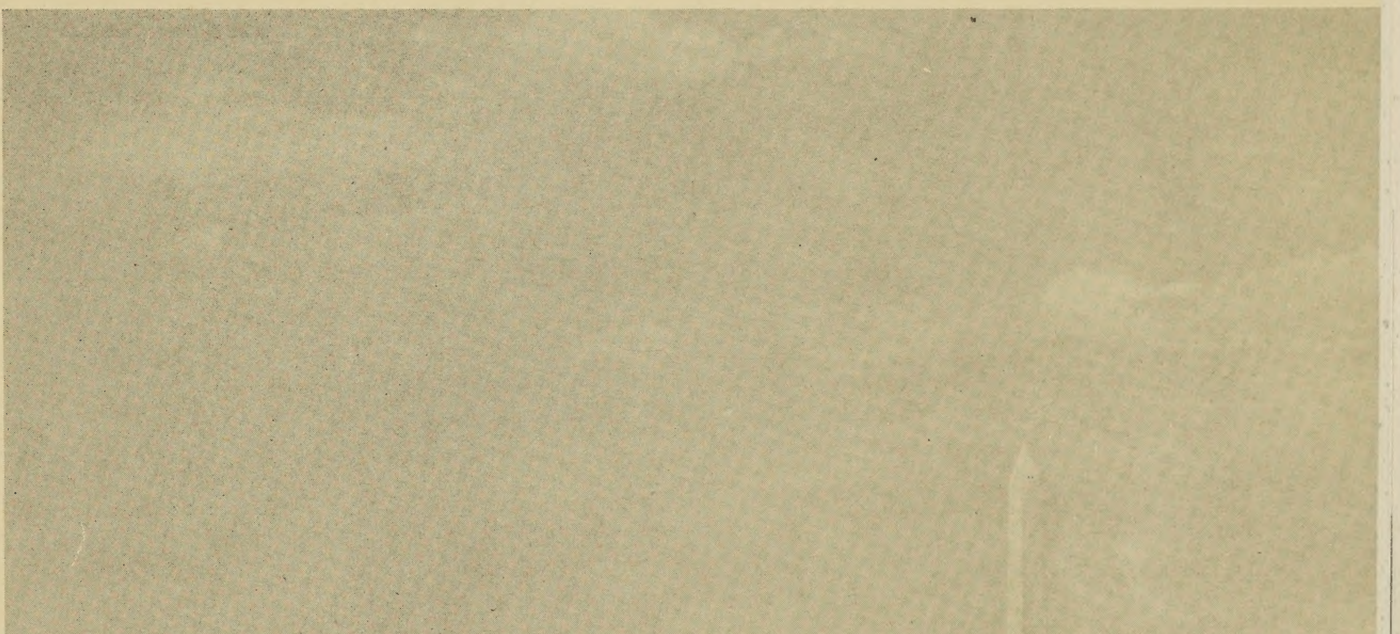
L. 26, NO. 11 DECEMBER 1951

Public Roads

A JOURNAL OF HIGHWAY RESEARCH



Boundary Channel Bridge, Washington, D. C.

UBLISHED BY
HE BUREAU OF
UBLIC ROADS,
S. DEPARTMENT
F COMMERCE,
ASHINGTON

Public Road

A JOURNAL OF HIGHWAY RESEARC

Vol. 26, No. 11 *December 195*

Published Bimonthly

IN THIS ISSUE

BUREAU OF PUBLIC ROAD
Washington 25, D.

REGIONAL HEADQUARTER
870 Market S
San Francisco 2, Cali

DIVISION OFFICES

No. 1. 718 Standard Bldg., Albany 7, N. Y.
Connecticut, Maine, Massachusetts, New Ham
shire, New Jersey, New York, Rhode Islan
and Vermont.

No. 2. 707 Earles Bldg., Hagerstown, Md.
Delaware, District of Columbia, Marylan
Ohio, Pennsylvania, Virginia, and West Vi
ginia.

No. 3. 50 Seventh St., N. E., Atlanta 5, Ga.
Alabama, Florida, Georgia, Mississippi, Nort
Carolina, South Carolina, and Tennessee.

No. 4. South Chicago Post Office, Chicago 17, Il
Illinois, Indiana, Kentucky, and Michigan.

No. 5. (NORTH). Main Post Office, St. Paul
Minn.
Minnesota, North Dakota, South Dakota, ar
Wisconsin.

No. 5. (SOUTH). Federal Office Bldg., Kans
City 6, Mo.
Iowa, Kansas, Missouri, and Nebraska.

No. 6. 502 U. S. Courthouse, Fort Worth 2, Te
Arkansas, Louisiana, Oklahoma, and Texas.

No. 7. 870 Market St., San Francisco 2, Cali
Arizona, California, Nevada, and Hawaii.

No. 8. 753 Morgan Bldg., Portland 8, Oreg.
Idaho, Montana, Oregon, and Washington.

No. 9. Denver Federal Center, Bldg. T-2, Denve
Colo.
Colorado, New Mexico, Utah, and Wyomin

No. 10. Federal Bldg., Juneau, Alaska.
Alaska.

PUBLIC ROADS is sold by the Superintendent of Documen
Government Printing Office, Washington 25, D. C., at $1
year (foreign subscriptions $1.25) or 20 cents per single co
Free distribution is limited to public officials actually enga
in planning or constructing highways, and to instructors
highway engineering. There are no vacancies in the free
at present.

The printing of this publication has been approved by
Director of the Bureau of the Budget January 7, 19

BUREAU OF PUBLIC ROAD
U. S. DEPARTMENT OF COMMER
E. A. STROMBERG, Edi

Observed Settlements of Highway Structures Due to Consolidation of Alluvial Clay

BY THE PHYSICAL RESEARCH BRANCH
BUREAU OF PUBLIC ROADS

Reported by E. S. BARBER
Highway Engineer

Laboratory consolidation tests, coupled with analysis of field conditions indicated by subsurface explorations, enable the engineer to anticipate the amount and rate of settlement of embankments and bridges under increased loads. In this article observed settlements at four locations are correlated with calculated values obtained from laboratory test results. Actual settlements were found to be in substantial agreement with the calculated values, the maximum difference being about 20 percent. Primary consolidation accounted for most of the observed settlements.

LABORATORY consolidation tests plus analysis of field conditions indicated by subsurface explorations are useful in estimating the amount and rate of settlement of embankments or bridges to be expected due to an increase in applied load. However, correlation of such analysis with recorded field displacements is needed, particularly in evaluating boundary drainage conditions for primary consolidation and in evaluating secondary time-consolidation effects which are independent of boundary drainage conditions.

This paper presents observations of settlements at four different sites along the Potomac River near Washington, D. C., as shown in figure 1, and their correlation with laboratory test results and analysis. Field data were obtained by the Bureau of Public Roads and the District of Columbia Department of Highways, and the tests were made in the Bureau laboratory.

Summary

The total settlements indicated by the field observations were in substantial agreement with the values calculated from laboratory compressibilities. The maximum difference was about 20 percent. Primary consolidation accounted for substantially all of the observed settlements except for the peaty material at one location, where secondary consolidation was quite appreciable. The rate of consolidation in clay with sand lenses was somewhat more rapid than that calculated for purely vertical consolidation, although much less rapid than would have been derived for free draining lenses.

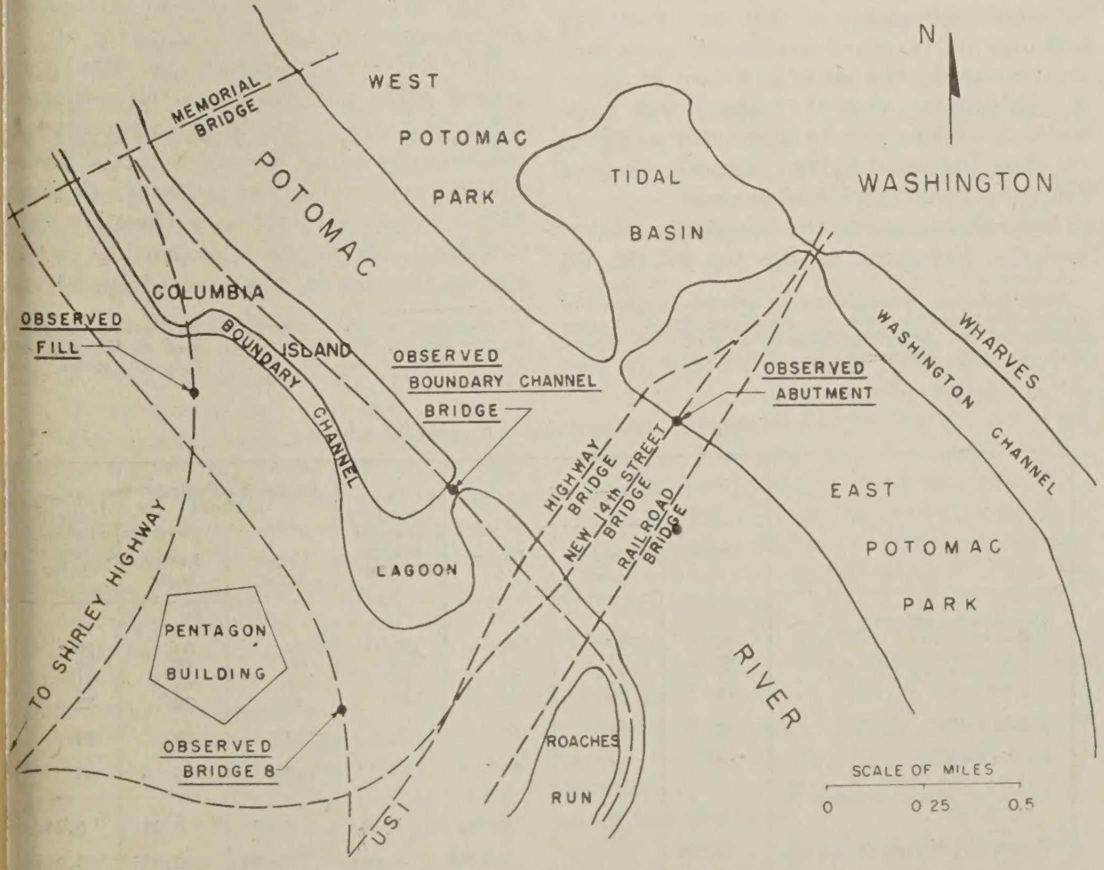


Figure 1.—Location of observed settlements.

Test Methods

Consolidation tests were made on undisturbed samples taken from each soil layer by the suggested method of test for consolidation of soil.[1] Illustrative consolidation test results are given in table 1 and the physical properties of the several soils over which settlements were observed are shown in table 2. Using the data from the consolidation tests, the coefficients of compressibility and consolidation for the loads appropriate to each problem were calculated by the methods shown in figure 2.

Loading intervals of 24 hours were used for obtaining all reduction in thickness values except for the samples from the upper layer of Bridge 8. In the latter instance, the time interval was 96 hours.

Fill on Three Compressible Layers

As part of the road network around the Pentagon, a 35-foot rolled fill of silty soil was constructed over a tidal flat at the location marked "observed fill" in figure 1.

Samples taken from borings at this location disclosed three layers of compressible soil, as shown in the cross section at the top of figure 3. Therefore, settlement of the embankment was anticipated but it was decided to raise the grade line of the roadway on the embankment at the bridge ends where necessary rather than excavate the soils in layers 1, 2, and 3 of the foundation and thus eliminate the settlement.

Using the coefficients of compressibility and consolidation obtained from consolidation tests, the computed time-settlement curves, shown in figure 3, were drawn before construction started. The points for

---

[1] *Procedures for testing soils,* American Society for Testing Materials, 1950, p. 240.

Table 1.—*Illustrative consolidation test results*[1]

	Layer		
	1	2	3
Percentage reduction in thickness for pressures of:			
0.02 kip per sq. ft	0.0	0.0	0.0
1 kip per sq. ft	5.1	14.8	1.5
2 kips per sq. ft	9.5	28.1	2.7
4 kips per sq. ft	18.4	39.7	4.3
8 kips per sq. ft	25.1	49.7	6.4
Average percentage of consolidation after:			
0.09 minute	10	9	22
.25 minute	14	13	28
.49 minute	18	17	33
1 minute	24	23	38
4 minutes	38	33	61
25 minutes	57	51	81
Initial sample thickness, inches	0.49	0.49	0.49
Initial moisture content, percent dry weight	73	232	22
Initial wet density, pounds per cu. ft	95	73	128

[1] The fill on the Pentagon network, designated "observed fill" in figure 1.

plotting the curves were calculated from the following formula based on an average vertical permeability and average compressibility:

$$t=T\sum mH\sum\frac{H}{mc_v}\ \ldots\ldots\ldots\ldots\ldots\ldots\ (1)$$

in which

t=time in years for a given degree of settlement.

T=time factor.

m=coefficient of compressibility.

c_v=coefficient of consolidation.

H=thickness of each layer.

The calculations for the two summations are shown in table 3. The time factors T are taken from table 4. In table 3, 2.69 feet is the maximum calculated settlement in the three layers due to the weight of the 35-foot fill. Thus, for 50-percent consolidation, or 1.34 feet, and drainage from two faces, the time would be, using equation (1), $t=0.05\times0.625\times6{,}130=191.6$ days=0.52 year.

Similar calculations were made for other percentages of consolidation to obtain data for plotting the computed curve for two drainage faces in figure 3. Adjustments were made for the period of load increase indicated at the top of the graphs in figure 3.

A similar procedure was followed in deriving the computed curve for one drainage face. For these computations the ratio of the pressure at the drainage face to presure at the impervious face was assumed as 1.00.

The observed settlement curve of figure 3 was drawn by plotting changes in elevation of the settlement plate. The settlement plate was placed during construction of the embankment and consisted of a steel plate 24 inches square to which was screwed a stem consisting of a 1-inch diameter pipe. The plate and first section of stem were placed 2 feet below the original ground surface and a 2-inch guard pipe was placed around the stem. Additional sections of stem and guard were added as the height of the fill increased. After completion of the fill, the guard pipe was capped. Elevation readings referred to a permanent bench mark were taken on the stem at regular time intervals and the fill settlement calculated.

A comparison in figure 3 of observed settlements with those calculated for two drainage faces indicates that the fill may have acted initially as a drain but that its resistance to flow of water from the foundation increased as it became saturated.

Consideration of degree of consolidation in each layer as affected by proximity to a drainage face[2] would make considerable difference in time calculations, but less difference than the uncertainty of boundary drainage. The section of curve designated in figure 3 as "secondary rate" will be discussed subsequently.

Calculations based on samples taken at two other locations on the same fill indicate ultimate settlements of 0.81 and 3.62 feet although the observed settlements were both approximately the same as shown in figure 3. This shows that the subsoil was more uniform with respect to support of a 35-foot fill than indicated by the samples obtained from the three individual borings.

Elevations taken on temporary stakes and the pavement at the top of the fill showed the same settlement as the plate b low the fill, indicating that there was n consolidation within the fill. A similar re ord of no movement within a rolled fill wa previously reported in PUBLIC ROADS.[3]

Displacements at the Boundary Channel Bridge

In 1931, as part of the Memorial Hig way to Mount Vernon, a bridge was bui over Boundary Channel connecting the rive bank to Columbia Island, newly formed b hydraulic fill. The sketch at the top figure 4 shows the deep layer of organ clay under the Boundary Channel Bridg and the adjacent fill. The bridge, consis ing of twin cantilevers with a small su pended span, was supported on piles to ad quate bearing and did not settle. Howeve the bridge buckled due to the lateral pre sure transmitted from the adjacent fi placed on the clay. A bench mark was s in the fill on June 1, 1934. The time, mea ured from the mean time of placement the fill almost 4 years previous, was plotte against the observed fill settlement as show in figure 4. The primary consolidation rel tion for one-dimensional drainage, as give in table 4 for two drainage faces, was a justed in scale to fit the plot of fill settleme as closely as possible, and the fitted theoret cal curve, shown in figure 4, was found b successive trials.

A record of the fill settlement betwee June 24, 1932, and June 1, 1934, was subs quently found. This record, as shown figure 4, agreed with the fitted theoretic curve indicating that the settlement w due to primary consolidation. This se tlement due to consolidation is addition to any that took place due to lateral di placement at the time of placing the fill.

The discrepancy between the fitted the retical curve and the actual fill settleme after 10 years is due to the 5-percent lo increase caused by the addition of 2 feet fill material, which was necessary to mai tain a satisfactory riding surface.

Table 5 shows the consolidation prope ties of samples of clay taken from borin

Table 2.—*Properties of alluvial clays*

	Pentagon fill			Old Boundary Channel Bridge, average	Bridge 8, Pentagon network		New 14th St. Bridge, lower layer
	Layer 1	Layer 2	Layer 3		Upper layer	Lower layer	
Percentage passing:							
No. 10 sieve	100	100	100	100	74	99	100
No. 40 sieve	99	94	98	99	72	97	87
No. 200 sieve	88	70	75	85	59	65	71
0.005 mm	47	25	45	30	27	22	32
Liquid limit	56	120	33	51	61	23	58
Plastic limit	18	24	16	13	13	6	26
Coefficient of consolidation, ft. sq. per day	0.14	0.24	0.10	0.28	0.17	0.46	0.04
Compressibility, sq. ft. per kip	0.043	0.090	0.0088	0.043	0.030	0.006	0.015

---

[2] *Simultaneous consolidation of contiguous layers of unlike compressible soils*, by Hamilton Gray. Transactions of the American Society of Civil Engineers, 1945, p. 1327. Discussion, p. 1345.

[3] *Research on the construction of embankments,* Henry Aaron, W. T. Spencer, and H. E. Marsh PUBLIC ROADS, vol. 24, No. 1, July-Aug.-Sept. 19

ade at the site of the Boundary Channel ridge. The variations in the coefficients consolidation for the samples indicate me sandy strata for which the continuity d extent could not be determined. Condering the pressure of 2.7 kips per square ot, due to the weight of granular fill on e 65-foot layer of organic clay, the 7.0-foot ttlement (4.8+2.2) indicated in figure 4 ould require a compressibility of 0.040 hich compares well with the 0.043 averge of the laboratory test results shown in ble 5. Assuming vertical drainage only, e settlement record indicates a coefficient consolidation c_v of 0.28 foot squared per y. This agrees with the average c_v shown table 5. However, the weighted average rtical c_v is calculated as follows:

$$c_v = \frac{1}{\text{avg. } m \times \text{avg.} \frac{1}{c_v m}} = \frac{1}{0.043 \times 229} =$$

0.10 foot squared per day.

his value is so low as to indicate some latal drainage which could not be evaluated om the data available before the recordg of field settlements.

The similarity of the curves for pier rotaon and fill settlement in figure 4 suggests at the lateral movement of the piers toard each other is controlled by the lateral nsolidation of the clay between the pile roups. Struts placed between the piers low water in August 1945 have had no parent effect on the rotation of the piers.

Secondary Consolidation

The foregoing calculations have assumed rimary consolidation based on soil permeility and location of drainage boundaries. aboratory time-consolidation records often dicate that primary consolidation is folwed by a secondary consolidation charactrized by an approximately linear relaon between thickness change and the logathm of time. The time for secondary conlidation is assumed to be independent of e location of drainage boundaries and apars to be unimportant until the primary nsolidation has slowed down so that its te is equal to the secondary rate, wherepon the secondary rate controls.

Predicted rate of secondary consolidation, ased on a projected linear relation between me from 1 to 24 hours and thickness ange of samples in the laboratory, is own between 7 and 9 years in figure 3, d between 16 and 20 years in figure 4. he fact that the rate of observed moveent is considerably greater than the secndary rate indicates that primary consolation is still predominant.

Evidence of more important secondary nsolidation was found at Bridge 8, a grade paration on the Pentagon road network, a silty clay layer, which was peaty in the pper portion as indicated by the profile figure 5. To support wing walls at elevation 25, piles were driven through 15 feet of rolled fill and 10 feet of dump fill into the clay. Due to the resistance to driving built up in the fill, the piles did not reach the sand and gravel below the clay. When fill was placed around the walls, settlements were observed as shown in figure 5.

In analyzing the record, the observed settlement values were adjusted to eliminate the settlement due to the October 1942 fill, leaving primarily the settlement due to the August 1942 fill. A curve for primary consolidation for simple vertical drainage was fitted to the adjusted curve. As shown in figure 5, the fit was very good up to 8 months or 90 percent of the indicated primary consolidation.

The thickness change of the laboratory samples of the peaty clay plotted against logarithm of time was linear from 1 to 96 hours and showed a secondary settlement per logarithmic cycle of 20 percent of the total for each load increment. If this secondary consolidation is assumed to start at 8 months, it would account for an additional settlement at 80 months of 20 percent of the indicated primary settlement or 0.2×0.71=0.14 foot. The observed difference between the adjusted observation and the fitted primary consolidation at 80 months is 0.96−0.71 or 0.25 foot. The excess (0.25−0.14=0.11) may be due to the secondary consolidation from the fill placed in January 1942. It should be noted that the record of observed settlement is concave upward, indicating that the linear relation shown up to 4 days in the laboratory is not maintained up to 80 months.

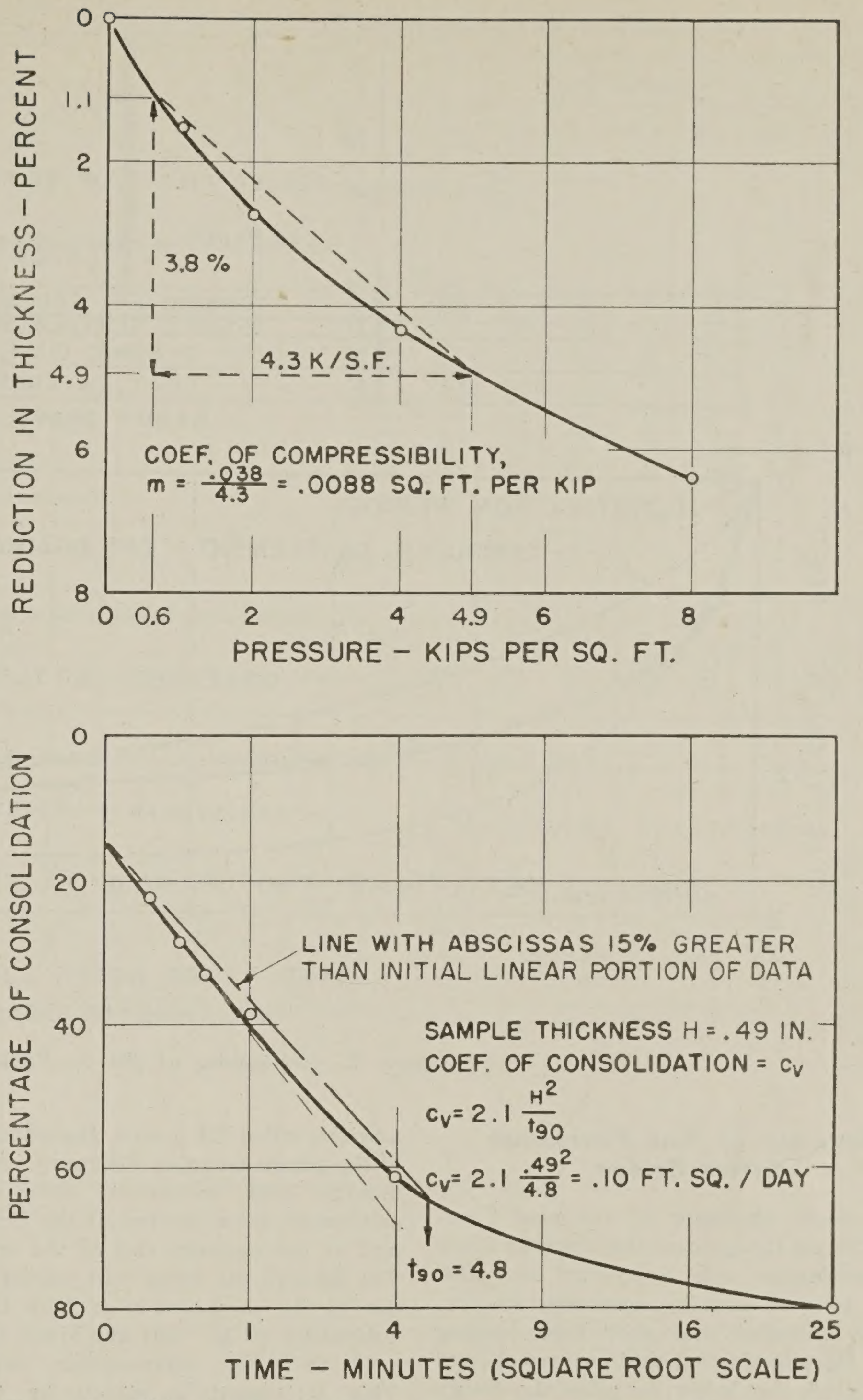


Figure 2.—Plot of consolidation test results: third layer of Pentagon fill.

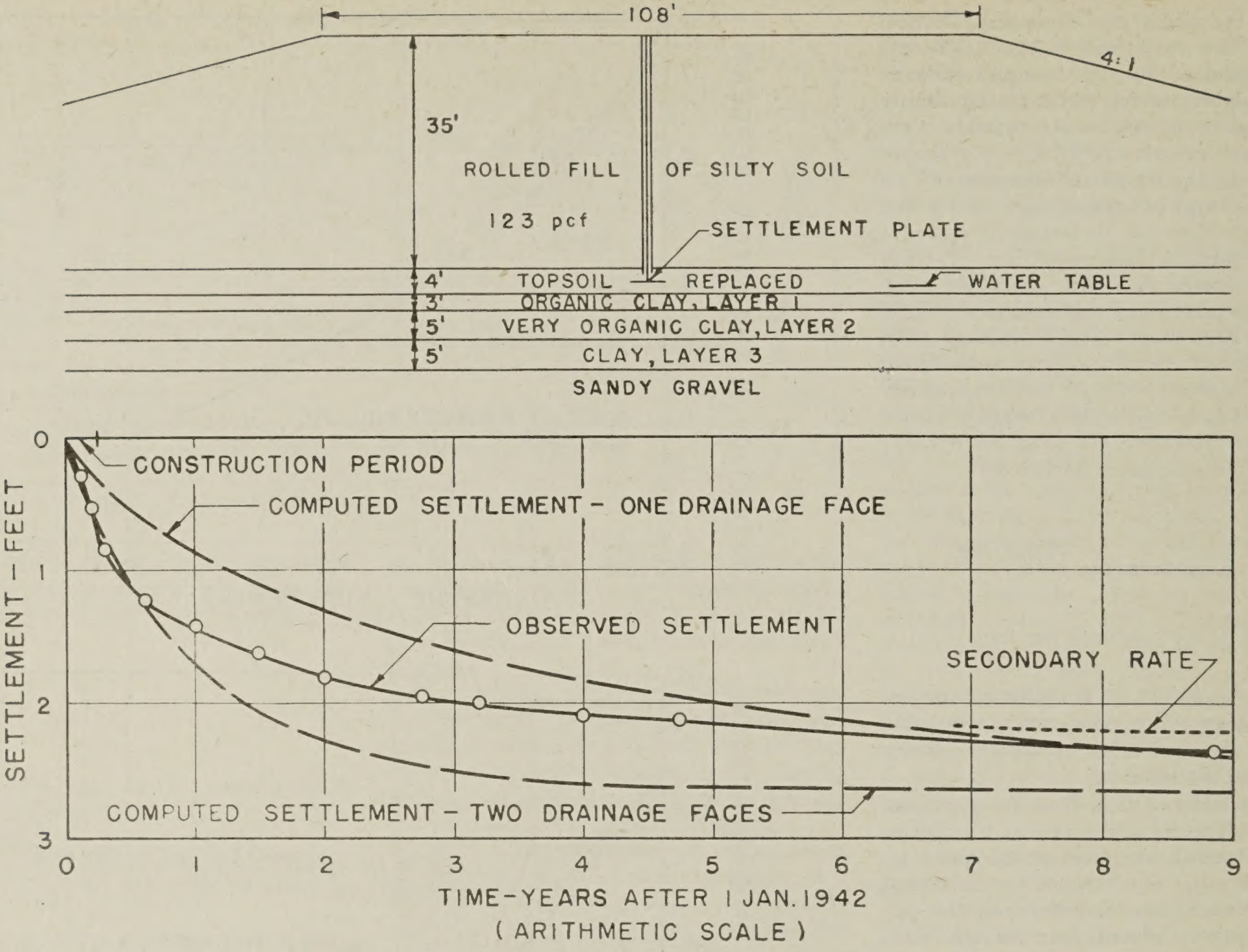


Figure 3.—Settlement of fill on Pentagon network.

Abutment of New Fourteenth Street Bridge

The north abutment of the new Fourteenth Street Bridge over the Potomac River at Washington was supported on piles driven to good bearing according to pile-driving formulas and short-time loading tests. Despite the fact that borings showed soft organic clay below the piles, the design was approved because no trouble had been experienced with the old bridge, which is situated nearby on a similar foundation. Subsequent investigation disclosed that the old abutment had settled 11 inches but without damaging the simply supported truss span. The presence of the settlement was obscured by the general settlement of the adjacent reclaimed marsh and the use of the abutment as a bench mark. An equal settlement could not be tolerated on the new bridge with continuous plate-girder spans. When the new abutment had settled 18 inches at the fill end of the wing walls and 2 inches at the bridge seat, it was decided to underpin the structure with steel piles driven to sand and gravel below the soft clay. An important factor in making this decision was the fact that the bridge seat had also moved 3 inches toward the fill.

The abutment, as shown at the top of figure 6, was built above the original ground and the rolled fill placed, the middle of the filling period being in February 1949. Four months later, continuous observations of settlement were started at the bridge seat and at the opposite end of the wing wall. The fill and the wing wall settled together due to the compression of both the upper (elevation +7 to —40) and lower (elevation —40 to —80) compressible soil layers. This settlement is shown by the solid portion of the lower curve in figure 6. The settlement of the bridge seat was due primarily to the consolidation of the lower layer, to which the piling was driven; there was no fill directly above the area under the bridge seat. The solid portion of the upper curve in figure 6, obtained by plotting settlement of the bridge seat against the square root of time, is linear except for the rebound due to excavation for underpinni
which started 10 months after constructio

Calculations from laboratory tests f
samples taken from borings showed that t
total settlement due to consolidation of t
lower layer caused by the load from the
and abutment would be 8 inches under t
bridge seat and 14 under the wing-wall e

The settlement in the upper soil-lay
under the end of the wing wall was calc
lated by subtracting 14/8 of the observ
bridge seat settlements from the observ
wall settlements. The calculated sett
ment as related to time is shown as the so
portion of the center curve of figure 6.
theoretical primary curve for one dime
sional consolidation was fitted to the calc
lated curve for the upper layer. The p
tions of the theoretical curve that extend l

Table 3.—*Time-consolidation of three-layer system*

Layer	Thickness H	Coefficient of compressibility m	Coefficient of consolidation c_v	mH	$\frac{H}{mc_v}$	Settlement under 4.3 kips per sq. ft.[1] (4.3 mH)
	Feet	*Sq. ft./kip*	*Ft. sq./day*			*Feet*
1...........	3	0.0434	0.14	0.130	490	0.56
2...........	5	.0902	.24	.451	230	1.94
3...........	5	.0088	.105	.044	5,410	.19
Total...	13	....	....	.625	6,130	2.69

[1] 4.3 kips per square foot is approximately the load applied to the three layers by the rolled fill, 35 f high, with a density of 123 pounds per cubic foot.

ıd the calculated values are shown by the
shed lines on the middle curve of figure 6.
When the underpinning was complete, the
vement of the wing wall stopped but the
continued to settle. By adding 14/8 of
projected bridge seat settlement to the
ed primary consolidation curve for the
per soil layer, a predicted curve for fill
tlement was derived and is shown as the
shed extension of the lower curve in fig-
6. A check observation made 24 months
er construction and plotted in figure 6
ws excellent agreement between the com-
ted and the observed fill settlement.

ased on the 8-inch settlement of the
dge seat calculated from test results on
lower layer, 25 percent of primary con-
idation occurred in 6 months, indicating
coefficient of consolidation of 0.11 foot
ıared per day based on vertical consolida-
n. As shown in table 2, the average lab-
tory value is 0.04, showing that the sand
ses had appreciable effect in accelerat-
the settlement.

Table 4.—*Effect of boundaries on time-consolidation*

	Degree of consolidation								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
TIME FACTOR $T=\frac{c_v t}{H^2}$									
Ratio of pressure at drainage face to pressure at impervious face:									
0	0.049	0.100	0.154	0.217	0.29	0.38	0.50	0.66	0.95
.2	.027	.073	.126	.186	.26	.35	.46	.63	.92
.4	.016	.056	.106	.164	.24	.33	.44	.60	.90
.6	.012	.042	.092	.148	.22	.31	.42	.58	.88
.8	.010	.036	.079	.134	.20	.29	.41	.57	.86
1.0	.008	.031	.071	.126	.20	.29	.40	.56	.85
1.5	.006	.024	.058	.107	.17	.26	.38	.54	.83
2	.005	.019	.050	.095	.16	.24	.36	.52	.81
3	.004	.016	.041	.082	.14	.22	.34	.50	.79
5	.003	.013	.034	.069	.12	.20	.32	.48	.77
10	.003	.011	.028	.060	.11	.18	.30	.46	.75
Infinity	.002	.009	.024	.048	.09	.16	.28	.44	.73
Two drainage faces	.002	.008	.018	.031	.05	.07	.10	.14	.21
TIME FACTOR $T=\frac{c_v t}{D^2}$									
Ratio of well diameter to effective spacing *D*:									
0.01	.046	.104	.167	.24	.33	.44	.58	.78	1.10
.025	.032	.075	.124	.180	.25	.33	.44	.58	.86
.1	.014	.037	.064	.096	.132	.178	.24	.32	.44
.2	.006	.019	.035	.054	.077	.105	.14	.19	.29

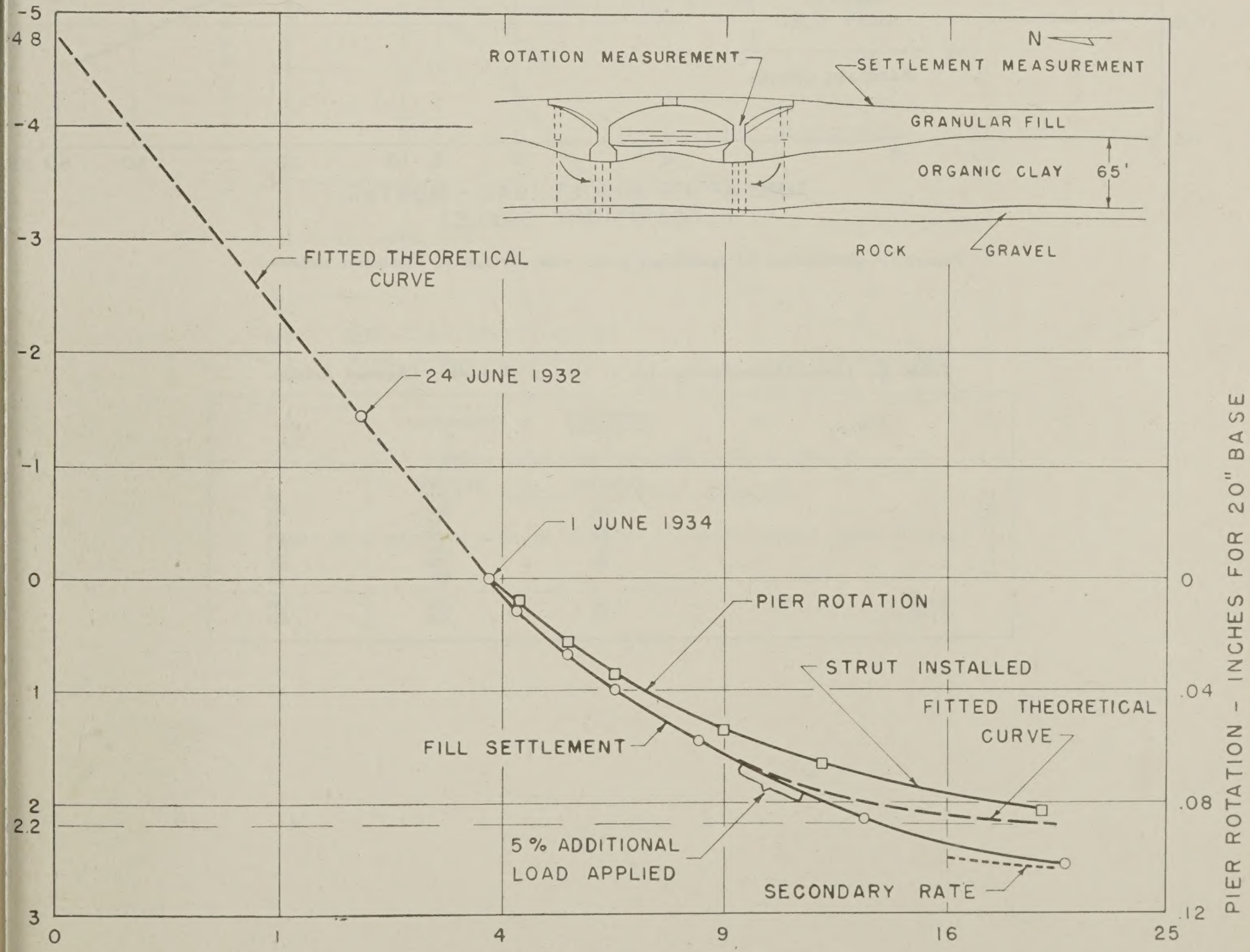


Figure 4.—Fill settlement and pier rotation at Boundary Channel Bridge.

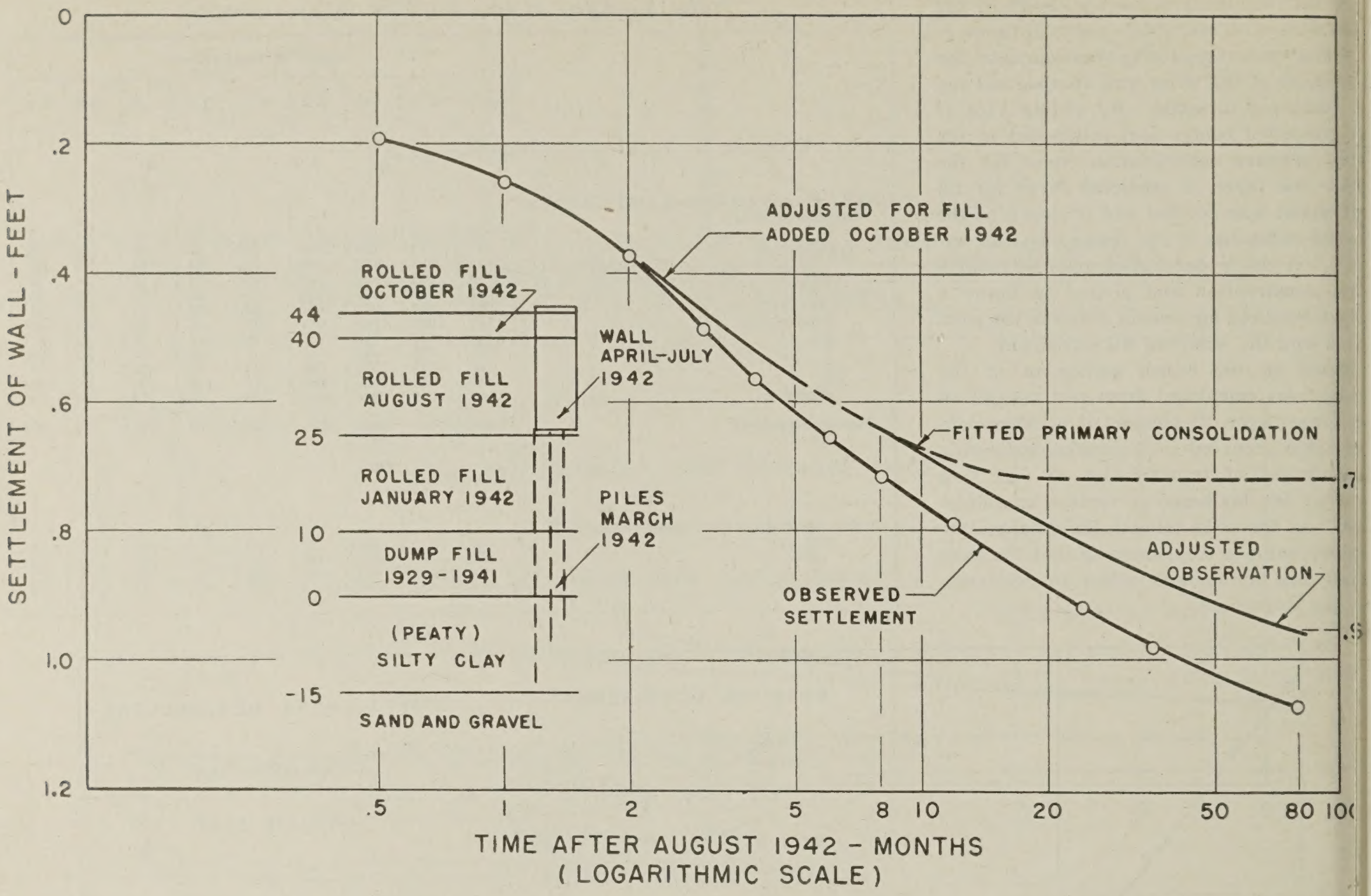


Figure 5.—Settlement of north-east wing wall, Bridge 8, Pentagon network.

Table 5.—*Consolidation properties of clay at Boundary Channel Bridge*

Sample	Coefficient of consolidation c_v	Compressibility m	$\frac{1}{c_v m}$
	Ft. sq./day	*Sq. ft./kip*	
3A	0.35	0.049	58
3B	.03	.059	566
4	.28	.046	78
5	.07	.033	430
6	.14	.046	155
11	.08	.050	250
12	1	.020	50
Total	1.95	.303	1,587
Average	.28	.043	229

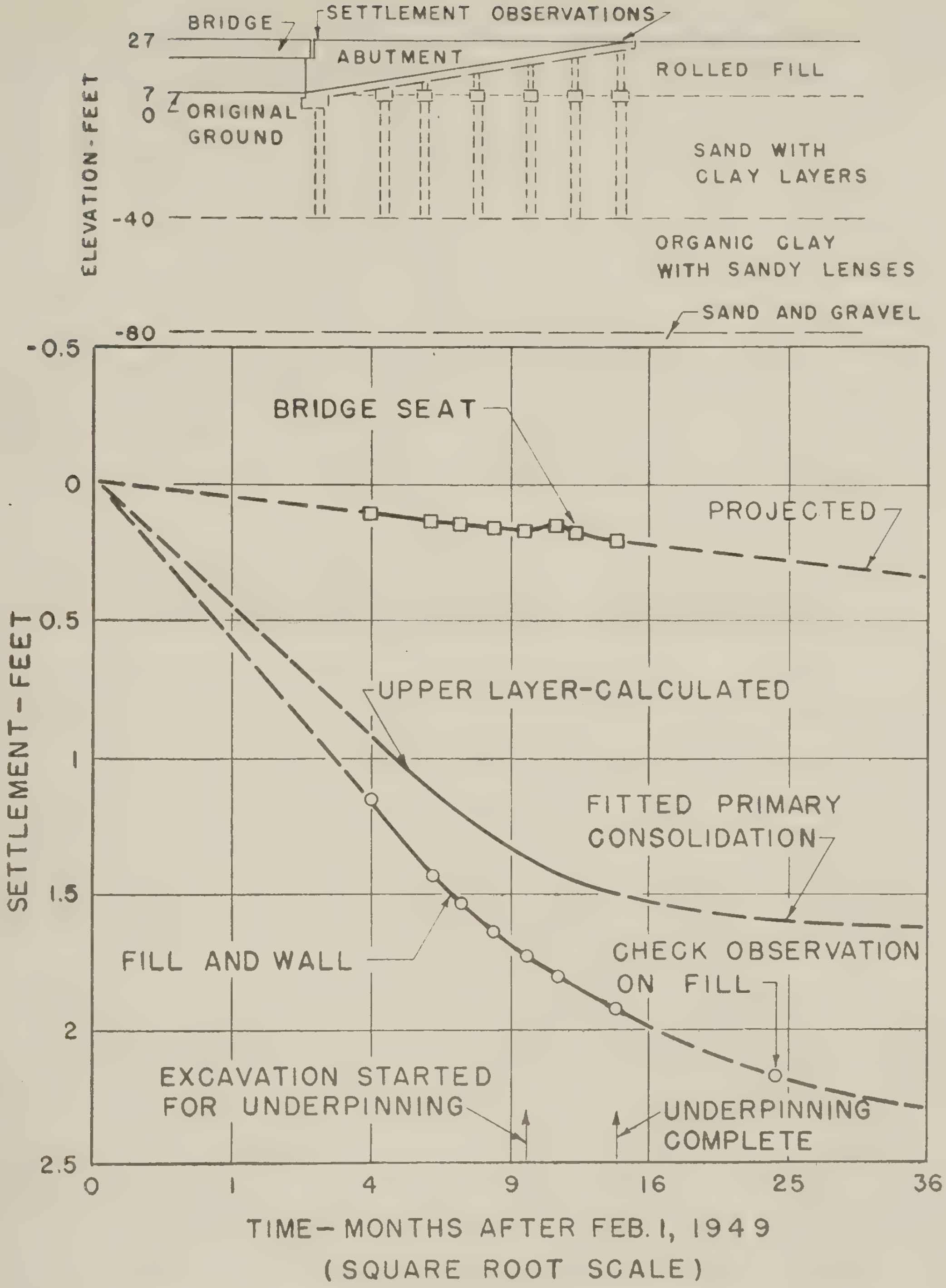


Figure 6.—Settlement at north abutment of new Fourteenth Street Bridge.

Second Inter-American Highway Film

Inter-American Highway Report — Part II, Central America and Panama, a motion picture produced by the Bureau of Public Roads, is now available for lending to interested organizations. The 16-millimeter sound and color film, with a running time of 62 minutes, shows the present condition of the southerly 1,600 miles of the Inter-American Highway extending from the Guatemala-Mexico boundary through the Central American Republics of Guatemala, El Salvador, Honduras, Nicaragua, and Costa Rica and thence through Panama to Panama City. *Inter-American Highway Report—Part I, Mexico,* covering the northern 1,700 miles of the highway, was announced in Public Roads, vol. 26, No. 10, October 1951.

Inter-American Highway Report—Part II is a study in rich, colorful, and vivid contrasts. Portions of the route are in splendid condition. On others no work has been done and the cars of the motion-picture men had to be dragged across muddy quagmires and through deep river fords. There are modern, bustling capital cities to compare with primitive rural villages, ox carts to contrast with present-day motor-vehicle traffic, handicrafts which hark back to the earliest times side by side with twentieth-century industrial plants, and an ever-changing kaleidoscope of beautiful scenery, historic structures, ancient ruins and Indian temples, and beautiful cathedrals.

Animated charts show the bypass around the uncompleted section in northern Guatemala as well as the steamship journey on the bypass route from Costa Rica to Panama. Animated maps are flashed upon the screen at the conclusion of the pictures for each country. These maps locate the capitals and give the location and mileage of the passable and impassable sections.

Sections of modern highway, up-to-date bridges spanning wide rivers, garages, f ing stations, haciendas, hotels, and all the other attributes of a main route, which will some day make touring through Central America a must for the motorist, appe The picture summarizes the present condition of this great thoroughfare—a unit of the greater Pan American Highway which will some day join North and South America—and gives an accurate appraisal of the work that still remains to be done before it will be possible for the casual motorist to essay the journey over the entire route.

Inter-American Highway Report — Part II, Central America and Panama, may be borrowed by any responsible organization, without cost except for the nominal transportation charges, by writing to the Visual Education Branch, Bureau of Public Roads, Washington 25, D. C.

Traffic Trends on Rural Roads in 1950

Y THE HIGHWAY TRANSPORT RESEARCH BRANCH
UREAU OF PUBLIC ROADS

Reported by
THOMAS B. DIMMICK,
Head, Current Data Analysis Unit

Total travel on rural roads in 1950 broke all records, exceeding the 1949 previous high by 9 percent and the 1941 prewar peak by 38 percent. On the 350,000 miles of main rural roads in the United States, travel in 1950 was over 174 billion vehicle-miles, of which 76 percent was by passenger cars, 1 percent by busses, and 23 percent by freight-carrying vehicles.

Trucks and combinations hauled 36 percent more ton-mileage of freight in 1950 than in 1949 and 106 percent more than in 1941, the increase resulting largely from greater use of heavier vehicles. Truck combination travel was 33 percent higher than in 1949 and 145 percent higher than in 1941. Comparable figures for single-unit trucks were 12 and 43 percent. The average carried load for all trucks and combinations in 1950 was 10 percent above the average in 1949 and 55 percent above that in 1941.

In 1950 almost 7 percent of all trucks and combinations exceeded a State legal weight limit, and 19 percent of the combinations were illegally overloaded in some particular. In comparison with 1949, the percentage of overweight vehicles for 1950 increased in all regions except in the South Atlantic States.

MOTOR-VEHICLE TRAVEL broke all previous records in 1950 for the fifth onsecutive year. The 1950 traffic on all ural roads was almost 9 percent higher han in 1949, 18 percent higher than in 1948, 26 percent higher than in 1947, almost 38 percent higher than in 1946, and slightly more than 38 percent higher than the 1941 prewar peak. Geographically, the increases over 1949 ranged from 7 percent in the western States to 8 percent in the eastern States and 10 percent in the central States. The largest increase over 1949 in any of the United States census regions[1] was 15 percent in the East South Central region. The smallest increase was 4 percent in the Pacific region. Records from about 900 automatic traffic recorders, operated continuously throughout the year at permanent stations on main and local roads in all States, were used generally to establish these trends. More extensive traffic surveys, made by a number of States, yielded valuable information concerning the total volume of rural traffic within their boundaries. Consideration has been given to all such available data in this analysis. Where States have prepared and submitted vehicle-mile travel estimates of their own, these have been employed rather than estimates made by applying trend factors.

---

[1] The States comprising each census region are indicated in table 1.

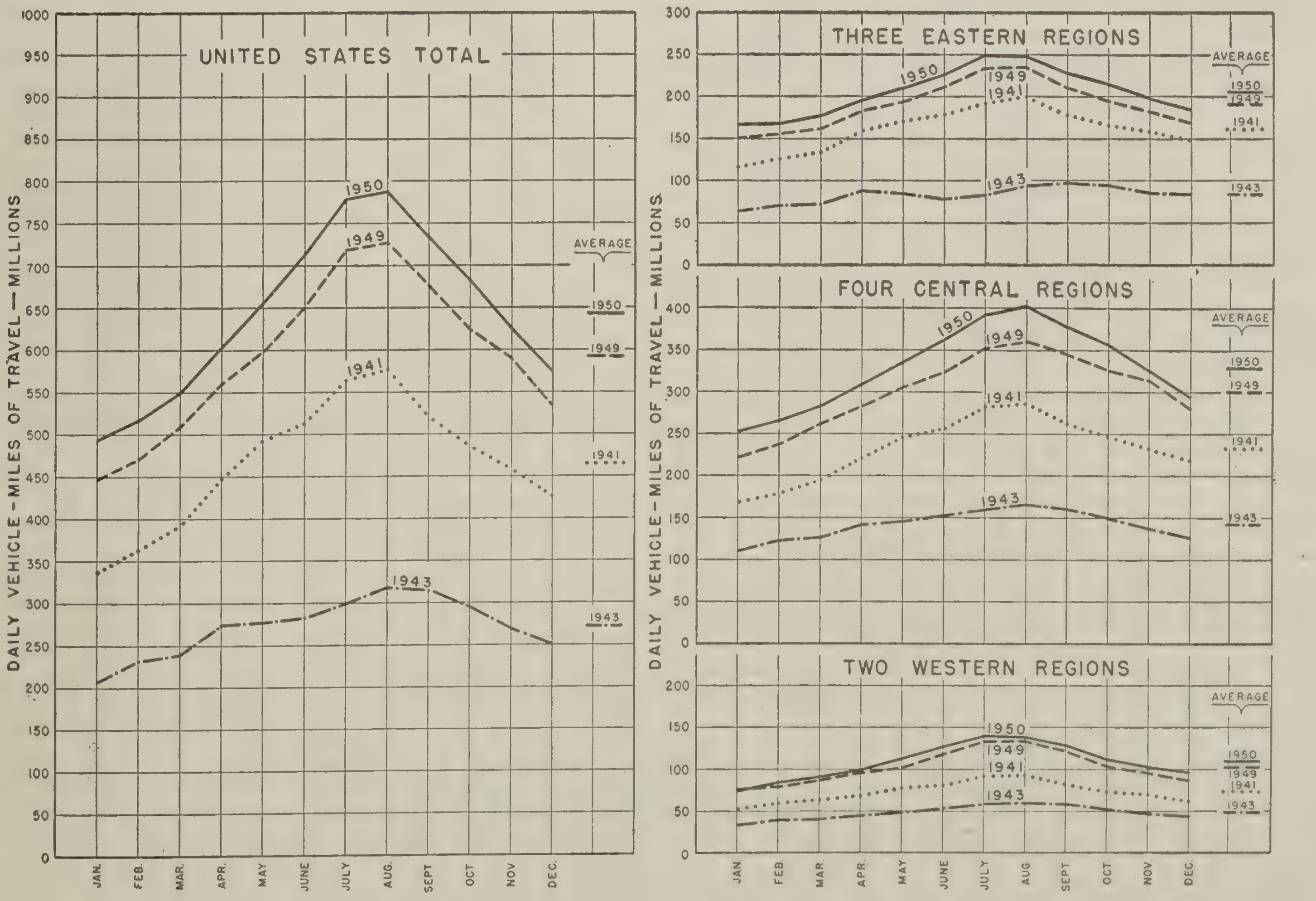


Figure 1.—Travel on all rural roads in 1941, 1943, 1949, and 1950, by months.

The variation in average daily travel on rural roads by months in the three main geographic divisions and in the United States as a whole is illustrated in figure 1 for the years 1950, 1949, 1943, and 1941, the latter being the prewar peak year. Travel in each month of 1950 in the eastern and central regions and in the United States as a whole was well above that of the corresponding month of the earlier years. The western region showed a slight decrease in January from 1949 to 1950.

Summer travel constituted a greater portion of the annual travel in 1950 than in any recent year. In the last two prewar years (1940 and 1941) the average daily traffic in July and August was 23 percent above the average daily traffic for the year. During the war this seasonal travel was reduced drastically, the average daily traffic in July and August being only 13 percent above the annual average in 1942 and 1943. Not until 1949 did vacation and other summer driving form as large a proportion of the year's travel as in the prewar years. In 1950 the average daily traffic on rural roads in July and August was slightly more than 24 percent above the annual average, a percentage even higher than in 1940 and 1941.

Source of Information

The large number of automatic traffic recorders operated on the rural roads of each State give a good indication of the trend of total traffic on those highways but provide no indication of the classification of vehicles by type, weight, or other characteristics. During certain prewar years, generally 1936 or 1937, nearly every State conducted a comprehensive survey of traffic in which all vehicles counted were classified by type. At the same time a large number of trucks and truck combinations were stopped and information recorded concerning their weight, dimensions, and other important features.

In order to determine the wartime trend in weights, dimensions, and other characteristics of commercial vehicles, a brief check survey was made in the summer of 1942 at certain typical stations in most States. From strictly comparable information gathered in the two surveys, trends were calculated which were used to determine the changes in traffic and vehicle characteristics that had taken place since the comprehensive survey was made. Since 1942, check surveys have been made annually. Most States have participated in these each year and all have participated at some time.[2] Forty-five States conducted such surveys in 1950.

Classification counts made in numerous States, in addition to those made at the weight stations, added valuable information concerning vehicle-type proportions. In a few States greatly expanded loadometer surveys have furnished more reliable data concerning vehicle types and weights than can be obtained from the trend data alone, and these have been used in the analysis when available.

Table 1.—***Survey period, number of stations operated, number of vehicles counted and number weighed in each State in the special weight surveys, summer of 1950***

Region and State	Survey period	Number of stations	Total vehicles counted	Trucks and truck combinations	
				Counted	Weighed
New England:					
Connecticut	July 24–Aug. 17	10	33,055	6,611	2,135
Maine	July 26–Aug. 11	10	27,710	5,453	2,311
Massachusetts	Aug. 7–Aug. 22	10	39,757	7,108	2,448
New Hampshire	Aug. 7–Aug. 11	5	14,753	2,061	610
Rhode Island	July 17–July 21	5	13,881	2,643	1,202
Vermont	July 31–Aug. 4	5	9,860	775	775
Subtotal		45	139,016	24,651	9,481
Middle Atlantic:					
New Jersey	Aug. 14–Aug. 29	10	83,027	16,354	1,590
New York	Aug. 1–Sept. 5	20	33,536	8,419	1,747
Pennsylvania	July 19–Sept. 21	14	56,742	13,042	2,680
Subtotal		44	173,305	37,815	6,017
South Atlantic:					
Delaware	Aug. 10–Aug. 23	9	40,861	8,547	1,443
Florida	No survey				
Georgia	Aug. 8–Oct. 24	18	25,107	6,701	3,485
Maryland	Aug. 14–Sept. 13	10	42,975	9,570	1,236
North Carolina	Aug. 8–Aug. 29	12	29,462	7,194	4,276
South Carolina	Sept. 11–Sept. 22	10	19,181	5,368	2,031
Virginia	Aug. 2–Aug. 15	10	25,030	6,003	3,926
West Virginia	Aug. 8–Aug. 24	9	14,381	3,762	1,418
Subtotal		78	196,997	47,145	17,815
Eastern regions, subtotal		167	509,318	109,611	33,313
East North Central:					
Illinois	No survey				
Indiana	Aug. 2–Aug. 29	20	51,375	12,849	5,295
Michigan	June 13–June 27	9	22,620	4,665	1,682
Ohio	July 18–Aug. 3	10	28,841	5,599	1,357
Wisconsin	Aug. 1–Sept. 29	10	24,502	4,879	1,080
Subtotal		49	127,338	27,992	9,414
East South Central:					
Alabama	July 18–Aug. 25	10	13,318	3,290	2,495
Kentucky	Aug. 2–Sept. 14	6	9,532	2,741	1,222
Mississippi	July 10–July 28	15	25,197	6,635	3,617
Tennessee	Aug. 1–Sept. 7	10	13,749	3,845	1,472
Subtotal		41	61,796	16,511	8,806
West North Central:					
Iowa	July 24–Aug. 23	10	13,937	2,679	2,674
Kansas	July 17–Aug. 12	10	11,089	2,263	993
Minnesota	July 10–Aug. 25	19	23,238	3,860	1,906
Missouri	July 31–Aug. 28	16	139,548	27,732	9,820
Nebraska	July 20–Aug. 29	20	24,011	5,250	5,157
North Dakota	July 20–Aug. 30	14	22,689	5,233	2,213
South Dakota	June 23–Sept. 20	11	9,985	1,350	1,149
Subtotal		100	244,497	48,367	23,912
West South Central:					
Arkansas	Sept. 11–Sept. 29	10	18,638	6,333	1,523
Louisiana	July 31–Aug. 4	10	11,769	3,460	925
Oklahoma	July 17–Aug. 14	10	15,512	3,443	3,225
Texas	June 1–Aug. 31	20	98,441	21,032	5,372
Subtotal		50	144,360	34,268	11,045
Central regions, subtotal		240	577,991	127,138	53,177
Mountain:					
Arizona	July 10–July 21	10	9,923	2,043	857
Colorado	Aug. 3–Aug. 22	13	26,180	4,266	915
Idaho	No survey				
Montana	July 31–Sept. 1	9	9,477	1,921	1,108
Nevada	Aug. 1–Aug. 18	10	7,613	1,084	988
New Mexico	July 31–Aug. 14	10	14,371	3,251	1,467
Utah	July 7–Aug. 4	10	18,954	3,595	1,306
Wyoming	July 31–Aug. 18	10	12,625	2,386	891
Subtotal		72	99,143	18,546	7,532
Pacific:					
California	May 31–July 7	20	[1] 80,740	14,855	5,117
Oregon	Aug. 8–Sept. 1	8	16,456	3,251	2,179
Washington	June 5–Oct. 10	20	97,088	17,373	12,984
Subtotal		48	194,284	35,479	20,280
Western regions, subtotal		120	293,427	54,025	27,812
United States total		527	1,380,736	290,774	114,302

[1] Passenger cars not counted; figure given is an estimate based on data from other reports.

1950 Summer Loadometer Surve

The stations used in these check surve were selected initially to give a represent tive cross section of traffic on main ru roads. They were operated for one or mo 8-hour periods on a weekday, generally fr

---

[2] See *Traffic trends on rural roads*, by T. B. Dimmick, PUBLIC ROADS, vol. 26, No. 5, Dec. 1950; vol. 25, No. 12, Feb. 1950; vol. 25, No. 7, Mar. 1949; vol. 25, No. 3, Mar. 1948; vol. 24, No. 10, Oct.-Nov.-Dec. 1946; and *Amount and characteristics of trucking on rural roads*, by J. T. Lynch and T. B. Dimmick, PUBLIC ROADS, vol. 23, No. 9, July-Aug.-Sept. 1943.

her 6 a. m. to 2 p. m., or from 2 p. m. to p. m. All traffic passing through the stans during the period was counted and ssified into the following categories: Lo- passenger cars; foreign (out-of-State) ssenger cars; panel and pick-up trucks;[3] ıer two-axle, four-tire trucks; two-axle, -tire trucks; three-axle trucks; truckıctor and semitrailer combinations; truck d trailer combinations or truck-tractor nitrailer and trailer combinations; and sses. The combination-type vehicles were rther subdivided according to the number axles of each.[4]

Most of the weight stations were operated ring July, August, and September. The rvey period, number of stations operated, mber of vehicles counted, and number ighed are shown for each State in table More than 1.38 million vehicles were ınted at all stations during the period of survey. Slightly more than one-fifth of se were freight-carrying vehicles, of ıich almost 40 percent were weighed.

Wherever traffic volume permitted, every ıck and truck combination was stopped d weighed. Where this procedure was practicable all of the less common types re weighed and the common vehicle types re weighed in sufficient numbers to estabh their characteristics from the sample. ıe type of vehicle, whether loaded or ıpty, the number of axles, and the weight each axle were recorded. The axleacing and total wheelbase length of the avier vehicles[5] were measured, and the mmodity carried and the type of operaın—private or for-hire—were recorded. ıssenger cars and busses were counted but t stopped for weighing.

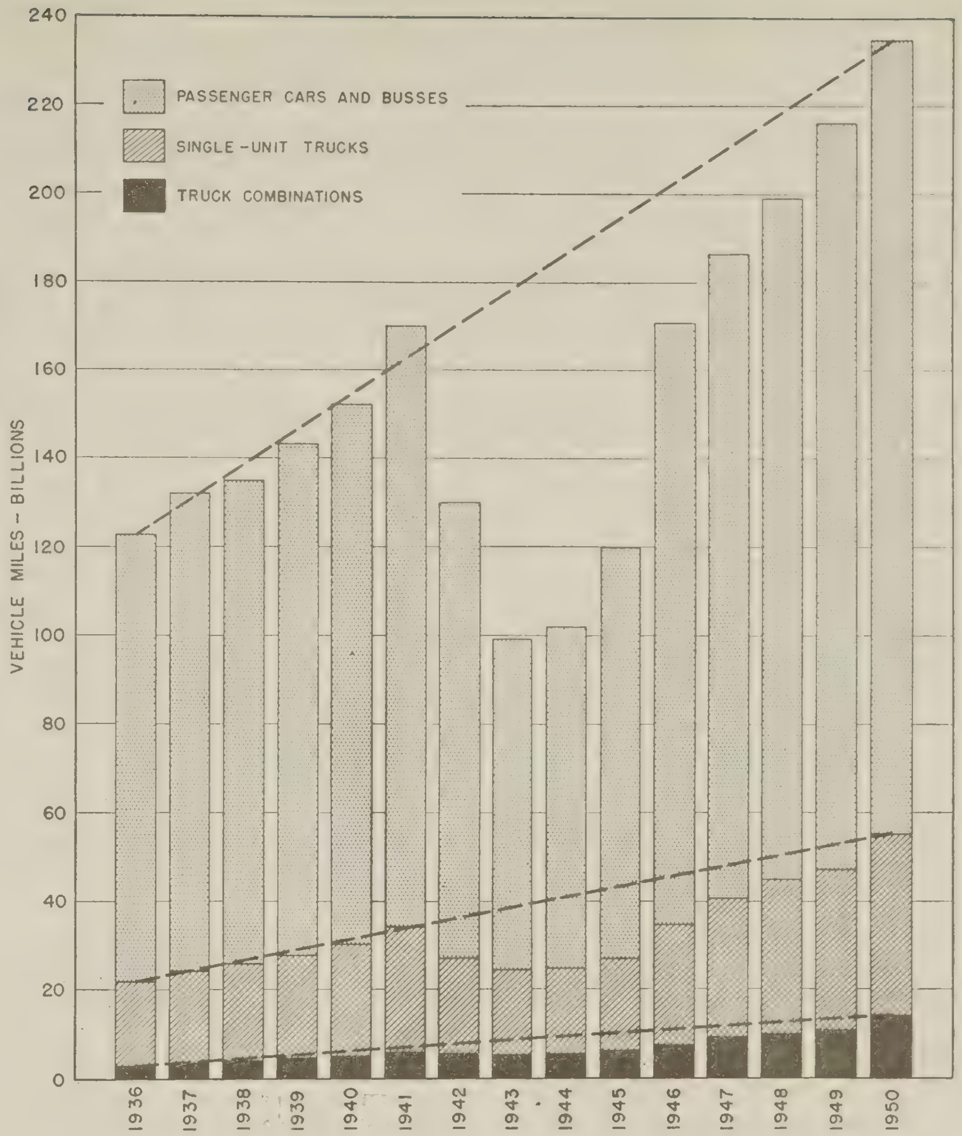


Figure 2.—Travel on all rural roads, 1936-50, by classes of vehicles.

Prewar Traffic Trend Increased

Figure 2 shows in chart form the vehicleileage of travel on all rural roads, by pes, for each year from 1936 to 1950, inclusive.[6] It is apparent that the effect of the drastic restrictions of travel during the war period, 1942–45, caused but a temporary dip in traffic growth and that the 1950 vehicle-mileage was as high as would have been estimated by any rational projection of the prewar trend. A straight line from the top of the bar for 1936 to the top of the bar for 1950 passes through the top of the bar for 1937, cuts below the top of the bar for 1941, and falls well above the tops of the bars for all other years.

Travel by trucks and truck combinations increased in a manner very similar to that observed for all vehicles. For truck combinations alone, the 1936–50 line lies above the tops of all bars from 1937 to 1949, inclusive, thus showing an accelerating upward trend in the travel by these heavier vehicles. This is emphasized by other trend data, given in other portions of this report.

---

[3] Single-unit trucks with a carrying capacity of less ın 1½ tons.

[4] In this article, the term "truck" is used to indicate single-unit vehicle; "truck combination" to indi:e truck-tractor semitrailer (with or without full ıiler) and truck with full trailer; and "trucks and ıck combinations" or "trucks and combinations" to licate all of these vehicles together.

[5] Trucks and truck combinations weighing 13 tons or ɪre, or having an axle weighing 18,000 pounds or ɪre.

[6] In a similar figure in *Traffic trends on rural roads in 1949*, PUBLIC ROADS, vol. 26, No. 5, Dec. 1950, the bar for 1938 was shorter than it should have been. The current figure is correctly plotted.

Table 2.—*Ratio of 1950 traffic on main rural roads to corresponding traffic in 1949*[1]

Vehicle type	Eastern regions				Central regions					Western regions			United States average
	New England	Middle Atlantic	South Atlantic	Average	East North Central	East South Central	West North Central	West South Central	Average	Mountain	Pacific	Average	
Passenger cars:													
Local	1.07	1.03	1.11	1.07	1.02	1.11	1.07	1.13	1.07	1.18	1.03	1.04	1.06
Foreign	1.04	1.06	1.11	1.08	1.19	1.16	1.10	1.13	1.16	1.08	1.02	1.06	1.11
All passenger cars	1.06	1.04	1.11	1.07	1.07	1.12	1.07	1.13	1.09	1.13	1.03	1.04	1.07
Trucks and combinations:													
Single-unit trucks	1.16	1.09	1.10	1.11	1.08	1.16	1.09	1.12	1.12	1.10	1.13	1.12	1.12
Truck combinations	1.32	1.23	1.34	1.31	1.39	1.34	1.14	1.22	1.32	1.28	1.36	1.35	1.33
All trucks and combinations	1.19	1.14	1.16	1.16	1.19	1.20	1.10	1.14	1.18	1.13	1.19	1.19	1.18
Busses	1.03	.78	.97	.91	1.17	1.02	1.04	.99	1.06	1.00	1.01	1.01	.99
All vehicles	1.08	1.06	1.12	1.09	1.09	1.14	1.08	1.13	1.11	1.13	1.06	1.07	1.09

[1] The ratios for "all vehicles" are based on year-around automatic recorder data, while those for the individual vehicle types are based principally on summer counts.

Table 3.—*Percentage distribution of travel, by vehicle type and by type of operation, on main rural roads in the summer of 1950*

Vehicle type	Eastern regions				Central regions					Western regions			United States average	U. S. percentage distribution of trucks and truck combinations by type of operation		
	New England	Middle Atlantic	South Atlantic	Average	East North Central	East South Central	West North Central	West South Central	Average	Mountain	Pacific	Average		Total	Private	For-hire
Passenger cars:																
Local	55.41	61.97	56.66	58.66	54.73	43.88	59.04	58.74	55.17	43.58	70.97	60.66	57.26	....	....	....
Foreign	24.39	16.17	18.83	18.51	22.64	22.76	15.64	14.99	19.19	32.75	10.33	18.77	18.89	....	....	....
All passenger cars	79.80	78.14	75.49	77.17	77.37	66.64	74.68	73.73	74.36	76.33	81.30	79.43	76.15	....	....	....
Single-unit trucks:																
Panel and pick-up	4.68	4.91	7.52	6.05	5.19	11.93	8.10	10.56	8.12	9.73	4.54	6.49	7.16	31.35	42.38	1.91
Other 2-axle, 4-tire	1.36	.88	.51	.78	.49	.51	.77	.33	.51	.66	.79	.74	.64	2.79	3.70	.37
Other 2-axle, 6-tire	8.04	7.82	7.46	7.69	6.48	12.22	9.21	7.19	8.08	6.22	4.53	5.17	7.45	32.63	36.72	21.68
3-axle	.32	.32	.40	.36	.40	.38	.28	.17	.31	.45	.72	.62	.38	1.68	1.54	2.02
All single-unit trucks	14.40	13.93	15.89	14.88	12.56	25.04	18.36	18.25	17.02	17.06	10.58	13.02	15.63	68.45	84.34	25.98
Truck-tractor and semitrailer combinations:																
3-axle	4.27	5.78	5.01	5.22	5.17	5.53	3.13	4.40	4.57	1.87	.98	1.31	4.23	18.50	10.16	40.79
4-axle	.27	1.33	2.34	1.64	3.24	1.09	2.40	2.41	2.54	1.54	1.36	1.43	2.05	8.99	4.01	22.31
5-axle or more	....	.01	.01	.01	.16	.02	.34	.06	.16	1.21	2.64	2.10	.44	1.94	.61	5.49
All truck-tractor and semitrailer combinations	4.54	7.12	7.36	6.87	8.57	6.64	5.87	6.87	7.27	4.62	4.98	4.84	6.72	29.43	14.78	68.59
Truck and trailer combinations:																
4-axle or less	.03	.02	.02	.02	.16	....	.25	.17	.16	.27	.48	.40	.16	.68	.48	1.21
5-axle	....	.01	(1)	.01	.46	....	.01	.01	.18	.33	.68	.55	.19	.82	.19	2.49
6-axle or more	....	....	(1)	(1)	.09	....	....	....	.04	.26	.99	.72	.14	.62	.21	1.73
All truck and trailer combinations	.03	.03	.02	.03	.71	....	.26	.18	.38	.86	2.15	1.67	.49	2.12	.88	5.43
All combinations	4.57	7.15	7.38	6.90	9.28	6.64	6.13	7.05	7.65	5.48	7.13	6.51	7.21	31.55	15.66	74.02
All trucks and truck combinations	18.97	21.08	23.27	21.78	21.84	31.68	24.49	25.30	24.67	22.54	17.71	19.53	22.84	100.00	100.00	100.00
Busses	1.23	.78	1.24	1.05	.79	1.68	.83	.97	.97	1.13	.99	1.04	1.01	....	....	....
All vehicles	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	....	....	....

[1] Less than 0.005 percent.

Travel Increases

The ratio of traffic volumes on main rural roads in 1950 to the corresponding volumes in 1949 is shown in table 2. Highways classified under the term "main" include about 350,000 miles and, in general, are those of the entire State systems. In such States as North Carolina, Pennsylvania, and Virginia, where all or a large part of the rural-road mileage is under State control, only the mileage in the State primary system is included. The consistent increase in travel on these main highways by most types of vehicles and in all sections of the country is evident in the table.

Travel by both local and foreign (out-of-State) passenger cars, single-unit trucks, and truck combinations increased in all regions. Travel by busses, however, decreased or remained about the same in four regions, declining slightly for the United States as a whole. In general, travel by out-of-State passenger cars increased more than that by local passenger cars, reflecting a higher rate of increase for tourist travel, which is consistent with the increased percentage for t summer peak, already noted.

The increase in travel by all types freight-carrying vehicles amounted to percent, compared to 7 percent for passe ger cars. Truck registrations increased or 7 percent, and greater use of the register vehicles is therefore indicated. Perhaps t most significant fact shown by table 2 s that travel by truck combinations increas much faster than travel by single-u trucks, the increase by these heavier ve cles amounting to 33 percent.

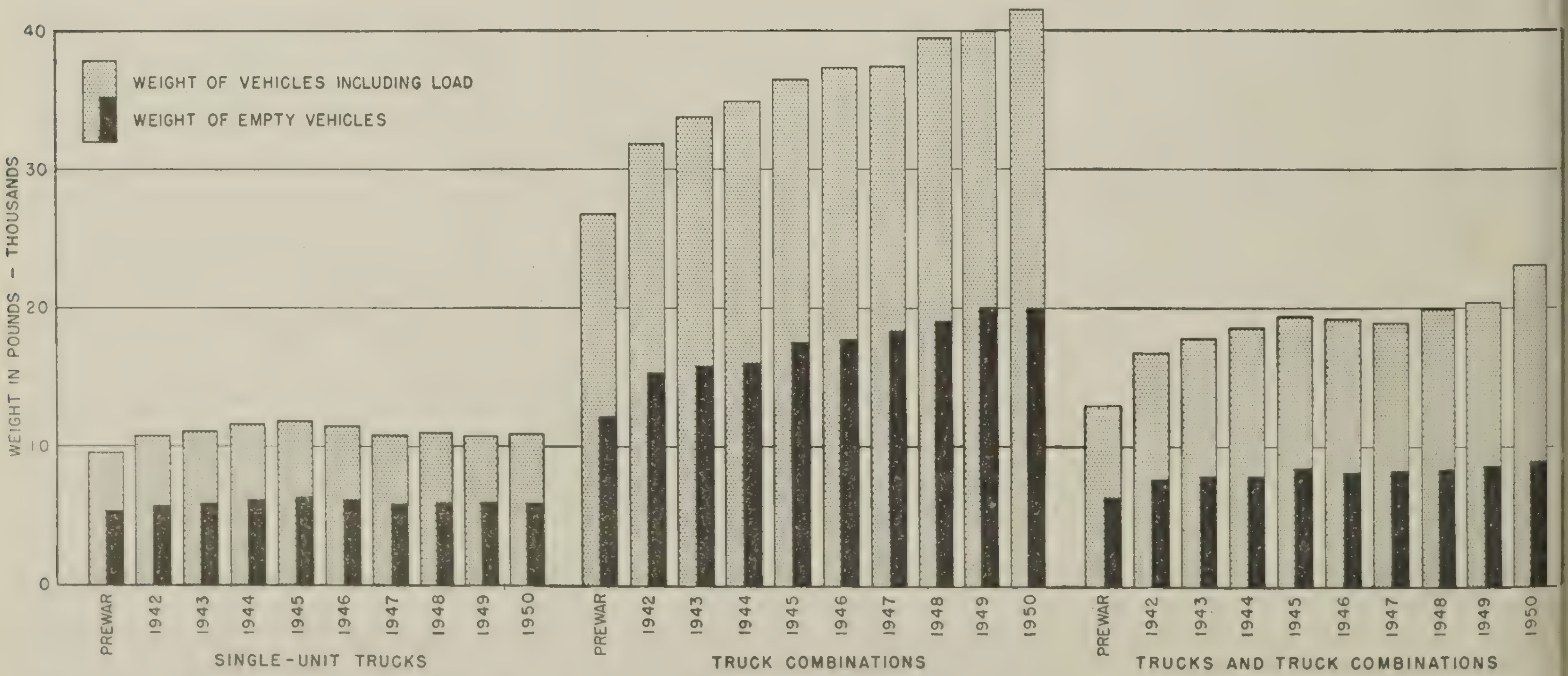


Figure 3.—Average weights of loaded and of empty trucks and truck combinations in the summers of 1942-50 and a prewar year.

Table 4.—*Average weights (in pounds) of loaded and empty trucks and truck combinations, by vehicle types, in the summer of 1950*

Vehicle type	Eastern regions				Central regions					Western regions			United States average	U. S. average by type of operation	
	New England	Middle Atlantic	South Atlantic	Average	East North Central	East South Central	West North Central	West South Central	Average	Moun-tain	Pacific	Average		Private	For-hire
AVERAGE WEIGHTS OF LOADED VEHICLES															
Single-unit trucks:															
Panel and pick-up	4,950	5,356	4,805	5,038	4,822	5,373	5,105	7,129	5,735	5,154	4,351	4,695	5,370	5,367	5,467
Other 2-axle, 4-tire	6,419	8,072	6,436	7,003	6,737	7,295	7,883	6,720	7,177	7,144	5,871	6,148	6,868	6,701	10,419
Other 2-axle, 6-tire	14,577	15,581	13,007	14,288	13,167	14,575	14,025	13,405	13,712	14,184	12,815	13,351	13,853	13,319	16,375
3-axle	29,566	31,246	28,193	29,426	27,291	26,736	26,770	27,252	27,073	32,279	26,552	27,748	27,939	26,974	29,790
Average	11,607	12,540	10,536	11,490	10,505	11,979	10,841	10,131	10,739	10,534	10,219	10,342	10,902	10,118	16,574
Truck combinations:															
Truck-tractor and semitrailer	38,666	41,731	38,175	39,687	38,888	35,068	40,495	38,316	38,612	46,859	51,078	49,721	40,557	39,225	41,231
Truck and trailer	(1)	57,897	(1)	43,308	64,466	....	25,365	34,497	54,572	63,154	56,069	57,259	56,111	42,692	62,694
Average	38,487	41,802	38,169	39,699	40,374	35,068	39,935	38,231	39,257	49,013	52,393	51,423	41,511	39,431	42,569
Average, all trucks and combinations	19,539	24,615	22,233	22,851	25,323	19,217	19,895	20,095	22,009	24,013	29,358	27,526	23,188	16,155	36,938
AVERAGE WEIGHTS OF EMPTY VEHICLES															
Single-unit trucks:															
Panel and pick-up	4,166	4,329	3,783	3,984	3,802	4,050	4,080	4,863	4,236	4,063	3,746	3,956	4,122	4,121	4,185
Other 2-axle, 4-tire	5,095	4,951	5,081	5,012	4,952	5,637	5,743	5,126	5,364	5,108	4,603	4,879	5,128	5,078	7,232
Other 2-axle, 6-tire	8,506	8,944	7,294	8,170	7,740	7,749	7,970	7,952	7,848	8,111	7,911	8,023	7,979	7,856	8,455
3-axle	15,371	16,903	13,526	15,063	13,731	9,483	15,469	16,957	13,802	15,377	13,896	14,521	14,406	14,152	14,871
Average	6,655	6,976	5,324	6,100	5,880	5,586	5,928	6,046	5,861	5,477	5,757	5,583	5,904	5,640	8,593
Truck combinations:															
Truck-tractor and semitrailer	20,391	20,348	18,843	19,656	18,587	17,339	20,586	18,971	18,877	23,833	23,530	23,683	19,555	19,265	19,731
Truck and trailer	(1)	24,144	(1)	20,050	25,611	....	13,232	20,997	23,390	29,074	27,513	27,906	25,601	21,199	27,176
Average	20,392	20,369	18,829	19,658	19,447	17,339	20,215	19,035	19,190	24,960	25,338	25,181	20,043	19,364	20,483
Average, all trucks and combinations	9,067	10,422	8,142	9,135	10,147	7,190	8,505	8,650	8,719	8,271	11,183	9,499	8,953	7,135	16,336

[1] Data omitted because of insufficient sample.

Use of Truck Combinations

The percentage of travel by vehicle types on main rural roads in 1950 is given in table 3. In this table all single-unit trucks are divided into classification types based on the axle and tire arrangements, while the truck combinations are classified according to the total number of axles of the combination. The classification of vehicles into these types has been used only in the last four annual surveys. It has several advantages over the old "light, medium, and heavy" grouping, particularly in that it provides more homogeneous groupings and more positive identification of the types. It is regrettable that no direct comparison can be made by vehicle types between the old and the new classifications, or between data collected in 1946 and earlier years with such data collected in 1947 and thereafter, but the convenience and advantages of the new system outweigh the disadvantages caused by the change.

The data in table 3 indicate that in 1950 truck and truck combination travel was more than 20 percent of the total travel in all but the New England and Pacific regions. It was between 20 and 26 percent in all of the remaining regions except the East South Central region, where it was well over 30 percent.

A comparison with the same table in the 1949 report shows that the proportion of trucks was higher in 1950 than in 1949 in every region except the Mountain region, where it remained about the same.

The table indicates that the usage of certain types of freight-carrying vehicles varies in different sections. For instance, the truck and trailer combinations with six or more axles and the truck-tractor and semi-

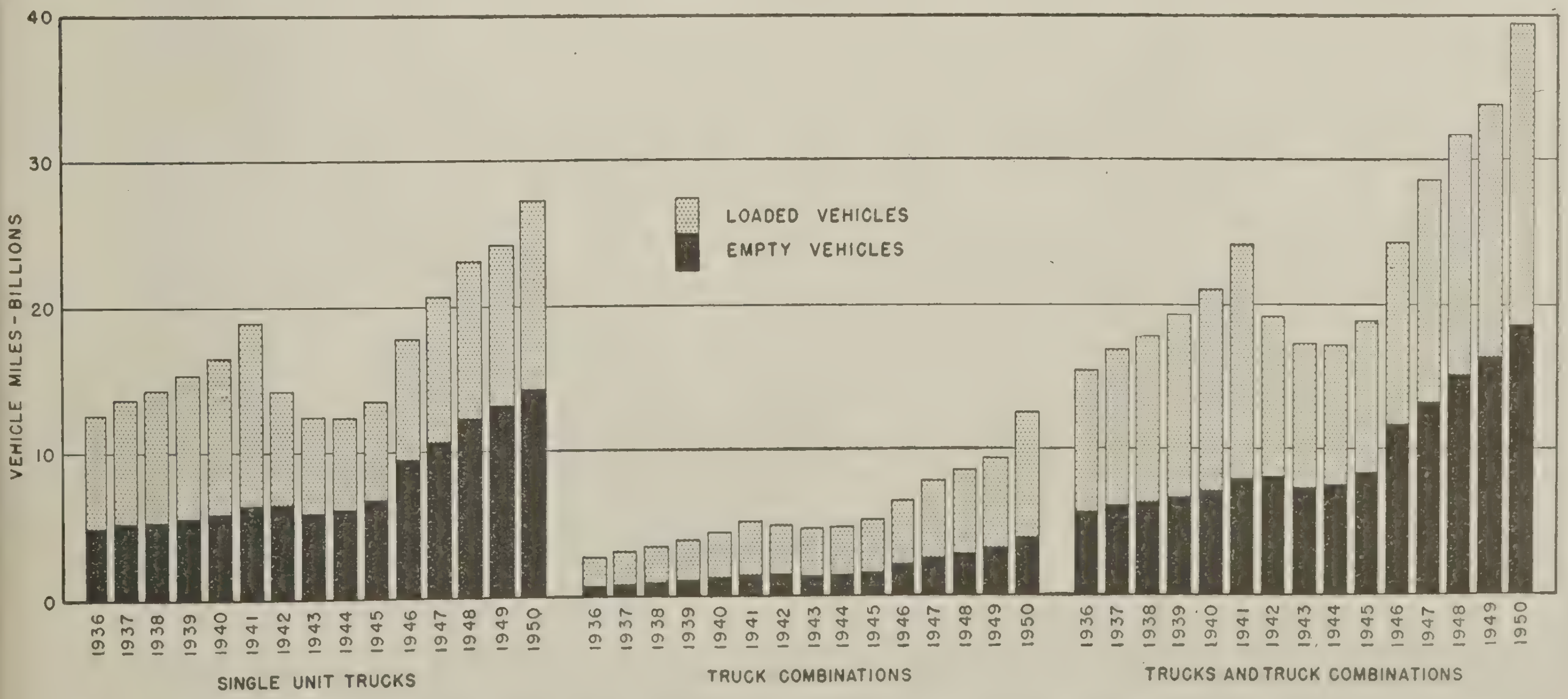


Figure 4.—Travel on main rural roads, 1936-50, by loaded and by empty trucks and truck combinations.

Table 5.—*Comparison of estimated vehicle-miles of travel on main rural roads in 1936, 1941, 1946, 1949, and 1950*

Year	All vehicles, vehicle-miles	Passenger cars and busses[1]		All trucks and truck combinations		Single-unit trucks		Truck combinations	
		Percentage of all vehicles	Vehicle-miles	Percentage of all vehicles	Vehicle-miles	Percentage of all trucks and truck combinations	Vehicle-miles	Percentage of all trucks and truck combinations	Vehicle-miles
	Millions		*Millions*		*Millions*		*Millions*		*Millions*
1936	88,412	82.6	73,005	17.4	15,407	82.1	12,650	17.9	2,757
1941	122,505	80.3	98,320	19.7	24,185	78.8	19,057	21.2	5,128
1941:1936 ratio	*1.39*	*.97*	*1.35*	*1.13*	*1.57*	*.96*	*1.51*	*1.18*	*1.86*
1946	124,149	80.4	99,803	19.6	24,346	73.3	17,838	26.7	6,508
1946:1941 ratio	*1.01*	*1.00*	*1.02*	*.99*	*1.01*	*.93*	*.94*	*1.26*	*1.27*
1946:1936 ratio	*1.40*	*.97*	*1.37*	*1.13*	*1.58*	*.89*	*1.41*	*1.49*	*2.36*
1949	159,379	78.8	125,602	21.2	33,777	71.9	24,295	28.1	9,482
1950	174,349	77.2	134,528	22.8	39,821	68.4	27,256	31.6	12,565
1950:1949 ratio	*1.09*	*.98*	*1.07*	*1.08*	*1.18*	*.95*	*1.12*	*1.12*	*1.33*
1950:1941 ratio	*1.42*	*.96*	*1.37*	*1.16*	*1.65*	*.87*	*1.43*	*1.49*	*2.45*
1950:1936 ratio	*1.97*	*.93*	*1.84*	*1.31*	*2.58*	*.83*	*2.15*	*1.77*	*4.56*
TRUCKS AND TRUCK COMBINATIONS IN PRIVATE OPERATION[2]									
1936				78.8	12,140	86.7	10,963	42.7	1,177
1949				77.2	26,077	91.6	22,262	40.2	3,815
1950				72.8	28,974	89.7	24,438	36.1	4,536
1950: 1949 ratio				*.94*	*1.11*	*.98*	*1.10*	*.90*	*1.19*
1950:1936 ratio				*.92*	*2.36*	*1.03*	*2.23*	*.85*	*3.85*
TRUCKS AND TRUCK COMBINATIONS IN FOR-HIRE OPERATION[2]									
1936				21.2	3,267	13.3	1,687	57.3	1,580
1949				22.8	7,700	8.4	2,033	59.8	5,667
1950				27.2	10,847	10.3	2,818	63.9	8,029
1950:1949 ratio				*1.19*	*1.41*	*1.23*	*1.39*	*1.07*	*1.42*
1950:1936 ratio				*1.28*	*3.32*	*.77*	*1.67*	*1.12*	*5.08*

[1] Percentages of total 1950 travel by passenger cars and by busses are reported separately in table 3.

[2] The percentages below are percentages of the total number of type of vehicle indicated in the uppermost column head. For example, 86.7 percent of all single-unit trucks in 1936 were in private use.

trailer combinations with five or more axles are used far more frequently in the Pacific region than in any other area. Combinations involving trailers are used much less in the East South Central region and in the three eastern regions than in other sections. The use of combination-type vehicles has increased steadily in all regions in the last 5 years, the Nation-wide percentages of total travel being 7.21 in 1950, 5.95 in 1949, 5.84 in 1948, 5.73 in 1947, and 5.26 in 1946.

Private and For-Hire Traffic

In the survey conducted in 1950 information was gathered in most of the participating States concerning the use classification under which each vehicle was being operated. The data were reported separately for private and for-hire vehicles of each type, making possible the calculation of vehicle-mileages, ton-mileages, and other items concerning traffic on the main rural roads by the various types of trucks and truck combinations operated privately and operated for-hire.

In the last two columns of table 3 are shown the percentage distributions of private and for-hire trucks and combinations, by vehicle type. In general the lighter types of vehicles predominate in the private classification and, conversely, the heavier vehicles constitute a much higher proportion of the for-hire vehicles. This difference is especially marked in the percentages for the light panel and pick-up truc and for the heavy combination-type vehicle Over 42 percent of the privately operate trucks were of the panel and pick-up typ while less than 2 percent of the for-hi vehicles were of this type. On the oth hand, less than 16 percent of the private operated vehicles were truck combinatio while 74 percent of the for-hire vehicl were combinations.

Average Weights Increase

The average weights of loaded and empt trucks and truck combinations, separate and combined, are shown graphically i figure 3 for each year from 1942 to 195 inclusive, and for a prewar year, general 1936 or 1937. The weights of single-un trucks, both loaded and empty, increase each year from the 1936–37 period throug 1945, then decreased somewhat or level off to an average amount slightly less tha 11,000 pounds for loaded vehicles ar slightly less than 6,000 pounds for empt vehicles. At the same time weights of tru combinations, both loaded and empty, ha increased each year during the peri shown. The increase in average weight loaded combinations from the 1936– period to 1950 was over 55 percent, con pared to 11 percent for single-unit truck

The increase for all loaded trucks ar truck combinations combined was 80 percen

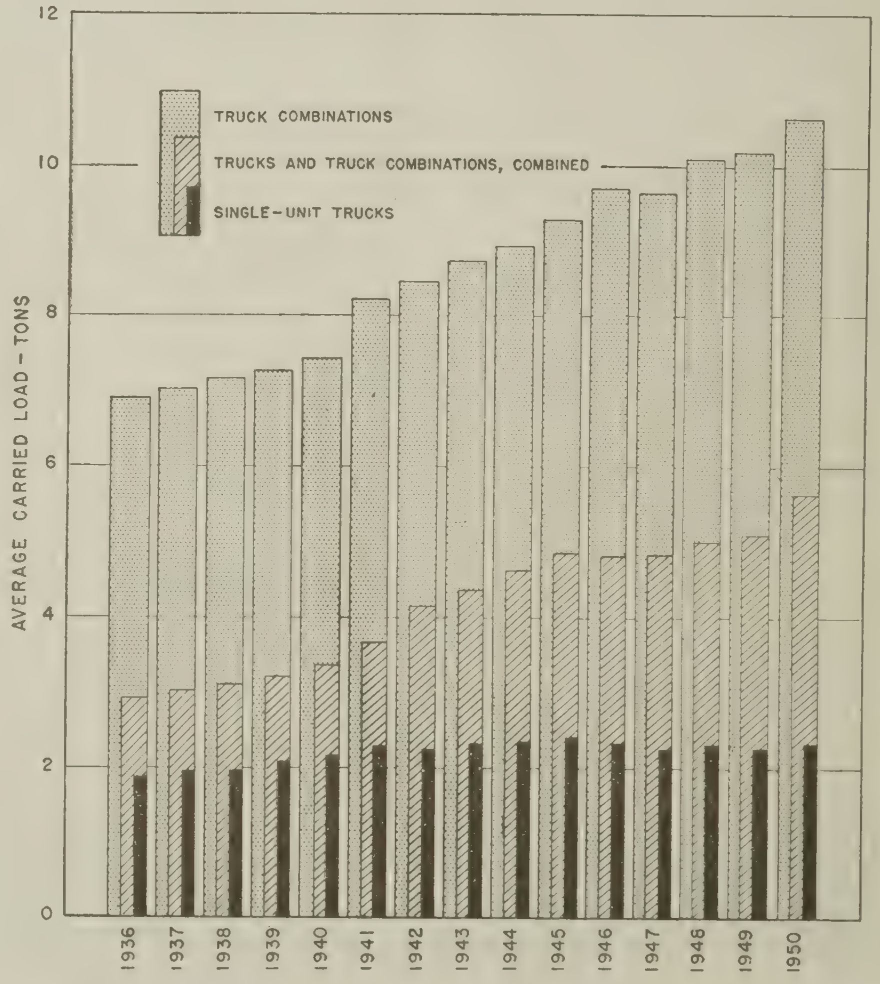


Figure 5.—Average load carried by trucks and truck combinations on main rural roads, 1936-1950.

It will be noted that the average weight of the loaded single-unit trucks was somewhat less than twice the average weight of the empty vehicles of this type, while the average weight of the loaded combinations was just about twice the average weight of the empty combinations. In the case of the vehicles of both types combined, the loaded vehicles included a higher proportion of combinations than the empty vehicles, since combinations are more often loaded, and the average weight of the loaded trucks and combinations was therefore considerably more than twice the average weight of the empty vehicles of both types.

The average weights of the various types of loaded and empty trucks and truck combinations in the summer of 1950 are shown in table 4 for the different regions. This table brings out clearly the important differences that exist in the weight characteristics of the vehicles in the different groups. It will be noted, for example, that for the United States as a whole, the loaded three-axle, single-unit trucks weighed about twice as much as the two-axle, six-tire trucks. The latter, in turn, weighed about twice as much as the two-axle, four-tire trucks. Similar differences existed throughout the various classifications. On the other hand, the regional differences in average weight for each of the vehicle types that are common throughout the country are surprisingly small. The rather low weights of truck and trailer combinations in the West North Central and West South Central regions indicate a predominance of small, home-made trailers of low capacity.

The average weights of loaded and empty trucks and truck combinations operated privately and for-hire in the summer of 1950 are shown in the last two columns of table 4. The for-hire vehicles, when compared by types, are generally heavier than those operated privately, and the average weight of all types of for-hire vehicles, either loaded or empty, is more than twice the average of the privately operated vehicles. It was shown in table 3 that most of the private vehicles consisted of small single-unit trucks while most of the for-hire vehicles consisted of the heavy truck combinations. This decided difference in the distributions of sizes of vehicles in the two operation classes accounts for the great difference between their average weights.

Truck Travel Increases

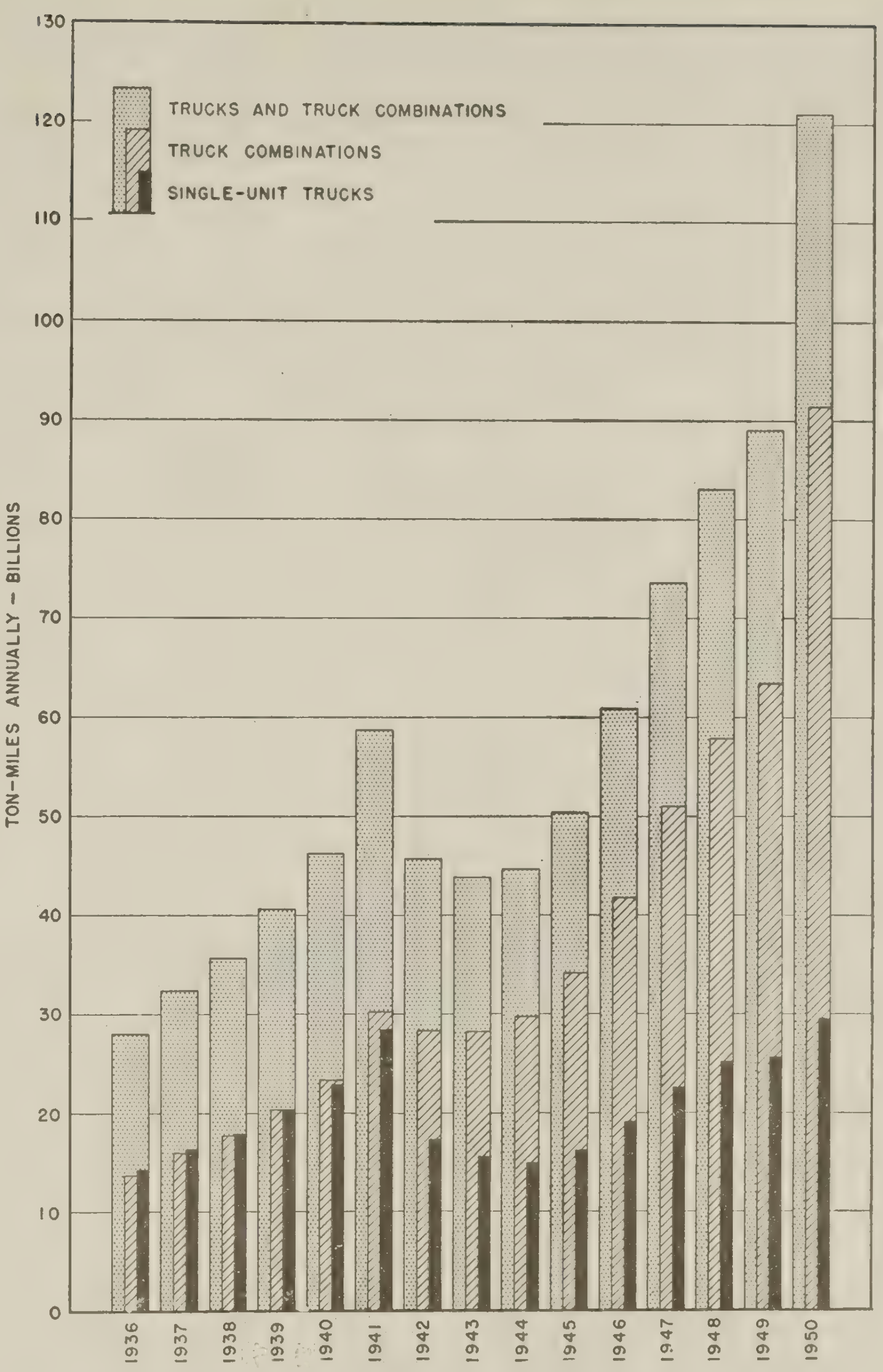


Figure 6.—Ton-miles carried by trucks and truck combinations on main rural roads, 1936-1950.

Figure 4 shows the estimated vehicle-mileage of travel by loaded and empty single-unit trucks and truck combinations, separately and combined, on main rural roads, for each year from 1936 to 1950, inclusive. This chart demonstrates graphically the steady growth of truck traffic during the prewar years 1936–41, the temporary effect of wartime restrictions in the period 1942–45, and the remarkable increases in truck transportation that have occurred since the end of hostilities in 1945.

Table 5 gives comparisons of the estimated vehicle-mileage of travel by vehicles of different types on all main rural roads in 1936, the earliest year for which comprehensive travel and weight data are available; in 1941, the peak prewar year, 5 years after the beginning of the surveys; in 1946, 10 years after the beginning of the surveys; and in 1949 and 1950. The ratios of 1950 travel to that of the preceding years indicate that increases for trucks and truck combinations generally were greater than for passenger cars and busses, and that increases for truck combinations were greater than for single-unit trucks. In the 14 years from 1936 to 1950, passenger-car and bus travel combined increased 84 percent, travel by all trucks and combinations more than doubled, increasing 158 percent, and travel by truck combinations (considered separately) more than quadrupled, increasing 356 percent.

The lower portion of table 5 gives comparisons of the estimated vehicle-mileage of travel in 1936, 1949, and 1950 by privately operated trucks and truck combinations, and by those operated for-hire. Travel by for-hire vehicles increased somewhat more than travel by private vehicles, the 1950:1936 ratio being 3.32 in the case of for-hire vehicles and 2.36 in the case of private vehicles. Most of the increase in for-hire vehicle travel was by truck combinations, there being only a 67-percent increase in the for-hire vehicle-mileage by single-unit trucks compared to a 408-percent increase by combinations. In the case of the private vehicles, on the other hand, there were substantial increases in the vehicle-mileage by both types, the increase in the combinations, how-

Table 6.—*Comparison of the estimated percentage of trucks and truck combinations loaded, average carried load, and ton-miles carried on main rural roads in 1936, 1941, 1946, 1949, and 1950.*

Year	All trucks and truck combinations			Single-unit trucks			Truck combinations		
	Percentage loaded	Average weight of carried load	Ton-miles carried	Percentage loaded	Average weight of carried load	Ton-miles carried	Percentage loaded	Average weight of carried load	Ton-miles carried
		Tons	*Millions*		*Tons*	*Millions*		*Tons*	*Millions*
1936	62.8	2.90	28,005	60.7	1.86	14,258	72.2	6.90	13,747
1941	66.7	3.64	58,737	65.4	2.29	28,487	71.6	8.23	30,250
1941:1936 ratio	*1.06*	*1.26*	*2.10*	*1.08*	*1.23*	*2.00*	*.99*	*1.19*	*2.20*
1946	51.7	4.84	60,892	46.4	2.31	19,101	66.2	9.70	41,791
1946:1941 ratio	*.78*	*1.33*	*1.04*	*.71*	*1.01*	*.67*	*.92*	*1.18*	*1.38*
1946:1936 ratio	*.82*	*1.67*	*2.17*	*.76*	*1.24*	*1.34*	*.92*	*1.41*	*3.04*
1949	51.6	5.11	89,100	46.1	2.29	25,639	65.7	10.19	63,461
1950	53.9	5.64	121,091	47.2	2.31	29,645	68.5	10.62	91,446
1950:1949 ratio	*1.04*	*1.10*	*1.36*	*1.02*	*1.01*	*1.16*	*1.04*	*1.04*	*1.44*
1950:1941 ratio	*.81*	*1.55*	*2.06*	*.72*	*1.01*	*1.04*	*.96*	*1.29*	*3.02*
1950:1936 ratio	*.86*	*1.94*	*4.32*	*.78*	*1.24*	*2.08*	*.95*	*1.54*	*6.65*
TRUCKS AND TRUCK COMBINATIONS IN PRIVATE OPERATION									
1936	60.3	2.20	16,094	59.8	1.71	11,180	65.5	6.37	4,914
1949	47.6	3.48	43,231	45.3	2.10	21,193	61.2	9.43	22,038
1950	49.1	3.69	52,509	46.2	2.07	23,370	64.5	9.96	29,139
1950:1949 ratio	*1.03*	*1.06*	*1.21*	*1.02*	*.99*	*1.10*	*1.05*	*1.06*	*1.32*
1950:1936 ratio	*.81*	*1.68*	*3.26*	*.77*	*1.21*	*2.09*	*.98*	*1.56*	*5.93*
TRUCKS AND TRUCK COMBINATIONS IN FOR-HIRE OPERATION									
1936	71.9	5.07	11,911	66.4	2.73	3,078	77.3	7.23	8,833
1949	65.1	9.16	45,869	55.1	3.97	4,446	68.7	10.65	41,423
1950	66.8	9.46	68,582	55.5	4.01	6,275	70.8	10.97	62,307
1950:1949 ratio	*1.03*	*1.03*	*1.50*	*1.01*	*1.01*	*1.41*	*1.03*	*1.03*	*1.50*
1950:1936 ratio	*.93*	*1.87*	*5.76*	*.84*	*1.47*	*2.04*	*.92*	*1.52*	*7.05*

Table 7.—*Percentage of vehicle-miles of travel, percentage loaded, average carried load, and percentage of total ton-miles carried by various types of trucks and truck combinations on main rural roads in 1950 compared to that in corresponding months of 1949*

Vehicle type	Percentage of vehicle-miles of travel		Percentage loaded		Average carried load		Percentage of ton-miles carried	
	1950	1949	1950	1949	1950	1949	1950	1949
					Tons	*Tons*		
Single-unit trucks:								
Panel and pick-up	31.35	31.55	37.4	35.9	0.69	0.64	2.65	2.75
Other 2-axle, 4-tire	2.79	3.46	52.4	49.4	.93	.78	.45	.50
Other 2-axle, 6-tire	32.63	35.34	55.9	54.5	3.20	3.17	19.06	23.15
3-axle	1.68	1.58	58.3	54.8	7.23	7.23	2.32	2.38
All single-unit trucks	68.45	71.93	47.2	46.1	2.31	2.29	24.48	28.78
Truck combinations:								
Truck-tractor and semitrailer	29.43	26.57	68.9	65.8	10.32	9.95	68.87	65.91
Truck and trailer	2.12	1.50	62.3	63.4	15.32	14.69	6.65	5.31
All truck combinations	31.55	28.07	68.5	65.7	10.62	10.19	75.52	71.22
All trucks and combinations	100.00	100.00	53.9	51.6	5.64	5.11	100.00	100.00
TRUCKS AND TRUCK COMBINATIONS IN PRIVATE OPERATION								
Single-unit trucks:								
Panel and pick-up	42.38	40.36	37.0	35.7	0.69	0.63	5.96	5.45
Other 2-axle, 4-tire	3.70	4.38	51.7	49.4	.87	.74	.92	.96
Other 2-axle, 6-tire	36.72	39.18	55.8	54.4	3.03	3.06	34.23	39.28
3-axle	1.54	1.45	57.1	53.4	6.99	7.11	3.40	3.33
All single-unit trucks	84.34	85.37	46.2	45.3	2.07	2.10	44.51	49.02
Truck combinations:								
Truck-tractor and semitrailer	14.78	13.85	64.3	61.1	9.88	9.39	51.80	47.98
Truck and trailer	.88	.78	67.8	63.6	11.21	10.08	3.69	3.00
All truck combinations	15.66	14.63	64.5	61.2	9.96	9.43	55.49	50.98
All trucks and combinations	100.00	100.00	49.1	47.6	3.69	3.48	100.00	100.00
TRUCKS AND TRUCK COMBINATIONS IN FOR-HIRE OPERATION]								
Single-unit trucks:								
Panel and pick-up	1.91	1.68	58.8	48.1	0.65	1.42	0.11	0.19
Other 2-axle, 4-tire	.37	.33	70.3	47.8	2.12	2.76	.09	.07
Other 2-axle, 6-tire	21.68	22.36	54.5	55.4	3.99	3.82	7.45	7.94
3-axle	2.02	2.03	60.8	58.1	7.68	7.52	1.50	1.49
All single-unit trucks	25.98	26.40	55.5	55.1	4.01	3.97	9.15	9.69
Truck combinations:								
Truck-tractor and semitrailer	68.59	69.63	71.6	69.0	10.55	10.27	81.93	82.82
Truck and trailer	5.43	3.97	59.9	63.2	17.34	17.75	8.92	7.49
All truck combinations	74.02	73.60	70.8	68.7	10.97	10.65	90.85	90.31
All trucks and combinations	100.00	100.00	66.8	65.1	9.46	9.16	100.00	100.00

ever, being much less than in the case o the for-hire vehicles.

Volume of Highway Freight

Figure 5 gives a comparison of the average load carried by single-unit trucks an truck combinations, separately and combined, in the 15 years that the planning surveys have been operating. The genera trend of load weights was upward throughout the period. The slight decline in th weights of loads carried by single-uni trucks since 1945 has been more than offse by the increased use of combinations and th increased weights of loads carried by veh cles of this type.

Figure 6 shows, for each year from 193 through 1950, the ton-mileage of freigh carried by trucks and truck combinations o main rural roads. The chart demonstrate clearly that truck combinations are transporting each year a larger proportion of th total amount of highway freight. In 193 the truck combinations hauled slightly les ton-mileage than the single-unit truck while in 1950 they hauled more than trip the amount transported by the larger number of lighter vehicles. The rapid rate annual increase in total freight carrie which took place in 1946 and 1947 was r duced somewhat in 1948 and 1949 to a ra of increase more nearly comparable wit that of prewar years. In 1950, howeve defense preparations appear to have bee the cause of a rather startling increase freight ton-mileage, somewhat similar to th rapid increase that occurred in 1941.

In table 6 are shown comparisons of th percentage of vehicles carrying loads, th average carried load, and the ton-mileag carried for single-unit trucks and truc combinations, separately and combined, 1950 with corresponding items for oth years, as in table 5. The trend from 19 to 1950 of average weight carried, show graphically in figure 5, and that of the to mileage transported during the same perio shown in figure 6, have already been di cussed.

The percentage of trucks and truck combinations carrying loads increased noticeably from 1949 to 1950 in all regions exce the West North Central region where slight decrease of this factor was foun In the country as a whole, the percenta loaded increased from 51.6 percent in 19 to 53.9 percent in 1950, an important factor in the striking increase in ton-mileag Both for single-unit trucks and for tru combinations, the percentage loaded w higher in 1950 than in 1949, and, in the ca of truck combinations, was higher than any year since 1945. However, the load proportion was considerably less for each the two vehicle types than in the prew surveys.

The lower portion of table 6 shows comparisons of the percentage loaded, avera carried load, and ton-mileage for single-un trucks, truck combinations, and the two types of vehicles combined, when operated as private and as for-hire vehicles. A considerably larger percentage of the for-hire vehicles are loaded and the loads carried by these vehicles are much heavier than in the case of the privately operated vehicles. Single-unit trucks transport an important part of the freight moved in privately operated vehicles, but only a minor part of the freight moved in for-hire vehicles.

The first part of table 7 gives a detailed comparison of the percentage of vehicle-miles of travel, percentage of vehicles loaded, average carried load, and percentage of total ton-miles of freight carried by the various types of trucks and truck combinations traveling on main rural roads in 1949 and 1950. Many interesting comparisons can be made from this table showing the relative importance from a freight-carrying standpoint of different portions of the traffic stream. In 1950, for instance, while panel and pick-up trucks traveled more than 31 percent of the vehicle-mileage, they accounted for less than 3 percent of the ton-mileage. The truck-tractor and semitrailers, on the other hand, traveled about 29 percent of the vehicle-mileage but carried almost 69 percent of the ton-mileage.

From the columns in table 7 showing the percentage loaded, by types, it can be observed that the percentage of vehicles carrying loads tends to increase directly as the size of the vehicle type, extending from light panel and pick-up trucks that are loaded 37 percent of the time to the heavy combinations that are loaded about 69 percent of the time.

The lower portion of table 7 shows the same information separately for private and for-hire trucks. A comparison of vehicle-mileage percentage with ton-mileage percentage, by operating classes, shows that single-unit trucks, privately operated, traveled over 84 percent of the vehicle-mileage while transporting only about 44 percent of the freight moved in privately operated vehicles. At the same time, for-hire single-unit trucks traveled about 26 percent of the total for-hire vehicle-mileage and carried only about 9 percent of the total ton-mileage moved by the for-hire vehicles. The heavy vehicle combinations, privately operated, traveled about 16 percent of the total mileage and carried over 55 percent of the freight moved by privately operated vehicles, while the for-hire combinations traveled slightly more than 74 percent of the total vehicle-mileage of all for-hire vehicles and carried almost 91 percent of the freight transported by all vehicles in this class.

Gross Weights Increase Sharply

Figure 7 shows by years, from the prewar years (generally 1936 or 1937) to 1950, for the United States as a whole, the frequency of gross weights of 30,000 pounds or more, of 40,000 pounds or more, and 50,000 pounds or more. The chart shows strikingly how the frequency of heavy loads soared upward in 1950, reaching amounts for the various weights considerably above any previous levels. For instance, the frequency of the loads of 30,000 pounds or more was 26 percent higher than in 1949 and almost 30 percent higher than in 1945, the previous year of highest frequency of such loads. The increase in loads of 50,000 pounds or more was even more startling, the frequency being 61 percent above the 1949 figure and 152 percent above the 1945 figure. These heavy loads were over 19 times as frequent in 1950 as in the prewar year, loads of 40,000 pounds or more were 10 times as frequent, and those of 30,000 pounds or more were over 4 times as frequent as in the 1936–37 period.

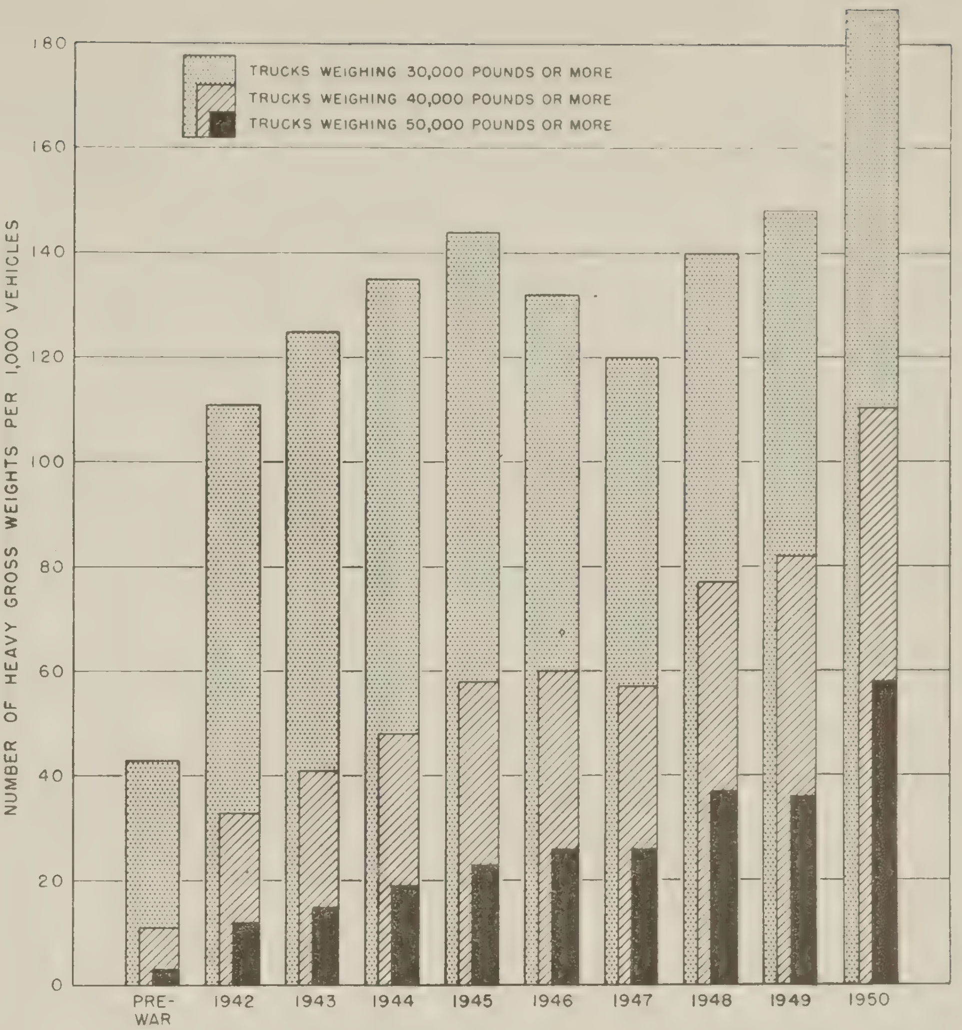


Figure 7.—Number of heavy gross weights per 1,000 trucks and truck combinations (empties included) in the summers of 1942-50 and a prewar year.

The 1950 gross-weight frequency data by vehicle type and region are presented in table 8. No panels, pick-ups, or other two-axle, four-tire, single-unit trucks were found in the survey weighing as much as 30,000 pounds, so there is no entry for these vehicles in the table, though they are included in the total number of vehicles weighed in computing the frequencies for all trucks and combinations. Heavy gross weights are much more frequent in the Pacific region than in other parts of the country. In this region 176 of each 1,000 trucks and truck combinations on the main rural highways in 1950, empties included, weighed 50,000 pounds or more and 289 of each 1,000 weighed 30,000 pounds or more. In the East North Central region, 251 of each 1,000 trucks and truck combinations weighed 30,000 pounds or more—almost as many as in the Pacific region—but only 78 of each 1,000 vehicles weighed 50,000 pounds or more, a frequency less than half of that in the Pacific region for this heavy class of vehicle. The lowest frequency of heavy gross loads was found in the East South Central region where only 7 of each 1,000 weighed 50,000 pounds or more and only 102 of each 1,000 weighed 30,000 pounds or more.

As was pointed out in the discussion of figure 7, the frequencies of heavy gross loads have increased sharply in the Nation as a whole. This increase is not limited to any certain area but is distributed throughout the entire country. Comparing the frequencies of gross weights of 30,000 pounds or more, 40,000 pounds or more, and 50,000 pounds or more found in the 1950 surveys with such frequencies found in 1949, increases are found, without exception, in every region. For instance, in the East South Central region, where heavy gross loads are somewhat infrequent, the fre-

Table 8.—*Heavy gross weights per 1,000 loaded and empty trucks and truck combinations on main rural roads, summer of 1950*

Vehicle type	Eastern regions				Central regions					Western regions			United States average
	New England	Middle Atlantic	South Atlantic	Average	East North Central	East South Central	West North Central	West South Central	Average	Moun-tain	Pacific	Average	
NUMBER PER 1,000 WEIGHING 30,000 POUNDS OR MORE													
Single-unit trucks:													
2-axle, 6-tire	16	27	1	14	1	1	(1)	1	1	3	(1)	2	5
3-axle	280	284	327	305	303	236	286	264	283	407	234	281	289
Average	15	22	9	15	10	4	5	3	6	12	16	14	10
Truck combinations:													
Truck-tractor and semitrailer	521	606	540	566	575	473	571	522	549	600	688	656	568
Truck and trailer	0	(2)	(2)	(2)	585	0	172	306	491	743	710	717	622
Average	518	606	539	566	576	473	554	516	546	622	695	672	572
Average, all trucks and combinations	137	221	177	189	251	102	142	146	170	160	289	233	187
Comparative average, 1949	117	191	130	153	208	87	139	107	144	118	176	147	148
NUMBER PER 1,000 WEIGHING 40,000 POUNDS OR MORE													
Single-unit trucks:													
2-axle, 6-tire	1	2	0	1	0	0	0	0	0	1	0	1	(1)
3-axle	104	137	59	93	13	4	21	97	24	117	21	47	52
Average	3	4	2	3	(1)	(1)	(1)	1	(1)	4	1	3	2
Truck combinations:													
Truck-tractor and semitrailer	315	387	298	337	314	215	337	283	299	410	547	498	336
Truck and trailer	0	(2)	(2)	(2)	505	0	142	225	418	505	486	490	459
Average	313	388	297	337	329	215	328	281	304	425	529	496	345
Average, all trucks and combinations	78	135	95	109	140	45	82	79	95	106	214	167	110
Comparative average, 1949	66	120	71	90	105	36	77	54	73	75	121	97	82
NUMBER PER 1,000 WEIGHING 50,000 POUNDS OR MORE													
Single-unit trucks:													
2-axle, 6-tire	0	0	0	0	0	0	0	0	0	1	0	(1)	(1)
3-axle	9	45	0	18	13	0	6	10	9	20	4	8	12
Average	(1)	1	0	(1)	(1)	0	(1)	(1)	(1)	1	(1)	1	(1)
Truck combinations:													
Truck-tractor and semitrailer	99	181	86	128	158	35	176	119	137	287	443	387	165
Truck and trailer	0	(2)	(2)	(2)	476	0	121	225	393	439	424	427	412
Average	98	183	87	129	183	35	174	122	150	311	437	397	182
Average, all trucks and combinations	24	63	28	41	78	7	44	34	47	76	176	133	58
Comparative average, 1949	15	52	21	33	48	6	32	18	29	51	99	75	36

[1] Less than 5 per 10,000.
[2] Data omitted because of insufficient sample.

quencies of loads of 40,000 pounds or more increased from 36 in 1949 to 45 in 1950; in the Pacific region the loads of 50,000 pounds or more increased from 99 in 1949 to 176 in 1950 for each 1,000 vehicles. The general prevalence of the heavier loads on the highways of all sections of the country gives a partial explanation of the large increase found in the ton-mileage of freight carried in 1950 compared to that carried in 1949.

Frequency of Heavy Axle Loads

Figure 8 shows the frequency of axle loads of 18,000 pounds or more, 20,000 pounds or more, and of 22,000 pounds or more for the prewar years (1936–37) and by years from 1942 to 1950. The frequency of these heavy axle loads increased year by year from the prewar period through 1948. The frequencies for 1949 were slightly lower than those found in 1948 yet they were higher than in any other previous year. The frequencies for 1950 are higher than those found in 1949, and the frequency of axles weighing 18,000 pounds

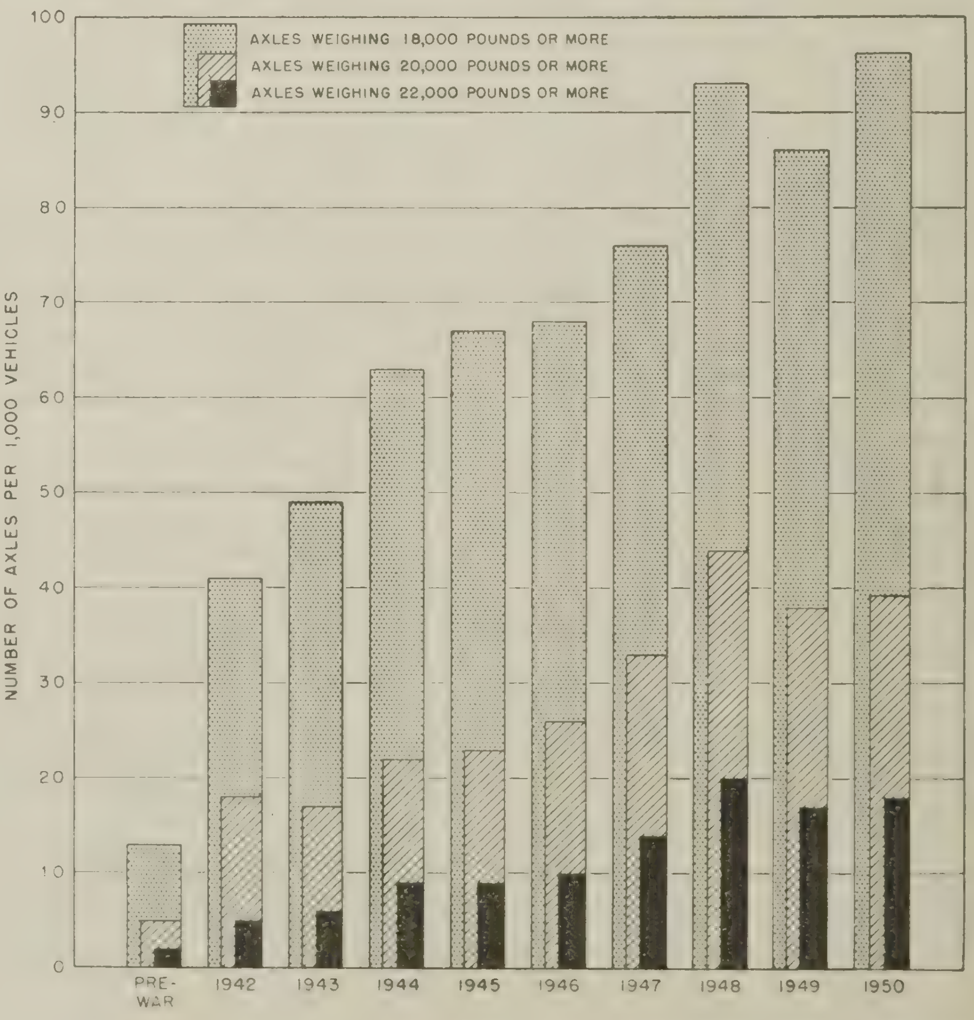


Figure 8.—Number of heavy axle loads per 1,000 trucks and truck combinations (empties included) in the summer of 1942-50 and a prewar year.

Table 9.—*Heavy axle loads per 1,000 loaded and empty trucks and truck combinations on main rural roads, summer of 1950*

Vehicle type	Eastern regions				Central regions					Western regions			United States average
	New England	Middle Atlantic	South Atlantic	Average	East North Central	East South Central	West North Central	West South Central	Average	Mountain	Pacific	Average	
NUMBER PER 1,000 WEIGHING 18,000 POUNDS OR MORE													
Single-unit trucks:													
2-axle, 4-tire	0	9	0	4	8	(1)	0	0	2	0	0	0	3
2-axle, 6-tire	46	74	22	47	15	35	9	17	18	25	32	29	29
3-axle	107	179	63	111	39	43	20	78	41	154	26	61	68
Average	28	46	12	27	9	18	5	7	9	13	15	14	16
Truck combinations:													
Truck-tractor and semitrailer	484	524	289	407	204	236	165	227	206	316	177	227	276
Truck and trailer	0	345	0	169	403	0	160	(2)	323	212	82	107	193
Average	480	523	288	406	219	236	165	222	212	299	148	196	271
Average, all trucks and combinations	137	208	100	147	98	63	45	67	72	83	69	75	96
Comparative average, 1949	124	195	99	140	89	50	50	51	63	57	37	48	86
NUMBER PER 1,000 WEIGHING 20,000 POUNDS OR MORE													
Single-unit trucks:													
2-axle, 4-tire	0	5	0	2	0	(1)	0	0	(1)	0	0	0	1
2-axle, 6-tire	31	47	6	27	2	10	3	7	5	6	7	6	12
3-axle	43	73	11	38	26	4	12	0	16	72	7	25	25
Average	18	28	3	15	2	5	1	3	3	4	4	4	7
Truck combinations:													
Truck-tractor and semitrailer	286	333	115	223	50	70	44	77	58	144	46	81	116
Truck and trailer	0	0	0	0	40	0	37	0	35	74	10	22	27
Average	284	331	114	222	49	70	44	75	56	133	35	66	110
Average, all trucks and combinations	82	131	38	80	22	19	12	23	19	35	16	24	39
Comparative average, 1949	73	118	46	78	27	18	12	18	20	26	6	16	38
NUMBER PER 1,000 WEIGHING 22,000 POUNDS OR MORE													
Single-unit trucks:													
2-axle, 4-tire	0	5	0	2	0	(1)	0	0	(1)	0	0	0	1
2-axle, 6-tire	19	27	2	15	1	3	1	2	1	2	2	2	6
3-axle	3	51	1	20	26	0	6	0	14	19	0	5	13
Average	11	17	1	8	1	1	1	1	1	1	1	1	3
Truck combinations:													
Truck-tractor and semitrailer	129	204	38	117	15	18	10	31	18	67	7	29	53
Truck and trailer	0	0	0	0	12	0	34	0	14	43	1	10	11
Average	128	203	38	116	15	18	11	30	18	64	5	24	50
Average, all trucks and combinations	39	80	13	42	7	5	3	9	6	16	3	9	18
Comparative average, 1949	33	65	18	39	9	5	3	6	6	11	2	6	17

[1] Less than 5 per 10,000.

[2] Data omitted because of insufficient sample.

or more is higher than in 1948, the previous high figure for that weight. The frequencies of axle loads weighing 20,000 pounds or more and those weighing 22,000 pounds or more, however, are lower in 1950 than in 1948. Altogether, the leveling off in the frequency of the heavier axle loads may possibly indicate that, although gross loads have increased sharply, more attention is being given to proper load distribution and that there is better observance of the axle-load restrictions.

Table 9 gives data concerning the number of heavy axle loads per 1,000 loaded and empty trucks and truck combinations of various types on the main rural roads by regions in 1950. Since no panel or pick-up trucks were found with axles weighing 18,000 pounds or more, there is no entry for these in the table though they are included in figuring the frequencies for all trucks and truck combinations.

Though the greatest frequency of heavy gross weights is in the Pacific region, as was shown in table 8, the lowest frequency of heavy axle loads is shared by that region with the West North Central region. In each of these two regions only three axles of 22,000 pounds or more were found in 1950 for each 1,000 vehicles weighed. By far the greatest frequency of heavy axle loads was in the Middle Atlantic region and the next greatest in New England. In these two regions the relatively high frequency is attributable mainly to the large number of two-axle truck-tractors pulling one-axle or two-axle semitrailers. The relative infrequency of heavy axles in the Pacific region, in the presence of a large proportion of heavy gross loads, indicates a better distribution of the loads over a larger number of axles.

Although the frequency of heavy gross loads has increased considerably and in all regions, as stated in connection with discussion of table 8, the trend in frequency of heavy axle loads followed an entirely different pattern. For the country as a whole, this was pointed out in the discussion of figure 8. The trend in frequency of heavy axle loads in the regions, likewise, is different from that of the gross loads. This is demonstrated by comparing the frequencies of heavy axle loads in 1950 with those in 1949 as shown for each weight class in table 9 and noting that the frequency of heavy axle loads in the different categories decreased in a number of cases, whereas table 8 shows that the frequency of heavy gross loads increased in all regions.

Loads Above Legal Limits

Table 10 shows the number of trucks and truck combinations of each type, per 1,000 such vehicles counted, empties included, that exceeded the legal axle, axle-group, or gross-weight limits in effect in the individual States in the summer of 1950, and the number per 1,000 that exceeded these limits by various percentages. Comparative figures are given at the bottom of the table, for the Nation as a whole, for 1948 and 1949.

Loads in excess of State law were most frequent in the East South Central region where a decided increase generally was found in the number of overloaded three-axle single-unit trucks and truck-tractor and semitrailer combinations. In this region, in 1949, 66 three-axle single-unit trucks of each 1,000 loaded and empty vehicles weighed exceeded one or more of the State weight limits; in 1950, 126 such vehicles exceeded these limits. In the same region 162 truck combinations per 1,000 such vehicles weighed in 1949 exceeded the legal limits while 437 exceeded these limits in 1950. After the East South Central region, where, of all loaded and empty trucks and truck combinations weighed in 1950, 115

Table 10.—*Number of trucks and truck combinations, per 1,000 loaded and empty vehicles, that exceeded the permissible axle, axle-group, or gross-weight legal limits in effect in the States by various percentages (maximum) of overload summer of 1950*

Region and type of vehicle	Number per 1,000 overloaded	Number per 1,000 overloaded more than—				
		5 percent	10 percent	20 percent	30 percent	50 percent
New England:						
2-axle, 4-tire	...	...	...	...	...	...
2-axle, 6-tire	15	10	6	2	1	(1)
3-axle	58	35	23	8	8	...
Average, single-unit trucks	10	6	4	1	1	(1)
Truck-tractor and semitrailer	113	74	45	19	6	2
Truck and trailer	...	...	...	...	...	...
Average, truck combinations	112	74	45	19	6	2
Average, all trucks and combinations	35	22	14	5	2	(1)
Middle Atlantic:						
2-axle, 4-tire	(2)	...	...	...	...	...
2-axle, 6-tire	30	24	17	8	3	(1)
3-axle	119	116	94	31	11	11
Average, single-unit trucks	20	16	12	5	2	(1)
Truck-tractor and semitrailer	181	137	102	51	20	4
Truck and trailer	330	112	112	112	51	...
Average, truck combinations	182	137	102	51	20	4
Average, all trucks and combinations	75	57	43	21	8	1
South Atlantic:						
2-axle, 4-tire	(2)	(2)	...	...	...	...
2-axle, 6-tire	9	5	3	1	(1)	...
3-axle	39	20	14	4	1	1
Average, single-unit trucks	5	3	2	1	(1)	(1)
Truck-tractor and semitrailer	132	75	45	16	5	1
Truck and trailer	...	...	...	...	...	...
Average, truck combinations	132	75	45	16	5	1
Average, all trucks and combinations	45	26	16	6	2	(1)
East North Central:						
2-axle, 4-tire	...	...	...	...	...	...
2-axle, 6-tire	9	4	1	1	(1)	...
3-axle	72	72	26	13	13	13
Average, single-unit trucks	7	4	1	1	(1)	(1)
Truck-tractor and semitrailer	155	96	52	14	5	(1)
Truck and trailer	229	148	69	15	...	...
Average, truck combinations	161	100	53	14	5	(1)
Average, all trucks and combinations	72	45	23	7	2	(1)
East South Central:						
2-axle, 4-tire	...	...	...	...	...	...
2-axle, 6-tire	57	40	25	11	2	...
3-axle	126	49	49	...	...	...
Average, single-unit trucks	30	20	13	5	1	...
Truck-tractor and semitrailer	437	280	157	51	19	3
Truck and trailer	...	...	...	...	...	...
Average, truck combinations	437	280	157	51	19	3
Average, all trucks and combinations	115	74	43	15	5	1
West North Central:						
2-axle, 4-tire	...	...	...	...	...	...
2-axle, 6-tire	9	4	3	1	(1)	...
3-axle	50	35	27	14	6	...
Average, single-unit trucks	5	3	2	1	(1)	...
Truck-tractor and semitrailer	188	115	69	25	12	2
Truck and trailer	77	72	58	37	34	34
Average, truck combinations	183	113	69	25	13	3
Average, all trucks and combinations	50	31	19	7	3	1
West South Central:						
2-axle, 4-tire	...	...	...	...	...	...
2-axle, 6-tire	16	12	8	2	1	...
3-axle	66	55	47	17	...	...
Average, single-unit trucks	7	5	4	1	(1)	...
Truck-tractor and semitrailer	213	139	90	43	21	3
Truck and trailer	(2)	(2)	...	...	...	...
Average, truck combinations	208	136	88	42	20	3
Average, all trucks and combinations	63	41	27	12	6	1
Mountain:						
2-axle, 4-tire	...	...	...	...	...	...
2-axle, 6-tire	30	17	10	6	2	1
3-axle	137	121	114	34	29	5
Average, single-unit trucks	15	9	7	3	2	(1)
Truck-tractor and semitrailer	224	165	122	65	35	4
Truck and trailer	246	170	112	41	24	9
Average, truck combinations	227	166	120	61	33	5
Average, all trucks and combinations	67	47	34	17	10	1
Pacific:						
2-axle, 4-tire	...	...	...	...	...	...
2-axle, 6-tire	14	12	9	2	(1)	...
3-axle	33	22	11	4	...	...
Average, single-unit trucks	8	7	5	1	(1)	...
Truck-tractor and semitrailer	162	97	54	22	8	1
Truck and trailer	257	157	115	83	51	1
Average, truck combinations	191	115	72	40	21	1
Average, all trucks and combinations	82	50	32	17	8	(1)
United States average:						
2-axle, 4-tire	2	(1)	...	...	...	...
2-axle, 6-tire	20	14	9	4	1	(1)
3-axle	70	55	38	13	7	4
Average, single-unit trucks	11	8	5	2	1	(1)
Truck-tractor and semitrailer	187	121	75	30	12	2
Truck and trailer	224	143	92	52	30	4
Average, truck combinations	189	122	76	31	13	2
Average, all trucks and combinations	67	44	27	11	5	1
Comparative average, 1949	51	35	23	10	4	1
Comparative average, 1948	55	38	26	12	6	1

[1] Less than 5 per 10,000. [2] Data omitted because of insufficient sample.

Table 11.—*Number of axles, per 1,000 loaded and empty trucks and truck combinations, that exceeded the permissible axle-load limit of 18,000 pounds recommended by the A.A.S.H.O. by various percentages of overload in the summer of 1950*

Region and type of vehicle	Number per 1,000 overloaded	Number per 1,000 overloaded more than—				
		5 percent	10 percent	20 percent	30 percent	50 percent
New England:						
2-axle, 4-tire	...	...	...	...	...	...
2-axle, 6-tire	45	37	31	19	11	3
3-axle	97	56	49	14	...	...
Average, single-unit trucks	27	22	18	11	6	2
Truck-tractor and semitrailer	477	394	306	145	62	8
Truck and trailer	...	...	...	...	...	...
Average, truck combinations	474	391	304	144	62	8
Average, all trucks and combinations	135	111	87	43	19	3
Middle Atlantic:						
2-axle, 4-tire	(1)	(1)	(1)	(1)	...	...
2-axle, 6-tire	69	56	47	28	15	7
3-axle	173	125	79	51	51	11
Average, single-unit trucks	43	35	29	17	10	4
Truck-tractor and semitrailer	504	422	345	224	132	35
Truck and trailer	319	82	...	...	...	...
Average, truck combinations	503	420	343	223	131	35
Average, all trucks and combinations	199	166	136	87	51	15
South Atlantic:						
2-axle, 4-tire	(1)	(1)	...	...	...	...
2-axle, 6-tire	14	8	6	2	(2)	...
3-axle	49	36	11	4	...	...
Average, single-unit trucks	8	5	3	1	(2)	...
Truck-tractor and semitrailer	261	184	123	47	16	2
Truck and trailer	...	...	...	...	...	...
Average, truck combinations	260	183	123	47	16	2
Average, all trucks and combinations	88	61	41	16	5	1
East North Central:						
2-axle, 4-tire	...	...	...	...	...	...
2-axle, 6-tire	9	4	2	1	(2)	(2)
3-axle	26	26	26	26	13	...
Average, single-unit trucks	5	3	2	1	(2)	(2)
Truck-trailer and semitrailer	171	102	61	18	5	(2)
Truck and trailer	289	120	58	11	8	...
Average, truck combinations	180	103	61	18	5	(2)
Average, all trucks and combinations	79	46	27	6	2	(2)
East South Central:						
2-axle, 4-tire	...	...	...	...	...	...
2-axle, 6-tire	57	40	25	11	2	...
3-axle	112	39	39	...	...	...
Average, single-unit trucks	30	20	13	5	1	...
Truck-tractor and semitrailer	499	295	153	43	17	2
Truck and trailer	...	...	...	...	...	...
Average, truck combinations	499	295	153	43	17	2
Average, all trucks and combinations	128	78	42	13	4	(2)
West North Central:						
2-axle, 4-tire	...	...	...	...	...	...
2-axle, 6-tire	9	4	3	1	(2)	...
3-axle	23	12	12	6	...	...
Average, single-unit trucks	5	2	2	1	(2)	...
Truck-tractor and semitrailer	155	82	48	12	4	(2)
Truck and trailer	102	52	40	...	...	...
Average, truck combinations	155	82	48	12	4	(2)
Average, all trucks and combinations	36	19	12	3	1	(2)
West South Central:						
2-axle, 4-tire	...	...	...	...	...	...
2-axle, 6-tire	16	12	8	3	1	...
3-axle	49	10	...	...	...	...
Average, single-unit trucks	7	5	3	1	(2)	...
Truck-tractor and semitrailer	214	128	82	35	16	2
Truck and trailer	(1)	(1)	...	...	...	...
Average, truck combinations	209	125	80	34	16	2
Average, all trucks and combinations	63	38	24	10	4	1
Mountain:						
2-axle, 4-tire	...	...	...	...	...	...
2-axle, 6-tire	30	17	10	6	2	1
3-axle	151	127	117	19	19	10
Average, single-unit trucks	15	10	7	3	1	1
Truck-tractor and semitrailer	225	146	89	37	18	1
Truck and trailer	177	101	51	12	12	3
Average, truck combinations	217	139	83	33	17	1
Average, all trucks and combinations	64	41	25	10	5	1
Pacific:						
2-axle, 4-tire	...	...	...	...	...	...
2-axle, 6-tire	14	12	9	2	(2)	...
3-axle	23	14	13	...	...	...
Average, single-unit trucks	8	6	5	1	(2)	...
Truck-tractor and semitrailer	134	76	43	10	4	1
Truck and trailer	129	45	15	1	(2)	(2)
Average, truck combinations	132	67	35	7	3	1
Average, all trucks and combinations	58	31	17	3	1	(2)
United States average:						
2-axle, 4-tire	3	1	1	1	...	...
2-axle, 6-tire	28	20	15	8	3	1
3-axle	65	44	33	14	10	2
Average, single-unit trucks	15	11	8	4	2	1
Truck-tractor and semitrailer	269	185	127	60	29	6
Truck and trailer	174	72	32	5	4	(2)
Average, truck combinations	263	177	121	56	27	6
Average, all trucks and combinations	93	63	44	20	10	3
Comparative average, 1949	75	54	37	17	8	1
Comparative average, 1948	85	63	45	23	11	2

[1] Data omitted because of insufficient sample. [2] Less than 5 per 10,000.

able 12.—*Number of trucks and truck combinations, per 1,000 loaded and empty vehicles, that exceeded the permissible axle-group loads recommended by the A.A.S.H.O. by various percentages of overload in the summer of 1950*

Region and type of vehicle	Number per 1,000 overloaded	Number per 1,000 overloaded more than—				
		5 percent	10 percent	20 percent	80 percent	50 percent
New England:						
2-axle, 4-tire	....	....	....	....	....	....
2-axle, 6-tire	(1)	(1)	(1)	....	....	....
3-axle	80	47	27	8	8	....
Average, single-unit trucks	2	1	1	(1)	(1)	....
Truck-tractor and semitrailer	74	44	25	12	7	1
Truck and trailer	....	....	....	....	....	....
Average, truck combinations	74	44	25	12	7	1
Average, all trucks and combinations	19	11	7	3	2	(1)
Middle Atlantic:						
2-axle, 4-tire	(2)	(2)	(2)	....	....	....
2-axle, 6-tire	1	(1)	(1)	(1)	(1)	(1)
3-axle	130	116	108	74	25	11
Average, single-unit trucks	4	3	3	2	1	(1)
Truck-tractor and semitrailer	156	127	95	50	26	10
Truck and trailer	390	299	278	112	103	....
Average, truck combinations	157	128	96	50	26	10
Average, all trucks and combinations	56	45	35	18	9	3
South Atlantic:						
2-axle, 4-tire	....	....	....	....	....	....
2-axle, 6-tire	....	....	....	....	....	....
3-axle	73	30	21	6	....	....
Average, single-unit trucks	2	1	1	(1)	....	....
Truck-tractor and semitrailer	59	40	26	12	5	2
Truck and trailer	....	....	....	....	....	....
Average, truck combinations	59	40	26	12	5	2
Average, all trucks and combinations	20	13	9	4	2	1
East North Central:						
2-axle, 4-tire	....	....	....	....	....	....
2-axle, 6-tire	....	....	....	....	....	....
3-axle	33	26	26	13	13	13
Average, single-unit trucks	1	1	1	(1)	(1)	(1)
Truck-tractor and semitrailer	137	98	57	15	3	....
Truck and trailer	447	406	366	195	77	24
Average, truck combinations	161	122	81	29	9	2
Average, all trucks and combinations	69	52	35	12	4	1
East South Central:						
2-axle, 4-tire	....	....	....	....	....	....
2-axle, 6-tire	....	....	....	....	....	....
3-axle	8	4	....	....	....	....
Average, single-unit trucks	(1)	(1)	....	....	....	....
Truck-tractor and semitrailer	36	22	12	4	1	....
Truck and trailer	....	....	....	....	....	....
Average, truck combinations	36	22	12	4	1	....
Average, all trucks and combinations	8	5	3	1	(1)	....
West North Central:						
2-axle, 4-tire	....	....	....	....	....	....
2-axle, 6-tire	....	....	....	....	....	....
3-axle	27	21	14	6	6	....
Average, single-unit trucks	(1)	(1)	(1)	(1)	(1)	....
Truck-tractor and semitrailer	111	68	40	15	6	(1)
Truck and trailer	71	54	40	34	34	34
Average, truck combinations	109	67	40	16	7	1
Average, all trucks and combinations	27	17	10	4	2	(1)
West South Central:						
2-axle, 4-tire	....	....	....	....	....	....
2-axle, 6-tire	....	....	....	....	....	....
3-axle	47	47	37	....	....	....
Average, single-unit trucks	(1)	(1)	(1)	....	....	....
Truck-tractor and semitrailer	98	65	40	15	6	1
Truck and trailer	(2)	(2)	(2)	(2)	(2)	....
Average, truck combinations	96	63	39	15	6	1
Average, all trucks and combinations	27	18	11	4	2	(1)
Mountain:						
2-axle, 4-tire	....	....	....	....	....	....
2-axle, 6-tire	(1)	(1)	(1)	(1)	....	....
3-axle	118	83	58	25	10	5
Average, single-unit trucks	3	2	2	1	(1)	(1)
Truck-tractor and semitrailer	178	143	108	54	27	2
Truck and trailer	214	155	105	49	23	6
Average, truck combinations	184	145	108	53	26	3
Average, all trucks and combinations	47	37	28	14	6	1
Pacific:						
2-axle, 4-tire	....	....	....	....	....	....
2-axle, 6-tire	....	....	....	....	....	....
3-axle	27	19	6	4	....	....
Average, single-unit trucks	2	1	(1)	(1)	....	....
Truck-tractor and semitrailer	265	206	135	43	8	1
Truck and trailer	369	267	132	13	3	....
Average, truck combinations	296	224	134	34	6	1
Average, all trucks and combinations	120	91	54	14	2	(1)
United States average:						
2-axle, 4-tire	1	1	1	....	....	....
2-axle, 6-tire	(1)	(1)	(1)	(1)	(1)	(1)
3-axle	56	40	31	16	7	4
Average, single-unit trucks	1	1	1	(1)	(1)	(1)
Truck-tractor and semitrailer	123	89	58	23	9	2
Truck and trailer	337	268	185	71	30	10
Average, truck combinations	137	101	67	26	10	3
Average, all trucks and combinations	44	33	22	8	8	1
Comparative average, 1949	28	21	14	7	3	1
Comparative average, 1948	30	22	16	7	3	1

---

[1] Less than 5 per 10,000. [2] Data omitted because of insufficient sample.

Table 13.—*Number of trucks and truck combinations, per 1,000 loaded and empty vehicles, that exceeded any of the permissible load limits recommended by the A.A.S.H.O. by various percentages (maximum) of overload in the summer of 1950*

Region and type of vehicle	Number per 1,000 overloaded	Number per 1,000 overloaded more than—				
		5 percent	10 percent	20 percent	30 percent	50 percent
New England:						
2-axle, 4-tire	....	....	....	....	....	....
2-axle, 6-tire	45	37	31	19	11	3
3-axle	121	93	62	21	8	....
Average, single-unit trucks	28	23	19	11	6	2
Truck-tractor and semitrailer	310	268	214	112	52	7
Truck and trailer	....	....	....	....	....	....
Average, truck combinations	308	266	213	111	52	7
Average, all trucks and combinations	95	82	66	35	17	3
Middle Atlantic:						
2-axle, 4-tire	(1)	(1)	(1)	(1)	....	....
2-axle, 6-tire	69	56	47	28	15	7
3-axle	134	119	108	74	40	11
Average, single-unit trucks	42	35	30	18	9	4
Truck-tractor and semitrailer	341	298	240	158	95	33
Truck and trailer	411	319	278	112	103	....
Average, truck combinations	341	298	240	158	95	33
Average, all trucks and combinations	143	124	101	66	38	14
South Atlantic:						
2-axle, 4-tire	(1)	(1)	....	....	....	....
2-axle, 6-tire	14	8	6	2	(2)	....
3-axle	90	41	26	10	....	....
Average, single-unit trucks	9	5	3	1	(2)	....
Truck-tractor and semitrailer	199	144	99	45	17	3
Truck and trailer	....	....	....	....	....	....
Average, truck combinations	198	144	99	45	17	3
Average, all trucks and combinations	69	49	33	15	5	1
East North Central:						
2-axle, 4-tire	....	....	....	....	....	....
2-axle, 6-tire	9	4	2	1	(2)	(2)
3-axle	54	26	26	13	13	13
Average, single-unit trucks	6	3	2	1	(2)	(2)
Truck-tractor and semitrailer	219	150	92	27	8	(2)
Truck and trailer	449	409	367	196	84	24
Average, truck combinations	237	170	113	40	14	2
Average, all trucks and combinations	104	74	49	18	6	1
East South Central:						
2-axle, 4-tire	....	....	....	....	....	....
2-axle, 6-tire	57	40	25	11	2	....
3-axle	116	43	39	....	....	....
Average, single-unit trucks	30	20	13	5	1	....
Truck-tractor and semitrailer	395	252	136	41	15	2
Truck and trailer	....	....	....	....	....	....
Average, truck combinations	395	252	136	41	15	2
Average, all trucks and combinations	107	69	39	13	4	(2)
West North Central:						
2-axle, 4-tire	....	....	....	....	....	....
2-axle, 6-tire	9	4	3	1	(2)	....
3-axle	30	16	14	6	6	....
Average, single-unit trucks	5	2	2	1	(2)	....
Truck-tractor and semitrailer	179	108	63	20	8	1
Truck and trailer	75	62	44	37	34	34
Average, truck combinations	175	106	62	21	9	2
Average, all trucks and combinations	48	28	17	6	2	1
West South Central:						
2-axle, 4-tire	....	....	....	....	....	....
2-axle, 6-tire	16	12	8	3	1	....
3-axle	67	57	37	....	....	....
Average, single-unit trucks	7	5	3	1	(2)	....
Truck-tractor and semitrailer	204	136	87	36	18	2
Truck and trailer	(1)	(1)	(1)	(1)	(1)	....
Average, truck combinations	199	133	85	35	18	2
Average, all trucks and combinations	60	41	26	10	5	1
Mountain:						
2-axle, 4-tire	....	....	....	....	....	....
2-axle, 6-tire	30	17	10	6	2	1
3-axle	137	115	110	47	19	5
Average, single-unit trucks	15	9	7	3	1	(2)
Truck-tractor and semitrailer	240	187	142	71	35	4
Truck and trailer	290	210	124	52	32	9
Average, truck combinations	248	191	139	68	35	5
Average, all trucks and combinations	72	53	39	19	9	1
Pacific:						
2-axle, 4-tire	....	....	....	....	....	....
2-axle, 6-tire	14	12	9	2	(2)	....
3-axle	37	25	12	4	2	....
Average, single-unit trucks	9	7	5	1	(2)	....
Truck-tractor and semitrailer	293	230	150	48	11	1
Truck and trailer	396	277	138	13	3	(2)
Average, truck combinations	324	244	146	37	9	1
Average, all trucks and combinations	136	102	62	15	4	(2)
United States average:						
2-axle, 4-tire	3	2	2	1	....	....
2-axle, 6-tire	28	20	15	8	3	1
3-axle	77	50	41	18	10	4
Average, single-unit trucks	15	11	8	4	2	1
Truck-tractor and semitrailer	249	183	125	56	26	6
Truck and trailer	359	280	191	72	33	10
Average, truck combinations	256	190	129	57	26	6
Average, all trucks and combinations	91	68	46	21	10	3
Comparative average, 1949	68	53	38	19	10	2
Comparative average, 1948	73	56	42	23	11	3

---

[1] Data omitted because of insufficient sample. [2] Less than 5 per 10,000.

Table 14.—*Number of trucks and truck combinations per 1,000 loaded and empty vehicles, in private and in for-hire operation, th exceeded various load limits by various percentages of overload in the summer of 1950 (United States average)*

Type of vehicle	Private operation						For-hire operation					
	Number per 1,000 over-loaded	Number per 1,000 overloaded more than—					Number per 1,000 over-loaded	Number per 1,000 overloaded more than—				
		5 percent	10 percent	20 percent	30 percent	50 percent		5 percent	10 percent	20 percent	30 percent	50 percent
NUMBER OF TRUCKS AND TRUCK COMBINATIONS PER 1,000 EXCEEDING PERMISSIBLE AXLE, AXLE -GROUP, OR GROSS-WEIGHT LEGAL LIMITS OF THE SEVERAL STATES												
2-axle, 4-tire	1	(1)	....	....	....	....	(2)	....	....	....	....	....
2-axle, 6-tire	16	10	6	2	1	(1)	39	27	19	10	3	(1)
3-axle	71	57	41	10	6	5	63	52	33	16	7	3
Average, single-unit trucks	8	5	3	1	1	(1)	38	27	18	10	3	(1)
Truck-tractor and semitrailer	173	108	68	29	14	2	196	129	79	30	12	2
Truck and trailer	122	65	42	27	21	4	267	174	112	61	32	3
Average, truck combinations	170	106	67	29	14	2	201	132	81	32	13	2
Average, all trucks and combinations	33	21	13	5	3	(1)	159	105	65	26	10	1
Comparative average, 1949	26	18	13	5	3	1	131	89	56	23	11	2
NUMBER OF AXLES PER 1,000 TRUCKS AND TRUCK COMBINATIONS EXCEEDING THE 18,000 -POUND LIMIT RECOMMENDED BY THE A.A.S.H.O.												
2-axle, 4-tire	2	(1)	....	....	....	....	(2)	(2)	(2)	(2)	....	....
2-axle, 6-tire	22	15	11	5	2	1	55	40	30	18	8	5
3-axle	57	43	35	14	9	1	79	46	29	14	12	4
Average, single-unit trucks	11	7	5	2	1	(1)	52	37	28	16	8	4
Truck-tractor and semitrailer	278	193	133	62	28	6	263	180	123	58	29	7
Truck and trailer	110	39	15	4	4	1	202	86	39	6	3	(1)
Average, truck combinations	269	184	126	59	27	6	259	173	117	54	27	6
Average, all trucks and combinations	51	35	24	11	3	1	205	138	94	44	22	5
Comparative average, 1949	39	28	20	8	3	1	195	141	99	46	21	5
NUMBER OF TRUCKS AND TRUCK COMBINATIONS PER 1,000 EXCEEDING THE MAXIMUM AXLE -GROUP LOADS RECOMMENDED BY THE A.A.S.H.O.												
2-axle, 4-tire	1	1	1	....	....	....	....	....	....	....	....	....
2-axle, 6-tire	(1)	(1)	(1)	(1)	....	....	(1)	(1)	(1)	(1)	(1)	(1)
3-axle	63	43	31	17	7	6	40	32	28	12	6	1
Average, single-unit trucks	1	1	1	(1)	(1)	(1)	3	2	2	1	(1)	(1)
Truck-tractor and semitrailer	101	71	44	18	8	2	136	101	66	25	9	2
Truck and trailer	175	118	85	22	14	4	405	330	229	93	36	11
Average, truck combinations	105	74	46	18	8	2	156	118	78	30	11	3
Average, all trucks and combinations	17	12	8	3	1	(1)	116	88	58	22	8	2
Comparative average, 1949	12	8	6	3	2	(1)	87	64	43	20	10	2
NUMBER OF TRUCKS AND TRUCK COMBINATIONS PER 1,000 EXCEEDING ANY OF THE MAXIMUM MOTOR-VEHICLE LOADS RECOMMENDED BY THE A.A.S.H.O.												
2-axle, 4-tire	2	1	1	....	....	....	(2)	(2)	(2)	(2)	....	....
2-axle, 6-tire	22	15	11	5	2	1	55	40	30	18	8	5
3-axle	77	52	41	19	9	5	71	45	40	16	11	3
Average, single-unit trucks	11	8	6	3	1	1	52	37	29	17	8	4
Truck-tractor and semitrailer	229	167	113	53	25	5	260	191	130	58	27	6
Truck and trailer	181	119	76	16	12	3	428	343	234	93	38	11
Average, truck combinations	226	164	111	51	24	5	272	202	138	61	28	6
Average, all trucks and combinations	45	32	22	11	5	2	215	159	110	50	23	5
Comparative average, 1949	34	26	19	9	4	1	184	143	103	52	25	6

[1] Less than 5 per 10,000. [2] Data omitted because of insufficient sample.

exceeded one or more of the State weight limits, the Pacific region had the second highest rate of overloads (82) and in descending order of rates of violation were the Middle Atlantic (75), the East North Central (72), the Mountain (67), the West South Central (63), the West North Central (50), the South Atlantic (45), and the New England region (35).

A comparison of the frequency of loads exceeding State limits in 1950, shown in table 10, with similar data collected in the previous year, indicates that the frequency of these illegal loads has increased in all regions except the South Atlantic, in which this frequency decreased from 53 to 45 per 1,000 vehicles weighed. In all other regions increases in the rate of weight violations were found although the increases did not extend to the larger percentages of violation. For instance, in the East North Central region 63 vehicles of each 1,000 weighed in 1949 exceeded one or more of the weight restrictions by some amount, while in 1950, 72 vehicles per 1,000 exceeded the restrictions. At the same time, of those weighed in 1949, 27 exceeded the limits by more than 10 percent, while in 1950, only 23 exceeded these limits by more than 10 percent.

No panel or pick-up truck was weighed that exceeded any of the State weight regulations and this classification is omitted from tables 10–14 although the number of such vehicles counted is included in the calculations.

Recommended Weight Limits

Uniform regulations concerning maximum allowable gross weights, axle weights, and axle-group weights have been adopted as a policy by the American Association of State Highway Officials and recommended to the State governments for adoption.[7] This policy recommends that no axle shall carry a load in excess of 18,000 pounds and no group of axles shall carry a load in excess of amounts specified in a table of permissible weights based on the distance between the extremes of any group of axles.

In table 11 is shown the number of axl
per 1,000 vehicles of various types that e
ceeded the axle load limit of 18,000 poun
recommended by the A.A.S.H.O. and t
number exceeding these limits by vario
percentages. This table emphasizes aga
the high frequency of heavy axle loads
the Middle Atlantic and New England r
gions. The number of axles per 1,000 v
hicles weighing more than the A.A.S.H.
recommended limits was 199 in the Midd
Atlantic and 135 in the New England r
gion, while only 58 such axles for each 1,0
vehicles were found in the Pacific regi
and 36 in the West North Central regic
There were 87 axles per 1,000 vehicles
the Middle Atlantic region exceeding t
18,000-pound recommended limit by
percent or more, compared to only 3 ea
in the Pacific and West North Centr
regions.

Table 12 shows the number of vehic
of various types, per 1,000 vehicles, wi
an axle-group load in excess of the lim
recommended by the A.A.S.H.O. and
excess of the limits by various percentag
As might be expected from the large

---

[7] *Policy concerning maximum dimensions, weights, and speeds of motor vehicles to be operated over the highways of the United States,* adopted April 1, 1946, by the American Association of State Highway Officials: published by the Association in 1946.

eases of frequencies of heavy gross loads licated in figure 7, the number of vecles of various types per 1,000 weighed at exceeded the A.A.S.H.O. recommentions increased in 1950 over the similar tes in 1949. For the country as a whole, each 1,000 loaded and empty trucks d truck combinations, 44 had axle groups 1950 weighing in excess of the recomended limits, 8 of which exceeded the limits more than 20 percent. In 1949, comparable figures indicated that 28 trucks and ck combinations of each 1,000 exceeded e axle-group recommendation, 7 of which ceeded the limits by more than 20 percent. each 1,000 combinations weighed, 137 d axle-group loads weighing more than e recommended limits, of which 26 exeded the limits by more than 20 percent. ne frequency of the excessive axle-group ads in 1950 was about 57 percent more an in 1949.

It will be noted that a higher proportion the vehicles have excessive axle-group ads in the Pacific region than elsewhere, hereas table 11 shows a comparatively w frequency of heavy axle loads for that gion. This is because of the widespread e of multiple-axle vehicles in California d neighboring States.

As might be expected, many vehicles were loaded that they exceeded more than one commended weight limit, and some vecles had more than one axle loaded in cess of the recommended limit. Counting ch vehicle only once, regardless of the mber of ways in which it exceeded any the A.A.S.H.O. recommended limits, table was prepared to show the number of hicles per 1,000 of each type, both loaded d empty, that exceeded the limits by varis percentages. Those vehicles which exeded more than one provision of the commended restrictions were tabulated ly in the column showing the highest rcentage excess of any item.

In the United States as a whole, 91 vehicles out of every 1,000 were overloaded to some degree and 21 out of every 1,000 exceeded some one of the recommended provisions by more than 20 percent. The frequency of vehicles exceeding the recommendations by any amount in 1950 was 34 percent more than in 1949, when 68 vehicles out of every 1,000 were overloaded to some degree. The frequency exceeding the recommendations by more than 20 percent in 1950 was 11 percent more than in 1949, when 19 vehicles out of every 1,000 vehicles exceeded some recommended limit to this extent.

State Limits Higher

In considering the data concerning the frequencies of axles or vehicles exceeding the State legal limits and the A.A.S.H.O. recommendations, especially the frequencies in the Middle Atlantic and New England regions, the fact should be recognized that higher limits generally are permissible under the State laws in these areas than are recommended by the Association. Axles exceeding the recommended limits by 25 percent may be within the legal limits of certain States, particularly in these two regions. Some States have no axle-group limits in their motor-vehicle restrictions, a fact that further complicates direct comparison of excess weights based on law and those based on the recommendations. Comparison of the frequency data for New England and the Middle Atlantic regions given in table 13 with those in table 10 shows that from one-third to one-half of the vehicles exceeding one or more of the Association recommendations actually exceeded a State legal limit. For the United States as a whole, nearly three-fourths of the vehicles exceeding one or more of the Association recommendations also exceeded a State legal limit.

Overloading of For-Hire Vehicles

The first part of table 14 shows separately the number of privately operated trucks and truck combinations and those operated for-hire, for each 1,000 such loaded and empty vehicles on main rural roads of the United States, that exceeded some State legal weight limit in 1950, and also comparative average figures for 1949. A comparison of the frequency of the excessively loaded vehicles in the two operation classifications shows, in striking manner, that type by type the for-hire vehicles generally are more frequently overloaded than are the privately operated ones. For instance, 8 of each 1,000 private single-unit trucks exceeded a State weight limit while 38 of each 1,000 for-hire trucks exceeded the same limits. Likewise, 170 of each 1,000 private truck combinations exceeded State weight limits, while 201 of each 1,000 for-hire combinations exceeded the same limits.

Of each 1,000 vehicles, the frequencies of all private and all for-hire trucks and truck combinations exceeding the State limits in 1950 were 33 and 159, respectively, while in the previous year the corresponding frequencies were 26 and 131. In both years, there were nearly five times as many excess loads among the for-hire vehicles as among the privately operated ones.

The following parts of table 14 show frequencies of private and for-hire trucks and truck combinations exceeding the A.A.S.H.O. recommended limits for axle loads, for maximum axle-group loads, or for any of the recommended maximum loads. These sections of the table show, in general, as did the first section, that the relation of the frequency of overload of privately operated and for-hire vehicles is approximately the same when based on A.A.S.H.O. recommendations as when based on State legal limits.

A complete list of the publications of the Bureau of Public Roads, classified according to subject and including the more important articles in PUBLIC ROADS, may be obtained upon request addressed to Bureau of Public Roads, Washington 25, D. C.

PUBLICATIONS of the Bureau of Public Roads

The following publications are sold by the Superintendent of Documents, Government Printing Office, Washington 25, D. C. Orders should be sent direct to the Superintendent of Documents. Prepayment is required.

ANNUAL REPORTS

(See also adjacent column)

Reports of the Chief of the Bureau of Public Roads:
1937, 10 cents. 1938, 10 cents. 1939, 10 cents.

Work of the Public Roads Administration:

1940, 10 cents.	1942, 10 cents.	1948, 20 cents
1941, 15 cents.	1946, 20 cents.	1949, 25 cents.
	1947, 20 cents.	

Annual Report, Bureau of Public Roads, 1950. 25 cents.

HOUSE DOCUMENT NO. 462

Part 1 . . . Nonuniformity of State Motor-Vehicle Traffic Laws. 15 cents.
Part 2 . . . Skilled Investigation at the Scene of the Accident Needed to Develop Causes. 10 cents.
Part 3 . . . Inadequacy of State Motor-Vehicle Accident Reporting. 10 cents.
Part 4 . . . Official Inspection of Vehicles. 10 cents.
Part 5 . . . Case Histories of Fatal Highway Accidents. 10 cents.
Part 6 . . . The Accident-Prone Driver. 10 cents.

UNIFORM VEHICLE CODE

Act I.—Uniform Motor-Vehicle Administration, Registration, Certificate of Title, and Antitheft Act. 10 cents.
Act II.—Uniform Motor-Vehicle Operators' and Chauffeurs' License Act. 10 cents.
Act III.—Uniform Motor-Vehicle Civil Liability Act. 10 cents.
Act IV.—Uniform Motor-Vehicle Safety Responsibility Act. 10 cents.
Act V.—Uniform Act Regulating Traffic on Highways. 20 cents.
Model Traffic Ordinance. 15 cents.

MISCELLANEOUS PUBLICATIONS

Bibliography of Highway Planning Reports. 30 cents.
Construction of Private Driveways (No. 272MP). 10 cents.
Economic and Statistical Analysis of Highway Construction Expenditures. 15 cents.
Electrical Equipment on Movable Bridges (No. 265T). 40 cents.
Factual Discussion of Motortruck Operation, Regulation, and Taxation. 30 cents.
Federal Legislation and Regulations Relating to Highway Construction. 40 cents.
Financing of Highways by Counties and Local Rural Governments, 1931–41. 45 cents.
Guides to Traffic Safety. 10 cents.
Highway Accidents. 10 cents.
Highway Bond Calculations. 10 cents.
Highway Bridge Location (No. 1486D). 15 cents.
Highway Capacity Manual. 65 cents.
Highway Needs of the National Defense (House Document No. 249). 50 cents.
Highway Practice in the United States of America. 50 cents.
Highway Statistics, 1945. 35 cents.
Highway Statistics, 1946. 50 cents.
Highway Statistics, 1947. 45 cents.
Highway Statistics, 1948. 65 cents.
Highway Statistics, 1949. 55 cents.
Highway Statistics, Summary to 1945. 40 cents.
Highways in the United States *(nontechnical)*. 15 cents.
Highways of History. 25 cents.
Identification of Rock Types. 10 cents.
Interregional Highways (House Document No. 379). 75 cents.
Legal Aspects of Controlling Highway Access. 15 cents.
Local Rural Road Problem. 20 cents.
Manual on Uniform Traffic Control Devices for Streets and Highways. 75 cents.
Mathematical Theory of Vibration in Suspension Bridges. $1.25.
Principles of Highway Construction as Applied to Airports, Flight Strips and Other Landing Areas for Aircraft. $1.75.
Public Control of Highway Access and Roadside Development. 35 cents.
Public Land Acquisition for Highway Purposes. 10 cents.
Roadside Improvement (No. 191MP). 10 cents.
Selected Bibliography on Highway Finance. 55 cents.
Specifications for Construction of Roads and Bridges in National Forests and National Parks (FP-41). $1.50.
Taxation of Motor Vehicles in 1932. 35 cents.
Tire Wear and Tire Failures on Various Road Surfaces. 10 cents.
Transition Curves for Highways. $1.25.

Single copies of the following publications are available to highway engineers and administrators for official use, and may be obtained by those so qualified upon request addressed to the Bureau of Public Roads. They are not sold by the Superintendent of Documents.

ANNUAL REPORTS

(See also adjacent column)

Public Roads Administration Annual Reports:
1943. 1944. 1945.

MISCELLANEOUS PUBLICATIONS

Bibliography on Automobile Parking in the United States.
Bibliography on Highway Lighting.
Bibliography on Highway Safety.
Bibliography on Land Acquisition for Public Roads.
Bibliography on Roadside Control.
Express Highways in the United States: a Bibliography.
Indexes to PUBLIC ROADS, volumes 17–19, 22, and 23.
Road Work on Farm Outlets Needs Skill and Right Equipment.
Title sheets for PUBLIC ROADS, volumes 24 and 25.

U.S. GOVERNMENT PRINTING OFFICE: 1951-951446

STATUS OF FEDERAL-AID HIGHWAY PROGRAM

AS OF OCTOBER 31, 1951

(Thousand Dollars)

STATE	UNPROGRAMMED BALANCES	ACTIVE PROGRAM											
		PROGRAMMED ONLY			PLANS APPROVED, CONSTRUCTION NOT STARTED			CONSTRUCTION UNDER WAY			TOTAL		
		Total Cost	Federal Funds	Miles	Total Cost	Federal Funds	Miles	Total Cost	Federal Funds	Miles	Total Cost	Federal Funds	Miles
Alabama	$11,992	$16,872	$9,011	316.6	$4,411	$2,050	71.8	$19,321	$9,682	397.2	$40,604	$20,743	785.6
Arizona	462	4,153	2,853	80.8	1,259	890	36.4	5,660	4,011	68.2	11,072	7,754	185.4
Arkansas	1,869	8,299	4,530	310.5	7,254	3,586	216.8	12,252	6,317	354.9	27,805	14,433	882.2
California	6,021	17,157	2,720	55.6	6,899	3,280	18.9	69,982	33,176	329.6	94,038	39,176	404.1
Colorado	2,087	3,559	1,992	87.5	2,140	1,114	44.1	14,572	7,917	293.5	20,271	11,023	425.1
Connecticut	3,251	3,264	1,682	11.3	1,018	508	.8	12,283	6,388	18.4	16,565	8,578	30.5
Delaware	2,033	3,497	1,096	16.7	490	248	13.5	4,608	2,237	28.6	8,595	3,581	58.8
Florida	3,793	9,385	4,889	223.3	8,987	4,610	152.5	17,284	8,621	325.7	35,656	18,120	701.5
Georgia	3,145	14,474	7,393	359.5	9,720	4,356	118.0	28,277	14,147	422.8	52,471	25,896	900.3
Idaho	3,067	11,056	6,908	349.5	639	397	19.2	4,486	2,939	105.7	16,181	10,244	474.4
Illinois	17,314	32,073	17,828	230.5	18,047	9,119	150.3	71,052	35,807	618.0	121,172	62,754	998.8
Indiana	10,573	29,843	15,038	161.4	9,519	4,602	64.2	17,786	9,048	212.3	57,148	28,688	437.9
Iowa	1,036	9,852	5,277	308.6	5,186	2,620	162.5	17,071	8,458	705.6	32,109	16,355	1,176.7
Kansas	5,466	8,741	4,233	1,055.1	2,555	1,286	325.3	16,447	8,190	565.5	27,743	13,709	1,945.9
Kentucky	917	17,154	8,973	264.6	7,039	3,592	182.0	11,774	5,872	149.5	35,967	18,437	596.1
Louisiana	2,279	17,377	8,338	80.8	7,571	3,503	77.9	19,948	10,111	167.9	44,896	21,952	326.6
Maine	1,559	6,896	3,811	44.1	3,170	1,553	25.7	5,246	2,670	49.9	15,312	8,034	119.7
Maryland	4,533	2,230	1,032	22.3	6,326	3,344	19.5	9,854	4,211	39.8	18,410	8,587	81.6
Massachusetts	485	10,456	4,373	24.6	10,660	4,977	10.1	58,005	28,695	52.1	79,121	38,045	86.8
Michigan	1,808	22,388	11,201	427.6	7,098	3,555	134.2	48,935	20,936	296.5	78,421	35,692	858.3
Minnesota	4,227	5,098	2,671	771.8	1,703	972	165.8	26,775	14,282	933.1	33,576	17,925	1,870.7
Mississippi	7,452	4,768	2,364	196.6	3,454	1,682	113.4	19,190	9,951	537.2	27,412	13,997	847.2
Missouri	8,172	22,277	11,754	653.8	9,654	4,742	190.6	37,281	19,565	682.3	69,212	36,061	1,526.7
Montana	4,128	13,782	8,404	392.7	3,030	1,806	32.6	13,478	7,965	224.7	30,290	18,175	650.0
Nebraska	5,368	16,612	8,602	622.6	4,632	2,333	68.6	16,230	7,998	547.2	37,474	18,933	1,238.4
Nevada	2,619	3,795	3,168	101.7	607	496	2.7	2,943	2,462	154.5	7,345	6,126	258.9
New Hampshire	1,834	2,940	1,654	16.4	681	339	4.2	4,448	2,210	34.7	8,069	4,203	55.3
New Jersey	1,961	9,133	4,447	19.0	11,082	5,427	9.4	18,558	8,943	27.3	38,773	18,817	55.7
New Mexico	1,426	3,833	2,453	149.9	659	433	12.3	11,935	7,631	213.6	16,427	10,517	375.8
New York	22,777	79,409	41,543	203.6	14,514	6,582	62.0	110,168	51,340	403.3	204,091	99,465	668.9
North Carolina	2,462	17,318	8,571	331.7	2,729	1,292	66.5	25,302	12,637	526.4	45,349	22,500	924.6
North Dakota	1,101	6,667	3,460	1,049.0	5,003	2,504	582.3	9,400	4,714	766.1	21,070	10,678	2,397.4
Ohio	10,267	28,217	13,621	217.9	10,860	5,348	56.5	68,653	34,807	267.7	107,730	53,776	542.1
Oklahoma	2,196	12,648	6,882	199.5	3,892	2,077	49.1	19,645	10,556	256.1	36,185	19,515	504.7
Oregon	652	1,927	1,139	18.6	1,318	691	20.8	15,820	8,782	200.9	19,065	10,612	240.3
Pennsylvania	3,253	24,803	12,395	32.0	20,248	9,864	62.4	57,716	28,644	180.2	102,767	50,903	274.6
Rhode Island	1,625	5,095	2,547	42.5	792	395	3.0	14,918	7,583	12.8	20,805	10,525	58.3
South Carolina	1,363	11,514	6,282	253.6	2,987	1,439	107.6	10,802	5,464	182.1	25,303	13,185	543.3
South Dakota	696	4,243	2,509	410.6	3,852	2,280	281.9	12,046	6,875	687.3	20,141	11,664	1,379.8
Tennessee	2,181	11,845	5,592	363.7	8,054	3,704	98.3	24,889	11,848	330.6	44,788	21,144	792.6
Texas	7,819	1,972	874	67.3	9,901	5,512	101.0	56,163	26,746	532.7	68,036	33,132	701.0
Utah	1,046	6,296	4,733	126.6	1,133	814	21.4	3,689	2,670	50.5	11,118	8,217	198.5
Vermont	493	4,168	2,294	44.1	1,056	527	12.1	4,930	2,447	29.9	10,154	5,268	86.1
Virginia	4,537	16,507	8,174	408.6	6,076	3,118	157.8	20,101	9,913	320.5	42,684	21,205	886.9
Washington	1,545	9,996	4,220	143.0	2,395	1,400	30.1	19,525	9,194	114.1	31,916	14,814	287.2
West Virginia	2,714	10,891	5,473	130.3	3,632	1,829	41.0	11,025	5,504	130.8	25,548	12,806	302.1
Wisconsin	5,451	18,983	10,443	330.9	6,943	3,380	102.3	20,832	10,344	441.8	46,758	24,167	875.0
Wyoming	328	1,204	877	25.4	1,329	867	27.9	6,754	4,369	199.1	9,287	6,113	252.4
Hawaii	832	7,837	3,387	11.1	843	412	3.8	8,373	3,066	23.8	17,053	6,865	38.7
District of Columbia	3,535	2,864	1,432	.7				3,953	2,169	2.8	6,817	3,601	3.5
Puerto Rico	3,029	10,336	4,820	46.8	1,385	622	2.9	10,019	4,594	36.2	21,740	10,036	85.9
TOTAL	200,779	625,704	319,963	11,812.9	264,432	132,077	4,334.0	1,150,404	574,706	14,252.0	2,040,540	1,026,746	30,398.9

U. S. GOVERNMENT PRINTING OFFICE 72196