REPORT

of the

MARYLAND TRUCK WEIGHT COMMISSION

To the

GENERAL ASSEMBLY

Session of 1951

As required by a Resolution of the House of Delegates
of the 1949 Session of the General Assembly

February 1951

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At the General Assembly of 1949 the House of Delegates adopted a Resolution, presented by Mr. Albert L. Sklar, requesting the Governor to appoint a Commission of seven persons, including representatives of the State Roads Commission, the public, and the trucking industry, to study the entire subject of the use of public highways of this State by all types of motor vehicles, trucks, tractors, and trailers, and to report its findings to the 1951 General Assembly.

On August 2, 1949, the Governor appointed a Commission consisting of the following:

FOR THE STATE ROADS COMMISSION

Albert S. Gordon	EXECUTIVE ASSISTANT TO THE CHAIRMAN OF THE STATE ROADS COMMISSION - Chairman
Geo. N. Lewis, Jr.	DIRECTOR, TRAFFIC DIVISION

FOR THE TRUCKING INDUSTRY

H. Guy Campbell	VICE PRESIDENT AND TREASURER HARRY T. CAMPBELL SONS CORPORATION
Robert W. Furtick	VICE PRESIDENT AND GENERAL MANAGER W. T. COWAN, INC.

FOR THE PUBLIC

Herbert S. Fairbank	DEPUTY COMMISSIONER, U. S. BUREAU OF PUBLIC ROADS
J. Trueman Thompson	PROFESSOR OF CIVIL ENGINEERING THE JOHNS HOPKINS UNIVERSITY
Philip C. Turner	MEMBER BOARD OF REGENTS THE UNIVERSITY OF MARYLAND

The Commission sought and obtained the assistance of the Department of State Police and the Department of Motor Vehicles, and there was assigned from these departments Major Ruxton M. Ridgely and Mr. Henry J. King, who acted in an advisory capacity in all of the Commission's deliberations.

The Commission has made its studies as directed and herein reports its conclusions and the reasons therefore.

SUMMARY OF RECOMMENDATIONS

1. The Commission recommends the reduction of the present axle load limit of 22,400 pounds to 18,000 pounds. This proposal is indicated as necessary by the evidence secured by the Commission, including the results of the La Plata Road Test, and is in agreement with recommendations of the American Association of State Highway Officials and the National Committee on Uniform Traffic Laws and Ordinances. The 18,000 pound limit proposed is the legal axle load limit in 32 states.

2. A second recommendation proposes the abolition, as a control no longer necessary, of a provision of the existing law limiting the wheel weight of vehicles to 600 pounds per inch of width of pneumatic tires.

3. In place of the so-called bridge formula contained in the present law, the Commission proposes the substitution of a table of weights varying with the distance between axles for the control of loads transmitted to roads and bridges by vehicles and their several axle groups. The table limits the weight that may be transmitted by axles less than four feet apart to 18,000 pounds and permits a load of 32,000 pounds on axles four feet apart. For axles of wider spacing an additional 1,000 pounds is permitted for each additional foot up to 56 feet. This proposal agrees in principle with recommendations of the American Association of State Highway Officials and the National Committee on Uniform Traffic Laws and Ordinances. The weights permitted are somewhat greater than those recommended by the two national bodies.

4. Concerning the length of vehicles, now limited at a maximum of 55 feet for all classes of vehicles, the Commission recommends separate length limits for single vehicles, tractor semi-trailer combinations, and other combinations: For single vehicles, including trucks and buses a general limit of 35 feet over-all dimension, including the load and front and rear bumpers; for buses with three axles a permissible length, including front and rear bumpers, of 40 feet; for tractor semi-trailer combinations, also including the load thereon and front and rear bumpers, a maximum length of 50 feet; for other combinations a similar length limit of 60 feet.

5. The recommendation of the Commission pertaining to the width of a vehicle and load is that the present limit of 96 inches be retained with one exception, namely, that incorporated cities and towns may by ordinance permit, within their respective municipal limits, the operation of buses and trackless trolleys with a maximum outside width of 102 inches. The liberalization in the transit vehicle width is made in the interest of passenger convenience.

6. The Commission recommends an addition to the law to govern the height of vehicles. The recommendation is that no vehicle, including any load thereon, shall exceed a height of 12 feet, 6 inches.

7. To insure that registered vehicles shall be able to maintain reasonable minimum speed on hills, the Commission recommends that the gross weight of vehicles and combinations of vehicles be limited to a maximum in pounds equal to 500 times the net brake horsepower of the power unit. It is proposed that this be accomplished by the appropriate registration of vehicles.

8. The Commission recommends that the same fine be imposed for violations of the gross weight for which a vehicle is registered and for any violation of the statutory weight limits: For a weight violation of less than 5,000 pounds over the registered weight or any statutory weight limit a fine of 2 cents for every pound of excess weight; for a weight violation in excess of 5,000 pounds over the registered weight or any statutory weight limit a fine of 6 cents for every pound of excess weight. Because of the fact that several types of weight violations may occur at one time the Commission feels that the violation constituting the greatest excess of weight should be the only violation for which a fine is imposed.

9. Because of the present prevalence of suspended fines and dismissals as shown in a table contained in an appendix to the report, the Commission recommends that the discretion of the Trial Magistrate to suspend fines be removed and that either party, that is the State or the accused, be given the right to appeal.

10. The Commission recommends that it shall be unlawful for any person or corporation to operate on a public highway any vehicle violating any of the foregoing recommended weight provisions. In this recommendation the Commission recognizes the inequities under which drivers, generally the only persons now fined, are required to work. Through this recommendation it is expected that persons or corporations having control over the loading of vehicles can be held responsible.

11. The Commission recommends a specific provision empowering the proper authorities to require the driver of a vehicle to stop and submit to measurement or weighing of the vehicle. For violation of this provision the Commission recommends a fine of $1,000.

12. To further protect the highways and bridges the Commission recommends that vehicles found to be overweight shall be unloaded before proceeding. An exception is recommended for vehicles carrying a full load of perishable products which may be allowed to proceed, on first offense only. For subsequent offenses within a calendar year such vehicles shall be unloaded. Considering that some vehicles carry indivisible loads it proposes that these on first offense may be allowed to proceed to their destination, after obtaining a permit from the State Roads Commission, but only on first offense. On the second, or subsequent offenses, a permit would have to be obtained but the vehicle would be required to return to its place of origin.

13. Where a weight violation is found by an out-of-state vehicle or driver, the Commission feels that some discretion should be placed in the Trial Magistrate. To remove possible inequities, authority should be given to the Trial Magistrate to impound the vehicle until such time as the fine is paid or acceptable collateral is posted. This is an alternative method to the existing authority in the Trial Magistrate with respect to the driver. Realizing that there may be some question of obstructing interstate commerce, the Commission recommends that the law specifically state that the cargo shall not be held. In order to insure collection of the fine after the vehicle has been impounded authority should also be given for the sale of the vehicle at public auction to satisfy the fine after 90 days have elapsed.

14. As a final recommendation the Commission urges that the cost of enforcing the weight and size laws be paid out of the fines imposed for the violation of those laws. At the present time the State Roads Commission is incurring a deficit in the enforcement of these laws.

PROCEDURES OF THE COMMISSION

The organizational meeting of the Commission was held on August 18, 1949. It was decided as a first step to conduct a series of hearings. Through the public press a general invitation was extended to anyone desiring to be heard. In addition, written invitations were sent to the following:

Maryland Motor Truck Association, Inc.

Maryland Franchise Motor Freight Lines

American Trucking Association

Maryland Petroleum Industries Committee

Maryland Petroleum Carriers Association

Maryland Highway Contractors Association

Maryland Dump Truck Owners Association

Maryland Aggregate Producers

Maryland Motor Bus Operators Association

Baltimore Transit Company

Automobile Club of Maryland

Keystone Automobile Club

Automobile Trade Association of Maryland

Maryland Bottlers of Carbonated Beverages

Associated Brewers of the Fifth Region

Farm Bureau of Maryland

Maryland State Grange

Laundry Association of Maryland

Industrial Traffic Managers Association of Baltimore

Association of American Railroads

Freight Drivers and Helpers Local Union No. 557

Bethlehem Steel Company

Western Maryland Dairy

Paul Jones and Company

Calvert Distillery

The following interests and groups appeared and were heard:

Freight Drivers and Helpers Local Union No. 557

Baltimore Transit Company

Automobile Club of Maryland

Maryland Bottlers of Carbonated Beverages

Maryland Franchise Motor Freight Lines

Automobile Trade Association

Maryland Dump Truck Owners Association

Maryland Motor Truck Association

The owners and operators of transit-mix trucks

Individuals representing Trans-Oil, Inc.

Maryland State Roads Commission

Mr. Joseph J. Hock, Jr.

Following the hearings several sub-committees were appointed:

Weights and Dimensions:	J. Trueman Thompson, Chairman Herbert S. Fairbank H. Guy Campbell
Penalties and Licensing:	Geo. N. Lewis, Jr., Chairman Philip C. Turner Henry J. King
Safety-speeds:	Robert W. Furtick, Chairman Major Ruxton M. Ridgely

The sub-committee reports were submitted and discussed at a series of meetings of the entire Commission. These discussions led to the conclusions and recommendations heretofore summarized.

U. S. Route 40, northeast of Baltimore, also known as the Pulaski Highway and sometimes as Muskrat Trail, began to fail seriously before it was 10 years old. The failure has been popularly attributed to the character of the road's foundation, which was known to be laid in part over swampy areas. The following photographs, made in 1945 both northeast and southeast of Havre de Grace, are all of sections of the road on high ground, near the tops of hills. Note that the failures are confined to the outer lane of the dual highway where the heavy trucks collect on the up-side of hills and are not in evidence on the inner lane where lighter vehicles pass the heavier ones. This road was one of the first in the State to show damage by heavy axle loads.

(Photographs by courtesy of the Bureau of Public Roads, U. S. Department of Commerce.)


ATLANTIC


CAUTION
EQUIPMENT
WORKING IN ROAD

REDUCED AXLE LOADS RECOMMENDED FOR PROTECTION OF PAVEMENTS

The truck weight problem, now recognized as serious - not only in Maryland, but the country over - has not long been a matter of grave concern. In essence, the problem is less one of truck weights than of truck axle weights. In almost all the states the serious ecomonic consequences of a slow, but steady increase in the weight of motor trucks and tractor-trailer combinations, and particularly their axle weights, have been recognized only within the last ten years.

The evidence of road damage resulting from the heavier truck loading now practiced was not noticed at an earlier date for the very good reason that such loading did not occur with a damaging frequency anywhere until the late thirties. In Maryland, the earliest effects became apparent on U. S. Route 40, northeast of Baltimore, and for a time were believed to confirm a prediction of failure in consequence of the road's location in part over swampy areas, a circumstance by reason of which the road had rather unjustly been nicknamed "Muskrat Trail".

The fact that the extensive cracking and settlement of the pavement slabs, which soon began to plague this very important highway, occurred predominantly in the outer lanes of the two roadways, where the heavy trucks traveled, was not immediately recognized as significant. Later recognition of this revealing circumstance, and the further fact that the road's failures were by no means confined to the sections built over the swampy areas, but extended to much of the road's length in three counties, has led those acquainted with the facts to a somewhat kindlier judgment of the road's qualities. It has become clear that this road - one of the most heavily traveled of all Maryland highways - was simply among the first to show the effects of the heavier truck loading which, now more widely applied, has caused similar, if not equal, damage to other roads throughout the State.

As late as 1931 - only 20 years ago - Thos. H. MacDonald, then as now the respected head of the U. S. Bureau of Public Roads, could testify under oath before an Examiner of the Interstate Commerce Commission that, in his opinion:

> "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."

As he has recently explained, in public hearings before a Sub-committee of the U. S. Senate /1 the greatly increased frequency of axle loading in excess of the loads anticipated in the design of most of our existing pavements has caused him substantially to alter his earlier judgment. Mr. MacDonald explained that his earlier statement was founded upon the belief that the roads then (in 1931) existing could withstand 18,000 pound axle loads on pneumatic tires and his knowledge that few vehicles at that time imposed greater axle loads.

1/ Hearings before the Sub-committee of the Senate Committee on Interstate and Foreign Commerce pursuant to S. Res. 50. Statement of Thos. H. MacDonald, Commissioner, Bureau of Public Roads, U. S. Department of Commerce, June 27, 1950.

"In 1931", he testified in his later appearance, "such excessive loads were occurring on no more than eight axles in each thousand trucks. Today (1950) there are about 86 such excessive loads for each thousand vehicles; and truck traffic volumes having increased about three-fold in the interval, the increase in frequency of excessive loading has been of the order of eight to 250, or over thirty-fold."

Having stated his opinion that most of the roads of the country are still safe for no greater load than 18,000 pounds per axle, he added: "In view of this increase of loading above the general design limits the probability that traffic loads are today an important factor in the causation of road damage is at least as great as the probability that they were a minor factor in 1931. And the probability of present load damage," he concluded, "is confirmed as an actuality by the widespread and numerous reports of such damage."

In Maryland, as in all other states, truck axles have been weighed at regular intervals, as part of the fact-gathering process of the State Roads Commission. Intentionally, this weighing has been done apart from the similar law-enforcement weighing. The purpose has been to obtain a dependable indication of tendencies in loading practice as a basis for the formulation of highway design policies and related policies.

In Maryland these weighings have revealed a trend of increased axle loading similar to that to which Commissioner MacDonald refers in its national manifestation, but more abrupt.

Figure 1 shows that in this State the weighing of 1937 recorded 20 axle loads of 18,000 pounds or more and only 2.3 as heavy as 22,000 pounds in each thousand vehicles weighed. These frequencies increasing in subsequent years, the graph shows that by 1950 the number of axles per thousand vehicles that weighed 18,000 pounds or more had reached 182, and that by that year, there were 20 axles per thousand vehicles that weighed 22,000 pounds or more; the latter a drop from more than 50 in the preceding year, due in all probability to a more rigorous enforcement of the law.

From Figure 1 it is evident that the occurrence of axle loads in excess of 18,000 pounds on the roads of the State was comparatively infrequent until the late thirties. Loads as great as 22,000 pounds per axle were until then exceedingly rare. In Maryland, as elsewhere, the marked evidences of load damage of the highways since appearing had not yet attracted notice, when a bill was introduced in the 1941 Session of the General Assembly to change the axle load limit from 18,000 to 22,400 pounds. So there was nothing of a very tangible character to warn the Legislature of the dangers of the bill then before it, and it was enacted into law.

There was even less to caution against the permission of two such loads on the same vehicle in a space of 50 inches. Such extreme load concentration was then so rare as to be almost non-existent. Fortunately, it has continued, despite the law's permission, comparatively rare, and it has remained for the test now in progress on U. S. Route 301 near La Plata to show how very dangerous is the present provision of the law which permits the loading of tandem axles to 44,800 pounds.

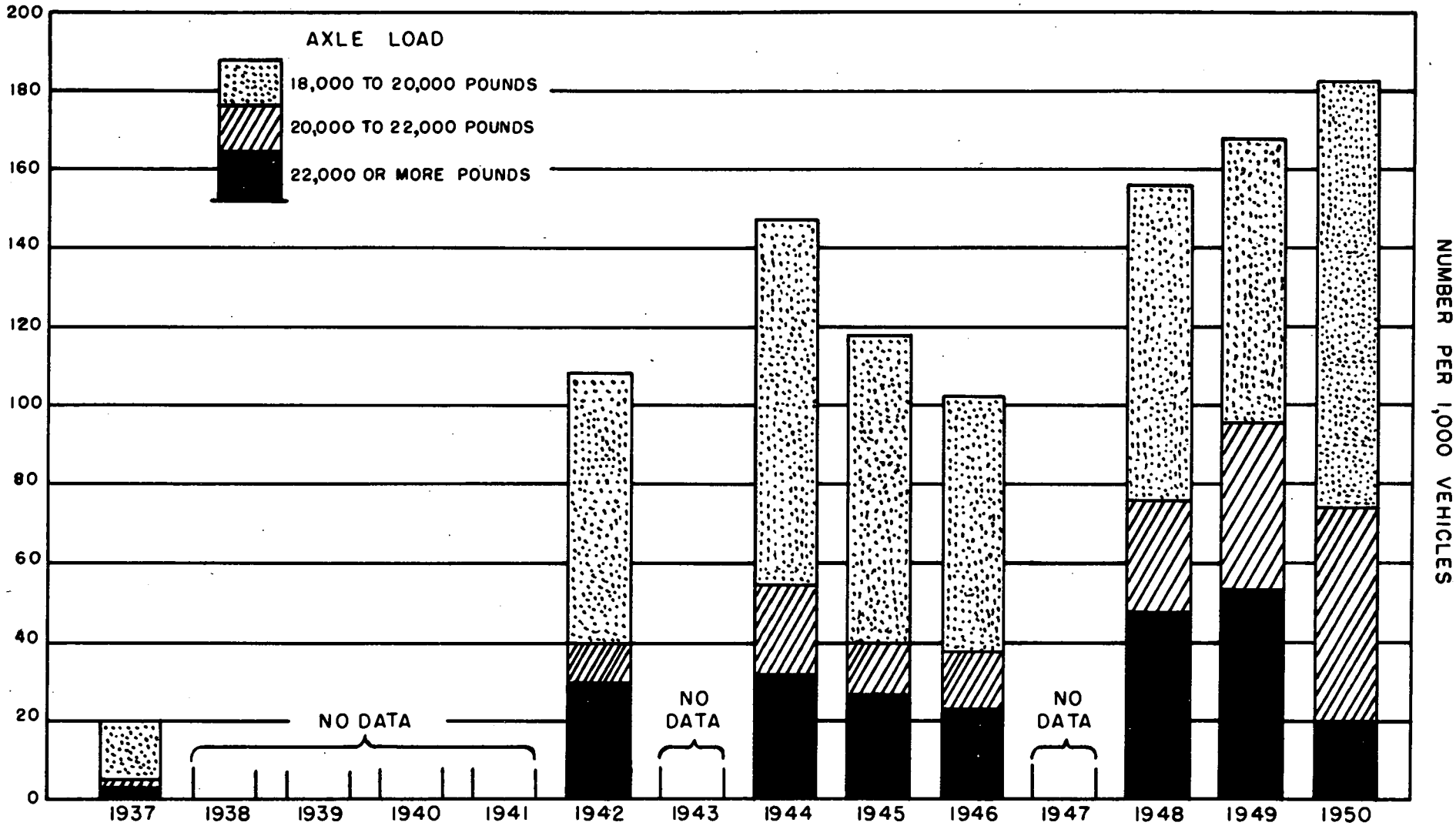


FIGURE 1. - FREQUENCY OF AXLE LOADS OF 18,000, 20,000 AND 22,000 POUNDS OR MORE PER 1,000 TRUCKS, BY YEARS

CONCRETE PAVEMENTS OF 9-INCH EDGE THICKNESS DESIGNED FOR 18,000 POUND AXLE LOADS

It is probable that Maryland in 1941, when the 22,400 pound axle load limit was written into its law, in view of the condition of its roads, was less ready for such a change than many another state. Engineering opinion then was as firm and unanimous as it is today the country over, that concrete pavements of 9-inch edge thickness should not be subjected with substantial frequency to axle loads exceeding 18,000 pounds.

The renowned Bates Road experiment conducted in Illinois in 1922 and 1923 had long since provided the first intimation of the necessity of such a load limitation. The pioneer Bates tests had subsequently been confirmed by the Bureau of Public Roads and other experimenters, and the mathematical analysis of concrete pavement behavior by Dr. H. M. Westergaard, later to become Dean of the Graduate School of Engineering at Harvard University, had resulted in the formulation of the theory of concrete pavement design which is still the universally accepted theory. According to this theory, confirmed by all the available experimental data, the expectance of frequent occurrence of 18,000 pound axle loading calls for 9-inch edge thickness in a concrete pavement.

By 1941, Maryland's concrete pavements were being designed according to the Westergaard theory. The design then standard provided a pavement cross-section 9 inches thick at the edges of the lanes and 7 inches thick at the lane centers, with a parabolic variation of thickness between the edges and the center. With rare exceptions, concrete roads of no higher standard were built anywhere in 1941, and there were no concrete pavements of heavier design in Maryland.

Had axle loads in excess of 18,000 pounds been expected with substantial frequency, engineering theory would have dictated a thickening of the standard 9-inch edge. For the support of frequent 22,400 pound axle loads the theory requires the provision of 10-inch edge thickness.

Accepting the theory, and considering the thickness and condition of the State's concrete pavements then existent - indeed even now existing - it is immediately apparent how ill-prepared the State was for the 22,400 pound axle load limit written into the law in 1941. With 9 inches of edge thickness required for the support of 18,000 pound axle loads, 797 miles of the State's concrete pavements have even now less than that thickness with which to meet the threat of the 22,400 pound law. All of these pavements, with the exception of 19 miles, were built before 1941. There are additionally 799 miles, now existing, that are 9 inches thick, and, theoretically and actually good for frequent axle load application no greater than 18,000 pounds; and there are only 45 miles, all built since 1941, that have edge thickness greater than 9 inches.

Besides these concrete roads, totaling 1,641 miles, there are today in the State road system 3,081 miles improved with pavements of flexible type

and bituminous binders. What thickness of these pavements can be regarded as the equivalent of 9 inches of concrete cannot be said with certainty. Much depends upon the nature of the subgrade support. However, it is widely accepted that a somewhat greater thickness of flexible surface is required to provide the equivalent in load support of a given thickness of concrete. With this in mind the inventory of existing flexible pavements makes it clear that these segments of the State's highway system are no better fitted for the support of loads now legally permitted than are the concrete pavements.

This is apparent from the fact that of the total of 3,081 miles of bituminous roads, 2,707 miles have a combined base and wearing-course thickness of less than 12 inches, and only 265 miles have a total thickness in excess of 12 inches.

The location of the concrete and bituminous pavement mileages of the several categories of thickness referred to above is shown in Table 1.

TABLE 1. MILEAGE OF STATE HIGHWAYS BY TYPE AND THICKNESS OF PAVEMENT - JANUARY 1, 1951 /1

County	Rigid Pavements				Flexible Pavements			
	Less than 9" thick	9" thick	More than 9" thick	Total	Less than 12" thick	12" thick	More than 12" thick	Total
Allegany	5.9	40.0	-	45.9	109.7	-	0.2	109.9
Anne Arundel	18.5	71.1	10.0	99.6	145.4	-	45.5	190.9
Baltimore	54.8	51.9	21.1	127.8	151.3	1.5	27.1	179.9
Calvert	2.0	6.8	-	8.8	83.0	12.8	17.9	113.7
Caroline	67.1	22.0	-	89.1	67.2	-	6.9	74.1
Carroll	49.3	42.5	-	91.8	122.9	-	-	122.9
Cecil	48.7	55.9	-	104.6	79.7	-	16.2	95.9
Charles	7.5	28.4	-	35.9	204.1	19.4	18.6	242.1
Dorchester	37.1	29.7	-	66.8	66.9	4.7	10.9	82.5
Frederick	48.0	34.2	-	82.2	208.7	-	20.7	229.4
Garrett	25.0	20.9	-	45.9	95.7	7.3	-	103.0
Harford	33.5	36.8	14.1	84.4	176.1	-	4.8	180.9
Howard	34.9	15.3	-	50.2	106.8	11.8	-	118.6
Kent	43.0	53.0	-	96.0	50.7	6.0	3.0	59.7
Montgomery	60.9	47.3	-	108.2	208.4	-	15.0	223.4
Prince Georges	20.1	36.9	-	57.0	160.0	10.8	57.7	228.5
Queen Annes	45.7	45.4	-	91.1	71.2	-	9.0	80.2
St. Marys	3.6	7.3	-	10.9	169.9	27.0	2.4	199.3
Somerset	44.0	25.7	-	69.7	45.1	1.9	-	47.0
Talbot	35.8	39.8	-	75.6	39.3	5.7	3.9	48.9
Washington	9.5	22.2	-	31.7	194.0	-	5.6	199.6
Wicomico	42.6	31.5	-	74.1	79.0	-	-	79.0
Worcester	59.9	34.7	-	94.6	72.1	-	-	72.1
	797.4	799.3	45.2	1,641.9	2,707.2	108.9	265.4	3,081.5

1 / Includes mileage under construction as of January 1, 1951.

THE EVIDENCE OF ROAD TEST ONE-MD.

The most conclusive evidence of the excessive liberality of the axle load provisions of the present Maryland law has been afforded by the accelerated traffic test which was conducted during the latter half of 1950 on a section of U. S. Route 301 in Charles County.

Nationally known as Road Test One-Md, because it is soon to be followed by similar tests in other sections of the country, this test subjected a typical Maryland concrete road, converted into four test lanes, to two intensities of axle loading of each of two forms, all of them legal in Maryland. The results of the intensities and modes of loading compared are clearly written on the test lanes themselves in the form of the relative amounts of cracking caused by the several loadings.

The test was conducted under the auspices of the highway departments of eleven states /2 and the District of Columbia and the U. S. Bureau of Public Roads, and under the direction of the Highway Research Board, a subdivision of the National Academy of Sciences, acting as their agent.

The proposal of the test first came to public notice by action taken by the Interregional Council on Highway Transportation at a meeting held on the call of the Governor of Ohio at Columbus, Ohio, on December 5 and 6, 1949. Actually, it had its inception in the needs of this Commission and was proposed to the representatives of other states at the Columbus meeting by the Chairman of the Commission. Early in the Commission's deliberations it became apparent that an objective determination of the effects of axle loads of various magnitudes would afford the only possibility of eventual agreement of the entire membership on the important question of axle load limitation. It was, therefore, most fortunate that the interstate discussions at Columbus resulted in the decision to undertake such a determination by means of a test road, and to choose the site of the road in Maryland.

The particular road chosen was selected by a committee of engineers representative of all the sponsoring State highway departments and other agencies. It is a 1.1 mile section of concrete road on U. S. Route 301, located approximately 9 miles south of La Plata in Charles County.

The pavement was constructed in 1941. According to information supplied by the State Roads Commission, the traffic to which it had previously been subjected had included few vehicles with axle loads in excess of 18,000 pounds. However, the pavement had been subjected to a variety of weather conditions ranging from heat to cold, to alternate freezing and thawing, to dry weather and wet, and all the seasonal changes of nine years. With this

2/ Connecticut, Delaware, Illinois, Kentucky, Maryland, Michigan, New Jersey, Ohio, Pennsylvania, Virginia and Wisconsin.

previous exposure to weather and traffic, the pavement, according to Dr. R. W. Crum and Mr. Fred Burggraf, Director and Associate Director of the Highway Research Board, "was in excellent condition at the start of the tests". /3

It is important to stress this fact, because spokesmen for the trucking industry usually assert that observed road damage is the result of natural, climatic and soil conditions, and is not caused by any known heavy vehicular loading to which the road may have been subjected. Here, definitely, was a pavement which had existed on the same subgrade soil upon which it now lies, which had been subject to all the natural forces which nine Maryland summers and winters could bring to bear upon it, and which, with a previous history of comparatively light traffic, "was in excellent condition at the start of the tests".

In view of the very serious conditions of subgrade pumping which developed during the tests it is important also to stress the fact that careful observation prior to the beginning of the test loading disclosed no evidence of previous pumping of a damaging character and only a conjectural possibility that pumping in any degree had previously occurred. During the early runs of the test vehicles all joints of the pavement were carefully inspected for visible deflection under the passing vehicles. There was none. This is conclusive proof that the pavement was in firm contact with its subgrade throughout at the beginning of the road tests.

Description of the Test Sections: The pavement tested is of reinforced concrete, 24 feet wide, and is divided at the center, with a longitudinal joint. The cross-section is of the double parabolic type thickened at both the outside and center longitudinal joint edges. The depth of the cross-section of each 12-foot lane is 9 inches at the edges and 7 inches at the center of the slab. Expansion joints 3/4 inch wide are spaced at intervals of 120 feet, with two intermediate contraction joints at 40-foot spacing between them.

The 1.1 mile test road was divided into two sections; the south section being 0.5 mile long and the north section 0.6 mile long. At each end of each section turn-arounds of 50-foot outside radius with 20-foot bituminous roadways were constructed to allow the test trucks to operate back and forth on the same lane.

On the west lane of the south section, two single-unit, two-axle trucks with rear axle loads of 18,000 pounds were operated. On the east lane of the south section two single unit, two-axle trucks with rear axle loads of 22,400 pounds were operated.

3/ Effect of heavy axle loads on Road Test One-Md, Report of Progress to November 1, 1950, by R. W. Crum, Director, and Fred Burggraf, Associate Director, Highway Research Board, presented at the annual meeting of the American Association of State Highway Officials, Miami, Florida, December 4-7, 1950.

On the west lane of the north section two single-unit, tandem-axle trucks with tandem loads of 32,000 pounds were operated. On the east lane of the north section two single-unit, tandem-axle trucks with tandem loads of 44,800 pounds were operated.

Concrete Quality: The average flexural strength of 28 test beams made during the construction of the pavement in 1941 was 485 pounds per square inch 7 days after the beams were cast. Nineteen beams, approximately 7 inches wide were sawed from four concrete specimens removed from the pavement for this purpose prior to the beginning of the test by the Maryland State Roads Commission. The average flexural strength of these beams, representative of the strength of the concrete at the beginning of the test, was 708 pounds per square inch. The average compressive strength of 20 cores drilled from the pavement included in the test section two months after it was constructed in 1941 and tested at an age of approximately 4 months was 4,838 pounds per square inch. The average compressive strength of 12 cores drilled in June 1950 from portions of the roadway not to be subjected to test traffic was 6,944 pounds per square inch.

The average height of the test cores showed the pavement to be of the designed thickness, as the required thickness for the areas from which the cores were taken was 7.5 inches and the actual thickness in these areas was found to be 7.6 inches.

All of these tests show that the concrete is of good quality and the pavement has the designed thickness. It is a pavement at least equal in thickness and design and in quality of materials to the majority of the existing concrete roads in the State.

Results of the Preliminary Soil Survey: Soil test data have been obtained from 50 auger borings made adjacent to the concrete pavement to a depth of approximately 30 inches, spaced uniformly from end to end of each test lane.

The data indicate that approximately 15 percent of the subgrade soils have granular characteristics and that the remainder are fine-grained plastic soils. The former are classed as good subgrade soils; the latter are susceptible to pumping and are not considered desirable as subgrade materials.

A comparison, on the basis of grain size, however, shows the average of the soils adjacent to the pavement of the test road "to be slightly better than the average of soils for the entire State of Maryland". /4

The better subgrade soil was mainly found at the south end of the test road under the lanes subjected to the 18,000 and 22,400 pound single axle loads. The poorer soils were found generally in the northern parts of

4/ Effect of heavy axle loads on Road Test One-Md, by R. W. Crum, Director, and Fred Burggraf, Associate Director, Highway Research Board.

the southern lanes and in the northern half of the road where the two weights of tandem axles were applied. The variation of the soil lengthwise of the road makes it inadvisable presently to compare the behavior of the lanes which have been subjected to tandem axle loading with that of the lanes subjected to single axle loading. Further tests shortly to be made of the soils directly under every slab of the pavement will eventually permit comparisons of behavior on a slab-by-slab basis, but this is not now possible.

The soil variation, however, is mainly longitudinal. Transversely, the available information indicates that the subgrades of Sections 1 and 2 (subjected to single axle loadings) are of similar composition; and likewise the subgrades of Sections 3 and 4 (subjected to tandem-axle loadings) are of similar composition. Comparisons of the cracking under load of the two lanes subjected to single-axle loading, one with the other; and of the two lanes subjected to tandem-axle loading, one with the other, can properly be made on the presumption that subgrade support is substantially uniform in a transverse direction.

Operation of the Test Traffic: The test vehicles were operated continuously over the respective test lanes on a twenty-four per day, seven day per week basis, with interruptions only as necessary for maintenance of the vehicles, meals and rest stops for the drivers and occasionally to permit the conduct of special tests. On one trip in every five the vehicles were driven with their rear outside tires on the edge of the pavement; on another trip in every five they were driven with their rear outside tires 2 feet from the pavement edge; on the remaining three trips in every five the vehicles were driven with their rear outside tires in a position between the two extreme positions previously described. This pattern of transverse placement of the wheels of vehicles represents the average operation of trucks in normal traffic on similar type highways, as determined by lateral placement studies of the Bureau of Public Roads.

Test Runs on Section 4 Halted Early: From practically the beginning of the test runs on June 23, 1950, the progress of cracking proceeded at a much faster rate on Section 4, subjected to the 44,800 pound tandem axle loads, than it did on other sections. By October 13, 1950, Section 4 had become so seriously affected that it was decided that nothing more was to be gained by continuance of the test traffic on that lane. It was, therefore, decided to suspend operation of the vehicles having the heavier tandem axle. This decision was based in part, also, upon the desire to preserve uncracked a few slabs of this section for subsequent instrumental measurements of their deflections and strains under special test loading. At the time of the suspension of test runs on Section 4, 92,166 applications of the 44,800 pound tandem axle loads had been made to that section, and a total of 3,403 lineal feet of cracks had formed in the lane during the test loading. A few days previously (October 9), Section 3 had been subjected to 92,000 applications of the 32,000 pound tandem axle load and at that time 307 lineal feet of cracks had been formed in that lane.

The operation of test traffic was continued on Sections 1, 2, and 3 until December 23, 1950, six months from the date of beginning, when test traffic on all lanes was suspended.

At the conclusion of the runs on these three sections, the total number of load applications and the total length of cracking observed to have formed during the test period on each was as follows:

	As of December 23, 1950	
	Total number of load applications	Total length of cracks formed - lineal feet
Section 1 - 18,000 lb. single-axle load	238,275	241
Section 2 - 22,400 lb. single-axle load	238,263	1,210
Section 3 - 32,000 lb. tandem-axle load	164,523	1,019

Reported Results of the Test: After the conclusion of the test runs on December 23, 1950, the Advisory Committee, which had guided the test from the beginning issued a statement, unanimously agreed to by all members of the Committee (which included representatives of the trucking industry and the truck manufacturing industry), from which the following is quoted:

"The more significant observations which may be made from the test results to December 23 (after six months of continuous operation) are as follows:

"1 - Soil tests made on samples obtained throughout the length of the pavement adjacent to the pavement edges and under certain sections of the pavement indicate that there is reasonable uniformity in the soils on the two sides of the pavement.

"2 - Based on these same soil tests, there is found to be a definite correlation between soil type and pavement behavior. The higher the granular content and the lower the plasticity of the soil, the better the performance. The subgrade soils on this project are typical of the soils underlying a very extensive mileage of concrete pavement throughout the country.

"3 - The progress of cracking and depression of joints in the test sections has a definite relationship to the occurrence of pumping. Previous research and observation have shown that four basic conditions must be present simultaneously to create a pumping slab. They are: (1) frequent heavy axle loads; (2) subgrade soils of such a nature that they may pump through open joints or cracks or at pavement edges; (3) free water under the pavement; and (4) joints or cracks in the pavement. These conditions were present on this project and pumping resulted.

"4 - Based on both quality tests and dimension measurements, the concrete in the test sections is of good strength and of the designed thickness.

"5 - All four sections were damaged as follows by the loads applied:

(a) The 44,800 lb. tandem axle loads caused approximately eleven times as much cracking (lineal feet) as the 32,000 lb. tandem axle

loads. This relationship held true over a period of almost four months, that is from 20,000 to 92,000 truck passes in each lane.

(b) The 22,400 lb. single axle loads caused approximately six times as much cracking (lineal feet) as the 18,000 lb. single axle loads. This relationship held true over a period of almost five months, that is from 35,000 to 238,000 truck passes in each lane.

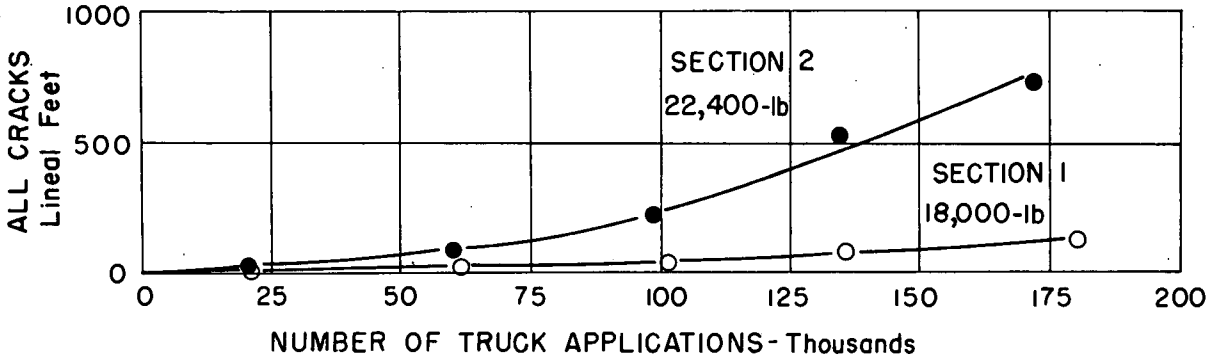
(c) After 84,000 truck passes, 80 percent of the joints in the section carrying 44,800 lb. tandem axle loads were depressed, whereas, with the same number of truck passes, only 10 percent of the joints in the section carrying 32,000 lb. tandem axle loads were depressed. (Depressed joints are defined as those joints at which a marked localized settlement of the pavement has occurred accompanied by cracking of the pavement in the vicinity of the joint.)

(d) After 137,000 truck passes, 22 percent of the joints in the section carrying 22,400 lb. single axle loads were depressed, whereas, with the same number of truck passes, only 2 percent of the joints in the section carrying 18,000 lb. single axle loads were depressed.

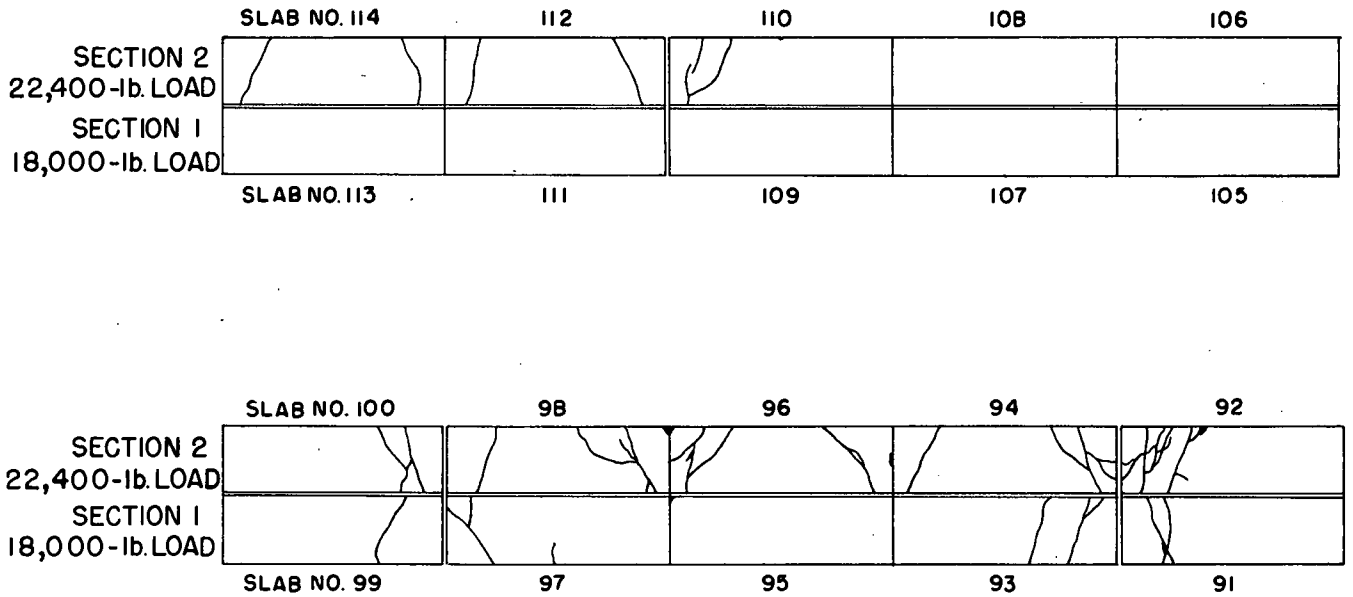
"6 - (a) After 238,000 truck passes, 28 percent of the slabs in the section under 18,000 lb. single axle loads and 64 percent of the slabs under 22,400 lb. axle loads contained cracks which have been analyzed as constituting structural failures due to the application of the test axle loads. Conversely, 72 percent of the slabs in the 18,000 lb. section and 36 percent of the slabs in the 22,400 lb. section show no such structural failures.

(b) After 92,000 truck passes, 27 percent of the slabs in the section under 32,000 lb. tandem axle loads and 96 percent of the slabs under 44,800 lb. tandem axle loads contained cracks which have been analyzed as constituting structural failures due to the application of the test axle loads. Conversely, 73 percent of the slabs in the 32,000 lb. section and 4 percent of the slabs in the 44,800 lb. section show no such structural failures."

Diagrams comparing the rate of development of cracking under the two weights of single axle loads and typical crack patterns formed in the sections subjected to these loads as of October 31, 1950, after approximately 175,000 applications of the loads, are shown in Figure 2. Similar diagrams comparing the rate of crack development and pattern of crack formation in the two sections subjected to tandem axle loads as of October 13, 1950, after approximately 92,000 truck applications are shown in Figure 3.

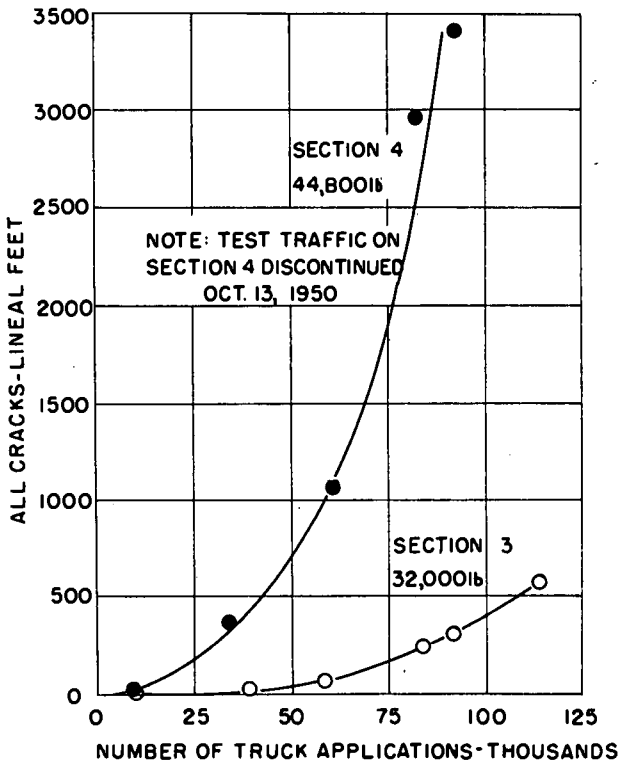


RATE OF DEVELOPMENT OF CRACKS
UNDER SINGLE AXLE LOADS



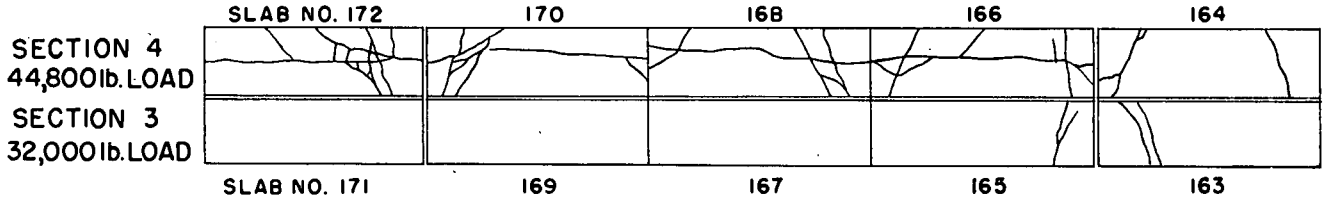
CRACK PATTERN IN TYPICAL SECTIONS OF
TEST PAVEMENT UNDER SINGLE AXLE LOADS
AS OF OCT. 31, 1950 AFTER APPROXIMATELY
175,000 TRUCK APPLICATIONS

FIGURE 2

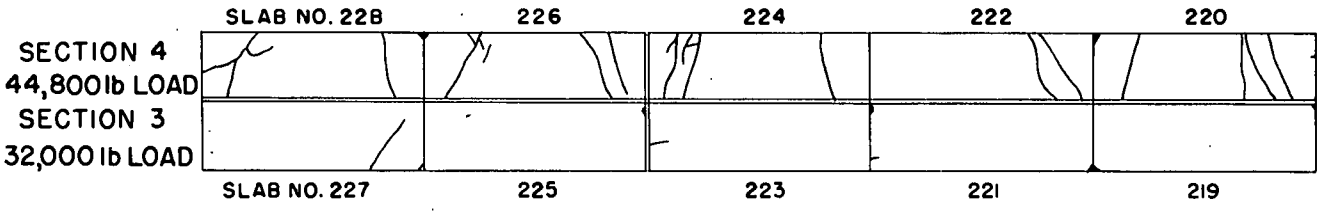


RATE OF DEVELOPMENT OF
CRACKING UNDER TANDEM AXLES

TYPICAL SECTION IN CUT



TYPICAL SECTION ON FILL



CRACK PATTERN IN TYPICAL SECTIONS UNDER
TANDEM AXLE LOADS AS OF OCT. 13,1950 AFTER
APPROXIMATELY 92,000 TRUCK APPLICATIONS

FIGURE 3

CONCLUSION OF THE COMMISSION CONCERNING AXLE LOADING OF VEHICLES

On the basis of all the information available to it, the Commission has concluded that a serious mistake was made in 1941 when the existing provisions, permitting the loading of a single axle of a vehicle to 22,400 pounds and permitting two such axles to be spaced as close as 50 inches apart, were incorporated in the law of the State.

The roads of the State were not then, they are not now of sufficient strength in either their surfaces and pavements or their bases and foundations to withstand, without substantial damage and shortening of their economic life, loads of the magnitude and spacing thus legally permitted.

The Commission recommends that the maximum load permissible upon a single axle be now reduced by amendment of the law to 18,000 pounds.

It recommends that an axle load, limited to the maximum of 18,000 pounds as recommended, shall be defined in the amended law as:

The total load transmitted to the road by all wheels whose centers may be included between two parallel transverse vertical planes 40 inches apart, extending across the full width of the vehicle.

It recommends additionally that the law be further amended to provide that the maximum axle load of 18,000 pounds shall not be permissible on either of two axles separated by a distance of less than 8 feet, and that two axles separated by distances less than 8 feet shall be permitted to carry a combined load of:

18,000 pounds if they are separated by less than 4 feet
32,000 pounds if they are separated by 4 feet and less than 5 feet
33,000 pounds if they are separated by 5 feet and less than 6 feet
34,000 pounds if they are separated by 6 feet and less than 7 feet, and
35,000 pounds if they are separated by 7 feet and less than 8 feet.

These conclusions and recommendations are endorsed by a majority of the Commission in the belief that immediate action in accordance with them is necessary for the protection of the existing highways of the State against unduly destructive loads.

The 18,000 pound maximum axle load recommended is proposed by the American Association of State Highway Officials and by the National Committee on Uniform Traffic Laws and Ordinances for uniform adoption in the laws of all states. It is the limit generally applicable on primary roads in the adjacent States of Virginia and West Virginia. It is less (and with good reason) than the limit of 20,000 pounds now provided by law in the neighboring States of Delaware and Pennsylvania. It is identical with the maximum axle load permitted by law in 32 states.

The limit of 32,000 pounds proposed for the combined weight permissible upon axles spaced 4 feet apart agrees with the recommendations of the American Association of State Highway Officials and the National Committee on Uniform Traffic Laws and Ordinances. The same limit or less is provided in the laws of 24 other states.

The tandem axle loading of 44,800 pounds now permitted by Maryland law on axles 50 inches apart far exceeds any similar allowance in any state except New York, Rhode Island and Vermont. The Commission is unanimous in the conviction that this excessive allowance of the existing Maryland law should be reduced.

REFUTATION OF OBJECTIONS TO AXLE LOAD LIMITS PROPOSED

Certain objections to the axle load limits herein proposed have been brought to the attention of the Commission and considered by it. These objections have been rejected by a majority of the Commission for reasons summarized following the statement of the several objections, as follows:

1. Objection:

Reduction of the axle load limit from 22,400 pounds permitted by present law to 18,000 pounds will be a step backward. It will seriously injure the trucking industry and necessitate an increase in haulage rates which will increase the cost and adversely affect the economy of highway transportation.

Answer:

It is a step in rectification of a mistake made 10 years ago, the serious consequences of which have only recently become apparent. Only 14 percent of the vehicles weighed in the loadometer survey on roads of the State in 1950 had single axles weighing as much as 18,000 pounds or more. (See Table 2). The assertion that trucking rates will necessarily be raised presumes that payloads are determined by the axle load limit. The amount of payload that can be carried is determined generally not by the axle load limit but by the limits placed upon gross vehicle and axle group loading. The Commission has recommended a liberalization of the latter limits as found in the present law, which if utilized should permit efficient truck loading and economical operation. The assumption that the economy of highway transportation is adversely affected if truck haulage rates must be raised neglects the obvious fact that the true cost of highway transportation is the sum of the costs of vehicle operation and road provision. The Commission is convinced that axle loads must be reduced to the supporting capacity of the majority of the State's highways in order to avoid an excessive cost of highway maintenance which it believes will outweigh any possible advantage that may accrue to highway transportation by continuance of the present axle load limit.

2. Objection:

Instead of reducing the axle load limit to the supporting capacity of roads as they have been built, better roads should be built to permit operation of vehicles with the heavier axle load. Notwithstanding the law's permission of 22,400 pound axle loads since 1941 the State Roads Commission has continued to build roads inadequate for the support of such loads.

Answer:

The Commission's proposal to reduce the axle load limit to 18,000 pounds is intended to protect the large mileage of existing roads incapable of withstanding, without excessive cost, greater loads. It does not limit the policy of the State Roads Commission with respect to the design of roads now built. If there is sound reason to suggest that axle loads in the future should be permitted to rise to a higher limit, the State Roads Commission

TABLE 2. FREQUENCY DISTRIBUTION OF THE GREATEST SINGLE AXLE WEIGHT PER VEHICLE AS FOUND IN A 16-HOUR SAMPLING OF TRAFFIC ON VARIOUS ROADS THROUGHOUT THE STATE IN 1950.

TYPES OF VEHICLES		Number and percent of Vehicles Weighed	Number and Percent of Vehicles having Various Maximum Axle Weights in Pounds							
			Less than 16,000	16,000 - 17,999	18,000 - 19,999	20,000 - 21,999	22,000 - 23,999	24,000 - 25,999	26,000 - 27,999	28,000 - 29,999
Panel & Pick-Up Trucks; Other 4-Tired Trucks; and 6-Tired Single Unit Trucks.	No.	2,511	2,389	57	37	19	8	1		
	%	100.00	95.14	2.27	1.47	0.76	0.32	0.04		
Three Axle, Tractor Semi-Trailer Combinations.	No.	1,615	930	219	246	152	55	12	1	
	%	100.00	57.59	13.56	15.23	9.41	3.41	0.74	0.06	
Four Axle, Tractor Semi-Trailer Combinations.	No.	738	414	188	94	30	8	3		1
	%	100.00	56.09	25.47	12.74	4.07	1.08	0.41		0.14
All Types of Vehicles	No.	4,864	3,733	464	377	201	71	16	1	1
	%	100	77	9	8	4	1 1/2	1/2	-	-

TABLE 3. FREQUENCY DISTRIBUTION OF TANDEM AXLES WEIGHT AS FOUND IN A 16-HOUR SAMPLING OF TRAFFIC ON VARIOUS ROADS THROUGHOUT THE STATE IN 1950.

TYPES OF VEHICLES		Number and percent of Vehicles Weighed	Number and Percent of Vehicles having Various Maximum Tandem Axle Weights in Pounds													
			Less than 16,000	16,000 - 17,999	18,000 - 19,999	20,000 - 21,999	22,000 - 23,999	24,000 - 25,999	26,000 - 27,999	28,000 - 29,999	30,000 - 31,999	32,000 - 33,999	34,000 - 35,999	36,000 - 37,999	38,000 - 39,999	40,000 - 41,999
Three Axle, Single Unit Trucks	No.	197	98	15	7	10	8	8	8	11	10	15	3	2	1	1
	%	100.00	49.75	7.61	3.55	5.08	4.06	4.06	4.06	5.58	5.08	7.61	1.52	1.02	0.51	0.51
Four Axle, Tractor Semi-Trailer Combinations.	No.	738	203	27	51	80	83	90	71	64	27	24	9	3	4	2
	%	100.00	27.50	3.66	6.91	10.84	11.25	12.20	9.62	8.67	3.66	3.25	1.22	0.41	0.54	0.27
All Vehicles with Tandem Axles	No.	935	301	42	58	90	91	98	79	75	37	39	12	5	5	3
		100	32	4	6	10	10	11	9	8	4	4	1	1/2	1/2	-

would be well advised to raise the standard of its present and future construction in anticipation of that eventuality. Actually, there has been no factual determination that vehicle loading at a higher intensity per axle and corresponding highway design will redound to the greater economy of highway transportation. Since 1947 the State Roads Commission has adjusted its design policies to the higher intensity of axle loading permitted since 1941. The mileage of roads constructed between 1941 and 1947 was small, and the damaging effects of greater axle loading of vehicles did not become apparent until late in the war period. The 9-inch edge thickness of concrete pavements, standard in Maryland until 1946, was exceeded at that time in the standard practice of only 10 states. /5

3. Objection:

Granted that the La Plata test proves that the tandem axle load of 44,800 pounds now permitted is excessive, such loading has rarely occurred, and the La Plata test by comparing its effects with those of a 32,000 pound tandem axle loading unfairly suggests the necessity of the latter loading as a limit. There is actually no need for a tandem axle load limit in excess of 36,000 pounds, and there is nothing in the results of the La Plata tests to indicate that this would not be a reasonable limit.

Answer:

The statement that there is no need for a tandem axle load limit in excess of 36,000 pounds is correct. Table 3 shows that only one percent of the tandem axles weighed in the 1950 loadometer survey weighed as much as 36,000 pounds or more. But the table also shows that there was little more use of tandems weighing in excess of 32,000 pounds. Only 6 percent of the vehicles weighed exceeded the tandem axle weight limit recommended by the Commission.

Measurements, by the Kansas Highway Commission, of stresses induced in concrete pavements by axle loads of various magnitudes and by combinations of axle loads with various spacing have shown that the stress produced by a tandem axle load of 36,000 pounds, with axles separated by 4 feet, exceeds the stress caused by a single axle load of 22,000 pounds. These Kansas tests also show that the stress resulting from two axles loaded at 18,000 pounds each remains greater than that caused by a single 18,000 pound axle when the two axles are spaced as far as 11 feet apart. (See Figure 4).

4. Objection:

The La Plata test proves nothing except that the road was improperly designed. Failures were the result of subgrade pumping which would not have occurred had the subgrade been properly designed, and had the pavement been built without the frequent joints that permitted water to reach the subgrade.

5/ American Association of State Highway Officials, Policy Concerning Maximum Dimensions, Weights and Speeds of Motor Vehicles to be Expected over the Highways of the United States, Adopted April 1, 1946; P 26.

KANSAS HIGHWAY COMMISSION

PROJECT 5001 INSTALLATION SG 264

(COARSE GROUND CEMENT – NON AIR)

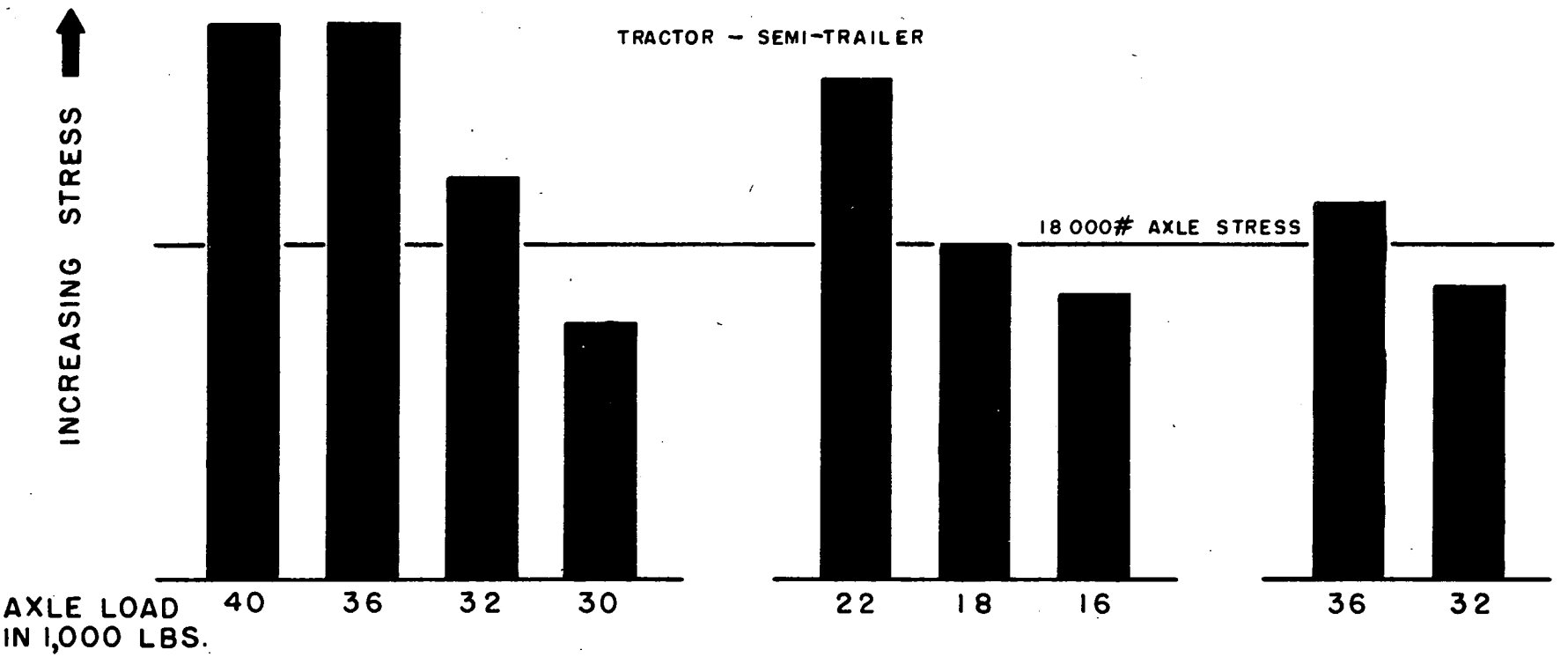


FIGURE 4

Answer:

The subgrade of the test road had not pumped in the nine years of the road's pre-test history. It remained for the application of the heavier and more frequent test loads to start the pumping. The same soils underlie the sections subjected to 18,000 and 22,400 pound axle loads and the same soils that support the 32,000 pound tandem axles also support the 44,800 pound tandem-axle lane. Both sides of the road were jointed precisely alike. The same rains fell on both sides of the road and drainage is as good on one side of the road as the other. Only the axle loads differed; and the results definitely prove, what was already known to engineers, that an 18,000 pound single axle load is the greatest that may safely be applied with frequency to concrete pavements of 9-inch edge thickness and that 22,400 pound single axle loads and 44,800 pound tandem axle loads are excessive for such pavements.

5. Objection:

Most of the observed damage of concrete roads is not due to vehicular loads at all but to the effects of weather, subgrade conditions, etc., witness, the Merritt Parkway in Connecticut, which though it is closed to all but passenger car traffic has nevertheless been so badly damaged that it has been necessary to resurface substantial sections. Longitudinal cracks elsewhere attributed to heavy axle loads have appeared in this highway which is limited to passenger car traffic only.

Answer:

The Deputy Commissioner and Chief Engineer of the Connecticut State Highway Department, says that resurfacing of the Merritt Parkway was necessitated by scaling of the concrete surface, the result of application of salts, especially during the winter of 1947-48. Contrary to the general belief that this road has been used only by passenger cars, he states that it is regularly used by maintenance trucks and during World War II was used by army convoys and various trucks, including some with exceptionally heavy loads. See his letter to the Chairman of the Commission, Appendix A.

6. Objection:

Too much weight is attached to damage observed on concrete roads. Road Surfaces of flexible type do not show evidence of damage even where they are known to carry a substantial traffic of vehicles with axles loaded to 22,400 pounds and more. For example, Church Lane in Baltimore County leading from a stone quarry to the York Road at Texas, although it has long been subject to frequent use by vehicles with axle loads equalling and exceeding the 22,400 pound limit remains nevertheless in good condition.

Answer:

The road referred to is presently in excellent condition, notwithstanding its severe usage, as described. The quarry has been operated for many years and most of its output has necessarily been transported over the road mentioned. The present ability of the road to support the heavy

Test Hole No. 2, located at the crest of a grade and near the center line of the road. The surrounding ground at this point is about 6 inches above the crown of the road on both sides. The surface at this point is dense but there is no excess of bitumin. The top 6 inches is identical with that encountered in Test Hole No. 1. The next 14 inches was a crusher run type material as found in Test Hole No. 1. At this point, 20 inches below the surface, a stone was encountered that had a face area of more than 1 sq. ft. This stone could have been ledge rock but it is believed to have been a large stone or slab floating in the crusher run material.

Test Hole No. 3, located about 200 feet east of railroad crossing and about 3 feet from the center line of the surface. The surrounding ground is about the same elevation as the crown of the road. The road surface here as at Test Holes 1 and 2, was dense but without an excess of bituminous material. The top 6 inches in this hole was found to be identical with that found in Holes 1 and 2. Under the 6 inches of bitumin there was found 19 inches of uncontaminated crusher run type material. Below the 19 inches of crusher run material there was found 4 inches of a mixture of stone and the underlying subgrade. The total thickness of road metal is 29 inches for this hole. The subgrade at this hole was a silt (A-4) with a group index value of 6.7 inches."

7. Objection :

The Reisterstown Road between Baltimore and Reisterstown carries a heavy truck traffic. If it is true that heavy trucks damage roads, why does this road held up so well?

Answer:

The answer is similar to that given to Objection 6. Truck traffic on the Reisterstown Road is reasonably heavy. The present bituminous concrete pavement of the road is laid on an earlier concrete pavement which, in turn, was built on the foundations of the old Hookstown Pike, the first turnpike constructed in Maryland, more than a century ago. Following is the report of an investigation of the surface and base thickness of this road:

"To: Mr. Gordon
From: Mr. Wood
SUBJECT: Reisterstown Road February 21, 1951

At the request of Mr. Campbell, District Engineer at Towson, representatives of the Materials Department witnessed the plugging of the surface of the Reisterstown Road between Pikesville and Reisterstown. A total of four holes were cut in the surface at locations selected by Mr. Chaney, also at the Towson Office.

The findings at the holes cut are as follows:

Test Hole No. 1 - 300 feet north of maintenance stake No. 32 in the outside, southbound lane. From road surface down.

1 1/2" Specification "C" placed about 1932
6" Portland Cement Concrete placed about 1917
15" of a mixture of stone and soil (the soil of this mixture was a good grade A-4 containing 17% coarse sand and 27% fine sand).

Test Hole No. 2 - At maintenance stake No. 30 - outside, southbound lane. From road surface down.

2" Specification "C" placed about 1932
8" Portland Cement Concrete placed about 1931
10 1/2" Crushed stone (old car line ballast) supported on a good grade A-4 subgrade. This subgrade material contained 17% coarse sand and 21% fine sand.

Test Hole No. 3 - 250 feet north of maintenance state No. 84 in the outside northbound lane. From road surface down.

2" Specification "C" placed about 1932
8" Portland Cement Concrete placed about 1931
7" Crushed stone (old car line ballast) supported on an A-2 subgrade.

Test Hole No. 4 - Located 140 feet south of maintenance stake No. 80 in the outside southbound lane. From surface down.

2" Specification "C" placed about 1931
8" Portland Cement Concrete placed about 1917 (this concrete was of poor quality)
18" Crushed stone and stone dust, at this depth was unable to go deeper but had not reached bottom.

In general the surface of this road was excellent. The surface was showing some distress at the location of Test Hole No. 4 probably due to the poor condition of the old concrete. According to Mr. Chaney, the road was surface treated in 1944 or 1945."

The general construction of bases and pavements of the thickness found to exist in the Texas and Reisterstown Roads would involve great expenditure over and above that required for the accommodation of traffic of lesser weight, and would properly be chargeable to the limited number of vehicles that necessitate it. It is probable that the additional cost would be prohibitively burdensome if so charged.

RECOMMENDED REPEAL OF PROVISION LIMITING WEIGHT PER INCH WIDTH OF PNEUMATIC TIRES

Section 252 of the Motor Vehicle Laws of the State - the same section which establishes maximum axle weights at 22,400 pounds, also provides that no axle of a pneumatic tired vehicle shall carry a load in excess of 600 pounds per inch of the aggregate width of its tires. This is now an unnecessary limitation, and is virtually a dead letter in the law.

It should be repealed, and the Commission so recommends. The provision is a carry-over of a type of limitation essential for the control of weight carried on solid rubber tires. With pneumatic tires, the area of the tire in contact with the road surface is automatically determined by the inflation pressure of the tire. It is the area of tire contact rather than the width of the tire that determines effects upon the roads, and modern tire equipment provides invariably an ample area of contact.

CONTROL OF GROSS LOADS AND GROUP AXLE LOADS FOR THE PROTECTION OF BRIDGES

Bridges, like roads, are affected by the axle loads of vehicles; but more importantly they are affected by the total load of vehicles, and often most seriously by the load carried on some group of a vehicle's axles. The members of a bridge, moreover, are affected in different ways and in differing degrees by the several axles or axle groups which stress them during the passage of a vehicle. Some understanding of the functioning of bridges and the effect of loads upon them may be gained by imagining a ladder laid flat across an opening and a man walking across it by stepping on its rungs. The rungs would be affected individually, like little beams between the long rails which they connect. The load on any rung would depend on whether at any instant the man's whole weight were upon it or whether the weight were shared by another rung. The rails, on the other hand, would always have to carry the man's whole weight and would receive their maximum stress when he was at the center of the spanned opening. In a bridge, the grillage of beams supporting the highway surface corresponds to the rungs of the ladder and the trusses or girders, visible on both sides of the highway, correspond to the ladder's rails.

From the foregoing it will be seen that it is not sufficient for the protection of bridges to restrict only the total weight of a vehicle, as is done ordinarily in posting and in some cases in regulatory laws; but that, on the contrary, it is essential to limit also the weight that may be borne on the individual axles and upon any group of the vehicle's axles as well.

In order to provide the necessary protection for bridges, the Commission recommends a table of permisible weights. The table follows a principle which is indisputably correct and which is accepted by engineers without question and by laymen too, when they understand it. It is simply the principle that loads must be spread out over a sufficient number of axles to prevent excessive concentrations. It follows the common-sense reasoning that several people crossing the ladder would not do so in lock-step, if they were wise.

Having decided on the principle, the Commission was faced with a decision as to the degree of restriction to be imposed by it. On the one hand, if its decision were too liberal, it would endanger the investment in bridges so painfully acquired by the people of the State over many years and would also increase the cost of all future bridges, since design standards would have to conform. On the other hand, if it were too restrictive, it would hamper the proper and orderly development of highway transportation.

In considering this decision, the Commission began by requesting that an analysis be made of bridges on the State system of highways. This study showed that present legal loads cause overstresses which run to about 40 percent in some instances. The highest overstresses were found in the shorter and by far the most numerous spans, running up to about 40 feet. This high overstress was mainly due to the currently legal dual axle arrangement which permits a concentration of 44,800 pounds on tandem axles 50 inches

apart. It should be said, however, that such high concentrations, though legally possible, are seldom found in Maryland at present except in the case of vehicles which are illegally loaded in one respect or another. On the other hand, there is a growing tendency, already prevalent in the West, to use a type of vehicle which produces maximum legal concentrations on such tandem axles. It is not improbable that the use of such vehicles may become more popular here, in which event concentrations of 44,800 pounds would become more frequent if the law were not changed.

The effect of the 44,800 pound tandem axle load on concrete pavements has been discussed previously. The facts brought out by the bridge analysis provide an additional reason for recommending in the bridge load table that tandem axle loads be reduced from 44,800 to 32,000 pounds.

In order to better appraise the effect of the gross and group axle weights made possible under the proposed recommendations, the Commission consulted Mr. Raymond Archibald, nationally known bridge engineer, currently Chairman of the Bridge Committee of the American Association of State Highway Officials. He was in charge of the construction of the Potomac River Bridge near Morgantown for the J. E. Greiner Company and more recently was associated with that company in the planning of the Chesapeake Bay Bridge. He said that he was concerned about the ability of existing bridges to carry the heavy loads that are permitted today, particularly because of the findings of certain tests conducted under the auspices of several national agencies interested in bridge behavior.

In these tests, which were made at the University of Illinois and at Northwestern University, repetitive loads covering a wide range of intensities were applied to structural members fastened together by welding, rivets, or bolts to form joints such as are used in bridges. These members failed in the joints, or just outside, at stresses considerably lower than were expected and in a number of cases below those for which they were designed. This resulted from the repetitive nature of the load applications, a condition similar to that experienced by highway bridge connections in withstanding heavy loads repeated a large number of times over a period of years. The phenomenon may be explained by referring to the common experience that if a piece of metal, a wire for example, is bent back and forth a number of times, it finally fails with but little effort.

Mr. Archibald stated that he had examined the table of gross and group axle weights proposed by the Commission and found that they were about the same as the requirements of the California law. He also said that he had looked into the degree of overstress which would be caused in H-15 /6 bridges by vehicles permitted under the California law. He gave examples of this analysis in which he stated he had found stresses due to the vehicle along in the range of 35 to 50 percent over the design allowance depending on the part of the bridge examined. Since the total stress experienced by

6/ Engineers rate the capacity of highway bridges in terms of the weight of the vehicle for which they are designed. Thus an H-15 bridge will carry a truck weighing 15 tons with specified axle arrangements without exceeding the specified design stresses.

bridge members is the sum of that caused by vehicles and that caused by dead load, i. e. the weight of the bridge itself, and since the dead load stress would remain constant, Mr. Archibald's statement meant that the total overstress to be expected would be in the neighborhood of 25 percent. When asked whether he regarded this as a dangerous overstress, he said that his personal view was that it was dangerous. However, he qualified "dangerous" by making it clear that an H-15 bridge overstressed to this extent would not immediately collapse, but that the useful life of the bridge would be shortened by many repetitions over a period of years. He could not say, nor is it possible for anyone to say, by how much it would be shortened.

Table 4 shows the number and percent of bridges on the State highway system which correspond to the several H ratings. In effect, Mr. Archibald's testimony was that loads permitted under the Commission's recommendations would probably produce total overstresses of about 25 percent in H-15 bridges and that the life of these bridges would be shortened thereby. The table shows that 18.1 percent of the existing State highway bridges have a rating of H-15. Presumably, the life of these would be shortened.

More certainly still, the life of bridges rated below H-15, which include nearly another 9 percent would be adversely affected in greater degree.

TABLE 4

SUMMARY OF THE RATED CAPACITIES OF
BRIDGES ON THE STATE HIGHWAY SYSTEM

Rated Capacity	Number of Bridges	Percent of Total
H-2 to H-5	7	0.8
H-6 to H-10	49	5.3
H-12	24	2.6
H-15	168	18.1
H-17	264	28.4
H-20	385	41.5
Above H-20	31	3.3
Total	928	100.0

Table 5 shows the corresponding status of bridges on the county road systems. These data result from a survey made for the defense agencies during the last war. The table does not include every bridge on the county systems, but only those on the more important highways. When it is noted that over three-quarters of them fail to qualify for a rating even above H-10, there is small wonder that county bridge engineers are apprehensive. This is particularly so when we consider the increasing presence of the heavier loads on county roads.

TABLE 5

SUMMARY OF THE RATED CAPACITIES OF BRIDGES ON THE COUNTY HIGHWAY SYSTEM

Rated Capacity	Number of Bridges	Percent of Total
H-2 to H-5	403	50.0
H-6 to H-10	210	26.2
H-12	45	5.6
H-15	42	5.2
H-17	18	2.2
H-20	87	10.8
Above H-20	0	0
Total	805	100.0

While the weakness of the county bridges is not to be wholly ignored, the fact remains that no general limits that might reasonably be fixed can be sufficiently low to afford them much protection. Their salvation must continue to depend, as at present, upon the individual posting of the structures in accordance with their individual strengths.

After a careful consideration of the effect of the possible overstressing of State highway bridges and the reasonable demands of efficient transportation, the Commission decided that it was of first importance to reduce materially the tandem axle load of 44,800 pounds possible under the existing law. The recommended reduction to 32,000 pounds still permits some overstress of the floor systems of H-15 bridges, but within tolerable limits.

CONTROL OF GROSS VEHICLE WEIGHT TO FACILITATE TRAFFIC AND PROMOTE SAFETY

The Commission recommends that the gross weight of vehicles be limited in accordance with the net brake horsepower of the power units which draw or propel them. This refers to the engine power of a truck or of a tractor-truck when it is connected to a semi-trailer, a vehicle with rear axles only, the front being flexibly supported by the tractor-truck. Or it may refer again to the engine power of an ordinary truck when it is connected by a draw-bar or tongue to a full trailer, i.e., a trailer with axles at both of its ends. In any event, it is desirable that there be available in any vehicle sufficient power to permit it to maintain a reasonable speed in relation to the speed of other vehicles. The speed it is possible for a vehicle to maintain under any condition of grade is measured by the ratio of the gross weight of the vehicle to the net brake horsepower propelling it.

The Commission obtained data concerning the weight-horsepower ratios of typical vehicles and combinations of vehicles using Maryland highways, and these data are summarized in Table 6.

TABLE 6

SUMMARY OF THE GROSS VEHICLE WEIGHT - NET BRAKE HORSEPOWER RATIO OF TYPICAL VEHICLES AND COMBINATION VEHICLES AS FOUND ON MARYLAND ROADS IN 1948 and 1949

Class of Vehicle	Number of Vehicles Having Gross Vehicle Weight-Horsepower Ratio of									
	50 to 99	100 to 199	200 to 299	300 to 349	350 to 399	400 to 449	450 to 499	500 and over	Total all ratios	Percent 500 and over
2-Axle Truck	35	69	26	1					131	0.0
3-Axle Truck		11	2	3	8	1	1		26	0.0
2-Axle Tractor 1-Axle Semi-trailer		29	54	52	51	28	19	9	242	3.7
2-Axle Tractor 2-Axle Semi-trailer		3	3	5	9	12	11	8	51	15.7
All Classes	35	112	85	61	68	41	31	17	450	3.8
Percent-All Vehicles	7.8	24.9	18.9	13.5	15.1	9.1	6.9	3.8	100.0	

Beyond the tandem axle spacing, the load limits recommended, in the form of a table, allow the total load on groups of axles to increase in direct proportion to the distance between extreme axles of the group. No loads thus permitted will overstress any bridge as much as the presently permissible 44,800 pound tandem axle load. The maximum total overstress of 25 percent previously mentioned would result from vehicles and loadings permitted by the table which are expected to be of comparatively infrequent occurrence. It is, therefore, in the Commission's judgment, possible without undue hazard to permit the increase of vehicular weights which the table allows.

The advantage sought at the tolerable price indicated is the possibility of carrying, on multiple axle vehicles and combination vehicles, within the limits imposed by essential axle load restrictions, somewhat greater payloads and gross loads. This, the table does. It follows:

Distance in feet between the extreme axles of any group of axles	Maximum load in pounds permissible on any group of axles	Distance in feet between the extreme axles of any group of axles	Maximum load in pounds permissible on any group of axles
Less than 4 feet	18,000	30	58,000
4	32,000	31	59,000
5	33,000	32	60,000
6	34,000	33	61,000
7	35,000	34	62,000
8	36,000	35	63,000
9	37,000	36	64,000
10	38,000	37	65,000
11	39,000	38	66,000
12	40,000	39	67,000
13	41,000	40	68,000
14	42,000	41	69,000
15	43,000	42	70,000
16	44,000	43	71,000
17	45,000	44	72,000
18	46,000	45	73,000
19	47,000	46	74,000
20	48,000	47	75,000
21	49,000	48	76,000
22	50,000	49	77,000
23	51,000	50	78,000
24	52,000	51	79,000
25	53,000	52	80,000
26	54,000	53	81,000
27	55,000	54	82,000
28	56,000	55	83,000
29	57,000	56	84,000

It will be observed that all single vehicles in this sample of typical vehicles has gross weight-horsepower ratios less than 500. Only 3.7 percent of the 3-axle tractor semi-trailer combinations (2-axle tractor, 1-axle semi-trailer) and 3.8 percent of the vehicles of all classes had ratios of 500 and over. And only the 4-axle tractor semi-trailer combinations exceeded a 500 ratio in significant percentage.

Vehicles of the higher weight-horsepower ratios perforce climb the steeper grades slowly. So doing, they reduce the traffic capacity of the highway and adversely affect the convenience and, potentially, the safety of the other users of the highways.

It is desirable at some point to limit, in the public interest, the gross weight of vehicles in relation to their power in order to prevent such loading of under-powered vehicles as will cause them so to inconvenience and endanger others.

After consideration of the existing situation as reflected in Table 6, the Commission concludes that it will be reasonable and not unduly burdensome to require that no motor vehicle hereafter shall be registered for a gross vehicle weight which, upon consideration of its net brake horsepower, as certified by the manufacturers thereof or otherwise ascertained by the Commissioner of Motor Vehicles, shall be found to have a gross vehicle weight-net brake horsepower ratio of more than 500. In effect, this would mean that no motor vehicle would be registered for a gross weight exceeding the product of its net brake horsepower multiplied by 500. The Commission so recommends.

This recommendation suggests the incorporation of a new, but desirable and useful principle in the regulatory law. The precise ratio to be fixed as a limit is a matter to be determined by the exercise of sound judgment. The value of 500 recommended is reasonable in the judgment of the Commission. To increase it would largely nullify the effect of the provision. Introducing the principle into the law at present with use of the value 500 it may be found desirable at a future date to lower the limit to 450 or even 400 in order to further enforce improvement of the general level of hill climbing ability of motor vehicles.

A STATEMENT REGARDING THE REGISTRATION CLASSIFICATION AND TAXATION OF VEHICLES

Although the Commission was not asked to make recommendations regarding motor vehicle taxation it desires to express certain views on a matter related to it. The views may have a bearing upon decisions of the Legislature upon other bills now pending before it, particularly in respect to measures for the raising of additional revenue by the taxation of motor carriers.

The matter referred to is the manner in which motor vehicles, trailers, semi-trailers and truck tractors are now classified for purposes of registration and assessment of license fees.

Single-unit commercial motor vehicles with two or more axles are now classified for purposes of registration on the basis of the gross shipping weight of the chassis and battery as certified by the manufacturer. Trailers and semi-trailers are similarly classified on the basis of the gross shipping weight of the chassis as certified by the manufacturer.

In each case, the existing law assigns specific maximum gross weight limits for each of the classes of vehicles, and for each class a registration fee payable.

Truck-tractors are not classified for purposes of registration, but are registered, regardless of their weight or power or any other indication of their capacity or utility, at a flat fee of $65.00.

The classification, of single-unit trucks especially, on the basis of gross shipping weight of the chassis has been the cause of much misunderstanding in the past because it may not be consistent with other requirements of the law. For example, if the shipping weight of the chassis of a truck is over 9,001 pounds, the owner must register it in the highest weight class, to which a maximum gross weight limit of 55,000 pounds is assigned, and must pay the fee of $250.00 required for that class. But, actually, the gross weight of the vehicle in use may be otherwise limited by other provisions of the law. If, for example, the wheelbase of the truck is 17 feet, then under the existing "bridge formula" it is permitted a gross weight of only 42,750 pounds. The owner naturally feels that he is forced by one provision of the law to pay a fee for the privilege of operating at a gross weight at which, by another provision of the law, he is forbidden to operate. A similar situation exists in respect to trailers and semi-trailers.

The gross chassis shipping weight of a truck or trailer is at best somewhat vague and uncertain, varying in the elemental weights which it includes with the practice of the particular manufacturer. Moreover, there is no fixed or readily determinable relation between the weight of the chassis of a vehicle and the reasonable or safe load it may carry or its consequent gross weight.

In view of these considerations the Commission suggests that the ultimately desirable revision of the present law may provide: (1) For the classification of truck-tractors on the basis of a classification of declared gross train weight, limited by the maximum gross weight - net brake horsepower ratio, with a corresponding scale of fees rising with weight; and (2) For the licensing of all trailers and semi-trailers at a fixed flat fee for each unit. This is the exact opposite of the present method. It would have the effect of halting some rather sharp practices now employed under the existing so-called shuttle or relay provisions of the law. But it would also require a careful consideration of the effects of the changes upon the revenue yield to be expected.

RECOMMENDED DIMENSIONS

Length: At present the law prescribes only a single limit of 55 feet maximum length, applicable to all vehicles and physically connected combinations of motor vehicles. In this respect, the law of Maryland differs from those of the great majority of the states, which limit separately and at different maxima the length of single vehicles, tractor semi-trailer combinations, and other combinations. The Commission finds that there is good reason for the establishment of different limits, and recommends: A limit of 35 feet for single vehicles, with one exception, namely for buses with three axles; for tractor semi-trailer combinations, 50 feet; and for other combinations 60 feet; all these limits to include front and rear bumpers and any load upon the vehicles.

There are two principal reasons for limiting the length of vehicles. They are:

1. To insure a reasonable ease and safety of passage of the longer vehicles by overtaking vehicles.

2. To insure that the vehicles will be able to turn around sharp corners and hold within reasonable limits the roadway width occupied by the vehicles on curves.

The first reason applies only to the length of the longest permitted vehicles; and the Commission's recommendation, if adopted, will permit an increase of five feet in the length of the longest vehicle. Long vehicles are generally relatively slow-moving vehicles. An overtaking vehicle moving only 10 miles per hour faster than a combination vehicle 60 feet long would by only one-third of a second longer in passing it than if the combination were 55 feet long.

There is a possible advantage in the additional five feet, in that it may permit the addition of another axle at appropriate spacing and by thus increasing the possible payload of a combination vehicle reduce the operating cost per ton-mile without offsetting increase of road or bridge cost. The potential net gain in economy of transportation thus made possible justifies, in the Commission's opinion, the slight disadvantage in passing ease and convenience.

The second reason suggests the differentiation of length by classes of vehicles. When vehicles round curves and corners, the rear wheels do not follow in the path of the front wheels. They follow a curve of shorter radius, and the difference between the paths followed is known as "off-tracking". This is a serious matter on sharp curves, requiring, for example, a widening of the road surface in order that the rear wheels may remain on the paved roadway. At street intersections and other sharp corners it may spell the difference between possibility and impossibility of getting around at all.

But linked and articulated vehicles of a given length off-track much less than single vehicles of the same length. For example, a single vehicle complying with the present legal limit of 55 feet would off-track more than 25 feet in rounding a curve of 50 foot radius; a truck-trailer combination of the 60 foot length recommended by the Commission would off-track only a little more than six feet in making a right angle turn on a curve of the same radius. The fact that a single vehicle 35 feet long takes practically the same amount of off-tracking as a full trailer combination of 60 feet, and that a tractor semi-trailer combination of 50 foot length takes little more space than either of the others, indicates the consistency as well as the reasonableness of the proposed limits. The limits proposed are in no way restrictive of any present operation and are, as a matter of fact, somewhat more liberal than those of surrounding states.

The exception in the case of a three-axle bus is made to permit the obtainment of slightly more interior space for the greater convenience and safety of passengers and the possible installation of lavatory and toilet conveniences. As passenger buses presently 35 feet long already have axle loads approximating 18,000 pounds, the Commission hinges its recommendation of an additional permission of five feet in bus length upon the requirement that the longer buses shall have three axles.

Width: The Commission recommends that the present limit of 96 inches upon the width of motor vehicles, inclusive of load, be retained, with one exception. The general limit is that imposed by practically every state.

The exception is made in the case of buses and trackless trolleys operating under municipal ordinances within city limits. The additional six inches of permissible width is recommended because it was brought out at public hearings that the convenience of passengers would be promoted by the slight increase of seat and aisle width thereby made possible. It should be noted that the exception does not permit the operation of extra-width buses or other vehicles on highways outside of municipal limits, nor within city limits except as sanctioned by municipal ordinances.

Height: At present there is no limit in the Maryland law on the height of motor vehicles. The Commission recommends that a limit of 12 feet, 6 inches, including load, be imposed. It makes this recommendation because it was brought to its attention that damage has been incurred to bridges and traffic lights by very high vehicles and loads. The principal reason, however, is that such a provision fixes a limit on the clearance to be provided between highways and the underside of bridges crossing over them, and serves as a guide to the future design of such grade separations. These separations are now an established part of modern highway design, and the expense of their construction may be materially increased unless such a limit is imposed. Only four other states do not restrict the height of vehicles. Thirty-five, including all the bordering states, have the limit recommended by the Commission.

While the Commission does not specifically so recommend, it recognizes the possibility that an exception from the application of the height limitation may be desirable in the case of automobile carriers. Should such an exception appear desirable, the permissible additional height for such vehicles should not exceed one foot.

FINES AND PENALTIES FOR VIOLATION OF THE LAW

The Commission made an exhaustive study of the 5,841 overweight cases brought to trial in which a fine was imposed by the Trial Magistrate Courts, during the period from February 14, 1949 to December 31, 1950. A summary of these cases is given in Appendix B. The average violator was fined $35.29. The low average fine was brought about principally by present laws which place the range of fines from $1.00 to $100.00 except for violation of Section 74 i, (Registration) which carries a mandatory fine of not less than $50.00 for the first offense and not less than $75.00 for any succeeding offense.

A further examination of the records of the State Roads Commission shows that a relatively large group of both Maryland and out-of-state owners was found in violation many times during 1949 and 1950 and paid only nominal fines. In view of this, it is only logical to assume that the present scale of fines stipulated in the Motor Vehicle Code is not high enough to remove the profit from overloading.

The record shows that only 43 or 1.2 percent of the 3,595 out-of-state violators brought to trial were given suspended sentences or were dismissed by the courts; while 533 or 18.8 percent of the 2,836 Maryland violators were given suspended sentences or dismissed. The Commission is of the opinion this evidences an unwarranted discrimination.

After reviewing the large amount of data accumulated by the State Roads Commission, the Commission has come to the belief that the practice of overloading, regardless of what the legal weight limits may be, cannot be broken up successfully, or appreciably lessened unless the fines prescribed for exceeding weight as shown by the registration of the vehicle and any statutory weight limit are increased and the right of suspension is denied the Trial Magistrate Courts. It is the recommendation of the Commission that the fine for overloading be made proportionate to the amount of excess weight with an increase in the scale of fines for flagrant violations and the right of suspension denied the Trial Magistrate Courts. It is also recommended that the State be given the right to appeal decisions rendered by the Trial Magistrate Courts, the same right as now accorded defendants.

To give further protection to our highways, the Commission recommends that the law require overweight vehicles to be unloaded before proceeding after weighing. An exception is recommended for vehicles carrying a full load of perishable products which it is believed should be allowed to proceed to their destination, after obtaining a permit from the State Roads Commission, but only on the first offense. On the second or subsequent offenses, the law should require that a permit be obtained for return of the vehicle to its place of origin, and such return be enforced.

The records of the State Roads Commission further indicate that some drivers of commercial motor vehicles refuse to be weighed. The only law now effective to combat such action is that which permits a summons to be issued the driver for failure to obey an officer's command, which carries

a fine of only from $1.00 to $100.00. If an increased scale of fines for overweight violations is provided, this condition, unless corrected, may prove profitable for owners and operators who may escape the larger penalties by refusing to be weighed and paying the lesser fine for refusing to obey an officer's command. To overcome this condition, the Commission recommends a fine of $1,000.00 for drivers who refuse to drive their trucks on a scale, with right of suspension by Trial Magistrate Courts denied.

The Commission feels that the present scale of fines, $1.00 to $100.00 - for violation of the statutory width and length limitations should be revised upward.

Following are the Commission's recommendations for imposing fines for violating the weight limit laws:

1. For a weight violation of less than 5,000 pounds over the registered weight or any statutory weight limit a fine of 2 cents for every pound of excess weight shall be imposed.

2. For a weight violation in excess of 5,000 pounds over the registered weight or any statutory weight limit a fine of 6 cents for every pound of excess weight shall be imposed.

3. If the driver of a vehicle sought to be weighed or measured shall refuse to stop upon proper order, or to drive the vehicle upon the scales as directed by an authorized officer, the driver shall be subject to a fine of $1,000.00 or imprisonment.

4. For Items 1, 2, and 3 above, it is recommended that the Trial Magistrate, upon finding of a violation, shall not have the power to suspend the fine.

The question of an officer's right to stop a vehicle for the purpose of weighing or measuring it has been raised at the trial of overweight cases. It has been the contention of some defense attorneys that under the "Bouse Act" a search and seizure warrant is needed. To overcome this technicality, the Commission recommends that any officer of the Maryland State Police, member of an authorized weighing crew of the State Roads Commission, or peace officer empowered to enforce the provisions of the Motor Vehicle Code, having reason to believe that the size or weight of a vehicle and load being operated on a public highway is unlawful, shall be authorized to require the driver of such vehicle to stop and submit to measurement of the vehicle and weighing by means of either portable or stationary platform scales.

APPENDIX A

COPY

STATE OF CONNECTICUT
STATE HIGHWAY DEPARTMENT

Hartford 15
February 1, 1951

Mr. Albert S. Gordon
Chairman, Truck Weight Committee
State Roads Commission
Baltimore 3, Maryland

Dear Mr. Gordon:

Mr. Fairbank has asked that I give you in writing some of the comments made to him orally on the telephone some days ago, regarding the alleged surface failure of the Merritt Parkway in Connecticut.

It is true that we have resurfaced approximately 20% of the length of the Merritt Parkway. The resurfaced length is 7.7 miles out of the total of 37.4 miles. The resurfacing consisted of the placing of approximately 2" of bituminous concrete over the Portland cement concrete pavement.

The resurfacing operations were undertaken because of the extensive scaling which developed very rapidly during the winter of 1947-48. In the opinion of the department the scaling was due to a combination of factors, but principally to the extremely severe weather conditions and the use of sodium chloride for ice control. The resurfacing was not necessitated by structural failure of the pavement but by the surface disintegration through scaling.

The longitudinal cracks on the concrete pavement have occurred both under the section resurfaced and at other sections along the parkway. It is our opinion that the condition which led to the development of this cracking was the unsatisfactory drainage at certain points. The cross section of the roadway on the Merritt Parkway consists of a dual roadway having two 13' concrete lanes in each direction; also 4" curbs, abutting turf shoulders and median strip. To a degree this type of cross section tends to prevent adequate subgrade drainage. There were some locations, apparently, where subgrade drainage conditions were such as to weaken the pavement support and end in the development of the longitudinal cracking referred to.

I think it is particularly important to point out in this connection that while the Merritt Parkway restricts general use to passenger vehicles only, there are trucks which use and have used the Parkway over its entire life. Our maintenance equipment allocated to the parkway is approximately equivalent to one large truck to every four miles of length. When these

vehicles are loaded with sand and equipped with snow plows, as they are during a great part of the most critical period of the year, they weigh approximately 15 tons. Thus there are load applications being applied much greater than those of passenger vehicles. Furthermore, during World War II and under the present emergency conditions, Army convoys use the parkway. So also was the parkway used, during World War II, by other trucks, notably the extremely large vehicles carrying oversized loads such as Navy vessels.

Mr. Fairbank asked about the faulting of the joints on the parkway. I cannot say positively that there are no faulted joints on the parkway. However, it is my observation from driving over the parkway, and this observation is confirmed by others in the department, that if there is any faulting it is of such a small and insignificant character as to be unnoticeable from our inspections. Forthermore, it is our observation that in general the riding characteristics at the joints on the Merritt Highway are very good.

Very truly yours,

ROY E. JORGENSEN
Deputy Commissioner
& Chief Engineer

APPENDIX B

ANALYSIS OF TRUCK WEIGHING OPERATIONS BY THE MARYLAND STATE ROADS COMMISSION

FEBRUARY 14, 1949 THROUGH DECEMBER 31, 1950

January 3, 1951

	2-14-49 thru 12-31-49			1-1-50 thru 12-31-50			2-14-49 thru 12-31-50		
	Maryland	Foreign	Total	Maryland	Foreign	Total	Maryland	Foreign	Total
Number of Trucks Weighed			101,740			192,498			294,238
" " Arrests			3,536			3,023			6,559
Percent of Arrests			3.48			1.57			2.23
Disposition of All Cases Tried									
Number Fined	1,171	1,873	3,044	1,126	1,671	2,797	2,297	3,544	5,841
" Suspended	179	7	186	176	25	201	355	32	387
" Dismissed	103	4	107	75	7	82	178	11	189
" Sentenced to 5 days in jail	0	0	0	0	8	8	0	8	8
" Jailed in default of payment of fine	1	0	1	2	0	2	3	0	3
" Death of driver prior to trial	2	0	2	1	0	1	3	0	3
Total	1,456	1,884	3,340	1,380	1,711	3,091	2,836	3,595	6,431
Amount of All Fines Collected	$45,643.80	$62,523.25	$108,167.05	$39,510.80	$58,472.65	$97,983.45	$85,154.60	$120,995.90	$206,150.50
Number of Violations by each type									
Axle	910	1,874	2,784	801	1,297	2,098	1,711	3,171	4,882
Tire	160	285	445	181	171	352	341	456	797
Formula	337	834	1,171	390	882	1,272	727	1,716	2,443
Registration	852	11	863	565	12	577	1,417	23	1,440
Posted Bridge	1	-	1	6	7	13	7	7	14
Width	-	-	-	59	20	79	59	20	79
Length	-	-	-	4	6	10	4	6	10
Refusal to obey officer	-	-	-	2	-	2	2	-	2
Destruction of State property	-	-	-	-	1	1	-	1	1
Total number of violations	2,260	3,004	5,264	2,008	2,396	4,404	4,268	5,400	9,668

Conviction Record of Companies	Maryland	Foreign
Number of companies with convictions during 1949	708	1,074
" " " " " " 1949 but not arrested during 1950	507	795
" " " " " " 1949 and 1950	201	279
" " " " " " 1950 only	493	724
Total number of companies with convictions during 1950	694	1,003

HOBOKEN
TRENTON
PHILADELPHIA
NEW YORK
FAST FREIGHT W.T. COWAN INC.
BALTIMORE
WASHINGTON

W. T. COWAN, INC.
Fast Motor Freight
EXECUTIVE OFFICES
BAYARD AND CLEVELAND STREETS
BALTIMORE 30, MD.

February 22, 1951

Mr. A. S. Gordon
Chairman of the Commission Studying
Truck Weights & Sizes
108 E. Lexington Street
Baltimore, Maryland

Dear Mr. Gordon:

In submitting the report of the Commission Studying Truck Weights and Sizes, it is important that it be brought to the attention of the Maryland Legislature and all other interested parties that the report contains some recommendations which represent only the majority opinion and certainly do not represent the opinions of such members as Guy Campbell and myself, the only truck owners and users on the Commission.

On the other hand, it is equally important that we, as a minority of the Commission, who own and operate trucks also point out that there are parts in the report which we heartily endorse. Particularly I refer to that section concerning penalties for overloading in excess of the law, also the sections concerning penalties for the failure on the part of any driver to submit to weighing and measuring of his vehicle and also that section pertaining to speeds. The limitations imposed upon truck heights and additional restrictions on length and width may be based upon some logic and, for the most part, do not appear to impose punitive restrictions on most truck owners. The fact that the automobile haulers may be given special consideration as far as height is concerned would seem to eliminate most inequities in that section. It may be important, however, to note that the 96" width may cause hardships on certain agricultural truck users.

The most important of the objections is to those sections which recommend reductions from the 22,400 pound maximum axle weight and the imposition of an 18,000 pound restriction. The same objection is raised to the reduction of tandem axle combinations

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to a 32,000 pound restriction. In making this objection, it may be noted that the present law, which provides a 44,800 pound maximum loading of tandem axles placed in excess of 50" apart, provides an excessive limit which is not required for an efficient truck operation and, for that matter, is not, according to surveys conducted, found to apply to any loaded trucks which fall within the legal limits of other sections of the weight law. Therefore, the objection is not to the correcting of the 44,800 pound maximum limit to a reasonable, logical and useful maximum weight limit, but is to the imposing of a restriction of 32,000 pounds for such combination of axles. The objections which are raised to the recommended restrictions are based upon the following reasons:

1. The economy of this State has for ten years been built up and developed with the important truck transportation element integrating itself into the total structure based on the weight law in existence for the ten years. The purchase of truck equipment, which represents a multi-million dollar investment, has been done with the present weight law as the basis.

   Rates for common carrier haulage have been predicated upon the level of efficiency dictated by the existing weight law. The price of commodities, which includes practically everything the public uses, reflect to a marked degree the cost of truck transportation. This cost has been arrived at based upon the existing weight law.

2. Truck transportation requirements are being expanded to a considerable degree by the present national emergency. This demand will increase as the rearmament program progresses. Other phases of the economy are demanding more truck usage. This applies to the farmers who own 25% of the trucks in the country, private industry who own the bulk of truck equipment and to the 13% owned by common carriers. Certainly, a reasonable weight law is mandatory in order to provide progress in this field of transportation. Trucks provide the only completely flexible means of transportation and in time of crisis where other forms of transportation are particularly vulnerable to bombing, sabotage or other chaos, trucks must be relied upon completely.

3. The conclusions which were reached by the Committee are based upon the test road which was for the most part (85%) laid on subgrades of the most inferior kind. The tests indicated that with extremely accelerated usage of a road, in the absence of equally accelerated maintenance, that a heavier axle would cause more cracking than a lighter axle. The test or the analyzation of the data does not dwell upon the fact that the road

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which had been in existence for 10 years, had, during its entire life span, been subjected to loads operating under a weight law which is not being recommended for abolition. The prospectus of the test does admit that the road, after 10 years of normal usage under this weight law, was in excellent condition.

The American Association of State Highway Officials and other interested groups have taken cognizance of the data compiled from the Maryland road test but indicate that conclusions concerning axle weight limits drawn from this one test would be premature. There are projected, at the present time, three additional tests in other parts of the country which may assist in ferreting out a proper answer to this controversial problem.

4. Fixing maximum axle loads at 18,000# will throttle highway transportation progress and it is contrary to the desire for progress in every other field of free enterprise.

5. The 18,000 pound restriction is allegedly proposed to protect an investment in roads built many years ago. These roads, to a large degree, are antiquated by the requirements of present day commerce and must be drastically improved in order to fulfill their role as arteries of commerce for the future. One means of modernizing such roads is found in the process of capping and sealing the concrete road with a bituminous material similar to the treatment given the Washington Boulevard between Baltimore and Washington. This process provides many additional years' usage from old roads and also makes a road which can withstand indefinite axle loads without apparent ill effects. Recognition must certainly be given to the problem of modernizing the roads system in order to catch up with the automobile engineering which has been estimated to be 50% ahead of highway engineering.

6. Many engineers point out that present day knowledge of road building provides the means of building much better roads for the money expended. An example of this modern technique may be found in the construction of runways for the new Friendship Airport which are designed for axle loads of 300,000 pounds as compared to 22,400 pounds and were constructed at an approximate cost of $3.50 per square yard as against approximately $4.50 for the concrete highways.

Another point which we are at variance with the majority of the Commission is in the application of the bridge formula. The bridge formula is stated to be 750 (L + 40) and this places a severe restriction on certain short-coupled vehicles such as

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the ready-mix concrete trucks. Under the existing weight law, there is no desire on the part of other truck owners to modify this formula but for this particular vehicle mentioned, some relief should be given by means of raising the constant of 750 to a more reasonable figure. Two years ago the Maryland State Roads Commission agreed to go along on a bill to increase the constant of the bridge formula from 750 to 875. This was for the particular purpose of giving relief to the trucks mentioned. It is therefore recommended that consideration be given to this approach at this time instead of adopting the escalator bridge formula recommended by the Commission. The recommendations provide no appreciable relief for the trucks which most need it.

In conclusion, may I again point out the desire of the trucking industry to eliminate overloading of vehicles on the Maryland highways. With a reasonable weight law similar to the one now in existence but with a much more severe schedule of fines for infraction of the law, this problem could be brought to a speedy correction.

Very truly yours,

W. T. COWAN, INC.

R. W. Furtick
General Manager

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