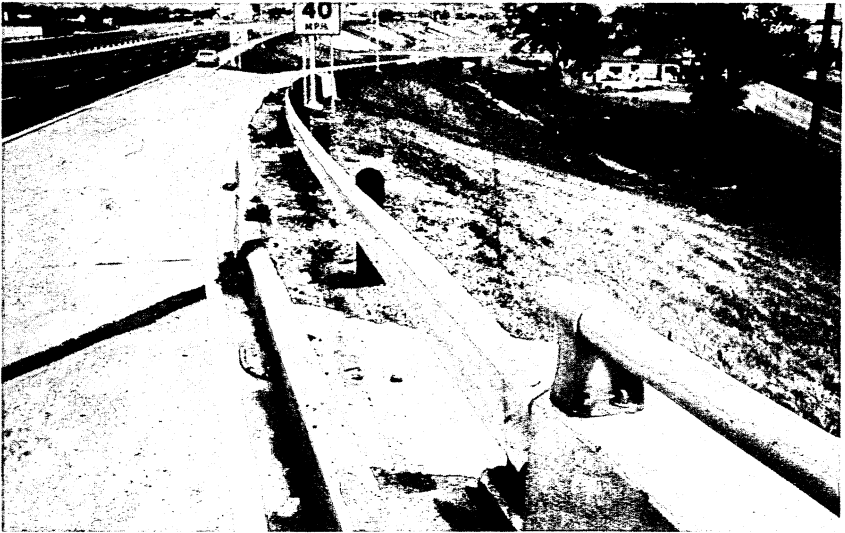
Here again is a dual bridge situation and the curb here about 4 or 5 inches wide, and entirely satisfactory as far as collision conditions are concerned. It lines up reasonably well with the approach



rail at this point. However, back here, the rail fades back behind the curb and the rail would not perform as well back in this area as it does up here [indicating].

Of course, here, we previously discussed the weak points of this anchorage.

Here is the curb so far in front of the rail that it would be a serious handicap to any effective service out of that rail.



Now we are on the new work in Oklahoma. You will find the median barrier coming up here in the same fashion that you found on the job that has just been opened a few months ago. This work is not



opened at all—the curb also coming out on the approach to a structure parallel with the alinement.

This area here, raised above the roadway, serves no real purpose. There are no pedestains permitted in that area. I cannot think of any other reason to have it there.

Here you find the curb on the structure, satisfactory design, projecting again somewhat in front of the rail.



Here is the situation in Missouri, now, where we find the very definite tendency to continue that bridge curb in the same line as it was on the bridge, even though the rail was pulled back here. [Indicating.]



You must remember, of course, that these things are built at different times. Undoubtedly the structure was built many months ahead of the guardrail installation. But if these were planned together, they could be made to conform.

This is the asphalt curb used extensively on the Nevada project to outline the roadway through much of its length. It is not put here to guard this signpost in any respect.

It does provide a measure of delineation, of course, as far as the edge of the roadway is concerned. This is one of the functions of the curb. But it does have some disadvantages from the standpoint of the operation of the vehicle.



Mr. HUFF. Mr. Prisk.

Mr. PRISK. Yes.

Mr. HUFF. Do you think it well to give the reason for the curb? Do you know why the curb is there?

Mr. PRISK. This curb I suspect is there because of highly erodable soil.

Mr. HUFF. That is correct. In the areas in the West where you cannot grow any grasses or anything, with the rains that you have, you need some protection for erosion on the slopes.

Mr. PRISK. Yes. I am sure that is the case here.

Mr. CONSTANDY. Is there any way of achieving that, Mr. Huff, other than the use of this type of curb?

Mr. HUFF. Our people who are involved in this have not come up with any other reason. We have challenged them pretty hard on it.

Our answer, of course, will be to put it back of the guardrail.

Mr. CONSTANDY. They use very little guardrail in Nevada. I noticed they have to curb frequently at fairly high points on the grade. There is apt to be less accumulation of water. I wondered if it is possible that you could compromise it in some other way than having a curb, depending on the amount of water which is collected on the road?

Mr. HUFF. Incidentally, as a matter of information, in arid areas, I believe there is more tendency to go to steeper slopes to prevent their erosion problem. That is by both wind and rain, both.

Mr. CONSTANDY. They have quite steep slopes. Of course, they have the Rocky Mountains there. Mr. Ricker?

Mr. RICKER. This type of asphalt curb is very useful during the period when you are getting grass started. It can be removed after the grass gets growing.

There is a problem in placing it, because if you put it in before the guardrail is erected, you break up the shoulder pavement. If you wait and put it in after the guardrail, it sticks out in front of it. You cannot get the machines in to put up the post.

It does look objectionable in those cases, but we rationalize it will only be there a few years until the grass gets started, then they will be removed.

Mr. CONSTANDY. That was a pretty good treatment in Utah, where they had placed it behind the guardrail.

Mr. RICKER. Yes; but I am not sure you can use this type of asphalt extruded curb in that position. There is difficulty placing it. It should go on top of the shoulder and in front of the guardrail in order to seal off the water.

Mr. PRISK. Continuing with our examination of curbs, this is a curb installation on the Montana project. You will see this is a mountable type curb about 5 or 6 inches high, again used to define the gore area.

It terminates here, just short of this problem area between the two structures, adjoining structures.



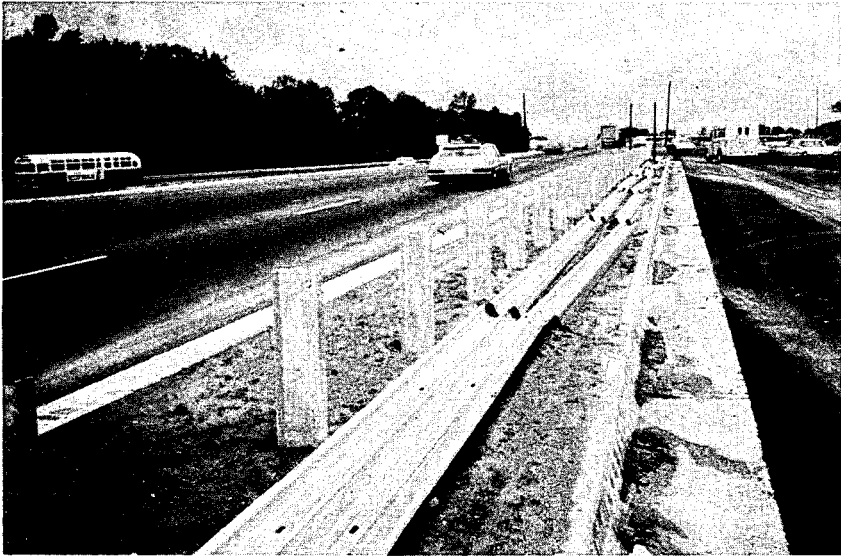
Here in Georgia you find sections where asphalt has been laid at a 45° slope, again for drainage considerations. This is an outlet ditch at this point. This does not present any terribly difficult problem, and certainly it is desirable to have a curb follow some reasonable line parallel with the movement of traffic. Otherwise I think it could be quite disturbing to have any edge like that varied back and forth laterally.



This curb projecting in front of the rail would otherwise serve its purpose.



And here we have a situation I think worthy of calling your attention to: a brand new job here, this is south of Atlanta off the subject project, but the one that we saw en route to the airport. A curb in front of a median barrier, double sided barrier, can hardly help that barrier to perform as effectively as it would if you paved over the barrier flush on both sides. So I think this is a case where money was spent for curb and gutter—as I recall, the price of this was \$3.20 a lineal foot for curbing and gutter along here—and I do not think we bought any safety with that.



Mr. CONSTANDY. That is on each side \$3?

Mr. PRISK. Yes.

Mr. CONSTANDY. For \$6 a foot, you should be able to pave that same footage flush?

Mr. PRISK. Oh, yes.

Mr. CONSTANDY. You would have some money left over, not having to maintain that so much too, I guess; is that true?

Mr. PRISK. I should think you would have enough left over to put the bolts through the posts here.

Yes. I think this a case where some money was spent unnecessarily.

Here is the Ohio situation, another use of the curb, again one to outline or delineate the course of the pavement, in this case the entrance ramp, which is here in the foreground, going on down to the main line. You start a curb at this point. This is a vertical barrier type curb, you can see from the closer picture.



Here it is shown as it starts. It has a little taper here, reaches its height very quickly, and is continued down here to a point where it reaches the edge of this shoulder.

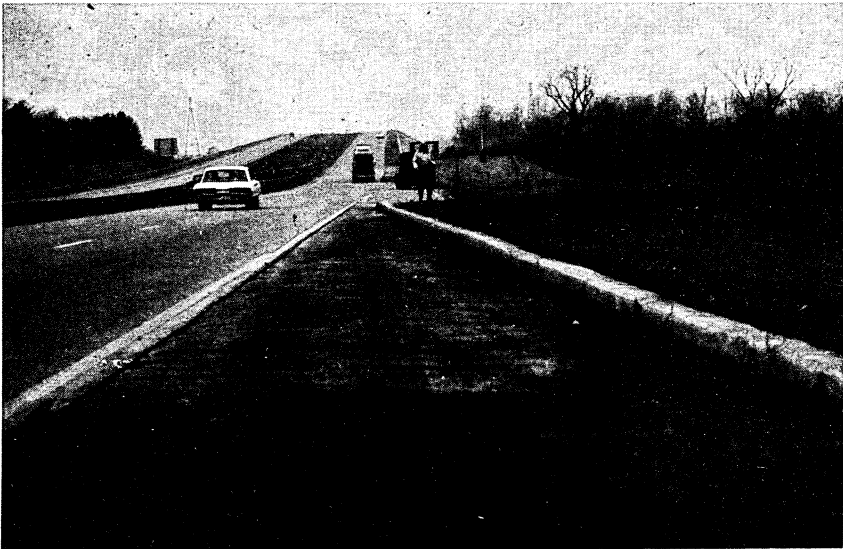


This curb is not thought to be much more really than a visual guide to traffic using that entrance ramp. I personally am not impressed with having curb at that location.

This is the use of curb in a similar fashion on another entrance ramp, on the same project, on a section not yet open. This is the end near where it joins the through lane.



And this is a similar or additional type of curb situation. This is in Indiana where cars are unable, as they approach the entrance ramp, to have use of the full shoulder. You see the shoulder continuing up



there in the distance, but the shoulder is cut off at this point [indicating] from about where the camera shot is taken.

This is older type. Yes?

Mr. WILKES. That was my point.

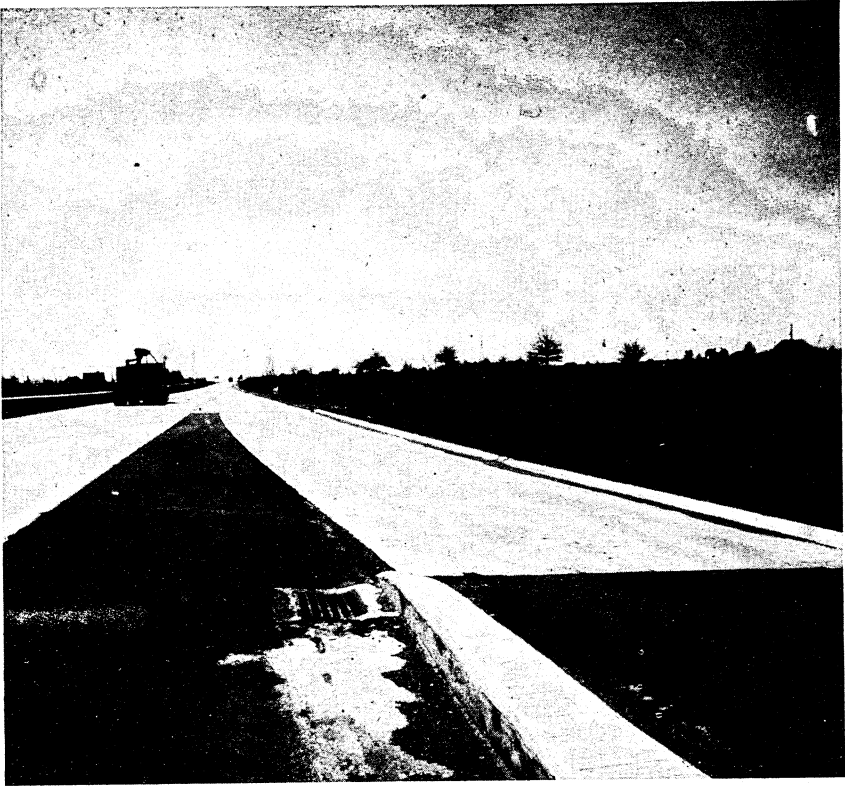
Mr. PRISK. This is a closeup picture on the Indiana project. This, as I say, is the older work. There is only about a foot-and-a-half or 2-foot clearance at this point. [Indicating.] This is the entrance ramp, and this is the throughway.



Here is the work as it stands today on the new job, which is certainly better from the standpoint of clearance; because instead of having 2 feet from here to the curb, you have the full shoulder width. Drainage is dropped here and taken over into this low spot.

The curb has the same disadvantage here, I would say, as I remarked on Ohio.

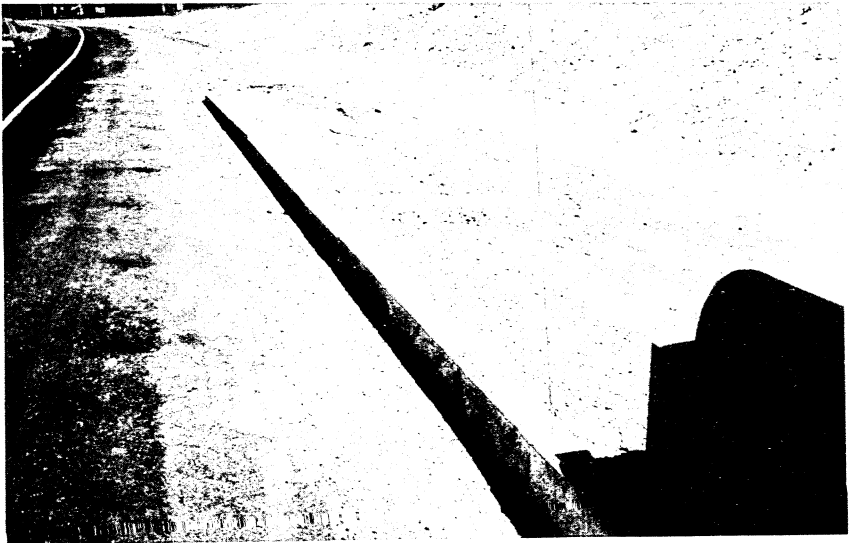
Another thing that is noticeable here and I think significant is the fact there is a curb on the outer edge of the entrance ramp. This is not regarded as a good feature, because it tends to confine the entrance movement to the point where the drivers are prone to stop in this area unless there is immediate opportunity to enter the traffic in the through lanes.



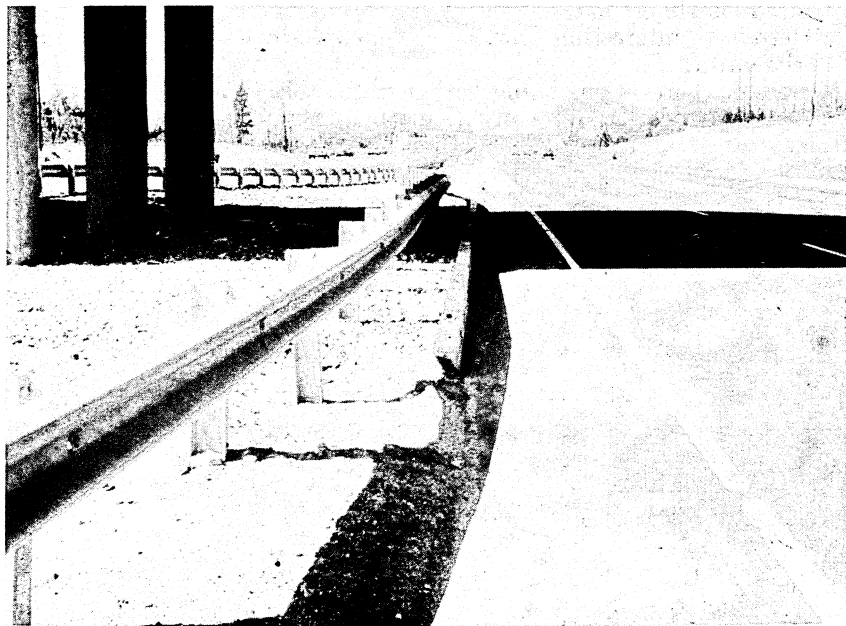
Here we are in Rhode Island with granite or precast concrete curb coming across these bridges, pretty much as though you had a sidewalk situation. There are no pedestrians permitted in this area. In fact, there are signs right in this vicinity prohibiting pedestrians from coming into the interstate section at all. So the curb at this point is quite an unnecessary imposition on the free flow of traffic.



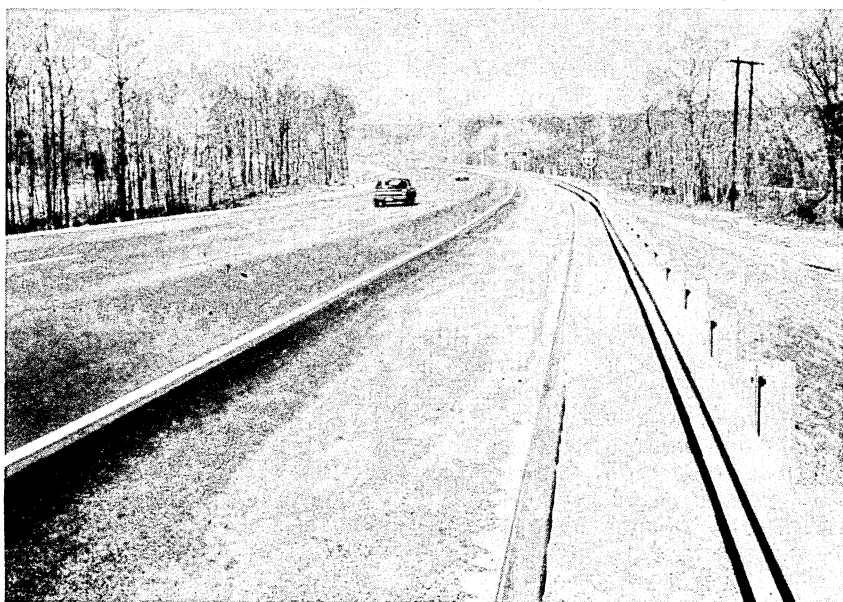
Here the curb extends, as you see it from the bridge structure, parallel. We have a little difficulty about seeing the need here, again. It might as well be stopped and graded from this point in here. [Indicating.]



This is a similar situation on an undercrossing, with the curb well in front of the guardrail structure by 2 or 3 feet.



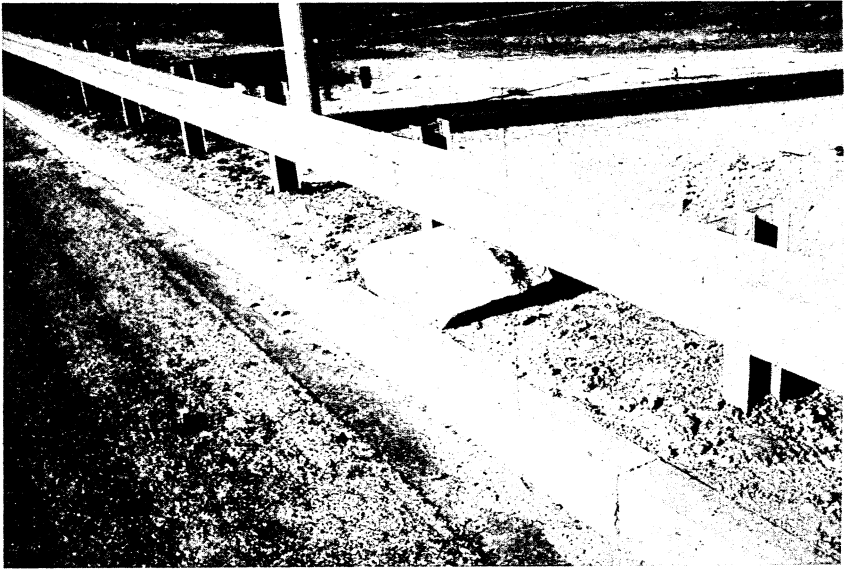
This is an asphalt curb, again used so as to provide a walkway immediately in front of the guardrail, and perhaps as much as 2 or 2½ feet wide.



With that curb not there, of course, you might lack the drainage control that would be necessary. From an operational viewpoint, it would seem you could go ahead and do without the curb on this kind of grade. It is almost flat.

Here is an interesting shot, a little curb left over here, laid in front of the railing.

I think there is one thing rather noticeable in all of the projects that we visited that were in the urban areas; it was that there was somewhat greater use of curbs than would seem desirable.



Mr. CONSTANDY. I think, Mr. Prisk, that completes the presentation on shoulders and curbs. We will adjourn for the day.

Before we do, Mr. Chairman, I would like for the members of the panel to give their evaluations of what they have seen on the curbs on the projects. Mr. Wilson?

Mr. WILSON. I think Mr. Prisk covered these points pretty well and I would certainly agree with him, there is a lot of money being spent for curb that could well go into some other type of facility.

I would like to comment that too often curb is used for delineation, and I want to make reference to the previous slides which indicate that guardrails are apparently used too often for delineation as well.

Quite often the use of these dikes, or curbs, confine a driver in an emergency to the shoulder itself, when in fact just behind this shoulder area is a very flat area where he could pull off and change a tire or take care of what emergency he may have. But if anybody has ever changed a tire in a 10-foot shoulder next to a 60-mile-an-hour traffic, that is a pretty terrifying experience, particularly if you are changing the one on the traffic side. So anything you can do to make that area behind the shoulder available for such emergencies would certainly be well worthwhile.

There is one point I would like to make. I talked to a group of maintenance engineers from our department not too long ago regarding use of curbs and dikes. They said if we had fewer of them, we would have to do less sweeping, which would cut our maintenance costs.

Where you have a vertical curb, dirt is allowed to accumulate there and must be swept away; it will not go away by itself.

Mr. CONSTANDY. Thank you, Mr. Wilson. Mr. Skeels?

Mr. SKEELS. Curbs seem to fall into the category of signs and gores; they should be eliminated wherever possible. And in many of the cases we have seen, it seems as though it would be possible. Certainly if they are placed in front of guardrails, they hinder the performance of the guardrail and they should never be placed there.

If you have to have a curb for erosion control, it should be as low and as mountable a curb as possible.

Mr. CONSTANDY. Thank you. Mr. Huff?

Mr. HUFF. A historical point, we inherited the curbs from the cities long ago. They were, I believe, used at that time primarily to keep the buggies from running up on the ladies' lawns and making them all mad.

Mr. CONSTANDY. This is an oldtime beauty program.

Mr. HUFF. They had a place for their purpose. Incidentally, a lot of the cities still have the same need for curbs for the same reason on the local streets where traffic does not go over 35, 45, or 50 miles an hour. But in my opinion, vertical curb over about 2 inches high has no place on a high-speed freeway closer than 12 to 15 feet, and if possible, eliminate them even that close wherever it is possible at all.

Now, there are in this country, including my own State, many, many medians that have been built with raised curbs of 6 or 8 inches or higher.

I have been told that many people have a lack of depth perception. To all of those people, a curb will look like any other surface; it will look flat. They are liable to run into it thinking it is a flat surface.

Because of the success of the so-called flush median with no curb, we built the guardrail just as if it were on part of the pavement, the only difference being a difference in color or texture of the material in the median; no separation by elevation.

Mr. CONSTANDY. Thank you, Mr. Huff. Mr. Wilkes?

Mr. WILKES. In summary, I think we can all agree that there is too great use of curbs in our freeway designs. Mr. Huff mentions, many designers feel that because this highway is located in an urban area it demands a curb and gutter. Many designers have discovered that this is not a true assumption, so we will say obviously we have used too many curbs in our highway designs.

Mr. CONSTANDY. Thank you, Mr. Wilkes. Mr. Ricker?

Mr. RICKER. I would agree with what Mr. Huff said about the history of curbs.

There was one other point that might be mentioned. Some of the slides showed curbing in the median with the apparent intent of finding grass in between the curbs. This is very expensive and hazardous to maintain. On many highways, the grass has been removed and replaced by other materials that require little or no maintenance.

Curbs will require costly maintenance, hand sweeping and so on, in many of the instances shown here. This is something we have to think about in the design, to keep them clean so maintenance can be done with a machine.

Mr. CONSTANDY. If we look at the broader aspects of the problem, we may very well find that it is cheaper to pave the median than had heretofore been thought?

Mr. RICKER. Oh, definitely. Several of the toll roads have removed the grass median at considerable expense afterwards and replaced it with other material to save maintenance costs.

Mr. CONSTANDY. Thank you, Mr. Ricker.

Mr. Chairman, we had one exhibit used in connection with the discussion on gores and I would ask that it be marked as "Exhibit No. 7."

Mr. SCHADEBERG. Without objection, so ordered.

(Exhibit No. 7 was marked.)

Mr. SCHADEBERG. On behalf of the subcommittee, may I thank you again, gentlemen.

I understand the chairman is reconvening the meeting at 10 o'clock tomorrow. We will adjourn for today.

(Whereupon, at 4:39 p.m., the subcommittee was recessed, to reconvene at 10 a.m., Friday, June 23, 1967.)

HIGHWAY SAFETY, DESIGN AND OPERATIONS

Roadside Hazards

FRIDAY, JUNE 23, 1967

HOUSE OF REPRESENTATIVES,
SPECIAL SUBCOMMITTEE ON THE
FEDERAL-AID HIGHWAY PROGRAM OF THE
COMMITTEE ON PUBLIC WORKS,
Washington, D.C.

The subcommittee met, pursuant to adjournment, at 10:58 a.m., in room 2167, Rayburn Building, Hon. William H. Harsha (acting chairman) presiding.

Present: Messrs. McCarthy and Harsha.

Staff present: Same as previous days.

Mr. HARSHA. The Special Subcommittee on the Federal-Aid Highway Program will please come to order.

We continue to have with us this morning the panel of experts in the highway engineering field whose advice and comments have been so helpful to us at our public hearings this week. These gentlemen are performing a great service to the subcommittee, and to their fellow Americans, by making available to us their expertise and experience in analyzing and discussing design safety features found in recently opened Interstate projects selected from various sections of the country.

We will continue this morning with that discussion.

You may proceed, gentlemen.

FURTHER TESTIMONY OF CHARLES W. PRISK, DEPUTY DIRECTOR, OFFICE OF TRAFFIC OPERATIONS, BUREAU OF PUBLIC ROADS; JAMES E. WILSON, TRAFFIC ENGINEER, CALIFORNIA DIVISION OF HIGHWAYS; EDMUND R. RICKER, DIRECTOR, BUREAU OF TRAFFIC, PENNSYLVANIA DEPARTMENT OF HIGHWAYS; PAUL SKEELS, CHAIRMAN OF COMMITTEE ON GUARDRAIL, HIGHWAY RESEARCH BOARD; T. S. HUFF, CHIEF ENGINEER OF TEXAS HIGHWAY DEPARTMENT; W. JACK WILKES, CHIEF OF BRIDGE DIVISION, OFFICE OF ENGINEERING AND OPERATIONS, BUREAU OF PUBLIC ROADS—PANEL

Mr. CONSTANDY. Mr. Chairman, we are pressed for time and I would like to ask Mr. Prisk if he could quickly go through the slides which cover the remaining three elements that we have—drainage, shoulders, and slopes.

I would like to ask if the members of the panel might perhaps jot down notes as we go through each section. As we complete it, perhaps

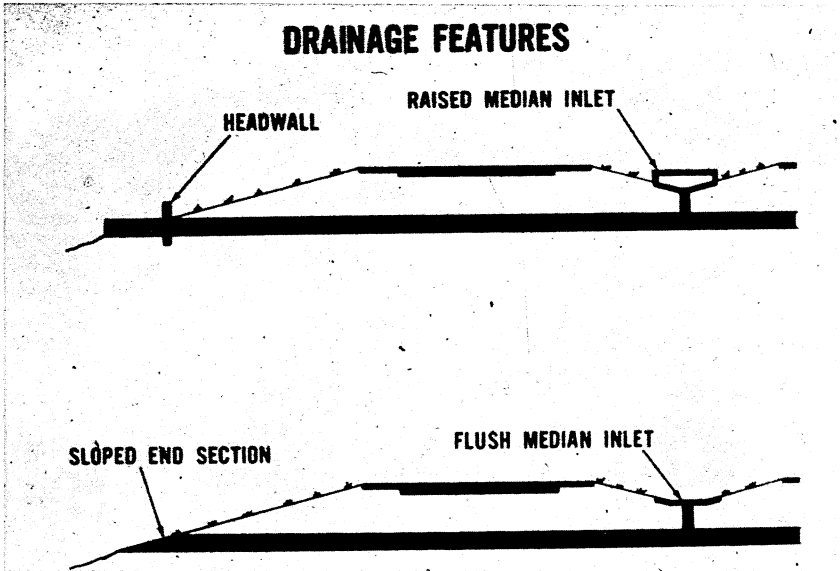
you could give your comments then. We can conserve some time this way.

Mr. Prisk, if you will please quickly go through the remaining slides.

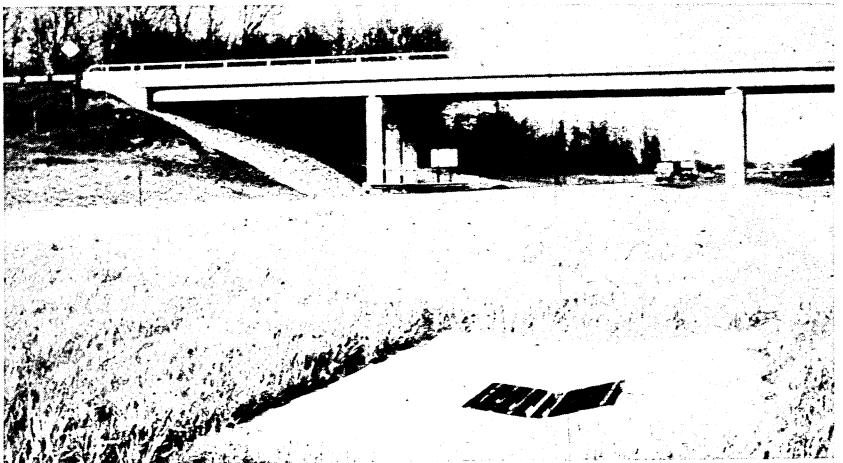
Mr. PRISK. Thank you, Mr. Constandy and gentlemen of the committee.

These are slides first that relate to drainage features of the highway.

At the top you will see the undesirable condition of an exposed headwall at the left and median inlet raised in the right hand. The lower part shows the more desirable condition where these drainage features are flush with the surrounding ground.



Now to look at some of the conditions that we saw. This is on an Ohio project, interstate, where the median is built flush with surrounding ground.



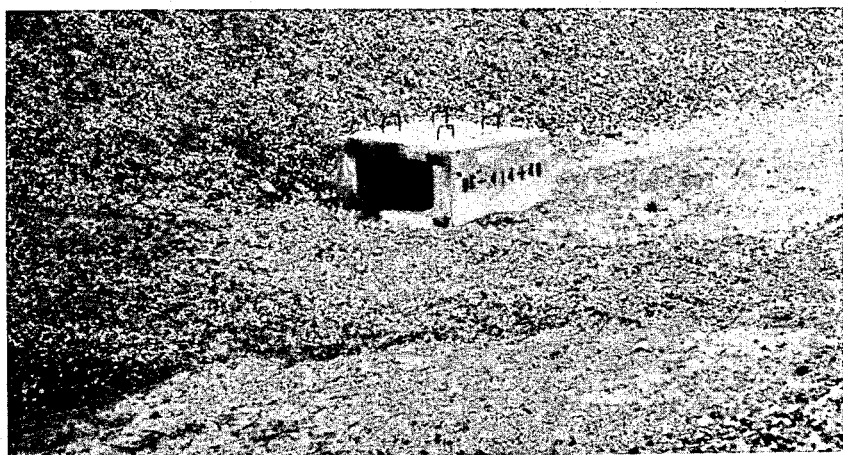
Here is a drainage feature at an interstate separation in Ohio where some obstruction is offered at the roadside.



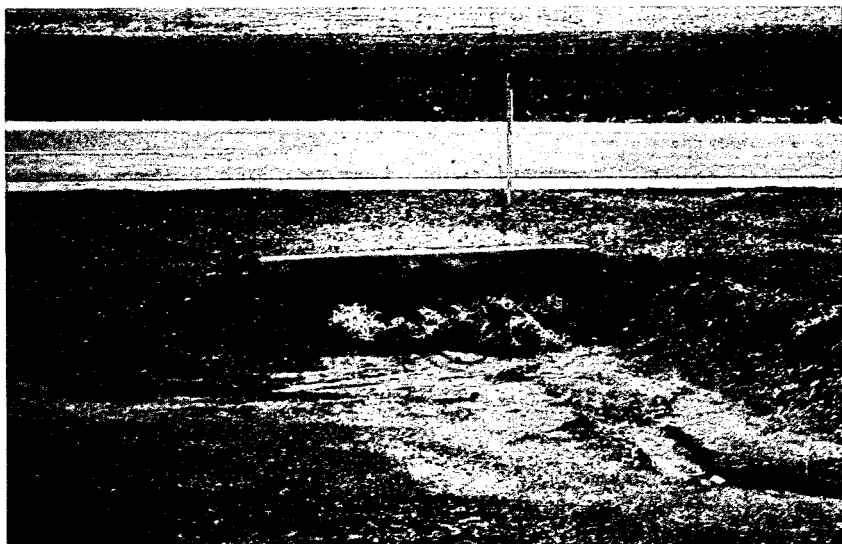
Here now in Nevada we find an exposed median drain built well above the surrounding surface. This is truly an obstruction to any traffic in that area.

Mr. CONSTANDY. This is in Nevada, Mr. Prisk?

Mr. PRISK. Yes.



Still another picture in Nevada, a cross-drain headwall.



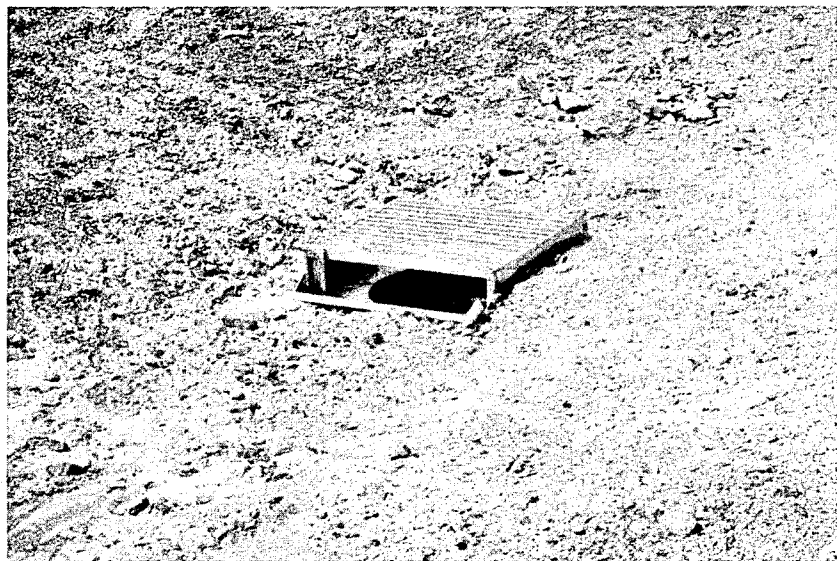
Here now in Oklahoma is a paved median with a surface drain. It serves very nicely to handle drainage and offers no obstruction to traffic flow.



Still another one on a new project just outside of Oklahoma City, not yet opened, another kind of a drain on a rural section.



Here is one in Montana which does project above the roadway surface in the median.



Also in Montana, we find this desirable cutoff culvert, which fits in with the slope profile.



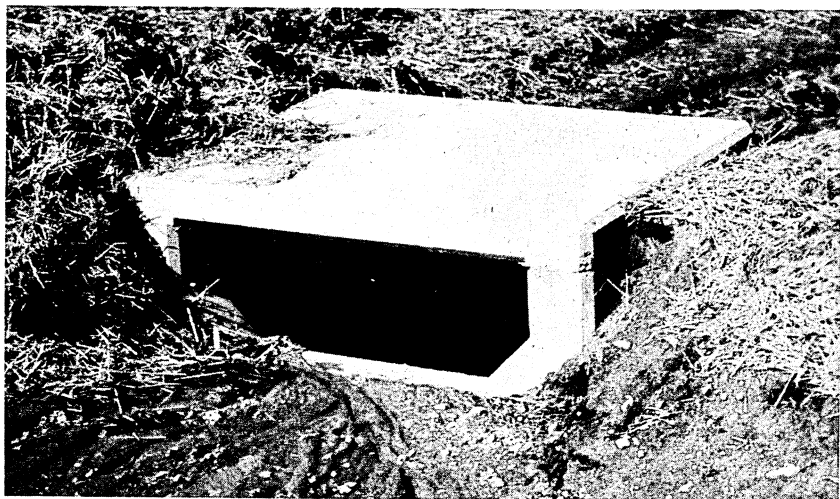
Here is another view of a drainage pipe extending out the side, also in Montana, where there is some hazard involved. It's very close to the roadway.

Mr. CONSTANDY. If that pipe had been extended, could not the slope have been brought back farther and that hazard been removed?

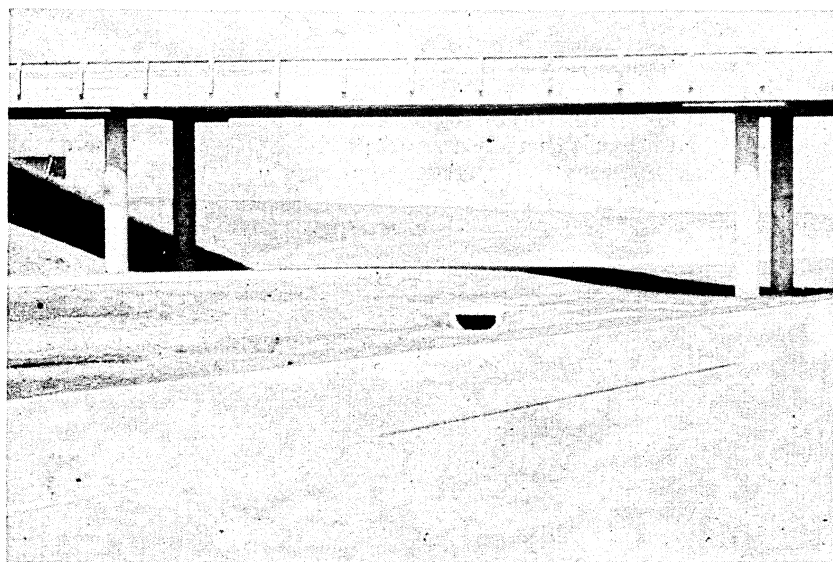
Mr. PRISK. It could have been; yes, sir.



Here we are in Missouri, with a drop inlet in the median, again raised above the surrounding terrain, level of the terrain. This would constitute quite a hazard if hit.



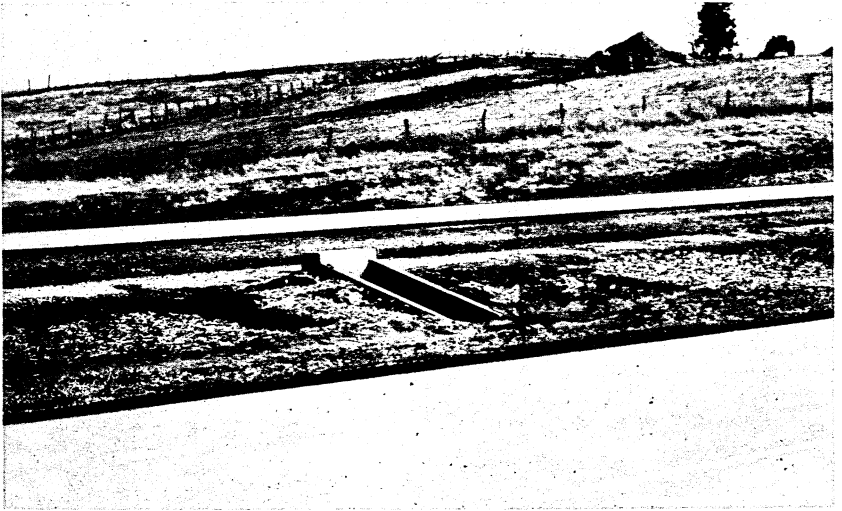
Here, also in Missouri, is drainage carrying through a grade separation structure, a very common type of drain inlet. There is a vertical surface there perhaps 8 inches high to hit.



This is a cross drain, again you have a headwall condition, and wing walls there, particularly the headwall. You can well imagine this being cut off more nearly to the ground surface.

Mr. CONSTANDY. I spoke to a highway patrolman in that State. He told me of an experience he had had with exactly that type of drain. He was pursuing a car and was pushed off the road, struck this type of structure, and his car was thrown some 15 to 16 feet in the air and struck a utility pole; it broke his back, caused very severe damage to the car.

Mr. PRISK. This is entirely needless and unnecessary concrete.



Here is a side drain which for a car out of control would present quite a hazard because there is an abrupt rise here, with concrete wall facing. This is not very well guarded against vehicles out of control.



Moving now to Rhode Island, we find in the median this sort of a drop inlet with a circular grate, paved areas around it, which seems to be functioning very well.



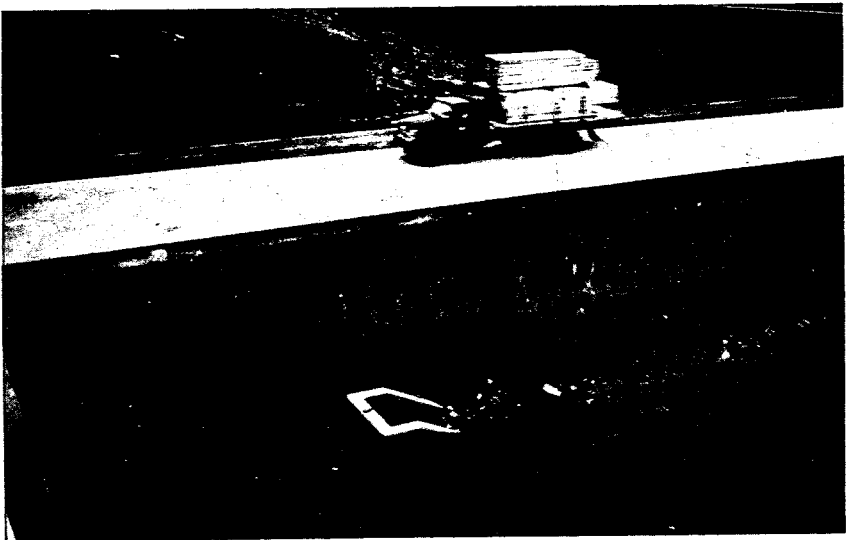
This is entirely safe, this type of drop inlet, here shown at the curb.



When we come out toward the rural section of this Rhode Island portion, we find this shaped wall, wing wall to handle the culvert which crosses the roadway at this point, which in fact does present a considerable hazard unless the grating is very carefully handled around that point. It looks to me like it is going to end up too high even so, particularly out in this area here. [Indicating.]



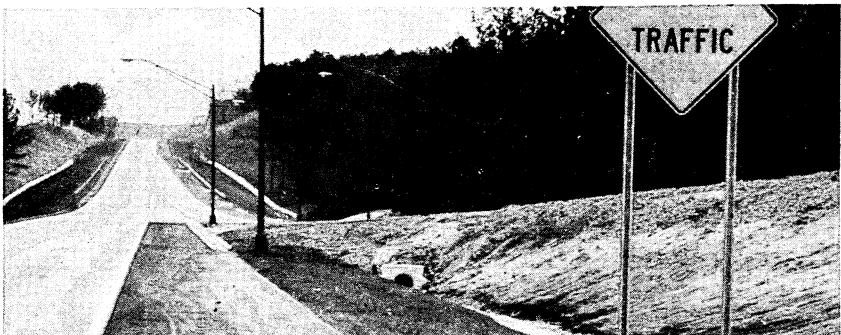
Here is the type of median drain, and an obstruction at the same time, seen on the Georgia project. This is going through a grade separation structure. And although the headwall has been cut off, there still does remain here a less than desirable facility for drainage, from the safety standpoint.



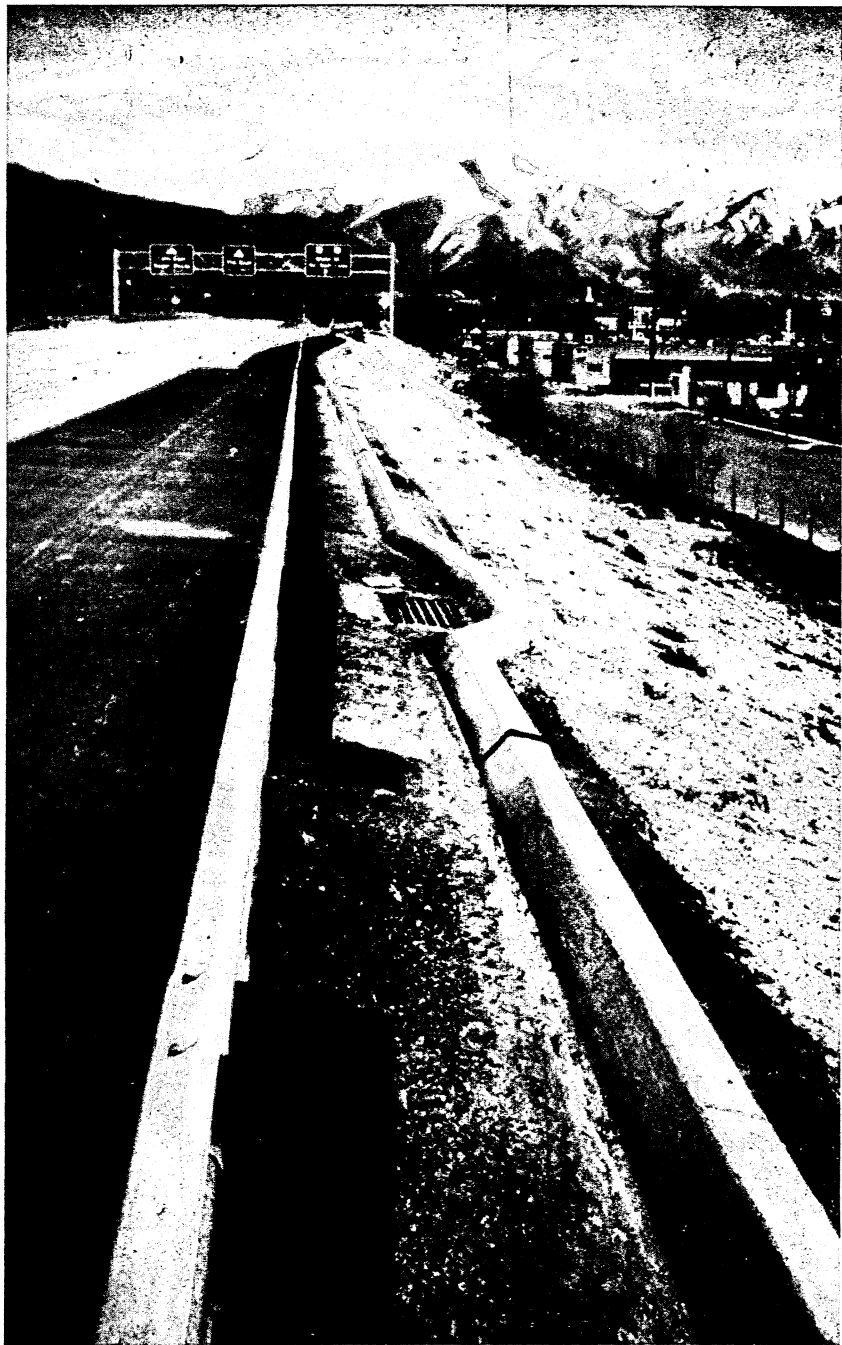
This is another type of inlet on that Georgia project where there is a vertical rise here, very obviously three or four bricks high, a table-top type of median inlet raised above the surface.



This is a parallel drain under the ramp roadway, and again with an exposed end of the type that is seen perhaps more frequently than is necessary.

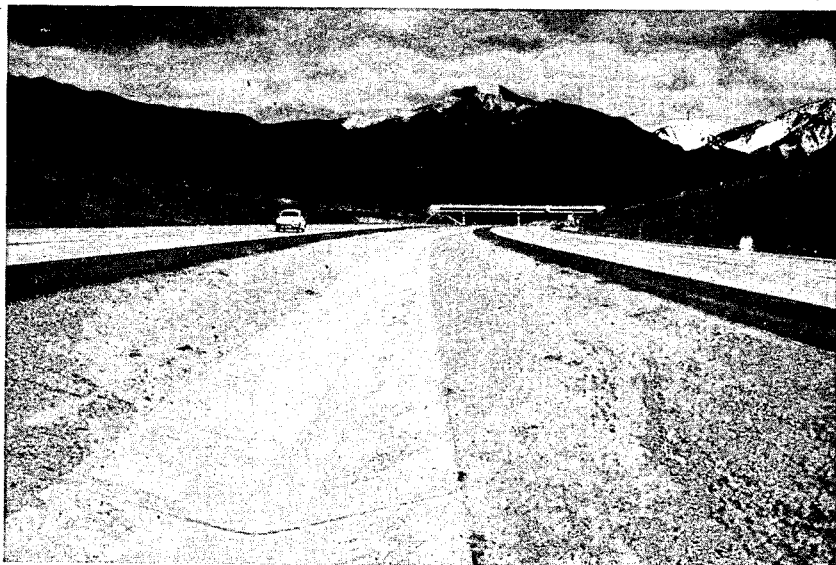


In Utah, on Interstate 80, we found drains of this type, and this curb that we saw yesterday, I think does tend to control the drainage. With these drop inlets that project seems to be quite well served.

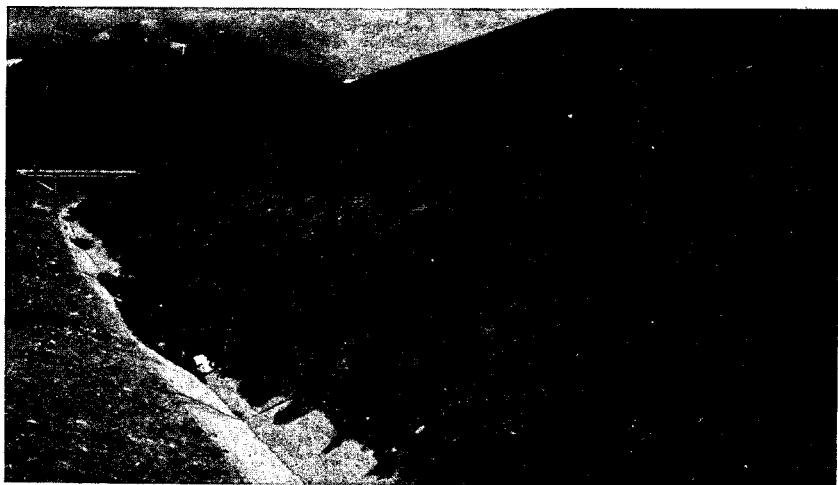


The median drainage is handled in a concrete paved ditch of this sort. Aside from the fact this has a rather sharp V at the bottom, I think it might be regarded as satisfactory.

A rounded bottom would probably be more safe, functionally.



At the side there is a sharper V ditch with a steep back slope, and as you can see, the erosion from this slope is beginning to fill up this particular drainage feature and certainly, from the standpoint of a car running into this type of a break in the slope, this is undesirable.



Mr. CONSTANDY. Mr. Prisk, in that situation would benching permit a flatter back slope at not a great cost?

Mr. PRISK. It is possible, depending upon the material, Mr. Constandy. This slope could have been benched with the right-of-way available on that project and handled in a better manner.

The principal difficulty here is with the sharp break at the bottom of the paved ditch and the steep back slope.

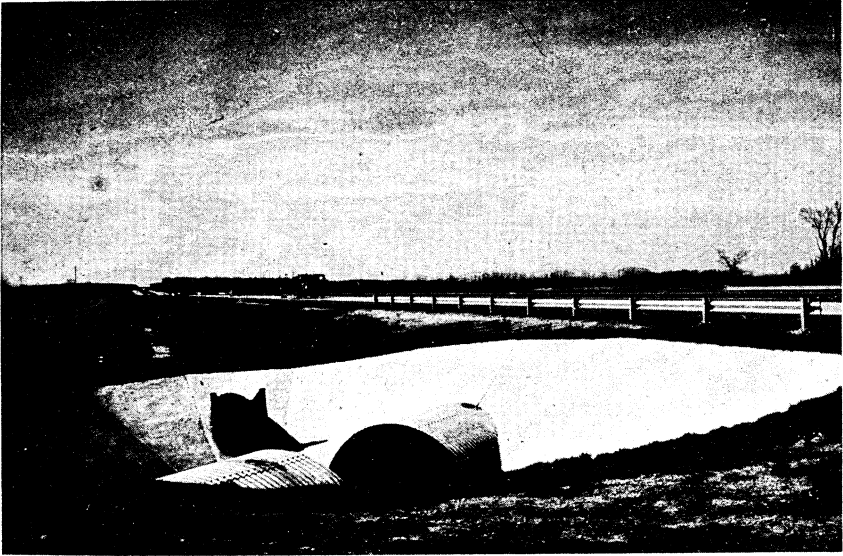
Here is the Indiana project, again showing a drain almost completely flush. Beyond it, however, is an undesirable feature of this median dam that we too often find on Interstate projects; the grate itself is quite harmless.



Also in Indiana we found pipes used under the roadway to drain the adjoining land and to handle natural water courses in the area. These are rather large pipes, and as you will see here, they are left open without any guard as far as approaching traffic is concerned.



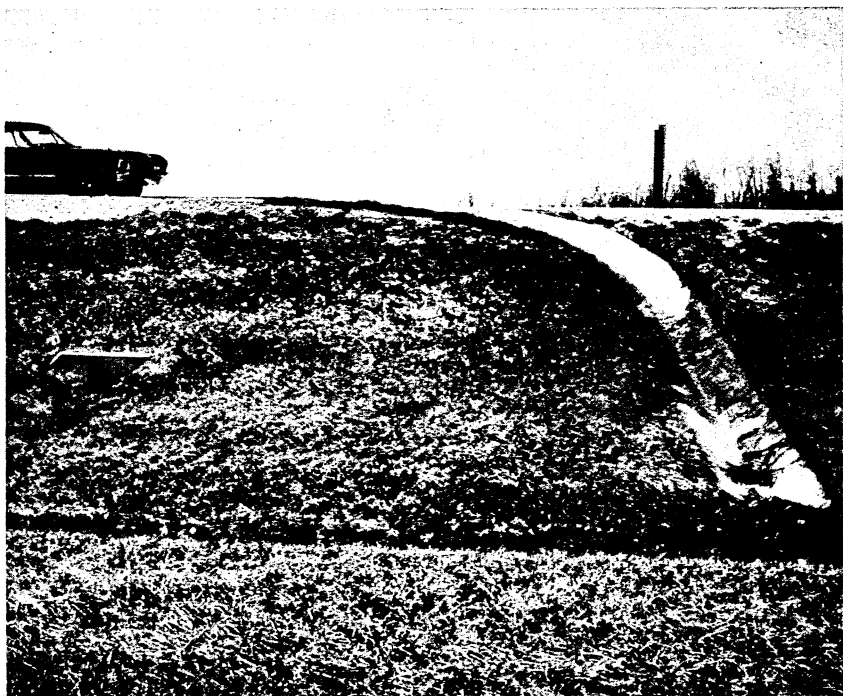
When you come to a major junction where there is a drainage along the highway as well as this cross drainage, very large pipes, some of them running up to 6 to 8 feet in diameter, are brought together in this large drainage sink to handle surges in the waterflow.



This gives you an idea of the Indiana project in terms of the amount of water that does, in fact, drain from adjoining land and collect along the project. You see cars in the upper right-hand corner of the picture. If they went out of control on this slope I expect the water itself could be a very serious hazard as far as the mobility of the vehicle is concerned and also in the event of an overturn.



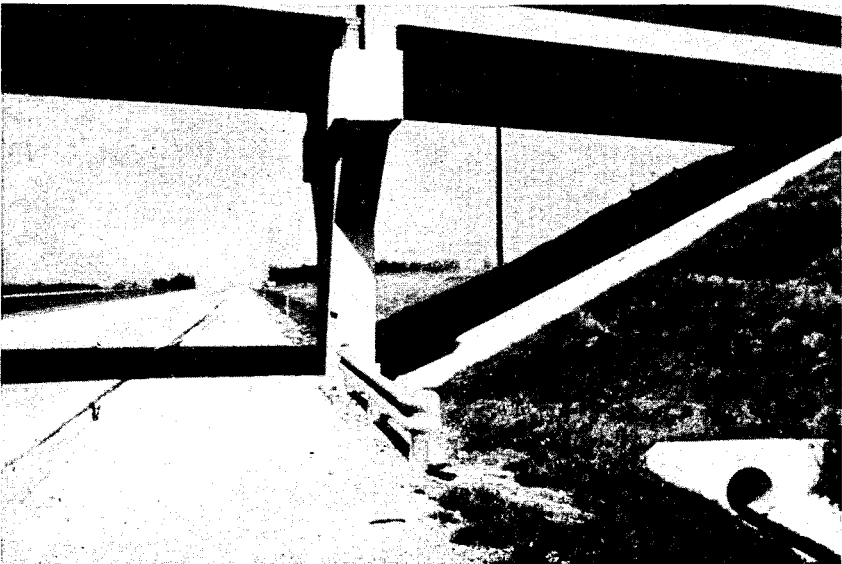
More of this same water condition. The water, I think, must be regarded as a hazard itself. The slopes here are good.



And here is an interesting drainage condition, also found on that project, where there is a ditch paved down the slope which, of course, is not unnatural, but up at the top there is a drop inlet at the same point, which [slide] going back to the previous slide for a moment, the outlet is at this point [slide] so you have two places for water to go immediately in front of that automobile.



Very flat territory. This is also on the Indiana project, showing how they carry their drainage through the embankment behind the side piers. This is rather typical of many jobs that we were touring.



Mr. CONSTANDY. Also undesirable, that headwall?

Mr. PRISK. It presents a very, very solid hazard.

Mr. CONSTANDY. Could we quickly go through the panel members and have your thoughts on the drainage? Mr. Wilson?

Mr. WILSON. To start out here, I think that we saw some fairly good things in some areas. The flush-top drop inlets that we saw in the earlier medians there were very good. In fact, the medians in general were good, I think—but it is very easy to destroy their quality by putting some hazard up in them.

And I saw later on, in some of these slides, that is exactly what happened.

Before we are too critical about the type of drop inlets, I think it should be pointed out here that snow and ice create such conditions, in some parts of this country, that possible a flat drop inlet would not handle them all properly. I am not a drainage expert; I just bring this up to your attention.

Mr. CONSTANDY. I think it is worth mentioning. Is it also not true, in that type of situation, that some other design might accommodate that problem, yet at the same time not present the hazard?

Mr. WILSON. That is quite possible, yes, sir.

I would like to point out that quite often deep ditches along the side of the road can be graded to a higher elevation by merely changing the style of the drop inlet or the manner of carrying the water onward. I would also like to point out that deep ditches along the highway can often prevent early deterioration of the pavement by giving proper drainage.

So you have to compromise this thing in this area.

Mr. CONSTANDY. Thank you, Mr. Wilson. Mr. Skeels?

Mr. SKEELS. I agree we have seen some excellent examples in here and some that are not so good. It seems to point out that it is possible to do a pretty fair job on this item if it is looked at in the light of automotive safety.

I am particularly concerned with dams across medians which sometimes are very abrupt and sharp, and with the parallel drains under the bridge piers along the side. These almost invariably start out in a vertical wall which better attention should be given to, as these would be very lethal.

Mr. CONSTANDY. Thank you, Mr. Skeels. Mr. Huff?

Mr. HUFF. I agree that the protruding inlets, tops, create a hazard to traffic and I agree with what the gentlemen have just said. However, we have had some expressions from people who are well versed in drainage. The so-called grate-top inlet is not efficient for carrying water. It is particularly bad where you have a lot of trash and things that cover it and stop the flow of water.

And I would say further that I believe some studies will have to be made to develop a more efficient inlet and to avoid some of the problems of stoppage I just mentioned.

Mr. CONSTANDY. Thank you, Mr. Huff. Mr. Wilkes?

Mr. WILKES. Many of the examples we saw were quite good. However, it is pretty obvious there are some details that were not executed very well.

As Mr. Huff has mentioned, this grated inlet does tend to become clogged with trash. There have been inlets developed, though, that

provide both the grated inlet and slot that will be self-cleaning. And we have attempted to distribute some of these details to the States. We hope that they will be adopted.

Other details we saw were the result, I am sure, or a designer attempting to produce a maximum economy. For example, the end wall that spilled down into the ditch could be eliminated completely by a longer bridge. So this designer, in developing what he thought was the most economical design, encroached into this ditch area with his embankment and, as a result, it produced a second area hazard.

I guess that is the point I am trying to make, that if we are willing to spend more money, many of these details could be corrected.

MR. CONSTANDY. Yes. We again are looking at situations where perhaps there were considerations of first cost and perhaps they were not really concerned with economics.

MR. RICKER?

MR. RICKER. Two points: One, it is certainly objectionable to run a large culvert out beyond the ditch line where it makes a hazard in itself. On the other hand, if it is cut back flush with the side slope, it is still a hazard, because there is a large hole there that vehicles could drop into. I don't know that we can get away from that hazard and maybe we need to evaluate which is worse, to have a round pipe or a hole.

The other point, I am not sure I entirely agree as to the hazard involved in a moderate amount of water in a ditch. Certainly if the water is deep enough to cover a vehicle, it would be a hazard, but—

MR. CONSTANDY. I am sorry—deep enough to what?

MR. RICKER. To contain a vehicle. If it went under the water it would be a hazard. But it could be that a relatively shallow body of water there would be a very effective deceleration device in itself. And there are many, many parts of the country where there will be water standing in the ditches a large part of the year.

MR. CONSTANDY. Would it be true, too, that the relationship between the depth of the water and the ratio of slope and height of it should be considered? A car going over a steep slope is apt to turn over; if it turns over in the ditch, it would not have to be deep to kill the driver. We all on the committee are acutely aware of an example of that very same thing.

MR. RICKER. I have never seen crash tests in the movie, vehicles running into a shallow body of water like this. I am just guessing that it might be well as a deceleration factor.

MR. CONSTANDY. Thank you.

MR. HARSHA. May I ask a question? Would an additional guardrail in the vicinity of these extended drainage pipes, these large corrugated pipes, possibly alleviate any of the hazard?

MR. RICKER. I believe, Mr. Congressman, as we have been discussing for the past several days, guardrail itself is a hazard and we need to evaluate whether it would be less of a hazard than the exposed end of the pipe or more. In each case, perhaps, it has to be thought of individually, depending upon the curvature of the road.

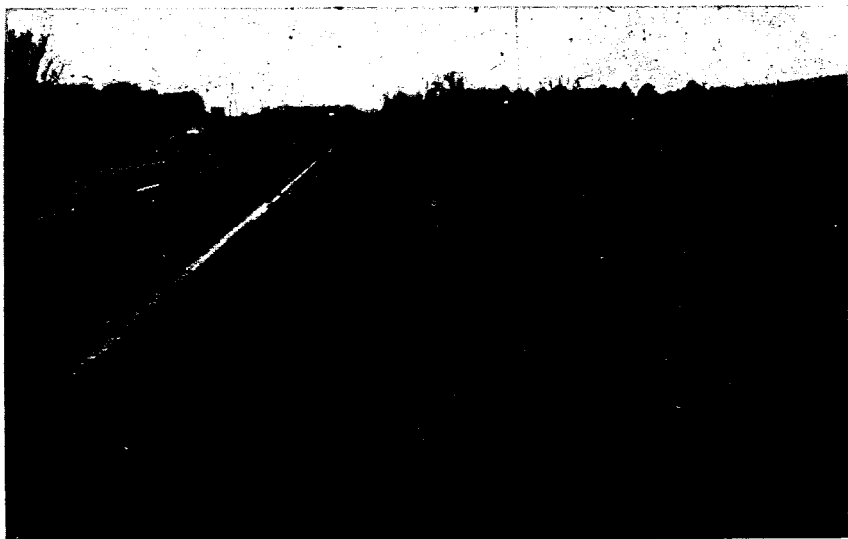
MR. HARSHA. Thank you.

MR. CONSTANDY. Some of the examples we saw, incidentally, did have a guardrail protection for the hazard. I would suggest in each

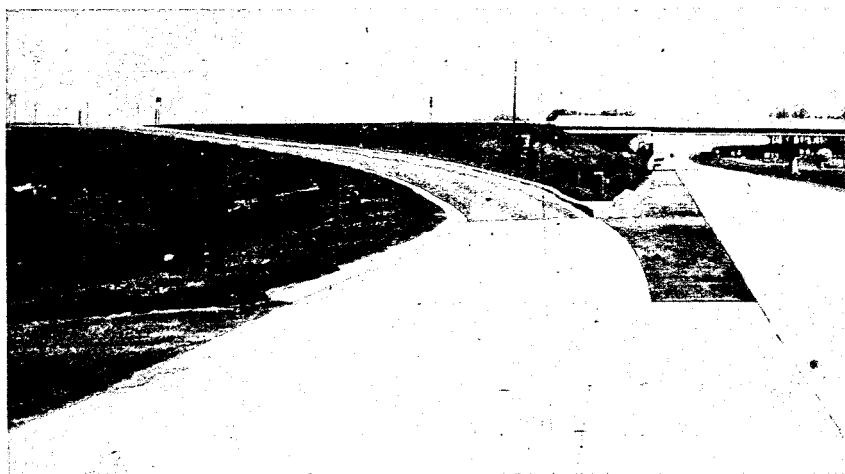
case it was not sufficient to prevent the car from getting into the hazard, particularly the one in Indiana, the large paved bowl. There was a section of guardrail there but it would be fairly easy to go behind it and end up in the hole. Back again, if you are going to install guard-rail it should be done correctly.

Mr. Prisk, you have the next section dealing with shoulders. Would you quickly run through that?

Mr. PRISK. Yes. This is a project in Indiana—the old section that was looked at the same time we looked at the new Interstate work. Here the shoulder is cut off by the use of a curb, which moves down into that entrance area to shield the entrance lane. This is the old type design in Indiana.

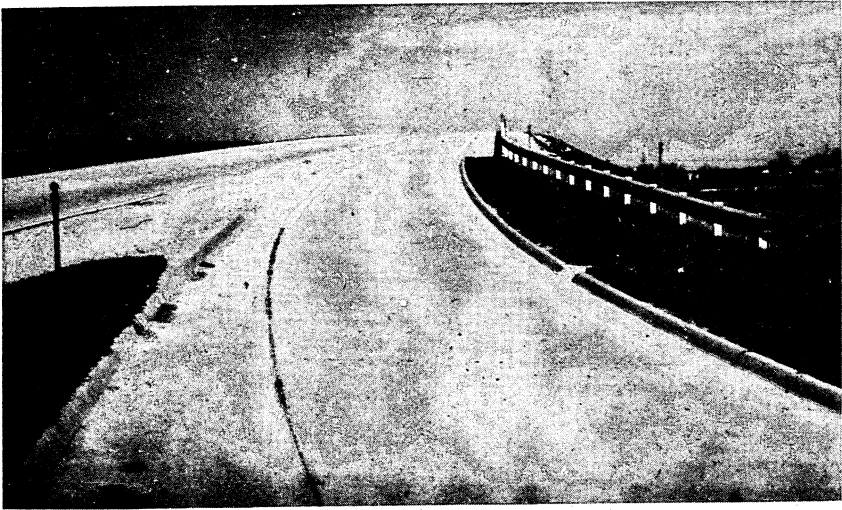


Here we come again to a consideration of shoulders on the Indiana project that has just been opened a few months. In this case, the



shoulder goes directly into the acceleration lane. And there are no shoulders, as you will see, on the ramps. This is an undesirable feature to omit shoulders from ramps. A shoulder does pick up, as you get to this point. [Indicating.]

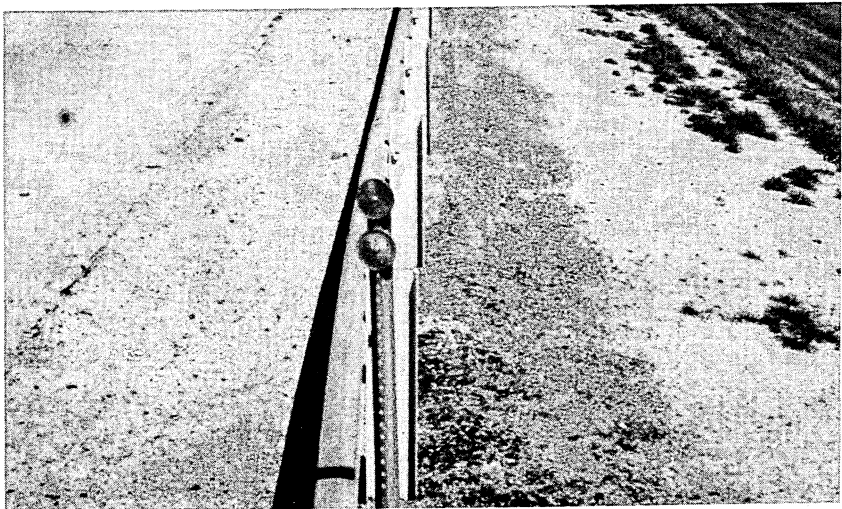
In this instance, a very unusual installation of guardrail which is shown here on the Indiana project, you see curbs that control movement of the entering traffic and the guardrail is pulled in here so that this shoulder, which normally starts here [indicating] and would run on up to the structure on top of the grade, is bisected by the guard-rail installation.



Mr. CONSTANDY. So half of the shoulder is behind the guardrail?

Mr. PRISK. That is true.

Here is a view close up so that you can see the shoulder paved out to here and the guardrail running down the middle.



Mr. CONSTANDY. Yes. That leads into a bridge that does not carry a shoulder across it. Is that not correct?

Mr. PRISK. That is true.

Now as we move into Nevada, we find this shoulder condition, which is very desirable from the standpoint of its appearance and for delineation purposes. These are the travel lanes, the black lanes; the shiny surface out here is the shoulder surface. From that standpoint, it does provide a good aid for traffic.



This is the same condition under poor weather conditions during a snowstorm. Again, along here you have this asphalt curb for drainage control.

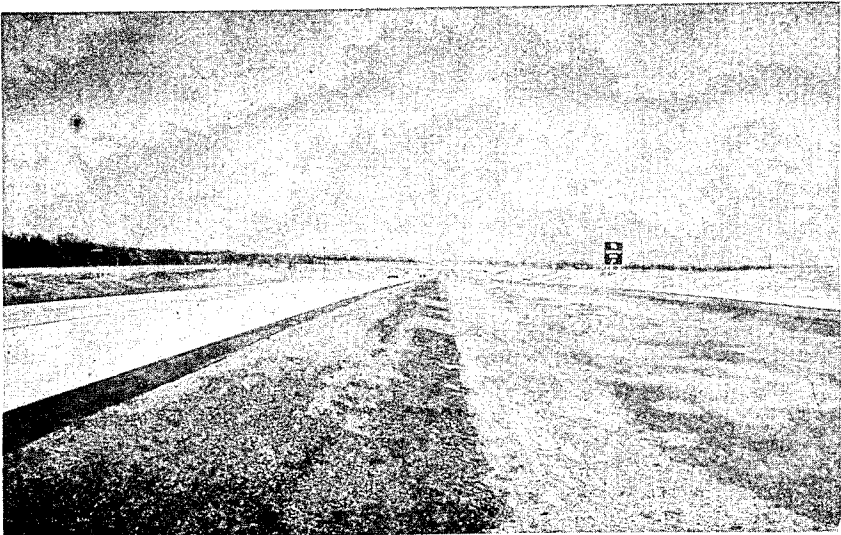


This picture is one on the Missouri project showing the shoulder, first paved 2 feet wide with an asphalt mat, then 8 more feet of treated material, and some slight oiling of the rounded surface. These slopes, as you see, are rather substantial as you move on down here. [Indicating.]

This is the type shoulder that they have. Not any too stable. We understand some additional work is to be done on this shoulder, and certainly is needed, because it is soft now, easily pressed in just walking on the shoulder.



Another view of this same shoulder on the median side, showing perhaps a little bit more transverse slope than is desirable. A shoulder should have a relatively light slope from the edge of the pavement over to this point. [Indicating.]



Here is the Oklahoma City project, which has the feature that we saw in Indiana, no shoulders on the ramp at all, both sides curbed. Of course, this is an urban section, perhaps a little more reason for that condition being found here. But we do have the shoulder through this area [indicating] which is cut off at this point, grass, and, in fact, the light pole is installed at that place.

And here you pick up the shoulder again as you move on through the job.

It is a matter of discontinuity of the shoulder. I think it is certainly undesirable. Motorists should always have a moving travel lane with a shoulder alongside, wherever possible.



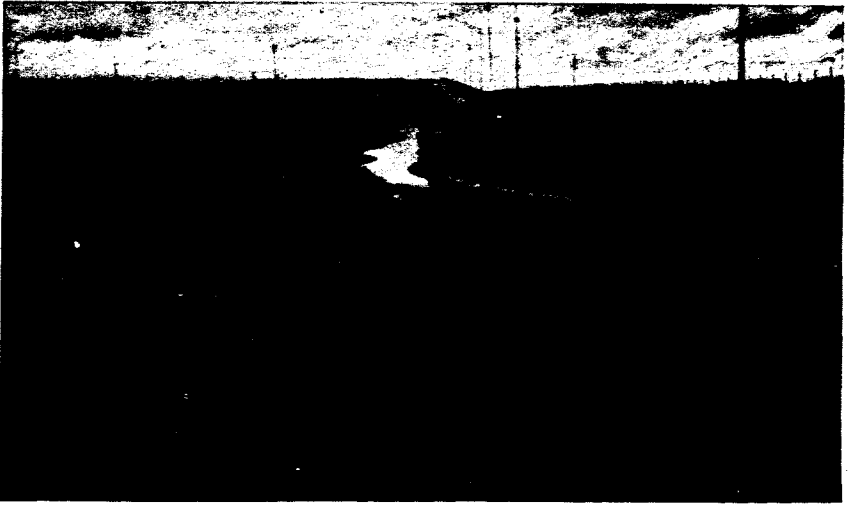
This is another example of how the shoulder gets cut off, and that, of course, shields the entrance movement, but at the same time it does make for an obstruction in the shoulder.

(At this point, Mr. McCarthy assumed the chair.)



Mr. PRISK. Here is a closeup of that obstruction. As you move up and over all of the intersecting streets, this is curbed at this point.





Now on brand new work, just outside Oklahoma City and off the subject project, we find this is still going on, that the shoulder is discontinued at this point, the curb is introduced directly in line with the shoulder, in order to permit this entrance ramp.

This, of course, saves a little bit on your design out in this area as far as space requirements are concerned. But it does not position through traffic too well.

Here is Rhode Island, Interstate 95, where your shoulder actually is employed, all of a sudden here, for a deceleration lane. And so you



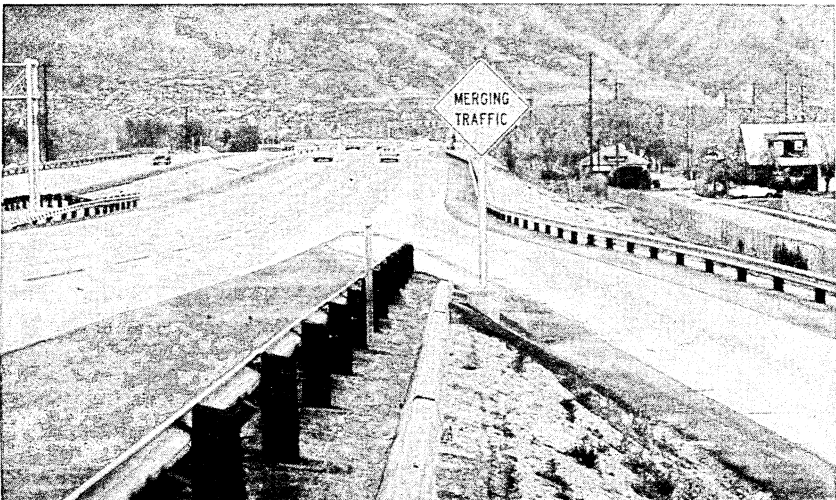
lose the shoulder at that place. And here again is a discontinued shoulder. People are apt to break down at almost any point on the moving lane. It is unpredictable.

Here is the kind of condition we have in Ohio on one of the entrance ramps where, with weather conditions, this soil is rutted out very bad-

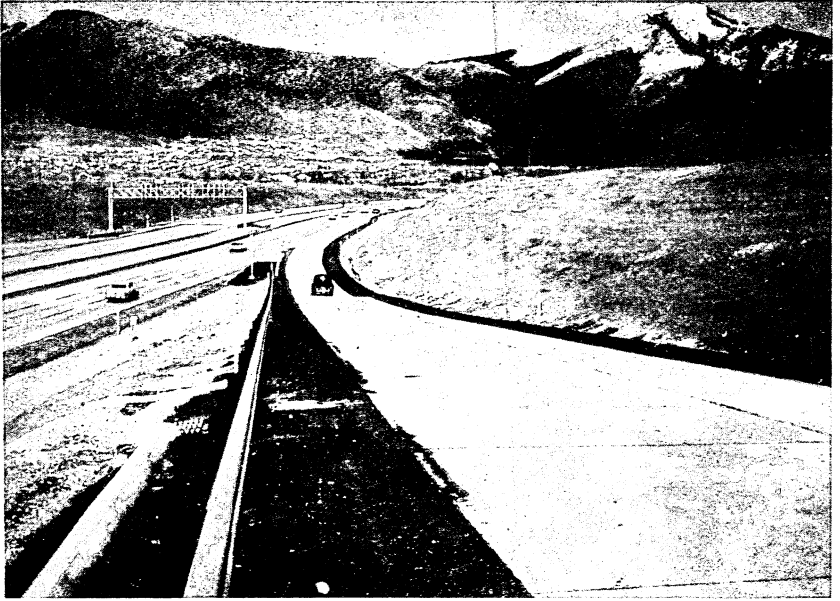


ly. And this is not a traversable shoulder. This is a ramp, of course, here [indicating].

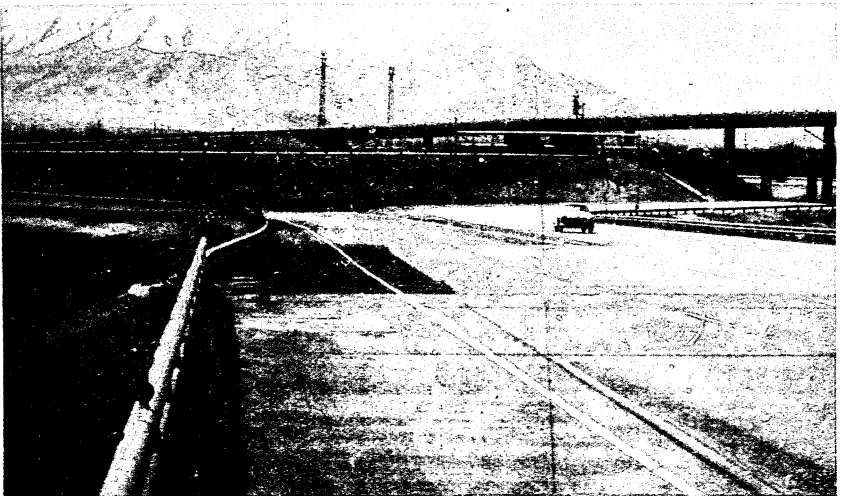
In Utah, you have somewhat the same condition that we saw in Oklahoma City. This is Salt Lake City here, and here is the shoulder interrupted again at that point.



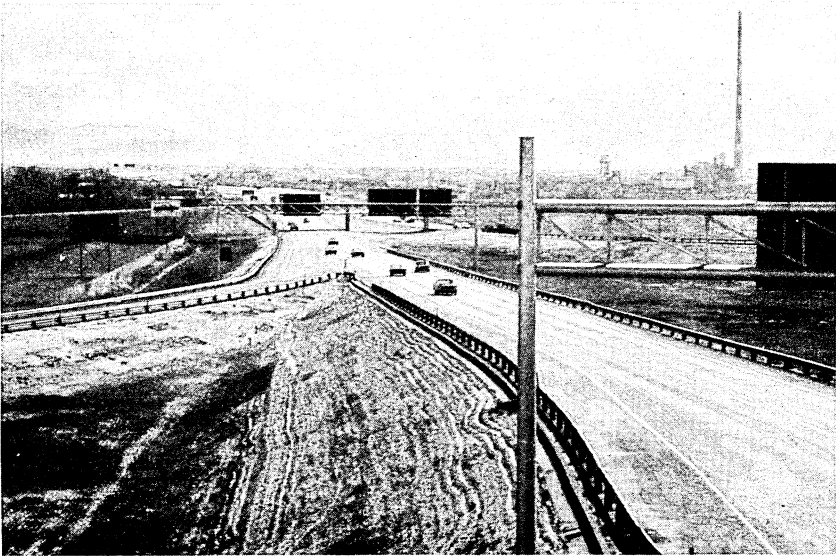
Here is a condition, also on that same Utah project, where shoulders on the ramps are carried on down through the ramp. The ramp alignment, as we pointed out in yesterday's discussion, is very good at this point. But the shoulder cutoff, as I showed you a minute ago, is also evident here.



Here, too, is a similar condition which shows how the guardrail gets warped at this point, even though we have a shoulder provided on the bridge. There is no shoulder commensurate in width provided back in this area. [Indicating.]



Proceeding north on I-15, with Salt Lake City to our right, you have a choice of turning off here to go into Salt Lake City on Interstate 80 or continuing north toward Ogden, Utah, on Interstate 16. This, in fact, is the shoulder [indicating] of this approach roadway that we have been on. You will see cars that move on right up through this, what appears to be the shoulder area.



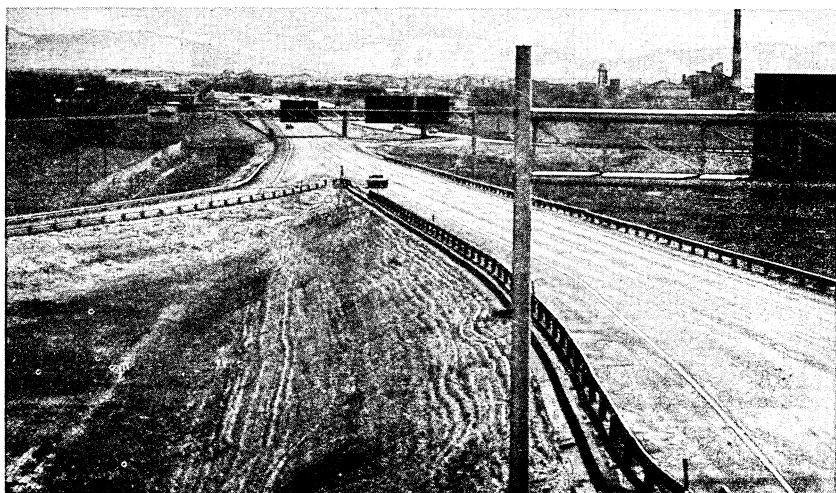


Here is a view of this same place, and this is this shoulder condition. And if you will just watch the red car as he moves from this place (slide) as he comes ahead, he progresses here (slide) and through here.

Mr. CONSTANDY. Of course, it is the one next to him we were concerned with, but the red one is easy to see. The car riding the shoulder, restricted shoulder, going over the bridge.

Mr. PRISK. Here the car is really induced into the shoulder because of this condition.

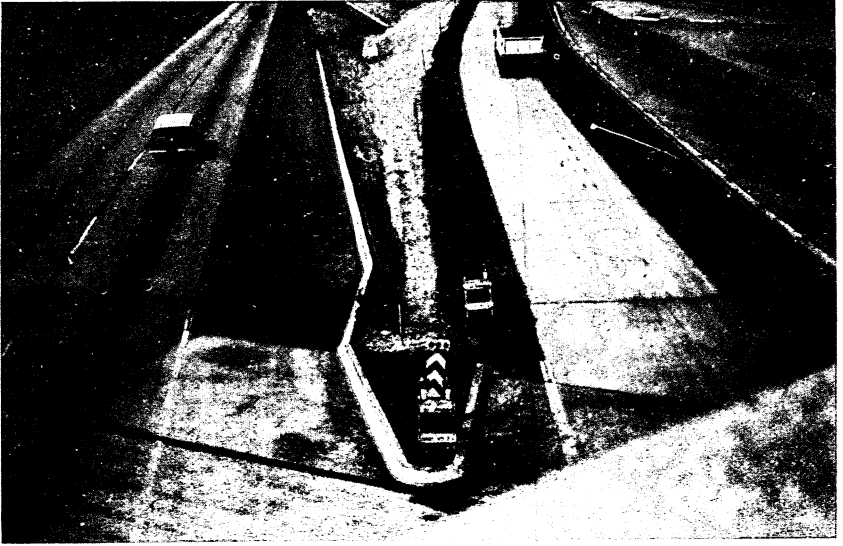




Going on ahead, here another one comes up on that shoulder in the same fashion as the first shot we saw. Watch his progress.

He comes on up the shoulder. You see what happens to the shoulder here. It narrows down at the structure and if he were to continue on the shoulder, he would find himself in some trouble.

As you go immediately under the structure where those pictures were taken, this is the condition that you run into: curb gore at this point not too traversable down through here. [Indicating.] That is the off-ramp and this is I-15 straight north. That concludes this series.



Mr. CONSTANDY. Let me ask the members of the panel their observations. Mr. Wilson?

Mr. WILSON. I would like to make about three points here in connection with shoulders.

If there is any place where vehicles need maneuvering room, it is in the vicinity of exit or the vicinity of entrance to limited access facility.

There is sometimes a great deal of hesitancy taking place on the part of drivers, not knowing exactly what to do or where to go; and you see some strange maneuvers take place, which is all the more reason why, not only should you give them a full shoulder, but you should give them every other available chance to get off the road if they do reach an emergency as well.

I would like to agree with Mr. Prisk on the desirability of using contrast treatment between shoulders and main line traffic lanes, particularly where you can use a concrete pavement with a black asphalt shoulder.

However, this can be accomplished in other ways as well by use of open graded mixes which have a different surface texture, and you can also use asphalt. It can also be done by using edge lines; and as I mentioned yesterday, it is desirable to carry this contrast treatment across structures, where the structure may be all white surface.

The shoulder itself may require some kind of black treatment.

I think it is important, in my own opinion, that shoulders should be paved. If you look at the skidding-type accidents the skids start on the travelway many times and are carried right off in the shoulder area.

Whenever you get into a soft material, there is always a chance that the vehicle may overturn by getting caught in the soft material.

I think we have paved our shoulders, and particularly the right-hand shoulders, in California for as long as I can remember. We have recently decided to pave our inside shoulders from a 2-foot width to a full 5-foot width on our freeways.

This will result in a slightly higher cost initially, but will certainly reduce maintenance overall.

Mr. CONSTANDY. Thank you, Mr. Wilson. Mr. Skeels?

Mr. SKEELS. Not being an expert in this area, I will make one point. It was not shown in Mr. Prisk's slides. This is the problem of the shoulder on the cloverleaf ramp.

Many of these cloverleaf ramps for various reasons are in restricted areas and have fairly short radius turns; and my observation is that the shoulders are paved on the inside and sometimes the outside of these turns, and that is where the traffic rides.

I wonder if there is a better solution to this?

The only one I know of is to eliminate the short radius turns, and this is not always practical.

Mr. CONSTANDY. Thank you, Mr. Skeels. Mr. Huff?

Mr. HUFF. I believe there is no need to comment on what Mr. Prisk said. I was more impressed by what he did not say than I was by what he did say.

He did not discuss the adequacy of the width of the shoulder as related to the needs of traffic. Nor did he dwell very much on the turbulence created when a shoulder has to funnel into a narrow bridge. Emphasis in discussion of shoulders should be put upon the question: How wide should a shoulder be on the road and how wide should it be on the bridge as related to the road?

In my opinion the bridge shoulders must be 2 to 4 feet wider than the road shoulder, and it is my personal opinion that road shoulders should be at least 12 feet wide instead of 10 as is now provided for in the standards.

Mr. CONSTANDY. Would you suggest that on both sides, Mr. Huff?

Mr. HUFF. Definitely on both sides. Originally the shoulder on the right side was provided for cars that got out of control and had to go over and stop. The shoulder on the left side was an obstruction clearance only. With increased speed of automobiles and increased number of automobiles, it is my opinion that the clearance—the obstruction clearance for the rail should be wide enough to provide for a stopped vehicle as well as for clearance.

Mr. CONSTANDY. Thank you, Mr. Huff. Mr. Prisk?

Mr. PRISK. I would like to say that I am impressed by what Mr. Huff says about the provisions for shoulder width. I think this is very definitely a move toward safer design, particularly on structures. And I would fully concur in the comments that he has made.

Mr. CONSTANDY. Thank you. I would like to say that Mr. Prisk's omission of those is probably my fault brought about by an effort to try to hurry this along so we can conclude it today. Mr. Wilkes?

Mr. WILKES. The early highway research showed that if you provide a side clearance of 6 feet you would not reduce the capacity of the main lanes. I expect that this is the source of many of our practices today, and we have not sufficient clearances for the out-of-control vehicle.

We fail to really appreciate the volume and magnitude of the hazard—of the frequency of this type accident.

Mr. CONSTANDY. You suggest along with Mr. Huff that this is an area which should be looked into? The adequacy of the present standard?

Mr. WILKES. Yes.

Mr. CONSTANDY. Mr. Ricker?

Mr. WILKES. Let me make one more comment. The photographs we saw of the Utah project illustrate the use of this shoulder as a recovery area where the vehicles were either undecided or deliberately rode through this.

They saw they had a clear lane and did not merge into the left as perhaps the previous signs had instructed. So this did provide some measure of safety to these vehicles through indecision or deliberate effort on their own. And I think that that is an important element in the design of the gore of the highways.

Mr. CONSTANDY. Thank you, Mr. Wilkes. Mr. Ricker?

Mr. RICKER. Could we be going back to the first picture of Utah showing the shoulder problem there while I am discussing other things?

The matter of closing off the shoulder at an entrance ramp has been controversial for many years, and we discussed this a number of places.

The Illinois tollway people told us that they had no evidence of problems because of that design, although it existed on all of their entrance ramps. So the opinion is not clear.

On the other hand, when we look at the reason why we have shoulders on this type of highway—a vehicle breaks down; the driver needs to get to a refuge point immediately, and if there is a long stretch such as this where he cannot get off on the shoulder, he cannot get to his refuge. And when he is ready to start up again, he needs an unobstructed path to speed up on the shoulder and get back to the travel lanes.

I am looking for the first picture of your last series. This is a very dramatic picture showing what happens when you pave the main roadway with the same material as the shoulder. Someone has tried to change the impression that that is the main roadway, to make it a gore or a shoulder; but the pavement itself clearly tells you that if you are going straight ahead, you follow the straight-ahead path and do not pay attention to the paint lines.

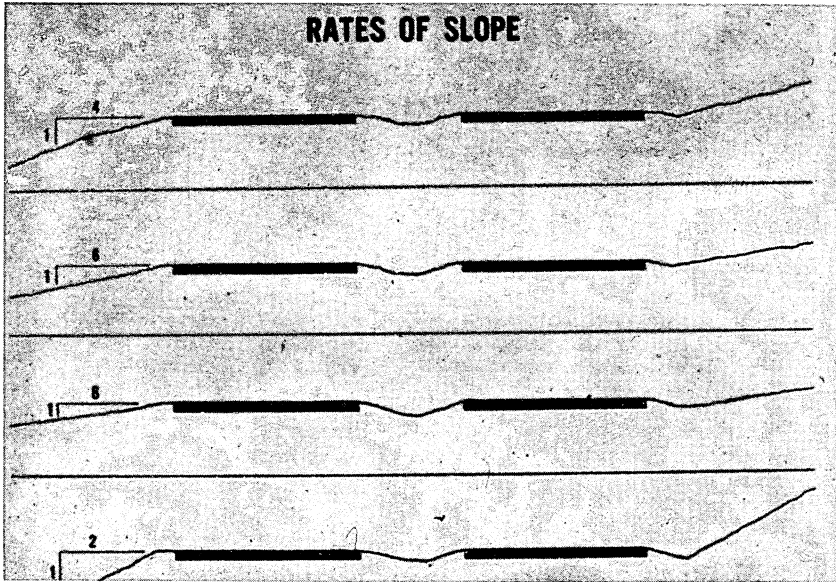
This happens in other areas as well, where joints in concrete pavement do not match up with the intended lane alinement and the paint lines cannot be strong enough to overcome them.

I think the answer would be to change the texture of that shoulder pavement so that it is clearly a different use.

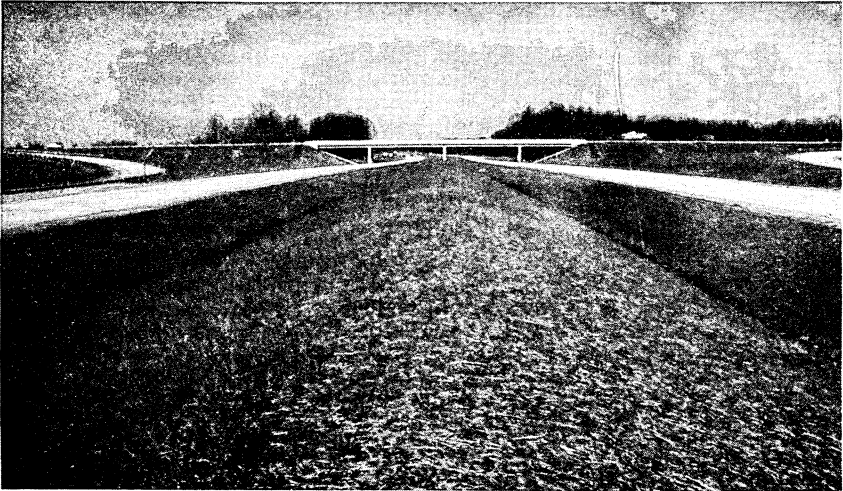
Mr. CONSTANDY. Thank you, Mr. Ricker. The last element we have to discuss is slopes.

Mr. PRISK. We have a few pictures of slopes on each one of the projects that I am going to run through rather quickly.

This subject I think has been appreciated by the panel and by the committee as they have looked at other features of design. This simply illustrates the various types of slopes in common use, 4 feet vertical—it is what we refer to as the 4-to-1 slope.



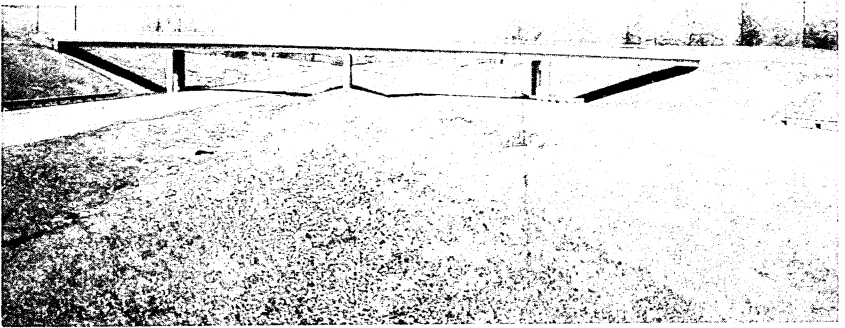
This is a view of the Ohio project, on the Ohio Interstate 80, very wide median, flat slopes, as you see throughout.



The median is mounded up in the center. Drainage carried on each side of each roadway.



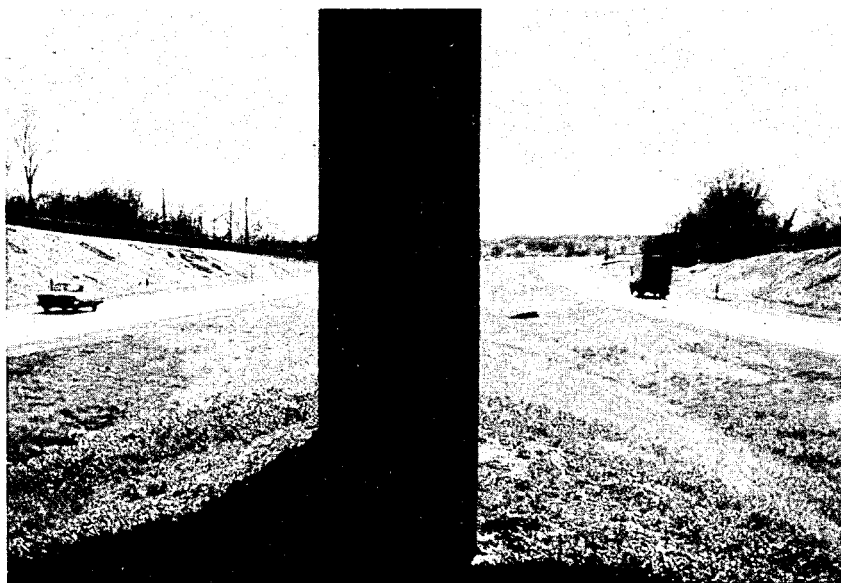
Here again slopes are flat. You have the advantage of turning cars away from the center median pier with the slope condition of this sort.



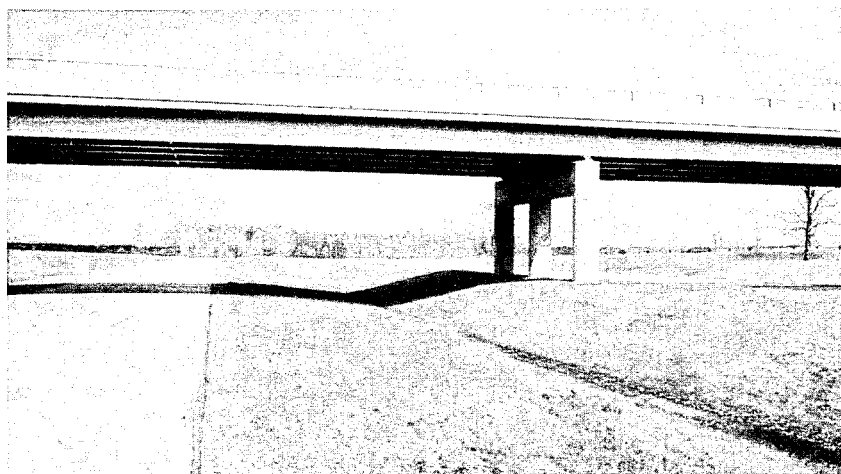
Here is a closeup, closer to that median pier.



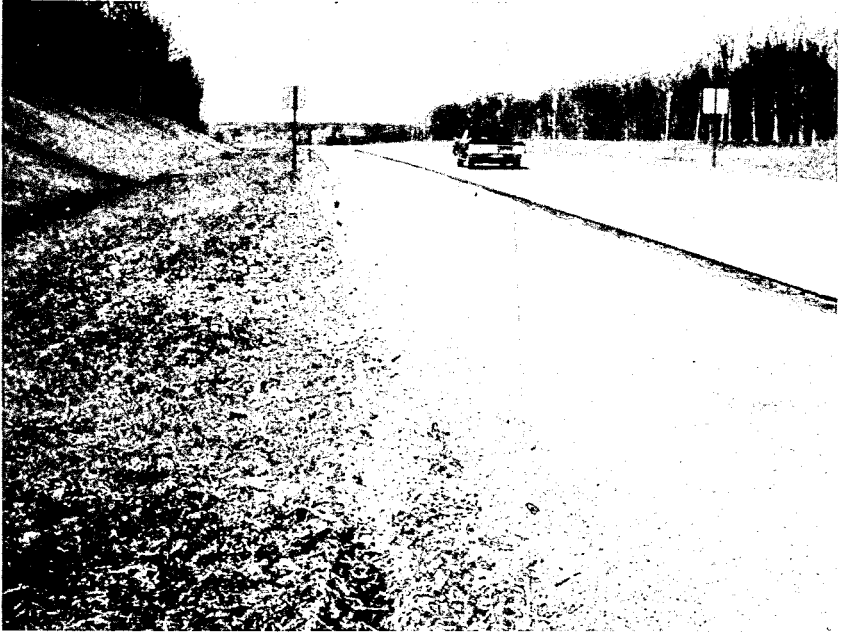
Slopes of this type are relatively stable and easy to maintain in contrast to the steeper slopes.



Here is the other side of this same center pier again.



Off to the side you have nicely sloping roadside to backslope, made up here about 4 to 1, which can be traversed by a vehicle safely.



This is the median condition at this point.

Mr. CONSTANDY. This is on the other design section. There is an obvious difference between two parts of the section that we looked at; one project had this type of swale and the other one had the berm.

Mr. PRISK. That is right. This is depressed median and also somewhat narrow.



And this continuation is on the same section. Side slopes are also a little steeper.



Now we move to Missouri, and we run into high fills of this type.



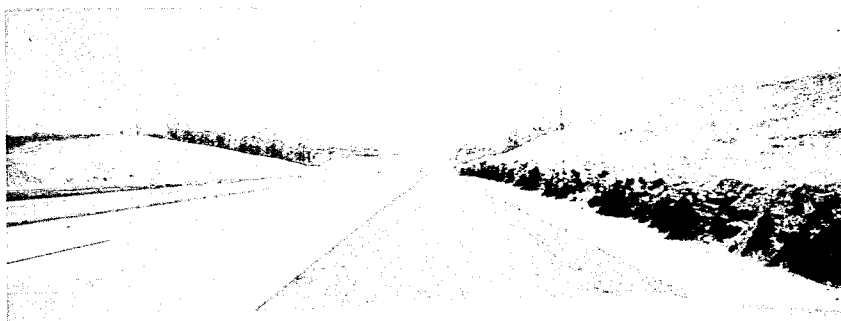
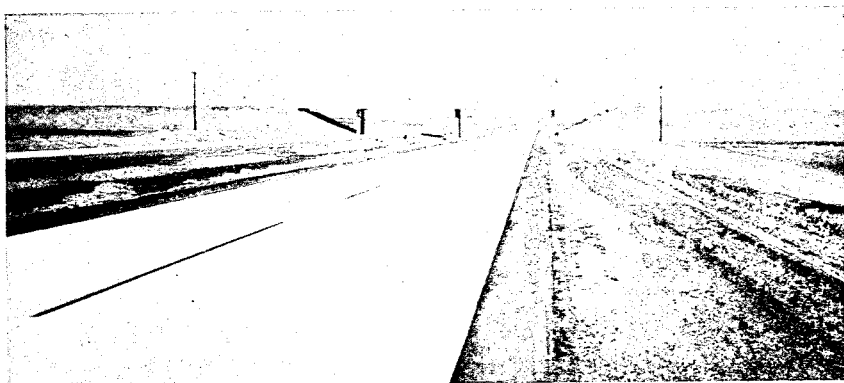
There is no guardrail put in on this project at all yet, and I think you can see that easing the slope in this kind of country is a rather substantial job, but at the same time it presents a substantial hazard.



Here there is a drainage facility down at the bottom.



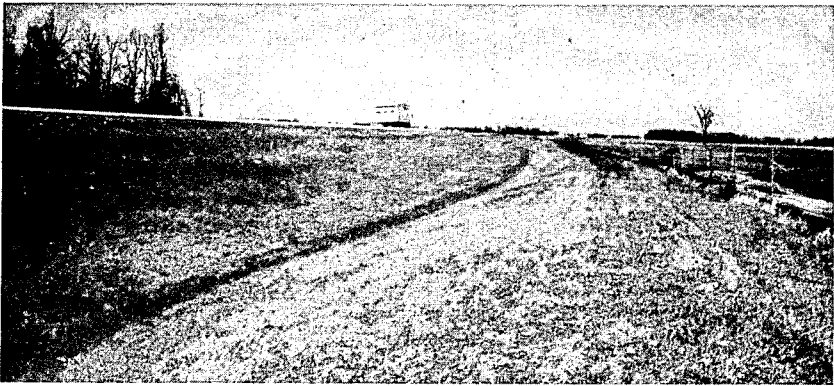
Moving along on the project, this is rather flat country, and slopes are easy to control under these conditions.



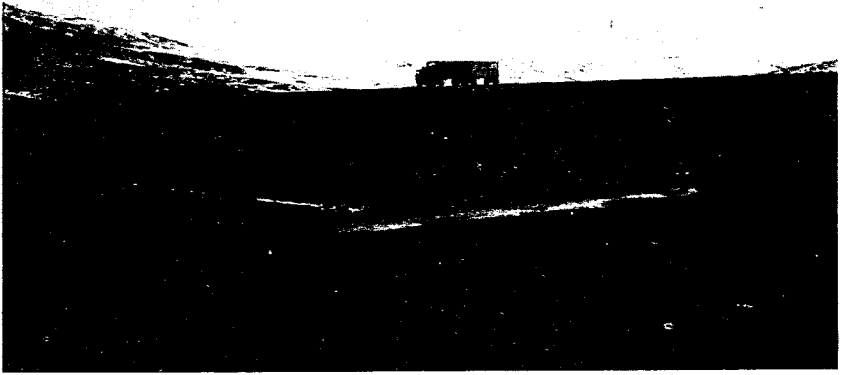
A special situation, of course, introduces itself if you find rock alongside, and in the severe cases here this has been cut back to 20 or 25 feet from the pavement edge, still stands there, somewhat of a hazard.



This on the Indiana projects shows relatively good slopes to the roadside, carrying on out all the way to the right-of-way line.



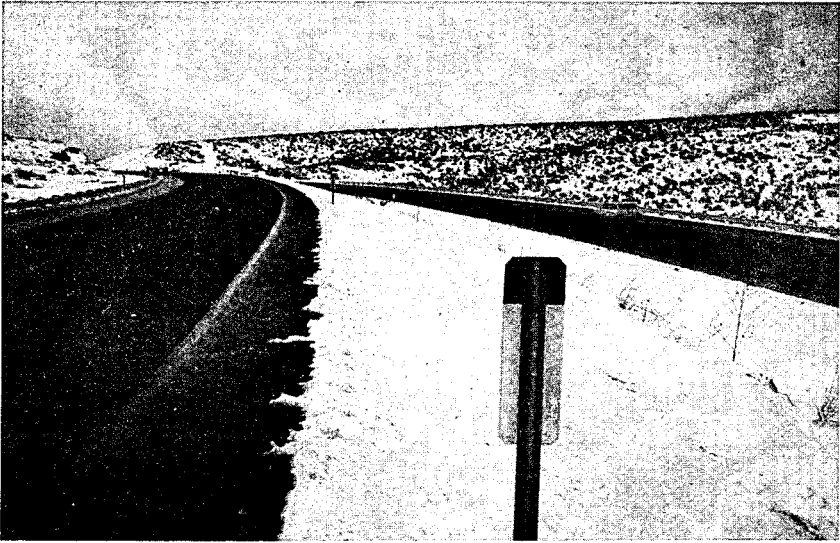
On the Nevada project there are differences in grades, as you will remember, between the two roadways, very high slopes here totally unprotected for the most part and probably standing about $1\frac{1}{2}$ or 2 to 1. Here is a view of a truck negotiating one of those slopes.



And here again you can see the difference in elevation, natural surroundings, and the roadway, types of slopes that are employed at this point.



Still another view of the countryside there in Nevada.



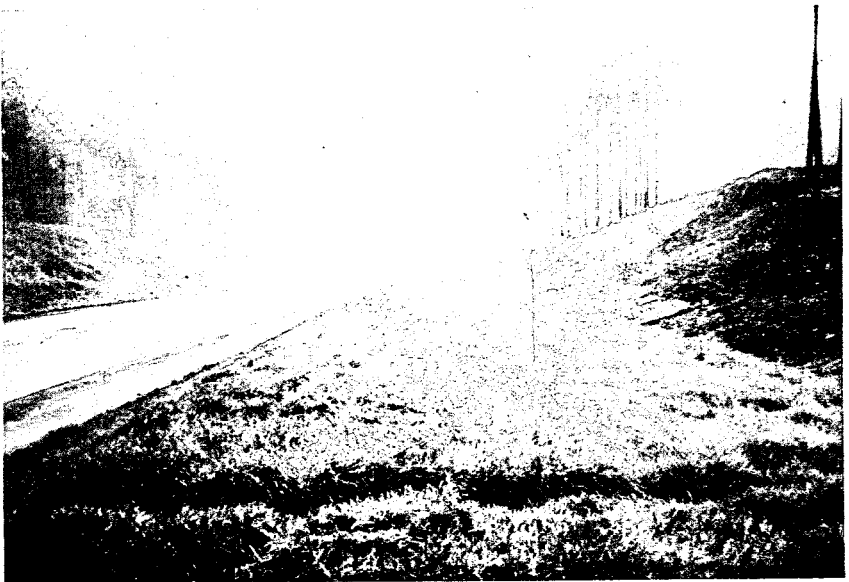
Under poor weather conditions, again this is the kind of slopes down through the median to the other roadway.



And here, as you enter a rock section, you get into a more severe, much more severe slope, and to a degree much more severe hazard.



In Georgia you find this kind of condition. The median has a good many trees standing, and the slopes move out to this point, with the median being mounted up where the trees are located.





On the roadside slopes are moderately good, but you find conditions of this sort where water is dammed up.

And you have, although with a fairly good slope here, quite a pond at the bottom. When these are wet, without being properly covered with vegetation, this becomes very hazardous to negotiate.



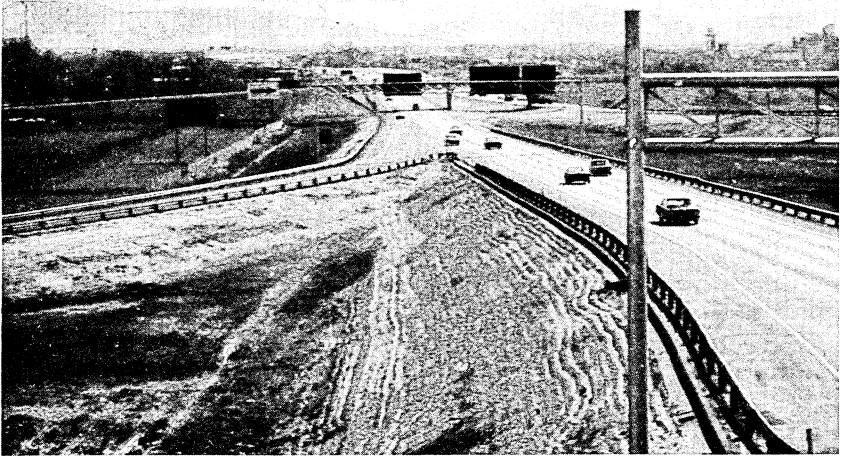


Occasionally on projects of this sort, as we did here in Georgia, we find mounds of dirt that are left in areas where it could so well, with a little bit of attention, be moved to adjoining sections to ease slopes. Slopes themselves right in this area were probably about 2 to 1 or so.

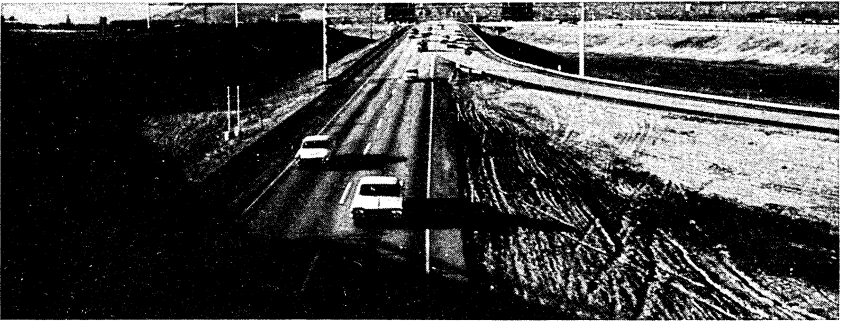
Nearby sources of material and modern earthmoving equipment make it possible to distribute soil in such a way as to make slopes negotiable. Some of that sort of thing was done here.



Going through to Utah, one of these gores that you looked at, it would be a good place to have some extra dirt down in here, and these slopes being—if they were a little bit flatter, this guardrail could well have been eliminated, and this would be a negotiable area.



Here is one that is in fact negotiable. We have all seen pictures of this previously.



Here are the slopes in the median. Again these slopes must be more abrupt, if the medium is not paved. A portion of this project does have a paved median, and the other part is unpaved. And steeper slopes of course are on the unpaved section.



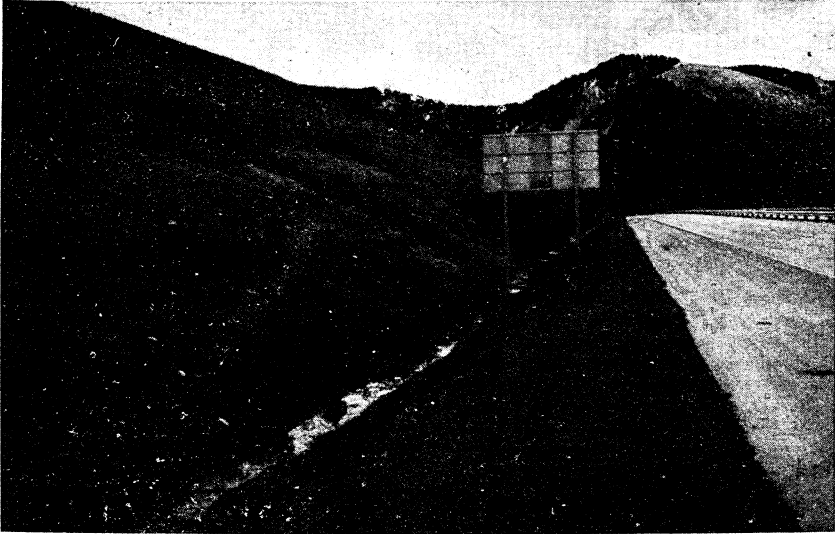
This is still another view of that side slope condition that we were looking at a moment ago.



Slopes here are such that if the dirt were readily available, right-of-way is setting back in here, and this could have been perhaps eased off to the advantage of anyone that might move on that side slope condition.



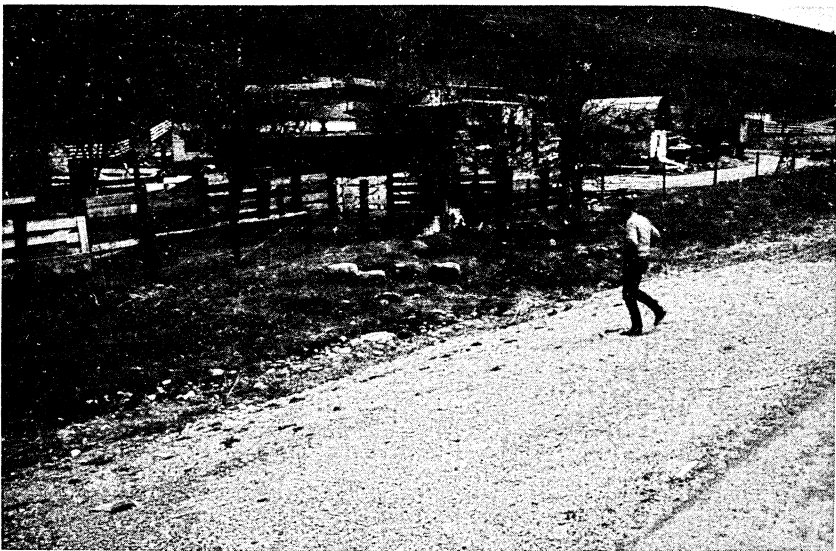
Next we come to Montana. This is one of the things that does happen under certain drainage condition. You gradually cut a ditch deeper and deeper into the roadside, so that it too becomes a hazard. And unless this ditch is properly controlled, sometimes lined, it will be very difficult to negotiate with a vehicle.



I am not quite sure why we have that. This is a man taking some of his porkers home, a nice flat slope.

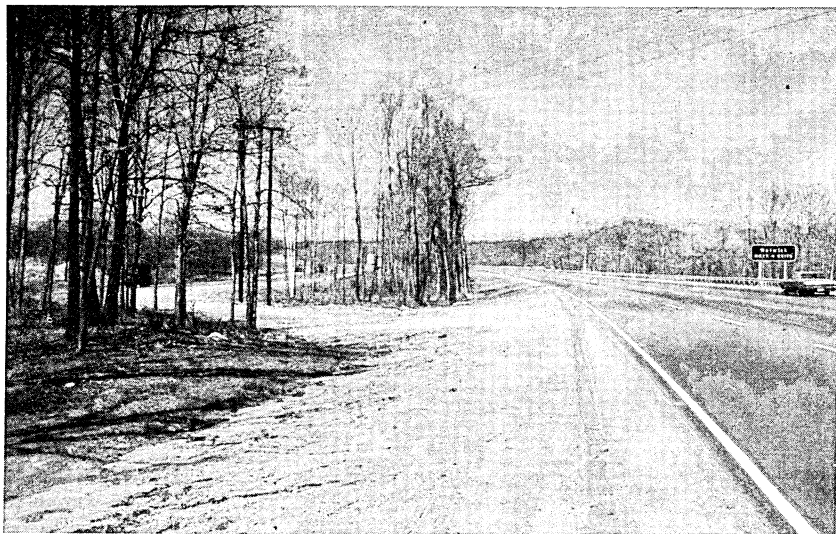
Mr. CONSTANDY. We thought it was an antifreeway demonstration.

Mr. PRISK. I guess.

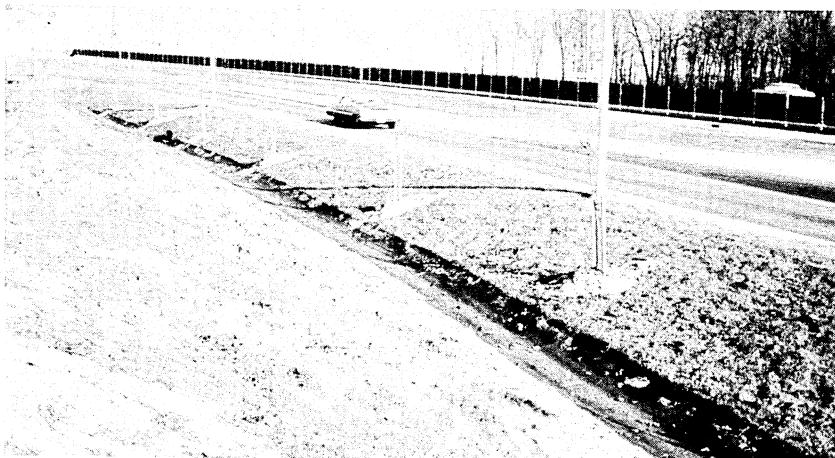




This is in Rhode Island. Your slopes, of course, are very easy here. They are fairly flat. The trees are the hazard. [Slide.] Here you have rocks coming through the surface of the earth—this happens in New England—as well as the trees. [Slide.] And more of the same.



Here we have trees very recently planted and rather too close to the pavement, if I might say so.

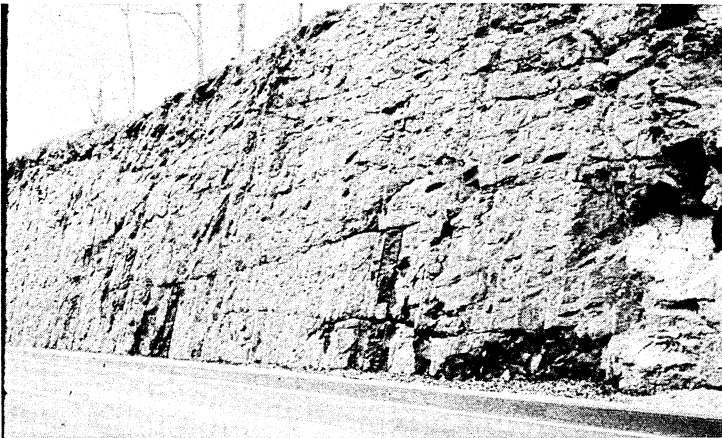




Here there is rock adjoining the roadside, and these slopes really ought to have some protection. It is hard to imagine how this can go on without ultimately proving to be a hazard. [Slide.] Here too is more of the same rock. [Slide.] Still more. [Slide.] And still more. There was an accident in this general vicinity.

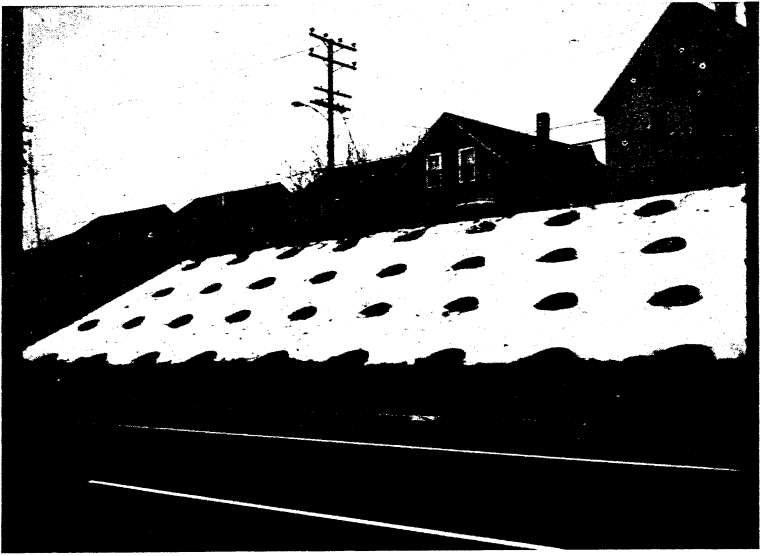


And here is a case where they cut the rock back in a slope plane, which leaves the rock with a relatively smooth surface as against the natural rock that we find in other places.



This is some landscaping that was done on the project, just north of Providence, on I-95. A great deal of money and effort went into design and construction of attractive roadside at this point.

How much attention is given to slopes, I do not know. Considerable to vegetation.



Mr. CONSTANDY. We would like a short comment from each member of the panel on these slides pertaining to slopes. Mr. Wilson?

Mr. WILSON. Here again I think we saw some evidence that we are trying to give the motorist a little bit of relief if he does have to leave the road. I do not think anyone could dispute the fact that we ought to have wider slopes and flatter slopes.

Particularly I was pleased to see some widened areas cut. Sometimes this is rather costly. Grading is a pretty costly part of the road project.

There is also another advantage here in that it helps during your snow removal operations. And I think we have to look at slopes of all kinds as a matter of economics.

The cost is not only involved in the grading of the slopes and the grading could be very costly. I notice in one of these areas, the ground was rather flat; and I imagine that the material would have to be hauled in considerable distances.

Not only that, you would have to buy additional right-of-way and it would have to be a part of the very early design or the very early planning stages of a job. That is the time when you have to lay down your limitations on slopes.

Mr. CONSTANDY. Thank you, Mr. Wilson. Mr. Skeels?

Mr. SKEELS. Well, I agree that flat slopes are good. However, the slope itself, the actual grade of the slope, is not so bad providing it does not get extreme. By extreme I am thinking of greater than 4 to 1.

The hazard is really—it really comes about at the bottom of the slope or toward the slope. Visualize a car going out of control, going

down this slope. He can negotiate a pretty steep hill. However, if he comes to the bottom and runs into a V-ditch or bunch of trees or a sharp back slope or rocks, that is where he really gets into his trouble.

In the rock cuts, these probably should be protected. One way might be to face them with a fairly low concrete wall that would at least make it smooth. It is pretty hard to make it soft, but you can make it smooth.

I have mentioned ditch bottoms. They should not be allowed to be V-shaped. They should be gradually rounded so that a car going through it will pass through and not be brought to an abrupt stop against or toward the back slope. Obviously, trees should not be tolerated close to the roadside. Trees should not be planted on the slope itself, as we saw them on the pictures.

One other item on the slope. In some cases the slope can be flattened and carried out farther from the road to protect an underdrain. In other words, if an underdrain is extended, it becomes less hazardous, and the slope can be flattened to cover it up. Carry it back a hundred feet from the road, and flatten your slope to cover it up, and you do not have to worry about the head wall or the end of the pipe.

Mr. CONSTANDY. Mr. Huff?

Mr. HUFF. Of course the advantage of the flat slopes has been demonstrated over and over. We might say that this was first brought strongly to our attention a good many years ago by one of the automobile manufacturers whose representative is sitting to my right. We should be grateful for the groundwork and the basis upon which this important feature was developed.

I might add that on the Interstate System it is entirely possible that we would have enough right-of-way to develop flatter slopes than on most of the roads that we have already built. However, highways where right-of-way has been a problem will constitute one of the greatest difficulties in developing flat slopes on already constructed highways.

In my opinion it is most important that we do move to developing slopes in the area of 6 to 1, which is recommended by the yellow book, on all new highways and on those which have already been built where it is possible.

Mr. CONSTANDY. Thank you, Mr. Huff. Mr. Wilkes?

Mr. WILKES. I do not believe I have any comments to add to those that have been made previously.

Mr. CONSTANDY. It is a little out of your field. Mr. Ricker?

Mr. RICKER. I do not know that I have much to add, except that in many parts of the country such as in Pennsylvania we have almost continuous cuts and fills as we traverse the hilly and mountainous areas; and it is literally not possible to get the flat slopes that might be desirable, the same way with the rock cuts that are exposed.

There is another area here which is probably not for discussion today, but the variation in scenery that is obtained by having rock cuts or changes in topography may result in drivers being more alert and staying awake longer; and I do not know that we have any data yet which shows that they can drive these roads safer, but I suggest there is a possibility.

Mr. CONSTANDY. Thank you, Mr. Ricker. Mr. Chairman, that concludes the presentation of the slides on the nine projects. It had been my intention at this point to ask Mr. Prisk to make some summary

observations. I think with the time we have remaining that I will ask leave that Mr. Prisk might prepare that statement and submit it at this point in the record as exhibit No. 8.

Mr. McCARTHY. Without objection, it is so ordered.
(The document referred to follows:)

SUMMARY STATEMENT OF CHARLES W. PRISK, CONSULTANT TO THE SPECIAL SUB-COMMITTEE ON THE FEDERAL-AID HIGHWAY PROGRAM

INTRODUCTION

The newest Interstate highway projects in nine States were inspected during the period from April 3 to May 2, 1967 for the adequacy of their design for safety. These improvements appeared to represent impartially the freeway design just now being opened for public travel on the Interstate highway system. Each section was located in a different geographic region of the United States, corresponding with the regions of the Federal Highway Administration. In four States the projects were entirely rural, in two States entirely urban, and in three States a mixture of urban and rural.

Roadside hazards were given special attention during the field review and a surprising number of these were observed on all nine projects. Because the projects visited are typical, it is not unreasonable to infer that many of the same weaknesses could and undoubtedly do exist throughout the 25,000 miles of the Interstate System that are now in use.

The prerequisite to improvement of this situation is a thorough understanding of the nature of the hazards. In my judgment, they arise not so much from willful violation of official design standards for the Interstate System as the widespread failure to recognize and treat a major freeway accident problem. The problem involves single vehicles that leave the roadway out of control, a type of accident that accounts for about three-fourths of the traffic deaths among users of the Interstate System.

A parallel and related difficulty stems from the insufficient and oft-delayed use of knowledge critical to safety. Much of this is readily available from reliable experience and research resources. In the nine State review, the principal design elements related to roadside hazards were classified in the following categories: Guardrail, median barrier, structures, shoulders, curbs, drainage facilities, signs and sign supports, lighting standards, gores, slopes.

Information was assembled on each of the nine projects for the items listed. During the past four days of this hearing, a review of the roadside conditions has been presented. My testimony has been based on a field visit to each project, conferences with many of the affected public officials, and close study of the design policies and practices applicable in each case.

Only four projects, those in Oklahoma, Georgia, Rhode Island and Montana, had roadway lighting installations and obviously the observations on lighting standards relate mainly to those States. In Missouri, even though the Interstate project inspected had been open for about six months, guardrail work was incomplete, being in place at only a few structures. Hence the comments on Missouri guardrail have application to only a small and perhaps unrepresentative sample of what later will be installed.

The nine projects had been open to traffic for periods ranging from three to eight months. More often than not, considerable work was generally still needed to obtain a facility as safe as had been originally planned. The missing work was typically classed as "clean up." Included were final alterations to guardrail grading and paving of shoulders, grading and seeding of medians and slopes, closing of construction crossovers in the median, installation of final signing, delineation, and mileposts, and numerous other features directly affecting the safety and quality of service available to users of the Interstate System.

Guardrail

Because guardrail is the roadway element most commonly struck as vehicles run off the roadway of the Interstate Systems, its design and use are of significant importance. Obviously the purpose of the usual guardrail installation is to protect the road user from a consequence more severe than that of striking the guardrail itself. It should be used only where necessary since it is itself a roadside hazard. Practices among the nine States visited vary substantially in this respect.

Heights of guardrail measured varied from 22 inches to more than 30 inches, sometimes as much as this within a given State. A growing appreciation of the value of 6'3" post spacing is spreading in all States visited and in their newest work at least, the closer spacing is being used to strengthen guardrail sections. In only three States, Missouri, Montana and Utah, were guardrail installations regularly found to have washers on the bolt heads to prevent their pulling through the rail in the event of collision. These simple, inexpensive washers, along with the stiffening sections used at intermediate posts, will greatly strengthen beam guardrail installations.

Blocking out of the guardrail, is found to be a standard practice in only a few of the States. On projects in Georgia and Utah, it was found that guardrail was blocked out only at the sign installations. Other sections had no blocks. On one project in Montana, the median barrier post had actually been notched so as to obtain the minimum standard lateral clearance between the face of the rail and the edge of the pavement.

Guardrail ends can be extremely hazardous to cars running off the road and should be buried in the ground at their approach end. They were treated this way in three of the nine States visited. In other cases, rail was either flared back or installed parallel with the roadway alignment and not buried.

Signs

Wherever permanent signs were installed in the gore areas of the nine Interstate projects, they were, without exception, unreasonably heavy or massive. Mounting supports for the standard 5' x 6' EXIT sign varied all the way from a three-inch steel post for a temporary installation to two steel I-beams six inches in depth. Other sign supports ranged up to multiple twelve-inch I-beams for the larger advance guide signs. The desirable breakaway feature which has been urged on the State highway departments by the Bureau of Public Roads for sign installations, was found on only one of the nine projects and in this case, only on relatively minor type signs.

Curbs

Barrier curb was used without clear justification at many locations. Frequently it was placed in front of a guard rail or a barrier rail where it could adversely affect the proper performance of the rail structure. Curb is used often for delineation purposes to outline gore areas and other locations where there is sometimes no functional need to control drainage. A highly commendable design noted on the Utah Interstate project in Salt Lake City was characterized by a curb located about two feet behind and parallel to the road edge guardrail. The entire shoulder was paved to and beyond the face of the guardrail and into the depressed gutter in front of the curb. Paving of the clearance area between the edge of the usable shoulder and the face of the guardrail would appear to be a very desirable contribution to safety.

Bridges

On the Interstate System bridges, safety walks 12 inches and often 18 inches in width were relatively common. The need for more than a brush curb 4 to 6 inches in width on bridges comprising the Interstate System is very questionable in my opinion. From a performance standpoint, the safety walk presents a vertical surface hazard at the entrance to the bridge and also can cause a vehicle to strike the bridge railing system at a higher elevation than would otherwise be the case. A nearly vertical wall with a small fillet section at its base is much to be preferred over the typical safety walk cross-section found on many recent projects.

Even though the standards of the American Association of State Highway Officials have been followed rather closely, the shoulder systems on these newest Interstate bridges on the nine State projects are largely inadequate for traffic needs. Only a few bridges of any length carried the full shoulder width. In one State there was undesirable variation in the width of successive similar bridges. Evidently, a design change that took effect for bridges designed within the Department was not applied to similar bridges on the same project which were being designed by a consulting engineering firm.

Median and side piers were given a wide variety of protective shielding to avoid having motorists contact them. In too many cases there was no protection whatever or only a few sections of guardrail placed in advance of the pier.

In contrast with the generally inadequate shielding of center and side piers, a fairly elaborate treatment was common at twin bridges where an Interstate

driver leaving on the median side might otherwise drop to a roadway below through the opening in the median. On most projects studied, long sections of approach guardrail were flared into the median center line or even beyond to divert vehicles from the opening between the bridges. The solution of decking the median area was not frequently practiced. This has the advantage of eliminating the hazard just referred to and also removes the additional hazard posed by the left edge parapet walls.

Among the States, Rhode Island has concluded that 20 feet is about the widest median that can be economically paved between twin bridges. Some States that have studied this item believe that median widths up to 30 feet can be economically justified for paving. On the nine Interstate sections inspected, there were many twin bridges with medians below ten feet that were not paved over. The separate structures were often less than 25 feet apart, and eliminating the two parapet walls on the left sides of approaching traffic would have saved their cost, plus that of the extensive length of guardrail used on the approaches to the structures. This could frequently support the incremental cost of paving the median area.

Noteworthy among the bridge safety design problems that still await solution is the development of a satisfactory transition structure between approach guardrail and bridge railing or other elements of a grade separation structure. In two States, Oklahoma and Utah, some attempt was made to obtain an anchorage but the design was not altogether successful. In the other seven States, there was no physical connection or evidence of any attempt to make the approach guardrail integral with the bridge railing, a pier, or any other structural component. The need for an answer to this transition problem ranks as high as any on the list of immediate safety priorities. Discussions and information obtained during the survey indicated that most States plan some remedy of this deficiency. It was interesting to notice the varying nature of the concern. In one State, there was almost no guardrail on the approach to structures, whereas in another, the approach guardrail had been built to a bridge location even before the bridge deck had been completed.

Bridge Railing

The effectiveness of rails on bridge structures is related to their height as well as to their design composition. Measurements were taken on many of the structures observed in the nine States. Bridge rail height, adjoining and measured from the roadway surface, was as low as 27 inches in some cases and as high as 44 inches in other cases. The most common height of bridge rail was 40 inches above the roadway surface. Only a few of the States had lower or higher bridge railing than 40 inches, which suggests that this dimension, as well as the functional design requirements of bridge railing, needs to be studied and specified more exactly for application to bridges of the Interstate System.

Aluminum was a common alternate for steel for bridge railing. Many different configurations were noted. Combinations with various heights of concrete bridge parapets make this element extremely elusive for evaluation. Bridge designers appear to exercise a great deal of individual expression in developing the configuration of bridge rails. Aesthetics and the desire to have a bridge rail that you can "see through" should not exceed the concern for a railing that is able to withstand the impact of a colliding vehicle without failure and unnecessary hazard to highway users.

Shoulders

Some attention was given during the study to the use of shoulders on the main roadway and on ramps. In Utah and in Oklahoma, the normal width of the shoulder was frequently obstructed by curbs placed at the entrance ramp terminal.

In addition to obstructions of the main roadway shoulders, which should in all cases be available for disabled vehicles, a great inconsistency existed in the design of shoulders for ramp roadways. In a few cases it was difficult to tell whether the ramp shoulder was paved. On one project the ramp had a paved shoulder six feet wide on the right and no shoulder paving on the left. In still another State, the shoulder of the ramp was paved three feet wide both right and left. Elsewhere, the ramps were outlined with curbs. The practice of paving shoulders on connecting ramps at interchanges obviously has not been sufficiently determined, and there is doubt that the need for adequate shoulders at all locations has yet been fully appreciated.

Slopes

Flattening side slopes and rounding ditch bottoms to increase the safety of the roadside was not characteristic of most of the nine projects visited. Numerous situations were noted where, at least in localized areas, readily available embankment material could have been used to flatten slopes to 6:1, a slope that can be safely traversed by a conventional vehicle. Because grading costs are becoming a somewhat smaller part of the total project cost, much more attention should be devoted to examining slope adjustments as new projects are constructed. Savings in guardrail installations, maintenance, and possibly drainage features that otherwise would be required can be credited against dirt-moving costs associated with flatter slopes.

Lighting

It was previously observed that only four States installed roadway lighting on the Interstate projects visited. Of these four States, two used steel poles on transformer or flange bases mounted on concrete footings no more than 1½ to 2 feet off the outside edge of the paved shoulder. In Oklahoma and Rhode Island, the same lateral location was used but the lighting installation was somewhat less hazardous because frangible bases were employed on the exposed poles. The aluminum poles used were of a type shown by experience to break away at the flanged base without causing serious damage to the vehicle or its occupants. Where roadway lighting is employed, concrete footings should be kept to the ground level and the lateral clearance from the edge of the shoulder or face of curb increased above presently used minimums. The enthusiasm for maximum lighting efficiency and aesthetics has sometimes resulted in having the poles in target positions and undesirably close to the roadway. Longer mast arms are possible and with more powerful luminaires at higher mounting heights, fewer lighting standards are needed.

Summary of needs

In summary of the study of the nine Interstate projects selected essentially at random for this study, it can be said that several urgent needs remain to be satisfied if the Interstate System is to become as safe as the public interest requires. The following statements highlight these requirements:

I. Decisions on engineering design frequently have been based on first cost considerations rather than on a true cost effectiveness principle. Long-range economic demands suggest the high importance of choosing initial designs that will serve traffic adequately over the full life of the improvement at a minimum cost and with a maximum of safety. The maintenance and operating requirements associated with the various alternate designs are vital cost determinants that should receive more attention during the decisions on design.

II. When separate contracts or subcontracts are negotiated for installation of signs, lighting, guardrail, drainage facilities, and similar elements, a maximum of coordination is needed to insure that these several items and the features of the principal construction contribute in a unified way to the finally completed highway improvement.

III. Immediate steps should be taken toward a closer working relationship between bridge and roadway design engineers to achieve safer design conditions for the roadway entrance to bridge structures. Liberal evidence exists that the vertical element of the transition between roadways and bridges is one of the weakest features of present roadside design.

IV. Multi-disciplinary review teams, operating before, during and after highway construction, are an aid to crystallizing timely decisions on many items affecting the safety of Interstate projects. Teams should be composed of representatives from design, construction, traffic, maintenance and perhaps other divisions of the highway department whose views result in decisions that affect safety features. Supplementary assistance of personnel from the Bureau of Public Roads and other component units of the Federal Highway Administration, and from enforcement authorities has proved valuable. The functions of the team logically start in the earliest planning stage in the consideration of such items as sign locations, guardrail placement, and lighting installations. Teams should also be active during the construction period so that adjustments then found to be desirable can be made. Before the project is open to traffic, the review team should examine the final state of the improvement to insure that the highway is in fact ready for public

use. In the administrative area also, care should be taken to avoid premature opening of projects that are not operationally safe for traffic.

V. The adoption of a safety cross section to provide 30 feet or more of clear area from the edge of pavement on Interstate projects is one of the more important steps toward greater safety on Interstate projects. This will require not only the revision of standards for new work but also the acceleration of programs to remove fixed object hazards such as unnecessary guardrail, signs, trees, utility poles, boulders and other similar items. The desirability is also evident of adopting 6:1 or flatter slopes at the roadside wherever practical, and the smoothing and removal of all substantial obstacles from the gore, except for the standard EXIT sign and light-weight delineator posts. In all cases, the EXIT sign should be on breakaway type supports.

VI. Where hazardous objects are not feasible of removal, installation of appropriate barrier devices should be considered. Under such conditions, barriers usually should be installed at a maximum distance from the roadway rather than at the conventional position along the outer edge of the shoulder. Special impact-attenuating devices now becoming available should be employed for shielding center piers in medians and for similar massive objects that cannot in any reasonable way be relocated or removed.

VII. Hundreds of relatively minor hazards exist in current designs or in projects now in use. These should be the focus of programs by traffic engineering and maintenance forces. Corrective work includes such readily adaptable features as frangible or breakaway bases for exposed sign supports and light standards, the lowering of concrete footings to ground level, the removal of unneeded barrier curb, the burying and flaring of guardrail approach ends, the removal of safety walks and wide curbs on bridge structures, and the placement of clear understandable signing sufficiently in advance of decision points.

VIII. One of the major breakdowns noted from the study of the nine Interstate projects is the inadequate communication and use of available research findings and improved techniques. The failure to communicate is noticeable at all levels and actually may be more serious in the higher administrative levels than at the technical level. A change of attitude which would characterize the highway as a more positive contributor to traffic safety is a pre-condition to progress in this area.

IX. Concerted efforts should be made to compress the time period between final design decisions and general use of the highway improvement so that the benefits of recent advancements in operational practices, designs and controls will be realized in new or remedial work on the Interstate System.

X. None of the findings from the observation of nine Interstate projects can or should be regarded as fully conclusive and final. Through properly directed research and additional investigation, more specific information as to highway design and operating deficiencies and solutions will surely be identified. Nevertheless, the findings of this study of nine new and representative Interstate projects do have high indicated value. Typical of the attention being devoted to betterment of the general situation is the listing of Interstate safety improvements contemplated or underway (See Addendum I).

ADDENDUM I

CURRENT AND CONTEMPLATED SAFETY IMPROVEMENTS FOR THE NINE INTERSTATE PROJECTS REVIEWED BY THE SPECIAL SUBCOMMITTEE ON THE FEDERAL-AID HIGHWAY PROGRAM

Each of the nine Interstate projects selected for review in the several regions of the Federal Highway Administration has been said to be deficient safetywise in some one or more of its engineering details. Total safety in engineering design and operation will never be reached but some brief mention of the justified striving toward that objective ought to be included in the record.

Within the regions and on the projects studied cooperatively by the Subcommittee staff and a qualified engineer from the Bureau of Public Roads, the safety improvements listed below are presently underway or contemplated:

Region One—Rhode Island Interstate 95

1. Signs originally placed 2 feet off the edge of shoulder will be moved back to 30 feet wherever viewing conditions permit.

2. Heavy sign bridge supports located in the gore at the junction with I-295 will be eliminated by moving the sign bridge to an advance location.

3. Curb and guardrail will be eliminated from gores and these areas will be graded with flatter slopes.

Region Two—Ohio Interstate 80S

1. The present temporary signing on this project will be replaced with permanent signs of modern design as the next stage of improvement.

Region Three—Georgia Interstate 75

1. Guardrail on this project will be revised to incorporate the safety refinements outlined by recent research. Posts will be spaced closer to increase stability. The ends of the guardrail exposed to traffic will be anchored at ground level.

2. Frangible bases will be employed, replacing the steel bases now supporting light standards wherever these are in exposed positions.

3. Traffic signs will be moved back at least 30 feet from the traveled way wherever possible.

4. Median inlets will be improved so not to be an obstruction to traffic inadvertently entering the median.

Region Four—Indiana Interstate 69

1. Guardrail revisions will be made to include the anchorage of approach ends at ground level and shorter post spacing at points where maximum protection is required.

2. Drainage facilities will be made less of an obstacle by elimination of headwalls and with extension of present culverts.

3. Consideration is being given lighting requirements at interchanges and other points of need.

Region Five—Missouri Interstate 35

1. Improvements will be made to medium drains and ditch blocks.

2. Break-away signs and light supports will be installed.

3. The installation of additional guardrail at points of special hazard will be undertaken and guardrail design will be improved to accord with latest safety standards.

Region Six—Oklahoma Interstate 40

1. Improvements are being made in the anchorage of guardrail to bridge structures.

2. Improved guardrail designs are to be installed.

Region Seven—Nevada Interstate 80

1. Traffic signs will be relocated at a further distance away from the roadway. They are presently 2 feet beyond the edge of the shoulder.

2. Additional guardrail installations will be made to protect motorists against the hazard of running off high embankments and some embankment slopes will be flattened.

Region Eight—Montana Interstate 90

1. The guardrail on this project will be blocked out throughout its length and shorter post spacing will be used to guard against penetration at locations of special hazard.

2. Improvements in the signing will include installation of breakaway design supports.

Region Nine—Utah Interstate 80

1. Some signs will be relocated to a position on overhead bridges so as to eliminate the hazard of ground structures.

2. Breakaway type signs will be installed throughout the project.

3. Better design will be used for the protection of motorists who strike the approach ends of guardrail.

4. The design of Exit and Entrance ramp terminals will be improved to reduce the fixed object hazards at these locations.

Mr. CONSTANDY. We have looked at the various roadside elements in the nine States which we believe to be representative of interstate projects completed in the latter part of 1966 and the beginning of 1967. It would be most pertinent at this point if each of the members of the panel were to evaluate what it is that they have seen.

I realize that some of you have some additional comments, which would be helpful and would enhance the record, but we would be appreciative if you would give your opinions as an evaluation of what you have seen overall on these projects.

Can we begin with you, Mr. Wilson?

Mr. WILSON. Well, as engineers in this field of endeavor, our mission is twofold, as I see it.

First we have got to keep the vehicle on the road by providing him with wider shoulders, wider travel lanes or wider roadways, delineation mark lines, and things of this nature.

The second thing is that we have got to prepare for the inevitable and that is when the vehicle leaves the highway. We must give the motorist a reasonable chance to avoid injury and death.

I would like to call this building-in a forgiving quality in the roadside.

This forgiving quality can take many forms, all of which we have discussed in the past few days. I do not think it will be necessary to elaborate on the specific items because my remarks regarding them are already a matter of record.

However, I am deeply concerned about what I have seen.

I believe there is knowledge available, knowledge that has been tested and proven. There is more experimentation going on right at this point that will help build in this forgiving quality that I mentioned.

Our attention has previously been concerned primarily with the single-vehicle wreck. We must not lose sight of the fact that some of these same features that cause the problem for the single car have caused the multiple-car wreck.

The limited-access facility has brought with it some problems concerning which our own accident records, until just recently, were not telling us the full story of just exactly what was happening.

To assure that good design practices are followed, I mention just two items. First, for the past several years we have been having operational reports made on completed facilities. These operational reports have been made by patrol officers, design engineers, traffic engineers, maintenance engineers, and people who are familiar with the area.

These operational reports lead to improved design standards and have in fact been instrumental in not only changing standards for our future projects, but have been making immediate modifications to recently completed work.

It is not unusual to go back and see things that need to be changed almost immediately after a project is finished, once the roadway is placed under traffic, and you can see what the behavior of traffic actually is.

Second, in order to forestall the construction of obsolete work, we have recently formed a review team to look at projects in the planning stage. Design engineers, traffic engineers, and other disciplines are making recommendations to change contract plans before the work commences.

I think here is one of the most fruitful areas and is resulting in many, many changes which will be beneficial.

I think that this process of review should continue on through the construction phase as well. And obviously from the pictures that we

have seen here in the last few days, many changes could be made at modest cost on the construction job itself, which would enhance the safety of the motorist.

Mr. CONSTANDY. That is fine. That is a very good statement.

Are you pleased or unsettled—what word would you use to characterize your overall impression?

Mr. WILSON. I think I am deeply concerned about this problem, and I think that, not only to use an old excuse, but I think that the matter of communicating some of the very latest developments to our people in the field who can do the most about it would be most helpful here.

Mr. CONSTANDY. Thank you. Mr. Skeels?

Mr. SKEELS. During these 3½ days of hearings, Mr. Prisk has shown the committee many examples of questionable highway design. I would like to point out that the good features were not emphasized.

Probably 95 percent of the design is excellent. The remaining 5 percent is what we have been seeing.

The deficiencies we have been shown are mainly concerned with details that are safety hazards and indicate to me that the safety of the traveling public has not always been the primary concern of the highway designer. And this neglect has undoubtedly been unintentional.

I do not for a moment believe anyone would accuse the designers of our Interstate System of being unconcerned with the safety of the traveling public. Rather, it is the result of other design pressures, such as cost, terrain problems, drainage problems, esthetics, the necessity used to establish standards and procedures, and the lack of information on this state of the art at the designer's level.

Overriding all of this is the necessity to have the enthusiastic support of top management at both the State and national levels. Without this, the best qualified and most safety motivated design engineer is helpless to put his design engineering in effect. With active top-level encouragement, even a mediocre design engineer using only ordinary commonsense should be able to improve on many of the design and construction deficiencies that we have seen.

I hope these hearings will inspire the agencies responsible for highway design to compete with each other to produce the safest road.

Surely the influence of this committee will go far to achieve this end. The following steps might be considered:

First, that safety design review boards be established at appropriate levels to catch as many deficiencies as possible at the design stage for new highways.

Second, that trained inspection teams check the finished highway for areas in which improvements could be made.

Third, that proven safety designs be immediately adopted by all States, even though they were developed by another State or another agency.

Fourth, that new but unproven designs be evaluated by an unbiased testing agency, and neither be adopted nor rejected on the basis of opinion alone. Most of the designs of which we are critical were thought to be good by somebody.

Fifth, that AASHO and other pertinent standards be undated and written in sufficient detail so that the engineer will have an adequate guideline from which to work.

Last, and most important, the top officials in all highway departments, who in the final sense are responsible for approving or rejecting projects, must motivate their entire staff to put safety first.

As a postscript, I would like to add that the nine States whose Interstate efforts were critically evaluated are typical of all States, and their highways are neither worse nor better than the others.

Mr. CONSTANDY. Thank you, Mr. Skeels. Very good. Mr. Huff?

Mr. HUFF. First, Mr. Chairman, I would like to express my appreciation for the honor of having been invited to appear on this panel. As far as criticizing the many, many illustrations of design that we have seen, I believe that we have made statements over and over regarding them, so I will confine myself to generalizing.

It seems that guardrail and bridge rail connections might be listed as public enemy No. 1. Close behind that would be curbs and possibly the massive ends of bridge rails. It is also significant, I think, that the installations that we have seen, all being on the Interstate System, could meet the standards for the National System of Interstate Highways.

Now, I say standards for the National System of Interstate Highways, and I mean that part of the standards which formulated in the beginning and was mandatory that all States follow. However, it must be remembered that there are other AASHO policies.

They are not called standards. They are called policies; and it is my opinion that most of the installations that we have seen would follow what ever is laid out in those policies, insofar as they are covered.

Some of the items that we have seen are not covered in the standards or the policies.

This in my opinion calls for a need for upgrading and broadening our—particularly our AASHO policies to cover these types of design, both on the Interstate System and on other highway systems for that matter.

For example, the width of shoulders should be examined critically as to whether we are now designing a proper width shoulder. The guard-rail design should be examined critically, remembering that the guard-rail on a fill approaching the bridge is a flexible structure. When it gets to the structure, it becomes a rigid structure.

Bridges have to be designed to carry trucks. It is entirely possible that a flexible rail should be run across the bridge, which would be a secondary rail inside the rigid rail. If a truck ran into the flexible rail, it would go through the flexible rail and then be contained on the rigid rail. Whereas, all passenger cars would be contained by the flexible rail.

Now, a good example of what AASHO is doing currently is the so-called Yellow Book, which was issued earlier this year. At recent AASHO design committee meetings—I am not sure whether all have done this, but the ones I am familiar with—have endorsed the so-called Yellow Book as a design standard.

It goes far beyond the specifications of the standards or the policies.

Another thing that I have been impressed with in these hearings is the need for better correlation between the various disciplines in

highway engineering. It has been stated that the bridge engineer goes here and the road engineer starts and goes the rest of the way. Now, wherever that correlation is not being done, I strongly recommend that it be brought into play as quickly as possible.

I might say that in our own State we have jointly—the divisions handling bridges and roads together with the traffic engineer—we have joined together and think that we have the best solution that we know how to make on transition from a road rail to a bridge rail. I am not sure that it is best, but we think it is the best that we have been able to find.

Of course we need also to inform ourselves as to what we should do to correct some of the deficiencies that we have seen here, and we all know—although my State is not represented in these pictures—we do have the same kind of deficiencies as were depicted here.

We need to establish priorities on the worst and the most dangerous deficiencies and get to work on them. I believe that the States should get to the job as fast as possible.

Now, we are not going to be able to do all of them at one time.

Another comment I would like to make would be—and this I hope is constructive criticism—I am a little bit afraid that this committee has tried to give too many answers to the deficiencies.

We are a group of six engineers here. We have our opinions, but you might get six other engineers somewhere else and say, well, and start picking holes.

I think rather than us trying to give the ideas here before this distinguished committee, we should develop through AASHO, which I think is the most capable organization to do it, standards based upon the great mass of research that has been accumulated during the last 10 years since the standards were developed and base our designs on that.

I believe somebody should say some good things about our Interstate System because I know that in our State, and I have been in many other States, the people like it.

They can go a great distance and at great ease, and I think one time we thought—and I was in our department in my same position before the interstate program was initiated—some of us thought that we were building too plush a highway, were just gold-plating and gilt-edging a special system here; and many of us thought the people would rebel against that.

I think we should be gratified that they are with us and are willing and anxious and almost make it mandatory that we make it even better than we have made it in the past.

Mr. CONSTANDY. Thank you, Mr. Huff, for your very pertinent remarks.

Mr. Chairman, Mr. Huff on June 5 delivered a paper to the AASHO Operating Committee on Design for Region 3, at Indianapolis, Ind. The title of it is "Highway Safety as Related to Design Involving Fixed Objects."

I would like to ask to make that exhibit No. 9 and with permission, to print it in the record, providing the size of the transcript will allow it. It is a very pertinent paper. I think it will add a great deal to the records that we have here.

Mr. McCARTHY. Without objection, it is so ordered.

(The document referred to, illustrations omitted, follows:)

HIGHWAY SAFETY AS RELATED TO DESIGN INVOLVING FIXED OBJECTS

Over the past year, the topic "Highway Safety" has received considerable attention by automobile clubs, law enforcement agencies, automobile manufacturers, civic groups, service clubs, and even the National Administration. The U.S. Congress has recognized the problem by passage of the National Traffic and Motor Vehicle Safety Act of 1966 and the Highway Safety Act of 1966. Therefore, the program this afternoon is both timely and in accord with this growing awareness of the problem.

My discussion is concerned with only one phase of the over-all accident record, those involving fixed objects. However, it also represents one of the fields in which we, as highway engineers, can exercise the most influence. We can exert only a limited control over pedestrian movements or animals encroaching upon the roadway. We have even less control over a driver's actions and reactions. We can, however, remove fixed impediments or render them safer so that the errant driver has a chance to recover control of his vehicle and return uninjured to the travelway.

During 1966, fixed object accidents in the State of Texas accounted for 14.5 per cent of the total rural traffic fatalities. Although this percentage is small compared to the total record, the number of people represented thereby is not. In human statistics, this percentage reflects a total of 500 people killed in our rural areas as a result of fixed object accidents. It is, therefore, obvious that such features deserve our immediate attention.

As has been the case since its very inception, the American Association of State Highway Officials has taken the initiative in this matter and in February of this year published a report entitled "Highway Design and Operational Practices Related to Highway Safety." The Special AASHO Traffic Safety Committee which compiled the report is to be commended for a job well done. It is my fervent hope that the findings and recommendations contained therein will gain immediate acceptance by the highway profession. This publication covers, in detail, the topic which I am to discuss; however, I would like to cover several features which, over the years, have been of great concern to the Texas Highway Department and, I trust, other highway agencies.

BRIDGES AND SEPARATION STRUCTURES

With the advent of the Interstate Highway System, we began an accelerated program involving, among other things, the construction of thousands of bridges and grade separations. These improvements have enabled us to reduce the potential hazards associated with at-grade crossings; however, they introduced fixed objects in the way of piers and wingwalls which have, unfortunately, taken their toll of drivers. In 1966, Texas recorded just over 1,000 rural accidents involving bridge ends or piers.

The construction of minimum length underpasses with short spans have introduced piers adjacent to the shoulders which are entirely too close to give the driver any possibility of error. In order to protect the sense of openness afforded by our modern highway section, the driver should experience no constriction when passing beneath a structure. The center or outside piers should be eliminated entirely or set back at least thirty feet from the edge of the main lane pavement. This would be an ideal arrangement; however, it must be recognized that such an arrangement is not always possible or practical.

Where this is the case and piers must be located nearer than thirty feet from the traveled way, they should be protected by an adequate length of guardrail, anchored on the ends so that it may develop its full ribbon strength. The Texas Highway Department has been using such installations for several years and we are quite encouraged by the accident record associated with the same.

Attenuation devices consisting of energy absorbing material may eventually prove to be the best means of protection. Several different types of devices are currently being considered such as honeycomb masses of aluminum, forests of posts and large polyethylene containers filled with water. Bales of hay such as are used at the Grand Prix race represent a fairly effective although somewhat primitive attenuation device. As most of you are aware, Texas has developed breakaway sign supports; however, the elimination of the hazard imposed by fixed sign supports is of little value if the sign is backed up by a pier.