BEFORE THE

INTERSTATE COMMERCE COMMISSION

Docket No. 23400

CO-ORDINATION OF MOTOR TRANSPORTATION

TESTIMONY OF

THOMAS H. MacDONALD, *Chief*
U. S. BUREAU OF PUBLIC ROADS

Washington, D. C.
March 5, 1931.

From Transcript of Testimony Furnished by Official Reporter

NATIONAL ASSOCIATION OF MOTOR BUS OPERATORS
WASHINGTON, D. C.

46658

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THOMAS H. MacDONALD

Q (By Chairman Brainerd) Just state for the record, Doctor, your full name and position?

A Thomas H. MacDonald. Chief of the Bureau of Public Roads, Department of Agriculture.

Q You may make your statement, Doctor.

A Mr. Commissioner, my appearance before you is in response to the invitation addressed to the Secretary of Agriculture by yourself to present through any of the Bureaus any material which would have a bearing upon the present inquiry of the Commission. If I may say this, my testimony does not appear for or against any particular proposition or any carrier or any agency, but, rather, is intended to present the latest scientific data which we have bearing upon the subject of the use of the highways and the relationship of the motor vehicle to the highways. I intend to present the evidence without statement of opinion except as justified by the facts. I have prepared a synopsis of part of the evidence which will be offered and I submit a copy for the record. We have not prepared full copies of this brief for distribution but we have copies of the essential tables or essential material which can be secured at the close of my presentation of this material from Mr. Fairbank by any one who may be interested in this material.

The first part of the testimony, Mr. Commissioner, which I wish to present relates to the relationship of the highway to the motor truck, the motor bus and automobile in relation to the design of the highway. These charts are prepared to illustrate the method by which we are arriving at the design of highways on a rational basis.

Up to a relatively few years ago the design of highways was purely invariably based upon experience or the trial and error method—the rule of thumb method. During the past ten years we have been conducting a series of tests, experiments and studies that are developing the necessary information upon which to design highways in the same way that we are able to design bridges or buildings or any other particular structures in which the stresses are determined.

The first chart which I present is an isodynamic curve showing the lines of impact for various types of tires on a particular street in the City of Washington. The design of the standard paved highways, which are now being largely built on the main thoroughfares of the nation consists either of a rigid base with a bituminous asphalt mix or a brick or stone block top or a concrete slab without other covering. The design of the dimensions, the thickness, the strength of that slab, whether it is the base or the surface itself, must be sufficient to carry not only the static load of the wheel of the motor truck and bus but must carry the impact. That is, the design must be based upon not the load of the wheel itself but the blow which that wheel delivers to the road in operating over it. This chart shows the lines of influence of impact for the various types of tire. With a pneumatic tire, a nine thousand-pound wheel load would have in the neighborhood of 12,500 pounds of impact. When you get over to the worn solid tire we find that the same wheel load would give an impact well above 21,000 pounds, or practically double the impact under the pneumatic tire for the same wheel load. I think it is not necessary, Mr. Commissioner, to elaborate upon the theory, except to illustrate the method of arriving at certain conclusions which I will present.

The second table shows the influence of the impact. We take then the impact of the wheel as the load, not the static load, not the wheel weight of the standing wheel, but the impact as the weight of the load for which

we must [redacted] formulas for arriving at the stresses in the slab of the roadway the influence of wheel l[redacted] subgrade reaction and the area of contact of the tire with the road. That becomes all impor[redacted] of the relative destruction of the heavier wheel loads upon the highways. (a) is the radius of t[redacted] tact of the wheel on the surface of the road. With the radius of the area of contact reduced to ze[redacted] the load of the wheel concentrated on the road in a single point, if it could be, and with a modulus of s[redacted] reaction of 50, we would have a stress of 833 pounds in the outer fibre of the road; but if we make contact with the same load through an area on the pavement with a radius of eight inches that stress in the road is reduced to 453 pounds, or approximately one-half. That point is extremely important because it has been entirely overlooked in comparing the relative effects of the automobile, the truck and the bus upon our highways.

These charts, I may say, showing these tests were not made particularly for this hearing. They are part of the regular research studies of the Bureau which have been going on for a long time and are for the purpose of determining in a definite way many of these contentions which are now merely based upon opinion and influenced by the interests of the individual holding the opinion. I think that is self-evident from many of the statements which have been made. I will not take a long time to show these particular charts, but these are the actual impressions of tires under certain loads. This is the contact area of a single 7½-inch balloon tire at 1,750 pounds wheel load. That is a 7-passenger car. Here is a 2-ton truck with a 4,400-pound wheel load, dual 6-inch high pressure pneumatic tires—high pressure. This is an 11,000-pound wheel load, which is a 2,000 pounds heavier wheel load than we think should be used on the road. That is, we believe that a 9,000-pound wheel load is about he load for which the roads should be designed. This shows the contact area on the surface of a highway for a 000-pound wheel load with dual 8-inch high pressure tires. Balloon tires would give a larger contact area and reduce the pressure.

These two charts are quite interesting as illustrating the difference in the area through which pressure is applied to the road surface by the same weight of wheel acting through high pressure pneumatic and through solid tires. These are dual 6-inch new solid tires and the reduction of area of these tires under that of the high pressure pneumatic is evident from the two charts. There is a much larger area through which the high pressure pneumatics exert their impact on the road surface. We have various other types of tires and various other wheel loads, but these charts are made and are the actual impressions taken during the test of the tires themselves on the road.

I want to call attention again to this table which shows the reduction of stress in the roads by the increase of the area through which the impact of the wheel is delivered to the road surface. Reducing this material to a tabular form as obtained in the manner illustrated, we find that a 7-passenger car gave us a rear wheel load of 1,750 pounds—that is a very nominal wheel load—and the impact reaction was 5,100 pounds. It carried a single 7½-inch tire; the area of contact was 35 square inches. The radius for application along the edge—that is, the weak point of our road slabs is along the edge when the weight of the wheel is applied along the edges. With a semi-circular application of 4.7-inch radius at the edge and at the center of the slab a circular application of 3.3 inches radius for a road slab with 7 inches of thickness at the edge and 6 inches at the center, we had a stress of 226 pounds at the edge and 218 pounds at the center. We take that as a standard of measurement. That is the thickness of road that would be required by an automobile or a very light truck operating on pneumatic tires. We would not build roads much less than 7 inches at the edge and 6 inches in the center, no matter what kind of loads we were going to carry. If we built thinner surfaces they would curl up like tissue paper in the rays of the sun. They would warp; the frost heave would destroy them. So we have a certain minimum thickness of road that it is necessary to build if there were nothing heavier than the ordinary passenger cars and farm trucks to use the road, and the whole question of the heavier busses and heavier trucks therefore begins with a certain minimum thickness of road which is necessary regardless of whether they existed or not.

We run up to the 2-ton truck with a 4,400-pound wheel load and an impact of 7,900 pounds and find that this same dimension road would have a stress of 280 pounds; the same road would carry a 3-ton truck with 320 pounds stress—well within the working limits of the material which we use at 350 pounds. It is not until we get to the 5-ton truck that it is necessary to increase the dimensions of the road and then only by one-half inch in thickness; so that as between the passenger cars and the lighter trucks—farm trucks, if you wish, taken as a value of one or as a unit, when you get to the 5-ton truck, in order to keep our stress, get the working stress of the material, 350 pounds, we must increase the thickness of the road one-half inch or about 7.7 per cent and for a 7½-ton truck, 1.154 or about 15.4 per cent.

I wish to emphasize that these figures are based upon the use of pneumatic tires. Balloon tires would give slightly less reaction, impact reaction, on the road, but the cushion tires and the solid tires give more; so that

for a 5-ton truck we would have a thickness index of 1.231 and a considerable increase if solid tires are to be used. We find, however, that the laws of the States and the practice of the manufacturers, and apparently the desires of the public, are all turning toward pneumatic tires.

The results of our investigation indicate that for rural road improvement for the use of motor busses and motor trucks, or any kind of motor vehicles, they ought to be limited to pneumatic tires. That does not come into your question, as I see it, because it makes no difference whether it is a farm truck, a contract hauler or a common carrier. The tire equipment would have the same disastrous effect if it is of the solid tire variety and would have very much less effect than has been asserted if it is a pneumatic tire. That is the actual increase that I can see for the use of the heavier trucks, and they are not all the common-carrier trucks, by any means—the only increase I can see necessary from the standpoint of strength of the road or the effect of the use of the tires upon the road is for the 5-ton truck there should be, perhaps, an 8 per cent increase in thickness and for the 7½—15.4 per cent. That gives some definite idea. I will submit this table for the record.

Chairman Brainerd: It may be admitted.

(Said document was thereupon received in evidence, marked "Exhibit 494, Witness MacDonald" and the same is forwarded herewith.)

The Witness: In other words, that testimony sums into about this statement: In my judgment, the heavier trucks and busses by the higher tax which they are paying, and particularly through the collection of gasoline taxes, are fully meeting all excess costs of construction, due to the increased thickness that is made necessary by these heavier loads. It is a statement that will undoubtedly be contested, but it will be contested largely because the effect on road surfaces of applying loads through a much greatly increased area has never been given the consideration which it demands. Using a very common illustration, we have it to some extent in a diamond edge that will cut glass, but if it were blunted it will not cut glass. That illustrates the point, that by spreading out through pneumatic tires and particularly through balloon tires, the pressure of the wheel loads on the road surface is decreasing their destructive effect as measured by the stresses which they place in the concrete. Take a road with a 9-inch thickness, which is a very ordinary thickness of highway now; with an area of load imposed, a 10,000-pound load gives us a fibre stress of 243 when our working stress is 300 to 350 pounds on concrete that we design for a modulus of rupture of 600 pounds. That is to illustrate the method of arriving at a definite conclusion.

This diagram illustrates then the application of the actual dimensions shown in the chart, that beginning with a minimum thickness—a minimum practical thickness of road—we carry up to the 5-ton truck; then we require a slight increase, but it is not until we operate 7½-ton trucks on new solid tires that we get as much as a 4/10ths increase in the required thickness. It is my judgment, Mr. Commissioner, that within the course of the next two or three years solid tires will not be permitted on the rural highways by the laws of the States, simply by the facts illustrated in these charts and figures which I have brought out; that we will be operating our motor vehicles on pneumatic tires exclusively.

Chairman Brainerd: If pneumatic tires are used, what would be the maximum load that could safely be carried on the improved highways in which the Government has aided?

A We believe that the maximum wheel load should be limited to about 9,000 pounds; gross loads heavier than that would make a 9,000 wheel load. We believe if it is desired to move heavier loads the number of wheels should be increased containing the 9,000-pound concentration, so that if you want to go above that then we should place instead of four wheels, six wheels, or an increasing number of axles, so that we will not obtain more than 18,000 pounds per axle. The roads that we are building today will stand 18,000-pound axle load on pneumatic tires.

I do not know whether I make that point quite clear. Our tests show that in the application of wheel loads to the road, if the wheel rests as much as 36 to 40 inches apart, if the point of contact of one wheel is 36 inches ahead of the next wheel, there is no overlap of stresses in the road structure. In other words, the road has to carry only the weight of each particular wheel. The stresses do not pile up. Therefore, if we had a load to move on the roads that would take more than 18,000 pounds on the rear axle it should be solved by placing two 18,000-pound rear axles with four wheels in place of two wheels. Do I make that clear?

Chairman Brainerd: It is very much like a railroad truck?

The Witness: Exactly. I have not investigated that subject, but I take it if railroad trucks are used in place of the multiple wheels, they would concentrate the loads in a single wheel—

Q As they do in foreign countries?

A Yes, sir; if they used our loadings here on the same type of design they do in foreign countries, I do not believe the tracks would last more than a week or so. They would break down under the impact. The multiplica-

tion of axles or wheels offers the true solution for moving heavier loads on the roads and I anticipate that that will be the development in the future.

Q How about the additional wheels on the same axle, running in pairs? Does that have the same effect?

A Yes, sir; so long as they are compensated and there is no chance of all of the load being directed through two wheels; so long as the four wheels must continually take each its fair share of the load it will make no difference, because for the wheel that delivers the impact and the stress to the road, it does not make any difference how the load reaches the wheel so long as they are compensated and each wheel continues to take its fair share of the load.

I do not know that it is necessary to develop this point any further, Mr. Chairman. The results are shown in the table which I submitted. We have additional tables to give out to those who are interested, so I will proceed to the second part of this testimony which is based on a survey in eleven western States, which we have just completed. This survey was made in cooperation with the State Highway Departments in 1929 and 1930.

The results of the surveys are shown in the chart. Of the total volume of traffic on the highways, truck traffic does not exceed 16 per cent.

Chairman Brainerd: We are very much interested. Take as much time as you need to make a full explanation.

The Witness: Of the total amount of traffic on the highways, the truck traffic does not exceed 16 per cent and common carriers do not exceed one and one-half per cent. This chart illustrates, in a graphic way, the amount of common carriers and particularly interstate common carriers in the eleven western States covered by the survey, and the relative amount of interstate common-carriers is shown by the solid black line at the top of each column representing the motor truck usage in those particular States.

Chairman Brainerd: Is that chart reproduced here in your exhibit?

A Yes, sir; it is the second sheet. We take it, however, that this relatively small amount—say one and one-half per cent interstate common-carrier truckage—does not represent accurately the amount which they utilized the highways, since we have found that common-carrier trucks appear to operate about four times as intensively as other trucks.

Q (By Examiner Flynn) Where did you get your figures as to whether they were interstate or intrastate?

A From the operators themselves. We asked that particular question.

Q It was through a road checking?

A I should explain. This traffic survey in cooperation with the State Highway Departments consisted of establishing stations at various points along the highways and keeping field parties operating at these stations for a period of one year, taking from the individual machine the data which we are here presenting. These statements that I make about common-carrier trucks are based upon the operations of 180,000 separate trucks. That does not mean we got all of them, but we did get 180,000, which would be very representative of the truck movement. I may say also that that 180,000 does not represent separate observations in which the same truck might appear several times operating back and forth but does represent 180,000 separate trucks. We have not counted in this 180,000 the same truck several times. We have eliminated observations made on the same truck.

Of the 180,000 trucks observed, 5.5 per cent were common carrier and 8.7 per cent were contract operated; the balance, or 85.8 per cent were privately owned.

In general, where taxes on common carriers are high, common carrier usage is correspondingly low. In every case where the fee is above average, usage is below average. That is illustrated by this diagram showing the different States. These States which I have identified only as the eleven western States, are Arizona, California, Colorado, Idaho, Nebraska, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming.

In this table the hatched area shows the taxes and the blank area shows the usage. We will take California where the taxes are above the average, the usage is below the average. The same thing is true, I think, in all cases, except in Arizona and Washington. We are unable to determine why they deviated from the general rule that where the common-carrier tax is above the average the common carrier usage of the road is below the average in these States.

If a uniform mileage be assumed for all three classes of trucks, a common-carrier truck pays 80 per cent more tax than a private operator and a contract operator pays 22 per cent more. That is brought out in table 5. The average tax for the owner operated for these ten States is $108.70. That is based on 10,000 miles of operation. Based upon 10,000 miles of operation the owner operated would pay $108.70, the contract operated, $132.98 and the common carrier, $195.66. That is figured from the fees and the gas taxes in force in these particular States. It is all detailed in table No. 5. Those figures which I gave are the averages.

Upon the basis of mileage traveled by the three classes of trucks, a 3-ton common-carrier truck pays over three and one-half times as much in motor vehicle taxes as the privately-operated truck, while the contract operator pays more than double. That observation is based upon the fact that the common-carrier trucks which were observed in this survey seemed to appear to use the road about four times as much as the owner operated. Of course, it is their business. The owner operated are used as an auxiliary to the business, while the common carrier is on the road as a business.

Q (By Examiner Flynn) Were those designations as common carrier, and so forth, taken on the statement of the operator?

A Yes, sir; they were taken on the statement of the operator.

Mr. Hall: Before the Doctor gets away from that, would it be appropriate for me to ask a question right there?

The Witness: I am practically through, and I will be glad then to answer any questions. Over two-thirds of all trucks observed were under 2-ton capacity. That rather bears out the experience which we have had. These surveys, I may say, have been going on since 1922 and our observation is that the use of all types of trucks on the highways is tending towards the lighter, faster trucks rather than toward the heavier trucks, although there is a tendency now to use rather lighter loads, trucks with lighter loads and carry or haul trailers, so that the gross load is much larger. There is a considerable development in the use of trailer loads. Over two-thirds of all trucks observed were under 2-ton capacity.

The average daily mileage of all trucks observed was approximately 100 miles.

I think it is a fair conclusion, based on the actual utilization of the roads by private automobile and private owners of trucks, to say, so far as the building of our roads are concerned, the main State roads, the relatively small amount of common carrier usage by trucks or even the operation of busses upon our highways makes very little difference in the building of the roads. We would be building the roads just as wide and just as thick if there were no common-carrier trucks as we are. The relative use is so small in comparison to the private use of the highways.

Chairman Brainerd: That might vary in different sections of the country. You are confining it to that in particular—

A I would not confine them to any section of the country, Mr. Commissioner. Wherever the utilization of trucks or busses runs high we have a congestion or a concentration of population which uses private vehicles more. My observation is this, that motor transport of all kinds, both passenger and freight, fits in to a very definite field that cannot be filled by either the railroads or the waterways or the airplanes, and that it is so flexible that any uneconomical regulation only succeeds in denting it at one point and bulging it at another. I may use as an illustration the picking up of a handfull of molasses. You can pick up a handfull of molasses, but it is impossible to hold it, because it will squeeze out through the fingers when it gets warm. It is this extreme flexibility of motor transport and the fact that it fits into a definite place in our scheme of transportation that will defeat any uneconomical regulation, because it will change over into some other type of utilization and that is reflected in all studies of highway transport.

When I appeared before the Commissioner at the former hearing I was somewhat concerned about the matter of regulation. Now, I am inclined to think it does not make very much difference as far as the use of the highways is concerned. If we get any kind of regulation that is uneconomical, the use of this type of transportation will simply take some other form.

Chairman Brainerd: You mean regulation in an attempt to curtail?

A I said uneconomical. I would say that there should be the closest regulation of the rights of the public, and particularly with reference to the protection of the public that use the highways.

Unless you have some further questions, I believe that is all.

There is one further exhibit I think should go into the record. It is a statement of road revenues, divided between States and local revenues by percentages. The State highways shown for which the funds are used, as shown in this table, constitute all of the main roads of the nation and comprise in the neighborhood of 300,000 miles of main roads. This table shows that the percentage of highway income from road users—that is, through motor vehicle fees and gasoline taxes—has been growing very rapidly since 1921 until for 1929 we had motor vehicle fees comprising 31.3 and gasoline taxes 32.4, or a total of 63.7 of the income for State highway purposes coming from road users alone. That is not separated between these different types. We have further bond issues of 18.2 per cent, which were almost wholly supported on the income from gas and motor vehicle fees or a total of approximately 81.9 per cent of the total income for State highways coming from the road user through the

license fees and the gas tax. That 81.9 per cent is a trifle high because all the bond issues were not supported on this basis, but practically all were. And there was, of this tax used for the local highways, 6.8 per cent in vehicle fees and 9.3 per cent in gasoline tax receipts, or 16.1 per cent of the income for local roads which came from the same source. I should file that as an exhibit showing the growth in the vehicle fees for the support of the highways.

Chairman Brainerd: That will be marked 495.

(Said document, so offered, was received in evidence, marked "Exhibit 495, Witness MacDonald," and the same is forwarded herewith.)

The Witness: I have completed my statement.

Q (By Chairman Brainerd) Most of the important highways of the country have been built, as I understand it, through Federal aid?

A No; the Federal aid contribution to highways for 1929 was only 8.7 per cent of the expenditure on State highways and the Federal aid since it was started in 1916 has never exceeded a small percent of the expenditure for State highways.

Q What is the improved highway mileage of the United States?

A In the neighborhood of 600,000 miles, State and local.

Q What percentage of that has the Government aided or contributed to?

A We have contributed so far to the improvement of around 90,000 miles. We are improving at the rate of about 10,000 miles per year, and if we continue long enough we will have contributed to a very large percentage, but up to the present time the contribution of the Federal Government has not been a major part at all of the road construction.

Q (By Examiner Flynn) At one of the hearings a witness stated that a Ford car did more damage to the roads than a loaded truck. Would you care to say anything on that?

It is in the record and I just wanted—

A I cannot conceive of any condition—

Q He stated it was on account of the Ford car not keeping the road and bouncing around.

A I cannot conceive of any condition in which that would be true. Any type of car will bounce if the road surface is rough. That is the reason I show on this chart, not a theoretical condition, but an actual highway condition in the City of Washington. If the roughness of the road is extreme the bouncing or the jumping of the wheel from the surface and its resultant impact will be greatly increased.

Q He had in mind not so much the surface of the road as the lightness of the car would cause more jumping?

A Well, I think that that is a wrong conception. I know we got greatly excited 20 or 25 years ago when we drove some trotting horses over some steel bridges and found that the impact or the vibration caused by the trotting horses was about 100 per cent; that is, we thought we would have to add 100 per cent of impact to our loads in the design of our bridges, practically doubling the cost, until we realized that it is only the impact of the maximum loads that makes any difference. The impact of a Ford car would make practically no difference on an ordinary road. I cannot see where it would. It is only the impact of the heavy load for which we have designed the roads.

Examiner Flynn: That is all.

Chairman Brainerd: Does any one else desire to ask questions?

Q (By Mr. Ware) Mr. MacDonald, I understand that the Bureau of Public Roads comes under the jurisdiction of the Department of Agriculture, is that correct?

A Yes, that is correct.

Q Any work done by your Bureau within the scope of the duties of your Bureau would necessarily have the approval of the Department of Agriculture, would it not?

A Oh, yes.

Q Any work done by your Bureau which does not come within the scope of your duties would not bear the approval of the Department of Agriculture, is that true?

Chairman Brainerd: That is a matter of argument, I think.

The Witness: We do not do any work that does not have the approval of the Department of Agriculture. Who do you mean by the "Department of Agriculture"?

Q (By Mr. Ware) Is it any part of the duties of your Bureau to make a study of the taxes paid by motor carriers?

A Yes, sir; we have a very broad power with reference to the collection of all kinds of research data relating to the use of the highways.

Q Is it any part of the duties of the Bureau to make recommendations with respect to the regulations of motor carriers over the highway?

A I think I stated we were not making any recommendation.

Q You stated you were opposed to regulations, did you not?

A No; I did not intend to make such a statement. I meant to convey the impression that the more we have studied the question the less we feel that the regulation of common carriers in interstate operation will have any effect upon road building or the utilization of the highway, was the statement I intended to make. I said that two or three years ago—1926—when regulations were first proposed, we were somewhat disturbed perhaps, but we have ceased to be so disturbed now. I did not intend in my testimony to convey the impression that I was making any suggestions as to regulations.

Q You do not make any recommendation one way or the other?

A No, sir, not as to common carrier interstate regulations.

Q (By Mr. Childe) Your point is, as I understand it, regulation of common carriers that might tend to restrict the use of the common carrier would be offset by a further use of some other form of highway transportation?

A Exactly.

Q Which would not be subject to such restrictive regulation?

A Yes, sir; exactly. It seems to me to be self-evident that where you have the bulk of an operation composed of other types or other forms of usage that a little more or less of the minority would not make any difference.

Q That is what your survey indicated to be the fact, that where regulation became a burden on common carriers, the unregulated carrier stepped in and substituted its service for the regulated carrier, as I understood you to say?

A I said that was indicated by what we found.

Mr. Childe: Thank you.

Mr. LaRue Brown: Just one question. Did the results of your most recent study of the eleven western States correspond with the results of your prior studies in other sections of the country?

A Quite closely with respect to the percentage, for example, of interstate common-carrier operation. There was some of the information we took on a little different basis, so that it is not comparable but where the results are comparable we feel it shows a striking similarity and between diverse or widely separated sections of the country. The first survey was made in Connecticut.

Q (By Mr. Cass) Over what period of time, Mr. MacDonald, was this last study made with regard to the thickness of the road slab?

A That study is the result of work that has been under way, I should say, for about six years. The principal impact studies, which is an essential part of that, were made last year, the last work.

Q When was the data compiled and made ready for this presentation?

A Well, some of the data was published in September. Practically all of the material has been published in the Bureau of Public Roads Magazine, entitled "Public Roads," but bringing it together in this form, in that particular—which table are you referring to? That particular table (indicating) was made after receiving the request from the Commissioner to submit any material that would have a bearing on the proposition.

Q It was prepared in this form particularly for use here?

A Yes, sir.

Q (By Mr. Dahl) There seemed to be some question when you were explaining the 9,000-pound wheel load and the 18,000-pound axle load as to why with those wheel loads and axle loads you could only carry a 5-ton load. I believe it would clarify if you would give us your idea of distribution of load on a two-wheel vehicle or motor truck?

A There is, of course, a variation as between different makes of vehicles as to the percentage of total load which is carried on the rear axle, but ordinarily, in our estimating we take the worst condition and figure that 80 per cent of the load will be carried on the rear axle. That, of course, penalizes the manufacturer who distributes his load better.

Q That is exactly the point. Even with an 18,000-pound axle load you still can carry a 5-ton pay load?

A Yes, sir.

Q Can you tell us whether your Department showed the difference in impact between high pressure pneumatic and balloon tires? You showed us the difference between the solid and the high pressure pneumatic, I believe.

A Yes, sir; I can show that. This is the chart. I did not go into this at the time of my testimony, but the high pressure tire at thirty miles per hour, you see, would have under this particular condition—this was a condition of putting blocks of wood on the surface of the road in order to exaggerate the impact, but it does give a direct comparison because we used the same obstruction in each case. The impact for the drop condition here runs up to about 450 per cent, we will say, at 30 miles per hour, and for the balloon tire at 30 miles an hour, it runs up to about 350 per cent. It is a comparison of 4½ to 3½ in impact times the static load of the wheel. That is very rough.

Q (By Mr. Webb) I just have one question. In your studies you observed a number of trucks and trailers, did you not?

A Yes, sir.

Q There is a statement in the record that under the present construction of the trailer, the swing of that vehicle constitutes a menace to other vehicles on the highway. Have you noticed any such condition as that?

A I am not qualified to answer that question because I did not take this material myself, and I have made no observations that would qualify me to answer that question.

Q (By Mr. Hall) Up until the period of the World War the general highways of this country appeared to be adequate for the then existing traffic over them, did they not?

A Well, I would not say so, no.

Q When was the first time we realized that the weight of the vehicles on the public highways was a critical factor in rural highway design?

A Well, under my experience I should say about 25 years ago when we had the narrow tired wagons of the farmer that were causing so much destruction of the roads at that time. I began about 25 years ago to realize that was the factor.

Q You do agree it is the weight of vehicles that is the critical factor?

A No; I submit it is the concentrated wheel load that is the critical factor, and that is modified by the way it is distributed to the road surface.

Q On October 6, 1926, you presented a paper to the Highway Division at Philadelphia, Pennsylvania, in which you made this statement, as the official report goes on:

"It was agreed at the outset that for the first time in history the weight of vehicles had become a critical factor in rural design."

May I ask you if you still concur in the view that weight is a critical factor, or have you modified your views in that respect?

A Have I said anything contrary to that here?

Q I am asking you. I just want to be certain that I understand you?

A Read that statement again.

Chairman Brainerd: Just hand him the document and let him look it over.

The Witness: Yes, I think the statements are entirely harmonious.

Q (By Mr. Hall) You are of the same opinion now?

A Absolutely, but I insist that the testimony stand as I gave it, that the load only reaches the road through points of application, so that it is the wheel weight and not the gross load.

Q You also made this statement, according to the official report: "It was recognized clearly for the first time that the cost of highway transportation is made up of the cost of the highway and the cost of operating the vehicles over the highways."

You are still of that opinion?

A Oh, yes, absolutely.

Q Now, is the pamphlet entitled "Public Roads," Journal of Highway Research, published by the Bureau of Public Roads of the United States Department of Agriculture, published under your general supervision and direction?

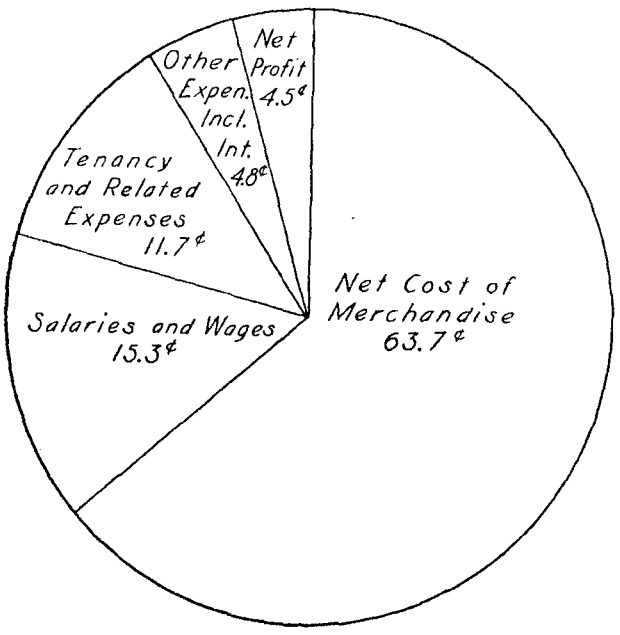
Q In the issue of May, 1930, No. 3, of Volume 2, there is this statement:

"Roads designed to carry 3-ton vehicles without undue deterioration would be satisfactory for about 95 per cent of the vehicles in use today. To accommodate four of the remaining 5 per cent roads of double this

omitted from the expense statement altogether. Thus, the Bureau's figures for net profit and for net gain both are before deductions for state and federal income taxes.

With the current increased interest in taxation, it has seemed desirable to provide more complete information on the tax burden borne by variety chains. The problem of disentangling real estate taxes from tenancy costs, however, has proved insuperable. It has been found possible, nevertheless, to add something to the information available on taxes by a study of income taxes.

Chart 1. Disposition of the Consumer's Dollar Spent in Chain Variety Stores: 1935



Reporting firms were asked to include figures for state and federal taxes on income for 1935 and 25 chains with aggregate sales of $734,523,921 complied with this request. For these firms, such tax payments amounted to $7,993,503, or 1.09% of sales. Net gain of these 25 firms amounted to $56,420,437, so that taxes on income represented 14.17% of the earnings before income taxes.

For these same 25 chains, sales taxes not collected from customers were $1,253,694, or 0.17% of sales, and other taxes amounted to $3,486,001, or 0.47 % of sales. Thus, the sum of the taxes which the Bureau has been able to distinguish from other expense categories was $12,733,198, which represented 1.73 cents of the average dollar spent by consumers in variety chain stores.

Rate of Stock-turn. The rate of stock-turn measures the number of times which the average inventory is sold. Based on an average of the inventory at the beginning and end of the year, the stock-turn rate of the 30 variety chains was 4.68 times. Using average monthly inventory, the rate was somewhat lower, 4.37 times, indicating that stocks on hand at the year end were lower than they averaged throughout the year.

In Table 7 are shown the ratios between inventories at the end of each month and sales in the following month. Many retailers have found these stock-sales ratios useful for internal control purposes because they apply only to a specific time and are not the result of averaging as is the stock-turn figure. Throughout most of the year, the ratio for the 18 chains combined fluctuated around three times, that is, enough merchandise was on hand to permit sales for three months at the rate of the first month. The only exception to this statement occurred in December, when Christmas business expanded sales to about twice the level of the average month.

Table 7. Monthly Sales and Inventories for 18 Variety Chains: 1935

Month	Average Sales per Store		Average Retail Inventory per Store		Ratio of Inventory for End of Preceding Month to Sales for Month
	Dollars	% of 1935 Average Month	Dollars	% of 1935 Average Month	
January	$9,821	74.47%	$34,532	90.84%	3.29
February	10,325	78.30	35,382	93.08	3.34
March	11,452	86.84	38,280	100.70	3.09
April	13,128	99.55	38,532	101.37	2.92
May	12,418	94.17	38,395	101.00	3.10
June	12,610	95.63	37,219	97.91	3.04
July	11,826	89.68	36,044	94.82	3.15
August	12,464	94.52	36,509	96.05	2.89
September	10,578	80.22	40,003	105.24	3.45
October	13,564	102.86	43,978	115.69	2.95
November	14,051	106.55	45,593	119.94	3.13
December	26,006	197.21	31,688	83.36	1.75

Q What I want to get at, if it be a fact, that a relatively few number of vehicles of enormous gross weight may wear out a road faster than a great number of small vehicles of very light weight?

A Very true; quite true.

Q So when we say that any given class of traffic only represents one or one and a half per cent of the total traffic, that in and of itself means nothing unless you know the weight of the vehicles that make up that one or one and one-half per cent of traffic?

A Well, I intended very carefully to qualify my testimony, that regardless of the heavier loads operated, the wheel load should be confined to a maximum of 9,000 pounds on pneumatic tires for the preservation of the roads, but that would apply equally to any type of operation. I mean private or common carriers. I feel very strongly that we should do everything possible to limit the wheel loads to a reasonable maximum and have the load applied through pneumatic tires. If that is done, then the number of loads have very little effect on properly designed roads.

Chairman Brainerd: You put that maximum at 9,000?

A That seems to us to be a reasonable maximum, Mr. Commissioner. We are now making a careful study of the utilization of trucks by business houses for commercial purposes to determine what seems to be the need or what seems to be the maximum size or load needed to be used for economical transportation, and we feel that the 9,000-pound wheel load will allow the operation of any size of load that is really economically needed for the transaction of business. We cannot conceive that an operator who wants to haul a heavy low-priced commodity ought to be permitted to move any size of load that he sees fit, sand, gravel, coal or something like that, when the maximum use of the road is for lighter vehicles. We feel that that load can be limited and put on two trucks, if necessary.

Chairman Brainerd: The hour of adjournment is past. Some of us may have engagements, so we will recess until 2 o'clock.

(At 12:35 o'clock p. m. a recess was taken until 2 o'clock p. m. of the same day.)

AFTER RECESS

The hearing was resumed at 2 o'clock p. m., pursuant to the taking of the recess.

THOMAS H. MACDONALD

was recalled as a witness, and having been previously sworn, was examined and testified further as follows:

Q (By Mr. Hall) Mr. MacDonald, will you please refer to Exhibit 495, introduced by you and entitled "Percentage of Highway Income, State and Local from Various Sources." In one column you give the contribution from motor vehicle fees; the cost of highway construction. What percentage of those motor vehicles were carriers for hire?

A I am only able to give an indication of that as contained in the statement in the western States out of the 180,000, 5.5 per cent were common carriers and 8.7 per cent were contract operated. That would be a total of 14.2 per cent operated for hire. That would include the contract carriers.

Now, I would not wish to give an opinion as to the sustaining of that same ratio in the eastern States at this time. It is fairly close to the results of previous surveys made in such States as Connecticut, Pennsylvania, Ohio, but in earlier years, and there might have been a change in the proportion.

Q Then, based on the study in the west solely, carriers for hire, including contract carriers, constituted in number as distinguished from gross weight about 10 per cent of the motor vehicles using the public highway?

A No, that was of the trucks operated. The total truck traffic was only 16 per cent of the total volume and the common carriers not to exceed 1½ per cent of the total motor vehicles.

Q In other words, in the west of all motor vehicles approximately 16 per cent were trucks and of that 16 per cent only about 14 per cent common and contract carriers—14 per cent of 16?

A Fourteen per cent of 16; yes, sir; that is correct—of the total traffic.

Q Yes, of the total traffic. Now, you have in another column for income for highway purposes, road bond issues. Do you know how the money to pay the principal and the interest of those bonds is raised?

A All of the large bond issues floated in recent years, since the first in the State of Illinois, which, I think, was about 1924 perhaps, have been predicated upon either the gas tax or upon the combined gas tax and motor vehicle receipts. I know of no large bond issues that have been made for roads in the last five years that are based upon property taxation.

Q Specifically now, with reference to the State of Tennessee, do you know of any county bond issue in Tennessee that is being paid off without a tax on property in general?

A No, I do not; however, this table does not refer to so-called county roads. These are State roads and county bond issues would only contribute to the extent there was transfer of the funds from the county to the State. That has been done to some extent, but also there has been a transfer of funds from the State receipts of road user fees to the counties and the two in recent years have about equalized. There has been in the neighborhood of $100,000,000 transferred from the State to the counties and somewhat less than that transferred from the counties to the States.

Q Now, please refer to that part of your Exhibit 494 which is entitled "Relative Thickness of Concrete Road Slab Required for Various Classes of Motor Vehicles." Have you that before you?

A Yes.

Q This portion of the exhibit states that a 7½-ton truck running at not exceeding 30 miles per hour on a street in the City of Washington would require a thickness of concrete slab of only about 15/100ths more than for a 7-passenger car. Is that correct?

A That is correct.

Q Now, when you refer to a 7½-ton truck—

A That would be correct with the same wheel load and the same distribution of the wheel load to the surface as used in the computation. I do not want to generalize a specific statement. That is the point I make.

Q What I want to know is what you mean by a 7½-ton truck? Is that the rating or is that the weight of the truck with load?

A That is the weight of the load plus—that is the gross load—no, that is the net load.

Q You mean that does not include the weight of the vehicle?

A No, it does not include the weight of the vehicle. Roughly, we take that as one-half. That is not exactly correct.

Q That also contemplates that this 7½-ton truck would have dual rear wheels, whereas the 7-passenger car has single rear wheels, is that correct?

A Yes, sir; that is quite correct.

Q Now, if the comparison was made between a 7-passenger car with two rear wheels and a 7½-ton truck with two rear wheels, what would it be?

A I cannot answer that question. These tests were made with the equipment as ordinarily used. We were not particularly interested in something that had no practical application. We were interested in the use of the vehicle as equipped ordinarily for operation and in conformance with this particular load limit.

Q Do you know what percent of all trucks have the dual rear wheels?

A No, sir, except I do know that the use of the solid tires is very rapidly disappearing from rural roads and very few are being sold. Most of those that were equipped with solid tires are being changed over into pneumatic equipment. I rather thought I answered that question. That is, that we believe thoroughly in laws that would put that traffic on pneumatics and would limit the load. I do not want to appear to be giving prejudiced testimony, because I am prejudiced only in favor of the roads and their preservation.

Q Now, what difference would it make in these figures if the speed instead of being 30 miles were 50 miles?

A It would not make much difference. This is a study of impact. We have two types of impact. One is occasioned when there is the dropping of the wheel and another where the wheel meets an obstruction on the surface. We call one the drop and the other the shock condition. They have rather different characteristics. This is for the high pressure pneumatics. The drop impact increases to the speed of about 30 miles per hour, then becomes practically constant. The shock has practically an even increase up to the point where it crosses the line of the drop impact and that is reached at 45 miles an hour. So that the condition of impact with high pressure tires apparently changes very little between speeds of 30 miles and 45 to 50 miles per hour with the high pressure tire, although there is a change in the type of impact which becomes maximum at that point. I mean, it changes from the drop to the shock type. With the balloon tires the maximum of the drop impact is reached at about 25 miles per hour and from that point it drops away, so that if you go fast it is really easier on the road. That does not seem quite logical until you think of the illustration that we are all familiar with of skating over thin ice; the thinner the ice the faster you must go.

Q I confess I am not an expert on that. Doubtless you are. Then, do I understand in general it is your view if you use pneumatics speed has nothing to do with the necessary construction of the highway?

A Within practical limits that is true, yes, sir. I think it would be conceded that we would not want to

build highways for speeds of under 25 miles per hour, and if we build them for 25 miles per hour the speed up to a reasonable maximum of say 45 would not affect the condition very much. That is due partially to the inertia of the road and the fact that impact of the same maximum amount is not as serious in the breaking down of a road as a static load of that same amount left on the road, because it takes into account the inertia of the road.

Q Now, this exhibit, as it states, is based on tests made on a street in Washington. In your opinion would those tests have been different had they been made on a road with curvature and grade in considerable degree?

A No, sir, the tests would not be different based on the alignment of any other road and the gradient, but it would be different for each particular road surface. We have made tests on a great many kinds of road surface. We have made tests on a great many kinds of road surfaces and to present as an exhibit in this meeting we selected an asphaltic concrete surface which represented a fair average of smoothness or roughness. It is not as rough as a bad pavement but it is not nearly as smooth as the best types of concrete pavement that we are building now. We endeavored to select what would be a fair average of the surface roughness or smoothness, as you may call it, of the standard pavements that are in use. What I have said applies only to the types of road surfaces in cases where the stresses are determined—I mean a stiff slab, rigid slab construction, where we can determine the stresses. With other types, such as gravel or macadam the stresses are not determined in the same way.

Q What, may I ask, is the reason in appropriating Federal aid funds the Government has fixed the grade and alignment of State roads to a certain small percent?

A We have not fixed either grade or alignment but do recognize a certain minimum as desirable and we endeavor to keep our gradients around 5 per cent.

Q Why?

A We endeavor to keep alignment with curve radiuses above 500 feet or a thousand feet.

Q Why?

A Because of what we consider the greater operating safety of such roads—the speeds of automobiles. The grades and alignment are little determind by any of the heavier vehicles. We have adjusted them more to meet the lighter vehicles which the public persists in driving at too high rates of speed on the road and the curvature and the grades are largely determined from that standpoint of safety. In impact, the curvature and grade has very little to do with impact. It is roughness of the road's surface.

Q This morning, in your testimony, about highways carrying vehicles with an axle load of 9,000 pounds—

A A wheel load.

Q May I ask you if you were referring to an 8-7-8 concrete highway or in substance that?

A I think the table shows that that would be safe for that particular load, but in this case 7½-inch edge thickness, with 6½ center thickness, would carry such a load with an extreme fibre stress of 358 pounds, just right at the maximum working stress we would use 350 pounds, but that does not necessarily mean, if I may explain, that we would use just these dimensions. There are other factors which enter, depending largely upon climatic or soil conditions or the interrelationship of those two. In the South, for example, where we have an absence of frost action and good sub-grades to support, we would approve a cross-sectional design for the same loads much lighter than we would in the northern States. Take in South Carolina, we are building roads even lighter than 8-6-8; that is, we have actually gone to about this point of 7½ edge thickness, but we could not use that same design in the northern States.

Q Now, when you refer to a vehicle with a wheel load of 9,000 pounds, what would that vehicle itself plus the proper authorized load actually weigh?

A Around 23,000 pounds.

Q How long would a concrete highway of the character you have referred, in your opinion, hold up under loads of vehicle plus load of 23,000 pounds?

A That is a very indefinite question; based on the same conditions of application of the load, as I pointed out, on the pneumatic tire, it would carry indefinitely. That is, it would depend upon the number of applications of the load.

Q When you say the number of applications, you mean the number of vehicles that go over it?

A In a given length of time. Material of any character can be fatigued if there are a sufficient number of applications of maximum load applied continuously, perhaps, but in the tests that have been made up to 50,000 continuous applications of loads which stressed the concrete, for example, to 50 per cent of its modulus of rupture, have not fatigued the material. The material will not fatigue within any practical basis of the application

of these heavier loads. The roads are more destroyed really by climatic and soil conditions than they are by any use that is made of them by the public.

Q You are familiar with the concrete road leading from Washington to Alexandria, paralelling in large degree the right of way of the R. F. & P. Railroad, are you not?

A Yes, sir, reasonably.

Q That road is torn up considerable. To what do you attribute that?

A Well, I would attribute it to several different factors; concrete that is not as strong as it should be, in the first case, poor sub-grade, and probably the application of loads occasionally that are in excess of the legal limits. In the beginning of building of concrete roads, concrete was regarded as a material that had fixed or arbitrary limits. That is, it was always good. So a great many miles of very poor concrete road were placed because of lack of proper proportion of the material. In fact, some of the early concrete roads that were built probably had a strength less than one-third of what the standard practice is today. There has been a great advance made in the design and construction of concrete roads.

Q Has there been a corresponding increase in the cost of those roads?

A No; I should not say so.

Q What would be the difference, in your opinion?

A There is very little difference in the cost of concrete roads of the same design today and before the war. In the meantime the price has been considerably higher—I should say as much as fifty per cent. I am calling on my memory now for these prices. Prior to the war we considered that a concrete road should be built for about a thousand dollars per foot of width per mile. That would be $18,000 for an 18-foot width of road per mile. We are getting contracts today for 18-foot concrete roads of much better design for 22 to 24 thousand dollars per mile.

Q Do you know what the State aid concrete roads in Tennessee costs per mile, excluding right of way and engineering?

A For the surface alone?

Q Complete.

A No, I do not have that data with me.

Q Well, it will be in the neighborhood of $48,000 a mile, will it not?

A I would not think it would run quite so high. In a State somewhat similar to Tennessee we have an estimate of about 45,000 per mile, including the bridges and the grading. The price which I gave you for the surface of $25,000 a mile is the only price that enters into the discussion, because the grading and the bridges would be the same for any type of road.

Q This morning you referred to a tax study in the 11 western States, among which was California. You gave a figure for the relation between taxation of common carrier trucks, as I got it, to the ordinary motor vehicle. Will you not please repeat that?

A On the basis of 10,000 miles operation, for which I stated an owner-operated truck would pay an average of $108, the contract operated $132, and the common carrier $195.

Q You mean the contract carrier paid $195 in taxes for operating 10,000 miles?

A Yes, sir.

Q That included the gasoline tax?

A Yes, sir.

Q Is that determined in any degree by the size of the vehicle?

A Yes, sir. This was based on a 3-ton truck. A smaller truck would be less than that perhaps and the heavier truck would be more; but the illustration was taken on a single type of truck. Of course, there is a wide variation between the States. I can give the figures for any particular State.

Q What I was getting at now, those figures were each for a 3-ton truck running 10,000 miles?

A Yes, sir.

Q Same load?

A Same load.

Q Now, wherein was the difference in tax—privilege—gasoline—ad valorem, or what?

A It varies with the State.

Q Well, take California, for example?

A In California we have for the owner operated a registration fee of $43, a gas tax of $37.50 or a total tax of $80.50. For the contract operated we have a registration fee of $43, a gas tax of $37.50, the same as for the

owner operated. For the common carrier we have what is listed here as a revenue tax, $150, a gas tax of $50 and a tax, I take it to be on the net load carried, of $80.

Q I do not understand why the gasoline tax of the common carrier would be $50 and on the others $37. Is there a different gallonage tax depending upon the nature of the vehicle?

A No. I am unable to account for the $13 difference there in the taxes. I think that might be an error.

Q That might be an error?

A Possibly.

Q If it is not you cannot account for it?

A No.

Q Do you know of a State in the Union where the gallonage tax varies as to the character of the vehicle using the gasoline?

A No, I do not, but the taxes paid vary considerably.

Q That is, per mile of road. You mean whether it is four or five cents a gallon?

A No; I mean that the common carrier is apparently operated much more than the contract or the owner operated, so that the revenue from the common carrier is higher in the course of a year than the gas tax.

Q But they use the highway proportionately more?

A Exactly.

Mr. Hall: Thank you very much, sir.

Chairman Brainerd: Any further questions from Dr. MacDonald?

Q (By Mr. Ware) Are there any roads in your jurisdiction which are designed to carry a greater wheel load than 9,000 pounds?

A Yes, sir, a considerable mileage of roads will carry higher than the 9,000 pounds or the stresses I have indicated here.

Q Can you give me what percentage of roads are designed to carry more than a 9,000-pound wheel load than those designed to carry only a 9,000-pound wheel load?

A I am unable to answer that.

Q There are some designed to carry a greater wheel load than 9,000 pounds?

A Well, some are so designed that they will carry more than 9,000 pounds. I tried to bring out in my testimony that these figures which I have given were based upon the relation of the motor vehicle load as applied through a wheel to a rigid slab, whether it be a base for a pavement or a concrete slab used as a pavement and that there are other factors than the load factor which enter into the design of roads.

Q What I am getting at, Mr. MacDonald, is this: This morning you made a statement that the increase in the cost of highway construction due to the use of those highways by 5-ton and 7½-ton trucks was paid for through the gasoline tax. Now, I want to know if that statement is based upon the cost of the construction of the highway designed to carry a 9,000-pound wheel load.

A That is not quite the statement I made. I will not attempt to repeat exactly what I said, but I will explain what is intended. The testimony that I have given here is the relationship of the wheel load of different weights to the theoretical design of the road, the theoretical thickness required and in developing that point I stated that the necessary increase in the thickness of a slab for a 5-ton load would be only a small percentage. I think I said about 8 per cent; but there are many other factors that enter into the actual designing of roads—particularly soil conditions and the climatic changes; that roads are designed not in accordance altogether with the loads which they must carry but to the freezing and thawing and the heaving which will go on, whether there are any loads applied or not. Taking into account the combination of loads that are legal in different States, 8,000 is more commonly a legal load than the 9,000-pound load; but taking into consideration the legal loads to be carried and the soil over which the road is to be built, and the climatic conditions, definite thicknesses of the slabs are determined upon, partially through experience—that is, we do not rely entirely upon the load that is to be carried in determining the thickness of the slab. So that a common design for a slab in the southern States, we will say, is 8-6-8. Now, that will safely carry a 9,000-pound load or the 8,000-pound load if applied through the pneumatic tires. In the northern States, because of the climatic conditions, we increase the thickness of the roads to 9-7-9 is the most commonly used thickness. In some States where the soil conditions are very bad we may increase it another inch. Both of those designs, we will say, are equally safe under the conditions that they are being used, but there is a material difference in the amount of material required in building them.

Q You stated in answer to Mr. Hall that the 9,000-pound wheel load truck would weigh about 23,000 pounds, including the load; is that right?

A Yes, sir; that is with 80 per cent on the rear axle.

Q Now, then, is it not a fact that there are much heavier busses and trucks which are operating over the highways, including load?

A Yes, sir, I think there are. In some States the higher loads are legalized. There are more States, however, where there is a 16,000-pound actual load limit required than any other weight.

Q Would a truck of a greater gross load than 23,000 pounds do more damage to the highway than one of 23,000 pounds or less?

A I do not understand your question.

(Last question read.)

The Witness: If all other conditions were equal, yes, sir. I tried to bring out the point that we are not particularly interested in the gross load. The gross loads do affect bridge construction, but we are not particularly interested in highway designs in gross loads, but in actual or wheel loads. If a truck of greater gross load was so balanced by the manufacturer that it had not to exceed the 18,000 pounds on rear wheels, it would do no more damage. We do not talk in terms of gross loads as affecting a design of highways.

Q (By Mr. Ware) Due to the increase in the damage to the road by the heavier bus than 23,000 pounds, or 9,000 pounds of wheel load, I want to know if that is paid for through the gasoline tax, paid by those busses and trucks as you stated, involving the increased cost in thickness, in the operation of the 5 and 7½-ton truck?

A Of course, that is a question that no one can answer definitely. Because of the higher, the considerably higher, taxes paid through the gas, registration and other special taxes, I gave it as my opinion that any increase in cost made necessary by the heavier loads was being paid by that increased tax, because it is not a large figure.

Q (By Mr. Hall) All Federal aid contributions come from taxes on general property and not from gasoline taxes at all, do they not?

A I think about 75 per cent of the Federal income comes from income taxes, does it not?

Q The point is, not one dollar of gasoline tax ever goes into the sums expended as Federal aid funds?

A No. I think that is true, but the Federal Government collected in special taxes which were abrogated—special taxes on the manufacture of motor vehicles a sum considerably greater than we paid out in Federal aid up to the present time.

Mr. Hall: That is all.

The Witness: There is just one statement that I wish to make in closing. All of these charts which I have given as illustrative of the use of this definite material in road design are based upon exact conditions. We cannot generalize as to all trucks in operation on the roads from the data which I have given and I tried to bring out very fully the opinion which we hold that the wheel loads should be very carefully regulated in order to preserve the highways and that the loads should move on pneumatic tires. If the wheel loads are regulated and if they do move on pneumatic tires, the speed becomes of small importance within reasonable limits and we shall see very little damage done to the highways because of common carrier operation in excess of the damage or depreciation that would result from the ordinary or use by the privately-owned motor vehicle truck or by the contract operated.

Q (By Chairman Brainerd) Well, are the present State regulations in regard to the load adequate, in your opinion?

A The present regulations in general are quite adequate, as to the gross loading, yes, sir, or the wheel loading, yes; but they have not up to the present time made a sufficient differentiation between the solid tire and the pneumatic tire. That is, there is some differentiation being made but I believe that a larger penalty should be placed upon the solid tire than is ordinarily the case in our State laws now, but the laws are moving rapidly in that direction. I think they are moving as rapidly as knowledge is being developed upon which to base legislation.

I thank you.

Chairman Brainerd: We are very much obliged to you.

Any objection to Mr. MacDonald looking up that one figure he thought possibly was an error and correct that if he finds it to be an error?

Mr. Hall: Not the slightest.

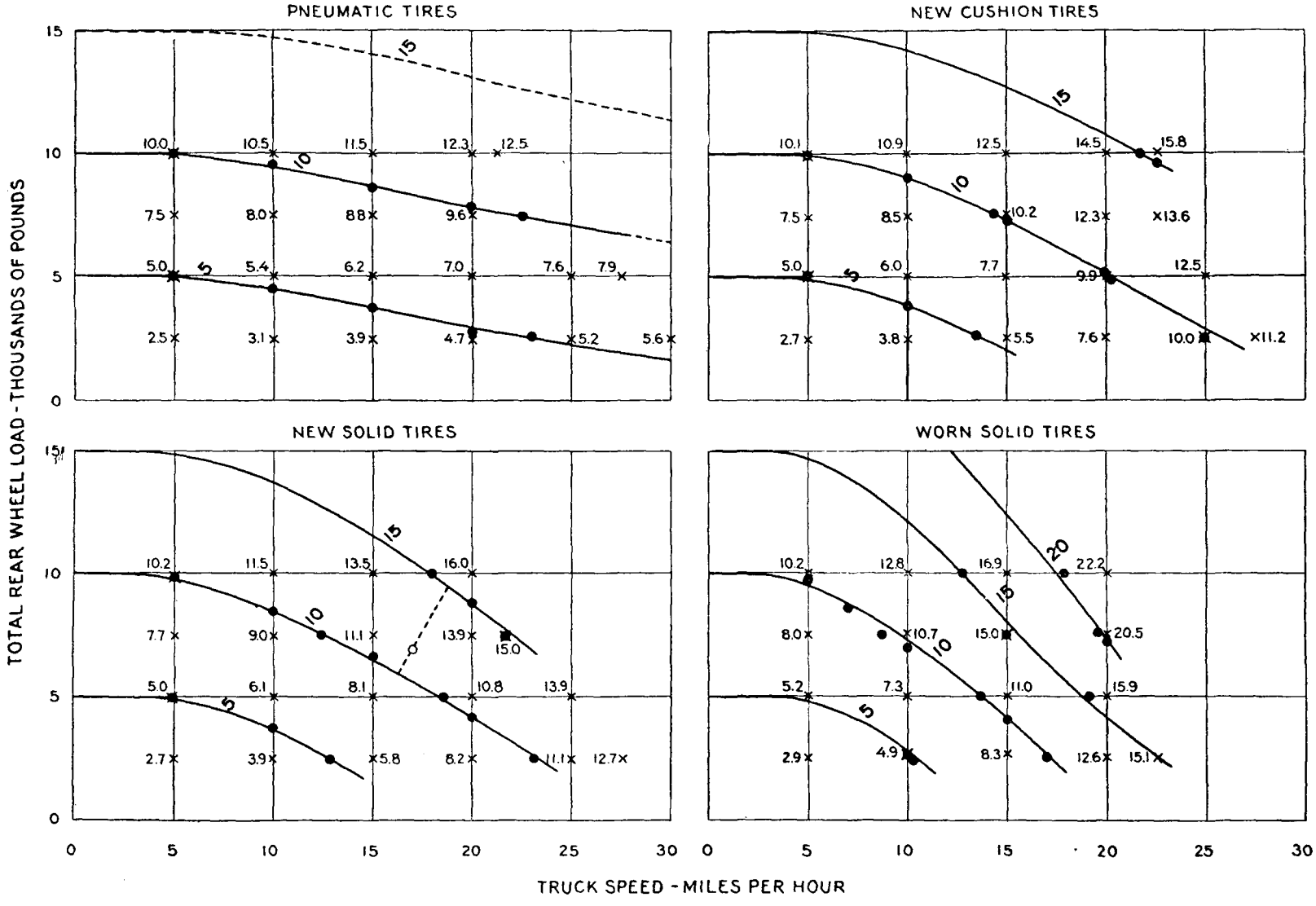
The Witness: I can correct that now. I simply read the wrong line. There is no difference.

(Witness excused.)

APPENDIX

The following are some of the charts and tables referred to and introduced in evidence by Mr. MacDonald during the course of his testimony.

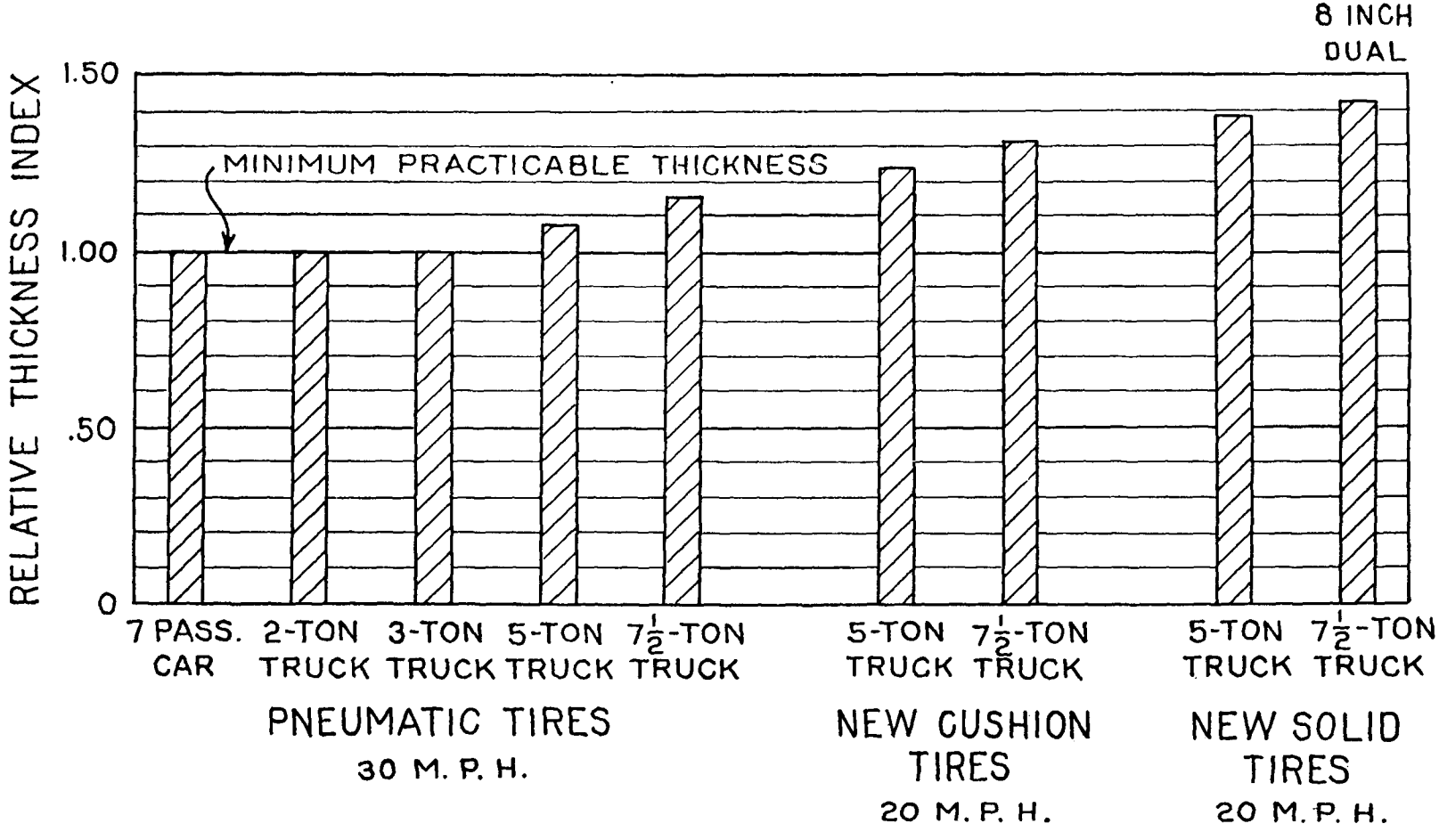
NOTE: Inasmuch as the exhibit numbers are not shown in the text of Mr. MacDonald's testimony in every instance where an exhibit was offered, no attempt has been made here to give the proper exhibit number. However, such charts and tables as are herein shown are in the same order as are the references in the text. The labeling given to the charts and tables by the Bureau of Public Roads in preparing the exhibit should be sufficiently clear to indicate the part of Mr. MacDonald's testimony each one illustrates.



ISODYNAMIC CURVES FOR FAIR SHEET ASPHALT SURFACE (N STREET, 2 ND. TO 1 ST, S.W., WASHINGTON, D.C.)
FOR DETERMINATION OF AVERAGE TOTAL VERTICAL IMPACT REACTIONS OCCURRING AT THE RATE OF 100 PER MILE.

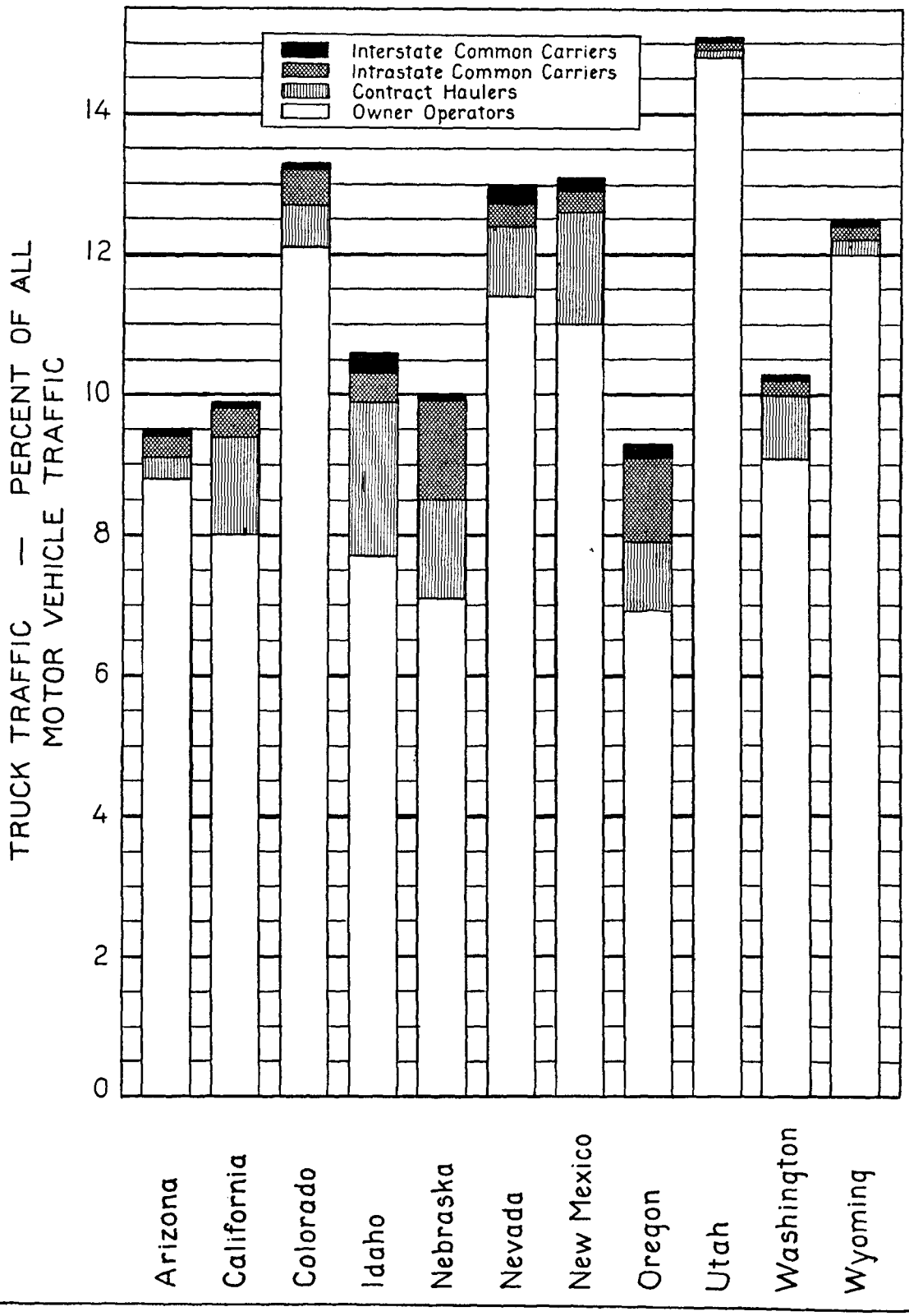
RELATIVE THICKNESS OF CONCRETE ROAD SLAB REQUIRED FOR VARIOUS CLASSES OF MOTOR VEHICLES

BASE ON A SURFACE SMOOTHNESS EQUAL TO THAT OF A FAIR SHEET ASPHALT PAVEMENT
(N STREET, 2ND. TO 1 ST. S.W. WASHINGTON, D.C.)



MOTOR TRUCK USAGE

Western States Traffic Survey — July-September-1930

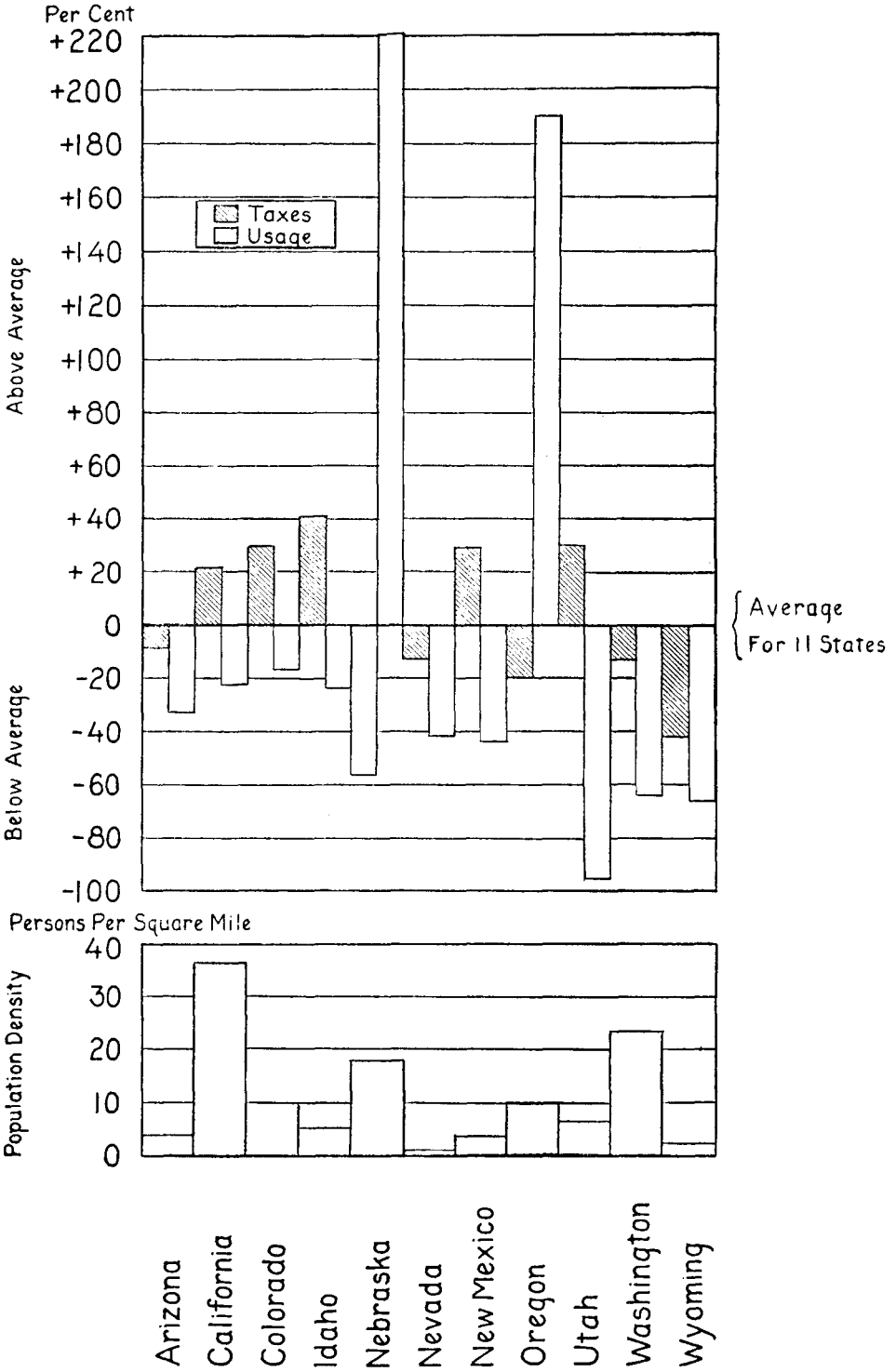


TAXES AND USAGE OF INTRASTATE COMMON CARRIERS

(PERCENT VARIATION FROM AVERAGE)

AND

DENSITY OF POPULATION



Population Density - 1930 Census
Average C.C. Tax - $308.95
Average Intrastate C.C. Usage - 4.45% of All Trucks

From: Western States Traffic Survey
July - September - 1930

MOTOR VEHICLE TAXES – PRIVATE AND COMMERCIAL – WESTERN STATES

State	Owner Operated			Contract Operated				Common Carrier					
	Registration Fee	Gas Tax	Total	Registration Fee	Other Fee	Gas Tax	Total	Registration Fee	Revenue	Mileage	Net	Gas Tax	Total
Arizona	$33.50	$50.00	$83.50	$33.50	– –	$50.00	$83.50	$33.50	$75.00	– –	$108.50	$50.00	$158.50
California	43.00	37.50	80.50	43.00	– –	37.50	80.50	– –	150.00	– –	150.00	37.50	187.50
Colorado	25.00	50.00	75.00	25.00	– –	50.00	75.00	– –	– –	$150.00	80.00	50.00	200.00
Idaho	74.00	62.50	136.50	111.00	– –	62.50	173.50	250.00	30.00	– –	280.00	62.50	342.50
Nebraska	35.00	50.00	85.00	35.00	– –	50.00	85.00	35.00 1/	– –	– –	35.00	50.00	85.00
Nevada	42.00	50.00	92.00	42.00	– –	50.00	92.00	170.00	– –	– –	170.00	50.00	220.00
New Mexico	149.00	62.50	211.50	149.00	– –	62.50	211.50	74.50	– –	100.00	174.50	62.50	237.00
Oregon	88.00	50.00	138.00	88.00	– –	50.00	138.00	88.00	– –	30.00	118.00	50.00	168.00
Utah	40.00	43.75	83.75	40.00	$137.50 2/	43.75	221.25	40.00	– –	137.50 2/	177.50	43.75	221.25
Washington	72.50	37.50	110.00	135.00	30.00	37.50	202.50	135.00	30.00	– –	[illegible]5.00	37.50	202.50
Wyoming	50.00 3/	50.00	100.00	50.00	– –	50.00	100.00	80.00	– –	– –		50.00	130.00
Average			108.70				132.98						195.66

1/ (From Nebraska Laws) Common carriers not locally taxed to pay tax at average general tax [illegible] on proportion of fixed value based on distance traveled within the State.

Assumption – One-half of mileage on hard surfaced road.

[illegible]nties are permitted to assess in addition a tax based on value of truck (in this case $90). Data on fees [illegible]axes from "Special Taxation for Motor Vehicles," 1931 Edition, Motor Vehicle Conference Committee, [illegible], N. Y. Specification – chassis weight 6,500 pounds; body weight 1,500 pounds; net weight 8,000 poun[illegible] per 6.7 tons; gross weight 14,000 pounds – value $5000 Operating assumptions – annual mileage 10,000 miles[illegible]0,000; annual gross receipts for commercially operated vehicles $3,000. Gasoline mileage – 8 miles