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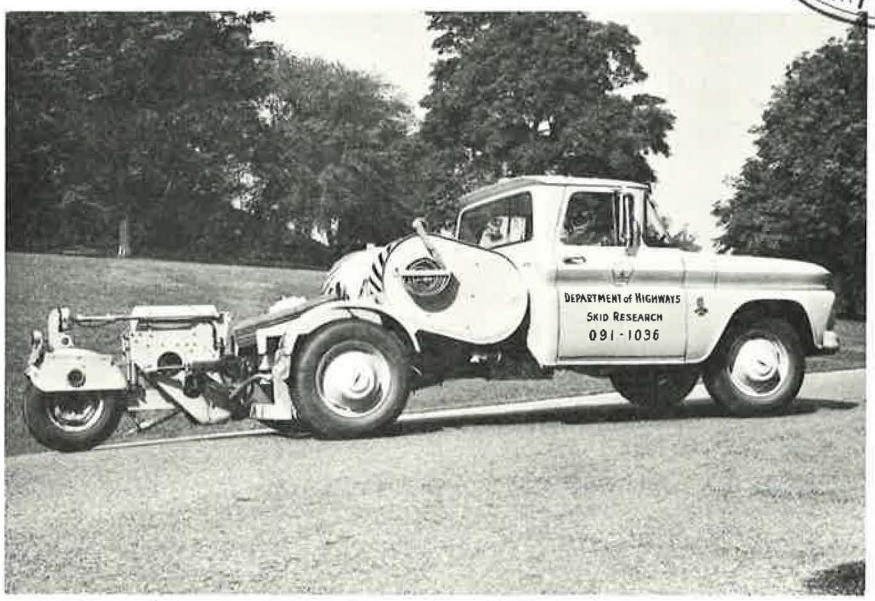
AN INVENTORY OF EXISTING PRACTICES AND SOLUTIONS TO SLIPPERY PAVEMENTS - 1969



FOREWORD

This report is a summary of the results of a questionnaire circulated to Highway Departments of 48 States, the District of Columbia and the Canadian Provinces. The purpose of the survey was to develop an inventory of existing practices and solutions to slippery pavements.

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AN INVENTORY OF EXISTING PRACTICES AND SOLUTIONS TO SLIPPERY PAVEMENTS - 1969

The development of this particular inventory assignment was conceived early in 1969 at a meeting attended by the chairmen of HRB Committees D-B4 and MC-A6, ASTM Committees E-17 and D4, Sub 3f, the AASHO Committee on Materials, IV-3, Skid Resistance, together with other guests prominent in the skid resistance and safety fields. The purpose of the meeting was to coordinate the activities of the technical committees that are dealing with the problem of skid resistance. Committee D-B4 undertook several tasks, one of which was the present survey assignment.

In making this assignment to the Task Group, the Chairman of D-B4 asked only that the survey be as comprehensive and accurate as possible. A word of caution was given to avoid the pitfalls of similar surveys, i.e., questionnaires being directed to those people or divisions within a highway department who are not totally cognizant of the problem area.

The purpose of this assignment was, as its name implies, an inventory to take stock of current practice and policy throughout the country regarding skid resistance. It was intended as a broad overview of the problem of pavement slipperiness and the corrective measures that are currently directed toward this problem area. It was not the purpose to elicit details of practices that have developed within highway departments nor was an attempt made to summarize and evaluate the current state of research.

It was therefore decided that, barring a personal interview approach which would be both costly and time consuming, a telephone interview would be the best alternate approach. In this manner, it was hoped that a freer discussion would develop to induce more valid answers.

The Task Group was selected from the membership of D-B4 so as to provide a geographical spread across the country. Since D-B4 membership has representation from the District of Columbia and Canada, these agencies were also contacted. Their replies, however, while included in the tabulation, have not been made a part of the analysis. Alaska and Hawaii were not included in the survey because of the cost involved in a phone contact. Each member was assigned a number of states to canvass and was instructed to contact the person in each state most directly associated with the skid resistance problem. It was suggested that this would presumably be someone in the research or materials divisions but did not necessarily have to be limited to these areas. Each Task Group

member was given the latitude to conduct the survey in a manner best suiting his own means.

The questionnaire used to obtain the information was developed by an exchange of correspondence among the Task Group and the final format was put together by the Task Group Chairman from the blend of suggestions and comments. The basic approach of the questionnaire was agreeable to the chairman of D-B4. The questionnaire used by the Task Group appears in the Appendix of this report.

Results of Survey

The information contained in this summary has been obtained from 48 states, the District of Columbia and nine Canadian Provinces; 58 respondents in all. These replies have been tallied in detail in table form (pages 13 and 14). The question-by-question analysis which follows is based on the replies from the 48 states since it was felt that the basic assignment was to assess the situation in this country.

1) Are slippery pavements recognized as a problem of major, moderate or minor concern?

Major, 22; moderate, 24; minor 2.

2) Are you now measuring skid resistance? If yes, how long?

Yes, 35; no, 13.

Minimum, $\frac{1}{2}$ year; maximum, 30 years; average, $6\frac{1}{2}$ years.

This question served to establish historical fact. The type of measurements made in some of the earlier programs was not determined.

3) What type(s) of skid testing equipment is used?

(1) Skid trailer, 29 states
(2) Portable tester, 15 states
(3) Stopping distance method, 11 states
(4) Decelerometer, 4 states
(5) Mu Meter, 3 states

4) Are skid resistance measurements adjusted for temperature or season?

Yes, 4; no, 31; not applicable, 13.

This question was intended to determine the extent of sophistication achieved or the degree of seriousness awarded to skid readings. Of those replying in the negative, three are considering such action.

5) If you are not using a skid trailer now (ASTM E274-T or similar), do you plan to build or acquire one within the next two years?

Using, 26; yes, 10; no, 12.

The following states have been reported as owning a locked-wheel trailer conforming to ASTM E274-T:

Alabama	Louisiana	North Carolina
Colorado	Maine	Ohio
Florida	Maryland	Pennsylvania
Georgia	Michigan	Tennessee
Illinois	Mississippi	Texas
Indiana	Missouri	Virginia
Iowa	New Jersey	West Virginia
Kentucky	New York	Wisconsin

At the time this report was written, Minnesota and Nebraska anticipated immediate delivery of a skid trailer. Idaho, New Hampshire, and Washington indicated the use of loaned equipment. Three states, Delaware, Utah and Wyoming, have or will acquire the Mu-Meter.

6) Are you presently conducting a research program on pavement slipperiness?

Yes, 30; no, 18.

Three states, replying negatively, indicated they had plans to begin soon. Six states replying yes to question No. 2, replied negatively to this question.

7) Are you conducting an annual inventory of pavement skid resistance on your highway system? How many years?

Yes, 17; no, 31.

Minimum, 1 year; maximum, 10 years; average, 3 years.

Six states, replying no, indicated that they would soon begin an inventory.

8) Do you use the skid test data as a criterion for resurfacing or deslicking?

Yes, 32; no, 12; not applicable, 4.

9) Do you use accident data for the detection or selection of slippery pavements?

Yes, 42; no, 6.

10) Do you specify or contemplate a minimum coefficient of friction for pavements presently in service? If so, what is it? What is the test speed?

Specify: Yes, 3; no, 27.

Contemplate: Yes, 18.

10) Three of the states that replied no indicated that they were giving serious consideration to the matter. Only three states are specifying a minimum coefficient of friction. These states and their respective minimum skid numbers (SN) are: Alabama (35), Mississippi (40), and Virginia (40 SDN_{40}). Those states contemplating such action reported proposed minimum skid numbers ranging from 32 to 38. It was uniformly reported by those who answered that the standard test speed using the ASTM E274-T Trailer was 40 mph.

11) Do you have a policy directing the resurfacing or deslicking of pavement surfaces falling below the minimum level of skid resistance?

Yes, 8; no, 38; no answer, 2.

At first, it might seem that there are some discrepencies between the answers in questions 10 and 11. Of the three states specifying a minimum coefficient, only two (Mississippi and Virginia) follow with a policy directing the resurfacing of pavements falling below the minimum level. On the other hand, four states (Kentucky, Louisiana, Michigan and Pennsylvania) stipulate that pavements falling below a certain minimum be resurfaced or deslicked, but they do not specify a minimum coefficient of friction. This is attributed to a general policy which recommends treatment when a pavement surface falls within an undesirable or dangerous range but where minimum values are not stipulated because of insufficient data upon which to base a specification.

12) Does your state produce aggregate types that are known to polish and become slippery?

Yes, 20; no, 27; no answer, 1.

If yes, do you restrict the use of these materials in pavement surfaces?

Yes, 10; no, 10.

What type of materials?

In addition to the 20 states who reported known sources of polish-susceptible aggregates, four other states (Indiana, Iowa, South Dakota and West Virginia) said that they had sources of aggregate suspected to be polish prone. Of these 20 states, 10 restrict the use of certain aggregates in wearing surfaces. These states and their polish-type aggregates were reported as follows:

Alabama - limestone
Arizona - NA
Colorado - dolomitic limestone
Florida - dolomitic limestone - specific source
Georgia - limestone
Kentucky - soft limestone
Maryland - serpentine; limestone
Michigan - limestone and stone sands
Mississippi - limestone
Missouri - NA
New York - limestone; dolomite
Ohio - limestone
Oklahoma - NA
Pennsylvania - Vanport limestone
South Carolina - limestone
Texas - siliceous sources; some limestone
Utah - NA
Vermont - NA
Virginia - limestone - dolomite aggregate
Wyoming - NA

13) Do you specify any minimum physical or chemical requirements for aggregates to obtain the desired skid resistant properties?

Yes, 11; no, 37.

Of the states reporting affirmatively, only two (New York and North Carolina) had any meaningful test really designed to restrict undesirable aggregates; both employ the acid insoluble test. Virginia specifies 95% silica in some mixes and is considering the use of the acid insoluble test. The other states listed affirmatively reported such tests as Los Angeles Abrasion, Moh hardness, degradation and fracturing, all of which would normally be assumed to be part of a state's nominal aggregate requirements.

14) Are you conducting any accelerated wear tests to evaluate the suitability of materials for use in surface courses or in deslicking operations?

Yes, 8; no, 40.

Those states that indicated activity in this area replied as follows:

California - developing wear and polish apparatus for lab and field use
Florida - Field test; lab equipment being built
Georgia - Laboratory polishing machine
Kansas - California surface abrasion method
Maryland - NA
Pennsylvania - various polishing techniques: rotating wheel (tire), rotating drum with tire, reciprocating slide polisher
Texas - NA
Oregon indicated the use of abrasion and soundness tests, but these are not applicable in this area.

15) Do you presently have pavement design criteria which specifies adequate skid resistance when the pavement is new?

Yes, 9; no, 39.

For the life of the pavement? Yes, 5.

Those states specifying skid resistant qualities for new pavements were Alabama, California, Florida, Maine, Massachusetts, New Jersey, New York, Virginia and Wyoming. Adequate skid resistance for the life of the pavement is being specified by California, Maine, New Jersey, New York and Wyoming. Ohio plans to make a statement in this regard soon. Only four states indicated how they intend to achieve this requirement. California specifies adequate crushing of aggregate and asphalt content by design. New Jersey is following AASHO guidelines; New York is accomplishing the goal through rigid specifications requiring crushed aggregate, an acid insoluble requirement and blends of aggregates with minimum carbonate limits; and Wyoming is specifying optimum gradation in plant mix seal coats. In addition, New York is requiring a transverse broom finish on concrete pavements and Pennsylvania will specify a minimum texture requirement on rigid pavements.

16) Do you specify certain materials for wearing surfaces to assure high skid resistance?

Yes, 17; no, 31.

16) This question differs from the one previous in that No. 15 was concerned with design requirements and new pavements while this question would primarily relate to resurfacing and retreatment. More affirmative answers were received to this question indicating great concern for materials used for resurfacing. Comments were received as follows:

Alabama - slag, sharp grained sand
California - crushed aggregate specification
Georgia - NA
Indiana - only natural sands permitted in P.C.C.
Kentucky - minimum 40% blend of river sand
Maryland - minimum percent of siliceous sand
Massachusetts - crushed aggregate and soundness
Michigan - research in progress
Mississippi - crushed aggregate and sharp sand
Missouri - NA
Nebraska - limestone informally limited to 30% in hot mixes; stone sand not permitted
New Hampshire - on overlays only
New Jersey - blast furnace and boiler slag
New York - see reply to question 15
Ohio - for corrective work: silica sand, slag, river gravel
Pennsylvania - silica sand, gravel, slag, selected non-carbonates
Virginia - polish resistant aggregate; sand mixes have minimum 95% silica
Washington - minimum soundness, hardness, degradation requirements
West Virginia - by special provision, slag and silica sand

17) Do you establish a priority for resurfacing or deslicking?

Yes, 18; no, 30.

The answers here fell into five basic classifications and for that reason, they are not listed state by state. In order of frequency, they were reported as accident areas, low skid

17) resistance, traffic volume, road classification and cost. Only two states put numbers on their priority: Michigan stipulates that any surface with a skid number below 30 be corrected immediately; for those between 30-40, action is recommended. Virginia specifies that all primary roads with a SDN_{40} less than 40 be corrected.

18) Do you specify different aggregate sizes for highways of different design speed?

Yes, 6; no, 42.

States responding affirmatively without comment were Connecticut, Georgia, Mississippi and New Hampshire. Maine specifies open textured mixes on high speed roadways and New York prohibits sand mixes on pavements with design speeds above 50 mph.

19) Do you impose reduced speed limits during rainy weather?

Yes, 6; no, 42.

In Delaware it was reported that a reduced speed limit is enforced. In Nevada and Ohio, it is not determined whether this is enforced or merely a "slippery when wet" warning. South Carolina is considering an enforced law. To many people, this aspect of safety is not receiving the consideration it deserves.

20) Is pavement slipperiness a problem on your cement concrete pavement?

Yes, 19; no, 29.

21) Is pavement grooving being performed to any extent?

Yes, 12; no, 36.

If yes, what is the performance relative to accidents?

Those replying yes to this question, offered these comments:

California - marked reduction in wet weather accidents
Colorado - too recent to evaluate
Connecticut - just recently performed
Georgia - NA
Idaho - performed experimentally on bridge decks
Minnesota - much improved
Nevada - lowers skid potential for a short period of time - then other measures needed
New York - reduces accidents on curves
North Carolina - appears to be effective
Ohio - definite reduction of accidents
Pennsylvania - too recent to evaluate
Washington - insufficient experience to evaluate

22) What methods of resurfacing or deslicking are used to restore skid resistance?

100% polish resistant aggregates: 14 states
Blends of polish and polish-resistant aggregates: 11 states
Thin sand-asphalt overlays: 18 states
Thin asphalt-concrete overlays: 35 states
Epoxy-silica sand: 3 states
Slurry seals: 16 states
Synthetic aggregates: 10 states
Seal coats (surface treatment): 37 states

23) Are you making any quantitative measurements of surface texture?

Yes, 11; no, 37.

Arkansas - texture metal
California - sand patch
Connecticut - sand patch
Florida - sand patch and grease patch
Kansas - linear traverse device
Mississippi - photos and plaster castings
New York - sand patch and RTV Silicone rubber surface texture test
Pennsylvania - sand patch, texture meter
Tennessee - NA
Texas - sand patch, silly putty, texture meter, SURI meter
Virginia - geologist assigned to explore methods

SUMMARY OF REPLIES TO THE QUESTIONNAIRE

Question / State	1 Concern	2 Measuring Skid (a)	2 Measuring Skid (b)	3 Type Equipment	4 Readings Adjusted	5 Skid Trailer	6 Present Research	7 Annual Inventory (a)	7 Annual Inventory (b)	8 Skid Criterion	9 Accident Data	10 Min. SN (a)	10 Min. SN (b)	10 Min. SN (c)	11 Policy to Resurface	12 Aggregate Polish (a)	12 Aggregate Polish (b)
Alabama	major	yes	3	1	no	using	yes	yes	3	yes[1]	yes	sp	35	40	no	yes	yes
Arizona	major	yes	NA	3	yes	yes	yes	no[2]	-	yes	yes	co	-	40	no	yes	no
Arkansas	major	yes	3	3	no	yes[3]	yes	no	-	yes	yes	co[4]	-	-	no	NA	-
California	major	yes	12	1,5(43)	no	using	yes	yes[45]	-	yes	yes	co	-	-	yes	no	NA
Colorado	moderate	yes	1	1,2,3	no	using	yes	yes	1	yes	yes	co	35	40	no[5]	yes	yes
Connecticut	major	no	-	-	-	yes	yes[6]	no	-	no	yes	no	-	-	no	no	-
Delaware	major	yes	30	2,3	no	no[7]	yes	no	-	yes	yes	no	-	-	no	no	-
Florida	major	yes	12	1,3	no	using	yes	yes[8]	1	yes	yes	co	NA	NA	no	yes	yes
Georgia	major	yes	7	1,2	no	using	yes	no[9]	-	yes	yes	co	NA	NA[10]	no	yes	yes
Idaho	moderate	yes[40]	1	1	no	yes	no	no	-	yes	yes	no	-	-	no	no	-
Illinois	moderate	yes	1	1	no	using	yes	no[2]	-	no[11]	yes	no[10]	-	-	no	no	-
Indiana	moderate	yes	½	1	no	using	yes	no[2]	-	no	yes	no[10]	-	-	no	no[13]	-
Iowa	moderate	yes	1	1	no	using	yes	yes	1	yes	yes	co[4]	-	-	no	no[13]	-
Kansas	major	no	-	2,3,4(44)	-	yes	no	no	-	no	yes	no	-	-	yes	no[13]	-
Kentucky	major	yes	11	1,2,3,4	no	using	yes	yes	6	yes	yes	co	32/38	40	yes	yes	yes
Louisiana	major	yes	3	1	no	using	yes	yes	1	yes	yes	co[4]	-	-	yes	no	-
Maine	moderate	yes	1	1	no	using	yes	no	-	yes	yes	co	35	40	no[5]	no	-
Maryland	moderate	yes	10	1,2,3	no[10]	using	yes	yes	10	yes	yes	no	-	-	no	yes	no
Massachusetts	moderate	no	-	NA	NA	no	no	no	-	-	no	no	-	-	no	no	-
Michigan	major	yes	12	1	no	using	yes	yes	8	yes	yes	no[10]	-	-	yes	yes	yes
Minnesota	moderate	no	-	-	-	yes	no	no	-	no	yes	no	-	-	no	no	-
Mississippi	moderate	yes	15	1,3	yes	using	no	no	-	yes	yes	sp	40	40	yes	yes	no
Missouri	major	yes	½	1	no[10]	using	yes	yes[32]	-	no[4]	yes	no	-	-	no	yes	no
Montana	moderate	no	-	-	-	no	no	no	-	-	yes	no	-	-	no	no	-
Nebraska	moderate	no	-	1(39)	NA	yes	no[9]	no	-	no	yes	no	-	-	no	no	-
Nevada	moderate	yes	1½	2	no	no	yes	no[2]	-	yes	yes	co[41]	-	-	no	no	-
New Hampshire	moderate	yes	1	1	no	yes	yes	no	-	yes	yes	no	-	-	NA	no	-
New Jersey	moderate	yes	15	1,2	no[10]	using	yes	yes	1	yes	yes	co	37	40	no	no	-
New Mexico	moderate	no	-	-	-	yes	no	no	-	no	no	co	35	40	NA	no	-
New York	major	yes	9	1	no	using	yes	yes	2	yes	yes	co	-	-	no[2]	yes	yes
North Carolina	major	yes	4	1,2,3	no	using	yes	yes	1	yes	yes	no	-	-	no	no	-
North Dakota	moderate	no	-	-	-	no	no	no	-	-	yes	no	-	-	no	no	-
Ohio	major	yes	5	1,2	no	using	yes	no	-	yes	yes	co	37	40	no	yes	no
Oklahoma	minor	yes	1	2	no	no	yes	no	-	yes	no	no	-	-	no	yes	no
Oregon	moderate	no	-	-(38)	-	no	no	no	-	no	no	no	-	-	no	no	-
Pennsylvania	major	yes	10	1,2	no	using	yes	yes	7	yes	yes	co	37	40	yes	yes	yes
Rhode Island	minor	no	-	-	-	no	no	no	-	-	no	no	-	-	no	no	-
South Carolina	moderate	yes	3	4	no	yes	no	no	-	yes	yes	no	-	-	no	yes	yes
South Dakota	moderate	no	-	-	-	no	no	no	-	no	yes[1]	no	-	-	no	no[13]	-
Tennessee	major	yes	15	1	no	using	no	no	-	yes	yes	no	-	-	no	no	-
Texas	major	yes	6	1	yes	using	yes	yes	1½	yes	no	no	-	-	no	yes	no
Utah	major	yes	½	5(36)	no	no	yes	no[2]	-	no	yes	co	35	40	no	yes	no
Vermont	major	yes	5	2	yes	no	no	no	-	yes	yes	no	-	-	no	yes	no
Virginia	major	yes	25	1,2,3,4	no	using	yes	yes	1	yes	yes	sp	40	SDN40	yes	yes	yes
Washington	moderate	yes	2	1(43)	no	using	no	yes	1	yes	yes	no[10]	-	40	no	no	-
West Virginia	moderate	yes	½	1,2	no	using	yes	no	-	yes	yes	no	-	-	no	no[13]	-
Wisconsin	moderate	no[34]	-	1	-	using	no[9]	no	-	no	yes	no	-	-	no	no	-
Wyoming	moderate	no[2]	-	5(36)	-	no	no[2]	no	-	yes	yes	co	NA	NA	no	yes	no
Dist. of Col.	moderate	yes	4	4	no	no	no	yes	4	no[2]	yes	no	-	-	yes	yes	yes
Alberta	minor	no	-	-	-	no	no	no	-	no	yes	no	-	-	no	no	-
Brit. Columbia	major	yes	5	2	NA	no	no	no	-	yes	yes	no	-	-	no	no	-
Manitoba	moderate	yes	1	1	no	using	no	no	-	no	yes	no	-	-	no	no	-
New Brunswick	moderate	yes	NA	2	no	no	no	no	-	yes	yes	no	-	-	yes	yes	NA
Newfoundland	minor	no	-	-	no	no	no	no	-	no	no	no	-	-	no	no	-
Nova Scotia	moderate	no	-	-	-	no	no	no	-	no	yes	no	-	-	no	no	-
Ontario	major	yes	7	1,2	no	using	yes	yes	3	yes	yes	co	30	60	no	yes	yes
Saskatchewan	major	yes	1	1	no	using	yes	yes	1	no	no	no	-	-	no	no	-
Quebec	moderate	yes	2	2	no	no	no	no	-	no	no[1]	no	-	-	no	no	-

NA no answer
SN skid number
Sp specify
Co contemplate
1. occasionally
2. planned in future
3. recommended
4. not developed yet
5. each case handled on its own merit
6. with accident data only
7. plan to acquire Mu-Meter
8. sampling only
9. will soon begin
10. under consideration
11. BPR spot-improvement is exception
13. some sources suspected
32. have just begun; anticipate more in future
34. will start in 1970
36. Mu-Meter
38. spot tests made with BPR trailer
39. immediate delivery anticipated
40. during summer of 1968 only
41. 15/20 at 50 mph; California Test Method T-342
43. California skid tester
44. past work; no testing at present
45. just starting

SUMMARY OF REPLIES TO THE QUESTIONNAIRE (CONTINUED)

Question / State	13 Phys-Chem Requirements	14 Accelerated Tests	15 Design Criteria (a)	15 Design Criteria (b)	16 Specify Materials	17 Resurface Priority	18 Aggregate Size	19 Reduced Speed	20 Slippery Concrete	21 Pavement Grooving	22 Methods	23 Surface Texture
Alabama	no	no	yes	NA	yes	no	no	no	no	no	1,4,6	no
Arizona	no	no	no	–	no	no	no	no	yes	no	4,6,8	no
Arkansas	no	no	no	–	no	no	no	no	no	no	3,4,6,7	yes
California	yes	yes	yes	yes	yes	yes	no	no	yes	yes	4,6,8	yes
Colorado	no	no	no	no	no	no	no	no	no	yes	1,3,4,7	no
Connecticut	no	no	no	no	no	no	yes	no	yes	yes	3,5	yes
Delaware	no	no	no	no	no	yes	no	yes	yes	no	1	no
Florida	no	yes	yes	NA	no	yes	no	no	no	no	3,4,6,7,8	yes
Georgia	no	yes	no	–	yes	no	yes	no	yes	yes	1,2,4,8	no
Idaho	no	no	no	–	no	yes	no	no	yes[28]	yes[29]	8(20)(30)	no
Illinois	no	no	no	–	no	no	no	no	no	no	1,3,4,7,8	no
Indiana	no	no	no	–	no[12]	no	no	no	no	no	4,8	no
Iowa	no	no	no	–	no	no	no	no	no	no	4,8	no
Kansas	no	yes	no	–	yes	yes	no	no	no	no	4,6,8	yes
Kentucky	no	no	no	–	yes[14]	no[3]	no	no	no	no	2,3,4,6,8	no
Louisiana	no	no	no	–	no	no	no	no	no[15]	no	3,4,6,7,8	no
Maine	yes	no	yes	yes	no	no	yes[16]	no	no	no	4,8	no
Maryland	no	yes	no	–	yes[17]	no	no	no	yes	no	1,2,8	no
Massachusetts	yes	no	yes	no	yes	yes	no	no	no	no	1,4,6,8	no
Michigan	no	no	no	–	no[10]	yes	no	no	yes	no	3,4	no[10]
Minnesota	no	no	no	–	no	yes	no	no	yes	yes	3,8	no
Mississippi	yes	no	no	–	yes[18]	yes	yes	no	yes	no	2,4,7,8	yes
Missouri	no	no	no	–	yes	no	no	no	yes	no	4	no
Montana	no	no	no	–	no	no	no	no	no	no	8(19)	no
Nebraska	no	no	no	–	no	no	no	no	no	no	4,8(20)	no[2]
Nevada	yes	no	no	–	no	no	no	yes	no	yes	4,8(42)	no
New Hampshire	yes[21]	no	no	–	yes[22]	no	yes	no	no	no	3,4,8	no
New Jersey	no	no	yes[23]	yes	yes[24]	yes	no	no	yes[1]	no	1,2,3,4	no
New Mexico	no	no	no	–	no	no	no	no	no	no	8(25)	no
New York	yes	no	yes	yes	yes	yes	yes	no	yes	yes	1,2,4	yes
North Carolina	yes	no[2]	no	–	no	no	no	no	yes	yes	3,4,6,8(26)	no
North Dakota	no	no	no	–	no	no	no	no	no[1]	no	8(20)	no
Ohio	no[10]	no	no[2]	–	yes[27]	yes	no	yes	yes	yes	1,2,3,4,6,7,8	no
Oklahoma	no	no	no	–	no	no	no	no	no	no	4,8	no
Oregon	no	yes	no	–	no	yes	no	no	no	no	4,6,8(20)	no
Pennsylvania	no	yes	no	–	yes	yes	no	no	yes	yes	1,2,8	yes
Rhode Island	no	no	no	–	no	no	no	no	no	no	NA	no
South Carolina	no	no	no	–	no	no	no	yes[31]	no	no	4,6,8	no
South Dakota	no	no	no	–	no	no	no	no	no	no	1,3,4,8	no
Tennessee	no	no	no	–	no	no	no	no	no	no	2,3,4,5,6,8	yes
Texas	no	yes	no	–	no	no	no	no	no	no	4,6,7,8(25)	yes
Utah	no	no	no	–	no	yes	no	no	yes	no	8	no
Vermont	no	no	no	–	no	yes	no	no	no	no	3,4,8	no
Virginia	yes[17]	no	yes	–	yes	yes	no	no	yes	no[32]	1-8(33)	yes
Washington	yes	no	no	–	yes	no	no	no	no	yes[31]	4,8(20)	no
West Virginia	no	no[2]	no	–	yes	yes	no	no	no	no	1,2,7	no
Wisconsin	no	no	no	–	no	no	no	no	no	no[35]	8(30)	no
Wyoming	no	no	yes[25]	yes	no	no	no	no	yes	no[10]	3,4,8	no
Dist. of Col.	yes	no	no	–	yes	no	yes	no	no	no	1,2,5(29)	no
Alberta	yes	no	no	–	yes	no	no	no	no[1]	no	8	no
Brit. Columbia	no	no	no	–	no	yes	no	no	no	yes[29]	5,8(20)	no
Manitoba	yes	no	NA	–	no	no	no	no	no	no	8	no
New Brunswick	yes	NA	no	–	no	no	no	no	no	no	(37)	no
Newfoundland	no	no	no	–	no	no	no	no	no	no	none	no
Nova Scotia	yes	no	no	–	no	no	no	no	no	no	8	no
Ontario	no	yes	no	–	yes	yes	no	no	yes	yes	1,2,3,4,6,7	yes
Saskatchewan	no	no	yes	yes	no	yes	no	no	NA	no	8	no
Quebec	yes	no	no	–	no	no	no	no	no	no	NA	no

NA no answer
1. occasionally
2. planned in future
3. recommended
10. under consideration
12. only natural sand in P.C.C.
14. minimum 40% river sand
15. only at intersections
16. open textured mix on high speed pav'ts
17. minimum % of siliceous sand
18. crushed aggregate and sharp sand
19. also use road mix overlays
20. heater-planer
21. all coarse aggregate 50% crushed
22. on overlays only
23. AASHO guidelines
24. blast furnace and boiler slag
25. plant mix seal coats
26. Kentucky rock asphalt
27. silica sand, slag, river gravel
28. on bridge decks
29. experimentally
30. kerosene and sand
31. in limited areas
32. have just begun; anticipate more in future
33. acid etching and sand blasting experimentally
37. lean asphalt mixes
42. grooving

Discussion

The consensus of this Task Group is that the survey served adequately to elicit the desired information from the highway departments and that the data contained herein are as valid as humanly possible to attain considering the limitations of the assignment. The ultimate approval, of course, would consist of a personal interview conducted by the same group. This was neither feasible nor practical. The survey has enabled us to determine, within acceptable limits, the awareness of slipperiness of pavements in all states, the assessment of the degree of importance by each state, the extent of efforts to obtain more information, and the measure presently employed to improve skid resistance.

The problem of slippery pavements was considered to be of major concern by 46 percent of the states; of moderate concern by 50 percent. Only two states felt it was of minor importance. The number of states using a skid trailer (29) to measure skid resistance was impressive, as was the number presently engaged in an inventory-type program (17). Sixty-three percent of the states are now conducting a research program on skid resistance.

Apparently much more research and more information is needed before any significant number of states are ready to assign minimum skid numbers with appropriate specifications. Only three states, at the present time, are enforcing a specification but an additional 18 states indicate that they are contemplating such action. It appears that the minimum acceptable skid number will fall within the 32 - 40 range. An

overwhelming percentage (88%) of states is using accident data as a criterion for corrective action and a large percentage (67%) is using skid test results to dictate corrective action. It appears that these two factors bear more influence than all others. In contrast, a much smaller percentage (19%) of states actually have a written policy directing the resurfacing of pavement surfaces falling below an acceptable level of skid resistance.

Polishing-type aggregates are recognized as a problem for 20 states and 10 of these states have restrictions against the use of these aggregates in wearing surfaces. Four other states indicated that certain aggregates were suspected of polishing but that insufficient data were available. Only two states are using any kind of meaningful physical or chemical specification requirements to eliminate the use of polishing-type aggregates.

A small number of states (8) reported that they were using design criteria to specify adequate skid resistance for new pavements and hopefully, throughout the service life of the pavement. When these replies are examined however, it is apparent that only three or four states actually have any design criteria capable of producing skid resistant surfaces. Sufficient data are not available yet for states to make a decisive step in this direction. While design criteria are not presently specified to any extent, the use of non-polishing type aggregates are specified by 35 percent of the states for resurfacing or deslicking operations.

Reduced traffic speeds during wet weather are enforced in only two or three states. This approach to traffic safety which would have the net effect of "improving" the skid resistance, is surprisingly being ignored by most highway departments.

Many people are inclined to associate slipperiness exclusively with bituminous surfaces. It is of interest that 40 percent of the states reported that slipperiness of cement concrete surfaces is considered a problem also. Very few states are presently grooving their pavements. While most of the work is being done on an experimental basis, the results appear favorable, where sufficient service has been attained.

Summary

The problem of pavement slipperiness is of deep concern to a great majority of the states. This is substantiated by the increasing number of states engaged in skid testing, research, and inventory-type surveys, together with the increased use of the ASTM E274-T Skid Trailer and other skid testing equipment.

Very few states, however, have sufficient background experience and research data upon which to form specifications including such requirements as a minimum coefficient of friction, minimum acceptance tests for aggregates and design criteria for adequate skid resistance.

This survey emphasizes the need for coordinated research in these areas together with the development of field practices for upgrading pavement traction. These answers must be available before the states can be expected to adopt skid resistance requirements.

APPENDIX

COMMITTEE D-B4 TASK GROUP QUESTIONNAIRE

INVENTORY OF EXISTING PRACTICES AND SOLUTIONS TO SLIPPERY PAVEMENTS

Name of agency or highway department_____

Person interviewed and title_____

1. Are slippery pavements recognized as a problem of _____ major, _____ moderate or _____ minor concern in your state?

2. (a) Are you now measuring pavement skid resistance? _____yes _____no. (b) If yes, how long? _____years.

3. What type of equipment is used?
   _____(1) skid trailer (truck)
   _____(2) portable tester
   _____(3) stopping distance
   _____(4) decelerometer
   _____(5) other (define)

4. Are your skid resistance measurements adjusted for temperature or season? _____yes _____no

5. If you are not using a skid trailer now (ASTM E274-T or similar), do you plan to build or acquire one within the next two years? _____yes _____no

6. Are you presently conducting a research program on pavement slipperiness? _____yes _____no

7. (a) Are you conducting an annual inventory of pavement skid resistance on your highway system? _____yes _____no. (b) How many years? _____

8. Do you use the skid test data as a criterion for resurfacing or deslicking? _____yes _____no

9. Do you use accident data for the detection or selection of slippery pavements? _____yes _____no

10. (a) Do you either ( ) specify or ( ) contemplate a minimum coefficient of friction for pavements presently in service? _____yes _____no. (b) If so, what is it? _____. (c) At what test speed? _____.

11. Do you have a policy directing the resurfacing or deslicking of pavement surfaces falling below the minimum level of skid resistance? _____yes _____no

12. (a) Does your state produce aggregate types that are known to polish and become slippery? _____yes _____no. (b) If yes, do you restrict the use of these materials in pavement surfaces? _____yes _____no. (c) If yes, what type(s) of materials?

(continued)

13. Do you specify any minimum physical or chemical requirements for aggregates to obtain the desired skid resistant properties? _____yes _____no. If yes, what?

14. Are you conducting any accelerated wear tests to evaluate the suitability of materials for use in surface courses or in deslicking operations? _____yes _____no. If yes, what?

15. (a) Do you presently have pavement design criteria which specifies adequate skid resistance when the pavement is new? _____yes _____no. (b) For the life of the pavement? _____yes _____no. (c) If yes, what are these provisions?

16. (a) Do you specify certain materials for wearing surfaces to assure high skid resistance? _____yes _____no. (b) If yes, what are these materials?

17. (a) Do you establish a priority for resurfacing or deslicking? _____yes _____no. (b) If yes, what are these priorities?

18. Do you specify different aggregate sizes for highways of different design speeds? _____yes _____no

19. Does your state impose reduced speed limits during rainy weather? _____yes _____no

20. Is pavement slipperiness a problem on your cement concrete pavements? _____yes _____no

21. (a) Is pavement grooving being performed to any extent? _____yes _____no. (b) If yes, what is the performance relative to accidents?

22. What methods of resurfacing or deslicking do you use to restore skid resistance? (Check as many as apply)
    _____(1) 100% polish-resistant aggregate
    _____(2) Blends of polishing and polish-resistant aggregates
    _____(3) Thin sand-asphalt overlays
    _____(4) Thin asphalt concrete overlays
    _____(5) Epoxy-Silica sand
    _____(6) Slurry seals
    _____(7) Synthetic aggregates
    _____(8) Seal coats (surface treatment)
    _____ other (specify)

23. (a) Are you making any quantitative measurements of surface texture? _____yes _____no. (b) If yes, what method?