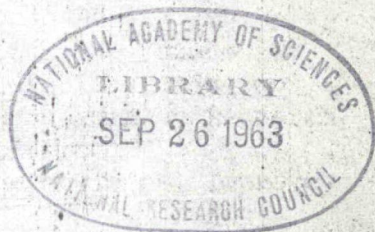


MINUTES

FIRST ANNUAL MEETING

ADVISORY BOARD ON HIGHWAY RESEARCH

**Held in New York City
January 16, 1922**



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MINUTES

ADVISORY BOARD ON HIGHWAY RESEARCH

National Research Council

Monday, January 16, 1922 - 10 15 A.M.

Past Presidents Room, American Society of Civil Engineers
Engineering Societies Building
29 West 39th Street, New York

FIRST ANNUAL MEETING

The first annual meeting of the Advisory Board on Highway Research was called to order at 10 15 A.M. in the Past Presidents Room, American Society of Civil Engineers, 16th floor, Engineering Societies Building, New York.

Present:

Members of Board

David Beecroft, Society of Automotive Engineers
A. J. Brosseau, National Automobile Chamber of Commerce
Henry M Crane, Alternate, Society of Automotive Engineers
Alfred D Flinn, Vice-Chairman, Engineering Foundation
A. T Goldbeck, Alternate, Bureau of Public Roads
W. K. Hatt, Director, Advisory Board on Highway Research
W. M. Kinney, American Concrete Institute
Nelson P. Lewis, American Society for Municipal Improvements
Thomas H MacDonald, Bureau of Public Roads
Anson Marston, Chairman, Advisory Board on Highway Research
H. deB Parsons, American Society of Mechanical Engineers
George H. Pride, Alternate, National Highway Traffic Association
S. Whinery, American Institute of Consulting Engineers
Col. E. Eveleth Winslow, Corps of Engineers, U. S. A.

Chairmen of Committees (Not Members)

- T. R. Agg, Committee on Economic Theory of Highway Improvement
- H. S. Mattimore, Committee on Character and Use of Road Materials
- C. A. Adams, Sub-committee on Tractive Resistance of Roads

Guests

- W. P. Blair, National Paving Brick Manufacturers Association
- Julian Chase, Class Journal Company
- W. P. Christie, Associated General Contractors of America
- L. R. Davis, United States Tire Company
- C. N. Forrest, The Barber Asphalt Paving Company
- George E. Hamlin, Connecticut Highway Department
- Major Mark L. Ireland, Tractive Resistance Research, Massachusetts Institute of Technology
- Pyke Johnson, National Automobile Chamber of Commerce
- E. J. Mehren, Engineering News-Record
- A. B. Rundall, representing Mr. Charles W. Leavitt, Civil and Landscape Engineer, New York, N. Y.
- John C. Long, National Automobile Chamber of Commerce
- Norman G. Shidle, Automotive Industries
- C. J. Tilden, Yale University

Regrets were received from Arthur H. Blanchard, Robert A. Cummings, W. O. Hotchkiss, A. N. Johnson, J. S. Langthorn, Manley Osgood, W. D. Uhler, George S. Webster, of the Board, also from J. R. Bibbins, Charles J. Bennett, E. N. Chandler, H. C. Dickinson, Wm. P. Eno, Dugald C. Jackson, Charles W. Leavitt, E. H. Lockwood, George E. Martin, Calvin W. Rice, E. Guy Sutton, A. L. Viles, Charles M. Upham, C. L. Warwick and George F. Zook.

Also absent Prevost Hubbard, American Society for Testing Materials, E. B. Mathews, Alternate, Association American State Geologists, F. A. Molitor, American Institute of Consulting Engineers, E. J. Moore, American Concrete Institute, and Daniel E. Moran, Alternate, American Society of Mechanical Engineers.

MINUTES

Minutes of the meeting of November 11, 1920 were approved as presented.

INTERIM ACTIONS OF EXECUTIVE COMMITTEE

VOTED: That the report of the Executive Committee and interim actions therein recorded be approved.

APPOINTMENT OF COMMITTEES

VOTED: That the Chairman be authorized to appoint necessary committees.

In accordance with authority granted, the Chairman appointed C. J. Tilden, Chairman, Col. E. Eveleth Winslow, A. T. Goldbeck, A. J. Brosseau and George H. Pride a committee on nominations.

After some discussion, it was decided that the Chairman should not appoint a committee on resolutions.

REPORT OF DIRECTOR

The Director presented a verbal abstract of his report (previously mailed to all members and guests). He withdrew for the present his recommendation for a Committee on Relation of Design of Vehicle to Design of Road.

VOTED: That the report of the Director be approved as amended and adopted.

Discussion of the Director's report followed, of which a brief abstract is given.

✓ Methods of Accounting. In response to inquiry, the Vice-Chairman stated that moneys received from various sources for the support of the Advisory Board are put into the custody of National Academy of Sciences, a federal corporation, which acts as treasurer. The National Research Council is legally a committee of the Academy, consequently, all financial and legal responsibilities for the Council are borne by the Academy. Contracts therefore are

made in the name of the Academy. All funds committed to the Academy are duly accounted for. Payments are made only on requisitions and vouchers properly signed. The Accounts are audited by certified public accountants semi-annually.

Federal Funds Available for Highway Research. In response to inquiry of Mr. Whinery, Mr. MacDonald stated that the $2\frac{1}{2}\%$ of Federal Aid Fund appropriated for engineering, as now provided in the law, is only sufficient for administrative expenses. Formerly 3% was stipulated, of which it was estimated that at least $\frac{1}{2}\%$ to $3/4\%$ would be available for research. Owing to overlapping of funds from year to year, there is on hand at present a fund of about \$150,000 available for research. Indirectly much other research work is done in connection with road construction.

Mr. Whinery renewed the recommendation made by American Institute of Consulting Engineers at the conference of 1920, that Congress should appropriate not less than three hundred thousand dollars to be expended under the direction of the Advisory Board. Major Ireland stated that the War Department was now contributing services of officers and others and use of equipment for the Board's work. It was pointed out that public money for research must, in the main, be expended by the Federal and State bureaus. This Board's functions must be to advise and coordinate.

ADMISSION OF NEW MEMBER ORGANIZATIONS

The Vice-Chairman presented a list of eight organizations suggested by the Executive Committee to be invited to join the Advisory Board on Highway Research, this list to be submitted to letter ballot before invitations are sent out. Information about these organizations was given by the Director and others.

VOTED: That the following six names proposed for membership be submitted for letter ballot and that the two others be referred to Director and Executive Committee to report later: Associated General Contractors of America, Western Society of

Engineers, Eno Foundation, Chamber of Commerce, U.S.A., Bureau of Standards, Department of Commerce, Rubber Association of America.

REPORTS OF COMMITTEE CHAIRMEN

Character and Use of Road Materials. Mr. Mattimore, Chairman, presented a report, attached as Appendix C. There has been no real functioning of committee because its members had been too fully occupied with their official duties. Mr. Mattimore proposed that one or more men be assigned to this committee for getting into personal contact with research work being carried on throughout the country.

VOTED: That Mr. Mattimore's report be accepted and filed.

Mr. Mattimore stated that the research committee of American Association of State Highway Officials, of which he is also chairman, was endeavoring to standardize methods of tests. Methods of tests cannot be uniform throughout the United States, but the country has been divided into nine sections with an endeavor to have uniform methods in each section. Standard methods of tests will lead to economy. This committee is just starting to function; its chairman is endeavoring to get coordination between it and the committee of the Advisory Board.

For answering letters of inquiry about research, Mr. Mattimore proposed that the Advisory Board's office should act as a clearing house to which such letters might be referred.

Mr. MacDonald suggested that employment of one or two men to work under Mr. Mattimore's direction would be comparatively a simple matter under a co-operative arrangement by which the State of Pennsylvania would contribute one-half and the Bureau of Public Roads the other half of the cost. The State would get more benefit than would offset the cost of one-half salary of one man or of two men.

There should be correlation of the Advisory Board's committee with the Association of State Highway Officials in identical work; personnel necessary to do work under

Mr. Mattimore's direction should be secured.

Mr. Pride suggested that the States should match dollar for dollar the research money provided by Bureau of Public Roads. The arrangement between them should include the franking privilege for reports and other mail connected with the national research program. Administration should be delegated to the Advisory Board and Bureau of Public Roads.

Director Hatt expressed the opinion that the problem was to finance activities of research committees. The overhead organization might be financed without much trouble. The chief difficulty is the legal inability of States to enter into cooperative agreements.

Economic Theory of Highway Improvement. Professor T. R. Agg, Chairman of the committee, presented his report (Appendix A) with verbal comments. The Chairman had spent much time in attempting to develop the personnel of the committee, to interest men already in research work and those who have shown ability along research lines; but it has proven difficult to secure cooperation because the committee could not offer anything in the way of financial support. This difficulty will be overcome through the arrangement whereby cooperative projects may be carried out under the appropriations to the Bureau of Public Roads. Investigations at Ames, Iowa, progressed on a large scale during the past year. It is hoped that by Spring a complete report will be forthcoming that will establish one theoretical basis for the determination of economical grades. Another element of information desired before determination of grades can be put on a definite basis is tractive resistance. The Chairman has maintained contact with the Mississippi Highway Association. Cooperation can be secured from other States, if the funds be expended in the State offering them; for example Michigan will place funds in the hands of the committee, provided arrangements can be made to carry on investigations in Michigan.

Through courtesy of Bureau of Public Roads, the Chairman has found it possible to visit all of the research work under his committee. The real problem is

finding men with research ability who have available resources for actually doing research work.

VOTED: That Professor Agg's report be accepted and filed.

Adjourned for luncheon at 12:30; reconvened at 2 p.m. with the Vice-Chairman presiding.

* * * * *

Major Ireland presented the report of the sub-committee on Tractive Resistance. He stated that there are at present five full-time men at work; there will be by early February three Army officers, three Public Roads men, and two students. There are four different types of vehicles on hand, and three other types available; with 14 different types of pneumatic tires, and 9 different kinds of treads representing 9 different manufacturers. Steel tires and rubber cushion tires will be added to make the investigation complete. The steel tire is particularly desirable, to compare the effect on the highway of the heavy animal-drawn truck, with the motor truck. See Appendix.

Professor C. A. Adams, chairman of the sub-committee, stated that this work was organized at Massachusetts Institute of Technology, with Major Ireland as chief functionary, some six months ago. Backing Major Ireland was the Quartermaster Corps of the Army, contributing trucks, supplies and officer assistants, and paying for certain civilian assistants. The Institute having in its electrical engineering department a research division with certain funds at its disposal, gave about \$1600.00 in cash, besides space and laboratory facilities. Bureau of Public Roads was also supplying research assistance. Portland Cement Association has contributed \$1000.00 and has promised another \$1000. The Connecticut Highway Commission, through Mr. Bennett, paid the expenses of a number of chauffeurs and other men on tests at New Haven. Tests for analysis of internal losses in the automobile trucks were made at Yale University under Professor Lockwood superintending tests. Massachusetts Department of Public Works, Harvard University and a number of other organizations and corporations

are also assisting. Dr. Dickinson, Director of Research for the Society of Automotive Engineers, is an active member of this committee. Mr. J. D. Ence, inventor, made a large number of tractive resistance measurements with electric transmission for automobiles. Data are very consistent and will be available for this committee. One interesting point was brought out by Mr. Ence when he showed some of his curves: up to 15 or 20 miles an hour the tractive resistance curve rises; then for a third of the range of the curve (which goes up to 50 miles an hour) the tractive resistance remains almost constant and finally shoots up again.

Mr. A. T. Goldbeck stated that the committee on Structural Design of Roads had not yet been formed. Work, however, has not been neglected; \$4000 or \$5000 has been spent on this problem. Three major investigations are under way: 1. Pittsburgh, California; 2. Bates, Illinois; 3. Bureau of Public Roads. All researches will finally lead to establishment of certain fundamentals in connection with design. Purpose is not to "direct" researches, but rather to get the men together, and by discussion steer the researches voluntarily so that desirable results will be reached in shortest possible time.

Professor Adams reminded those present that the function of this Advisory Board is to coordinate all the research activities of all organizations in the country that are interested. Coordination does not mean direction. At present there is a great deal of overlapping and duplication of research carried on independently by various universities and organizations. In many cases work is being done without competent guidance. The Board can be of great assistance to State departments and other agencies, by getting them together, by laying out a program, by finding out what is being done, what gaps are, and by spreading information. As stated on its letter paper, the purposes of the Advisory Board are, "to prepare a comprehensive national program for highway research; to assist existing organizations to coordinate their activities therein; and to collect and distribute information of completed and current research."

Mr. Goldbeck, continuing, stated that the Bureau of Public Roads has data that will aid judgment in design-

ing concrete road slabs, but data sufficient for rational designing of slabs will not be gotten in a year.

Mr. Crane mentioned investigations of sub-grades by C. M. Upham and H. G. Shirley; it is very important all over the country and should be brought into connection with the work of the advisory Board.

Statements by Representatives of Organizations

Men representing various organizations were then asked individually for statements.

Mr. Beecroft suggested that the relative importance of highway investigations should be determined and effort concentrated upon them successively in the order thus indicated. He hoped that the discussion at this meeting would aid in establishing which were the most important studies for first attention.

Mr. Brosseau: Director Hatt asked me to come prepared to discuss those fields of highway research that are of special interest to the society which I represent. Before discussing any particular topic, I want to suggest that it might be well to broaden the membership of the Board. I am prompted to suggest this because there is a very general opinion on the part of the public that the activities of the Advisory Board are confined to engineering and construction problems.

My conception of the highway problem is best expressed by the foreword in the California report of Mr. Thomas H. MacDonald, Chief of Bureau of Public Roads:

"The California study is the most comprehensive study of results obtained through the development of a State highway system that has yet been undertaken. The work of this study has followed two principal lines; one that includes those questions that are engineering in character, and the other those that are economic in character. These two groups of questions are so inter-related and so inter-dependent that they cannot be separated.

All road improvement is a means to an end - improved transportation facilities. The proper development of such facilities ought to be based on both the engineering and economic considerations involved. But the practical application of these considerations is always modified by the attitude of the public."

The report itself is a history of the practical experience of the State over a period of twelve years and is perhaps the best answer as to the attitude of the public toward highway transport.

We hear a good deal nowadays about the burden being put upon the poor taxpayer to develop highway transport. It seems to me that the best answer as to what the taxpayer thinks of highway transport is to relate the experience in California. The first bond issue of \$18,000,000 in 1909 passed by a bare majority. The second issue of \$15,000,000 in 1916 carried every county in the State by approximately four to one. The third bond issue of \$40,000,000 in 1919 carried the State by a vote of approximately seven to one. I recently gave these figures to a railroad president, with whom I was discussing transportation, and I was very much impressed by his comment: "They seem to like it."

We also hear a good deal nowadays about the importance of developing agriculture and "back to the farm." Perhaps the development of highway transport in California may not be responsible for it, but the fact remains that while the population in California increased 44% from 1910 to 1920, the population along the improved highways increased over 63%, and agricultural products increased over 300%.

Another interesting thing in the California report is that the operating income from the use of the improved highways has more than paid for the roads. We are also told that the present value of the roads is more than their original cost, that the roads have not been pounded to pieces but are in very fair condition and can be repaired for a comparatively small amount of money. These facts are not generally known, but they should be.

I believe it is a very important part of the work of this Board to see to it that it lives up to its purposes as printed on its letterhead:

"To prepare a comprehensive national program for highway research; to assist existing organizations to co-ordinate their activities therein; and to collect and distribute information of completed and current research."

A subject in which the automotive industry is particularly interested, is continued research and investigation to determine the cause of road failure. I have talked with many men who have to do with highway transport and I find that the best informed of them have come to the conclusion that many of the theories regarding road failure do not square with the facts, and almost without exception these men recommend that it would be well to wait until the investigations now in progress are finished before attempting to pass drastic laws restricting motor vehicles - particularly trucks.

In the meantime, it seems wise to adopt a uniform basis of legislation and I suggest for the consideration of the highway official members of this Board, the proposed Uniform Vehicle Law, recommended by the American Association of State Highway Officials, National Automobile Chamber of Commerce, American Automobile Association and the Highway Industries Association.

My understanding is that all of these associations have agreed as to the principles and nearly all of the details of the proposed law. I understand it is now generally admitted by the best informed highway officials that gross load is not the only factor, or the most important factor, of road failure. The law covers this point very well, inasmuch as it provides for a maximum of 800 pounds pressure per inch width of tire, 11,200 pounds per wheel, 22,400 pounds per axle and 28,000 pounds gross load.

In addition to these restrictions as to weight I believe it would be quite proper to incorporate in the laws authority for the state highway officials to restrict the

use of the roads at certain seasons of the year. It might also be well to give them authority to regulate or restrict the use of the lighter and less permanent roads with regard to the heavier truck units.

Mr. Crane called attention to the fact that this Advisory Board has a wonderful advantage in its research work. The research committee of the Society of Automotive Engineers and most of those connected with the N.R.C. are dealing with 90% private research. In this case the research is almost entirely public, in other words, carried out by national, state, county and city governments. All information connected with it is public. In our business we cannot go to the laboratory of a competitor and watch an engine test, unless invited. For that reason the public information obtained from research work is much more valuable. Importance of how to build a road to carry certain traffic was emphasized. Attention was called to the fact that the highway system of the country at present is deficient in proper terminal facilities, the Manhattan end of Queensboro Bridge, New York City, and the situations in Jersey City and Newark being instanced as examples. In many places it is impossible for a truck to pass a street car unless it has the good fortune to hit a block where no vehicles are parked at curbs. Another bad situation arises in New York and other cities from tearing up of streets; due to restrictions of labor unions that work is largely done between the day hours of 8 and 5 when traffic is densest. The important feature in economic transport is that of the making of the highway itself.

Mr. MacDonald. Mr. Crane has revolutionized my thoughts on the real function of the Advisory Board. He paid his compliment to the highway engineer and the way he builds his road, pointing out deficiencies of highway engineers. Each will get help from Board meetings in having deficiencies pointed out. We find in making careful analyses of motor trucks for the purpose of arriving at proper loads for bridges that manufacturers have balanced trucks rated at the same load-carrying capacity so that the load on the rear axles, which is the determining feature of concentration of load on road, ranges as high as 90 percent of the total weight. The real function of Advisory Board is to outline a national program of high-

way research, act as a clearing-house, and then find someone who will tackle each problem when formulated. The Bureau of Public Roads is interested in the designing of the vehicle and in its use as well as in the designing of roads. It will aid with funds and personnel.

Mention of the discontinuance of "Public Roads" brought forth expressions of appreciation of the value of this publication.

VOTED: That the Advisory Board on Highway Research express its desire to have the magazine of the Bureau of Public Roads continued under the auspices of that Bureau.

The Chairman was authorized to appoint a committee of three to carry out the purpose of this motion. Each member society was urged to take action on its own account.

Mr. Kinney. For ten years, the American Concrete Institute has felt the need for specifications to cover concrete roads. During that time there have been few changes. It seems appropriate that a committee should direct the writing of these specifications in the proper way. A proper research program involves a study of past experience and of what is going on. The Director, in his travels, passes on from one research group to another the ideas that are current, and if the Director and the committees are provided with sufficient assistance, this exchange of current ideas will be very helpful. The Portland Cement Association has found it desirable to keep in touch with current experiments.

Mr. Lewis said that he feared some people are frightened at the word "research." Many people believe that research is something the results of which can only be expressed in formulas or by calculus. There are a number of lines of research that can properly be taken up: Economic width of roads is important; Separation of motor trucks and pleasure vehicles would eliminate great danger of accidents. More serious accidents on rural highways than in cities. Greater width of road and the possibility of furnishing the motor truck its own separate space on the road, or a different road, would separate the kinds

of traffic. There are other means for overcoming this difficulty, but all need careful examination.

Mr. Whinery. Activities of American Institute of Consulting Engineers have been largely confined to the effort it has been making to assist in the financing of highway research. A year ago we introduced a resolution asking Government aid especially for this purpose. In the year that has expired, we have continued to urge that policy on public bodies. Our organization is a unit on that point. The most important thing connected with this whole business is a thoroughly sound policy for the provision of means to enable the Director to go on without being uncertain as to whether the means for a certain line of work can be secured or not.

Colonel Winslow. My opinion is that as a general rule more is learned if the boards conducting research work will put down their failures instead of their successes only, and give the reasons for their failures.

Professor Tilden. Professor Hatt in his report has referred to the Committee on Highway and Highway Transport Education, of which I was Director for the first year of its existence. Its activities are along educational lines. Results are always published. The Committee arranged for exhibits which would help technical institutions in presenting certain important phases of highway transport. The first of these, the rubber exhibit, showing rubber as used in tires, is just ready. It was prepared by the Firestone Tire Company. The idea is that the Committee will send these exhibits, of each of which there are ten sets, to different institutions which can make use of them in an educational way. The Bureau of Public Roads is making for the Committee a similar exhibit of highway construction including not only methods of building highways, but also highway structures of various kinds. The Committee is also arranging for a motor and machinery exhibit, which has not progressed beyond the initial suggestion. The Committee also carried out several contests to stimulate interest among grammar and high school children, - one for the Firestone University scholarship, an educational prize of considerable value, carrying with it free tuition and all expenses for four years in any university or college chosen by the

winner. Another contest, which has been completed, under the auspices of the National Automobile Chamber of Commerce was on the subject of Safety on the Highways. It has been suggested that a similar prize could be offered to students in colleges. The Committee started out on a small program of research, in the way of bibliographies. As soon as this Board came into action, with Director Hatt, that phase was left to him. There is much work for the Committee to do. It must now be carried on by individuals on whom other activities have no prior claim. What makes things drag is the fact that each member of the Committee has a prior claim on his time.

Mr. Mehren. From my standpoint the way to get the greatest ultimate benefit is to prepare your work in advance. Then tell others what you are doing so that they may benefit. Mr. Older, in Illinois, for example, first told that he was going to build a certain experimental road. Then he gave details of the road, and shortly after told just how the work was being done. As a result everybody is informed of just what he is doing, and are awaiting results of his tests. Give out news as it develops and you will get the best results.

REPORT OF NOMINATING COMMITTEE

Your Nominating Committee recommends the following candidates for officers:

Chairman - Anson Marston, of Ames, Iowa.
Vice-Chairman - Alfred D. Flinn, of New York.

Additional Members of Executive Committee:

Comfort A. Adams, of Cambridge, Massachusetts.
Henry M. Crane, of New York.
Thomas H. MacDonald, of Washington.

Signed for the Committee,
CHARLES J. TILDEN, Chairman.

Members of Committee: E. Eveleth Winslow
A. J. Brosseau
A. T. Goldbeck
G. H. Pride

Mr. Flinn. By-laws state that officers shall serve for one year from January following election, but also provide that the annual meeting should be held in November.

VOTED: That the officers to be elected at this meeting be the officers for the Board for the calendar year 1922.

A regulation of the National Research Council sets a time limit to the membership in the Divisions of the Council. By-laws of Advisory Board state that the three additional members of the Executive Committee shall also be members of the Division of Engineering. This situation has arisen. The Chief of the Bureau of Public Roads is at the present time a member of the Division, but according to the limitation, he will not be a member throughout the current year. Because of the large support and great interest of the Bureau in the activities of our Advisory Board, it is manifestly essential that Mr. MacDonald should be continued, as suggested by the Nominating Committee, as a member of our Executive Committee. It has been proposed that By-law 6a be slightly amended as follows:

6(a) Executive Committee, consisting of the Chairman, the Vice-Chairman, and three additional members chosen by the Board, at least two of whom shall be members of the Division of Engineering.

Amendments may be made by a majority of the Board, on 30 days' notice, by letter ballot.

VOTED: That the director cast one ballot for the names in the nominating committee report as the officers of the coming year.

The Director cast the ballot and the Chair declared the officers named therein elected.

DISCUSSION OF HIGHWAY PROBLEMS.

Mr. Crane: It is of great importance that the S. A. E. be urged to invite one or more English engineers to cooperate, for example, Harry S. Riccardo, undoubtedly, in automotive lines, the best research engineer in England..

If the Director can get to different parts of the United States and tell what is being done, describing to each group researches different from its own, it is bound to make all think a great deal more.

Mr. Beecroft. Would like to see a complete program of the research activities of the Advisory Board arranged in the order of precedence.

Director Hatt. As I have traveled in the past few months, problems of economics loom up larger all the time. It is very important to get a picture of this thing we are dealing with. The traffic service investigation being conducted in Connecticut is of increasing importance. Besides problems of economics, there are also costs. One of the deciding elements is cost of maintenance. Questions of sound theory of finance are looming up, especially correlation of different elements of transport and who shall pay. Suggested that by doubling road license fees we can meet road bill of United States. Road fees for automobiles, are small proportion of their operating expense, - for trucks little over 1 percent. Doubling the road fees would increase the total operating expense only 2 percent. We have kept too close to the purely engineering features of testing materials and mechanical design. We should study highway transportation. Interest seems to be leading up to the study of economics of transportation, to traffic studies, and studies like those conducted by Professor Agg.

Mr. W. P. Blair. There are 88,000 miles of road in Ohio. For the great part of that highway system, wherever improvement goes, money is being expended for more than is represented in our Federal highway appropriation, far more than comes from the State Treasury, or far more than comes in from the automobile tax. Thirty million dollars are being expended in repairs and maintenance of roads. The important thing is to correct the mistakes in the building of roads that result in great expenditure for maintenance. In my opinion, 75 percent of the injury to our highways is due to natural causes, and 25 percent to traffic. We may eliminate these destructive agencies. Until we do that, our maintenance charges are going to be beyond our ability to keep our roads in repair. All roads

that have been repaired in the last 15 or 20 years are calling for a burden of maintenance. Research in that direction is really paramount.

NEXT MEETING.

It was the consensus of opinion that the Advisory Board should meet oftener than once a year. It was suggested that a meeting be held in June, if practicable in conjunction with a meeting of some national organization interested in highway transport, at or near a place where important experimental work is in progress. Referred to Executive Committee with power.

Chairman Marston returned to the meeting and took the chair at 4 p.m.

SUGGESTED RESEARCHES AND RESEARCH COMMITTEES.

Professor Agg presented a written report. (See Appendix D) Purpose of Committee on Highway Traffic Analysis is to insure adequate study relative to the characteristics of heavier traffic. Committee on Highway Finance is suggested because of the prevailing feeling that the present methods of financing highway improvements are not what are to be desired. As the expenditures increase in volume new methods in distributing the cost must be devised. Committee on Maintenance was suggested by the Director and included in this report at his instance. So far as Professor Agg was advised, members of his committee are entirely agreeable that such a committee should be established. It will occasion modification of the field of Committee No. 1, and as chairman of the latter he was willing that suitable adjustment be made. Committee on Sub-grade is suggested because of the activities of certain organizations, and the great importance of that subject. Heretofore it has been listed under Committee on Structural Design of Roads; before these committees are constituted proper division of work should be made.

VOTED: That the report on Researches and Research Committees by Professor Agg be accepted.

VOTED: That the Committee on Sub-grade be made a sub-committee of the Committee on Structural Design of Roads and that the matter be referred to the Director and Executive Committee.

The Vice-Chairman reported that there is enough money in sight to cover the largest items of expense, the Director's salary and travel; but in order that the Director's efforts may be most effective (and consequently the services of the Board to the associations which it represents, and to our States and nation) there should be provided \$11,000 or \$12,000 more so that the Director may have the necessary assistance and office facilities. Members of the Board were asked to aid in securing contributions from suitable sources. It would be safe and above criticism to accept contributions from associations of manufacturers, but to receive money from individual corporations might be objectionable.

A Committee on Ways and Means, of three members, will be appointed by the Chairman soon to give attention to such matters.

The Director stated that only through the effective interest of Mr. MacDonald in highway research, and the assistance given by the Bureau of Public Roads, has it been possible for the Director to discharge his responsibilities. As soon as possible a research census should be started to find out what is going on before attempts are made to coordinate research. It is to create the research census and research information service that funds are needed now. It requires employment of technical men who can sit at their desks and attend to this business under the direction of the Board. There should also be an emergency fund for researches. An example of the need for this was given by Professor Agg, who stated that Professor Conrad was unable to complete important research work due to lack of \$500. The N. R. C. has no fund for this purpose.

Chairman Marston urged that committees be so organized that chairmen will put in full time and receive pay for it. Cooperative arrangement with Bureau of Public Roads by which some Federal fund can be used for such

purpose may be feasible. Committee chairmen must be employed on committee work at least part time.

Arrangements can be made with N. R. C. for informational and advisory services, but State highway departments should have a right to spend a small portion of their funds for service of this kind.

Mr. Whinery again urged that Congress should amend the Federal Aid act so as to make available for highway research a sufficient sum, not less than \$250,000 to be expended under the direction of the National Research Council.

VOTED: That the Advisory Board on Highway Research recommend that in the future Federal Aid Legislation the percentage set aside for research and administration, which is now $2\frac{1}{2}$ percent, be restored to 3 percent, as in former legislation, with the understanding that the increase shall be available for highway research.

VOTED: That the tentative budget submitted for 1922 be approved, on condition that the funds be secured.

PUBLICATION OF A VOLUME OF REPORTS.

The Chairman's suggestion that a volume should be printed for general distribution containing reports on progress of Advisory Board was favorably received.

VOTED: That the Advisory Board on Highway Research recommend to the National Research Council the publication of the proposed volume of progress reports on highway research, and that the Executive Committee be authorized to negotiate with the Research Information Service of the Council.

ADJOURNMENT.

The meeting adjourned at 4:45 p.m. subject to the call of the Executive Committee.

ALFRED D. FLINN, Vice-Chairman,
and Secretary of the meeting.

APPENDIX A
Advisory Board on Highway Research
National Research Council

Report of Chairman, Committee No. 1, on Highway Research Program.

Committee Membership: T. R. Agg, A. N. Johnson, Mark L. Ireland, H. J. Kuelling, L. E. Conrad, R. B. H. Begg, H. J. Hughes, D. C. Fenner, H. S. Fairbanks, R. B. Gage, Charles Manly, H. J. McIntire.

Research Field: The research field of Committee No. 1 as defined by the Advisory Board on Highway Research is as follows: To institute the investigations necessary to determine all of the elements of cost of highway transport. For convenience of discussion these may be grouped as follows:

1. Elements of cost that are directly chargeable to type, design or condition of road.
2. Elements of cost that are directly chargeable to type, speed, or condition of use of vehicle.
3. Elements of cost that may be grouped as overhead due to vehicle use.
4. Elements of cost that may be grouped as overhead due to road construction and maintenance.
5. Elements of cost arising out of use of highway by vehicle.

Highway Investigations Now Under Way: It will be of interest to record the highway investigations of note now under way in the United States. These have not all been sponsored by the Research Council but are directly or indirectly the result of the persistent effort on the part of the Advisory Board on Highway Research to focus attention upon the vital need of a knowledge of the basic principle of highway engineering.

1. Economical Highway Grades, at the Iowa Engineering Experiment Station, - 90 percent completed.
2. Tractive resistance of certain types of vehicles and certain types of surfaces, at Iowa-Engineering Experiment Station, - under way.
3. Tractive resistance certain types of vehicles on concrete road surfaces, including a study of methods of observation and of internal power losses in vehicles and tires, at Massachusetts Institute of Technology in cooperation with the Bureau of Public Roads, and at Yale University.
4. Tractive resistance and economical grades at University of Michigan.
5. Effect of relative air speed, at Kansas Agricultural College.
6. The establishing of the relation between traffic and maintenance costs; recently inaugurated by the Bureau of Public Roads.

New researches for which arrangements are complete or are pending.

1. Relation between the roughness and the rigidity of a road surface and rolling resistance, at Iowa Engineering Experiment Station in cooperation with the Bureau of Public Roads.
2. Elements of cost of highway transport, by Society of Automotive Engineers (pending).
3. Operating costs of motor transport, project pending for studies in connection with motor transport activities in and near Los Angeles.

Relations of Committee No. 1 to other Research Agencies:

- A. Mississippi Valley League of Highway Depart-

ments. The chairman of Committee No. 1 is also Chairman of Research Committee of above association.

- B. Chairman maintains contact with all other known research agencies such as the Society of Automotive Engineers, University Experiment Station and Committee of Association of State Highway Officials.

Financial: No accurate statement of funds expended is available but no project has suffered for lack of funds, so far as the chairman is advised. Estimated expenditures for past year by all agencies associated with Committee No. 1 were \$23,500.00 in 1921.

The projects contemplated for next year will involve an expenditure of about \$100,000.00, about three-fourths of which is available from funds now allocated to the work.

Research Personnel: It has been apparent from the outset that the volume of research work accomplished would depend upon available personnel rather than upon financial limitations. The development of research personnel is the outstanding need at the present time and it is apparent that the selection, training and utilization of research personnel should be given the utmost attention during the coming year. The membership of Committee No. 1 should be increased as rapidly as desirable men can be interested in the work. Just now it is particularly desirable to secure one or two economists who would be interested in the investigation of highway transport costs, and who would develop that field.

Respectfully submitted,

T. R. AGG, CHAIRMAN.

APPENDIX B
Advisory Board on Highway Research
National Research Council

Report Regarding the Status of Work on Structural Design of Roads.

The Committee on the Structural Design of Roads has not been formed up to the present time. Not more than a month ago the writer gave his informal and verbal consent to the Director of the Highway Research Board to serve as chairman of this sub-committee. Therefore, no report from this committee can be presented.

The preliminary work which such a committee will finally consider has, however, not been neglected, but as the Director has pointed out, the work on structural design of roads is being pushed vigorously through a number of different sources. It is felt that so far no great harm has been done through the lack of formation of this sub-committee. Results are now being obtained, however, and the time is now ripe for beginning to coordinate them and the formation of this particular sub-committee should be consummated.

My conception of the work of the various committees is that they shall not perform researches, nor even direct them, but through discussion the various lines of activities will be molded voluntarily in a way such as to lead most directly to the desired end without too much duplication of effort.

I am of the opinion that all sub-committees should be formed through invitation by some officer, preferably the Director of Highway Research of the National Research Council, after consultation with the Chairmen of the sub-committees.

After the sub-committee on the Structural Design of Roads is formed in this way no doubt discussion by the members will bring forth a mutually agreeable plan by which the greatest amount of good will be accomplished. As a nucleus of this sub-committee I would suggest the following:

Mr. Clifford Older, Illinois State Highway Department.

A representative from the California State Highway Commission.

A representative from the Pennsylvania State Highway Commission, Mr. H. E. Hilts.

Mr. C. A. Hogentogler, Bureau of Public Roads.

Dr. L. I. Hewes, Bureau of Public Roads.

A representative from the Pittsburgh Tests in California.

Mr. Charles M. Upham, North Carolina State Highway Department.

Dr. C. M. Strahan, University of Georgia.

The proper representatives of the above organizations and representatives from other organizations not mentioned above could be chosen in consultation with the Director. No attempt will be made at this time to suggest a plan of procedure. This should be left strictly for the sub-committee to formulate in order that there might be heartiest and most lasting cooperation.

Respectfully submitted,

A. T. GOLDBECK, CHAIRMAN.

APPENDIX C
Advisory Board on Highway Research
National Research Council

Report of Committee on Character and Use of Road Materials.

This committee was organized by the appointment of the Chairman January 15th, 1920, and the membership was completed April 28th, 1920. The attached preliminary program was submitted to the membership of the committee August 5th, 1920. It will be noted in the conclusion of this program that it was not considered practical to have detailed research work done by the members of the Committee, but it was hoped that the members would try to keep in contact with research work being carried on and report progress.

The Chairman of the committee received little or no cooperation from most of the members, which in my experience is not unusual. This can be accounted for mainly that the members have such responsible and exacting duties in their regular employment that little or no time could be given to this work.

The Chairman has given some thought to a change in personnel on the committee in order to obtain more active cooperation. This procedure should not by any means be considered a criticism of any of the present membership, in fact it is more a criticism of the present appreciation of research work, especially in the highway line throughout the United States. This research work previously has never offered any incentive so that men could specialize on it, and the men with proper training and experience for this class of work were tied up with other responsibilities. At the present time I am not in a position to recommend any new members of this committee; because by personal interview and correspondence with men whom I considered for appointment I found that their time was so fully occupied with their regular employment that they would have very little opportunity to give consideration to committee work. My opinion is that we should start with a small membership and keep adding to it rather than to try to form a large

committee, thereby running the chance of having a number of inactive members.

Although very little has been accomplished through the membership functioning as a committee, there is a considerable amount of work being carried on throughout various organizations interested in highway work along the line proposed by the Chairman in the preliminary program submitted August 5th, 1920. Some contact is maintained with this research work through correspondence, and occasional advice is given to the individual investigator where this is sought.

During the past year the chairman attended conferences with Dean Marston, Chairman, and Prof. W. K. Hatt, Director of the Advisory Board on Highway Research. During these conferences one of the main problems which was presented was that of the committee having personal contact with the research investigations being carried on throughout the United States. It is not possible for me to undertake this, from the standpoint that the duties of my present position are very exacting, and do not allow of my spending any considerable time away from the office, especially out of the State. I believe that some kind of personal contact is essential, and it was proposed at these conferences that the Advisory Board employ an assistant to the Chairman who could give his full time to this work. His headquarters could be at the office of the Chairman in Harrisburg, Pa. This man could visit the site of research investigations and make his reports to the Chairman. Advice could be given this assistant and I believe if the right caliber of man is secured that it will work out satisfactory.

The Chairman keeps in contact with the various National Technical Societies which are investigating materials of all kinds; through memberships on the committees, thorough cooperation is secured. I might mention in this regard that Committee on Tests and Investigations of the American Association of State Highway Officials is organized for the purpose of recommending standards to this association. This Committee is now functioning through several sectional and sub-committees, and it is hoped that much can be accomplished within the next year.

Your Chairman of the Committee on Character and Use of Road Materials of the Research Council, is also Chairman of the Committee on Tests and Investigations of State Highway Officials. This naturally will lead to excellent cooperation between these two organizations, and I personally believe that the American Association of State Highway Officials will develop into an authoritative source for anything relating to highway construction

H S MATTIMORE, CHAIRMAN.

APPENDIX D
Advisory Board on Highway Research

Suggested Researches and Research Committees

I. Committee on Economic Theory.

Problems: To determine all of the elements of cost of highway improvement.

The following will suggest the type of research involved.

- A. Effect of grades, alignment, rise and fall, weather and speed and methods of operation on cost of transport.
- B. Determination of all of the elements entering into the resistance to translation of vehicles (Tractive Resistance) and magnitude of each element.
- C. Determination of the elements of cost of vehicle transportation classed as capital costs, and operating costs exclusive of those included in A & B.
- D. To determine the relation between traffic and capital and maintenance costs of roads.

II. Committee on Structural Design of Roads.

Problems: To establish all of the data required for the rational design of a road surface.

The following will suggest the type of research involved.

- A. Determination of all facts relative to the behavior of the soil upon which roads are constructed, when under load from the road structure.
- B. To determine the relation between traffic loads and stress in road surfaces, and to establish the laws that control.

- C. To determine the effects of the elements on road structures.
- D. To determine the structural strength of all types of road surfaces.
- E. Relation of the vehicle to the road.

III. Committee on Road Materials.

Problem: To determine the most effective combinations of materials to give desired strength and to investigate possible new combinations of materials.

The following will suggest the type of research involved.

- A. To establish the most effective combinations of materials now in use, with particular reference to the exigencies of field control.
- B. To promote research looking to the establishment of new combinations of materials, or of the new materials suitable for road surfacing.

IV. Committee on Highway Traffic Analysis.

Problem: To establish an adequate method of studying highway traffic and to show how traffic records should be interpreted.

The following will suggest the type of research involved.

- A. A study of relation of community development to the origin and destination of traffic, and to devise means for estimating potential traffic.
- B. Proper methods for studying and recording volume of traffic, and for interpreting traffic records.
- C. To devise units of measure to apply to traffic and to define those units.

- D. To study the relation of highway betterment to traffic increases.

V. Committee on Highway Bridges.

Problem: To establish all of the data required for the design of highway bridges.

The following will indicate the type of research required.

- A. Determination of loads for which bridges should be designed.
- B. Study impact on highway bridges.
- C. Determination of the proper requirements for standards of design as regards allowable stresses, widths and requirements of foundations.

VI. Committee on Highway Finance.

Problem: To determine the equitable basis for financing highway improvements.

The following will indicate the type of research involved.

- A. Definition of an equitable basis for highway financing.
- B. Study of possible methods of financing improvements in the various political units.
- C. Administrative methods required to insure equitable financing.

VII. Committee on Maintenance.

Problem: To determine the relation between traffic and maintenance costs of roads to investigate methods of maintenance and organization of maintenance forces.

The following will suggest the type of research involved.

- A. Establishment of accounting methods that will give accurate data on cost of maintenance.

B Methods of correlating maintenance costs
 and volume of traffic

C Relation of maintenance costs to methods of
 maintenance

VIII Committee on Sub-grade

Problem To determine the supporting power of soils
 under all conditions, to investigate meth-
 ods of increasing the stability of sub-
 grades and to consider any similar problems
 having to do with the characteristics of
 sub-grades

These two committees were added to this report at the sug-
gestion of the Director of Highway Research and have not
been considered by the entire committee on Research, due
to the lack of time for the necessary correspondence. If
these are constituted, the field of committees No 1 and
No 2 should be modified so that no overlapping exists

It is believed that the results of the work of the six
committees suggested herein will show the need for inves-
tigational committees on Vehicle Design and Construction
Methods, but the establishment of such committees is not
recommended at this time

Respectfully submitted,
COMMITTEE ON RESEARCHES AND RESEARCH COMMITTEES
T R. AGG