PUBLIC ROADS

A JOURNAL OF HIGHWAY RESEARCH

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS

VOL. 12, NO. 1 ▽ MARCH, 1931

AN OLD-TIME TOLLHOUSE

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UNITED STATES DEPARTMENT OF AGRICULTURE

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VOL. 12, NO. 1 MARCH, 1931 G. P. St. CLAIR, Editor

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TOLL ROADS

A STUDY OF THE HISTORY AND PRESENT STATUS OF TOLL ROADS IN THE UNITED STATES AND OTHER COUNTRIES

Reported by H. H. KELLY, Division of Highway Transport, United States Bureau of Public Roads

THE conception of roads as free means of communication has been fundamental in man's economic thought. Imposition of direct tolls upon travelers as a means of paying for usage of the road, wherever it has occurred, has been of comparatively short duration, and to-day exists in only a few places in the world.

Highway tolls, levied for the purposes of constructing or maintaining roads, are not to be confused with customs duties or octroi taxes, which in all ages have been imposed upon goods transported for sale as a means of raising revenue or protecting domestic interests. Neither are they to be confused with the fees exacted from travelers as payment for safe passage of themselves and their goods, a practice universal in Europe in the Middle Ages and still to be found, for example, in the bandit-ridden areas of interior China.

SUMMARY OF ESSENTIAL FACTS AND CONCLUSIONS

Public sentiment and policy, which traditionally regard the highway as a free means of communication, are generally antagonistic to the toll-road principle.

The total length of toll roads now existing in the world is negligible—in the United States perhaps 150 miles, as contrasted to 3,000,000 miles of public roads.

Where public need for express highways is greatest, they are being built successfully without recourse to the toll method of financing, and the trend is toward increasing development of such free superroads built and operated at public expense.

Present systems of taxation place the major burden of highway construction and maintenance upon the highway users almost as directly as by the toll method, and in a much more equitable and acceptable manner.

Current proposals for toll roads in the United States generally appear to ignore the basic economic factors involved. The problem of toll roads is first and foremost, economic; and second, technical. The engineering difficulties are not insuperable; the economic difficulties, however, have not yet been satisfactorily solved.

Under present conditions, there would seem to be no justification for toll roads in any highly-developed country where a large mileage of public roads already exists; however, in undeveloped regions of the world some basis might be found for employing the toll method as the first step in financing a trunk-line system of highways.

EARLY HISTORY RECORDS FEW TOLL ROADS

There is little evidence in antiquity of the use of the toll system upon roads. Probably the earliest recorded instance of the collection of tolls was upon the great Persian military road leading from Babylon to Syria, as reported by Strabo, the date being approximately 2000 B. C. (*1*).[1] Under Babylonian law, every city of that great commonwealth had its own customs, ferry dues, and highway and water rates, levied on all but its own citizens (*2*). Levying of tolls on caravans passing through Palestine was part of King Solomon's fiscal operations, which were based on the systems prevailing in neighboring States, especially Egypt (*3*). It is significant, however, that in all these early instances the tolls were imposed either for military purposes or as a means of taxing foreign travelers and goods. On the other hand, the Appian Way, most famous road of classical times (begun in 312 B. C.) and other Roman highways, built primarily for military purposes, appear to have been free for public use when this did not interfere with the business of Empire (*4*).

The first actual record of a toll road or "turnpike," in the true meaning of the term,[2] was in England in the year 1346, when King Edward III granted permission for levying toll on all passing from St. Giles's to Temple Bar, London, for the reason that roads there had become impassable for want of other provisions for their maintenance (*5*).

Three hundred years later, in 1663, the first English turnpike act was passed, giving a franchise to the "Great North Road to York and Scotland" and permitting collection of tolls as a means of providing funds for maintenance. Coincident with the industrial revolution, the need for improved means of communication caused formation of numerous turnpike companies, state funds not being available for road purposes. At the time of the death of the great road builder McAdam in 1836 English turnpikes had reached their maximum development, with 1,100 turnpike trusts operating 20,000 miles of road; he himself had contributed largely to this result by his services in improving road-construction methods. Shortly thereafter, the decline of turnpikes began with the advent of railroads.

France at various times employed the toll system, the Government professing to devote the proceeds to the improvement of roads. The tolls gave rise, however, to gross peculations and widespread abuse, barriers springing up on all the roads and bridges and at the gates of towns, which one could not pass without making payment. Napoleon I finally abolished the tolls about the year 1806 (*6*) (*7*).

In the United States, the first toll road was built in Virginia in 1786 to carry the increasing traffic from Alexandria—which Washington had hoped to make one of the principal ports of the new republic—to northwestern Virginia and the navigable streams flowing toward the west. It was known as the Little River Turnpike. Similar roads appeared in Connecticut in 1792, Maryland in 1793, Tennessee in 1801 (through Cumberland Gap), North Carolina in 1804 (through the Cherokee lands). Necessity for expensive repairs on poor-surfaced roads which were subject to ever-increasing traffic and for tracing new routes westward, together with the lack of public funds, made inevitable the use of the toll system.

An outstanding example of American turnpikes was the Philadelphia and Lancaster Turnpike Road, the first macadam road in the western hemisphere, built 1792–94 at a cost of $465,000. It was 62 miles long, macadamized throughout with stones broken to pass through a 2-inch ring, and was guarded by nine toll-

[1] References to the bibliography at the end of the article are indicated by italic numerals inclosed in parentheses.

[2] Webster's dictionary supplies the following definition: "Turnpike road.—A road that has, or had formerly, turnpikes, or tollgates, established by law to collect from users tolls to defray the cost of building, repairing, etc."

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gates. It followed the location of the "King's Highway," a public road which had been constructed in 1741. Rates of toll ranged from 1 to 13½ cents per mile for each vehicle, depending upon the width of the tires and the number of horses used. This road enjoyed 25 years of prosperity, with annual dividends sometimes exceeding 15 per cent, and its success led to the formation of many similar enterprises. By 1811 there were 137 chartered roads in the eastern United States, with a total of 4,500 miles under operation, capitalized at $7,500,000 (*8*).

TOLL ROADS SERVED THE TRAFFIC OF AN EARLIER DAY

GREATEST DEVELOPMENT IN EARLY NINETEENTH CENTURY

In 1808, Albert Gallatin, Secretary of the Treasury of the United States, made a report on "Turnpikes, or Artificial Roads" in which it was stated that "great numbers" of such roads had been completed in eastern and southern States at costs varying from $1,000 to $14,000 per mile. Turnpikes were then in existence in Connecticut, Massachusetts, New York, "where in less than seven years 67 companies have been incorporated with nominal capital of near $5,000,000 for the purpose of making more than 3,000 miles of artificial road," New Jersey, Pennsylvania, Maryland, and Virginia.

The famous National Pike, the only highway of its kind ever wholly constructed by the Government of the United States, was a toll road, with commissioners named by the various States through which it passed to administer the toll collections. The main section of the road as laid out by the Federal Government was from Cumberland, Md. (from which the name of "Cumberland Road" often applied to it, was derived) to Wheeling, W. Va., via Uniontown, Pa., although the highway continued on westward to lose itself in the prairies of Illinois. The first definite proposal for construction of this road came in 1806; it was opened to the public in 1818; and was reconstructed in 1832. Tolls were collected at certain points on this road as late as the opening of the present century.

The peak of turnpike development occurred about 1830, and the decline began soon afterward with the rapid extension of railroads and canals (*5*).

MODERN TOLL ROADS [3]

Compared with the total mileage of roads in the world to-day, the extent of toll roads is infinitesimal. Even in Europe, where unusual postwar conditions might have been thought to justify the use of tolls at least temporarily, there are few toll roads. Despite such special circumstances as the poor condition of public highways following the war, lack of public funds for large reconstruction programs, the considerable volume of de luxe tourist traffic, and the large numbers of animal-drawn vehicles and bicycles which hamper the movement of motor cars on the public roads, serious consideration has been given the toll-road principle in only a single country.

Italy.—Foremost among modern toll roads are the autostrade of Italy, principally located in the northern part of the country. The first autostrade, connecting the city of Milan with the lake resorts of Como, Varese, Arona, and Bergamo and representing a total length of 85 miles, were begun in 1925 by a private company

[3] The assistance of the Bureau of Foreign and Domestic Commerce of the United States Department of Commerce in supplying data regarding modern toll roads, particularly those in foreign countries, is gratefully acknowledged. The American Automobile Association also supplied valuable information on toll roads in the United States.

known as the Societa Anonima Autostrade, capitalized at 50,000,000 lire (about $2,500,000). The moving spirit behind the enterprise was the engineer Puricelli, head of one of Italy's most important construction firms. These roads are now in year-round operation. As an example of the toll charged, the round-trip rate between Milan and Como (46 miles) for a medium-sized automobile is about $1.25, with seasonal tickets available at reduced rates. The roads are of modern construction, principally 4-lane width, built of concrete with bituminous surface treatment, without grade crossings or intersections, and without speed limit save for trucks. Only rubber-tired passenger cars and trucks and motor cycles with side cars are permitted upon them. Other autostrade have since been built from Naples to Pompeii, from Florence to the coast, and in part from Milan to Turin.

The Milan-to-Lakes autostrade cost $80,000 per mile. The method of financing was by constitution of special companies for each main section of the highway and by issue of obligations guaranteed by the Italian Government, which in compensation for this service becomes owner of the highway after 50 years without making any disbursements (*9*).

During the first year of operation, revenues were barely sufficient to meet carrying charges; the second year a 2 per cent dividend was declared, and modest dividend disbursements have been made annually ever since. Recently, however, the improvement and extension of the national highways have diverted much traffic from the toll roads. For example, the national road from Milan to Como, having been resurfaced, is now more popular with motorists than the autostrada. This fact, together with the general business depression, which has reduced both local and tourist traffic, has given rise to general doubts that these toll roads will ever prove the lucrative venture which they were originally hoped to be.

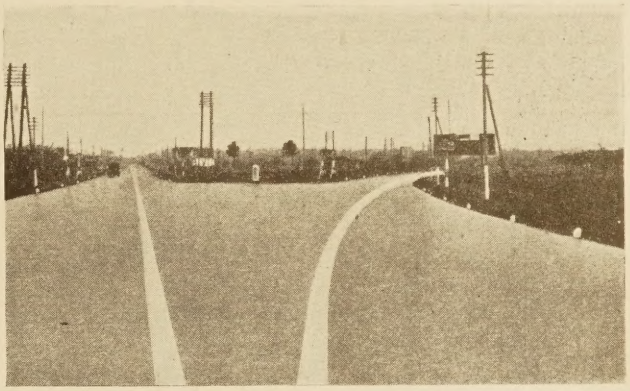
Germany.—The only toll road in Germany is the Avusbahn, 12½ miles long in a closed circuit, between Berlin and Charlottenburg. It was built in 1921, chiefly for test or racing purposes. The round-trip toll is 50 cents. For several years, a proposal to build a series of toll roads—Hamburg-Basel, Stettin-Berlin-Munich, Dusseldorf-Cologne—has been given occasional publicity, but no definite action has yet been taken (10).

England.—During discussion of the road bill in Parliament in 1929, the fact was brought out that there were 55 toll roads in England and Wales at that time, all of a local character, and for the most part under 1 mile in length. Passage of this bill, which is now known as the road traffic act of 1930, permits of the compulsory transfer of such roads from their private owners to the public authorities, if necessary (*11*) (*12*).

Switzerland.—Tolls were charged in former years on a number of mountain roads where construction costs were very high, but these were abolished by law throughout the Swiss Confederation in 1928.

Austria.—Construction work was begun in 1930 upon a 30-mile road across the Grossglockner range, between Ferleiten and Heiligenblut, to cost about $1,750,000 and to be completed in three years. It will be one of the highest roads in Europe, with a maximum elevation of 8,200 feet. Present plans are to operate it as a toll road, charging about $3.50 per automobile.

In other countries of Europe, there doubtless are roads of local interest upon which tolls are charged, but accurate information on this point is lacking. In no case, however, are tolls charged upon a traffic artery of national importance. (Indicated by reports to International Road Congress.) In one or two countries there is agitation for express highways; in France, for example, a Compagnie des Auto-Routes has been formed to push a project for an express route from Paris to Lille and Calais, cost of which is estimated at 1,400,000 francs per kilometer (close to $90,000 per mile). Public sentiment, however, appears to be unenthusiastic about the creation of toll roads and to prefer the Government itself to build any superhighways of this kind.



THE FORK AT LAINATE, ON THE MILAN-LAKES AUTOSTRADE

Peru.—A toll road is under operation between Huaral and Huacho, primarily as means of access to a pleasure resort; and another 25 miles long, between Lima and Ancón, is partially completed. Concessions for highway construction granted under the recently deposed Leguia régime have largely been canceled by the new Government.

Brazil.—A 25-year concession was granted in 1929 for construction of an automobile toll road from São Paulo to Santos, to cost $5,000,000. At the end of 25 years, the road is to revert to the State without cost, and at any earlier date may be taken over by the State upon payment of cost plus 15 per cent (*13*). There are reported to be a number of local roads operated elsewhere in Brazil under the toll system.

Argentina.—The Government at the end of 1930 called for bids upon a project which, if it materializes, will be the largest toll-road enterprise ever undertaken. Two highways are proposed, one northwest from Buenos Aires to Rosario and Cordoba, and the other southwest from Buenos Aires to Azul and Bahia Blanca. The combined length of the two projects is about 800 miles. These toll roads must parallel free roads, but the latter are of low type and not passable at all seasons of the year. The period during which tolls may be imposed must not exceed 15 years, at the end of which time the highways will become the exclusive property of the Argentine nation. As protection for the constructing and operating company, if net receipts are not sufficient to cover interest and amortization on the capital investment, the Argentine Government will grant the company a subsidy sufficient to make up the difference; if net receipts are greater than the interest and amortization charges, however, the surplus must be given to the Government. The chief uncertainties in the project appear to lie in the legal technicality that the present Argentine Government is "provisional," and its power to enter into an agreement of this kind and support it

with adequate guarantees is questioned, and in the fact that the national constitution seems to insure the freedom of all highways.

FEW TOLL ROADS REMAINING IN UNITED STATES

Hardly more than a score of toll roads are known to exist in the United States to-day, all of them being privately owned. Only one of them can be said to attract traffic by the special facilities it offers, while the others are of a scenic character, of interest almost exclusively to tourists and sightseers. The total length of all these United States toll roads is estimated at less than 150 miles, as contrasted to the 3,000,000 miles of the public road system. An official inquiry to the highway departments of all the States of the Union early in 1931 revealed that there are no toll roads of any character in 35 States. The following paragraphs describe briefly the few toll roads now in operation in the other States.

Arizona.—The San Francisco Mountain Boulevard is a toll road extending from the vicinity of Flagstaff to the summit of San Francisco Mountain nearby. The toll charge is $1 per automobile.

California.—Six toll roads, on only one of which there may be said to be arterial traffic, exist in California. They are as follows: Darwin, easterly to Death Valley, toll charge $2; Mount Diablo, toll charge $1.25; Tamalpais Mountain, toll charge $1; Sears Point Road, which has some value as a traffic artery although there is an alternate free road through Napa which is only a few miles longer; Mount Wilson, and Seventeen-Mile Drive.

Colorado.—The Pikes Peak Auto Highway leads to the 14,000-foot summit of Pikes Peak, Colo. It was constructed in 1915 by E. A. Sunderlin, of Colorado Springs. The company owning this highway has offered to convey it to the United States Government at the end of 1935, and the offer has been accepted (*14*) (*15*).

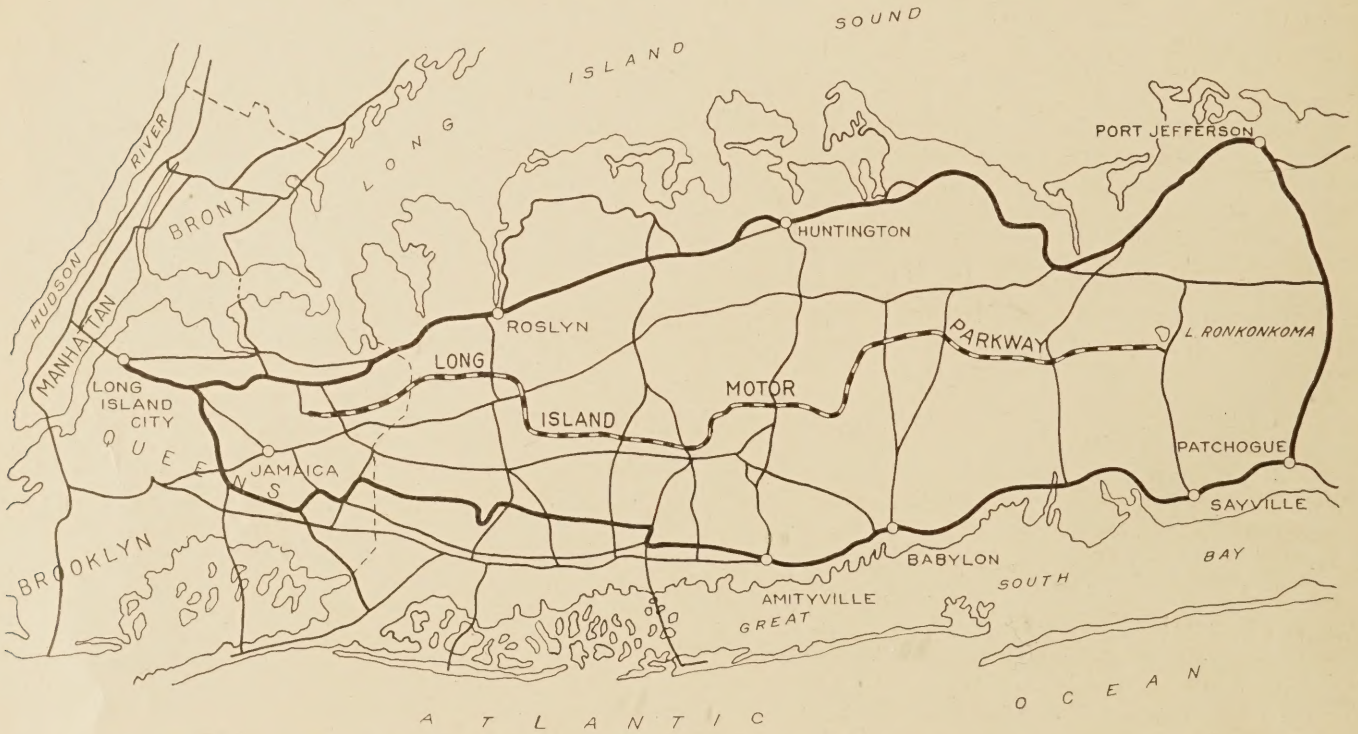
Florida.—Tolls are collected on the Beach Road between St. Augustine and Daytona, a thoroughfare used principally for its scenic value.

New Hampshire.—The Mount Washington Summit Road, 8 miles long, extends from the Glen House at an elevation of 1,543 feet to the summit of Mount Washington, elevation 6,293 feet. The franchise to this company was granted by the legislature in 1859 and the road is still operated under this original franchise.

New Jersey.—Tolls are collected on a road between Ocean City and Longport, this road forming an approach to a toll bridge, and connecting with two public roads.

New York.—The best-known toll road in the United States is the Long Island Motor Parkway, a privately owned highway handling automobile traffic of a restricted character; that is, pleasure cars to the exclusion of trucks and other commercial traffic. It is about 45 miles long and extends from the congested metropolitan district adjacent to Flushing, Long Island, to Lake Ronkonkoma in the center of the Island. Construction of the road was commenced in 1908 and most of it was completed by 1910, although short stretches have been added from time to time since that year. The right of way for it, from 50 to 100 feet in width, was acquired by purchase or lease, the company that built it having no power of condemnation. As now constructed the actual roadway has a width of from 16 to 22 feet, surfaced with concrete or bituminous macadam; it has many curves, and although for a considerable distance from its westerly end intersecting highways are crossed by bridge or underpass, toward its easterly end there are several highway crossings at grade.

The company which built this road, and which still operates it, was organized by a group of automobile enthusiasts in the early days of motoring. Capital stock was issued to subscribers who paid more than $800,000 for it, and while the stock was never listed on



Map Showing Location of Long Island Motor Parkway

any exchange it had a fairly wide distribution; later, to complete construction, there was an issue of mortgage bonds to the amount of $1,000,000, and all of these bonds, together with more than three-fourths of the outstanding stock, are now owned by one man who was active in the original enterprise. The company has never paid a dividend and its bonds have long been in default as to interest payments, although for several years its receipts have exceeded actual operating expenses. Including with original cost the interest on borrowed money accrued and unpaid, this parkway to-day represents an investment estimated at between

Main Tollgate on the Long Island Motor Parkway, Longest Toll Road in the United States

$6,000,000 and $7,000,000. The rate of toll is $1 for a single 1-way trip. Statistics on the traffic passing over the road have never been made public, for reasons of company policy, but the volume is said to vary between wide extremes in summer and winter.

This parkway has not been a financial success. Its operation is continued chiefly because of the personal interest of the owner of the bonds and stock above mentioned and his hope eventually to justify in some measure the investment made in it.

The "Conditions" printed on the back of each ticket of the Long Island Motor Parkway are of documentary interest.

Conditions

Every person exercising the license granted by this ticket consents and agrees in consideration of the granting thereof, to the following conditions:

First. Each person entering upon the premises of the Long Island Motor Parkway (Inc.) by virtue of this ticket thereby assumes all risks of injury, damage, and loss to himself or his property while on said premises and will in no event hold the Long Island Motor Parkway (Inc.) responsible for any injury to his person or for any loss or damage to his property while on said premises, whether caused by the negligence of said Long Island Motor Parkway (Inc.), or by the negligence or willful acts of its agents or employees, whether such willful acts be done within the scope of their employment or otherwise.

Second. The license granted by this ticket will be so exercised as not to interfere in any way with the exercise of a similar license granted to others.

Third. Each person entering upon the premises of the Long Island Motor Parkway (Inc.), by virtue of this ticket will obey and conform to all State, county, and local laws and regulations relating to automobiles or their operation and all rules and regulations for the use and operation of the motor parkway and will at all times while on said premises exercise all possible care and prudence, to avoid exposure of himself and others to risk of damage, injury, or loss and will keep to the right of each white line along the center of the parkway and generally keep to the right of said center whether or not so marked.

Fourth. Automobiles when stopping must clear pavement with all wheels. Automobiles shall not be stopped or parked on top of or under bridges or on approaches to bridges or on curves.

Fifth. Picnic parties shall keep the parkway and adjoining land as clean as they find it by disposing of their waste paper and refuse before leaving. No fire shall be made in the wooded sections. No parking west of Huntington Lodge, except in parking enclosures designated by signs.

Sixth. The following speed limits shall be observed: Forty miles per hour west of large warning sign at Wyandanch; 30 miles per hour east of said sign. Except, however, that speed shall be reduced as required for safety, on curves and wherever necessitated by traffic conditions, and except that the speed limit shall be 10 miles per hour at each grade crossing of a public road and the traffic on such public road shall be given the right of way.

Seventh. The police maintained by the Parkway Co. shall have entire charge of the traffic on the motor parkway and the movement of cars thereon shall be subject to their direction.

EIGHTH. The company reserves the right to take up this ticket at any time.

The Bear Mountain Bridge Road, privately owned, which is the eastern approach to the bridge from Peekskill, N. Y., might be termed a "toll road," since the toll-gate for the bridge is located upon it.

North Carolina.—Mount Mitchell Toll Road leads to the summit of Mount Mitchell, near Asheville, N. C. It was established in 1920 on the location of an old lumber railway. It is 18½ miles long, and wide enough for only one-way traffic. The toll rate is $1 for adults and 50 cents for children.

South Carolina.—A toll road about 12 miles long leads from Charleston to Folly Beach, a seaside resort of Charleston County.

Texas.—Two toll roads are in operation in the region of Medina Lake in southern Texas, carrying recreational traffic from the public roads to the lake. The first was opened in 1917 by the Medina Lake Toll Road Co.; its length is 7 miles, its surface is oiled gravel, and it cost $66,000. The toll rate is 50 cents each way for passenger cars, and $1 per ton each way for trucks. The second road was opened in 1927 by the Medina Highland Toll Road Co.; its length is 9 miles, its surface is gravel and graded earth, and it cost $75,000. The toll rate is the same as on the first road. Volume of traffic on both roads averages from 20 to 30 cars per day.

Utah.—Fees are charged for the issuance of automobile and motor-cycle permits on a road traversing the southeast corner of Zion National Park, the charge per automobile being $1. Residents of the counties adjoining the park are exempt from payment of this fee when in pursuit of their usual business.

Vermont.—The Mount Mansfield Toll Road, approximately 3¼ miles long, permits tourists to visit the summit of the mountain.

Virginia.—One of the few relics of the numerous toll roads of a century ago is the Great Falls Toll Road, leading to Great Falls, Va., near Washington, D. C. Its traffic is now limited principally to tourists, picnickers, and others wishing to visit the falls of the Potomac River, where there is a small pleasure resort. The toll rate is 25 cents per car.

An example of a toll road recently taken over by public authorities is the Conners Highway, a 51-mile road from West Palm Beach to the northern shore of Lake Okeechobee, Fla. Originally built and financed by W. J. Conners, of Buffalo, its outstanding obligations were assumed by the County of Palm Beach and it was freed from tolls in 1930. It is to be incorporated in the State highway system.

During the last five years, the public press has reported numerous suggestions for the construction of toll superhighways, but none of these has ever been actually undertaken. Among the specific locations mentioned have been the following: From One hundred and thirty-eighth Street in New York City to the village of Peekskill (elevated structure); from the New Jersey side of the Holland tunnel along the Atlantic coast to Atlantic City (semielevated); Atlantic City to Philadelphia; Detroit to Pontiac (elevated); San Francisco to Los Angeles; the Merced River Valley in California; Wilson River in Oregon; Buffalo to Niagara Falls; Milwaukee, Wis., to Gary, Ind.; New York to Boston. For most of these, no definite projects have been advanced, and public sentiment as reflected by the press has shown itself unfriendly to the toll feature of these suggested highways.

Probably the most ambitious of all toll-road plans advanced in this country is that of the Union Highways Association for a nation-wide express motorways system. This association was incorporated in 1925, with headquarters in New York City, to encourage formation of "an express motorways system which eventually will spread over the United States, Canada, and Mexico, and link up all of the nations of this hemisphere." It proposed to form 42 individual motorways corporations as members of the Union Highways Association, each of which would build and operate a separate section of highway under the toll plan until its cost was entirely paid off, when it would revert to the State. The 42 highways involved would include one transcontinental route from east to west, two routes roughly paralleling the Atlantic and Pacific coasts, and a compact network of roads between the Middle-Atlantic and Middle-Western States.

To promote the first of these 42 suggested highways,[4] the New York and New England Motorways Corporation was incorporated under the laws of the State of New York. The scope of this first motorways project is indicated by the fact that the corporation estimates that the cost of the 65-mile section between The Bronx (New York City) and New Haven, Conn., will be $200,000,000.

These toll projects are not to be confused with the activities of various organizations whose purpose is to encourage the building of publicly-owned express highways. An example of such organizations is the National Highway Association, incorporated in 1912, the aim of which is the construction of 50,000 miles of national highways "to be built and forever maintained by the United States Government." With somewhat the same ultimate object in view, a joint resolution known as the Phipps-Robsion resolution was introduced in Congress in 1929, "creating a commission to study proposals for a national system of express motorways." As attested by documents supporting the resolution and by the statements of the authors of the resolution, only publicly owned highways were under consideration, and the use of tolls as a means of financing was not mentioned. This resolution was passed promptly by the Senate, but is still awaiting action by the House of Representatives. In 1929, a bill was introduced in the Senate (S. 309) providing for the construction of a post road and military highway from the Atlantic to the Pacific coasts, to be known as the Central Highway, in which the interesting provision was made that portions of the right-of-way could be leased to provide additional funds.

DEDUCTIONS FROM THE FACTS

From the evidence of past experience, certain conclusions may be deduced:

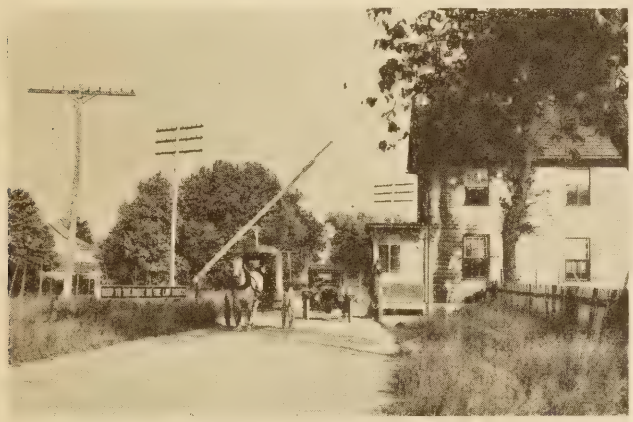
1. Reasons for the establishment of toll roads in the past have been: Nonexistence or inadequacy of free public roads, lack of State funds for construction of free roads to meet the public demand, and necessity of raising emergency revenue for the State treasury. Only the first two of these reasons appear applicable to modern conditions; and they are usually cited as the basis for current agitation for toll motorways in the United States.

2. Conditions under which toll roads have been successful are: Economically strategic location, assured volume of traffic, reasonable rate of toll, and absence of competition by free roads or other cheaper means of communication. Lack of any one of these basic conditions has been sufficient to make toll roads unsuccessful. Thus, even at the peak of toll-road development in the United States and Great Britain during the early part of the nineteenth century, numerous toll roads failed because of their poor location and consequently

[4] The information given here and in subsequent pages regarding this proposed motorway was obtained from literature issued by the promoters.

insufficient traffic. Moreover, the most successful toll roads (e. g., the Philadelphia-Lancaster turnpike) went into rapid decline as soon as competition by railroad and canal appeared. And the Italian autostrade, largest and most recent of such enterprises, appear to have already entered upon a period of diminishing returns because the improvement of free public roads serving the same territory has impaired their monopolistic character.

3. The possible advantages of toll roads may be summarized as: The relief of existing congestion on roads by early accomplishment of large highway improvements which the State in its normal program might not be able to undertake until considerably later; placing the burden of cost of the road directly upon its users, thus insuring that both foreign and local traffic pay an



A New Jersey Tollgate in 1911

equitable share in the facilities which they enjoy; and potential savings in time and cost of vehicle operation, as well as reduction of accidents.

4. The disadvantages of toll roads are: Antagonistic public opinion, which traditionally regards the roads as free means of communication; additional expense of financing immediate huge expenditures; additional expense of collecting tolls (a "nonproductive" activity which in the case of toll bridges has been estimated to absorb from 15 to 27 per cent of the total amount of tolls collected); impossibility of giving monopolistic guarantees, since paralleling free roads must be maintained for use by the general public, and consequent uncertainty of traffic volume; finally, that inherent dilemma in enterprises of this kind which presents on the one hand the necessity of building at heavy expense a superhighway capable of attracting large volumes of traffic from the free thoroughfares, and on the other hand the prime requirement of a low toll rate.

The above considerations apply to toll roads constructed and operated by public authorities. They are also applicable in all respects to toll roads promoted by private capital, but with such grave additional disadvantages in the latter case as intensified unfriendliness on the part of public opinion, materially higher costs in financing and possibly in construction and operation as well, and risk of loss to investors.

THREE SPECIFIC CASES STUDIED

In the light of these basic considerations, three outstanding examples of the toll-road principle—two of them in operation, one contemplated—may be briefly analyzed.

1. The Italian autostrade were built by private enterprise, but with the guarantee and support of the Government, at a time when public roads had been practically ruined by the war. They, therefore, enjoyed virtual monopoly, as well as a strategic location and a good volume of traffic; the power of the Fascist Government insured them a friendly public opinion, and they became an object of national pride. The toll rate—approximately 2½ cents per mile—did not prove a deterrent to traffic in a country where there is heavy tourist travel and where ownership of automobiles is still largely confined to the wealthier classes. Despite these exceptionally favorable factors, the financial success of the autostrade has been much less than originally anticipated, and their future as business ventures facing the competition of improved free roads is problematical.

2. The Long Island motor speedway was built by private enterprise, largely on the initiative of a single individual whose prestige and personal interest are still regarded as chiefly responsible for its continued existence. Its construction almost a quarter of a century ago was favored by conditions which could not be duplicated to-day: Comparatively low property values along the right of way, lack of good public roads, and accessibility to the first large automobile market in the country, New York City. The toll rate—about 2¼ cents per mile—is no deterrent to its de luxe traffic.

Tollgate Still in Existence on the Great Falls Toll Road, Virginia

The character of this traffic, and that of the wealthy and highly-developed region it traverses, have given it a practical monopoly little affected by the improvement of free public roads nearby. Nevertheless, its operation has not proved profitable.

3. The New York and New England express motorway has not been built. Its first section would extend from The Bronx, New York City, to New Haven, Conn., a distance of 65 miles. Purchase of the right of way alone for these 65 miles, paralleling in large part the line of the New York, New Haven & Hartford Railroad, would cost approximately $69,000,000, and the entire cost of building this 65-mile highway is estimated at $200,000,000. This tremendous cost is explained by the proposed specifications of the roadway: Right of way 200 feet wide in rural districts, 120 feet in towns; four separate tracks for traffic, each 25 feet wide, surfaced with concrete or other high-type material; the two inner (no speed limit) tracks divided by a 5-foot gravel space and a fence; the outer tracks divided from the inner tracks by 20-foot gravel spaces; all crossings of railroads or public roads to be by underpass or overpass; all crossings through towns or cities to be on elevated structures, carried wherever possible on the tops of specially constructed buildings one to four stories high; all approaches and exits to be by

ramps. It is estimated that such a highway could carry 200,000 cars over the entire distance between the Bronx and New Haven in a period of 24 hours without congestion or delay.

As originally proposed, the speedway was to be built by a private corporation with recapture clauses permitting each State through which it passed to take possession of that portion of the motorway lying within its borders, whenever desirable. The motorways corporation was to be capitalized at probably $20,000,000, which would be raised by sale of stock to concessionaires of a bus line, servicing and fueling enterprises, and contractors and suppliers of materials. The remaining $180,000,000 would be raised by the sale of debenture bonds, participating in the net earnings of the motorways corporation equally with the stock. Ten per cent of the total cost, or $20,000,000, was to be set aside as financing expense. The promoters estimated that the net earnings of the motorway would be over $20,000,000 per annum, a return of between 8 and 12 per cent on the stocks and bonds, permitting the motorway to earn its entire cost within a 10-year period.

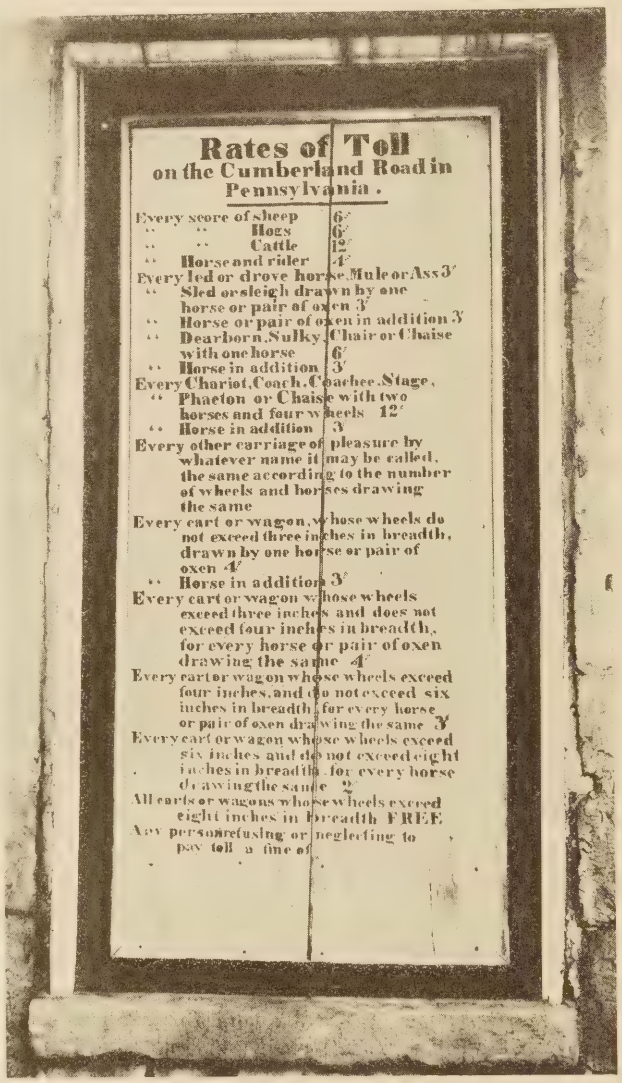
As these are estimated as the net earnings the gross receipts would necessarily have to be considerably larger. For a rough determination of the feasibility of the project, however, the same amount may be assumed to represent the gross receipts.

The following figures show the volume of traffic that would be required to produce a gross income of $20,000,000 per year which is equivalent to $308,000 per mile per year, or $844 per mile per day:

At 1 cent per mile toll	84,400 vehicles per day
At 2 cents per mile toll	42,200 vehicles per day
At 3 cents per mile toll	28,133 vehicles per day
At 4 cents per mile toll	21,100 vehicles per day
At 5 cents per mile toll	16,880 vehicles per day
At 6 cents per mile toll	14,067 vehicles per day
At 7 cents per mile toll	12,057 vehicles per day
At 8 cents per mile toll	10,550 vehicles per day
At 9 cents per mile toll	9,378 vehicles per day

An average of 84,400 vehicles per day over the entire distance of 65 miles, at 1 cent per mile toll, is beyond the realm of possibility for many years to come, and this minimum rate may therefore be regarded as entirely impractical. Probably the heaviest volumes of traffic in America to-day occur at the Holland Tunnel under the Hudson River at New York, and at the Delaware River Bridge at Philadelphia. The daily averages of vehicles passing these two structures during 1930 were respectively 32,930 and 33,660. The 2 cent and 3 cent rates, which roughly correspond to the present rates on the Italian autostrade and the Long Island Motor Parkway, may also be discarded as entailing too high a volume of traffic to meet expenses.

A partial measure of the actual current traffic between New York and New Haven is afforded by traffic counts made in 1930 at Milford, Conn., on the Boston Post Road, a modern 4-lane highway connecting the two cities, which show an average of 18,500 vehicles per day passing that point (annual average). (From T. R. Agg's report to Highway Research Council in December, 1930.) Assuming that all this traffic is through traffic between the two cities, and that the motorways would secure one-half of it, or 9,250 vehicles per day—both of which assumptions are entirely unwarranted, considering the large volume of local short-distance traffic and the excellence of the free Boston Post Road—the toll rate on the motorways would necessarily be at least 9 cents per mile, or $5.85 for the entire distance.



RATES POSTED ON OLD TOLLHOUSE ON THE NATIONAL HIGHWAY

In this connection, it is noteworthy that where public demand for express highways has been greatest, such highways have actually been built or are being built by public funds without recourse to the toll method of financing. Some of these highways would meet the most difficult requirements of the proponents of toll-supported superhighways. To cite only a single example, the Hutchinson River Parkway in Westchester County, N. Y., north of New York City, is a thoroughfare 14 miles long, without a single grade crossing, landscaped throughout in an elaborate and imposing manner. The Westchester County Park Commission which built this road also has under way a Pelham-Port Chester Parkway, for which the right of way has been purchased by county funds at a cost of $4,410,000. This public superhighway will have two separate roadways, each 44 feet wide (4-lane) and although it passes through a built-up area, it will be entirely free of grade crossings. Such projects clearly indicate the future progress of public highway development in regions where traffic is heaviest (*16*).

CONDITIONS FAVORABLE TO TOLL ROADS FOUND IN SOME REGIONS

The question naturally arises, "Are there any localities where present-day conditions might favor the creation of toll roads?"

In view of the essentials previously outlined for theoretical success of a toll-road project—economically strategic location, assured volume of traffic, reasonable rate of toll, and absence of competition—it is at once apparent that opportunities for successful toll roads in any such highly developed areas as the United States and western Europe are lacking, since nowhere could these basic desiderata be guaranteed.

In less developed regions of the world, where the need for improved roads is a vital one, and yet where public funds are not sufficient to finance extensive trunk-highway development, there are perhaps localities where the toll road would be both feasible and profitable.

The Argentine project, previously mentioned, to connect Buenos Aires with important cities several hundred miles distant, is a case in point. Although Argentina has the highest total automobile registration of any country in Latin America, and the highest per capita registration of any country in the Western Hemisphere outside of the United States and Canada, it possesses to-day less than 500 miles of hard-surfaced roads. There are now 365,000 automotive vehicles in Argentina, of which 35 per cent are concentrated in the municipality of Buenos Aires, with other large proportions in the districts of Cordoba and Bahia Blanca which the proposed toll road would serve. Here, then, is an assured volume of traffic and a strategic location; practical absence of competition is indicated by the low state of the free roads, which are passable only part of the year. With a conservative type of construction, and a reasonable rate of toll, the success of such a project is possible.

Similar possibilities might be found in other countries where the demand for improved roads already exists, and where the need for a start to be made on a national highway system is urgent. In such localities the toll road might prove worthy of serious consideration as the initial step in a highway program.

PUBLIC OPINION GENERALLY HOSTILE TO TOLL ROADS

In the final analysis, the toll road must answer for itself at the bar of public opinion. As one commentator put it, in reviewing the early development of turnpikes, "The capital supplying the turnpikes . . . was in fact, subjected to two risks: First, the ordinary business risk; and secondly, a risk incidental to the fear of arbitrary interference by a public whose preconceptions were of an unfriendly nature." (Frederic J. Whiting, in preface to Wood's "Turnpikes of New England.") That double risk still exists.

Motor vehicle manufacturers have a predominant interest in highway development. Their complete opposition to the toll-road principle was expressed in an official resolution adopted by the National Automobile Chamber of Commerce, which numbers among its members practically all of the passenger car and truck manufacturers of America, under date of February 1, 1928:

> Whereas, the free use of the public highway is a fundamental principle of Government; and
>
> Whereas motor vehicle owners of the United States through special taxes are to-day largely meeting the costs of the construction of these highways; and
>
> Whereas so-called express highways are simply a step in the further improvement of our public highway system which will be found necessary in those localities where traffic is heavy and congestion great: Therefore, be it
>
> Resolved, That the National Automobile Chamber of Commerce opposes any effort to place control of any part of the public highways in the hands of private promoters; and be it further
>
> Resolved, That the National Automobile Chamber of Commerce emphatically supports the principle that the public highways shall be kept forever free to the general public (*17*).

The public will, as expressed in laws of Congress, has shown itself to be opposed to the toll-road principle. Under the Federal-aid road act of 1916, Federal aid for toll roads is prohibited, and all highways constructed or reconstructed under provisions of that act "shall be free from tolls of all kinds." In 1927, it is true, Congress passed an act permitting use of Federal aid funds on construction of toll bridges and approaches "providing that such bridge is owned and operated by the State or a political subdivision thereof, and tolls are used to repay the State and permit the freeing of the bridge." A sharp distinction was thus drawn between publicly owned and privately owned structures. To-day the only roads in the Federal-aid system still excluded by law from the benefits of Federal aid are those approaching a ferry or bridge built by private individuals or private companies (*17*).

A Tollhouse in Vermont, Photographed in 1912

From the international point of view, a significant change in the public attitude toward toll roads is evidenced in the proceedings of the Permanent International Association of Road Congresses. This association, headquarters of which are in Paris, is officially supported by more than 60 nations, and includes among its members leading engineers, traffic specialists, and government authorities from all parts of the world. At its fifth congress, held in 1926 in Milan, Italy, where the first autostrada had just been completed, the association passed resolutions encouraging the construction in all countries of highways reserved exclusively for motor traffic, and advocating the use of the toll system as a means of financing. The delegates of the United States and Great Britain abstained from voting on these resolutions, making a formal statement to the congress in which they described public sentiment in their countries as being opposed to the toll principle, and suggested that as regards the operation of toll-supported motor roads, "time has been too short to provide experience on which definite conclusions capable of general application can be based" (*18*).

Despite the action of the Milan Congress, the question of special motor roads was not deemed important enough to be included in the agenda of the next congress of the same association, held in Washington, D. C.,

in 1930. There was no discussion of the matter in the congress, and the various resolutions adopted by the delegates made no recommendation on the subject. However, in a preliminary report submitted by the delegates from Italy, who had been the chief proponents of the resolution in the Milan meeting, the following noteworthy statement was made, reflecting a much more cautious attitude toward toll roads than was the case four years earlier.

> . . . the autostrada can not expect to take all motor-vehicle traffic from the ordinary existing roads, even for journeys of equal length. . . . It is true that where the autostrade are of the same length or connect centers already served by ordinary routes which are to be rebuilt or improved, it is to be expected that, after the completion of the improvements, automobile traffic will prefer the good road which is free to the autostrada, which may be slightly better but on which a toll is charged. Since, on the other hand, the financial scheme of the autostrada is based principally upon the number of vehicles that will make use of it, there is danger of failure unless the ordinary road is or becomes so congested as to cause those motorists who want to make higher speed or enjoy a higher class of service to abandon it in favor of the autostrada. These considerations appear to us so striking that they can not fail to be recognized by the authorities and boards that consider the requests for concessions and by the statesmen who have the decision. We believe, therefore, that if a few concessions are granted under the above-mentioned circumstances, this presupposes an anticipated traffic density sufficient for the two roads, the ordinary and the special road, or an encouragement of the construction of the autostrada for the higher reasons of general benefit, independently of its economic success as an industrial enterprise (*19*).

The latest official pronouncement on the subject of toll roads, expressing complete opposition to the toll principle, is contained in the Official Report of the Royal Commission on Transport of Great Britain, issued at the end of 1930. A section of the report headed "Motorways" reads as follows:

> Periodically proposals are put forward for the construction by private enterprise of special roads reserved for motor traffic. The suggestion is that the necessary capital should be sought in the open market and that the promoters should look for their revenue to the tolls to be charged to users. The commissioners are strongly opposed to any suggestion of this nature. They have recommended the abolition of tolls and are not prepared to support any proposal which would have the effect of creating new tolls or prolonging the life of existing tolls (*20*).

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THE EFFECT OF VIBRATION ON THE PRESSURE OF CONCRETE AGAINST FORM WORK

Reported by L. W. TELLER, Senior Engineer of Tests, United States Bureau of Public Roads

FROM time to time during the past 35 or 40 years several investigators have made experimental determinations of the pressure of freshly placed concrete against the form work. As a result of experiments performed in 1894, Ernest McCullough found that the pressure obtained was equivalent to that of a fluid weighing 80 pounds per cubic foot.

Later experiments by other engineers indicated that the maximum pressure obtainable was equivalent to that of a fluid weighing 140 to 150 pounds per cubic foot. Among those whose efforts are noteworthy are F. R. Shunk,[1] E. B. Germain,[2] A. B. McDaniel and N. B. Garver,[3] and R. A. Sherwin.[4] Still later efforts were made to express in empirical formulas, terms which would take care of such variables as temperature and rate of fill. Paaswell[5] derived such a formula,

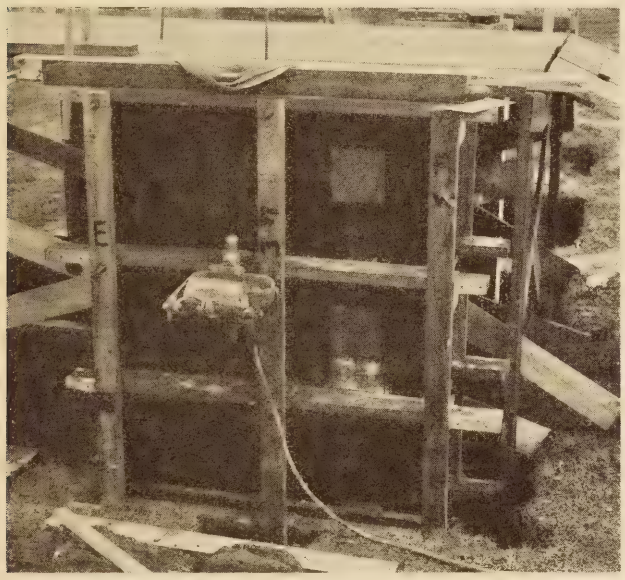

FIGURE 1.—ELECTRIC FORM VIBRATOR ATTACHED TO A FORM BATTEN

making use of the experimental work of Major Shunk a decade before, and E. B. Smith,[6] in reporting a series of tests by the United States Bureau of Public Roads, derived a formula based upon the data obtained in the tests reported by him.

While the conclusions reached by these investigators are not in complete accord, their work has been of great value to engineers in designing form work, particularly deep forms such as walls and columns.

Recently there has appeared a new factor which seems likely to have an important effect on the design of form work and that is the method of consolidating concrete by vibration. Several such methods are in use to-day and all of these tend to give temporary fluidity to very dense dry concrete mixtures which, as a rule, could not be placed without vibration.

In the course of a research project dealing with another subject at the Arlington Experiment Farm, Va., in the spring of 1930, an opportunity was presented to obtain a limited amount of data concerning the effect of vibration on the pressure of concrete against deep forms, and these limited data are being presented in this report in the hope that they may be of use to those who have this problem before them.

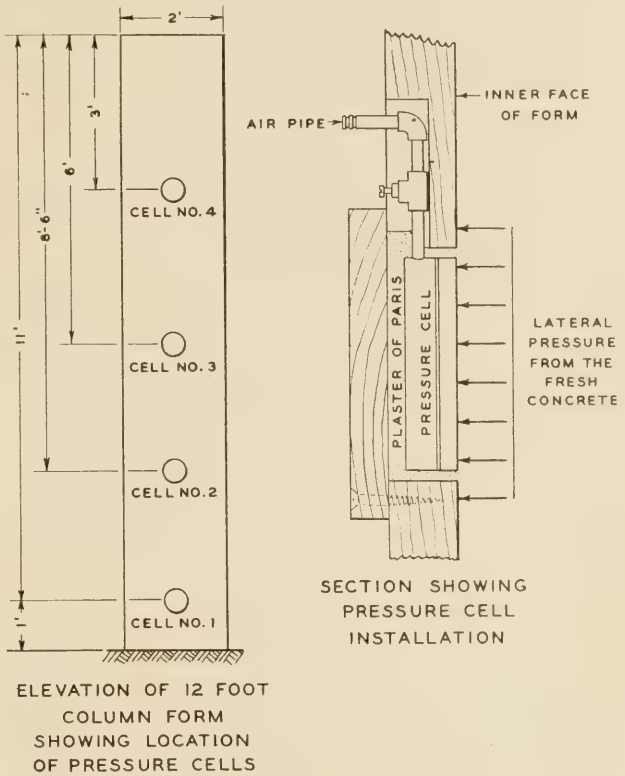

FIGURE 2.—DETAILS OF PRESSURE CELL INSTALLATION

TESTS MADE ON 12-FOOT COLUMNS

The forms which were used in these tests were for columns 12 feet high, 2 feet wide, and 8 inches thick. They were made of a 2-inch tongue and groove wood planking and were water-tight. The surface against which the concrete was placed was oiled.

The concrete used in all of the specimens was of the same proportions, aggregates, and grading, although the consistency varied w th the different specimens. The proportions used were 1:2:4 by volume, with all materials batched by weight. The coarse aggregate was a well rounded local gravel with a maximum size of 1¼ inches and the fine aggregate was a fairly coarse sand from the Potomac River.

The rate of fill was nearly the same in all of the five columns on which pressure measurements were made and was approximately 20 feet per hour.

In two of the forms consolidation was accomplished by hand spading and, in these, concretes showing slumps of 3½ and 7½ inches, respectively, were used. The other three forms were vibrated and, in these,

[1] Pressure of Concrete on Forms, by Francis R. Shunk. Engineering News, vol. 62, No. 11, Sept. 9, 1909, p. 288.

[2] The work of Germain and McCullough is referred to in the paper by McDaniel and Garver. (See footnote 3, first reference).

[3] Pressure of Wet Concrete on the Sides of Column Forms, by A. B. McDaniel and N. B. Garver. Engineering News, vol. 75, No. 20, May 18, 1916, p. 932; and Wet Concrete Pressure on Column Forms, by the same authors. Concrete, vol. 10, No. 5, May 1917, p. 191.

[4] Designing Concrete Formwork Reduces Costs, by R. A. Sherwin. Engineering Record, vol. 73, No. 9, Feb. 26, 1916, p. 278.

[5] Pressure of Concrete in Forms, by George Paaswell. Engineering and Contracting, vol. 53, No. 8, Feb. 25, 1920, p. 209.

[6] Concrete Pressure Against Forms, by Earl B. Smith. PUBLIC ROADS, vol. 2, No. 23, March, 1920, p. 15.

concretes showing slumps of 1½, 3½, and 5 inches, respectively, were used.

The hand spading was very thoroughly done, being started as soon as the first concrete was placed in the form. The vibration was supplied by a special electric form vibrator clamped securely to the exterior of the form. This vibrator consists of an electric motor carrying an eccentric weight on the shaft and operating at the high frequency of 3,600 vibrations per minute. It is shown attached to a form batten in Figure 1.

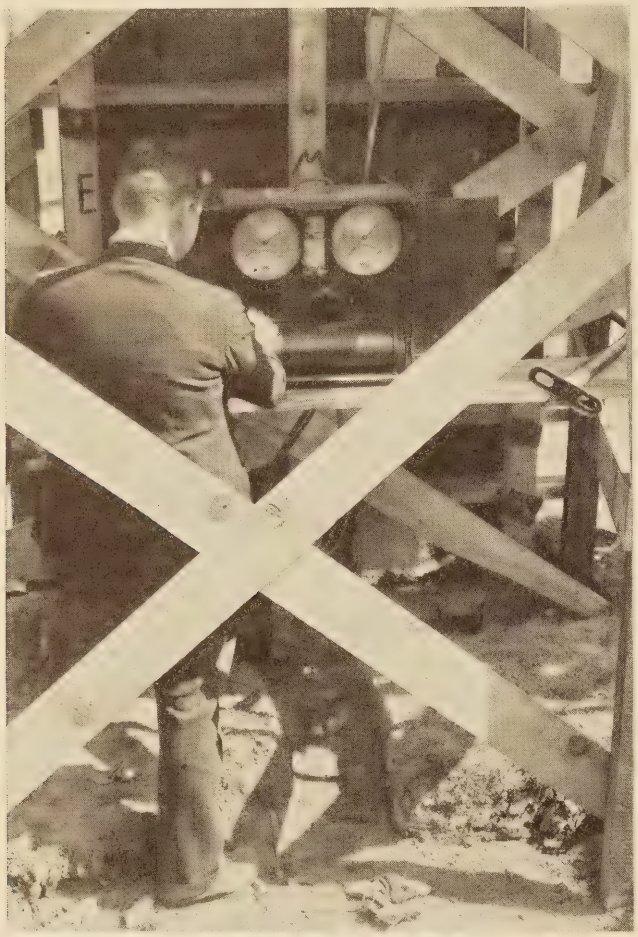

FIGURE 3.—AUXILIARY EQUIPMENT USED WITH PRESSURE CELLS

The tests were made during April and the temperatures were rather low (49° to 62° F.) except in the case of one section where the concrete was placed at a temperature of 74° F.

MEASUREMENTS MADE WITH SOIL PRESSURE CELLS

In order to measure the pressure of the concrete against the side of the column form four soil pressure cells, of the type developed by the bureau, were set into the side of the form at various heights as shown in Figure 2. This device consists of a flat cylindrical metal box, one face of which is slightly movable but is tightly sealed by a thin metal diaphragm. Normally the two faces of the box (ends of the cylinder) are in contact internally and this contact closes an electrical circuit. External pressure tends to maintain this contact. If air under pressure is introduced into the box or cell through the small pipe provided for the purpose, it will tend to expand the walls and when the internal pressure just exceeds the external pressure on the cell face, actual movement of one end will occur.

FIGURE 4.—GENERAL VIEW OF THE COLUMNS ON WHICH PRESSURE MEASUREMENTS WERE MADE

This movement interrupts the electrical indicating circuit and if the air pressure present in the cell at this moment is measured by suitable gauges, the external pressure on the face of the cell is determined. The movement necessary to break this circuit is extremely small and repeated tests have indicated that the device is thoroughly reliable, if properly installed and carefully used. The pressure cell and its use has been described in detail elsewhere.[7] The case containing the pressure gauges, air tank, control valves, and indicating light is shown in Figure 3.

Figure 4 shows several of the columns after the forms had been removed. The circular spots on the concrete are oil stains showing where the greased surfaces of the pressure cells were in contact with it.

The procedure followed in reading pressures was as follows: The gauges were first attached to the cell nearest the base of the form (cell No. 1; see fig. 2), and the pressure exerted against this cell was measured

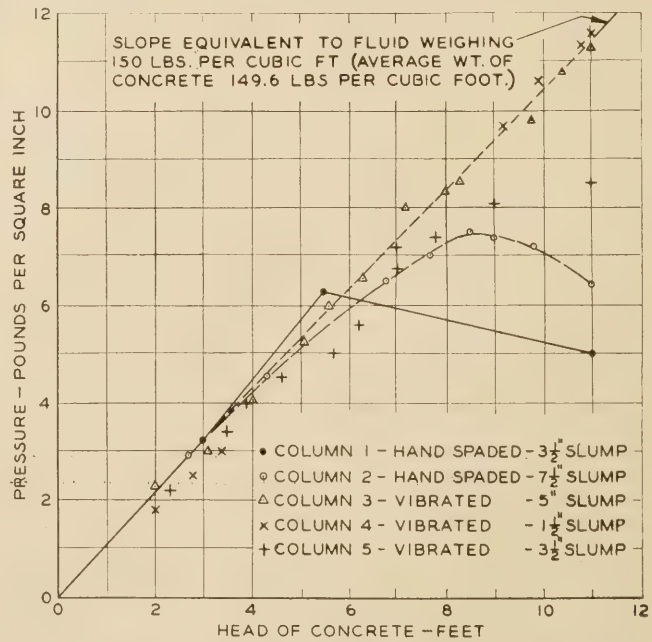

FIGURE 5.—CURVES AND PLOTTED POINTS SHOWING PRESSURE AS A FUNCTION OF HEAD FOR ALL COLUMNS DURING PERIOD OF FILLING. DATA OBTAINED FROM CELL NO. 1 ONLY

[7] An Apparatus for Determining Soil Pressures, by A. T. Goldbeck and Earl B. Smith. Proc. Am. Soc. for Testing Materials, Vol. XVI, Part II, 1916, p. 309.

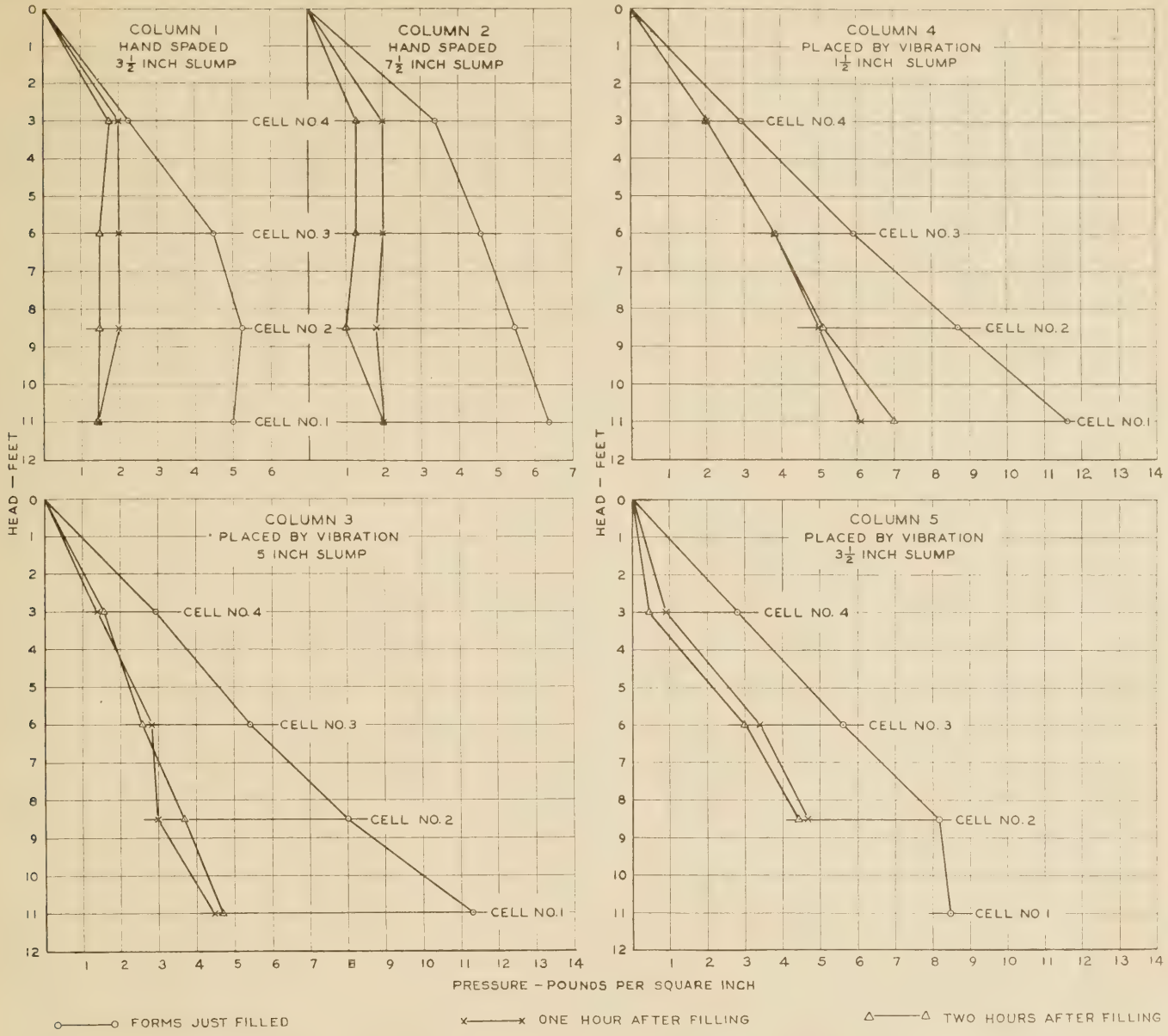

FIGURE 6.—PRESSURE DIAGRAMS FOR ALL COLUMNS

periodically as the form was being filled. The pressure, head of concrete, and the elapsed time since the filling started were recorded. As soon as the form was full, periodic readings on all four cells were begun. These observations were continued at 15, 30, or 60-minute intervals for several hours.

Practically all of the data obtained have been included in the graphs which accompany this report. It may be observed, however, that certain data pertaining to cell No. 1 and column 5 are not shown in Figure 6 and an explanation for this omission is offered. For some reason not entirely clear, there was noticeable segregation in the first batch of concrete placed in the base of this column. Perhaps this was due to the violence of the vibration, perhaps not. The result of the segregation was that the concrete in front of cell No. 1 in this particular column gradually lost its fine material and its fluidity and the pressure data for this cell were affected accordingly, as will be noted in the discussion later. The condition described can readily be seen in the photograph of the columns (fig. 4) in which column 5 is the one in the center, farthest from the camera. The fine material collected in the bottom of the form in a layer about 3 inches in thickness.

DATA SHOW FLUID CHARACTERISTICS OF VIBRATED CONCRETE

For the purpose or comparing the effect of the two methods of consolidation used, the pressure readings for cell No. 1 of each column during the period of the filling of the forms, expressed as a function of head of concrete, are grouped in Figure 5. It will be noted that, for the hand-spaded columns, even when concrete having a slump of 7½ inches was used, the concrete at the bottom of the form had ceased to act as a fluid long before the form was filled. The pressures increased hydrostatically up to a certain value, after which they decreased. This maximum pressure appears to increase with the fluidity of the concrete, as indicated by the slump test. In the case of the vibrated concrete, however, the fluidity was retained even for concrete having a slump of only 1½ inches so long as the vibration was continued.

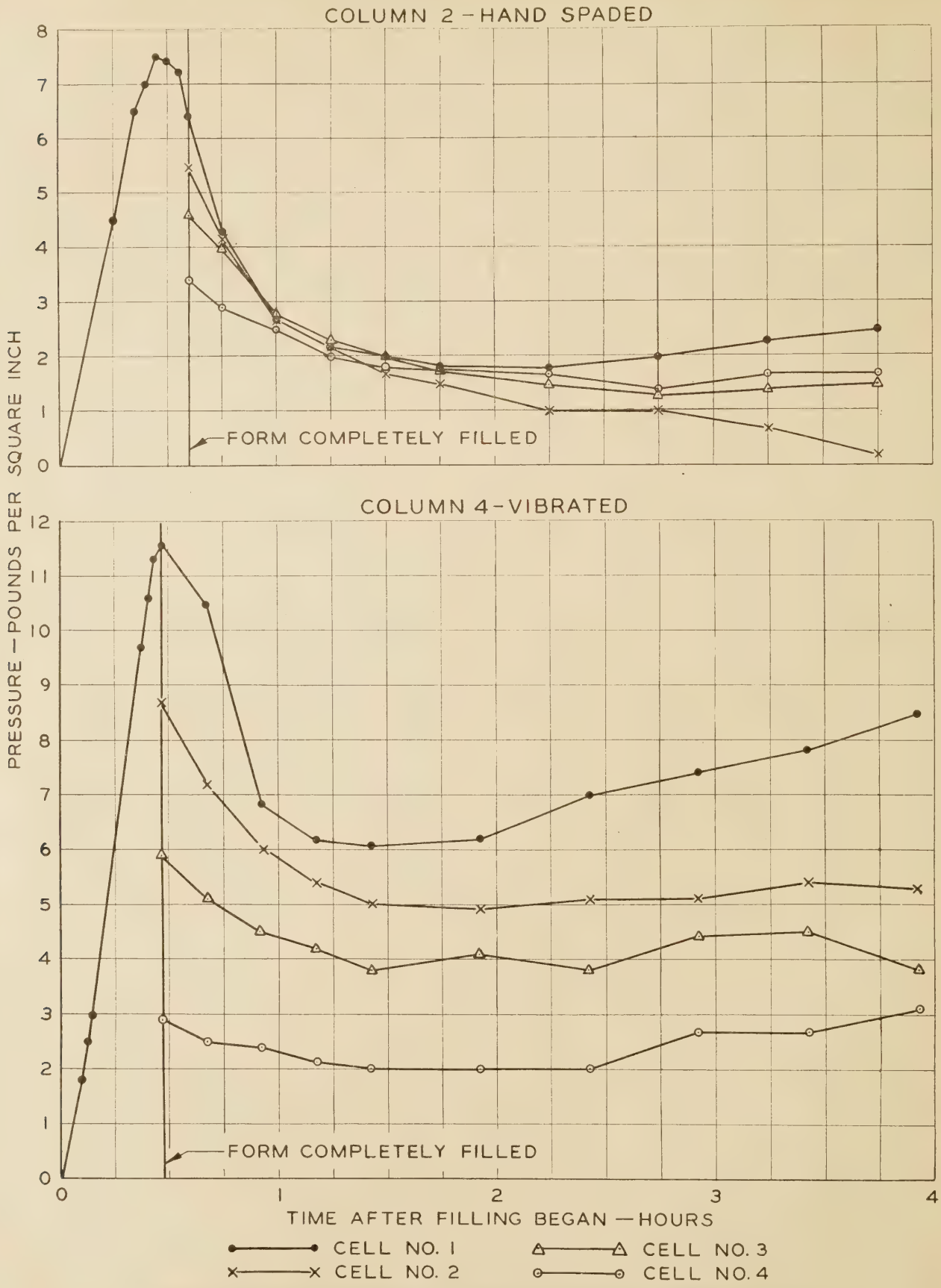

FIGURE 7.—CURVES OF PRESSURE AS A FUNCTION OF TIME FOR COLUMNS 2 AND 4

It is obvious that the complete fluidity of concrete with a 12-foot head is a matter for careful consideration in form design.

In Figure 6 are pressure diagrams for all five columns at three periods of time. Since the first curve for each column represents the pressure condition at the time the forms were just filled, the maximum pressure is not always shown. In the hand spaded columns the maximum pressures were recorded on cell No. 1 at some time before the forms were full. The rate and manner in which the pressure decreased during the first two hours after the concrete was placed is indicated by the diagrams. It will be seen that in the columns which were vibrated all of the pressure cells, except cell No. 1, column 5, indicate that the entire mass is acting as a fluid which weighs about 150 pounds per cubic foot at the time when the form is just filled.

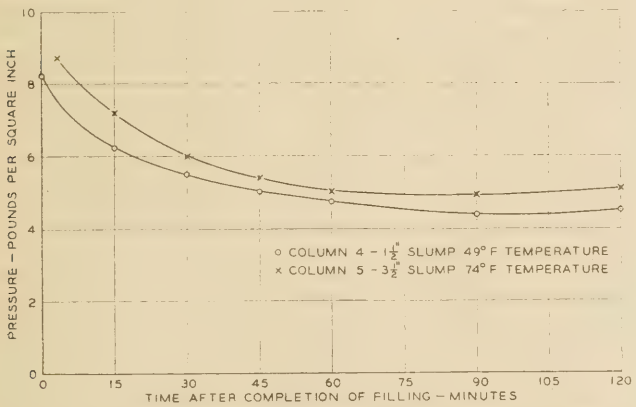

FIGURE 8.—CURVES OF PRESSURE AS A FUNCTION OF TIME FOR COLUMNS 4 AND 5, PLACED AT DIFFERENT TEMPERATURES. DATA OBTAINED FROM CELL NO. 2 ONLY

In both Figures 5 and 6, the effect of the segregation in the bottom of column 5 is noticeable. Since Figure 5 includes only the data from cell No. 1, the points shown for column 5 in this figure give an erroneous idea of the condition of the concrete in this column. The pressure diagram for column 5 in Figure 6 shows that the entire mass of the concrete above cell No. 1 was in a fluid condition at the time that the filling of the form had just been completed.

It is interesting to compare the pressure diagrams (fig. 6) for column 2 (hand spaded, 7½-inch slump) with those for column 4 (vibrated, 1½-inch slump) and note that vibration appears to be much more effective than water for obtaining a fluid condition in concrete.

While Figure 6 shows in a rough way the pressure variation with time for the different columns, in Figure 7 this relation for two of the columns (2 and 4) is given in more detail and for a longer period of time.

The most striking thing about these data is the great difference in the residual pressures resulting from the two types of consolidation.

After the 2-hour period there seems to be a tendency for the pressures to fluctuate, some increasing, others decreasing in a more or less orderly way. The cause for this is not known although it is thought that absorption of moisture by the wooden forms may have caused slight and gradual warping of the forms which, acting against the stiffening concrete, would produce such an effect.

TEMPERATURE EFFECT APPARENTLY NOT IMPORTANT

In order to determine whether there was any indication in the data of temperature effect on pressures, Figure 8 was prepared. These curves of time-pressure relation for columns 4 and 5 represent conditions in two specimens of concrete, both of which were in a fluid state at the completion of the filling of the forms. The comparison was made on these specimens because of the comparatively large temperature difference which obtained (25° F.) Since a comparison could not be made on cell No. 1 for the reasons previously described, the data from cell No. 2 on each column were used. Unfortunately for this comparison, another variable (consistency) is present, which may influence the relation to some extent. In spite of these factors, it is indicated that moderate variations in temperature did not greatly affect the pressure value or rate of change in these tests.

It is recognized that the tests are extremely limited in scope and no attempt has been made to draw any very definite conclusions. The data regarding the hand spaded columns are in general agreement with those of other investigators and those obtained on the vibrated columns are sufficiently conclusive to indicate the importance of giving consideration to this matter in the design of forms where consolidation by vibration is contemplated.

MOTION-PICTURE FILMS ON ROAD CONSTRUCTION AVAILABLE

A number of motion pictures have been prepared for the Bureau of Public Roads by the Office of Motion Pictures, United States Department of Agriculture. These pictures cover a variety of topics including the construction of various types of road, highway research, forest and national park roads, historical subjects, and road building in Latin America.

The purpose of these films is to acquaint the public with the methods and significance of highway work, to gain public cooperation, and to spread the knowledge of improved methods in the construction of roads. Persons or agencies desiring to borrow films should make application to the Office of Motion Pictures, Extension Service, United States Department of Agriculture, Washington, D. C., indicating specific dates and, if possible, alternative dates, on which they are desired for use. The films are furnished free of charge, except for transportation, which the borrower is required to pay both ways.

There follows a list of the available films, with a brief description of each.

TYPES OF ROADS

Low-Cost Road Surfaces—First Stage.—Indicates the savings in motor-vehicle operating costs made possible by low-cost road surfaces. Outlines the essential operations in the construction of the three representative types of low-cost untreated surfaces—gravel, sand-clay, and topsoil. (2 reels.)

Low-Cost Road Surfaces—Second Stage.—Shows that some form of surface treatment is usually necessary on low-cost surfaces where the traffic exceeds 500 vehicles per day. Describes the construction operations for the representative bituminous surface treatments as used in Florida, Tennessee, and South Carolina. (1 reel.)

Mixed-In-Place Bituminous Surfaces.—The methods employed in the construction of the mixed-in-place bituminous surfaces in the far Western States, the alternate "plant-mixed" type as used in California, and the retread surface as developed in Indiana and other Middle Western States. (2 reels.)

Penetration Bituminous Macadam.—Methods of equipment used in the construction of penetration bituminous macadam surfaces, which have reached a high degree of perfection in the New England States, particularly in Massachusetts and Rhode Island. (1 reel.)

Hot-Mixed Bituminous Pavements.—The essential features in the design and construction of "hot-mixed" bituminous surfaces, including coarse-aggregate asphaltic concrete, fine-aggregate asphaltic concrete, and sheet asphalt. (1 reel.)

Concrete Road Construction.—Illustrates the essential requirements in the design of concrete pavements to provide the necessary stability to resist the destructive action caused by the volume, weight, and speed of modern motor traffic. Shows the principal operations in the most advanced methods of concrete pavement construction. (2 reels.)

Brick—From Clay to Pavement.—The progress of clay through the plant until it is laid on the road as vitrified paving brick; some finished brick roads. Of general technical interest. (1 reel.)

Granite Block Paving.—From the quarry to the finished pavement in large cities. Of general technical interest. (1 reel.)

HIGHWAY RESEARCH

Impact of Traffic on Roads.—Tests made by the Bureau of Public Roads to determine accurately the effect on highways of the pounding tendencies of motor-vehicle wheels. Many tests in detail. Of special interest to road engineers. (1 reel.)

The Bates Road Tests.—The story in pictures of one of the most important road tests in highway history, depicting the methods by which a road was built to be destroyed. (1 reel.)

America's Great Bridge Test.—A technical study of the tests made to determine the strength of a modern reinforced arch bridge; made on the Swift Island Bridge over the Peedee River in North Carolina. (1 reel.)

FOREST ROAD BUILDING

Around the West by Forest Roads.—Examples of forest roads built by the Bureau of Public Roads in Colorado, Oregon, California, and Arizona. Of general interest. (1 reel.)

Building Forest Roads.—Men and machinery at work in the national forests, pushing good highways through the great mountains and woodlands. Of general interest. (1 reel.)

Highroads and Skyroads.—Building Government roads through the national forests; obstacles overcome and scenic beauties reached. Of general interest. (1 reel.)

Roads from Surf to Summit.—Scenic wonders of the national forests of the Pacific Coast States now revealed by modern highways: Lake Crescent in the Olympic National Forest, Mount Hood, Mount Rainier, Mount Baker, Mount Shuksan, and other natural wonders. (1 reel.)

Roads to Wonderland.—Scenic spots reached by roads that are being built by the Federal, State, and county Governments, Mount Hood in the Oregon National Forest; Crater Lake in Crater Lake National Park; and Yosemite National Park. Of general interest. (1 reel.)

The Road Goes Through.—How the western road builder overcomes barriers to transportation and builds the modern roads of our national forest and Federal-aid highway systems. (1 reel.)

NATIONAL PARK ROAD BUILDING

Roads in Our National Parks.—A panorama of the service performed by the Bureau of Public Roads in constructing modern highways in our Western National Parks. The scenic wonders of Yosemite, Glacier, Rocky Mountain, Mount Rainier, Mount Lassen, and Mesa Verde National Parks make this film one of the unusual beauty and interest. (1 reel.)

A Road Out of Rock.—How engineers and road builders overcome huge obstacles to construct a modern highway through Glacier National Park. Details of construction of a road which now brings the magnif-

icent "Garden Wall," picturesque Lake McDonald, and other scenic wonders of the park within easy reach of the tourist. (1 reel.)

The Men Who Build the Roads.—A tribute to the courage and ingenuity of the builders of our mountain highways; glimpses of the builders engaged in the task of penetrating the rocky barriers of Glacier National Park with a modern road. (1 reel.)

New Roads in Rainier.—A picturization of the work performed by the Bureau of Public Roads in improving the highways that make the natural wonders of Mount Rainier National Park so easily accessible to the public. Majestic Mount Rainier with its perpetual ice-capped peak and the 28 glaciers which clothe its sides, offer a scenic background of unusual beauty for this film. (1 reel.)

Rocky Mountain Park Roads.—The construction of the new road into Colorado's famous national park under the supervision of the Bureau of Public Roads engineers. Long's Peak, 14,225 feet above sea level, the Continental Divide, and picturesque Fall River Canyon, reached by this new highway, provided scenic material for the cameraman. (1 reel.)

Yosemite's New Roads.—The planning and building of new roads into the Yosemite National Park by the engineers of the Bureau of Public Roads. Yosemite Falls, 2,350 feet, highest in the world, El Capitan, and the exquisite beauty of the Yosemite "back country" feature the scenic views included in this film. (1 reel.)

HISTORICAL

Travelers' Toll.—Shows how the public pays for good roads; how the gasoline tax serves the same purpose as the turnpike toll. (3 reels.)

Wheels of Progress.—A pictorial tale of transportation in America from the day of the bicycle and the fancy turnout to modern methods of transportation. How the gasoline engine revolutionized American transportation and how the motor car and the truck are contributing to progress and prosperity in the United States. (1 reel.)

MISCELLANEOUS

Crossing the Great Salt Desert.—Difficulties overcome by engineers in building the Wendover Road, a short cut across the Great Salt Desert in Utah; unusual road engineering; mirages. Of general interest. (1 reel.)

Road Building in the United States.—Methods of building important types of highway in the United States, as seen by the Pan American Highway Commission on a tour of this country; topsoil, gravel, penetration macadam, concrete, and asphaltic concrete roads; how the work is financed. Of general interest. (2 reels.)

A Highway of Friendship.—Reception of the Pan American Highway Commission by Federal and State officials and people of States visited; interesting places and events in North Carolina, Kentucky, Ohio, Illinois, Minnesota, Wisconsin, Michigan, Pennsylvania, New Jersey, and the city of Washington. Of general interest. (2 reels.)

Roads for All America.—Visit to Buenos Aires, Argentina, of the United States delegation to the first Pan American Road Congress. The Pan American Highway commission with President Coolidge, the Panama Canal, types of highways, scenes of general interest, and leading men, including the Presidents of Panama, Peru, Chile, Argentina, Uruguay, and Brazil. Of general interest. (6 reels.)

SOUTH AMERICAN ROAD BUILDING

Highways of Argentina.—A sight-seeing tour of the wealthy capital of Buenos Aires over its broad avenues; an inspection trip of the rural road construction in the Provinces of Cordoba, Santa Fé, and Entre Rios. Of general interest. (1 reel.)

Highways of Brazil.—Traffic on the streets and drives of Rio de Janeiro; the high-type concrete pavement to Petropolis; the road to São Paulo, the coffee center; the Paineiras road; and typical road construction scenes. Of general interest. (2 reels.)

Highways of Chile.—An automobile trip from the seaport of Santiago to the capital at Valparaiso, annual review of the crack military and naval cadets and the transportation facilities of the rich copper and nitrate mines in northern Chile. Of general interest. (2 reels.)

Highways of Peru.—The remains of the early highway system laid out by the Incas, the modern highway system under construction following the plan of the Incas, and the great national obstacles to road construction. Of general interest. (2 reels.)

Highways of Uruguay.—The well-paved and lighted avenues of Montevideo, the roads radiating into the agricultural and cattle-raising regions, the new road under construction from Montevideo to Colonia, and characteristic scenes of the country. Of general interest. (1 reel.)

Highways of Venezuela.—A loop automobile trip from the harbor of La Guaira, on the northern coast of Venezuela, to the capital at Caracas, and through the fertile agricultural region in the vicinity of Maracay and Valencia to Puerto Cabello on the Caribbean Sea. Of general interest. (2 reels.)

Highway Glimpses of Colombia and the Dutch West Indies.—Street and rural road scenes in the vicinity of Puerto Colombia and Barranquilla in Colombia and traffic at Willemstad on the Island of Curaçao in the Caribbean Sea. Of general interest. (1 reel.)

Highway Glimpses of Panama.—Business activity of the streets of the new city of Panama contrasted with the ruins of Old Panama laid waste by the buccaneer and freebooter, Sir Henry Morgan, and the rural road development of the Republic. Of general interest. (2 reels.)

Highway Glimpses of Trinidad.—The superb highway system of the island, the natural bituminous deposit of Asphalt Lake, which is the source of material for many streets and roads in the United States, and typical road construction scenes. Of general interest. (1 reel.)

1930 MOTOR VEHICLE REGISTRATIONS AND RECEIPTS

Reported by L. A. ABBOT, Associate Statistical Engineer, United States Bureau of Public Roads

DURING the year 1930 there were 26,523,779 different motor vehicles regularly registered by the various States and the District of Columbia, according to reports received by the Bureau of Public Roads. The States and the District of Columbia collected in registration fees, licenses, operators' permits, fines, etc., gross receipts totaling $355,704,860.

If the above two figures for the year 1930 are compared with similar totals for 1929, it will be noted that there was a gain in registration of 22,336 motor vehicles, or only eight hundredths of 1 per cent, and a gain in receipts of $7,861,317, or 2.3 per cent.

The 10-year growth in registration is shown in Table 1, covering the years 1921 to 1930, inclusive. The first three columns show the generally used method of comparing each total to the previous year and basing the increase and percentage of increase on the preceding year regardless of whether or not it was a peak, average, or depressed year. The last three columns show the results obtained by using a constant basis (the year 1921). The last column shows that 1929, with more than 19 per cent increase over the preceding year, on the 1921 basis, was a remarkable year in motor vehicle expansion.

TABLE 1.—*Ten-year growth in motor-vehicle registration, from 1921 to 1930, inclusive, showing accumulated increase since 1921, with annual increases based on 1921*

Year	Total motor vehicles registered	Increase over previous year		Accumulated increase over 1921		Annual per cent increase based on 1921
		Number	Per cent	Number	Per cent	
1921	10,463,295					
1922	12,238,375	1,775,080	17.0	1,775,080	17.0	
1923	15,090,936	2,852,561	23.3	4,627,641	44.2	27.2
1924	17,593,677	2,502,741	16.6	7,130,382	68.1	23.9
1925	19,937,274	2,343,597	13.3	9,473,979	90.3	22.2
1926	22,001,393	2,064,119	10.4	11,538,098	110.2	19.9
1927	23,133,241	1,131,848	5.1	12,669,946	121.1	10.9
1928	24,493,124	1,359,883	5.9	14,029,829	134.1	13.0
1929	26,501,443	2,008,319	8.2	16,038,148	153.3	19.2
1930	26,523,779	22,336	.1	16,060,484	153.5	.2

In the table of motor-vehicle registration the total motor vehicles are classified into two groups according to type of service. One group for passenger service comprises passenger cars, taxis and busses, and the second group is made up of motor trucks and road tractors, which are used for freight service. From a comparison of these group totals for 1930 with the same groups in 1929, it is noted that the passenger vehicle registration decreased, while that of motor trucks increased 3 per cent. This percentage increase is only one-third of the 1929 motor truck increase, yet it indicates that business was moving ahead in spite of the depression. This indication relating to business is also confirmed by a noteworthy increase in trailers, which are not included in motor-vehicle registration; for in 1930, trailer registration increased 36 per cent over the previous year's figures.

Regarding the registration by States, New York still leads with 2,307,730 motor vehicles, gaining 44,471, and is followed closely by California with 2,041,356. This State made the largest net gain, namely 67,015. These two States are the only ones now registering more than 2,000,000 motor vehicles. There are five other States having over 1,000,000 registration as follows: Ohio, 1,759,363; Pennsylvania, 1,753,521; Illinois, 1,638,260; Texas, 1,365,896; and Michigan, 1,328,209. The order of precedence is the same as in 1929, except that Texas, with a gain of 17,789, has passed Michigan, which reported the greatest loss of any State, amounting to 66,893, or 4.8 per cent under 1929. This drop in Michigan, which accounts for almost one-quarter of the decrease in registration of the 21 States showing decreases, is due not only to the acute manufacturing depression in that State but probably also to a large scrapping of cars sold for junk to manufacturers desirous of ridding the market of old cars.

The increase in receipts already mentioned was chiefly due to higher registration fees, but gains in both trailer registrations and operators' permits helped to increase the total. In the disposition of the gross receipts according to the laws of the various States, the collection and administration expenses amounted to $19,196,926 (excluding these expenses in six States which make State appropriations); State highways were allocated $222,146,682, a little less than in 1929; local roads received $68,577,899, about 3 per cent increase; road bond payments were allotted $36,309,682 and $9,473,671 was reported "for other purposes." This latter classification includes $3,454,962 for State highway patrol; $1,403,280 for city streets, and for a free bridge commission (New Jersey); $185,587 assigned to funds used for refunds; and last, $4,429,842 (1¼ per cent of gross receipts) to general funds of city, county and State as noted on the table of motor vehicle receipts.

MOTOR VEHICLE REGISTRATIONS, 1930 [1]

[Compiled for calendar year from reports of State authorities]

State	1930-registered motor vehicles individually and commercially owned [2]			Other registered vehicles		Tax-exempt official motor cars and motor cycles		Number of licenses or permits		Total registered motor cars and trucks, in 1929	Year's change in motor-vehicle registrations		State
	Grand total registered motor cars and trucks	Passenger automobiles, taxis, and busses [3]	Motor trucks and road tractors	Trailers	Motor cycles	United States, [4] State, and local cars	Motor cycles (official)	Dealers	Operators and chauffeurs		Number increase, or decrease (−)	Per cent	
Alabama	277,146	239,170	37,976	3,550	663	1,368		4,181	2,989	285,533	−8,387	−2.9	Alabama.
Arizona	110,525	98,480	12,045	1,346	390	1,457	47	117	13,468	109,013	1,512	1.4	Arizona.
Arkansas	220,204	193,218	26,986	2,805	380	939		481	5,137	233,128	−12,924	−5.5	Arkansas.
California	2,041,356	1,810,969	230,387	48,532	9,405	18,122		3,325		1,974,341	67,015	3.4	California.
Colorado	308,509	276,847	31,662	188	1,059	283		3,474	7,296	303,489	5,020	1.7	Colorado.
Connecticut	331,026	279,830	51,196	480	2,371	2,390	277	3,178	409,557	328,063	2,963	.9	Connecticut.
Delaware	56,109	45,533	10,576	412	295	44		680	63,452	54,960	1,149	2.1	Delaware.
Florida	327,801	274,705	53,096	5,000	1,490	3,871	160	1,724	2,514	345,977	−18,176	−5.2	Florida.
Georgia	341,580	294,461	47,119	2,704	1,178	934		2,796	3,045	358,905	−17,325	−4.8	Georgia.
Idaho	119,077	104,526	14,551	450	359	1,329	11	441	923	118,074	1,003	.8	Idaho.
Illinois	1,638,260	1,430,676	207,584	7,341	6,245	979		4,368	108,538	1,615,088	23,172	1.4	Illinois.
Indiana	875,763	747,366	128,397	13,646	2,862	8,593		2,706	58,847	866,715	9,048	1.0	Indiana.
Iowa	778,386	706,196	72,190	1,542	1,712	3,789	77	2,340	17,911	784,450	−6,064	−.8	Iowa.
Kansas	594,523	511,384	[5] 83,139	1,083	1,275	2,833	40	2,607		581,223	13,300	2.3	Kansas.
Kentucky	331,002	295,161	35,841	[6]	681	2,282		1,082	12,481	332,848	−1,846	−.6	Kentucky.
Louisiana	275,283	230,586	44,697	5,443	518	209		407	22,735	280,868	−5,585	−2.0	Louisiana.
Maine	186,157	148,722	37,435	2,207	1,170	1,629	68	1,239	227,723	184,506	1,651	.9	Maine.
Maryland	321,702	283,870	37,832	1,008	1,941	2,000		5,788	82,468	319,873	1,829	.6	Maryland.
Massachusetts	846,206	743,288	102,918	701	4,642	1,556		3,112	982,795	817,704	28,502	3.5	Massachusetts.
Michigan	1,328,209	1,161,051	[5] 167,158	44,441	3,530	371		2,034	70,710	1,395,102	−66,893	−4.8	Michigan.
Minnesota	732,972	624,902	108,070	9,541	1,825	3,680		1,991		730,399	2,573	.4	Minnesota.
Mississippi	237,094	203,443	33,651	3,890	217	74		4,942		250,011	−12,917	−5.2	Mississippi.
Missouri	761,600	670,145	[5] 91,455	3,742	1,746	2,086	5	2,438	36,221	756,680	4,920	.6	Missouri.
Montana	135,168	109,549	25,619	56	242	1,640		575	412	140,387	−5,219	−3.7	Montana.
Nebraska	426,229	367,587	58,642	10,320	900	1,681		3,251		418,226	8,003	1.9	Nebraska.
Nevada	29,645	23,388	6,257	330	74	544		109		31,915	−2,270	−7.1	Nevada.
New Hampshire	112,183	93,155	19,028	935	1,132	484		600	130,023	108,880	3,303	3.0	New Hampshire.
New Jersey	852,850	719,696	133,154	2,639	5,998	8,420		3,207	1,018,335	832,332	20,518	2.5	New Jersey.
New Mexico	84,150	70,450	[7] 13,700	850	200	956	10	230		78,374	5,776	7.4	New Mexico.
New York	2,307,730	1,966,981	340,749	10,205	12,355	20,886	1,302	4,965	2,900,198	2,263,259	44,471	2.0	New York.
North Carolina	453,241	397,133	56,108	5,845	1,350	8,070		5,575		483,602	−30,361	−6.3	North Carolina.
North Dakota	183,019	155,383	27,636	[8]	235	3		650		188,046	−5,027	−2.7	North Dakota.
Ohio	1,759,363	1,555,093	204,270	24,356	6,886	13,854		3,772	60,925	1,766,614	−7,251	−.4	Ohio.
Oklahoma	550,331	490,947	59,384	[8]	1,226	5,230				570,791	−20,460	−3.6	Oklahoma.
Oregon	252,123	234,766	17,357	1,893	1,348	3,003	58	517	26,705	269,007	−16,884	−6.3	Oregon.
Pennsylvania	1,753,521	1,534,834	218,687	5,684	12,961	2,478		10,704	2,181,006	1,733,283	20,238	1.2	Pennsylvania.
Rhode Island	136,423	116,792	19,631	90	770	901	112	333	156,532	134,009	2,414	1.8	Rhode Island.
South Carolina	218,402	192,141	26,261	2,976	559	3,550		1,259	314,702	231,274	−12,872	−5.6	South Carolina.
South Dakota	205,172	180,195	24,977	[6]	239	997		894		204,199	973	.5	South Dakota.
Tennessee	368,259	330,436	37,823	[6]	1,228	4,552		628		362,431	5,828	1.6	Tennessee.
Texas	1,365,896	1,159,139	206,757	29,853	4,045	2,505		3,879	18,804	1,348,107	17,789	1.3	Texas.
Utah	113,997	96,128	17,869	[6]	488	1,373		300	2,650	112,661	1,336	1.2	Utah.
Vermont	86,624	78,398	8,226	315	524	28		363	97,699	93,030	−6,406	−6.9	Vermont.
Virginia	375,889	318,582	57,307	1,318	2,084	5,053		4,063	9,962	387,205	−11,316	−2.9	Virginia.
Washington	446,062	382,874	63,188	3,147	1,993	6,449	179	4,738	85,714	442,341	3,721	.8	Washington.
West Virginia	266,273	225,900	40,373	928	1,330	3,057	123	10,702	87,606	268,888	−2,615	−1.0	West Virginia.
Wisconsin	782,562	677,452	105,110	715	2,666	5,225	324	2,912	79,059	793,502	−10,940	−1.4	Wisconsin.
Wyoming	61,501	51,579	9,922	[6]	121	591		352		60,680	821	1.4	Wyoming.
District of Columbia	156,676	139,733	16,943	[8]	903	3,412	153	1,759	71,743	151,450	5,226	3.4	District of Columbia.
Total	26,523,779	23,042,840	3,480,939	262,507	107,811	[9] 173,619	2,946	121,788	9,370,885	26,501,443	22,336	.08	Total.

[1] This table lists only the number of registrations, licenses and permits. For financial statement see table on next page.

[2] The first 3 columns show regularly registered motor cars and trucks, eliminating reregistrations, nonresident registrations, etc.

[3] Busses are included with passenger cars except as noted in next column. A bus census is published in a magazine devoted to busses.

[4] These official cars are exempted from paying regular registration fees and are excluded from "registered motor vehicles."

[5] Busses included with trucks.

[6] Classified with trucks.

[7] Large increase in trucks due to change in recording small commercial trucks, formerly classified with passenger cars.

[8] Not registered.

[9] Includes 7,859 "cars-at-large," owned by United States Government and not allocated to any State.

MOTOR VEHICLE REGISTRATION FEES, LICENSES, PERMITS, FINES, ETC., 1930 [1]

[Compiled for calendar year from reports of State authorities]

State [2]	Total gross receipts	Registration receipts [2]					Miscellaneous receipts [2]			Disposition of gross receipts					State [2]
		Motor-car receipts			Other vehicles		Dealers' licenses	Chauffeur and operator permits	Other miscellaneous	Collection and administration [3]	For highway purposes			For other purposes	
		Total motor cars	Passenger cars and busses	Trucks and tractors	Trailers	Motor cycles					State highways	Local roads	State and county road bonds [4]		
Alabama [2]	$3,799,761									$225,541	$890,029	$740,953	$1,943,238		Alabama.[2]
Arizona	734,626	$540,516	$313,233	$227,283	$13,438	$1,186	$890	$13,682	$164,914		734,626				Arizona.
Arkansas	4,283,959	4,242,757					5,746	35,456		69,135	2,874,910		[5] 1,339,914		Arkansas.
California	9,858,810	8,639,234	6,202,593	2,436,641	313,170	33,612	47,692	183,701	641,401	1,493,292	3,387,537	3,387,537		[6] $1,590,444	California.
Colorado	1,901,230	1,784,685	1,415,926	368,759	2,558	1,832	28,204	14,535	69,416	131,723	884,754	884,753			Colorado.
Connecticut	8,290,404	6,353,650	4,878,046	1,475,604	17,741	9,725	93,628	1,234,969	580,691	716,337	7,574,067				Connecticut.
Delaware	1,110,047	864,085	636,215	227,870	4,501	1,047	7,710	192,229	40,475		598,292		[7] 511,755		Delaware.
Florida	4,813,495	4,728,559	3,545,445	1,183,114	24,358	5,435	22,698	4,757	27,688	288,810	3,393,539	1,131,146			Florida.
Georgia	4,482,257	4,417,915	3,605,889	812,026	21,051	5,231	31,087	6,032	941	211,212	4,271,045				Georgia.
Idaho	1,998,290	1,958,605	1,548,966	409,639		1,803	26,190	1,846	9,846	59,949	193,834	1,744,507			Idaho.
Illinois	18,444,247	17,292,244	12,858,506	4,433,738	151,722	20,138	84,040	364,316	531,787		10,468,503		7,975,744		Illinois.
Indiana	6,346,879	5,941,606	4,532,881	1,408,725	65,352	5,056	54,320	15,327	265,218	326,834	6,020,045				Indiana.
Iowa	12,693,621	11,978,356	10,251,169	1,727,187	16,994	6,066	77,815	35,823	578,567	612,753	11,955,810			[8] 125,058	Iowa.
Kansas [2]	6,084,348									170,735	4,163,613	1,750,000			Kansas.[2]
Kentucky	5,547,069	5,375,879	4,204,514	1,171,365	[9]	5,253	30,290	33,594	102,053	275,612	4,685,774	585,683			Kentucky.
Louisiana	4,609,042	4,528,346						68,205	12,491	50,000	4,559,042				Louisiana.
Maine	3,166,642	2,423,428	1,815,083	608,345	7,273	6,162	48,505	510,410	170,864	316,422	1,443,300		1,266,922	[10] 139,998	Maine.
Maryland	3,437,796	2,712,922	2,303,398	409,524	26,341	9,354	30,456	212,717	446,006	343,780	2,475,213			[11] 618,803	Maryland.
Massachusetts	7,120,583	4,117,530	2,883,475	1,234,055	33,169	6,601	9,300	1,965,590	988,393	1,643,710	4,841,249		635,624		Massachusetts.
Michigan	22,482,412	20,771,694	15,998,470	4,773,224	371,124	13,794	91,148	226,896	1,007,756	875,279	14,525,073	6,000,000	1,082,060		Michigan.
Minnesota	11,062,150	10,926,205	8,936,703	1,989,502	35,125	6,662	36,864	30,083	27,211		6,977,428		[12] 4,053,439	[13] 31,283	Minnesota.
Mississippi [2]	3,046,393									159,818	241,324	2,645,251			Mississippi.[2]
Missouri [2]	10,150,000									498,517	6,078,983		3,572,500		Missouri.[2]
Montana	1,583,276	1,503,003	1,208,904	294,099	280	970	20,285	824	57,914	56,100		1,527,176			Montana.
Nebraska	3,804,950	3,631,476	3,117,510	513,966	10,944	2,911	44,131		115,488	116,600	1,106,505	2,581,845			Nebraska.
Nevada	373,966	287,489	206,365	81,124	2,245	330	3,527		80,375	14,069	189,647		170,250		Nevada.
New Hampshire	2,290,435	1,868,051				5,965	28,809	303,517	84,093	175,319	2,115,116				New Hampshire.
New Jersey	15,382,456	11,270,251	7,240,775	4,029,476	100,975	11,996	79,995	3,060,836	858,403	1,034,187	9,362,269	4,735,000		[14] 251,000	New Jersey.
New Mexico [2]	1,279,623									78,063	444,577	204,265		[15] 552,718	New Mexico.[2]
New York	40,857,715	36,459,709	26,545,479	9,914,230	167,608	54,241	211,171	3,026,794	938,192	2,662,798	28,260,942	6,088,134		[16] 3,845,841	New York.
North Carolina [2]	6,835,743									300,000	2,847,402		3,688,341		North Carolina.[2]
North Dakota	1,958,662	1,945,936	1,518,362	427,574		1,355	11,064		307	77,115	1,098,674	782,873			North Dakota.
Ohio	13,287,352	12,700,300			[17]	17,215	75,440	182,737	311,660	507,329	6,383,546	6,396,477			Ohio.
Oklahoma [2]	6,536,361									256,412	2,358,132	3,921,817			Oklahoma.[2]
Oregon	9,617,930	9,059,567	7,511,493	1,548,074	42,112	8,306	37,025	66,184	404,736	555,627	2,295,500	3,315,488	3,451,315		Oregon.
Pennsylvania	33,112,371	23,859,639	16,109,236	7,750,403	77,038	31,988	264,060	4,593,592	4,286,054	2,048,435	26,513,678		3,449,847	[10] 1,100,411	Pennsylvania.
Rhode Island	2,280,849	1,834,238	1,350,203	484,035	2,076	3,514	16,890	323,260	100,871	249,437	2,014,012	17,400			Rhode Island.
South Carolina	2,878,352	2,581,458	2,130,068	451,390	34,348	1,759	30,838	143,482	86,467	40,692	2,681,185			[18] 156,475	South Carolina.
South Dakota	2,959,913	2,900,648	2,462,517	438,131		856	22,010		36,399	92,574	1,462,557	1,404,782			South Dakota.
Tennessee [2]	4,767,239									88,830	2,220,656	2,220,656		[10] 237,097	Tennessee.[2]
Texas	13,961,362	13,061,103	9,252,280	3,808,823	289,832	17,662	57,683	56,349	478,733	843,749	4,153,585	8,964,028			Texas.
Utah [2]	855,584									118,084	402,100		335,400		Utah.[2]
Vermont	2,392,152	2,058,025	1,679,680	378,345	[9]	3,512	28,343	252,077	50,195		2,392,152				Vermont.
Virginia	6,493,989	6,234,559	5,108,796	1,125,763	11,508	7,920	67,581	54,726	117,695	212,206	6,116,058			[10] 165,725	Virginia.
Washington	7,616,676	7,354,120	5,744,588	1,609,532	65,539	11,089	85,735	87,799	12,394	187,519	5,279,245	2,062,113		[10] 87,799	Washington.
West Virginia	4,702,812	4,295,618	3,331,457	964,161	5,514	5,869	44,766	141,127	209,918	209,798	1,622,139		2,833,333	[8] 37,542	West Virginia.
Wisconsin	13,083,521	12,724,232	9,123,136	3,601,096	41,089	15,415	101,078	22,197	179,510	700,000	6,897,506	5,486,015			Wisconsin.
Wyoming [2]	691,509										691,509				Wyoming.[2]
District of Columbia	636,001	178,907	152,257	26,650		918	1,759	215,229	239,188	102,524				[19] 533,477	District of Columbia.
Detailed totals	311,658,299	275,406,545	[20]	[20]	1,955,025	342,748	1,958,773	17,680,898	14,314,310						Detailed totals.
Grand total	355,704,860									19,196,926	222,146,682	68,577,899	36,309,682	9,473,671	Grand total.

[1] Financial date only on this table. For number of registrations, etc., see table on preceding page.
[2] Ten States thus noted do not report complete details, and receipts are not included in "detailed totals."
[3] States for which no figures are shown make State appropriations for administration.
[4] Payments on State bonds except as noted.
[5] Includes payments on county bonds $1,026,754.
[6] Includes $10,495 for refunds; remainder State highway patrol.
[7] Includes payments on county bonds, $362,568.
[8] For refunds.
[9] Included with truck receipts.
[10] For State highway patrol.
[11] For Baltimore Streets.
[12] For payments on county bonds.
[13] For State general fund.
[14] For free bridge commission.
[15] For State general fund $252,328; remainder to general county fund.
[16] For New York City general fund.
[17] Included with motor car receipts.
[18] For refunds $12,492; remainder State highway patrol.
[19] For signals and streets as appropriated by Congress.
[20] Only 34 States and District of Columbia separate motor-car receipts as follows: Passenger car and bus receipts $189,723,618, and truck and tractor receipts $62,343,473.

ROAD PUBLICATIONS OF BUREAU OF PUBLIC ROADS

Applicants are urgently requested to ask only for those publications in which they are particularly interested. The Department can not undertake to supply complete sets nor to send free more than one copy of any publication to any one person. The editions of some of the publications are necessarily limited and when the Department's free supply is exhausted and no funds are available for procuring additional copies, applicants are referred to the Superintendent of Documents, Government Printing Office, this city, who has them for sale at a nominal price, under the law of January 12, 1895. Those publications in this list, the Department supply of which is exhausted, can only be secured by purchase from the Superintendent of Documents, who is not authorized to furnish publications free.

ANNUAL REPORTS

Report of the Chief of the Bureau of Public Roads, 1924.
Report of the Chief of the Bureau of Public Roads, 1925.
Report of the Chief of the Bureau of Public Roads, 1927.
Report of the Chief of the Bureau of Public Roads, 1928.
Report of the Chief of the Bureau of Public Roads, 1929.
Report of the Chief of the Bureau of Public Roads, 1930.

DEPARTMENT BULLETINS

No *136D. Highway Bonds. 20c.
*314D. Methods for the Examination of Bituminous Road Materials. 10c.
*347D. Methods for the Determination of the Physical Properties of Road-Building Rock. 10c.
*532D. The Expansion and Contraction of Concrete and Concrete Roads. 10c.
*583D. Reports on Experimental Convict Road Camp, Fulton County, Ga. 25c.
*660D. Highway Cost Keeping. 10c.
*691D. Typical Specifications for Bituminous Road Materials. 10c.
1216D Tentative Standard Methods of Sampling and Testing Highway Materials, adopted by the American Association of State Highway Officials and approved by the Secretary of Agriculture for use in connection with Federal-aid road construction.
1279D Rural Highway Mileage, Income, and Expenditures 1921 and 1922.
1486D. Highway Bridge Location.

DEPARTMENT CIRCULARS

No 331C. Standard Specifications for Corrugated Metal Pipe Culverts.

TECHNICAL BULLETIN

No 55T. Highway Bridge Surveys.

MISCELLANEOUS CIRCULARS

No. 62M. Standards Governing Plans, Specifications, Contract Forms, and Estimates for Federal-Aid Highway Projects.
*93M. Direct Production Costs of Broken Stone. 25c.
109M. Federal Legislation and Regulations Relating to the Improvement of Federal-Aid Roads and National-Forest Roads and Trails, Flood Relief, and Miscellaneous Matters.

MISCELLANEOUS PUBLICATIONS

No. 76MP. The Results of Physical Tests of Road-Building Rock.

SEPARATE REPRINTS FROM THE YEARBOOK

No. *914Y. Highways and Highway Transportation. 25c.
937Y. Miscellaneous Agricultural Statistics.
1036Y. Road Work on Farm Outlets Needs Skill and Right Equipment.

TRANSPORTATION SURVEY REPORTS

Report of a Survey of Transportation on the State Highway System of Ohio. (1927)
Report of a Survey of Transportation on the State Highways of Vermont. (1927)
Report of a Survey of Transportation on the State Highways of New Hampshire. (1927)
Report of a Plan of Highway Improvement in the Regional Area of Cleveland, Ohio. (1928)
Report of a Survey of Transportation on the State Highways of Pennsylvania. (1928)

REPRINTS FROM THE JOURNAL OF AGRICULTURAL RESEARCH

Vol. 5, No. 17, D- 2. Effect of Controllable Variables upon the Penetration Test for Asphalts and Asphalt Cements.
Vol. 5, No. 19, D- 3. Relation Between Properties of Hardness and Toughness of Road-Building Rock.
Vol. 5, No. 24, D- 6. A New Penetration Needle for Use in Testing Bituminous Materials.
Vol. 6, No. 6, D- 8. Tests of Three Large-Sized Reinforced-Concrete Slabs Under Concentrated Loading.
Vol. 11, No. 10, D-15. Tests of a Large-Sized Reinforced-Concrete Slab Subjected to Eccentric Concentrated Loads.

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* Department supply exhausted.

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

CURRENT STATUS OF FEDERAL-AID ROAD CONSTRUCTION

AS OF

FEBRUARY 28,1931

STATE	COMPLETED MILEAGE	UNDER CONSTRUCTION					APPROVED FOR CONSTRUCTION					BALANCE OF FEDERAL-AID FUNDS AVAILABLE FOR NEW PROJECTS	STATE
		Estimated total cost	Federal aid allotted	MILEAGE Initial	MILEAGE Stage[1]	MILEAGE Total	Estimated total cost	Federal aid allotted	MILEAGE Initial	MILEAGE Stage[1]	MILEAGE Total		
Alabama	2,210.7	$ 4,521,782.51	$ 2,191,003.00	180.4	15.8	196.2	$ 1,958,366.12	$ 907,465.28	27.0	59.5	86.5	$ 4,058,209.08	Alabama
Arizona	885.7	4,119,489.04	3,183,956.66	145.9	162.2	308.1	774,769.25	425,227.35	19.0	40.2	59.2	1,566,028.21	Arizona
Arkansas	1,811.5	7,030,511.52	3,244,190.29	205.6	19.5	225.1	2,099,376.14	999,655.11	29.4	45.1	74.5	1,199,901.42	Arkansas
California	1,949.0	8,078,426.67	3,538,178.46	179.7	31.8	211.5	1,477,097.26	420,557.14	49.8	2.3	52.1	3,852,608.09	California
Colorado	1,287.1	4,307,101.13	2,315,285.04	163.5	67.7	231.2	950,847.26	498,490.32	40.6	21.3	61.9	3,257,731.19	Colorado
Connecticut	258.2	1,524,709.41	661,789.48	7.6		7.6	2,384,528.77	816,705.04	27.0		27.0	504,913.04	Connecticut
Delaware	318.9	106,632.85	53,316.42	4.4		4.4	1,257,177.78	516,724.26	51.8		51.8	134,468.17	Delaware
Florida	527.1	4,517,261.88	2,187,119.82	103.4		103.4	949,280.26	444,589.36	45.7		45.7	2,260,670.67	Florida
Georgia	2,712.0	7,015,390.64	3,346,843.00	193.9	109.5	303.4	4,014,721.48	1,872,244.99	140.0	44.3	184.3	2,414,573.97	Georgia
Idaho	1,297.3	2,232,519.81	1,356,810.82	155.3	11.3	166.6	824,004.42	465,027.87	64.7	7.3	72.0	1,460,117.22	Idaho
Illinois	2,183.4	21,248,092.12	9,595,697.70	590.4	57.3	647.7	4,391,959.60	2,023,452.74	133.9	2.2	136.1	5,268,851.49	Illinois
Indiana	1,579.0	3,838,237.47	1,429,853.80	83.6		83.6	4,664,043.40	2,059,512.65	141.1		141.1	3,228,024.04	Indiana
Iowa	3,225.6	105,290.11	1,892.77		4.1	4.1	7,713,655.15	3,333,554.28	157.9	89.4	247.3	24,088.04	Iowa
Kansas	2,991.7	6,146,363.84	2,951,872.20	367.4	53.8	421.2	1,409,202.77	671,342.92	115.8	16.3	132.1	2,744,811.20	Kansas
Kentucky	1,565.4	4,750,196.33	2,116,694.66	165.9	71.4	237.3	1,245,189.90	572,305.31	62.2	22.0	84.2	1,302,992.39	Kentucky
Louisiana	1,429.2	4,484,662.35	2,216,546.33	191.3	13.8	205.1	4,314,025.10	1,933,180.17	87.6	10.0	97.6	413,902.19	Louisiana
Maine	591.3	2,000,256.80	654,021.27	43.5		43.5	1,572,664.78	620,895.13	25.6		25.6	1,568,538.42	Maine
Maryland	706.5	125,448.40	36,825.00		1.5	1.5	734,444.38	329,911.42	19.7	2.4	22.1	711,369.97	Maryland
Massachusetts	710.7	8,439,645.87	2,123,067.27	73.2		73.2	73,542.42	22,980.00	1.5		1.5	2,513,059.23	Massachusetts
Michigan	1,777.1	9,332,000.02	3,858,681.53	231.8	34.2	266.0	889,076.01	408,377.17	49.3	1.5	50.8	3,680,601.12	Michigan
Minnesota	4,313.4	2,041,829.15	753,117.07	22.3	92.9	115.2	5,151,384.65	1,987,745.64	54.7	159.3	214.0	1,040,956.03	Minnesota
Mississippi	1,805.6	1,571,632.45	781,989.35	39.1	42.2	81.3	1,285,450.34	636,393.64	43.6	23.1	66.7	4,599,175.39	Mississippi
Missouri	2,639.2	6,790,285.18	2,499,675.93	131.5	37.5	169.0	2,570,650.93	1,147,299.89	86.8	26.0	112.8	2,299,870.20	Missouri
Montana	1,885.6	7,880,704.85	4,441,886.54	621.4	40.9	662.3	3,476,591.22	1,957,561.95	232.8	50.4	283.2	3,019,201.27	Montana
Nebraska	3,874.4	4,691,609.65	2,250,879.50	254.9	65.8	320.7	1,631,092.60	703,606.94	40.8	77.6	118.4	3,553,569.91	Nebraska
Nevada	1,277.4	1,005,734.41	871,720.23	52.4	63.4	115.8	546,593.67	240,300.21	10.2	49.0	59.2	1,685,542.05	Nevada
New Hampshire	392.1	609,439.04	229,098.40	9.7		9.7						566,223.93	New Hampshire
New Jersey	554.9	3,677,523.26	1,119,784.41	32.4		32.4	1,585,049.24	634,539.13	24.2		24.2	1,563,079.54	New Jersey
New Mexico	2,023.6	4,291,546.06	2,880,595.50	180.7	25.5	206.2	107,277.63	67,700.35	.3		.3	1,938,697.16	New Mexico
New York	2,674.8	16,432,610.33	3,189,755.00	215.7		215.7	19,863,526.90	7,989,742.50	344.1		344.1	5,238,397.91	New York
North Carolina	1,893.6	4,425,205.29	2,074,275.97	139.5	33.5	173.0	1,529,668.50	757,717.43	84.8	10.2	95.0	3,320,316.82	North Carolina
North Dakota	4,593.0	1,695,242.85	847,437.09	224.8	128.2	353.0	1,651,754.51	824,576.28	236.3	168.3	404.6	2,335,456.81	North Dakota
Ohio	2,541.7	11,604,392.49	3,583,280.18	162.5	12.0	174.5	2,963,355.50	900,389.68	35.4	17.1	52.5	3,929,614.49	Ohio
Oklahoma	1,989.1	4,433,224.42	2,081,041.74	145.3	64.1	209.4	2,762,246.55	1,519,724.66	180.9	16.5	197.4	1,291,583.00	Oklahoma
Oregon	1,264.5	6,410,149.02	3,647,017.27	200.3	78.7	279.0	1,014,348.85	452,465.61	56.7	11.9	68.6	1,091,985.95	Oregon
Pennsylvania	2,658.1	7,304,923.48	2,600,345.48	47.0		47.0	404,741.83	69,187.89	2.9		2.9	5,157,112.91	Pennsylvania
Rhode Island	209.5	1,720,027.14	664,901.84	26.4		26.4	181,782.06	90,891.03	3.7		3.7	546,776.15	Rhode Island
South Carolina	1,819.9	7,027,073.48	3,008,001.03	100.7	178.2	278.9	1,335,214.88	665,373.98	.1	57.1	57.2	102,336.61	South Carolina
South Dakota	3,773.4	3,242,704.64	1,791,413.91	299.0	75.4	374.4	870,191.12	478,604.96	118.3	51.3	169.6	2,056,320.20	South Dakota
Tennessee	1,448.6	2,230,944.97	1,114,232.84	104.6		104.6	1,994,956.00	990,473.68	78.4		78.4	2,480,085.80	Tennessee
Texas	7,036.7	12,746,853.18	5,456,814.53	634.1	107.9	742.0	4,876,976.25	2,308,820.33	130.0	191.6	321.6	7,392,332.91	Texas
Utah	985.8	1,410,125.09	1,027,795.86	94.6	58.6	153.2	815,124.10	278,686.70	49.5	40.5	90.0	1,336,177.19	Utah
Vermont	303.6	259,217.03	111,090.83	3.1		3.1	861,308.36	340,907.17	22.6		22.6	235,909.27	Vermont
Virginia	1,628.5	4,590,875.76	2,221,631.43	182.5	16.4	198.9	884,463.18	328,587.89	28.5	14.1	42.6	1,559,972.14	Virginia
Washington	1,012.2	3,229,842.46	1,484,350.00	76.9	36.3	113.2	702,010.86	305,385.24	21.1		21.1	2,121,925.32	Washington
West Virginia	765.5	4,294,672.68	1,632,086.09	99.1	12.2	111.3	1,467,856.03	500,207.34	31.4	.3	31.7	586,634.56	West Virginia
Wisconsin	2,490.4	3,496,677.92	1,492,374.55	81.8	13.0	94.8	382,045.63	186,121.15	24.2		24.2	2,420,775.29	Wisconsin
Wyoming	1,729.6	2,963,986.87	1,937,053.56	188.8	125.2	314.0	454,805.19	269,465.64	10.0	70.9	80.9	1,034,513.72	Wyoming
Hawaii	41.4	1,081,873.35	473,002.56	31.5		31.5	462,952.21	126,119.93	7.6		7.6	1,711,971.90	Hawaii
TOTALS	89,642.5	237,094,945.27	103,330,294.21	7,489.4	1,961.8	9,451.2	106,531,389.04	46,100,795.31	3,249.5	1,399.0	4,648.5	108,360,973.58	TOTALS

[1]The term stage construction refers to additional work done on projects previously improved with Federal aid. In general, such additional work consists of the construction of a surface of higher type than was provided in the initial improvement.

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