HIGHWAYS IN THE PUBLIC SERVICE

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Some day a long over-due insignia - I. P. S. - In the Public Service - will come into use to carry merited recognition. In England for generations H.M.S. - His Majesty's Service - has ranked high as a passport, and as a command to all loyal subjects to render any assistance possible to the one wearing this symbol of responsibility. These letters open all doors, smooth the way, defeat obstruction. They attest the performance of service to King and country.

In these United States do we have anything, measured by a yardstick of true value, more worthy to carry the symbol I. P. S. than our public highways? Do we have anything more entitled to honest treatment than our roads and streets? Do we have anything more indispensable to more people than the public ways? Yet, in the use of our highways, do we have anything to which we give less thought or more irresponsible treatment, while demanding from them continuing, ever-increasing service?

These reflections may seem elementary to a group composing a cross-section of the nation's road building industry, and of those who design, administer and use our highways. The past summer's exposition in Chicago, staged by the American Road Builders, was a marvelous reality of the coming of age of the road-building equipment industry.

There were also the models and other representations of highway work completed and in use only because of the fantastic production potentials of this modern equipment. The great scope and endless variety of available tools and equipment surpassed the most extravagant pre-conception. The whole panorama was a spectacular demonstration of the mechanical means for the building of roads, and which, used intelligently and competently, will well satisfy production demands. We have reached a high level of ability to design and to produce roads.

In shabby contrast, however, is our failure to control the use of the roads to serve best the public interests as a whole. We may have passed to the graduate and post-graduate conception of engineering and construction, but the a,b,c's of highway knowledge yet constitute the only alphabet we have, and it is high time to take an honest look at some of these a,b,c's. We are in somewhat the same position as the little girl who failed in an examination. Her indignant parent explained that the little girl was studying way over on Page 40 of her book, and the questions asked by the teacher were answered clear back on Page 10.

In our case, the a,b,c's are that the highways are built for the whole public service. All the equipment, all the engineering and construction skills, the labor and the funds are combined to produce a utility for public use. They are not dedicated to this purpose, and thus taken away from other important undertakings, to build

facilities for misuse. Our inarticulate roads cannot put on a publicity campaign against mistreatment, but they are reflecting misuse in other more positive and more costly ways. Specifically, we are overloading our highways in their traffic volume capacity and in their structural capacity. There is more than ample proof. The overloading of safe capacity by numbers and by driver misuse is reflected in the accident record. The overloading of safe structural capacity is reflected in the skyrocketing maintenance and reconstruction costs. The lessons in the first pages of the highway-use primers have not been learned, and the results are so costly both to individuals and to the public, that they total a disgraceful and extravagant waste in the nation's true economy.

I.P.S. - In the Public Service.

What does this mean applied to our highways? More particularly, what does it not mean? If we accept the principle that highways are provided to serve the public's interest as a whole, it reasonably follows that the costs of building and maintaining them must be held at the level of true economy. This involves the limitation of axle and wheel loads to those for which the highways are designed. The highway user is concerned because the burden of paying highway costs falls largely on him. He does not wish to pay for new highways to replace those destroyed by excessively heavy loads. The highway engineer is concerned that the roads he has built shall not be subjected to loads greater than they can stand, and he desires definite assurance as to what the loads of the future will be, so that new highways may be built with adequate strength. The heavy truck operator

is, or should be, concerned, because most certainly he will be held accountable for whatever damage these trucks do to the highways.

This matter is now of most serious interest because of the number of States in which a drive will be made to increase axle-load limits. Bills are to be presented to State Legislatures within the next few weeks authorizing axle loads heavier than the 18,000-pound limit recommended by the American Association of State Highway Officials.

Axle loads in excess of 18,000 pounds should not be authorized, and any revision of laws governing gross weight of vehicles should take the form recommended by the American Association of State Highway Officials, which relates gross weight to the number and spacing of axles. This code is the product of many years of research, of field tests, of numerous conferences, and of experience. It has generally the support of State highway and motor vehicle officials, of automotive manufacturers and of user organizations. The essentials have been written into the laws of a majority of the States. This code provides limits on sizes and weights of motor vehicles which should be rigidly enforced to serve the public's interests.

Axle loads, and consequently weights imposed by wheels resting on the pavement, have increased continually, and these heavy loads have multiplied in frequency for a number of years.

At the end of World War 1, the big highway problem was the damage being done to road surfaces by solid rubber-tired trucks. Wherever truck traffic was large the pavement was destroyed. The development of pneumatic tires for trucks soon relieved this situation. Almost over night the solid tire was either taxed or legislated off the highway. The truck manufacturers, truck operators and tire manufacturers first were alarmed that the moves to outlaw solid rubber tires meant the doom of the industry. On the contrary, the heavy-duty, pneumatic tires became the prime builder of the trucking industry.

In the years following the development of dependable pneumatic tires, truck usage in all forms of activity stands out as a great accomplishment in the history of transportation. But trucks did not grow to their present power, weight and speed over night. In our transportation surveys during the early twenties, we obtained the gross weights of trucks to determine the pay load carried, and the service to business and industry. Pneumatic tires had stopped the surface damage to pavements. No need was seen for weighing wheel or axle loads, as there were no vehicles that approached the larger sizes and weights of those that roll over the highways today. By the late twenties some effects of truck traffic were observed, but it was not considered serious. Highways were being designed for 18,000-pound axle loads, and field observations indicated that the

newer pavements were not being seriously damaged by traffic. Most of the damage could be attributed to the effects of subgrade soils and climate.

Data from ealy traffic surveys indicate that in the period 1925-1930 axle loads of as much as 18,000-pounds were found only for five to eight trucks of every thousand, and the volume of truck traffic was far below its present level.

In 1931 I stated, "The roads are more destroyed really by climatic and soil conditions than they are by any use that is made of them." This statement was correct eighteen years ago when it was made. The loads we were then carrying on the highways were very infrequently heavy enough to overtax their structural capacity.

In the intervening years there have been great changes in the total number of trucks on the highways, in the proportion of them with heavy loads and over-loads, and in the observed effect on highways.

The volume of truck traffic is nearly three times what it was then. Even more significant is the proportion of trucks that carry heavy loads. In 1931 trucks traveled 11.4 billion miles on main roads. This year the figure may well reach 34 billion. In 1931 only about eight trucks in every thousand had axle loads of 18,000 pounds, and there were practically no axle loads in

excess of 20,000 pounds. In 1947, 76 trucks in every thousand had axle loads of 18,000 pounds or more, 33 of which were 20,000 pounds or more, and 14 were 22,000 pounds or more. Axle loads of 28,900 pounds have been found in Connecticut, 29,000 pounds in Massachusetts, 26,000 pounds in Ohio, 40,420 pounds in New Jersey, 31,820 pounds in New York, and 26,200 pounds in Maryland.

A main highway of average traffic characteristics which in 1931 carried 5,000 vehicles per day, including 780 trucks, in 1947 had a traffic of 9,500 vehicles per day, including 1,980 trucks. Daily the highway in 1947 was subjected to 137 axle loads of 18,000 pounds or more, 65 of which were 20,000 pounds or more, and 27 were 22,000 pounds or more.

What has been the effect of this great increase in loading at, or in excess of, what in many States is both the design standard and the legal limit?

During the early thirties a gradual increase in damage to pavements was observed. Prior to the war, damage had reached alarming proportions. With the marked increase in heavy loads since the end of the war, the damage has become even more alarming.

Damage has occurred on all types of high-type pavements. Bituminous pavements are made rough and rutted. Excessive pressures shove and knead the surface out of shape. Concrete pavements are subjected to pumping at joints, followed by rapid deterioration of the whole surface.

Water gets beneath a concrete pavement through joints and through the soil at the edge. As a truck wheel passes over a joint in a concrete pavement, the slabs are bent downward. Several passages of the heavier truck wheels cause the formation of a soupy mud. Soon the passage of a truck wheel forces this material out through the joints and at the edge of pavements. Muddy water has been squirted as much as three or four feet into the air. The action is almost identical with that occurring when one steps on a board lying on wet ground and muddy water squirts out.

Wherever pumping occurs the soil is ejected from beneath the pavement. Soon that portion of the pavement is without subgrade support, and a heavy wheel load breaks it off from the rest of the slab. Then the action begins all over at the new crack, only the action is now accentuated by heavy wheel load impacts caused by surface roughness resulting from the first break. With every rain the heavy loads cause damage at an accelerated pace.

There is conclusive evidence that this damage is caused by heavy wheel loads. Pumping was known, but was of little consequence during the twenties. Characteristically it occurred on clayey soils

known to be inferior as road support. Now occurrence is widespread and includes pavements on sandy soils regarded as excellent road support. This matter has been the subject of serious study by practically every highway research agency, and they all reach the same conclusion - the damage occurs only on pavements subjected to frequent heavy wheel loads and particularly overloads.

They find that the outer lanes of 4-lane pavements used by the heavier vehicles suffer damage not found on the inner lanes. Where numerous trucks carry loads to a particular destination and return empty, they find a significant increase in damage on the pavement carrying the most loaded vehicles.

Here are some examples taken from studies made by other agencies. Last year it became necessary to detour traffic from U. S. Highway 66 over 30 miles of Missouri State Route 30 between St. Clair and St. Louis, Missouri. This detour is in a hilly section with silty-clay soil, and normally carries local traffic which includes a number of trucks. It was paved with concrete 15 years ago. Prior to use as a detour, the pavement was in excellent condition and the maintenance costs were low.

The detoured traffic included 1,200 to 1,500 trucks per day. The majority of the axle loads were over 14,000 pounds, and a small percentage exceeded the legal limit of 18,000 pounds. Within two months of use as a detour, pumping started at the joints in the concrete pavement. At the end of the six months required to complete

the construction on U S. 66, the pavement damage on Route 30 was extensive. Necessary repairs cost $5,000 per mile, but did not restore the pavement to its initial condition.

The unusually heavy truck traffic on New Jersey's primary highways has produced serious pumping on soils that have been reported as resisting such action elsewhere in the United States. On one section of pavement on a better than average soil, serious pumping and faulting occurred over a period of years. Repeated repairs were required to maintain the pavement in serviceable condition. When reconstruction finally became necessary, it was found that many of the 3/4-inch steel reinforcing bars placed across joints to prevent breakage of the slab, had themselves been broken. In 1947 this road carried a daily average of 1,300 axle loads of 16,000 pounds and over.

A pavement designed to carry axle loads of 18,000 pounds should be able to carry large numbers of such loads, but should not be subjected to heavier loads. Pavements intended to meet this requirement did so during the twenties, but began to suffer severe damage with increase in frequency of heavy overloads during the thirties. It became increasingly evident that the old designs were not adequate under the changed conditions. In some instances damage occurred under frequent passage of axle loads below the 18,000-pound limit. Particular emphasis must be given this fact. Once the pavement is broken and distorted by even one excessive overload, all heavy truck

traffic, including wheel loads, within the legal limit, is a destructive force.

Truck operators have said that prevention of damage to bituminous pavements, and the pumping and breakage of concrete, are technical matters; that engineers must find and apply a remedy. This is true only to the extent the design of roads fails to provide for loadings within the legal limits. The chief destructive factor is overloading far beyond the legal limits.

We are faced primarily with the problem of maintaining the existing highways with the funds currently available for the purpose. We cannot materially alter the design of surfaces already in place except by reconstruction. We cannot dig beneath the surface and place material in the subgrades of greater load resistance except at prohibitive cost - a cost that the heavy truckers would not be willing or able to pay. There has been a carry-over of the false assumption of the war years, - that roads are expendable. There is a wide difference between roads in an area of advance, where they are expendable, and roads that in a time of national emergency can neither be replaced nor reasonably maintained, but which are essential elements of production that make possible the nation's all-out defense effort.

In some quarters it has been suggested that there be a gradual raising of axle load limits over a period of years. No policy would be more wasteful of public funds. Highway engineers can change their designs to meet new requirements, but there is no method of raising

the existing mileage to higher standards except by reconstruction. Always we would have a large mileage of earlier roads being subjected to destructive forces.

New highways are planned to last for a considerable period of years. The starting point in their design is determination of the loads that will be legally imposed during that period. Load limits must be carefully fixed and rigidly adhered to.

The claim of heavy truck operators that savings in operating cost are reflected in widespread public benefits holds true only to the extent that truck operations do not destroy capital investment in the highways and increase maintenance costs. Truck transport is of incalculable value in our economy. It is indispensable to almost every business, farmer and family. Every effort should be made to develop it for greatest benefit to the nation. For the large majority of trucks now in use there is no problem of critical overloads or destructive concentrations of axle loads. The size and gross load limits necessary for optimum economy of highway transport, all costs considered, can be accomplished within the code of the American Association of State Highway Officials. Every proposal advanced to raise these sizes and weights should be rejected summarily.

That excessive wheel load concentration can be materially reduced by vehicle design is illustrated by comparison of the observed use of the heavier vehicle in the eastern and the western States. The typical vehicle used for heavy hauling in the east has three axles as compared with five in western States. The western

vehicle has a gross weight 35 per cent heavier than the eastern vehicle, but the average heavy axle load of the western vehicle is 30 per cent below that of the eastern vehicle. The western vehicles have 67 per cent more axles per vehicle, but only 48 per cent more load axles are required to haul the same aggregate gross weight, since 26 per cent fewer vehicles are required. The western vehicles, to do the same hauling job, use three load axles of 14,000 pounds, where eastern vehicles use two load axles of 20,000 pounds. In western practice there is a definite advantage in economy of truck operation, and the pavement is subjected to much safer loads.

During the two decades 1920 to 1940, the major mileage of today's principal highways was constructed. This mileage has now been in service an average of around eighteen years. To serve the public's interests, then, the major problem is to keep a very large mileage of old roads in condition to carry the rapidly increasing traffic. There are many problems within this overall problem. For example, over a large part of the United States, when the frost leaves the subgrades after the winter's freezing, the soils are reduced to a near-liquid state. Their capacity in this condition to carry loads has been measured by the Minnesota Highway Department, and found to be about one-half that when in a normally dry condition. Another example is the reduction of the numbers of vehicles of all types that can be carried by our highways when trucks constitute an appreciable percentage of the total. This loss of numerical capacity is accented on roads with the narrower lanes.

If 20 per cent of the total traffic is made up of trucks, the capacity of a road in rolling terrain is reduced by more than one-third of its passenger-car capacity. About one-half of the mileage of two-lane roads which carry 1,000 or more vehicles per day, have a width of 20 feet and less. It must be evident that a very much greater number of road users will be benefited by widening to two 12-foot lanes with safe shoulders than by an equal expenditure of road funds to carry a relatively few heavier loads.

This year the total maintenance costs are estimated, for State, County, City and local roads, at 1,103 millions of dollars. This amount represents 72 cents for each one dollar expended for construction. Even such a comparison does not reveal the cost of keeping the present road system in operation, because a large percentage of the construction expenditure of 1,531 millions of dollars goes for reconstruction of roads depreciated beyond the possibility of maintenance.

Research is reaching into the fields of highway transport economics, and the safe operation of the heavier trucking units, particularly as to the performance of brakes. In these studies there are many cooperators representing industry and users as well as public officials. There is no doubt as to the earnest desire on the part of those who represent industry, or of the official, to find the facts as a basis for agreement in these and other phases of safe, efficient and economical highway transport. Only through a recognition of the pertinent facts and through policies reached in good faith, will it be possible to build and maintain our road systems In the Public Service.