

## HIGHWAY TRANSPORTATION

by

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A recent study on the State highways of California made by the Bureau of Public Roads discloses the average week-day traffic units to be divided in the ratio of 97.3 per cent motor driven and 2.7 per cent horse drawn. This result is quoted to indicate the degree to which as rural pavement mileage is completed on the principal traffic lines of the State, highway transportation is measured in terms of the motor driven vehicle. An adequate background, therefore, against which to project the discussions of the day on highway transportation, since this is the opening paper, is furnished by a brief resume of the growth in the number of the major traffic units, - motor vehicles, - and the development of the roadways over which to operate these units. The proper combination of these two provides highway transportation, in a physical sense, characterized by the ease and speed with which it may be expended, and by the flexibility with which it may be adapted to a wide range of utility.

This Society is doing a real service in directing public attention, not to the component parts of highway transportation, but rather to the product itself. A comparative statement covering the eleven-year period, 1910 to 1921, is indicative of the relative development of these component parts.

	1910	:	1921
Automobiles	487,000	:	8,404,000 est.
Trucks	14,000	:	1,346,000 "
Totals	501,000	:	9,750,000 "
		:	
Maintenance Fund	25,000,000	:	180,000,000 "
Construction Fund	95,000,000	:	420,000,000 "
Totals	120,000,000	:	600,000,000 "
		:	

Lag in Development of  
Highways

It is evident that highway development has lagged far behind the development of motor vehicles. This is visualized strikingly by a graph plotted to show relative automobile registration and highway expenditures by years. The conclusions reached are: 1. During the period 1910-1921 the potential number of motor vehicles demanding highway service increased more than eighteen hundred per cent; our actual expenditures for highways increased about four hundred per cent. 2. During the period 1910-1918 motor vehicles increased more than eleven hundred per cent; highway expenditures about one hundred forty per cent. 3. During the period 1918-1921 motor vehicles increased about seven hundred per cent and highway expenditures about two hundred sixty per cent of the 1910 figures. In fact, it was not until the Federal Aid Act of 1916 that the public as a whole undertook to support the building of highways on an adequate scale compared with the already existing users of the highways.

Since 1918 a very large annual program of highway improvement has been carried on, and there is now the assurance of systematized

development beginning with the more important roads connected into a State and inter-State network, including not more than seven per cent of the total road mileage within each State. The total length of this proposed program will undoubtedly exceed 150,000 miles. The total mileage undertaken by the joint cooperation of the States and the Federal Government had on December 31, 1921, reached 35,500 miles including all projects from those in the initial stage only, to those fully completed. This is the cumulative program of Federal aid highways for the five-year period just ended, but including the period of the war. In the past six months there have been actually completed 7,533 miles of the various types. The estimated expenditure for 1921 of \$600,000,000 was derived from the following sources:

Motor vehicle licenses	19	per	cent
State road bonds	7	"	"
Local road bonds	33	"	"
State taxes and appropriations	12	"	"
Federal aid	14	"	"
County, township and district taxes, appropriations and assessments	14	"	"
Miscellaneous sources	1	"	"

This total expenditure was divided, approximately \$420,000,000 to construction and \$180,000,000 to maintenance. About fifty per cent of the construction program was carried on under Federal aid projects, bringing the control under both the State and the Federal highway departments, and in addition a considerable portion of the remaining construction fund was handled under the direct supervision of the State, thus bringing probably about eighty per cent of the total construction expenditure under engineering control of centralized departments. This is contrasted with twenty-seven per cent of the total expenditure in

1916 which was under the control of the State highway departments. In the 26 years prior to 1916 a gain of about one per cent per year in securing control of the highway funds was made by the State highway departments. Since 1916 the increase alone has amounted to more than fifty per cent of the total expenditures. The Massachusetts highway department in 1892 was the first highway organization to engage in administrative and engineering control of the design, construction and expenditures made by the State for building highways. When the Federal Aid Act of 1916 was passed, approximately thirty-one States had established highway departments, having varying degrees of control and varying amounts of highway funds with which to work. But in 1916 and 1917, in response to the demands of the Federal Aid Act, 17 new departments were established and many others were strengthened and given larger funds. As a consequence, all of the States are now carrying on their major work under the direct supervision of State highway departments, and the supervision of the Federal Bureau of Public Roads extends in detail to all Federal Aid roads.

The typical State highway department is organized in two major divisions - administrative and engineering. Quite generally the administrative heads are commissions of which the members serve only part time and are responsible for the major policies only. This leaves the entire executive and engineering control to the engineering staff under a chief engineer, or commissioner. Thus the highway engineering organizations have been developed with very definite administrative functions as well as those of construction and maintenance. The

engineering organization engaged upon the actual building of highways in the average department is divided into sections of design, construction, and tests. In the order of their authority is the chief engineer, district or division engineer, resident engineer, and inspector. An estimate of the number of men employed as engineers by the State highway departments in 1919 totaled approximately 10,000 men. The construction program has practically doubled since then, but the number of engineers has not increased in the same proportion. On these men we must depend for the character of the construction which goes into our highways.

The general subject of this session, inspection, is broadly interpreted as the engineering control which must be exercised over the construction program to insure first-class results. The building of roads must be considered as a manufacturing process undertaken where the roads are to be built, not where this manufacturing process can be most advantageously performed. The wide distribution of the contracts undertaken annually within the average State, and the conditions under which the work is carried on, demands the highest type of engineers from the highest to the lowest grades. The closest estimates that we could make in 1919 indicated that not less than 1,000 to 1,200 new engineers would be required in the highway work each year. These must be furnished from the engineering schools, and while at present there is a lack of employment for engineers generally, with the opening of the construction season the road building industry will be able to absorb and will need more than are available of those men who are fitted to assist in producing the

character of roads needed. As indicative of the training of men who are needed for the highway program, and the character of instruction which they should receive in the colleges and universities, the following are suggestions:

1. Human relations.
  - The ideals of public service.
  - Proper contacts with the public.
  - Proper relations with the contractor.
2. Management.
  - Laws - State and national
  - Layout of plans.
  - Material supplies.
  - Transportation.
  - Estimates.
  - Contractor's obligations.
  - Engineering and administrative reports.
3. Construction proper.
  - Design, - interpretation and relative values.
  - Specification interpretations
  - Workmanship.
4. Materials.
  - Interpretation of laboratory tests.
  - Field tests.
  - Soils.
5. Traffic management during construction.
6. Relative values.
  - Economics of highway transportation.

These suggestions are not to be interpreted as advocating the adoption in college and university courses of superficial specialized instruction, but the curricula of the average engineering course should be and can be revised and broadened to give thorough training in some of the broad fundamentals of science, English, economics, and ideals of public service in addition to sound courses which may be offered in the junior and senior years which will fit men to enter

the highway work much better than they are now prepared. But this responsibility should not fall upon the schools alone. The highway departments - State and Federal - must assume responsibility for bringing to the assistance of those in charge of engineering courses contacts and opportunities of which those men who are interested in highway engineering may avail themselves and thus obtain a correlation of theory and the practical application before graduation. The development of the short course for those already engaged in highway building, and the development of the graduate courses for research in special fields, are both of great importance in the advancement of engineering training and knowledge so seriously needed in the highway field today. The close correlation and cooperation of the highway departments with the educational institutions is a result greatly needed if the public is to be the best served.