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POTHOLES AND BRIDGE DECK CORROSION

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HEARING
BEFORE THE
SUBCOMMITTEE ON TRANSPORTATION,
AVIATION AND COMMUNICATIONS
OF THE
COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
NINETY-SIXTH CONGRESS
FIRST SESSION

MARCH 19, 1979

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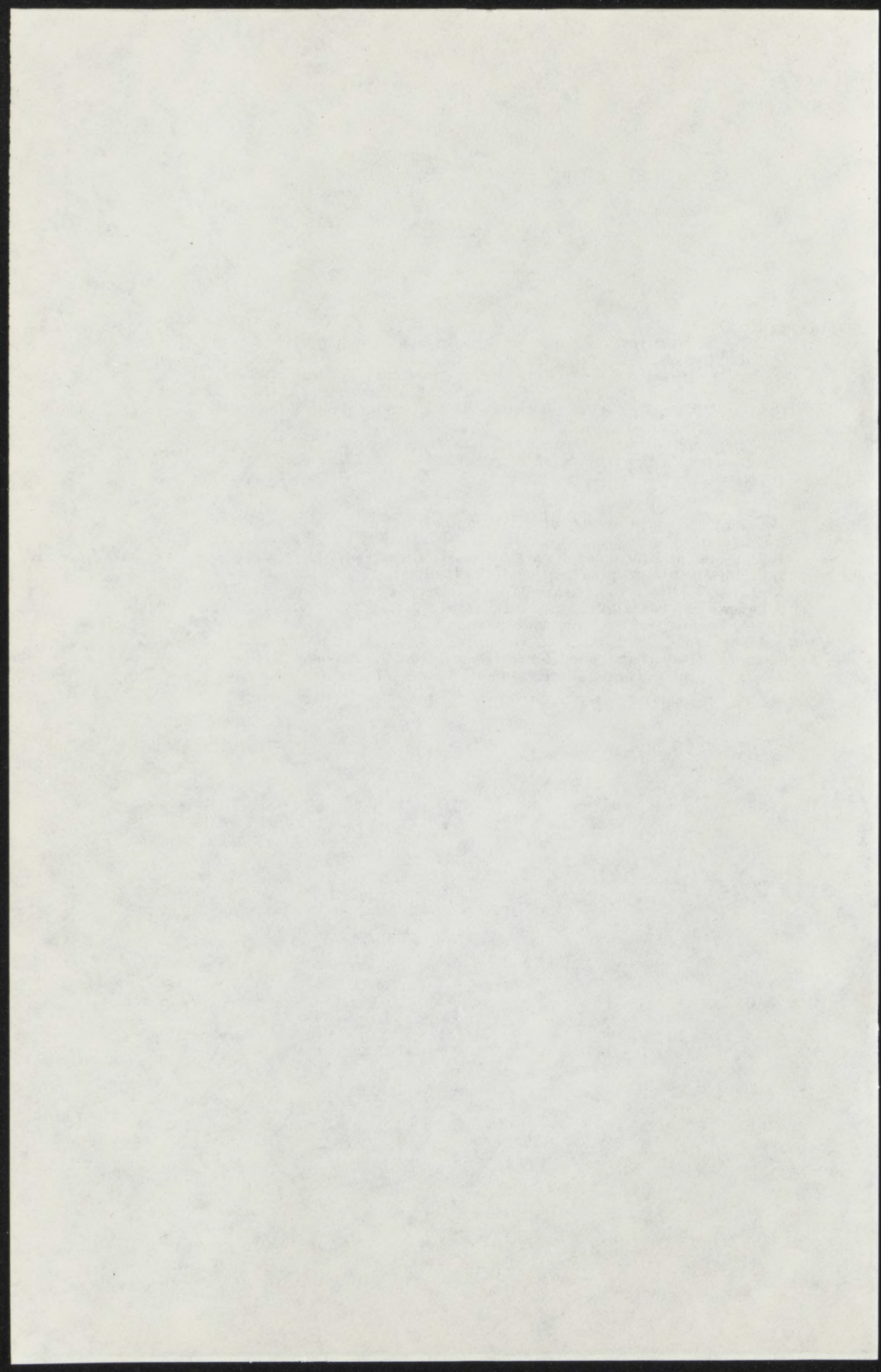
CONTENTS

WITNESSES

	Page
March 19, 1979 :	
Jerome H. Stolarow, Director of Procurement and Systems Acquisition, General Accounting Office-----	5
Rex C. Leathers, Director, Office of Engineering, Federal Highway Administration -----	9
Charles F. Scheffey, Director, Office of Research, Federal Highway Administration -----	23
Leo Sandvig, director, bureau of materials testing and research, Pennsylvania Department of Transportation-----	38

AFTERNOON SESSION

Dr. Phil Cady, professor of civil engineering, Pennsylvania State University -----	53
Joseph Moses, director of maintenance, Allegheny County, Pa-----	55
William Dickinson, president, Salt Institute-----	58
Edward J. Siodlowski, executive director, Pennsylvania Asphalt Pavement Association-----	60
R. C. Cronin, for the regional paving engineer, Portland Cement Association -----	61
Appendix: Additional statement for the record from Mr. Michael M. Shoor, director of legislative affairs, National Society of Professional Engineers -----	75



POTHoles AND BRIDGE DECK CORROSION

MONDAY, MARCH 19, 1979

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON TRANSPORTATION,
AVIATION AND COMMUNICATIONS,
Pittsburgh, Pa.

The subcommittee met, pursuant to call, at 9:20 a.m., in the Federal Building, Pittsburgh, Pa., Hon. Tom Harkin (chairman) presiding. Present: Representatives Harkin, Walgren, and Atkinson.

Mr. HARKIN. The subcommittee will please come to order.

The Subcommittee on Transportation, Aviation and Communications of the Committee on Science and Technology of the House of Representatives will please come to order.

Congressman Walgren, Congressman Atkinson, distinguished guests, ladies, and gentlemen.

Congressman Atkinson originally had called for public hearings on the results of the Government Accounting Office, the report that came out in January, and this is the first public hearing to be held to discuss that report.

When Congressman Walgren, as a member of the subcommittee in which I chaired, asked me to schedule this hearing in Pittsburgh, and he was more than explicit in his description of the bridge and road problems in this important part of our Nation, I can tell you after taking me across the Thornburg Bridge, down the Sawmill Road, I can understand why he is so interested in this special problem, and why he has been very instrumental in pushing this subcommittee and our committee to really be active in this area, so this firsthand experience he has given me this morning has helped me to understand the special needs of this area and the special urgency of the solution with the help of the witnesses here today which I hope to learn a good deal more about the R. & D. work that has been done, and what needs to be done to solve these problems in this area.

I especially want to express a special greeting to Congressman Atkinson. His contribution to our committee's efforts here is particularly welcome, and I can tell you that Pittsburgh is in good hands with Doug Walgren on the R. & D. committee and Gene Atkinson on the other committee that implements it, I think you have got a good team working for this area and a good team working to solve this one special problem of bridge deterioration and potholes, so on behalf of the subcommittee, I want to thank Congressman Walgren for chairing this hearing in Pittsburgh after I leave.

It is an excellent location to open our hearings which will continue throughout this week and next week.

As I mentioned, we will continue these hearings during the rest of the week in Washington in this important area.

Congressman Walgren?

Mr. WALGREN. Mr. Chairman, we want to give you a special welcome to Pittsburgh.

The jurisdiction of the subcommittee that you chair, and that I serve on, and that we are all interested in is really essential to the problems that we are trying to solve.

So often congressional committees forget that the issues that we are involved with are really felt on the local level by all our citizens, and I think it is most important that you took the time to bring a hearing to the field, so that we could take back to Washington so much more direct experiences with the problem than we might when it simply comes before committees in Congress, either on paper, or even with individuals coming from the country to Washington, so it is very important that you came, and we are particularly pleased that we could take you to the Thornburg Bridge.

The Thornburg Bridge is a classic example of what the GAO report is all about.

The General Accounting Office did a report recently that Gene was particularly involved in on the deterioration of bridge decks and found essentially that we are suffering the first generation of salt erosion to the point that the bridge no longer functions, and in the Thornburg Bridge, we have a bridge that has a road surface on it, one that was substantially repaired, and then immediately closed down because the understructure of the bridge had been so damaged by salt over the years that there was no way that the bridge could be used.

We were out there this morning and brought back a couple of cement reinforcing rods from the bridge itself, and as you can see, at the top what starts out as a quarter inch round rod tapers down to paper thin and disappears to a point like it was some creation of prehistoric man to kill animals.

So, your coming is especially appreciated in that sense, and I want to also express a special thanks to Congressman Atkinson for joining us.

We feel very much together, our districts abutt, and we really have the same concerns, but as Chairman Harkin noted, Gene is a member of the Transportation Subcommittee of the Public Works Committee, which is really involved in implementation of whatever newer methods we can develop through research and development to do differently what obviously has not worked in the past, so Gene is absolutely essential to this effort.

The purpose of the hearing today is to focus on solutions to what is a chronic and literally life threatening problem in bridge deterioration and potholes.

In the news these days, we not only have the news covering how we are trying to grapple with the past, but articles like five nuns from St. Benedict Academy just in the north hills here being injured in an automobile accident that was caused by a pothole.

There was a report on a fatality just last week of a man in Virginia, so we are really talking about life and death, and we make fun of it here in Pittsburgh, but it is not something to be made fun of.

The bridge problems in this part of Pennsylvania are literally massive in scale.

There are hundreds of bridges in the region like the Thornburg Bridge that suffers from the same problem.

We have 2,000 critical bridges in Pennsylvania, and that list is growing and growing.

One hundred and five bridges in Allegheny County alone need repair or replacement at a total price tag of \$268 million and so as we build new bridges, and do the basic repairs, it is important that we find whatever new solutions might be helpful to prevent the same thing from happening again, or else we are really just throwing good money after bad, just as we did on Banksville Road, where we came in this morning, we know literally that only two winters ago, the road was the site of a \$1.8-million repair operation, which redid the surface completely.

The Federal Government participated in that at the rate of 70 cents on the dollar, and yet it was destroyed in the first winter, repaired, and now you can see the results of the second winter, it literally was a waste of money, and this is something that the people have a right to expect that we will not keep on doing, that we will find effective solutions that are useful to them.

Every time a bridge is forced to close because it is unsafe, our residents are more than just inconvenienced, local economies suffer, ambulances and firetrucks add critical minutes to time needed to do their job in responding to emergency calls.

There was a fellow truckdriver who happened to come up with us to the Thornburg Bridge this morning, he said that the added cost just in the detour around that bridge alone is something like \$2 million over the space of a year or thereabouts, just because that bridge is closed, and so we seem to be doing so many things in a self-defeating way that we ought to be on about finding ways to do things differently.

The second problem after the bridges that we hope to address today is one that western Pennsylvanians are all expert on, I am embarrassed about our roads in Pittsburgh to be truthful.

One of the reasons I did want you to come was because people who do not live in Pittsburgh cannot quite believe it.

I know that Iowa has its problems, and bridge problems, and road problems too, and in that sense you have got your share of rough highways, but I think it is fair to say that Pittsburgh is unbelievable, and it shows up wherever you turn.

I understand nationwide there are estimated to be some 93 million potholes, 49 potholes for every mile of road.

Well, if that is true, I think we have most of them here in Allegheny County.

In the final analysis it may well be that the Federal Government working with State and local government need to do much more to promote research and development.

There are new ideas that have yet to be incorporated in what we do in public works and with our roads.

They are complicated, and they are sort of beyond the recent public awareness.

It is basic that the Federal Government has done almost nothing in terms of maintenance in the past, but we are starting to get into that area, and our real question is what efforts are we making in research and development, what new ways are we finding on the Federal level, do we have a good research program going that is coming up with suggestions that are potentially able to solve the problem.

There is no question that solid maintenance and repair saves hundreds of dollars in replacement and reconstruction costs down the line.

The GAO report estimated that we will be asking for the need to expend some \$5 billion if we cannot maintain the present bridge decks that are in a state of disrepair.

If we do not find a cost-effective way of maintaining those, we are literally asking to replace the whole system which is something that will tax our financial abilities long into the future.

The poor roads in Allegheny County have caused the port authority to spend on our buses literally \$100,000 a month more in the purchase of replacement parts, simply because of the damage that going over the kinds of roads that we have here in Allegheny County have caused, so the problem is severe, and I really want to thank you for going out of your way to bring hearings here so that we can make a record of new ideas that then might be able to be emphasized in Washington, and in the Congress, so that we can really find a solution to our problem rather than just curse the darkness, so thanks for coming.

Mr. HARKIN. Thank you.

Congressman Atkinson?

Mr. ATKINSON. Thank you very much, Mr. Chairman.

I very much appreciate the invitation you extended to me to join you on the Transportation Subcommittee.

We share common concerns, and we know this is a very difficult thing for those in the construction business and of highway transportation to come up with solutions, and that is why this committee hearing, and what is going to take place in Washington is so important.

I know both of our staffs, Doug's and my own in Washington are researching to try to see what can be done to speed up the process.

We know what the problems are, people have been talking about them for a long time.

We share a common interest in the areas as Doug mentioned, Mr. Chairman.

The impact here, if the roads are detoured, it is a statewide situation, probably national, some 33 States are adversely affected by roadways, and situations that we see very much here in evidence in Pennsylvania.

Really, I have talked, as Chairman Harkin mentioned, we tried to have subcommittee hearings on the Transportation Committee, and at some point of time we will have them, but after the transportation laws were passed last year, they did cover in many instances some of the things that concern us today, and they had improved considerably on the funding percentages and the amounts of moneys, et cetera, that are involved.

When you start thinking of \$6 billions to cover the problems created by salt and chloride into the bridge systems, and on the decks, it is just an amazing kind of a figure, and if we do not do something about it now, then we will be looking at bridges down the road a few years from now that are deteriorating now.

It is natural when you go into a State, you put that money into the worse bridge, the most damaged bridge, the most deteriorated bridge, and yet we realize full well that some of the other bridges have not reached that point yet, are going to be in the same condition if something is not done about it, and I know the new type steel used in construction, will prevent this from happening, but some of those in exist-

ence now have to be cured in some ways so this does not continue to happen.

I think they estimated in the report that I just spoke to, that bridges are intended to last some 40 years, and they have only been lasting some 10 to 15 years, so it is a serious problem, that you come here to Pittsburgh, from the great State of Iowa, and where you do not have the problems we have, it is a different kind of a problem so your interest is vital, and I am a freshman member, and I just know the subcommittee hearings, and the subcommittee work, and the efforts of your chairman will bring about the results to a system that does work.

Mr. HARKIN. Thank you very much, Gene.

We are happy to have you here, and now you can see why I said earlier you have got a good team here working on this problem.

I might just add one little footnote, that is that we always drive cars, and we drive over potholes, we drive over bad bridges, and we always curse them, we never think about what we can do to stop it, and we always pour more money into the repairing of them and taking care of them, but perhaps we really have to take a hard look to see if we can come up with new kinds of materials that will make these bridges last the 40 or 50 years they are intended to last.

As I mentioned before, we will continue these hearings in Washington this week and next week.

We will start our witness list here, the first witness today is Jerome H. Stolarow, Director of Procurement and Systems Acquisition, General Accounting Office.

Mr. Stolarow will summarize the GAO report of January 19, 1979, in which the GAO concluded that bridge surfaces expected to last for 40 years will need replacement in 15 years because of bridge corrosion.

Also at the table we have Mr. Rex C. Leathers, Director, Office of Engineering, Federal Highway Administration, and also Charles F. Scheffey, Director, Office of Research, Federal Highway Administration and one other person who does not have a name there, so will you just identify yourself for the record so we will know?

Mr. FULK. My name is Harold Fulk from the General Accounting Office.

Mr. HARKIN. What I would like to do is if we could start out with Mr. Stolarow, then Mr. Leathers and then Mr. Scheffey, so if you will each present your statements, and then we would like to open up for a general discussion between ourselves.

I see, Mr. Stolarow, you do have a prepared statement, and without objection, the entire statement will be made a part of the record.

You may proceed in any way you wish.

STATEMENT OF JEROME H. STOLAROW, DIRECTOR OF PROCUREMENT AND SYSTEMS ACQUISITION, GENERAL ACCOUNTING OFFICE

Mr. STOLAROW. Thank you, Mr. Chairman.

We are pleased to be here today to summarize our report on the problems of bridge corrosion which was issued on January 19, 1979, and Mr. Fulk was our general manager generally responsible for the work leading to this report.

Our report discusses the magnitude of the bridge deck deterioration problem facing the Federal Government and the States. It also discusses ways of stopping premature deterioration of bridge decks.

In summary, our report says that:

Bridge surface deterioration is a serious problem in 32 States, because of increased use of chlorides to melt ice and snow.

Cost-effective systems are available to protect bridges where contamination has not yet reached the corrosion threshold, but installation has been limited by lack of both Federal and State funds.

There is a potential future savings of almost \$3 for every \$1 spent to protect these bridges before deterioration takes place.

Proven systems are not available to protect already heavily contaminated decks. Increased or accelerated research efforts are needed to identify cost-effective systems for stopping further deterioration of these bridge decks.

With your permission, I will discuss each of these items in more detail.

The Federal Highway Administration estimates that about \$6.3 billion is needed to restore Federal-aid highway system bridge decks which are deteriorating prematurely. Instead of providing maintenance-free service for about 40 years as expected, many bridge decks require major repairs within 5 to 10 years, and often must be completely replaced after 15 years.

The major cause of this problem is the increasing use of chlorides to melt ice and snow—a procedure that was begun extensively in the mid-1950's. With repeated applications, the chemicals penetrate the concrete surfaces, eventually causing corrosion of the reinforcing steel and deterioration of the bridge deck.

The problem is naturally most prevalent in the States that get a lot of snow, such as Pennsylvania. We asked each State to complete a questionnaire on the magnitude of the deterioration problem and the protective systems that had been applied. Thirty-two States reported moderate to very major bridge deck problems. These States have about 163,000 of the approximately 236,000 Federal system bridges in the United States.

This figure of 163,000 does not mean these are problem bridges.

This is a total universe of bridges for the 32 States that have bridge problems.

Pennsylvania, for example, has about 22,000 Federal system bridges and reports a major deterioration problem.

Since 1976, the Federal Highway Administration has required States to install protective systems on all new or completely rebuilt bridges in areas where the likelihood of chloride use exists. The problem, therefore, relates to bridges constructed prior to 1976 which do not have protective systems. Many of these bridges can still be protected by use of protective systems now available.

With your permission, I would like to insert in the record a chart on the use of protective systems in the State of Pennsylvania, and to the extent they are being used.

Mr. HARKIN. Without objection, it will be entered in the record.

[The chart follows:]

INFORMATION CONCERNING EFFECTIVENESS OF BRIDGE PROTECTIVE SYSTEM AS OF SEPT. 30, 1977

Protective system	Extent use by Pennsylvania	Test results	FHWA conclusions
1. None-----	Common-----	Concrete cracks after 6-8 mo of daily saltings. Threshold level chloride penetrated to 1 in. with as little as 7 salt applications.	Something needs to be done.
2. Epoxy coated reinforcing bars--	Moderate-----	After 35 mo of daily salt applications in laboratory tests, there has been no cracking. Field experience to date is very good.	Now in widespread use for new or complete replacement.
3. Galvanized reinforcing bars-----	do-----	Accelerated lab tests show they have limited protective value. Field data inconclusive. Monitoring continuing.	FHWA directive does not authorize use in bridges subject to salting.
4. Low water-cement ratio, dense concrete (Iowa system)-----	Little or none-----	After 830 salt applications, lab results show a maximum penetration of a threshold level of chloride of 1.4 in.. Field experience good. Some difficulty in application.	Highly resistant to penetration of chlorides.
5. Polymer modified concrete- (Dow system)-----	Major (since 1968)-----	After 830 salt application, lab results show maximum penetration of a threshold level of chloride of 1.0 in. Field experience good.	Provides durable overlay with excellent bonding properties.
6. Membranes-----	HD Bituthene—Minor Royston No. 10—Minor Nordel—Little or none Petromat—Little or none. Asbestos—Little or none.	No controlled labs test. Field experience has been spotty. Problems include: Pinholing of liquid lack of hot weather stability; lack of cold weather ductility; and need replacement in 8-12 yr. Lab tests show no penetration of concrete after 90 days of continuous ponding with a 3 percent salt solution. Field installation began experimentally in March 1976—too early to tell. Evaluations continuing.	In general these systems have not been overly successful. Therefore, these are not as desirable as 4 and 5 above.
7. Internally sealed concrete-----	Little or none-----		Promising new technique. Widespread use probably will require a simpler system for heat treating than now available.

Mr. STOLAROW. Thank you, Mr. Chairman.

The effectiveness of current protective systems, when installed on existing bridges, depends on how much chloride has already penetrated the concrete. Where the amount of chloride is still below the corrosion threshold [the level at which active corrosion of the reinforcing steel begins], currently available protective systems are effective. When corrosion is already above the threshold level, however, the effectiveness of treatment is questionable.

There are bridge decks that contain either no areas, or only small areas where chloride levels are high enough to cause deterioration. If these bridge decks were protected with one of the systems now used for new construction, significant savings could be realized by avoiding more expensive repairs later. The potential benefit/cost ratio of repairing and protecting an existing bridge deck needing only minor repair, versus completely replacing the deck at a later date, by our calculation, is about 3 to 1. Even so, progress has been slow.

Proven systems are not available to protect already heavily contaminated decks. Most of the existing unprotected bridge decks in the 32 States contain chloride levels above the corrosion threshold. These bridge decks will deteriorate and require premature replacement, unless a means is soon found to halt the deterioration.

The question of whether these physically sound, but chloride-contaminated, bridge decks can be protected to achieve their expected 40-year life, has not been resolved by the Federal Highway Administration. The repair procedure of completely replacing the contaminated portions of the deck is expensive and, as a result, is not being attempted by the States. Numerous techniques have been suggested as possibilities for protecting existing bridge decks from further deterioration. These techniques—which are in various stages of development—include asphalt membranes, concrete overlays, internally sealed concrete, deep polymer impregnation, cathodic protection, and electrochemical removal of chlorides. However, very limited data is available on the effectiveness of these potential protective systems.

We believe that it is time for the Federal Highway Administration to emphasize the development of tools and methods to rapidly and accurately determine the effectiveness of the various protective systems. Time is important. The sooner these issues can be resolved and applied to existing bridge decks, the fewer the decks that will require complete replacement. A program to protect existing contaminated bridge decks instead of completely replacing them could save billions of dollars.

Installation of protective systems on existing bridges has been slow. Replies to our questionnaire by a majority of the 32 States with a serious bridge deterioration problem indicate that lack of Federal and State funds is a major reason why bridge decks are not being protected. The States' bridge replacement funds were earmarked for those bridges that must be replaced. As a result, funds were generally not available to install protective systems on existing bridge decks.

As of 1977, our statistics show that less than 10 percent of existing bridges in 23 of the 32 States reporting serious deterioration problems had protective systems installed. For example, Pennsylvania had installed protective systems on only 46 of its 22,000 bridges during the 18-month period ending October 1977. The States expected little improvement in the near future.

The result of such slow progress will be greater cost in the future. Most States reported that, unless repairs are completed in the next 3 to 5 years, currently salvageable bridge decks will deteriorate to the point of requiring complete replacement at greatly increased costs. For example, a Federal Highway Administration study indicated that, if the 29,000 interstate bridge decks then requiring minor repair were neglected to the extent that they require moderate repair, the current repair cost of about \$600 million would increase by an additional \$4.4 billion. These estimates are in 1975 dollars.

By way of closing I would like to reemphasize the critical need to quickly find an effective protective system for heavily contaminated bridges and to resolve the funding problems at both the Federal and State level. Prompt resolution of these problems is essential so that existing bridge decks can be protected. The alternative—completely replacing the decks later at a cost of billions of dollars more—is not very attractive.

Mr. Chairman and members of the committee, this concludes my statement. We will be glad to respond to any questions you have.

Mr. HARKIN. Thank you very much.

We will turn now to Mr. Rex C. Leathers, Director, Office of Engineering, Federal Highway Administration.

Mr. Leathers, who was formerly Director of the Office of Development, will speak about the research and development work the FHWA has conducted on solutions to the bridge deck corrosion problem.

Mr. Leathers, I do not know if you have a prepared statement.

STATEMENT OF REX C. LEATHERS, DIRECTOR, OFFICE OF ENGINEERING, FEDERAL HIGHWAY ADMINISTRATION

Mr. LEATHERS. I do not have one ready.

Mr. HARKIN. That will be fine. We will hold the record open for you to make any prepared statement a part of the record.

Proceed in any manner you wish.

Mr. LEATHERS. I will attempt this morning to very briefly identify the significant research and development work which addresses the problem of bridge deck deterioration specifically.

I know that later witnesses will very likely expand upon my discussion. It is, I believe, important to take a couple of minutes to discuss the relative roles of the Federal Highway Administration and the State highway agencies in the highway program.

Very simply stated, the State highway agencies select, design, construct, maintain and operate the transportation facilities. We, traditionally, have a partnership relationship in the selection, design and construction activities. The States have the exclusive responsibility for the maintenance and operation of the completed facility. Federal aid highway funds have not been available to assist the States in either maintenance or operation.

Because of the rapid increase in the cost of doing maintenance in recent years, the Congress has seen fit to provide the legislation and funding to assist in major rehabilitation work. The 3-R program and the bridge rehabilitation and replacement program are examples of this legislative assistance.

More than 10 years ago, the bridge deck problem attracted the attention of both the operating and research people and an all-out effort was initiated to define the problem and seek answers. A look at the procedures, techniques, materials and processes investigated suggest that this was a very significant undertaking. Industry, the States, universities and colleges and government worked together to identify and evaluate not one but many solutions to the problem. I will discuss some of them today.

The initial effort was to define the problem. That is, what was the principal cause of bridge deck deterioration. Research has identified corrosion of the reinforcing steel as the major cause of concrete spalling and delamination. The corrosion is initiated when a critical amount of the chloride ion penetrates the concrete to the level of the reinforcing steel.

When sufficient moisture and oxygen are present, corrosion of the steel begins. The iron oxide or rust which forms occupies more volume than the parent iron and as a result induces tensile stresses in the surrounding concrete. When these stresses exceed the strength of the concrete, cracking and delamination and eventual surface spalling occur. Research and field experience have shown conclusively that traffic, freezing and thawing and cracking are not necessary prerequisites to corrosion induced distress but may accelerate the formation of a spall after the initial corrosion damage has occurred.

The search for solutions to this problem has recognized the real world. What can be done to those bridge decks in service and new decks yet to be constructed. That is to say, some of the developed solutions are applicable to in-service decks and new decks alike, whereas other solutions are exclusive.

Among the methods available to prevent or delay chloride penetration are:

1. Surface sealers: These are commercially available waterproofing compounds. None were found to be effective for extended periods of time.

2. Waterproof membranes: Industry developed both sheet and liquid membranes to be placed with an asphaltic concrete overlay on the deck. Extensive evaluation of field installations of several types through the FHWA experimental projects program resulted in a few types being accepted as the best performers. Extremely rigid quality control of the placement is necessary to assure some degree of success. The membranes are better than no protection at all and thus are cost effective.

3. Low permeability concrete: There are several techniques available which will result in a less permeable concrete mixture. Some of these are:

- (a) Conventional concrete: A high quality concrete placed with very rigid controls has demonstrated good results. The mix design and control techniques identified as the Iowa dense mix has been approved by FHWA as a standard bridge deck system.

- (b) Polymer-modified concrete: The most successful of which is a latex-modified concrete mixture. Test results and field evaluations have shown this mix to be effective in slowing the rate of chloride penetration. Four commercially available latex modifiers have been approved for experimental construction. The modified concrete over-

lay is superior to conventional concrete but is not totally impermeable. Other polymer [plastic] concretes are being evaluated and show some promise. These are identified as polymer concrete in which the portland cement is replaced with a monomer [plastic] and polymer-impregnated concrete in which the monomer is placed on the conventional concrete deck when cured.

(c) Internally-sealed concrete: This concrete is made by mixing small spherical particles of wax with the conventional components of concrete. After the concrete has cured, heat is applied and the wax melts and flows into the capillaries of the concrete. When the heat is removed, the wax solidifies in the pores and capillaries. The penetration of water and chlorides is thereby blocked. Work is continuing on this technique in research and the FHWA's demonstration program. Approximately 13 decks have been constructed with an additional 8 to 10 proposed this year.

Of the techniques noted to this point, all have been aimed at reducing the permeability of the concrete and thus preventing or delaying the penetration of the chloride ions. Other solutions have been directed to developing a noncorrosive reinforcing steel.

The most promising development is the epoxy-coated reinforcing steel. The initial problems of quality of the epoxies and coating have been solved. Tests fully confirm the level of protection anticipated. Over 100 bridge decks have been constructed using this technique and 22 or more States are using the epoxy-coated re-bar as a standard. FHWA has approved their use for Federal aid activity.

Galvanized reinforcing steel is still in the experimental stage. Field installations are being encouraged and will be evaluated to determine the effectiveness of this material.

Many other techniques were and are being evaluated. Those I have discussed in some detail appear to be the better solutions and generally the most cost-effective.

In passing, some other techniques being used are: cathodic protection which makes use of sacrificial anode, a conductive medium [overlay] and a low electrical current, is an effective way of stopping chloride corrosion on an existing bridge deck. Some 14 bridge decks have been treated in this manner, including one on the George Washington Parkway in Virginia.

Noncorrosive deicers have been evaluated. A number have been identified that are effective but because of prohibitive costs and adverse environmental effects are not being used except in very limited quantities.

A combination salt and mechanical process has been developed which shows some promise. Salt solution is sprayed at pressure on the packed snow or ice. If this proves to be workable, the amount of salt per application would be greatly reduced.

Attempts have been made to develop methods for removing chloride ions from an existing deck. Laboratory scale tests of electro-chemical and electro-osmotic techniques are encouraging but not ready for extensive field tests.

Although I have discussed a number of approaches to solving this problem, I have by no means covered the subject. I hope it has, however, given you some idea of the magnitude and direction of this research and development effort.

Many of those discussed are standard procedures in many States. The full benefit of the Iowa dense mix, epoxy-coated reinforcing steel, internally sealed concrete and polymer-modified concrete among others will not be totally known for many years; but the initial evaluations suggest that the research and development effort was extremely successful.

Thank you again for inviting me to participate today and I hope I have contributed in some way to your knowledge on the subject of bridge deck deterioration problem.

Mr. HARKIN. Thank you very much, Mr. Leathers. That statement I am sure will give us a lot to think about, about some of the different methods, especially that Iowa thing.

Our next witness is Mr. Charles F. Scheffey, Director of the Office of Research, Federal Highway Administration.

Mr. Scheffey will discuss the efforts of the Federal Highway Administration in researching and developing solutions to the pothole problem.

Do you have a prepared statement?

Mr. SCHEFFEY. I do have a prepared statement, Mr. Chairman.

[The prepared statement of Mr. Scheffey follows:]

STATEMENT OF
CHARLES F. SCHEFFEY
DIRECTOR, OFFICE OF RESEARCH
FEDERAL HIGHWAY ADMINISTRATION
DEPARTMENT OF TRANSPORTATION

BEFORE THE
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON TRANSPORTATION, AVIATION, AND COMMUNICATIONS
Tom Harkin, Chairman

Mr. Chairman, it is a pleasure to appear before the House Committee on Science and Technology to discuss the concerns and activities of the Offices of Research and Development of the Federal Highway Administration with respect to the so-called "pothole" problem. While the legislation related to the Federal-aid highway program has never permitted the participation of Federal funds in maintenance and repair, except for the recent provisions of the 3R program, the particular sections of the legislation dealing with the authorization for research under Section 307 of Title 23 is not so restrictive. There have, therefore, been activities in the Offices of Research and Development related to the maintenance function for many years.

The long tradition of a partnership between the Federal Government and the State highway agencies in the development of the highway system has been carried over into the research programs. This is reflected in our funding arrangements in which approximately half of the total resources are derived from the 1½ percent "set asides" for highway planning and research derived from the State apportionments from the

Highway Trust Fund. These funds are matched appropriately by the States and the individual States have the right of initiative with respect to their use. The remaining funding in the program is by direct appropriations from the Highway Trust Fund to provide for the contract programs of research administered by our offices and the staff research conducted in our laboratories at the Fairbank Highway Research Station, McLean, Virginia.

In view of these arrangements, when we speak of our program we mean the program of the whole research team whose efforts are brought to bear on critical problems. This includes not only the contract program and the activities of the individual States with their Federal-aid research and development funds, but also our staff studies and the studies financed through the National Cooperative Highway Research Program utilizing a portion of the State's 1½ percent funds and operated by the Transportation Research Board, National Academy of Sciences, on behalf of the participating States and the Federal Highway Administration.

Much of the early research activity related to maintenance concentrated upon the management function. There was also considerable activity in the landscaping area to ensure selection of appropriate plant materials to minimize the cost of mowing, pruning, and other roadside maintenance activities. In addition, some of the highway construction productivity studies were related to specific maintenance

operations. In our more recent research and development programs since 1970, there has been a shift in emphasis toward dealing with more specific maintenance problems such as the bridge deck deterioration problem. The outputs of that research activity have already been discussed by Mr. Leathers in his presentation. Some research activity continues on that problem to refine the successful methods which have been developed to build new decks which are immune to chloride attack, to provide better tools for the precise assessment of the conditions of damaged decks, and to reduce the cost of methods now available for rehabilitation of these decks without the necessity of total replacement.

Under the same research project, which was somewhat broader than the deck problem alone, there was considerable activity to evaluate some of the newer materials available for local patching of concrete. A report was issued in April 1974, covering detailed evaluations of nine such materials, including a number of proprietary materials marketed under names such as "DURACAL," "Five Star Highway Patch," and a number of latex modified concrete mortars. More recently, a report has been issued under the National Cooperative Highway Research Program synthesis series titled, "Rapid Setting Materials for Patching of Concrete." In April 1977, our Implementation Division issued two reports related to the use of polymer concrete for patching bridge decks and local defects in concrete pavement.

With the conclusion of these studies and those now in progress, we believe that the bridge deck related part of the "pothole" problem will have been covered rather thoroughly inasmuch as research can contribute to its solution. Our program is also attacking a number of other problems which affect the safety of our bridges. Corrosion of the structural steel by sea coast and industrial environments and environmental effects of existing paint systems have provided impetus for an accelerated program for new coatings to protect steel structures. There are inherently more subtle and more dangerous problems because of their difficulty of detection which fortunately are also more rare. These are associated with slow crack growth in steel structures and the possibility of sudden and abrupt fracture. Such crack growth can occur due to fatigue by repeated loading, stress-corrosion effects, or as a residual of the welding process. Much of our bridge research program has been directed at understanding these problems and providing appropriate inspection equipment.

In terms of numbers or in the degree of distress and inconvenience to the public, the "potholes" in pavements are far greater in numbers and significance. The term "pothole" is rather imprecise and is used by some to denote any abrupt defect in the pavement running surface and by others to mean specifically that type of hole which develops in bituminous concrete surfaces and becomes rapidly enlarged by weakening and displacement of the base course if unattended. The surface of a pavement is somewhat like the human skin in that small defects, unless

given immediate first-aid, rapidly become "infected." In the remainder of this discussion, I shall use the broader definition since I believe that the matter of concern is the whole question of the deterioration in safe and acceptable riding conditions of our pavement surfaces.

A pothole in a bituminous concrete pavement can develop because the basic supporting structure is inadequate for the design loads, or because extreme environmental conditions have occurred, or because loads in excess of the intended design loads are using the pavement. In many cases the real cause of the pothole is economic rather than technical. Many of our existing pavements today are carrying traffic in far greater numbers and with heavier, although perhaps legal, loadings than they were originally designed to carry. This problem is particularly severe in the growing fringes of our great metropolitan areas where many highways now serving as major arterials were originally constructed to carry light, low density rural traffic. The best way to cure the pothole problem is to prevent them in the first place. But, this is a rather idealistic statement in view of the budgetary history of the jurisdictions in which many of these problems are severe. There was frequently no choice but to attempt to provide the required level of traffic service by adding a layer to the existing pavement, even though it may have been recognized at the time that it was not good investment economics. A major project in our current research and development program is aimed at the development of reliable design technology for the rehabilitation and major reconstruction of existing

pavements to provide adequate load and traffic capacity. The level of participation by States in this program is exceptionally good and interim procedures for the reliable design of structural overlays are now being evaluated.

When a pothole does occur, the responsible jurisdiction must have the resources to provide a durable patch if extensive damage to the total pavement structure is to be avoided. Since the damage is frequently associated with severe weather conditions of cold and water saturation, techniques for temporary patches to prevent further damage until conditions favorable to an appropriate permanent job are also essential. The interest in these problems has, of course, been quite intense in all of the State highway agencies. There have, therefore, been many research and evaluation studies in the program to examine both State developed and proprietary patching materials and techniques. Our Offices of Research and Development have worked closely with the Materials Committee of the American Association of State Highway and Transportation Officials on this problem and with their cooperation have sponsored an information exchange known as the SPEL (Special Products Evaluation List). The cooperating States send in brief reports on their evaluation of special products for a variety of purposes, which are then stored on our computers and used to provide information to other States which are interested in the same products. Rather than store the detailed reports, we record merely the appropriate State report references and furnish this

information to other States which make inquiries. A complete list is printed and distributed once every two years. The latest edition was in December 196⁷⁷. That edition listed more than 400 State evaluations of patching materials. A recent computer run on the current file indicated about a 20 percent expansion in the list. Participating States can obtain up-to-date computer printouts on specific subject areas like patching materials upon request. The biennial edition of the complete list is available to the public through the National Technical Information Service.

Our Implementation Division has recently made a wide distribution (5,000 copies) of a brief report and how-to-do-it manual on bituminous patching. This was prepared with the cooperation of teams in four States, including Pennsylvania. The report indicates effective patching methods and makes some comparisons of costs. A new effort now being initiated will seek the cooperation of about 10 States in a more detailed evaluation of the more popular proprietary patching materials which will also obtain performance data and cost effectiveness data for a wide variety of conditions.

The Federal Highway Administration has seldom found it necessary to get into the construction equipment development business. Private industry has been normally very responsive to the needs of highway agencies in this regard. We have just received the draft final report of one assessment of this type, however, related to the

development of automatic patching equipment. The contractor has concluded that at least one of the semi-automatic systems now on the market approaches the performance specifications which we had envisioned. At this point we are making our own assessment as to whether or not this matter should be pursued further, or whether we can count upon private development to continue to improve this area of maintenance technology.

I should like to mention that the July 1978 "Maintenance Aid Digest" of the American Association of State Highway and Transportation Officials Committee on Maintenance featured an excellent summary of existing patching materials, including such cold patch mixtures as SYLVAX. There has also been an NCHRP Project underway titled "Bituminous Patching Mixtures." This will be a synthesis of existing publications and data and is currently in the draft report review status at the Transportation Research Board. I would sum up the status with respect to the patching of potholes in bituminous pavements by saying that there are now many products on the market which permit emergency patching during cold and wet weather and reasonably complete technology for placing permanent patches when conditions are more favorable. It must be remembered, however, that if the basic problem was an inadequate base structure or insufficient subsurface drainage, the conditions which caused the pothole to form in the first place will soon repeat the process at a nearby location. Indeed, if adequate restoration of the base at the location of the original pothole is not performed, one may be faced with a pothole on a patch.

I would like to conclude with some brief remarks about other types of pavement distress. In properly designed heavy duty pavements, we are most often confronted with fatigue cracking, thermal cracking, or rutting. The first two types of failure can occur in either bituminous or portland cement concrete rigid pavements. Longitudinal rutting occurs primarily on bituminous pavements, although grooves approaching the depths of unacceptable rutting have been cut into some rigid pavements by studded tires. Both of the cracking modes of distress require prompt attention to avoid more serious damage of the type that might be called potholes. Rutting becomes primarily a safety problem in that the longitudinal grooves trap pools of water which create ice hazards in winter and hydroplaning problems at other times of the year.

Portland cement concrete pavements are subject to another class of severe distress due to the breakdown of the seals and load transfer devices at the joints. The loss of seals permits the entry of water into the base layers, resulting in pumping out the fine materials and consequent loss of support. The deterioration of dowel bars or other load transfer devices results eventually in "faulting" of one pavement slab with respect to its neighbor and consequent sharp bumps in the running surface. It is usually also associated with cracking 6 to 8 feet away from the joint due to the fact that the entire axle load is carried by the end of the slab instead of being partially

distributed to the adjoining slab. Finally, the intrusion of solid materials into joints with defective seals sometimes leads to "blowups." These are caused when the first hot day of summer expands the concrete slabs. With this expansion restrained by tightly packed solid materials in the joint, resulting in excessive compression stresses and upward buckling of the pavement. These classes of distress in portland cement concrete pavement were addressed by NCHRP Report No. 56 in the synthesis series, which incorporates the results of a number of previous State and Federal Highway Administration reports on the subject.

STATEMENT OF CHARLES F. SCHEFFEY, DIRECTOR, OFFICE OF
RESEARCH, FEDERAL HIGHWAY ADMINISTRATION

Mr. HARKIN. Thank you, Mr. Scheffey. That is a very comprehensive statement.

I would like to open our discussion with Congressman Atkinson.

Mr. ATKINSON. I would like the witnesses to add comments as we talk around the subject, because I feel there is such a problem that no linear line of questioning will share all that much light on the subject.

It seems to me that some of you are saying that we have great difficulty evaluating the effectiveness of these methods, and yet I get a strain of optimism from Mr. Scheffey at one point saying that, I cannot quite put my hand on it, but that you seem to be satisfied that the research in these areas had gone about as far as it could, if those were your words.

Mr. SCHEFFEY. With respect to the construction of new concrete decks, I think we have evolved not one, but at least four, both technically and economically feasible solutions.

With respect to the protection of existing decks, we are not at all satisfied with the current status, and we are continuing with quite an active program to upgrade these methods.

We do have methods that will protect existing decks; however, the cost involved is still at a level which we feel unsatisfied with.

We also are rather optimistic about improving these with respect to decks where the corrosion is not advanced to the point where the concrete is actually spoiled.

Once we have reached that level, there is probably no solution, but at least to remove the concrete above the upper layer reinforcing steel, and in some cases, it may require complete deck removal.

Mr. ATKINSON. So your satisfaction is limited to the techniques of protecting newly installed bridge decks, because I think I heard Mr. Leathers say that the tests that we have are really long-range tests, that we may be surprised by the answers down the road, and may be very dissatisfied with some of the methods we are using.

Mr. LEATHERS. I hope I did not give that impression.

The point I was trying to make, we are talking about a 40-year life of bridge deck.

The techniques we have on the new bridge decks have been underway for perhaps 4 or 5 years, that is the length of time we have been able to evaluate them.

Our laboratory tests under more severe conditions have led us to believe that these techniques will give us a bridge deck that will last that many years, but I am just a little bit concerned to make a statement that a method, or something will be 40 years from now.

I think I am projecting myself a little further than I can.

Mr. ATKINSON. What I am trying to get at, I would like to try to understand the depth of our research efforts in general, and I got sidetracked on the first warnings that the tests that we have really take such a long time that we are not sure what the real protections are going to provide are, and I am wondering whether the first research efforts that have to go into this might be in the range of devising the

tests, and I wanted to ask what efforts we are making to test these materials, and what effort is going into developing a good test.

Mr. SCHEFFEY. May I expand a bit on that.

We do have an accelerated method of testing to determine the relative resistance in these different measures to deterioration from chloride intrusion.

We have at our backyard down there at the Fairbanks Station several hundred 6-foot-square-concrete slabs in which the conventional techniques have been used, and in which all of these advanced protective techniques have been used.

Those slabs are, it is a small raised edge around them, and they are salted with very concentrated salt solutions twice every day.

Now, some of those tests have been in progress for as long as 4 years, and what we derive from these accelerated tests, which are of course much more severe, than the typical deck receives through the winter months alone.

We get relative durability from these different types of treatments.

We also feel we understand the process quite thoroughly now, so our confidence in these treatments is very high.

We would still have to say, and I would agree with Mr. Leathers, that we have had enough nasty surprises in this highway business not to be so positive in saying that we can absolutely guarantee that these decks will last 40 years, but in the same sense that the aircraft industry can fly an airplane on which they have performed full-scale tests and limited fatigue tests, we feel these decks have been given these different methods of protecting decks have been given an equally valid accelerated test program.

Mr. ATKINSON. How much is our research budget in this area, what kinds of budget figures are we talking about going toward testing?

Mr. SCHEFFEY. We have expanded on the bridge deck problem together with the States that have been working with us something in the order of about \$10 million since 1966.

Approximately a third of that has been in our direct contract program, the other two-thirds in a combination of the State-Federal cooperative studies, and the experimental field test program.

Mr. HARKIN. If I may interject one thing, one question, in talking about the data that is available, the General Accounting Office, Mr. Stolarow mentioned on page 5, however very limited data is available on the effectiveness of these potential systems, then he goes on to say we believe it is time that the Highway Administration emphasizes the development of tools and methods to determine the effectiveness of these various protective systems.

Are you saying that you believe you do have the data that you need, you do have the systems at McLean to get the kind of accelerated data you need?

Mr. SCHEFFEY. We have a great deal of data that has been derived from accelerated tests.

I think we do agree with the General Accounting Office that some improvement in our monitoring of full-scale decks built in the field was warranted, and we have taken steps to achieve that.

There is the final proof of the pudding, is what do these decks do in actual service.

We believe that we have done everything we can do with control and accelerated tests.

Mr. STOLAROW. Mr. Chairman, may I clarify to make sure we are all dealing with the same subject.

Our statement you just referred to deals with the research and the evaluation of means of correcting the problems on already contaminated decks.

We were comfortable with the efforts that the Federal Highway Administration was making, and has been doing on new construction, but we have a serious problem right now of what to do with the already contaminated decks, and we felt that acceleration of the research program, and looking at that particular problem was a critical need at the time we did our work.

So I think the statements that have been made kind of support what we said, that much work has been done, and it shows promising results for new construction, but we still have a long way to go on those bridges that are already contaminated.

Mr. WALGREN. Do you feel there is any further progress to be made on the procedures of already contaminated decks?

Mr. STOLAROW. We felt there was not enough effort, and this is a subjective judgment, going into the possible solutions of those already contaminated bridge decks.

Most of the effort had been going into the new construction, the testing of preventive systems.

Mr. WALGREN. Let me ask another question, when we are thinking of bridges in my State anyway, we put the new deck systems on 46 out of the 22,000 bridges, and so that is a description of the dimension of the previously contaminated deck problem that we face.

Do you have a breakdown in this effort?

You say you felt that the Federal Highway people perhaps should have been putting more emphasis on previous contaminated bridges.

Do you know what the dollar values are in terms of effort in that area?

Mr. SCHEFFEY. I could obtain a breakdown of how we spent our past efforts between the business of building new decks and controlling the problem in existing decks.

I think I have already indicated that we ourselves are not satisfied where we are with respect to the existing decks.

I would also like to point out it is an immensely more difficult problem than dealing with the construction of a new deck.

We are neither emptyhanded nor idle in this regard.

We have a great deal of work underway at the present time, not only to improve instrumentation for assessing exactly what degree of damage exists on the deck, because this has a lot to do with what is cost effective, whether you can salvage the deck, whether you can protect it, or whether it is beyond salvage, and you must remove it.

Second, we have developed methods that will control and will halt corrosion in existing decks, using cathodic protection methods; however, these are still somewhat to the expensive side, and we are not resting because we would like to have more cost-effective methods.

Mr. WALGREN. What is a simple description of cathodic methods?

Mr. SCHEFFEY. Virtually all electrical methods to halt corrosion, it is an electrical current involved in the corrosion process itself, so if you can impress on the steel the proper kind of a reverse potential, you can prevent this corrosion from occurring.

One method by which we now do this is to place on the surface of the deck a conductive type of asphalted concrete.

It has mixed in it an ingredient derived from the coking industry, which is a very fine carbon.

This is mixed in the concrete and gives us a conducting surface, and we attach the other side of the electrical circuit by reinforcing steel.

By putting a volt on this the corrosion process can be stopped.

Whether or not that is a cost-effective method, depends on how far the process has advanced when you get to the bridge, and a lot of our effort is aimed at better methods of determining exactly where that corrosion has proceeded.

Mr. WALGREN. Is it cost effective on a new bridge?

Mr. SCHEFFEY. No, sir, it is not a cost-effective way to provide for new protection, for protection of new bridges.

It is more costly than any of the permanent schemes.

Mr. WALGREN. You feel the epoxy coating is more cost effective in that sense?

Mr. SCHEFFEY. The epoxy coat had steel, the internal sealed concrete, the extremely dense concrete mixes, if you are building a new deck, are more cost effective than trying to prevent the corrosion by imposing an impressed voltage.

Now, one of the things that makes the cathodic method expensive, is the coke freeze does not have sufficient stability to carry the direct contact of the wheel load, so we must place another protective layer on top of that.

That is one of the areas that is continuing in research to develop a thinner and more stable conductive layer, so that that method can be more widely applied.

Mr. HARKIN. Excuse me.

On the cathodic treatment, you mentioned the bridge near Washington.

How close is that?

Mr. SCHEFFEY. That is on the George Washington Parkway, about 2, 3 miles above the Roosevelt Bridge.

It is the first bridge coming in from 495.

Mr. HARKIN. And that has a cathodic treatment?

Mr. SCHEFFEY. Yes, placed 2 years ago.

Mr. HARKIN. Using solar energy?

Mr. SCHEFFEY. Yes, two solar panels if you will notice sitting between the bridges at the Virginia end.

Mr. HARKIN. What kind of data do we have?

Mr. SCHEFFEY. The measurement of that have indicated electricity measurements, measuring the corrosion of the steel, is that there has been no change, no more corrosion of the steel.

The deck was repaved, and the coke freeze and surfacing placed on top of it, and so it did have chloride iron in the deck at that time.

It has stopped the corrosion right on the steel.

Mr. WALGREN. So this is a way of addressing the problem that we are talking about, that the General Accounting Office is talking about, of stopping the ones that have already started?

Mr. SCHEFFEY. But it is an extremely expensive operation, and we do have some problems with the surfacing.

Remember that George Washington Parkway carries very little heavy traffic. It is primarily passenger traffic.

There are three stages of deterioration of the deck, which we can now detect with instrumentation, and depending on where that deck is in its circle of deterioration, will determine whether or not you can use cathodic decks.

If it has advanced to the third stage where the actual spalling of the surface concrete has occurred, then by itself it is not a useful technique.

We then have to go to a combination of cathodic protection with injection of materials, and when we have done that, we find the epoxy insulates portions of the surface, so that cathodic protection is or it can be effective, but we are still working on that end of the problem.

In the early stages you get corrosion on the steel, you get the establishment of conditions which are conducive to corrosion, the degree to which that has occurred can be detected by electrical protection measurements on the surface.

In the next stage you get active corrosion of the steel, but it has not progressed to the point where it has spoiled the concrete, and, finally, you develop enough internal pressures to lift the upper inch or inch and a half of concrete over the steel, and you are into the third phase of deterioration.

Mr. WALGREN. You mentioned the figure of \$10 million as being directed toward testing.

Was that testing alone?

Mr. SCHEFFEY. That is the total research and development program on the bridge deck since about 1966 or 1967.

Mr. WALGREN. I see. And that would not include moneys spent on your efforts in the management function area, or in the vegetation and beautification side?

Mr. SCHEFFEY. No, sir.

Mr. WALGREN. Not that at all? And that would also lead you to bringing out the efforts to lead toward pothole repair by itself.

Now, in your analysis, it led to two areas, one is the new engineering structure of the road, and efforts to come up with designs of road strength, and then also these various mixtures apparently that have been tried on potholes from time to time.

Can you tell me briefly what mixtures in terms of the patch that the Federal people have been involved in evaluation, I know these is a great reliance on private industry to come up with these efforts, is that correct?

Mr. SCHEFFEY. Well, the reliance on the patching material has been primarily on working with the individual States, utilizing in many cases this 11½-percent Federal aid research and development funds.

We have done some work in our own laboratories, we have spent some of our contract funds more recently in this field; for example,

the polymer concrete patching activities were financed out of our contract program at the Brookhaven National Laboratories.

Mr. WALGREN. What is the annual research and development budget you are working with now?

Mr. SCHEFFEY. Total budget?

Mr. WALGREN. For research and development.

Mr. SCHEFFEY. Of all types?

Mr. WALGREN. That are directly related to highway repair and maintenance.

My problem is that traditionally, I understood the Federal Government has not been involved, and we mentioned the three-R program, involving reconstruction, rehabilitation, and replacement, none of which applied to maintenance, and I am trying to understand exactly what the Federal Government has done in terms of research on new maintenance techniques, because the present ones are clearly failing.

Mr. SCHEFFEY. The maintenance program in terms of direct Federal funding is relatively recent, at least related to the repair items.

It has been underway since perhaps 5 or 6 years back, because we have been able to generate, we felt up until that time the necessary activity with the Federal aid research dollars through the State programs.

In the pavement design area, there have been very heavy investments from both the Federal aid programs and Federal contract programs in research and development.

I do not know whether I am really answering your question, but I would be happy to put together some numbers for the record here.

I hesitate to do it from memory, because there are so many questions about what is really applicable.

Mr. WALGREN. Thank you, Mr. Chairman.

Mr. HARKIN. Mr. Atkinson?

Mr. ATKINSON. Thank you, Mr. Chairman.

I think you have testified that the problems we have are primarily caused by chloride, and gets into the cement, and with the moisture, the oxygen, there is interaction that causes the member to rust, and as it rusts, it expands, and then that comes up through the concrete, and that causes what we call a pothole.

Mr. SCHEFFEY. Yes.

Mr. ATKINSON. Is there a system other than chloride that can be used, that would give the same effect?

Of course, that is important in our area, the geography being what it is with hills and all that, we have to have clear roads, and I think I forget when it was, the Federal highway system said there shall be, and that was the clear pavement policy in the 1950's.

So, they have to be clearly obvious, so the chloride is what is used.

I know it is damaging, but it is taking it away from highway and bridges, and most of the people probably experience here as I have, and some of the others on our own sidewalks at home, you pour this stuff out to try to get the ice off the sidewalk, and the following spring, you can see what has occurred, it is obvious just what happened.

I notice, again talking about sidewalks back home, the general sidewalk as opposed to the walkway up to the house, the sidewalk seems to last a longer time than the walkway up to the house, and I am just

wondering if the cement mixture, is that what you are saying in part of your testimony, that it is different?

Mr. SCHEFFEY. The kind of surface damage you see on concrete from the use of chloride chemicals is another phenomenon we call scaling. That is not related to the corrosion of reinforcing steel, but it also is preventable and has been prevented in decks built since about the last 15 years.

When the deck is built with the concrete, this scaling phenomenon does not damage the surface of the concrete when certain methods of protection are used.

There are also other methods of protection; for instance, surface treatments with linseed oil have been used to eliminate that scaling type of damage.

There are undoubtedly many concrete decks that were built before the technology of air entrainment; one of the methods I meant to mention, was thoroughly understood, and that are out there that have a scaling problem as well as a problem from the corrosion of reinforcement steel in the deeper layer.

Mr. ATKINSON. You said in the testimony that the bridges now being constructed that should have a useful life of 40 years or so is around 15 or so.

How about the bridges that we looked at today, which I guess are 50 years old, when it started its rapid rate of deterioration, I don't know, but I would have to assume when the highway systems said it has to be clear, and with the heavy use of chloride, I am wondering was the material content in prior years, as I made reference to the sidewalks that were old in our town, as opposed to walkways which is current, was there a better system used, where the specifications called for material content of better use, or could be more strength, could be better engineering make up, why did they last so long, and, of course, the other reference we make to railroad bridges that last forever, is that because there was never any chloride dropped on it?

Mr. SCHEFFEY. I cannot explain your durable sidewalks without knowing what concrete is in them.

The problem we have had with the bridge decks did begin some 5 or 6 years after the beginning of the bare pavement policies in the mid-1950's with heavy use of the ice and chemicals in our program, not once, but three extensive occasions we have gone out with extensive contract efforts to find a chemical to replace the chlorides for deicing.

It is quite a trick to find a chemical that is effective as a deicer, it is also environmentally compatible, and it is cheap.

The last cycle of this we just received is the draft final report, there are now a couple of promising substances that may eventually replace the use of chlorides, but there are still in the technology development these:

One family of substances is calcium magnesium acetates, which can be developed from cellulosis waste products, but the technology is in its infancy, and to make that in large quantities, we are not sure at this point whether it will be cost effective or not.

Mr. ATKINSON. You mentioned I think earlier in response to substances, about the set-aside money being 1½ percent, that is not the \$10 million we are speaking about, it is a lot more than that involved in research and development?

Mr. SCHEFFEY. I am sorry for the confusion.

The \$10 million figure includes that component where it was invested in the bridge deck deterioration problem.

The annual amount of those 11½-percent moneys are currently running about \$21 million a year for the total reserve and development program.

There again, the state of the options of where we use that money for planning, whether it is for planning or for research.

It is authorized for either. It has become somewhat of a Hobson's choice in many cases, because there are many planning functions which are legally in legislative requirements in order to qualify for the trust fund apportionments, so in many States, they have been forced to the point where they have very little dollars left to invest in their research program.

Mr. WALGREN. The \$20 million a year is what?

Mr. SCHEFFEY. The \$21 million is the current level of this Federal aid research and development activity in the State highway agencies.

That is the part of the so-called 11½-percent money which is getting into the research programs conducted by the States.

Mr. WALGREN. So our total program is the State part, the \$21 million there, and then another figure which we do not really know exactly what is, what that is, is that correct?

Mr. SCHEFFEY. We have four components actually in this program, the State-Federal aid component which is part of the 11½-percent money, currently running about \$21 million a year.

We have a direct contract program which is funded by appropriations from the trust fund that we go up before the Appropriations Committee and defend, that is administered by our office and currently running about \$23 million a year, and then there is the NCHRT program I mentioned, which is really, part of the 11½-percent money also, but operated by the National Academy of Sciences, and that can currently run about \$4 million a year, and finally, the salaries and expenses in the general Highway Administration that pays our salaries and runs our laboratory, and the laboratory program is the smallest component, it is running about \$1½ million per year at this time.

Mr. WALGREN. And it is only the State figure which you do not know at all how much is put toward research versus some other needs the State might have for that money?

It is only true with respect to the State component?

Mr. SCHEFFEY. We have good data on the State expenditures, because we are responsible for monitoring all of this activity. We do not consider it an independent program, but rather a part of the total program in our cooperative efforts to get solutions to these problems.

Mr. WALGREN. Could you then in a later submission characterize how the States are spending those funds, how much of the \$20 million is going toward research, and how much might be getting off into some kind of planning function that is not in our view delivering the remedy the public needs?

Mr. SCHEFFEY. I am sorry again, apparently there is some confusion here, the \$21 million is the current level of that part of the 11½-percent money which is getting into research studies.

Mr. WALGREN. I see.

Mr. SCHEFFEY. The total 1½-percent money is like \$150 million, and the other \$120 to \$130 million is in the planning function.

Legislatively, the States have the right to make the decision as to how they divide those funds.

Mr. WALGREN. I see.

I have to apologize because I thought I heard you say you did not know how the States spent that money, and that you did not know how much was getting into the research.

Mr. SCHEFFEY. No, sir. I am responsible for nothing there.

Mr. WALGREN. I apologize then for that.

Mr. ATKINSON. Carrying on with Doug's thought, is there sufficient communications between the various agencies and groups as to what one is doing or the other, as far as research is concerned, is there a central clearinghouse where all this funnels through?

Mr. SCHEFFEY. That is really one of our main roles in the Office of Research Development, is to coordinate the activities of the State studies with those of our own contract program, the NCHRT program and our staff study and my project managers have heard my speech many times, that they cannot depend on the contract funding alone, they cannot turn their back on these other resources, their job is to get them to work together.

Now, we do respect the fact that when the Congress originally made those 1½-percent moneys available for research and planning, it was intended that the States have some resources to work their local problems that are not national problems, and, therefore, we do not put all of that money into the projects that we have identified as national projects.

We have, for example, in the State of Florida, they have a very difficult problem of finding suitable aggregates, they have a rock down there that nobody else has, called lime rock, it is different from limestone, and they have spent some of their 1½-percent money to do intensive research on how they can utilize that unique source of aggregate, and that I think is within the intent of the legislation.

At the present time there is approximately 60 percent of the total moneys available to the States through that fund, that is in what we call the federally coordinated program, these are the projects we have selected for national emphasis, and which we make a more than normal effort to coordinate State work with our own.

Mr. ATKINSON. If you will excuse this, I never miss an opportunity to talk about this, they talk about the match, and Pennsylvania has had its problems with the match money, and when I first went to Congress to ask why the match, in fact, I asked the Commissioner, I will direct it to you, and whether you can respond that is something else, but I just want to say what I say and think, the problem of course that was a 70-30 match, and the House wanted to make it 80-20, and came back, and the Senate would not go along, you do not have the 25 percent, it does not really matter about the other part, and there is some \$800 million in the Federal highway trust fund earmarked for Pennsylvania, for Pennsylvanians who pay that 4 cents a gallon for gasoline, so it is all built up in there, and down the road we will lose it all if we do not come up with our match.

When you ask the question why the match, they say, well, highway needs are greater than moneys available, therefore, more money is

necessary, and therefore the match, and yet they do not consider in my view that last year according to the Carter administration, that there has been a 30-percent increase on highway construction costs in a 1-year period.

We had testimony last week with the Director of Transportation, Mr. Bowers, and he said there is a containment cost factor now that the first quarter is a 2½-percent, which works out to be a considerable reduction in a year period.

Forgetting all of that kind of situation, it just seems to me as if the inflationary spiral is greater than the required match that is counter-productive, and that the moneys laying there in Washington in the highway trust fund earmarked for Pennsylvania should be used now in the match waived, they waive the match because of an economically depressed time period, and we are now in a situation where there are fatalities caused by potholes, and bridges are falling down, and the energy costs alone by rerouting and detouring is 5 miles, I guess, on the Thornburg Bridge, we heard testimony today, and the mayor spoke of some \$2 to \$4 million of that in cost of gasoline, based on today's prices, and they are really going strong toward that dollar, which I have opinions on that, too, but I will not express those here today.

My only thought is that the highway departments in seeing that, the Federal Government knowing this, whether or not there is strong recommendation, because your recommendations and GAO study which is the oversight of Congress, and the investigating arm for Congress, why we cannot get strong recommendations that this be looked into.

Another thing, it is not considered as far as Pennsylvania is concerned, is the geography, and the weather factors, and the industrial density, the industry here in this area, and that is not considered, I know, that is the question I have asked, and it has never been responded to, and I am just wondering, whether because of the real problems here in Pennsylvania, and realizing that there is an awareness of it, whether Pennsylvania is getting some extra consideration as far as bridges are concerned, and as far as highways are concerned, in comparison with Southern States, which probably do not have near the cost of construction that we have, in land acquisition, in terms of people, the environmental impacts, and all of the other things that come strong in our area, has there ever been any thought given, or would you care to recommend that this kind of consideration should be made, anybody want to tackle that?

Mr. SCHEFFEY. You are discussing policy issues I would much prefer to duck.

We carry out the legislation, and it is the legislation which has prescribed the manufacturing ratios, and the formula for the apportionment to the individual States.

As to the preferential treatment because of crises, that is out of my department; I am not sure even whether Rex wants to address that or not.

Mr. LEATHERS. No; I think Mr. Scheffey hit it quite well, the legislative intent is established, and not at the level in which I am operating, in which any changes can be made.

I think you are aware this year that an attempt was made in three projects; in Allegheny, in which we call the soft match, the State had expended considerable dollars in the purchase of right-of-way, and so forth, at 100 percent State.

Now, they have determined what the value of that was, and that so-called soft match will be matching Federal dollars.

Those are done on an individual basis, the Secretary of Transportation works that out with the Governor, and these things administratively can be done.

Those of us on my level can get the work done if somebody makes the administrative decision.

Mr. ATKINSON. I have asked the same question to Brock Adams, not as a Congressman, but as a commissioner, and he said by statute, and when you see it was a 50-50 match, then it worked its way down to 80-20, and it was 90-10 on Interstates, so it is flexible, they recognize the fact that States do not have the money, and they keep reducing it down.

We are not the only State having the same kind of problem.

It seems to me inflation being what it is, with energy conservation be what it is, and gasoline apparently going up, that a whole different attitude ought to exist as far as match money is concerned.

Pennsylvania does not get it, then it will go to some other State.

It is by statute, and I guess it is up to Congress to try to take some action, but my whole point is since you have some Members of Congress, and some States not having the trouble, we need some strong recommendations coming from outside the Congress, people who factually studied and made strong recommendations on the best interest of the country, and I know the Eastern and Midwest caucus, that we are all a part of, with raw materials coming from the Midwest into our area, they should be as concerned with roads and bridges as we are, and the finished product going back, so I would like to ask from a personal standpoint, as a member of this subcommittee hearing, that somebody have a deep and general discussion along this line, and if you feel it is worthy of recommendations, I would sure like to have it.

Mr. STOLAROW. The problem you speak of, Mr. Atkinson, is not limited to highway funds.

Anytime the Federal Government has set up some kind of sharing programs with the States, where you have a formula that determines allocations, whether it is in welfare programs, or in highways, there is always the political problem of how you balance everybody's interest, on some program; some feel they are not getting enough, and on others they are satisfied, so it is a continuing problem on all of the sharing programs of how to equitably approach it so that these needs can be met, and I think it is more serious, or more of a problem, than just the highway program.

Mr. ATKINSON. Just a final question, Mr. Chairman. Because of the salt runoff into streams, do you get any problems of environmental questions along that line?

Mr. SCHEFFEY. Yes, sir, there are environmental problems associated with the use of deicing chemicals. Fortunately, these are generally pretty localized.

We have a situation where a highway runs along the edge of a public reservoir, for example, and in situations like that, alternate means are used to control the ice and snow at somewhat higher expense.

One switch, for example, is to go from sodium chloride, common salt, to calcium chlorides in those situations.

Where the chloride concentrations are so low, that is not a problem, but the sodium can be to people with heart problems a problem, so

where we are close to public water supplies, there are procedures to limit the use of the sodium chloride.

Mr. ATKINSON. And the substitute for that is what?

Mr. SCHEFFEY. Calcium chloride can be used.

Mr. ATKINSON. Does that do as good a job?

Mr. SCHEFFEY. Per ton of snow melted, it is more expensive, but if you have a critical water supply problem, then that expense has to be borne.

Mr. ATKINSON. Does it have the same impact on the surface, does it have the same interaction?

Mr. SCHEFFEY. The chloride ions in calcium chloride behave just like any other chloride ions when they get on a bridge deck, yes, sir, and that is why this intensive search has been made for alternative deicing agents, but the cheapest ones we find are not environmentally compatible, things like phosphates, which we would not dare use.

The most promising at this moment are the calcium-magnesium acetates, and then there is the common wood alcohol.

Mr. ATKINSON. Wood alcohol sounds interesting. I do not have any further questions.

Mr. WALGREN. I want to very quickly ask if anybody on the panel could give us a description of several of the more noteworthy pothole patching systems you have tried.

Is there some material that has the potential? If not, what are the specific reservations along this line?

Could someone give us a quick rundown of the most carefully looked at and promising materials, and why they are not promising?

Mr. SCHEFFEY. I could make a crack at trying to describe a few of them.

The principal use of these proprietary materials is to replace what the highway maintenance people call a cold-patch mix; that is, a mix that can be used in the wintertime, can be loaded on a truck, and go out and do patrol maintenance.

They drive along, they find the holes, they place the patch and move onto the next one.

In the wintertime it is very difficult to carry that operation out with hot mix asphalted concrete, because you cannot keep it hot enough, you have problems with mix setting prematurely, so a number of cold mix types of patching materials have been in use for many years.

These are generally formed with cutback asphalts; that is, with petroleum solvents.

Now, the proprietary mixes like Sylvax are combinations of petroleum solvents with a number of mixes that tend to mix more compatible with wet surfaces to improve bond.

They also make the material more quicksetting, and this has been evaluated by 20 or 30 States; the position of those States are somewhat mixed.

I have the latest computer runout on all of the proprietary mixes, but it would take some time to go over that.

Basically it seems to work rather well, when it is placed on a shallow pothole, where there is still a good substantial base underneath.

It is not satisfactory in the opinion of many States for very deep holes, or where the base has begun to come up, where the soil is beginning to come up through the base.

Mr. HARKIN. I just have a couple of things, to try to wrap it up here. In the GAO statement, by way of closing, you state, Mr. Stolarow:

By way of closing I would like to reemphasize the critical need to quickly find an effective protective system for heavily contaminated bridges and to resolve the funding problems at both the Federal and State level.

The funding problems we will address ourselves to here, but the effective protective system of heavily contaminated bridges we cannot.

I think GAO is right, but one area we do not move into is going to cost us many more dollars down the road.

I think perhaps too often in this country, we always wait until the crisis is upon us, and then we spend all of the money to resolve it, so if we could just look ahead we could save a lot of money.

I guess I still do not have it clear in my mind, even after the last couple of hours we have been here, as to what Federal Highway Administration is doing to address that problem, in quickly finding an effective protective system.

You mentioned the cathodic treatment, you talked about the polymer concrete, the epoxy coated R bars, the galvanized steel mix, and what is the Iowa dense mix?

You have got the problem, the bridges are falling apart, OK.

When are we going to have a number of different items that we can get out to the States so they can begin to take care of the problem, how soon?

Mr. LEATHERS. You touched on a couple of other things, if I may, even though I am not in the research and development community anymore, I think that perhaps we can think about whether we can address the problem here.

Mr. HARKIN. I am saying this subcommittee has not got the responsibility, the jurisdiction to resolve the funding.

Mr. LEATHERS. I do think because of the competition in the other needs of research and development, not just the bridge deck, the competition for the dollar has caused this program to slow down.

I think if more resources could be applied to the program, we could respond, we are not disagreeing with the GAO, we admit we do not have solutions.

You used the words there are badly deteriorated decks.

I guess it is a choice of descriptive words.

Mr. HARKIN. Heavily contaminated bridges.

Mr. LEATHERS. We do not disagree that we do not have solutions to those that Mr. Scheffey has talked about.

He does not have some activity scheduled in the research program now, and the funding is dependent upon that which is available to us in our need.

While I still have it, I will tell you what Iowa dense mix is.

It is really a high quality concrete. It has a higher cement content, or what we call lower water cement ratio, it is placed in a very stiff mix, it is difficult to place, it is expensive to place, good quality control must be maintained in the field when placing it.

Iowa experimented with this on their own, they do it as a second lift on a new bridge deck, they will place conventional concrete up to the steel line and place the dense level next. They have removed some concrete from the contaminated deck down to the steel line, and put it back as one of those protective systems. As I said in my presentation,

the FHWA has accepted this as being a good bridge deck protective system.

Mr. STOLAROW. Mr. Harkin, may I comment on the funding problem also. I think the testimony here today has indicated on the bridge deck problem, less than \$1 million a year has been spent on the multi-billion dollar problem over the last 13 or 14 years, and putting that in context of what is spent in other research and development programs, for example, it is not unusual for the Defense Department to spend \$300, \$400, \$500 million on development of one system over a short period of time.

I think it indicates that possibly more could be done in this area to solve this problem.

Mr. HARKIN. I really agree with you on that aspect.

Mr. WALGREN. It seems to me the \$10 million that has been spent since 1966, and as Mr. Stolarow said that is less than \$1 million a year on a problem that will present us with a multibillion dollar bill.

I would like to ask, and I do not know whether it can be done verbally, and I will accept the chairman's guidance on this, it seems that we are saying that because of the competition for the dollar, you are not able to do some things you would like to do, and I would like to know what the next thing you would like to do that you were not able to do was.

Is that something that is possible to respond to quickly, and if not, perhaps each of you could address yourselves to that very briefly so that we can get some feel for the limitations of your work, that you are working under, and what it is that is not being done, because that is the greatest governmental question, what is it that we are not doing, because we are doing something else, and are we cutting off our nose to spite our face.

Mr. SCHEFFEY. Well, I would say in this particular work, that right now we are at a point where we are doing the things we know how to do. We could go, of course, more rapidly if we had more money and more people to push this, but we have come to a point where the solutions are not clear about what direction we ought to be moving, and how we would be investing the funds if we had additional money to put into this problem.

We are continuing to work the things that are clear to us, like development of weather instrumentation so we can find out in detail what is going on in these decks.

We are working on chemical methods of removal of chloride, we are working on improvements in the cathodic protection process, we are working on the business of combining methods of protection for existing decks that we already have, such as the epoxy injection, the polymer injection, in conjunction with the cathodic protection.

Mr. WALGREN. Yet we push a skid resistance surface where we have failed completely and literally wasted \$2 million.

Mr. SCHEFFEY. I think that problem is unrelated to the work we are doing on the bridge problem, and it is coming out of a different pocket; the money for that kind of a surfacing thing is not in our research and development fund, so we could not have attacked that in any event.

I would say also here, it must be clear that the money figure I quoted for the research and development program does not include the cost

of building these decks in the field by these processes after they come out of the research and development activity.

Those are paid for out of normal construction funds; if there are new techniques that are not yet standard, they are paid for from those construction funds, but they are registered as so-called experimental projects.

Now, that is money that is in the States, money for construction; the State has the option to go with experimental methods when they see fit to do so, but it is not new money, it is not extra money that they are given for this purpose, and that is not included in the \$10 million figure that I indicated here.

All of these experimental decks built around the country have been paid for out of another pool of funds, that is not part of the R. & D. dollars I quoted, so if you add that in, we will be talking about a much larger piece of money.

Now, I am very prejudiced, and I think we ought to have more money in R. & D. too, but that is because I am Director of the Office, and there are a lot of things I could do with additional resources if I had them, but when I go up to defend my budget, I have to do these things in competition with each other.

Mr. HARKIN. One last question, is there a clear and definite superiority in performance of either of the two most popular construction materials and/or concrete or asphalt?

Mr. LEATHERS. No.

Mr. SCHEFFEY. My answer is no.

Mr. HARKIN. Does it depend on the environment?

Mr. SCHEFFEY. The environment, the type of traffic, the conditions of the material availability to you for construction, the aggregates, they all count.

Mr. HARKIN. So then it does depend on the environmental conditions?

Mr. LEATHERS. Certainly.

Mr. HARKIN. Are we taking that into account when we use either one of those two materials?

Mr. LEATHERS. To some degree, yes.

There are no set design of features that incorporate all of those things, but design features do take into consideration the strength of the individual components to make it up.

It also takes into consideration the amount of traffic, the actual loading of the traffic that proposes to using that road.

Mr. HARKIN. Then prior to laying down the road, or resurfacing or rebuilding it, do you run a computer model on the amount of traffic, the weight it carries, the environmental aspects of raising and cooling, that kind of thing, and then look at the costs involved and make a determination?

Mr. LEATHERS. Those things are all figured in. I am not saying we are using a computer model.

Mr. HARKIN. You are reassuring yourselves though that you are not laying down the most expensive mix in places where the least expensive mix would work as well?

Mr. LEATHERS. You should ask me when you took into consideration all of these things, traffic, environment, engineers do that.

The material ultimately used on that roadway is perhaps a choice made by someone else.

Mr. HARKIN. So the choice may not be because it is the best?

Mr. LEATHERS. For both of them to be satisfactory, both of them should be designed to do that job.

Mr. HARKIN. But one might be cheaper, only to put it in, but it might not be cheaper to maintain?

Mr. LEATHERS. Those factors should also be considered, you have life cycle costs, you have improvement costs.

Each State has different techniques.

Mr. HARKIN. I guess what I am concerned about, we are on the Science and Technology Committee, and we look at the limitations of science technology in everyday problems, to increase our standard of living, to cut costs, to make us more efficient, but time and time again when we see artificial forces at work, that tend to take what are clear technological answers, scientific answers, and bend them a little bit for other reasons, and if there is one thing after 5 years on this committee, I am very concerned about is that aspect, there are a few areas in our society where there are clear technological choices, but they do exist, and when you can get your models, and you can take into account all those factors and make a decision based upon what is best scientifically and technologically correct, then it would seem to me that ought to be done, rather than letting artificial forces, as you say, other inputs, perhaps makes it an expensive deterioration.

Well, thank you very much, gentlemen.

I appreciate your coming up from Washington. I am sure we will be in contact with you later on, as we proceed with these hearings.

Mr. SCHEFFEY. Thank you.

Mr. HARKIN. Our next witness is Mr. Leo Sandvig, director, Bureau of Materials, Testing, and Research, Pennsylvania Department of Transportation.

We will take a break at 11:30, but I would like to hear from Mr. Sandvig at this time.

Mr. Sandvig will discuss the research and development efforts of Pennsylvania DOT in both the bridge corrosion and pothole areas.

Mr. Sandvig, we welcome you to the subcommittee.

STATEMENT OF LEO SANDVIG, DIRECTOR, BUREAU OF MATERIALS, TESTING, AND RESEARCH, PENNSYLVANIA DEPARTMENT OF TRANSPORTATION

Mr. SANDVIG. Mr. Chairman, thank you for the opportunity for appearing.

I am going to try to cut my presentation down, because I think you have had some education in this area, as we have gone along, and I will try not to be repetitious.

On the bridge deck corrosion problem, we became concerned in the mid-1960's about the performance of our concrete bridge decks.

At the time we thought it was with the quality of the concrete, so we improved the specifications for concrete, decreased the water to

cement ratio, raised the cement factor, tightened our control and improved the control of the air entrainment, which was discussed by Mr. Scheffey, as far as the mixture is concerned. Then as a part of a HPR program, Pennsylvania DOT made a study in 1971 and 1972, of 271 decks, that were then 5 years old.

They had these improvements in quality of the concrete but to our alarm, we found one-third of the decks still in distress.

Now, this is in 1972. As a result of that, the department organized a multidisciplinary task force to help us in the development of research. When I say multidisciplinary task force, I mean construction people, maintenance people, materials people. The cross-discipline in order to help us solve this problem. The assignment was to consider and pursue any reasonable procedure to obtain satisfactory bridge deck performance.

This resulted in further improvement to all bridge decks in Pennsylvania built since 1972, all bridge decks have these new features in them. This is new construction I am talking about now.

More emphasis was placed on the quality control of the concrete, and particularly with the curing, decks placed during hot weather. Curing seemed to have some dissatisfactory results.

We changed the live-load deflection to stiffen the bridges, because some people thought they were flexing a little bit too much, and that cracked them, so we made those changes.

As we became aware of the corrosion problem, as alluded to here, because of the chloride, attacking reinforcing steel, we increased the depth of the reinforcing in our standards from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches—moving it deeper—and emphasizing in the construction practice the need of uniformity, to be sure you have this $2\frac{1}{2}$ -inch level in place in the hardened concrete after it has set up.

Also, as a result of these task force deliberations, all decks built in the past 5 years in Pennsylvania, new decks, have some experimental feature in them.

Such things as epoxy coated rebars which have been referred to. Pennsylvania placed the first epoxy coated rebar deck in 1973 in the Nation, the first one ever done.

We also placed a galvanized rebar deck, the first one in Pennsylvania, in 1972.

Since then we have had large numbers of epoxy coated rebar decks and galvanized bridge decks.

We also placed one stainless steel coated rebar. We are trying everything to solve this problem. Also, we went to the denser concrete overlay by specifying a latex modified concrete.

In the wearing course, we placed one of those surfaces for the first time in 1966.

We have also used in a limited extent the so-called Iowa mix.

We have a wax bead deck in place, we have one cathodic protective deck, and we have a number of membranes of the various five different types in place on decks that are older decks that have been resurfaced with bituminous concrete. So as you can see, we have been quite active in trying to get out these various solutions that were discussed earlier out into the field, for examination and evaluation.

We have supported research in Pennsylvania DOT on polymer impregnation application, and including impregnation of linseed oil.

We have as a result of these actions since 1974 placed latex overlays on bridges that were under construction at the time, that had not been opened, and structures we have determined did not meet the threshold of contamination as far as chloride by putting latex overlays to stop the penetration of chloride.

However, that program has been controlled by the funding.

In the future, we will continue to evaluate all of the methods that I have outlined to you.

We agree that more research effort needs to be done, and placed on the stopping of the corrosion of the now heavily contaminated decks.

We cannot use these systems on them, it is too late, and we are interested in what to do and what to use more funding in that area.

We will continue to look at polymer impregnated types of decks.

Right now one of the problems with the polymer impregnation is penetrating the contaminated area. It is not exactly the cost of the polymers or the linseed oil to seal the deck.

The cost is in developing production type drying equipment to dry the moisture in the concrete down to the level of the steel so you can get penetration of the types of materials down to that level.

There is no on-the-market equipment at reasonable cost that contractors can use at the present time, so it makes that system cost prohibitive in our judgment at the present time, but we should continue on with the research.

Frankly, all of these different methods, epoxies, galvanized steel, stainless steel, the latex, the low slump, all of those methods look good in the lab, they look good on what we have done, they look good as far as what other people have done, and particularly the research, it looks like a high probability of success with these, but only time is going to tell us.

In research, we can do so much in the lab, and then sometime you have got to tie it into the field performance. Time has to march on, gentlemen, regardless of whether we like it, it will have to march on so we can tie the laboratory results with the field results. That is the place we are at the present time.

As a result of the seriousness of the problem, we have all of these experimental features built into the bridge decks. We would normally not approach a research project like this, we would take more time and do it with lesser numbers of decks, et cetera. Because this is a serious problem, these are crash programs.

Now, let us talk about chloride problems that is there, frankly, because of what Mr. Atkinson said earlier, it is not practical to do without chloride, and have clear pavements.

We ought to know, we have just gone through trying to educate the public about studs, when we took them away.

If you thing that was a problem, take away chlorides, so we do not have clear pavements, it is something the public will continue to demand of us.

We support heavily the need to withdraw from the chloride field, if we can find that it is practical.

We are making every attempt and every effort to reduce the use of chlorides in Pennsylvania, as a part of this program, in mixing them with anti-skid materials, et cetera, that we do use, but frankly, there are still chloride materials needed.

It has already been alluded to that other materials that would take the place of the chlorides seem to be too costly, the pollutants, et cetera, but we need research to continue on finding those materials.

That is the end of my statement on bridge decks, if you would like to have me address the potholes now, or would you like to fire questions on bridge decks?

Mr. HARKIN. We will try to get into that, or would you like to go ahead on the potholes?

Mr. SANDVIG. Fine.

Mr. HARKIN. Then proceed.

Mr. SANDVIG. Pothole research, well, over the years, many years, Pennsylvania has evaluated and researched different types of cold patch material to be used for patching potholes, and as a result of those evaluations on a yearly basis, we do have meetings with the maintenance and materials people, where we have adjusted specifications, gradations of the mixes, the types of asphalts, et cetera, learning by process what is better from the year before.

Now, let us talk about some of the so-called miracle products that are on the market today.

Most of the salesmen for the miracle products oftentimes claim you can put these materials in water, you do not have to prepare the hole, it will bridge everything, but they are very costly as a general rule. Frankly, we always have our doors open to look at these miracle products, we think that somebody is going to come forward with the material that is workmanship proof, and it is a bridge over the soft areas. Let's face it, we are working at a time of the year when we have very adverse weather, low temperatures, frost, it is to be applied in water, or dry the hole out, or something like that.

Frankly, there are materials on the market, some of the expoxies and polymers, when we talk about patching a bituminous surface, we could put those in the pothole, but what will happen.

All of the material around that area is going to fail, and you can picture a road out there, with all of the patches in place and no road. It's too good. A good example of that is—there is no criticism of the types of flexible pavement or rigid pavement—at any place where those two types of pavement join, there is a bump, so the problem is the two perform differently under traffic, so what we have got to have here is some kind of material that is similar to the material around.

In the last 2 years we have been experimenting with some of these miracle products, and one of these items, Sylvax, has been brought to our attention.

It is not exactly workmanship proof, but really what we have developed as a result of looking at that material, and others, is a new experimental patching materials which we are using in five of our districts. Really, they have in them a good quality cutback asphalt with the additives that Mr. Scheffey talked about, that makes the asphalt stick on the aggregate, particularly under water attacks, remember, we are in a wet situation. It is a good quality aggregate, and it is very clear—fine dust less than 200 mesh. That is one of the things we found out about miracle products, so we have that specification out in the field in five districts experimenting this year, and it is looking good, and performing just as well as some of the trade products.

We know that hot mix is the best patching material.

The hot mix plants are not open at the time of the year when you need the mix. It is during an adverse weather condition, so we have to go to these cold mixes, and these cold mixes are generally produced in the fall of the year, they go to stockpiles, and then they draw out of the stockpiles during the winter months, until the hot mix plants open up, and then you can then get in there and do a workmanship-type job.

One of the problems is you need workmanship also in putting in a patch.

It has to be done in a workmanship-like manner, the hole has to be prepared, it has to be dried out, all of the loose material around the area has to be taken out.

You butter up the holes, so to speak, that is with asphalt, to make it cling to the side, you tamp it in, and you tamp it in thin layers, if you have a chuck hole a foot deep, you do not pack that all in at one time, and then you seal the edges.

Now, that is a workmanship-type patch that takes time and effort to do, and it is extremely difficult to achieve during adverse weather conditions.

We are able to achieve it like on a day like today, when there is dryer weather.

We feel that there ought to be continued research into workmanship proof materials for pothole patching, and for particularly mechanical equipment that we might be able to replace the manpower, maybe the machine will not let us down on workmanship.

I think they alluded to that, the FHWA people that we need to stimulate the equipment industry to develop pothole patching machines and mixing machines that produce hot patch material.

Pennsylvania is probably the only State in the Union I know that owns three asphalt mobile machines, which is a small plant that is on wheels.

Now, the trouble with that machine is it is terribly costly, the air pollution things are not the concrete mobile, where they have this same machine, where they mix concrete on board, that machine costs about \$40,000, to \$50,000.

By the time they got all of the air pollution satisfied on the asphalt mobile, that equipment is a \$70,000 or \$90,000 machine, so it kind of gets out of the ball park as far as its use is concerned.

I am not sure that we will ever be able to develop this workmanship material that will bridge over these soft areas, and really, that is not the solution to pothole problems, not in any State, not even in Iowa, Mr. Harkin.

The solution to the pothole problem is really preventive maintenance, and the application of the technology that we all know.

First of all, we have to ask ourselves more often what caused the pothole.

There are too many times that people go out there, and they fill the hole up, but they did not cure what caused it, which is drainage. Drainage and water, I will keep emphasizing, is the enemy of the highway.

Both subsurface drainage and surface drainage, and particularly in the Pittsburgh area, many of the surrounding terrain drains onto

the pavement, and the pavement is kind of an aqueduct, carries the water away, that is no good.

No material is that good, no material performs under those circumstances.

We have to get subsurface, or surface drainage moving away from the pavement.

We need to improve the bases, on many of the old roads all over, particularly in the Pittsburgh area, where the old bases, those built under the old technology, not as thick, do not have nonfrost susceptible materials in them and do not have drainable materials in them.

When you have a bituminous surface, it has to be maintained.

Let us face it, a bituminous surface is good for about 8 to 10 years.

It depends on the amount of traffic, and the environment, et cetera, maybe on heavily traveled expressways, it is good for about 5 years, but after that period of time, it ages, and there are cracks and the surface becomes pourous, and water seeps into the base, and so the problems take place.

Now, it is like the roof on your house, you can patch some holes here and there, that is the pothole patch. Soon if you do not put a new roof on it, a new bituminous surface to provide this adequate seal over the top of it, like your roof, if you neglect that, the ceiling will start dropping, and what happens in the road, it continually goes.

Maybe the first year you observed cracks in the bituminous surface is not the time that you have the funding to do it.

There is a couple of year periods there, but the trouble is when you go 3 and 4 and 5 years without putting that surface on, after winters like we have had of cycles of freezing and thawing and water getting into that surface, that road will turn up upside down.

It will be full of potholes, if you do not get surfaces on those roads this year, there will be more potholes next year, and even more the following year.

It goes progressively on. This is some of the technology that we know about.

In the case of concrete roads, portland cement concrete roads, they need to be sealed, the cracks need to be sealed to stop the penetration of water into those underlying surfaces.

They need to be patched, and a concrete surface is generally in need of new surface after 20 years as well.

Usually it turns out to be a bituminous surface presently, but those things are needed to stop the intrusion of water which is our enemy. That is preventive pothole treatment. The few potholes that we hope that are left we will try to find better materials and develop the equipment needed, so we will get that job done, but first let us treat why we get potholes.

Thank you.

Mr. HARKIN. Thank you very much, Mr. Sandvig.

We are running a little bit late.

I would like to call on Mr. Walgren and Mr. Atkinson, who have some questions, and see if we can recess in about another 7 or 8 minutes.

Mr. WALGREN. I am wondering whether you could stay for the start of the afternoon session.

Mr. SANDVIG. Yes, sir.

Mr. WALGREN. And perhaps you could join in that time period.

Mr. SANDVIG. Yes, sir.

Mr. WALGREN. Because you raised some problems as to how do you really repair or change the base of a road, to improve the drainage, and that area is a real job, and I would like to have your contribution for the afternoon too, if you could stay.

Mr. SANDVIG. I would be glad to.

My plane does not leave until 5:30.

Mr. HARKIN. I do not know what time constraints Congressman Atkinson is under.

Mr. ATKINSON. I will stay for the day.

Mr. HARKIN. Then we will break now.

Mr. ATKINSON. So I know the water problem, it just drains and it goes all through our land here, and it gets underneath and erodes the base and swells along the roadways, water is a problem.

Mr. SANDVIG. Even more in this local area because of the terrain, and I think you addressed that earlier, about the fact that some of the more recent technology was not into some of the pavements we are working over.

Mr. HARKIN. We will recess the subcommittee now, and Mr. Walgren will call it to order at 1:15 p.m.

We thank all of you for participating this morning.

We stand in recess.

AFTERNOON SESSION

Mr. WALGREN. The subcommittee will please come to order.

I want to express Chairman Harkin's apologies for not being able to be here this afternoon.

Mr. Harkin had to meet other obligations in Washington, and so he had to return, but I want you to know he is very interested in what we do and say here, and we will take the transcript as it is ultimately prepared and try to work with it in Washington, not only with Mr. Harkin, but with the other members of the committee as well, so please accept his apologies.

When we reached the conclusion of the morning session, we had heard the statement of Mr. Sandvig, and maybe we could explore that and form a panel of all of us together, and ask Mr. Sandvig to stay within that panel, because I would like to get people's reactions to each other, and in some ways that is sometimes wiser than what we might have to contribute from this side of the table.

I wanted to just add as an opener, to ask Mr. Sandvig, we are placing this emphasis on preventive maintenance and drainage, but is it not the problem to deal with the basic question of drainage, that you are really talking about the substructure of the road itself, and absent completely redoing the road, we really cannot get at that problem very well, is that accurate?

Mr. SANDVIG. Yes and no.

Some of the roads would take total reconstruction, that is true.

There are others that a lot can be done on surface drainage, and putting lateral drainage, subsurface drainage, and making sure that the slope of the roads are away from the roadway, and surrounding property does not drain onto the roadway, it drains away, with some kind of

drainage system, depending on what kind of highway it is, whether it is a ditch or curbing or something to take away the water.

Mr. WALGREN. I have heard that in western Pennsylvania, many people blame the roads on Governor Pinchot, if he was the Governor, I really do not know whether he was, but I hear that we in Pennsylvania have Governor Pinchot roads, and essentially they are saying they were built at a time when they really were not well built in terms of drainage or the roadbed at all.

Mr. SANDVIG. That is true. I think he is the father of the road system in Pennsylvania, and really, there was not too much attention given to drainage.

Really, the old Pinchot roads are the real Pinchot roads that are made of big man-size stones that were laid side by side to form a foundation, that is the real Pinchot system.

It does not provide any drainage. The theory was that the transmission of the loads, which were rather light in those days as opposed to today, the big stones were used to spread it out further down.

Mr. WALGREN. Let me ask just a couple of thoughts, I understand that you referred to some research that is going on at the State level.

How big an effort is that?

Have we essentially been stripped of our ability in the State to do new research, because of demands for funds?

Mr. SANDVIG. I would say so.

You put me in the same position as Chuck Scheffey here, I am responsible for research activities in Pennsylvania, like he is at the Federal level, I am at the State level, and just to throw a few dollars out here, in the past our research program total, this is not just on this problem, it has been in the neighborhood of \$3 million.

Now, that is about 80-percent Federal funds and 20-percent State funds.

That recently has been reduced to about half, it has fallen in the last few years, it has fallen to between \$1.5 and \$2 million, and that is a pretty small percentage of the total Department's budget, which is almost \$1 billion.

That is about one-tenth of 1 percent, which is a kind of pittance by any standards that I know of of any research organization or any governmental agency, or industry generally. I guess industry plows in the neighborhood of 5 percent of their expenditures into research.

Mr. WALGREN. What specifically are we able to do with that \$3 million, where does it go?

Mr. SANDVIG. That is split up between contract research at the various university levels.

Right now that level is about \$1 million split up between the different civil engineering universities on particular research projects, and then presently, about \$1½ million to State administration in my organization.

In looking after the research that we have done on bridge decks, etc., when I state the funding, that is just the administration.

Research programs and the laboratory testing, it does not include the additional cost for experimental work over and above the normal amount, that is absorbed by the construction program.

I am not including that.

Mr. WALGREN. So those are personal and individual projects that are in fact being carried out, other than construction of the test units themselves?

Mr. SANDVIG. Yes, sir.

Mr. WALGREN. Do you see anything particularly promising in the contracts that we have out to universities of Pennsylvania and elsewhere?

Mr. SANDVIG. Oh, yes, you mean promising, as far as things that they do over the years, yes, there has been a lot of good work, in fact, this bridge deck program was as I told you earlier, was the result of the Penn State program looking at 271 bridge decks.

They have helped us with tightening air control, by developing air systems to find out if we have that air in the mix.

There is much structural research done at Lehigh University, and it has been very significant on making changes to department standards, as well as national standards as a whole.

There is good active research.

Mr. WALGREN. So the dollar has really returned some value in spending that amount?

Mr. SANDVIG. It certainly has.

Mr. WALGREN. Have we done anything in Pennsylvania with this thing that has the salt built into it?

Mr. SANDVIG. No; we have not. We have kept informed about the research that other people are doing on it, and we have not undertaken a project review to look at that material ourselves.

Mr. WALGREN. In district No. 12, I understand they are using crushed stone in potholes.

Is there a different treatment in potholes from district to district?

Mr. SANDVIG. There may be. There is not supposed to be.

Mr. WALGREN. Have we ever given any thought to allowing the individual contractors who might have a process which they think is just the greatest thing since blue cheese to take the 100 years of Sawmill Run and try the product on it, or do we limit what goes into the roads to what PennDOT may be doing or using at the moment?

Mr. SANDVIG. I think we do limit it to the particular standards at the moment, but my office is, and as demanded by the management, is always open to new ideas, looking at new products, new procedures, etc., in cooperation with any of the other active units, districts, design offices, the maintenance, the construction, and we do work with the various contractor associations in trying to be innovative about different processes.

Mr. WALGREN. So from your point of view, you are really ready to try almost anything that seems reasonable that is proposed by the private sector?

Mr. SANDVIG. Yes, sir.

Mr. WALGREN. And give it a chance on trial, and after all, there are certainly a whole number of places they could try it.

Mr. SANDVIG. Right. Right. We have plenty of roads to try it on.

Mr. WALGREN. Can you give us just a very brief description of the problems with McKnight Road?

Mr. SANDVIG. I am responsible for research and materials in the Department, but we get into the position of tearing those jobs apart trying to reconstruct what happened, and I am quite familiar with McKnight Road.

Mr. WALGREN. What happened there?

Mr. SANDVIG. Well, first of all, it is a reconstruction job, as you probably know, there is an old concrete portland cement pavement underneath, and as a part of the design, they wedged in a variable thickness base course out of a binder to get a crown on the road. That was the part of the problem, trying to be brief here, that was a part of the design, and then they said we want 1 inch surface over this wedged surface, which to begin with, is rather ununiform, because of the fact that you have got a variable thickness going in, and I will just throw out some numbers since I do not remember the numbers, if you have a thickness of a course 3 to 4 inches here, and you are building it up to 8, during the compaction process, and the placing of that binder course, that plain you have there, that slope there is rather uniform.

I think you can see that, you end up with a rather ununiform course, and then they are trying to put in a 1 inch course.

Mr. WALGREN. When you say they, who is the they?

Mr. SANDVIG. Penndot.

Penndot is specifying the contractor to do this.

You build a rather ununiform surface there because of the wedging of the binder course, and then the Department calls for a 1-inch thickness over the top of that.

Now, that was a part of the design phase, whether it was the fault of someone, anyway it went to construction, and the construction group in there made an earnest effort to try to get a good riding surface, approved the contractor to place a 33-foot-wide pass.

Now, it is desirable to have a 33-foot-wide pass so you do not have joints, you can lay it 12-foot wide and you have a joint, but sometimes when you have a joint there, it gets cold, and so it is an advantage to place 33-foot-wide pass, so there will not be deficiencies there, but in this case, you are trying to strike a 1-inch surface on a rather rough base, in trying to get a 1-inch minimum on this, and you have got valleys and high peaks, and as a result, some places got thin, less than 1 inch, as they put the 33-foot-wide pass.

In addition, there was some difficulties as determined, the mix varied in two cases, it had lower asphalt content by one-tenth than it was supposed to have.

The job mix formula allows a plus or minus four-tenths.

It varied down to as low as five-tenths below that asphalt content in some places.

There was also introduced more No. 200 [fine dust] into the mix than was planned in the mix design.

Now, what does that do, you might ask.

That comes into mixes nowadays because of the air pollution, et cetera. You cannot blow it into the neighborhood, you collect it; so they try to find some use for it. So some went back into the mix, and that makes a mix sometimes a little bit more difficult to compact, and particularly gives you trouble of variance. If you design the mix with less No. 200, and it changes during production, the mix is changed.

Those are the facts, generally what happens, it was a design problem, a construction problem and a material control problem, which all added up to bad performing situation.

Mr. WALGREN. What has been the resolution of the responsibility question on McKnight?

Mr. SANDVIG. Internally within the Department?

Mr. WALGREN. No; I am thinking between the parties involved, between the contractor.

Mr. SANDVIG. It is my understanding the contractor will be resurfacing it this year.

He will resurface at his expense those portions that were thin, and that the Department will in cooperation with the Federal Highway Administration, because it was a Federal funded project, will take the cost of the balance.

Now, the reason for that is because generally, we all as engineers, the Department, and the Federal Highway Administration, and the contractor who controlled it, feel that what happens as far as the asphalt content, the No. 200, with things that we tried to prevent, but they do happen from time to time, and we have to recognize the world is not perfect, and once in a while we stub our toe, and must go back and redo it.

It is not that I am trying to cop out and justify the Department did not get the job done on behalf of the taxpayers on McKnight.

I am trying to get you to realize that there are sometimes when things happen that are disappointing to all, but it does happen.

Mr. WALGREN. Do we have adequate inspection checks that would catch a mix being below the margins before it is put into the road?

Mr. SANDVIG. Before it is put into the road, yes, but sometimes it is not 100 percent failsafe. It is not absolutely failsafe.

Mr. WALGREN. Let me ask you to turn briefly to Banksville Road.

Banksville Road is a little different, is it not?

Mr. SANDVIG. Yes. Banksville Road as far as I know, that is a bonding problem, where the surface did not bond to the underlying course there.

I think it is also an overlay of a concrete pavement of which there was questionable amount of work done, and lack of preventive maintenance on that concrete pavement, to see that it is well drained, joint seal, patch before it was overlaid.

When you make your comment about the \$2 million, I do not think it was the resurfacing only.

Part of that was that concrete jersey barrier, which is very costly.

Mr. WALGREN. I see.

I will have to check that out.

If you could privately check that, if you have resources and maybe send it to me.

Mr. SANDVIG. On Banksville?

Mr. WALGREN. Yes. Just what the cost of the resurfacing there was.

My figure came from the newspaper, and I am sure it was not the most accurate figure.

Mr. SANDVIG. Banksville is a little bit different.

It is coming up in blocks. Some of the other, like the McKnight Road you mentioned, in other areas, areas other than where it was thin, the pavement kind of ravel off around the perimeter of these areas, it is kind of feather down.

I think you will find Banksville goes right down, that is kind of a bonding failure, that some water got in there, or some way that the two surfaces did not bond together.

I can only speculate. I told you earlier that we tear these jobs apart trying to reconstruct what happened. I can tell you, it is a bonding failure, but how it became a bonding failure, we cannot go back there and sit there, when it was reconstructed.

Mr. WALGREN. Mr. Atkinson?

Mr. ATKINSON. I have just a couple of questions.

The figure you mentioned, as far as using a base for melting, some items that would be keeping the roads clear, you said other items than salt are too costly.

I just wonder when you consider all of the factors when you determine it is too costly, do you determine some other factor, such as sand, and do you consider the cost of repairing, maintaining, and all that, to determine what they should use for keeping the streets clear of ice and snow?

Mr. SANDVIG. I think we are.

Maybe there have not been recent calculations made because of the escalation of the prices.

Now, when you mention sand, one of the things, and this is where we are trying to cut down on chloride, you cannot just put these materials out there, there has got to be some mixture of the chlorides with that antiskid to make it stick.

If you just drop the sand out there, the first vehicle that came by just blows it off, so this is a good example of effective use of, you can get by with less chlorides, if you can embed the aggregate into that icy surface.

Mr. ATKINSON. How much of an impact does the lack of enforcement of overweightes have to do with the roads deteriorating?

Mr. SANDVIG. A lot.

A lot of these roads were certainly never designed for the loads we are giving them now, and as far as enforcement, it does not exist.

It just has not existed in Pennsylvania, because it has been a system that has been controlled by the local political units, rather than the State.

Now, I think there has been recent activity on the interstates, because of FHWA flexing its muscles, so we are building weight scales on interstates.

Mr. ATKINSON. I know because when the bridge went down, and they used a substitute bridge, you could count the police to keep the trucks 100 feet away following each other.

Mr. SANDVIG. Like the gentleman from Iowa out there, of course they have got regular State operated weigh scales all over the place.

Mr. ATKINSON. That seems to be an important part of it, at least in my thinking, because there are a lot of reasons that causes the roads to be like this, and chlorides seem to be one, and stopping and starting seems to be a big problem on bridges, and again, with respect to heavy industrial areas, where they are stopping and starting on bridges, and causing that vibration, Mr. Scheffey, I guess, he stated that immediate first aid, that once a pothole occurs, to get right on it, and I know the plants close down sometime in October, I guess.

Mr. SANDVIG. Right.

Mr. ATKINSON. And he mentioned durable patch, and you cannot do that in the winter, you use a cold patch, and pound it in, is there

anything there that can be used, or is that part of the research going on?

Mr. SANDVIG. There is some of the research we have been trying to do to get asphalt to do a better job in sticking to the aggregate.

The workmanship problem is tremendous under those adverse weather conditions.

Frankly, you know, for years, we looked at cold patches as being a temporary patch, and hypothetically, if it stayed, you were supposed to go out there and take the cold patch out and put a good hot patch in during the summer months, but that is not the way it worked.

If it stayed at all, it stays there, and nobody ever replaces it.

There is of course a lot of them that do not stay very long.

I go out from time to time and see the situation and I get blamed because the materials are bad, because when they throw it in a wet hole and back over it with a truck, or pat it with the back of a shovel, and they walk off, that kind of disturbs me when they say the materials are not good.

Mr. ATKINSON. This upsets the general public when they see something being patched in the rainy weather, and the next morning it is all gone, they realize it is money thrown away.

Something has to be done.

You mentioned about the universities participating, how about industry, those in the business of materials supply, do you work cooperatively with them?

Mr. SANDVIG. Yes, I think we have a good relationship, maybe you can confirm that, there are later witnesses coming up here that we work with their associations quite actively trying to trade ideas and so forth, there are times when we get our way, because we want our way, but we try to be open-minded and try to profit by their experience and let them know ahead of time, and certainly in the patching materials area, this is a part of it, I guess I did not cover that, a part of these meetings that we have to review experimental patching jobs in the specifications.

There are industry representatives from Pennsylvania Asphalt Paving Association that are on that committee to look at them and do give us advice.

Mr. ATKINSON. Maybe a question I will hold for them as to of course, asphalt, I know we saw a demonstration the other day in Butler County, where they would pour water right on the asphalt, and it would just immediately go into the earth, and the reason, the reason for the purposes there, are the heavy water runoff created by shopping centers and other buildings, runoff water, and because of the blacktop, it cannot get into the earth and absorb that way, so it rushes on down and finds another route, and it streams downtown miles away, and as one demonstration, they pour the water right on it, and into the road.

I guess the subsurface, the lack of a better term, is that a consideration or a possibility?

Mr. SANDVIG. That is a very selected possibility. We have some parking lots, not particularly roadways, built with those open course mixes in Pennsylvania.

Really, it takes the right kind of situation.

If the subsoil is sand, it drains very freely. Let us say you are at the beach, and you constructed those on the sand, the water would drain away and get there.

Now, if it was a heavy clay or something that is like in Lancaster County, and in Lebanon, et cetera, the water would not go any place.

You would have to have a free-draining soil underneath it, so that it would get in there.

Now, I do not know whether we would want to be using those kind of bases, or those kinds of pavements in areas where chlorides are used, like you said, chlorides could get into the groundwater. We have a very positive instruction on our storage areas, for maintenance, where we store stockpile chlorides, to make a good base that is waterproof and has can curbs around them. We have had some experiences of contaminating local water from those stockpiles.

MR. ATKINSON. Just one final question, Mr. Chairman, on the report that was made out by Commonwealth of Pennsylvania to the General Accounting Office, the survey of the Nation's Federal aid systems, in earlier testimony, it said the ratio for replacement as opposed to repair was 2.75, almost 3 to 1, and the figures we have in Pennsylvania, shows the new construction, the complete replacement of \$6.70 average additional cost per square yard, partial reconstruction is \$25, which is almost a 4 to 1 ratio, and we realize they probably took a survey of all of the States and came up to an average.

Is there any reason Pennsylvania would be 4 to 1 average as far as nationally 3 to 1?

I assume the Federal contracts are held to the same wage scales.

MR. SANDVIG. No.

We have higher wage scales in Pennsylvania, I would say, than most of the other States.

I would say that the labor and material costs might be higher here, that is why we are higher.

MR. ATKINSON. Is not that a factor that should be considered, when they determine the percentage of match between the States?

MR. SANDVIG. I am with you.

MR. ATKINSON. I have no further questions.

MR. WALGREN. Just one thought, you mentioned workmanship and repair in potholes goes a long way, toward making the repair effective or not.

Who controls the quality of the workmanship?

MR. SANDVIG. The foreman, the superintendent at the county level.

MR. WALGREN. At the county level?

MR. SANDVIG. Yes, and if you remember in Pennsylvania, the county level supervision—

MR. WALGREN. These are State employees on a county district, doing these repairs, is that right?

MR. SANDVIG. Yes, sir, of the 67 counties.

MR. WALGREN. And going back, your research budget in Penndot is one-tenth of 1 percent of the total budget approximately, is that correct?

MR. SANDVIG. Yes, sir.

MR. WALGREN. OK.

Well, we certainly thank—

Mr. SANDVIG. That includes development, research and development. I emphasize that, because I believe in development.

I heartily believe in development, but when the Federal Highway Administration gets involved in the development business, we get another assignment with no additional people so they pass onto us ideas for development, and we are answering their correspondence to get their development work, so those people answering correspondence are not doing research anymore, so my staff is further watered down in the area of research and development.

Mr. WALGREN. The difference between research and development, development being how would you describe it?

Mr. SANDVIG. You have got a research, conclusion, it has to be developed into specifications and standards, and then you have to go to the operating bureau and keep pushing them to change the standards and change the specifications so it gets out onto the road finally.

Mr. WALGREN. And the Federal Government pushes you to apply your resources toward development?

Mr. SANDVIG. They have a lot of funds nowadays to do a dandy job in the area of development.

They do a good PR job nowadays, like in the development area like selling a trade project, but it dewateres our research in the States, because we are asked to do development work, and there is no additional people and funds to do it.

We keep answering their questions, which is proper, they have a good research, for example, that they feel ought to be implemented, and that came out of Arizona, let us say, so they have got a good idea, and they are implementing it, and they are suggesting around the States that they try it.

Are you going to try it and when, things like that.

Mr. WALGREN. And since they are not building any highways, except the State builds them for them, they push that new idea on you without any support money for something you feel is relatively expensive?

Mr. SANDVIG. Support money, and telling my administrators to assign more people and money to get the job done.

I am trying to bring out the point of how the emphasis they place on development has reduced the amount of research we can do, because we are now doing more development work than we have been doing before, because of their push on development.

I am not objecting to the development. For one thing, I really feel earnestly, and I have said this before to the Transportation Research Board, sometimes you look at everything, and I would like to say let us stop doing all of the research we are doing, let us just stop it for about a period of 3 or 4 or 5 years, and let us implement what the heck we know, and then let us start up the research again.

I do not really mean it in that context, because I think the research ought to go on too, but it is kind of, you get overwhelmed, and you are not able to do a job with both of them at the same time.

Mr. WALGREN. Do you know offhand how much PennDOT's public relations budget is?

Mr. SANDVIG. They have a public relations budget, but I have no idea.

Mr. WALGREN. Well, the Federal Government's push on you to dilute your research efforts is something we ought to pursue, and I think we can.

Thank you for that lead.

At this point, why don't we ask the rest of the panelists to come up and join Mr. Sandvig at the table, and we certainly appreciate your staying with us.

I would like to invite each of you to make any kind of a presentation that you would like, either in prepared form, or in informal form, anything you would like to submit, we would make a part of the record, and so you could feel free to give us submissions in that capacity, but let me sequentially go through the list as I have them here, and then we will all come back and see if we can develop points that you might raise, and I would like first to call on Dr. Phil Cady, if I might, if you would just identify yourself for the reporter and proceed however you would like.

STATEMENT OF DR. PHILIP CADY, PROFESSOR OF CIVIL ENGINEERING, PENNSYLVANIA STATE UNIVERSITY

I will try to cover briefly a few major points without belaboring points that have already been covered very well by the previous witnesses.

First of all, by way of background, Mr. Sandvig mentioned some of the areas that I have been involved in with regard to research on the corrosion problems on bridge decks, while engaged in research sponsored by PennDOT.

In addition, I have been involved with researchers at Lehigh University in work that was supported by PennDOT, as well as the National Highway research program and the Pennsylvania Science and Engineering Foundation. That work involved looking at the deep polymer impregnation procedure for protecting bridges that are chloride contaminated. We worked on this research from about 1972 through 1977. It included deep impregnation using linseed oil, which was sponsored by PennDOT.

These projects demonstrated the technical feasibility of deep impregnation in the field; that is, it is technically feasible to impregnate concrete bridge decks down to a level such that you completely encase the top level reinforcing steel, and thereby immobilize the chloride present.

As Mr. Sandvig indicated, however, the major problem that is holding the procedure back in the field right now is the lack of development of commercial scale equipment that can do a whole bridge deck at once, that is, we just do not have the equipment to do it even though it is technically feasible.

During the past few years, I have also been involved in two studies that involved looking into the literature published on research that has been carried out in the area of corrosion of reinforcing steel and bridge decks. Both of these recently completed studies plus the previously mentioned work I have been involved in has led me to certain conclusions, which I would like to put forth very briefly. Some of these are points that have been brought up by the previous witnesses will not be dwelt on.

First of all, the damage that is caused by deicing salts is tremendous, and it is increasing with time. If you take the estimates of damage that have been published at various times by the agencies responsible for the collection of such data—I am speaking principally of the

FHWA—you can see that the costs attributable to bridge deck deterioration are rapidly increasing. I see no reason to believe they will level off.

Furthermore, the continued application of deicing salt is continuing to build a major maintenance headache into our highway system. Presently, we are seeing it in the bridge decks. I would not be surprised if we would start to see it beginning to surface in our reinforced concrete pavements as time goes on. We do not see an awful lot of chloride corrosion yet with our reinforced concrete pavements, but I am saying it might happen. Certainly if we keep applying salts the way we have, we are going to build a time bomb that our children and grandchildren will be paying for in the decades to come.

As our previous witnesses said, particularly Mr. Sandvig, Mr. Leathers, and Mr. Scheffey, number of methods have been proposed for alleviating this problem, or hopefully taking care of it. All of them are fairly expensive.

The cost effectiveness of the various potential techniques is not known, and that is one of the major problems right now. That is, I think, the major point that was brought out in the GAO report. We do not know the cost effectiveness of these various techniques simply because we do not know their long-range effectiveness, that is, performance capabilities.

Now, with regard to prevention and mitigation of the corrosion problem or repair technology, there is one thing we have to recognize, and again the previous speakers mentioned this, but I think it bears reiterating, we really have four problem areas that have to be addressed. First, we must consider protection of new construction or replacement decks. Second, we must look at the protection of sound, uncontaminated decks—that is, existing decks, but not contaminated with chlorides. Third, we must consider the protection of sound, but chloride contaminated bridges. Finally, the repair of deteriorated or damaged bridge decks must be addressed. Different techniques have been put forth for each of these problem areas.

As mentioned by Mr. Scheffey, and Mr. Leathers, the techniques that we have available are fairly good for protecting new construction, or bridges that are not chloride contaminated. It is primarily the area of chloride contaminated, but sound, and deteriorated bridges, that currently present the greatest challenge. Techniques that show considerable promise do exist, but, as mentioned previously, they are still very expensive.

Taking all of the foregoing considerations into account, I have been led to a conclusion which is bound to be difficult, certainly politically unpopular, and fraught with difficulties. That suggestion is that we stop at this point and at least seriously consider halting the use of chloride type deicer chemicals.

I realize the implications of this suggestion, legal, political, and so on, but I think it is something that should be seriously considered.

If, for example, we could do without chloride deicing chemicals and use only antiskid materials and plowing to take care of ice and snow problems, it would no longer be necessary to use special, expensive processes to protect new bridges from the attack of deicing salts. The existing bridges that do not have high chloride contents in them,

likewise, would not have to be provided with expensive protective treatments.

For those bridges that have chloride contents that are in excess of the corrosion threshold value, some means of protection would have to be supplied. Here I would suggest there that immediate concentrated effort be applied to develop to the level of practical field application, a proven technique for removal of chloride from concrete. This is one of the techniques the Federal Highway Administration has been developing. It has been technically proven, but as yet the equipment and facilities for carrying it out on a full-scale basis have not been developed. This would remove the chloride from the concrete, and if we did not put any more salt on it, we would not have any more corrosion problems.

Finally, those bridges that are presently deteriorated and salt contaminated could be repaired by conventional techniques without the necessity for providing expensive protective treatments.

With these advantages in mind, I would like to reiterate, at this point, my recommendation that a serious study be made of the possibility of eliminating the use of chloride de-icing chemicals. In the event that this study should show that de-icer salts cannot be abolished for various reasons, be they political, safety, or what have you, I would agree completely with the proposals that the FHWA has made as expressed in the GAO report. The only addition that I would add to the proposals in the GAO report is cathodic protection systems for bridge decks that are contaminated, but sound.

That basically covers my testimony to the subcommittee. I have prepared and submitted to the subcommittee an outline covering my testimony and a summary of pertinent supportive information.

Mr. WALGREN. All right. Well, I appreciate that.

Why don't we go forward with the rest of the statements, and then we can talk about that.

I am going to go down the list as I see it, and the next person we had anticipated was Mr. Joseph Moses, and after that Mr. Dickinson, then Mr. Siodlowski, and Mr. Cronin in that order.

So if that is a reasonable way to proceed, why don't we do that?
Mr. Moses?

**STATEMENT OF JOSEPH MOSES, DIRECTOR OF MAINTENANCE.
ALLEGHENY COUNTY, PA.**

Mr. MOSES. Congressman, I just have an outline and summary of Allegheny County's approach to snow and ice control on the bridges, and what we are doing with our pothole problem.

Mr. WALGREN. Fine.

We are most interested. For the record, let me identify Mr. Moses as the director of maintenance of Allegheny County, Pa.

Mr. MOSES. Thank you.

Allegheny County has seven major bridges, all of which are under major rehab, or will be very shortly, and several years ago it was brought to our attention whereas we will be spending \$75 million to update our bridges, and bring them into a safe fashion.

Last year I went out to the greater Pittsburgh International Airport realizing that they were only permitted to use sand and noncorrosive materials for runway snow and ice control.

After several meetings, and how they applied these various materials, they have a chemical they pre-spray the runways in advance of a pending snowstorm, and it acted as a deicer.

They also used a urea, and we called representatives in from the various suppliers, and went into an in depth evaluation of both chemicals or products and the costs.

The cost on urea was more or less prohibitive, and also in the granular form, it would not stay on the deck itself.

In using U-car, we thought the next best step was to investigate U-car, U-car as used in airports is sprayed on with sophisticated type equipment which the road people do not have.

Mr. WALGREN. Let me ask, how do you spell it?

Mr. MOSES. U-car. It is a trade name. If over applied, it causes a skidding type problem, and again, we did not have these type equipment to spray the bridge decks.

We decided to pre-spray the materials, that is sand and cinders, and that is all that was used on the major bridges in the county, and in the downtown and outlying areas, Rankin Bridge, which just had a new bridge deck this past year completed.

We found out that by prespraying the material in the various maintenance sheds, and what had happened really, it not only worked as a deicer, but as an antiicer.

Mr. WALGREN. When you say prespray the material in the maintenance sheds—

Mr. MOSES. In stockpiles. In other words, you have a sand and cinder mixture already stockpiled in the various road districts, OK, and we brought in the U-car chemical and sprayed it into the stockpile. had a front end loader mix it up and sprayed it again, and it proved again very successful on the downtown bridges.

Although we had special crews just assigned to the snow and ice control on the bridges, because naturally our other road bridges had salt, and whatever else was available, tied in with the U-car and sand cinder operations, in the past the county has always more or less winterized the road sweepers, and put them out of service for the winter months.

What we had scheduled, anything above 35 degrees, the sweepers were brought out, the vachaul is a sewer type cleaning machine, and we sent them out on the major bridges to open up where you have your sand and cinder deposits, and also sweeping the curve lanes on the bridges.

Tied in with not just snow and ice control, our preventive maintenance program for bridges, we do the rockers and skid plates twice a year, which God know how long it has been done in the county, to give the bridge the capabilities of expanding and contracting, and also, we take a look at our expansion ends, and right now we are getting back this information as to our costs, that is for the bridge snow and ice control, and also the materials used and the first indications were, we are well pleased with.

It is a few dollars more in the normal snow and ice control operations, but we feel in the long run it is advantageous.

On the pothole problem, if I can get into it briefly, the last year the county went into a new method, most people call it resurfacing, we would like to call it reconstruction, because that is what we are doing.

We resurfaced I believe 70-plus miles of roads. This year we have a 75-mile program scheduled, of which half of it was done by in-house forces, we purchased the necessary equipment, we adjusted our materials specifications, when we go out for advertising, we tell the suppliers we want *x*-number of tons within a certain time frame.

I remember last year when the county went out with a 100-ton minimum per road district, the suppliers said you will never put down a hundred tons a day, which was the case.

At that time we only put 40 tons. We modified our specifications to have the suppliers deliver on site, using our pavers and in-house people.

This year we again modified our contract that we had, like we will have 400 tons delivered in a 5-hour period.

Last year one road district which had a record of one of our best resurfacing crews, prior to last year, was putting down probably 50 tons.

Last year in 1 day they put down 495 tons, that is a difference in mode, in looking at your specifications, delivery method and proper equipment.

We purchased three tag-along spreaders-pavers. This is basically a computerized type paver, you set the depth, sensors out front pick up depression, and you set it for an 1½ inch, 4 inches, whatever, it automatically takes care of it, it cuts down the need for real expertise as far as an operator goes.

Going into our resurfacing program, we went into three lifts, the first left we called a scratch coat, it is an ID mix.

What this does is fill the cracks and the voids in the roads.

Now, that can vary anywhere from zero to depending on the tire, et cetera, sometimes 1 inch, three-quarters of 1 inch.

We come in with a second lift which is a binder, we establish the crown of the road to control the surface drainage into the drainage areas.

The third is the county despecifications, which I believe has a 9-percent liquid content, it has a three-quarter inch aggregate for stability, due to the impact on the roads with the heavier trucks.

The county has gone to a 1-inch aggregate instead of the three-quarter inches, so you can image the pounding the runways with the huge planes at the airports, and tied in with this, we rely on our field people, they are the people to deal with it, day in and day out, they set their priorities as to roads, the roads that have to be resurfaced, and there are nine road districts in Allegheny County.

We rely heavily on them, the roads they need to have reconstructed, they come in with their drainage needs before we go in and apply any type of resurfacing to a road, we upgrade our drainage.

Homestead Duquesne Road, which is scheduled for this year, they have 18 catch basins that have to be installed, and if the need calls for it, we increase our lateral sites due to the development going on in that area.

This is all done before we go in and resurface a road.

Tied in with that we improve our shoulders, we pave our shoulders, and it has proved very successful.

In fact, the roads that we work on, in other words roads this year that we felt would have to be resurfaced this year, last year we applied a scratch code.

We took a lot of heat from the taxpayers saying that is a waste of county dollars, it looks like hell, cosmetically it did not look good, but everyone of the roads we scratch coated last year are virtually pothole free.

If you take the center two lanes of the road, it stayed, and then they say: Why did not you go to four lanes.

The outside two lanes are curblike, we have to remove 6 inches by planing so we could have the curb rebuilt, so we figured if we get the middle two lanes scratch coated, and we will pay a little closer attention to the potholes that develop in the side.

We took the Mansville Bridge, there is no way we could keep up with it last year if we did not apply a scratch coat, and in the minor unravel, it is minimal, because you are teetering from zero to three-quarters of 1 inch.

What also happens after the road becomes traffic bearing, it works fine into the cracks, into the void, where you are not able to get mayb with a roller, and it has proved quite successful.

On the potholes, again, we purchased three porter patchers.

It is basically a machine that more or less converts a conventional cold mix into a hot mix, right into the filled conditions.

We had to modify our specifications on the cold mix to make the mix more compatible with the machine, which we did, and we had patches last as long as 3 weeks.

Unfortunately, we need about seven more, we only have three.

We have been using Sylvax, you heard of the Sylvax product, 3 years ago they came to us and asked us to try it.

We used it, that has proved successful, except that the cost makes it limited, though not prohibitive.

It is around \$42 a ton, so right now we have a mix that costs us around \$20, which is the going rate for cold mix, we tie it in with the port-a-patcher, and this is how we are handling the pothole problem.

Thank you.

Mr. WALGREN. That is a very interesting statement. We appreciate the reality of the description, I think it lends to what this is all about to the whole day.

Thank you. We will now hear from Mr. Dickinson of the Salt Institute.

STATEMENT OF WILLIAM DICKINSON, PRESIDENT, SALT INSTITUTE

Mr. DICKINSON. I am president of the Salt Institute which is a non-profit association whose members are the world's salt producers.

We have 28 members around the world. We are involved in research and engineering in most of the programs involving all users of salt.

I would like to discuss briefly the role of salt in snow and ice control as the most effective and economical material which is widely used in connection with plowing to provide safety and mobility for the traveling public in the winter months.

Back in the early seventies we studied the situation along with a number of highway departments and other agencies. At that time we felt the two biggest problem areas were one, improper storage, where you have salt stored out in the open, it rains, or it snows, and the salt

dissolves and runs out into streams, and, second, I am sure you have all seen salt applied at too heavy an application rate. We feel we have solved a lot of our problems by emphasizing first proper storage, either a water-proof cover, or preferably in a shed or building, and, second, proper calibration of equipment, so that only the amount is used that will do the job.

One of the things there of course is getting better equipment, there are now ground control sensors which regulate the the ground application rate, regardless of how fast the truck goes.

If it is going 10 miles or 30 miles per hour, it is still spreading the proper amount.

In the past 6 years we have put on 125 seminars each winter around the country for highway departments to get this story on proper use of salt across to the people out there on the firing line.

We have also looked into alternate deicing methods and we have looked at the overall cost benefit of use of road salt.

In this latter connection, I would like to mention the study by the institute, for safety analysis, copies of which are available to the committee, and included in the formal testimony.

This study indicated the benefit was somewhere between 18 to 1, or a low of about 6.3 to 1, depending on which cost figures are used.

This is based only on economic benefit, such as reduced wage loss in lateness to work and absenteeism, reduced production losses, reduced losses in goods shipment and reduce fuel costs.

We put no dollar figures on lives saved in reduced traffic accidents or lives saved in response time to medical emergencies such as heart attacks and work and home accidents.

The two problems that this committee has been considering today, I think it would be redundant to continue with what I have to say, because I am in agreement. As far as the new bridges, there are a couple of very effective methods available to prevent corrosion of steel, and we have certainly recognized that the use of salt on bridge decks is a very definite contribution to the bridge deck problem.

As far as the pothole question, really that has been well covered too, the fact is that if you have a weak subgrade, or a weak base course, if you develop cracks in the pavement, you get water in it, you get freezing and thawing, you will get a pothole, something will give.

The bridge problem too is, in some cases, a question of age and neglect of bridges. Much was made out of the Westside Highway bridge in New York City, a truck went through it, if you recall a few years back.

That bridge had not been maintained for 50 years, you cannot go away and leave anything, you have to maintain it.

I do not mean to relate that to the concrete and reinforcement problem, but again we do think there are promising methods of protecting the bridge decks, and we would like to see more done in that area.

I would just close by saying as far as a method of preventing the salt from causing this corrosion, it has been studied thoroughly by our industry and others, and we have not come up with a good inhibitor.

We wish we could, but I did want to mention we have studied it.

One last thought, it is interesting that this cathodic protection system, which has been described in my research for this presentation, I learned that the Transportation Research Board of the National Academy of Science through NCHRP contract is designated to United

States Steel Engineers and Consultants, Inc. of Pittsburgh to study the laboratory phase of cathodic protection for reinforced concrete bridge decks.

It is of interest, it is here in Pittsburgh that it has been studied.

Thank you.

Mr. WALGREN. Thank you very much. We appreciate that, and we will now hear from Mr. Edward J. Siodlowski, the executive director of the Pennsylvania Asphalt Pavement Association.

**STATEMENT OF EDWARD J. SIODLOWSKI, EXECUTIVE DIRECTOR.
PENNSYLVANIA ASPHALT PAVEMENT ASSOCIATION**

Mr. SIODLOWSKI. Thank you, Mr. Chairman.

I am Edward J. Siodlowski, the executive director of the Pennsylvania Asphalt Pavement Association, and my remarks will be primarily based on our situation in the Commonwealth of Pennsylvania.

I have no prepared statement. I would refer to my notes, and some of it I heard discussed earlier by Mr. Sandvig. Some of the statements he made I concur with, and I would like to start by saying that for the past 7 years or more, we have cooperated, our association, through our technical committee, with the bureau of maintenance.

We are concentrating on developing a cold mix product for winter patching of potholes.

There have been several that we have come up with in these past 7 years, and there have been several proprietary products as I call them and experimental products.

Getting back basically is that these cold mixes were made as a temporary repair, and as they stated before, for many reasons, whatever they may be, lack of funding, personnel, they end up to become permanent if they are still there.

Getting back, I believe that we first must establish a system to define a pothole.

By this, is this pothole related to a surface failure, is it related to a water problem, or is it a structural failure.

I think once this is done, then our path can be chosen of which way to go.

But it is an established fact that many of our potholes start when we design the pavement. There is insufficient subsurface drainage, many times no drainage, and sometimes very little consideration given to surface drainage, and some of our pavements were underdesigned for the amount and weight of traffic that they will carry, and I heard remarks about Governor Pinchot roads, which is true, as a matter of fact. I believe it was about 6 years ago when the last Pinchot road was resurfaced, so some of them have contributed to our farm to market roads, and given us good surface life, many of them have not for various reasons, but what we have done in order to cover these mistakes is to make pancakes, literally our road system is like a stack of pancakes, with very little consideration given to the structural strength, and many times these thin overlays although they can be utilized, they should never be utilized as a structural base, for a structural purpose, because we are going to construct an additional failure or pothole.

Along with improper maintenance for vast numbers of years, compounded by the lack of funding, and extreme curtailing of maintenance on our interstate system, we see that as a problem.

Recently, as a matter of fact, 2 weeks ago, our present administration had an emergency patching program, and they were concentrating on hot mix patching.

This was to be done in accordance with good practices, by good, I mean the procedures that are recommended on the sound engineering basis.

I would like to relate to you our interstate system, although the interstate system was of adequate design thickness to carry the vehicles, and the weight, again, many of the faults lie with improper drainage in both subsurface and surface waters, and since our funding, our insufficient maintenance, that is a fault also.

Now, to get back for what we are here for I believe is that our industry, namely the Pennsylvania asphalt pavement industry, and our association has been cooperating with Penn DOT.

We will continue to do so, but also we would like to make this recommendation, that we define a pothole, such as defining what caused it, and we can determine this, and then to adopt the procedures that when the cause is determined, the proper repair work for the situation be done as soon as practical, and if a temporary patch is placed because of weather conditions, or whatever, then the cold patch should be placed properly, and as soon as weather permits, all temporary patches should be replaced with permanent patches.

I would like to close by saying there is ample literature available in outlining these procedures, that is the procedures to be followed for temporary or permanent pothole repairs, and there have been many studies made throughout the country and in our commonwealth, which most of them indicate if a repair be made, whether it be made using cold or hot materials, whether it be made properly, and how, and then the chances of recurring drastically reduced, and then the biggest problem is to have these correct patching procedures adhered to and utilized.

Thank you.

Mr. WALGREN. Thank you for your statement. I appreciate that.

The last witness for today is Mr. R. C. Cronin from the regional Paving Engineering Portland Cement Association.

Mr. Cronin, you may proceed however you would like.

STATEMENT OF R. C. CRONIN FOR THE REGIONAL PAVING ENGINEER (PENNSYLVANIA AND NEW JERSEY), PORTLAND CEMENT ASSOCIATION

Mr. CRONIN. Thank you.

I am Randall C. Cronin. I am the senior regional structural engineer with the eastern region of the Portland Cement Association.

I am substituting for Mr. Berg, our regional paving engineer.

I would like to, as an aside, address Congressman Atkinson's minor problem of concrete sidewalks, and point out to him that probably the reason for the difference between the sidewalk up to his house, and the sidewalk along the street is that the sidewalk along the street was probably built under specifications for the township or borough,

and probably involved better materials and workmanship, whereas the sidewalk up to his house was probably done by the homebuilder, and quite possibly did not include the quality concrete, and the air entrainment that was mentioned to prevent scaling as a problem.

Mr. ATKINSON. That is a good point. I would like not to ask questions at this juncture. That was the point I was making, if better materials were used that would help eliminate the problem, and forgetting the fact the maintenance and the erosion and the replacement should be considered anyway. I brought this up because it is a very good example of the difference in looking at only the first cost, the homebuilder, and working under specifications where you do get the quality of materials and workmanship.

Mr. CRONIN. I have submitted an outline of the material I was prepared to cover. Much of it has already been covered by the previous witnesses, so I will only refer to some of the major points.

First, dealing with concrete pavements, and the problems associated with concrete pavements, generally speaking, potholes are not one of our problems.

Scaling, which in the past was a major problem, can be and is being taken care of by adequate air entrainment and quality control of the concrete materials.

Our primary problems are associated with joints as was pointed out by Mr. Scheffey, that is spalling at the joints and blow ups, which he also covered. He pointed out that these were primarily due to the lack of continual maintenance. Another aspect of this also is the joint spacing. This is an area in which we have been involved for many years in research and development. We see a trend toward shorter joint spacing, which might seem strange since joints are the problem in concrete, but by going to shorter joints, you have less movement in each joint, and therefore less opportunity for untrusion of material were the joints are not properly maintained.

Here in Pennsylvania, we have seen the joint spacing on the State highway system, and Mr. Sandvig can correct me if I am wrong, go from approximately 70 feet down to 46½ feet, and now I think they are considering 40 feet in reinforced concrete pavement, in which the reinforcement serves to control the intermediate cracking between the joints.

Another area for possible reduction of the joint problem is going to plain pavements with very short spacing in the range of 20 feet, and skewing the joints, so that the vehicle crosses the joint without producing a single heavy loading. Continuously reinforced concrete is also a development area that is being pursued here in the State, as well as across the country.

With regard to recommendations for existing pavements, certainly periodic joint cleaning and resealing is a must in maintaining concrete pavements.

With proper joint sealing and joint cleaning and resealing, you can expect the 20 or more year life from concrete pavements.

As far as correcting existing problems, two areas, we think should be considered. One is the use of bonded concrete resurfacing. This is being tried now, basically looking at the procedure similar to that being used on bridge decks, the low slump dense concrete method. This can be facilitated with some of the new equipment that is now

available, the heavy duty planing profile equipment, which prepares the surface for such operations. The other is, as Mr. Scheffey I believe mentioned, the use of like materials for paving. We suggest that the use of concrete for patching concrete can be more effective for long-term performance.

As far as new pavements are concerned, we feel that short-joint plain pavement is a valid approach to the reduction of the joint problem, and the use of concrete shoulders on primary highways, serving two purposes: To reduce deflections of the pavements, and also to improve surface drainage, which has been raised as a problem.

One other point that I would like to mention: Where flexible pavements have been used and are seriously deteriorating, one potential method for reducing cost of reconstruction is the in-place recycling and reuse of the material, stabilized by portland cement.

Going to the problem of bridge decks, much of the material I have prepared has been covered.

I would like, though, to add a little bit of background data with regard to the basic problems of bridge deck deterioration, and this deals with some of our past practices.

One is the area of design. I think too often in trying to save weight in bridge construction, particularly in long-span bridges, we have gone to thinner and thinner decks.

I know I did this myself when I was a design engineer, and this has resulted in more difficulty in providing the proper concrete cover protection for the reinforcing steel, and has led, in part at least, to the spalling problem on bridge decks.

The other I have referred to as the 3,000 PSI syndrome, and this again pertains to the practice in the past of assuming that a 3,000 PSI concrete was of adequate quality to be durable, when in fact we now know this is not always the case.

We also have to look at the problem of construction of bridge decks. It is a very difficult procedure. You have bridge decks normally of very heavy steel concentration, reinforcing steel.

The nature of the work: it is concentrated in a small area.

The contractor performing the work normally does not have a crew that is doing the same thing day after day.

You have problems of scheduling materials into the site, and so on. All of this has contributed to certainly less than the best of construction in bridge decks.

In the area of research, one of the basic research efforts was completed in 1970. This was a cooperative study by the Portland Cement Association, with 10 of the State highway departments and Bureau of Public Roads, and resulted in this report, "Durability of Concrete Bridge Decks," which I will submit to the committee. I can get additional copies if they are necessary.

This report, when it was completed, presented some recommendations, and was a reflection, of course, of the research that had been done up to that time.

Those recommendations are covered in the first two attachment sheets that you have, and deal primarily with, first, design, as to the quality of the concrete, and a requirement for adequate cover of the reinforcing steel. This has been mentioned by other witnesses. Then in the area of construction, techniques to assure that the quality of con-

crete was adequate, and also that adequate reinforcing steel cover was provided.

Since that report was submitted, of course, there have been some new developments. In particular, I would like to refer to the two course construction, the use of low slump dense concrete, which has been mentioned, and latex modified concrete. With respect to those two methods, I think it should be pointed out that the Iowa method, the low slump dense concrete method, has been used now by the State of Iowa for more than 12 years. It is significant, I think, that when the problem of the level of salt contamination was developed by the Federal Highway Administration, they arrived at a figure of 2 pounds per cubic yard of chloride content as being the threshold for consideration of removal of the bridge deck. At that level you were almost assured of future deterioration of the bridge deck.

In examining some of the bridge decks that had been overlaid by Iowa, using this method, they found that they had overlaid concrete that had as much as 7 to 8 pounds of chloride ion content per cubic yard, and this very high level had not resulted in any further deterioration. The reason being, that in order to have the chloride corrosion of steel, you not only had to have the chloride, and the steel, but you must also have moisture. The low slump dense concrete overlay had been effectively preventing moisture penetration, so the decks have performed well, and that is for a period of more than 11 years.

The latest modified concrete apparently also provides this same degree of resistance to moisture penetration on a bridge deck, so I would submit the use of these overlays as a valid approach to the correction of existing bridge deck deterioration. It is necessary to go in and remove unsound concrete, but you can overlay existing material that may be highly contaminated and yet still obtain a durable future deck.

It is important to provide a very high quality durable material which will resist the wear, as well as moisture penetration.

Thank you.

Mr. WALGREN. Thank you very much, Mr. Cronin.

Mr. Atkinson?

Mr. ATKINSON. I would like to ask Mr. Cronin, not to misinterpret my question as being rude, or as an aspersion of any sort, but what are the incentives of having a product manufacturer, of either asphalt or cement, because as it wears, there is more usage of your product. What are the incentives of the product manufacturer—well, in your view, what is the trouble, is it the cement, is it the asphalt, or is it the way it is installed, or is it maybe to the depth or the amount it should be? As Mr. Cronin stated, in trying to have an excellent product, using the proper amount of material, which is the cost factor that reduces it down, is that a fair question?

Mr. CRONIN. Certainly our association, since its inception in 1916, has been heavily involved in research and development, and one of the prime directions of our research and development has been in the development of higher quality and better materials, because we have felt from the inception that only by doing this could we extend and improve the uses of our product. So, certainly, our efforts have been primarily aimed at improvement of quality in promoting our materials.

Mr. SIODLOWSKI. With us it is repetitious business in a sense, if we keep getting the black eye we have been getting, because as they literally say in western Pennsylvania, the pavements are down several months and they blow away.

Our industry cannot stand this, because they are primarily small businessmen, independent businessmen.

There are 200-plus asphalt plants in the State of Pennsylvania, and we have to keep them as a viable industry, and the only way we can do this is by developing products and making the products that our customers depend on, and local governments require.

Hopefully in the process, in cooperation with them, we can develop a better product, improve on it, I say not develop a better one, but improve on what we have, and we feel we have reached the point where we do have a quality product, however many times we have seen as I stated in this situation here, a misuse of the product.

Again, we get the same statement, you have a lousy product, et cetera.

Mr. ATKINSON. That is why the question was asked to clear the air on that, and as Mr. Cronin stated, even dealing with the installation of the sidewalk, as opposed to the sidewalk, it is all in the workmanship sometimes, and what your specifications called for.

Mr. CRONIN. We recently had a seminar here almost a year ago, a seminar on just that topic of residential flatwork, and how to achieve the proper construction, and it was widely attended by contractors in the area.

Mr. ATKINSON. You also have, you deal with private firms as well as of course the public sector, and they have as many problems as we have, but they have to use salt too.

Mr. CRONIN. Yes, indeed, they have the same problem.

Mr. ATKINSON. Do they have the same problem?

Mr. CRONIN. Yes. The particular problem of scaling came to a head in the last 3 years, because of the very severe winters we have had.

Unfortunately there were many pavements, I am talking primarily about sidewalk and residential construction, which were marginal in their original construction, and just had not been subjected to the type of weather that we normally get in this area. We have had quite a few mild winters prior to these three last winters.

Mr. SIODLOWSKI. Could I add to that, one of our biggest problems has been many times in budgetary reasons, and you have seen no doubt in your travels of shopping centers, the pavement is also the last thing to be done, and we all know whenever there is a budget, you overrun them, I do not care who is building it, even if it is a home, so generally, what suffers the most is the parking lot, and here they have a tendency to keep cutting the costs, it is always taken out of that parking lot, and that is the thing that is the cinder in the eye of the customer, and that is where our biggest failures take place, improper design of the pavement.

In case the pavement could be designed properly, but for budgetary reasons, you have a loss, and you build it in, is what I stated earlier.

Mr. ATKINSON. If I could—

Mr. WALGREN. Let me follow up, as I understand is the incentive to make a better product, is to compete with the purchase orders of all of the customers including government, but then the second part of

the question is, how much effort is really being spent by the industry to actually develop new and better product.

Maybe it is wishful thing that there is a magic mix some place, but are the industries, both asphalt and cement, devoting a substantial amount of resources toward this, and do we know how much we are devoting, can you make an estimate of, for example, for the cement industry, or the asphalt industry, how much of the profit that is retained by the corporation is spent in those efforts?

Mr. CRONIN. Speaking for the cement industry, our association is supported by cement producing companies exclusively that support our association. Up until perhaps 9 years ago, I would say roughly a third of this industry support went directly into research and development.

Since that time, because of a reduction in industry support level, we have had some reduction in that effort.

I would like to point out, however, that some of our research work that was done perhaps 15 years ago in the area of bonded concrete resurfacing, has provided the direct supporting information or data, which was used by Iowa, in determining how they should proceed with their low slump dense concrete overlay method. So there was a direct result of research work that we had done, and it is typical of the type of work that our research and development laboratories performed in our offices out in Skokie, Ill.

Mr. WALGREN. But we have only the association, and one-third of the industry, we do not have the information on the effort that might be made by an individual company.

What bothers me to cite an example of what was a good idea, and it apparently was a substantial breakthrough, and the question was how much of our effort are we putting in toward looking for good ideas, and if it is not being called or drawn out of the private sector, then we have got to be looking for it someplace else, if we need the ideas, and clearly we need the ideas, and I wanted to ask perhaps in general to everybody, what is your estimate of the amount of research that is being done in this area, either by the private companies, or by the Government, and what would you like to see being done in terms of even basic research in the area.

Maybe I could start with Dr. Cady.

Dr. CADY. Actually, I am not in much of a position to know what amounts are being allocated by Government or industrial organizations. I am more on the receiving end in terms of doing the research for these organizations.

My experience has been that most of the research has been funded by Government, or what I will call quasi-Government agencies such as the national cooperative highway research program, which is actually funded through the American Association of State Highway and Transportation Officials.

In recent years, some support for the study of corrosion of reinforcing steel in concrete has come from a couple of trade or professional associations, such as the International Lead-Zinc Research Organization [ILZRO], and also from the Metals Properties Council. So there is an indication that some of the professional and trade organizations are funding some research, but by and large, the bulk of the research

that is being done is being funded by the governmental agencies, in my experience. As to quantities, I cannot give you numbers.

Mr. WALGREN. No estimate about whether more could be done by those with a direct interest in the problem?

Dr. CADY. I really do not have a feeling for their operations as to whether or not they can afford to.

Mr. WALGREN. Mr. Sandvig, do you have any reaction to the problem?

Mr. SANDVIG. I think more could be done by industry and research.

I really do, and I have already told you what I think about Government research as far as the State-Federal, and when you talk about applied as against basic research, I think as a nation, recently we have devoted some little amount of money to research efforts, it is all being applied to applied research, and we have really made a serious mistake in not putting funds into basic research, and we certainly have not in Pennsylvania, and we have not been for sometime at all levels of government, whether you talk about roads or what it is, we are really falling behind, because we are not investing money in basic research in this country, both the industry at the university level and the government.

Mr. WALGREN. Thank you.

Let me ask Mr. Dickinson. I know that as a purveyor of salt, you are in a somewhat, people would suspect that is part of the problem, and you recognize that, and you have certainly directly spoken to that in your statement.

You mentioned your industry does have some efforts in terms of trying to neutralize that salt.

Can you measure that effort, how much is the salt industry, not even through associations, but I mean here is a fellow out there producing salt, and realizing a profit on the sale, is he giving anything back to solving the problem to those reinforcing bonds being shown?

Mr. DICKINSON. I would have a hard time to put a dollar figure on it.

But let us take the corrosion thing first, one of our companies devoted a vast amount of time and effort and money into trying to develop an inhibitor, they call it car-guard, it is a couple of components, and they went into a 3-year field test, to pick three different highway systems in Minnesota, where they used nothing but sand on one section, these were lightly traveled rural roads, so there was no need to keep a bare pavement, and another where they used the car-guard, and another one where they used the straight salt, and after much laboratory investigation, and then 3 years of field demonstration, we could not show any benefit at all in this product, it was the best looking thing, and it has been looked at for many years.

The dollars I could not tell you, but I know we have spent a considerable amount, and nobody would be more happy to develop something that would solve the problem.

Mr. WALGREN. Mr. Sandvig?

Mr. SANDVIG. A number of years ago we did look at that rust inhibitor, really, it was so costly, it would cost the taxpayers less if we had installed little washing machines to spray the bottoms of the cars, we could do that cheaper than using the rust inhibitor.

At that time we were looking at the corrosive effects on automobiles, not bridges.

Mr. ATKINSON. You speak about cars, but I am not trying to give anybody a hard time, but could you tell me, would that adhere to concrete, or could that be a mix in your asphalt?

Mr. SIODLOWSKI. Basically, I think it was in asphalt. We made it years ago when I was in the industrial field, it becomes really particularly expensive to try to do a road, for many reasons, safety, whatever.

We have looked at many pavements, but I do not think you could pave a road with it, if that is your question.

Mr. DICKINSON. The epoxy is probably better.

Mr. SIODLOWSKI. I would not recommend paving a road.

Mr. ATKINSON. Against what, that is what we are talking about.

We are talking of 22,000 bridges in Pennsylvania, on the Federal system, 6,000 for total rehabilitation, 4,000 for partial, and 12,000 we have not figured, which involves billions of dollars, I am just wondering, if it is done right the first time, the point you made also, Mr. Cronin, are we too cost conscious on the installation and not looking down the road?

Mr. CRONIN. I would like to comment on that particular point, one of our basic problems again in bridge construction, for instance, is that we are looking at the low bid as the man who does the work. Under the pressure of low bid he is trying to cut every corner he can. Even the good contractor is trying to save every dollar he can, and this sometimes results in less than the best of construction.

Mr. SIODLOWSKI. Getting back to the original question, I would like to address that if I may. I am sorry, we are a statewide organization of independent bituminous concrete producers, with very limited funds, budget, as a matter of fact, I am the man; however, we have tapped our people who without question, and I think Mr. Sandvig can vouch to that, whenever a problem comes up, we call our technical committee, about 25 men throughout the entire commonwealth, they serve on national committees as well as our State committee, and they have the expertise in the particular field, and we lean heavily on these people to help us out in the field, and they are all knowledgeable people, how do you measure this in dollars. I would not dare put a dollar on it, because you as an owner will send your technical man to these committees for 2 or 3 days, maybe 4 or 5 times a year, so how do you measure this, we have 20 to 25 people from our technical committee.

We meet with PennDOT people to relate to the problems, how do you measure this?

We fall heavily and lean heavily on two national associations, if you will, our National Asphalt Paving Association, I do not know their exact dollar volume, but they in turn work similar to us, except on a national scale, again how do you measure dollars with the time of the people, et cetera, and then we have the Asphalt Institute, which is sponsored totally by the refinery people, and their sole job is for engineering and research, et cetera.

I do not know their budget, but when you come to dollars, I feel there is an extreme amount of dollars in time and personnel, maybe not dollars per se, but in time and people, I think we do have a vast

knowledge of people that are people knowledgeable in the business, and sometimes we are not utilizing them carefully.

That is my basic statement.

Mr. WALGREN. At two points, I am trying to recall, it was said there was a machine that might be able to do something, but that it was not commercially developed by the industry.

One was the deck impregnating machine, and I believe another one was mentioned as being some kind of a hot porter patch, I am remembering something someone was saying does exist as technically feasible, but has not been developed.

Now, who would develop that if it has not been developed, is that the problem, is it the problem of a lack of development of that machine?

I was out at the Federal Bureau of Mines where they are constructing literally a mine above the surface, simply to test machinery that is apparently being developed, and probably play a role in that development, a machine that will mine a continuous wall at one time.

That is not being done by a private developer. Is this the kind of problem we have in this field?

Dr. Cady, could you speak to that?

Dr. Cady. Yes; I think this is exactly the problem.

We are kind of at a Mexican standoff, where you have the researchers who have developed a technique that has proven technically feasible, and the highway people—the users—who would like to use the technology, but no equipment to bridge the gap, and right now the problem is who should develop this equipment.

You cannot go out and tell a contractor you want this bridge impregnated to a depth of 4 inches with something. He says, "great, what will I do it with?" The highway department cannot say, "we will impregnate this bridge deck to 4 inches," because they do not have the equipment to do it, and that, I believe, is the current major impediment to the implementation of presently existing technology.

Mr. WALGREN. Why is not the equipment being developed, is there a block to the private industrial development, like a John Deere coming in and creating a big combine of some kind, that will not happen because of certain reasons?

Dr. Cady. A manufacturing firm will not put the money necessary to develop a piece of equipment unless they see the incentive to do it.

They will have to invest a lot of capital, and they must have a reasonable assurance of return on that investment.

Mr. WALGREN. And you feel that incentive is not there?

Dr. Cady. I think it is not so much a matter of incentive as communication. I think the industry has to be convinced that the techniques are feasible, that the highway departments will use them if the equipment is developed, and then they have the incentive.

Mr. CRONIN. In some areas there has been such an effort and a good example is in the area of bridge deck operations.

One equipment supplier, to specifically meet the need to place the low slump dense concrete on bridge decks, came out with a new piece of concrete placing equipment, specifically for that.

Another area is the development of the heavy duty planing profiler, which is intended to remove and prepare existing roadways, or bridge deck surfaces for resurfacing. There are several companies

involved in that type of equipment, because they have seen an immediate need, and they feel it is being used. So when there is a feasible solution presented, and the industry feels that it will be adopted, they will go ahead and develop the equipment.

Mr. SIODLOWSKI. I think it is a known fact that the construction industry, the profit margin in spite of what a lot of people think is very, very low, so let us take a hypothetical situation: A machine comes up that Dr. Cady is talking about, and I as a contractor have the opportunity to bid on it. So is this a one-shot deal a question, and I am going to make the cost of the equipment, say \$100,000 out of that one job, and then if the Department does not bid anymore projects, I am stuck with the \$100,000 machine. I as a small individual cannot take this kind of loss, if you will, and I think that is, I refer that to what Dr. Cady said, we have some ideas for the researchers, but to get them to the development, we lean heavily on the equipment manufacturers.

Now, we do have in our national organization a cooperative committee that works with the manufacturers to develop equipment; yet this is very costly, that in this industry I am speaking of, with low profit margins, be able to afford this, so we must I think lean very heavily on the Government for assistance.

Mr. ATKINSON. The tax incentives, that could be one incentive.

Mr. SIODLOWSKI. Whatever you could develop for the industry.

Mr. ATKINSON.. You mentioned "U-car," is that a substance?

Mr. MOSES. Yes. It is a trade name.

Mr. DICKINSON. It is a liquid.

Mr. MOSES. It is glycolate.

Mr. ATKINSON. You say they will not use salt on runways, the Federal Highway Administration, the FAA says it is not allowed, but you can use it on bridges?

Mr. DICKINSON. The problem is you have stress corrosion that can be induced by salt on aircraft, and it is different if you have a plane with a couple hundred people and the wing falls off.

Mr. ATKINSON. Yes; if you really take that general view though, say if it works on airstrips, it should work on highways.

Mr. MOSES. I think the problem may be the cost.

You are talking about a bridge of several hundred feet or a thousand feet, as opposed to miles and miles of roads, you will be up from the big dollars.

Mr. ATKINSON. Still, when you look at the whole picture, that is the kind of thing we are talking about here today.

Mr. DICKINSON. The thing that bothers me, and I had the same thought, and if it does, fine, but what troubles me, if you are treating the miles of highways approaching that bridge with salt, you are going to get a lot of slush falling off of that bridge deck, in other words, practically speaking, it is difficult to keep the salt off the bridge deck.

You see it happen in parking garages, where the car goes in, and the slush falls off, and you see the white deposits there in the spring.

Mr. MOSES. It is one of the reasons we tied in our road sweepers, realizing that a certain amount of salt will be carried on.

On behalf of the salt industry, I guess it was about 3 years ago, we went to the Salt Institute for some help as to proper application of

salt, and I think I should call it to your attention, we were probably using, I would say 1,500 to 1,600 pounds per mile, and we had enrolled in a sensible salting program which the salt institute came into Allegheny County, and specifically the county at that time, the county works department had worked with out field people on the proper application of salt.

They reduced it to a recommended use of 750 pounds, I am just going from memory now. They calibrated our spreaders and showed them how to calibrate them, and I thought it was a tremendous gesture on behalf of the Salt Institute.

You would think they would be trying to sell their product, in a sense they reduced the usage that we were using.

Another thing that we did, and there again with some feedback from the Salt Institute, we looked at a spreader, not the tailgate spreader, and it applies directly to the road, whereas your tailgate has a tendency to spin, and a good portion of that would hit the cartway, and go onto the berm.

We found out by using this, that a good portion of the method is directly applied to the roadbed, and again, as in the past, our drivers had a tendency, if they did not see the salt flying out of the truck, if they saw it flying out of the truck, they had a tendency to turn up the controls, so we locked the spreaders in the position where the truck drivers cannot adjust, either increase or decrease the salt application.

Mr. WALGREN. Along the lines of the use of salt, I wanted to ask Dr. Cady whether you have any comment on the Salt Institute, that would go beyond what you said in your statement.

It seems we have a conflict of recommendations here, and it is difficult for us to resolve those conflicts, but if there is anything further to be said about the use of salt, I would like to hear it.

Dr. CADY. I am not sure there is a direct conflict of recommendations. My recommendation was that a study be made—an in-depth careful study of the benefits and costs of salting. It should include all related costs. I mean the total, including damage to the environment, corrosion of the vehicles, and so on.

Mr. WALGREN. Have we made such a study governmentally at all that you know of?

Dr. CADY. Well, the study that is referred to most often was the one carried out in 1970 by EPA, and since that time there have been offshoots from that. However, there has not been what I would consider an in-depth study, that is, a study of all of the facets related to this problem, bringing in all of the costs, direct and indirect, related to salting and related to not-salting. For example, if you do not use deicing salt, what will happen to accident rates? Authorities presently differ widely on this question.

One recent study indicates that there is actually little difference between accidents on snow covered and ice covered roads, as opposed to wet and dry pavements. This sounds strange, but it is simply because there are fewer drivers out, and the drivers that are out are driving a lot slower. So you have to compare accidents, cost of accidents, cost of corrosion to vehicles, and all the costs involved. In summary and in answer to your question, there is not to my knowledge a complete study that has been carried out along the lines I have suggested.

Mr. WALGREN. Well, certainly when you look at it, as what we all know, the damage salt does, there was a fellow on the radio the other Saturday signing off his 4 hours as a disc jockey, saying for relaxation that afternoon, he was going to take his easy chair out to the driveway and lift up the garage door and watch the salt eat his car.

Mr. DICKINSON. What is that fellow's name. I want to talk to him. [Laughter.]

Mr. WALGREN. So I only want to say that we all admit that salt does a tremendous amount of damage, and it strikes me if the basic study in 1970, from one viewpoint anyway, that that is well before we have suffered the bridge corrosion, the awareness of what has happened to the bridges.

Mr. DICKINSON. It was 1976.

There was one published in May of 1976.

Dr. CADY. The earlier EPA study was done in 1970.

Mr. DICKINSON. It could be, but I am talking about the latest one. and there was a study of what was the cost of using salt, and then we sponsored a study by the Institute for Safety Analysis, which attempted to determine what are the benefits also.

The EPA made a study, but it did not look at what the benefits were, they said what are the costs, and they included bridge decks, car corrosion, vegetation, et cetera.

I also wanted to ask whether there was any good public opinion surveys done about the need for salt as perceived by the public, and I am sure that the public if we were not removing the snow from their streets, would be very upset and yet at the same time, I think it is probably true that the public may not have the most accurate perception of what happens if you do not salt the streets directly, or as heavily as we do, I am thinking of the studies first, and it has been my impression that there are many people in the public who hold onto those studies well beyond any real benefit, and I am wondering, are there any public opinion studies that have been done in this area, by either the public, or by the private sector.

Mr. DICKINSON. I think what could be looked at as a public opinion study was done in several cities, three in Massachusetts, a scattering in the midwest, most recently in Oklahoma City, where salt was banned, usually in July, because of the alleged damage, and when I say alleged, I mean exactly that, because while there is no question about reinforcing steel, some of the other alleged problems with salt are not as real as some people think, damage to vegetation, trees, for instance, is not a real widespread thing, but in no case has that ban not been overturned rather quickly.

Oklahoma City was the most recent. Last fall they banned salt, and they had about 9 days of ice in December and January, and the council decided they had made a grievous error, and they met and rescinded the ban, because they probably just could not tolerate the conditions, they could not move.

Mr. ATKINSON. And the FHA says it must be clear.

But even more than that is the public demand.

You get the people to see that they cannot move in the wintertime, then you hear from them.

Do you think that you and Dr. Cady could get a salt agreement?

Mr. DICKINSON. Probably.

Mr. ATKINSON. I have no other questions.

Mr. WALGREN. Just one other area that we had noted, and that was Mr. Moses as I understand it, he said we have reduced our use in Allegheny County of emulsion oil that is used in surface treatment substantially, supposedly 4 years ago we used 1 million gallons of emulsion oil, and now only this year 75,000 gallons.

Mr. MOSES. Where does that come from?

Mr. WALGREN. I don't know.

Is that familiar at all to you?

Mr. MOSES. I don't know.

Mr. SANDVIG. It must be going the other way. There is an effort to do away with the cutbacks, because of the pollution problem toward emulsions.

In our department, we have been encouraging the use of emulsion over cutbacks, except for these latest season or adverse wetter patching, and in fact EPA is going to put on a regulation in 1980, that cutback surface treatments and those kinds of cold mixes will be out.

Mr. SIODLOWSKI. Except for extreme weather, wet weather conditions.

There are only four cases where they will permit cutbacks.

Mr. SANDVIG. One of them is this kind of patching in adverse weather.

Mr. WALGREN. Has EPA regulations given you substantial problems, and do you see bad effects from EPA regulations at this point in the industry?

Mr. SIODLOWSKI. The high cost of the product.

Mr. DICKINSON. Indeed.

Mr. WALGREN. How about mechanically?

Mr. SANDVIG. It is an educational problem with our agency, however we embarked upon that 5 years ago, but we have got a group of people that have learned the business by rote, both contractor and maintenance people, they have had long experience with using some of these, and some of them prefer a cutback, because they have been using a cutback for years, and now they have been asked to use emulsions, which is really in the end, it does not matter how the asphalt goes on there, whether it is by heat, water or by solvent. I have even gotten calls from the legislators that called and said quit watering down our asphalt.

They are referring to the emulsions. It is an educational thing.

You cannot go through the same operations like the surface treatment, the same procedure with an emulsion as you do with the cutback, so it takes some retraining, and reconvincing that they can still do a decent job if they just change their ways.

Mr. WALGREN. All right.

Gentlemen on behalf of the committee, and Mr. Harkin, and Congressman Atkinson, I want to thank you very much for all of the effort you put in the making of these presentations today, for both your time and for your thoughts.

I do not think anyone can come away from this without realizing more fully what a difficult problem it is.

At the same time, I do not think you can come away from it without realizing how little an effort in the sense we have put toward basic research in this area, and it is likely to get worse as the costs of main-

taining and meeting the immediate demands that the people put on those responsible for the roads increases.

There will be less money left over for perhaps using our heads more wisely, and trying to find some new ways to do things that will work better.

We will take the record back to Washington, and believe me, we will look through and try to find openings to explore, perhaps both with yourselves and with others in the Federal highway area, in hopes that we can encourage some change.

Thank you very much.

[Whereupon, the subcommittee was recessed at 3:30 p.m.]

APPENDIX

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS,
Washington, D.C., April 6, 1979.

HON. THOMAS HARKIN,

Chairman, Subcommittee on Transportation, Aviation, and Weather, Committee on Science and Technology, Rayburn House Office Building, Washington, D.C.

DEAR CHAIRMAN HARKIN: On behalf of its nearly 80,000 individual members, the National Society of Professional Engineers would like to present its statement on the issue of potholes and bridge corrosion.

One of the major causes of potholes and bridge deterioration is the use of overweight trucks. NSPE believes that effective steps should be taken to unite the efforts of vehicle and bridge engineers to plan future designs to insure more resilient structures. Also, Federal aid should be available to states for investment in weight scales.

We ask that this statement be made a part of the official hearing record. NSPE thanks the Subcommittee for the opportunity to express its views on this topic.

Sincerely,

MICHAEL M. SCHOOR,
Director of Legislative and Government Affairs.

Enclosure.

STATEMENT OF THE NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS ON POTHoles AND BRIDGE CORROSION

The National Society of Professional Engineers, a nonprofit organization which represents nearly 80,000 individual members who are engaged in every branch and aspect of the engineering profession, appreciates the opportunity to present its views on pothole problems and bridge corrosion.

Potholes are generally viewed as benign nuisances. They are good material for tongue-in-cheek segment set to music on local news shows. They made good "can you beat this" stories at cocktail parties. But potholes are a symptom and a cause of a serious safety problem—bridge corrosion.

Of 235,000 bridges on the Federal-Aid System which have been inventoried, 7,000 were found to be structurally deficient and almost 27,000 were found to be obsolete.

There are many obvious reasons for bridge deterioration. Heat, cold, rain, and frost slowly chip away at the surface cover, creating potholes. The use of salt, chains, and studded snow tires add to the surface deterioration. This is a slow process, occurring over years of the bridge's life.

A much more serious and immediate cause of potholes and bridge destruction is the use of overweight trucks. Many bridges built and designed years ago are unable to hold the weight of today's large truck traffic.

NSPE believes that there should be stronger enforcement of highway size and weight laws. The law states that no Federal-Aid interstate funds may be apportioned to a state which allows overweight and oversized vehicles to use the interstate system. Also, each state must certify annually with the Secretary of Transportation that it is enforcing state laws on all state Federal-Aid roads.

However, it is difficult and expensive for states to strictly enforce size and weight laws. Federal funds should be made available for the purchase or rental of weight scales and for twenty-four hour manpower enforcement.

It is inevitable that as technology increases so will the size and weight of trucks. However, weight limits can not be indiscriminately raised without consideration of the impacts such action will have on bridge deterioration.

One way to stop this destruction is by bringing together vehicle and bridge engineers to examine and plan future growth models. If a plan is worked out in advance, building engineers will be able to construct newer, more resilient bridges while strengthening older ones. They will also be able to inform truckers as to the bridges which will not be able to stand more weight thus decreasing the possibility of serious accidents.

NSPE supports this conciliatory effort for while there is no way this country can run without trucks, we cannot be expected to endanger public safety for the trucking industry. Until this happens, pothole formation and bridge deterioration will continue on the rise.



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