PUBLIC ROADS
A JOURNAL OF HIGHWAY RESEARCH
UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS

VOL. 18, NO. 4 ▽ JUNE 1937

A SECTION OF U S 1 IN MD.

For sale by the Superintendent of Documents, Washington, D. C.

See page 2 of cover for prices

PUBLIC ROADS ▸ ▸ ▸ *A Journal of Highway Research*

Issued by the

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

Volume 18, No. 4 June 1937

The reports of research published in this magazine are necessarily qualified by the conditions of the tests from which the data are obtained Whenever it is deemed possible to do so, generalizations are drawn from the results of the tests; and, unless this is done, the conclusions formulated must be considered as specifically pertinent only to described conditions.

In This Issue

THE BUREAU OF PUBLIC ROADS - - - - Willard Building, Washington, D. C.

REGIONAL HEADQUARTERS - - - - - Federal Building, Civic Center, San Francisco, Calif.

▼

DISTRICT OFFICES

DISTRICT No. 1. Oregon, Washington, and Montana.
Post Office Building, Portland, Oreg.

DISTRICT No. 2. California, Arizona, and Nevada.
Federal Building, Civic Center, San Francisco, Calif.

DISTRICT No. 3. Colorado, New Mexico, and Wyoming.
254 New Custom House, Denver, Colo.

DISTRICT No. 4. Minnesota, North Dakota, South Dakota, and Wisconsin.
907 Post Office Building, St. Paul, Minn.

DISTRICT No. 5. Iowa, Kansas, Missouri, and Nebraska.
Masonic Temple Building, Nineteenth and Douglas St., Omaha, Nebr.

DISTRICT No. 6. Arkansas, Louisiana, Oklahoma, and Texas.
Room 502, United States Courthouse, Fort Worth, Tex.

DISTRICT No. 7. Illinois, Indiana, Kentucky, and Michigan.
South Chicago Post Office Building, Chicago, Ill.

DISTRICT No. 8. Alabama, Georgia, Florida, Mississippi, and Tennessee.
Post Office Building, Montgomery, Ala.

DISTRICT No. 9. Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont.
505 Post Office Building, Albany, N. Y.

DISTRICT No. 10. Delaware, Maryland, Ohio, Pennsylvania, and District of Columbia.
Willard Building, Washington, D. C.

DISTRICT No. 11. Alaska.
Room 419, Federal and Territorial Building, Juneau, Alaska.

DISTRICT No. 12. Idaho and Utah.
Federal Building, Ogden, Utah.

DISTRICT No. 14. North Carolina, South Carolina, Virginia, and West Virginia.
Montgomery Building, Spartanburg, S. C.

Because of the necessarily limited edition of this publication it is impossible to distribute it free to any person or institution other than State and county officials actually engaged in planning or constructing public highways, instructors in highway engineering, and periodicals upon an exchange basis. At the present time additions to the free mailing list can be made only as vacancies occur. Those desiring to obtain PUBLIC ROADS can do so by sending $1 per year (foreign subscription $1.50), or 10 cents per single copy, to the Superintendent of Documents, United States Government Printing Office, Washington, D. C.

CERTIFICATE: By direction of the Secretary of Agriculture, the matter contained herein is published as administrative information and is required for the proper transaction of the public business

THE VALUE OF PETROGRAPHY IN DETERMINING THE QUALITY OF ROCK

Reported by D. G. RUNNER, Assistant Materials Engineer, Bureau of Public Roads

ALL rocks are constantly being subjected to forces, both chemical and physical, that tend to destroy them. In contrast to these destructive forces, most rocks have many qualities that give them the capacity to withstand this destruction. The capacity of a rock to endure the many destructive agencies is commonly known as durability. At the present time vast quantities of rock are being used daily in the construction of roads and structures, and it is the duty of the engineer to know something of the durability, or "life expectancy" of this material. The science of petrography is of great value in determining the strength and durability of rocks.

Quite often a sample of rock will appear perfectly sound and durable to the eye, while in reality it may contain harmful minerals that are known to be nondurable under freezing and thawing, temperature change, or the decomposing action of other natural weathering agencies. In certain parts of the United States sections of highways, portions of retaining walls, bridge piers, and other types of structures show the effects of the use of nondurable materials (fig. 1). If a petrographic examination of the rocks had been made prior to their use, the inferior materials could have been detected and rejected as unfit for use.

The earliest rocks were solidified from molten magma emanating from the interior of the earth. Upon exposure to weathering and erosion, these igneous rocks in turn have produced sedimentary rocks. Continued burial of igneous and sedimentary rocks, heat, and pressure have altered their composition into the metamorphic type of rock. Elevation of new beds of these rock, together with weathering and erosion, produce new sedimentary rocks, thus these new rocks contain fragments of the original igneous strata. Consequently there exists today a great variety of rocks differing widely in texture, mineralogical character, alteration products, etc. These various types of rock are shown in table 1.

TABLE 1.—*General classification of rocks* [1]

Class	Type	Family
Igneous	Intrusive (plutonic)	Granite. Syenite. Diorite. Gabbro. Peridotite.
	Extrusive (volcanic)	Rhyolite. Trachyte. Andesite. Basalt. Diabase.
Sedimentary	Calcareous	Limestone. Dolomite.
	Siliceous	Shale. Sandstone. Chert (flint).
Metamorphic	Foliated	Gneiss. Schist. Amphibolite.
	Nonfoliated	Slate. Quartzite. Eclogite. Marble.

[1] From U. S. Department of Agriculture Bulletin 348, by E. C. E. Lord, 1916.

FIGURE 1.—THE LEFT HALF OF THIS CONCRETE RETAINING WALL CONTAINS SATISFACTORY AGGREGATE; THE RIGHT HALF CONTAINS UNSOUND LIMESTONE.

(Photograph by H. S. Mattimore, Pennsylvania Department of Highways)

THIN SECTIONS OF ROCK EXAMINED UNDER THE MICROSCOPE

Petrography may be defined as the descriptive and systematic classification of rocks. This is accomplished with the aid of the petrographic microscope (fig. 2). At this time it might be well to describe briefly how the rocks are prepared for study by this type of microscope. A cursory examination of coarse-grained rocks, such as the granites, enables one to obtain a comprehensive idea of the constituent minerals. However, the minerals contained in fine-grained rocks, such as the basalts, are more difficult to identify. A study of the innermost sections of rock often reveals textural and mineralogical conditions that are interesting and of considerable practical importance.

The first step in making a microscopic examination of a rock is to prepare a small piece so thin that it is transparent to the naked eye. The sample is prepared by first breaking a small chip from the hand sample. This fragment is ground smooth on one side on a revolving lap using an abrasive powder such as emery. (See fig. 3.) The smooth side is cemented to a small glass slide with Canadian balsam and the opposite side is ground smooth. This grinding is continued until the rock slice is about 0.03 millimeter thick, and a thin protective cover glass is then cemented over it. When a specimen is prepared in this manner and examined in the microscope, an accurate idea of the texture and mineral content of the rock can be obtained.

Figure 4 shows a sample data sheet upon which petrographic descriptions of rock specimens are recorded.

All rocks are subjected to weathering by natural agencies, and some materials are more susceptible to this weathering than are others. Each mineral of which a rock is composed has a different rate of decomposition under exposure.

145535°—37

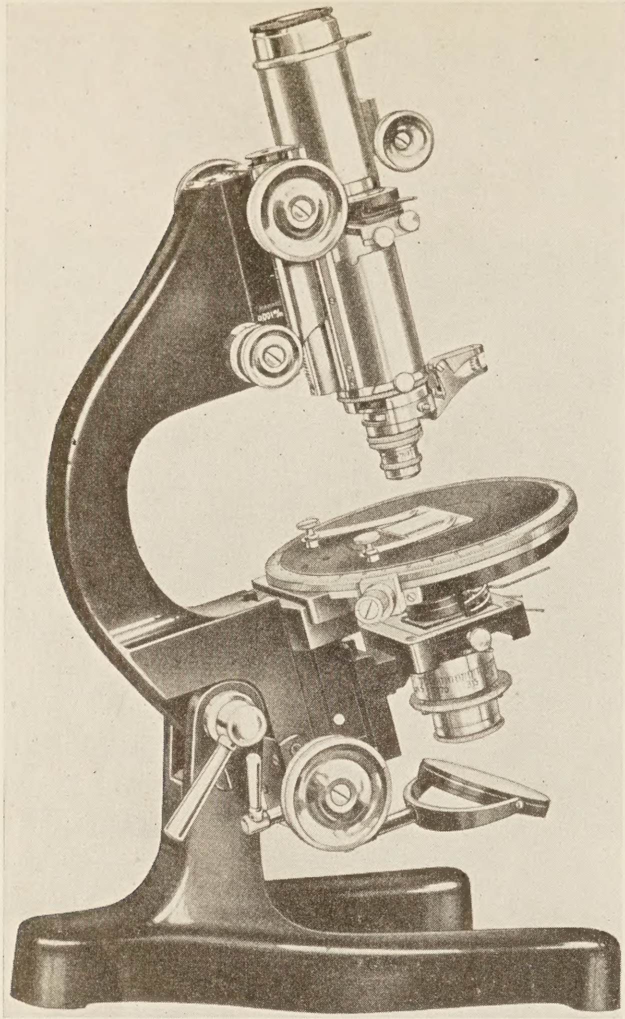

Figure 2.—Microscope Used in Petrographic Work.

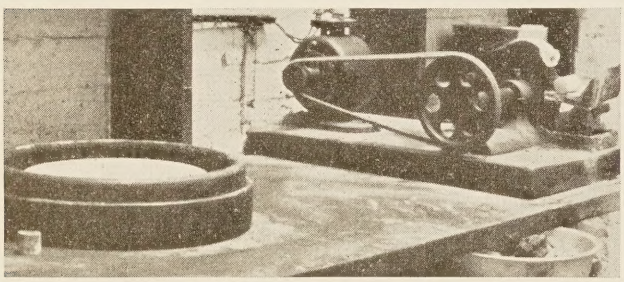

Figure 3.—Saw and Grinding Lap Used in Preparing Thin Sections of Rock.

Igneous rocks are composed of several different minerals, while sedimentary rocks consist essentially of one mineral. The minerals of the former are usually interlocking, while those of the latter are united by thin coats of cementing material. Because of inequalities in the rate of expansion of the different particles, stresses are set up in igneous rocks which tend to disrupt the rock. Sedimentary rocks, containing nearly equal-size grains of one mineral, are quite often less injured by temperature changes than are igneous rocks. Other actions that hasten rock decay are: The solvent action of water, carbon dioxide, sulphurous acids, and organic acids; the wedging action of rocks; mechanical abrasion; etc.

Rock strata that have weathered unevenly are illustrated in figure 5. Table 2 gives the alteration products of some common minerals.

Table 2.—*Alteration products of some common minerals*

Mineral	Formula	Alteration product
Pyrite	FeS_2	Oxide of iron.
Magnetite	Fe_3O_4	Hematite, limonite.
Ilmenite	$FeTiO_3$	Leucoxene.
Quartz	SiO_2	None.
Enstatite	$MgSiO_3$	Serpentine.
Chrysolite	$(MgFe)_2SiO_4$	Do.
Augite	$RSiO_3$	Chlorite, serpentine.
Hornblende	$RSiO_3$	Chlorite, talc, serpentine.
Biotite (mica)	$(HK)_2(MgFe)_2Al_2(SiO_2)_3$	Chlorite.
Muscovite (mica)	$H_2KAl_3(SiO_4)_3$	None.
Orthoclase (feldspar)	$KAlSi_3O_8$	Kaolin, muscovite.
Plagioclase (feldspar)	$NaAlSi_3O_8$	Kaolin, zeolite.
Sodalite	$3NaAlSiO_4NaCl$	Sericite.
Tremolite		Talc.
Zircon	ZrO_2SiO_2	None.

PYRITE AND FELDSPARS MOST DETRIMENTAL MINERALS FOUND IN GRANITES

Regarding the granites, Washington has stated [1] that:

* * * almost any light-colored, more or less coarse-grained, nonfoliated, igneous rock is called granite by quarrymen, irrespective of its composition, whereas to the petrographer granite denotes a definite species of coarse-grained igneous rock, composed of quartz, alkali (mostly potash), feldspar, and white or black mica or both, in some cases other dark minerals taking the place of the mica. The mineral that is most hurtful to the quality and lasting power of granite is the sulphide of iron, pyrite. On exposure to the action of air and rain this oxidizes, the sulphur forming sulphuric acid, which decomposes the feldspar of the rock and thus disintegrates it, while the iron oxide forms a brown stain. If pyrite is present in granite it is almost always in such small amount and in such small grains that in spite of its usual bright brassy luster, it is seldom visible to the naked eye or by using a hand lens, but its presence is clearly shown under the microscope in the thin section.

Biotite, or black mica, is another mineral common to granites. This mineral alters readily but its effect upon the durability of granite is not so marked as the effect of pyrite and feldspars. Biotite alters in several ways. It may change in color from brown to green while still retaining its micaceous character, the optical constants changing with the chemical change. The most common alteration product is chlorite, but the peculiar cleavage of biotite is retained. Quite often the alteration is accomplished by the deposition of lenticular accumulations of carbonates between the laminae of the mica.

Orthoclase feldspar is another easily altered mineral found in granite. This mineral is composed essentially of potassium-alumina-silicate, with some replacement by sodium. The process of alteration is not likely to be the same in all instances but usually commences along cleavage cracks, and when it has progressed very far the whole mass appears cloudy when viewed through the microscope. The common alteration products are muscovite (sericite), or kaolin, and quartz. Hence the microscopic examination shows at once, by the absence or presence of clouded feldspar, whether the rock is fresh or has begun to weather.

Nephelite, a mineral somewhat akin to the feldspar family and sometimes found in the so-called "granites" quarried for building stone, weathers much more readily than the feldspars and it consequently lessens the durability of the rock. Pyroxene and amphibole

[1] How Petrography Can Aid the Stone Producers, by H. S. Washington, The Explosives Engineer, October 1925.

PETROGRAPHIC DESCRIPTION

I. FIELD NOTES

ORIGINAL NO. 11A LOCALITY Westerly, Rhode Island

OCCURRENCE:

II. HAND SPECIMEN DESCRIPTION

GENERAL APPEARANCE: Fine grained pink rock consisting of feldspar, quartz, and biotite

III. MICROSCOPIC STUDY FOR CLASSIFICATION

TEXTURE: Hypidiomorphic SIZE OF GRAINS:

ORIGINAL STRUCTURE: Cooled from magma

PRIMARY PROCESS REPRESENTED:

SECONDARY STRUCTURE:

SECONDARY PROCESS REPRESENTED:

MINERALOGY (MINERALS ARE GROUPED FOR INTERPRETATION PURPOSES AND ARE ARRANGED IN EACH GROUP IN APPROXIMATE ORDER OF ABUNDANCE)
(IN SOME CASES APPROXIMATE PERCENTAGES ARE GIVEN)

PRIMARY (X) ESSENTIAL MINERALS	%	(Z) SECONDARY ALTERATION PRODUCTS	%	(M) METAMORPHIC RECRYSTALLIZATION MINERALS	%	(T) TERTIARY CHANGES AND ENRICHMENT EFFECTS
Quartz	45	Chlorite				
Plagioclase	10	Sericite				
Orthoclase	15					
Biotite	15					
Muscovite	4					
Microcline	10					
(Y) ACCESSORY MINERALS				(O) INTRODUCED SUBSTANCES OR MINERALIZATION		
Magnetite	1					

SPECIAL FEATURES:

Some of the biotite mica has been bleached into chlorite.

Microcline shows lattice twinning.

ORIGIN OF THE ROCK: Plutonic

CLASSIFICATION: Biotite granite

FIGURE 4.—SAMPLE DATA SHEET UPON WHICH PETROGRAPHIC DESCRIPTIONS OF ROCK SPECIMENS ARE RECORDED.

are more durable constituents than the black micas, although when long exposed they decompose and disintegrate slowly. Those varieties of granite rich in iron weather most readily, and because of large percentages of iron oxide resulting from the decomposition are classed as undesirable.

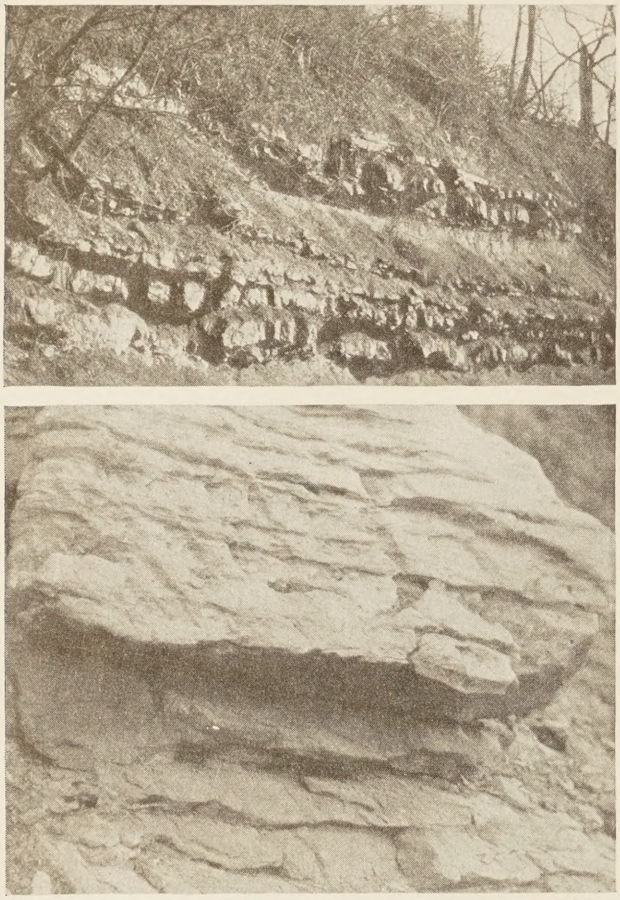

Figure 5.—Rock Strata That Have Weathered Unevenly Because of Variations in Resistance to Weathering. (upper), The Projecting Seams Contain the More Durable Rock; (lower), Differential Weathering of Limestone.

Table 3 shows the effect of weathering upon some of the minerals commonly found in granite, and table 4 gives the chemical analyses of three rocks before and after weathering.

CLAY MOST HARMFUL IMPURITY FOUND IN LIMESTONES

Limestones and marbles are examples of rock that to the eye appear to be pure and unadulterated. However, upon examination by the petrographic microscope, they are quite often found to contain minute particles of pyrite or marcasite. Here again the sulphuric acid produced by the oxidation of pyrite (iron disulphide) reacts with the calcium carbonate to cause decomposition of the rock. Marcasite, another iron disulphide, is even more harmful than pyrite because of the rapidity with which it oxidizes and decomposes. The clay contained in some limestones is not visible to the eye but is readily discernible with the microscope. The clay contained by some limestones has often been the cause of unsoundness when used in concrete.

Table 3.—*The effect of weathering upon the minerals commonly found in granite*

Mineral	Chemical composition	Changes	Ultimate product
Quartz	SiO_2	Remains undecomposed	Sand grains.
Orthoclase (feldspar).	K_2O	Goes into solution as carbonate, chloride, etc.	Soluble material.
	Al_2O_3, $6SiO_2$	Hydrated and combined to form hydrous aluminum silicate, with liberation of soluble silica.	Clay, soluble material.
Oligoclase (feldspar).	$3Na_2$	Goes into solution as carbonate, chloride, etc.	Soluble material.
	CaO	Forms carbonate ,which is soluble in water containing carbon dioxide.	Do.
	$4Al_2O_3$, $20SiO_2$	Decomposes	Clay.
Muscovite (mica).	$2H_2O$, K_2O, $3Al_2O_3$, $6SiO_2$	Remains undecomposed	Mica flakes.
	H_2O		Water.
	K_2O	Goes into solution as carbonate or chloride.	Soluble material.
Biotite (mica)	2(Mg, Fe) O	Goes into solution as carbonate or chloride; iron carbonate oxidizes to hematite or limonite.	Do.
	Al_2O_3, $3SiO_2$	Forms hydrous aluminum silicate and soluble silica.	Clay, soluble material.
Zircon	ZrO_2, SiO_2	Remains unaltered	Zircon grains.
Apatite	$Ca_3(PO_4)_2$, (F, Cl).	Is soluble	Soluble material.

Table 4.—*Chemical analyses of rocks before and after alteration by weathering*

Chemical	Micaceous granite		Diabase		Diorite	
	Unweathered	Weathered	Unweathered	Weathered	Unweathered	Weathered
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
SiO_2	69.3	66.8	47.3	44.4	46.8	42.4
Al_2O_3	14.3	15.6	20.2	23.2	17.6	25.5
Fe_2O_3	----------	1.9	3.7	12.7 (with FeO)	16.8 (with FeO)	19.2 (with FeO)
FeO	3.6	1.7	8.9			
MgO	2.4	2.8	3.2	2.8	5.1	.2
CaO	3.2	3.1	7.1	6.0	9.5	.4
Na_2O	2.7	2.6	3.9	3.9	2.6	.6
All others	4.5	5.5	5.7	7.0	1.6	11.7
Total	100.0	100.0	100.0	100.0	100.0	100.0
Loss on ignition	1.2	3.3	2.7	3.7	.9	11.0

Chert is another material that is used quite extensively in certain parts of the United States. It is often found in limestone and dolomite deposits, and is found in many deposits of gravel. Its durability when used in concrete has been questioned by some authorities. Chert is composed essentially of opaline silica together with some impurities such as calcite, pyrite, and organic matter. To the eye, chert appears to contain nothing but silica. However, examination with the microscope sometimes reveals the presence of disseminated pyrite and minute fractures, that may be partly responsible for the reported failures of chert in service.

Kriege has stated: [2]

> * * * one of the most common minerals associated with cherts is pyrite. This has been seen in every chert sample examined by the author. In most cases it is microscopically visible, some samples having been found in which the pyrite crystals are several millimeters in length. A very finely divided pyritic mass is sometimes seen coating a chert piece and giving it a brassy green color. More often these sulfide minerals are, as microscopic units, distributed as a specular deposit throughout the mass or in seams and planes. These pyritic bodies soon become oxidized on exposure of the chert and grow into dark iron oxide spots and in time stain the chert mass yellow or brown.

Argillaceous limestones, or those containing fairly large percentages of clay, have been known to cause

[2] The Stability of Chert, by H. F. Kriege, Rock Products, vol. 32, no. 9, Apr 27, 1929.

disintegration when used in concrete. Miller[3] has stated that:

> * * * a concrete road and a retaining wall where the stone had been used went to pieces after a few years and the cause was traced to the disintegrating effect of the limestone aggregate. Careful microscopic work showed the presence of considerable argillaceous matter, especially the mineral beidellite, which has adsorptive and absorptive properties. The rock fragments in the concrete road were wet after each rain and with the clay absorbing an undue amount of moisture the rocks were shattered after a limited number of freezings.

Lang[4] has stated that:

> * * * use of argillaceous limestones as coarse aggregate in concrete subjected to exposure has probably resulted in more concrete failures than could be attributed to the use of any other unsound type of aggregate.

KIND OF CEMENTING MATERIAL GREATLY AFFECTS DURABILITY OF SANDSTONE

The mineral content has less effect on the quality of sandstones than do the shape of grains and the kind of cementing materials that bind the grains together. Quartz, in more or less rounded grains, is by far the most abundant constituent of sandstones. This is because the chemical processes of weathering do not destroy quartz, except with extreme slowness. Other constituents of sandstones include feldspar, mica, and such accessory minerals as zircon, magnetite, and hematite. Sandstones containing more than about 5 percent of feldspar are usually called "feldspathic sandstone."

The kind of cementing material between the grains of sand greatly affects the durability of the rock. A cementing medium of silica produces a hard rock, while calcium carbonate cement produces one less durable. Argillaceous and ferruginous materials and gypsum may also act as cements. The argillaceous cement does not form a strong bond, and when it is abundant the sandstone tends to break down into sand.

Many sandstones contain layers in which flakes of white mica are abundant. This mica may be mixed with clay material, and may weaken the rock so that it can be easily split into thin slabs. The value of the cementing medium depends chiefly upon its adhesive and cohesive powers. It may be observed that sandstones with silica cement, or limestones with little or no quartz, are relatively strong and durable. Apparently the reason is that the force binding like materials is stronger than that uniting unlike materials.

By means of the microscope the cementing medium can be readily detected and, with the character and shape of the individual constituents determined, the probable durability of the rock can be stated. In discussing the durability of aggregates, Walker[5] has stated that:

> Certain shales, soft, loosely bound sandstones, argillaceous sandstones and limestones, ochers, etc., are typcial of unsound aggregate particles causing pits. Their effect on the durability of a concrete structure is approximately in proportion to the amount of pitting which occurs. For ordinary quantities of unsound particles of this nature, the surface pits are usually the only obvious effect. Large proportions of such unsound particles, however, may lead it to progressive disintegration, particularly in the wear surfaces of concrete road slabs.

[3] Limestones of Pennsylvania, by B. L. Miller, Bulletin M20, Pennsylvania Topographic and Geologic Survey, 1934.

[4] Report on Significance of Tests of Concrete and Concrete Aggregates, Proceedings, American Society for Testing Materials, 1935, p. 98.

[5] Report on Significance of Tests of Concrete and Concrete Aggregates, Proceedings, American Society for Testing Materials, 1935, p. 75.

FOLIATED VARIETIES OF METAMORPHIC ROCK APT TO BE UNSATISFACTORY

Marble (crystalline limestone) is usually considered to be the metamorphic equivalent of limestone, chalk, etc. It is quite definitely distinguished from limestone by the crystalline and coarse-grained structure. However, we have dolomitic marbles as well as the calcitic (or limestone) marble, but the distinction is not apparent to the eye, and a chemical or petrographical analysis is usually necessary to bring out the real difference between the two marbles. The probable durability of calcitic and dolomitic marbles may be indicated by knowledge of the accessory minerals present in the original limestone or dolomite. The chief varieties of limestone, based on mineral composition, are named from the accessory minerals listed below:

ACCESSORY MINERAL	VARIETY
Aluminum silicate.	Argillaceous limestone.
Siderite.	Ferruginous limestone.
Detrital quartz.	Arenaceous limestone.
Chalcedony.	Cherty limestone.
Glauconite.	Glauconitic limestone.

A relatively pure limestone, when metamorphosed, may develop into a compact marble, but the impurities shown in the above tabulation produce a broad range of end products. For example, if quartz is the only major impurity, it may react with calcium carbonate to form wollastonite.

Dolomite is essentially a double carbonate of calcium and magnesium. However, this combination is never quite attained to perfection in nature, as there are usually some impurities in the rock. For example, the effect caused by metamorphism on the siliceous or argillaceous impurities may be illustrated by the following equations:

$$\text{Dolomite} + \text{silica} = \text{calcite} + \text{forsterite} + \text{carbon dioxide.}$$

With an increase in the quantity of silica, the following reaction takes place:

$$\text{Dolomite} + \text{silica} = \text{diopside} + \text{carbon dioxide.}$$

With alumina as an impurity the reaction is as follows:

$$\text{Dolomite} + \text{alumina} = \text{spinel} + \text{calcite} + \text{carbon dioxide.}$$

Common usage of the term marble leads one to believe that there is no difference between marbles; however, petrographically there is a decided difference between the two types of marbles as shown by the impurities in the original limestone or dolomite.

Of the metamorphic rocks, the foliated varieties such as gneiss and schist are most liable to be unsatisfactory. Loughlin has stated[6] that:

> * * * the outstanding feature from the standpoint of weathering is the foliated structure. The more finely foliated a rock is, the greater is its tendency to crush into small scaly fragments undesirable for concrete aggregate. Concentration of the micaceous minerals along foliation planes furthermore tends to promote disintegration. The comparatively small amount of mica in gneisses and some schists renders them less subject to disintegration than the highly micaceous schists. Unusually fine-grained schists that appear to consist entirely of mica may exfoliate appreciably after a few months of exposure in humid regions. The beginnings of weathering may extend a considerable distance below the surface of outcrops, and rock that looks satisfactory when newly quarried may soon begin to disintegrate.

[6] Qualifications of Different Kinds of Natural Stone for Concrete Aggregate, by G. F. Loughlin, Proceedings American Concrete Institute, vol. 23, 1927.

DURABILITY OF ROCK PARTLY A FUNCTION OF ITS TEXTURE

The texture of rocks depends upon the shape, size, physical condition, and manner of arrangement of their constituents. The durability of a rock is in part a function of its texture. For example, a coarse-grained sandstone consisting of well-rounded grains is not as durable as an extremely dense, fine-grained sandstone. Likewise a coarse-grained granite is less durable than a dense diabase or basalt.

The uniformity and size of the mineral particles influence the manner in which the rock weathers. For example, in a porphyritic granite the large crystals of feldspar decompose more quickly than the smaller ones, thus pitting the surface of the rock. This differential weathering is usually noted in coarse-grained rocks composed of minerals having various degrees of hardness.

Figure 6 shows photomicrographs of four rocks having different textures.

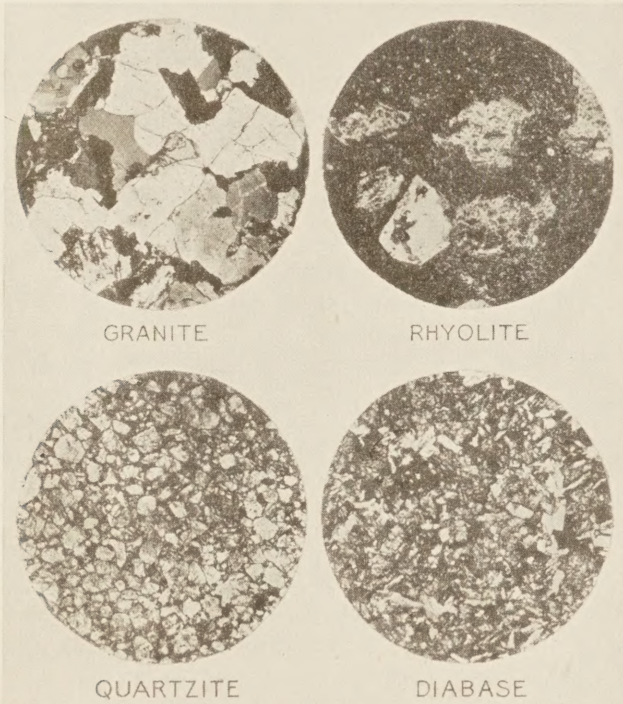

FIGURE 6.—PHOTOMICROGRAPHS OF ROCKS HAVING DIFFERENT TEXTURES.

The grains of sedimentary rocks are usually limited to one size in each particular bed, and may be fine, medium, or coarse. Thus the texture is usually of nearly uniform character, in contrast to the many-sized crystals found in igneous rocks. Because of this, the following discussion will be confined chiefly to igneous rocks.

The texture of a rock depends chiefly upon the mode of formation as shown by the size, shape, and arrangement of the grains of the minerals. The chemical composition of the magma is reflected in the texture of igneous rocks because the original composition determines the minerals that are finally formed. Magmas cooling beneath the earth crystallize slowly. In contrast, the lavas pour out on the earth's surface and cool quickly, sometimes so quickly that they form glass. Between these two extremes of slow and of rapid cooling various rates of cooling occur and cause all gradations of texture.

One common textural term is "granular." This term is applied when most of the constituent minerals are of about the same size, as is often found in the granites. Rocks more basic in composition than the granites have different textures, because of differences in crystallization and the absence of quartz.

"Porphyritic" texture is descriptive of rocks having large crystals, fragments, or flakes contained in a dense ground mass. In such rock structures the crystals have had opportunity to grow unimpeded by other mineral crystals.

"Micrographic" texture refers to the structure produced when quartz simultaneously crystallizes with another mineral, the two interpenetrating and giving a mottled appearance as exemplified by graphic granite.

"Flow" texture is common to the glassy ground mass of extrusive rocks, and has been produced by the cooling of the lava in swirling lines. There are other textural terms such as "ophitic", "cataclastic", and "poikilitic", but these are restricted more or less to special cases and will not be considered here.

SUMMARY

Whenever possible, the engineer should visit the quarry site to note and examine the degree of rock weathering. This examination is particularly advisable in an old quarry where much of the rock to be used has been exposed to the weather. Such features in the rock as laminations, schistose structure, and weathered minerals can be seen with the unaided eye. Weathered feldspar in granites is readily discernible inasmuch as it is usually soft, yellowish to white in color, and is found scattered throughout that portion of the rock directly exposed to weathering. It is not expected that an examination of the quarry will show whether a rock is durable or not, but an examination in connection with a petrographic study will give a fairly definite idea of the lasting quality of the rock.

Loughlin has stated [6] that:

> * * * general review of the weathering qualities of natural rocks used as concrete aggregates shows that most of them, if free from weathering, are satisfactory; that certain minerals, particularly the clay group and certain zeolites are very objectionable and that others including micas concentrated in fine grained flaky masses and calcite in finely disseminated grains among other minerals may promote disintegration under certain conditions; that certain textures and structures, notably fragmental texture and shaly structure in sedimentary rocks, flow structure in volcanic rocks, and highly schistose structure in metamorphic rocks, aid in the disintegration of rocks that are mainly composed of durable minerals.

Microscopic study enables an estimate to be made of the probable durability of aggregates. Component minerals can be identified and, having a knowledge of their characteristics, an approximation can be made of the rock's durability. Rock features such as segregations of clay, weathered feldspar, mica, variations in texture, kind of cementing medium, shape of particles, etc., have an important bearing upon the rock's durability.

It is realized that this paper has treated the subject matter in the briefest manner. For more detailed study of the petrographic microscope and the durability of aggregates, the appended list of references may be consulted.

[6] Qualifications of Different Kinds of Natural Stone for Concrete Aggregate, by G. F. Loughlin, Proceedings American Concrete Institute, vol. 23, 1927.

(Continued on p. 77)

VEHICLE SPEEDS ON CONNECTICUT HIGHWAYS

Abstract of report by C. J. TILDEN, Professor of Engineering Mechanics, Yale University [1]

A STUDY to determine the speeds of vehicles on Connecticut highways was made during the period from November 14, 1933, to September 26, 1934, in connection with a highway traffic survey carried on by the United States Bureau of Public Roads and the Connecticut State Highway Department.[2] Observers timed passing vehicles at 78 stations along straight or nearly straight stretches of road. The speeds recorded ranged from that of a heavy truck moving at 9 miles per hour on a wet pavement to the 80-mile-per-hour speed of passenger cars observed on two occasions. The speeds of 91,044 vehicles were measured, and the average was found to be 38.9 miles per hour.

Vehicles were timed by means of a speed detector. This consisted of an L-shaped box, open at each end and painted black on the inside, with a 5- by 7-inch mirror fixed upright across the inner angle of the L. It was mounted on a tripod and set on the roadside in such a position that one end of the box pointed straight across the road, while the other end was directed toward the observer. The mirror was then at an angle to each of these sight lines.

The observer, looking parallel to the road and into the open end of the box, could see in the mirror the reflection of any vehicle on the section of the road directly opposite the box. Each passing car caused a distinct flash or flicker that was readily seen by the observer. The instant the observer saw the flash he pressed the starting button of a stop watch graduated in tenths of a second. At the end of the measured distance (usually 176 feet) the car was reflected in the mirror of another detector, and the observer stopped the watch and recorded the time elapsed. Observations at night were made with the aid of a flashlight set up in such a position that passing cars momentarily cut off the reflection of the light beam in the mirror.

[1] The full report, Motor Vehicle Speeds on Connecticut Highways, has been published by the Committee on Transportation, Yale University. The Bureau of Public Roads does not have copies for distribution.

[2] A digest of the report on the Connecticut traffic survey was published in PUBLIC ROADS, vol. 16, no. 11, January 1936. The Bureau of Public Roads does not have copies of the full report for distribution.

The observations were made from a car parked beside the road. Thus, observers were protected from the weather, while the presence of a car alongside the road aroused less suspicion or curiosity on the part of drivers than would the sight of two men holding stop watches and making notes.

The survey was divided into three main periods: Winter, from November 14 to March 29; spring, from April 4 to June 2; and summer from June 16 to September 10. A summary of the observations made during these periods (table 1) reveals the surprising fact that the average speeds of passenger cars and busses were highest in winter and lowest in summer, despite the fact that 25 percent of the winter observations were made in bad weather. Trucks also made their lowest average speeds in summer, but ran slightly faster in spring than in winter. It seems probable that the slower speed of passenger cars in summer results from the presence of numerous pleasure drivers.

OUT-OF-STATE CARS DRIVEN FASTER THAN CONNECTICUT CARS

The effects of weather and road-surface conditions upon the speed of passenger cars at different seasons were also studied. The results are shown in table 2. The effect of weather on speed ranged from stopping altogether during bad snowstorms to driving at high speeds on clear, crisp winter mornings when the road was free from snow or ice. Practically every kind of weather was encountered during the study. The lowest average passenger-car speed recorded (28.4 miles per hour) was on a clear winter day, when the road was covered with 3 inches of hard-packed snow.

That passenger cars from outside the State are driven at markedly higher rates of speed than Connecticut cars was revealed by the study. The recorded speeds also show that the driver farthest from home drives the fastest. During the summer period, for the daylight hours, cars from Massachusetts and New York averaged, respectively, 40.3 and 41.3 miles per hour, and those from more distant States averaged 41.3 miles

TABLE 1.—*Summary of average speeds of vehicles on Connecticut highways*

Vehicle classification	Winter period (Nov. 14, 1933–Mar. 29, 1934)		Spring period (Apr. 4–June 2, 1934)		Summer period (June 16–Sept. 10, 1934)		Complete survey (Nov. 14, 1933–Sept. 10, 1934)	
	Vehicles observed	Average speed	Vehicles observed	Average speed	Vehicles observed	Average speed	Vehicles observed	Average speed
Passenger cars (daytime):	*Number*	*Miles per hour*	*Number*	*Miles per hour*	*Number*	*Miles per hour*	*Number*	*Miles per hour*
Foreign—								
New York	1, 839	45. 2	1, 259	43. 6	6, 020	41. 3	9, 118	42. 4
Massachusetts	1, 473	45. 4	813	44. 4	3, 435	40. 3	5, 721	42. 2
Other	1, 385	45. 6	873	44. 0	4, 928	41. 3	7, 186	42. 5
All foreign	4, 697	45. 4	2, 945	44. 0	14, 383	41. 1	22, 025	42. 4
Connecticut	14, 003	41. 4	6, 370	39. 9	20, 273	38. 2	40, 646	39. 6
All passenger cars (daytime)	18, 700	42. 4	9, 315	41. 2	34, 656	39. 4	62, 671	40. 6
Passenger cars (nighttime)	3, 196	37. 8	1, 821	38. 6	5, 483	35. 2	10, 500	36. 6
Total all passenger cars	21, 896	41. 8	11, 136	40. 8	40, 139	38. 8	73, 171	40. 0
All trucks	5, 498	34. 2	1, 746	34. 4	4, 723	33. 0	11, 967	33. 8
All busses	764	43. 5	305	42. 5	1, 003	39. 9	2, 072	41. 6
Total all vehicles	28, 158	40. 3	13, 187	40. 0	45, 865	38. 2	87, 210	39. 2

TABLE 2.—*Effect of weather on passenger-car speeds*

Road type	Bad weather conditions				Normal conditions		Decrease in speed	
	Date (1933–34)	Weather and road condition	Vehicles observed	Average speed	Vehicles observed	Average speed		
			Number	*Miles per hour*	*Number*	*Miles per hour*	*Miles per hour*	*Percent*
4-lane concrete	Dec. 11	Snow flurries; snow on road	915	39.2	812	43.7	4.5	10.3
2-lane concrete	Dec. 15	Sleet storm; icy road surface	212	35.4	925	46.3	10.9	23.5
Do	Dec. 27	Clear; road 30 percent snow covered. Some cars using chains	177	35.2	231	36.8	1.6	4.4
Do	Jan. 7	Steady rain	206	37.8	675	43.8	6.0	13.7
Do	Jan. 13	Snow, rain, and slush	81	38.1	103	46.4	8.3	17.9
4-lane concrete	Feb. 5	Clear; snow on road	394	38.8	812	43.7	4.9	11.2
2-lane concrete	Mar. 2	Clear; 3 inches hardpacked snow	182	28.4	298	45.4	17.0	37.5
Macadam	Mar. 8	Light snow	305	36.2	386	40.8	4.6	8.9
2-lane concrete	Mar. 28	Light rain	269	43.1	197	44.7	1.6	3.6
Macadam	June 19	Hard rain	129	34.3				
Do	June 27	Clear; fresh oil on road	147	30.7				
Do	Aug. 7	Dense fog	35	35.3	640	37.1	1.8	4.9
2-lane concrete	Aug. 16	Light rain	324	39.4	205	42.6	3.2	7.5
Macadam	Sept. 6	Dense fog	20	31.4	603	40.8	9.4	23.0

per hour as compared to 38.2 miles per hour for Connecticut cars. Cars from four midwestern States averaged 44.9 miles per hour. The conclusions drawn from these figures are that the driver of the foreign car, because he is farther from home, places a higher value on his time, and that since he is making a longer trip, his car is probably newer or in better mechanical condition, and accordingly can travel faster than the average.

A comparison was made of the daytime and nighttime speeds of passenger cars operated on different types of road surface. The results, shown in table 3, were as anticipated. Daytime speeds were higher than nighttime speeds; and speeds on concrete roads exceeded speeds on macadam roads.

TABLE 3.—*Comparison of daytime and nighttime passenger-car speeds by road type and by season of the year*

Season, and type of road	Daytime observations		Nighttime observations	
	Vehicles observed	Average speed	Vehicles observed	Average speed
	Number	*Miles per hour*	*Number*	*Miles per hour*
Winter (Nov. 14 to Mar. 29):				
2-lane concrete	9,400	42.8	1,108	37.5
4-lane concrete	7,071	42.2	1,858	37.9
Macadam	2,229	41.5	230	37.9
Total or average	18,700	42.4	3,196	37.8
Spring (Apr. 4 to June 2):				
2-lane concrete	4,403	41.6	1,228	39.9
4-lane concrete	4,912	40.8	593	35.9
Total or average	9,315	41.2	1,821	38.6
Summer (June 16 to Sept. 10):				
2-lane concrete	13,591	41.3	1,260	36.2
4-lane concrete	6,348	39.3	2,841	35.4
Macadam	14,717	37.8	1,382	33.6
Total or average	34,656	39.4	5,483	35.2
Complete survey:				
2-lane concrete	27,394	41.9	3,596	37.9
4-lane concrete	18,331	40.8	5,292	36.4
Macadam	16,946	38.2	1,612	34.2
Total or average	62,671	40.6	10,500	36.6

With respect to speed during the day, observations at certain stations from 6 a. m. to 10 p. m. showed that the average speed decreased as the day progressed. The highest speed occurred shortly after daybreak. Speeds then decreased gradually until late afternoon, rose to a minor peak between 5 and 6 p. m., and fell rather sharply after nightfall to the lowest average of the day—about 7 or 8 miles per hour less than the morning peak.

One objective of the survey was to determine the manner in which speed might be affected by traffic volume. Unfortunately, analysis of the data collected indicated that they were inadequate as a basis for any conclusions in this respect. The relationship between speed and volume of traffic, if any exists, depends upon factors such as width and type of pavement, visibility, and general weather conditions.

An answer to the much-debated question of whether women drive faster than men, or vice versa, was sought during two periods of the survey. The conclusion reached was that there is no significant difference. During the period from November 24 to January 31, the men drove 1.1 miles per hour faster than the women; but during the period from July 12 to September 6, the women drove 0.6 mile per hour faster than the men. During the first period, only 9.8 percent of the observed drivers were women; during the second period 17.1 percent of the observed drivers were women.

FAST DRIVERS FOUND TO HAVE WORST ACCIDENT RECORDS

The driving speeds of drivers with and without passengers were studied during these same two periods. It was found that during the winter drivers with passengers drove at a rate only 0.5 mile per hour slower and during the summer they drove 2 miles per hour slower than unaccompanied drivers.

The relation between speed and accidents, a widely discussed and important traffic safety problem, was studied for 6 months during the winter and spring periods. The method used was to select two groups containing nearly the same number of cars: One group included cars observed to be traveling at moderate speeds (35 to 45 miles per hour); the other group included cars whose speeds were 50 miles per hour or more. The observers recorded the license numbers as well as the speeds of these cars. A list of the license numbers was sent to the office of the Connecticut Department of Motor Vehicles, where the name of the owner of each car and his accident record since 1928 were ascertained. Because of duplications, the final figures included 981 cars observed at high speeds and 1,054 observed at moderate speeds.

Results of these observations given in table 4 show that 27.8 percent of the drivers observed traveling at high speeds had been involved in accidents, as compared with 21.3 percent of the drivers observed traveling at moderate speeds. In other words, 30 percent more of the fast drivers had been in accidents. Moreover, those fast drivers who had been involved in accidents had had more of them and accounted for 45 percent more accidents.

TABLE 4.—*Accident records of owners of cars observed traveling at high and at moderate speeds*

Speed group	Total cars	Owners with accident records	Total accidents	Owners with the following number of accidents—					
				1	2	3	4	5	6
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
High	981	273	438	168	71	15	13	5	1
Moderate	1,054	225	324	152	54	13	5	1	0
ACCIDENTS PER THOUSAND CARS									
High	1,000	278	446	171	72	15	13	5	1
Moderate	1,000	213	307	144	51	12	5	1	0

The objections can be raised that since each car was observed only once, a car in the high-speed group may have been going fast only during the interval when it was timed, and vice versa; also, that while the record of the driver was consulted, the owner may not have been the driver at the time the car was observed. The effect of any such errors, however, is to minimize the differences between the records of the two classes of drivers.

Observations were made at a dangerous curve on the Boston Post Road (U S 1) in Madison during 4 days of good weather—2 days in January and 2 in September. Observations were also made during 1 day in February when the road was covered with hard-packed snow. On the days of good weather, the average speed of all the cars observed was 30.4 miles per hour. This included one car that was recorded at 43 miles per hour. On the day when snow covered the road, the average speed was 25.8 miles per hour. For comparison, the speeds of cars were observed during the same 2 days in September on a long straight stretch of road 0.7 mile west of the curve, and were found to be 9.2 miles per hour faster than on the curve.

(Continued from p. 74)

LIST OF REFERENCES

ON THE PETROGRAPHIC MICROSCOPE

(1) HARKER, A.
1923. PETROLOGY FOR STUDENTS. Cambridge University Press, London. Ed. 6 rev. 302 pp. illus.

(2) HOLMES, A.
1921. PETROGRAPHIC METHODS AND CALCULATIONS. D. Van Nostrand Co., New York. 515 pp. illus.

(3) KEYES, MARY.
1925. MAKING THIN SECTIONS OF ROCKS. Amer. Jour. Sci. 5th Series, no. 60, vol. X, pp. 538–550.

(4) LUQUER, L. M.
1925. MINERALS IN ROCK SECTIONS. D. Van Nostrand Co., New York. Ed. 3 rev. 153 pp.

(5) ROGERS, A. F., AND KERR, P. F.
1933. THIN-SECTION MINERALOGY. McGraw-Hill Book Co., New York. 311 pp. illus.

(6) WEINSCHENK, E.
1912. PETROGRAPHIC METHODS. McGraw-Hill Book Co., New York. 396 pp. illus.

ON THE APPLICATION OF PETROGRAPHY

(7) GONNERMAN, H. F. AND WARD, G. W.
1931. DURABILITY STUDIES OF AGGREGATES AND CONCRETE. Nat. Sand and Gravel Bull. 12:13–24.

(8) LOUGHLIN, G. F.
1927. QUALIFICATIONS OF DIFFERENT KINDS OF NATURAL STONE FOR CONCRETE AGGREGATE. Proc. Amer. Concrete Inst. 23:319–51.

(9) ———
1928. USEFULNESS OF PETROLOGY IN THE SELECTION OF LIMESTONES. Rock Prod. 31:50–59.

(10) PEARSON, J. C., AND LOUGHLIN, G. F.
1923. AN INTERESTING CASE OF DANGEROUS AGGREGATE. Concrete 22:144–7.

(11) WASHINGTON, H. S.
1925. HOW PETROGRAPHY CAN AID THE STONE PRODUCERS. The Explosives Engr. 3:331–3.

GENERAL REFERENCES

(12) AMERICAN SOCIETY FOR TESTING MATERIALS. (COMMITTEE C–9 ON CONCRETE AND CONCRETE AGGREGATES.)
1935. REPORT ON SIGNIFICANCE OF TESTS OF CONCRETE AND CONCRETE AGGREGATES. Amer. Soc. Testing Materials, Philadelphia. 123 pp.

(13) LORD, E. C. E.
1916. RELATION OF MINERAL COMPOSITION AND ROCK STRUCTURE TO THE PHYSICAL PROPERTIES OF ROAD MATERIALS. U. S. Dept. of Agr. Bull.348. 26 pp.

(14) MCMILLAN, F. R., AND WARD, G. W.
1929. INFLUENCE OF COARSE AGGREGATE ON THE DURABILITY OF CONCRETE. Proceedings, Amer. Soc. Testing Materials, V. 29, pt. 2. pp. 816–23.

(15) MATTIMORE, H. S.
1937. THE DURABILITY OF CONCRETE. Civil Engineering 7:14–17.

(16) REINECKE, L.
1918. NON-BITUMINOUS ROAD MATERIALS. Economic Geology 13:557–97.

STATE MOTOR-VEHICLE REGISTRATIONS, 1936

[Compiled from reports of State authorities for calendar year, except as otherwise noted [1]]

State	Registered motor vehicles, private and commercial [2]					Other registered vehicles		Publicly owned vehicles						Dealers' registrations and plates [7]		1935 total registered motor vehicles (revised)	Year's change in motor vehicle registrations	
	Total motor vehicles	Passenger motor vehicles			Motor-trucks, tractor trucks, etc.			Federal [5]			State, county, and municipal [6]							
		Total	Automobiles (including taxicabs)	Motor-busses [3]		Trailers and semi-trailers [4]	Motor-cycles	Motor vehicles	Trailers and semi-trailers	Motor-cycles	Motor vehicles	Trailers and semi-trailers	Motor-cycles	Regular registrations	Extra sets of plates		Increase or decrease	Percentage change
Alabama	297, 292	246, 557	243, 314	3, 243	50, 735	4, 634	720	1, 881	40	7	2, 969	----	134	2, 889	----	242, 676	54, 616	[8] 22. 5
Arizona	115, 035	94, 852	94, 473	379	20, 183	3, 302	345	1, 845	51	10	1, 727	----	36	1, 813	----	103, 122	11, 913	11. 6
Arkansas	217, 227	169, 389	169, 079	310	47, 838	10, 253	417	1, 783	15	----	1, 179	15	16	468	----	207, 429	9, 798	4. 7
California	2, 327, 984	2, 060, 533	2, 060, 533	(9)	267, 451	112, 088	9, 832	5, 838	239	83	22, 812	1, 403	985	4, 560	----	2, 151, 501	176, 483	8. 2
Colorado	316, 050	284, 120	284, 120	----	31, 930	1, 491	1, 108	1, 700	12	2	(10)	(10)	(10)	3, 151	----	284, 578	31, 472	11. 1
Connecticut	398, 254	338, 196	337, 216	980	60, 058	4, 226	1, 931	869	3	----	3, 373	46	242	2, 752	7, 463	366, 827	31, 427	8. 6
Delaware	59, 629	49, 619	49, 619	(9)	10, 010	2, 227	242	369	2	3	677	9	90	694	----	56, 560	3, 069	5. 4
Florida	386, 907	323, 022	321, 467	1, 555	63, 885	13, 472	1, 000	1, 625	32	11	4, 971	----	142	2, 502	----	356, 244	30, 663	8. 6
Georgia	410, 583	337, 857	337, 391	466	72, 726	11, 903	1, 002	2, 653	92	43	(10)	(10)	(10)	2, 047	----	394, 096	16, 487	4. 2
Idaho	133, 037	107, 185	107, 060	125	25, 852	16, 141	472	1, 203	65	----	1, 233	27	8	443	----	118, 266	14, 771	12. 5
Illinois	1, 659, 750	1, 456, 652	1, 456, 652	(9)	203, 098	18, 168	5, 201	3, 445	159	19	8, 371	240	723	3, 963	----	1, 525, 817	133, 933	8. 8
Indiana	905, 088	767, 279	766, 284	995	137, 809	52, 601	3, 443	1, 598	144	5	5, 095	----	86	2, 385	----	850, 650	54, 438	6. 4
Iowa	728, 414	644, 565	644, 253	312	83, 849	[11] 58, 462	2, 074	1, 252	17	3	[12] 4, 880	[12] 215	[12] 56	1, 885	----	699, 016	29, 398	4. 2
Kansas	577, 906	490, 793	490, 793	(9)	87, 113	5, 070	718	1, 443	55	8	(10)	(10)	(10)	1, 559	1, 165	553, 106	24, 800	4. 5
Kentucky	372, 576	320, 736	320, 138	598	51, 840	(13)	866	1, 813	19	39	[12] 4, 044	----	----	826	----	346, 130	26, 446	7. 6
Louisiana	302, 420	228, 792	228, 361	431	73, 628	12, 038	776	1, 683	32	25	[12] 4, 767	[12] 277	[12] 49	348	----	268, 824	33, 596	12. 5
Maine	191, 554	150, 606	150, 454	152	40, 948	[14] 9, 124	926	890	6	8	2, 228	132	71	748	----	181, 165	10, 389	5. 7
Maryland	378, 462	324, 064	323, 115	949	54, 398	3, 224	1, 453	2, 067	156	46	(10)	(10)	(10)	8, 068	----	345, 578	32, 884	9. 5
Massachusetts	816, 711	714, 081	709, 256	4, 825	102, 630	10, 488	1, 319	2, 229	57	19	[15] 4, 559	----	----	2, 741	19, 668	785, 572	31, 139	4. 0
Michigan	1, 373, 676	1, 234, 692	1, 234, 692	(9)	138, 984	119, 771	3, 233	2, 716	46	18	(10)	(10)	(10)	5, 400	----	1, 239, 431	134, 245	10. 8
Minnesota	783, 627	669, 179	668, 915	264	114, 448	26, 567	1, 894	2, 415	45	8	4, 346	----	----	(16)	----	726, 993	56, 634	7. 8
Mississippi	205, 890	162, 531	159, 051	3, 480	43, 359	1, 294	200	1, 431	33	----	(10)	(10)	(10)	2, 174	----	186, 289	19, 601	10. 5
Missouri	809, 615	681, 644	681, 190	454	127, 971	26, 821	1, 631	2, 235	16	5	1, 423	----	8	1, 872	----	766, 369	43, 246	5. 6
Montana	167, 150	127, 839	127, 839	(9)	39, 311	1, 829	416	1, 362	7	----	[12] 1, 604	----	----	969	----	149, 712	17, 438	11. 6
Nebraska	413, 787	353, 192	352, 930	262	60, 595	26, 273	959	992	8	5	1, 984	----	----	3, 109	----	406, 178	7, 609	1. 9
Nevada	38, 509	30, 829	30, 700	129	7, 680	1, 060	115	479	20	1	585	26	8	85	453	34, 858	3, 651	10. 5
New Hampshire	122, 236	97, 361	97, 361	(9)	24, 875	3, 952	969	666	15	----	389	----	----	383	----	117, 154	5, 082	4. 3
New Jersey	943, 412	813, 472	808, 254	5, 218	129, 940	5, 645	4, 739	2, 227	77	10	8, 678	----	596	2, 599	----	888, 292	55, 120	6. 2
New Mexico	108, 729	85, 906	85, 427	479	22, 823	2, 044	288	1, 651	59	----	970	200	12	320	----	92, 457	16, 272	17. 6
New York	2, 453, 542	2, 134, 350	2, 134, 350	----	319, 192	30, 251	10, 171	5, 780	510	105	[12] 24, 458	[12] 847	[12] 987	4, 924	----	2, 330, 962	122, 580	5. 3
North Carolina	504, 517	434, 779	434, 194	585	69, 738	35, 857	1, 296	2, 247	81	1	731	----	----	7, 649	----	463, 123	41, 394	8. 9
North Dakota	167, 241	137, 591	137, 523	68	29, 650	517	251	733	3	----	560	----	----	549	----	164, 217	3, 024	1. 8
Ohio [17]	1, 777, 048	1, 604, 775	1, 604, 775	(9)	172, 273	103, 308	7, 914	2, 505	318	9	20, 027	----	----	3, 932	21, 540	1, 714, 627	62, 421	3. 6
Oklahoma	531, 914	441, 276	438, 803	2, 473	90, 638	6, 960	1, 049	2, 225	81	9	[12] 5, 508	----	----	3, 386	----	502, 101	29, 813	5. 9
Oregon	332, 729	278, 130	277, 437	693	54, 599	(9)	1, 425	2, 329	28	1	3, 947	----	----	653	918	297, 112	35, 617	12. 0
Pennsylvania	1, 918, 116	1, 641, 006	1, 635, 138	5, 868	277, 110	24, 737	12, 018	4, 254	95	23	(10)	(10)	(10)	29, 329	----	1, 745, 401	172, 715	9. 9
Rhode Island	159, 140	140, 417	139, 935	482	18, 723	372	672	456	12	----	1, 292	27	99	370	----	148, 597	10, 543	7. 1
South Carolina	278, 829	243, 662	243, 509	153	35, 167	3, 320	740	1, 258	9	4	3, 520	----	97	664	1, 438	235, 919	42, 910	[18] 18. 2
South Dakota	186, 480	158, 264	158, 192	72	28, 216	19, 349	409	1, 048	13	2	1, 021	109	9	592	----	179, 271	7, 209	4. 0
Tennessee	380, 792	329, 405	328, 955	450	51, 387	[19] 7	1, 348	1, 660	31	----	4, 671	----	----	552	----	351, 898	28, 894	8. 2
Texas	1, 478, 124	1, 192, 147	1, 191, 313	834	285, 977	41, 660	3, 544	4, 459	192	79	13, 897	1, 083	347	3, 651	----	1, 382, 104	96, 020	6. 9
Utah	116, 816	97, 419	96, 768	651	19, 397	1, 066	414	1, 573	44	11	1, 212	86	55	1, 186	----	106, 006	10, 810	10. 2
Vermont	84, 155	75, 310	75, 195	115	[20] 8, 845	1, 464	542	937	13	1	(10)	(10)	(10)	573	----	81, 513	2, 642	3. 2
Virginia	417, 463	352, 281	352, 281	----	65, 182	6, 359	1, 761	3, 288	203	63	[12] 5, 058	[12] 116	[12] 150	5, 021	----	385, 555	31, 908	8. 3
Washington	499, 760	420, 222	419, 493	729	79, 538	12, 122	1, 775	3, 283	59	40	6, 335	257	171	1, 217	2, 778	453, 660	46, 100	10. 2
West Virginia	280, 015	236, 532	235, 913	619	43, 483	2, 721	1, 144	1, 071	18	----	4, 425	147	58	11, 545	----	248, 379	31, 636	12. 7
Wisconsin	835, 178	690. 525	690, 041	484	144, 653	4, 736	2, 852	2, 345	18	6	7, 480	139	295	2, 377	----	754, 037	81, 141	10. 8
Wyoming	76, 603	61, 129	61, 129	----	15, 474	8, 542	220	941	31	9	624	30	----	313	----	69, 998	6, 605	9. 4
District of Columbia	181, 319	162, 922	161, 725	1, 197	18, 397	1, 843	707	1, 310	23	44	2, 600	118	202	3, 609	----	171, 464	9, 855	5. 7
At large	----	----	----	----	----	----	----	2, 976	29	10	----	----	----	----	----	----	----	----
Total	28, 221, 291	24, 197, 685	24, 156, 606	41, 079	4, 023, 606	869, 359	98, 541	99, 038	3, 333	795	200, 230	5, 549	5, 732	142, 845	55, 423	26, 230, 834	1, 990, 457	7. 6

[1] Registration periods ending not earlier than Nov. 30 and not later than Jan. 31 are considered as calendar-year periods. In the case of States in which the registration period is definitely removed from the calendar year registration figures were obtained for the calendar-year period. The figures for Ohio, however, represent registrations for the 9-month period ended Dec. 31, 1936.

[2] Wherever possible publicly owned vehicles and vehicles not for highway use have been eliminated from these columns.

[3] A complete segregation of motor busses from other vehicles is not available. The figures given represent common-carrier busses in most cases, although in some States contract busses and contract school busses are included. In a number of cases city busses are not included, rural and interurban carriers only being given. Where no busses are tabulated the busses are included with automobiles, except as otherwise noted.

[4] Figures for trailers and semitrailers are as reported. Apparent inconsistencies are due to the fact that some States require the registration of tourist trailers, light work trailers, and similar vehicles, whereas other States register only freight-carrying trailers and semitrailers.

[5] Preliminary figures based on incomplete data for 1936 and complete data for 1935; obtained through agency of Procurement Division, Department of the Treasury.

[6] Data on State, county, and municipal vehicles are incomplete in many cases. Some States give State-owned vehicles only; others exclude certain classes, such as fire apparatus and police vehicles, from registration.

[7] Figures include new-car, used-car, and motorcycle dealers' registrations, and in some cases wreckers' and repairers' registrations. Data on dealers' extra plates incomplete, although extra plates are apparently included with dealers' registrations in some cases.

[8] Large increase due to fact that 1935 figures represent registrations during fiscal year ended Sept. 30, 1935, whereas 1936 figures represent registrations during calendar year 1936.

[9] Included with motor trucks.

[10] Included with private and commercial registrations.

[11] Includes 53,551 light trailers registered without charge.

[12] Includes unknown number of Federal vehicles.

[13] Trailers of 1,000 pounds capacity or more prohibited on highways, although permitted in cities under city licenses. Tractor-semitrailers registered as trucks. Light trailers permitted but not registered.

[14] Includes light trailers and commercial semitrailers. Commercial full trailers included with motor trucks.

[15] Of these vehicles approximately 1,500 are included with private and commercial registrations.

[16] Not reported.

[17] For 9-month period ended Dec. 31, 1936. Data for full calendar year not available.

[18] Large increase due to fact that 1935 figures represent registrations during fiscal year ended Oct. 31, 1935, whereas 1936 figures represent registrations during calendar year 1936.

[19] Trailers for passenger vehicles only. Freight trailers registered with trucks.

[20] Light delivery trucks included with passenger cars.

STATE MOTOR-VEHICLE RECEIPTS, 1936

[Compiled from reports of State authorities for calendar year, except as otherwise noted [1]]

State	Total receipts, registration and other fees	Motor-vehicle registration fees					Registration fees, other vehicles		Total registration fees, all vehicles	Miscellaneous receipts							
		Total [2]	Passenger motor vehicles			Motor trucks, tractor trucks, etc.	Trailers and semi-trailers	Motorcycles		Total	Dealers' licenses and plates	Operators' and chauffeurs' permits	Certificates of title	Fines and penalties	Transfer or re-registration fees	Miscellaneous receipts, less unclassified refunds [4]	Estimated service charges, local collectors [5]
			Total	Automobiles (including taxicabs)	Motor busses [3]												
	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars
Alabama	4,101	3,777							3,777	324	(6)	227		88		9	
Arizona	1,028	754	365	337	28	389	48	1	803	225	3	35	88	2	36	61	
Arkansas	2,829	2,361	1,287	1,232	55	1,074	262	1	2,624	205	18	123		7	8	49	
California	21,087	18,758	14,713	14,713	(7)	4,045	784	45	19,587	1,500	47	176		71	1,128	78	
Colorado	2,589	1,893	1,436	1,436		457	26	2	1,921	668	24	344	195	4	91	10	
Connecticut	5,957	3,904	2,580	2,470	110	1,324	15	6	3,925	2,032	102	1,546		195	123	66	
Delaware	1,102	804	544	544	(7)	260	25	1	830	272	6	123	38	67	16	22	
Florida	5,546	5,017	3,539	3,396	143	1,478	180	5	5,202	344	21	8	203		1	13	98
Georgia	1,302	1,230	1,013	1,013		217	35	3	1,268	34	6	11			8	9	
Idaho	2,175	2,066	1,478	1,454	24	588	29	2	2,097	78	26	41				11	
Illinois	19,410	17,612	12,339	12,339	(7)	5,273	143	14	17,769	1,641	87	314	501		639	100	
Indiana	9,044	7,133	5,330	5,243	87	1,803	290	6	7,429	1,615	46	566	352		484	−35	202
Iowa	10,793	10,297	7,713	7,713		2,584	74	7	10,378	415	47	78		1	203	86	
Kansas	3,815	3,584	2,769	2,769	(7)	815	66	4	3,654	161	22	40			73	26	
Kentucky	4,591	3,262	2,146	2,102	44	1,116	(8)	2	3,264	1,327	24	391		1	107	482	322
Louisiana	4,112	3,605	2,531	2,480	51	1,074	418	3	4,026	86	13	77		9		−13	
Maine	3,582	2,703	1,949	1,935	14	754	[9] 54	5	2,762	820	58	523		21	156	62	
Maryland	4,744	3,141	2,566	2,413	153	575	93	7	3,241	1,503	42	303	716	275	127	40	
Massachusetts	6,795	4,188	2,699	2,578	121	1,489	19	2	4,209	2,586	67	2,442		11		66	
Michigan	19,737	16,768	11,697	11,697	(7)	5,071	854	12	17,634	2,103	71	673	854		369	136	
Minnesota	8,189	7,691	5,861	5,740	121	1,830	225	6	7,922	267	47	126	1	68		25	
Mississippi	1,869	1,830							1,830	39	2			33		4	
Missouri	8,988	7,832	6,560	6,560	(7)	1,272	110	9	7,951	1,037	77	206	437	2	293	22	
Montana [10]	1,730	1,480	1,087	1,087	(7)	393	5	1	1,486	244	19	112	34	30	43	6	
Nebraska	2,158	1,951	1,219	1,198	21	732	34	2	1,987	171	15	26			124	6	
Nevada	279	252	154	153	1	98	9	1	262	17	3		1	(*)	11	2	
New Hampshire	2,635	2,149						5	2,154	481	23	357		88		13	
New Jersey	17,850	12,641	8,817	8,522	295	3,824	209	9	12,859	4,991	65	3,582	547	146	557	94	
New Mexico	1,318	1,217	819	789	30	398	17	1	1,235	83	7			1	23	52	
New York	46,291	40,443	29,190	29,190		11,253	466	46	40,955	5,336	196	3,188		453	1,217	282	
North Carolina	7,589	7,350	4,820	4,780	40	2,530	(7)	5	7,355	234	(6)	136	163			−65	
North Dakota	1,456	1,338	1,017	1,008	9	321	3	1	1,342	114	16	41	56			1	
Ohio [11]	23,256	21,029	13,439	13,439	(7)	7,590	1,020		22,049	1,207	174	651				68	314
Oklahoma	4,743	3,700	2,404	2,341	63	1,296	130	4	3,834	909	43		295			271	300
Oregon	2,832	2,475	1,422	1,388	34	1,053	(7)	5	2,480	352	21	85	190	27		29	
Pennsylvania	35,331	25,626	17,518	16,944	574	8,108	313	29	25,968	9,363	347	5,204	1,958	471	1,179	204	
Rhode Island	2,596	2,045	1,583	1,537	46	462	2	2	2,049	547	16	397			90	44	
South Carolina	1,876	1,523	1,103	1,103		420	50	1	1,574	302	17	178		40	19	48	
South Dakota	1,540	1,464	1,264	1,262	2	200	27	(*)	1,491	49	15		25			9	
Tennessee	3,706	3,526							3,526	180	(6)			35		12	133
Texas	17,725	16,711	10,982	10,856	126	5,729	390	16	17,117	608	44	186			209	169	
Utah	976	808	484	484	(7)	324	22	1	831	145	12	17	66	5	25	20	
Vermont	2,245	1,899	1,348	1.332	16	[12] 551	8	4	1,911	334	25	268			50	−9	
Virginia	5,737	5,075	3,724	3,724		1,351	48	5	5,128	609	55	82	246		171	55	
Washington	2,980	2,403	1,405	1,341	64	998	162	6	2,571	409	12	111	141			15	130
West Virginia	5,832	4,438	3,396	3,376	20	1,042	53	6	4,497	1,335	48	196	1,001		66	24	
Wisconsin	12,213	11,588	8,552	8,373	179	3,036	317	14	11,919	294	28	35			219	12	
Wyoming	541	501	336	336		165	25	(*)	526	15	6				8	1	
District of Columbia	963	186	163	162	1	23	2	1	189	774	5	287	103	329	37	13	
Partial totals [13]			207,361	204,889	2,472	85,385	7,062	308									
Full totals	359,783	304,028							311,398	48,385	2,068	23,512	8,211	2,480	7,910	2,705	1,499

* Receipts less than $500.

[1] Registration periods ending not earlier than Nov. 30 and not later than Jan. 31 are considered as calendar-year periods. In the case of States in which the registration period is definitely removed from the calendar year, data on receipts were obtained for the calendar-year period. The figures for Ohio, however, represent receipts for the 9-month period ended Dec. 31, 1936.

[2] No segregation of registration fees by type of vehicle was available in Alabama, Mississippi, New Hampshire, and Tennessee. For these States the total motor-vehicle registration fees include those of trailers and motorcycles, except in the case of New Hampshire, for which motorcycle fees were reported separately. Dealers' license fees in Alabama and Tennessee are also included.

[3] The figures for registration fees of motor busses are incomplete. (See footnote 3 of preceding table.) Where no fees are tabulated, the fees of busses are included with those of automobiles, except as otherwise noted.

[4] Deduction of refunds results in a negative item in a number of cases.

[5] In a large number of States service charges are collected or deducted by the county or local officers who issue registrations. In the majority of cases these charges are included in the registration and other fees as listed. The amounts shown in this column are estimates of service charges collected and retained by local officials and not reported elsewhere in the table.

[6] Included with motor-vehicle registration fees.

[7] Included with fees of motor trucks.

[8] Trailers of 1,000 pounds capacity or more prohibited on highways, although permitted in cities under city licenses. Tractor-semitrailers registered as trucks. Light trailers permitted but not registered.

[9] Fees of light trailers and commercial semitrailers only. Fees of commercial full trailers included with those of motor trucks.

[10] Registration fees are collected by counties, and State does not maintain complete record. Figures given are estimates supplied by State.

[11] For 9-month period ended Dec. 31, 1936. Data for full calendar year not available.

[12] Fees of light delivery trucks included with those of automobiles.

[13] Totals of columns for which fully classified totals were not available for all States.

STATUS OF FEDERAL-AID HIGHWAY PROJECTS

AS OF MAY 31, 1937

STATE	APPORTIONMENT 1/	COMPLETED			UNDER CONSTRUCTION			APPROVED FOR CONSTRUCTION			BALANCE OF FUNDS AVAILABLE FOR NEW PROJECTS
		Estimated Total Cost	Federal Aid	Miles	Estimated Total Cost	Federal Aid	Miles	Estimated Total Cost	Federal Aid	Miles	
Alabama	$ 7,872,980	$ 51,600	$ 25,800	9.0	$ 1,354,601	$ 677,300	58.5	$ 667,250	$ 333,625	37.2	$ 6,836,255
Arizona	5,394,661	2,578,176	1,972,485	145.1	1,049,303	811,285	31.7	880,898	573,145	23.3	2,037,746
Arkansas	6,463,681				3,084,246	3,081,271	184.0	870,040	869,086	68.8	2,513,324
California	14,366,891	7,459,280	4,225,587	196.6	8,176,442	4,573,646	197.4	2,595,986	1,318,052	57.6	4,249,606
Colorado	6,911,198	4,506,541	2,407,190	176.3	3,395,599	1,890,122	128.3	439,333	240,544	4.7	2,373,342
Connecticut	2,388,339	771,388	384,238	14.2	745,158	370,176	8.7				1,633,925
Delaware	1,843,750	688,441	333,428	33.0	469,148	234,444	12.3	316,098	155,861	20.5	1,120,018
Florida	5,020,323	1,022,926	505,396	31.5	1,690,655	845,323	57.9	609,970	304,985	7.4	3,364,619
Georgia	9,569,722	1,856,155	886,717	117.7	2,519,984	1,259,977	136.5	1,921,920	960,960	103.6	6,462,068
Idaho	4,635,991	2,825,120	1,632,661	263.4	1,594,295	953,976	104.4	483,186	287,966	39.4	1,761,388
Illinois	15,564,720	8,864,008	4,404,074	139.1	7,989,182	3,944,825	212.5	6,869,378	3,431,827	196.2	3,783,993
Indiana	9,333,269	5,968,995	2,942,550	197.4	5,855,691	2,927,736	150.3	1,896,120	948,060	49.1	2,514,924
Iowa	9,757,950	7,200,433	3,536,382	495.8	4,515,529	2,059,231	140.8	2,175,612	946,059	62.4	3,216,278
Kansas	10,005,211	4,732,267	2,364,033	833.9	6,478,352	3,212,729	263.3	2,124,113	1,062,046	143.6	3,366,403
Kentucky	6,961,271	2,249,866	1,085,244	152.5	2,418,979	1,137,899	63.2	2,277,934	1,138,967	81.6	3,599,161
Louisiana	5,387,420	2,014,682	1,004,304	72.1	1,085,777	542,584	32.3	9,246,580	1,135,750	32.4	2,704,781
Maine	3,299,867	1,911,539	933,106	58.9	1,636,665	818,333	49.5	637,830	318,915	15.6	1,229,513
Maryland	3,094,808				1,305,676	652,804	19.9	516,051	258,026	8.0	2,183,979
Massachusetts	5,255,300	333,935	166,968	3.1	4,329,066	2,164,533	20.3	511,780	255,890	2.3	2,667,909
Michigan	11,562,296	9,288,948	4,548,784	332.2	6,120,169	3,059,181	154.4	3,250,100	1,614,449	76.2	2,339,882
Minnesota	10,344,485	8,207,986	3,861,650	537.3	3,335,995	1,648,314	187.6	1,719,765	859,877	69.9	3,974,644
Mississippi	6,635,344	4,640	2,320		1,737,210	868,500	100.1	3,853,890	1,925,740	173.7	3,838,784
Missouri	11,479,090	4,914,088	2,440,070	477.5	8,044,731	4,009,086	293.0	3,732,924	1,648,903	185.8	3,381,031
Montana	7,744,061	4,131,050	2,247,844	409.3	3,166,965	1,774,575	215.7	1,091,040	493,457	63.2	3,228,185
Nebraska	7,809,353	3,225,232	1,598,845	190.8	3,233,957	1,636,341	370.6	1,700,042	850,021	195.0	3,724,146
Nevada	4,821,864	1,642,101	1,394,112	272.2	1,766,518	1,526,190	54.9	258,341	216,907	37.6	1,684,655
New Hampshire	1,843,750	850,588	404,321	24.8	194,187	96,641	2.3				1,342,788
New Jersey	5,054,295	2,667,645	1,327,644	39.3	2,075,259	960,334	20.3	20,880	10,440		2,755,877
New Mexico	6,030,708	3,997,848	2,452,029	334.6	1,969,311	1,157,131	115.7	1,726,512	1,170,521	115.5	1,251,027
New York	18,565,567	8,220,786	3,995,419	169.9	18,308,914	8,530,207	290.5	2,795,600	1,363,850	43.3	4,676,091
North Carolina	8,877,837	2,944,435	1,467,210	347.5	4,942,372	2,348,636	335.4	2,189,840	1,022,670	72.6	4,039,322
North Dakota	5,914,683	197,000	105,473	.3	366,260	275,716	25.3	1,493,570	1,493,570	238.7	4,039,924
Ohio	13,771,548	2,965,171	1,466,760	47.4	7,627,261	3,689,627	79.7	3,080,610	1,535,539	40.6	7,079,621
Oklahoma	8,880,547	3,958,051	2,063,516	144.0	2,394,352	1,255,960	91.4	2,889,546	1,498,783	101.7	4,062,288
Oregon	6,182,079	3,083,627	1,853,241	117.5	4,588,881	2,705,023	157.6	500,528	285,325	29.9	1,338,489
Pennsylvania	16,129,804	6,533,546	3,226,952	110.4	10,942,129	5,458,961	157.5	1,845,158	919,546	20.5	6,524,345
Rhode Island	1,843,750	215,607	104,733	3.3	794,476	397,238	6.6	346,360	170,310	5.8	1,171,469
South Carolina	5,103,525	561,512	246,900	53.8	4,957,391	2,050,523	317.3	659,435	298,700	36.8	2,507,402
South Dakota	6,162,747	1,315,271	739,076	176.7	1,173,903	657,691	108.5	795,324	442,723	105.6	4,323,257
Tennessee	7,949,380	2,664,334	1,311,738	115.0	1,844,922	922,461	59.9	634,540	317,270	20.4	5,397,911
Texas	23,506,431	13,670,181	6,810,279	778.2	11,912,022	5,898,003	803.6	3,737,350	1,765,643	179.5	9,032,507
Utah	4,274,740	2,191,492	1,530,051	144.8	1,047,653	755,719	77.9	512,870	344,790	56.6	1,644,180
Vermont	1,843,750	1,301,605	641,741	62.9	1,043,485	494,780	32.2	60,200	30,100	1.2	677,129
Virginia	6,887,569	3,503,837	1,745,178	146.3	3,169,962	1,545,891	130.7	879,960	439,980	26.1	3,156,520
Washington	5,907,615	4,373,407	2,258,713	164.6	1,973,371	1,034,271	76.2	922,679	481,098	11.8	2,133,533
West Virginia	4,107,201	863,017	431,486	42.3	900,256	450,116	23.9	1,124,578	558,439	26.8	2,667,160
Wisconsin	9,197,557	3,976,182	1,913,908	167.7	5,380,511	2,444,448	165.2	4,192,342	1,730,182	96.8	3,109,019
Wyoming	4,722,322	3,041,068	1,870,594	399.1	2,992,166	1,840,849	263.1	790,370	463,017	71.4	547,861
Puerto Rico	625,000										625,000
Hawaii	1,843,750	29,953	14,542	.8	855,062	420,545	17.2	124,030	58,735	.8	1,349,928
TOTALS	368,750,000	159,575,560	82,885,292	8,750.1	178,553,999	92,071,152	6,606.1	81,968,463	38,550,349	3,057.5	155,243,207

1/ APPORTIONMENTS FOR FISCAL YEARS 1936 TO 1938 INCLUSIVE.

CURRENT STATUS OF UNITED STATES WORKS PROGRAM HIGHWAY PROJECTS

(AS PROVIDED BY THE EMERGENCY RELIEF APPROPRIATION ACT OF 1935)

AS OF MAY 31, 1937

STATE	APPORTIONMENT	COMPLETED			UNDER CONSTRUCTION			APPROVED FOR CONSTRUCTION			BALANCE OF FUNDS AVAILABLE FOR NEW PROJECTS
		Estimated Total Cost	Works Program Funds	Miles	Estimated Total Cost	Works Program Funds	Miles	Estimated Total Cost	Works Program Funds	Miles	
Alabama	$ 4,151,115	$ 3,321,378	$ 3,306,391	109.2	$ 771,036	$ 771,036	29.1				$ 73,687
Arizona	2,569,841	2,797,425	2,256,485	178.5	357,455	242,725	17.3				70,631
Arkansas	3,352,061	2,791,353	2,768,637	303.8	532,396	531,222	55.3	$ 16,282	$ 15,714	1.2	36,489
California	7,747,928	6,300,614	6,113,621	233.7	1,831,563	1,624,227	30.6	7,200	7,200		2,880
Colorado	3,395,263	1,889,495	1,831,891	99.1	89,597	89,596	6.0				1,473,776
Connecticut	1,418,709	580,639	534,508	4.4	537,218	517,407	13.2	84,583	82,500	2.8	284,294
Delaware	900,310	605,917	580,185	48.9	247,538	247,538	17.7	37,945	29,151	.2	43,436
Florida	2,597,144	1,970,774	1,937,280	77.9	608,719	608,719	21.2				51,145
Georgia	4,988,967	671,162	661,215	39.6	1,033,689	1,033,689	75.9	769,552	769,552	36.4	2,524,511
Idaho	2,222,747	2,242,791	2,151,838	185.3	44,665	44,665	.3				26,244
Illinois	8,694,009	7,819,498	7,706,054	440.1	950,754	950,676	31.1				37,279
Indiana	4,941,255	2,985,205	2,795,259	122.8	2,137,232	2,137,232	112.0				8,764
Iowa	4,991,664	3,715,647	3,485,929	424.6	1,513,751	1,433,134	103.0	44,378	43,070	.4	29,531
Kansas	4,994,975	3,885,339	3,855,480	325.4	1,124,880	1,062,708	50.2	55,360	55,360	14.2	21,427
Kentucky	3,726,271	2,850,194	2,758,762	317.9	613,277	613,277	28.5	268,879	268,879	7.8	85,353
Louisiana	2,890,429	1,767,022	1,587,428	129.7	1,330,755	1,196,389	38.0	106,613	106,613	3.6	
Maine	1,676,799	1,303,328	1,289,370	59.3	323,032	323,032	13.3	52,100	52,100	1.8	12,296
Maryland	1,750,738	478,755	473,816	17.7	730,571	730,571	17.0	210,134	176,302	6.9	370,049
Massachusetts	3,262,885	216,783	216,783	2.5	2,687,114	2,333,754	15.9	816,540	443,818	.4	268,530
Michigan	6,301,414	6,325,701	5,965,311	287.9	291,871	291,871	4.8	11,466	10,350		33,882
Minnesota	5,277,145	5,186,071	4,411,073	823.2	1,130,865	734,783	77.7	131,648	114,798	2.3	16,492
Mississippi	3,457,552	2,242,832	2,238,300	164.0	1,105,017	1,103,977	70.7	8,900	8,900	.6	106,375
Missouri	6,012,652	4,441,704	4,399,532	747.1	1,666,075	1,481,358	29.6	37,060	34,964	1.1	96,798
Montana	3,676,416	3,375,707	3,368,616	195.1	249,598	249,598	.3	215,634	53,538	9.8	4,665
Nebraska	3,870,739	3,086,730	3,007,972	323.7	573,739	573,736	43.8	20,461	20,461	2.0	268,571
Nevada	2,243,074	2,030,445	1,969,541	89.1	279,244	264,244	13.7	9,289	9,289	5.2	
New Hampshire	945,225	615,425	587,476	26.7	285,524	282,466	10.9	3,812	3,812		71,471
New Jersey	3,129,805	832,403	829,403	15.3	2,222,746	2,209,591	18.8	56,533	56,533	2.0	34,278
New Mexico	2,871,397	2,252,349	2,247,612	179.2	398,230	398,230	17.0	139,585	139,585	7.5	85,970
New York	11,046,377	9,703,228	9,224,042	136.1	1,599,860	1,599,860	34.2	37,477	37,477		184,997
North Carolina	4,720,173	2,946,831	2,914,118	209.0	1,799,730	1,758,852	81.2	1,600	1,600	.1	45,603
North Dakota	2,867,245	1,675,425	1,661,201	248.7	735,375	735,220	87.6	281,120	281,120	54.1	189,704
Ohio	7,670,815	3,324,629	3,260,320	145.0	4,177,467	4,130,032	143.6	189,640	187,120	10.9	93,344
Oklahoma	4,580,670	3,449,175	3,382,040	338.3	960,857	960,272	57.2	248,332	203,732	12.7	34,625
Oregon	3,038,642	2,046,351	2,025,483	149.3	1,294,918	933,484	15.3				79,675
Pennsylvania	9,347,797	2,040,064	1,939,709	97.1	3,669,408	3,616,608	102.0	3,572,023	3,024,650	79.7	766,830
Rhode Island	989,208	1,073,470	983,058	18.8				6,520	3,837		2,312
South Carolina	2,702,012	1,507,295	1,418,056	142.5	1,035,143	1,015,319	90.1	190,564	143,558	11.2	125,079
South Dakota	2,976,454	2,095,805	2,093,686	399.1	745,237	745,237	82.7	101,640	101,640	11.3	35,892
Tennessee	4,192,460	2,342,026	2,331,290	96.8	1,206,932	1,206,932	38.4	492,461	492,461	13.4	161,777
Texas	11,989,350	12,124,223	11,110,121	1,083.1	827,641	727,915	23.8	76,061	60,474	6.0	90,840
Utah	2,067,154	1,677,446	1,517,840	171.0	458,762	427,398	26.1	19,921	19,921	.9	101,995
Vermont	924,306	829,040	729,663	20.7	239,160	180,517	2.5				14,126
Virginia	3,652,667	2,926,358	2,865,020	933.0	526,731	514,550	100.0	52,053	52,053	.8	221,044
Washington	3,026,161	3,088,032	2,776,368	162.6	294,844	223,272	1.8				26,521
West Virginia	2,231,412	849,360	845,863	38.5	1,473,870	1,337,971	56.4	57,960	47,577	5.4	
Wisconsin	4,823,884	4,898,678	4,426,150	329.2	470,612	348,912	14.3	24,572	24,204	.3	24,617
Wyoming	2,219,155	1,655,804	1,653,365	124.1	549,869	546,972	28.4	22,200	18,609		209
District of Columbia	949,496	949,496	949,496	8.8							
Hawaii	926,033	635,899	617,792	8.9	322,161	298,335	8.5				9,906
TOTALS	195,000,000	140,421,321	134,060,449	10,832.3	48,056,728	45,389,109	1,957.0	8,478,098	7,202,522	313.0	8,347,920

CURRENT STATUS OF UNITED STATES WORKS PROGRAM GRADE CROSSING PROJECTS

(AS PROVIDED BY THE EMERGENCY RELIEF APPROPRIATION ACT OF 1935)

AS OF MAY 31, 1937

STATE	APPORTIONMENT	COMPLETED					UNDER CONSTRUCTION					APPROVED FOR CONSTRUCTION					BALANCE OF FUNDS AVAILABLE FOR NEW PROJECTS
				NUMBER					NUMBER					NUMBER			
		Estimated Total Cost	Works Program Funds	Grade Crossings Eliminated by Separation or Relocation	Grade Crossing Structures Reconstructed	Grade Crossings Protected by Signals or Otherwise	Estimated Total Cost	Works Program Funds	Grade Crossings Eliminated by Separation or Relocation	Grade Crossing Structures Reconstructed	Grade Crossings Protected by Signals or Otherwise	Estimated Total Cost	Works Program Funds	Grade Crossings Eliminated by Separation or Relocation	Grade Crossing Structures Reconstructed	Grade Crossings Protected by Signals or Otherwise	
Alabama	$ 4,034,617	$ 2,686,501	$ 2,686,501	37	1	9	$ 1,152,869	$ 1,152,869	11			$ 87,220	$ 87,220	1		3	$ 108,027
Arizona	1,256,099	1,119,207	1,094,094	13			104,506	104,506	1			9,740	9,740			3	47,759
Arkansas	3,574,060	1,791,281	1,785,984	38	4	2	1,558,421	1,556,271	17	2		199,984	199,714	1		30	32,092
California	7,486,362	5,041,619	4,875,772	29	8		2,366,957	2,298,880	17			311,710	205,938	6			105,772
Colorado	2,631,567	1,234,005	1,200,507	21	1		939,941	939,940	8			75,890	75,890	1			415,231
Connecticut	1,712,684	73,479	73,479		1		779,991	758,630	5		1	283,610	283,610	2			596,965
Delaware	418,239	130,000	130,000	1								277,993	277,993	2			10,246
Florida	2,827,883	1,660,162	1,657,852	17	5		826,541	826,197	12	1		79,200	79,200	1			264,634
Georgia	4,895,949	59,085	57,593	1	2		905,444	905,444	19	4		493,098	493,098	12		44	3,439,814
Idaho	1,674,479	908,936	902,471	14	1	5	385,595	385,482	5	1	9	248,737	248,737	2		7	137,789
Illinois	10,307,184	4,846,297	4,842,579	49	2		5,305,219	5,305,219	27	5							159,386
Indiana	5,111,096	1,830,400	1,694,405	20	11		3,427,682	3,391,082	22	1	162						25,609
Iowa	5,600,679	2,784,798	2,720,038	68	7	4	2,681,187	2,664,571	37	2	2	229,876	216,070	2		2	
Kansas	5,246,258	2,384,404	2,372,609	36		4	2,914,248	2,839,405	22	1	1						34,244
Kentucky	3,672,387	1,051,182	1,050,873	13	3		1,817,182	1,527,450	9	3		814,500	814,500	4	5		279,564
Louisiana	3,213,467	288,468	288,468	4			1,681,522	1,681,522	16	2		1,209,330	1,023,934	9	3		219,543
Maine	1,426,861	798,899	797,486	14		2	347,194	346,603	6	1		240,350	240,350	1			42,422
Maryland	2,061,751	358,388	358,388	3	3		518,504	518,504	3		19	638,004	615,536	3	2		569,323
Massachusetts	4,210,833	1,001,729	1,001,643	8	2		2,033,499	2,033,499	15	2		1,059,621	1,056,041	4			119,650
Michigan	6,765,197	3,476,224	3,394,989	35	4		3,397,177	3,326,708	10	4		43,500	43,500		1		
Minnesota	5,395,441	3,161,230	3,091,181	63	10	37	2,290,188	2,248,093	22	3	3	3,448	3,448			1	52,719
Mississippi	3,241,475	1,172,764	1,172,600	31	3	1	1,481,858	1,481,858	24	2	1	105,000	105,000	2		10	482,017
Missouri	6,142,153	786,713	783,740	14			5,560,303	5,250,107	35	1	1	1,650	1,650			1	106,655
Montana	2,722,327	2,538,405	2,494,780	35	7		178,582	178,582	2			75,278	30,000		1		18,965
Nebraska	3,556,441	1,939,514	1,929,459	65	2	8	1,382,819	1,382,819	15	1	3	31,678	31,678			13	212,485
Nevada	887,260	692,129	690,197	7	3		211,658	193,432	1			3,630	3,630			5	1
New Hampshire	822,484	341,748	341,748	3	3		395,145	395,100	5	1	1	15,452	15,452			6	70,184
New Jersey	3,983,826	760,036	760,036	6	2		2,558,322	2,547,277	15	5		139,100	139,100	1			537,414
New Mexico	1,725,286	1,044,613	1,043,684	13	1		673,090	670,400	5								11,202
New York	13,577,189	3,340,870	3,328,645	12	16		9,694,911	9,446,265	31	31		388,150	388,150		1		414,129
North Carolina	4,823,958	1,777,842	1,777,842	23	15		2,186,507	2,166,956	25	3	108	63,890	63,890	1			815,270
North Dakota	3,207,473	1,043,506	1,043,216	23	1		1,775,043	1,771,763	28	3							392,494
Ohio	8,439,897	347,806	282,313	2	1	2	5,595,268	5,438,779	38	6	1	2,625,300	2,301,242	16	1		417,562
Oklahoma	5,004,711	2,676,501	2,670,355	42	4	1	970,588	970,588	14	3	4	873,383	873,383	8	2	31	490,384
Oregon	2,334,204	1,193,881	1,187,909	10	5	2	1,170,816	1,089,215	6	1		49,093	49,093	1			7,987
Pennsylvania	11,483,613	2,256,542	2,009,765	37	9	9	8,086,045	7,594,504	39	11		1,079,528	968,128	7			911,216
Rhode Island	699,691	624,125	623,059	4	1		61,626	61,626		2							15,006
South Carolina	3,059,956	991,114	980,397	20	5	3	1,230,084	1,221,671	23	6	8	278,450	275,700		3	37	582,188
South Dakota	3,249,086	1,042,381	1,042,175	27	2	25	1,686,171	1,686,171	35	3		203,010	203,010	3		25	317,730
Tennessee	3,903,979	754,800	750,456	15	2	18	2,339,790	2,339,790	25	1	4	490,020	490,020	6		14	323,713
Texas	10,855,982	6,539,708	6,531,664	99	13	21	3,460,579	3,460,572	30	1	10	543,156	543,155	1	1	148	320,591
Utah	1,230,763	338,576	337,171	3	1	1	873,921	873,921	14								19,670
Vermont	729,857	500,765	495,086	7	5	15	271,833	231,750	3	2	5						3,021
Virginia	3,774,287	1,977,625	1,867,760	33	11	8	989,658	989,658	11	6	3	362,584	356,795	5	1	9	560,074
Washington	3,095,041	2,119,054	2,094,014	19	10	8	1,026,083	990,668	4	2		10,359	10,359			3	
West Virginia	2,677,937	79,454	79,454	1		4	1,631,021	1,629,053	15	3		575,069	575,069	8		1	394,362
Wisconsin	5,022,683	2,601,047	2,559,272	27	4		2,380,496	2,289,244	10	3							174,167
Wyoming	1,360,841	653,621	653,513	9			538,776	538,775	3			101,000	85,100	1			83,453
Dist. of Columbia	410,804	170,643	170,643	2			254,921	226,161	1								14,000
Hawaii	453,703	170,404	170,389	2			351,976	283,314	3								
TOTALS	196,000,000	77,162,481	75,948,254	1075	191	189	94,451,757	92,210,894	744	129	346	14,320,591	13,484,123	111	21	393	14,356,729

PUBLICATIONS of the BUREAU OF PUBLIC ROADS

Any of the following publications may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. As his office is not connected with the Department and as the Department does not sell publications, please send no remittance to the United States Department of Agriculture.

ANNUAL REPORTS

Report of the Chief of the Bureau of Public Roads, 1924. 5 cents.

Report of the Chief of the Bureau of Public Roads, 1927. 5 cents.

Report of the Chief of the Bureau of Public Roads, 1928. 5 cents.

Report of the Chief of the Bureau of Public Roads, 1929. 10 cents.

Report of the Chief of the Bureau of Public Roads, 1931. 10 cents.

Report of the Chief of the Bureau of Public Roads, 1933. 5 cents.

Report of the Chief of the Bureau of Public Roads, 1934. 10 cents.

Report of the Chief of the Bureau of Public Roads, 1935. 5 cents.

Report of the Chief of the Bureau of Public Roads, 1936. 10 cents.

DEPARTMENT BULLETINS

No. 583D. .Reports on Experimental Convict Road Camp, Fulton County, Ga. 25 cents.

No. 1279D. .Rural Highway Mileage, Income, and Expenditures, 1921 and 1922. 15 cents.

TECHNICAL BULLETINS

No. 265T. . .Electrical Equipment on Movable Bridges. 35 cents.

MISCELLANEOUS PUBLICATIONS

No. 76MP. .The Results of Physical Tests of Road-Building Rock. 25 cents.

Federal Legislation and Rules and Regulations Relating to Highway Construction. 15 cents.

No. 191. . . . .Roadside Improvement. 10 cents.

The Taxation of Motor Vehicles in 1932. 35 cents.

An Economic and Statistical Analysis of Highway-Construction Expenditures. 15 cents.

Highway Bond Calculations. 10 cents.

Single copies of the following publications may be obtained from the Bureau of Public Roads upon request. They cannot be purchased from the Superintendent of Documents.

SEPARATE REPRINT FROM THE YEARBOOK

No. 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).

Report of a Survey of Traffic on the Federal-Aid Highway Systems of Eleven Western States (1930).

UNIFORM VEHICLE CODE

Act I.—Uniform Motor Vehicle Administration, Registration, Certificate of Title, and Antitheft Act.

Act II.—Uniform Motor Vehicle Operators' and Chauffeurs' License Act.

Act III.—Uniform Motor Vehicle Civil Liability Act.

Act IV.—Uniform Motor Vehicle Safety Responsibility Act.

Act V.—Uniform Act Regulating Traffic on Highways.

Model Traffic Ordinances.

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

CURRENT STATUS OF UNITED STATES PUBLIC WORKS ROAD CONSTRUCTION

AS PROVIDED BY SECTION 204 OF THE NATIONAL INDUSTRIAL RECOVERY ACT (1934 FUNDS) AND BY THE ACT OF JUNE 18, 1934 (1935 FUNDS)

AS OF MAY 31, 1937

STATE	APPORTIONMENTS		COMPLETED				UNDER CONSTRUCTION				APPROVED FOR CONSTRUCTION			BALANCE OF FUNDS AVAILABLE FOR NEW PROJECTS	
	Sec. 204 of the Act of June 16, 1933 (1934 Fund)	Act of June 18, 1934 (1935 Fund)	Total Cost	1934 Public Works Funds	1935 Public Works Funds	Mileage	Estimated Total Cost	1934 Public Works Funds	1935 Public Works Funds	Mileage	1934 Public Works Funds	1935 Public Works Funds	Mileage	1934 Public Works Funds	1935 Public Works Funds
Alabama	$ 8,370,133	$ 4,259,842	$ 15,673,675	$ 8,301,315	$ 3,813,459	770.8	$ 171,795	$ 55,923	$ 115,872	5.8		$ 285,822	1.5	$ 12,895	$ 44,689
Arizona	5,211,960	2,641,935	9,006,025	5,203,675	2,607,439	542.9	44,046	5,574	24,073	.1		810		2,711	9,613
Arkansas	6,748,335	3,428,049	10,979,516	6,637,864	3,371,459	622.4	120,291	70,019	49,922	3.9	$ 33,944	4,200	10.9	6,509	2,468
California	15,607,354	7,932,206	30,662,474	15,607,354	7,752,490	763.9	114,733		109,877						69,839
Colorado	6,874,530	3,486,006	11,269,838	6,874,530	3,465,039	633.2						10,880			10,087
Connecticut	2,865,740	1,454,868	4,559,316	2,794,586	1,319,700	74.0	23,300	23,300				36,690	.3	47,854	98,477
Delaware	1,819,088	923,395	2,782,832	1,818,804	916,149	128.9						7,100		284	145
Florida	5,231,834	2,661,343	9,024,260	5,175,534	2,414,688	307.3	289,764	56,300	233,464	2.9					13,190
Georgia	10,091,185	5,113,491	13,462,239	9,272,425	3,313,943	766.1	1,056,956	375,323	681,633	65.7	84,072	240,400	10.2	359,365	877,516
Idaho	4,486,249	2,277,486	7,078,041	4,486,249	2,154,127	501.4	87,853		85,693	.1		12,110			25,556
Illinois	17,570,770	8,921,401	26,474,576	17,337,114	7,948,338	724.2	1,141,513	129,245	885,007	13.3		7,100		104,411	80,956
Indiana	10,037,843	5,088,963	15,555,334	9,892,557	4,814,846	482.8	227,844	129,083	98,761	2.4		61,727		16,203	113,629
Iowa	10,055,660	5,118,361	15,580,604	10,055,660	4,920,929	1,222.3	209,734		197,432	5.0					
Kansas	10,089,604	5,117,675	15,426,435	10,089,029	5,009,852	1,132.3	115,038		86,599	13.1				575	21,225
Kentucky	7,517,359	3,818,311	12,168,487	7,480,592	3,719,296	812.7	67,504		67,504	2.8	11,054	23,834		25,713	7,678
Louisiana	5,828,591	2,963,932	9,135,047	5,763,651	2,694,156	258.9	215,480		215,459	11.5		20,500	6.9	64,940	33,817
Maine	3,369,917	1,711,586	5,248,678	3,348,968	1,671,457	193.5	43,100	15,000	26,540	1.4		4,800	.1	5,949	8,790
Maryland	3,564,527	1,810,058	5,721,749	3,488,916	1,102,724	152.3	68,343		68,343	1.5		299,044	7.3	75,611	339,947
Massachusetts	6,597,100	3,350,474	10,401,683	6,550,778	3,094,281	115.5						91,944	.1	46,323	164,249
Michigan	12,736,227	6,452,568	20,726,161	12,736,227	6,298,778	768.1	96,788		96,788			40,000	.4		17,002
Minnesota	10,656,569	5,425,551	16,203,120	10,510,789	4,846,656	1,641.9	556,215	58,110	469,579	7.4		34,800	.6	87,670	74,516
Mississippi	6,978,675	3,540,227	12,796,784	6,795,654	3,000,647	724.4	628,159	125,000	488,813	21.2	3,960	14,860	.2	54,062	35,907
Missouri	12,180,306	6,173,740	18,185,313	12,088,271	4,998,938	1,441.2	1,125,699		1,121,765	6.3				92,035	53,036
Montana	7,439,748	3,769,734	11,764,611	7,425,285	3,655,874	1,058.4	56,546		56,546					14,463	57,314
Nebraska	7,828,961	3,964,364	12,969,984	7,812,918	3,746,021	1,035.5	201,659	16,043	185,616	16.3					32,727
Nevada	4,545,917	2,302,356	7,068,886	4,545,917	2,269,237	758.8	21,979		21,979			1,650			9,491
New Hampshire	1,909,839	969,462	3,007,886	1,904,951	953,689	78.3								4,888	15,773
New Jersey	6,346,039	3,220,879	9,213,234	6,166,170	2,448,230	88.4	1,197,850	100,280	663,430	8.6		9,212		79,589	100,007
New Mexico	5,792,935	2,941,700	8,908,408	5,749,069	2,920,579	749.8	3,536		3,536	.2		2,709		43,866	14,876
New York	22,330,101	11,327,921	39,994,755	22,196,547	10,551,869	823.7	806,142	119,856	525,499	1.6	6,600	112,200		7,098	138,353
North Carolina	9,522,293	4,840,941	14,951,839	9,205,888	4,513,514	1,345.2	564,251	303,110	261,141	21.4		6,400	.2	13,294	59,886
North Dakota	5,804,448	2,938,967	8,629,934	5,609,071	2,243,105	2,118.8	282,009	158,643	123,366	21.0		369,590	30.6	36,735	202,905
Ohio	15,484,592	7,865,012	24,759,236	15,377,745	7,513,301	792.1	404,871	98,678	245,354	6.7		45,000	1.5	8,170	61,356
Oklahoma	9,216,798	4,685,180	14,746,797	9,214,657	4,429,653	806.6	196,489		196,489	.4		• 36,174		2,140	22,864
Oregon	6,106,896	3,097,814	9,973,039	6,047,835	2,960,906	468.0	64,223		64,223	.8	55,000		.7	4,061	72,686
Pennsylvania	18,891,004	9,590,788	29,038,106	18,555,365	8,909,961	1,054.0	913,639	281,923	587,195	16.7		82,607	1.4	53,716	11,025
Rhode Island	1,998,708	1,014,572	3,150,270	1,998,708	1,012,094	89.2	2,478		2,478						
South Carolina	5,459,165	2,770,954	8,035,990	5,220,362	2,482,798	622.3	400,309	148,148	224,531	12.6	40,000	40,613	1.4	50,655	23,012
South Dakota	6,011,479	3,047,643	9,392,065	5,909,991	2,904,076	1,589.5	96,671	5,440	91,231	17.3	76,862	23,771	21.7	19,186	28,565
Tennessee	8,492,619	4,302,991	13,732,614	8,490,706	4,184,693	492.8	83,140		61,140	3.5	76	57,158	8.0	1,837	
Texas	24,244,024	12,291,253	38,019,184	24,197,558	11,908,921	2,781.9	360,325	2,797	347,542	.9		500	7.1	43,668	34,290
Utah	4,194,708	2,132,691	7,461,119	4,194,708	2,132,691	590.9									
Vermont	1,867,573	948,007	3,166,359	1,867,452	940,847	141.0								121	7,160
Virginia	7,416,757	3,765,387	11,591,713	7,328,534	3,347,391	621.2	268,951	27,651	235,668	28.8	6,735	9,652	.1	53,836	172,676
Washington	6,115,867	3,106,412	9,412,616	6,112,042	3,035,027	303.0	46,596		46,596					3,825	24,789
West Virginia	4,474,234	2,280,335	6,483,744	4,334,882	1,805,838	213.2	357,457	54,892	279,519	8.9		66,425	.7	84,460	128,553
Wisconsin	9,724,881	4,941,837	15,454,144	9,724,881	4,884,329	619.7	15,050		15,050						42,458
Wyoming	4,501,327	2,287,712	6,924,304	4,476,692	2,212,462	1,040.2	11,100	11,100		.3				13,534	75,250
District of Columbia	1,918,469	973,842	2,887,584	1,918,469	968,979	22.3						4,863			
Hawaii	1,871,062	949,778	2,972,062	1,857,812	555,221	53.7	359,759		342,210	2.2	13,250	39,680			12,667
TOTALS	394,000,000	200,000,000	631,832,670	389,754,757	184,740,697	35,139.5	13,119,185	2,371,438	9,703,463	332.6	331,553	2,104,825	111.9	1,542,252	3,451,015