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ENGINEERING EXPERIMENT STATION
OREGON STATE UNIVERSITY
CORVALLIS, OREGON

Proceedings of the 1966 Northwest Roads and Street Conference

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Proceedings of the
1966 NORTHWEST ROADS AND STREET CONFERENCE

Corvallis, Oregon
February 9-11, 1966

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Engineering Experiment Station
Oregon State University
Corvallis, Oregon

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TABLE OF CONTENTS

PROGRAM

Wednesday - February 9

WELCOME

Presiding: VICTOR D. WOLFE

Welcome: DR. JAMES JENSEN

LESSONS FROM THE BIG FLOOD

Presiding: TOM EDWARDS

Cause and Intensity:
TOM EDWARDS

Emergency Repairs:
E. S. HUNTER
JOHN ANDERSON

Adequacy of Design:
ROY TOKERUD
HERB SCHELL
D. J. BARBEE

LUNCHEON

Presiding: FORREST COOPER

Transportation of the Future:
W. A. BUGGE

CONSTRUCTION AND MAINTENANCE SIGNING

Presiding: TOM EDWARDS

Contractor: BILL McNUTT

Motorist: NEWT WEIR

Traffic Engineer: REX STILL

State Police: CAPTAIN FARLEY MOGAN

Wednesday - February 9

WHAT'S NEW WITH THE NATIONAL ASSOCIATION OF COUNTY ENGINEERS

Presiding: B. LOYAL SMITH

Speakers: WILLIAM G. HARRINGTON
HOWARD BUSSARD

CONFERENCE BANQUET

Presiding: C. G. PRAHL

Speaker: JOHN BEALL

Thursday - February 10

COMPACTION OF ASPHALTIC CONCRETE

Presiding: CARL MINOR

Research: HOWARD SIEVERS

Field Application: WALTER KASTNER

Findings: PAUL RENSEL

TRAINING PROGRAMS FOR HIGHWAY ENGINEERS AND TECHNICIANS

Presiding: B. J. McCLARTY

Counties: JOE ANDREOTTI

States: BOB CHRISTENSEN

Bureau of Public Roads: B. J. McCLARTY

LUNCHEON

Presiding: VICTOR D. WOLFE

Thursday - February 10

LUNCHEON (Con'd)

Objectives of the Civil
Engineering Technology Curriculum
at Oregon State University:
G. W. HOLCOMB

URBAN STREET DESIGN AND IMPROVEMENT

Presiding: HUGH McKINLEY

Planning Urban Streets:
ROBERT BALDWIN

Standards for Sub-Divisions:
WALT WINTERS

Maximum Road Improvements
on Minimum R/W:
ELMER J. LELAND

THE HIGHWAY BEAUTIFICATION ACT OF 1965

Presiding: FRED KLABOE

Legal Interpretation:
LEONARD I. LINDAS

Application:
MARK ASTRUP

Administration:
HUGH B. HENRY

Friday - February 11

CAN THE ACCIDENT TOLL BE REDUCED

Presiding: J. AL HEAD

Design:
MARVIN LOTSPEICH

Enforcement:
MAJOR P. A. JOHNSON

Results of Traffic Safety Program:
J. AL HEAD

Friday - February 11

THE CONTRACTOR AND THE ENGINEER EVALUATE CONTRACT ADMINISTRATION

Presiding:	HERBERT HUMPHRES
Contractor:	
	CARL M. HALVORSON
Bureau of Public Roads:	
	B. M. FRENCH
State Highway Department:	
	FRED KLABOE

ADJOURN

WELCOME

Presiding: Victor D. Wolfe

WELCOME ADDRESS

by

Dr. James Jensen

WELCOME ADDRESS

Dr. James Jensen

There are many conferences held on this campus. Each conference is important, each conference is important to us, each conference is important to every person who attends.

I think there are many ways of looking at the general problem of the subject matter of your conference, and most any way one looks at it, the layman comes to a number of conclusions.

First of all, it is very complicated, this subject that deals with politics, deals with materials and contractors. Perhaps you do not always bear this in mind simply because there are other things that take your attention, but the significant thing to the man on the street is that of all of the operations and activities of mankind in his present society, nothing takes more lives than the activities of society on the highways and streets. So, if you have no other reason to regard your presence here and your profession and your occupation with great deliberateness and great purpose, certainly this should have sobering reflections.

I am aware that each of you could say, "That's fine--we build the roads and they're good roads, but you fellows that are educators don't teach them how to behave." I guess I would have to buy that, with a certain discount, but it seems to me that in this general area of the action of society, with all its new developments, with its increasing speed, with its change in modes of living, with its population which is becoming very top-heavy among the teenagers and young people, we do have something on our hands.

Certainly, the facilities, the roads, streets and highways, of which you men have primary concern, are by all odds one of the most important aspects of all of modern society's growing points and growing pains. I know you know these things. We know them, too. If I knew, or if any of you knew, a desirable move to make or an advantageous move to make, I am sure you and I would take them.

Oregon State University is extremely interested in the industry and the agriculture, in the forestry, the sociology, the politics, in almost every possible aspect of the life of this state and this nation. We aim to continue to be extremely interested and extremely involved in all these things which make up the tumultuous and boiling aspects of modern society.

You have an illustrious panel before you, and you have a most interesting program in your hands which will be put before you in the next two days. Let me say to you again, it has been a great pleasure for me to say "Welcome to the Oregon State University Campus." May your conference here be very meaningful to you, to us, to this state and to this area. May you be ever mindful of the obligations which you as professional gentlemen have and may you never hesitate to remind us, in the universities, of those aspects and those responsibilities which you feel we have and which you feel we may better bolster and more properly carry out.

PANEL DISCUSSION

LESSONS FROM THE BIG FLOOD

Presiding: Tom Edwards

INTRODUCTION

THE CAUSE AND INTENSITY OF THE 1964 CHRISTMAS FLOODS

by
Tom Edwards

During the latter part of December 1964, and again in the latter part of of January 1965, northern California, Oregon, southern Washington, western Nevada, and Idaho suffered a major flood disaster. Various agencies and water forecasters have estimated the frequency of this flood to be as low as 50 years and as high as 500 years.

There is no question that it was one of the big ones. The experts generally agree that it may have been surpassed by the 1894 flood in the Willamette Basin but at no other time.

In order to have a flood of this intensity, an exact set of circumstances must occur.

The pattern itself is not too much out of the ordinary, as most of our winter storms originate somewhere in the vicinity of the Gulf of Alaska and high-pressure areas off the West Coast create westerly winds which carry moist air over the mainland. The extraordinary thing in this case, however, is the length of time the condition existed. This general pattern held for about 10 days, December 15 to 25. The obvious result of the weather pattern just described would be heavy rainfall as Figure 1 shows. The eight-day total for the period December 17 to 25 was 8.14 inches, far exceeding the normal of 7.37 inches for the entire month of December.

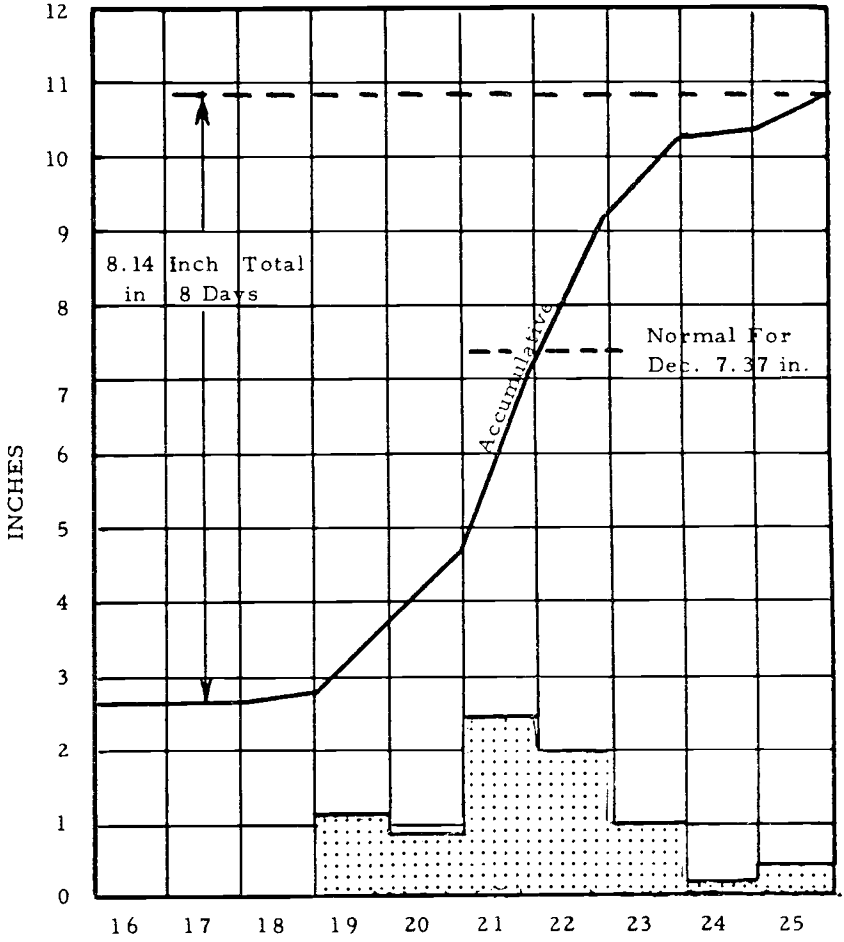
The extraordinarily heavy precipitation fell in the form of snow throughout the entire state during the period of December 15 to 20. Just as though heavy snow in the mountains and several inches in the Willamette Valley and the city of Portland did not cause enough trouble, Mother Nature decided to wield another decisive blow.

As Figure 2 indicates, the temperature at Salem made a rather rapid rise of 43 degrees in six days.

The rise in temperature at Salem was only indicative of what could be happening at higher elevations. Figure 3 shows that the freezing level over Salem rose from ground elevation to 10,000 feet in four days and

Figure 1

PRECIPITATION
Salem, Oregon



DAY OF MONTH
December, 1964

Figure 2

TEMPERATURE

Daily Average
Salem, Oregon

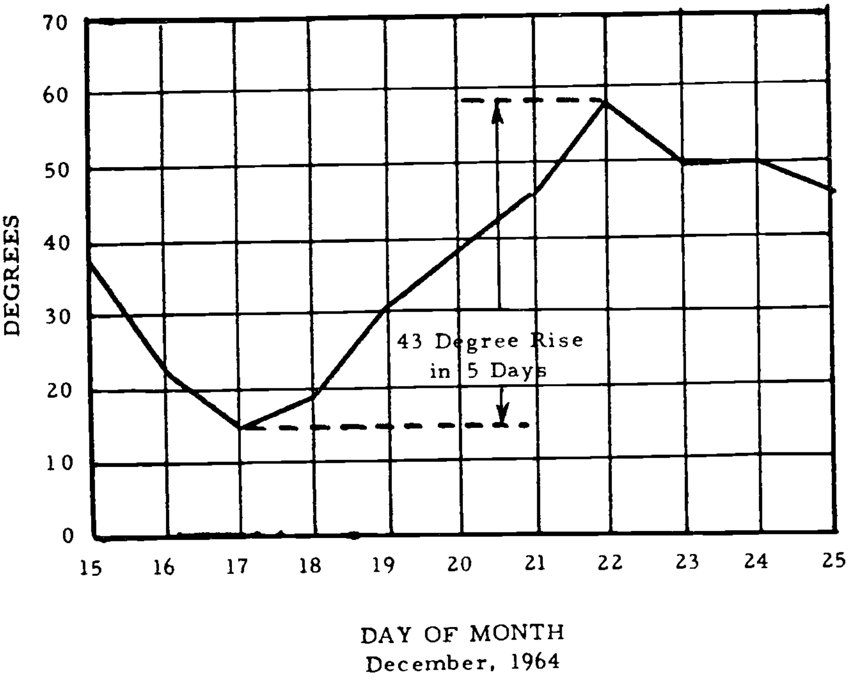
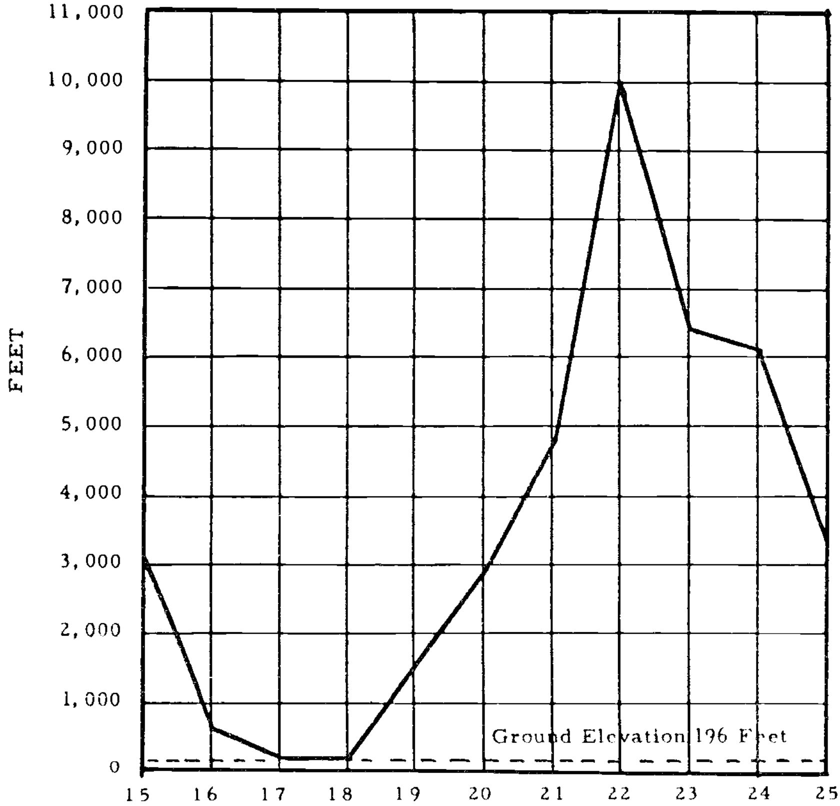


Figure 3

FREEZING ELEVATION
Salem, Oregon



DAY OF MONTH
December, 1964

remained above the 5,000-foot elevation for approximately four days. This, coupled with intermittent heavy rain and a warm Chinook wind, caused a rapid melt of the snow pack. The behavior of the snow pack during this period is plotted in Figure 4. This graph shows what happened to the snow pack in the Cascade Mountains at an elevation of approximately 4,000 feet during the warming trend. A loss of nearly 4 feet of snow occurred in a four-day period. At higher elevations such as Crater Lake, there was as much as 10 feet of snow on the level of which 7 feet went off in the same period.

The six major drainage basins which took the brunt of the runoff are shown on the map in Figure 5. In southwestern Oregon the Rogue River at Agness had a previous record high discharge of 138,000 cubic feet per second in December 1962. The runoff for December 1964 was 290,000 cubic feet per second. It has been reported that the water level at Agness rose about 100 feet during this runoff.

The Umpqua River had a previous record runoff in December 1955 of 218,000 cubic feet per second. In December of 1964 the runoff reached 263,000 cubic feet per second, far exceeding the previous record.

In December 1861 the Willamette River at Salem recorded a high of 500,000 cubic feet per second. The discharge during the December 1964 flood was 309,000 cubic feet per second. This discharge has been corrected by applying factors so that it illustrates what the discharge could have been without the flood control dams which exist on the Willamette and its tributaries. The major damage in the Willamette Basin was not caused by the Willamette River. Instead, it was caused by tributaries such as the Clackamas River, the North Santiam, and Salt Creek.

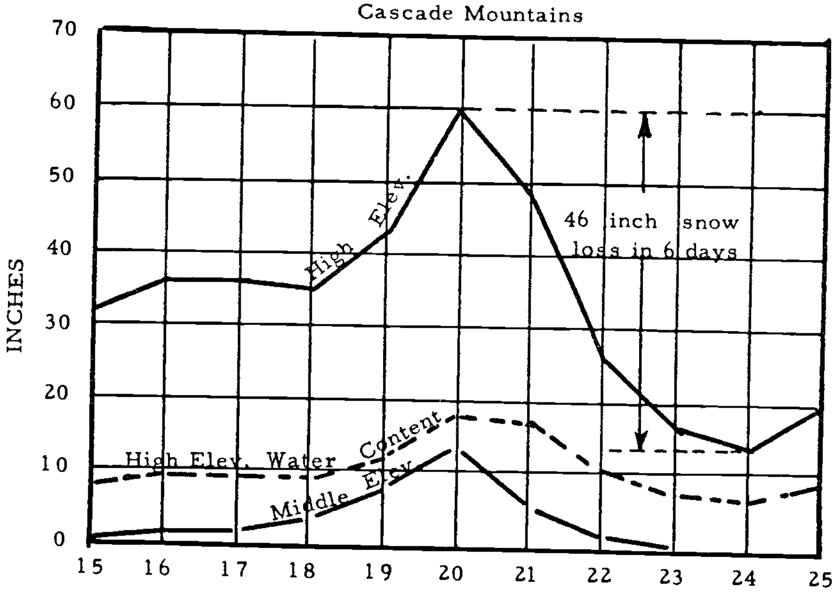
In Central Oregon the Deschutes River and its tributaries caused widespread damage. The previous record discharge for the Deschutes River at Biggs was 43,600 cubic feet per second in January of 1923. During December 1964 the discharge reached 73,900 cubic feet per second, nearly doubling the previous record.

The John Day River established a previous record discharge of 39,100 cubic feet per second in December 1894. In December 1964 the discharge was 42,300 cubic feet per second. This discharge was almost equaled in the latter part of January when the John Day again went on a rampage.

Figure 4

DEPTH OF SNOW

Average
Cascade Mountains



DAY OF MONTH
December, 1964

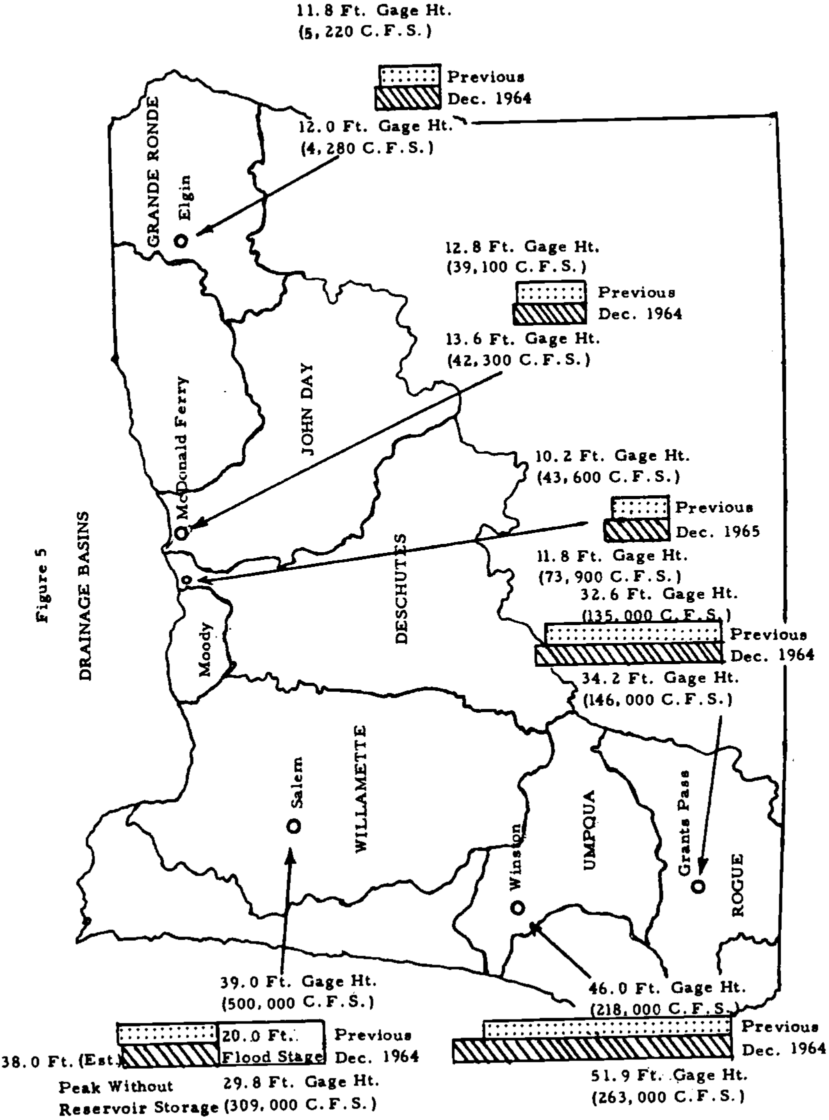


Figure 5

DRAINAGE BASINS

The northeastern part of Oregon is centered around the Grande Ronde River, which did not set a new record during this flood. The previous high at Elgin, in May 1948, was 5,690 cubic feet per second. In December 1964 the Grande Ronde River reached a peak discharge of 5,280 cubic feet per second. This drainage basin was also hard hit in the latter part of January, at which time the Grande Ronde approximated the December discharge.

This, then, is the weird set of circumstances which brought about the now famous Christmas flood of 1964.

EMERGENCY REPAIRS TO HIGHWAYS

by
E. S. Hunter

The subject of emergency repairs, I am sure, is not a new one to you. Generally speaking, those in attendance at this conference have as one of their primary responsibilities the maintenance of a city, county, or state road system. Since the subject is not a new one for you I will attempt to explain, not the repairs as such, but, instead, how the Highway Department is organized to handle such a widespread disaster as occurred in December 1964 and January 1965.

All of our agencies faced the same problems. They varied only by the difference in the area of responsibility in that the Highway Department is statewide.

The Highway Department has as its basis for emergencies a plan called the Emergency Operations Plan. This plan came into being following the October 1962 wind storm which, you will recall, caused extensive damage and many road closures. Immediately following the storm there was considerable comment in the news media regarding a lack of communication between various branches of the state government. The reference was, primarily, to the lack of advance warning for the northern part of the state. All public employees were generally taken to task for the lack of organized effort and an accurate method of disseminating information and issuing storm warnings.

Because of this, the Governor established an Emergency Command organization. The organization consists of the heads of all the major state agencies. These people are on a 24-hour call basis and subject to a standard operating procedure prepared by the State Civil Defense Director. I am sure it is obvious to all of you what a tremendous job of coordination and dissemination of information can be achieved when the actual heads of all operating agencies are in the same room and coordinated by the Governor, himself.

The Command Post in the basement of the Capitol Building is equipped with radio, teletype, and telephone, all of which are tied directly to the Forest Service, State Police, and Highway Department networks. All messages sent by either radio or teletype on any of these networks may be received in the Command Post message center. Highway information and road conditions were sent to the Command Post through regular departmental channels as soon as the information was checked for accuracy and severity of damage.

As I previously mentioned, the Highway Department formulated an Emergency Operations Plan which somewhat followed the standard operating procedure for the Governor's Command Post. This plan basically provided for an alert system, stand-by procedures, authority for prosecuting the work, reporting procedures, record keeping, and duty assignments for key personnel at top-level Salem administrative offices. Branch offices in the field are required to provide their own duty rosters and supplementary emergency plans suited to the facilities of their office.

The maintenance engineer's headquarters office in Salem operated on a 24-hour basis and coordinated the repair activities throughout the state. This office maintained situation maps which were virtually up-to-the-minute on all road conditions, road closures, and status of the repairs thereto. This information was assembled and disseminated by radio, telephone, and teletype to all interested parties. Hundreds of telephone calls were handled daily. The headquarters office found itself playing an important role in coordinating the repair efforts of the 138 section maintenance crews. With all the major routes closed, it was necessary to concentrate our efforts on the most important routes having the least damage. Still, none could be neglected. With all the damage information in front of the maintenance engineer, this analysis could be made and a concentration of contractor- and state-owned equipment placed in the most advantageous positions.

As you know, the storm hit at a particularly awkward time, during the Christmas holidays. On the night of December 22, all major trans-mountain highways were impassable. The Santiam Highway was opened again, then closed again for the following two days, until finally travel was re-established. After two weeks of concentrated effort, using all available men and equipment, five routes were back in service, with only two remaining closed. These were the North Santiam and Willamette highways. The Santiam was opened with four more weeks of concentrated effort and the Willamette in six.

The damage was most severe on the highways I have already mentioned; however, damage was statewide, and virtually every highway of the state system required emergency repairs.

Probably the primary reason we were able to operate as effectively as we did was that delegation of authority was at an all-time high. The usual red tape of government spending was eliminated during the height of the emergency. The Highway Department is subdivided into five geographic divisions, each headed by a division engineer. Each division is further subdivided into maintenance districts. These districts are each headed by a district maintenance superintendent, of which there are a total of sixteen.

Ordinarily, rental of equipment must be cleared with the Salem office, along with many other things. In the case of this disaster, all such red tape was thrown in the wastebasket. Division engineers and district maintenance superintendents were instructed to hire any and all equipment that was available and to put it to work. They were instructed to further delegate this authority to their maintenance foreman, some of whom they were unable to contact for several days at a time.

There are 138 foremen with permanently established crews. These men did a remarkable job in rounding up loggers, farmers, contractors, equipment dealers, and equipment operators and getting them to work on the project in the most expeditious manner and at the most effective location. They not only worked around the clock in organizing this activity, but within a few days after the flood began, started sending in the required reports which would be necessary to substantiate our future claims against the federal government's Emergency Relief Fund.

The enormity of this repair job can be expressed by several statistics. At one time the situation map in my office indicated more than 200 major closures requiring emergency repair work. This emergency work was being accomplished by 5,000 pieces of state-owned equipment, 892 pieces of major construction equipment, and 193 pieces of support equipment.

This imposing list of equipment was rented from 238 companies and individuals. Involved in the work were 24 major construction contractors, 54 smaller construction contractors, 20 equipment rental firms, 38 lumber and logging companies, and 102 private owners of equipment, not generally referred to as established companies.

As if the initial flood at Christmas was not enough, there followed in the latter part of January a flood of almost as great intensity. In fact, in some drainages the January flood was of greater intensity than the December flood.

The final tally shows that the December floods resulted in 320 separate closures on 125 of the state's 201 primary and secondary highways.

The January floods caused 149 closures on 56 of those same highways. Some of these closures consisted of several washouts and slides, and the total number will probably never be known.

All of the repair work is not complete, and all of the cost records have not been assembled. However, it is estimated that the repair to the state highway system will total $27.5 million. Of this amount, $7.5 million was expended during the actual emergency period. All of the remainder is what we commonly refer to as permanent repairs. Of the $27.5 million, the federal government, through its Emergency Relief program, will reimburse the state $23 million, leaving $4.5 million to come from state funds.

The county road systems throughout the state also suffered major damage. The Highway Department coordinated the programming of repairs to the county road systems with the Bureau of Public Roads. These repairs are estimated to total $6 million. Of the $6 million, $1.7 million will be reimbursed by Emergency Relief funds and the remainder will come from county road funds.

These figures which I have just quoted represent large sums of money. I have some slides that will illustrate the massive repair job that was necessary. These slides were made from black and white glossy prints taken by our Highway Department Photography Section. Altogether, they took about 1,000 pictures which covered most of the state highway system.

This first slide shows the North Santiam Highway at a point just easterly of Idanha. The damage illustrated here is somewhat typical of the damage sustained from Detroit Dam to about 5 miles above Marion Forks. The repairs are now all completed at a cost of $1.8 million.

During the actual emergency period, repairs to these roads consisted of the construction of the roadway wide enough to accommodate two-way traffic at a speed considered safe and commensurate with the surrounding highway considering the use of adequate warning devices. As most of you know, these roads were unsurfaced and generally quite rough following the actual flood.

The next slide shows the Willamette Highway just above the Upper Salt Creek Bridge. The photo actually covers about a half-mile section of the highway and serves to illustrate the nearly complete destruction which occurred for a distance of 18 miles. The road is now reconstructed at a cost of about $3.5 million.

The third photo shows the Fulton Canyon Secondary, which leaves Interstate 80N about three miles westerly of Biggs Junction. The road follows Fulton Canyon in a southeasterly direction for a distance of 10 miles to the town of Wasco. In the upper part of the picture is the Columbia River. Along its near bank is the partially completed Interstate freeway and the existing U.S. 30. As you can see, the junction point was completely obliterated. The damage to the highway in the lower part of the picture is typical of what occurred for about 2 1/2 miles. The repairs have now been completed at a cost of $323,000.

In summary, gentlemen, it is my opinion that two things are essential in handling an emergency situation such as this one. First, there must be a written, organized plan of attack to the overall problem. Secondly, but certainly not the least important, there must be complete delegation of authority.

(Editor's Note: Photographs referred to by the author are not included in this circular. His descriptions of them in the text serve to indicate the extent of damage which occurred.)

EMERGENCY FLOOD REPAIRS

by
John Anderson

(Editor's Note:

Mr. Anderson's presentation was a discussion in which numerous slides and photographs were used to illustrate emergency flood repair methods employed by the Marion County Highway Department. The reproduction of the illustrative material was not feasible and the discussion was dependent upon the illustrations. Therefore, the paper was not reproduced for these Proceedings.)

ADEQUACY OF BRIDGE DESIGN

by
Roy Tokerud

The question has been raised many times since the big flood in December 1964 as to whether we have learned any lessons. I think the question before us is not so much whether we learned any lessons--because certainly we must have--but rather, what, if anything, are we doing about it or going to do about it? Some people appear inclined to dismiss the flood by saying that we really made out very well, considering the magnitude of the flood. Others argue that if you do not lose a few bridges, you are overdesigning, or that it would cost too much to design for the real big floods--I wonder? It is true that the great majority of our structures came through the big flood in an excellent manner; however, the least we can do is take a look and see if we might not improve on some aspects of bridge design.

I will limit my discussion to the subject of drift forces and their effects on structures. The other big culprit, of course, is scour. Mr. Schell will follow with a discussion of this subject.

With a few exceptions, our most spectacular bridge losses were those caused by heavy drift accumulations against bridges. Figure 1 shows the remains of a fairly new three-span concrete structure. This structure was literally torn out of the ground and deposited upside down on the bank of the stream.

One of the biggest losses was that of a nearly complete structure over the Illinois River at its confluence with the Rogue River at the remote little town of Agness in southwest Oregon. Figure 2 shows the collapsed and broken bridge lying on its side across the mouth of the Illinois River.

Figure 3 shows the status of the bridge at the time the high water came. The falsework was in place and the bridge was 85 percent complete. The concrete in the box girder was poured except for two 70-foot long sections of deck slab, as shown in Figure 3. In addition to the unpoured sections of deck which of course formed the top flange of the box girder, the approach embankment at the right end of the structure was not in place. The support at this right end (Pier 6) consisted of a stub abutment resting on timber piles. With about 25 feet of these piles exposed above the ground line, the end pier (abutment) had very little ability to resist lateral forces. During the big flood, the water rose

Figure 1

Figure 2

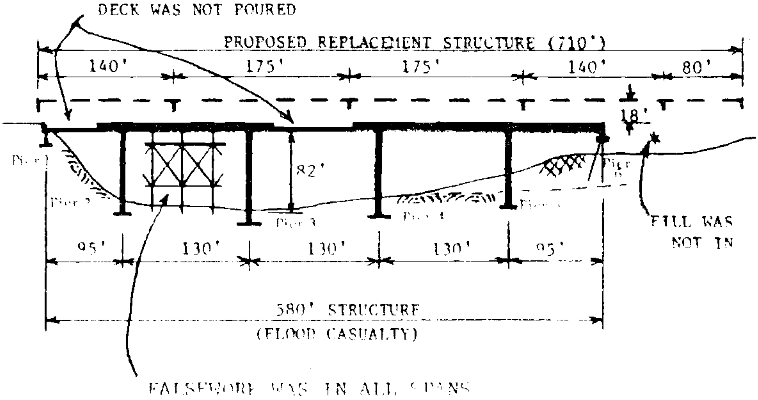
to , and possibly a little above, the deck of this structure. With the lack of lateral support at the right end, it then fell upon Pier 5 to resist lateral forces against all of the 95-foot end span and against half of the 130-foot adjacent span. It is my theory that Pier 5 was unable to resist these large lateral forces and that it, along with Pier 6, failed first. Progressive failure of other piers followed immediately.

Other theories are that the collapse was triggered by loss of falsework and subsequent failure of the partially completed superstructure. This seems doubtful, though, since the falsework went out at least one full day before the structure collapsed. In any event, the consensus is that this structure would have withstood the flood had it been completed and the embankment in place. A new crossing is now being designed for this same site. It will be some 18 feet higher and 130 feet longer, as indicated by the dash line in Figure 3.

Drift is a much more serious problem on many of our streams today than it was years ago. The accumulations against structures and behind dams in the 1964 flood were greater than anything we had seen in the past. It has been said that drift did not really cause too many of our losses, but rather that it was scour. While it is true in most cases that scour was the culprit that caused our structures to twist, settle, and break, it was accumulated drift that frequently caused, or at least contributed to, the serious scour.

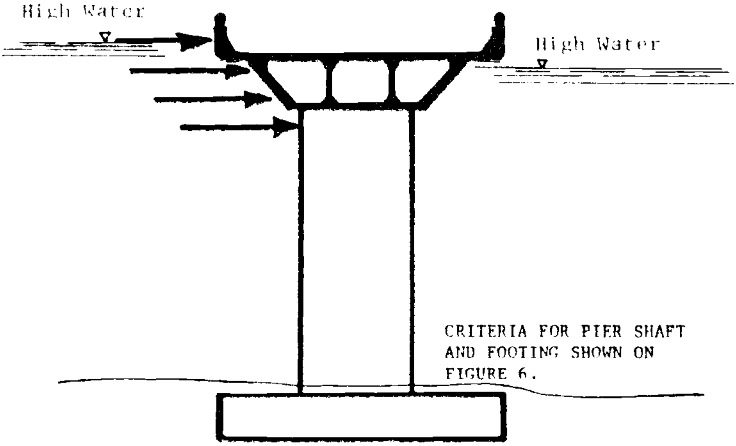
In some instances drift hung up on piers, thus increasing the turbulence to the point where serious scour occurred. In other cases, as drift blocked part of the channel, the velocity through the remaining opening increased and again we had scour, or the water overflowed the roadway and caused another washout, of which we had so many. There were instances where drift accumulated against the superstructure when the water rose to heights greater than it was supposed to. This led to some of our spectacular losses, as shown in Figures 1 and 2.

It is under these conditions that some engineers apparently think we should give up and succumb to the so-called "act of God." I maintain that the forces involved, although large, are not something we cannot design for. We know that many of our bridges were subjected to such forces and came through in fine style, utilizing only the normal factor of safety. We also know from evidence found after the flood that quite a few structures that came through the flood were, nevertheless, on the verge of collapse.



ILLINOIS RIVER BRIDGE

Figure 3



DESIGN CONDITION FOR EXTREME HIGH WATER

Figure 4

It follows, then, that by putting a little more muscle in our structures we can build them to withstand the forces of drift even though they are acting directly against the superstructure, as indicated in Figure 4. The sloping sides of the box girder are incidental and were drawn thus only to indicate a trend in present-day design which is being advocated to improve bridge aesthetics. There has been some speculation that the sloping sides might also contribute to the passage of drift below the superstructure in cases of extremely high water.

One of the problems that confronts designers is the lack of criteria on drift forces. The American Association of State Highway Officials says that we should design for drift when it may occur, but it gives no clue as to the magnitude of the force to use. They do give a stream flow formula which can be used providing we know the proportion of the accumulated drift. Some design offices have used this formula with an assumed depth of 5 feet spread over a span length or part of a span length, and applied this force at the designated high water elevation. The effect of this force, which may be on the order of 20 to 40 kips, is small. Actually, it would have about the same effect on the design of the structure as wind forces. I believe the fact that the assumed condition results in such a small force is exactly why designers are apt to forget drift forces altogether. This last flood demonstrated that we should be designing for much bigger forces.

It has been recommended that I propose to the American Association of State Highway Officials some specific criteria for designing for drift. I feel the problem varies so much depending on the section of country, and even from stream to stream, that it hardly can be adequately covered by such a general book as American Association of State Highway Officials. We have an example of this in the case of ice forces. For these, American Association of Highway Officials specifies a pressure of 400 psi, which represents the crushing strength of ice. This can result in a very large force, although it depends on exposed area which in turn depends on the thickness we assume for the ice blanket. However, it is not specified how or in what direction the force should be applied. Some designers have applied this force to the small end of the piers (in the direction of stream flow) only to find that the piers cracked or were otherwise damaged by forces acting perpendicular to the stream flow.

Although ice was not a problem in the recent big flood, I have mentioned it because the action of ice and drift can be quite similar. In fact, if bridge piers happen to be properly designed for ice forces, they no doubt will be amply strong to resist drift. As with ice, we know that drift forces can also act perpendicular to the direction of stream flow when we get a wedging and jamming of drift between piers. We very nearly lost a large Bureau of Land Management bridge over the Umpqua River from just such a force. In that case the top of a single-shaft rectangular pier with round ends was pushed 12 inches toward the center of the river. Had the pier moved a few more inches, it would have dropped one or both spans, and we might have had another progressive and total failure.

I recommend that each design office make some study, or further study if you prefer, of this growing problem of drift, in order to come up with a realistic force that may occur when the next big flood comes. In the absence of something better, we can use the stream flow formula from American Association of State Highway Officials of $P = KV^2$. Even so, we still must exercise our judgment in determining the area of drift against which we will apply this pressure. Another approach might be to work backwards from some of our failures and compute the force required to have caused these failures.

For those of you who wish to pursue the subject of drift forces further, I suggest you study a recent report, "The Effects of Ice Formations on Bridges," prepared by Montana State University in cooperation with the Montana Highway Department and the Bureau of Public Roads. It should get you to thinking along the proper lines. Better yet, I would like to see someone make a similar study of the drift problem. Bureau of Public Roads' funds are available for this type of study.

As for type or shape of piers, this is the area where bridge engineers have failed most often. By adopting appropriate shapes and proportions of piers, and by the addition of a little more concrete and reinforcing steel, along with some attention to details, we can come up with designs that will withstand the forces about which we are talking. In determining the type and shape of piers, we must remember to consider both drift and scour. What is good for one sometimes is bad for the other. This problem became much more complicated when highways started crossing streams on skews, rather than at right angles, as we used to insist.

If we learned nothing else from the big flood, it is that we should be cautious about using multiple-column bents on stream crossings. The extreme example of multiple-column construction is the pile bent. When we have used this type of construction, we have assumed that the stream would not carry drift; however, we found in this flood that many did carry drift, and pilings were broken off in several instances. The two-, three-, and four-column bents are very vulnerable to damage from the wedging and prying action of drift. We had examples of this in the big flood, where individual columns were damaged and, in a few cases, completely broken off. One structure in southern Oregon which had two-column bents lost one column out of two different bents, but fortunately it did not collapse. Repairs, including the installation of web walls, are now under way; and, needless to say, they are expensive.

I have been gratified to note that bridge designs coming out since the big flood rarely include multiple-column bents for stream crossings. A few designers, however, seem to like this type and even insist on putting a column beneath each beam. If so, they had better consider including some web wall between columns. If the bent is skewed with the direction of flow, then the web wall should be omitted and the number of columns should preferably be limited to two, and these should be round rather than square or rectangular. The multiple-column bent has generally given way to the solid, or wall-type, pier. Providing these are not too thin, they are substantial and can be very nice looking. This type pier, however, must be aligned with the direction of stream flow.

Another substantial type pier, an old-timer still in use today, is the dumbbell pier (two shafts and web wall). This type also should be used only when it can be aligned with the stream flow. In this regard we must be aware of those crossings where the direction of flow changes when we get extremely high water. We had a costly example of this many years ago when a dumbbell-type pier on the North Umpqua River was broken off, as shown in Figure 5. The bridge was under construction at the time, and the center truss span was not yet in place. The piers were in fair alignment with the low-water flow, but at high water, the river straightened out and hit the piers nearly broadside. A lesson was learned in that case. The replacement pier was a single circular shaft.

The single round pier has become very popular, and these have often worked very well, particularly on skew crossings. In Figure 1 we saw an exception, but in that case the piers were not designed to resist large overturning forces. One disadvantage of circular piers that prevents their use in many instances is that they are stiff in all directions, with the result that temperature stresses may become excessive. This, of course, depends on size, ratio of span length to height, and whether the piers are attached rigidly to the superstructure.

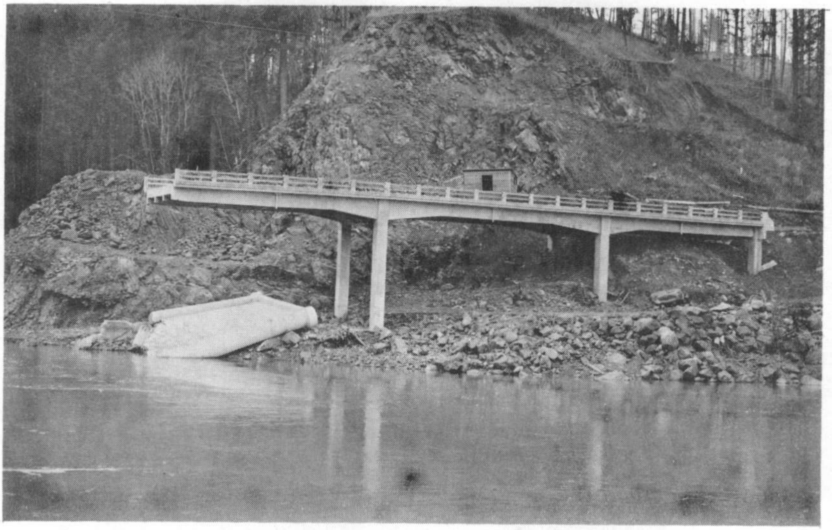


Figure 5

One of the most practical piers today is the single-shaft rectangular shape with either round or square ends. These piers are sometimes referred to as "T" type piers. When these are proportioned properly, they work very well for many of our stream crossings. They can be designed to be sturdy, economical, and nice looking. They have the advantage that they can be thickened, as appropriate, to resist the forces acting perpendicular to the stream flow at a lesser cost than the solid full-width type. This thickening, however, should not be overdone, since their limberness about the transverse axis is one of their advantages over the single circular shaft when we are considering temperature stresses. Obviously we must avoid such construction if we want our structures to resist large overturning forces.

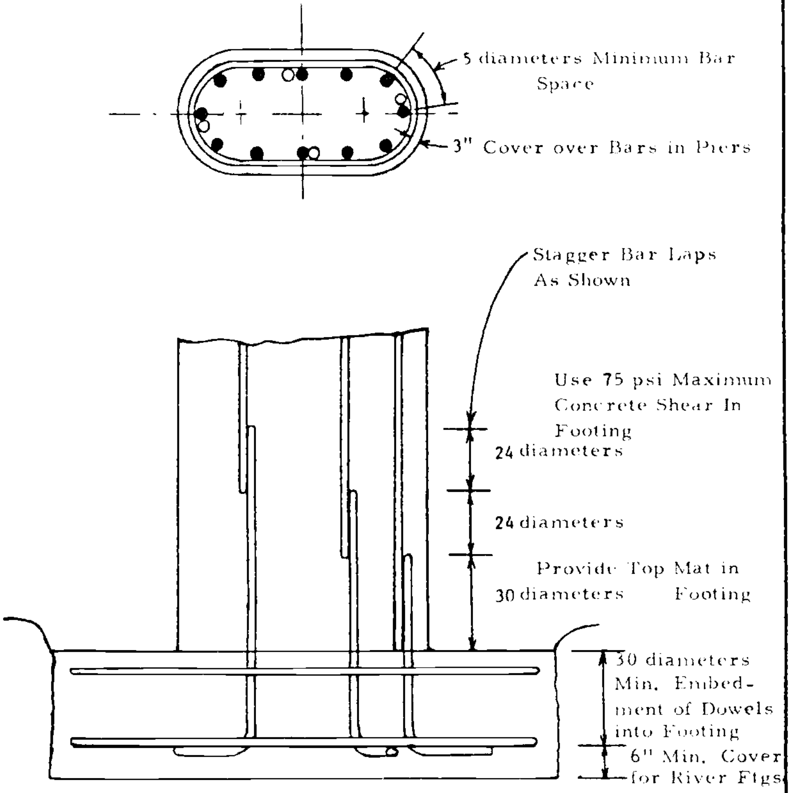
There has been some tendency over the years to come up with pier designs that are less massive and, unfortunately, also less able to resist large forces from extreme floods. Economical designers have taken advantage of increased working stresses to come up with quite thin sections, including footings. For example, the allowable concrete flexure stresses have increased from 1,000 psi or less, up to 1,320 psi or more. Also, and possibly more significant at least with regard to footing thickness, the allowable bond stress on reinforcing bars has more than doubled in the last 20 years.

Until a few years ago, American Association of State Highway Officials included a requirement that minimum footing thickness at edges should be 2 feet. Although it seems incredible to me, I have seen footings in streams that were less than 2 feet thick, not only at the edge, but throughout. American Association of State Highway Officials used to include another safeguard against the too-thin footing by specifying that punching shear be limited to 160 psi. This was deleted for some reason. I personally feel that these two deletions were a step in the wrong direction.

In order to improve the strength of our bridges, we should take precautions to eliminate points of known relative weakness. To accomplish this, it is recommended that we adopt certain criteria as listed in Figure 6. These should be used in conjunction with an appropriate and realistic drift force against the structure. Essentially these will result in a more substantial base for our bridges, and I think this is as it should be. I subscribe to the theory that if we are to build something "hell-for-stout," it should be the underwater or underground portion of a bridge. This is the part we cannot readily inspect and also the part where we too often find deficiencies when the big floods come along.

From observation of damaged bridges, we know that a relative point of weakness occurs whenever we lap reinforcing bars. This is apparently not due to lack of bond strength of individual bars, but rather to the formation of a weakened cleavage plane because of insufficient concrete between adjacent bars. We can do four things to improve this specific deficiency. First, increase the spacing of vertical bars from the normal 2 1/2 or 3 diameters to 5 diameters. Second, provide minimum cover over column bars of 3 inches which, by the way, is specified in American Association of State Highway Officials but is seldom done. Third, use longer bar laps; and fourth, stagger these so no more than one-third of the vertical bars are lapped at any one elevation.

Thin footings can be another relative point of weakness. Here it is recommended that we use a maximum concrete shear of 75 psi. (This is merely a clarification of American Association of State Highway Officials.) Also, it is recommended that we provide a thickness that will permit vertical embedment of the dowels into the footing a minimum of 30 diameters. In addition, the dowels should be hooked below the bottom mat of steel and the hooks should be turned outward. Figure 7 is a close-up view of a column shaft that pulled out of a rather thin footing.



POUR FOOTING FULL DEPTH AGAINST UNDISTURBED MATERIAL WHEN POSSIBLE

HOOKS ON DOWELS BELOW FOOTING MAT AND SPLAYED OUTWARD

CRITERIA FOR SINGLE-SHAFT PIERS

Figure 6

Figure 7

For river footings which are frequently poured under adverse conditions, it is desirable that we raise the bottom mat of steel to provide 6 inches clearance between the mat and the bottom of the footing. Bridge engineers were embarrassed a few times when footings overturned in the big flood and it was found that the bottom mat of steel was not even attached to the footing. This can happen as a result of running water or deposited mud in the bottom of the excavation. Therefore, designers should make some allowance for this possibility. To avoid overturning of the footing itself, we should when possible pour the footing against undisturbed rock. If the footing is poured on top of a seal, the footing should be tied to the seal. When the pier rests on piling, some provisions should be made for mechanical attachment of at least some of the pile tops to the concrete in the footing.

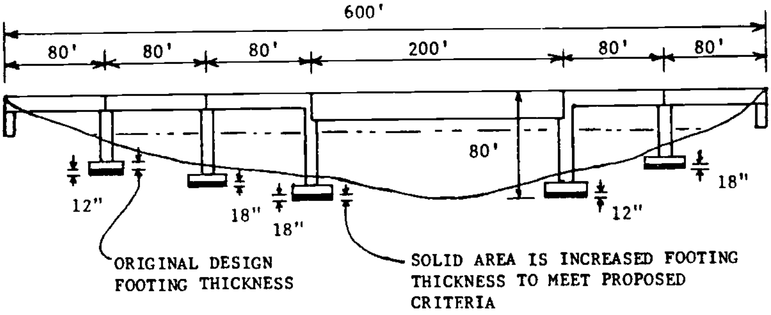
The criteria listed in Figure 6 have been developed in cooperation with the Bridge Department of the Oregon State Highway Department. Some of the items listed have been standard practice with them for several years. All of the listed criteria are being adopted in their current design.

Other things which we must keep in mind when designing for the extreme high water include buoyancy (particularly true in case of submerged box girders) and the attachment of the superstructure to the piers. This may involve special anchor bolts, and these can be high-strength steel in order to avoid too large bolts. Also, remember that end bents become as vulnerable as the others when the fill is not in place. When we design piers that possibly will have to stand through the winter without benefit of the superstructure deadload being in place, we should check their stability for this condition. I also would like to suggest that bridge engineers get in the habit of more frequently calling on the hydraulic engineers to review the design of our stream crossings.

To get some idea of what we may be talking about costwise if we apply these criteria to some of our designs, I selected a bridge where the designer was particularly economy-minded and had designed the substructure to the limit. This is shown in Figure 8. The principal change, and the only one that really had any significant effect on cost, was increased footing thickness and deeper excavation to get full depth embedment of the footing into rock. The increased cost in this case was less than 0.75 percent. In other cases, where the designer was not so economy-minded, increases would be less or negligible. Of course, if we must raise the grade line with an accompanying lengthening of structure, the cost increases considerably.

In some cases, rather than raising the grade line to clear the highest flood of record or a super flood, we will be way ahead economically to set the grade line to clear the 50-year flood and then design our structure to withstand the real big ones. In any event, if we average out the cost over many structures and consider the increase on a percentage basis, we will find it is very small. We might, for example, compare this increase with the amount currently being considered for improved aesthetics. Again, it would seem quite small. It is not meant to imply by this that we should not be spending some additional money to obtain better-looking structures.

Any discussion of bridge damage in Oregon would certainly be incomplete without some mention of the John Day River Bridge. One of the main piers was undermined by scour and two spans collapsed into the river. The footings of the pier which failed were raised some 13 feet during construction due to difficulties encountered. The engineering judgment that led to this decision has been widely discussed, as you know if you read the newspapers. Hindsight now tells us that it was a grievous error.



AVERAGE INCREASE IN FOOTING THICKNESS	50%
COST OF STRUCTURE AS INITIALLY DESIGNED	$ 500,000
INCREASED COST FOR COMPLIANCE WITH PROPOSED CRITERIA . .	$ 3,800
PERCENTAGE INCREASE IN COST	0.75%

THIS INCREASE WAS DUE PRIMARILY TO THICKENING OF FOOTINGS AND THE LOWERING OF THE FOOTINGS AN EQUAL AMOUNT TO OBTAIN FULL FOOTING EMBEDMENT INTO SOLID ROCK.

EXAMPLE OF INCREASED COST DUE TO APPLICATION OF CRITERIA GIVEN IN FIGURE 6.

Figure 8

SCOUR AND EROSION OF STRUCTURES

by
H. A. Schell

Scour and erosion is a problem that occurs in almost all streams that flood. Generally you cannot always economically eliminate it; however, it can be controlled at an equilibrium point, whereby a continual deposit is equal to the amount being removed from the stream channel. Keep this in mind--the deeper the flood flow, the greater the potential scour depth and the ability of the stream to carry sediment. To give an example of the sediment being carried by streams in the December 1964 flood, the sediment carried by the John Day River at McDonald Ferry was approximately 100,000 ppm. For the quantity of flow at that time, this equals a daily movement of 6,960,000 tons.

The Santiam River near Jefferson was carrying 1,040 ppm or 223,000 tons per day. The Willamette River in the Portland area had a sediment of 1,960 ppm or a movement of 1,690,000 tons per day. This movement of sediment can be critical if the material is removed from localized areas.

In the construction of structures across waterways, man has the prerogative of keeping scour around the structure at a minimum or contributing appreciably to the scour problem by shortening or misalignment of structures. I hope to outline in this presentation some of the more obvious problems in scour and erosion: the design and location of facilities to reduce the amount of scour, the problem of detecting scour, riprap protection, pier geometry, built-in design protection, and external protection. Please keep in mind that the presentation is based on a flood condition equivalent to the 200-year recurrence interval. Most structures use a 50-year design flood, and it is very seldom that we ever estimate the magnitude of the 200-year flood. In some cases, however, design for a partial failure or overtopping might be economically justifiable.

What can happen when a bridge is improperly aligned with the stream flow? Consider the Carter Bridge (240-foot center span) over the Clackamas River. At the maximum flood stage there is deposit downstream from the structure. The left approach to the bridge was initially protected by a rock dike; however, it is obvious that this was ineffective in maintaining the river within the stream channel at flood stage. The correction of this facility will be accomplished by rolling the truss structure back over the waterway onto new piers and constructing new approach spans and approach fills in the gravel bar of the river.

A small-scaled sketch of the structure and its relation to the valley and expected stream channel should be indicated on the plans for a considerable distance upstream and downstream (say 1,000 feet) of the bridge site. This will give the resident engineer some idea of the alignment design assumption, and he should verify the same when staking the structure.

The failure of approaches to structures in maximum floods such as occurred in December is not always bad, as indicated by the failure of the roadway in the Sandy River area around Troutdale. The failure of this fill not only protected the bridge but also some private homes and property upstream from the structure. For major floods, this type of failure might be designed into the fill; however, consideration must be given to the importance of the road. (Is it the only route into an area? Is the traffic heavy?)

Consider the installation in the Coal Creek area in Southern Oregon. In this area three structures have been toppled over by drift in the past few years (last structure was built in 1958). The proposed installation will allow the water during the high flood stage to flow over the roadway. The downstream side is grouted riprap while the upstream side has riprap in place with several 8-inch weep holes to allow seepage or entrapped water in the roadway fill to flow out. There are two pipes in the fill which will contain the maximum flow expected in a 25-year interval. When this flow is exceeded, it is expected that the water will go over the road with little or no damage to the highway fill. The pipes are purposely offset from the stream channel to reduce a difficult drift problem.

How do you detect scour? What does it look like? There apparently was little scour on the Sandy River Railroad Bridge; however, there was a difference in elevation from the upstream and downstream sides of the pier. This would indicate a pier that should be carefully observed after the flood stage has receded.

During high water, the Bear Creek Bridge near Medford represents a condition that could be critical--the debris is held against the pier. This requires inspection after the floodwaters have receded. In many instances of the 1964 flood, the lodging of debris against a structure contributed appreciably to scour.

Inspection of structures can be made in many ways. One of the more sophisticated ways in deep-river channels was performed by Lane County engineers on the pier of the Armitage Bridge over the McKenzie River. It was determined that there probably was some scour under this pier, and initially a skin diver was sent down to confirm this. He found that sack riprap which had been placed previously had been completely washed away. In order to get a more complete idea of the extent of the scour, a video-scan, waterproof TV camera was utilized. Sheet piling was driven around the pier and a diver submerged to the stream bottom and held the camera in the proper position. The picture on the 17-inch screen showed some reinforcement was exposed, and a corrective approach was initiated to backfill the undermined footing with concrete and to riprap the scour hole.

In major stream crossings it is relatively difficult to determine scour. However, Pier 2 of the Marquam Bridge at maximum flood stage showed some disturbance that required investigation. The downstream end showed obvious turbulence, and with the 75-foot depth of the river at this point, this indicated significantly that a problem was probably occurring at the base of the pier.

Let us review a pier and see what actually happens when flow strikes. The water is deflected and erodes the upstream side of the pier. Eddy currents occur on the back side of the pier. The scour develops as the flood stage increases, and as the flood recedes the scour hole fills again. Estimating the depth of scour after a flood is very difficult. On inspection, Pier 2 at the Marquam Bridge indicated considerable scour at the upstream side, and yet very little disturbance was observed in this area. In order to correct this situation, riprap was carefully placed around the pier within the scour hole, so that additional turbulence was not incited. This is a very important feature when riprapping piers in streams. Too much riprap might create a scour problem far in excess of the one for which the bridge was originally designed. Also, it is just as important to place the footings well below the streambed. This will assure the least amount of stream turbulence, which induces scour by the high-velocity eddies.

A sonic method for detecting scour at maximum flood stage is being developed. By sending sound waves through the water, an accurate picture will be given that can greatly increase our information about scour. This instrument is not workable to date.

Riprap is still one of the most predominant methods of protecting against scour and erosion. In the use of riprap, the material should be well-graded from the largest to the smallest size, and 65 percent of the material should be of significant weight to withstand movement under the terrific current it will encounter. In the Handbook of Heavy Construction (4) there are curves which indicate the minimum weight of stone that should be utilized for the various velocities of stream currents. These curves are useful guides in determining the minimum size of riprap. Also, in the Bank and Shore Protection Handbook (6), published by the California Highway Department, a method is indicated for determining the riprap size. But there is no substitute for observation during the extreme high-water flow.

The Bybee Bridge over the Rogue River during high water, showed failure of the approach slabs due to scour. The correction of this scoured pier consisted of a basket riprap installation, utilizing the wire mesh and wire rope to contain the small riprap available from the local area. The advantage of this installation is that it is expected to conform to any future scour easily and still continue protecting the pier.

A small blanket material is placed prior to installation of the basket riprap to prevent excessive high-velocity eddies from scouring underneath the riprap. On any footing when grade is reached, it is certainly desirable, where possible, to probe by rod below to determine if there is an obvious change in foundation material that might be erosive or insufficient to support the load. The high-velocity eddies combine, and the uplift pressures they create are almost unbelievable. To cite an example, an upward velocity of 12 feet per second, not uncommon in many river piers, would require 38 inches of concrete to withstand the pressure difference.

Some scour problems are very obvious, for example, the one on the Molalla River Bridge. On this river the maximum flood of record was 25,000 cubic feet per second. This was an estimated 20-year flood. However, the December 1964 flood was 45,500 cubic feet per second and was considered to be a 200-year recurrence period. The scoured pier was placed in approximately 1913 and has withstood the various flood conditions throughout the years until this time. It is felt that one of the important features that saved this structure was the heavy anchor bolts placed in the abutment. No scour was obvious in the abutment.

Pier geometry in research studies by Laursen and Toch (1) indicated that a scour depth of a rectangular shaft is increased 15 percent over that for a cylinder of the same breadth. There is also a considerable advantage of round piers in passing drift. When the exact direction of current is not known in flood stage, round piers are desirable.

The most pronounced effect of scour in the research studies was shown by the use of a web. A pier with a full-depth web between columns gave scour depths of 2 to 2 1/2 times the separate column scour for angles of 30 degrees to 45 degrees with the stream flow. If there is a question in regard to the direction of flow at flood stage, the use of piers without solid webs should be considered.

The study indicated that the use of a partial web (one-half of the depth of flow) gave scour depths ranging between those for full piers and those for no-web piers. Of particular significance, however, is the use of pile piers. This type of pier gave excellent results, even when the angle of stream attack was 45 degrees and the pier cap depth occupied 33 percent of the stream depth at maximum flow.

Next we will consider a condition of scour at structures that are similar in span arrangement. The first one is located on the East Fork of the Hood River (48-60-48). The river washed out the approach, and the structure failed at about the middle of the end span. The second structure is the Reload Bridge (50-76-50) across the North Santiam River on Cooper's Ridge Road. Again, the river washed out the approach footings and columns; however, the structure remained in place.

Here are two structures of similar span arrangements--one failed when the approach washed out and the other did not. The reason for this situation can be attributed to extra steel designed and placed in the top portion of the girders over approximately one-third of the length from either side of the river pier. This steel was designed into the beam for protection of partially poured girders in the event falsework washed out during construction. The extra cost on the Reload Bridge was approximately $150. As you can see, with a small increase in reinforcing steel, a considerable saving was experienced in the overall correction of the flood damage.

Mill Creek Bridge is on the Camp Creek Road east of Reedsport. The foundation of this structure was placed in hard sandstone. However, due to excessive drift and extreme velocities, the one pier was undermined, causing it to drop 3 feet and hence causing damage. This points out the importance of placing footings on good solid rock. They should be embedded well into the rock, and in order to ensure maximum resistance to scour and uplift, they should be poured in the rough.

The pier correction for the Brown Bridge out of Roseburg on the Umpqua River is a footing placed in the rough, with filler concrete poured around the entire footing flush with solid rock. This is recommended on any bridge subject to high stream velocities and heavy overturning drift forces. Filler concrete is relatively inexpensive and should not cost over $30 per cubic yard. It is easy to place and assures the ultimate in resistance.

Prediction of scour is a difficult design problem. There are some workable research articles which give curves whereby the depth and width of scour can be predicted for sand (1), (2). With these references, an estimate can be made as to the extent of scour and a solution such as riprap provided for in the contract.

Some other questionable methods that might be utilized to control scour are the use of fascines, a weighted bundle of saplings. These were utilized in controlling the scour in the Astoria Bridge. The bundles are placed slightly upstream from the footings, in the expectation that they will reduce the flow in and around the footings and induce sediment to fall and fill up the scour area. Their placement was measured by cable and their filling effect was measured to determine by trial and error the proper location for optimum placement. The fascines are about 20 feet long, 2 feet in diameter, and are weighted with about 30 sandbags.

Scour around abutments is a problem that still is receiving much study. The maximum scour occurs at the corners of the upstream edge, so any sharp corners should be eliminated. In order to combat this corner scour problem, the abutment should be placed below the scour area or the current direction aligned with the upstream side of the abutment. No backwater eddies should be allowed near the abutment. This can be accomplished by plantings such as multiflora rose and willows which are normal to the stream flow in the disturbing area, or by the construction of spur dikes.

Use of the spur dike aligns the stream flow prior to the structure. Scour occurs at the upstream point where the side water changes direction abruptly. Results have indicated (9) that an elliptical dike with a ratio of 2 1/2 : 1 gives the least amount of scour. Bridges with a minimum opening require longer dikes than those with more waterway opening.

The spur dike reduces the mean velocity and decreases the turbulence. The advantage of the dike is that its erosion would not be critical to the roadway operation and could be corrected after the water receded.

In any major crossing, a hydraulic engineer should certainly review the location and design and additional features such as scour and spur dikes.

Let us review briefly the items covered in protecting structures from scour.

1. Structure abutment and pier location should be aligned with valley direction where stream flow is not protected by revetments. Consideration should be given in the design to overtopping or failing fills and possibly to overtopping structures in major floods.

2. Scour detection can be accomplished during high water by skin divers and TV cameras. Consideration should be given to the stream depth when observing the structure in high water. Take pictures for future study.

3. Round columns are somewhat better in resisting scour than rectangular columns. When using solid piers, much care should be taken to align the pier with the flood flow. Pile footings should be used when it is impractical or difficult to place the footing below the scour depth. Consideration should be given to cutoff walls above the streambed when drift is not a problem.

4. A minimum increase in reinforcing steel when designing concrete girders can be made at little or no increase in total cost.

5. Stream flow should be aligned prior to the structure crossing. This can be accomplished effectively by spur dikes.

References

1. Laursen, E.M., and A. Toch. Scour Around Bridge Piers and Abutments, Iowa Highway Research Board, Bulletin No. 4, May 1956.

2. Laursen, E.M. Scour Around Bridge Piers and Abutments, Iowa Highway Research Board, Bulletin No. 8, August 1958.

3. Rantz, S. E., and A. M. Moore. Floods of December 1964 in the Far Western States, Open File Report, U.S. Geological Survey, Water Resources Division, Menlo Park, California, March 1965.

4. Handbook of Heavy Construction, 1st edition, McGraw-Hill Book Company, Inc., New York.

5. Liu, H.K., and M.M. Skinner. Laboratory Observations of Scour at Bridge Abutments, Highway Research Board, Bulletin No. 242, Publication 728.

6. Bank and Shore Protection in California Practice, State of California, Department of Public Works, Division of Highways.

7. McCullough, C.B. Design of Waterway Areas for Bridges and Culverts, Oregon State Highway Commission, Technical Bulletin No. 4.

8. Laursen, E. M. Scour Around Bridges, Highway Research Board, Research Report No. 13-B, 1951.

9. Karaki, Susumu. Laboratory Study of Spur Dikes for Highway Bridge Protection, Highway Research Board, Bulletin No. 286, 1960.

ADEQUACY OF DESIGN

by
D. J. Barbee

The storm in December 1964 produced an all-time record discharge for many streams and set a record in covering such a wide area. Damage was widespread, occurring on nearly every highway in the state. I would like to discuss the discharge at points on three typical streams.

The first is the Santiam River at Jefferson. When the recorded data was plotted, the 50-year recurrence interval of the discharge was determined at 170,000 cubic feet per second, while a 100-year recurrence interval discharge was 192,000 cubic feet per second--13 percent greater. The 1964 discharge reached a maximum of 197,000 cubic feet per second, or 16 percent above the discharge at the 50-year recurrence interval. On this scale, the recurrence interval of the 1964 flood was 120 years.

Since the observed discharge had been reduced by the control of the Detroit Reservoir, the discharges of the streams above this point were unprecedented.

The second stream to be considered is the Clackamas River. Discharge showed 66,000 cubic feet per second at the gaging station that is operated 17 miles above Estacada. The previous highest record--34,800 cubic feet per second--was observed on March 31, 1931. Records have been kept at this station since 1910. When the reported data for this stream was plotted, the 50-year discharge was found to be 48,000 cubic feet per second. The December 1964 discharge was 40 percent greater than the 50-year discharge, and on the same scale the recurrence interval was 230 years.

The violence of the flood was greatest in the upper part of the Santiam and Clackamas drainage areas. The opposite seemed to be true on the John Day River, which is the third stream to be considered.

The lowest gaging station on the John Day River is McDonald Ferry, 19 miles above the Columbia River. Local observations indicate that streams entering below this point discharged tremendous flows on December 22, and it is considered likely that the maximum discharge at the mouth of the river was on December 22. The maximum discharge recorded at McDonald Ferry on December 24 was 42,300 cubic feet per second; the previous record, set in 1894, was 39,100 cubic feet per second. The 50-year recurrence interval discharge was found to be 39,000 cubic feet per second. The December 1964 discharge on this same scale has an interval of 165 years.

The present design policy is the result of the evolution in standards for determining the capacity of structures and the probable spring discharges. The first efforts were makeshift and primitive. As time went on, information was assembled which indicated the discharge of small drainage areas. Highways were designed on the basis of this information in combination with observations of the operations of other structures on the same stream. In recent years small structures have generally been designed to accommodate a discharge of a recurrence interval of 50 years. However, this practice involves risk, since the odds are one in three that the 50-year design flood will be equaled or exceeded in a 20-year period.

The designer of facilities for handling drainage is subject to greater vicissitudes than designers in many other fields. Funds are always limited. The highway must be designed in such a manner that the course of natural drainage is not disturbed, and any channel changes must not interfere with the spawning of fish or of the passage of fish to and from the spawning ground. The natural beauty of the stream must be preserved and, if possible, enhanced. The highway must primarily serve a route for the desire of the traveling public, and the selection of a location free of flood hazards may not always fall within the established control.

Many unforeseen factors operate to alter the problem: A logging operation upstream may fill the flooding stream with floating debris. Erosion may open up a source of gravel, and at high water this may be placed within a structure or carried through with major scour damage. The worst hazard is the major channel change. This may be caused by a natural stream meandering or cutting across. It sometimes results in the pirating of one drainage area by another. More commonly it is caused by the act of man--such as leveling land for irrigation or construction of irrigation ditches and emergency spillways. Many of these events occur at some distance from the highway and would be difficult to evaluate even with complete information.

The highway system as we find it today was constructed at various times, ranging from about 1920 to the present. The provisions for drainage were made in accordance with the practices current at the time of construction. Nearly all construction has been tempered by limitation of funds. The system reflects the design to accommodate high water, if experienced frequently, and some provision for unusual conditions. The 1964 flood subjected this highway system to extreme variations in the normal discharge--it was a discharge beyond the wildest imagination.

A large number of failures was due to the inability of the structures to handle the discharge. Usually this was complicated by obstructions. A few examples will illustrate this problem.

A thick box culvert was constructed in 1951 east of Dodson on the Columbia River Highway. An alluvial fan formed below the outlet of the culvert. It appears that this culvert began carrying both water and material. The material built up at the outlet end of the culvert, holding the water within the culvert. The culvert filled with rock and water and overflowed on the highway, depositing material on the highway surface.

What design would handle this problem? The stream must either be prevented from carrying the material, or the material must be deposited above the highway or carried through the highway structure. In this case there was an obstruction at the head of the valley just above the frontage road. If this were removed, storage space could be provided for stream-carried material in the future. This material could then be removed at the convenience of the maintenance crews. We must be careful in solving the problem in this manner because of the scenic requirements of preserving natural vegetation.

Another example is a box culvert on the North Santiam Highway about six miles east of Idanha. The problem here is also complicated by deposition of material. A larger opening alone would not solve the problem. Provision for passage of material or storage above the highway would be necessary.

At mile post 86 west of Spray on the John Day Highway is an example of damage that is almost impossible to anticipate. The water flowed up over the cutbank, and the level area of the highway provided an excellent place to deposit the stream-carried material.

Another example is along the John Day Highway just east of Spray. The location of the highway is restricted to the edges of the rolling hills and preserves a small amount of agricultural land in the valley. A considerable amount of channel jumping occurred along the roadside ditch, and the culvert capacity was simply too small to handle the runoff.

Larger culverts would solve this problem of channel jumping as far as the highway is concerned, but they might cause considerable erosion in the fields.

On the Sherman Highway between Fulton Canyon and the John Day River the intensity of the 1964 flood was severe. The construction was completed in 1962. This is a case where better records should help to prevent some of the damage, as special studies had been made for design purposes by the Research Section of the Highway Department.

Fulton Canyon is very narrow and had to accommodate the railroad as well as the highway and the stream. The channel for the stream had riprap designed to accommodate the greatest discharge for which records were available. A minimum of a 15-foot-wide bottom channel with 1 1/2 : 1 side slopes and 2 feet of riprap with specifications requiring more than 59 percent of the material--one cubic foot or more in volume -- was used. But that was not sufficient.

What exactly are the lessons to be learned from the big flood and what steps can be taken in design? It would be impractical to say that all features of our highways could be designed to withstand the magnitude of the December 1964 flood, but we can and should look into measures to keep damages to our highways at a minimum. As stated previously, one stream has a recurrence interval of 230 years. Unquestionably, on some streams the recurrence interval is much greater than this. It would seem that a design policy based on a 50-year recurrence interval is still valid.

In the case of small structures, the cost of increase in capacity of 25 to 50 percent would be extremely small and certainly should be investigated. Sudden changes of alignment, either horizontally or vertically, near the entrance or outlet of a structure should be studied carefully. Consideration should be given to a settling place above a structure on any stream that is apt to carry depositable material. Any highway sloping along a stream should be investigated for the need of riprap. Riprap material must be the proper size and hardness to withstand velocities greater than those in the design channel.

In conclusion, the highway engineer will lack adequate information on the discharge of any stream. He also will be required to take the calculated risk on some of his designs, but at least let us investigate the use of the factor of safety in our designs.

LUNCHEON

Presiding: Forrest Cooper

LUNCHEON ADDRESS

TRANSPORTATION OF THE FUTURE

W. A. Bugge

LUNCHEON ADDRESS

TRANSPORTATION OF THE FUTURE

by
W. A. Bugge

Today we are hearing a great deal about new concepts of transportation; hardly a month goes by without some team of industrial engineers coming up with some new kind of scheme. Some of these tax the imagination while others seem to have some merit, but all of them are interesting to us as transportation officials and engineers. They are bound to affect our daily lives in the future, so I think it might be well in talking about the transportation of the future to review a few of these new ideas.

As most of you know, Congress has authorized the expenditure of some $90 million for a three-year study and demonstration program to develop a rapid rail program in the northeast corner of the United States from Boston to Washington, D. C. The first allocation of these monies will be spent to boost the speed of existing services to about 125 miles per hour. Thereafter, any new kind of ground transportation will be considered.

The Massachusetts Institute of Technology has just recently recommended that the federal government spend some $10 million for a research program to produce completely new kinds of ground transportation which will carry passengers at a speed from 200 to 300 miles per hour; this may be some kind of a vehicle, or a train riding a guideway on grade, or it may be constructed underground as much as 500 to 1,000 feet below the surface. The MIT has recommended that hard rock tunneling devices could be developed which would reduce the cost of this tunneling dramatically. Again, it may be a train shaped like a projectile and powered by jets or rockets or driven by air pressure. It may be equipped with passenger conveniences such as a restaurant, a bar, a television room, or a barber shop and the whole trip from Boston to Washington may take only two hours.

Dozens of ideas have been produced for this high-speed run, and some of them seem outlandish; some would create most unique engineering problems. For example, a guideway for such a train at the grade would have to be on an alignment much more precise and stable than the ones we use in constructing highways and railroads today. It may be necessary to put the whole route underground to avoid congestion and minimize movement. Some engineers have proposed that we go from 500 to 1,000 feet below the surface to install this system in hard rock. It would not be difficult, I am sure, if we concentrated on it, to develop machines that could tunnel rapidly and economically through hard rock. The technology to create such a system is already available. The space program has produced a host of concepts which engineers have not yet begun to apply to the ground transportation problem--means of producing and controlling propulsion, ways of reducing friction, new standards of air conditioning, new knowledge of how the human body reacts to inertial forces, new metals, and many other innovations.

The idea of a train propelled through a compressed air tunnel at a speed of 400 miles per hour is new to many of us, but experts have been working on this idea for the last 15 years and have already designed vehicles which are close to the demonstration stage. Some of these men would go further and adapt the idea to cross-country travel; they believe that by using ram jets they could boost speeds to somewhere between 1,000 and 2,000 miles per hour. It would cost millions of dollars to design and construct such a system, but that is not so unthinkable when one considers the tremendous investment we made in railroad construction during one period in our history--or, for that matter, the $50 billion cost of our Interstate System.

The Japanese have shown us that train speeds of 125 miles per hour are possible. The success of their Tokoyo-Osaka run was due not so much to the innovation of the vehicle as to the roadbed. The train is almost a conventional electrical vehicle (incidentally, it was designed by Westinghouse), and the railroad is a custom-built production. The tracks are heavy, with mile-long welded rails, rubber blocks, and prestressed concrete ties. The alignment is very smooth with a minimum of curves. Something of this nature may be attempted in the northeast corridor of this country, and if it works out it may be applied to railroads on cross-country routes.

Another new idea for mainline routes is a rollway--a combination of the two words, railroad and tollway. This is a new kind of train riding on a wide-gage track which would carry automobiles and their passengers for long stretches and let them drive off at their destination. This would be an electric train with cars 128 feet long and 24 feet wide which would carry 12 automobiles parked sideways. Passengers could disembark, walk around, view movies, eat, and otherwise entertain themselves; yet at the end of the ride, they would have their own car and be ready to travel as they pleased. The promoters of this idea believe that such transportation could be furnished at 6 cents per mile, about what a motorist would pay for toll expense for vehicles operating on a toll road.

Other ideas have been proposed for vehicles which would operate on freeway-type roadbeds, running part of the distance in combination with trains and then separating into individual units to operate as small buses locally. The Federal Housing and Urban Development Department will undoubtedly encourage all kinds of transportation between metropolitan areas. In fact, the federal government is determined to advance a technology of urban mass transportation.

The era of the freeway is certainly not over; we shall continue to build them as we need them. But we are going to see a lot of new thinking concentrated on mass transportation schemes, and I feel sure that highway men will contribute much of what they know to this new field. Meanwhile, traffic engineering continues to distinguish itself as the field of engineering that has not reached its full capabilities. I safely predict that the capacity of the highway as we know it, almost any type of highway, will be substantially increased through application of modern traffic engineering techniques. Let me give you a few examples of what is happening without much fanfare.

Installation of a computer-operated traffic signal system in Toronto, Canada, has reduced travel time by as much as 25 percent during rush hours. The system controls 300 signals now and will control 700 eventually. In Chicago, installation of the traffic detection control system on the Eisenhower Highway has doubled the speed of traffic from 20 miles per hour to nearly 40 miles per hour. The evening rush hours have been reduced from 2 1/2 hours to 1 1/2 hours at a cost of nearly $800,000. I can remember some time ago when Mr. Still, traffic engineer of the state of Washington, installed the computer-operated signal system on a short section of highway from Tacoma to Seattle. The good feature of this particular system was that there was a button on my car (this was when I was Director of Highways) that was called the <u>Bugge button</u>. When I pressed this button, all the traffic signals would go on "green" from where I was on into the city. I do not know what happened to the button or who has it now, but I had the button.

New York City has installed a $100 million traffic control system which covers 9,000 intersections. Some of the research programs getting under way will even more dramatically influence transportation of the future in the highway field. Last month, the research and development chief in the Bureau of Public Roads reported that individual highway research projects a few years ago averaged about $30,000 per project and today there are a great many more projects in this category. The Bureau has assigned some $20 million to the field of research. This constitutes a relatively massive effort compared to what we have had in the past, but the pressure for new highway transportation improvements is going to shoot this figure further than we now imagine.

The pressure for highway safety is going to be a major stimulant. You will be interested to know that this year the automotive industry is going to give $10 million to just one institution, Northwestern University, for a comprehensive and continuing investigation of traffic accidents. The whole area of transportation is alive with new schemes, and the traffic and highway engineer will have to continue to pour money into research and development both to make rural, two-lane roads safer and to increase the capacity of an eight-lane freeway.

If we are to keep abreast in the highway field, we shall have to embrace some ideas just as revolutionary in the field of government. You have heard this before, and I am sure that you will hear it many, many times in the future. People do not care how many county lines there are between point "A" and point "B". They are impatient with the explanation that the counties are sovereign and the cities are sovereign so that each can be held responsible only for its own needs. In urban areas particularly, city limits and county lines are becoming increasingly artificial. Local governments in such instances must get together. We must learn to coordinate our programming and must develop some kind of joint financing. And we certainly must agree to uniform standards, particularly in traffic control. I do not believe super-governments are inevitable in order to solve the problems of metropolitan-area transportation.

Metropolitan area governments or special districts are the answer sometimes--certainly it was the answer in the San Francisco Bay area, where it was necessary to construct the new rapid transit system which eventually may serve five counties and a dozen cities. These instances are still not the rule. In the highway field the major routes are state- and federally-controlled anyway. These governments have been quite successful in forcing coordination of planning, financing, construction, and traffic control. The federal and state highway agencies have learned how to work with local governments and determine what prerogatives can be and should be left to local control. This relationship is well enough developed to permit a solution of most metropolitan-area transportation problems without the creation of yet another layer of government. It is possible that state and federal control of our backbone highway systems could become increasingly impressive; however, local governments can stem this tide in several ways. First, by removing the walls which legally surround their jurisdiction. Here is an example of how this can be done:

The metropolitan area around Washington, D. C., incorporates two states, the District of Columbia, a half-dozen strong country governments, and several dozen cities. Several years ago the traffic engineers in these jurisdictions began to meet informally to discuss their common problems and to seek common solutions. They have developed uniform standards, have brought in experts to discuss area-wide issues, and have arranged two-day schools and conferences to bring in experts which no one city or county could have afforded on its own. For all practical purposes they have been able to achieve as much in this congenial, informal way as with a super-government forcing arbitrary compliance. This approach is always open to reasonable men in local governments. It takes initiative and ability to see one's problems in the broader framework of the whole metropolitan area, but it keeps control in local hands, which is important, and it preserves a good many political intangibles which all of us value.

Another admonition we have frequently heard in recent years, and shall hear even more often in the future, is that we must not tie ourselves to any one form of transportation--automotive, rapid transit, or what have you. Instead, we should use whatever tools are available and be willing to develop new forms of transportation where our existing ones do not suffice. As engineers, our responsibility is to become more objective in such matters. Let us avoid being trapped into the largely artificial competition between road-building interests and rapid-transit interests. Most always the justification for freeways or rapid transportation routes speaks for itself after appropriate research.

In several cases in the San Francisco Bay area, major corridors are being developed jointly with both kinds of transportation on the same right-of-way. I know this is going to work out and I hope to see more of these corridors carrying far more traffic than the freeway or rapid-transit line could do by itself.

In looking at transportation of the future, I see not only changes in the technology of moving people and goods, but changes also in official attitudes. The whole area of regional planning in which the local engineers cooperatively develop a comprehensive plan which crosses all jurisdictions and includes all forms of transportation is now just opening up. The federal government, to protect its investment in highway and rapid-transit construction, is insisting on joint planning since just getting the feel of working together will make it easier for local engineers to continue such an arrangement on a voluntary basis.

I just recently read an objective prepared by the Canadian Good Roads Association on the objectives of transportation planning.

> The basic objectives of transportation planning are to identify the present and future transport requirements of an area and to design and adjust, as conditions change, functional transportation systems in accordance with appropriate study procedures which are continually being refined and developed through research. These functional transportation systems should be designed by a special planning group to provide a workable solution for the movement of persons and goods. This must be consistent with the resources and needs of the inhabitants and be an important part of the broader plan for the development of the area.

I feel that this is a very poignant statement of objectives and one that all of us could use because comprehensive planning of transportation in coordination with other community goals is going to affect transportation of the future in a marked manner. I think it is comparable to the planning surveys of the early 1930's when the state highway departments launched a determined effort to discover their highway needs and to classify roads into systems. Many of you will remember this survey well. This classification effort led eventually to the establishment of the Interstate System and the assignment of financial responsibilities that in turn led to its authorization. Comprehensive planning studies in the future are going to be every bit as influential in determining where traffic patterns are forming and where they will develop. Thus, they will point the way to a clear definition of responsibilities in the metropolitan areas.

This brings me to another way that transportation of the future may be different. Transportation financing may be in for some changes, too. It was rather a dramatic departure from the established federal-state relationship when Congress authorized the federal government to pick up 90 percent of the costs of the Interstate System, and in this action we have had far-reaching results. One is our realization that we are not bound to any traditions in matching aid for highway system improvement. After 1972 we may want Uncle Sam to participate in our state and local problems on a 50-50 basis, or a 40-60 basis, or a 30-70 basis, or some other basis. A great deal will depend upon trends in the relative incomes of the state and local governments and the federal government. The money for future highways will come from the level of government that has the fullest purse, regardless of how we might wish it to be. As local officials and engineers, you would probably like to see local governments in a position to finance more of their own public works. Right now, local governments with new bonding powers granted by state legislatures are financing a larger share of their own highway improvement programs than they did 10 years ago. This is being done in spite of the publicity given to the federal-aid programs for urban renewal, public works planning advances, and the road-building program. So the transportation of the future, as far as most of us are concerned, means a look at the financing prospects also.

There is another factor which I think will influence transportation of the future a great deal on the local level, and this is maintenance engineering. Will we still be working on our maintenance problems in the same old way 10 years from now--using the same kind of research, repairing the same kind of curbs and gutters, repainting bridges with the same paint and equipment, installing the same kind of traffic signals, painting the same color of lane lines, and mowing roadsides with the same kind of machines? I do not think that we pay much attention to these things--they have changed very little in the past. A part of the reason for our lack of invention in these commonplace work areas may be simply a lack of imagination.

The California Council for Civil Engineers and Land Surveyors each year gives awards to men who have advanced the technology of the surveying and mapping profession. Last month the award for first place was given to a county surveyor who had developed a device for accurately taking the temperature of a steel tape in the field. It was an ingenious device, and he had field-tested it to the point where the possible error of any single reading was in the area of one part in 375,000.

The second award was given to a retired chief of surveys for inventing a combination of a level rod and a stake driver. With this device, it is possible for a member of a survey party to drive a larger number of stakes in a much shorter period of time.

Why does it take so many years to bring such seemingly simple instruments into being? Why are we in the highway departments still working with techniques and tools that were tradition 30 years ago?

We think of ourselves as a nation of inventors, but the lack of inventiveness is apparent on every side. We spend hundreds of millions of dollars on maintenance of highways, and I dare say we could cut this expenditure considerably by the application of some conceptual engineering to the machinery we use in our daily chores. I would like to see some national organization develop a program for recognition of such inventiveness and reward it publically. Such a program would develop new techniques, new equipment and new materials, and it should include everyone from the chief engineer to the trash collection crews. This is one way that we can assure some improvements in transportation of the future.

Finally, I foresee another development which has been emerging for several years and reached its peak in the last session of Congress--the national administration is committed to improving the appearance of our highways. Congress was told to pass a bill demanding that the states take certain measures to eliminate billboards and roadside eyesores. Veteran observers in Washington have reported that no other measure was pushed more vigorously.

The federal government will, starting this year, spend $320,000,000 in this effort. Very shortly you are going to feel the effects of this pressure. In short, highways of the future are going to be more beautiful; more people (including architects) are going to be moving into the act to tell you what is beautiful and what is not. This will pose new problems for your designers--even those who are experts in the field of asthetics. I think the greatest effect will be in maintenance operation. More and more of the right-of-way will have to be put under perpetual care, including more and more planting, with more and more watering, and more and more mowing. I would not be surprised to see maintenance costs on some stretches of highway doubled, and as yet there is no provision for federal assistance in this field.

In my look into the future, I range from the exotic to the mundane. I hope the chairman of this program did not expect me to predict the future in glowing terms. I do not have a crystal ball, but we are seeing many exciting new transportation developments in the nursery stage, and I have tried to review some of them for you.

The future will demand some changes in the parochial attitudes about cooperative planning--I have tried to make a point of that. We can expect to see some new approaches to financing--some realignment of local, state, and federal contributions. We badly need to begin to think more imaginatively about our everyday tools and techniques.

The transportation of the future in the communities we serve will depend upon these and a lot of other influences which we can not foresee today. The speed with which such improvements arise to make it easier for people to get around and make their own work more productive will depend largely upon how willing we are to explore these frontiers.

To that extent, the transportation of the future depends on you who are charged with the responsibilities of building and maintaining the highway system of our country.

PANEL DISCUSSION

CONSTRUCTION AND MAINTENANCE SIGNING

Presiding: Tom Edwards

CONSTRUCTION AND MAINTENANCE SIGNING

by
Bill McNutt

Presented by L. A. Runkle

Since Bill is grounded in Boise, Idaho, he has requested that the following remarks be brought before this panel. He has four salient points listed here regarding the signing of projects under construction. If I had composed these four points myself, I am sure that they would be headed just as Bill has them.

First, should the state or awarding agency furnish the signs? This has been discussed many times, and we firmly believe as contractors that we should have a uniform system of signing on our projects. Whether or not the state furnishes them is beside the point. If we knew what had to be furnished, whether it be a bid item or whether we should incorporate it into some of the other items of our project is immaterial. I do, however, believe that good uniform signing would help a great deal in moving traffic through construction projects.

It is not only a responsibility of the contractor, but of the awarding agencies, to see that the public travels through these construction projects in the best possible way. After all, this is public money we are spending, and we feel definitely sure that the public is entitled to that consideration. I, for one, believe we should have more uniform signing and planning by the awarding agency.

Second, speed zoning is necessary on all of our projects. We have taken this up with both the State of Washington and the State of Oregon many times. We would like to see the State Police take part to a larger extent than they do. Evidently there are some technicalities involved. The police cooperate with us to the very best of their ability and are a great help to us.

Some consideration should be given to increasing the waiting periods on the part of traffic through a project to speed up construction time. This is possibly a little selfish; however, I am sure from the economic standpoint there is a lot of merit in what Bill says.

I realize the public must travel through a project, but there is a break-even point somewhere when costs are considered. Costs of labor and equipment are becoming so high that if we do not get production, ultimately the public will have to pay this bill.

A third point concerns detours. I am a firm believer in providing detours, even though they are costly, wherever possible to get the public through our projects. This will pay off in big dividends. But, where a detour is not possible and the road is not traveled too extensively, a longer waiting period would certainly reduce the costs of construction. After all, what we are after is to get more miles per dollar expended.

The fourth item concerns forewarning of traffic at interchanges and Y's by suggesting alternate routes, therefore keeping disgruntled motorists away from the project. We have done that on our own, with the consent of the Bureau of Public Roads and the state, where there are alternate routes. We have no right to keep people off the roads, of course, since our contract specifically states that we must have traffic going through. However, where there are alternate routes it makes no difference to the public. It helps them and helps us to expedite the project. I think this should merit consideration.

Comments by Mr. McNutt

I wish to thank Mr. Runkle for presenting my notes to the Conference.

One thing I would like to comment on is the type of signing that the State of Oregon is now doing that lists the type of project and the contractor's name. I think this is of some help in case of a mishap because the motorist immediately knows whose job it is. If he has an accident, he files with the proper authority. This may be a negative way to look at it; but, nevertheless, contractors feel that we would like to have the credit or the discredit, whichever we deserve, on a project.

I think I would be a little bit remiss, being thoroughly indoctrinated in Associated General Contractors, if I did not mention the fact that I think the Associated General Contractors emblem should be on the project sign, too; this is one thing we are plugging for a little.

I might mention one item which is of interest to the contractor. On one particular job, one contractor did the grading; it was completed and finaled out. Another contractor was to do the surfacing and paving. After the contract was awarded to this man, prior to the start of the work, someone ran through the barricade and blamed the contractor and subsequently sued the contractor and collected for the manner in which the signs were placed at the end of the project.

Here is a sort of "no man's land," gentlemen, for which I do not know the answer, but some solution should be found. Actually, the paving contractor had nothing to do with the placement of the signs and still was held liable; this is just a little food for thought.

CONSTRUCTION AND MAINTENANCE SIGNING

by
A. N. Weir

I have been asked to serve on this panel to give you some ideas of the motorists' viewpoint on street and highway signs. It is safe to assume that all of you are motorists, but you are also technicians who are concerned with street and highway matters other than driving. The motorist is not concerned with the psychological study or the technical difficulties involved in placing signs along streets and highways. About all he knows, or wants to know, is that there are signs for his direction and instruction which make his trip as fast and convenient as possible. What may seem perfectly logical and intelligent to a traffic engineer may be very complex to the motorist and fail entirely to get the message across, especially when the motorist observes it for the first time at speeds of 40 to 70 miles per hour. Of course, he may observe this sign at a slow speed of 15 to 25 miles per hour, but at the same time he may be hemmed in by traffic on both sides, making it impossible to perform the maneuver required by the sign directing him to his destination.

We must also assume that many motorists are unobserving and fail to see signs placed in advance of a decision point, consequently reaching that point too late to make a change in their driving pattern. Because of sudden, unexpected moves, these drivers create hazardous conditions and many times cause accidents. A driver's success or failure hinges on his ability to reach the proper decision at points where he must choose among two or more alternative courses of action.

Sign messages at such points should be related directly to the information the driver needs in order to make the correct decision in advance of the point of action.

We use the term "uniform signing" and endeavor to reach uniformity as nearly as possible. By definition, "uniformity" means treating similar situations similarly. Hence, different, novel, and unique situations must be treated individually. There are times and places where a deviation from the uniform pattern is necessary. By this deviation, I do not mean the shape, color, or design of the sign, but rather the wording on the sign.

Designation, by name, of freeways at an interchange may be understood by frequent users of the highway, but a stranger may look for a route number. Both should be, and in many cases have been, incorporated in the sign. A misunderstanding by highway people as to the prohibition of highway names has been cleared up, I believe, so inclusion of the name is now possible and has helped to clear many situations.

I have observed, when traveling from state to state and in various cities, a considerable variation in specific signing. However, I feel that as the motorist travels more extensively and observes the messages on all types of signs, his understanding of their basic meaning improves and his interpretation becomes more accurate and immediate.

Advance information concerning route changes or area exits is, of course, advantageous. The greater the speed of the vehicle, the greater the distance the advance notice must be from the point of decision. For example, I have observed that some freeways that are designed for high speed may be perfectly safe at that speed, provided there are few interchanges, exits, and oncoming ramps. But, when a number of lane changes are required in comparatively short distances, it would seem to me that such conditions would not justify a high rate of speed, such as 70 miles per hour, and that speed should be reduced because of these conditions. This occurs primarily on urban freeways. It is true that freeways are designed for greater speed with safety, but safety is jeopardized when the motorist feels he must comply with the various lane changes while doing 70 miles per hour. The time allowed at that speed to complete the maneuver is entirely insufficient, especially for one unfamiliar with that particular route. A good rule would be: Do not confuse the motorist by requiring him to make sudden decisions within restricted distances while traveling at high speed. He should be given adequate time to make the decision safely, well in advance of the point at which he must make his maneuver.

Some years ago, I received numerous complaints and occasionally still do hear complaints about the problem of directional guidance signs. The difficulty of the motorist is based on the fact that even-numbered highways run east and west and odd-numbered ones run north and south. However, there are times when highways appear to violate this cardinal rule of direction. It is essential at such times to indicate on the sign the direction in which the motorist is generally headed, such as 99 North or 20 East.

Positioning of the sign is also important. For example, a sign may be placed too far in advance, or even beyond, the exit or turn-off lane. I have noticed, from time to time, that exit signs sometimes are placed on the near side and sometimes on the far side of the exit lane. This variation tends to confuse the motorist, as he is never certain whether he should turn before or after the sign. This is especially true when driving after dark or during poor visibility periods of rain, fog, or snow. Uniformity of sign location should be observed.

Lane designation is very important for all multiple-lane highways and through streets. For example, the driver should be informed as to which is the proper lane for the destination he has in mind. Sometimes, the outer lane he is using will lead him onto an off-ramp, so he should be informed as to which lane he should move into to avoid being taken off the highway by being trapped in the off-ramp lane. If he happens to be following a large truck with his view ahead impaired, he may easily be led into the off-ramp lane if he does not receive adequate information well in advance.

A frequent cause of confusion is in connection with lanes that offer two choices to the motorist: If he is traveling in the lane nearest the center divider, he may go straight ahead or he may turn right onto a branch connection. If he is traveling in the right-hand lane, he is required to turn right <u>only</u>. The word 'only' usually designates the right-turn only from the right lane, while in the other lane, an arrow indicates he may go straight ahead. But, here is the trouble: He does not know far enough in advance that he may turn right out of the left lane, so he crowds over into the right lane, only to find out later that he could have made the right turn out of the center lane. This is unfortunate, as it confuses the motorist and forces him into one or perhaps more lane changes where none would have been necessary if he had received sufficient advance information. Thus, the lack of adequate advance information signs results in increased congestion at a critical point in the freeway.

This difficult situation is often compounded when the motorist who is making a right turn off the freeway will shortly be required to change lanes to make a left turn in order to reach his destination. Thus, if he already has been forced into one unnecessary lane change, he must now make another, adding to the confusion of lane changing with the resultant danger of accidents. It would be better if the motorist could be given advance information of the permissive right turn from the center lane. Then, he would proceed straight ahead rather than changing lanes to get into the right lane, would swing right at the point where the lane turns, and would then be in the proper lane to swing to the left to reach his ultimate destination without all the unnecessary and dangerous lane changing.

Now I have a few observations on city signs. I have driven in some cities where it is almost impossible to recognize a street by a posted sign, principally because the sign is (as if by design) difficult to see. In cities having 4-6-8 lane highways, it would seem an obvious necessity to have street signs large enough to be seen from any lane on the street. Many cities have made changes in this respect and have realized the importance of advance street designation in addition to designation of the street at the intersection. There are a number of methods used to improve street signing. Street name signs, for example, have for some inexplicable reason been lettered on 2 1/2-inch boards nailed to the top of posts set in the ground near the sidewalk or, at best, near the curb near the intersection. Some are lettered vertically on small 3-inch posts and at times are not more than 3 feet out of the ground, while others are stenciled on the curb! Thank goodness these are becoming more scarce every year. Reflective paint on signs has made a great improvement, especially for night driving.

The location of street signs is also confusing to motorists. Some cities place street signs at all four corners, some on the opposite side of the street, some on the near side, some on opposite corners. Modern signing on busy streets reflects the use of mast-arm signs extending over the street and raised to an elevation of some 16 feet or more, using letters 6 to 8 inches high. Many mast-arm signs are placed at the curb and extend over the street or are on the median strip. A great improvement has been made for one-way streets, as they have become more popular means of speeding traffic. Overhead signs indicating direction of one-way traffic and allowing the sign for each lane of traffic have been a great help to motorists because the signs are visible for a greater distance.

I have observed some large mast-arm signs indicating the name of the street and the direction of one-way traffic prevailing on the intersecting street. I have noted large signs indicating the names of principal intersecting streets where left turns are permitted or where right turns only are allowed.

Adequate highway route signing through many cities is woefully inadequate. A motorist traveling from state to state may be required to enter the business section of a metropolitan area. He is kept extremely busy by watching traffic, trying to follow route signs, observing traffic signals, and desperately trying not to miss the particular intersection where he should turn. If the signs are not large, properly placed, and simple in information, he may find himself in the suburbs rather than on his way to his destination. I have followed through large cities and small towns with a great deal of satisfaction and with little confusion when they are properly signed. I have also been very confused and even lost in small towns where signs are inadequate, infrequent, and obscured by commercial signs.

I have had experience with signs operating at specific periods during a day and not at other times. The message is for lane observance or turn permission at certain times only. In one instance, I recall, the neon sign overhead provided this information only when lit. Motorists are apprehended by law enforcement agencies because they fail to observe the sign or follow a normal traffic pattern without observing the sign when it is turned on. Intermittent use of directional signs should be avoided, in my opinion, if there is any other way to control the traffic.

Another situation which, thank goodness, is being eliminated at a busy intersection, is a post literally loaded with signs. This multiplicity of signs is usually in a field of black and white route numbers. This requires the motorist to make an instantaneous decision by quickly observing some dozen or more signs advising him as to which way to proceed on his chosen route. I think most of these have been eliminated from our western cities, but on a recent trip through the east and northeast, I became confused at several intersections by such clutter still remaining to confuse the motorist. The same rules for erecting signs on multiple-lane streets are not usually necessary or required for streets with two or less lanes. However, I believe that the official responsible for placing and maintaining signs should be made aware by actual observation of the effectiveness of the signs he has erected. Signs have been necessary at some time, or they would not have been placed where they are. Circumstances change, traffic flow changes, physical aspects of streets, intersections, and buildings change, necessitating continual up-dating and maintenance of signs. One of the common causes of traffic violations is an important traffic sign obscured by summer foliage, other signs, or buildings.

Early last year, the Oregon State Motor Association introduced a program of traffic hazard reporting. We asked our members to report signs and conditions of streets and highways throughout the state which, in their opinion, should have some attention. It might be a situation contributing to accidents, it might be a need for signalized intersections or stop signs, or perhaps merely a confusion as to the meaning of signs. We had exceptionally good response on those complaints and received suggestions which merited further investigation. These were, if possible, investigated by our staff. When, after investigation, we felt justified in reporting these situations to the proper authority, we did so. I am very pleased to say that in such instances we received hearty cooperation from city, county, and state officials. Where necessary, remedial action was taken.

It is not possible for the engineer charged with the signing of city streets and highways to personally review every sign that is erected.

It is necessary that those under his direction be constantly reminded of the necessity to observe motorist reaction to newly located signs. I am not sufficiently familiar with the procedure of highway departments to know just who is the final authority on determining the wording on signs, but occasionally, through error or omission, boo-boos occur. For example, when the first portion of the Foothills Freeway in Portland was opened to traffic from I-5, the motorist was able to drive into the city center, northbound, via S.W. 4th and 6th avenues, by off-ramps. He could not go further than 6th avenue, as the highway was not completed. He was supposedly directed to these off-ramps by large overhead signs on I-5. The signs, however, were so worded that they directed the motorist to the ocean beaches and did not mention either 6th or 4th avenue exits. Soon after the signs were placed, one of our highway officials was on his way to Portland and decided to use one of these exits into the city center. It was but a very short time until I was asked if I had heard the roar which seemed to extend from California to Washington and from the coast to Idaho because of this oversight in preparation of signs. Needless to say, the next time I used this route to our office (within 24 hours), the signs were changed to properly indicate 4th and 6th avenue exits. This points up to me the importance of several people reviewing the contents of the signs and the message to be displayed thereon, before actual erection.

Signs are expensive, and the wholesale changing of signs in the city or along a highway is not to be expected simply because a new idea has been advanced. But I do believe constant up-grading of signs is necessary for safety and convenience of the motorist, and when it is necessary to change signs for any reason, consideration should be given to modernization of the sign to be replaced if improvement could be effected.

In the past, some signs have remained in position and effective for decades without change, but today traffic increases so rapidly that changes in our thinking is necessary. I am aware of locations in Portland where constant research and study is necessary to determine the best signing possible to accommodate the ever-increasing flow of traffic. This situation, many times, reaches what appears to be impossible proportions because of the increased speed, short blocks, multiple approaches, and constant construction problems. These interferences with normal traffic are constant problems and will ever be with us. Therefore, I think the intelligent cooperation of the motorist should be encouraged and could be used to determine his reaction, opinion, and suggestions for improvement of street and highway signs.

CONSTRUCTION AND MAINTENANCE SIGNING

by
Rex G. Still

It is my feeling that in past years the importance of necessary signing for the protection of the traveling public and construction men and equipment has been greatly underestimated. Many nonstandard signs were being used, transition tapers were too short, and the responsibility for the uniform installation of standard traffic control devices was not clearly established by some governmental agencies.

Recent court actions in the State of Washington have <u>increased</u> the importance of signing. By tort action, Yakima county paid a cost of $16,000. A fatal accident which occurred on a horizontal curve involved teen-agers driving a vehicle at a speed they admitted was between 70 and 80 miles per hour, which is far in excess of the legal speed limit. As the warning signs at the curve were not consistent with the State of Washington Manual for Signing, the Superior Court declared that the county was negligent. This decision was confirmed by the Supreme Court.

The State of Washington was sued in the amount of $500,000 in an accident case where one vehicle operator did not comply with a stop sign and collided with a vehicle on the freeway. The state was also confronted with a suit in the amount of $200,000 in the Pasco area, where a vehicle crossed the median of a multi-lane highway and collided head-on with a vehicle proceeding in the opposite direction.

The courts and attorneys have given evidence that the governmental agency having jurisdiction over the highway or street is liable for driver failure. It is, therefore, evident that to improve this condition the use of traffic control devices must be uniformly used throughout the nation. This can be accomplished if all states, counties, and cities will rigidly abide with the traffic control standards established by Part V (Traffic Controls for Highway Construction and Maintenance Operations) of the 1961 Manual on <u>Uniform Traffic Control Devices</u>.

Strict adherence to the standards set forth in the national manual by all highway department, county, and city officials will be a great help to the traffic engineer who is concerned with traffic control problems. Any deviation from these traffic control standards which have been established by qualified professional men from all parts of this country will destroy the benefits attained by such standards and will result in noncompliance with traffic devices by vehicle operators.

Vehicle operators today are traveling more extensively than in past years. To the automobile driver traveling through states unfamiliar to him, the use of various types of traffic control devices which are not consistent with adopted standards can only result in confusion. This, in turn, can result in a hazardous condition.

As an example, the use of red-on-white speed limit signs, white-on-green overhead crosswalk signs, and white-on-red diamond slow signs are not consistent with the sign manual; and, consequently, they confuse the unfamiliar driver. Such signs have been observed. It is very essential that the procedure established in the manual be followed to avoid possible tort action and to provide for the safe movement of traffic.

The State of Washington Department of Highways supplies to the contractor and, of course, to our maintenance forces all necessary traffic control signs for the protection of the traveling public and construction men and equipment. It has been emphatically expressed to our engineers that the responsibility for the installation of uniform traffic control devices rests with the project engineers on construction projects and with the maintenance lead man on maintenance projects. Traffic control at work sites in the State of Washington has been of such great concern that the legislature, in 1957, enacted R.C.W. 47.36.200, which makes it mandatory to have work sites posted with signs that are consistent with the Manual on Uniform Traffic Control Devices.

Our maintenance operations at a given location are usually of short duration and rather infrequent. Therefore, they are a surprise to the driver. On high-speed highways, control signs for construction and maintenance operations must compete for the driver's attention. Therefore, the use of fluorescent orange-colored material should be considered for daylight emphasis.

Part V of the national manual is an excellent guide for the installation of signs for traffic controls for construction and maintenance operations. We must make provision for all demands to adequately protect the traveling public and men in work areas. Traffic control devices should be installed before any work begins. The party responsible for these installations should drive the area, look at it closely, and determine if the traffic control devices tell the driver clearly and simply what to do.

Traffic control devices should remain in place <u>only</u> <u>when</u> <u>necessary</u>, and they <u>must</u> be removed immediately when the work is completed. If traffic control devices are permitted to remain in place during lunch-hour periods or when work is not actually being performed, they will breed contempt in the motorists' minds and cause noncompliance with the signs and loss of respect for the traffic control devices.

Another important factor is the flagman. The flagman makes public contact and is responsible for human safety. He must be intelligent, mentally alert, have good sight and hearing, and be courteous and neat appearing.

In conclusion, I would like to state that, in order to provide the necessary protection for construction and maintenance operations, we <u>must</u> <u>uniformly</u> abide by the procedure established by Part V of the national manual.

CONSTRUCTION AND MAINTENANCE SIGNING

by
Captain Farley Mogan

Last Fall when Victor Wolfe asked that I participate in this panel on Construction and Maintenance Signing and discuss the problems we have been experiencing with such signing, my first reaction was to ask "What problems?"

As head of the Traffic Division for the Oregon State Police, I am located across the street from the Highway Department; any problems involving our two departments that come to my attention are discussed between us on an informal first-name basis and a solution is worked out so that no problem exists. For the most part, any problems that occur are discussed at the scene by our field personnel. For that reason I could not, at the moment, recall a problem relating to signing of construction or maintenance areas.

However, as you know, if you look for trouble you can usually find it, and when I sent out the word to our field commands that we had been invited to comment on this subject, the reports began to trickle in from various parts of the state. Some of these comments were relative to general procedures and practices that have been followed on some occasions. Others reported specific examples of what our officers considered inadequate signing. I have sorted out their reports and will cite some of the comments. In most of these we just present the problem, not the solution.

The most common report from our officers is relative to "Men Working" signs left in an area when the work is no longer in progress. They believe that observing these highway signs, warning of men working, and then proceeding through the area without seeing any activity in progress, tends to promote disregard for all signs. Removal or covering of such signs during periods when men are not working would solve this problem.

The next most frequent comment is to the effect that some warning signs are too far from the work, and the motorist drives on around turn after turn looking for the grader or the crew; then, when the driver has forgotten about the sign, he comes upon the crew without warning. This usually occurs late in the day, after the sign was put up in the morning.

There was also some comment about the use of construction zone signs by contractors to the effect that contractors start the job with clean, well-placed signs, but as the job progresses the signs get dirty or knocked over and little or no effort is made to keep them clean and in the proper place.

A very hazardous practice is sometimes followed when a detour from the highway turns away from the center stripe on the old highway. If the old center stripe is not removed and then repainted to follow the new lanes, it can lead drivers into head-on collisions in the dusk or in other times of poor visibility.

One complaint from the public relative to construction areas is the depositing of rocks and mud on the highway by equipment crossing the highway. It was suggested that warning signs would give motorists a chance to slow down and that the highway could be cleaned off during slack periods and at the end of the day.

We had several comments in connection with flagmen. The first was about the tired flagman who sits on a stump or a rock until the car is almost there and then causes the oncoming car to skid to a halt by throwing up his sign. The next one referred to the flagman who stands in front of the first car in line and lets the cars line up back to a curve or crest of a hill. Also mentioned was the flagman on the downhill side of the job who lets the traffic go through uphill until a heavy freight truck gets to the point and then he stops the truck so the next line can form behind the truck and then be forced to follow through in low gear. We have also had several complaints from motorists about lazy flagmen who lurk on the road shoulder unnoticed and let cars run by them into the work area without warning. We also hear about the sign that is left up over a nonworking day that says "Watch for Flagman"; then you watch and watch, but no flagman is ever seen.

Some of the flagmen for surveyor's crews appear to get lonesome and try to warn traffic while standing only a few feet away from the crew. They should be far enough away to give people time to react and to locate the survey party members before they are upon them.

I believe that any further recitation of specific examples would be redundant. However, I believe there are certain lessons to be learned from these examples.

First, we must review the fundamental objective of the signs and flagmen. It is <u>communication</u>. It is communication of an important message to a person who is busy with the complex operation of a moving machine over a route and through an area that is at the same time being used by persons who are working in his path and who are even changing his normal lane of travel. This complicates the problem of communication.

Our first problem is to gain the driver's attention and to then impart the message to him in such terms that he not only receives the message but has time to understand it and to react to it in the desired manner and at the required moment.

We are also faced with the problem of retention. If we impart the message too soon, other thoughts may push our message into the background so that it has become forgotten when the moment for action arrives.

We must also deliver our message only when it is telling the truth. Signs that warn of nonexisting hazards cry wolf too many times and dull the reception of the communication during periods of actual hazard.

I hope that you do not get the impression that the examples I have used are representative of routine operations. These are the exceptions and are only cited to point out some areas where there might be room for improvement.

PANEL DISCUSSION

WHAT'S NEW WITH THE NATIONAL ASSOCIATION OF COUNTY ENGINEERS

Presiding: B. Loyal Smith

WHAT'S NEW WITH THE NATIONAL ASSOCIATION OF COUNTY ENGINEERS

by
B. Loyal Smith

What's new with the National Association of County Engineers? The whole thing is new. The National Association of County Engineers is only about 10 years old. About 10 years ago a dozen county engineers got together to see if there was some way to instill into the minds of engineers serving the public, and also into the mind of the public itself, the idea that an organization existed that could help all county engineers become better. It was with this thought in mind that NACE was set up.

This was a working organization. It set out to try and do something and do it well, and it was decided that the persons to do it were those who actually were on the job. They started to look around the country and see if they could find some information on how to be a better county engineer. There were no guidelines--so a plan was set up for putting into writing some things that would help any man, or woman, or board, to do a better job of building county roads in America.

As a result, the organization which started only 10 years ago with about 12 men has now developed into an organization with over 1,000 members. They have been successful in publishing 10 manuals of "how to do it better" at the county road level.

They started by getting some men from every part of the United States interested in the field of a particular subject, realizing that there were things to be gained from county engineers all over the nation. Rough manuals were circulated to practicing engineers, reviewed by experts in the universities, and then sent back to the operating engineers who again reviewed the manual. These manuals turned out to be quite successful. Nearly all of you who are or have been in county government have seen them.

There has been a manual on actions, one on relations, one on organization, one on cost records and budgets, one on personnel, one on purchasing, one on public relations, one on building advance road programs, a series on development: the first of which was how to do a job of comprehensive planning, the second was the open street, the third one (which is well under way and will soon be published) is the location of utilities and sanitation. I have read the preliminaries on that manual, and it is a dandy. There is also a new one on traffic operations.

The panel will now tell you about a couple of these manuals that are currently in the production stage.

NACE MAINTENANCE MANUAL

by
William G. Harrington

It is rather difficult to tell you something about the NACE maintenance manual without giving a little bit of an idea of why we bothered with it, what it is made up of, and the contents in general. One thing you should keep in mind is that this manual is for the whole country.

The highway engineer today is well aware that the Interstate and Defense Highway System has presented the greatest technical challenge in modern highway engineering. Because of this, many people, even some of the engineers, think that only intricate design in construction problems requires the attention of the professional highway engineer. The primary road system in the various states also shares a part of this glamorous spotlight, and, occasionally, on the periphery of this spotlight are a few of the secondary roads on the fringe areas of the metropolitan districts. The qualification to share in the spotlight is still primarily the technical challenge in the design and construction.

In construction work, when many of these glamorous projects are completed and the last report is filed, the public and the engineers involved usually give a big sigh of relief at the satisfaction that the job is completed and the paper work is done; then the project is turned over to the maintenance department--this is the final curtain. The spotlight is turned off, and this project will soon become just another highway.

Then a small group of engineers who have not yet had much to do with the project are just beginning to stir in their unglamorous role of seeing to the eternal drudgery of maintenance. They might be compared somewhat to the stagehands who just begin their work after the stars of the play have gone.

All of the spectacular design and construction problems are well written up and widely distributed to professional publications. Some of these things are even included in future textbooks. These articles are interesting to the inquisitive nature of the engineer, so naturally they are the first ones generally read. There are many volumes of this kind of writing, and you can find articles on just about every phase of design and construction that has ever been encountered.

There is a sharp contrast though--highway maintenance has never enjoyed this literary coverage or attention. There are a few excellent books and writings on this subject, of course, but they have not been widely distributed or generally used. Perhaps this is because these books lack the exciting glamour of the design and construction challenges. Many engineers feel that maintenance is a repetitious type of routine; once the pattern of procedure is set, it is rarely ever changed and presents very little opportunity for original thinking. Generally speaking, a thorough search of any technical library rarely will yield anything of consequence on maintenance.

The county engineer is in a rather unique position, however, since he is first involved with design and construction and then with equal responsibility he becomes the maintenance engineer on the project. Oftentimes the public is prone to forget this. It is the maintenance phase of county engineering with which we are now concerned. We must discard the mass feelings that the maintenance of the highway is just a necessary evil, a tolerated nuisance, and probably something subprofessional to the engineer. Today, when just about half of the money spent on the ABC systems is for maintenance, it is time we take a long, close look at the subject.

If there is any conceivable way to reduce this maintenance expenditure, we have a moral responsibility to find it. Then the savings can be applied to further construction in the future. Tradition has stereotyped inefficient maintenance. It does not have to cost "this amount of money"; it can be reduced and we know some excellent examples of this.

First, we need to do some original and creative thinking about maintenance. In general there are three ways to reduce the maintenance expenditure: (1) select the most effective method of performing a specific function, (2) improve the efficiency of the existing method of performing a function, and (3) design and construct the projects initially to minimize future maintenance problems.

As to the future, wisdom gained in the past and present experiences of the engineer should certainly make him increasingly conscious of this factor as a new project is being designed. This kind of economic judgment calls for the engineer to think about every phase of the project in a true professional manner as opposed to blindly following a minimum design criteria in cranking out numerical answers to stock formulas.

The NACE philosophy of reducing expenditures is quite simple-- in fact it may appear to be oversimplified at first glance, but experience has shown that it works. All engineers know that the quickest way to get into trouble is to begin using unfounded shortcuts or to start guessing when they should be calculating. The same thing applies in the NACE procedure, and a special note of caution is well worth emphasizing.

The national results can only be obtained by the complete analysis of any single function, and this will change from county to county, state to state, and region to region. The initial release of the maintenance manual represents the combined efforts of well over 200 county engineers. The basic subjects, theories, and methods are the compilation of the best practices being used throughout the country. These are actual practices of the engineers today.

It is essential that the engineer, when he receives the manual, review his local conditions before passing judgment on accepting or rejecting any procedure and extract only those parts which apply to his county. Obviously, the type of soil, surfacing material, climate, precipitation, equipment available, and such related factors must be considered. The county engineer's technical training, coupled with his experience, gives him the knowledge to weigh these factors and make such decisions. We, therefore, caution everyone that these guides should be used only after modification for specific geographical areas.

In general, these manuals are not intended to be complete "do-it-yourself kits" for the maintenance employee. The successful use of these maintenance guides will depend upon adoption of the general principles and perseverance of their use by the maintenance men.

The engineers who helped to develop these maintenance guides are the first ones to recognize that writings on these topics are subject to change. For this reason, the various topics are made up in ring-binder form so they can be changed, added to, or deleted.

We further urge that state-county engineer associations establish a maintenance committee. The committee function would be to review each chapter as it is released and analyze it as to application for their immediate areas. The members of the committee may want to revise parts of a chapter by either adding, deleting, or even changing certain details to better conform to their specific conditions. They might find that it would be best to completely rewrite a whole chapter and give emphasis to other parts. If each state association will do this, use of the guide manual will have far better results. We do not pretend to know all conditions that exist throughout the country. Therefore, the best we can do is only hope to touch on the highlights; the guide manual should be considered as an outline and its expansion into complete narrative form is left to the state association.

This process of state review should also serve important secondary functions. Discussions will provide one more opportunity for each of us to communicate with our associates. The very nature of the group discussion should help educate all the participants to a more knowledgeable purpose and inspire an interest in creative maintenance thinking.

If the participants will be objective in this matter, they will find that each discussion meeting will elevate their level of maintenance awareness. We must think before we act, but also all of the good thinking in the world is useless if we do not follow it through. It is our sincere hope that the NACE Maintenance Manual will be of assistance to you in intensifying and economizing the maintenance programs of your own counties.

NACE INTERGOVERNMENTAL RELATIONS MANUAL

by
Howard Bussard

The NACE Manual on Intergovernmental Relations is now under development. The subject of intergovernmental highway relations is one that we are all concerned with. Some of the questions that naturally arise are: Why have a manual on this subject in the first place? What should it include? Who should publish it? Who should read it?

Highway transportation is a dynamic and ever-changing field. Every year the matter of highway construction, maintenance, and traffic operations on our roads and streets becomes more complex. This is understandable, for in round numbers the United States today has some 3, 500, 000 miles of roads and streets. Responsiblity over these roads and streets is shared by some 35, 000 different agencies of government which employ more than 500, 000 persons. It seems to me that these very brief statistics point up the need for cooperative relationship between the various agencies and levels of government that have highway responsibility.

Intergovernmental relations is the cooperative working together of all units of government that share roads and streets responsibilities. The area of intergovernmental relations includes those between the federal government and the various states. It includes those between states. It includes within-the-state relations between state government and the county, between one county and another; and between the various political subdivisions of the cities, towns, townships, burroughs and special road districts.

Those of you who are perhaps near my vintage in the highway engineering field will remember some of the problems in the early days of intergovernmental relations between the several states, particularly in regard to route continuity. One state would build a highway to the state line, and the highway would end there because the neighboring state would refuse to connect up the route. That problem has long since been solved and to a large measure the happy relationship that exists between the several states is due to the work of the American Association of State Highway Officials. Likewise, thanks to the efforts of American Association of State Highway Officials and the Bureau of Public Roads, we have a successful functioning state-federal partnership in the federal-aid highway field.

Help is needed in the matter of intergovernmental relations and largely the state itself as far as highway matters are concerned. This situation arises because in most states the different segments of our state highway network are under control of different road agencies. Benefits occur to each segment when all segments work together constructively.

While the NACE guide is concerned mainly with state-city relationships, all local agencies within a state that have highway responsibilities also are involved. The concepts of state-city relationships apply equally to municipal and township organizations, and improved relations will benefit each in the total network. In only five states are all rural roads under the jurisdiction of one road agency. In the other 45 states the respective legislatures have divided road responsibility between different road agencies. Underlying this division is the desire to keep local roads the responsibility of local agencies.

A number of considerations enter into intergovernmental relations. Some that could be mentioned are legal, financial (including both the collection and distribution of highway revenue), technical, and engineering considerations.

On the legal side, let me summarize by saying that among the 45 states in which different road agencies have delegated responsibilities for a part or parts of the road network, not a single state prohibits working relations between these agencies. On the contrary, and to various degrees, every one of these states has encouraged relations.

However, in a number of states, legislatures clearly spell out the responsibility of the different road agencies, give their definite goals, and provide working relationships between them. Many of these legislatures constantly review existing statutes and revise them to keep them up to date. In other states responsibilities are not clearly spelled out. Working relations are permitted but not required, and little attention is paid to keeping laws current with conditions.

While there are some good relations in spite of inadequate legal framework, these are exceptions. States that recognize relations between the various agencies have the advantage of clear directives through adequate laws and responsive legislatures that revise the legal frameworks to fit modern needs.

The obligation of the counties which have been granted road authorities, is to work effectively within the mandate of the legislatures. Counties are numerous and, to prevent a variety of road management types, standards, and practices, there is a need to standardize and coordinate their activities in order to assure a minimum level of performance by every county.

To carry out legal directives, specific procedures on what to do and how to do it are necessary. For example, state legislation may require a state-aid plan for county roads and establish a state-aid division responsible for the administration of the plan. This involves a series of cooperative actions or procedures between a state agency and each county and could include use of design standards, preparation of plans, contracts, reports and so forth. Because these procedures create the working relations, the individuals concerned must be in agreement as to need, purpose, and form of the procedures. Experience in the state shows the importance of this concept in producing good relations. Counties which become equal partners in preparation realize the benefit of the procedures and are willing to take part in their adoption.

The state highway department can exercise leadership and make suggestions pertaining to these procedures without dictating. Counties can take to the state departments the need for new procedures and revisions of existing practices. The principal areas where mutual concept principles can be applied are classifications, needs appraisals, preparation of advance road programs, budgets and records, reports, standards of design of construction, and maintenance.

Turning to the matter of finance, every state in which counties have road responsibilities has a physical plan to aid counties in road affairs through collection and redistribution of state-collected user taxes. Some states allocate funds on an outright grant with little or no reporting or control of these expenditures. In other states, while counties have complete control over the state funds that are expended, they must fully document these expenditures. In some states, the state aid is directed to a system of principal county roads, and control is exercised by approval of engineering plans, contracts, and final improvements.

Since the Federal-Aid Act of 1944, state aid to counties has increased because in some states federal-aid secondary routes are principal county routes. As federal-aid secondary funds are allocated to the state, its highway department is responsible for the allocation and control of these expenditures. To do this, the states where counties are involved with federal-aid secondary funds have established a secondary roads division within the state highway department to supervise the expenditure of these funds. This development has greatly increased the state-county relationship. In the development of desirable relations between state and county agencies, many of the involved relations are of a professional nature.

Several states are legally directed to work together. The experience of these states indicates that if a partnership status is to be obtained, both agencies should have similar qualifications for engineers. This allows them to meet as professional equals. An additional advantage is the legal opportunity for engineers to move from one agency to the other through the interchange of personnel. Such laws allow transfers between county and state departments with continuing service benefits. This allows a wider experience and a better understanding of each agency and provides the incentive for engineers to move to important positions in both state and county departments. This principle recognizes that an engineer qualified to conduct road activities for one agency responsible for part of the transportation system should be qualified and able to work for other agencies who have responsibilities for other parts of the system.

Legislatures in a number of states directly allow the highway department to assist in counsel with the county in a variety of highway problems which require relationship. Such legislatures require that state departments have staffs composed of specialists in various fields of engineering. The counties will benefit from use of their knowledge. The extent of such assistance varies between the different states. Policies in some states provide a state service provided that the counties will pay for other services.

The benefits of this counsel assistance to counties are many because special knowledge is needed in modern county road administration, traffic operation, unusual drainage design, and so forth. Other areas are in comprehensive planning, traffic information and projections, equipment, and construction specifications. So important is this service to many counties that legislation in many states requires highway departments to give such advice and assistance.

There are many states in which counties do not use engineers and qualified superintendents. Hence, the relations assume a different level and perhaps place a greater burden on the state highway department. Basic guides can be developed at this level and should be included in the manual.

These are some of the matters in the area of intergovernmental relations that need to be put down in manual form providing the information to all concerned. Those of us who have been actively working on the manual believe it should have broad sponsorship because of the interest to state, county, and municipal offices. By the same token, we are confident that the manual will have wide readership and render an important contribution to the advancement of highway transportation.

The preparation of this manual has been going on for three to four years. We are on about the fifth draft, which I think is good enough to call a firm first draft. As is our custom, this draft will be circulated to perhaps 40 or 50 engineers in both county and state highway departments throughout the country for a last review before the final writing. We do hope the final product of the Joint AASHO-NACE Committee will be published late this year.

PANEL DISCUSSION

COMPACTION OF ASPHALTIC CONCRETE

Presiding: Carl Minor

COMPACTION OF ASPHALTIC CONCRETE RESEARCH

by
Howard Sievers

I wish to present some background concerning the formation of the Joint Research Committee of the State of Washington Department of Highways and the Asphalt Paving Association of Washington. To my knowledge, our Joint Research Committee is unique in that it is the only one of its kind in the United States where the state highway engineers and contractors are cooperating jointly on research projects. This joint committee is composed of members of the State of Washington's Research Committee and members of the Technical Committee of our Asphalt Paving Association.

Fundamentally, this is a joint venture between highway department engineers and the asphalt paving contractors, working on the basis of mutual respect and cooperation between technical ideas that are formulated in the laboratory and the practical application and economic results that can be obtained in the field.

As to the historical background which gave our Asphalt Association authority to proceed on projects of this scope on a joint-venture basis, we had to have some kind of legal authority to do this, so I might read from the Article of Incorporation of the Asphalt Paving Association:

> "The objects for which this corporation is formed are: (1) To promote better relations between its members and public bodies. (2) To promote high professional standards in the asphalt paving industry. (3) To combat unfair trade practices and encourage efficiency among contractors and contractor's associations. (4) To encourage sound business methods tending to raise the standards of asphalt paving contractors generally in the business world."

Paragraph 5 of the covenant is to furnish members expert counsel and advise them on all phases of asphalt paving construction activities, including study, analysis and reports, with recommendations on technical problems and questions.

Paragraph 6 provides for the collection, compilation, and distribution to the members and others by bulletins, radio, news advertising, billboards, or other media, the current information on new and improved methods in asphalt paving construction.

The foregoing objectives were recognized by our association at its inception, but it was not until 1963 that we realized there was an urgent need for locally obtaining more information regarding certain phases of our industry--locally in the state of Washington. This affected the quality and cost of our finished products. Subsequently in 1964, a technical committee was appointed from our association and funds were allocated to proceed with an investigation of forming a joint research committee between the State of Washington Department of Highways and members of the Technical Committee of the Asphalt Paving Association of the state of Washington.

Here I wish to bring out the point that I am unable to report on the history of the formation pertaining to our Asphalt Paving Association, and I do not have the facts available which gave authority for the State of Washington Department of Highways to be a member of a joint research project of this nature.

After we formed and arrived at a joint venture, we held our first meeting on January 5, 1965, where the following rules and regulations were adopted:

1. The Joint Committee on Research on Asphalt Paving shall have authority to designate and set up such research projects on asphalt paving as may be determined by the committee to be beneficial to both organizations.

   In other words, any of our projects must be beneficial to both organizations--the projects must be impartial.

2. The cost of such research projects shall be shared by the Highway Department and the Asphalt Paving Association of Washington in a manner to be determined by our Joint Committee.

3. The extent of the financial participation by both parties will be determined by the Joint Committee at the time the test project is approved and an estimate of cost is prepared.

   In other words, prior to starting any project there would be a definite contract between the State and the Asphalt Paving Association as to financial arrangements and what portion each one of us would take.

4. The Highway Department shall have authority and responsibility to evaluate all of the data obtained from research projects developed by the Joint Committee.

5. The Asphalt Paving Association of Washington shall have full access to all of the data obtained in the joint research projects sponsored by the committee.

6. No release of any of the data obtained from the joint research projects may be made without the approval of the Joint Committee.

7. Regular meetings of the Joint Committee shall be held on a quarterly basis; however, special meetings deemed necessary can be called by the chairman.

8. The Joint Committee will make a report on the progress of all test projects each year at the annual meeting of the Standards and Specifications Committee between the State Highway Department and the Asphalt Paving Association.

In our committee we have an almost unlimited number of future projects we would like to proceed with, and these projects are probably equal in importance to the ones we attempted this last year.

I would like at this time to express our gratitude and thanks to the Washington Department of Highways and all the members who have contributed so unselfishly of their technical knowledge and time. Many beneficial results have been obtained in the first year of our operation. These results demonstrate convincingly the many benefits of working cooperatively in serving the traveling public by research to provide quality pavement surfaces at the lowest cost.

COMPACTION OF ASPHALTIC CONCRETE FIELD APPLICATION

by
Walter Kastner

I represent the contractor, and I would like to reemphasize the importance and real significance of this type of research project in which the state and the contractor cooperate in practical application in the field.

I think we are all aware that asphalt concrete is probably the most complex and difficult construction material to analyze. It goes through a number of stages in its application. It exhibits elastic properties, plastic properties, or a combination of both of these, depending upon the temperature and the rate of loading the material. To compound these problems, various types of laboratory compactors all exhibit different properties than we can achieve in the field under the rolling technique.

It, therefore, seems best to take the laboratory to the field. This is the best place to actually get some basic knowledge of what asphaltic concrete can do.

The basic or fundamental property for good asphaltic construction is compaction. If we can reduce the void content of asphaltic concrete somewhere to around 10 percent (preferably about 8 percent), we are sure that we will have durable, stable, and smooth-riding asphalt concrete roads. Void content is an important property and one of the basic things we wanted to study in this project.

Experience over a period of years shows that actually we are not compacting asphalt concrete sufficiently. The field samples are too high in void content and this results in early deterioration. So, the main objective is to reduce this void content.

Our first project was to determine the effect on density and riding quality of laying asphaltic concrete with a thicker lift. Also we wanted to test the use of a rock-laying machine for a thicker base lift and see what roller pattern would best achieve the required density.

In establishing the Joint Committee, both the state and the contractor furnished personnel. The contractor on our first project had two men, and the state furnished two men under the direction of Paul Rensel. These teams checked temperatures, counted rolling passes and sequence, recorded air flow readings, and so forth. The result of this will be presented by Paul.

In starting the project when we calibrated our rollers, it was interesting to discover what we did not know about rollers. Our 10-ton rollers were closer to 8 tons, our 8-ton rollers were closer to 5 tons, and our rubber-tired rollers were completely out of balance.

It took about two days to juggle ballast back and forth in order to get the proper weight over each axle so each wheel had the same load. We were attempting to get about 2,000 pounds per wheel. It would be surprising if you were to take a check on your rollers in the field right now and see how far out of balance they might be. It means nothing if you put the same tire pressure on a roller and do not have the same load on each wheel. The contact pressure will be different for each tire. So, it is very important that the rollers are calibrated (especially the rubber-tired rollers) before you start your rolling operation.

During the operation we found some very necessary features in the design for rubber-tired rollers. Namely, when the rubber-tired rollers were used for breakdowns it became evident that the spacing of the tires for proper overlap, placement of the tires with respect to the body (such as ample clearance), the positraction drive to pull out of deeply rutted mixtures, and the use of heavier rollers and larger tires produced denseness and neatness with a minimum of effort. It is this type of study that will help not only the state, but particularly the contractor, in selecting the proper roller to do the best job most economically.

In setting up the project, the contractor reimbursed the state association (Washington Asphalt Paving Association) for any extra cost that would occur. We were interested not particularly in what rollers were on the job but what rollers would give the proper void content. If a roller was not doing a proper job, then that roller was replaced with another that would achieve the results we wanted.

In order to permit the contractor to progress with his work with a minimum of interference, there was a briefing session each morning. The contractor's representative and the research team would establish the program for the day. A very important part of this research program was to set up a good communications system between the members of the group. This morning briefing contributed to the success of the operation.

After the briefing, the team would lay out certain sections where testing was to be done. The complete history of the construction was recorded: lift thickness, laydown temperatures, breakdown temperatures, number of rolling passes, air flow, records at various stages of rolling, and so forth.

The only interference to the contractor would be a change in the rolling pattern, which always disturbs an operator who may be used to a set method of rolling. However, outside of the time taken for the morning briefing and slight changes in construction procedures, the research project can be run with very little interference to the contractor. In future projects, when research teams become more experienced in techniques, the research should proceed with no interference to the project.

The contractor realizes the great benefits that can be realized in this cooperative effort with the State Highway Department. We are indeed fortunate that the Department is so cooperative and willing to stimulate this program. As a result of this program, our association in the state of Washington has set aside an initial budget of $20,000 for research and tools for these studies. It is apparent in Washington that research on the local level is much more important to us than work done on a national scale. I think the reasons why this is true are fairly obvious: climate, aggregate source, topography, and other factors which are peculiar to each locality. Although national research is valuable, it must be tried on local levels to ensure proper adaptation.

The success of this program can only be realized by our active participation and continued effort in selection of worthwhile studies for research. Most important is that the results and information are immediately distributed to all participants through publications and training schools. The first efforts have been very successful, as evidenced by the fine publication the State Highway Department has edited, and there are plans for several seminars to discuss this with state and contractor personnel.

The practical application of this type of research program is one of its very important features. This was evidenced last year by the application of our research to lay thick lifts on current jobs and the use of rock-laying machines on present black base construction. Since this program, several hundred thousand tons have either been let or advertised for black base construction in a single lift and laid with a rock-laying machine.

We, as members of the Washington Asphalt Paving Association, know that we will benefit greatly from the knowledge we will gain, and this in turn will be reflected in better quality work. The State Highway Department will benefit by having a much clearer concept of what to achieve from asphaltic pavement based on actual experience rather than specifications.

All the data from the rolling application we have collected on our first effort have stimulated further research. We have not decided on the actual project for next year's program, but it is under study now and likely will include further compaction studies and pavement smoothness studies with emphasis on the use of aggregate and black base construction. The final schedule will be decided by the Joint Committee.

THE EFFECT OF PLACING METHODS AND LIFT THICKNESS ON DENSITY AND RIDING QUALITIES OF ASPHALT CONCRETE

by
Paul Rensel

(Note: This report by Paul Rensel is reproduced here as it was originally submitted to the Asphalt Paving Association and Washington State Highway Department. Several photographs have been omitted, however).

In February 1965, at the suggestion of the Asphalt Paving Association of Washington, the Association and the Washington State Highway Commission, Department of Highways, formed a Joint Research Committee to investigate problems of mutual concern in the general field of Asphalt Pavement Construction.

The group delegated to a special subcommittee responsibility for the selection of suitable research problem areas. On the recommendations of the subcommittee, the Joint Committee selected for the first study area the "Effect of Placing Methods and Lift Thickness on Density and Riding Qualities of Asphalt Concrete."

The Joint Committee consisted of the following members:

Howard Sievers - Asphalt Paving Association - Chairman
Carl E. Minor - Department of Highways - Vice Chairman

Association	Department of Highways
Walter Kastner	C.K. Glaze
George Mason	V.G. Rinehart
Rich Hewitt	H.W. Humphres
Frayne McAtee	W.W. Jayne
J.D. Shotwell	J.L. Stackhouse
Clifford Gailey	George Stevens
R.P. Collucio	W.E. McKibben - Ex-officio
Vaughn Marker	
Carl Kilgore - Ex-officio	

The Committee agreed that the cost of the experimental work would be shared equally by both parties, that the general conduct of the experiments, collection of data, and analysis of results would be controlled by the Department of Highways and that the Association would provide up to two technicians to assist in data collection with the technicians administratively responsible to the Department of Highways during the actual progress of the work.

Summary

The effect of placing and lift thickness on density and riding qualities of asphalt concrete was the purpose of investigations on two projects just completed.

The work was planned and carried out as a result of a cooperative effort between the Asphalt Paving Association of Washington and the Department of Highways. In addition to the stated purpose of the experimental work, a good opportunity was provided to explore more fully the potential of high-pressure pneumatic-tired rolling and the application of air flow testing to compaction control. A minor experiment of placing asphalt base with a rock spreader was so successful that it was repeated later in the project. The role of placing thickness, cooling curves, and rolling temperatures on final pavement density had not been previously examined in detail.

For the first time, ride tests were made with more than one instrument on the several pavement lifts as constructed to determine how a "ride" is built. Future work with automatic screen controls and a comparison of spreading machines will benefit by the information gained in these studies.

That portion of the collected information that confirms and extends previous studies by the department on compaction and its control can now be used with more confidence in the development of new asphalt pavement design and specifications. Much of the information can be practically applied to construction and testing of the pavement without changing a line of the specifications.

As a result of this and previous studies, the following statements may be made. They are intended to apply to new construction. Some are firm enough to serve as a basis of action. They are valid within the framework of our experience with the materials and under the conditions by which we operate.

1. Density of asphalt concrete can be improved by:

    A. Increased lift thickness
    B. High-temperature compaction
    C. High-pressure pneumatic-tire breakdown rolling
    D. Increased steel roller weight

2. The final riding qualities of the pavement do not appear to be significantly affected by:

   A. Placing the asphalt base in one, two, or three lifts or by its method of compaction.
   B. Placing the leveling course in one or two lifts or by the compaction method.

3. Asphalt base mixtures can be spread in thick lifts by a rock spreader as well as by conventional paving machines.

4. The pneumatic-tired roller can be used in any assignment for compaction of asphalt mixtures. It is most effective in the breakdown position.

5. The nature of the underlying surface does not appear to affect the efficiency of the pneumatic roller in the breakdown position.

6. A mixture that must be redesigned to prevent its cracking, cutting, and shoving under a steel roller may present no difficulty to pneumatic breakdown rolling.

7. There is a relationship between compactor tire sizes and compaction depth, not fully explored, in favor of larger tires for thicker lifts.

8. The approximate number of rollers required to insure optimum compaction with pneumatic breakdown can be determined by the development of a simple table relating thickness, paving speed, and production.

9. Pick-up of the mix on the pneumatic tires is eliminated when their surface temperature reaches at least 140° F.

10. An air flow (permeability) device can be used to control compaction.

Definitions

Wherever mentioned in this report, the following expressions have a special meaning.

Density

Expressed in terms of the volume of air voids related to a voidless mass. 8% air voids is presently considered an optimum value for the wearing surface course. Voids as low as 4 to 5% may be desirable in lower courses.

Air Flow

Related to the air permeability of the pavement, air flow is the time in seconds for 300 milliliters of air under 0.25 inches of water pressure to flow through a 4-inch diameter area on the pavement surface.

Pass

The movement of a piece of rolling equipment in a single direction over an area on the pavement as wide as the equipment.

To be more accurate, a pass should mean the passage of a wheel over an area on the pavement the width of the wheel.

Examples:

1. A 3-axle tandem roller will apply three passes or loadings, one each wheel to an area, while the roller and operator travel just once over the area.
2. Disregarding slight overlapping of the wheel tracks, a 3-wheel steel roller and a pneumatic roller will apply one pass or one loading to an area, while the roller and operator travel once over the same area.

It may be that this definition will be applied in future studies.

Compaction

The expressions, "breakdown, intermediate, and finish" have been traditionally used to describe the operation or position of various rollers; each contributed in part to the final density of the pavement. However, with the use of the high-pressure pneumatic-tired roller directly behind the paver, it would be more accurate to describe its assignment as compaction roller because its action alone appears to impart the necessary density to the pavement. The steel wheel roller merely assists the pneumatic by edge-rolling and flattening small ridges left by the pneumatic in a "blanket" roll. In this assignment, the steel roller is not intended to compact or densify the pavement.

Pick-up

Two types of pick-up have been generally observed with pneumatic tire rolling.

One type is where sand/asphalt mortar collects along the outer edge of the hot, dry tires. Removal of this material causes a textural change in the surface of the mat but except for visual evidence that a pneumatic tire has passed, it is no problem. These slight marks or shadows will be removed by subsequent traffic or the surface may be treated with a light fog coat of emulsion.

The second type of pick-up permanently scars the surface as cold or wet tires move into the mix when its temperature drops to 140 to 150° F. It is most pronounced when the roller is reversed. It can be prevented by rolling off the mat to reverse the roller or by water or tire treatment.

Ride Analysis

A "ride" evaluation is a very complex and difficult matter because it is so subjective. However, there are certain variations in the surface that can be measured in "inches per mile" with roughometers. A reduction of these variations to a minimum results in a more comfortable ride. In this investigation, a comparison of "inches per mile" plus a visual examination of the pavement was used to evaluate the riding qualities. The information is preliminary in nature; no particular attempt was made to reduce the ride count, simply to measure it.

Mix Design and Control

Interpretation of some parts of this report depends on a familiarity with design and control measures used for dense graded asphalt concrete in the State of Washington. Basically they include the features of the Hveem Stabilometer system combined with some of the concepts advocated by McLeod of Canada for use with the Marshall method.

Key

Where compaction equipment is listed in this report, it is abbreviated in the following way:

10TPN(90) = 10 Ton Pneumatic, 90 psi Inflation
10T2A = 10 Ton 2 Axle Tandem Steel
10T3W = 10 Ton 3 Wheel Steel

Introduction

Plans and specifications must be used to insure the orderly progress of any paving project. Good practices and procedures, developed over a period of time, become standard plans and specifications. They become the "book." That each project differs and new knowledge is accumulated is recognized by the design engineer when he includes a group of special provisions to add to or modify the standards. However well planned and engineered a project may be, there are areas of construction where the "book" is silent; there are other areas where the "book" is incorrect.

Decisions or modifications must be made on the spot by the project engineer. If these decisions or changes are successful, they gradually become specifications for later projects. Once accepted as standard and printed in the "book," however, they tend to become "frozen." Some of them are even copied over and over again into new specification manuals without critical appraisal because it is impossible for the specification writer to examine them all in the light of new methods and procedures that are constantly being developed.

Research and development procedures are designed to speed up the process of specification improvement. An aggressive research division should be included in all well-organized highway departments.

No two paving projects are alike in every respect; even the second half of one project profits by the experience and knowledge gained from the first half. Location, weather, materials, equipment, timing, and manpower cannot be duplicated with any precision on any two projects. Therefore, it is important that paving research exploits to the fullest extent possible the opportunities provided by each project studied. By its very nature, research is permissive; it allows the engineer and the contractor to break the rules, or at least bend them, to find improved procedures.

Remembering the size of the investment and its relative permanence, it is important that the job not be damaged in any way by the broken rules or experimental work. On the contrary, the net result should be one of job improvement. As long as the main objective of the study is kept in view, even the ground rules or specifications that are set up before the study begins must be subject to alteration by positive or negative findings as the investigations proceed. This fluid approach to research was used on the two paving projects that are the subject of this report.

Investigation

Synopsis
Project No. 1

Experimental test sections of asphalt base totaling two and one-half miles were constructed on a four-lane freeway west of Olympia in May and June, 1965.

Placing

The 1-1/4" minus dense graded base was placed to design thickness of 0.35' in one, two, and three lifts with a conventional asphalt spreader and finisher. In addition, a rock-spreading machine pushed by a Caterpillar tractor was used to place the mix in a single lift of 0.35'. Two 12-foot lanes approximately 4,000 feet long were placed in this manner. All the asphalt base was covered by two lifts totaling 0.25' of 5/8" minus dense graded asphalt concrete.

Compaction

Compaction equipment included three types of steel wheel rollers and four high-pressure pneumatic-tired rollers, one with air pressure variable from 30 to 105 psi (11 x 20 tires). Each roller was tried in various positions on the thirty or more test sections. When the pneumatics were used in the breakdown or intermediate position, the hot, dry tire technique was used.

Testing

Cooling curves were obtained in each section by thermocouples buried in the mix at various levels. Air flow tests were taken to correlate with mix density as determined by core analysis for each section. The mix was designed to be stable with void content of laboratory compacted samples at 3%. The intended optimum void content for the compacted pavement was set at 8%.

During and after completion of construction, smoothness measurements were made by a BPR Roughometer, a California type Profilograph and a Washington State Roughometer.

Synopsis
Project No. 2

The second project on which experimental tests and procedures were carried out was a three-mile section of freeway near Moses Lake in eastern Washington in August 1965.

It was selected to be typical of projects involving high mix production rates that are expected to be more common in the future. An attempt was made to determine the most effective use of rollers usually available for compaction and the number that would be necessary to keep pace with production rates up to 400 tons per hour.

Placing

The dense graded asphalt concrete was placed over CTB to a total thickness of 0.35' in two lifts on the eastbound lanes, and in three lifts on the westbound lanes by two conventional spreading and finishing machines. The pavers were operated singly and in echelon, at various times at speeds up to 70 feet per minute. However, most of the mix was laid at 30 to 39 feet per minute. Paving widths were mostly 12 feet--some were 10 feet and others 16 feet wide. An effort was made to establish uniform compaction conditions by placing the mix on the roadway at 300° F and using the same number of passes or coverages on each lift for the full length of pavement.

Compaction

Rolling equipment included two high-pressure pneumatic-tired rollers and three steel wheel rollers. The rolling pattern commonly used was a pneumatic in the breakdown position operating closely as possible to the paving machine with hot, dry tires. This was followed by one of the steel rollers making a single coverage to roll the edges and smooth the mat. One of the steel rollers was also used to finish rolling the mat.

Testing

Air flow tests, cooling rate curves, core densitites, and smoothness determinations were made as each course was placed. The mix design criteria used was the same as that for Project No. 1.

The following pages compare the two projects, the equipment used, the tests made, and the changes in experimental plans.

EXPERIMENTAL ASPHALT CONCRETE PAVING PROJECTS SELECTED TO BE TYPICAL AND REPRESENTATIVE OF WASHINGTON STATE CONSTRUCTION

I. Description	Project #1	Project #2
Paving Studied	Base	Leveling and Wearing
Paved Over	Crushed Gravel	Cement-Treated Base
Climate	Cool and Wet (May) (West)	Hot and Dry (August) (East)
Length, Miles	2.3	3.5
Width, 12' Lanes	4	4
Tons Asphalt Concrete	14,000	38,000
II. Equipment		
Mixing Plant	Batch	Continuous
Production T.P.H.	100	400
Spreading Machines	1 Conventional 1 Rock	2 Conventional
Total Thickness	0.35'	0.35'
Number of Lifts	1, 2 & 3	2 & 3
Compaction Equipment Available	4 Pneumatic 3 Steel	2 Pneumatic 3 Steel
Breakdown Rolling Variations	7 Pneumatic 3 Steel	8 Pneumatic
III. Mix Design		
Mineral Aggregate	Basalt-Ledge	Basalt-Gravel
Size Aggregate	1-1/4" - 0	5/8" - 0
Asphalt Grade	85-100	85-100
Asphalt Content	4.8	5.1
Asphalt Absorption	0.57	0.24
Stabilometer	30	34
Cohesiometer	500	220
% Voids	2.8	3.4
% Voids in Mineral Agg.	14.6	15.6
% Voids in Mineral Agg. Filled	80.8	78.2
Weight/Cubic Foot (Lab)	161.2	155.9

EQUIPMENT USED

Project #1

Compaction

Type	Tires	Weight	With Ballast	Inflation PSI Front	Inflation PSI Rear	Width
Pneumatic	9 - 7.50 x 15 12 Ply	14,910		106	101	5'8"
"	9 - 7.50 x 15 14 Ply	19,000		90	90	5'8"
"	9 - 7.50 x 15 12 Ply	19,700		90	90	5'8"
"	7 11.00 x 20 18 Ply	16,360		30# to 105#		6'3"
	Water Ballast		26,650	30# to 105#		
	Wet Sand Ballast		33,700	30# to 105#		
Steel	2 Axle Tandem	16,390				4'6"
"	3 Axle Tandem	26,600				4'6"
"	3 Wheel	20,410				7'0"

Paving

Barber Greene
Blaw-Knox Rock Spreader

Project #2

Compaction

Pneumatic	11 - 7.50 x 15	22,215	25,000	7'0"
Steel	2 Axle Tandem	16,155	20,000	4'6"
"	2 Axle Tandem	20,000	24,000	4'6"
"	3 Axle Tandem	28,215	34,000	4'6"

Paving

		Speed
Barber Greene	Model B	35' Min.
Blaw-Knox	PF-180	39' and 70'/Min.

COMPACTION PRESSURE 7.50 x 15 TIRES 12 PLY
11 TON 11 TIRE PNEUMATIC

Roller Wt.	Wheel Load	Pressure - PSI				
22,500	2000	Inflation	50	70	90	110
		Contact	53	61	69	75

TABLE OF TEST SECTIONS

Project # 1

Thickness	Breakdown Equipment		No. Test Sections
.175'	9 Ton Pneu.	80 psi	1
.175'	9 Ton Pneu.	90 psi	1
.175'	10 Ton 2 Axle Tandem Steel		4
.175'	10 Ton 3 Wheel Steel		3
.35'	13 Ton 3 Axle Steel		5
.35'	17 Ton 3 Axle Steel		2
.35'	9 Ton Pneu.	80 psi	3
.35'	13 Ton Pneu.	90 psi	5
.35'	17 Ton Pneu.	80 psi	4
.35'	17 Ton Pneu.	40 psi	1
.35'	17 Ton Pneu.	40 to 80	1

Project #2

		Spreader Variations
. 10'	All Pneumatic Breakdown with 11 to 12. 5 Ton 80 to 90 psi Inflation	Single Paver
. 10'		2 Pavers
. 10'		2 Pavers and 2 Pneu.
. 15'		Single Paver
. 15'		2 Pavers
. 15'		10, 12, and 16' Wide
.20'		Single Paver
.20'		2 Pavers

	Air Flow Tests	Cores	Density Tests	BPR Roughometer	Profilograph
Project #1	334	200	250	45 Miles	30 Miles
Project #2	500	140	300	62 Miles	62 Miles

CHANGES IN THE PLANNED RESEARCH

	Planned	Changed	Reason
Project No. 1			
1.	To place shoulder rock after asphalt base paving	To placing before paving bladed as berm for rolling	To provide roller support on edge, prevent undulations
2.	Equal lengths 0.175' and 0.35' lifts	More 0.35' lifts	Improved density
3.	Equal steel and pneumatic breakdown rolling	More pneumatic rolling	Improved density - new type roller, variable tire pressure available
4.	Standard rolling pattern outside edge first	Keep pneumatic or steel away from edge 6" - 8"	Minimize edge undulations; compacted mat supports roller when edges are rolled last. Thick lifts amplify problem.
5.	To place 1,500 feet with rock spreader	Placed 4,000 feet with rock spreader	First section more successful than expected.
6.	To test mostly by air flow	Tested mostly by core density	Poor weather, rain, hail, etc.
Project No. 2			
1.	Equal steel and pneumatic breakdown rolling	All pneumatic breakdown	Mix shoved and cracked with steel. Had to be altered to accept rolling. No problem with pneumatic.
2.	Pneumatic, steel, steel rolling pattern	Pneu., Steel, Pneu., Steel & Pneu., Pneu., Steel, Steel rolling patterns	To heal steel cracks, to keep up with high production.

RESULTS SUMMARIZED IN EXIBIT FORM

Results of the investigation are presented, one main idea to each page in the following series of exhibits.

The first three illustrate typical effects of placing methods and lift thickness on density.

Representative "roughometer" ride information is included in the next four exhibits.

The important relationship of asphalt viscosity to temperature and rolling procedures is shown in Exhibit No. 8.

Suggested rolling patterns for pneumatic and steel breakdown are shown in Exhibits No. 9 and No. 12.

Exhibit No. 10 shows how the selection of equipment and paving widths affects the lateral density of the pavement.

Tire surface temperature is related to "pick-up" in Exhibit No. 11.

Air flow testing and its application to compaction analysis is the subject of Exhibit Nos. 13, 14, and 15.

Time has not permitted further exploration of the possibilities of more effective steel rolling patterns suggested in Exhibit No. 14. Two ten-ton rollers exert twenty tons of pressure on the pavement in about the same time interval as required for one roller. A sharp decrease in permeability and possible increase in density is noted.

A simple table was made to estimate the number of pneumatic rollers that would be required on a project to achieve optimum density. See Exhibit No. 16.

EFFECT OF CONSTRUCTION VARIABLES ON ASPHALT CONCRETE PAVEMENT DENSITY

(SEE EXHIBITS IN APPENDIX)

Project #1 100 - 120 Tons/ Hour

		Lift	Breakdown	% Voids
2 Lifts 0.17'	1	1	10T3W Steel	11.3
		2	10T3W Steel	10.8
	2	1	13TPN(90) Bd.	6.5
		2	10T2A Steel	9.1
	3	1	13TPN(90) Bd.	6.4
		2		10.8
1 Lift 0.35'	4		13T3A Steel	8.2
	5		13TPN(90)	6.6
	6		17TPN(40-80)	6.8 Hot 11.1 Col
	7		10TPN(90)	6.3 Hot 9.3 Col
Rock Spreader	8		13T3A Steel	6.5 Slow 9.4 Ra 9-12 Pass 4-7 Pas
1 Lift 0.35'	9		17T3A Steel	6.6

With this table, there is a danger of oversimplification. However, it should be noted that in every instance (except for cold mix) the pneumatic breakdown produced a void content of about 6.5%. This is true without regard to net roller weight, thickness, or subpavement. While the information is not listed here, 10-ton pneumatics were also more effective than their steel counterpart in the breakdown position for the 0.17' lifts.

A relationship of about 11% voids for standard rolling practices versus about 8% voids for high pressure pneumatic breakdown has repeated itself on several projects with a wide range of construction variables. 1% void difference = approximately 1.5 pounds per cubic foot.

EXHIBIT NO. 1

DENSITIES OF PAVEMENT
PLACED BY TWO METHODS

Project #1

Paving

Tow Lifts	Single Lift
Barber Greene	Blaw-Knox Rock Spreader
0.175' Each Lift	0.35' Thick
2 Lanes, 4,000 Feet	2 Lanes, 4,000 Feet

Core Density

11.3	6.6
10.6	6.0
12.1	6.2
9.5	5.9
7.9	5.8
7.2	6.3
12.1	7.1
8.9	6.2
10.0	7.7
10.0	7.6
9.3	7.2
9.9	6.6

BPR Roughometer
Inches/Mile

130	133

Compaction

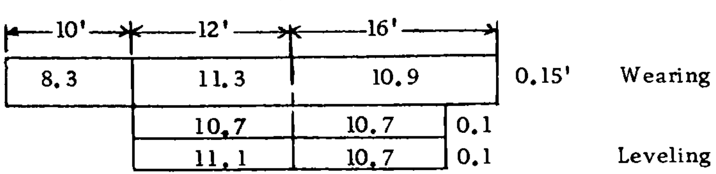
1st Lift		Single Lift	
Bd.	17T3A	Bd.	17T3A
Int.	10TPN(70)	Int.	10TPN(70)
		Finish	10T2A

2nd Lift	
Bd.	10TPN(90)
Int.	10T2A

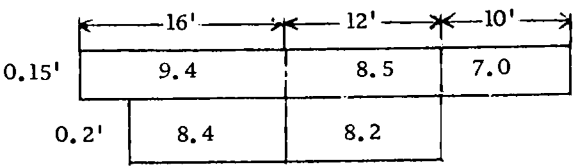
Note the higher density (low voids) with the single lift. No significant difference in roughness indicator.

EXHIBIT NO. 2

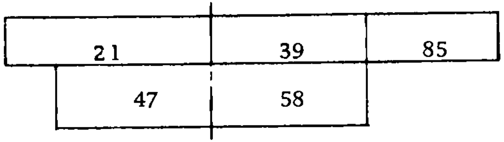
CORE DENSITY PAVEMENT PROFILE



Average Void Values for 3 Miles



Average Void Values for 2 Miles



Average Air Flow Values for Above Area

A greater number of construction variables are included in these results, but generally the L Line, placed in three lifts, has the lower overall density. Note best density obtained on each 10' shoulder. The BPR Roughometer readings for both Lines are identical.

TEST SUMMARY

R. Line

% Voids		Air Flow	
Average %	No. Cores	Avg. Seconds	No. Readings
7.0	21	85	24
8.2	16	58	59
8.4	16	47	47
8.5	16	39	73
9.4	8	21	94
	77		297

EXHIBIT NO. 3

BPR ROUGHOMETER VALUES

Maximum and Minimum

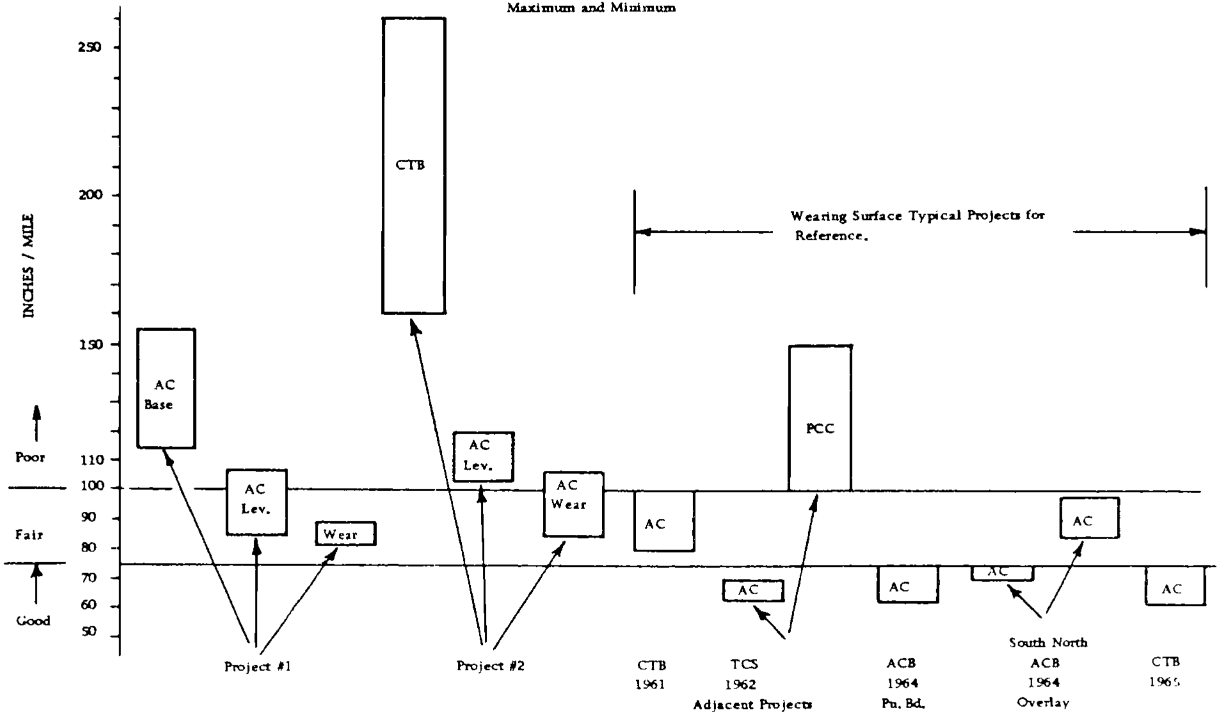


EXHIBIT NO. 4

BPR ROUGHOMETER (INCHES/MILE) (20 MPH)

Project #1

R Line 2 Miles	Left		℄	Right		
.15' Wearing	84	88		86	86	
.10' Leveling	105	92		87	104	
.35' Base	117	129		143	152	(2 and 3 Lifts)

WASHINGTON ROUGHOMETER (INCHES/MILE) (35 MPH)

R Line 1 Mile	Left OWP	℄	Right OWP
.15' Wearing	14		12
.10' Leveling	21		21
.35' Base	55		34

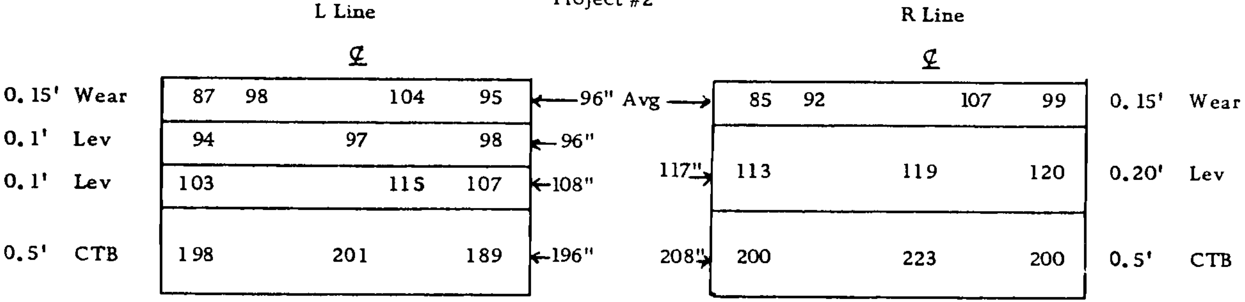
BPR ROUGHOMETER

L Line 2 Miles	Left		℄	Right		
.15' Wearing	90	76		82	84	
.15' Leveling	105	92		108	84	
.35' Base	---	--		---	--	(1, 2, and 3 Lifts)

EXHIBIT NO. 5

BPR ROUGHOMETER
INCHES/MILE
3+ MILES

Project #2



WASHINGTON ROUGHOMETER
INCHES/MILE

EXHIBIT NO. 6

TYPICAL BPR ROUGHOMETER VALUES

0.5' CTB + 0.2' Leveling + 0.15' Wearing

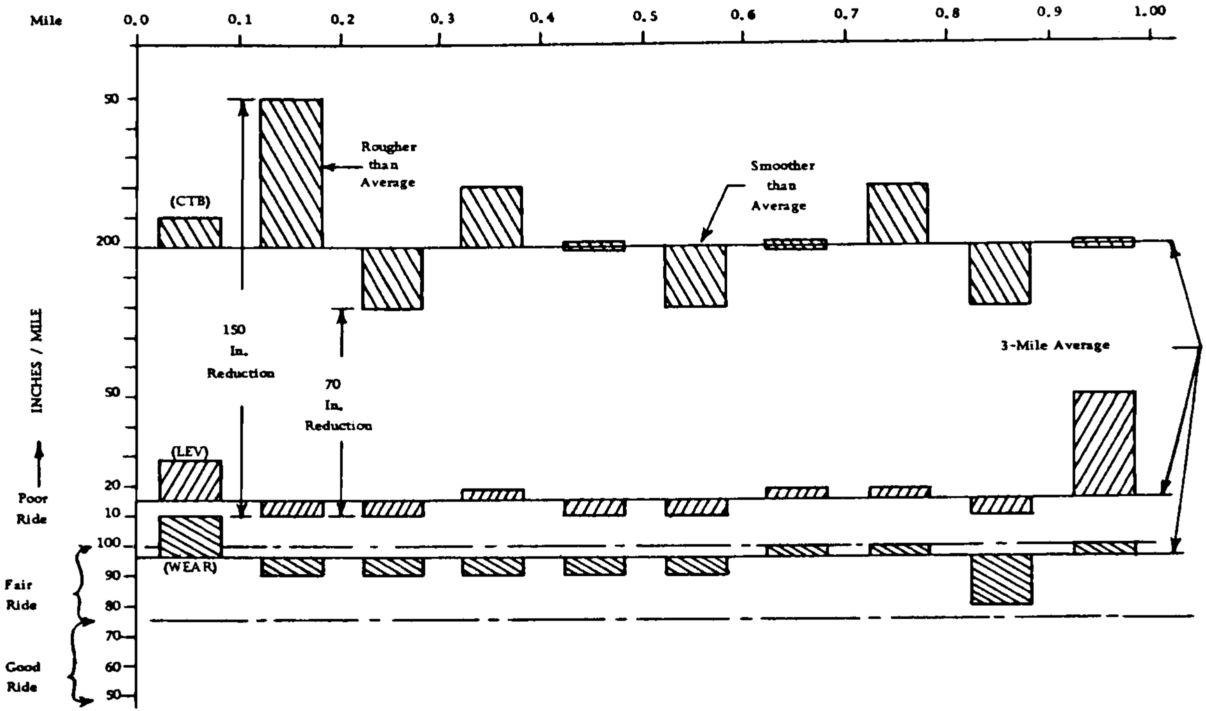
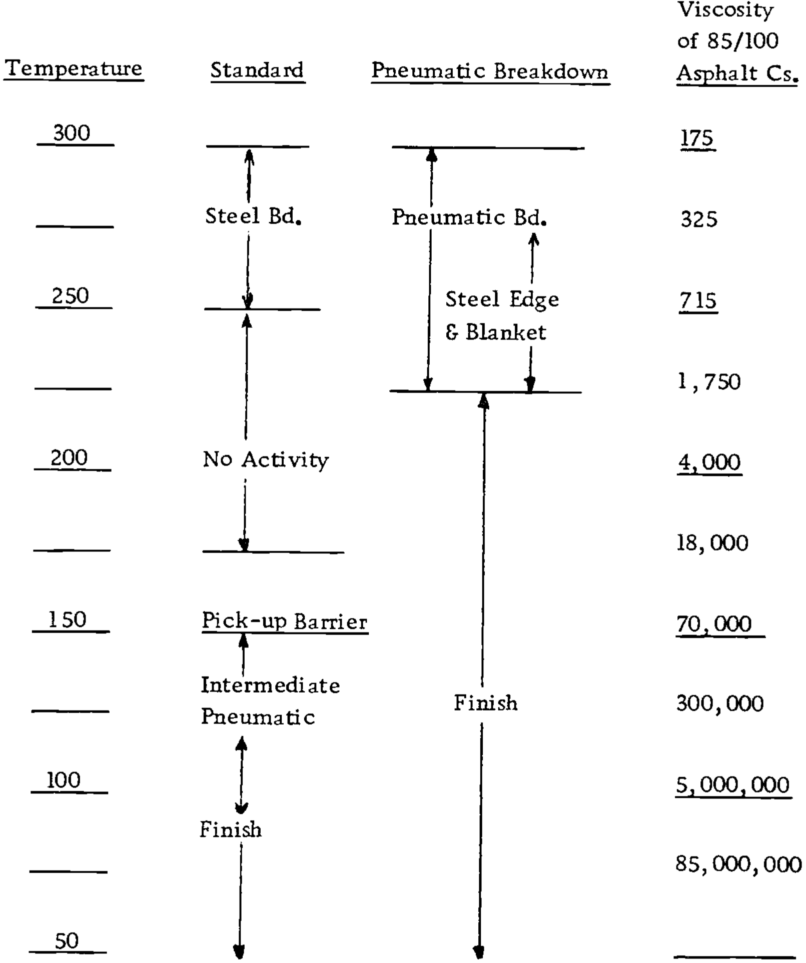


EXHIBIT NO. 7

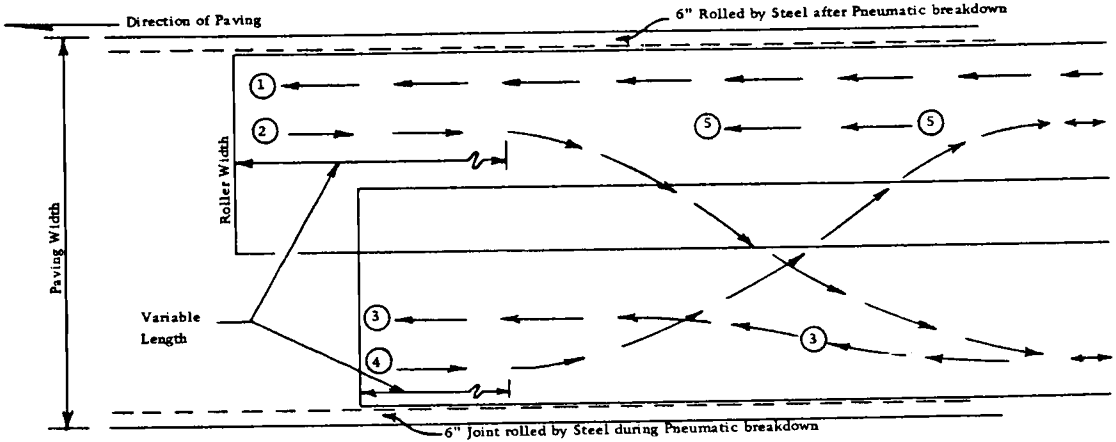
TEMPERATURE - COMPACTION - ASPHALT VISCOSITY
ROLLING OPERATION



With the standard pattern, the compactive effort of the pneumatic roller must be delayed until pick-up is no problem. In the meantime, the viscosity of the asphalt has increased tremendously thus inhibiting compaction. With pneumatic breakdown and steel blanket rolling, compaction is complete before mix reaches 225° F. Viscosity of asphalt is low and offers little resistance to compaction.

EXHIBIT NO. 8

ROLLING PATTERN
OF
PNEUMATIC BREAKDOWN



Length of each section is determined by pavement cooling rate. Entire breakdown compaction should be completed (including steel blanket roll) before mix reaches 225° F for highest efficiency.

Roller moves very slowly on the first pass; the speed is increased gradually as each section is completed.

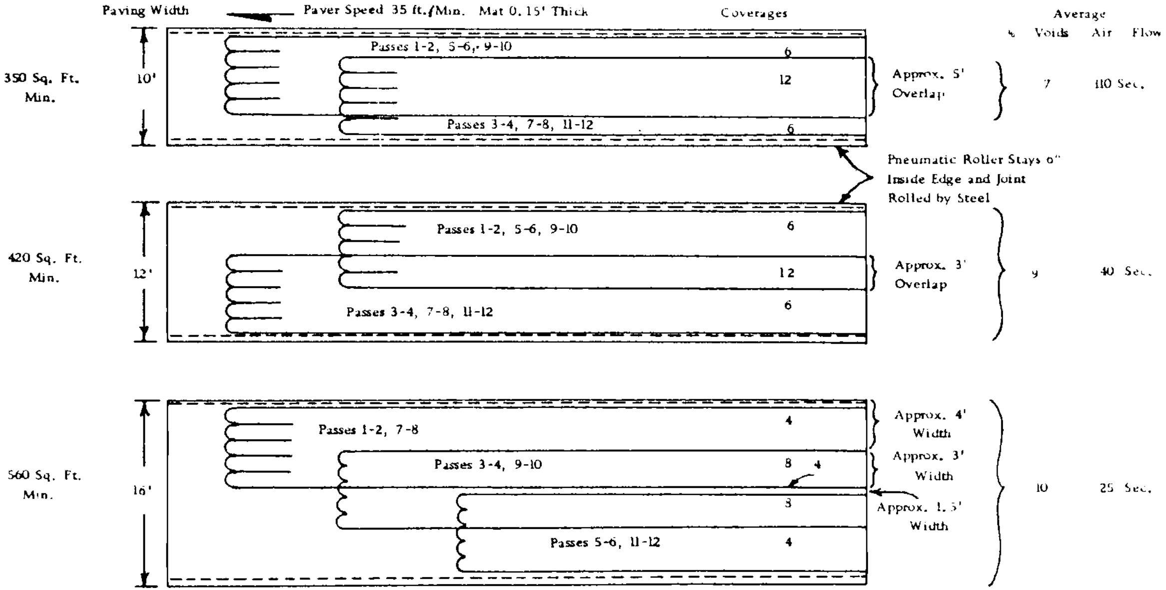
The roller moves very slowly each time it moves into the fresh hot mix to avoid a bump where it leaves the compacted mat.

Roller turns are made on the cooler compacted end of the section.

EXHIBIT NO. 9

COMPACTION NON-UNIFORMITY
WITH
7 FOOT WIDE 11-TON PNEUMATIC ROLLER

(Results of an Equal Number of Passes)



Conclusion: Minimum of 8 to 10 passes required over each portion of pavement to insure 8% voids.

EXHIBIT NO. 10

TIRE SURFACE TEMPERATURE RELATED TO PICK-UP OF MIX

Air Temp. 70 - 90° F

Mix Surface Temp.	Tire Surface Temp.	Pick-up Condition
140	100	Severe
140	110	Severe
160	105	Some
205	120	Some
160	140	Very little
240	140	No Pick-up

TIRE SURFACE TEMPERATURE RELATED TO TEMPERATURE OF THE MIX

Air Temp. 65 - 70° F

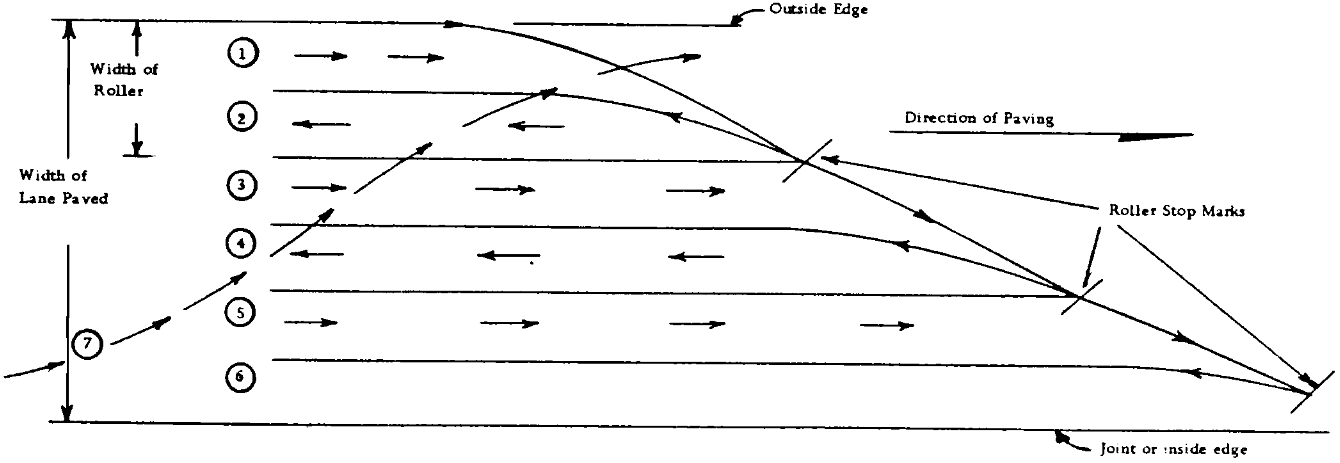
Mid	Surface	Tire Surface Temp. ° F		Pick-up
Mix ° F	Mat ° F	Outer Tire	Inner Tire	Condition
280	180	160	---	None
260	195	175	185	"
255	190	165	170	"
250	205	160	165	"

Tire surface temperature taken by thermocouple. Technically difficult to make rapid and accurate measurements. A one-minute delay can cause a rapid drop of temperature.

EXHIBIT NO. 11

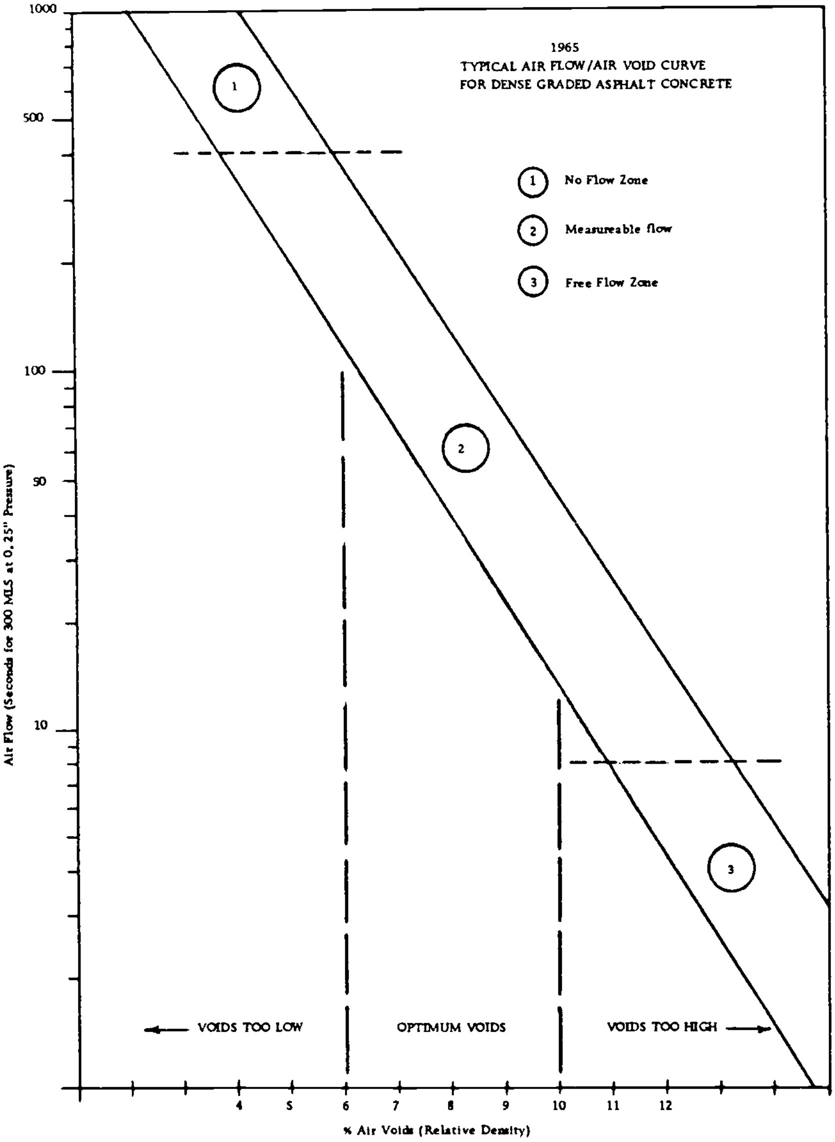
STEEL ROLLING PROCEDURE

(breakdown)



Roller stop marks are never perpendicular to direction of rolling and are more easily removed by succeeding passes in this pattern than by conventional method.

EXHIBIT NO. 12


1965
TYPICAL AIR FLOW/AIR VOID CURVE
FOR DENSE GRADED ASPHALT CONCRETE
1 No Flow Zone
2 Measureable flow
3 Free Flow Zone
1
2
3
1000
500
100
50
10
Air Flow (Seconds for 300 MLS at 0.25" Pressure)
VOIDS TOO LOW
OPTIMUM VOIDS
VOIDS TOO HIGH
4
5
6
7
8
9
10
11
12
% Air Voids (Relative Density)

USE OF AIR FLOW TESTS TO ANALYZE ROLLING PROCEDURES

Test Area (1) Standard Procedure

Station	←16'→		℄	←12'→		
	10'L	6'L	2'L	2'R	6'R	10'R
724	120	60	35	45	65	121
735	135	85	55	65	90	135
744	118	45	55	65	55	110
761	112	50	38	55	40	100

Two pavers in echelon followed by a 10- to 12-ton steel breaking down behind each paver. Each roller starts at outside edge and moves in. Note that the high readings (lowest flow permeability) follow the roller pattern.

Test Area (2) Standard Procedure

Station	←16'→		℄	←12'→		
	10'L	4'L	2'L	2'R	4'R	10'R
659	460	760	214	212	780	540
675	500	900	250	254	843	600

Only change here is that mix was rolled by two steel rollers, one following 3 to 5 feet directly behind the other, always within 250' of paver. 6 passes average, paver 33'/min (each) breakdown completed before mix reached 250° F.

EXHIBIT NO. 14

COMPARING TWO METHODS OF COMPACTION
BY AIR FLOW TESTING AND CORE VOIDS
CLASS B LEVELING CSE 0.10'

	Left Lane			℄	Right Lane		
	OWP	BWP	IWP	Sta.	IWP	BWP	OWP
				581			
	30	21	21	579	39	114	52
	18	⑮	15	577	(57)	18	㊵
	27	23	18	575	66	72	~~270~~Erratic
	15	12	⑫	573	48	45	30
	⑮	39	48	571	30	72	30
	35	㉚	30	569	(108)	54	㊴
	45	57	60	567	30	42	33
	㉓	21	㉜	565	66	27	(90)
Average Flow Each Path	26	27	30		56	56	45
Cores from Numbers Circled Above	12.1	12.2	11.7		8.8	8.4	9.4
	10.8	10.5	8.4		7.8	10.0	8.6
						9.9	
Avg. % Core Voids Each Wheel Path	11.5	11.4	10.0		8.4	9.4	9.0
Avg. for Land	----	11.0	----		----	9.0	----

This lane: 40 psi inflation pressure pneumatic breakdown followed by steel finish.

This lane: conventional steel wheel breakdown, pneumatic intermediate, and steel finish.

Indicates that low-pressure pneumatic breakdown is less effective than conventional steel breakdown.

EXHIBIT NO. 15

HOW TO DETERMINE THE NUMBER OF PNEUMATIC-TIRED ROLLERS REQUIRED FOR OPTIMUM COMPACTION ON PROJECT #2

1. Paving a lane 12 feet wide.
2. Assume 75% paver/asphalt plant efficiency. (See Table 7A of Washington State Construction Manual)
3. Assume mix placed at 300°F, compaction completed by 225° F.
4. Pneumatic roller specifications: 11 Ton, 11 Wheel, 80 to 90 psi inflation (60 to 70 psi contact).
5. Approximate production rates and thickness:

		Paver Speed Ft/Min			Breadkown Roller Speed MPH Req. for Lane Width	
Tons/ Hour	Thickness	Intermittent	Steady	Exposed Sq.Ft./Min	12 Passes	16 Passes
200	2 1/2"(0.21')	24	18	216	2.5	3.3
	1 1/2"(0.13')	40	30	360	4.1	5.5
300	21/2"	36	27	324	3.7	4.9
	1 1/2"	60	45	540	6.1	8.2
400	21/2"	48	36	432	4.9	6.5
	1 1/2"	80	60	720	8.2	10.9

It was determined by air flow and core tests that 12 to 16 passes (6 to 8 each roller width) with this pneumatic were required to insure 8% voids or optimum density. With the speed of the pneumatic limited to three miles per hour, the number of rollers needed is found by dividing three miles per hour into the speed listed under the passes required. An alternative to more rollers would be increased contact pressure by ballasting or by using heavier rollers.

EXHIBIT NO. 16

INTERPRETATION OF RESULTS

Pavement Density

Four basic facts seem to appear each time an investigation of compaction of dense graded asphalt concrete is made.

1. Standard compaction methods (steel breakdown rolling followed by high-pressure pneumatic rolling and finishing with steel) have usually resulted in an air void (density) content of 11± 2%.
2. The simple expedient of switching the pneumatic roller to the breakdown position and using the steel rollers to compact edges, smooth the mat and finish has usually resulted in an air void content of 8± 2%.
3. Better densities have resulted each time compaction studies were made. When the roller operator discovers what can be done by aggressive rolling of stable mixes, even steel compaction improves.
4. Air flow from 20 to 400 seconds for 300 milliliters at 0.25" pressure usually means an air void content from 10% to 6%.

Test results show that density is directly related to:

a. Rate of surface exposure of the mixture (mix available, lift thickness, paver speed, width of spread)(width more important than length).

b. Temperature of compaction completion (when pneumatic roller has rolled out of its tire track, i.e., number of passes).

c. Sufficient compaction equipment to accomodate the requirement of points a and b.

d. Ambient temperature and weather as it influences Points a and b.

Temperature of Compaction

It seems unnecessary to state, but the key to effective compaction of asphalt concrete with any type of equipment is temperature.

Compaction must be completed at the highest possible temperature to achieve the highest densities. On these projects, where the pneumatic breakdown roller was used, it was possible in many instances to complete all but the finish rolling before the temperature reached 225 ° F.

Tests show that prolonged rolling is of no value in mix consolidation when temperatures, roller weights, viscosity/temperature susceptibility of the asphalt exceeds the compactive ability of the equipment available.

With conventional compaction it has often been observed that it is necessary to delay rolling until the right temperature is reached to prevent marking or distortion. This practice depends on the increased viscosity of the asphalt to support the roller and thus inhibits its compaction.

Lift Thickness

Thicker lifts, without question, result in a marked improvement in density over thinner lifts. As lift thickness increases, the greater mass retains heat longer. With thicker lifts, the reduced length of pavement per ton of mix permits more coverages with the same rolling equipment before the mix temperature drops below that for optimum compaction. These factors are additive in achieving better compaction.

If thick base lifts (0.5') are placed, it may be necessary to provide roller support along the shoulder edge.

As the thickness of the lift is increased, the need for a pneumatic-tired roller becomes less important in obtaining optimum density. However, if maximum density is to be achieved, the advantage of the pneumatic over the steel roller is still evident with thicker lifts.

As the thickness of the lift is decreased, the advantage of using the pneumatic roller for breakdown compaction to improve density becomes sharply evident.

Rock Spreader for Placing Asphalt Base

It seems to be as feasible to place asphalt base in a single lift (0.5' loose) with a rock spreader as with a conventional spreader/finisher.

The rock spreader appears to have some advantages over the conventional paver for the placement of the base course. For example, because this machine rides over the freshly placed mix, it tends to minimize reflections of subgrade undulations in the overlying pavement.

One of the sections placed with the rock spreader produced a pavement with the best longitudinal and transverse profile and had some of the lowest values measured by the BPR Roughometer. A part of this improvement may be attributed to more careful base preparation.

Economic advantages of the spreader include its lower equipment cost and the elimination of some manpower.

High-Pressure Pneumatic-Tire Compaction of Dense Graded Asphalt Concrete

A review of the test data from these projects shows that the results obtained from earlier jobs where the pneumatic breakdown technique was used were confirmed. In addition, because of the more intensive testing program during construction, much information was gained that was not previously available.

A high-pressure pneumatic-tired roller (90 psi) can be used in any position on stable, dense graded, asphalt concrete. It can be used most effectively directly behind the paver with hot, dry tires to produce high density very rapidly. The pneumatic roller can also be used in the intermediate position behind another pneumatic or behind a steel roller. The closer it can operate to the first roller, the more effective it should be in increasing density and healing steel roller cracks and checks. Hot, dry tires should be used wherever possible; where they cannot be used, additives or detergents will help prevent mix pick-up by the tires. As a finish roller, the tires may be used wet and the pressure lowered, if necessary, since densification of the mat is not the purpose of the roller at this stage.

Optimum density can be achieved by the pneumatic-tired roller without much regard to the type of subpavement. Densities obtained in the mix placed over gravel and compacted by the pneumatic roller were much higher than densities obtained in an equal lift by steel-rolling the mix placed over an asphalt concrete mat. The highest and most uniform densities were achieved on a 10-foot shoulder section paved over a primed gravel surface. If the pneumatic roller can be operated on the surface prior to the paving, it should be capable of compacting the mixture.

The relationship between tire sizes, contact pressure, and lift thickness has not been completely explored for the pneumatic breakdown technique. However, a practical limit seemed to be reached when a 6-inch loose mat was placed with the rock spreader. A 10-ton pneumatic roller with 7.50 x 15 tires inflated to 90 psi bogged down and could not move in the loose mix. When the mix was given a single pass with a steel roller, no further difficulty with the pneumatic roller was observed. This particular roller lacked "positraction" or power to each wheel. Earlier tests with the mix placed 6 inches loose by a conventional paver presented no problems to a roller with "positraction." The best performance by far in pneumatic roller operation was obtained with a roller with 11:00 by 20-inch tires and tire pressure variable "on the run" from 30 to 105 psi. Its single drawback was the longer period required to get the larger size tires warmed up to prevent "pick-up" of the mix.

On the first lift it was beneficial to keep the roller (pneumatic or steel) about 6 to 8 inches from the edges until the rest of the mat was compacted. Thus, most of the roller weight was supported by the compacted mat and undulation along the pavement edge caused by lateral movement was prevented.

Ride Analysis

Time has not permitted any thing but the briefest examination of roughness measurements with the California type Profilograph. They seem to compare generally with that recorded by the BPR and Washington State BPR and Washington State Roughometers. It may be that the vertical excursions of the recorder pen that reflect the profile of the pavement would have to be amplified to analyze the wearing course.

It was determined on the basis of the test equipment used, visual examination, and interview that there was no significant difference in the ride on the wearing surface whether the base was placed in one, two, or three lifts. The same was true when the leveling course was placed over CTB in one or two lifts. The density of the mat is improved by thicker lifts, and if it cannot be shown that thick lifts are detrimental to the ride there seems to be little reason for thinner lifts on new constructions.

Air Flow Testing

The air flow test proved again to be very useful as a compaction control method. It was used at various times and places to determine the general level of compaction on the completed mat, warm and cold; it was used on the hot mat as early as the second pass of the pneumatic breakdown roller to demonstrate compaction growth curves by the reduction in air flow (permeability). It was used to demonstrate the ineffectiveness of rolling (even with high-pressure pneumatic) when the mat was 200° F or below.

It was determined that there was good agreement of air flow with air voids, even for lifts as thick as 0.35' compacted depth. Air flow differences as small as a few seconds reflected changes in density when lateral sampling was made across the lane. (See Appendix Exhibit A-11)

Air flow tests showed a drop when a steel roller was applied after pneumatic compaction.

In the most useful range of air flow readings from 10 to about 100 seconds, the test was not much affected by temperature.

While the air flow test appears to be very sensitive to changes in density, it must be realized that it is also affected by changes in gradation and asphalt content. This reason alone may cause erratic results. It is not necessary to rely on its precision, however. Higher readings on the freshly compacted mat almost always mean higher density, lower readings, and lower density.

RECOMMENDATIONS

The results of paving research present a problem to the engineer. He must decide what to do with the information.

He can:
- a. Decide it has no value and take no action.
- b. Decide it shows promise and investigate more deeply.
- c. Decide to act on it and change plans and specifications.

Various engineers who see this report may assign it to any of the three categories or possibly even ignore it. In the State of Washington some of the information contained in the report has been moved to Category "c":

1. An asphalt base placed in a single thick lift (0.3' compacted depth), with the use of a rock spreader permitted, is presently under construction.
2. High-pressure pneumatic-tired breakdown (compaction) rolling has been used in each district by almost all contractors for two seasons on the lower courses of the pavement, and on several projects in one district on the wearing surface.
3. Plans are under way to revise rolling specifications to permit the use of the pneumatic-tired roller in any position.
4. Air flow testing has been in experimental use for five years; it has been included in the Special Provisions on one project for compaction control.

Category "b" must be assigned for the present to ride analysis. While it is possible to compare the riding qualities of the finished pavement with one another, it will require much more work to compare various equipment and construction procedures. More precise tools will have to be developed and the results interpreted to see how a ride may be improved.

INTRODUCTION TO APPENDIX

Exhibits A-2, A-19, and A-20 use the gradation chart recommended by the Bureau of Public Roads for the purpose of showing the relationship between mixes used on these projects and maximum density, which is a straight line be+ween the top sieve size and zero on the chart. They also show the effect of small changes in grading on workability and testing parameters.

There are a series of nine isometric charts, A-3 to A-11, that illustrate the effect of construction variables on the final density of the pavement. They are summarized as Exhibit No. 1 in the body of the report. A-8 and A-9 show an interesting test method for determining the effect of temperature on compaction. Note the correlation of air flow tests (especially lateral) with density of thick lifts on Exhibit A-11.

Exhibits A-13 to A-17 are selected cooling curves that are typical of the range of weather conditions during construction in the State of Washington. They can be used to show the amount of time that is available for rolling if the mix is to be compacted before it reaches a critical temperature. Note the tendency of the curves in A-13 and A-17 to flatten out about 100° above the ambient temperature. The heat loss appears to reach a balance with the gain from sunshine. This feature can cause hours of delay with conventional rolling.

Exhibit A-15 illustrates the sharp drop in temperature that can occur in the mix when it is placed and compacted in the rain. The difference in temperature in various levels of the mat can contribute to compaction problems such as shoving, rutting, cracking, and tire pick-up. In this instance, only a few minutes are available for effective compaction. While it was not checked, it is safe to assume that there would be a layer of higher density in the middle of the lift, particularly when steel rolling is used.

Exhibit A-16 includes the approximate asphalt viscosity with a family of curves obtained in hot weather. If compaction is to be completed by 225°F, there is about 40 minutes available.

A mix that could be classified as a "tender" or a "problem" mix is analyzed in Exhibits A-18, A-19, and A-20. When a portion of the dust was removed, the mix presented no further difficulties to steel rolling. A sand/silt ratio of about 7 or 8 to 1 should be maintained for dense graded asphalt concrete. Note that the mixture was not particularly unstable as measured by the Hveem Stabilometer. Present mix design standards call for 3 to 5% voids in the mix, avout 15% voids in the mineral aggregate (VMA), and up to 80% of the VMA filled (VMAF).

Because of the intermittent nature of the mix problem and the time it took to solve it, many of the planned experiments had to be abandoned. It does serve to illustrate, however, that changes should be made in the mix if compaction is a problem rather than to take the easy way out by waiting for the mat to cool and allowing the asphalt viscosity to make up for mix deficiencies.

Typical air flow testing results are listed in Exhibits A-21 to A-26.

The rice vacuum pycnometer is used to determine the density of a voidless mass for compaction reference. Its reproducibility as a mix parameter is shown in Exhibit A-21.

TYPICAL TEST DATA STRIP MAP

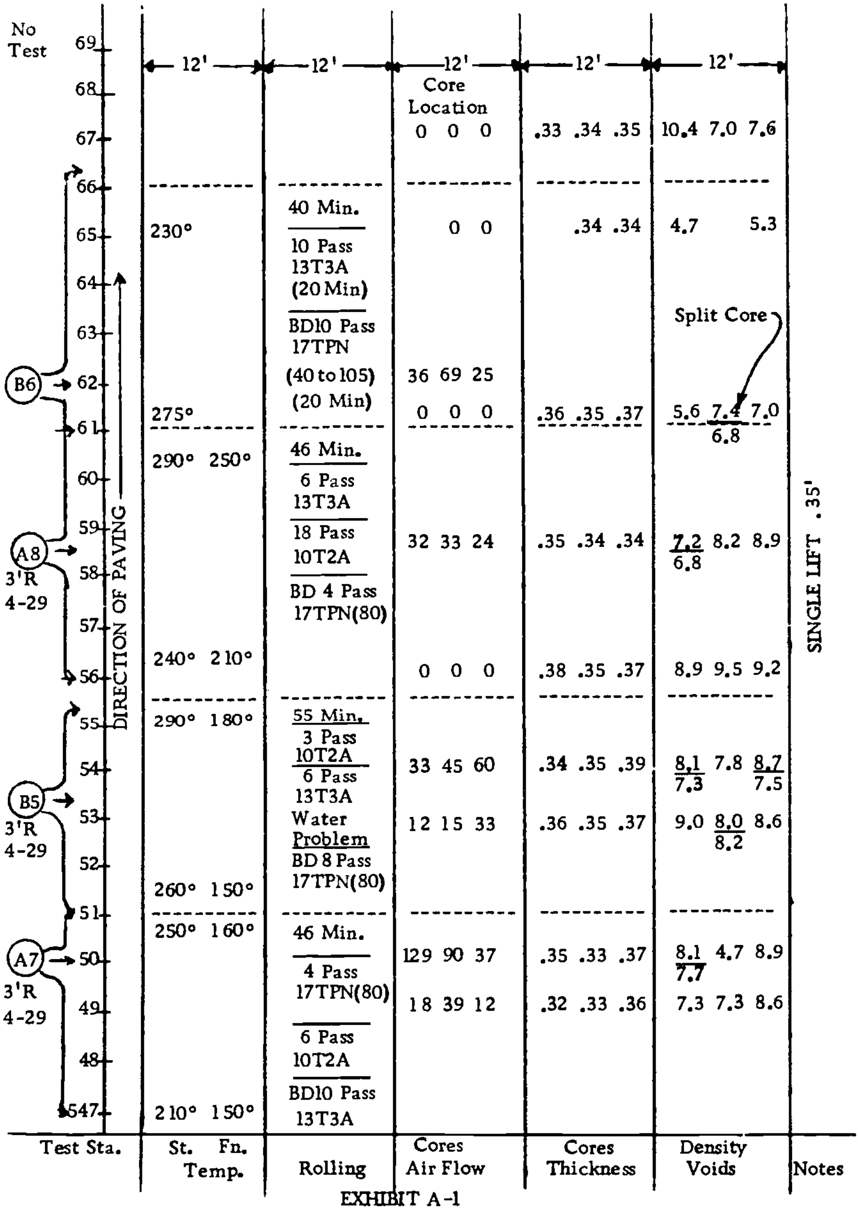
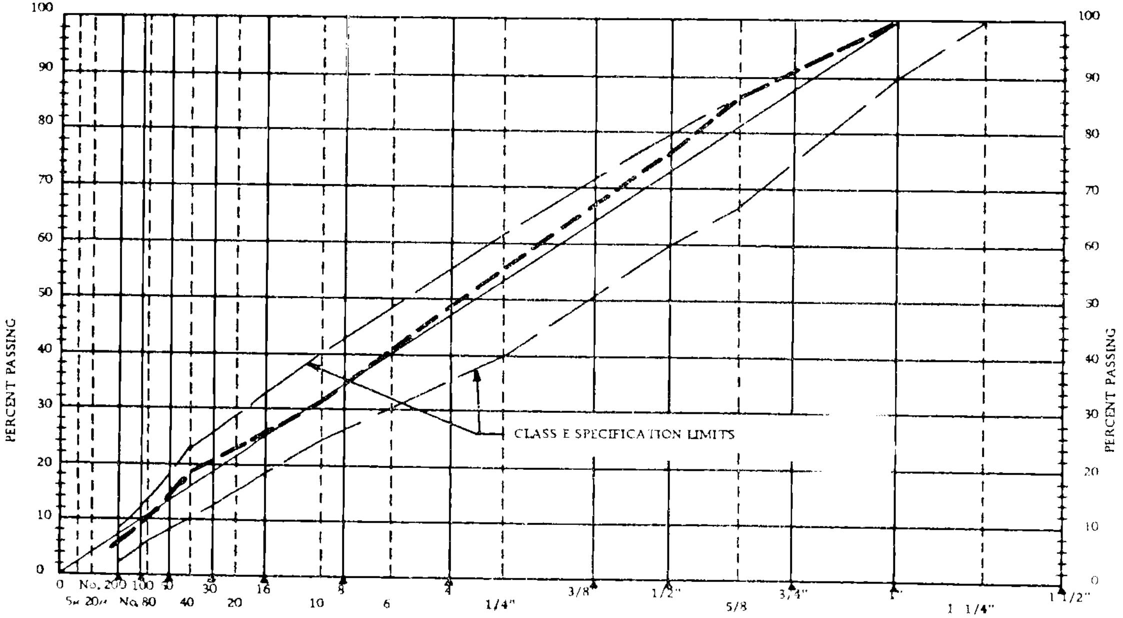


EXHIBIT A-1

GRADATION CHART

Sieve Sizes Raised to 0.45 Power



▲ This symbol identifies simplified practice and compatible sieve sizes

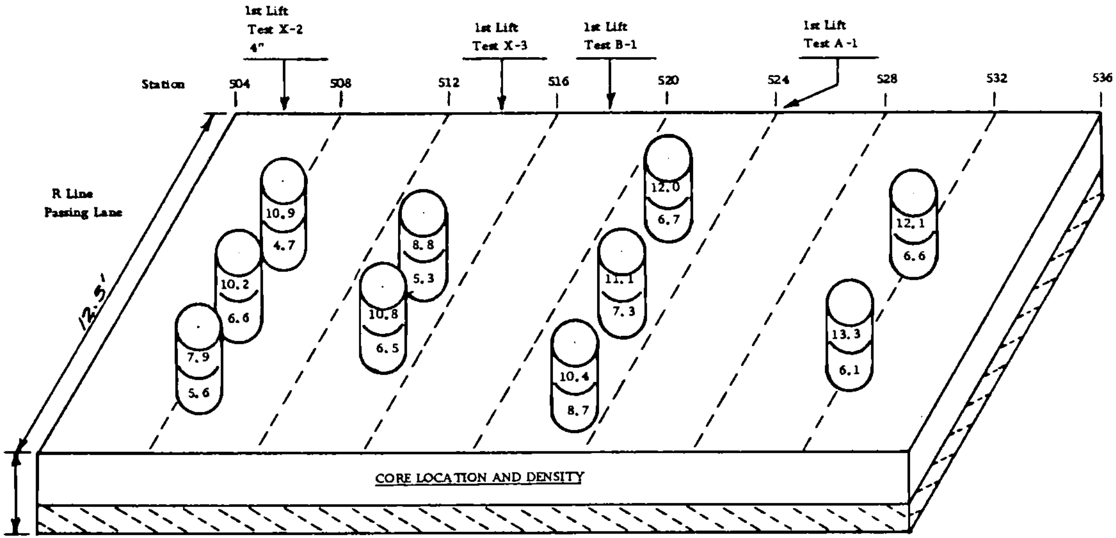
Identification of gradations: GRADING OF 10 CONTROL SAMPLES - CLASS E BASE 7573565

X-64 Hard, Dense, Fine Grained Basalt Ledge Rock

EXHIBIT NO. A-2

VARIABLES AFFECTING PAVEMENT DENSITY

Class E Base



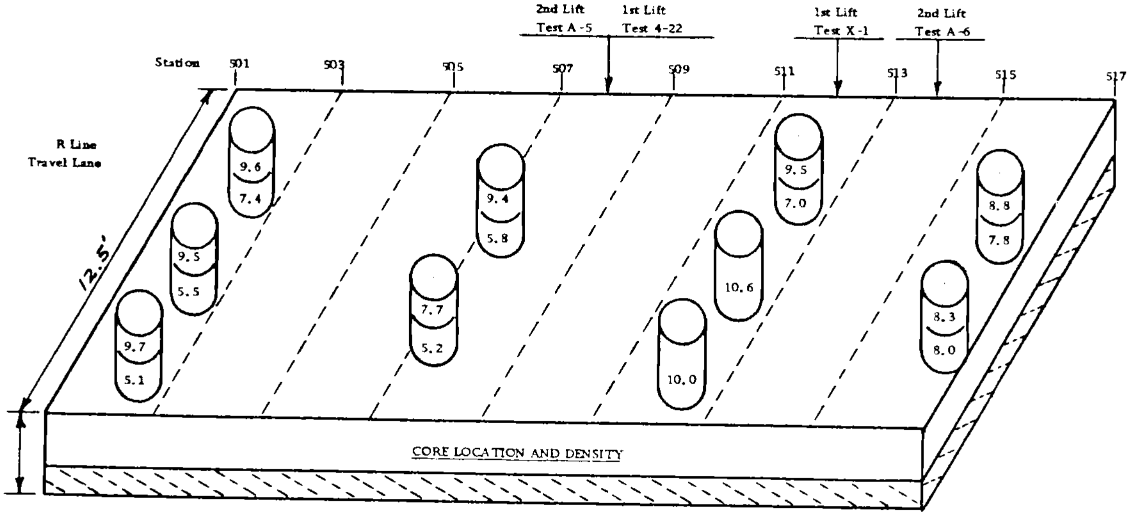
CONSTRUCTION VARIABLES

				Compaction			Avg.
Lift	Thickness	Air Temp °F	Subpavement	Breakdown	Intermediate	Finish	% Voids
1	.17'	70°F	Top Crse. Surf.	13TPN (90)	10T3W		6.4
2	.17'	60-70°F	Lift #1 Mix	10T2A	10TPN (90)	13T3A	10.8

EXHIBIT NO. A-3

VARIABLES AFFECTING PAVEMENT DENSITY

Class E Base



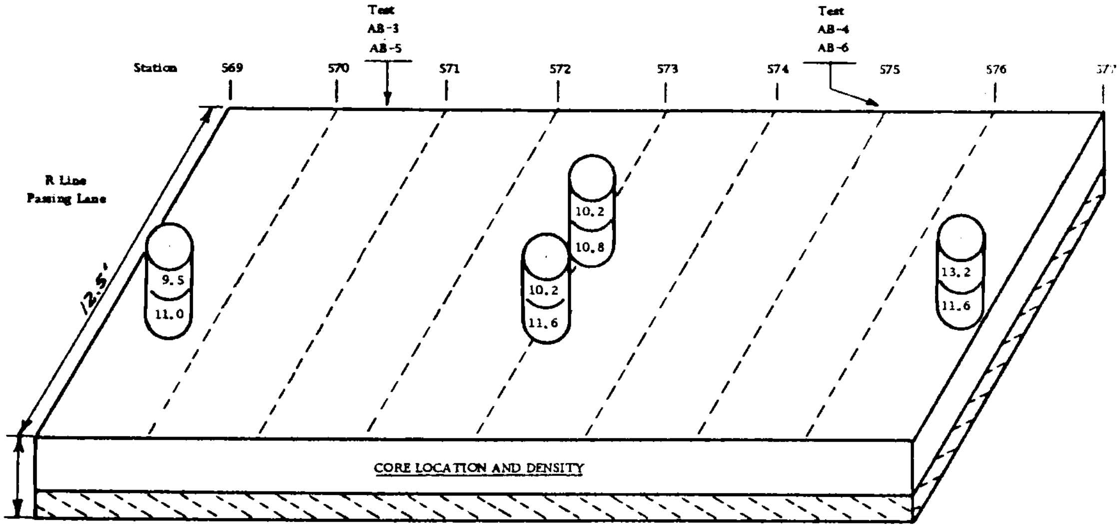
CONSTRUCTION VARIABLES

Lift	Thickness	Air Temp °F	Subpavement	Compaction Breakdown	Intermediate	Finish	Avg. % Voids
1	.17'	70 °F	Top Crse. Surf.	13 TPN (90)	10T3W		6.5
2	.17'	65 °F	Lift #1 Mix	10T2A	10TPN (84)	13T3A	9.1

EXHIBIT NO. A-4

VARIABLES AFFECTING PAVEMENT DENSITY

Class E Base



CORE LOCATION AND DENSITY

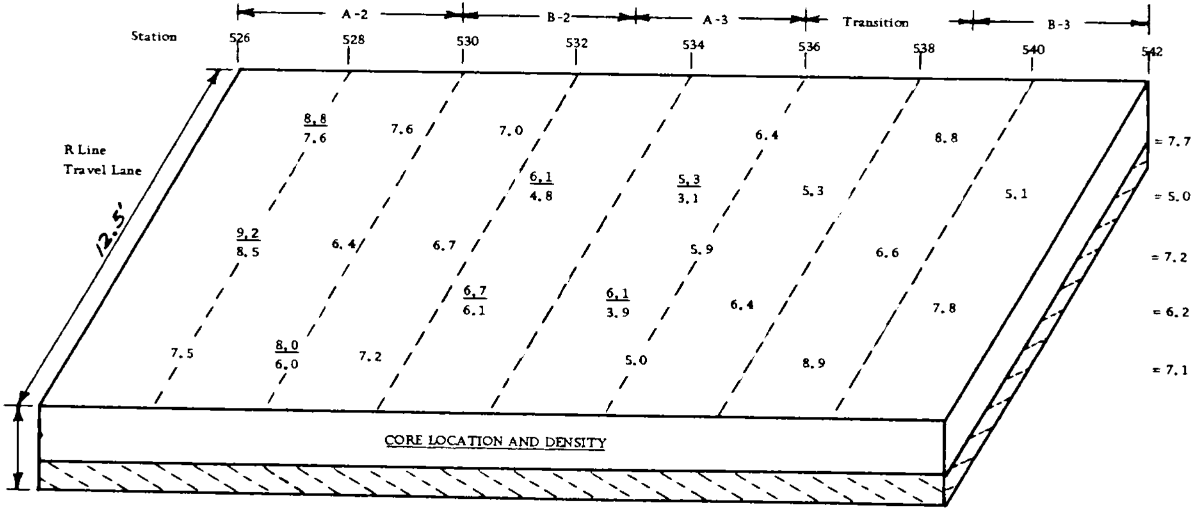
CONSTRUCTION VARIABLES

Lift	Thickness	Air Temp °F	Subpavement	Compaction Breakdown	Intermediate	Finish	Avg. % Voids
1	.17'	59° F (Rain)	Top Cme. Surf.	10T3W		10T2A	11.3
2	.17'	50-60°F (Rain)	Lift #1 Mix	10T3W	10T2A	13T3A	10.8

EXHIBIT No. A-5

VARIABLES AFFECTING PAVEMENT DENSITY

Class E Base



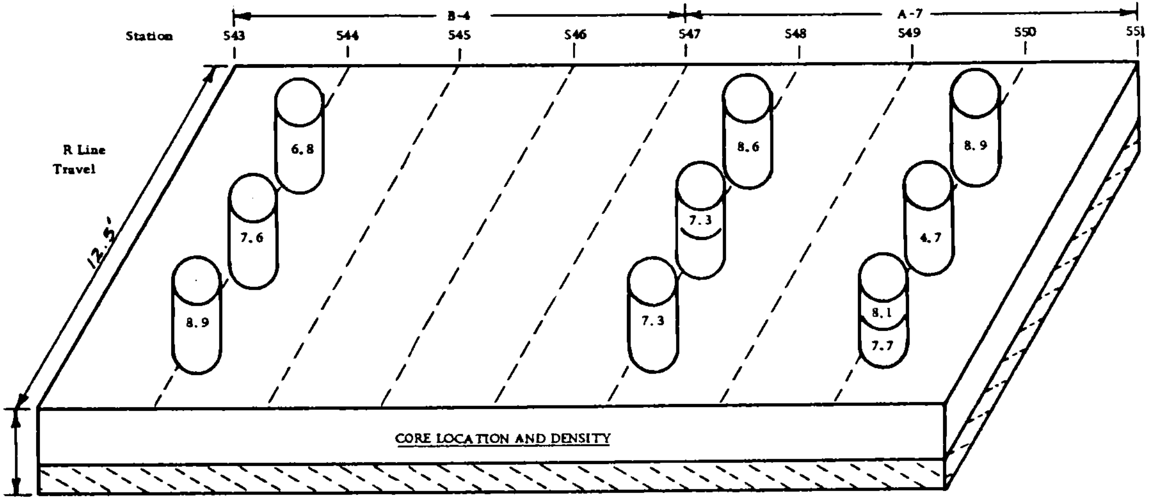
CONSTRUCTION VARIABLES

Lift	Thickness	Air Temp °F	Subpavement	Compaction Breakdown	 Intermediate	Finish	Avg. % Voids
1	.35'	60-80 °F	Top Crse. Surf.	13TPN (90) (4-12 Passes)	10T3W	13T3A	Top 7.2 Bottom 5.7 All 6.6

EXHIBIT NO. A-6

VARIABLES AFFECTING PAVEMENT DENSITY

Class E Base



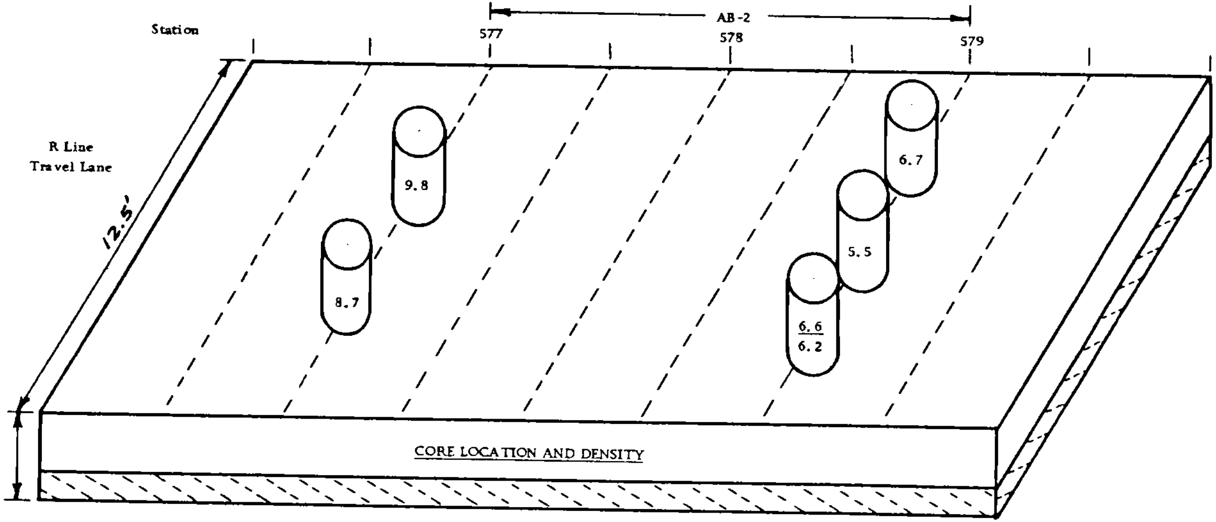
CONSTRUCTION VARIABLES

				Compaction			
Lift	Thickness	Air Temp °F	Subpavement	Breakdown	Intermediate	Finish	Avg. % Voids
1	.35'	55-60° F	Top Cse. Surf.	13T3A	10T2A	17TPN(90)	8.2

EXHIBIT NO. A-7

VARIABLES AFFECTING PAVEMENT DENSITY

Class E Base



CONSTRUCTION VARIABLES

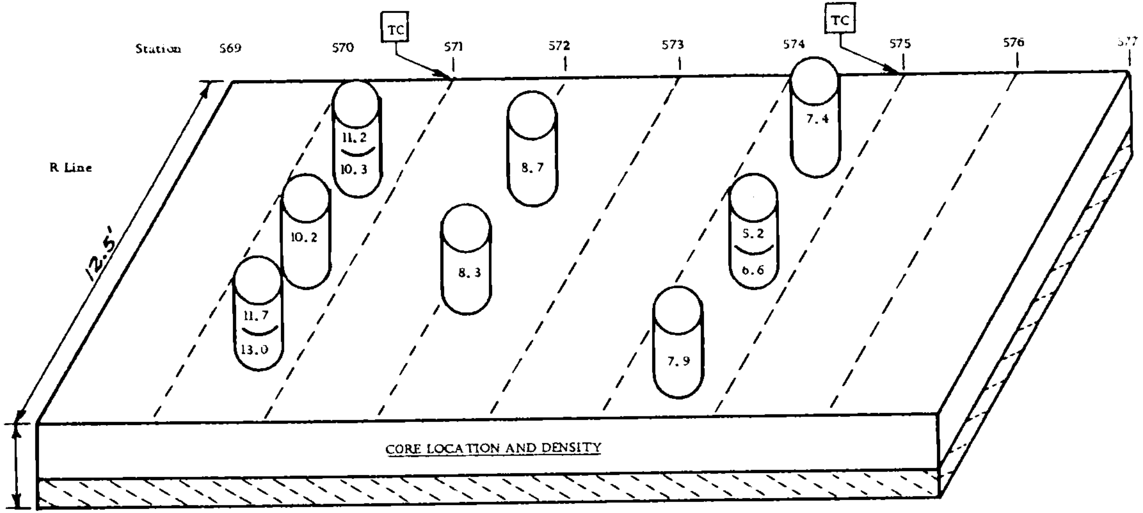
Lift	Thickness	Air Temp°F	Subpavement	Compaction Breakdown	Compaction Intermediate	Compaction Finish	Temperature Station	Temperature Start	Temperature Finish	Avg. % Voids
1	.35'	52° F Rain	Top Crse. Surf.	10TPN(90)	10T2A	13T3A	577	220	160	9.3
							579	280	215	6.3

EXHIBIT NO. A-8

VARIABLES AFFECTING PAVEMENT DENSITY

Class E Base

Test Area AB-1



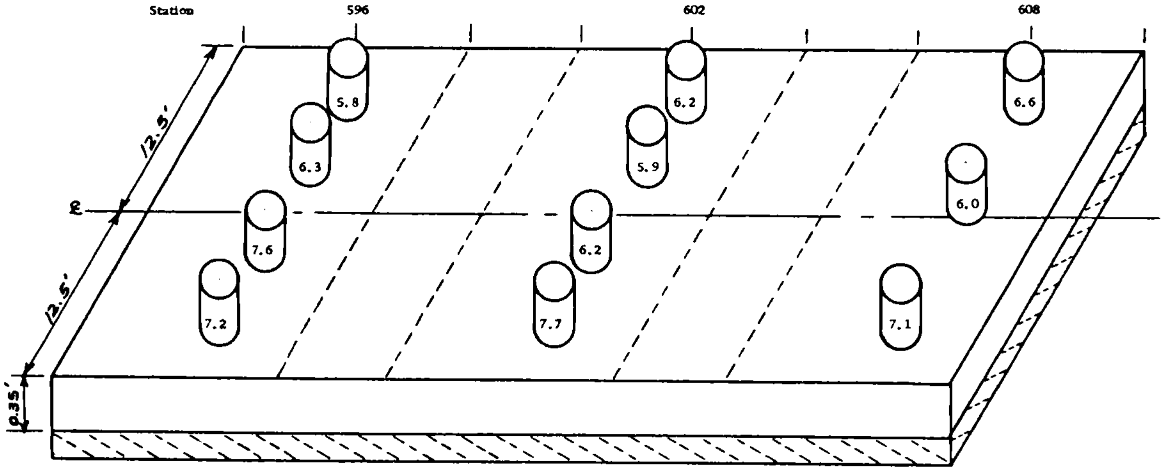
CONSTRUCTION VARIABLES

				Compaction			Temperature			Avg.
Lift	Thickness	Air Temp°F	Subpavement	Breakdown	Intermediate	Finish	Station	Start	Finish	% Voids
1	.35'	50-55°F(Rain)	Top Cse. Surf.	17TPN(40-80)	13T3A	10T2A	571	210	130	11.1
							575	265	135	6.8

EXHIBIT NO. A-9

VARIABLES AFFECTING PAVEMENT DENSITY

CLASS E BASE



CONSTRUCTION VARIABLES

				Compaction			
Lift	Thickness	Air Temp °F	Subpavement	Breakdown	Intermediate	Finish	Avg. % Voids
1	.35'	60-65	Top Cse. Surf.	17T3A	8TPN(70)	10T2A	6.6

Note: 1. Placed by Rock Spreader.

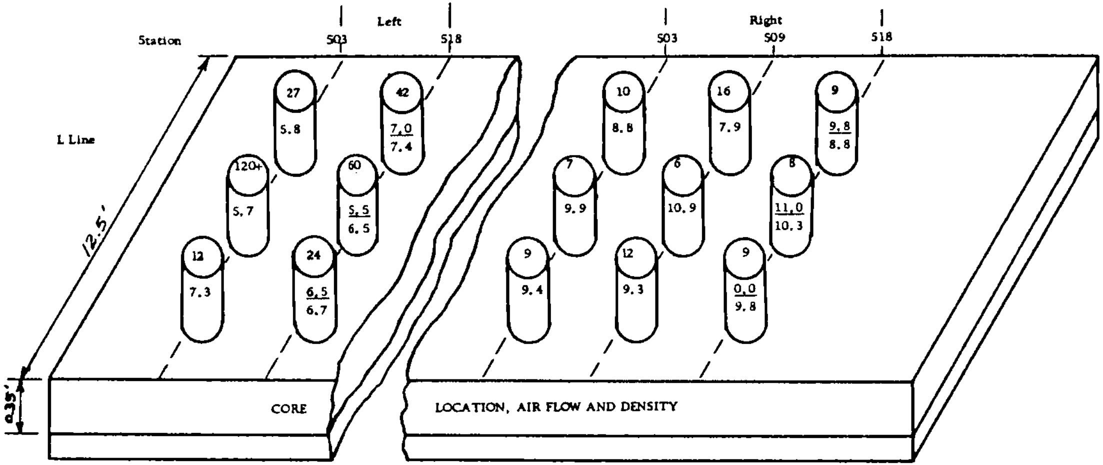
2. BPR Roughometer = 133 Inches/Mile.
Adjacent Pavement 2 Lifts Conventional = 130 Inches/Mile.

EXHIBIT NO. A-10

757376S

VARIABLES AFFECTING PAVEMENT DENSITY

CLASS E BASE



CONSTRUCTION VARIABLES

				Compaction			Avg.
Lift	Thickness	Air Temp°F	Subpavement	Breakdown	Intermediate	Finish	% Voids
1	.35'	55-80	Top Crse. Surf.	13T3A	8TPN(90), or 10T2A	10T2A	---
				Left 9-12	Slow Passes		6.5
				Right 4-7	Rapid Passes		9.4
				Right Sta. 518	Pneu. Bogged Down. Switched to Steel		10.0

Notes:
1. Placed by Rock spreader.
2. Even with .35' Lift, Good Air Flow/Density Agreement Especially lateral

EXHIBIT NO. A-11

AIR FLOW AND CORE VOIDS

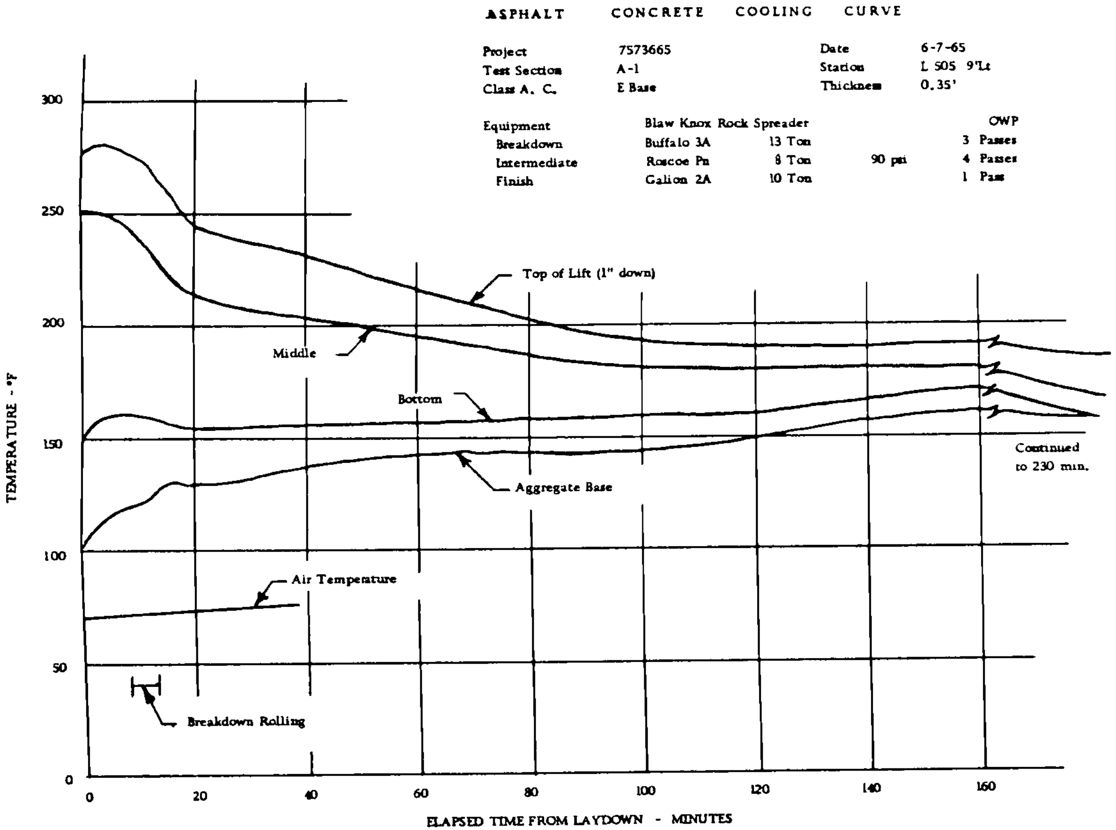
Class E Base
0.35' Compacted

Air Flow Seconds	Core % Air Voids
120+	5.5
60	5.5
42	7.0
27	5.8
24	6.5
16	7.9
12	7.3
12	9.3
10	8.8
9	9.8
9	10.0
9	9.4
8	11.0
7	9.9
6	10.9

Cut Core % Voids

Core No.	Top Half	Bottom Half
1	7.0	7.4
2	5.5	6.5
3	6.5	6.7
4	9.8	8.8
5	11.0	10.3
6	10.0	9.8
Avg.	8.3	8.3

EXHIBIT NO. A-12

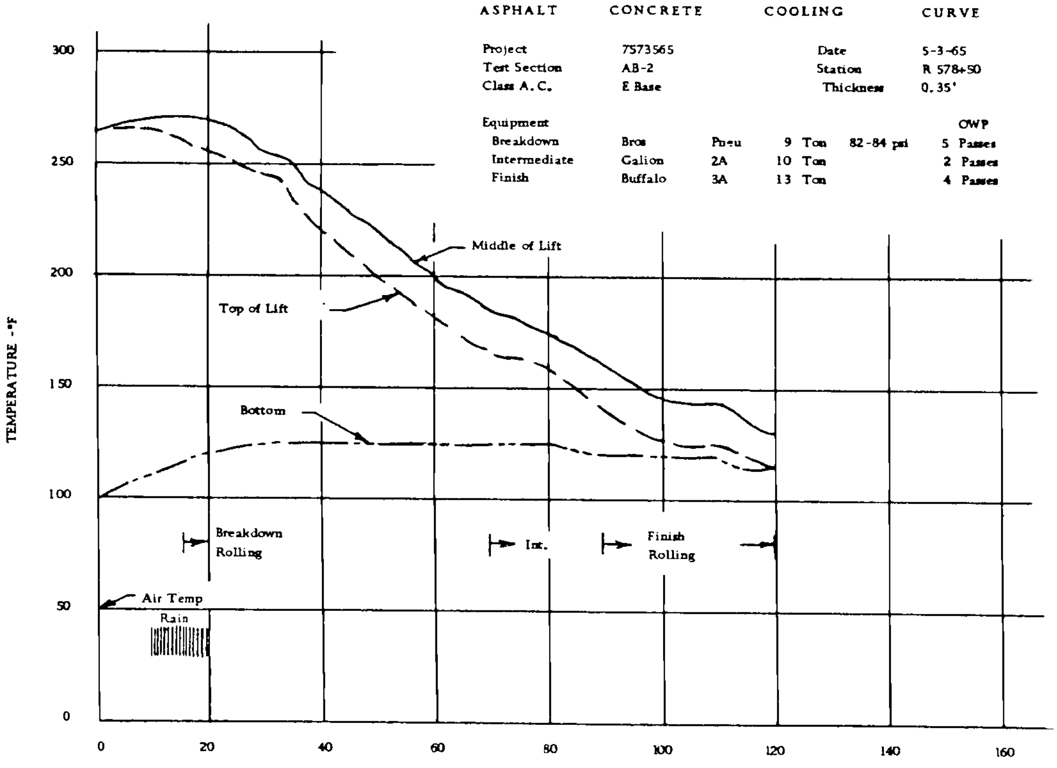


ASPHALT CONCRETE COOLING CURVE

Project 7573665
Test Section A-1
Class A. C. E Base
Date 6-7-65
Station L 505 9'Lt
Thickness 0.35'

Equipment	Blaw Knox Rock Spreader			OWP
Breakdown	Buffalo 3A	13 Ton		3 Passes
Intermediate	Roscoe Pn	8 Ton	90 psi	4 Passes
Finish	Galion 2A	10 Ton		1 Pass

EXHIBIT NO. A-13

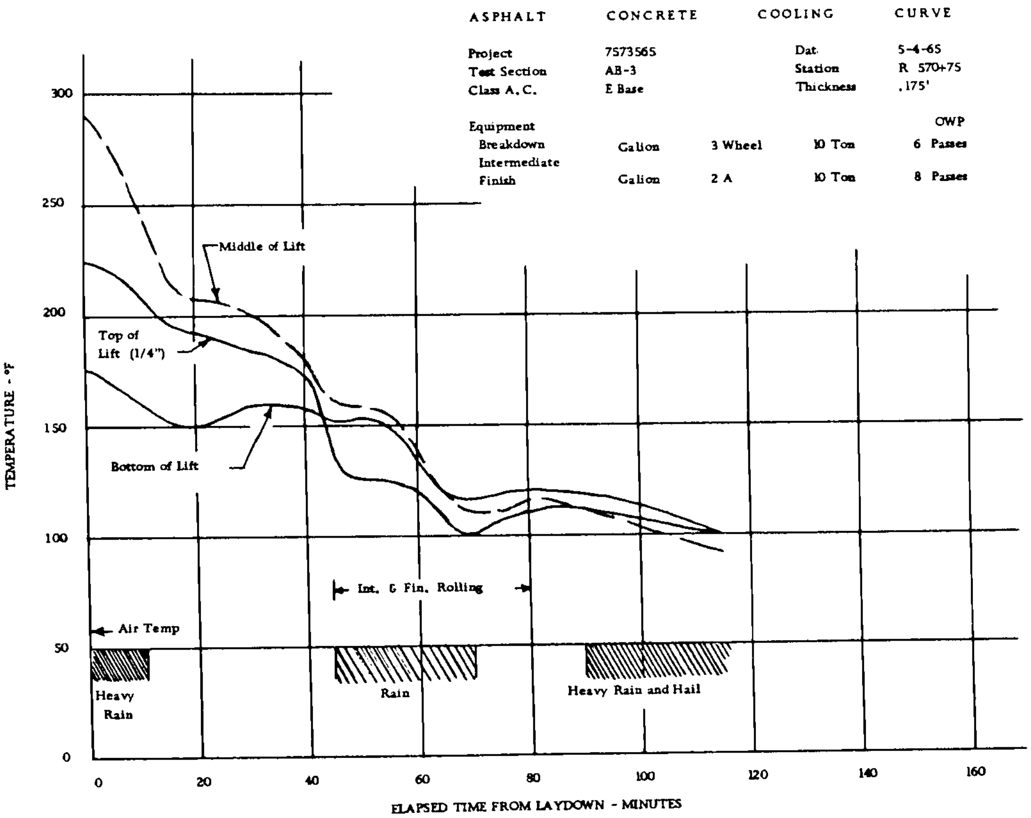


ASPHALT CONCRETE COOLING CURVE

Project	7573565	Date	5-3-65
Test Section	AB-2	Station	R 578+50
Class A.C.	E Base	Thickness	0.35'

					OWP
Equipment					
Breakdown	Bros	Pneu	9 Ton	82-84 psi	5 Passes
Intermediate	Galion	2A	10 Ton		2 Passes
Finish	Buffalo	3A	13 Ton		4 Passes

EXHIBIT NO. A-14



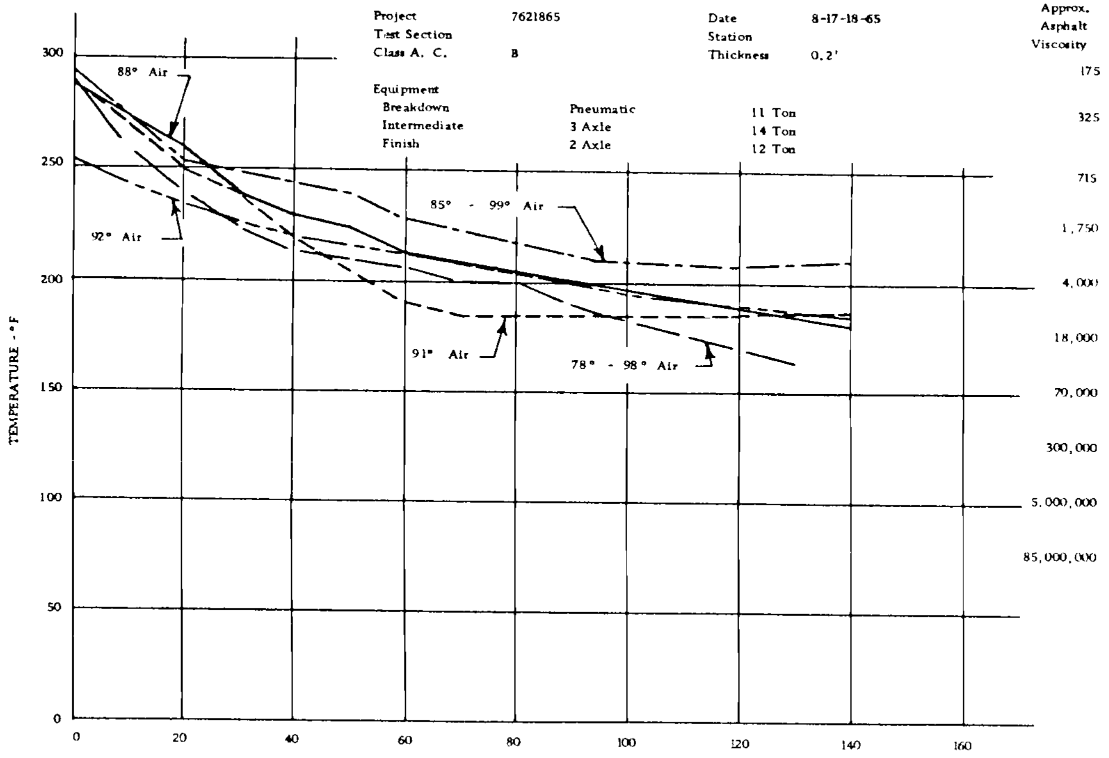
ASPHALT CONCRETE COOLING CURVE

Project 7573565 Dat. 5-4-65
Test Section AB-3 Station R 570+75
Class A.C. E Base Thickness .175'

Equipment OWP
Breakdown Galion 3 Wheel 10 Ton 6 Passes
Intermediate
Finish Galion 2 A 10 Ton 8 Passes

EXHIBIT NO. A-15

ASPHALT CONCRETE COOLING CURVE



Project 7621865
Test Section
Class A. C. B
Date 8-17-18-65
Station
Thickness 0.2'

Equipment
Breakdown Pneumatic 11 Ton
Intermediate 3 Axle 14 Ton
Finish 2 Axle 12 Ton

EXHIBIT NO. A-16

ASPHALT CONCRETE COOLING CURVE

Project	7621865	Date	8-17-65
Test Section		Station	473+50
Class A. C.	B	Thickness	lst Course .2'

Equipment

Breakdown	Pneumatic	11 Ton	80 psi
Intermediate	3 Axle Tandem	15 Ton	
Finish	2 Axle Tandem	8 Ton	

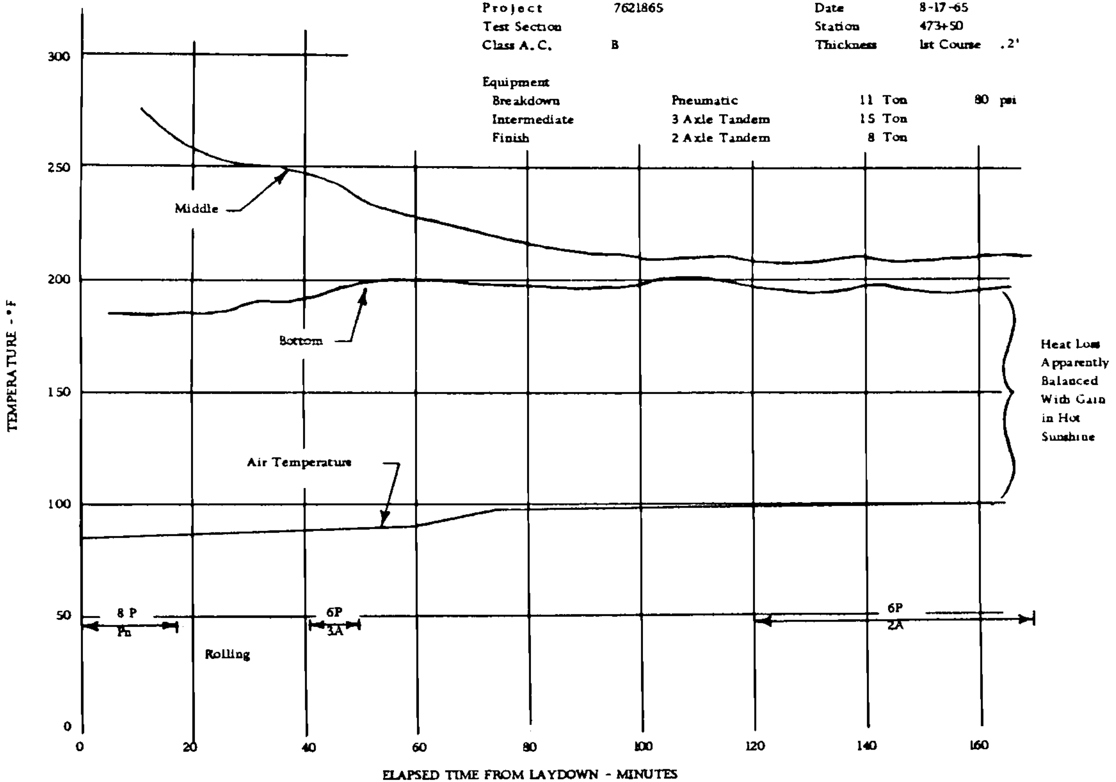


EXHIBIT NO. A -17

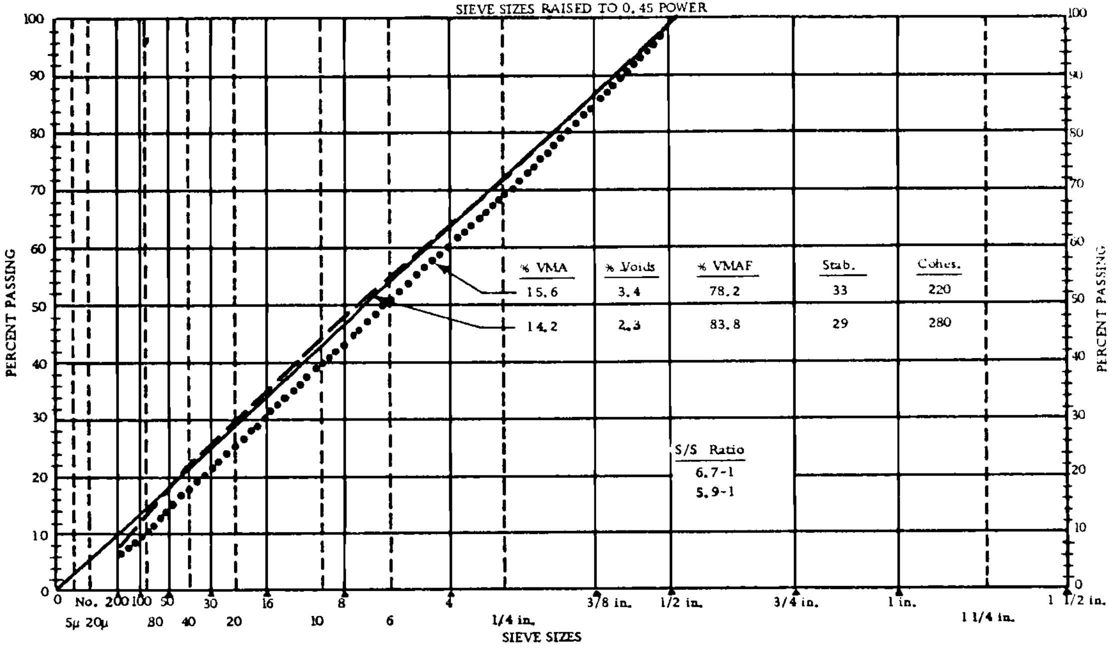
MIX ANALYSIS AND CONTROL
FEATURES USED TO COPE
WITH MIX COMPACTION PROBLEM

Day	Compaction Problem With Blanket Steel Roller	At Plant	Quick Wash	Result % Passing #10	Result % Passing #200	Sand/Silt Ratio #10 #200	Stabil-ometer
1	Intermittent Roller Checking or Cracking	5.7% Asph.	4	42	6.6	6.4-1	26
2	Intermittent Roller Checking or Cracking	5.3% Asph.	4	38	6.0	6.3-1	32
3	Intermittent Roller Checking or Cracking	5.3%	4	42	8.0	5.3-1	32
4	Very Severe Cracking (Cores 8% 200-)	Open Cyclone	5	42	7.3	5.8-1	32
5	Very Severe	5.1%	4	41	6.0	6.8-1	34
6	Using Second Pneumatic to Heal Cracks	5.1%	4	40	6.4	6.3-1	34
7	Use Lighter Steel Roller 12 & 8 Ton	5.1% Auger Out #200	6	38	6.8	5.6-1	34
8	Improving Resistance to Cracking	5.1%	5	39	4.9	8.0-1	34
9	Improving Resistance to Cracking	5.1%	5	39	5.4	7.2-1	34
10	Cracking Nil	5.1%	5	39	5.3	7.4-1	34
11	Cracking Nil	5.1%	4	37	5.2	7.1-1	34

29,930 Tons-50 Tests

EXHIBIT NO. A-18

GRADATION CHART
SIEVE SIZES RAISED TO 0.45 POWER



Identification of Gradations:

▲ This symbol identifies simplified practice and compatible sieve sizes

7621865

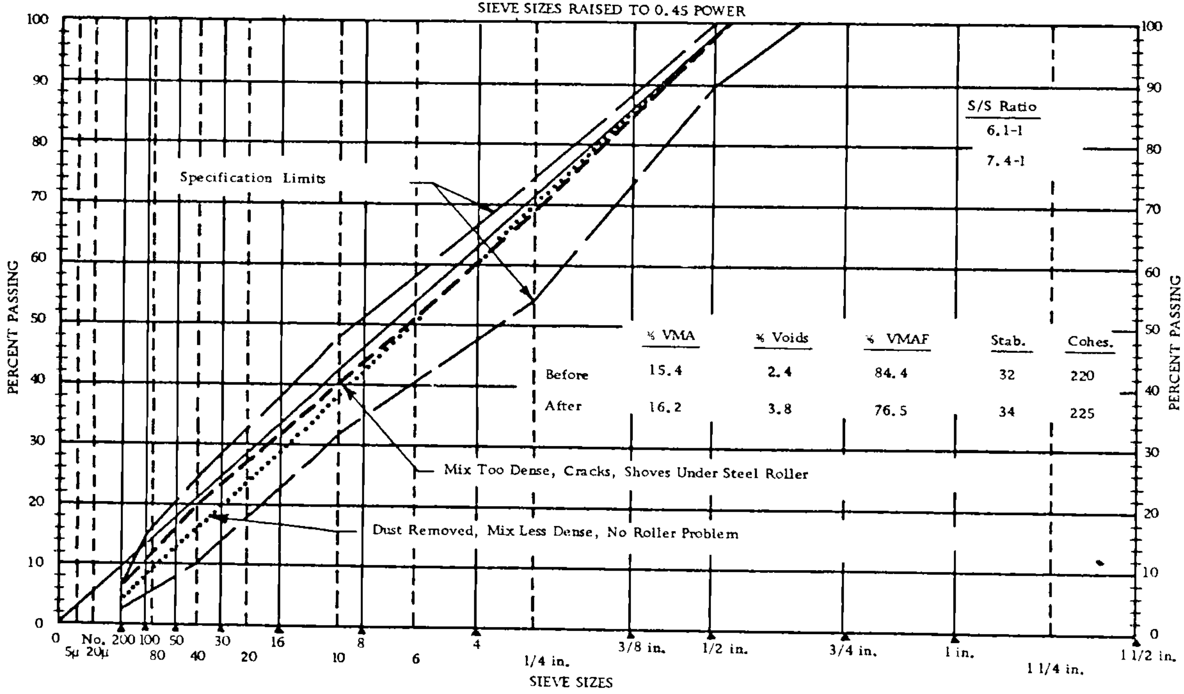
•••••• = 11 Control Samples -- 11 Days Work
— — = 4 Cores from Area of Severe Rolling Cracks
—— = Maximum Density Line
GT 18
Hard, Subrounded Basalt Gravel, Part Vesicular, Light Silt Coating.

Date
8/15/65

EXHIBIT NO. A-19

GRADATION CHART

SIEVE SIZES RAISED TO 0.45 POWER



S/S Ratio
6.1-1
7.4-1

	% VMA	% Voids	% VMAF	Stab.	Cohes.
Before	15.4	2.4	84.4	32	220
After	16.2	3.8	76.5	34	225

▲ This symbol identifies simplified practice and compatible sieve sizes

Identification of gradations:

7621865

— — = 7 Control Samples Before Augering Out ✲ 200

•••••••• = 4 Control Samples After Augering Out ✲ 200

—— = Maximum Denisty Line

Date
8/15/65

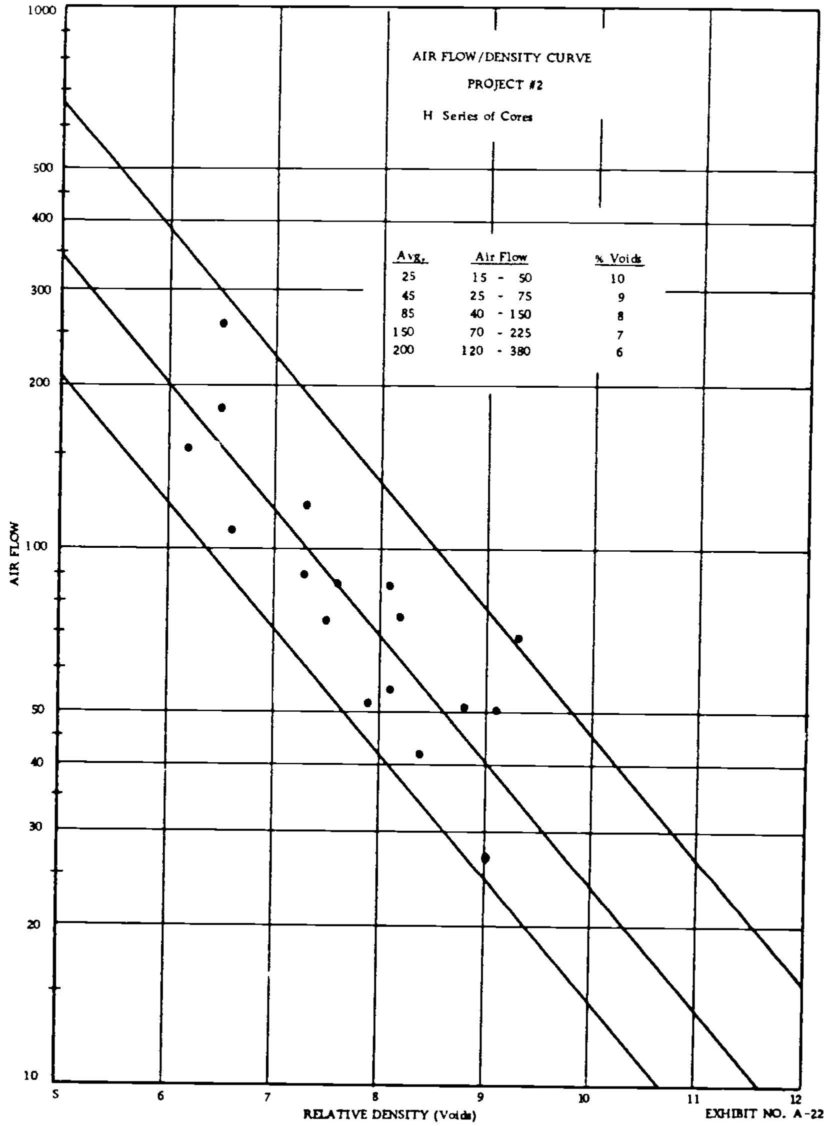
EXHIBIT NO. A-20

BASIC CORE DATA FOR H-SERIES AIR FLOW/DENSITY CURVE

Bulk Sp. Gr.	Rice Vac. Pycn.	% Relative Density	% Air Voids	Air Flow Seconds
2.444	2.615	94.1	5.9	254
2.436	2.597	93.8	6.2	153
2.424	2.593	93.4	6.6	183
2.417	2.606	93.1	6.9	90
2.415	2.585	93.0	7.0	108
2.405	2.593	92.6	7.4	120
2.401	2.597	92.5	7.5	87
2.392	2.604	92.1	7.9	75
2.390	2.583	92.5	7.5	54
2.390	2.598	92.0	8.0	24
2.388	2.606	92.0	8.0	42
2.379	2.587	91.6	8.4	55
2.379	2.608	91.6	8.4	51
2.374	2.584	91.4	8.6	87
2.371	2.574	91.3	8.7	52
2.356	2.596	90.8	9.2	69
2.355	2.589	90.9	9.1	51
	2.595			
	± .02			
	± 1.2#/Ft^3			

Cores obtained from 10' shoulder paved over primed top course surfacing. Data used to prepare typical curve.

EXHIBIT NO. A-21



Avg.	Air Flow	% Voids
25	15 - 50	10
45	25 - 75	9
85	40 - 150	8
150	70 - 225	7
200	120 - 380	6

EXHIBIT NO. A-22

TYPICAL AIR FLOW PATTERN ON PAVEMENT

	12'			
	IWP	BWP	OWP	
480	30	33	24	
	30	93	45	
70	33	99	51	
	30	162	57	Erratic
60	36	48	24	
	24	72	27	
50	21	45	27	
	9	24	15	
40				
	18	30	18	
30	12	24	12	
Sta. 420	9	21	9	
Avg. Air Flow	23	49	28	
Core Voids %	10.6	9.6	--	

Air flow values appear to be related to roller overlap and paver crown. Note that without exception the higher figure is in the center of the mat at each station.

EXHIBIT NO. A-23

TYPICAL ROLLING, AIR FLOW, DENSITY DATA

			Rolling				
Test	Time	Temp	Pneu. Breakdown		Steel Inter	Air Flow Sec. ←12'→	% Air Voids Core
A	8:10AM	78°					
No. Pass Each 12'Lane			4		9		
Temp. Mix Start-Finish			290	240	215	60 48 30	8.7
Elapsed Time, Minutes			0-22		23-39		
B	9:20AM	85°					
No. Passes			8		6		
Temp. Mix Start-Finish			280	265	235	45 57 39	8.0
Elapsed Time, Minutes			0-17		41-49		
C	10:55AM	91°					
No. Passes			8		6		
Temp. Mix Start-Finish			265	250	220	51 90 30	8.6
Elapsed Time, Minutes			0-18		23-48		
D	12:05PM	92°					
No. Passes			7		7		
Temp. Mix Start-Finish			245	235	225	66 60 69	7.0
Elapsed Time, Minutes			0-20		21-31		

Paving - 2 Pavers in echelon 35' Min. 0.2' two 12' Lanes, approx. 300 Tons/Hr. Rolling 11TPN + 10T2A finish.

Significant figures here are elapsed time and high temperatures for the completion of pneumatic rolling.

EXHIBIT NO. A-24

TYPICAL HOT AND COLD AIR FLOW PATTERN

Approx. 1 Mile

12'			12'			
60	48	30	66	117	45	← Hot
52	54	27	30	93	48	← Cold
27	27	21	87		135	← Hot
30	27	21	69		69	← Cold
27	57	39	75	105	54	
36	54	39	66	81	105	
78	87	60	90		36	
75	63	51	51		30	
51	90	24				
42	34	48				
126		48	30		150	
96		60	30		63	
66	60	69				
60	69	60				
47	66	45			36	
72	66	60			60	

Avg. Hot 23 = 54
Avg. Cold23 = 52

Hot 13 = 79
Cold 13 = 61

Comparing air flow readings 175 to 275° F (Hot) with duplicates on Cold 80-100° F taken 24 hours later. 0.2' thick mat compacted to 8 - 9% air voids.

General observation: There is a greater difference between hot and cold readings in the higher range.

EXHIBIT NO. A-25

TYPICAL PROGRESSIVE ROLLING
AIR FLOW REDUCTION TABLES

Test	Passes Pneu.	Steel	Mix Temp°F	Elapsed Time From Laydown	Air Flow (Sec.)	Avg. % Air Voids Same Area
1	2		192	30	15	
	6		190	35	15	
	8		190	40	15	9-12
	10		---	45	18	
	12		178	50	18	
2	2		270	10	27	
	6		---	15	66	---
	8		240	20	99	
3	2		200	5	18	
	4		---	10	15	
	6		190	23	24	9-11
	8		---	30	27	
	10		180	40	24	
4	2		---	10	12	
	4		230	15	27	
	6		---	20	24	
	8		---	25	30	6-9
	10		---	28	39	
	12		190	30	36	
	14		185	40	63	
5	4		250	15	24	
	6		---	--	24	
	8		---	--	45	---
	10		---	--	90	
		2	---	--	36	
6	2		270	10	27	
	6		---	15	66	
	8		240	20	99	---
		6	190	35	63	

EXHIBIT NO. A-26

COMPARING AIR FLOW TESTS AND NUCLEAR DENSITY ONE YEAR LATER ON A PAVED SHOULDER

Core No.	% Air Voids	1964 Air Flow (Sec.)	1965 Air Flow (Sec.)
1	15.1	6	10
2	13.9	7	14
3	12.7	7	26
4	11.1	10	39
5	11.1	20	46
6	10.4	18	40
7	8.8	62	189
8	7.8	97	150

Arranged in descending order of air void from 1964 cores. 1964 readings by State, 1965 by BPR Research Team. General level of flow indicated only slightly lowered permeability. 1965 readings offset 1 foot each side of core location.

Core No.	1964 Core Weight/Cu.Ft.	1965 Nuclear Density Weight/Cu.Ft.
1	140.2	143.5
2	142.0	144.1
3	144.1	146.9
4	146.7	150.2
5	146.8	152.9
6	147.9	140.0
7	150.5	153.5
8	152.1	153.8

Same cores as above. Nuclear readings, 1965, by BPR Research Team were offset 1 1/2 feet from 1964 core location. Reference was a standard block provided by manufacturer. Lift thickness of 0.15' may have had a part in erratic reading for #5 and #6. The device brackets and generally indicates the proper level and order of density.

EXHIBIT NO. A-27

Pneumatic Compaction Notes

A mix is designed to be stable. This makes it difficult to compact. A steel roll builds a surface stability by bridging, and it compacts from the top down by the application of weight.

Pneumatic compaction with great sheering stress frustrates the stability of the mix by penetration to the bottom layers and begins by compacting the bottom layers first and builds its own platform and "walks out" of the mix to the top.

Equipment presently required on the project is used much more effectively to achieve a high and more uniform level of density in the mat. The key to the efficiency of the method appears to be movement of the mixture at high temperatures. Most of the compaction of the mat occurs in the breakdown operations; the intermediate hot rolling removes pneumatic tire marks, and the finish roll is a touch-up operation.

Pneumatic-tired roller compaction can be considered as self testing, that is, when the roller walks out of the grooves to the top of the mat, further compaction should not be necessary or perhaps even possible. When the intermediate roller removes the remaining tire marks, it is time to move forward. It is theoretically possible to achieve more than 100% of laboratory compacted density if this method is used successfully.

It is suggested that this procedure be used on base and leveling courses. When the operators have gained enough confidence and experience, it will be possible to use it on the wearing surface as well.

A tendency to lower tire pressure or ballast or number of coverages to minimize roller marks must be resisted. Each of these measures reduces density and may only serve to seal the surface.

Ground contact pressure should not be considered alone as an index of the compactive ability of a pneumatic roller. A bicycle tire can provide adequate pressure but would not be feasible to use for compaction.

Whenever pneumatic compaction is mentioned, two subjects are always brought up. What about the ride and appearance? As far as the ride is concerned, experience on many projects has shown that poor, fair, good, and excellent rides can be obtained when the pneumatic is used, just as with steel wheel rolling. As a matter of fact, one of the best rides was obtained last season on a project where the pneumatic was used on all lifts from the base up! Textural changes in the surface where the sand/asphalt mortar has been removed from the mat by the roller tire edges has been an aesthetic rather than a roughness problem. Marks can be minimized by careful rolling, keeping tires warm, or by applying a very light fog seal to the surface. An open graded plant mix seal could also be used. In time, under traffic, the marks will disappear. In the State the use of the pneumatic in the wearing course has been discouraged until techniques are improved.

AGREEMENT

THIS AGREEMENT made and entered in to this______ day of ___________, 1965, by and between the WASHINGTON STATE HIGHWAY COMMISSION, Department of Highways, acting by and through the Director of Highways, hereinafter referred to as the "State", and the ASPHALT PAVING ASSOCIATION OF WASHINGTON, INC., a Washington corporation, hereinafter referred to as the "Association";

WITNESSETH:

WHEREAS, the parties hereto acknowledge the need for and the mutual benefits to be derived from conducting experimental and research projects relating to asphalt paving, and

WHEREAS, it is proposed to undertake a certain research project, as more fully described in Exhibit "A" attached hereto and by this reference made a part hereof, in connection with an existing contract on Primary State Highway No. 18 (SR 90), Wheeler Road to Raugust, Contract No. 7621, I-90-4(31)178, and

WHEREAS, in order to properly carry out the purpose of the research project, it will be necessary to perform additional testing, sampling, and laboratory analysis over and above that normally required on an asphalt paving project, and

WHEREAS, the parties hereto desire to participate in the additional costs involved in carrying out the research work proposed herein,

NOW THEREFORE, it is agreed by and between the parties hereto as follows:

I.

The purpose of the proposed research project covered by this Agreement is to investigate the effect of lift thickness on density and riding characteristics of compacted asphalt concrete.

II.

The State agrees to make the necessary arrangements with and obtain approval from the Bureau of Public Roads to make such changes in the plans and specifications as may be necessary in order to carry out the research project. The State further agrees to make the necessary arrangements with and obtain approval of the State's Contractor, together with consent of Surety, for the proposed changes in specifications and plans in order to carry out the research project.

III.

The State's participation in the cost of carrying out the research project shall consist of the following:

Furnish direct supervisory personnel.
Furnish two engineering technicians for approximately 30 days, for collection of test data.
Furnish one assistant highway engineer for approximately 15 days.
Furnish a roughometer.
Furnish one passenger vehicle.
Perform all laboratory tests.
Furnish miscellaneous small tools and instruments not otherwise specified herein.
Summarize and analyze test data and prepare a written report, 50 copies of which will be furnished to the Association.

All costs in connection with furnishing the above items or as subsequently modified in accordance with Section VI will be at the State's sole expense, estimated to be $________.

IV.

The Association's participation in the cost of carrying out the research project shall consist of the following:

Furnish two technicians for approximately 30 days, under supervision of the State, for collection of test data.
Furnish special temperature recording equipment.
Furnish special construction equipment that may be required by the Contractor.

All costs in connection with furnishing the above items or as subsequently modified in accordance with Section VI will be at the Association's sole expense, estimated to be $__________.

V.

It is recognized that because the work proposed herein is of a research nature that modifications to the proposed work may be necessary or desirable from time to time. It is hereby agreed that such modifications may be made upon the joint approval of Mr. Carl Minor, representing the State, and Mr. Walter Kastner, representing the Association.

VI.

It is agreed that the parties hereto will keep accurate cost records for carrying out the research project and shall report said costs each to the other upon completion of the research project.

VII.

It is understood and agreed that no liability shall attach to the State by reason of entering into this Agreement except as expressly provided herein.

IN WITNESS WHEREOF the parties hereto have executed this Agreement as of the day and year above written.

WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

By: ______________________________
Director of Highways

ASPHALT PAVING ASSOCIATION
OF WASHINGTON, INC.

By: ______________________________
President

Approved as to form:
____day of ______, 1965

____
Assistant Attorney General

PANEL DISCUSSION

TRAINING PROGRAMS FOR HIGHWAY ENGINEERS AND TECHNICIANS

Presiding: B. J. McClarty

YAKIMA COUNTY TRAINING PROGRAM

by
Joe Andreotti

We began our on-the-job training program seriously in 1960. At that time we lost several key personnel through retirement and also a number of employees to the Washington State Highway Department. After interviewing all the applicants available, it became evident there just were not many qualified people which had the training to fill the positions we required.

The only solution was to hire what was available and try to institute a training program. We realized the results of this sort of program would not solve our immediate problem but would possibly solve future ones.

The work classifications we desired to fill with such a training program were inspectors, lab technicians, instrumentmen, chainmen, field technicians, and elementary design technicians. We realized the graduate civil engineer would have to be bargained for from the open market. We also realized regardless of the particular classifications for which a person was being trained that a certain amount of general theory and mathematical knowledge was necessary not only to understand his work better but also to give him that degree of confidence which is necessary to get the best results.

Therefore, we initiated an evening class of three-hour duration once a week. The first classes began with elementary algebra, which was a review for those who had studied algebra and an introduction for those who had not been exposed to the subject. We would assign approximately three hours of homework at the end of each class, so the trainee spent approximately six hours each week on building a foundation from which to apply his training. We followed this same procedure through theory of logarithms, plane geometry, trigonometry, and a little chemistry and physics. In conjunction with the above work, we introduced the use of the slide rule and it became a functional part of our class.

We were selfish in our teaching in that we followed a very narrow and defined path. Everything we studied was related as nearly as possible to highway work and more particularly to our own procedure.

The time necessary to cover, in our limited way, these many subjects was approximately 12 months. Every five or six weeks we gave a three-hour examination which covered all the material we had studied up to that time. We gave numerical grades to show the trainee how he was doing and to show us if we were getting the subjects across as instructors.

The class was composed of surveyors, inspectors, technicians, and draftsmen. Class attendance was between 12 and 15 trainees. A file was set up for each of the trainees, in which they kept each week's homework and test papers. Upon completion of the course, this became the trainee's property to use as a reference in his future work. Each week we checked the homework of the previous week and returned it to the trainee for corrections, if any; when this was completed, the homework was placed in the trainee's file.

I think most of you who have on-the-job training programs will agree that we are dealing with people who through their own choosing or circumstances beyond their control failed to get the education and training their abilities would have permitted. The sad condition is that these people often realize their error after they have assumed family obligations and cannot afford to take time off as a breadwinner to obtain further education and training. In general, therefore, we are dealing with serious, sincere individuals with an ardent desire to improve themselves. All they need is a starting place.

We do not give any compensation to a new employee to attend these classes other than that his chances for advancement are greatly accelerated. By this I mean the trainees are not paid for the hours they spend in class nor for the time they spend on their homework. The county does provide all the necessary supplies for the class except textbooks which the trainees wish to keep.

At the present time we have three full-time survey parties. All of the instrumentmen and the Head and Read chainman have attained their positions from our training program. Much of this training was actually on-the-job training, where each individual was given an opportunity to do each of the various jobs required on the survey party. We also require all of those who have the mathematical background to make all the vertical and horizontal curve calculations with the instrumentman, and in this manner we are training individuals for higher positions on the party. We feel the time thus spent will pay dividends in future standards of our organization.

In the summer months we hire some 20 engineering students; some of them are used to make up additional survey parties. We use our head chainman as instrumentman on the summer crews, of which there are a total of six. Our inspection is handled in a similar manner. We train a new prospective inspector with a seasoned one until we feel he is capable of handling a project by himself. The first job a newly trained inspector receives is the less complicated job. During these first few jobs, the chief inspector and the assistant county road engineer make frequent checks of the project to make sure the inspector is carrying on his duties properly and that the project is progressing satisfactorily.

Our inspectors are in complete control of the projects, and in many respects they are similar to resident engineers for the State Highway Department. There is a difference between a State Highway Department resident engineer and a county inspector because the chain of command is very short. Usually a radio call and confirmation or approval can be received from the county road engineer within the hour. Our inspectors are trained to make all necessary field checks even though we have technicians on the job taking density tests, gradation tests, sand equivalent tests, and so forth. We feel that an inspector who is well versed in these procedures will be better able to advise and assist the technicians assigned to his project.

In the winter months, when most of our projects are shut down, we have several half-day sessions in which we cover the past season's construction work. At this time we check to see that our inspection procedures are uniform and review the methods of record-keeping. We also cover the various testing methods to make sure they are fully understood. Any effective training program must be a perpetual one. For example, we have lost all but 30 percent of the employees we had working in our engineering department in 1960. Some of these people retired, others were relieved of their duties, and some found better wages for the same requirements with other organizations. Since 1960 we have increased the number of employees in our engineering department by 38 percent.

We realized that an advanced class would have to be initiated to provide a continuing interest for the employees who had received the fundamentals. So last year we split our classes into elementary and advanced groups. The classes are held on the same night and scheduled so that an individual may attend both classes. This gives the people who have had the fundamentals a chance for a review if they feel it is necessary.

The classes have been reduced to a duration of 1 1/2 hours each, with approximately 1 1/2 hours of homework. Through this method, we can help the new employee start his training and still give our older employees a more broadening knowledge of their particular field.

We do not feel that we have solved the problem, but we feel we are helping to solve the problem until more two-year technical schools are established to train highway technicians. We think our training program has helped to upgrade the State Highway Department personnel, with those who have quit us to work for them. We have developed a sense of pride in training personnel to do a competent job within our organization.

We feel our program has added greatly to the spirit and attitude of the employees and we plan to continue it as long as we can find interested people.

TRAINING FOR IMPROVED COMPETENCE

by
R. B. Christensen

Organizations of any significant size have long recognized the value of specialized training programs to improve the competence of their employees. This has been true for many years in the highway field. As a result of a few regrettable situations overamplified by news media and highway program critics, we are today experiencing increased control and regulation. One phase of control, the "procedural audits," is now generally a matter of routine and has focused increased attention on the background, qualifications, and technical competence of highway department employees, especially those responsible for construction inspection.

The Idaho Department of Highways, like many others, has intermittently conducted limited training programs for various classifications of employees. While the effect of this type program was generally beneficial, something more was obviously needed. "Without doubt, our 'Achilles heel' is our field inspector capabilities when the matter is viewed over the entire nation."

The above quote was the first paragraph appearing in a letter dated March 4, 1963, from the secretary of the American Association of State Highway Officials (AASHO) to the chairman of the association's special committee on inspector training.

In Idaho we were quite enthused about the work of this special AASHO committee and participated in the formulation of the recommendations reported by the committee to the Executive Committee of the AASHO. The committee's report and recommendations were not adopted as a guide by the AASHO. A further need was observed that indicated more study should be applied to develop a refined and detailed program. I understand that this work is still advancing.

It was our feeling that the basic program envisioned in the AASHO committee report was a do-it-yourself type of training that was within our capacity to handle. There was no doubt as to the need for a program. Pressures were building up daily. In this climate we made our decision to move into a comprehensive inspector training program.

The three Idaho Department of Highways offices most directly concerned (construction, materials, and personnel) outlined an action program. The first order of business was to establish sufficient support for the program to overcome the inertia that could obviously be expected. The solution of this basic problem was far more direct than subtle. On December 5, 1963, at the recommendation of the division and section heads implementing the program, the State Highway Engineer signed a directive to all districts and divisions stating that effective May 1, 1964, all employees assigned construction inspection responsibilities shall be trained and certified as being qualified to handle the classes of inspection work assigned to them. The time was deliberately short and carefully scheduled to fit the season of year when the training and certification process could be accommodated. Needless to say, with the mandate from the chief administrator of the department, everyone rolled up his sleeves and went to work on this high priority project.

The form of the program was determined by the steering committee using much of the work of the special AASHO committee. Inspectors would be trained and certified in one or more of five different specialties. These would be a basic inspection classification followed by advanced categories in earthwork, aggregate, concrete, and asphalt. It was also determined that a written examination would be required of each trainee at the culmination of each training course as a condition of certification. The certification procedure would also consider experience, other training, and a personal rating of each inspector made by the supervising resident engineer and reviewed jointly with the district materials engineer and the assistant district engineer responsible for construction.

The planned program can be defined in four steps.

1. Classify employees for training.

2. Conduct training courses.

3. Certify employees in one or more inspection area, and

4. Document the training and certification in the personnel and project records.

Before a man could be intelligently assigned to a particular level of training, it was necessary to inventory his qualifications and determine just where he would properly fit into the program. This process involved personnel ratings and interviews by key district office supervisors, including the resident engineer or project engineer directly supervising the inspector concerned. A man considered qualified in a particular inspection area was given a written examination. An acceptable examination grade allowed certification without further training.

From the first day of the first training session the enthusiasm of the trainees was quite apparent. They quite obviously liked the idea of learning more about their jobs. This was evidenced by their attitude in the formal training sessions as well as in their demonstrated individual initiative in seeking even more information than that offered in the session itself.

Program Evaluation

Contrary to expectation, the examinations caused little consternation among the trainees and, in fact, served to boost morale. Perhaps this was because goals had been set and the department had developed methods for achieving them. Each inspector who carries a certification card is justly proud of his achievement.

The program must, of course, be a continuing one. At the end of the initial training session, all district materials engineers attended a critique on what had been accomplished so far. Almost without exception these engineers voiced satisfaction with what the program had achieved.

Ideas will be solicited for improving curricula and for additional training aids. The headquarters of the materials section plans to develop visual aids for several phases of inspection. Every effort will be made to improve the written examinations so they will reflect the conditions encountered on construction.

It is anticipated that a recertification period will be established. For those inspectors who are working in their qualified areas, this period will be three years. For those who have not worked in the areas for which they were certified, the required time will be two years. In other words, each inspector will be required to participate in the training program at least once every three years.

The program can be counted as a success. This success is due in no small measure to the effort expended by the people who administered the training. Their cooperation was most gratifying.

The reasons for the effectiveness of the program can be summed up as follows:

1. The program was established by administrative directive and was applied uniformly in all districts.

2. Certification was based on written examination and an evaluation of each trainee by a committee whose members were familiar with each individual's qualifications.

3. The cooperation of the inspector-trainees and the people who administered the program was genuine and whole-hearted.

The highway department is pleased with the acceptance given the program thus far. The areas involving recertification procedures, improvement of course outlines, and examinations are being reviewed. The current construction season may point up weaknesses in the program which are not now apparent. Further training programs will be expanded to include text material and inspection procedures for prestressed concrete and miscellaneous general inspections concerned with fencing, illumination, signing, cover materials, guard rails, and related areas.

The approach Idaho has taken features uniformity in curriculum, written examinations, and implementation centralized in the construction division. Department initiative in the area of inspector certification and training has achieved a program which is suited to Idaho's needs. Excellent teamwork by representatives of materials, construction, district administration, and personnel has realized a certification concept and a training effort which will produce the technicians necessary to assure competent, uniform, and quality construction inspection. Maximum use of department facilities, teaching talent, and carefully selected training material, plus the scheduling of class sessions during the nonconstruction season, has produced a program which Idaho believes is progressive, effective, and economical.

Training sessions were conducted in each district. General course outlines and instructors were handled through the headquarters of the materials section of the department. We also relied heavily on industry specialists from the Portland Cement Association and The Asphalt Institute. Their services were very helpful.

By the time the May 1, 1964, deadline for training and certification rolled around, some 200 inspectors had been trained and certified.

The certification requirement was imposed primarily to establish clearly the responsibility for insuring that only those men capable of doing the job would be assigned to inspection work. It also serves the purpose of letti the individual inspector know that the department has confidence in his ability to perform the work as well as stimulating the individual inspector to more fully assume his job responsibilities. Each certified inspector is given a wallet card attesting to the classes of inspection for which he is certified.

Like all other highway departments, we must rely on hourly, temporary employees to handle certain routine assignments associated with construction. These assignments would generally include such things as weighing and checking, assisting a certified inspector in conducting field tests, or assisting on field survey parties. As a part of our inspector training and certification program, we require that each of these hourly employees be afforded sufficient on-the-job training to insure adequate familiarity with the work assigned. This on-the-job training must be documented on a special report form, a copy of which is given the employee, which not only describes the training given but lists the specific responsibility and authority of the employee and gives him the name of his immediate supervisor and the name of each successive supervisor up through the resident engineer. It also advises him of the false statement provision of the U.S. Code and instructs him as to what should be done in the event of an emergency or a breach of the specifications. This process has served well in making the short-term, temporary hourly employee more aware of his responsibility and the supervisor more aware of the importance of properly indoctrinating this type of employee.

The program to date has produced 265 certified inspectors and has involved some 29,000 man-hours of formal training. It is anticipated that during his career with the department, each inspector will attain certification in all five inspection categories. Those inspectors who have attained basic and soils certifications the first year have subsequently moved onto advanced certifications.

The inspector training program is our principal continuing training program. I would like to mention several other areas of training that we feel have been beneficial to our operations.

We have just topped the 1,000 mark in the National Safety Council's Driver Improvement Program. Professionally trained instructors will complete this training for all department employees who drive cars or equipment within the next two months. Through the State Board of Education, we have provided a comprehensive course in the Techniques of Supervising People to over 225 of our field-level supervisors, resident engineers, and maintenance foreman. We are expanding this course into a middle management training program. Also, through the State Board of Education's vocational training program, we offer special courses in mathematics, surveying, and physics. Internal training programs in right-of-way appraisal, computer programming, and radiological monitoring have been well received.

One program that has won commendation is our first aid training, where 758 employees have been given the Red Cross standard first aid course.

We are in the training business and recognize that a well-trained employee is happier, more efficient, and better qualified to fulfill his or her assigned responsibilities.

BUREAU OF PUBLIC ROADS TRAINING PROGRAMS

by

B. J. McClarty

The Bureau of Public Roads started a training program for highway engineers approximately 30 years ago. A surprising number of our top supervisory personnel today in the Washington, regional, and division offices are graduates of that first training program. However, it was not until after World War II that a comprehensive, continual training program for highway engineers, limited to college graduates, was adopted.

In addition to our training program for highway engineers, which is a national program, Public Roads in Region 8 conducts extensive training courses for technicians. Every year we conduct training courses for instrumentmen and officemen; in addition we present comprehensive courses in materials control for inspectors and resident engineers.

I am going to explain how and what we try to accomplish with each of the training courses, with emphasis on the training for technicians. It is my understanding that this is the emphasis desired by the coordinating committee of the Conference.

First let me review briefly our training program for highway engineers--what we in the field offices generally refer to as the junior engineer training program. We recruit for this program on a national basis. Applicants must be graduate civil engineers with a grade point that places them in the top 25 percent of their class. At present we are hiring 75 graduates each year.

The graduates are given a three-year training session in highway engineering. The program consists of six major assignments. Under the operation procedures of the program, the length and arrangements of the assignments go something like this: direct federal highway construction projects--12 months (two construction seasons, both in same region); federal-aid field operations in regional and division offices--6 months; highway engineering and administration course, in Washington office--4 months; inspection-in-depth procedures in regional or division office--4 months; special assignment in phase of particular interest, in field or office--4 months; and assistant area engineer in a division office--6 months.

I will not attempt to describe any of the details of these assignments. In general, during the three-year period we try to expose the graduate to practically all aspects of highway engineering. On some of the assignments, the junior engineers are quite productive. This is particularly true of the field assignments to direct federal construction projects.

On completion of his training, the junior engineer has a choice of type and location of his first permanent assignment. His choice is respected to the extent job openings are available.

So much for our highway engineer training program. We are very proud of it, and we are particularly proud of the fact that 555 engineers have graduated from it since World War II, and over 90 percent of them are still with Public Roads.

Now I would like to discuss our training program for technicians. Our problem is, I believe, quite similar to that faced by the highway department--keeping a sufficient supply of competent instrumentmen, officemen, and inspectors to staff our field projects; in addition we must provide special training for technicians who have demonstrated they have the potential to make good resident engineers.

Many years ago we faced up to the fact that we were not going to be able to retain the graduates of our highway engineer training program on field assignments of location and construction for any appreciable length of time. Other opportunities in Public Roads for men of their education and training were too frequent and appealing. Also, field assignments to our projects, although quite comparable from a monetary standpoint, were not attractive to most of the highway engineers because of the moving and living conditions involved. So an adequate training program for our key field personnel was mandatory.

We started our training courses for instrumentmen in 1949. We conduct two classes of three-week duration each winter. Class size varies from 12 to 15 people. The men are assigned to the course from field projects and paid salary while in attendance. All courses are held in the classrooms at our design and computer headquarters in Vancouver, Washington. To date we have graduated 275 employees from the instrumentman school.

The instruction given instrumentmen includes both field and office work. Each man is taught to care for, adjust, and run a transit and a level; the instruction includes actual layout problems in the field. The men are taught all the basic math needed to compute horizontal and vertical curves and coordinates and to solve various field problems. In addition, they are given instructions in earthwork computations, and in the form and content of all field notes.

A final exam is given, and the men are graded on the basis of this exam plus their class attitude and apparent potential. They are then assigned to a field project as an instrumentman and receive a promotion after demonstrating satisfactory performance during a short probationary period.

We started training people for our project field offices in 1949. These courses are also three weeks long, and we conduct one class each winter. Size of classes varies from 12 to 20 participants. We have put 246 employees through this school to date.

The officeman's school covers the use and care of typewriters and calculators, recording and computing of all pay quantities, checking transit and level notes, plotting cross sections, preparation of all forms such as contractor's progress estimates, force accounts, payrolls, expense accounts, and equipment rental. We have a good construction manual, and therefore the emphasis is placed on understanding, utilizing, and conforming to the data in this manual to the fullest extent possible. In addition, these men are given a 10-hour standard Red Cross first aid course sometime during the three-week period.

We did not begin our training in materials control until 1962. Until late in 1961 we did not have a materials laboratory. Then we were shocked into action by the findings of the first Blatnik Committee investigations. We have a good materials laboratory. However, except for testing in connection with survey and design, it is used exclusively for training. The materials training courses begin in October and run continuously until June.

There are three different courses conducted, and each is adjusted to fit the calibre of the engineers attending. There is an 80-hour (two-week) course on quality control of construction materials for our area engineers. Two of these courses, with eight area engineers in each, are held each winter.

Then there is an 80-hour (two-week) course in materials control for resident engineers. Each course is attended by six engineers, and there are four sessions each winter.

Finally, there is the four-week course in materials sampling and testing for inspectors or, as we call them, "engineering aides." These are also held to six men per class, and we average five classes annually.

As you might expect from the size of the classes, our materials training courses for engineering aides are complete and intensive. With the small class, each participant has the opportunity to actually perform all the tests. Instructions are detailed, and the curriculum includes considerable preparatory work and night studying. A final exam is given, and each participant is graded on this exam, day-to-day performance during the course, attitude, and potential. If an employee fails to get a passing grade, all resident engineers are advised that the employee cannot be used for materials sampling or testing assignments. If the instructor thinks it desirable and appropriate, the failing employee is given the opportunity to take the course again.

The materials courses for resident and area engineers are designed to reach a different objective than those given for engineering aides. The interpretation of test results is emphasized. Tests are not performed by the participants, but are observed. Also, considerable stress is placed on how to recognize improper methods of materials control and construction practices during rather brief inspections of construction projects.

We have put 126 inspectors and 56 project engineers through these materials courses to date. We have also trained a limited number of engineers from the Bureau of Land Management and the Bureau of Indian Affairs.

Instructions at all our training sessions are handled by our own engineers on special assignment. In addition, we utilize representatives of industry and highway departments wherever needed to provide more comprehensive coverage of a particular subject.

I believe it would be appropriate right about here to acknowledge the excellent cooperation and assistance we receive from The Asphalt Institute and the Portland Cement Association in making all these training courses more effective. Their representatives have contributed time generously to improve instructions concerned with their respective materials.

Some basic guidelines we have learned should be followed if any type of training program is to be successful; and I pass along a few of them to you:

1. Be sure to establish a good comprehensive outline of the training courses.

2. Be careful in selecting instructors. They must not only know their subjects, but should be sympathetic with the aims of the program.

3. Be careful that the engineers in the program feel that supervisory personnel has a personal interest in their improvement.

4. Try to recognize above-average performance during training by a good job assignment; and if that performance continues on the job, recognize it as quickly as possible with a pay raise or promotion.

5. Always recognize ability disclosed in training with assignments carrying all responsibility feasible.

In a close-knit, relatively small engineering organization such as our Direct Federal Section, word on the calibre of the training programs, treatment of the trainees, and so forth gets around pretty fast. If the general evaluation of the trainees is unfavorable, a poor reflection will be conveyed to future trainees.

I have not made copies of the course outlines for any of the training discussed as part of this paper, However, if any of you would like any of these, drop me a line and they can be furnished.

There is one other training course we conduct for technicians that should be mentioned. We call this a Supervisor Development Course. Each year we select 15 to 20 of our young field engineers who have just reached project engineer status, or have shown good potential for project and resident engineers. These men attend a two-day Supervisor Development Course, in which we stress getting along with employees, communication, delegation of authority, and public relations. We started these courses in 1961.

That completes my review of the various training programs of the Bureau of Public Roads, more particularly those conducted by Region 8. There are many others arranged and supervised by our Washington office. These involve urban design, rights-of-way, and management. However, I assumed those of you in attendance here would be primarily interested in training for field engineers who are concerned mostly with the various phases of construction.

We believe all of these training programs are a worthwhile expenditure of time, effort, and funds. We expect to continue them. We recognize that measuring the results of such training is difficult. But none of us question that the competency and efficiency of our field crews and inspection performance have been substantially improved by this training.

LUNCHEON

Presiding: Victor D. Wolfe

LUNCHEON ADDRESS

OBJECTIVES OF THE CIVIL ENGINEERING TECHNOLOGY CURRICULUM AT OREGON STATE UNIVERSITY

G. W. Holcomb

LUNCHEON ADDRESS

OBJECTIVES OF THE CIVIL ENGINEERING TECHNOLOGY CURRICULUM AT OREGON STATE UNIVERSITY

by

G. W. Holcomb

The proposed technology program at Oregon State University will start in fall of 1966. We have had a program of engineering technology under observation for a good many years and also a program of professional education.

We have had approved at Oregon State a Bachelor of Science curriculum in Civil Engineering Technology, a Bachelor of Science in Electrical Power Technology, and a Bachelor of Science in Mechanical Technology. These are all four-year curriculums that will be instituted in the fall of 1966. It should be understood, of course, that we will not put this into operation all at once because it will be four years before we have our first graduates.

I would like to go into a bit of the historical background of engineering technology before I tell you just what is in this proposed program. In 1944 a Technical Institute Committee was set up on the campus, of which I happened to be chairman, and members of that committee were from the Agricultural School, the Forestry School, and the technology field. We prepared a report on a proposed program which was turned down by the administration. This was about the time that war surplus was becoming available to the institutions. This report was so thick and detailed that it was a good means for us to get a reasonable amount of war surplus. That is about all the good it did.

Now going back into history a little further, the American Society of Engineering Education has made many surveys of engineering curricula and studies. The first one I participated in was in 1928-29. I remember I helped write a report on personnel methods in engineering for this study. There were a lot of tables, we called them tables then I think, and correlations--the volumes were thick. The dean made me study them at that time, and I sometimes wondered why. That was along about the time that statisticians predicted, however, that the population of the United States was going to round off at about 170 million. Now these are statistics. You know it has been proven beyond doubt that smoking is one of the leading causes of statistics. We have lots of statistics today in this country, and this is one group of them.

In the intervening time between 1928 and 1965, two more comprehensive reports were made on engineering education. The last one, now under discussion, is called "The Goals of Engineering Study." There is a lot of discussion of this report in engineering education circles. There is a lot of disagreement, but in some ways it always seems like something good comes out of these reports. Probably this last report, the Goals Study, was stirred up by the 1952-53 report on engineering education which is quite commonly referred to as the Grinter Report. Dr. L. E. Grinter was chairman of the committee which prepared that report. Incidentally, Dr. Grinter is a civil engineer. The Grinter Report brought out some rather caustic recommendations which, if carried out, would substantially raise the level of some areas of engineering education, particularly in mathematics and science. The report also recommended some extra courses in what is called the "humanities and social sciences." If you included these extra courses -- additional mathematics, additional science, and additional humanities courses -- something had to give. As many of you in this room know, much of the surveying, drawing, and some of the so-called art of engineering was crowded out.

Some of the schools did not go along with this report; that is, they were a little bit slow in adopting it and putting it into effect. These schools became aware of a committee called the Engineering Council for Professional Development which reviewed the schools from time to time, supposedly at five-year intervals. A school might not be accredited if it did not adopt the recommendations of the report. We stayed accredited by adding the necessary courses to our curriculum. This, of course, as many of us feel, made the engineering curriculum almost a science curriculum because we lost many of the so-called practical courses or art courses of engineering -- whether you want to call them design or art courses is, of course, the question. It caused some drop in engineering enrollment and quite high mortality. In the fall of 1964 we had 105 freshman civil engineers. In the fall of 1965, 50 of those 105 came back to register in the sophomore class. Some may have changed into other courses, and I suppose others dropped out for financial reasons, but this is quite a high mortality however you figure it. We were seeing the result of the 1952 report; we began to feel it and recognize it, as you people out on the firing line of engineering did, in about 1962.

This program of professional engineering with mathematics and science in it certainly does fit the excellent student, the gifted student, the research-oriented student, or one entering the "exotic" industries -- space age, space travel, rocketry, and that sort of thing. You need additional mathematical background for these fields. Many question the fact, however, that this background is needed by all engineering students.

I venture to say that if I were to ask how many of you people in this room uses a differential equation once or maybe twice a year, very few of you would raise your hands. This condition of high mathematical requirement and a low number of subjects in the art of engineering brought about the development of the civil engineering technology program, which we think will fit a man for "the ordinary walks of life." It certainly will not fit a man for areas of research, but it will fit him for the smaller industries: normal construction, building, surveying, city engineering, most highway engineering, and most Corps of Engineers work. We believe this program will orient a man and give him the basic knowledge he needs to fulfill at least 90 percent of the present engineering jobs or positions.

Certainly, if a man wants to aim for research and has the capability, we should urge him to do so. We must have people working out on the fringes if we are going to advance.

Public Vocational Technical Engineering in Oregon conducted a survey in 1957 and prepared a report. I believe the State Board of Engineering examiners requested this. At that time it was recommended that a technical institute be established at Oregon State University, since this two-year program at the technical institute level would fit right in with our professional program. I think this was not a difficult conclusion to make, since Oregon State is a land-grant institution under the Morrill Act of 1862, which says that education in land-grant institutions should be directed to the mechanical arts.

The three proposed technology curricula (civil, mechanical, and electrical) are designed to provide a four-year technical education combined with business, social, and general education--in which I include sociology, psychology, and the humanities--to meet the requirements of industry. By using the word "industry," I am talking about construction, surveying, or drafting. The programs will train a man to meet the needs of the existing conditions but will not meet the present professional curriculum standards as set up by the Engineering Council for Professional Development.

You may be interested in the content of this curriculum and how it is divided. We have 18 term-hours in the area of mathematics and physics. This means that one term of probably three credits in calculus is required; this would not be very stiff calculus, just the rudiments of it. The mathematics requirement includes 9 1/2 percent of the curriculum. The present professional curriculum requires between 25 and 30 percent of mathematics. We have 48 term-hours in humanities and social sciences, which is 25 percent of the curriculum; 30 term-hours in business courses, or 15 percent; and 78 term-hours in technology, or 40 percent. I will discuss these requirements in a little more detail later. This curriculum, we believe, will provide a knowledge in engineering subject matter that would be potentially at the same level as 10 to 15 years ago, with the exception perhaps of mathematics and science. However, bear in mind that we expect practically all of our high school graduates in the professional engineering curriculum to be ready to take calculus when they enter college in their freshman year. Not very many engineering graduates in this room had to take calculus the first term of their freshman year--maybe a few, but not very many. Hence, the technology graduate will probably reach about the same level as the engineering graduate of 10 years ago.

The humanities and social science courses in the technology curriculum amount to 25 percent, or 48 credits, and six of these are free electives. These include writing, speech, economics, business English, and report writing. This is considerably more humanities and social sciences than are required in the professional engineering curriculum. The present professional engineer gets nine credits in writing, speech, business English, and report writing, which is about 12 or 15 percent of the total curriculum. This ought to settle the argument about the ability to write. I am not so sure it does. I notice the reports of lawyers, who we know study a lot of writing, and I have never been able to read a law report. But we are always criticizing the fact that engineers cannot write. This requirement, we think, will give a thorough training, as much as anybody else gets, in the field of humanities.

In the field of business--many, many people come to us and say, "Why don't we require more business courses?" I think we should. The technology curriculum has 15 1/2 percent, or 30 term-credit of business. These courses include basic accounting, financial analysis, business statistics, production marketing, finance, and nine credits (a one-year sequence) of free electives. This, with other electives, should give the students sufficient training in business.

In the engineering technology field, we have 78 term-credits, which is 40 percent of the curriculum. I do not think more than 25 percent of the present engineering curriculum includes surveying and drawing. In the sophomore year--I will not bother with the freshman year--there is a little drawing and orientation. In the proposed civil engineering technology curriculum there is civil engineering drawing and computation, and this is what we used to have in the sophomore year of the professional curriculum. These will be courses that we are going to try to start next fall--if we get any takers. We are going to limit the program to one section of 25 students in civil engineering technology because we do not have the staff to handle a larger enrollment. I think Professor McClellan is worrying about whether we are going to get the staff to handle this much. There will be a surveying course throughout the freshman year of three credits a term. In the sophomore year there will be a civil engineering drawing course, a laboratory techniques course, mechanics (statics, dynamics, and strength of materials), humanities, and business courses.

The junior and senior years are set up in a flexible way. In the junior year, besides the business and humanities courses which in the most part are required courses, there are 15 credits of technology which can be elected; in the senior year, there are 28 elective credits. This, in a program, looks like quite a lot, and experience may cause us to revise it. These 15 and 28 credits in the junior and senior years are planned in different fields in which the individual student may want to specialize. We used to call them options, then "option" became a dirty word and we were not allowed to use it any more. These are elective courses. If a person, for example, is interested in surveying, his interest in the subject might increase after taking his first year in surveying and he might go into photogrammetry and all the other series of surveying courses. We will provide elective courses in this field for him. If he is interested in laboratory work, particularly in testing, and demonstrates this in his sophomore year in the laboratory techniques course, we might have him elect a three-term sequence in materials testing or have him elect a project in materials testing. If the student is interested in construction and field work, be it construction for a contractor or for a highway department, we would steer him toward construction courses. We have a construction materials laboratory course (three credits a term), contracts and specifications, estimating and cost analysis, highway location courses, control survey courses, and some others he might choose. These could make up a program for the junior year.

In the senior year, 28 credits of technology are required. By his senior year, the student will have had a little more experience and will be more particular about which way he is going. But, if he were interested in construction, I assume he would elect construction methods and control, for nine credits. He could elect a technical projects course, say in structural problems or in concrete form design. In construction, he might take the construction surveys course or a construction seminar. From this group of courses (I have not referred to all of them) we believe we can train a man to be at least a little bit familiar, more familiar than our present group, with the fields of construction. Other elective courses include the fields of equipment maintenance, water and sanitary engineering (water resources now), computer technology, and land survey law.

This engineering technology will not be the same type of course as the professional engineering course at the present time. It fits a particular individual, and I am going to digress a little and give you my philosophy about students and education. I believe that we are all different; I am almost certain of that. Each person has capabilities of doing certain types of things. I have used this example may times--I do not care how hard I trained, I would never be able to lick Jack Dempsey, because I am not made that way. I think our minds differ in that same manner; so do our vocal chords--we are not all singers. In education we have not yet found a way to classify people so we will know whether they will be successful.

I am convinced that if a man takes a couple of terms of calculus and gets "D" grades in it, he had better get out of engineering. I don't believe he likes it. On the other hand, I have seen individuals who were pretty capable in calculus that couldn't sharpen a knife. It is the way they are made. Our objective is to guide people into the right field as near as we can. It is quite obvious at the present time that we have many people who have an interest in something that looks like engineering, whether we call it that or not, and I think we should get these people interested in engineering. This is part of our objective. In addition, many employers are asking for people to do work like surveying and to assist in engineering branches of construction or in water plants or the like. This type of trained individual, I believe will be as valuable as the professional engineer. I am not so sure that in many classes of work he will not be more valuable than the presently classified professional engineer.

Where this new technology curriculum will lead us and how much success we will have remain to be seen. My guess is that we can fill the sophomore year from our own group in the school right now. We expect to have small brochures published, but I do not know how widely they will be distributed. We would appreciate your thinking about this program and making it known to anyone you think might be interested. Also, we would be interested in hearing any of your comments. I have tried to tell you a little bit about the technology curriculum. We believe it will help the engineering profession and will help many people get a good degree and have a good career.

PANEL DISCUSSION

URBAN STREET DESIGN AND IMPROVEMENT

Presiding: Hugh McKinley

INTRODUCTION

by
Hugh McKinley

To those of us in city administration fields, I do not think there is anything of more significance from the public works standpoint than the kind of street planning that takes place outside of our city limits. I refer to those areas immediately adjacent to our cities which we anticipate at one time or another we will inherit through annexation or through default. Therefore, the question of city street standards for the immediate suburban area is of great importance to us.

In Lane County we have been very fortunate in that the Board of County Commissioners has been very cognizant of the importance of setting county road standards to agree with those of city streets, so that when these streets become city streets, we will not have to completely rebuild them in order to make them fit into drainage systems and into our street pattern. We now have a reasonably good set of uniform standards that will avoid a lot of extra cost in the future. In the meantime, we are repairing a lot of old county roads at a very high expense. These were designed to be county roads and are now city streets.

PLANNING URBAN STREETS

by
Robert Baldwin

The urban centers of the United States are experiencing a growth unprecedented in our history. We are not only in the midst of a population explosion, but at the same time there is a very great movement of people from the rural areas to the cities and the suburbs. It is now estimated that the urban complexes of the Pacific Northwest will double their 1960 populations by the year 2000. The metropolitan areas of California are present examples of the kind of environment that we can expect here unless new policies, programs, and techniques are developed to assure the character of our cities of the future.

Hopefully, a large share of this new growth will occur within the boundaries of our present cities. There is really a very great need in our urban centers to reuse the slums, or the blighted or run-down sections. Civic investment in these poorly used sections must be made to accommodate much of the new population with which we expect to restore the tax base in our communities to its proper perspective.

These events can only take place if our metropolitan areas formulate the necessary programs now. There is an obvious need to regroup in some cases and to reinforce in others, our local political institutions. There is a need to adopt some bold new policies and to develop some imaginative programs and plans to cope with the challenges of the future.

In any case, the suburban areas will continue to expand in the future. The magnitude of this expansion will depend on the efforts and the success of efforts to direct some of this growth back into the central city area. We can evaluate now the effects of rapid suburbanization on our environment. Every city and suburb is a living, sick, or dying laboratory in which we can study the occasional successes and the all-too-frequent failures of our efforts to build satisfying human communities.

If our need really is for cities, towns, and suburbs, which are efficient, healthy, economical, safe, prosperous, pleasant, valuable, and beautiful, then we should consider every one of these needs in establishing policies for the future. It seems to me that as a nation we have a talent for adapting an apparently successful solution to a whole range of seemingly similar problems. We often insist on using these solutions even in circumstances where a casual study would indicate that they are really not appropriate.

Often the problem itself is not understood and more often the solution is incompletely applied.

An example of this phenomenon may be seen in the building called Leverhouse in New York. When it was built, this structure represented a fresh contribution to the art of designing multi-storied office buildings. There was a generous setback to open up the canyons of the city; there were plazas and gardens provided, together with a glass-faced tower. The vitality of Leverhouse was in its ability to reflect in interesting patterns the solid shapes of the adjoining buildings. Now most of this is lost. For the adjoining buildings have been replaced with the same kind of glass-walled structures, copied from the original but without the gardens and without the setbacks. The result of this bit of city building is a profusion of monotony, with each building reflecting only the sameness of its neighbor. It seems sometimes we do not know when to stop using the same devices over and over until it is too late.

In building our cities we have often not varied from exercising this exact same talent. For commercial and industrial areas the grid-iron street plan is frequently superior to any other street system. The regularity of this pattern, of rectangular blocks and lots and the repetitive streets, lends itself to the proper functioning of these districts; and yet the same use of the grid-iron in every community across the country and in every conceivable situation often passes the point of the ridiculous. The streets of the grid-iron in our cities now go uphill and across the steepest contours, to the edges of cliffs, and even down river banks. The improper application of the grid-iron plan leaves unbuildable lots and streets and difficult or impossible water and sewer line runs. On flat land in residential neighborhoods too much land in the grid-iron plan is devoted to streets. There are too many dangerous four-way intersections, and every long, straight street is a candidate for conversion to an arterial.

As an example of this, in a 12-square-mile area in Southeast Portland there were 80 percent more miles of arterial streets in 1965 than there were in 1945, but without any new building construction. This 80 percent increase introduced traffic into neighborhoods which were formerly quiet residential areas.

In the early part of the 20th century, some far-sighted planners in England re-examined the grid-iron plan, identified many of its faults, and developed a new concept of urban design, particularly for residential areas. They created a community which was compatible with its site and with its function. Recognizing the natural environment, they established what is known as The Garden City. The key features of this development are open areas and green belts with dwellings sited for pleasant views and privacy, but without any loss in the density ratio. The streets serving these communities are curved to fit the contour of the land more often than they are straight and they are designed to be as unobtrusive as possible. This street pattern was easily recognizable in the plan of each of these garden city communities, although the other features of greater value were not so easily noticed from an examination of the plan.

The street pattern was quickly adopted as the street layout for growing suburbia in the United States. Almost without exception the street pattern in every subdivision created in the last 20 years has been based on this curvilinear plan. The suburbs of every city, the ranch woods without ranches or woods, the vista hills with picture window vistas only of the neighbor's picture windows, and towns of monotony by the square mile are the result. The basis of the Garden City plan with open areas in green belts and the siting of homes was forgotten. The curvilinear plan has become some sort of warped, or a bent grid-iron pattern with only one objective: economy of construction.

The job of continual designing and building or rebuilding of our cities and towns is one for all disciplines and all interests. The public, the building industry, political leaders, and technicians all contribute to the development of our cities and should work from a common set of goals and policies. We need to return to first principles if we are to be more successful in accommodating the explosive growth that is foreseen for the future. Our communities need to set forth their desired goals for the design of new suburbs and for the rebuilding of our present cities.

Great opportunity for experimentation with new forms of urban development is present now in the suburbs and outlying areas. The raw land is an inviting and a valuable resource, but we must learn to use it wisely.

Hopefully, some new concepts of plan development patterns now are emerging from recent studies and developments. Neighborhoods are now being recognized for what they should be--pockets of quiet, residential use with a diversity of living types that enriches the fabric of urban life. These new neighborhoods are protected from the inroads of commerce and industry and from the blighting effect of streets converted to arterials with heavy car and truck traffic as a result.

In the new neighborhoods the schools and parks and open spaces are located so that they can be reached safely and conveniently by all of the residents. Streets are designed to serve the neighborhoods much the same way as utilities do--as a service, rather than as a factor dictating the form or the pattern of the building site itself. Many of these emerging concepts are based on a return to the philosophy that lay behind the Garden City approach.

Cluster subdivisions are being developed where dwellings are grouped around a common access and service point with rear yards opening out into common greens and open spaces. These new subdivisions often have a variety of housing types, such as an ancient Greek idea of an enclosed house with a garden in the center, or townhouses and row houses, along with the usual simple family dwelling. These new residential design concepts attempt to satisfy the desires of the residents rather than recognize only the habits of those residents from the past. Often these habits stem directly from the physical patterns of the older developments rather than from the real needs of community living.

Why should our children have to play in streets which are designed to move traffic and to carry the automobile? Why should they walk to school along the sides of roads? Why is it necessary to provide a first-class speedway in front of every single home? Do we really want views only of other people's picture windows?

These new subdivisions for residential use are often developed at the same density of population per acre as are common in the grid-iron or the curvilinear plan, but with smaller individual lots for privacy. There are, however, vistas of common, open space owned by all of the people in the subdivision and often developed on portions of the total site which would be difficult or very expensive to develop for houses. There are within such subdivisions open areas for children to play, to dig holes and build tunnels and forts, and even to play in the mud. The pedestrian walks are located in the open spaces separate from the streets, and this secondary circulation pattern for people provides a safer means of movement from homes to schools and parks. The streets in these subdivisions which provide access to residences only are not for through traffic; they are built to standards related to their function as access to those homes.

Too often, I think, we tend to develop rigid standards based on our estimated need at the moment, but often these standards become their own reason for being, with the policy on which they were based at the time having been lost. It is important to re-examine our standards from time to time, as well as our policies, to see if they really apply to the needs and desires of the present and of the demands for the future. It is important to establish, sometime for the first time, the real goals of the community in regard to its shape, its design, and its function.

We need to determine what kind of communities we really want, to review our design standards and our criteria in relation to the community development, and to test them against the actual desires of the residents of the community. We need to give new consideration to such apparently noneconomic factors as beauty, safety, and freedom from neighborhood disruption. We need, all of us, to recognize that there are other matters related to community development than construction costs or road-user costs and that the long-term benefits of a satisfying environment often outweigh the short-term gains which may be derived from low-cost construction. Finally, we need to be on guard against becoming slaves of past design devices which no longer fit our present or future needs. It is important to avoid using these new land development concepts just because they are popular.

The larger population of the future is likely to have different characteristics than exist today. Each person will be better educated than we are, having gone to school for a longer period of time in their lives. All of them will be more experienced in the art of living in cities, having for the most part been brought up and lived in cities all their lives instead of having come from the rural areas. The number of working years of each individual will be reduced, but at the same time the total life span is going to be increased. Hence, there will be more time to enjoy the advantages of urbanism and a far greater demand on the part of the residents that our cities really be pleasant places in which to live.

STANDARDS FOR URBAN DESIGN

by
Walter F. Winters

The adoption and use of proper standards for road and street regulation are just as important as the basic land and transportation planning which often initiates road and street construction. In fact, sound planning invariably is based on the assumption that correct standards will be used. Many times in the past, subdivisions have been approved which included streets that were very evidently arterial in nature, yet they carried the same right-of-way widths as the adjacent collector streets.

In the state of Washington the interest in standards dates way back, as is true in most areas, but attempts to adopt uniform standards were not really accelerated until after the war. By uniform standards, I mean criteria which control construction, for example, for all of the counties in the state. This uniformity is highly important, as it is usually the product of engineers having long experience and sound judgment. It is not a static development and must, of course, be changed from time to time when new and varied conditions warrant a review.

In 1949 the Washington legislature, at the request of the County Commissioners Association, passed a bill which authorized the executive committee of the County Commissioners Association to appoint a committee on standards which, when approved, had the full effect of law in regulating county road and street improvements. Several different committees have been appointed since 1949 by the Commissioners Association, and these committees have updated the regulations in effect at the time. The present standards in use by counties are quite simple but very effective; they are the product of the collective thinking of most of the counties in the state.

The cities, also, have developed standards for use by the various cities of the state. One of the first reports of this nature was prepared by the "State of Washington Design Standards Committee," and it was submitted in 1962 as a revision of design standards which had been published in 1950. This manual is interesting in that certain standards are set forth for cities under 1,500 population, and other criteria are available to cities of over 1,500 population. The committee felt this differentiation to be desirable in recognition of the substantially different traffic problems experienced by the smaller cities. These design standards indicate rather simple regulation for cities under 1,500 population, but go into considerably more detail in connection with freeways, expressways, parkways, primary arterials, and community arterial streets. Neighborhood collector streets are included, as are commercial and residential access streets. In June 1965 the Bureau of Governmental Research and Services at the University of Washington, under the direction of Joseph H. Vogel, prepared a manual for cities entitled, "Design of Subdivisions." This excellent manual goes into considerable detail regarding standards for various types of subdivisions, and it is recommended that any city contemplating the adoption of subdivision standards review this manual.

In King County, in addition to the regulations or standards previously mentioned, we have our own regulations; these supplement the state standards and control work on subdivisions and other private work on county right-of-way. The last issue of the King County regulations was published in 1962, but a revised edition will be published this year. It covers, in general, data required by the county before approval is given for the construction of streets in a subdivision. This includes the information required on both the plan and profile, together with recommended limits on grade, curvature, vertical curves, and so forth. It contains a section on definitions, terms, and general notes in connection with drainage and the required drainage plan, surfacing, inspections required, roadside paths, utility locations, and the like. These data are also illustrated by plates showing dimensions and locations. Also shown are the approved standards for catch basins, inlets, manholes, curbs, and gutters.

If you are contemplating the development of a street or highway standards manual, you may consider one of several methods. One system quite commonly used is to show the actual dimensions on pavement width, curb height, and related subjects. Another method is to show general criteria in terms of allowable minimums. We feel the former system is superior since there is no question about what can or cannot be constructed.

Standards will contain various types of pavement sections showing, for example, the number of lanes. In this connection, I would like to mention a five-lane section we use in which the center lane is a two-way turn lane. We have found this type of installation to be particularly appropriate in commercial areas. In addition to the number of lanes, the location of all types of utilities must be noted, pavement widths should be shown, sidewalks or path positions indicated, and cut and fill slopes specified.

I could spend considerable time in review of standards in use in King County and other areas; however, this data can be obtained from the agencies involved and need not be repeated here. We feel it highly important to have uniformity among governmental agencies, particularly in connection with geometric standards, and any accomplishment along this line is certainly to the advantage of the agency involved.

OBTAINING MAXIMUM USE ON EXISTING RIGHT-OF-WAY

by

E. J. Leland

The following information, which I have been asked to present at this 1966 Northwest Roads and Street Conference, is based upon the experience of the city of Spokane following a street improvement bond issue passed by the voters in the spring of 1962.

A Street System in an Undeveloped Area

If an engineer or planner can begin with a clean slate and determine just what right-of-way will be necessary for a particular street width in advance of urban development, his problem is simplified tremendously. This allows the engineer, along with the planner, to accommodate an arterial system on adequate right-of-way and still allow ample setback of all land adjacent thereto. This would truly be a utopian situation.

Unfortunately this condition is not commonplace. For the most part, the right-of-way problem is very apparent and requires a solution. This usually happens after an area has developed. Through lack of adequate foresight and planning, or inability to sell adequate long-range planning, many present-day traffic problems have occurred.

Wellesley Avenue

The following is a description of how a specific problem was approached in Spokane to solve a growing arterial need with inadequate right-of-way.

The Problem

Traffic	Growth -- 24-hour, 2-way volume	
Year	West of Division St.	East of Division St.
1937	450	3,000
1959	9,600	10,500
1963	11,800	12,400
Street Width	35-foot	40-foot

Right-of-way	60-foot for the most part
Setbacks	Variation of numerous 5-foot side-yard setbacks, with several cases where no setback existed. Other cases were 15-foot minimum front yard setbacks.
Congestion	Morning and evening peak hours had noted congestion, particularly at signalized intersections east of Division. West of Division Street, both at signalized intersections and midblock, congestion was commonplace where motorists attempted to drive the facility as a four-lane arterial on a 35-foot street.

Solution

A bond issue was passed in the spring of 1962 for street improvements in Spokane. Wellesley Avenue was a part of this bond issue. The plan was to design the widening of Wellesley to carry anticipated traffic growth for at least 20 years. Rather than equal curb-to-curb widening over the entire length, the channelized areas were flared to accommodate the fifth, or left-turn, lane. This called for four 12-foot lanes, or a 48-foot curb-to-curb width throughout the major portion to be widened, with additional widening to 65 feet curb to curb for left-turn channelization at signalized intersections. It became obvious that additional right-of-way was required for the channelized intersections.

We had a number of public hearings concerning this particular street in an attempt to communicate particularly with the adjacent residents as to what was to be expected. The major discussion on the street improvement, however, took place following the decision to widen the street. The adjacent residents were not fully appraised of the situation and did not understand the project. In many cases property owners who thought they owned land clear out to the sidewalk were shocked to find they only owned property five feet out from their homes, which was their side yard. Numerous trips were made by various city personnel to visit with home owners and describe the exact location of the new proposed curb in relation to their property line.

In addition, where differences in ground elevation were aggravated by street widening, the city of Spokane consented to construction of retaining walls, in many cases at the request of property owners.

Results

The construction of Wellesley Avenue began in 1963 and was completed in 1964 at a cost of approximately $800,000. The city of Spokane obtained accelerated public works funds and was able to apply these funds as a part of the construction of Wellesley Avenue. This required the beginning of construction before all right-of-way was acquired. Starting a major project of this nature before having all right-of-way made the task an extremely difficult one. The necessity of court decisions as a part of right-of-way acquisition, along with private negotiations, extended the project through the winter of 1963 and into the year 1964.

There has been inadequate time since completion of construction to get a fair picture of traffic growth. Traffic flows more efficiently, however, with a minimum of congestion over the entire length of the avenue. There is still one problem area, however, at the intersection of Division and Wellesley, but this is not a reflection on Wellesley Avenue widening. Division Street is the principal north-south arterial in Spokane and is presently demanding a heavy portion of signal green time, thereby affecting the traffic flow east and west on Wellesley Avenue.

Conclusion

It is not an easy job to widen an arterial to good standards in a built-up urban area when inadequate right-of-way is available. Each problem usually requires an independent solution. If building setbacks are adequate, right-of-way acquisition is usually made easier, particularly if there are side yards. Our experience on Wellesley Avenue shows that it can be done. To do the job properly requires good publicity and public relations. Many personal home visits are desirable to help residents along the arterial understand where their property line is, what is being done adjacent to their home, and what they can expect from the final improvement.

PANEL DISCUSSION

THE HIGHWAY BEAUTIFICATION ACT OF 1965

Presiding: Fred Klaboe

HIGHWAY BEAUTIFICATION ACT OF 1965
INTRODUCTION

by
Fred Klaboe

In his January 1965 State of the Union Message to Congress, President Johnson called for a major program to protect and enhance the beauty of America as seen from its highways. A part of his message was the following:

> "In a fruitful new partnership with the States and the Cities, the next decade should be a conservative milestone. We must make a massive effort to save the countryside and establish as a green legacy for tomorrow more large and small parks, more seashores and open spaces than have ever been created during any period in our history. A new and substantial effort must be made to landscape highways and provide places of relaxation and recreation wherever our roads run. Within our cities imaginative programs are needed to landscape streets and transform open areas into places of beauty and recreation."

Acting on the President's recommendation, Congress passed the Highway Beautification Act of 1965 in October. This Act calls for the States to:

1. Have an effective method for the control of outdoor advertising signs within 660 feet of interstate and primary highway right-of-way by January 1968. It also required that the states remove all signs not meeting the new standards by July 1, 1970.

2. Have an effective plan for the control of junkyards and garbage dumps visible to the motorist within 1,000 feet of interstate and primary highways by 1968. It further requires that existing junkyards be screened from sight by January 1, 1968, or removed by January 1, 1970.

3. The Act authorized an amount of 3 percent of the state's federal-aid highway funds for acquisition and improvement of land adjacent to federal-aid highways or within the highway right-of-way for preservation and restoration of scenic areas and for the development of rest and recreational areas.

These are the guidelines and the goals that all the highway departments in the United States will be following.

HIGHWAY BEAUTIFICATION ACT OF 1965

by
L. I. Lindas

That the Highway Beautification Act of 1965 is not the epitome of excellent draftsmanship is probably the understatement of the year. I cannot envision the act remaining in its present form for too long, otherwise one can anticipate problems of interpretation and possibly future litigation involving some areas of the new law. For the purpose of this discussion, however, we shall have to deal with the act as it is now written. The bill is composed of several sections, and while the sections dealing with outdoor advertising and junkyards are somewhat repetitious, I believe it best to discuss the sections individually.

Control of Outdoor Advertising

Under the new law the states must, by January 1, 1968, make provisions for the effective control of the erection and maintenance of outdoor advertising signs, displays, and devices within 660 feet of interstate and primary systems of highways. Failure to accomplish this imposes a requirement on the part of the Secretary of Commerce to reduce federal-aid monies to be apportioned to the offending state by 10 percent until control is effected. In the interim the amounts withheld shall be reapportioned to the other states. The Secretary may, however, suspend this penalty portion of the law if he feels it to be in the public interest.

The phrase, "signs, displays, and devices" is used throughout this portion of the act, so when I later refer to signs only, I mean signs, displays and devices.

Effective control of outdoor advertising signs means that after January 1, 1968, the only signs that may remain within 660 feet of the nearest edge of the right-of-way of the interstate and primary systems of highways are limited to the following: (1) directional and other official signs and notices; (2) signs advertising activities conducted on the premises upon which the signs are located; (3) signs advertising the lease or sale of the property upon which they are located; and (4) signs in commercial or industrial areas, zoned or unzoned, as may be determined by agreement between the Secretary and the State, as to size, lighting, and spacing consistent with customary use. In connection with the latter, the states shall have full authority to adopt their own zoning statutes, which will be accepted for the purposes of the new law.

It should be noted, however, that the proponents of the new law, in their presentation before Congress, made it unmistakably clear that the states could not place a label, "zoned, commercial, or industrial" on land adjacent to the interstate and primary systems solely to permit billboards and junkyards and thereby frustrate the intent of Congress to control outdoor advertising.

The language, "as may be determined by agreement between the Secretary and the State" seems to me to give unlimited power to the Secretary to exercise control of signs in zoned or unzoned, commercial or industrial, areas respecting their size, lighting, and spacing, and until the state develops standards agreeable to him, he could refuse to execute an agreement.

Additionally, as the law is now written, we have the paradoxical situation where control is exercised over those signs in commercial or industrial areas advertising activities conducted off the premises, but no control is exercised over signs which advertise activities being conducted on the premises. This is one area of the law which might well become the basis of litigation as being violative of the equal protection clause of the Fourteenth Amendment to the Constitution of the United States, and therefore unconstitutional. The equal protection clause is a guaranty of like treatment to all similarly situated under similar conditions. It permits reasonable classification based on differences reasonably related to objects or persons dealt with and the public purpose sought to be achieved by the legislation involved.

In light of the public purpose involved, which is the control of outdoor advertising to protect the public investment in our highways, to promote the safety and recreational value of public travel, and to preserve natural beauty, it might be questioned whether the classifications in the Highway Beautification Act are reasonable.

The bill goes on to provide that signs lawfully in existence along the interstate and primary systems on September 1, 1965, which do not conform to the provisions of the law have until July 1, 1970, in which to be removed, and that any other sign lawfully erected shall not be required to be moved until the end of the fifth year after it becomes nonconforming.

Another provision of the act provides that just compensation, the federal share of which shall be 75 percent, shall be paid upon the removal of signs that are:

1. Lawfully in existence on the date of the enactment of the law (October 22, 1965);

2. Lawfully on any highway made a part of the interstate and primary systems on or after the date of the enactment of the law and before January 1, 1968; and

3. Lawfully erected on or after January 1, 1968.

This section of the act, as now written, is somewhat confusing, to say the least. Sub-section 1 seems clear enough and indicates federal participation is available for the cost of removal of nonconforming signs lawfully erected and in existence on October 22, 1965, the date the act was signed into law. Sub-section 2 refers to lawfully erected signs now in existence on other highways within a state, not a part of the interstate or primary systems, that may be incorporated into those systems after October 22, 1965, and before January 1, 1968. A literal interpretation of this sub-section would seem to indicate that unless the other highway was incorporated into the interstate or primary system before January 1, 1968, federal participation in the cost of the removal of nonconforming signs lawfully in existence on the other highway at the time of its incorporation into the interstate or primary system would not be forthcoming.

A recent publication by the Bureau of Public Roads containing questions and answers on the new act intimates that sub-section 3 must be read in conjunction with sub-section 2, and states that federal aid would be available even if the other highway was incorporated into the interstate or primary system after January 1, 1968. While the Bureau of Public Roads views sub-section 3 in conjunction with sub-section 2, the House Committee Report on the bill suggests that sub-section 3 was placed in the law to cover a situation where a change of regulations, necessitated by changing conditions, would cause the removal of signs that conformed under initial regulations, but which would be nonconforming under the changed regulations.

The just compensation required to be paid for the removal of signs, the federal share of which, as I have stated before, is 75 percent, shall be for: (1) the taking from the owner of such sign at all right, title, leasehold, and interest in said sign; and (2) the taking from the owner of the real property on which the sign is located of the right to erect and maintain such signs thereon.

In the Bureau of Public Roads publication previously referred to, the Bureau has ruled that payment to the owner will be limited to compensating him for the loss of the right to erect and maintain only those signs in existence on his property as of the date of the new law. In a situation where the landowner has not fully utilized his land for the erection of other sign boards, we might find our courts saying we have further deprived the owner of the right to grant leases or to use the balance of his property for the erection of other outdoor advertising signs, and assess additional compensation for the loss of this right. If this occurs, the state will have to absorb this added cost, since the law does not authorize federal participation in such an event.

Another section of the law that is disturbing to highway administrators ha to do with the allowance, within rights-of-way at appropriate distances from interchanges on the interstate system, of signs giving specific information in the interest of the traveling public, which signs of course will be erected at public expense. In connection with this part of the law, the Secretary of Commerce has stated these signs would designate the brand names of gasoline, the names or other specific information of lodging and food facilities, and other specific information regarding recreation, historic sights, hospitals and so forth. Here again one might anticipate litigation challenging the use of public funds to erect signs within highway rights-of-way for the purpose of advertising private commercial activities. Additionally, state laws may prohibit such signs. If, under the new law, it is mandatory that the states erect such signs within the rights-of-way, then it is possible that existing state statutes will have to be modified.

Other sub-sections of the act provide: (1) that all public lands and reservations of the United States which are adjacent to the interstate or primary systems shall also be controlled in accordance with the terms of the act and the national standards adopted by the Secretary; (2) for authority to establish information centers; (3) for judicial review of the withholding of funds, or failure to agree as to the size, lighting, and spacing of signs in commercial or industrial areas; (4) that no part of the Highway Trust Fund shall be available to carry out the provisions of the outdoor advertising section of the act; and (5) for the continuance of bonus payments to those states that had previously entered into agreements with the Secretary to control outdoor advertising. These states will not be entitled to their bonus payments, however, unless they maintain the control required under the agreement or the controls required by the new law, whichever is stricter.

Before leaving the section on control of outdoor advertising, I would like to point out that implementation of the act may further involve a condition where federal-aid would not be available and which could be extremely costly to the state. I am thinking of a situation where, after all signs along the interstate and primary systems have become conforming, it becomes necessary to widen the highway involved. In such an event it will again become necessary to move all the signs affected so they will be 660 feet from the edge of the right-of-way. Unless this cost can be said to be a part of the construction or right-of-way costs, the state will have to absorb the expense with state funds.

The question has also been posed whether federal funds could be used in the cost of the acquisition of sign rights and thus, in this manner, secure effective control and prohibit future erection of signs. This method could be used, but the cost of the acquisition of the sign rights would have to be assumed by the states, since the new law does not authorize federal participation in such cases.

Another area which may cause difficulty is the interpretation of the phrase "signs, displays and devices which are within 660 feet of the nearest edge of the right-of-way and visible from the main traveled way." Does the word "sign" refer only to the advertising content, the billboard upon which it is placed, or both? There will be situations where the advertising content will not be visible from the main traveled way, but the billboard itself will. In such cases, will the sign have to be removed? The Bureau's answer is that the matter is being given legal study now.

Control of Junkyards

The states must make provision for effective control of the establishment and maintenance of junkyards which are within 1,000 feet of the nearest edge of the right-of-way along the interstate and primary systems of highways by January 1, 1968. As in the outdoor advertising section of the law, failure to accomplish this will result in an additional 10 percent reduction in federal-aid highway monies; the Secretary may also suspend the penalty provision if he feels it to be in the public interest. Effective control of junkyards means that by January 1, 1968, such junkyards shall be screened by natural objects, plantings, fences, or other appropriate means so as not to be visible from the main traveled way, or shall be removed from sight.

This section of the law is an interesting little gem. As you will recall, the effective control provision of the outdoor advertising section states that after January 1, 1968, no signs shall be established or maintained within 660 feet of the right-of-way with certain exceptions. The effective control provision of the junkyard section of the law states that by January 1, 1968, such junkyards, and here they must be referring to junkyards that are in existence and nonconforming as of that date, must be screened or removed. But I can find nothing in this section of the law that would require the states to control the establishment, use, or maintenance of junkyards within 1,000 feet of the right-of-way created subsequent to that date.

A junkyard is defined as an establishment or place of business which is maintained, operated, or used for storing, keeping, buying, or selling junk, which is also defined in the act, or for the maintenance and operation of automobile graveyards, and shall include garbage dumps and sanitary fills.

Notwithstanding the provisions as to screening or removal, junkyards may be operated within 1,000 feet of the right-of-way in areas which are zoned industrial, or used for industrial activities, as determined by the state, subject to the Secretary's approval. The law also provides that any junkyard in existence on the date of the enactment of the new law which does not conform to the requirements thereof and which the Secretary finds as a practical matter cannot be screened, shall not be required to be removed until July 1, 1970. It is interesting to note that no provisions are made in this section of the law for a moratorium period for the removal of junkyards that may have been lawfully established subsequent to the effective date of the new law.

As in the outdoor advertising section, there is a requirement that just compensation be paid to junkyard owners for the relocation, removal, or disposal of junkyards that are:

1. Lawfully in existence on the date of the enactment of the law;

2. Lawfully along any highway made a part of the interstate or primary systems on or after the date of the new law, but before January 1, 1968; and

3. Lawfully established on or before January 1, 1968.

The federal share of this just compensation, including the cost of landscaping and screening, is 75 percent. Since the Bureau of Public Roads reads sub-section 3 in conjunction with sub-section 2, it is apparent that federal funds will only be available for the cost of landscaping and screening, or the relocation, removal, and disposal of those junkyards that were in existence on the date of the enactment of the new law, or those that were situated on secondary or other highways that were subsequently incorporated into the interstate or primary systems.

As in the outdoor advertising section, other subsections require cooperation and control by other governmental agencies exercising supervision over public lands; provide for judicial review; and prohibit of the use of Highway Trust Fund money to carry out provisions of this section.

Landscaping and Scenic Enhancement

This section of the law authorizes the Secretary of Commerce to approve, as a part of the construction of federal-aid highways, the cost of landscape and roadside development. The money allocated for this purpose, which does not have to be matched by the state, is an amount equivalent to 3 percent of the federal-aid funds apportioned to the state. Since Highway Trust Fund money cannot be used for this purpose, a special appropriation is made. The money shall be used for landscape and roadside development within the highway right-of-way, and for the acquisition of interests in and improvement of strips of land adjacent to the highway necessary for the restoration, preservation, and enhancement of scenic beauty, including the acquisition and development of publicly owned and controlled rest and recreation areas and sanitary and other facilities within or adjacent to the highways. Upon failure to use the funds apportioned, the same will lapse.

There is also a provision that a detailed estimate must be made by the Secretary in cooperation with the states, to be submitted to Congress not later than January 10, 1967, of the cost of carrying out this section of the new law, including estimates of the economic impact, effectiveness, and the public and private benefits derived from the program. There is also provision for public hearings in each state before the promulgation of standards, criteria, and rules and regulations by the Secretary in connection with the control of outdoor advertising and junkyards. An additional provision states that nothing in the act shall be construed to authorize the use of eminent domain to acquire any dwelling or related buildings in implementing the provisions of the act.

This would appear to apply to all sections of the new law. Senator Jennings Randolph, in his presentation of the bill to the Congress, stated that the purpose of this language was to provide that a person would not be forced to vacate his dwelling, in which he actually resides. This simply reiterates that the new law shall not be construed to authorize the taking of private property or restricting its use without the payment of just compensation as provided for in the act. The act authorizes an appropriation not to exceed $5,000,000 for administrative expenses in carrying out the act.

In conclusion, I can only repeat that the act is ambiguous in some areas, inconsistent in others, with problems of interpretation to be dealt with. We can only hope proper action will be taken to seek amendments that will result in a workable product.

APPLICATION

by
Mark H. Astrup

I feel that we should begin a discussion of the application of the Highway Beautification Act with a few words about the Fund Allocation. The funds allocated for landscaping and scenic enhancement are available for expenditure on or adjacent to either the federal-aid Primary Highway System, including the Interstate System, or the federal-aid Secondary System without restriction as to the amount of available funds to be expended on any system. Funds allocated to the states--3 percent of funds apportioned to a state's federal-aid highways--are available for obligation only during the fiscal year for which they are appropriated. Unused funds lapse and cannot be reallocated to any other state as they can in the other two titles of the act. And, best of all, funds that are authorized and appropriated for landscaping and scenic enhancement do not require matching funds by the states.

Federal Highway Beautification Funds have one important restriction--they are not available for maintenance. In general, they may be used for a sufficient number of projects to implement the program specified in President Johnson's memorandum of January 21, 1965, to the Secretary of Commerce. These are: 1) to accomplish landscaping projects on federal-aid highways in addition to erosion control work; 2) to acquire land or easements adjacent to highway right-of-way to enhance the beauty of the highways; 3) to provide more rest areas adjacent to the highways for convenience, safety, relaxation, and recreation; and 4) to screen unsightly areas adjacent to our highways, either as separate projects or in conjunction with general roadside improvement projects.

There are two parts to Title II, Section 319 --Landscaping and Scenic Enhancement. Sub-paragraph "A" pertains only to the expenditure of federal-aid funds within the right-of-way. It provides, as a part of the construction of federal-aid highways, the cost of landscape and roadside development, including acquisition and development of publicly owned and controlled rest and recreation areas and sanitary and other facilities reasonably necessary to accommodate the traveling public.

Sub-paragraph "B" enlarges on the program authorized under the previous sections and permits funds appropriated to be expended both in and outside the right-of-way on federal-aid highways as follows:

> "For landscape and roadside development within the highway right-of-way and for acquisition of interests in and improvements of strips of land necessary for the restoration, preservation and enhancement of scenic beauty adjacent to such highway."

With respect to Acquisition of Scenic Strips, under the provision of Section 319-B, the Bureau of Public Roads has established certain priorities. The highest priority is assigned to the Interstate System for the acquisition of interest in strips of land necessary for the purposes enumerated in the Act.

The second highest priority is assigned to similar projects on the Federal-Aid Primary System. In addition, in PPM 24-4.60:

> "Insofar as utilization of Section 319-B - Federal Funds for acquisition of interests on strips of land adjacent to the highway right-of-way is involved, projects should be selected in an orderly sequence that first will preserve existing scenic beauty, second, will permit the improvement, restoration or enhancement of the strip and third, will make available supplemental areas whereon to provide facilities such as a rest and recreation area and scenic overlooks that are lacking on the highway right-of-way."

These provisions, plus the admonition that Section 319-B fund expenditures for acquisition of highway right-of-way needed for rest and recreation areas should be held to a minimum comprise the major guidelines pertaining to Section 319-B. Additional details concerning these fund expenditures and authorizations can be found in PPM 21-4.6, dated January 24, 1966.

To date, no other restrictions have been placed on the types of landscaping or projects normally carried out under the broad general term of landscaping. These include the preservation, selected clearing and thinning of desirable or undesirable natural growth, and the planting of trees, shrubs, and ground covers--both for aesthetic and functional purposes. Planting includes screen planting of objectional features or, conversely, planting to emphasize attractive views; barrier planting to minimize headlight glare or confusing traffic movements; plantings to increase safety and give traffic direction; and plantings to provide additional interest to minimize monotony.

Screening out unsightly views adjacent to highways warrants primary attention if objectives of beautiful highways are to be achieved. Screening may be accomplished by planting of trees and shrubs, the use of solid or semi-solid fences or walls, earth mounds, or any combination of these.

Junkyards, as defined under the terms of the act, now require separate programming, as no part of the Highway Trust Fund may be used to screen them from highway view.

The last major category is Safety Rest Areas and Scenic Overlooks. Both qualify for acquisition and development under either "A" or "B" of Section 319. It seems a little difficult to rationalize the restraint on the use of these funds for the acquisition of highway right-of-way on which to develop rest areas with the earlier recommendation that the number of interstate rest areas be doubled and an equal number of simple, less elaborate rest areas and scenic overlooks be provided. Authorization for informational activities in rest areas is contained in the Beautification Act, but apparently federal participation in construction of informational buildings is not authorized.

This briefly summarizes the application of the act. We now have the basis for each state to accomplish an adequate highway beautification program, and I believe that it is inherent upon us to take full advantage of the means now available to accomplish the laudable objectives of the National Highway Beautification program.

ADMINISTRATION

by
Hugh B. Henry

There is some duplication in my paper of the subjects covered by the two previous speakers. However, I think this repetition will not be objectionable, as a somewhat different conclusion is developed. In preparation for my remarks here this afternoon, I found my greatest difficulty to be in selecting for discussion those specific features of the Highway Beautification Act that would be of greatest interest to this group.

There has been much written on this legislation, both before and after its enactment by the Congress. Mr. Lindas, being an attorney, would no doubt have a keener appreciation of the legislative intent of the Congress than I; however, I have found the report on the Committee Hearings informative. I would especially recommend the reading of an exchange of correspondence between Chairman Kluczynski and the Secretary of Commerce relative to the administration's position in the implementation of this program.

This legislation is new, and perhaps the concept of highway interest outside the normally established right-of-way is different from what we have done in the past. But the basic objectives of the law are not new. The idea of giving primary consideration to the appearances of our engineering works is as old as engineering itself. Both private industry and government make aesthetic factors an integral part of their preliminary layouts of major projects such as buildings and dams. They obtain sufficient surrounding land to insure the protection of their investment.

Perhaps some of us older engineers have difficulty in realizing our engineering products have evolved during our lifetime from the simple roads to get the farmer out of the mud to immensely complicated freeways costing as much as $20 million a mile. I remember during the early thirties hearing an eminent engineer warn our civil engineering class against highway engineering; he said it was not a truly professional career and, further, all the necessary roads had been built.

The Highway Beautification Act of 1965, like Gaul, is divided into three parts.

Section 131 of Title 23, U. S. Code, is amended to provided control of outdoor advertising within 660 feet of the right-of-way on the interstate and federal-aid primary systems. The federal share is 75 percent. Twenty million dollars for each of the fiscal years 1966 and 1967 was appropriated out of the general fund of the U. S. Treasury.

This section of the act requires the Secretary of Commerce to hold public hearings in each of the states for the purpose of gathering information on which to base the promulgation of standards for outdoor advertising. This public hearing notice was published in the January 28, 1966, issue of the Federal Register. It contains the listing by states, giving the dates, time, and place. In addition, the published notice includes six categories of draft standards, criteria, rules, and regulations which are to be considered and discussed at the public hearings. Incidentally, I have about 50 copies of these notices with me and they will be available here at the platform. Other copies may be obtained upon request to any Public Roads office.

A new section 136 has been added to Title 23, U. S. Code. This provides for the effective control of junkyards within 1,000 feet of the right-of-way adjacent to interstate and federal-aid primary highways. This would include screening so as not to be visible from the main traveled way of the highway or removal from sight. The federal share of compensation involved is 75 percent. Twenty million dollars for each fiscal year 1966 and 1967 has been appropriated out of the general fund of the U. S. Treasury. As in the case of removal of signs, use of the Highway Trust Fund is not permitted in carrying out the provisions of this section.

The amendments to Section 319 of Title 23, U. S. Code, are those in which we have been most involved to date. The original Section 319 provided for about what the present section does, except that there was no provision for enhancement of scenic strips outside the normal right-of-way and that all federal financing was done from the Highway Trust Fund.

Under the new legislation, subsection (a) of Section 319 provides that the Secretary may approve the costs of landscape and roadside development as part of the construction cost of federal-aid highways. Financing is to be done from the Highway Trust Fund. This was also permitted under the original law.

However, subsection (b) of Section 319 provides for an allocation equivalent to 3 percent of federal-aid highway funds apportioned to a state, for landscape and roadside development within the highway right-of-way; for the acquisition of interests in and improvement of strips of land necessary for the restoration, preservation, and enhancement of scenic beauty adjacent to such highways; and for the acquisition and development of publicly-owned rest and recreation areas and sanitary and other facilities within or adjacent to the highway right-of-way. These funds need not be matched by the states. This subsection authorizes an appropriation out of the general fund of the Treasury of $120 million for each of the fiscal years 1966 and 1967. Further, the use of the Highway Trust Fund is not available for carrying out the provisions of this subsection.

From this comparison, it will be noted that the law permits the use of the general treasury funds for landscaping and building of safety rest areas within the rights-of-way on interstate projects. However, as a practical matter the total funds allocated to each state for this purpose are quite limited and would soon be completely exhausted on a relatively few projects and would not be available for the newer objectives of the legislation. For this reason, the Bureau of Public Roads has established a priority which it urges the states to observe in programming these funds. The recommended use of these funds is for acquisition of interests in adjacent strips of land along interstate and primary highways. The next best use is highway beautification on such adjacent strips and on the primary system. Approval for use of these funds on the Interstate Highway, when Highway Trust Funds are available, is given only where Section 319 (b) funds cannot be used for other purposes.

There is one important point I would like to leave with you here this afternoon. Many believe that the ultimate impact on the appearance and shape of our highways resulting from the President's and Congress' emphasis goes far beyond these immediate goals. The greater effect could well be realized in the years ahead as the results of these added considerations in location, design, and construction take form. The wider use of separate and independent roadways, further aesthetic considerations in structural design, and stricter attention to the preservation of natural growth during construction operations are examples of what I have in mind.

We recognize there are possible imperfections in the law as written. As with most laws, there will no doubt be amendments. However, the objectives are in harmony with the overwhelming majority of our highway users--and, I might say, the viewers.

It has been said that consideration has always been given to aesthetic values in the location, design, and construction of our highways. This is true; but we must, in all candor, also admit that these values are too often quite low on our priority list. Absence of adequate topography during the location stages, unwillingness to acquire sufficient right-of-way, and the yield to the great variety of expediencies always confronting the designer contribute many deficiencies to the final product that no amount of "tacked-on beautification" can correct. What I am trying to say is that good-looking highways begin in the planning and location stage. Fitting the alignment to the topography is a cardinal rule in highway development. For example, the aesthetic and safety benefits obtained by reducing cut and fill heights warrant their appropriate evaluation along with other user-benefit analysis and right-of-way economics.

It would not be proper to close this discussion on highway beautification without a reference to the safety aspects associated with this program. Rather than being competitive with each other as some think, the design features for safety and beauty are generally interchangeable with and complement each other. Trees properly retained in the median area will both improve attractiveness and inhibit headlight glare. Easy alignment and curvature are employed in design both for aesthetics and to relieve monotony, driver fatigue, drowsiness, and thus possible accidents.

With the objective of stressing the importance of safety and aesthetics in highway development, design seminars have recently been conducted by our regional staff in each of our four divisions in Region 8. In preparation for these sessions, we found an abundance of material available on these related subjects, and almost without exception, the compatibility of safety and beauty was demonstrated.

Time is too short here for more than a passing comment on the literature available. We all note that hardly a week passes without pertinent editorials in our local papers on this subject. Life Magazine's double issue during the past Christmas week had some unusually good articles along these lines. I was particularly impressed by the guest editorial in that issue written by Peter Blake, architect and editor of "The Architectural Forum." He warned his fellow architects that it was time to stop fighting freeways as such and accept them as the central theme in city planning.

The AASHO Landscape Design Guide of 1965 offered four suggested reference books for detailed discussion of alignment and profile. All are excellent and worthy of study:

1. The Highway and the Landscape, edited by W. Brewster Snow, Rutgers University Press, 1959.

2. Man Made American - Chaos or Control, by Christopher Tunnard and Boris Pushkarev, Yale University Press, 1963, Part 3, pages 157 to 276.

3. The Landscaping of Roads, by Sylvia Crowe, Architectural Press, London, 1960.

4. The View from the Road, by Donald Appleyard, Kevin Lynch, and John R. Meyer, M.I.T. Press, 1964.

I would especially recommend the first book, The Highway and the Landscape. It is very interesting and includes an introductory chapter written by Bill Bugge, whom many of you heard yesterday noon.

In several recent appearances Francis Turner, Public Roads Chief Engineer, has stressed the compatibility of safety and beauty. In a recent circular memorandum to his regional and division engineers, he stated that safety cannot be overemphasized nor can it be minimized. We can and must exert greater efforts to see that federal-aid highways are located, designed, and constructed so as to be safe for those who use them.

No doubt most of you are familiar with the Highway Research Board Bulletin No. 5 on Highway Safety and the work Dr. Stonex of the General Motors Proving Ground has done relative to roadside design for safety. Briefly, he has found that if a zone some 30 feet along the traveled roadway could be kept cleared and properly designed with rounded ditches and slopes no steeper than 6:1, 80 percent of the out-of-control vehicles could recover without being involved in a serious accident. Incidentally, General Motors has an excellent new film on the subject of designing safe roadsides. We have this film in the regional office and will be glad to make it available to interested groups.

In closing, I would like to say that, in the opinion of many, the next few years will bring great changes in design concepts. We know more problems than we know answers. Bridge piers, sign supports, and light standards, while necessary under present criteria, create hazards and detract from the appearances of our highways.

The challenges are many, and the young highway engineer may rest assured that he has even more opportunities for creativeness and leadership than we older engineers who received much of our early highway indoctrination in the "Model T" era.

PANEL DISCUSSION

CAN THE ACCIDENT TOLL BE REDUCED?

Presiding: J. Al Head

CAN THE ACCIDENT TOLL BE REDUCED?

by
Marvin Lotspeich

What causes accidents? Why do accidents occur? Where do accidents occur? The answer to the first question, what causes accidents, is the most difficult. I cannot answer it. There is no one single cause for accidents. In an attempt to answer this question, we have to start with the driver; his training, experience, background, abilities, reactions, expectations, and personality are all basic factors that influence driving behavior.

In addition to these personal characteristics, the driver is also influenced by many other factors while behind the wheel. Enforcement, for example, is an influencing factor. Major P. A. Johnson will discuss this later. Engineering, another important factor, is the one which I am going to primarily discuss, as the design of the road or street is a very important factor relating to where accidents happen. Accidents occur where the situation confronting the driver is beyond his ability to handle; and is too complex or rapidly changing, and where the driver fails to perceive or comprehend the situation confronting him. The demand upon him is too great at these locations. As this demand increases, there is greater chance for human error.

To avoid accidents the driver has to correctly perceive the situation ahead. He then has to make a decision; it must be an easy decision, since he can only make one at a time. After this decision is made he has to react, and this requires time. Time is distance in a moving vehicle, and the operating speed is a very important consideration. Too often the engineer fails to consider this time factor adequately. He must make it easy for the driver to decide and also provide time and distance for him to react and maneuver (stop, turn, or whatever is required). The engineer must remember that the driver can only do one thing at a time. This is basic.

Thus accidents generally occur where it is not evident to the driver what is ahead, where traffic volumes are greater, where there is more roadside interference, where the possibility of conflict is greater, and where the situation is complex. A good surveillance program will help to identify these locations. Accident records are the foundation of a surveillance program. Facts from these records are essential. Through research, observation, and study of traffic operations and accident records, we have learned a great deal about traffic behavior under various volume and road conditions. We have learned how to design adequate facilities and avoid mistakes made in the past.

In the design of new facilities, control of access has been the most important single accident reduction feature recently developed. This is exemplified in the low accident rates prevailing upon the National System of Interstate and Defense Highways and other controlled access highways.

However, we cannot be content with just building new and better facilities, and we certainly cannot design all facilities with control of access. We have to recognize and provide for local traffic and local service requirements. More attention has to be given to traffic operations on our existing streets and highways which are most important to our overall street network. Many of these roads have been in operation for a long time and were originally constructed to meet much lower design standards than we follow today.

Traffic volumes are greater than were ever anticipated and traffic friction created by commercial build-up, traffic signals, and so forth has created conditions that encourage traffic congestion and accidents. Accident-prone locations on these facilities can be corrected through planned construction improvements together with a good traffic regulation and control program.

For example, the traffic-carrying capacity of downtown and busy arterial streets has been increased substantially and the number of accidents reduced by utilizing one-way streets and couplets. One-way streets have demonstrated their improved safety characteristics. This is obvious if you study the potential points of vehicle conflict that exist on one-way versus two-way operation. Pedestrian crossings are safer, and more efficient traffic signal timing for progressive movement is possible on one-way streets.

A good signing and marking program is also very important. The motorist has to be advised so that he has time and distance to make a decision and react to the conditions that confront him. Signing must be realistic and uniform, or else they will be of no value to the motorist. He will not know what to expect if all similar locations are not signed in the same manner. Sometimes additional emphasis such as doubling up on signs, larger signs, or the addition of a supplementary flashing beacon is helpful when handling special unusual problem locations. It is important, however, that care and good judgment be exercised and traffic control uniformity be retained.

Speed has all too often and justly so been blamed as a cause for accidents. The public generally feels that lower speeds are safer. We are all familiar with the slogan "Speed kills." Actually, it is driving too fast for prevailing conditions that causes the accident, and prevailing conditions may vary at the same location, depending upon time of day, weather, traffic volumes, and other factors. Studies show that the chance of becoming involved in an accident on a main rural highway is greatest at very low and very high speeds and is least at about 65 miles per hour in the daytime and 55 miles per hour at night. The fatality rate is lowest at the average speed.

Pavement markings define the travel lane, provide guidance and direction, and separate opposing flows of traffic. Shoulder delineation and edge striping outline the road ahead and make driving easier and more comfortable, particularly during the hours of darkness. Markings should be repainted as often as necessary to insure good visibility and driver respect.

Traffic signals must be updated and their operation periodically reviewed to keep delay to a minimum, maintain efficient timing and coordination, and retain good visibility. Unwarranted signals should be removed. They create unnecessary delay and often cause more accidents than they prevent. Rear-end accidents always increase after a signal is installed and are prevalent at unwarranted locations of signals. All traffic control devices must be kept clean and well maintained at all times to retain their identity and the respect of the public and enforcement officials. Good housekeeping pays dividends in traffic safety.

The design of minor construction projects should be functional and operational. The design should simplify the driver's task by giving him advance visibility, sufficient sight distance, time to react and make a decision, and distance to take this action. More projects of this type will do a great deal to improve operations and reduce the accident toll.

CAN ENFORCEMENT REDUCE ACCIDENTS?

by
Major Paul Johnson

Our present-day lives are filled with wonders of the space age. Each day the arrival of a man on the moon becomes closer to reality. Everywhere around us we see improvements being made for the benefit of man. The dawn of each day brings new inventions that will make life on this earth more pleasant and livable. Each day more people inhabit the face of the earth. In our present society, we have found that motor vehicle registration has increased 50.8 percent in the past 10 years--calling for more highways to handle the vast amount of vehicular travel.

Records indicate that the accident toll on our highways continues to grow at an alarming rate. However, over the last 10-year period, the death rate has been reduced from 6.4 percent deaths per 100,000,000 miles in 1954 to 5.7 percent in 1964. On this basis, we are making inroads into the accident problem. We are making progress in our efforts to preserve life, limb, and property on the public highways of the nation.

The traffic engineer has contributed considerably to the decrease in the death rate, and we do not have to travel far to see that the results of the engineer's efforts--new highways, improved traffic control methods, and modification of older highways--have done much to reduce the death rate. The educator has assumed his responsibility in the traffic problem and has contributed greatly to the decrease in the death rate. Enforcement has played a very vital part in the saving of lives and property, and our traffic officers must be commended for dedicated service.

These three tools I have mentioned are the three "E's" of which we are so familiar, and it takes all three to have a balanced program. Today, however, I am going to discuss the one of these three "E's" for which I am best qualified--the matter of traffic law enforcement.

When we speak of traffic law enforcement, many people think only of restraint and the trooper or officer issuing an arrest citation. We know that the trooper, the officer, the prosecutor, the courts, the Motor Vehicle Department, the Accident Prevention Division, and public support all play an intricate part in an effective traffic law enforcement program.

Traffic law enforcement is not a popular vocation. In my 30 years of traffic law enforcement, I believe I could count on my fingers the number of violators I have encountered who actually appreciated the need for good traffic law enforcement. We know the law enforcement officer is only human, and that he is subject to many pressures and arguments by the erring motorist as to why his particular violation in the operation of his motor vehicle should be excused. Occasionally, complaints are received by law enforcement agencies concerning action taken by a particular officer or trooper, resulting in an investigation as to whether the allegations of the officer are fact or fiction. This tends to instill in the mind of the good, conscientious officer wonderment about the job he is performing and if it is for the benefit of his fellow man. Unfortunately, in a few instances, it has been established that the law enforcement officer has erred in his judgment; and these are the cases imprinted in the memory of the citizen. In short, I do not believe that the average citizen appreciates the efforts put forth by law enforcement people. Their thoughts along these lines are always communicated to the officer.

For years enforcement people have been attempting to obtain professional status for the law enforcement officer. Police agencies have recognized the need of training to prepare and efficiently equip the officer so that he can perform his duties. Many departments, today, have training academies or training schools for their personnel. Universities and colleges, recognizing this need, offer courses in traffic law enforcement which are available to police agencies.

Police administrators in their training programs today know that the keeping of records is of the utmost importance in developing a good, sound, effective, and intelligent traffic law enforcement program. We cannot intelligently enforce the traffic laws unless we know where, when, and why the accidents are occurring. This information can only be obtained by the keeping of accident records. Most departments of any size maintain accident records plus a spot map which visually portrays where the accident intensity is the greatest. These records and spot maps are of little value unless they are transmitted to the field and used by the field forces.

As an example, in the State of Washington we furnish each of our detachments with an accident summary of all of the accidents reported and investigated in their respective detachments for each six-month period. This summary gives the time, location, and cause of the accidents and also indicates our enforcement efforts in the particular section we are summarizing. By the use of this accident study, the detachment supervisor can readily determine where and when his troopers should be assigned.

Availability of adequate manpower to do the job well is one of the problems of all police administrators. To get the results they would like to obtain, their available manpower must be deployed on the basis of factual information. In other words, officers must be assigned during the hours when the accident problem is the greater and to the areas where the accidents are occurring. Enforcement in these areas must be directed toward the violation that are causing the accidents. We know by experience that the leading accident-causing violations include driving while intoxicated, following too closely, failure to yield the right-of-way, and driving too fast for existing conditions. These violations are not the easiest to detect or prove in court, but we can only perfect a cure when we direct our efforts toward the violations creating the problem in a given area.

Enforcement action is only part of the solution. Members of the judicial branch of the government must assume their responsibilities in upholding the enforcement program, and this can only be done when the enforcement officer provides the court with sufficient evidence to sustain conviction. It is most important that the police administrator makes sure that the court is cognizant of the traffic problem. This can be accomplished by keeping the court informed on the traffic problem and the methods used by the administrator to alleviate it.

Let us spend a few minutes now with the traffic law enforcement officer. He must be a man who is dedicated in service to his fellow man. He must be a man who is convinced that through his actions he can do something about the ever-growing accident problem. He must be thoroughly and properly trained in the laws of arrest, rules of evidence, accident investigation, first aid, violator contact, patrol technique, and case preparation; also, he must be supplied with the best equipment available in order to cope with the problem.

Much has been said about the value of the unmarked car in traffic law enforcement. We in the Washington State Patrol feel that there is a place for both the marked and unmarked vehicle; however, the trend in our department is for the majority of our vehicles to be highly marked. Radar must be made available to the traffic law enforcement officer, and the use of chemical tests to determine the extent of intoxication is most important. Closed-circuit TV is being used on the newly developed freeways through the city of Seattle; and within a very short time, it will be used by all traffic law enforcement agencies across the nation.

One of the problems on our freeways results from disabled vehicles. We are installing gasoline transfer kits, means of transporting water, and tools in all of our patrol cars used on the freeways in order to assist the motorist having trouble. Practically all of our patrol cars have been equipped with push bars so that disabled cars can be removed from the busy highway.

Many police administrators feel that assisting disabled vehicles is not a police function, but we in the Washington State Patrol believe that it is and our troopers perform this service. We feel that the time and effort spent in assisting a stranded motorist is a positive type of contact as compared to the enforcement contact which is of a negative nature.

The greatest problem facing any department is determining whether enforcement is adequate to cope with the accident problem in its respective jurisdiction. A reduction in the reported number of accidents is, of course, the best measuring device. In our department we use the enforcement index. This is a method that has been advocated by police administrators for several years. The enforcement index is determined by dividing the total number of moving violation arrests with convictions by the number of personal injuries and fatal accidents. This is not a total answer, but it is a measuring device used constantly by our department. A recommanded enforcement index for a rural area would be between 10 to 15. In a rural area adjacent to an urban area the enforcement index would probably be a little more than 10 to 15. It has been suggested that an adequate enforcement index in cities would run between 20 to 25. Of course, we must remember that the enforcement index is only a measuring device which indicates whether or not an enforcement program is effective. Citations that are issued only for the purpose of increasing the total number of arrests are of little value. Citations must be directed toward the violations that are causing the accident problem.

More and more of our enforcement agencies are employing the technique of selective enforcement. In other words, the officers are assigned to the areas where and when the accidents are occurring and are taking action on the violations that are causing the accidents. We know that in order to have an effective traffic law enforcement program, we must have:

1. Trained police officers who are dedicated to their profession.
2. An enforcement policy that is followed by every officer in the department.
3. No fixing of citations. Citations can only be adjudged by the court.
4. Uniform bail schedules.
5. Reasonably similar penalties assessed by the court. They must correspond and measure with the offense that has been committed.

Great gains in the overall accident problem have been made due to the activities of our highway engineers, our educators, and our enforcement agencies.

In closing, gentlemen, I wish to remind you that if today is an average day, 131 people will die in traffic accidents in our nation; 27,648 people will be hospitalized due to traffic accidents; and property damage alone will amount to $500 per second. And when you leave here today, remember:

It isn't the vehicle that begins to whine
When forced to stop for an old stop sign--
It's the driver.

It isn't the vehicle that takes a drink,
Then quickly loses its power to think--
It's the driver.

It isn't the vehicle that fails to heed
The dangers of reckless, discourteous speed--
It's the driver.

It isn't the vehicle that steps on the gas
And causes an accident, trying to pass--
It's the driver.

A vehicle may be bent and twisted awry,
But it isn't the vehicle that will have to die--
It's the driver.

CAN THE ACCIDENT TOLL BE REDUCED?

by
J. Al. Head

It is a pleasure to return to Corvallis, an area so familiar and dear to me. I want to share with you certain developments that I have been involved with in recent weeks and months. I am confident these developments will ultimately lead to a reduction in the traffic accident toll.

The other members of this panel have discussed highway design and police traffic supervision. Their thoughts coupled with mine, I trust, will generate certain areas of interest on your part. This interest, if it stimulates action that assists in reducing the accident toll on our roads and streets, will have made these few moments together meaningful and useful.

Problem Areas

Turning to the subject of this panel, "Can the Accident Toll be Reduced?" I would like to ask several questions before attempting to answer this query.

Can we design a better highway?
Can we train better drivers?
Can we design safer vehicles?
Can we install better and more uniform traffic controls?
Can we improve police traffic supervision?
Can we identify the traffic problem?
Can we coordinate our present highway safety programs?
Can we correct our past mistakes?
Can we afford the monies to reduce the accident toll?
Can we afford not to reduce the accident toll?

Presuming that each of you has been thinking about these questions and hopefully that you have answered all or a majority of them in the affirmative, then, what are _you_ doing about it? What am _I_ doing about it? What are _we_ going to do about it?

The panelist from Idaho has told us what has been done, what is being done, and what can be done through highway design. The panelist from the state of Washington has told us what has been done, what is being done, and what can be done through the efforts of enforcement and a good program of police traffic supervision.

These are two of the many basic areas and disciplines involved in working on the problem of accident reduction. There are many other areas that are concurrently of vital concern to all of us--driver licensing, motor vehicle inspection, motor vehicle registration, construction and maintenance signing, vehicle design and accessories, accident records programs, and others. The professionals who develop and administer these areas are many and diverse. They consist of a blending together of engineering, enforcement, public administration, medicine, law, and psychology, to name but a few.

The Bureau of Public Roads Office of Highway Safety

Let me digress for a moment to tell you about the efforts of the Bureau of Public Roads and its Office of Highway Safety. The concept of blending the different disciplines together for the purpose of attacking traffic accidents was the basic motivation for my leaving the Oregon State Highway Department and joining the Office of Highway Safety. The Office of Highway Safety has brought together the disciplines of traffic engineering, police traffic supervision, motor vehicle administration, driver education and training, and public information and is molding them into a cohesive unit geared to attack the overall program of highway safety.

A New Law--State Highway Safety Programs

Recent legislation by the 89th Congress has brought an added responsibility to the Bureau of Public Roads and particularly the Office of Highway Safety. I am sure that most of you are familiar with the "Baldwin Amendment." This is the "popular" name given to Public Law 89-139, relating to State Highway Safety Programs. More particularly it is the new section 135 of title 23, United States Code.

This law states, "After December 31, 1967, each state should have a highway safety program, approved by the Secretary of Commerce, designed to reduce traffic accidents and deaths, injuries, and property damage resulting therefrom, on highways of the Federal-aid system. Such highway safety programs should be in accordance with uniform standards approved by the Secretary and should include, but not be limited to, provisions for an effective accident records system, and measures calculated to improve driver performance, vehicle safety, highway design and maintenance, traffic control, and surveillance of traffic for detection and correction of high or potentially high accident locations."

In signing this new law, President Johnson said: "The approach provided is in keeping with the traditional Federal-State relationship through which the Federal-aid highway program has operated so successfully. It recognizes the primary responsibility of the States for highway safety and at the same time acknowledges the Federal Government's responsibility to lead and coordinate."

Since passage of the Baldwin Amendment, the Office of Highway Safety has been working in cooperation with AASHO (American Association of State Highway Officials), AAMVA (American Association of Motor Vehicle Administrators), and IACP (International Association of Chiefs of Police) in studying existing standards and preparing recommended measures to be submitted to the Secretary of Commerce.

This has been a most challenging assignment and has stimulated a wide range of thinking on the part of people of the Office of Highway Safety who are assigned the primary responsibility for this work. Many of you, I hope, will contribute to this important standards work.

The Scope of the Program

The full meaning and scope of the act can be understood by looking at the tentative definitions of its several elements:

1. Highway safety programs. Relate to a comprehensive state program with authority, organization, and resources that effectively meet the highway safety requirements established pursuant to section 135, title 23, United States Code, Public Law 89-139.

2. Accident records system. Relates to an orderly process for collecting, recording, analyzing, and using motor vehicle traffic accident reports and traffic records to detect and correct accident-inducing locations and to gain insight into pertinent causative factors.

3. Driver performance. Relates to the basic or beginning education and training of drivers, driver examination, suspension or revocation of driver licenses, and the improvement of licensed drivers through instruction, training, reexamination, and other action.

4. Vehicle safety. Relates to motor vehicle design, equipment, and performance; vehicle registration, and motor vehicle inspection.

5. Highway design and maintenance. Relates to the functional design of streets and highways, as this is involved with their safe use, and to the maintenance of safe operating conditions through the application of traffic engineering and suitable physical maintenance.

6. Traffic control. Relates to measures which govern or regulate the actions of highway users so as to effect the orderly movement of people and goods including traffic laws and adjudication, enforcement, and traffic direction through devices or by police officers.

7. Surveillance of traffic. Relates to the processes of detecting and correcting high or potentially high accident locations by utilizing the functions of traffic engineering, police traffic supervision, traffic records systems, construction and maintenance, laws, and the public, individually and collectively.

8. Manpower and training. Relates to the total manpower requirements for effective management of the state highway transportation system and the professional or technical preparation, recruitment, and in-service training of such personnel.

I feel that the Baldwin Amendment is one of the most far-reaching laws that has been passed in the field of highway safety. It focuses attention on the operational responsibilities of highway transportation. It is most significant in our fields of endeavor--traffic engineering, enforcement, and administration. It emphasizes the operation of the system rather than its construction. This emphasis on traffic operation is evident in the recent effort of the Bureau of Public Roads calling for a stepped-up spot improvement program by requiring greater programming of funds.

The spot improvement program got under way two years ago when President Johnson directed the Secretary of Commerce and the Bureau of Public Roads to undertake an accelerated attack on traffic accidents through the federal-aid highway program. Now the bureau is asking the states to inventory all high-hazard locations on the federal-aid systems and schedule their improvement on a priority basis by September 1969.

Many of you here have long been in a position of leadership in utilization of accident records to identify needed spot improvements; however, some states must develop an accident records system from the ground up. The Oregon State Highway Department and State Department of Motor Vehicles have been cooperatively operating such a system for the past 25 years, and its results have been available to the political subdivisions of the state. The city of Portland also cooperates with the state in order to satisfy its special engineering and enforcement needs. How fortunate you are in Oregon; you are one step ahead of many other jurisdictions.

Standards for the Program

Referring briefly to the development of standards for an adequate state highway safety program, recently we prepared an inventory of current traffic safety standards and found a woeful lack of substantive standards or related information available in certain areas. In a review of the available standards, we found that much remains to be done in many areas. The American Association of Motor Vehicle Administrators has developed standards that might be applicable to a limited degree in the fields of motor vehicle inspection and driver licensing and registration, but these need to be improved. I do not mean to infer they are bad, but they could be made stronger.

The standards that have been developed by the American Association of State Highway Officials and accepted as policy are much more meaningful in the operational sense of the highway system, and many of these will be heavily relied on. The federal-state partnership of many years standing has helped to bring about these standards and policies. Let us hope that partnership in other areas will also bring meaningful results.

It is too early to present the manner in which the elements of a State Highway Safety Program will be implemented or evaluated. The first draft of the standards applicable to statewide programs will be made available at the earliest possible date and only after all groups have contributed so that we can have the benefit of professional judgment and recommendations. After this review, the Secretary of Commerce will make public the preliminary standards applicable to the program. The program, as you know, becomes effective after December 31, 1967.

There undoubtedly will be need for legislative changes and adjustments in the states. There may also be need for administrative reorganization or rearrangement of assigned functions and responsibilities if this program is to be a vibrant one. I am sure that these actions will take place as soon as the program areas are identified.

Evaluation of the Program

In the evaluation of how effective a state's program is, bear in mind that a state's program does not necessarily apply to those things wholly under the jurisdiction of the state. A state's program is a statewide program applicable to all citizens of the state and all jurisdictions in that state. It is not practical to license drivers, to register vehicles, to apply traffic control devices, or to apply one level of enforcement to the federal-aid system only. The road user does not understand or differentiate between a federal-aid highway or street and other roads and streets. He wants and deserves a consistent uniform level of traffic programs on all the streets and highways on which he must drive. Therefore, the evaluation of the program will of necessity have to be based upon the manner in which the states adhere to a statewide program of implementing the standards.

Reducing the Accident Toll

Turning now to the subject, "Can the Accident Toll be Reduced," the answer is definitely yes. But do we want to reduce it? I realize this is a leading question. If we do not want to reduce the accident toll, then why are we wasting our time pretending to do so?

Possibly the term we should be defined. Do I mean by we, the professionals, or do I mean we the citizens? If I think in terms of the professional, I am sure the answer is yes. When I think in terms of the whole of the population, subconsciously the answer is yes. Yet the people as a whole have not necessarily brought themselves to a point where they want to exert their influence for the program or completely accept the influence of those dedicated to reducing the accident loss.

There is no question in my mind that we have the technological "know-how" to reduce the accident toll. We now need to apply this "know-how." If we extend the interdisciplinary approach to studying causative factors of accidents and apply current technology to accident reduction, much can be accomplished.

The engineer alone, the administrator alone, the enforcement official alone, the motor vehicle administrator alone, the medical doctor alone, the automotive engineer alone, the psychologist alone, the sociologist alone, or the educator alone cannot solve this problem. But, if they bring together in a cohesive sense the best judgments of their professions, there will be a true interdisciplinary approach to the problem. I am sure we are headed in that direction; therefore, we must work together if we are to accomplish our goal of reducing traffic accidents.

Let me ask another question. How much longer can we afford not to design safety into our highways or build safety into our cars? How much longer will we continue to pay the "piper" in accident deaths and injuries? The answer obviously rests with the American people. Let us not forget that as professionals in the traffic safety field, much of the responsibility to solve the accident problem rests on our shoulders. We may have to go through a complete sociological evolution before we, as citizens, come to the realization of our independent and collective responsibilities toward highway safety. As a nation, we cannot afford to live with death and destruction on our highways.

Our Responsibility

Each of us in his own way can insist and persist that we go forward doing, to the best of our ability, those things that we know can and must be done. We need to be responsive to the problems of others, to the needs of others, and we need to appreciate the abilities of others.

If nothing else has happened to me in the 2 1/2 years that I have spent with the Bureau of Public Roads, I have come to the realization that the traffic engineer does not have all the answers. I did not necessarily feel that the traffic engineer had all of the answers when I practiced my profession here in Oregon, but I felt our profession came very close to it. I now realize it takes an interdisciplinary effort approach to the problem to deal with it effectively. If each of us will return to our own jurisdictions, to our respective jobs, and dedicate ourselves to do a better job, and boldly and courageously apply the standards with which we are now operating, we will effectively begin our campaign to reduce highway deaths and injuries.

By taking these actions we shall not be alone. President Johnson in his State of the Union message advised Congress he would soon call upon it to pass a "Highway Safety Act of 1966." The challenge is evident. Can we afford not to accept it?

PANEL DISCUSSION

THE CONTRACTOR AND THE ENGINEER EVALUATE CONTRACT ADMINISTRATION

Presiding: Herbert Humphres

CONTRACT ADMINISTRATION

by
Carl M. Halvorson

"Contract administration," as far as the contractor is concerned, is probably the most important area of his work. Actually, the job is one of the incidental things--one of the little things off on the side.

If a man is truly going to be a wonderful contract administrator, he needs one of two things: a great big bundle of money or a very munificent loan officer at a very substantial bank. This gives him a lot of muscle.

To get this job done, he is going to have to get someone to do it for him. This means he is going to be involved with a lot of business agents and business representatives. He is going to have to get a whole bundle of forms for health and welfare funds, pension funds, apprenticeship funds, and on occasion, vacation funds. He is going to have to contend with things like jurisdiction as to whether or not an operating engineer or a teamster runs a rig. If he happens to pick the wrong one, he has a dispute on the job. His contract administration is further complicated by extensions of time, which are very hard to come by in most situations.

In addition to this, he has the federal government to contend with, and he soon finds out how big an organization it is. There are a great number of forms plus various opinions of different people in the hierarchy that he has to deal with. He even finds that the President of the United States will sit down at night and write out orders that affect him specifically, and then he must get on his bicycle and travel around the countryside to find people of the proper hue and color to man the job.

In St. Louis right now we have a very interesting situation which, incidentally, is something that contract administrators are all going to become more and more familiar with. When this job in St. Louis was let a short time ago, the contract administrator from the government side was Mr. Udahl, who was also the Secretary of the Interior. He made a special trip to St. Louis before actually awarding the contract. Before the contract was awarded, the contractor had to assure the government officials that he would take affirmative action as far as hiring members of minority groups for the work. In other words, it was not adequate that he just sign the contract and know that he had certain obligations. He had to give evidence directly to the Secretary that he was going to take affirmative action; that he was going to go out of his way to assure that there would be representation of minority groups on this job.

This type of activity is like a little cloud--the sun is up behind it, and it is a very small, thick cloud, but it casts a very big shadow. The cloud today is what occurred in St. Louis, but the shadow is going to fall over all of us, I am sure. We are going to see affirmative action on the part of the contractor and on the part of the highway departments in this area.

It so happened that the only way this poor individual, the contractor, could make an affirmative effort to put minority groups in certain crafts was to get unions that were not affiliated with the AFL-CIO Building Trades Department. Naturally, he did this and he wound up with a secondary boycott and they picketed his job. He had to shut down, and a big law suit resulted.

When the President sits down at night and forgets about Viet Nam and all of that and writes these orders and sends some bills to Congress, sure, the Congressmen are affected. But do not think that you are not affected. The contractors are going to be increasingly affected.

Other areas of contract administration prior to the contract deal more in terms of the auditors, the bankers, the bond people, and the insurance people. All of these people have set up various snares to catch the contractor unaware. If the contractor wants to be awarded a certain job, he has to convince the bond man that he (the contractor) is the finest man in the world and has all the assets in the world, and they are mostly liquid. This fine equipment he has out in the yard cost millions of dollars and really he must admit that it isn't worth very much after all. The only thing that is good is a bunch of round dollars in the bank. When the contractor goes to the banker, he has to convince the banker that, on the other hand, this equipment is worth a lot of money because the banker knows that the contractor does not have any money in the bank and has to have something to back up his loan. So on one hand the contractor is selling his dollars to the bond man and on the other he is selling his equipment to the banker.

The insurance people are very important. A Workman's Compensation case was tried in court yesterday in Eugene because of the fact that the man was paid travel transportation allowance of one dollar a day to go from Eugene to Fall Creek Dam. He left the job at 3:30 p.m. to go home and at 6:30 p.m. that evening he was involved in an automobile accident. This unfortunate individual was killed three hours after he left the job. So the contractor was being sued for $46,000 because this unfortunate individual had an accident. Thus, insurance is very important if you do not have the $46,000.

After you have been in this business for a few years, you come to the conclusion that a contractor is the downtrodden individual of the species.

You see what all the laws have done to him, what all the labor unions have managed to do by way of laws, you find out how smart the engineers and the administrators for the highway departments are; you find that they write specifications that just tie him right up in a knot--not a square knot, it's a granny knot, or a slip knot, or a hangman's knot.

Immediately you must become a member of an association. You join the Associated General Contractors or the Road Builders or some trade association so you can get your two-bits worth in to change these laws, to get an equal footing with labor, to get some joint cooperative committees with the highway departments and the bureau and with fellow government agencies. Then you find out that this takes so much time that there really is not much time for administrating that contract.

If you finally go through all these steps and come down to administering the contract, then you find that you really are not as smart as you thought you were. There are so many devious things about this situation that about the best you can do is keep plenty of money in the bank by hook or crook and deal only with the most reputable equipment houses so when the machine stops they will have a man out there in five minutes to get it running again.

You will always sign your estimates in indelible ink so there is no question about whether it is a true and just account of the work you did in the past month. Then you will get into conditions where you will find that as the work is being done you are not getting fast enough decisions--say you are putting in a grade and maybe they are not making tests fast enough on your embankments so it is holding up your equipment. Then you start writing letters.

I think that in contract administration probably the greatest single boon has been the typewriter. This is <u>the machine</u>. You can take all of the D8's, D7's, motor scrapers, and shovels--those are one kind of machine; but the contract administrator's greatest machine is the typewriter.

Unfortunately, in our industry some firms and some contractors are very good at this type of administration; that is, keeping very good records and putting people on notice forthwith (preferably even before the incident occurs), but at any rate, not much later than the actual occurrence. As a matter of fact I have even seen some of them with a tablet with around five copies so they could just stand out on the job and write all these things as they occur. But the typewriter is still the machine. This machine must be used seriously if the contractor is to protect those very substantial rights that he thinks he has under the terms of the agreement. In many cases it so develops that these rights he thinks he has go very good on pages 1, 2, 3, and 4 of the specifications but somehow slip off over on page 5. It is difficult enough to bid a job and figure out whether it is dirt or rock, or whatever, and read the special provisions for the job without ever getting over to read page 5.

Of course, after the contractor has been in the business for a number of years page 5 even gets quite familiar. When he becomes familiar with page 5, then he is "over the hill" and has mellowed to the extent that he is thinking about getting a place in Honolulu or Palm Springs; he has become so smart that in spite of everything he has done he has probably made a few bucks and is now trying to get out.

The greatest thing that will push him on his way out is the fact that a great number of people through these years have taken notice of what a stupid individual this guy really must be from the mistakes he has made off and on over his lifetime. They come to the conclusion that if he can make it in the contracting business it must really be a lulu and they think they had better get into it. There are enough other people going into the contracting business all the time that by the time this fellow gets to this mellow position and has a few bucks, these people are in there taking the work for half of what it is worth. So they are pushing him on down the road and he usually winds up in a very small cottage on a very big beach in Hawaii or California or Florida.

Fellows, it is a tough road and I hope these other gentlemen are very kind to contractors for the rest of this morning.

CONTRACT ADMINISTRATION

by
B. M. French

Federal-aid contracts are administered by officials of the state; the bureau does not get into contract administration. All our contacts are with the state itself and we are not a part to those contracts. We pay our part of the cost when the work is completed, as the AASHO Guide Specifications say now "in reasonably close conformity" (a pretty elastic term).

On our own contracts we have the same problem of administration the state has with federal contracts. I hate to think that our administration is any worse than the state's; I hope it is just as good. We have ideas as to how a contract should be administered, whether it be by the state or by the Bureau of Public Roads.

This was quite well "spelled" out in 1960 in the Informational Guide to Project Procedures. This does not mention contract administration by those words, but it provides procedures on the project that govern the progress of the work by the resident engineer. This publication represents the best thinking in all of the AASHO states, and it was worked on for a long time--believe me. It was not hastily drawn up. Our only criticism is that we do not all follow it as closely as we might. We follow it, in the Bureau of Public Roads, on the theory that if it is good for the states, it is good for Public Roads. What it actually advocates is the uniform application of sound business, accounting, and engineering methods to the work at hand. We think it gives some chance for the exercise of that elusive term we have come to call "engineering judgment."

What the guide does is to spell out what is to be done on the contracts so that both parties to the contract know what is meant. We make it required reading for all our people; it is not a specification, but it does represent some of the best thinking in the country as to how field procedures should be carried out on federal-aid highway work.

You cannot discuss contract administration without some mention of specifications. I know all of you have some acquaintance with the AASHO Guide Specifications; apparently the highway field is not the only field that has trouble with uniformity and specifications. This set of specifications was worked out by the states and the bureau--also members of Associated General Contractors were consulted. It represents the best thinking so far, and is the only place where the phrase "reasonably close conformity" has been used.

This is one place where the engineers and the contractors have agreed. We think it leaves a chance for engineering judgment, and I know that the contracting fraternity figures it leaves a big enough hole to get out through, so we are both reasonably satisfied with it. The guide has come in for some criticism among the legal profession as not being exact enough in some places. It gets away from the terms, "in exact conformity" or "close conformity," which were used for years. We know that the professional side is not governed by exact science because you cannot get that close.

Another objective in recent years with the Bureau has been a construction manual to be used by all the states. We were beating the drums pretty hard for that up until recent months when AASHO took it up. That is one of the national objectives of AASHO, and we are quite sure that effort is being made toward the provision of a construction manual in all the states.

The Bureau, like any other organization, is trying to figure out ways to get more out of the limited number of people at hand. We are told we are not going to get any more people, so we are trying to use the ones we have to a better advantage. One thing we have tried for the last year in a number of states is what we call "phase inspections." That is an inspection of one phase of the work all over a state. We tried it in Idaho last year; it has some good points and some bad points. What we hope to do is promote a uniform contract administration throughout a state and to some extent throughout all the states. It is part of the bureau's plan now to monitor or to inspect methods and procedures rather than to inspect individual projects, each piece of paper, and each individual item on each job. At one time we inspected each job each month, but the 1964 Secondary Road Plan got us pretty well out of that. We now expect a plan from each state that spells out how they will administer secondary road contracts. This is getting away from inspection of each document and each item on a contract. We do not have enough people to cover all of these details, as we once did. We are striving also to get the states to set up inspection units of their own -- an inspector-general, or some surveillance unit in the state to make a statewide study of how they are applying their own procedures and how the procedures are being applied to secondary work where the county is involved.

What this means is that we are painting with a broader brush. We get more paint on and get more surface covered, but we do not get all the trim and all the corners painted quite as exactly as we did before. This new procedure makes it somewhat more difficult for our engineers to keep up with all the details on the individual job. In some ways this is bad. Apparently after a year of trial the credits to this new procedure are more than the debits, so the decision has been made to continue it in all the states this year. We think we may render a service to the states in doing this by helping them find out how uniform the procedures are throughout the state. The procedure does not point a finger at an individual item on an individual job or at an individual resident engineer.

Now something on what this panel is about -- "contract administration." When we who are engineers think of that term we think of the cooperation on the project between the representative of the contracting officer (the resident engineer, project engineer, or the inspector) and the contractor. There has been a great deal said in recent years about partnership between the public officials and the construction industry. The representative contractor and the engineer must cooperate, but in my opinion they are not partners in the strict sense of the word. A partner is generally a man who shares fully with another the responsibilities, losses, and profits of a business. One of the troubles that we have encountered are places where this cooperation has actually been a partnership and some of the engineers have participated in the profits of the contracting business.

In my opinion the representative of the contracting officer, the resident engineer on the project, is in a position of public trust, and he has a very grave responsibility in that position. When he puts the ink on that contract, the contractor has agreed to deliver certain materials and services up to a standard that is quite exactly spelled out in the contract. The engineer has a responsibility to see that the contractor delivers, substantially or in reasonably close conformance with that contract. In the absence of any contract change, the engineer on that job has no legal authority to change that. He also has a responsibility to the contractor who has his money and his life invested in the business to see that he gets a "square shake" under the contract.

If more is delivered than is called for in that contract, more in quantity, if the situation is changed from that contemplated by both the engineer and the contractor when the contract was let, it is up to the resident engineer in administering the contract to see that those changes are reduced to writing so it is equitable to both parties. I think he has a serious responsibility.

I am a great believer that the contract and specifications say what they mean; I do not mean that you never change them, or never exercise any judgment, but I think that the administration of the contract should be rigid and in accordance with the contract. When you do it that way, the contractor knows what to expect. He should bid the job to do it the way the contract says, or if he cannot do it that way to make reasonable changes.

If the specifications are not reasonably obtainable, they certainly should be changed. They should not be left there and winked at. They should be enforced. If you get rigid, but just, enforcement, there is neither the opportunity or the incentive for either party to the contract to depart from the specifications. It has been that departure from the contract that grows successively in some states that has gotten us in trouble.

I feel that the contract should mean what it says and no more, that the resident engineer has a serious responsibility, and the contractor does, too. Admittedly, the contracting business is a pretty tough game and people who survive and are successful have to be good businessmen; above everything, they have to be smart and real hard-working men over the years.

CONTRACT ADMINISTRATION

by
Fred Klaboe

To measure the quality of contract administration requires certain yardsticks. I have enumerated three of them here that I would like to discuss.

1. Are we doing a good job of constructing modern highways?

   I would answer "I think so" -- at least three northwestern states represented here are doing a good job. All three of them are above the average in the latest Bureau of Public Roads list showing the amount of trust funds obligated for construction. One of the three states leads the list.

2. Are we getting the work done to measure up to the needs of the user?

   Again, I think I can answer affirmatively. Of course, there is no denying that there are certain deficiencies on some of the major highways. Our urban systems in particular are lagging behind to a marked degree. However, in my trips through other portions of the United States I have found that their problems are even larger than ours and in my opinion their systems lag further behind.

3. Is the taxpayer getting the maximum amount for the dollar he invests in the highway system?

   I think he is; at least within our capability to provide it. The reputation of the northwest states for honesty and integrity is something that we can all be proud of. There have been no major investigations of any of the highway systems in this area. Furthermore, the Northwest has been a pioneer in many new methods of construction and many of the innovations which are contributing enormously toward the reduction of the traffic accident rate.

I would like to digress a moment and add that while we are doing a good job, we must not become enamored with ourselves and our accomplishments. Complacency and the reluctance to accept new ideas has been the cause of many failures. There are areas in which great improvements in techniques are badly needed, and if the Northwest states are to maintain their position of superiority these improvements must be provided. As with any program, the states are not doing all the work alone. There are at least two other major contributors: the contractor who performs the physical part of the work, and Bureau of Public Roads who oversees it all.

Let us focus our attention on the somewhat unique relationship of the contractor and the engineer. As Mr. French said, "They aren't partners." In fact, their interests are in many ways divergent. To stay in business, a contractor must first of all make a profit. Please do not misunderstand me, the successful contractor will also provide the products specified, but he is under no obligation to do more. To stay in business, the engineer must first of all obtain the specified products regardless of whether or not there is a profit or loss involved. It therefore follows that the first responsibility of the engineer is to provide the clearest possible set of specifications and plans so that the contractor knows exactly the requirements of the job.

According to many of the contractors, there is room for improvement, and I agree. However, I do not agree in all of the particulars in which the contractors claim the need for improvement. Number one on the contractors' list of desirable changes is what is now commonly called "the changed condition clause," whereby the buyer assumes the risk when conditions not anticipated are encountered. There are many arguments presented for and against inclusion of this clause into the specifications. Two of the three states represented here today have it. Oregon does not. We have examined the results of the use of it and have concluded that its shortcomings outweigh its benefits. The clause is replete with vague language such as "unknown physical conditions of an unusual nature" which could give rise to a greater number of disputes. Furthermore, there is no evidence to show any benefit to the buyer. On the contrary, it is a one-way street protecting only the seller. I know of no instance where it has ever been used to the advantage of the buyer when these "unknown conditions" result in an easier job. Besides that, how does one know what the contractor was thinking of when he made his bid? When some agency originates a specification that we believe is fair to both sides we will, of course, change our position.

Just as the contractor believes he is entitled to more consideration in a few specific areas, so do the buyers. One of the biggest problems is that of getting some prime contractors to be responsible for the quality and the quantity of the work of the subcontractors. This failure is not prevalent with all contractors, of course. It is, however, widespread enough to be our largest headache in the field of contract administration. After all, there is very little control over the work of a subcontractor. He is not bonded to the buyer and the buyers do not pay him directly. The contractors should examine this carefully and come up with a solution of their own. I know it is not easy, but the alternatives are not attractive.

The engineers and contractors together have at least one common problem of large magnitude. It is the scrutiny with which nonengineering groups are eyeing them. Auditors are going far beyond the historical limits of their profession in the examination of records and documents. They are beginning to second-guess engineering opinion--and I do not use the adjective "competent engineering opinion" as I do not think it is needed. The effect is being felt.

More and more of the engineer's and contractor's time is being spent on endless reams of paper work that no one but an auditor pays any attention to. It has already reached the point where an engineer must thoroughly document every item on a job no matter how small. For instance, he must explain in writing why he used an 18-inch pipe instead of the planned 12-inch pipe. If he moves or adds a pipe, his valuable time is again expended in useless documentation. No one is perfect, of course, and so the engineer occasionally slips and forgets to make this proper documentation. You can bet that the auditor will pick it up even if it is such a minor item as not dating a material receipt. The citation, which is refusal to pay the federal share, is sure to follow, along with a written condemnation of the act. We must resist to the best of our ability this unnecessary encroachment into our affairs.

I have touched just briefly on some of the major items of this subject, and I will be first to admit that they constitute my opinions and that some of the items are controversial.

In summation I would say that we are doing pretty well on most counts as far as contract administration goes; however, there are many, many areas in which improvement is still needed.

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Royer, R. E.	Oregon Highway Dept.	Salem, Oreg.
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Shaner, B.	Shaner's Engineering	Roseburg, Oreg.
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Sweet, H. R.	Yakima County	Yakima, Wash.
Templin, D.	Josephine County	Grants Pass, Oreg.
Thomas, B.	Wildish Constr. Co.	Eugene, Oreg.
Tibbetts, J. R.	Tillamook County	Tillamook, Oreg.
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Oregon State University

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- School of Forestry (B.S., B.F. degrees)
- School of Home Economics (B.A., B.S. degrees)
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- Engineering (M.A., M.S., M.Bioeng., M.Eng., M.Mat.Sc., A.E., Ch.E., C.E., E.E., I.E., M.E., Met.E., Min.E., Ph.D. degrees)
- Forestry (M.S., M.F., Ph.D. degrees)
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Agricultural Experiment Station (1888)

Branch stations at Astoria, Union, Klamath Falls, Ontario, Hood River, Aurora, Pendleton, Moro, Medford, Burns, Hermiston, and Redmond.

Computer Center (1965)
Engineering Experiment Station (1927)
Forest Research Laboratory (1941)
Genetics Institute (1963)
Marine Science Center at Newport (1965)
Nuclear Science and Engineering Institute (1966)
Nutrition Research Institute (1964)
Radiation Center (1964)
Science Research Institute (1952)
Transportation Research Institute (1960)
Water Resources Research Institute (1960)

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