DEPARTMENT OF TRAFFIC AND OPERATIONS

WILBUR S. SMITH, *Chairman*

AXLE LOAD AND GROSS LOAD TRENDS

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ABSTRACT

This paper, which was presented at the Twenty Ninth Annual Meeting of the Highway Research Board, December 16, 1949, has been printed in full in *Public Roads*, February 1950, Volume 25, No 12 It is given here in brief abstract in order to furnish a reference to this important analysis of one part of a traffic situation that poses grave problems.

Following World War I, there was much complaint that heavy trucks were damaging the newly-built surfaces and pavements However, surveys made in six States prior to 1927 did not reveal any loads we would regard as heavy today, except in Connecticut and Cook County, Illinois. Principally, it was the impact of solid tires on the comparatively thin pavements then prevailing that caused the damage All States passed laws regulating the weights and dimensions of vehicles and through a combination of law enforcement and improvement in pavement design and vehicle design, the problem of heavy loads seemed to be satisfactorily solved in the early 1930's

The State-wide highway planning surveys provided the first Nation-wide data on frequency of heavy loads for the 1936–37 period, and have annually collected such data beginning in 1942 The information, presented in this article, shows how rapidly the frequencies of heavy loads have increased in recent years. In the 1936–37 period, gross loads of 40,000 lb. or more amounted to only about 1 percent of the total number of commercial vehicles on the highways By 1942 this frequency had tripled, and by 1948 had again doubled. Frequency of heavy axle loads shows a similar rise. But, since the number of trucks has also increased greatly, the total number of heavy axle loads found on the highways in 1948 was 18 times the number in the 1936–37 period, and the rate of increase appears to be accelerating rapidly

A study of heavy load frequencies by regions indicates that the most favorable situation exists in the Western regions, where legal limitation of 50 ft. or more in length permits advantageous distribution of heavy loads on vehicle combinations with five or more axles In the remainder of the country, where the length is limited to 45 ft. in most States, vehicles with more than four axles are little used, and three- and four-axle combinations carry the bulk of the highway tonnage It is these two types that have the highest frequency of heavy axle loads

Figures 2, 3, 5, 8, and 10, from the *Public Roads* paper summarize the situation graphically.

The major part of the Nation's principal highways was constructed in the period from 1920 to 1940. These existing highways must be maintained, and gradually reconstructed or replaced, with the funds currently available for the purpose. It is obviously impossible to meet the rapidly increasing frequency of heavy axle loads by thickening the pavements, as was done to some extent in the earlier years of road building. Legal limitation of axle loads, with effective enforcement, seems to be the only way our pavements can be protected. This does not necessarily mean, however, that gross loads and pay loads may not be allowed to increase, provided the vehicle is so designed as to spread the load over a sufficient number of axles

Two companion papers in the same issue of *Public Roads* (February, 1950) round out the picture by giving data on rural traffic trends and on motor-vehicle travel in 1948 These

are noted in brief synopsis as follows.

TRAFFIC TRENDS ON RURAL ROADS, 1948
By Thomas B. Dimmick

Total travel on rural roads in 1948 broke all records, exceeding the previous year's high by 6 percent and the prewar peak by 17 percent. made, notwithstanding small drops in the proportion of trucks loaded, because of the rise in use of heavier commercial vehicles, beginning during the war and continued in 1948, although at a reduced rate Truck-combination travel was 9 percent higher than in the previous year, 63 percent higher than in 1941,

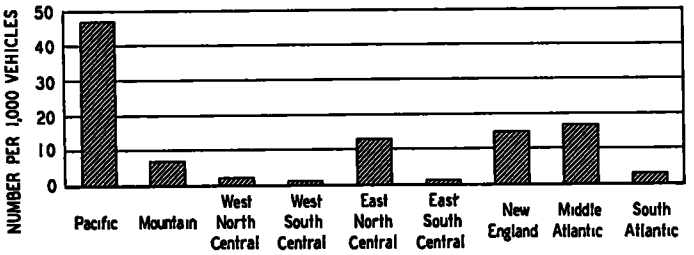

Figure 2. Frequency of Gross Loads of 40,000 lb. or More, per 1,000 Vehicles, by Region, in 1936–37

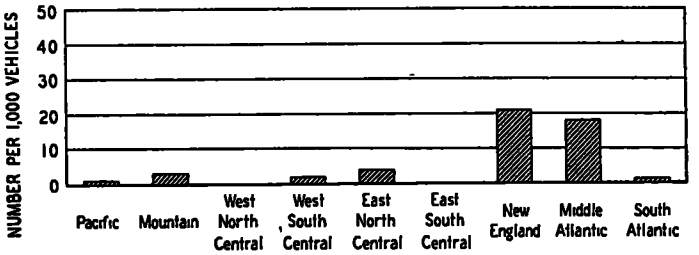

Figure 3. Frequency of Axle Loads of 20,000 lb. or More, per 1,000 Vehicles, by Regions, in 1936–37

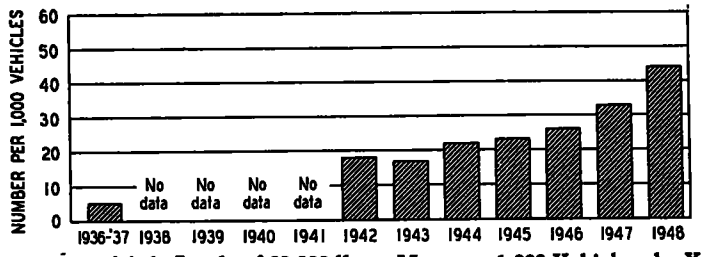

Figure 5. Frequency of Axle Loads of 20,000 lb. or More per 1,000 Vehicles, by Years

On the 345,000 miles of main rural roads in the United States travel in 1948 was almost 148 billion vehicle-miles, of which about 77 percent was by passenger cars, 1 percent by busses, and 22 percent by freight-carrying vehicles.

Trucks and combinations hauled 13 percent more ton-mileage of freight in 1948 than in the previous year and 42 percent more than in 1941. These increases in freight carried were and 213 percent higher than in 1936. The average load carried by commercial vehicles in 1948 was 73 percent heavier than in 1936 and about 4 percent above the 1947 load weights

In 1948, over 5 percent of all trucks and combinations, loaded and empty, exceeded a legal weight limit, and 18 percent of the combinations were overweight in some particular. The highest percentage of overloading was in

the East North Central region where 8 percent of the vehicles of all types and 21 percent of the combinations were found to exceed legal weight limits. From 1947 to 1948 the percentage of overweight vehicles increased in all regions except the Pacific and New England regions.

accounted for 319 billion vehicle-miles of the total, busses 4 billion, and trucks and combinations 74 billion. Except for urban travel of busses, estimated travel in 1948 was greater than in 1947 for every category, although in all cases the increases were smaller than those from 1946 to 1947 As in the previous year,

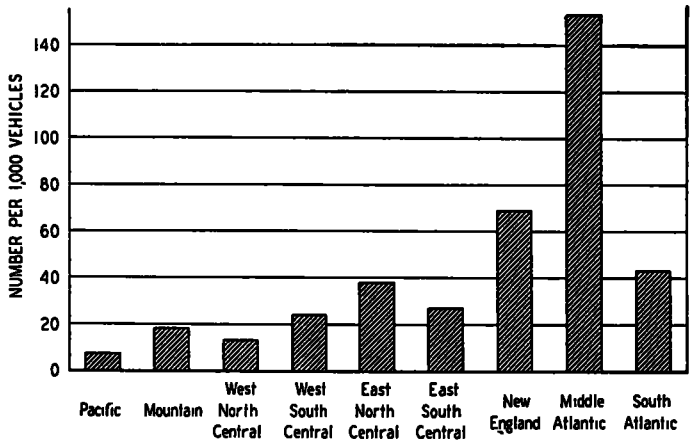

Figure 8. Frequency of Axle Loads of 20,000 lb. or More, per 1,000 Vehicles, by Regions in 1948

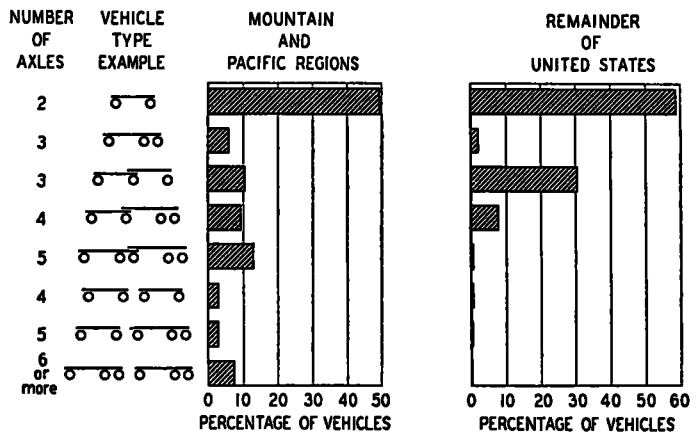

Figure 10. Percentage Distribution of Vehicles of Various Types (Exclusive of Two-Axle, Single Tire Vehicles) in the West and the Remainder of the United States, in 1948

TRENDS IN MOTOR-VEHICLE TRAVEL, 1948

By G. P. St. Clair[1]

Total motor-vehicle travel in 1948 is estimated as more than 397 billion vehicle-miles, about evenly divided between rural highways and urban roads and streets. Passenger cars

truck travel in 1948 increased at about twice the rate of passenger-vehicle travel.

The average vehicle in 1948 traveled 9,707 miles, using 741 gallons of motor fuel at a rate of 13 miles per gallon. Annual average passenger-car travel continued to decrease from the 1946 peak, while average truck-mileage, though maintaining a steady rise, was still below the 1941 maximum.

[1] Chief, Financial and Administrative Research Branch, Bureau of Public Roads.

Total travel has been very nearly equally divided between rural highways and urban roads and streets since the end of the war As indicated in this article, the ratios of rural to urban travel for the past 3 years vary in a range of less than 2 percent

SURVEY OF UPHILL SPEEDS OF TRUCKS ON MOUNTAIN GRADES

WM E. WILLEY, *Engineer, Division of Economics and Statistics, Arizona Highway Department*

SYNOPSIS

The report represents a study of the uphill operational speeds of heavily loaded trucks on mountain grades as encountered on the highways in Arizona during 1948 The object of the survey was to provide basic data to determine how far a heavy truck will travel up various rates of grades before the crawl speed will be reached From these data will come indications as to when uphill truck lanes, or passing bays are necessary and how they can be incorporated in engineering design and planning Seven typical field locations on transcontinental routes were studied with mountain grades ranging from plus 2 to over plus 6 percent Elevations varied from sea level to 7200 ft. while traffic varied from 1000 to 3000 vehicles per day

Commercial trucks were stopped and the driver was interviewed while the vehicle was being weighed and measured The truck under observation was then followed up the mountain grade after normal operational speed had been resumed Observers in the survey vehicle recorded the speed of the truck with a calibrated speedometer and noted changes in speed in connection with identifying stations on the highway. When the lowest crawl speed was reached the vehicle was observed until the hill was negotiated at which time the same procedure was repeated with another truck A composite speed performance chart was plotted and it was determined that on a 6-percent grade a heavily loaded truck will lose speed at the rate of 23 mph per thousand feet of grade A distance of 1700 ft is required to reach the crawl speed of 7 mph from a level approach speed of 47 mph All other common grades are included in the report It was concluded that consideration could be given to changing the percentage of grade from plus 3 to plus 4 as the point at which the difference in elevation should be obtained in the shortest possible distance by going immediately to a 6 percent grade, in highway location and design It was also observed that within the same brake horsepower to gross vehicle weight group diesel and butane powered trucks gave a somewhat better speed performance than did the gasoline powered vehicles

Driver habits were also found to be an influencing factor in operational performance No difference in speed was noted for trucks operating on the same percent of grade at different locations ranging in elevation from sea level to 7200 ft Trucks operating in good mechanical condition had no trouble with overheating.

The Division of Economics and Statistics of the Arizona Highway Department completed in 1949 the field survey and office analysis of one phase of a study of the performance of heavily loaded motor vehicles on various mountain grades This survey was conducted at the suggestion of the Bureau of Public Roads and the Engineering Design Division of the Arizona Highway Department We are greatly indebted to the helpful comments and assistance of Mr O K Normann and Mr Carl Saal of the Bureau of Public Roads

Although there are three phases to this study the paper presented herewith will deal only with the first phase, i.e. "Uphill Speeds of Trucks on Mountain Grades." The second phase is now in progress and is a companion study having to do with, "Downhill Speeds of Trucks on Mountain Grades." The third and final report in this series will analyze the congestion caused by slow moving trucks on uphill grades We will attempt to show that the congestion caused on certain lengths of various grades with certain traffic volume, when eliminated, will result in sufficient sav-