

# **MOTOR ROADS IN BRAZIL**

**U. S. DEPARTMENT OF COMMERCE  
BUREAU OF FOREIGN AND DOMESTIC COMMERCE**

U. S. DEPARTMENT OF COMMERCE  
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# MOTOR ROADS IN BRAZIL

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## FOREWORD

Brazil has the nucleus of an excellent system of highways, but much remains to be done before the system can be considered complete. Most of the roads now in existence are of dirt; hard-surfaced highways are rare except in and near the populous coast cities.

Many of the roads, even in the interior, date from the Empire, when military roads were constructed along strategic routes. The Federal irrigation service constructed many roads from 1919 to 1923, and equipment and materials remaining from those operations have been made available for maintenance and further construction. Many roads were built by private enterprises; these are mainly toll roads. Interest in good roads is very strong and developing rapidly. New roads are being built and old ones improved as fast as economic and political conditions will permit.

There are many natural obstacles to the construction of good roads in Brazil. The country is very large and the population sparse in most of the area. Most of the country is tropical, with definite rainy seasons. In those seasons dirt roads are washed away or, if they remain, are impassable. Bridges have not been built extensively, and when the streams are swollen the fords can not be used. The roads cut through the jungle will be entirely overgrown in a very short time unless the vegetation is constantly cut back.

The Federal highway law of January 5, 1927, greatly stimulated road building throughout the country. Under its provisions plans were drawn for a nation-wide network of roads, and some financial aid was provided for those to be constructed by the State governments. The States, too, grant subsidies to the municipalities for the construction of State roads. The activity of 1927 continued through 1928 and most of 1929. The coffee crisis in the latter part of that year and the political unrest of 1930 caused a suspension of work on the roads, but there were persistent reports that in the last few weeks of 1930 the new Government was planning road building to relieve unemployment.

The new roads which are projected will be built to uniform specifications as to width of roadway, width of surface, materials used, radius of curves, tangent between curves, and grades. The new bridges are of reinforced concrete or wood on concrete piles; cuts and fills are now being made to make the roads more nearly permanent. When finished, the roads will be entirely suitable for use by motor vehicles.

The newly organized Foreign Construction Division of the Bureau of Foreign and Domestic Commerce has information at hand concerning roads and highway development throughout the world which it will gladly make available to interested American firms or individuals on specific application.

WILLIAM L. COOPER, *Director,*  
*Bureau of Foreign and Domestic Commerce.*

FEBRUARY, 1931.

# MOTOR ROADS IN BRAZIL

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## GENERAL CONSIDERATIONS

The United States of Brazil is the largest country in South America and the fourth largest in the world. It occupies an area of 8,494,299 square kilometers (3,279,649 square miles), or 45 per cent of the continent of South America. The estimated population on December 31, 1928, was 39,103,856, almost half that of the continent. The southeastern States of Minas Geraes, Sao Paulo, Rio de Janeiro, Espirito Santo, Parana, Santa Catharina, and Rio Grande do Sul occupy only 18 per cent of the area of Brazil but contain 57 per cent of the population. The eastern and northeastern coast States of Bahia, Sergipe, Alagoas, Pernambuco, Parahyba, Rio Grande do Norte, Ceara, Piahy, Maranhao, and Para comprise the next most densely populated section; they contain 39 per cent of the inhabitants and represent 33 per cent of the area. The interior States of Amazonas, Goyaz, and Matto Grosso and the Territory of Acre occupy 49 per cent of Brazil's area but have only 4 per cent of its population.

The most prominent topographical feature of the country is the central plateau, which comprises more than half the total area of the Republic. This region extends from the Andes Mountains on the west to the mountain ranges along the eastern coast and from the Amazon Valley to the plains in the south. It averages in height from 2,000 to 3,000 feet and rises in ranges and peaks to a height of 5,000 feet. Between the eastern mountain range and the sea lies the coastal plain, which is wide in the States of Ceara and Maranhao in the north and in Rio Grande do Sul in the south but becomes very narrow between Rio de Janeiro and Santos. The plateau region slopes off in the broad basins of the Amazon, Paraguay, and Parana Rivers.

Brazil lies entirely within the South Temperate and Tropical Zones; the climate is modified in different sections of the country by the many high table-lands and mountain ranges, and a variety of climatic zones is encountered. The rainfall, moderately heavy in the south, increases in the north except on the northeast coast, where the constant trade winds often cause severe droughts.

Brazil is a republic of 20 States, the Federal District (which embraces the capital city of Rio de Janeiro), and the national Territory of Acre. The States have broad political and fiscal powers, maintaining military police forces, collecting export duties, which are the chief source of revenue of the majority of the States, and contracting foreign loans, but their jurisdiction over commerce is limited to minor regulations and the levying of nominal taxes.

## TRANSPORTATION

*Ocean shipping.*—The coast line of Brazil is over 4,000 miles in length, and the ports of Rio de Janeiro, Santos, Bahia, and Recife are among the foremost in the world. Regular freight and passenger services are maintained between the more important of the Brazilian ports and the United States and European ports. In addition, three Brazilian companies operate regular passenger and freight services from Belem in the north to Porto Alegre in the south, and a number of smaller companies operate shorter lines touching the less important ports.

*Inland waterways.*—The Amazon River and its tributaries form a system of inland waterways navigable for a total distance of 20,000 miles for vessels drawing 3 feet or less. Steamers with a 24-foot draft reach Porto Bello, 1,500 miles inland, and a regular ocean service is maintained from Manaus to Iquique, in Peru, a distance of 2,000 miles. The Paraguay River is navigable for vessels of 8-foot draft to Corumba, in Matto Grosso, a distance of nearly 2,000 miles from Buenos Aires. Smaller vessels operate above Corumba to the more important points on the Paraguay River and its tributaries. The total length of navigable rivers in Brazil is estimated at something over 27,000 miles. The largest lakes are Lagoa dos Patos, navigable for vessels drawing 9 feet, and Lagoa Mirim, both of which are located in the State of Rio Grande do Sul. The former is approximately 140 miles long and 40 miles wide.

*Railroads.*—On January 1, 1929, there were 31,851 kilometers (19,791 miles) of railroads in Brazil. Nearly 62 per cent (19,546 kilometers) of this total was in the southeastern States. The States of Minas Geraes and Sao Paulo had 7,724 and 6,920 kilometers, respectively, or nearly 46 per cent of the total railroads in the country. Rio de Janeiro and Sao Paulo are connected by rail with the interior States of Minas Geraes, Goyaz, and Matto Grosso, with the States to the south, and also with Argentina and Uruguay. These cities are also connected with the extreme southwestern parts of the country by a line operating from Sao Paulo to Porto Esperanca on the Paraguay River. North of Rio de Janeiro, short lines extend inland from the coast, and in the interior railways connect isolated sections with the river ports. The gage is 1 meter on 90 per cent of these lines, 1.6 meters (5 feet 6 inches) on 6 per cent, and less than meter gauge on the other lines.

## HIGHWAY SYSTEM

### EARLY DEVELOPMENT

Prior to the colonization of Brazil by the Portuguese, early in the sixteenth century, no roads whatever existed and even horses were unknown. Some roads were built during the early colonial period, but these were little more than trails cut through the dense growth, which served for pack animals and the movement of troops. In the seventeenth century a number of roads were built connecting what is now Sao Paulo with the coast, with other towns in the State, and with towns in Minas Geraes.

In 1725 work was commenced on the first road connecting Sao Paulo and Rio de Janeiro. During the eighteenth century roads were also built to Goyaz, Matto Grosso, and Rio Grande do Sul.

From Rio de Janeiro roads were built into the State of Minas Geraes, and there are records of a trip from Bahia via Minas Geraes to Rio de Janeiro. From indications which exist in northern Brazil it is believed that during this period or early in the nineteenth century roads were built from Belem to Maranhao and others paralleling the Amazon River. None of the roads built before 1800, however, could be classed as more than trails.

The period from 1800 to 1880 was one of considerable road-building activity. Steady progress was made from 1800 up to the declaration of Brazil's independence in 1822. Under the reign of Dom Pedro I, which lasted only nine years, further progress was made in road building, especially in the vicinity of Rio de Janeiro. It was in this period that the first bridges were built and much attention given to the improvement of existing roads.

During the reign of Dom Pedro II, from 1831 to 1889, road building on a large scale was undertaken throughout the country, the most active period of the century being between 1840 and 1864, during which many miles of earth and paved roads were built in the States of Rio de Janeiro, Minas Geraes, and Sao Paulo.

The State of Rio de Janeiro was one of the most progressive and allotted 15 per cent of its tax receipts to paying for road maintenance and improvements. Some of the roads were paved throughout, others only in the mountainous regions. The principal roads had a 5-meter (16.4-foot) surface with grades not in excess of 8 per cent, and minimum curve radius of 30 meters (98.4 feet). These were well drained and were paved with trapezoidal stone blocks, apparently laid on a well-compressed foundation. Some of these roads are still in service.

One of the most important road projects of the period was that known as the "Estrada Uniao e Industria." This road was authorized under a concession from the Emperor which provided for the building of a road from the Parahyba River, on the boundary of Rio de Janeiro and Minas Geraes, to Barbacena in the latter State, with various branches. The initial work was begun in Petropolis in 1856 and completed as far as Juiz de Fora, a distance of 144 kilometers (89.5 miles), in 1861. This was one of the finest roads which had been built in the country. The width of the roadbed was 6 meters (19 feet 8¼ inches) and the maximum grade 5 per cent. The road was well drained throughout and paved with crushed stone. The total expenditures on the road up to December 31, 1860, amounted to 9,995,222\$460 (between \$5,080,571 and \$5,587,329; the average rate of exchange varied during this period from the highest yearly average, \$0.5559 in 1856, to \$0.5083 in 1859).

This road was a toll road and one of the few early roads on which statistics of any kind are available. From April, 1858, to December, 1860, 738,081 sacks of coffee with a total weight of nearly 37,000 tons, 392,867 miscellaneous packages, and 25,508 passengers were transported over the road. The revenues received amounted to 1,312,440\$254 (\$667,113 to \$687,062) for freight and 71,499\$680 (\$36,343 to \$37,430) for passengers, and the maintenance costs during the period were 784,445\$346 (\$398,734 to \$410,657). Thus the earnings of the road during the period amounted to 599,494\$588 (\$304,722 to \$313,835). The building of the road had been financed

in London and Rio de Janeiro, but after the construction of a directly competing railway, the road failed to continue on a profitable basis.

Soon after 1860 active construction commenced on railroads in various parts of the country, and with this the interest in roads declined. The only roads of any importance built after 1860 until recently were one connecting Curitiba and Antonina (State of Parana), 79 kilometers (49.1 miles) long, and one from Joinville to Campo Alegre (Santa Catherina), 70 kilometers (43.5 miles) long. Both of these were well-constructed macadam roads. Railroads were built paralleling the existing roads, and the latter rapidly fell into disuse. Practically no new road building was undertaken, and very little was done for the maintenance of the existing roads.

#### RECENT GOOD-ROADS MOVEMENT

There was very little interest in the subject of roads from about 1875 until after 1910. In 1916, the Automovel Club do Brasil organized the First Highway Congress. Other than to consolidate the growing interest in roads and to serve as a stimulus to it, few concrete results were obtained by this congress.

In the following year, a State road congress was organized by the governor of Sao Paulo, and, as a result, the *Associação Permanente das Estradas de Rodagem* was formed. That association fostered the good-roads movement in Sao Paulo and, through its connection with road organizations and similar institutions in the various States, had a decided effect in the improvement of roads throughout Brazil. The organization later became known as the *Associação Paulista de Boas Estradas* and has supported other State highway congresses. That association and the Automovel Club do Brasil, which promoted additional national road congresses in 1922 and 1924, have been most influential in the creation of a national interest in good roads. Numerous other good-roads associations have been formed in various States of the Republic, and other organizations have been actively cooperating in the movement. The activity and importance of the organizations supporting good roads have increased each year until to-day there is a very strong demand in practically all parts of Brazil for the improvement and building of roads.

Brazil's highway system dates back only to 1920. Obviously, numerous roads existed prior to that time, but with practically no important exceptions, they were all simple earth roads on which little was done in the way of maintenance. Some work was undertaken by the Federal Government in the northeastern States, and a small amount of road work was also done by the State governments prior to 1920, but largely without any preconceived plan or program. The State of Sao Paulo took the initiative by adopting a definite road program in 1921, but the activities of the Federal Government in road building did not assume major proportions until 1927.

Following the lead of Sao Paulo, several States have created highway departments and appropriated large sums for the improvement and maintenance of roads. Some States have also enacted laws encouraging private initiative by offering money premiums for each kilometer constructed, and several have enacted highway laws providing special highway funds and providing a definite building program.



Road building is carried on by the Federal and State Governments and by the municipalities, which roughly correspond to counties in the United States.

#### ROAD BUILDING BY THE FEDERAL GOVERNMENT

The Federal road-building work is now entirely under the direction of the Ministry of Communications and Public Works, though certain work fell under the jurisdiction of the Ministry of Agriculture Commerce and Industry until 1923.

As early as 1905 an attempt was made by the Government to encourage road building by granting subventions to States or private organizations constructing roads, generally a fixed amount for each kilometer built. These subventions mainly proved ineffectual. The work was done under the direction of the Ministry of Agriculture until 1922, when all road building was transferred to the Ministry of Communications, although subventions previously provided continued to be administered by the Minister of Agriculture. Roads built under Federal subventions from 1918 to 1922 totaled 5,677 kilometers (3,528 miles), with a total expenditure by the Federal Government of 8,652:649\$000 (between \$1,120,518 and \$2,192,581; the milreis fluctuated during this period from an average of \$0.2534 in 1918 to \$0.1295 in 1922).

A division known as the *Inspectoria Federal de Obras Contra as Seccas* (Federal irrigation service) was organized under the Department of Agriculture in the latter part of 1909 to undertake relief measures against the frequent droughts occurring in the northeastern States. Some road building of relatively little importance and on no preconceived plan was carried on by the new division up to 1919. In 1922 it was transferred to the Department of Communications and Public Works with the other road-building work of the Department of Agriculture.

#### ROAD WORK UNDERTAKEN

As a result of the very severe drought of 1918-19 in the northeastern States, the Federal Government conceived a plan on a monumental scale for sinking wells and building dams for irrigation and hydroelectric purposes under the direction of the Federal irrigation service. The project included work in the States of Bahia, Sergipe, Pernambuco, Parahyba, Rio Grande do Norte, Ceara, and Piauhy. In order to commence the various irrigation and hydroelectric projects, it was necessary to construct a large number of roads in order to haul the material to the dam sites. Thus the first Federal road building of importance was an indirect result of the project of Federal irrigation service, and it was this work that brought the importance of good roads to the attention of the northeastern States.

A small amount of road work was begun in 1918 by the Federal irrigation service, but the principal activity occurred in 1919 and 1920. The work continued until the end of 1922 and the early part of 1923, when practically all work was suspended by a lack of funds. Practically all of the activity of the irrigation service from the time of the initiation of its project was in the construction of roads, practically no progress having been made in the irrigation and hydro-

electric features. The road work consisted mainly of scraping, grading, and draining the existing cart roads. Some stretches of new road were built, and routes of others were modified to meet the needs of the project. All roads were of a simple earth construction. In many sections bridges were not built up to the time work was suspended, which made many of the roads useless during the rainy season when the rivers were swollen. From the suspension of work of the Federal irrigation service until the latter part of 1926 practically nothing was done by that department of the Federal Government in the way of new construction or in the conservation of these roads.

The following table shows the work done by the Federal irrigation service in the various States in which it was operating during the period from 1919 to 1923.

ROAD WORK OF FEDERAL IRRIGATION SERVICE, 1919-23

State	Extent of roads planned		Extent of roads completed	
	Kilometers	Miles	Kilometers	Miles
Piahy.....	449.300	279.2	181.500	112.8
Ceara.....	2,791.724	1,734.7	1,711.200	1,063.3
Rio Grande do Norte.....	1,126.770	700.1	1,065.570	662.1
Parabyba.....	2,134.611	1,326.4	2,134.611	1,326.4
Pernambuco.....	268.215	166.7	164.595	102.3
Sergipe.....	164.900	102.5	163.400	64.2
Bahia.....	203.997	124.0	42.360	26.3
Total.....	7,199.517	4,473.6	5,403.236	3,357.4

Since the beginning of 1926 isolated work has been going on in various of the northeastern States of Brazil through arrangements made by the State governments with the Federal irrigation service whereby the latter furnishes engineers and materials and the various States furnish funds and labor for road construction and improvement. The bulk of this work has consisted of reconditioning existing roads and building bridges planned in the original project. Since the roads have all been built of a simple earth construction and little maintenance work done, it has been necessary practically to rebuild the roads in many instances.

As has been indicated, the early road work of the Department of Communications and Public Works was not based on any definite plan. Some road building was undertaken during the last part of the administration of President Epitacio Pessao (1918-1922), the most important project being the road from Petropolis to Therezopolis, approximately 50 kilometers (31 miles), which was practically completed during the period. During the administration of President Bernardes (1922-1926) much of the Federal road-building work was discontinued, including the work of the Federal irrigation service.

The work of the Department of Communications and Public Works did not assume major proportions until after Dr. Washington Luiz took office as president in 1926 and a highway division organized in the Ministry of Communications. The activity of the Federal Government has increased very rapidly since that time.

## FEDERAL ROAD PROGRAM

The principal Federal road-building projects during 1927 and 1928 included the completion of the road from Sao Paulo to Rio de Janeiro and the building of a road from Rio de Janeiro to Petropolis, and another from Sao Joao, in the State of Santa Catharina, west to Barracao, which is on the Argentine frontier at the Parana and Santa Catharina borders. This latter road follows in a general way the State boundary of Parana and Santa Catharina and is approximately 900 kilometers (559 miles) in length.

*Rio de Janeiro-Sao Paulo.*—That part of the road from Rio de Janeiro to Sao Paulo which lies within the State of Sao Paulo was entirely constructed by the State authorities. Thus the projects of the Federal Government included only the building of the road through the State of Rio de Janeiro and the Federal District. This, however, is a distance of 124.424 kilometers (77.31 miles). It is the plan of the highway division to make the road the link between Rio de Janeiro and the entire southwestern part of the country. Work was commenced on March 29, 1927, and the road was completed and officially inaugurated on May 5, 1928.

That part of the road in the Federal District is for the most part either concrete or asphaltic macadam, whereas that portion lying in the State of Rio de Janeiro is of water-bound macadam, sand clay, or improved earth surface. The road is well drained and maintained throughout the Federal District and the State of Rio de Janeiro, and under ordinary circumstances is in good condition throughout the year. The abnormally heavy rains during the early part of 1929 washed out parts of the road, which made it impassable for about two weeks. The traffic on the road is moderately heavy, and its economic value is demonstrated by the fact that regular trucking lines are operated between the terminal cities for the transportation of merchandise. Property values along the road have also increased remarkably during the past two years.

It is planned to substitute improved surfaces in many parts of the road as rapidly as possible and to resurface the mountainous parts of the road with concrete.

*Rio de Janeiro-Petropolis.*—The road from Rio de Janeiro to Petropolis was planned as the initial part of trunk road connecting the Federal capital with the northern and central parts of the country. Work was commenced in January, 1927, and the road was officially inaugurated on August 27, 1928. It was closed to traffic, however, soon after to permit resurfacing the mountainous section with concrete. That section of the road is 23 kilometers (14 miles), the majority of which was completed by the end of August, 1929, and the remainder before the end of the year. A large part of that section of the road had to be cut into the side of steep cliffs.

The total length of the road is 62 kilometers (39 miles). The concrete portion of the road is built in three sections, two outside sections 3.25 meters (10 feet 8 inches) in width and a central section 1.5 meters (4 feet 11 inches) wide treated with an asphaltic composition. Various types of surface have been used on the balance of the road.

The Rio de Janeiro-Petropolis Road will form a part of the main artery from Rio de Janeiro to Bello Horizonte, the capital of Minas Geraes.

*Other roads.*—In addition to these two main projects, 15 kilometers (9.3 miles) of new roads in the vicinity of Mount Tijuca were constructed in 1927. Other construction was undertaken in 1928 and much repair work done in both years. These roads serve primarily touring purposes and also a number of small towns in the vicinity of Rio de Janeiro. The road from Sao Joao to Barracao was placed under the supervision of the army engineers. Relatively little work was done in 1927, though some progress was made in 1928 and 1929.

#### ADMINISTRATION AND FINANCE

Prior to 1927, roads built under subventions and by the Federal irrigation service were paid for out of the general revenues of the country. The system of subventions was discontinued with the approval of a highway law of January 5, 1927, which provided a special fund for construction and maintenance of roads. Under that law revenues for the highway fund were provided through an increase in the import duty amounting to 20 per cent of the existing duties on automotive products and a tax of 60 reis a liter (approximately \$0.027 a gallon) on gasoline and 50 reis a kilo (\$0.0027 a pound) on automobile accessories. It was calculated that the receipts in 1927 would amount to approximately 25,000 contos (approximately \$2,990,750) and in 1928 to approximately 35,000 contos (approximately \$4,187,050), but the actual receipts amounted to slightly less than half those amounts. In order to bring the income up to the point originally estimated, the President, by decree of September 5, 1928, increased the additional rates of duty to 30 per cent on automobile products, to 80 reis a liter (approximately \$0.0362 a gallon) on gasoline, and to 60 reis a kilo (\$0.0033 a pound) on accessories which pay duty on a weight basis.

In order to continue the Federal highway building program, the issuing of highway bonds was also authorized. These bonds bear interest at 5 per cent, are redeemable in 20 years, and are to be amortized each November at the rate of 5 per cent of the total in circulation on September 30 of each year. It is provided that the interest and amortization charges of the total amount of the bonds in circulation shall not be greater than provided in the budget for the highway fund, and that these bonds shall be merely considered an advancement of the fund and guaranteed by the fund itself. The fund shall not affect the general revenues of the country.

At the end of 1928 the results were still unsatisfactory. The Federal Government had spent on road work the amount of 63,416:991\$000 (\$7,586,575), of which amount only 17,898 contos (\$2,141,138) was provided directly by the special road-building fund derived from the additional import duties. The remaining 45,519 contos (\$5,445,438) represented the proceeds of the sale of highway bonds. The total collection from the additional import duties amounted in 1927 to only 10,784 contos (\$1,290,090), or less than half the amount that had been expected. In 1928 the additional import duty produced 20,670:818\$000 (\$2,472,850). A part of this money was used directly for the purpose of paying obligations which had been contracted in the construction of highways during 1927 and 1928. Against the remainder, highway bonds were issued. Of 80,000 contos (\$9,570,400) of bonds which the Govern-

ment was authorized by law to issue, 76,000 contos (\$9,091,880) were sold by the end of 1929. Since the beginning of 1929 the issuance of 20,000 contos (\$2,392,600) more of highway bonds has been authorized, but it is not believed that they have been sold.

The Minister of Finance on June 1, 1929, ordered the 30 per cent additional import duty on automobiles, etc., to be thenceforward so calculated as to represent 30 per cent of the duties payable after the gold portion of the nominal duty—60 per cent—had been converted to paper. The significance of this order lies in the system of collecting import duties in Brazil, by which 60 per cent of the nominal duty is computed on the basis of a theoretical gold currency and the remainder in paper milreis. Hitherto the additional duties for the highway fund have been computed only on the nominal duties. The effect of the change was to increase the amount to be collected for highway purposes over 200 per cent.

Assuming a steady rate of imports, the income in 1929 from the additional duty should have amounted to over three times as much as in 1928, which was 20,671 contos (\$2,472,872), but as a matter of fact it reached only 38,626 contos (\$4,620,828).

#### SPECIFICATIONS AND MAINTENANCE

According to plans adopted by the highway division, all Federal roads are to have a width of at least 8 meters (26 feet 3 inches) and a grade of not greater than 6 per cent. The minimum radius of curves is set at 50 meters (164 feet) and the minimum tangent between opposing curves at 40 meters (131.2 feet).

The following table shows the extent of various types of surfaces used on the federal highways up to August, 1929.

SURFACE OF BRAZILIAN FEDERAL HIGHWAYS

Type of surface	Square meters	Square yards	Type of surface	Square meters	Square yards
Concrete.....	15,680	18,753	Sand and clay.....	997,768	1,183,316
Bituminous macadam.....	77,387	92,554	Road-oil surface treatment....	34,940	41,788
Silicated macadam.....	4,200	5,023	Total.....	1,545,607	1,848,524
Waterbound macadam.....	346,320	414,194			
Gravel.....	69,312	82,896			

Maintenance squads are constantly maintained on the roads not having hard surfaces. The size of the squads and the extent of road covered by them depends on the type of road and the season of the year. The roads are maintained by both mechanical equipment and hand labor. At intervals of 50 kilometers (31 miles) are residences for inspectors and shop facilities for repairing the mechanical road equipment.

#### PROJECTED FEDERAL ROADS

In addition to completing the Rio-Petropolis Road and continuing the Sao Joao-Barracao Road, the principal projects of the Federal Government include the following:

1. Continuation of the Rio de Janeiro-Petropolis Road to the boundary of Minas Geraes; this project consists principally in repairing and improving the old "Uniao e Industria" road.

2. Petropolis to Therezopolis; it is planned to continue this road north through the State of Rio de Janeiro to Espiritu Santo.

3. Areias to Caxambu, Cambuquira, etc.; a branch of the Rio-Sao Paulo road running north into Minas Geraes.

#### INTERSTATE HIGHWAYS

A number of the States are coordinating their highway programs with those of adjoining States, thus developing important interstate highways. Sao Paulo has taken the lead in this respect. The most important of these interstate roads are in the southern part of Brazil, radiating from either Rio de Janeiro or Sao Paulo. The most important and best of these, of course, is the highway linking these two cities.

The interstate roads radiating from Sao Paulo are as follows:

1. Sao Paulo to the capitals of the three southern States of Parana, Santa Catharina, and Rio Grande do Sul. This road, when finished, will connect

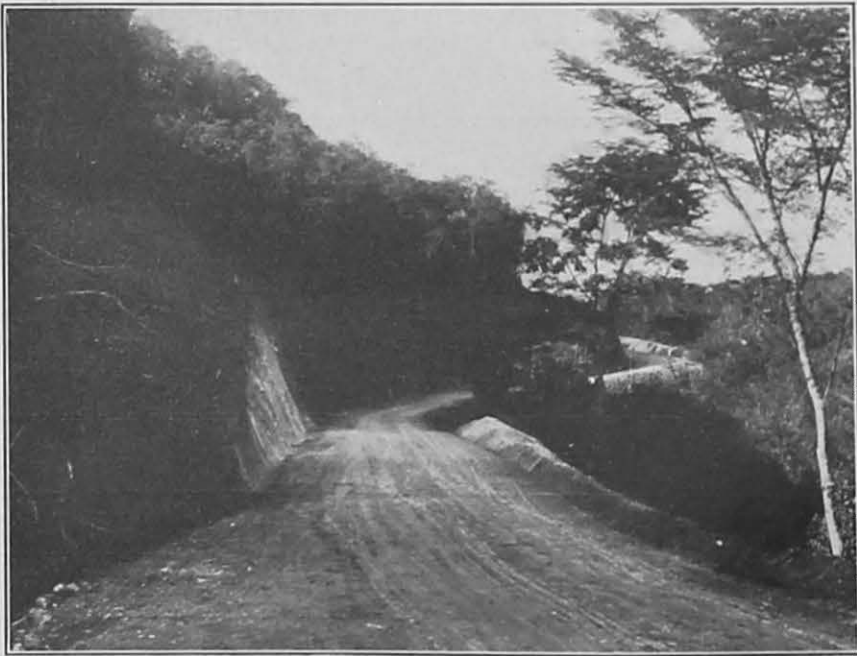


Figure 1.—A section of the Bello Horizonte-Rio de Janeiro road in Minas Geraes

Sao Paulo with Curitiba, Florianopolis, and Porto Alegre, and will have a total length of approximately 1,900 kilometers (1,181 miles). The Sao Paulo part of this road is practically completed and is a good motor road. Thence to Curitiba the road is partially completed. Approximately one-half the distance in the State of Santa Catharina is a good improved earth road. The entire trip can be made without difficulty in the dry season.

2. Sao Paulo to Goyaz, the capital of the State of Goyaz, via Riberao Preto (Sao Paulo) and Uberaba (Minas Geraes), a total distance of about 1,230 kilometers (764 miles). This road is now passable most of the year.

3. Sao Paulo to Bello Horizonte, Minas Geraes, a distance of approximately 600 kilometers (373 miles). The Sao Paulo section of the road is completed and in good condition. Part of the Minas Geraes section has been finished and the balance projected or under construction. In dry weather it is now possible to go from Sao Paulo to Bello Horizonte via Riberao Preto, but the distance is much greater by that route.

4. Sao Paulo to Cuyaba, Matto Grosso, via Rio Preto, a distance of approximately 2,330 kilometers (1,448 miles). The Sao Paulo section of the road as far as Sao Manoel (287 kilometers or 178 miles) is in good condition. The balance is under construction or projected. That part of the road in Matto Grosso is, for the most part, an unimproved earth road.

The principal interstate roads out of Rio de Janeiro are the one to Sao Paulo, previously mentioned, and that to Bello Horizonte. The former is 520 kilometers (323 miles) in length and is a good hard-surfaced and improved earth road. The road from Rio to Bello Horizonte is approximately 500 kilometers (311 miles) in length.

Numerous other less important interstate roads have been built, but for the most part they are entirely of simple earth construction. Some are passable the year round, such as the road from Recife to Parahyba, but most of them are passable only in the dry season. Further reference to these and other State roads is made in later sections.

#### EXTENT OF ROADS IN BRAZIL

The prosperous and thickly settled southeastern States of Brazil have better highways than the others, though some of the northern States are making rapid progress. The section including Espirito Santo, Rio de Janeiro, the Federal District, Minas Geraes, Sao Paulo, Parana, Santa Catharina, and Rio Grande do Sul have approximately 4,590 kilometers (2,852 miles) of good motor roads, about 9,450 kilometers (5,872 miles) of additional roads passable for automobiles in practically all seasons of the year, and 59,080 kilometers (36,711 miles) passable in the dry season. This comprises about 65 per cent of all the roads in Brazil suitable for motor traffic, 90 per cent of the good motor roads, 65 per cent of the roads passable for automobiles in all seasons, and 63 per cent of those passable in the dry season.

The eastern and northern coast States have about 11 per cent of the country's good motor roads, 540 kilometers (336 miles); 35 per cent of the roads passable all year, approximately 5,046 kilometers (3,135 miles); and 26 per cent of the roads passable for automobiles in the dry season, nearly 24,000 kilometers (14,913 miles); making a total of 29,553 kilometers (18,363 miles), roughly 26 per cent of the motor roads in Brazil.

The interior States of Amazonas, Matto Grosso, and Goyaz, sparsely settled and dominated by the great river systems, have only approximately 10,600 kilometers (6,587 miles) of motor roads, or 9 per cent of the total. Very few of these can be classed as good. The following table shows approximately the extent of roads of various types in the different States of the Republic.

## MOTOR ROADS IN BRAZIL

## EXTENT OF MOTOR ROADS IN BRAZIL

(In kilometers)

State	Concrete	Asphaltic concrete	Macadam	Gravel	Improved earth	Unimproved earth	Total
Amazonas.....					77,540	238,000	315,540
Para.....					105,000	250,500	355,500
Maranhao.....					470,000	2,649,000	3,128,000
Piauhv.....					181,500	2,832,500	3,014,000
Ceara.....					635,014	2,632,210	3,267,224
Rio Grande do Norte.....				30,000	516,570	3,426,000	3,972,570
Parahvba.....					750,292	3,062,587	3,812,879
Pernambuco.....			100,000	120,000	956,980	3,726,000	4,902,980
Alagoas.....				95,000	49,200	1,427,000	1,571,200
Sergipe.....				40,000	128,840	159,660	328,500
Bahia.....	9,000			146,000	1,243,435	3,502,038	4,900,473
Esprito Santo.....	500		38,125		468,910	627,030	1,134,565
Rio de Janeiro.....	23,000		158,000		622,000	3,087,020	3,890,020
Federal District.....	260	18,160	253,100		230,380	46,500	548,400
Sao Paulo.....	12,719	30,991	73,404	2,364,115	2,674,771	22,006,000	28,062,000
Parana.....		10,000	90,000	279,450	351,320	7,757,230	8,488,000
Santa Catharina.....				370,000	557,000	6,122,000	7,049,000
Rio Grande do Sul.....			70,000	278,000	2,020,000	9,174,000	11,542,000
Minas Geraes.....			21,000	500,000	2,525,844	9,359,890	12,408,734
Goyaz.....					589,500	3,831,334	4,420,834
Matto Grosso.....					994,000	4,846,000	5,840,000
Total kilometers.....	45,479	59,151	805,629	4,222,505	16,157,006	91,962,409	113,252,419
Equivalent in miles.....	28.25	36.76	500.60	2,623.77	10,030.52	57,142.75	70,371.65



## HIGHWAY DEVELOPMENT BY STATES

### FEDERAL DISTRICT

The city of Rio de Janeiro, the capital of Brazil, is located on the northern edge of the Federal District. The district is surrounded on three sides by water and on the north by the State of Rio de Janeiro, and is 451 square miles in area. Most of this area is mountainous, the only level portions being several small valleys and the terrain bordering the sea. The city of Rio de Janeiro occupies some 50 square miles of the coast land. The city has the largest population of any in Brazil, and it contains most of the population of the Federal District, which was estimated as 1,431,688 on December 31, 1928. The Federal District is second to Sao Paulo as an industrial center and manufactures a number of different articles, the most important being textiles.

The Central Railway of Brazil provides communication with the capitals of the States of Minas Geraes and Sao Paulo and places Rio de Janeiro in touch with lines operating to the Paraguay River, on the western boundary of Matto Grosso, and also with Argentina, Uruguay, and all of southern Brazil. The Leopoldina Railway, which is the other of the two lines operating from Rio de Janeiro, connects the capital with States of Rio de Janeiro, Espirito Santo, and Minas Geraes. Brazil's capital is in close water communication with all the principal ports of the world. Regular sailings give excellent passenger accommodations and fast-freight service.

### HIGHWAYS

With the exception of the main trunk roads in the Federal District, such as the Rio de Janeiro-Sao Paulo and the Rio-Petropolis roads, road building and maintenance is under the direction of the local government of the Federal District. A division of the Obras e Viacao Department, known as the Directoria de Estradas de Rodagem, is directly responsible for this work. In 1928 some 3,000 laborers were employed in road building and maintenance work of the Federal District. For the most part, the roads in the district are well maintained and passable throughout the year. Some of the earth roads are impassable after an extremely heavy rain, but all of the macadam roads are passable throughout the year and generally may be considered first-class motor roads.

The road system of the Federal District comprises 548.4 kilometers (340.8 miles) of motor highways. Of this amount 466.5 kilometers (289.9 miles) were in service as first-class roads at the close of 1928. The 1928 road work consisted of building 183 kilometers (113.7 miles) of roads, the reconstruction of 156.5 kilometers (97.24 miles) and repairs to 127 kilometers (78.9 miles). Detailed statistics as to the expenditures on road construction and maintenance are not available.

Of the roads in the Federal District, macadam surface predominates, with 253.1 kilometers (157.3 miles). The authorities had laid 18.16 kilometers (11.3 miles) of asphaltic concrete and 0.26 kilometer (0.16 mile) of concrete, a total of 271.52 kilometers (168.7 miles) of hard-surfaced roads. Of the earth roads, 230.38 kilometers (143.2 miles) were improved and passable the year round, and the remaining 46.5 kilometers (28.9 miles) were unimproved earth roads.

## PRINCIPAL ROADS IN THE FEDERAL DISTRICT

Road	Length		Width in meters <sup>1</sup>	Type
	Kilo- meters	Miles		
Paineiras Road.....	5	3.1	5	Rolled earth, repaired in 1928; an additional 10 kilometers (6.2 miles) under construction.
Ave. Niemeyer.....	5.5	3.4	9	Formerly water-bound macadam; 1,600 kilometers (994 feet) bituminous macadam and 260 meters concrete laid in 1928 (835 feet).
Gavea Road.....	15	9.3	9	Good motor road. About 2 kilometers (1.25 miles) concrete, balance macadam laid in 1928.
Tanhanga-Jacarepagua.....	22	13.7	7	Macadam, repaired in 1928.
Fao Ferro Road.....	12	7.5	6	Improved earth road; 9 kilometers (5.6 miles) rebuilt in 1928, remainder under construction.
Vargem Grande Road.....	21	13.0	7	Being resurfaced with macadam, 8 kilometers (5 miles) of which were completed in 1928.
Gavea Pequena Road.....	8	5.0	(?)	Macadam.
Floresta Road.....	20	12.4	(?)	Improved earth road.
Tijuca Road.....	5.5	3.4	7	Macadam, improved in 1928.
Furnas Road.....	6	3.7	6	Macadam, much of surface renewed in 1928.
Donna Castorina and Vista Chineza Road.....	12	7.5	7	Earth road, improved in 1928.
Cascatimba da Tijuca.....	8	5.0	5	Macadam, maintained by Federal Government; repaired in 1928.
Taquara Road.....	11	6.8	7	Macadam, repaired in 1928.
Royal Road of Santa Cruz.....	40	24.9	8-12	Macadam; part of this forms a section of the Rio de Janeiro-Sao Paulo Road.
Campo Grande to Guaratiba.....	30	18.6	6-9	9 kilometers (5.6 miles) macadam, remainder earth surfaced; improved in 1928.
Campo Grande to Pedra.....	21	13.0	6	17 kilometers (10.6 miles) macadam, remainder earth surfaced.
Branch from Fazenda do Sacco to Pedra.....	5	3.1	6	Earth surfaced.
Grota Funda Road.....	11	6.8	7-9	Earth surfaced, parts rebuilt and improved throughout in 1928.
Sepetiba Road.....	65	40.4	6	Earth surfaced, improved in 1928.
Campo do Collegio Road.....	9	5.6	7	Earth surfaced, rebuilt in 1928.
Aeria Branca Road.....	3	1.9	7	Do.
Morro do Ar Road.....	6	3.7	7	Do.
Palmares Road.....	13	8.1	7	Earth surfaced, 4 kilometers (2.5 miles) completed, remainder being reconstructed.
Mendanha Road.....	7	4.3	7	Macadam, rebuilt in 1928.
Santissimo to Guandu.....	8	5.0	6	Earth surfaced.
Uhas Road.....	2.5	1.6	6	Improved, earth surfaced.
Joary and Rio da Prata do Cabussu Road.....	7	4.3	6	4 kilometers (2.5 miles) macadam, remainder earth surfaced; improved in 1928.
Bangus to Mendanha Road.....	13	8.1	7	Earth surfaced, improved in 1928.
Viegas to Rio da Prata.....	6	3.7	5	Do.
Piabas and Pontal Road.....	10	6.2	6	Earth road, rebuilt in 1928.
Consulado to Rio da Prata.....	9	5.6	7	Do.
Retiro Road.....	5	3.1	6	Earth road; 1 kilometer (0.62 mile) finished, rest under construction.
Morro Cavado Road.....	4	2.5	6	Earth road; 2 kilometers (1.25 miles) completed, remainder under construction.
Pre Road.....	3	1.9	6	Earth road completed in 1928.
Posse to Lameirao.....	5	3.1	6	Do.
Santissimo to Posse.....	2	1.2	6	Do.
Villa Nova to Bangu.....	6	3.7	(?)	Do.
Inhoahyba to Palmares.....	2.5	1.6	(?)	Do.
Furado to Paciencia.....	7	4.3	6	Earth road, under construction.
Senador Vasconcellos.....	2	1.2	7	Macadam; 1 kilometer (0.62 mile) completed in 1928, balance under construction.
Nazareth to Rio da Prata.....	6	3.7	(?)	Macadam, repaired in 1928.
Anchieta to Pavuna.....	5	3.1	(?)	Do.
Automobile Club Road.....	15	9.3	(?)	Macadam, undergoing repairs.
Pavuna Road.....	3	1.9	(?)	Macadam.
Freguezia Road.....	3	1.9	(?)	Macadam, repaired in 1928.
Itarare Road.....	2	1.2	(?)	Do.
Vicente Carvalho.....	4	2.5	(?)	Macadam.
Quitungo Road.....	5	3.1	(?)	Macadam, undergoing repairs.
Braz de Pinna.....	2	1.2	(?)	Macadam.
Braz de Pinna to Vigario Geral.....	4	2.5	(?)	Asphaltic macadam; forms part of the Rio de Janeiro-Petropolis Road.
Intendente Magalhaes Road.....	9	5.6	(?)	Macadam; most of this road was incorporated in the Rio de Janeiro-Sao Paulo Road.
Madureira to Vigario Geral.....	10	6.2	(?)	Under construction.
Joao Vicente Road.....	7	4.3	(?)	Macadam, rebuilt in 1928.

<sup>1</sup> Conversion, meters to feet:

5 meters.....	16	4 $\frac{3}{4}$
6 meters.....	19	8 $\frac{1}{4}$
7 meters.....	22	11 $\frac{1}{16}$
8 meters.....	26	3

Not available.

Conversion, meters to feet—Contd.

9 meters.....	29	6 $\frac{3}{16}$
10 meters.....	32	9 $\frac{3}{16}$
11 meters.....	36	13 $\frac{1}{16}$
12 meters.....	39	4 $\frac{3}{16}$

## CITY PAVING

The city of Rio de Janeiro is well paved throughout, and the streets are well maintained. Many of the streets in the down-town business districts are very narrow, but there are numerous wide avenues which help to relieve traffic congestion.

During 1927 and 1928 the municipal administration paved 205 streets, representing an area of 937,658 square meters (1,121,425 square yards). The cost amounted to 14,490 contos (approximately \$1,733,439), the city's expenditures being paid from its general revenues without resorting to any special loan or increasing the 25 per cent contribution levied on fronting property. The paving material varied, as follows:

*Asphalt.*—Seventeen streets, with a total of 67,004 square meters (80,136 square yards); total cost 4,545 contos (\$543,718), average cost 67\$832 a square meter (\$6.79 a square yard).

*Asphaltic concrete.*—Fifty-five streets, an area of 248,918 square meters (297,702 square yards); total cost 8,746 contos (\$1,046,284), average cost 35\$136 a square meter (\$3.52 a square yard).

*Paving block over concrete.*—Fourteen streets, with an area of 91,740 square meters (109,820 square yards); total cost 5,404 contos (\$646,481), average cost 58\$900 a square meter (\$5.89 a square yard).

*Bituminous macadam.*—Thirty streets, with an area of 121,875 square meters (145,761 square yards); total cost 2,766 contos (\$330,897), average 22\$695 a square meter (\$2.27 a square yard).

*Construction with secondhand paving block.*—Eleven streets, with an area of 12,980 square meters (15,524 square yards); total cost 474 contos (\$56,705), average cost 36\$517 per square meter (\$3.65 a square yard).

*Paving block over dirt.*—Eight streets, with an area of 12,110 square meters (14,483 square yards); total cost 194 contos (\$23,208), average cost 16\$198 a square meter (\$1.60 a square yard).

## SAO PAULO

The State of Sao Paulo is as large as the combined area of the New England States and Pennsylvania, but ranks only ninth in size among the States of Brazil; its area represents slightly over 3 per cent of the total area of Brazil. The estimated population on December 31, 1928, was 5,175,685. The State is geographically divided into two very distinct regions, the lowland and the plateau. The low coastal plain is very narrow in the north but becomes gradually broader toward the south, attaining a width of about 80 miles. The plateau constitutes the most important part of the State, forming an immense table-land with an average altitude of about 2,000 feet above sea level.

Sao Paulo is the chief agricultural State of Brazil. Besides producing over half of the world's coffee, it has a large annual production of cotton, sugar, tobacco, beans, maize, rice, and other cereals. Cattle raising is an important industry, as is also the raising of small stock and poultry. The mineral riches of Sao Paulo include gold, petroleum, marble, building stone, iron, and manganese. The State is the great industrial center of Brazil and produces a great variety of manufactured goods. The city of Sao Paulo ranks as the second largest manufacturing center in South America.

Railroads connect the principal cities and important communities. The present lines total nearly 4,300 miles, the second greatest railroad mileage of any Brazilian State. One of the finest railways in existence connects Sao Paulo with Santos, the world's greatest coffee port. Railroads spread fanlike over the whole State except the ex-

treme western part, cross the center of the State to Uruguay and Argentina, extend into Minas Geraes, Goyaz, and Matto Grosso, and connect Sao Paulo with the Federal capital. Although there are some 560 miles of navigable rivers in Sao Paulo, they play a relatively small part in the State's transportation facilities. The Tiete River, which rises in the mountains near Sao Paulo and flows southward into the Parana, is the largest. This and several other branches of the Parana are used to some extent by small craft in the undeveloped regions of the western part of the State.

#### HIGHWAY SYSTEM

The highway system of Sao Paulo somewhat resembles the railway net, in that the roads extend in all directions from the city of Sao Paulo. The system may be said to have had its beginning in 1773, when a monthly land-mail service was inaugurated between Sao Paulo and Rio de Janeiro. Then, between 1788 and 1797, Governor Bernardo José de Lorena constructed a zigzag path 3 meters wide, paved with rocks, over the mountains from Sao Paulo to Santos. It was not passable for wheeled vehicles, as the grade was so steep that animals descending the path often slid on their haunches from one turn to another, and the path was lined with the bones of mules which had died under their burden. This road had superseded a very rough trail cut across the range by the Jesuits from San Vicente to their mission settlement at Sao Paulo. During the early half of the nineteenth century the discovery of gold in Minas Geraes caused the construction of some good roads. These were abandoned when the mines became exhausted.

Practically no road work was done from 1854 until 1908, when a group of Paulistas united in a project to build an automobile road from Sao Paulo to Santos. In that year the Automobile Club of Sao Paulo did much to repair the existing road. The State government later took over the work, and an automobile road from Sao Paulo to Santos was completed in 1919.

Sao Paulo took the lead among the Brazilian States in the matter of a campaign for good roads and has maintained it to the present time. State road congresses were held in Sao Paulo in 1917, 1919, and 1923. In connection with the 1919 congress a reconstruction of the road from Sao Paulo to Campinas was commenced. This road and that from Sao Paulo to Santos form the nucleus of all recent road building in the State.

#### HIGHWAY PROGRAM

On December 26, 1921, the State Congress approved a law creating a State highway-inspection service, which was responsible for the construction and maintenance of all State roads. A later decree amended this law, providing a general plan for State roads and regulating the financing, methods of construction and maintenance, police service, and traffic security. In 1927 an entirely independent highway department was created.

The highway program adopted by the State of Sao Paulo includes the construction of five main trunk highways. These include the following:

1. Sao Paulo to the State of Rio de Janeiro, the Sao Paulo section of the Rio de Janeiro-Sao Paulo Road.

2. Sao Paulo to the State of Minas Geraes, via Riberao Preto and Ituverava, connecting with roads in Minas Geraes and Goyaz and leading to the capital of the latter State.

3. Sao Paulo to the State of Matto Grosso, via Botucatu and Araccatuba.

4. Sao Paulo to the State of Parana, via Itapetininga and Ribeira, eventually to link Sao Paulo with the capitals of the three southern States.

5. Sao Paulo to Santos and Iguape, a coastal road to the southeastern part of the State.

In addition to these, there are five main routes provided in the plan, as follows:

(a) Itapetininga to Presidente Epitacio, via Salto Grande, supplementing route 4 above and serving the western part of the State.

(b) Novo Odessa to Potyrendaba, via Piricicaba and Jahu, supplementing route 3 above.

(c) Rio Clara to Rio Preto, via Sao Carlos and Araraquara, supplementing route 2 above.

(d) Riberao Preto to Rio Preto, via Jaboticabal, supplementing route 2 above.

(e) Sao Paulo to Ribeira via Itapeirica and Xirica, second route to the State of Parana.



Figure 2.—A section of the Bello Horizonte-Sao Paulo road

This program provides for the construction of nearly 9,000 kilometers (5,592 miles) of State highways, of which over 2,656 kilometers (1,650 miles) had been completed up to the end of 1928, practically all first-class roads. This left approximately 6,300 kilometers (3,916 miles) to be constructed under the scheme. The existing roads had been practically all completed during a period of about seven years. Based on the cost of roads previously constructed, it was estimated that 40 contos a kilometer (\$7,740 a mile) would be required, approximately 190,000 contos (\$22,729,700) to complete the State program. It was estimated that 5 to 10 years would be needed to finish the work.

## PROGRESS IN ROAD BUILDING

The following table shows the total length of roads built and maintained by the State since 1921.

## LENGTH OF ROADS BUILT AND MAINTAINED BY STATE OF SAO PAULO AS OF DECEMBER 31

[In kilometers]

Type	1921	1922	1923	1924	1925	1926	1927	1928
Earth.....	105	614	1,226	1,310	1,558	1,677	1,575	1,243
Gravel.....		124	118	350	260	357	739	1,322
Macadam.....		55			118	81	63	63
Concrete.....					2.5	8	8	8
Asphaltic concrete.....								14
Wood.....					1.5	2	6	6
Total kilometers.....	105	793	1,344	1,640	1,940	2,125	2,391	2,656
Equivalent in miles.....	65.2	492.7	835.1	1,019.1	1,205.5	1,320.3	1,495.7	1,650.4

The initial years, 1922 and 1923, were those of greatest construction work. During the following years the greatest activity occurred in the relaying of various roads which required improved surfaces to handle the increased traffic. In 1926 there were 60 kilometers (37.3 miles) relaid with gravel or macadam, whereas in 1927 this was increased to 364 kilometers (226 miles). The bulk of the road work in 1928 consisted of improving existing earth roads and in building 583 kilometers (362.3 miles) of gravel roads.

A comparison of the road-building work of the three past State administrations is interesting. During the administration of 1916-1920 only 32.8 kilometers (20.4 miles) of road were built. During the following administration, from May 1, 1920, to April 27, 1924, 1,535.377 kilometers (954 miles) were built, and from April 27, 1924, up to December 31, 1928, 1,088.24 kilometers (676.2 miles) of roads were built.

The foregoing figures represent only the State highways; to these figures must be added the roads built by the various municipalities and by private enterprises. Many of these are moderately good motor roads and passable the year around. Complete figures are not available showing the totals of all roads in the State, but based on official and other sources, it was estimated at the close of 1927 that there was a total of 20,466 kilometers (12,717 miles) of roads in the State, as compared with less than 7,000 kilometers (4,350 miles) at the close of 1924. The present system is divided as follows: Good motor roads, 2,717 kilometers (1,688 miles); passable all year, 7,749 kilometers (4,815 miles); passable in dry season, 10,000 kilometers (6,214 miles). In addition, much work is planned covering the reconstruction and building of new roads, but detailed figures are not available.

As regards the actual progress made on the State highway program, the following outlines the accomplishments up to the close of 1928:

*Sao Paulo to Rio de Janeiro.*—Construction was commenced in 1921 and the road officially opened on May 5, 1928. That part of it from Sao Paulo to the boundary of the State of Rio de Janeiro, 379 kilometers (235 miles), was constructed by the State of Sao Paulo. The road is 8 meters wide. Numerous branch roads with a total length of 118.6 kilometers (73.7 miles) serve adjacent towns.

*Sao Paulo to the State of Minas Geraes.*—The State has completed this road as far as Riberão Preto, a distance of 344 kilometers (214 miles). This will continue to Igarapava on the Minas Geraes border. It is a first-class earth road 8 meters wide. Various branch roads with a total length of 380 kilometers (236 miles) have also been built. The width of these is 6.5 meters (21 feet 3 $\frac{1}{8}$  inches).

*Sao Paulo to Matto Grosso boundary.*—This road has been completed as far as São Manoel, a distance of 287 kilometers (178 miles), and is a first-class earth road 6.5 meters in width. The road is definitely projected to Aracatuba, an additional 331 kilometers (206 miles), and will eventually be continued to the Matto Grosso boundary. That part from São Manoel to Bauru, 80 kilometers (50 miles), was under construction in 1929.

*Sao Paulo to Parana.*—The total length of this road from São Paulo to the Parana boundary is 367 kilometers (228 miles). It was completed as far as Guapiara, 274 kilometers (170 miles), in 1928, and the remainder was under construction in 1929. It is a first-class earth road 6.5 meters wide. Branch roads with a total length of 161 kilometers (100 miles) have also been built.

*Sao Paulo to Santos, Iguape, and Cananea.*—The road from São Paulo to Santos, 62 kilometers (39 miles) in length, is known as the Fergueiro road and is one of the oldest in the State. This part of the road is paved almost entirely with gravel, macadam, or concrete, and the present traffic amounts to approximately 700 vehicles per day. Concrete was laid over an old macadam surface in the mountainous section in 1925 and 1926, the first concrete road to be built in Brazil. From Santos the road climbs abruptly to nearly 2,500 feet and the grades reach a maximum of 14 per cent in some parts. An asphaltic-concrete paving was also laid from Santos across the coastal plain to the concrete mountain road in 1928. Relatively little has been done on the remainder of the road.

Other important roads constructed by the State include the one from São Paulo to Bragança and that connecting Campinas, Itu, and Sorocaba. The former is a fifth-class road at present and 85 kilometers (52.8 miles) in length. It is 5 meters (15 feet 4 $\frac{7}{8}$  inches) in width, with average grades of 6 per cent, but it is constantly being widened and improved, as it will eventually form a link of the interstate road connecting São Paulo and Belo Horizonte. The latter road connects three important cities on three of the main trunk roads leading out of São Paulo, and it is a first-class earth road, 86 kilometers (53.4 miles) in length.

#### ROADS UNDER CONSTRUCTION

The roads under construction or authorized by the State at the commencement of 1929 were as follows:

Conclusion of the São Paulo-Parana Road, from Guapiara to Ribeira, 93 kilometers (57.7 miles).

Itapetininga to Angatuba, 40 kilometers (24.9 miles), and Bom Sucesso Piraju, 88 kilometers (54.7 miles); these roads form part of the subtrunk road serving the southwestern part of the State.

São Miguel Archanjo to Sete Barras, 87 kilometers (54.1 miles), serves the extreme southeastern part of the State.

Capella do Alto to Tatui, 20 kilometers (12.4 miles); Itapetininga to Guarchy, 34 kilometers (21.1 miles); Pinheiros to Cotia, 27 kilometers (16.8 miles). (These are branches of the São Paulo-Parana Road.)

São Manoel to Bauru, 80 kilometers (49.7 miles), part of the São Paulo-Matto Grosso Road.

Villa America to Piracicaba, 38 kilometers (23.6 miles), branch of São Paulo-Minas Geraes Road.

Bigua to Una, 12 kilometers (7.5 miles), in the southeastern part of the State.

#### CLASSIFICATION OF ROADS

In 1927 a definite classification for roads built and maintained by the State was adopted, depending on the traffic and economic

importance. The classification and specifications for each class are as follows:

Item	First class	Second class	Third class	Fourth class	Fifth class
Minimum right of way.....meters..	12	12	10	10	8
Minimum width of pavement.....do...	6.5	6	6	5	5
Maximum grade.....per cent..	6	6	6	6	6
Minimum radius of curves.....meters..	50	50	40	40	30
Minimum tangent between opposing curves.....do...	40	20	10		

#### HIGHWAY FINANCING

As has been indicated, the law of 1926 authorized a loan of 100,000 contos for State road building. This law also created a separate highway fund which was to serve as a guarantee for the loan. To provide further revenues for the highway fund special taxes were assessed on property paralleling the State roads. State vehicle taxes were also provided; formerly, all vehicle registration fees were collected only by municipalities. The early returns from these taxes proved very disappointing, and during the year the taxes were reduced by the congress and provision made that municipal vehicle-registration taxes should not be collected without a receipt for the State tax. Although an external loan has been authorized, no attempt has been made to float it; and it is not likely that this will be undertaken in the near future.

The taxes for the highway fund, which have been in effect since January 1, 1929, are as follows:

*Property tax.*—Two hundred reis per hectare (about 1 cent per acre) on land paralleling State roads up to a distance of 10 kilometers from the road; 100 reis per hectare on land paralleling state roads of a distance from the road of 10 to 20 kilometers (6.2 to 12.4 miles).

*Vehicle taxes.*—

#### PASSENGER VEHICLES DRAWN BY ANIMALS

Vehicles having two wheels and pneumatic rubber tires.....	\$11.80
Two-wheeled vehicles having solid rubber tires.....	17.70
Two-wheeled vehicles having wooden or steel tires.....	23.60
Four-wheeled vehicles having pneumatic tires.....	17.70
Four-wheeled vehicles having solid rubber tires.....	23.60
Four-wheeled vehicles having wooden or steel tires.....	20.50

#### VEHICLES DRAWN BY ANIMALS, USED FOR HAULING

Two-wheeled vehicles with springs.....	17.70
Two-wheeled vehicles without springs.....	23.60
Four-wheeled vehicles with springs.....	17.70
Four-wheeled vehicles without springs.....	23.60

#### PASSENGER VEHICLES

Automobiles up to 25 horsepower.....	8.25
Automobiles from 25 to 35 horsepower.....	11.80
Automobiles from 35 to 60 horsepower.....	17.70
Automobiles more than 60 horsepower.....	23.60
Motorcycles.....	8.25

#### TRUCKS, TRACTORS, AND BUSES

Trucks hauling up to 1 ton:	
Having pneumatic tires.....	9.44
Having solid rubber tires.....	15.34



Trucks hauling 1 to 3 tons :	
Having pneumatic tires.....	\$23. 60
Having solid rubber tires.....	35. 40
Trucks hauling 3 to 6 tons :	
Having pneumatic tires.....	59. 00
Having solid rubber tires.....	94. 40
Trucks hauling more than 6 tons :	
Having pneumatic tires.....	94. 40
Having solid tires.....	177. 00
Trailers pay the same as trucks of equal tonnage.	
Tractors :	
Having rubber tires.....	59. 00
Having steel wheels.....	82. 60
For use of dealer license plates.....	17. 70

*Auto omnibus.*—Auto omnibusses, apart from paying as freight vehicles the tax corresponding to their tonnage, shall pay an additional tax of 5 milreis per seating capacity for each passenger.

The rates on trucks over 1 ton represent material increases over the rates in effect in 1928, which ranged from \$21.55 for trucks of 1 to 3 tons capacity with pneumatic tires, to \$47.20 for trucks of over 6 tons capacity with solid tires. No change occurred in taxes on other vehicles.

The only vehicles exempt from the State taxes are those of the Federal, State, or municipal Governments or institutions of charity, and those used by agriculturists only within the limits of their property. Vehicles registered after July 1 pay only one-half the fees listed above.

The following table shows the total highway expenditures of the State of Sao Paulo during the past 10 years.

HIGHWAY EXPENDITURES OF SAO PAULO, 1919-1928

[In contos]

Year	Average exchange value of conto	Roads			Bridges		Ferries	
		Mainten- ance under contract	Mainten- ance by State	New construc- tion	Mainten- ance	Construc- tion	Opera- tion	Construc- tion and mainten- ance
1919.....	\$262. 05	284	312	156	219	110	53	8
1920.....	210. 17	335	510	1, 015	43	86	57	6
1921.....	128. 77	334	254	1, 817	117	136	66	19
1922.....	129. 20	315	550	8, 831	251	93	61	18
1923.....	101. 77	340	449	9, 201	111	321	70	27
1924.....	108. 92	316	1, 916	13, 968	214	342	68	19
1925.....	120. 28	248	3, 539	8, 011	253	488	58	25
1926.....	142. 84	297	5, 665	16, 384	247	267	121	17
1927.....	118. 25	223	8, 876	21, 572	-----	1, 437	78	2
1928.....	119. 57	224	12, 470	18, 860	22	507	125	78

The amounts allotted during 1928 were \$322,472 for bridge construction and maintenance, \$2,245,741 for construction of new roads, and \$1,459,755 for maintenance of roads, including \$388,788 spent on repairs of the Sao Paulo-Santos road.

The State highways budget for 1929 amounted to \$1,653,836. State aid was granted to 113 of the 252 municipalities. The others do not share in these State-aid appropriations either because the work is of less importance, because they have previously had State aid, or because application was not received in sufficient time to be provided for.

Among the most important projects for 1929 was the resurfacing of the road from Sao Paulo to Campinas, 105 kilometers (65.62 miles), part of the road from Sao Paulo to Santos, and part of the Sao Paulo-Rio road. The surfaces are to be of concrete or asphalt replacing the existing earth surfaces.

The Sao Paulo 1930 appropriation called for one expenditure of 12,539,400\$000 (approximately \$1,479,649). The largest share of this appropriation was destined to cover maintenance and repair expenditures (\$708,000). The breakdown of the 1930 budget was as follows:

General expenses:	
Maintenance and repair of existing highways.....	\$708,000
Improvement and emergency.....	236,000
Repairs and maintenance of bridges and trestles.....	118,000
Contract maintenance and repairs.....	53,100
Purchase and maintenance of machinery.....	47,200
Passenger service in rafts and boats.....	23,600
<b>Total.....</b>	<b>1,185,900</b>
Bridges, completing work undertaken and new work.....	160,480
Municipal aid, subsidies for certain municipal roads; aid to 117 municipalities.....	71,862
Aid for specified highways.....	61,407
<b>Total.....</b>	<b>1,479,649</b>

#### MUNICIPAL AND PRIVATE ROADS

Largely as a result of the State's interest in highway building, a constantly increasing number of municipalities have undertaken road building since 1921; at the present time most of them are actively engaged in constructing roads which serve as feeders to the main State highways and other roads serving various sections of the municipality. No comprehensive data are available showing the total work done by the various municipalities in the State, and as there are some 252 municipalities it is very difficult to secure even an accurate estimate of the roads which have been built by them. All but 92 of the municipalities have separate appropriations for highway work and some have separate highway divisions, but very few report regularly on their road progress. In the 92 municipalities not having separate road appropriations, such expenditures come under the general public-works appropriation. Among these municipalities are included Santos, Rio Preto, Sao Bernardo, Bebedouro, etc., and the total public-works appropriations for these in 1929 reached 6,326,729\$000 (\$759,204).

The 160 municipalities which have special highway appropriations were to spend during 1929 a total of 5,502,910\$000 (\$660,360), excluding the State aids granted. There is a very marked difference in the ratio of the municipal road expenditures to their total expenditures. In one case the road expenditures slightly exceeded 40 per cent of the total budgeted expenditures, in 12 municipalities it exceeded 20 per cent, and in 64 it amounted to 10 per cent or more.

The municipality of Sao Paulo led all others in its 1929 road appropriations, with 1,084,672\$000 (\$130,200), and 10 municipalities appropriated 100 contos (\$12,000) or more for 1929.

Obviously, the total road expenditures of the municipalities can not be definitely arrived at; but, based on the statistics available for 160 municipalities, it is estimated that 4.1 per cent of the general appropriations for the 92 municipalities was to be spent on roads. Thus the total State and municipal expenditures of Sao Paulo for 1929, not including special appropriations made from time to time, may be estimated as follows:

State appropriations.....	13, 781 : 962\$500
Appropriations of 160 municipalities.....	5, 502 : 910\$000
Estimated appropriations of 92 municipalities.....	1, 266 : 161\$549
Total.....	20, 551 : 041\$049

Only very incomplete data are available as to the total extent of roads built and maintained by the various municipalities, but according to the State's official estimates at the close of 1928 there were 25,406 kilometers (15,787 miles) of municipal roads. These are all, with the exception of some roads in the municipality of Sao Paulo and a few others, of earth construction. It is impossible to make a division of existing roads according to municipality because of the incompleteness of returns.

The municipality of Sao Paulo is the most important and most progressive in respect to good roads in the State. According to official figures the types of pavements built and maintained by that municipality up to May, 1929, were as follows:

	Miles
Concrete.....	2. 95
Penetration asphaltic macadam.....	9. 48
Macadam with asphalt surface.....	2. 32
Gravel treated with road oil.....	1. 85
Waterbound macadam.....	3. 30
Gravel roads.....	37. 34
Improved earth.....	16. 50
Other earth roads.....	176. 93
Total.....	250. 67

The above roads do not include the city streets of Sao Paulo.

In addition to the municipal roads there are numerous privately built roads. Many of these are entirely within the limits of a single coffee plantation and serve only the needs of the owner, but others have been built under concessions from the municipalities or the State, and on those a toll is collected.

An important concession was granted in 1929 to a Sao Paulo firm for the construction of a concrete road from Sao Paulo to Santos, paralleling in a general way the existing road. Under the contract a toll was permitted, and the road was to become the property of the State at the end of 25 years. It was estimated that this road would cost \$5,000,000. The contract was signed by the State government on July 4, 1929, and under the terms of the contract it was required that it must be signed by the concessionaires within three months and that work be commenced on the road before July 4, 1930. Otherwise, the concession was to lapse without any obligations whatever on the part of the State. Work was not commenced, however, and financial difficulties have further retarded developments.

## CONSTRUCTION AND MAINTENANCE

The actual work of construction on State roads is done by contractors, generally under contracts for short sections, but the roads already constructed are generally maintained by the State. The contractors receive monthly payments.

Most of the State roads and practically all of the municipal and private roads are of simple earth construction. Some hard-surfaced roads have been built, and many of the earth roads are well drained, graded, and maintained and may be considered good motor roads. There is a total of 10,471 kilometers (6,544 miles) of roads which are passable throughout the year.

The cost of road building varies greatly in different parts of the State; while some cost figures are available, these are not sufficient to arrive at an average cost for the various types of roads.

## FUTURE ROAD WORK

A continuation of the road work in Sao Paulo may be definitely expected on a growing scale in the coming years. Throughout the State there is an increasingly insistent demand for good roads. The economic value of the road improvement is evident in many ways; regular truck services are operated between Sao Paulo and Rio de Janeiro, and interurban bus services are rapidly increasing in the interior parts of the State.

The State of Sao Paulo now has 453 miles of good automobile roads 26 feet wide, 647 miles 21 feet wide, and 282 miles 16 to 20 feet wide. Of the dirt roads, 1,612 miles are passable all the year, 1,183 miles are passable in dry weather, and 91 miles are under construction. While these figures include most of the important roads, some of those in the State are omitted for lack of data, and many of the less important roads are not included.

## MINAS GERAES

Minas Geraes is one of the four inland States of Brazil and is the most populous State, having an estimated population on December 31, 1928, of 7,257,799. It ranks fifth in area among the Brazilian States and is larger than the combined area of California and the New England States. It lies just north of Sao Paulo.

Minas Geraes is one of the leading agricultural and pastoral States of the Union. It supplies the capital with 75 per cent of the dairy products consumed there. Coffee is by far the most important agricultural product. Corn, beans, rice, and tobacco are also of some importance, and large herds of cattle are raised. Great mineral wealth exists within the State, including gold, manganese, lead, iron, and many other metals. The diamond-mining industry is well developed, and there are large areas where various semiprecious stones are found in abundance. Although primarily an agricultural and mining State, Minas Geraes has important manufactures and ranks second to Sao Paulo in that respect. The principal industrial center is the city of Juiz de Fora, in the southeastern part.

Minas Geraes is served by two railroad systems administered by the government, called the Central and the West Minas Railways. In the east a railroad through the port of Victoria, Espirito Santo, and one to Caravellas, Bahia, give an outlet for the mineral products

of the districts which they serve, while in the west the line from Goyaz connects the agricultural area with Sao Paulo and Santos. The greater part of the products of Minas Geraes is sent to Rio de Janeiro via the Central, Western Minas, Leopoldina, and Sapucahy systems. The total length of railroads in operation at the close of 1927 was nearly 4,900 miles, giving Minas Geraes the greatest railroad mileage of any of the Brazilian States. A number of rivers cut the State, but the only one of importance to navigation is the Sao Francisco, which is navigable from Pirapora north to the State of Bahia.

#### HIGHWAY SYSTEM

Minas Geraes to-day probably ranks next to Sao Paulo in both extent of highways and activity and interest in road building. Practically speaking, the present road system of the State dates from the first of 1924. In November, 1923, a special highway division was created in the State department of agriculture which was given entire charge of all construction and maintenance work. The construction and maintenance of bridges, however, comes under the public works division. Prior to 1924 practically all of the roads in the State were little more than rough, poorly maintained cart trails. In the days of the Empire some road building was undertaken. One of the most important of the roads built then was from Rio de Janeiro to Ouro Preto, constructed on the discovery of gold at the latter place. The road was a very good one; new towns sprang up along its course, some of which are still in existence. This road fell into disuse long ago, when railroad construction commenced.

Shortly after the organization of the highway division a complete study of the existing roads was made. Plans were made for the construction of some 552 miles of new roads in the State, and work was actually commenced on the construction of 107 miles under an appropriation of 700 contos (\$84,000). The road-building activity of the State continued to increase until 1926, when construction was commenced on 517 miles of roads. In 1927 road work was curtailed somewhat for financial reasons, but there was renewed activity in the latter half of 1928 and during 1929. The 1930 program has been greatly curtailed because of the general economic conditions.

At the close of 1928, there were in Minas Geraes a total of 12,408 kilometers (7,755 miles) of roads, according to the official State figures. The division of these according to type and in comparison with the previous two years is shown below.

#### EXTENT OF ROADS IN MINAS GERAES

[In miles, as of January 1]

Type	1927	1928	1929
Built and maintained by State.....	1,352	1,679	1,906
Built and maintained under State aid.....	517	532	570
Built and maintained by municipalities.....	2,580	15,280	15,280
Total.....	4,479	7,491	7,756

<sup>1</sup> Of these only 414 miles are passable all the year.

From the inauguration of the highway division on November 8, 1923, to December 31, 1927, the State had spent a total of 43,186:-256\$509 (\$5,150,000) on its roads. In 1928 total highway expenditures were \$2,666,950, and in the first six months of 1929, \$749,495.

Minas Geraes has, up to the present, worked on the system of "pay as you go" in its road-building program. No bond issues or loans for road building have been made and no special taxation levied for the purpose. All funds used for road building and maintenance have come from the general revenues of the State, and the work has depended entirely on regular budget appropriations and special appropriations for the purpose.

In addition to the roads constructed by the State government, a number of the municipalities have been very active in road-improvement work. The total length of municipal roads opened to traffic during the period from November, 1924, to December 31, 1928, was 5,267 miles. Complete data are not available as to the expenditures of the municipalities, but the municipality of Bello Horizonte has projected for 1929 the construction of some 42 miles of roads at an estimated cost of about 292 contos (\$35,000) and has appropriated nearly 17 contos (\$2,040) for conservation work.

In addition, some road work is done by private individuals, but such work is generally to meet the needs of a single large property owner, and no data are available as to expenditures or the extent of those roads.

#### ROAD PROGRAM

According to the State highway program, a series of trunk roads is provided, most of them leading out in various directions from Bello Horizonte, the capital, which is located approximately in the center of the State. The principal roads provided in the plan are as follows:

Road	Length completed (miles)	Total length (miles)
Bello Horizonte to Rio de Janeiro.....	137.0	1 218.75
Bello Horizonte to Pecanica.....	109.0	218.75
Bello Horizonte to Sao Paulo.....	67.5	1 331.75
Diamantina to Theophilo Ottoni.....	18.0	246.00
Monte Claros to Salinas.....	37.5	167.00

<sup>1</sup> Includes only that part of the road in the State of Minas Geraes.

In addition, there are numerous branch roads serving these main trunk routes. The program also provides for the construction of roads connecting each zone with the respective consuming centers, whether inside or outside of the State, and for a secondary system of intercity highways.

In the road program three general classifications of roads are made: (1) State roads, (2) subvention roads, and (3) municipal roads. The State roads are built and maintained by the State, with maintenance squads permanently stationed at regular intervals.

The subvention roads are built by either municipalities or private enterprises, the State aid being in the form of a definite allowance per mile. The municipally built roads are free public roads, but those built by private enterprises are toll roads, the charge being

regulated by the State. All roads built under State aid must be approved by the State highway division and must comply with the standard specifications for first-class State highways. The concessions for roads built by private enterprises are generally for a 25-year period, after which time the road reverts to the State. Such roads must be maintained in good condition under State supervision during the life of the concession. According to a report of the director of highways and public works, the State-aid system has not given the desired results, and it is not likely that any great extension will be made in the future.

Municipal and private roads are built without State aid in any form. These are generally constructed without any preconceived plan. There is no uniformity whatever in the type of construction. Some of them are poorly built and maintained, but all are generally passable in the dry season and some are passable the year around.

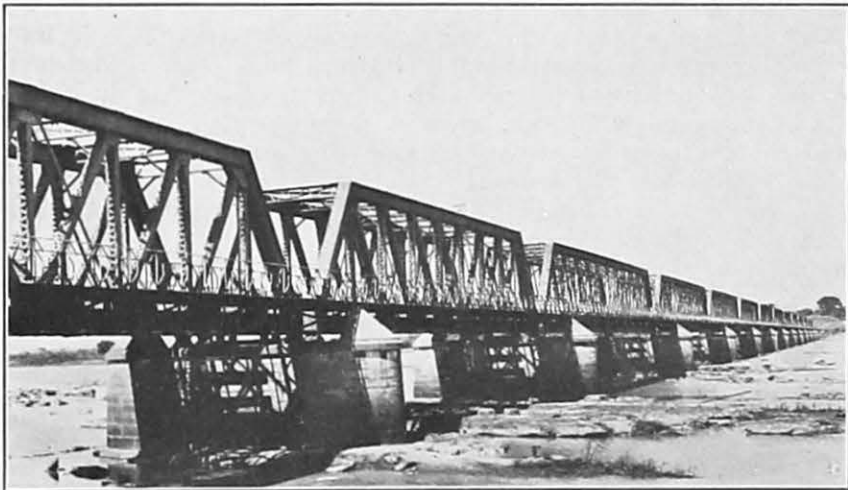


Figure 3.—Highway bridge across the Sao Francisco River, Minas Geraes

#### SPECIFICATIONS AND MAINTENANCE

Almost all of the State road building in Minas Geraes has been of the low-cost types. The majority of the roads built are improved earth types with gravel surface or earth and broken stone. The total length of roads of this type is approximately 1,250 miles. Only 14.4 miles of macadam have been laid by the State. The simple earth roads total approximately 642 miles.

For some roads the traffic is proving too heavy for the improved earth surfaces, and additional parts of macadam are being substituted. The State has made investigations as to the ultimate cost of the various types of paving and, including cost of construction, maintenance, etc., it has been found that water-bound macadam and asphaltic concrete give approximately the same results. The State authorities have decided in favor of the water-bound macadam as the type of hard surface to be used, not only because of the material saving in the initial cost, but also because it serves as an excellent base for higher-quality pavings which may be used in the future. Additional macadam is now being built and experiments made with various oil and asphalt treatments.

All State roads are classified as either first or second class roads, depending on the construction specifications. The principal standard requirements of these are as follows:

Item	First class	Second class
Minimum right of way.....feet.....	323	26
Minimum road surface.....do.....	193	13
Maximum grade.....per cent.....	6	10
Minimum radius of curves.....feet.....	164	98
Minimum tangent between opposing curves.....do.....	132	66
Minimum level stretch between opposing grades.....do.....	66	
Minimum surface width to be macadamized.....do.....	13	

On first-class roads open transverse drains are prohibited and the surface must be crowned, the grade being in the ratio of 1:50 to the width of the road. Curves must be banked to give the minimum grade of 6 per cent.

With a view to giving the State's road work a permanent character, 10 inspection and maintenance stations have been established in the State. A resident engineer is in charge of each, with a maximum of 186.4 miles under his supervision. Section squads are maintained under the engineer for every 15.5 miles for road-repair work in the section. Most of the inspection stations are provided with some mechanical road-building equipment, but generally this is inadequate to meet the entire needs of the section. It is the plan of the State constantly to maintain and improve such roads as it builds, and this policy is being rigorously followed. According to the director of communications and public works, the minimum length of State roads required is 19,446 miles, but it will, of course, be many years before this goal is accomplished.

#### ROAD PROGRESS

While the State of Minas Geraes has a number of important road projects in hand, by far the most important are the roads from Bello Horizonte to Rio de Janeiro and from Bello Horizonte to Sao Paulo. Only a small amount of work was done on these roads during 1927, owing to a lack of funds, but during 1928 and 1929 the work was actively pushed forward.

At the close of 1928 all but 36.5 miles of the Bello Horizonte road had been completed; the balance was completed in 1929. The total length of the road from Bello Horizonte to the boundary of Rio de Janeiro is 233 miles. The surface is principally of gravel or earth and broken stone, but there are 12.5 miles of macadam and 0.65 mile paved with granite block. It is on this road that experiments are being made with various types of surface treatment;  $\frac{2}{3}$  mile with Trinidad asphalt,  $\frac{5}{8}$  mile with road tar, and 1 mile with road oil.

On the road from Bello Horizonte to Sao Paulo only that part from Bello Horizonte to Oliveira, a distance of 122 miles, has been definitely projected. Up to the close of 1928 only 48 miles remained to be completed. This work was in hand in 1929 and it was expected that most of it would be completed by 1930. Moderately good municipal roads exist from Oliveira via Lavras, Pouso Alegre, and Ouro Fino to the Sao Paulo boundary. Various routes are under





Figure 4.—A section of the Bello Horizonte-Guanhaes road in the Serra de Cipo

discussion for the proposed State road, one of them being via Lavras to Caxambu, which would connect with the proposed Federal highway between the latter point and Areias, on the Rio de Janeiro-Sao Paulo highway. A project has also been discussed for the construction of a State highway from Caxambu via Turvo to Barbacena, which is on the trunk road from Bello Horizonte to Rio de Janeiro. This would involve the construction of approximately 93 miles of road, but would shorten the distance between Bello Horizonte to Sao Paulo from 572 miles to 424 miles.

The major work of the State during 1928 was on these two roads, though considerable work was done on shorter stretches in other parts of the State. Work continued in 1929, as the present government was much interested in a continuation of the road program. There is every reason to believe that the next few years will witness material progress throughout the State.

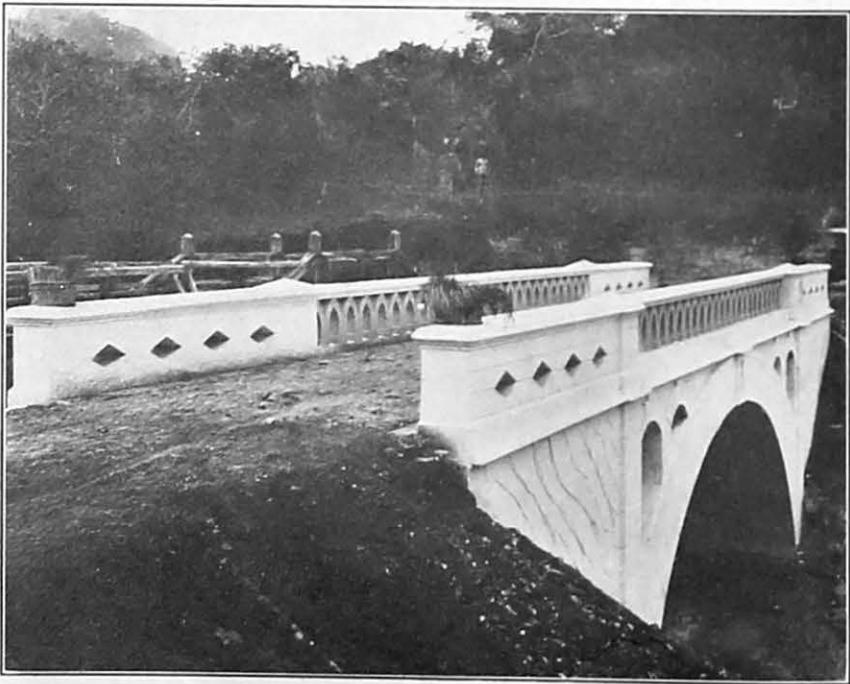


Figure 5.—Concrete bridge in Minas Geraes, showing (to the left) the old wooden bridge

#### COST OF CONSTRUCTION

Practically all of the roads in the State are of earth construction or with a gravel surface, and few stretches have been built of macadam. Based on the figures for the work done during 1928, the cost of new constructions average from slightly over 6 contos to 123 contos (\$720 to \$14,760) per kilometer, depending on the type of roads built, the amount of preparatory work to be done, etc. During the year 1,023 miles were maintained at an average cost of \$140.76 a mile.

#### RIO DE JANEIRO

The State of Rio de Janeiro is the third smallest State in Brazil, slightly smaller than the combined area of Massachusetts and

New Hampshire. It lies on the coast between Espirito Santo on the north and Sao Paulo on the southwest. The State is principally hilly and mountainous, though there is a narrow coastal plain in which there are numerous lakes and lagoons. The estimated population on January 1, 1929, was 1,944,680, which gives it sixth place among the Brazilian States.

Rio de Janeiro ranks third, after Sao Paulo and Minas Geraes, as a producer of coffee, and it is second only to the State of Pernambuco in the production of sugar. Corn, rice, cotton, cacao, and vanilla are also of some importance. The timber and mineral resources, including lime, iron, granite, and kaolin, are also important; most of them are being worked to some extent. Some of the most important manufacturing establishments of the country are located in this State. The textile industry is the most important, producing woolens, silk goods, and cotton fabrics. A wide variety of manufactured products is produced throughout the State.

The State of Rio de Janeiro is well served by railroads, having a total of 1,663 miles which cover practically all parts of the State. One line connects Nitheroy, the State capital, with Victoria, the capital of Espirito Santo, another runs north to the State of Minas Geraes, and still another connects with Sao Paulo. The principal river in the State is the Parahyba, 435 miles in extent, which has numerous tributaries within the State. The Parahyba River has a steamboat service, as have also the Bay of Rio de Janeiro and several of the coastal lagoons. The State is well provided with ports and harbors, in addition to the great harbor of Rio de Janeiro.

#### HIGHWAY SYSTEM

Although there has been agitation for good roads for some years, the State of Rio de Janeiro has accomplished relatively little in the matter of road building. Practically all of the road work done in the State has been undertaken by the Federal Government. With the exception of two main highways leading through the State from the Federal capital—one to Sao Paulo and the other to Petropolis, which were completed in 1929—all of the roads in the State are of simple earth construction. The continuation of the Rio-Petropolis road to Entre Rios on the Minas Geraes border and the road from Petropolis to Therezopolis were also built by the Federal Government. Of the 2,415 miles of roads existing in the State at the close of 1928, all but 109 miles were of simple earth construction, or earth and gravel. The hard-surfaced roads, concrete and macadam, are principally those built and maintained by the Federal Government.

Up to 1924 very little new construction was undertaken, practically all of the work consisting simply of grading and draining existing cart roads. During the period 1924–1927 a much more serious interest was taken and considerable progress made in the improvement of roads in the State. Road work received a further impetus in 1928.

The expenditures of the State on road work have increased steadily since 1924, as shown in the following statement:

1924-----	\$423, 891	1927-----	\$621, 791
1925-----	608, 157	1928-----	859, 090
1926-----	581, 727		

The highway expenditures during this period have amounted to roughly 13 per cent of the total revenues of the State. Of the 1928 expenditures \$779,842 was appropriated for the construction, reconstruction, and maintenance of roads and the balance, \$82,122, for the construction and reconstruction of bridges.

A large part of the road work done in 1928 was in maintenance and reconstruction of existing roads. A total of 86.6 miles commenced previously was completed in 1928. In addition, 159 miles were rebuilt or newly constructed within the year, and construction of another 180 miles was commenced or authorized. The maintenance work authorized covered 168 miles. The State highway statistics are not entirely clear, but it is understood that all of the construction work listed includes general repairs. During 1928 several major bridge constructions were also completed and a number of smaller bridges built.

In addition to the work done by the State many of the municipalities have been engaged in repairing roads. This work has consisted almost entirely of grading and scraping the earth roads. No statistics whatever are available as to the total work done.

It was estimated at the close of 1928 that there were 2,417 miles of roads in the State, of which 1,918 miles are earth roads which are not passable after heavy rains. Of the balance of 499 miles ranked as first-class roads, 10.5 miles are of concrete, 98 miles macadam, and 390.5 miles earth or earth and gravel. Most of the roads have a width of 13 to 19 feet, but 19.6 feet is the standard width for the new roads.

#### ESPIRITO SANTO

The State of Espirito Santo is situated on the east coast of Brazil, between Bahia on the north and Rio de Janeiro on the south, while Minas Geraes adjoins it on the west. It is the fourth smallest State in Brazil, with an area about equal to that of Massachusetts and Vermont combined. The estimated population on January 1, 1929, was 635,780. The northern half of the State is a dense tropical forest, partly unexplored. The southern part is highly mountainous, the Serra do Caparaó in the southwestern part having some of the highest mountains in Brazil. The southeastern littoral is characterized by low hills and wide, level valleys. A large part of this coastal plain, however, consists of swamps and shallow lakes.

The most important product of the State is coffee, which is grown on the hillsides of nearly all the valleys accessible to transportation. The State has vast timber resources, including most of the varieties of hardwoods grown in Brazil. Though little developed, the timber industry is the second most important in the State. Rice, sugar, and some other agricultural products are grown, though they are of relatively little importance.

There are two principal railroad lines in Espirito Santo. The combined total length of all railway lines is about 482 miles. These connect the capital, Victoria, with Nictheroy and Rio de Janeiro, and with the State of Minas Geraes. Victoria has regular weekly connections with other Brazilian ports by means of coastwise steamers, and smaller coastwise vessels call frequently. It also has direct and frequent communication with United States and European ports.

## HIGHWAY SYSTEM

Up to a year or two ago little road work was undertaken in Espirito Santo. In the southern part of the State a relatively complete system of cart roads existed, but they were in rather poor condition and impassable during the rainy season. In the north there were very few roads. Up to 1929 the entire road work of the State was the construction of a vehicular bridge connecting the island on which Victoria is situated with the mainland. In the early part of 1929 this was practically completed, the only work remaining to be done being the completion of the paving on the bridge and grading around the approaches.

The State government is now much interested in the subject of road building and has done considerable work in improving existing roads. A large part of the actual road work has been done by the various municipalities.

The State has under consideration a highway law which will provide funds for the construction, maintenance, and improvement of roads. This law provides for a tax on all vehicles and merchandise using the roads, a tax on all land within 6 miles of the road amounting to about 1 cent per acre, and a gasoline tax of slightly less than 2½ cents per gallon. The secretary of agriculture has been instructed to draw up a program of construction covering the roads which are most necessary to the State.

During 1928 the State government road work consisted principally of continuation of the work on the road from Santa Thereza to Collatina, less than 4 miles remaining uncompleted at the close of the year. An additional 5 miles was built on the road from Victoria to Santa Leopoldina, which was widened and improved. A branch was built from that road to the railroad station and another to Convento de Penha.

With the exception of 23.6 miles of macadam, all of the roads in the State are of simple earth construction. The improved roads are graded and drained but, for the most part, are not passable during the rainy season.

Detailed statistics as to road expenditures by the State are not available, but based on a report of the Government for the administrative period of 1924-1928, a total of approximately \$642,960 (at current rates of exchange) was spent on road construction, repairs, etc., and \$754,320 on the construction and maintenance of bridges. Of this latter amount practically all was spent on the bridge connecting Victoria and the mainland. Commencing in 1927 a separate record was kept of expenditures for road maintenance, which from January 1, 1927, to May 31, 1928, amounted to slightly over \$19,200. Part of the expenditures was in the form of State aid to various municipalities for the maintenance of municipal roads.

In addition the roads built by the State, the various municipalities have undertaken considerable road work. Data of the municipalities are not complete, but such information as is available is that there are 518 miles of motor roads and 528 miles of cart roads impassable after heavy rains. In the entire State there are 15.5 miles of concrete roads, 163.5 miles of dirt roads passable in all weather,

258 miles of dirt road passable only in dry weather, and 95.7 miles under construction.

#### PARANA

The State of Parana lies just south of the State of Sao Paulo. It is approximately the size of Nebraska, and the estimated population on January 1, 1929, was 938,281. Topographically, the State can be divided into two principal zones, the littoral and the highland region. This latter section, which includes all of the State except a narrow strip along the coast, can be divided into three zones. The first zone includes a narrow strip in the eastern part of the State at an average height above sea level of approximately 2,400 feet, the second zone takes in the balance of the eastern half of the State with an average height of approximately 2,950 feet, and the third zone includes the entire western half of the State with mountains rising to 4,250 feet and higher. Road building between the plateau region and the coast is difficult because of the steep grades and engineering difficulties encountered.

The principal products of the State are yerba maté, lumber, and coffee. Other agricultural products of some importance include cereals, cotton, fruit, and tobacco. The plantings of coffee have increased considerably during the past two years, and the State is rapidly assuming an important position in the country's production. The principal industries of Parana are the preparation of yerba maté and timber for market. Next in importance comes the match industry, which employs nearly 75 per cent of the factory employees.

There are approximately 766 miles of railroad in Parana, practically all in the eastern third of the State. Four great rivers, the Paranapenema, the Parana, the Iguassu, and the Rio Negro, follow the State boundaries, and various waterfalls offer great potential power. About 400 miles of rivers in the State are navigable for small boats.

#### HIGHWAY SYSTEM

The western half of the State is sparsely settled and but little developed, and practically all of the road development has taken place in the eastern third of the State. In the days of the Empire a military road existed through the State of Parana to the Matto Grosso boundary. As was the case of the other States of Brazil, little work was done on the roads from the time railroad building was commenced until a few years ago. In 1923 and 1924 considerable interest began to be taken in the matter of road building and, especially since 1926, material progress has been made.

In 1928 a definite road program was adopted providing for a number of trunk roads, and a separate highway division was created in the department of agriculture. In general, this plan provides for roads radiating from Curitiba, the capital, to the interior cities and to the States of Sao Paulo and Santa Catharina, and for other roads, which commence at cities along the Sao Paulo-Rio Grande Railroad, to serve the western and northern regions of the State and permit the connection of these cities and the capital with Paraguay and Argentina and with the State of Matto Grosso. Subordinate to these trunk lines in the road program are the roads which already exist and those which will be constructed in order to complete the highway system of the State.

The first trunk road to receive attention by the State government was that leading from Curitiba to the littoral. This connects Curitiba with Antonina, a distance of 49 miles, with a branch to Morretes which is to be continued to Paranagua, the principal port of the State. A road from Curitiba to Antonina had originally been built in the reign of Dom Pedro II, but when the railroad was built connecting Curitiba and Paranagua the highway fell into disuse and complete rebuilding was necessary. This road is now in excellent condition to Antonina and Morretes, being of macadam construction. A large amount of automobile traffic, both freight and passenger, is handled on it. The continuation of the road from Morretes to Paranagua was under construction in 1929. The section between Paranagua and Alexandra,  $7\frac{1}{2}$  miles, had been completed by July 1, and the balance was under construction or definitely projected. A number of branch roads are also projected or under construction to serve the littoral.

A road now exists between Paranagua and Curitiba, but it is not in good condition. The original location was not well planned, grades in some parts reaching 18 per cent.

The Curitiba-Sao Paulo road is also one of the most important trunk lines. That part of the road from the city of Sao Paulo to the State border is already nearly completed, as is a large part of the road from Curitiba to the Sao Paulo boundary. This road will be of greater importance to both States, since it will cut the travel time between the two capitals, which now requires about 30 hours by railroad, to about 10 hours. The distance from Curitiba to the Sao Paulo boundary is 79.5 miles.

It was originally provided that this road should be provisionally opened by May 1, 1930, with a width throughout of 9.8 feet. The completed road, 19.6 feet wide, was to be finished by July 1, 1931. The grades on this road are not to exceed 6 per cent, and the minimum radius of curves is fixed at 164 feet.

Three trunk lines are provided south from Curitiba to the State of Santa Catharina. The first goes almost due south via Sao Jose dos Pinhaes and Tijucas to Bateias de Cima, a distance of 41.6 miles. Another road to the Santa Catharina border branches off at Sao Jose dos Pinhaes and goes to Bateias de Baixo, a distance from Curitiba of 59.6 miles. This latter road is more used since it connects with a road to Joinville, one of the most important cities of Santa Catharina. Both roads are moderately good and passable except after heavy rains.

The second road connects Curitiba with Rio Negro on the Santa Catharina boundary, via Auracaria and Lapa. The total distance by this route is approximately 59.6 miles. From Curitiba to Lapa, 42 miles, the road is permanently maintained and moderately good. The balance is passable in dry weather. A bridge connecting Rio Negro and Mafra, Santa Catharina, is now under construction.

The third road connects Curitiba and Uniao da Victoria via Palmeira and Sao Matheus, approximately 155 miles. The road is well maintained as far as Palmeira and forms part of the trunk roads to Iraty and to Ponta Grossa. Old roads exist for the balance of the distance.

The Parana road program also provides for two trunk roads from Curitiba to the west and on to the northwest. Those to the west are to Ponta Grossa, the second most important city of Parana, and to Iraty, both via Palmeira. The road to Ponta Grossa is 93 miles in length and is passable practically all of the year. Only part of the road from Palmeira to Iraty has been completed. The road to the northwest will extend to Jaguarihyva, but as yet the route has not been definitely determined; it will serve a very rich agricultural section of the State.

In addition to the trunk roads radiating from the capital, various trunk roads of "penetration" are planned. As has been previously indicated, the western two-thirds of the State has been but little developed, and as it is not served at all by railroads, highway transportation will play an important part in the development. All of the "penetration" highways will connect with points on the railway operating across Parana from Sao Paulo to Rio Grande do Sul. The roads planned are as follows:

*Jaguarihyva—Cambara (near Sao Paulo border).*—Parts of this road are completed.

*Road serving agricultural zone between Laranginha and Tibagy Rivers.*—Projected only.

*Ponta Grossa—Tibagy—Queimadas—Matto Grosso boundary.*—Practically completed as far as Queimadas (99.5 miles); earth road passable in dry weather.

*Ponta Grossa to Guarapuava.*—Fair earth road, improvements projected (93 miles).

*Iraty to Guarapuava.*—Approximately one-half completed (62 miles).

*Guarapuava to Iguassu Falls.*—Earth road passable in dry weather (278 miles).

*Uniao da Victoria—Palmas—Clevelandia—Argentine border.*—Forms part of the Federal road from Sao Joao Barracao; under construction.

*Uniao da Victoria—Mangueirinha—Chopin.*—Fifteen and one-half miles completed.

#### CONSTRUCTION AND MAINTENANCE

The present Government's construction program consists principally of work on the roads above indicated, though some other road-building work of a less important nature has been undertaken. During 1928 abnormally heavy rains were experienced and, as a result, it was necessary to devote more time to maintenance work than has been anticipated; consequently, less new construction was undertaken. Not only does the program of the present Government include the consistent maintenance of the existing State roads, which at the beginning of 1929 were estimated to total 1,350 miles, but it also calls for the improving and reconditioning of existing roads. The State highway plan specifies that existing roads are to be maintained by the State government and leaves to the municipal governments the work of constructing and maintaining roads complementing the State roads; road-maintenance work is undertaken both with permanently stationed squads and with traveling groups to cover sections with particularly heavy damage by rains.

The 1929 program called for the continuation of the work on the trunk road to the Sao Paulo boundary, continuation of the work on the road from Paranagua to Morretes, and the completion of the road from Serro Azul to Jaguarahyva. Numerous other road constructions were planned, though these were the most important and considered the most urgent.



With the exception of the road from Curitiba to Antonina, 49 miles, and Curitiba to Campo Largo, 24 miles, and certain parts of the road from Curitiba to the Sao Paulo boundary, none of the roads in the State are hard surfaced. The hard-surfaced roads are of macadam construction and are passable the year round. The balance of the roads in the State are of simple earth construction and practically all impassable during the rainy season.

#### HIGHWAY FINANCING

Up to 1929 the road-building work in the State of Parana was paid for from general appropriations, with very few exceptions. There were no taxes collected specifically for highway purposes. In the case of the road from Curitiba to the Sao Paulo boundary the work is being largely covered by funds from a foreign loan, made in 1928.

Only very incomplete figures are available as to the expenditures of the State on road maintenance and construction work. The only figures separately shown for road building are the expenditures for the fiscal year 1925-26 with a total of 2,156 contos (approximately \$260,000); the roads built during the year totaled 281 miles. The rebuilding of the macadam road from Curitiba to Antonina involved the expenditure of over 1,715 contos (nearly \$206,000).

More complete data are available concerning expenditures on road maintenance, as is shown in the following statement:

1920-21	-----	\$37, 831	1924-25	-----	\$38, 340
1921-22	-----	27, 428	1925-26	-----	72, 529
1922-23	-----	35, 918	1926-27	-----	98, 384
1923-24	-----	41, 115			

Figures are not available as to the extent of road maintained in the earlier years, but the distance was 1,193 miles in 1924-25, 1,311 miles in 1925-26, and 1,434 miles in 1926-27.

In addition to the sums spent by the State government, a number of the municipal governments have made moderate expenditures for road building and maintenance, but no data are available.

In 1928 the Good Roads Association of Parana petitioned the president of the State to establish a "good roads" tax to form a special road fund. Law No. 2683, of April 23, 1929, created a road institute to have charge of all work on State roads. Its revenues would consist of all taxes on vehicles and of such appropriations as it may receive from the State and Federal Governments. The institute, for 10 years after its installation, would also contract internal or external loans biennially in such a manner that it would not obligate for interest and amortization more than 50 per cent of its total initial revenue. The institute could make agreements with the municipalities regarding assistance to be given them on their road work. Municipalities could no longer tax vehicles, and this would decrease municipal revenues by as much as 10 per cent in such large centers as Curitiba.

According to an estimate made by a Parana journal, the vehicle taxes would produce about \$194,000 annually. The State appropriation is estimated by a semiofficial newspaper at about \$538,200 for 1930, to be increased \$60,000 a year until 1940. The revenue, expended in part directly on road work and in part for the service of

loans, will provide, according to the estimate, about \$10,000,000 by 1940.

The concession method is also in use in Parana, and a law passed in April, 1929, authorized the executive to grant a concession for a road from Jaguariahyva to Paranagua. The concessionaire will be permitted to collect tolls on the road for 45 years, after which the road reverts to the State unless purchased by the State in the meantime.

#### CITY PAVING

The city of Curitiba is one of the best-paved cities in Brazil. At the end of 1928 there were 20,230 square yards of asphalt pavement, 260,300 square yards of granite block, 387,227 square yards of simple macadam, 5,463 square yards of bituminous, and 4,359 square yards of cobblestone pavement in the city. However, some 238,000 square yards of this amount were in bad condition and would have to be relaid in the next three years. In 1928 the city spent a total of \$13,400 on street paving, but this includes only one-third the cost, as property abutters on each side of the street are also required to pay one-third of the cost. The paving included 9,445 square yards of macadam and 2,468 square yards of granite block.

In addition to the 238,000 square yards of pavements which must be relaid, the municipal program from 1929 to 1931 calls for the laying of 257,000 square yards of new pavements to meet the growing needs of the city. The 1929 program alone calls for the laying of approximately 190,400 square yards of pavement. Contracts were let in January, 1929, for the laying of 171,550 square yards at a total cost of \$617,248.40. The municipality has approved the use of asphaltic concrete, granite block, bituminous penetration macadam, or macadam with bituminous surface in its street paving.

Macadam roads in Parana total 194 miles, penetration roads 173 miles, earth roads passable all year 304 miles, earth roads passable in dry weather 2,818 miles, and roads under construction 33.5 miles.

#### SANTA CATHARINA

Santa Catharina is fourteenth among the Brazilian States in point of size and approximately the same area as Indiana. It lies in the southern part of Brazil between Rio Grande do Sul and Parana. The estimated population on December 13, 1929, was 913,553. Topographically, the State is divided into three zones, the littoral, the Serra, and the plateau region in the west. The littoral is narrow in the north and widens in the south. The plateau region is of approximately 3,000 feet elevation and drops off very suddenly in the north at the coast.

The chief products of the State are lumber and yerba maté. The State is one of the most important producers of dairy products, and a serious effort is being made by the State government to encourage the growing of wheat and other cereals. The mineral possibilities have scarcely been explored, but precious metals, iron, lead, and zinc are known to exist in appreciable quantities; coal is being mined and exported from some of the southern municipalities. The lumbering industry is centered in the northeastern part of the State, the dairy

products in the central, and the mining and cattle raising in the southeast. The bulk of the yerba maté is produced in the central and western parts of the State.

There are approximately 700 miles of railroad in Santa Catharina. Nearly one-half is composed of the line from Sao Paulo to Rio Grande do Sul which crosses the State from north to south approximately in the center. Another line connects the port of Sao Francisco with Porto Uniao on the Sao Paulo-Rio Grande line. This line parallels the Parana boundary most of the way. These two lines make up nearly 75 per cent of the railroads in the State. A short line operates from Blumenau to Hansa in the east-central part of the State, and several towns in the southeastern part of the State are also connected by short lines. Although the State is well served by numerous rivers there are very few that are suitable for navigation.



Figure 6.—Road leading into Herval, Santa Catharina

#### HIGHWAY SYSTEM

Owing to the fact that the railroads in the State are limited in extent, as is the area served, the development of highway transportation has been extremely important. Although a moderately extensive system of rather poor earth roads had existed in the State for some years, the most active work in road building was done under the administration of Dr. Victor Konder, 1922-1926, who became Federal Minister of Communications and Public Works under the administration of Dr. Washington Luiz. The work has been continued with increasing activity under the administration of Dr. Adolfo Konder, the present governor. Under the latter a separate division has been created in the State government for the construction, maintenance, and improvement of roads.

As is the case in most States of Brazil, the capital serves as the focal point of the State highway system. Florianopolis, the capital of the State, is located on an island which is connected to the mainland by one of the finest and largest bridges in Brazil. This bridge, which is of the suspension type, has a total length of 890 yards, including the viaducts at either end, and was completed in 1926. The

main span is 370 yards long and is 98 feet above the sea. A moderate toll is collected to cover the amortization of bonds, which were issued to cover the cost of construction and maintenance.

Although not entirely completed, the highway system of Santa Catharina includes the road from Florianopolis north to Joinville via Itajahy, Blumenau, and Jaragua; a road south to Tabarao and thence to the Rio Grande do Sul border; and another road west to Lages and then northward toward Barracao on the Argentine border, with branches to the States of Parana and Rio Grande do Sul. Roads branch off the latter road at Lages in various directions, the most important one being to Blumenau. A direct road from Itajahy to Joinville is under construction which will materially shorten the distance from Florianopolis to Joinville, and it was expected that this would be completed by the end of 1930.

At the beginning of 1928 there were in the State 1,953 kilometers (1,215 miles) of State highways open to traffic. The State had under construction at that time 204.3 kilometers (126 miles), and an additional 668.2 kilometers (415 miles) were projected. In addition to the work done by the State government, a number of municipalities have been very active in highway work, and it was estimated that at the beginning of 1928 there were 5,096 kilometers (3,163 miles) of municipal roads in the State which were suitable for automobile use and another 5,616 kilometers (3,492 miles) of cart roads and trails. Statistics as to the road work done by the various municipalities are very incomplete, but it is certain that Blumenau, the most populous municipality, has done the most in road building. Florianopolis and Joinville have also been very progressive in this respect.

Material progress was made in the matter of road building in 1927, and several new stretches of road were opened to traffic. During the latter half of 1927 and the first three months of 1928 exceptionally heavy rains were experienced, with the result that much of the previous road work was undone. Consequently in 1928 the road work consisted principally of rebuilding and repairing roads which had been seriously damaged in the preceding months. Ordinarily, however, the main roads in the State are passable throughout the year and combination bus and mail services operated over many of them. Practically none of the municipal roads are passable during the rainy season.

#### CONSTRUCTION AND FINANCE

Practically all of the roads in the State, with the exception of an old road built in the days of the Empire from Joinville in the east to Maffra on the Parana border, are of earth or gravel construction. Many of them, however, are well drained and rolled and constantly maintained, so that the principal highways of the State are passable the year round. The road from Joinville to Maffra is macadam, but very little was done on its maintenance from the time the railroad was built connecting the two cities until the past two or three years. Consequently, many parts of it are in very poor condition and are impassable except in dry weather, and even then with difficulty. Many of the rivers and streams of the State must be crossed by small ferries or by fords, as bridges are lacking in many cases.

Only limited funds are available in Santa Catharina for highway work. With increased taxation in 1927, the entire revenues of the State were calculated at only 15,200 contos (\$1,800,000), of which 4,500 contos had to be applied to amortization and interest charges of the internal and foreign debt. Since 1927 the State has had a special fund for highway work, the revenues being derived from a special land tax amounting to 0.2 per cent of the value, a vehicle tax, and a transit tax. Santa Catharina is one of the few States having a vehicle tax. This ranges from \$13.60 for private cars and trucks to a maximum of \$38 for certain types of public trucks and busses. The revenues collected for the highway fund in 1927 amounted to \$216,652, 68 per cent of which was derived from the land tax, 26 per cent from the vehicle tax, and 6 per cent from the transit tax. The total highway expenditures in 1927 amounted to 2,100 contos (\$250,000), and the 1929 budget provides \$260,000 for road construction and maintenance.

#### OUTLOOK FOR FUTURE CONSTRUCTION

Because of the inadequacy of the rail and river transportation facilities, steady progress may be expected in the next few years in highway building and maintenance in Santa Catharina. The economic value of highway transportation is now fully appreciated throughout the State, and there is an increasingly insistent demand for the construction of new roads. Owing to the small financial resources of the State it is not expected that any great progress will be made in the building of hard-surfaced roads, but steady progress may be expected in the construction of improved earth roads. The State now has 468 miles of road passable all the year; 747 miles passable only in dry weather; 126 miles under construction; and 415 miles projected.

#### RIO GRANDE DO SUL

The State of Rio Grande do Sul is located in the extreme southern part of Brazil and is somewhat larger than the combined area of New York and Pennsylvania. It ranks as the eighth largest State in area and fourth in population, having an estimated population on January 1, 1929, of 2,864,629. Mountain ranges extend from the northeast toward the southwest decreasing in altitude toward the south.

Rio Grande do Sul is primarily an agricultural and livestock State, the latter being the chief source of wealth. It leads all other Brazilian States in the production of wheat, grapes, and rice, and also produces a wide variety of other agricultural products. The principal manufacturing industries have developed in conjunction with the livestock industry, though many other products are manufactured in the State. Some coal of a rather inferior quality is mined in the State, but there has been practically no other mineral development.

There is a fairly good network of railroads in Rio Grande do Sul, the length of line being nearly 1,900 miles at the beginning of 1929. Practically all of the railroads are State owned and connect the coast cities of Porto Alegre, Pelotas, and Rio Grande with the interior cities, with the States to the north, and with Uruguay and Argentina.

The river systems, except the Uruguay, bordering the western part of the State, are of little importance. Some rivers emptying into the Lagoa dos Patos are navigable for small river craft.

#### HIGHWAY SYSTEM

Road work in the State of Rio Grande do Sul comes under two divisions of the department of public works, the highway transportation division and the land and colonization division. The work of the former has been confined largely to the eastern half of the State, especially in the northern part. The latter is engaged in road-building work principally in connection with various colonization projects, and its activities have been confined largely to the western half of the State. The division of highway transportation commenced the construction of the first highway in recent times in 1903, and the division of lands and colonization commenced its work in highway construction in 1908.



Figure 7.—Country road in Rio Grande do Sul

Roads built by both divisions are classified as either general highways or district highways, the former being the principal State roads. A moderate amount of road work was done by these two divisions in the early years, but the work consisted principally of improving the existing earth roads.

It was not until 1926 that the highway work of the State assumed major proportions, and even in that year the combined expenditures of the two divisions probably did not exceed \$720,000. In 1927 the combined expenditure of the two divisions totaled nearly 8,000 contos (\$840,000), and the Government proposed to spend in excess of 16,000 contos (nearly \$2,000,000) during 1929.

#### EXTENT OF ROADS—EXPENDITURES

According to official State figures the highway transportation division had built, since its organization in April, 1903, to the close of 1927, 405 miles of roads, and the division of lands and colonization since 1908 had constructed 616 miles, making a total of 1,021 miles of roads constructed by the State from 1903 to the close of

1927. Up to the end of 1927 there were only 47 kilometers (29 miles) of hard-surfaced roads, which were of a macadam type of construction. In addition to the State highways constructed, there were, of course, many miles of municipal and district roads built in this period.

Although its work has been largely confined to the northwestern section of the State, which has been but little developed, the division of lands and colonization has accomplished more than any other individual unit in the State in the matter of road construction. The total construction in the 10-year period 1919 to 1928 was 433 miles of State roads and 1,570 miles of district roads at a total cost of \$1,992,666.

There are no figures available for the division of highway transportation for the corresponding period, nor as to the work done by the various municipalities. However, the official State estimate of existing roads in Rio Grand do Sul on January 1, 1928, was 944 miles of State roads with maximum grades of 4 to 6 per cent and a minimum curve radius of 30 to 80 feet, 29 miles of macadamized stretches with maximum grades of 6 per cent and minimum radius of 30 feet on curves, 2,796 miles of district roads with 6 to 10 per cent maximum grades and 15 to 30 feet radius at curves, and 34,175 miles of State and district roads in poor condition, making the total open to traffic 37,994 miles.

These figures indicate something over 3,700 miles of roads suitable for automobile traffic, though the majority are passable only in the dry season. In addition to the work done by the State government a number of the municipalities, particularly in the southern part of the State, have been very active in the maintenance of roads.

In a number of cases regular bus lines are operated for passengers and mail between cities and towns on the railroads and those located at some distance from them. Most of these services are operated throughout the year, though in some instances it is necessary to suspend them for several days at a time after very heavy rains. Generally speaking, the roads in the southern part of the State are better than those in the northern part.

Detailed statistics of the work done in 1928 are not available, but it is the general impression that more work was done during that year than in previous years. According to the best data available, there were approximately 44 miles of macadam roads, 173 miles of gravel roads, and 1,255 miles of improved earth roads in the State at the beginning of 1929. The macadam and gravel roads may definitely be considered as passable throughout the year, as is also the case with the majority of the improved earth roads.

Only incomplete data are available for the year 1928, but it is moderately certain that the total expenditures on roads did not exceed 8,000 contos (\$960,000). The funds for the highway transportation division reached approximately \$430,000, and those for the division of lands and colonization probably were slightly less.

#### THE 1929 PROGRAM

The government which took office in January, 1928, was very much interested in the construction of roads and developed a definite and comprehensive road program for the State. In January,

1929, a highway law was approved which provides a definite fund for the road-building program. Under this law all highway vehicles—passenger cars, trucks, motor cycles, busses, and animal-drawn vehicles for passengers and freight—are subject to a State registration tax and sales tax. The taxes are uniform throughout the State for all motor vehicles, depending on the type of vehicle. This tax is in addition to the regularly imposed municipal registration fees. The taxes on horse-drawn vehicles depend on the type of vehicle and the location, three separate schedules having been drawn up covering the various municipalities in the State, depending largely on their size and importance. The sales taxes include 100 reis per liter (about 4.8 cents per gallon) on gasoline, pneumatic tires, one-half of 1 per cent, and solid tires one-fourth of 1 per cent on the value, and a sales tax on vehicles valued at under 10 contos (about \$1,200) of one-half of 1 per cent, and on vehicles valued at over 10 contos of 1 per cent. In addition, the president (governor) may designate a part of the 1.5 per cent export tax for the highway fund.

In 1929, a road program was developed classifying the roads of the State in three categories. For the first of these are planned some 2,743 kilometers (1,705 miles) of trunk roads, of which 189 miles are completed. As adopted, these trunk roads will connect most of the more important cities of the State with each other and with Argentina, Uruguay, and the State of Santa Catherina. Roads of the second category connect a number of the municipal capitals not included in the main trunk-road system with that system or with the railroads of the State. The total length of these roads is 1,043 kilometers (650 miles), most of which already exist but require improvements to make them usable throughout the year. Some 8,092 kilometers (5,028 miles) of roads of the third category are also included, which serve primarily as connecting links between the roads of the first and second categories and as feeders to them. A large majority of these roads also already exist, but much is needed in the way of improvements.

When the plan is completed the State will have a very complete system of highways with practically all the municipal capitals connected. The roads of the first category are to be principally hard-surfaced types, though some gravel surfaces will be used. Considerable macadam and concrete is planned for the hard-surfaced roads.

As previously indicated, 16,000 contos (\$1,920,000) was regularly appropriated on January 9, 1929, for the State road work by the highway transportation division. This amount was divided as indicated in the following statement:

Road building-----	Contos	5,000	Bridge building-----	Contos	3,000
Road repairing-----		500	Bridge maintenance-----		500
Road maintenance-----		2,000	Miscellaneous charges-----		2,500
Consolidation of roads-----		2,500			

These appropriations do not include any funds which may be made available by the president of the State from the 1.5 per cent export tax, nor do they include the regular budget allowance for the division of lands and colonization. The 1929 appropriation for that division's road work was 3,668:447\$000 (approximately \$440,000).



Very little information is available as to the appropriations of the municipalities, though Montenegro alone appropriated 1,600 contos for 1929, and it is probable that the combined municipal highway budgets reached 15,000 to 20,000 contos (or an additional outlay of around \$2,000,000). However, depressed economic conditions greatly curtailed public works throughout the State.

#### CONSTRUCTION COSTS

The only figures available as to the cost of constructing roads in Rio Grande do Sul are those covering the roads built by the division of lands and colonization in 1927. Although the work of that division has been confined to the northeastern part of the State and to the construction of simple earth roads, the cost per mile varied considerably. Based on the total work done by the division in 1927, the average cost per mile was under \$900 for State roads and under \$250 for district roads.

#### CITY PAVING

Very little data are available on street paving in the cities of Rio Grande do Sul. In the larger cities, such as Porto Alegre, Pelotas, and Rio Grande, granite block predominates. Some asphalt paving has been laid, and macadam is common in the streets with lighter traffic. According to the report of the mayor, Porto Alegre spent about \$475,000 on street paving and about \$186,000 on opening new streets in 1928.

Rio Grande do Sul has 49 miles of macadam road, 664 miles of earth road passable all year, 6,588 miles passable in dry weather, and 157 miles of concrete projected.

#### BAHIA

The State of Bahia is one of the larger and more important States in Brazil, ranking sixth in size, with an area greater than the combined size of California and Ohio. In population it ranks third and on January 1, 1929, had an estimated population of 4,041,540. It lies on the coast and, in addition to the port of Bahia, has numerous smaller ports. The central portion is broken up by many low ranges of mountains sloping off to the west and south into level or rolling plains.

Bahia is largely agricultural, although a certain amount of manufacturing is carried on. The agricultural products include cacao, tobacco, sugar, coffee, manicoba, rubber, oil nuts, cotton, fiber, and medicinal plants. There are extensive mineral resources in the State, some of which are actively exploited. Livestock also forms an important product. Bahia is the second largest cacao-producing region in the world and raises approximately as much tobacco as Cuba. The principal port and manufacturing city of the State is Bahia, the capital. The principal manufactured products include cotton, tobacco, cigarettes, and cigars. Sugar is also refined in the State.

There are nearly 1,300 miles of railroad in Bahia, and it has been the plan of the Federal Government for some years to complete the stretch linking Bahia with the city of Rio de Janeiro. Numerous

rivers in the State are navigable for small craft, the most important of which is the Sao Francisco, which is navigable for over 550 miles in the State.

#### HIGHWAY SYSTEM

Bahia is the most southerly State in which road building was provided under the program of the Federal irrigation service. That organization commenced the construction of two roads, one from Amargoso to Sitio Novo and the other from Quemadas to Monte Santo and Cumbe, in May, 1920. Work was discontinued on the former in September, 1923, and on the latter in December, 1924. The two roads have a total mileage of about 237 kilometers (148 miles), but only slightly over 42 kilometers (26 miles) were completed. Prior to that time practically no road work had been done in the State by the Federal Government and none since.

Bahia was one of the first States in Brazil to adopt a definite highway program. On August 28, 1925, a comprehensive and definite highway program which had been passed by the legislature of the State was approved.

According to this highway law all roads in the State are classified as either public or private highways of first and second class. The public State roads include those passing through two or more municipalities, and the public municipal roads are those constructed exclusively within a single municipality. Private roads are those constructed by individuals or companies on their own property and for their exclusive use; a toll may be exacted for their use. Under certain conditions as to maintenance, etc., the State is authorized to give financial assistance to municipalities and private concessionaires on road-building projects which are approved by the State.

First-class roads are to be constructed with a broken stone and sand foundation, which is well rolled and consolidated. The final surface is to be of broken stone, gravel, macadam, asphalt, or cement. Second-class roads are to have a simple graded or rolled earth surface and foundation. Open transverse drains are to be eliminated on both classes of roads. On first-class roads the banking recommended on curves is 5 per cent and all bridges must have a minimum width of 5 meters.

All the State highways and those built under concessions by the State must conform with the highway system outlined in the law. This provision does not apply, however, to public municipal roads or to the cart roads. Changes in the routes of first and second class roads outlined may be made with the approval of the State after a detailed study has been made. All other roads are classed as "cart roads."

#### FINANCIAL PROVISIONS

Under the highway law of the State, certain revenues are set aside for highway construction. These include the following taxes:

1. Tax on vehicles using State roads:
  - (a) Horse-drawn vehicles (passenger) of three or four wheels, 60 to 100 milreis (\$7.20 to \$12).
  - (b) Horse-drawn vehicles for freight use, 50 to 120 milreis (\$6 to \$14.40).
  - (c) Passenger motor vehicles of two to four wheels, 60 to 120 milreis (\$7.20 to \$14.40).
  - (d) Four-wheel trucks with pneumatic or solid rubber tires, 80 to 200 milreis (\$9.60 to \$24).

(e) Passenger or freight vehicles belonging to rural property owners bordering on roads, according to type of vehicle, 20 to 60 milreis (\$2.40 to \$7.20).

(f) Bicycles, 10 milreis (\$1.20).

(g) Two-wheel carts and bullock carts when using bridges, charge per vehicle and per animal 40 to 100 reis (\$0.005 to \$0.012).

With the exception of the provision under section (g) the above taxes are paid annually. Unlicensed tourists' vehicles provided in the first five classes are subject to a 5-milreis (60-cent) tax, and bicycles to 1 milreis (12 cents).

## 2. Land taxes:

Property adjoining the road and up to a distance of 1 kilometer from the road is to be taxed 0.1 per cent per annum based on the official valuation. The highway tax on property adjoining roads shall not, however, be less than 5 milreis (60 cents) or greater than 200 milreis (\$24) per annum.

In addition, it is provided that the highway fund shall be supplemented by regular budget appropriations and such Federal aid and municipal and private contributions as may be made.

## STATE AID IN ROAD BUILDING

Under the provisions of the State highway law, the State government is authorized to grant concessions to individuals, groups, companies, and others for the construction, maintenance, and exploitation of earth roads and to give State aid to such concessionaires. Concessions are to be granted up to a maximum period of 30 years in accordance with the capital required in the construction of the road, the amount of any subvention granted by the State being deducted. At the end of the period for which the concession is granted, the road will revert to the State without any indemnification whatever. Tolls for the use of these roads must be uniform and approved by the State. Private vehicles used for conveying adjoining property owners and their families are required to pay one-half the toll to the concessionaire and the other half to the State.

The subventions granted by the State depend on the type of roads to be built. For simple earth roads a subvention of about \$60 per kilometer may be granted, provided the road is well drained and rolled; a subvention of 1 conto (\$119.50) per kilometer may be granted for a similar road of sand and gravel surface; a subvention of 2 contos per kilometer may be granted for a similar road with a broken-stone foundation; a maximum subvention of 4 contos (\$478) per kilometer may be granted on roads having a macadam or other improved surface.

Payments of subventions will be made only for each stretch of 20 kilometers (12.5 miles) after it has been opened to traffic and approved by the highway department. State aid may be granted to the municipalities for the construction of public municipal roads, in units of 6.25 miles or greater, provided the technical conditions meet the State specifications of first or second class roads and are approved by the State government. The amount of aid granted depends on the type of road and the necessity for the work.

## STATE ROAD BUILDING

The road program provides a very extensive system of roads serving practically all parts of the State. Not only trunk roads, but also branches and connecting roads are provided.

Although a very comprehensive plan of roads is proposed, it can not be hoped that the program will be carried to completion for many years to come. Many parts of the interior are far from settled and are but little developed.

It was officially estimated at the close of 1924 that there were 765,600 kilometers (475 miles) of roads in traffic or under construction. Many parts of these roads were of very poor quality and the bulk of them passable only in the dry season. In 1925, under the direction of the highway section authorized under the highway law of that year, some progress was made in the matter of road building. The activities of the highway section were concentrated on the road from Bahia, the capital to Feira do Sant'Anna, a road 136 kilometers (84.5 miles) in length. A very poor road of earth construction had previously existed between the two cities and the bulk of the work done during 1925 was improving the existing road, rebuilding certain stretches, building bridges, and maintenance. Two unimportant stretches of road were also repaired during the year and State aid given for the construction of other roads. The total road expenditures of the State of Bahia during 1925 amounted to \$84,140.

In 1926 it is estimated that more than 310 miles of roads were constructed in the State. Much of this work consisted of reconditioning and improving existing roads. In that year the State spent about \$139,713, of which slightly more than 55 per cent was spent on the road from Bahia to Feira do Sant'Anna. Approximately 20 per cent, 170 contos, was spent in the form of State aid to organizations in Bahia. A number of roads were studied in detail and complete specifications drawn up for their construction. At the close of the year, there were 1,528 miles of roads open to traffic, 186 miles under construction, and 785 miles under survey or definitely projected, giving a total of 2,500 miles.

Further progress was made in 1927, it being officially estimated that at the close of the year there were 3,480 miles of roads open to traffic, under construction, or definitely projected. The principal project in 1927, as in the two previous years, was in continuation of the road from Bahia to Feira do Sant'Anna. The second most important project of the State during the year was a branch from that road to Santo Amaro. The expenditures on these two roads amounted to approximately 70 per cent of the total expenditures of the State on highway building during the year, which were about \$451,966. This latter sum represents only the amount expended by the State government, either in the form of actual road building or in State aid to municipal or private enterprises. A considerable amount of road building and repairing was done by the various municipalities and private organizations throughout the State.

The greater activity in road building occurred in 1928, and in March of that year a separate highway division, under the secretary of agriculture, was created. At the close of the year there was in the State a total of 3,045 miles of roads definitely open to traffic and 1,785 miles under construction or being studied and definitely projected, bringing the total to 4,830 miles. These figures include, of course, only the State roads. Of the 3,045 miles indicated as open to traffic, 868 miles are first-class roads and 2,177 miles second-class.

Most of the first-class roads are passable throughout the year, and many of the second-class roads are passable except during the worst part of the rainy season.

The greater part of the road work has been grading, draining, and generally improving the existing roads, but many parts of the roads have been entirely rebuilt, generally with a crushed-stone surface and some macadam. Some short stretches of reinforced concrete have been laid, but the majority of the roads in the State are graded earth or gravel roads.

The government which took office in 1928 was definitely committed to a continuation of the State's road program. A number of projects were in hand. The State is faced with one difficulty in its road work in that the rainy season is very pronounced and during it torrential rains are experienced. In the worst of the season only the hard-surfaced roads are readily transitable. The latest figures show that the State has 175 miles of road passable all the year, 3,939 miles passable in dry weather, and 1,467 miles under construction, a total of 5,583 miles.

#### SERGIPE

Sergipe is the smallest of the Brazilian States. It lies in the north-eastern part of the country, between Bahia and Alagoas, and topographically it may be divided into three zones, the coastal, the central, and the "Sertao," the latter being the principal livestock section. The coastal plain is low and sandy, but the low table-land which comprises the central zone is watered by several rivers and its soil is very fertile. The estimated population on January 1, 1929, was 539,890.

The principal agricultural products are sugar and cotton, though some rice, beans, tobacco, maize, and coffee are grown. There are rich forest and mineral resources, but there has been very little exploitation of them. The cattle-raising industry is steadily growing in importance and value. Manufacturing is not yet of importance, although there are some textile mills, sugar mills, tanneries, etc., located in Aracaju, the capital and principal port.

There are nearly 190 miles of railroads in the State running from Propria, in the north, south to Bahia by way of Aracaju. The only navigable river is the Sao Francisco, which forms the boundary between Sergipe and Alagoas.

#### HIGHWAY SYSTEM

Sergipe has made relatively less progress in highway building than most of the other States in Brazil, but since 1927 a constant effort has been made to improve and maintain the existing roads.

The early program of the Federal irrigation service originally included road work in the State of Sergipe. Up to 1922 and 1923, when that department abandoned further work on its projects, a total of approximately 64 miles of roads had been built. The Federal irrigation service's program had called for the building of 102 miles of roads. The total expenditures for the work completed amounted to \$293,502 (at the average exchange rate for the period). From 1923 until 1927 very little was done other than the most necessary maintenance work, which was carried on by the State. All of

the roads in the State were of earth construction, with no hard surfacing whatever, and very little work of draining or grading was done.

In 1927 the State government undertook considerable work in the repairing of existing roads and built a number of bridges. During that year reconstruction of the road from Salgado to Annapolis, via Lagarto, was also begun, and several other projects of less importance were undertaken. Up to the end of 1927 practically none of the roads were passable all of the year. Roads which would otherwise have been passable were unusable in the rainy season because of a lack of bridges over the rivers.

In the governor's message of August 18, 1928, it was estimated that there was a total of 204 miles of roads in the State and another 26 miles under construction. In his message the governor outlined a comprehensive road-building program which was to be completed by 1930. While this program outlines the work to be done, no highway legislation has been adopted by the State to provide for a definite program of construction, maintenance, etc., with funds for the work.

A hard-surfaced road of broken stone and gravel was opened to traffic on June 22, 1928, connecting Larangeiras and Itabaiana, a distance of 25 miles. This road is 21 feet wide and has a maximum grade of 5 per cent. The minimum radius of curves is 262.4 feet, and bridges and drains are of reinforced concrete. It is proposed to connect this road with Aracaju, the capital, and also continue it to the border of Bahia. An earth road over this route now exists, but it is passable only in dry weather and much work is required on it. The part from Larangeiras to Aracaju is now under construction. When the road is completed it will link the capitals of Sergipe and Bahia.

An earth road also exists from Larangeiras to Propria on the Alagoas border, but as is the case in the road south via Aracaju to the Bahia border, it is passable only in dry weather. That road, with the one to Bahia, will eventually form the main trunk road of the State, with various branches built to the coast and interior.

#### HIGHWAY FINANCING

Road funds in Sergipe are almost wholly derived from general revenues. The cost of road construction has at times been met partly by contributions from the municipalities. Specific sums are frequently allotted for a particular road project, and various methods are adopted for financing maintenance. In one instance a contract was made with a private individual whereby he was to maintain the road and was allowed to collect a toll for the use of it.

The State government has allotted for roads during 1929 the following sums: Construction of new roads, \$598,000; repairs, \$59,800; maintenance, \$239,200; consolidation of roads, \$299,000; construction of bridges, \$358,800; maintenance and repair of bridges, \$59,800; other expenditures, \$737,741; a total of \$2,352,341.

#### ALAGOAS<sup>1</sup>

The State of Alagoas is the second smallest State of Brazil. It is located in the northeastern part of the country, between Sergipe

<sup>1</sup> Based largely on report of American Consul Nathaniel P. Davis, Recife.

and Pernambuco. In general, the State is made up of rolling plains, with a few elevations covered with forests in the interior. There are no natural obstacles which make the construction of roads particularly difficult, though the torrential rains which fall during the rainy season—March to September—make the maintenance of roads something of a problem. The estimated population on January 1, 1929, was 1,164,654.

Alagoas is primarily an agricultural State, the principal crops being sugar, cotton, tobacco, rice, corn, and mandioca. Hides and skins, mangabeira rubber, coconuts, oils, and lumber are of some importance.

There are over 200 miles of railroads in the State, most of which operate in the northern half from Maceio, the capital. There is some navigation on the Sao Francisco River, which forms the southern boundary of the State. Motor-vehicle transportation has assumed a constantly increasing importance, especially during the past two or three years, with the extension of highways.

#### HIGHWAY SYSTEM

Practically nothing has ever been done in Alagoas by the Federal Government in the matter of road building; the program of the Federal irrigation service did not include work there. Until very recently there were no good motor roads in the State. All were dirt surfaced, and ditches, drains, and bridges were inadequate. In the dry season, most of the rivers can be forded, but in the rainy season many ferries have to be maintained. These ferries, many of which are still in use, are log rafts which are poled across the rivers. It was not until the administration of Governor Costa Rego (1924–1928) that any real progress was made in the matter of road building. In his administration material progress was made, and the State highway program was adopted in 1925. At the present time Alagoas ranks as one of the most progressive of the northeastern States of Brazil in the matter of highways.

Under the highway program of the State all highways are classified as either public or private. The public highways are subdivided into Federal, State, or municipal roads. The Federal roads include those which may be built by the Federal Government. While there are none at the present time, it is anticipated that roads designed for interstate traffic will eventually be built by the Federal Government, or else the latter will take over existing roads and improve and maintain them. The State highways will include practically all of the important roads linking Maceio, the chief seaport of the State, with the interior points. The State roads are classified as first, second, and third class. Municipal roads include all city and village streets and the unimportant country roads leading to State highways. There are no uniform specifications for the construction or maintenance of these latter.

All first-class roads will have deep ditches, high crowns, and concrete drains and culverts as needed. Short bridges may be built of wood temporarily, but eventually all are to be of reinforced concrete. These roads are to have a foundation of crushed stone, the surface is to be built of rolled earth, clay, and gravel, and they are to be kept in constant repair. The plans of the public works de-

partment on road construction eventually call for macadam surfaces throughout on first-class roads.

The regulations regarding ditches, bridges, drainage, construction, and maintenance of second-class roads are generally the same as those applying to the first-class roads, except that broken-stone and earth surfaces are provided.

The third-class roads include all State roads not conforming to the specifications in the above group; there are no specified requirements as to construction, etc. They vary in character from fairly good, though very narrow, dirt roads to mere wheel tracks through sand or scrub.

#### HIGHWAY FINANCING

Up to the beginning of 1928, State roads were built and maintained with funds appropriated for the purpose by the State legislature from available resources. From the middle of 1925, when the construction of the original first-class road under the above-mentioned legislation was commenced, to December 31, 1927, the State spent \$310,000, completed 47 miles of first-class road, and made extensive improvements on the other existing highways. These expenditures did not include part of the drainage system, which is now in the course of construction.

The highway expenditures in 1927 totaled approximately \$92,370. Practically all the work was done under contract, and only very short stretches involving small expenditures were undertaken by the State itself. Under a law approved on December 10, 1927, a special highway fund was created. The revenues for this fund are provided through vehicle taxes; consumption taxes on gasoline, motor vehicles, tires, bicycles, side cars, and automobile accessories; fines for the violation of traffic laws; and from special donations. It was estimated that from these taxes there would be available for highway construction in 1928 between \$60,000 and \$70,000 exclusive of salaries and wages of regular employees of the department of public works, which are provided for elsewhere in the budget.

#### PROGRESS ON THE ROAD PROGRAM

Up to the end of 1928 there existed in the State of Alagoas 152 miles of first-class roads, including 61.5 miles still under construction. There were 915 miles of second-class roads and another 186 miles under construction.

The most important road built by the State since the adoption of its highway program is that from Maceio to Sao Miguel, which with several short branches has a total length of nearly 59 miles. It was completed in 1928 and is beyond question the best motor road in the entire northeastern part of Brazil. The road is well drained throughout and has a surface of road clay mixed with gravel. The traffic is kept to the right of the road on curves by a line of posts in the middle of the road; the outer edge is protected in a similar manner. Concrete drains have been provided at regular intervals. The old fords have all been replaced with reinforced-concrete bridges. Up to December 31, 1927, a total of \$315,000 had been spent on the road, the total cost being estimated at \$360,000.



The other first-class road in the State at the close of 1928 was the one leading from Maceio to the Barra de Santo Antonio. This, however, was built prior to the adoption of the State highway program, and while it does not conform strictly with the specifications set out in that program the road is in good condition and the old fords replaced by reinforced-concrete bridges. Another first-class road which is now under construction will connect Maceio with Palmeiros dos Indios.

#### MAINTENANCE

A corps of men is especially designated for maintenance work. All first and second class roads are divided into sections; for the maintenance of each section an official of the department of public works is held responsible. For ordinary upkeep, these sections are subdivided in stretches of 1.25 miles, each stretch being entrusted to a farmer living near by, under the supervision of a section chief. Each person in charge of one of these subdivisions is provided with the necessary hand tools. In parts subject to particular damage by rains, regular squads are constantly maintained by the State.

#### PRIVATE HIGHWAYS

Owners of large tracts of land, particularly sugar planters, frequently build roads for their own use. There are no State regulations covering such roads, and when one lies entirely on the property of the builder he may build as he pleases. Where a property owner wishes to build a road which will pass through other than his own land, the specifications must be approved by the State as may be determined in each particular case.

#### PERNAMBUCO<sup>2</sup>

Pernambuco is one of the smaller States and lies in the northeastern part of Brazil. While in area it ranks thirteenth among the Brazilian States, it is larger than Indiana. In population it ranks fifth, having on December 31, 1928, an estimated population of 3,783,049.

The State is primarily agricultural and produces nearly all varieties of products not requiring a temperate climate. It is the principal producer of sugar and cotton in Brazil, but apart from those two products the agricultural importance of the State is not great. Sugar far exceeds cotton in importance. The pastoral industry is of some importance, and a small amount of manufacturing has developed, principally in the production of cotton textiles, the refining of sugar, etc., but most of the manufacturing is for local consumption.

Pernambuco has approximately 600 miles of railroad. One line connects Recife, the capital of the State, with Maceio, the capital of Alagoas, to the south and with Parahyba to the north. The line running to the north also extends to Natal, the capital of Rio Grande do Norte. Branches of both lines connect other interior cities with the capital. Another main line runs from Recife to Barrao do Rio Branco, in the interior of the State. The Sao Francisco River, which

<sup>2</sup> Based largely on report of American Consul Nathaniel P. Davis, Recife.

forms the southern boundary of the State in the western half, is navigable through its entire length along the borders of the State. The high rail-freight rates and the fact that many parts of the State are not served by railroads have greatly increased the importance of highway transportation during the past few years.

#### HIGHWAY SYSTEM

The roads radiating out of Recife are among the most important in the northeastern part of Brazil, owing to the fact that the city ranks as the leading commercial center in that part of the country. The large number of automobiles and trucks in Pernambuco has had an important bearing on the road development in the State. At the close of 1928 it was estimated that there were approximately 745 miles of automobile roads and approximately 2,300 miles of cart roads. These classifications are rather loosely drawn and do not always describe actual present conditions; some of the roads built



Figure 8.—Grading and filling on the road from Santa Cruz to Torre, Pernambuco

as motor roads have been allowed to deteriorate to such an extent that they are less suitable for automobile traffic than some of the cart roads which have been better maintained.

There are practically no natural obstacles to the construction of roads in Pernambuco. Along the coast is a narrow sandy strip of land beyond which lies a belt of fertile forest land. This strip is covered with various kinds of timber and has numerous small rivers. Following the well-wooded section comes a region covered mainly with scrub, and the hinterland is good pasture land cut by hills and low mountains. For many years there has been an active interest in the building of roads, though it was not until 1928 that definite steps in the realization of a highway program were taken.

The only road work done by the Federal Government is that which was undertaken by the irrigation service. The program of that division called for the building of 166 miles in the State, of which 102 miles were completed up to the suspension of activities in 1924.

Little was done, however, in the way of maintenance, and in the past few years much of the work has had to be completely rebuilt. The total expenditures of the irrigation service up to the suspension of its activities amounted to approximately \$411,360 (at the average exchange rate for the period).

#### HIGHWAY PROGRAM

Several laws affecting the construction of highways in the State were adopted during 1928. On December 13 of that year the governor approved a law which consolidated all previous highway legislation and provided funds for highway construction.

Under the State's present highway program, the principal roads are specified as State highways and will serve as the trunk roads through the State. Some of these roads are to be maintained by the State and others by the municipalities through which they pass. Roads built entirely within a single municipality are to be built and maintained by the municipality, though authority may be granted for financial assistance from the State. Under the provisions of the law of December 13, 1928, the State is authorized to enter into agreement with the Federal Government for the construction of roads under a Federal aid plan. The State may also enter into agreement with the various municipalities through which the State roads pass for the construction and maintenance of those roads or may contract for their building through competitive bidding.

Under the program adopted in April, 1928, the State government approved new highway-construction projects with a total length of approximately 360 miles. Most of this work was on the State trunk highways and that outline comprised the first work on the State's program.

The trunk roads provided in the entire State program are as follows:

	Miles
Recife-Itambe and Parahyba State line.....	119.3
Recife-Umbuzeiro and Parahyba State line, via Pau d'Alho.....	128.0
Pau d'Alho-Timbauba and Parahyba State line.....	68.0
Recife-Petrolina, via Rio Branco, Villa Bella, and Leopoldina.....	820.0
Rio Branco-Jatoba.....	157.0
Leopoldina-Piauhy border.....	120.0
Recife via Garanhuns to Alagoas border.....	410.0
From Recife-Cabo road via Barreiros to Alagoas border.....	70.0
<b>Total.....</b>	<b>1,892.3</b>

These trunk lines will connect all of the States bordering on Pernambuco—Parahyba, Alagoas, Bahia, Piauhy, and Ceara. A regular passenger service is operated between Recife and Parahyba City, and the work which is being carried on to the south and will soon link Alagoas and Recife.

No uniform specifications for the trunk roads have been drawn up. In general, it is expected that the minimum width between ditches will be 16 feet; routes over which heavy traffic is expected may be wider. In ordinary terrain the maximum grade will be 6 per cent; in mountainous districts it will be 9 per cent or possibly somewhat less. No minimum curve radius has been adopted. Macadamized roads will be the water-bound type. Others will be rolled earth, in most cases with a gravel-clay surface rolled down. One State official

connected with the bureau of public works made an effort to have bituminous macadam specified for the most important sections, but he was overruled by his superiors on the ground of economy. Bridges are to be of reinforced concrete or of timber on concrete piers.

Prior to the adoption of the highway program there were approximately 62 miles of macadamized road. Most of this was rough, full of holes, and badly in need of rebuilding, but was passable for automobiles in all seasons. The remainder of the roads have rolled-earth surfaces and, when kept in proper repair, are good but are often allowed to deteriorate, particularly in the rainy season.

Under the road program, such macadamized roads as existed are to be resurfaced with macadam where necessary. Otherwise, the roads are merely to be repaired and the earth roads to be resurfaced.

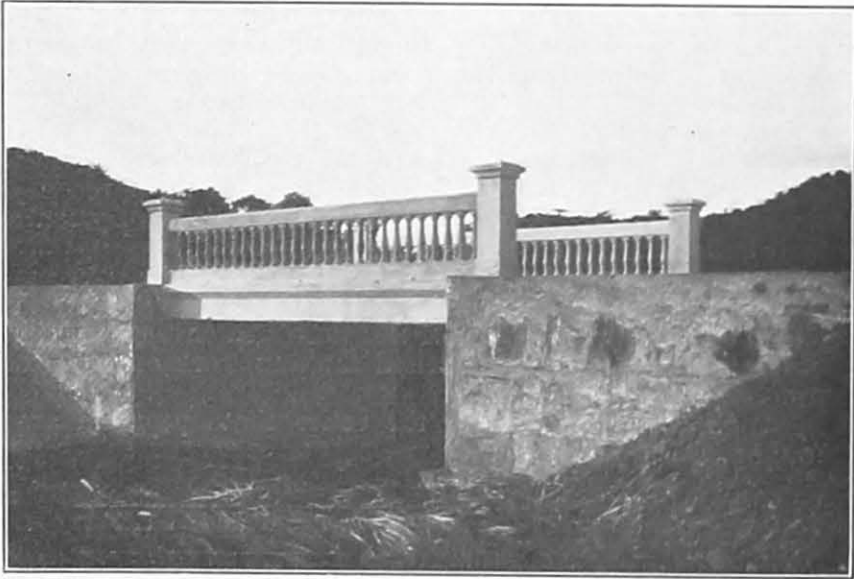


Figure 8.—Concrete bridge in Pernambuco on the road from Recife south toward Alagoas

With a large proportion of the road of simple earth construction, it is essential that the roads be constantly maintained, especially during the rainy season (March–September).

#### MAINTENANCE

Lack of proper upkeep has been the great fault of preceding efforts at road building in Pernambuco. Good roads have been built and then neglected until it was necessary practically to rebuild them. In the case of the few macadamized roads nothing was done until the surface was so full of holes as to be all but impassable. Then, in the dry season, the holes would be filled in with earth and a top dressing of earth or gravel spread over the surface and rolled in; the road would be excellent until the next rainy season, when the top dressing and filling would be washed away.

Under the highway law of December 13, 1928, provision is made for the constant maintenance of roads throughout the State. Roads in

the coastal zone will have maintenance squads of an inspector and an average of 12 men for each 31 miles of road. For roads in the interior and those roads in the coastal zone having light traffic, the squads will be composed of an inspector and an average of 12 men for every 62 miles.

In order to make the maintenance of the State roads less of a problem, vehicles with a single axle (ox carts) are prohibited from the use of these roads. A speed limit equivalent to 36 miles per hour for passenger cars and 18 miles per hour for trucks has also been established.

#### HIGHWAY FINANCING

A law passed in the latter part of 1927 provided that all State revenues from motor-vehicle registrations, vehicle and gasoline sales taxes, and certain other sources should be credited to a road-building fund, together with such funds as the governor should allot from the general revenues. In order to have funds immediately available for road work, the governor issued a decree on April 3, 1928, opening this fund with a credit of \$238,000. A few days later an additional credit of \$17,850 was added for the special purpose of constructing the Leopoldina-Exu road, which serves the extreme northwestern part of the State. Both of these sums were for expenditures on roads during 1928.

As stated above, actual construction is to be paid for by the State. The Federal irrigation service agreed in 1928 to assist to the extent of granting free of charge the materials necessary for bridges, culverts, and drains. These materials consist chiefly of timber and cement, large stocks of which are already on hand. The irrigation service also agrees to supply engineers, but labor and transportation are to be furnished by the State.

Maintenance costs will be divided between the State and municipalities traversed by the roads, the municipalities paying in proportion to their revenue and to the mileage of trunk road within their borders. The minimum municipal contributions are to be 20 per cent of the cost of keeping up the roads in its territory, and the maximum 50 per cent.

The State authorities estimate upkeep cost of dirt roads at approximately \$190 per mile.

Under the consolidated highway law of December 13, 1928, the following sources of revenue are provided:

(a) Sales tax on gasoline, approximately 2.3 cents per gallon; on motor vehicles, ranging from \$4.19 to \$10.17 on passenger cars and \$10.17 to \$14.95 on trucks; tax on gasoline pumps.

(b) State vehicle tax (registration fee).

(c) Twenty per cent export tax on alcohol and its derivatives.

(d) Ten per cent of the gross receipts of each municipality.

(e) Special State appropriations.

(f) Various fines for traffic violations.

No statistics are available as to the highway expenditures of the government which took office in 1928. Road work on an extensive scale began with the previous administration. According to the message of the governor of September, 1926, the road work which was commenced preceding his administration and finished in his administration involved an expenditure of \$162,160.

## EXTENT OF ROADS

Principal State roads in the State of Pernambuco include 450 miles passable all the year, 2,840 miles passable in dry weather, and 38 miles under construction.

PARAHYBA<sup>1</sup>

The State of Parahyba lies just north of Pernambuco and is roughly half the size of the latter. The estimated population on December 31, 1928, was 1,277,652. Topographically, the State has but two zones, the low coastal and the mountainous section. The eastern part of the coastal zone is low and sandy and, in the part approaching the mountainous section, red clay, such as is found in Pernambuco and Alagoas, is common. This extends to many sections of the mountainous parts of the State.

The principal agricultural crop is cotton, which is followed by sugarcane, coconuts, and tobacco. Parahyba not only is the greatest cotton-producing State in the northeastern part of Brazil but also produces what is reputed to be the best quality. Hides and skins are also of considerable importance to the State and among these goat-skins hold first place. The lumber resources of the State are moderately extensive, though they have been relatively little exploited.

There are over 250 miles of railroads open to traffic in the State, consisting of the Great Western Railway of Brazil and the Ceara Railway. These lines connect Parahyba with the capitals of Rio Grande do Norte, Pernambuco, and Alagoas. Branch lines running from the main roads connect with Bananeiras, Campo Grande, and Alagoa Grande. River transportation is not important in the State. All goods shipped through Parahyba must be transshipped to Cabedello as ocean steamers are unable to go up the Parahyba River to the capital, though the river is navigable to small boats as far as Santa Rita.

## HIGHWAY DEVELOPMENT

Parahyba enjoys one advantage not shared by its neighbors to the south; there is already in existence a fairly good network of roads built by the Federal irrigation service before that department suspended its activities. The program of the irrigation service called for the construction of 2,134.611 kilometers (1,325 miles) of roads in the State. When work was stopped all but 47.5 miles had been completed, and those stretches were under construction. Although the roads were in one sense completed and open to traffic, more than half of them were classed as cart roads and the program called for the improvement of many of them. All of the roads were of simple earth construction, and few bridges were built. For the most part, the roads were not passable after heavy rains. During the period from 1919 to 1923 the Federal irrigation service spent a total of approximately \$2,494,473 (at the average exchange rate for the period).

Very little maintenance work was done in the State from 1923 until 1927 when a new arrangement was made between the irrigation service and the State, whereby the irrigation service furnishes engineers and material and the State provides funds and labor. This work

<sup>1</sup> Based largely on report of American Consul Nathaniel P. Davis, Recife.

consisted principally of reconditioning roads previously built by the irrigation service and building bridges. Since the roads were all earth surfaced, in the absence of systematic upkeep they deteriorated rapidly, especially in the rainy season. While some work was done in both 1927 and the first half of 1928, very little work has been done since then.

Very little new construction has been undertaken. The existing roads, however, if properly maintained, would furnish the State with a very satisfactory system of trunk routes. These roads connect practically all of the more important centers and give a fairly complete transportation system for most parts of the State.

It is estimated that there are between 650 and 700 miles of motor roads which form the trunk highways of the State. In addition, there are probably 100 miles of the other so-called motor roads built by the Federal irrigation service branching off at various places from those described above, including an alternative route from Soledade to Patos through Passagem.

With the exception of the road from Itambe to Santa Rita, all of those described above except a few short and unimportant sections were built by the irrigation service, mostly by rebuilding existing cart roads. The Itambe-Santa Rita road, being part of the direct route from Recife to Parahyba, is one of the most traveled highways in the State.

Until the end of 1927 that road was mere tracks through a sandy desert plateau. At that time a minimum of ditching was done and the surface was leveled after a fashion. Heavy rains have largely undone that work, but with the exception of about 500 yards leading up a steep clay hill from Santa Rita to the plateau it is quite passable for light passenger cars and trucks. Motor traffic is passing over it daily.

With a few exceptions all of the roads in the State are simple earth surfaces, the old cart roads simply having been drained, graded, and rolled. Some sections have graveled surfaces, but there are no hard-surfaced roads in the State. The total length is about 1,325 miles, generally passable in dry weather only.

#### ROAD PROGRAM

No systematic highway program has been adopted by Parahyba, though there is an increasing interest in the good-roads movement and it will not be surprising if some definite action is taken soon, although no important new construction is contemplated for the immediate future.

As mentioned above, the State has entered into a contract with the Federal Government whereby the irrigation service supplies engineers and materials for road building and repair, while the State provides laborers and the funds with which to pay them. The engineers receive their salaries from the Federal treasury. The materials, chiefly timber, cement, and steel wire for reinforced-concrete construction, of all of which large stocks are on hand, are furnished free of charge.

The State has adopted no uniform specifications for the highways, other than to divide them into first and second class roads.

The first-class roads are suitable for automobile traffic in all seasons. In general, they are those built by the irrigation service plus such new construction as the State may undertake. These roads follow the minimum requirements of the irrigation service, which call for deep ditches, high crowns, rolled dirt or gravel and clay surfaces, a maximum grade of 9 per cent, minimum width between ditches of 6 meters (19.5 feet), concrete culverts, and bridges of reinforced concrete or timber on concrete piers. Considerable latitude seems to be permitted in the matter of width, grade, and bridges, however.

Second-class roads are all other roads, not necessarily passable for motor vehicles in wet weather. Many of them, in fact, are not. There are no specific requirements.

As indicated above, the work to be done under the agreement between the State and Federal Governments amounts practically to improvement and maintenance of existing roads. No provision has been made for constant vigilance and upkeep, as was done in Alagoas and Pernambuco. This is a serious fault, as dirt roads in this district, particularly during the rainy seasons, require constant attention if they are to be kept in proper condition.

The State of Parahyba has the ground work for a very satisfactory highway system, but unless it develops a thorough maintenance system its road-building energies will be wasted on periodic rebuilding of fairly good roads, which are being allowed to deteriorate almost as fast as completed.

#### HIGHWAY FINANCING

Neither the last nor the current State budget makes definite provision for road work. The president (governor) of the State is authorized to expend such sums as may from time to time be available for the purpose. The books of the treasury do not show how much was expended in 1927. An unofficial estimate places the probable total available for highway expenditure in 1928 at not more than 300 contos (\$36,000).

Of 39 municipalities, 31 reported total expenditures on road work between July 1, 1926, and June 30, 1927, of \$20,600. No reports were made by the remaining 8, all of which are small and unimportant. Expenditures in 1927-28 were probably about the same, though no figures have been made available. The above figures include expenditures on city streets as well as on country roads.

#### RIO GRANDE DO NORTE<sup>4</sup>

The State of Rio Grande do Norte is located in the extreme north-eastern corner of Brazil, just north of Parahyba. Its area is slightly smaller than that of Parahyba, and the estimated population on January 1, 1929, was 714,069. The physical aspect is very irregular, being low at the coast and cut by mountains and some rivers in the interior.

Cotton is by far the most important agricultural product, though sugar cane, manicoba rubber, carnauba wax, rice, and lumber are of some importance. The State is subject to droughts which often

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<sup>4</sup> Based largely on report of American Consul Nathaniel P. Davis, Recife.



do great damage to the crops. The raising of livestock is carried on to some extent, and the production of pork in the northwest is very important. The manufacturing development has not been great. Rio Grande do Norte is the principal producer of salt in Brazil, supplying over one-half the country's needs.

There are approximately 250 miles of railroad in Rio Grande do Norte. One line connects the capital, Natal, with Parahyba and Pernambuco, and one runs from the capital to Eptacio Pessoa, slightly beyond Lages; the continuation of this line to Macao is projected. A third line connects Mossoro with the sea and extends south to Caraubas. There are practically no rivers available for transportation, and highways have increased greatly in importance during the past few years. With the material increase in rail-freight rates in the State which occurred in 1928, truck transportation gained materially.

#### HIGHWAY DEVELOPMENT

Rio Grande do Norte shares with Parahyba the advantage of previous road construction by the Federal irrigation service. Nearly 1,000 kilometers (600 miles) of roads were built by that department before it suspended its activities in 1923, 50 miles were under construction, and 30 miles projected. Of these roads only about half were more than cart roads, and even the better roads were of simple earth construction. The total expenditures of the irrigation service from 1919 to 1923 on roads in Rio Grande do Norte was \$2,003,749 (at the average rate of exchange for the period). A small amount of repair work was done by the department in 1927.

Very little road work was done by the State prior to 1927, other than a small amount of maintenance work. The president (governor) of Rio Grande do Norte who took office on January 1, 1927, was interested in the development of highways as a means of solving the transportation problem of the State, and early in his administration a State highway program was adopted. This program divides all public roads into State and municipal highways. As in other States, it is anticipated that eventually roads for interstate traffic will be built, or at least maintained, by the Federal Government. Federal-built roads of the irrigation service designed primarily for traffic within the State will be taken over by the State. State highways are to include all public roads traversing more than one municipality, and will eventually come under State supervision. State roads are classified as first or second class.

First-class roads are to have a minimum width between ditches of 19.5 feet and be surfaced with a mixture of clay and gravel. The maximum grade allowed is 7 per cent. All will have deep ditches and suitable bridges, culverts, and drains. No minimum curve radius is specified. There are already in existence 220 miles of roads conforming in general to these specifications, and very little remains to be done to bring them up to first-class standards; 135 miles more are projected.

Second-class roads are to be all other State roads, without any uniform specifications except that they must be passable for vehicular traffic in all seasons. Only absolutely necessary complimentary works will be constructed, and these will not be so elaborate as on

the first-class roads. At present there are 2,100 miles of State roads called second class, but probably at least 60 per cent of this mileage is not suitable for vehicles in wet weather. A considerable proportion consists of roads begun but not completed by the irrigation service, and many bridges are yet to be built. It is planned to improve these roads gradually and build the necessary bridges, etc., until all conform to the second-class standards.

The principal first-class roads in the State connect Natal, the capital, with Jardim do Serido in south central part of State, Lages with Curraes Novos, on the Natal Jardim do Serido road, Lages with Assu, and Parelhas with Caico via Jardim do Serido. The first and last of these are in good condition and passable at practically all times of the year. It is planned to continue the Lages-Assu road to Mossoro, and a road is projected to Macau. Eventually a first-class road will connect Lages with Natal via Ceara Mirim. In dry weather it is now possible to make this trip, continuing to Mossoro and Ceara.

#### HIGHWAY FINANCING

Beginning with January 1, 1928, motor-vehicle registration fees are being collected by the State instead of by the municipalities as heretofore, and the gross income from that source is credited to the road-building fund. The State authorities anticipated an income in 1928 of \$6,000. In addition to this, 10 per cent of the gross revenue of the State was to be set aside for road building. This would mean about 1,000 contos, or \$120,000. In addition, there are other minor provisions for the highway fund. Though detailed figures are not available for 1928 it is not believed that more than half of this amount was actually available for road work, owing to the pressing obligations of the State. In 1927 the State spent approximately \$12,000 on highways. No later figures are available.

#### CEARA

The State of Ceara is located on the northern coast of Brazil between the States of Rio Grande do Norte and Piauhly. In area it ranks twelfth among the Brazilian States and is approximately the size of Michigan. In population it ranks seventh, having an estimated population on December 31, 1928, of 1,590,003. Mountain ranges along the western and southern borders form a triangle from which numerous rivers drain into the sea.

The principal agricultural crops are cotton, sugarcane, coconuts, tobacco, carnauba wax, fruit, timber, and medicinal plants. Ceara is one of the leading producers of carnauba wax. Hides and skins, especially goatskins, also form an important product. Some mineral resources are known to exist but very little has been done to exploit them, and manufacturing has been but little developed in the State. The climate is hot and dry, and periodic droughts cause much damage to the crops and livestock; at times they are sufficiently serious to cause a great deal of suffering even to the people.

There are approximately 730 miles of railroad in operation in the State of Ceara. The principal road runs from Fortaleza to Crato, south of Lavras in the extreme southern part of the State, a distance of 375 miles. The Sobral railway runs from Camocim on the northwestern coast through Sobral to Cratheus and the Piauhly

border, a distance of about 230 miles. The rivers are useless for transportation purposes. There is no harbor at Ceara, the capital, and as the sea is usually rough, vessels are forced to anchor a mile or so offshore. Passengers and freight are taken off in small boats or lighters.

#### HIGHWAY ACCOMPLISHMENTS

During 1927 the trunk highway from Natal to Jardim do Serido, in the south-central part of the State, was improved and repaired as far as Santa Cruz. From a point on this road about 10 kilometers from Natal a new road was opened to the site of the State aviation field, a distance of some 12 kilometers (7 miles). The principal work in 1927 consisted of scraping, grading, and installing drains. In 1928 considerable gravel and broken-stone surface was laid. During 1929 and 1930 very little work was done.

During the first three months of 1928 work was concentrated on bridges and drains for the unfinished roads left by the irrigation service. The work was done by the State with materials furnished free of cost by the irrigation service from the supplies left on hand when work was suspended. This policy was continued until the dry season, about October, when active construction on the projected first-class roads was commenced.

In the governor's message of October, 1928, he reported that in his administration 415 miles of roads had been rebuilt and 48 miles had been newly constructed. The federal irrigation service also repaired in this period a road from Caico to Jardim Piranhas and Serra Media. In addition to this it also built 23 new bridges on existing roads and rebuilt and repaired 10 others and had replaced numerous drains.

During the dry season it is possible to go practically anywhere in the State, only two or three towns located on high hills in the interior being inaccessible by roads. The chief difficulty during the rainy season is that the rivers become swollen and, because of a lack of bridges, the roads become impassable. A good many of these rivers entirely dry up during the dry season and present no difficulties to motor transportation. Practically all that is required to give Rio Grande do Norte a system of good motor highways is to repair the existing roads and improve them, since for a number of years a fairly complete system of roads has existed through the State. At present there are some 197 miles passable all year and 452 miles of roads passable in dry weather.

#### MUNICIPAL HIGHWAYS AND CITY PAVING

There are no standard specifications for municipal highways, and as the State program foresees a complete system of trunk roads linking up all important towns, they are of only minor importance. Following the example set by the State, however, the municipalities agreed to set aside 10 per cent of their 1928 gross receipts for road building. This would mean a total of some \$8,333 if followed out. While figures are not available for 1928, it is not felt that more than \$4,000, or \$4,500 at the most, was spent by the municipalities. In 1927 the municipalities spent \$7,140 on their roads, but more than half of this amount came from motor-vehicle registration fees, which no longer go into the municipal coffers.

During the administration of the present mayor of Natal, who had held office in 1924, about 49,100 square yards of pavements were laid in the 4-year period ending December 31, 1928. Of this, 42,000 square yards were new pavements, and 7,100 square yards were pavements which were rebuilt.

#### HIGHWAY SYSTEM

The State of Ceara has been one of the least progressive in Brazil in the matter of highway building. Practically all of the roads which exist are a result of the work of the Federal irrigation service, which built about 1,000 miles of roads, of which 298 miles were moderately good and the balance little more than cart trails. A total of \$2,961,999 (at the average rate of exchange for the period) was spent on the work.

More work was done in Ceara by the irrigation service than in any other State. Practically all of the work, however, consisted of scraping and draining existing cart roads. Few bridges were built and no hard-surfaced roads, but those completed would serve as an excellent nucleus for a State highway system. What little highway work which has been done since the termination of the work of the Federal irrigation service has been undertaken mostly by the municipalities rather than by the State.

The entire State is covered with a network of cart roads. The great majority of them have been traversed by light motor vehicles at one time or another, but they are not to be considered in any way as suitable for regular motor traffic. The State authorities have made no surveys whatever as to existing roads and are not in a position to show even accurate estimates of the total mileage of existing roads. However, it is roughly estimated that there are approximately 1,200 miles of Federal, State, and municipal roads in the State which are generally classed as motor roads, but most of them are little more than cart trails. In the dry season it is possible to go from Fortaleza, the capital, to practically any part of the State. The trip has been made by automobile from Fortaleza to Recife and from Fortaleza to Therezina, the capital of the State of Piauhy, but such trips are hailed as rather remarkable feats. During the rainy season practically all of the roads are impassable.

Very little road construction or maintenance work has been done in the State since 1923, but it now appears that some progress will be made, for early in 1929 a special highway division was created. While sufficient time has not elapsed for a complete survey, a general program of projected roads has been drawn up. It is expected that the work of surveying, and actual construction on some of them, will be begun in the near future. The State plans to improve other existing roads which are in poor condition owing to lack of maintenance.

The State has no special highway fund, and such expenditures as are made come from the general revenues. No data are available as to the amount spent by the State in its road work.

#### PIAUHY

Piauhy is the tenth largest State in Brazil in area and is large as New York and Pennsylvania combined. It ranks fifteenth among

the Brazilian States in population, which on December 31, 1928, was estimated as 785,196. It lies in the northern part of Brazil and touches the Atlantic Ocean on the north, the narrow part of the State, for about 38 miles. Mountain ranges rise in the east and are drained by numerous rivers flowing into the Parnahyba, which flows to the north and forms part of the western boundary of the State. The central and southern sections are rich grazing lands, and most parts of the State are suitable for agriculture.

The most important product of Piauhy is livestock, principally cattle and goats. The cattle are all native breed and little care is taken to improve the stock. Less attention has been paid to agriculture, though some cotton, sugarcane, tobacco, vegetable-oil nuts, particularly the babassu, and mangabeira and manicoba rubber are produced. Manufacturing is still undeveloped.

One of the principal reasons for the economic backwardness of the State is the lack of cheap and easy transportation, both rail and highway. Therezina, the capital of the State, is located in the interior and is connected with the coast by a railroad operating to Sao Luiz, the capital of Maranhao, and by river to the principal seaport, Parnahyba. The Parnahyba River is navigable for a total distance of over 400 miles. The rail service to Sao Luiz is slow, infrequent, and expensive. The Parnahyba River is navigable beyond Therezina and much merchandise is shipped by this route, though transportation is slow. The exports of the State are generally transhipped at Parnahyba to Tutoya, in the State of Maranhao. There are slightly less than 100 miles of railroad in the entire State. The principal railroad operates from Parnahyba south toward Therezina as far as Piracuruca, and also from Parnahyba to Amarracao, which serves as a port for vessels which are unable to go up the river to Parnahyba.

#### HIGHWAY SYSTEM

The topography of the State is such as to be relatively favorable for the construction of roads. Much of the State is a plateau with rolling hills, well drained with rivers. Many of the rivers are dry except during the rainy season, but to make the roads passable the year round it is necessary to construct numerous bridges. In the period of its activity, 1919-1923, the Federal irrigation service undertook a small amount of road building. Much less work, however, was done in Piauhy than in most of the other States in which the department operated; 112 miles were built, of the 279 miles projected, at a total cost of \$562,218 (at the average rate of exchange during the period).

Up to less than two years ago very little work was done by the State on the construction of highways. Cart roads and trails have existed for some years to practically all parts of the State, although little construction or maintenance work has been done. These are, for the most part, passable in the dry season for light cars. Such maintenance work as has been done on these roads has been largely by the municipalities through which they pass.

According to the only figures available, there are approximately 1,740 miles of roads in the State, all of simple earth construction and, for the most part, not passable during the rainy season.

It is reported that during the past year or two considerable progress has been made in improvement of existing cart roads. It is also reported that the State government is interested in the subject and that, in all probability, a definite highway program will be adopted in the near future.

At present, such funds as are available for road work are derived from the general revenues of the State.

### MARANHAO

The State of Maranhao is located on the northern coast of Brazil and is approximately equal to the combined size of Michigan, Ohio, and Indiana. It ranks seventh among the Brazilian States. The estimated population on December 31, 1928, was 1,108,601.

Along the coast the country is level, but in the central districts it is broken and mountainous. Maranhao has rich agricultural possibilities, the principal crops being cotton, rice, sugarcane, tobacco, and oil nuts. The last named are important, there being a large number of cocoanut palms, babassu, and other nuts of very high oil content. Hides and mandioca flour also make up important export commodities. Rich deposits of copper, gold, coal, iron ore, and other minerals are thought to exist, although as yet they are practically untouched. Manufacturing is relatively unimportant, though there are some small textile mills.

The principal railroad in Maranhao is that connecting Sao Luiz, the capital, with Therezina, the capital of Piauhly. This road belongs to the Federal Government and is more than 280 miles in length. The construction of another road, from Coroata on the Therezina-Sao Luiz line to the Tocantins River, which forms the boundary between Maranhao and Goyaz, is under consideration. Numerous rivers flow from the mountains southward to the sea, many of them being navigable for considerable distances. The Parna-hyba and the Itapicaru are the most important from the standpoint of navigation.

### HIGHWAY SYSTEM

Up to about three years ago, Maranhao ranked as one of the most backward States in Brazil in the matter of highway construction. Road building is difficult in the coastal region, where the rainfall is extremely heavy and vegetation dense. No road-building work has been undertaken by the Federal irrigation service or other National Government agencies, and such roads as existed were maintained largely by the municipalities. Cart roads and trails have existed in the State for a number of years, but these were for the most part unsuitable for automobile traffic. None of the roads were passable during the rainy season.

Practically no serious effort was made of road building until the latter part of 1927, when the governor of the State made an active campaign for the construction of highways as a means of solving the transportation problem. Under his administration between 600 and 900 miles of passable earth roads were constructed. Practically all these roads, with the exception of those on the island of Sao Luiz, on which the capital of the State is situated, are in the southern part of the State. They connect the various centers in

that territory and serve as feeders to the railway operating between Sao Luiz and Therezina. At the close of 1928 the governor made a trip covering 1,180 miles by automobile in a period of five days which two years before had required 49 days on horseback. As an indication of the progress which was made in 1928, the same trip made in December, 1927, required 14 days.



Figure 10.—Earth road in interior of Maranhao, showing dense vegetation which must be kept out back

All of the roads in the State are of simple earth construction; the majority of them are merely improved old cart roads and trails which have been graded and drained. Numerous bridges, most of which are of light construction, have been built. Except in the rainy season the roads are moderately good for light motor traffic; during that season most of the roads are extremely muddy and generally impassable and the rising rivers frequently carry away the light bridges. The total mileage at present is about 1,700 miles.

## SPECIFICATIONS AND FINANCING

Up to the early part of 1929 the State of Maranhao had not adopted any standard highway program, though the president (governor) had repeatedly indicated his intention of providing the State with an adequate highway transportation system. It was his intention to construct roads which will serve as feeders to the Sao Luiz-Therezina railroad and connect the interior settlements. Up to the present time no set specifications have been drafted for the various roads in the State, all of them being simple earth type of construction and for the most part maintained by the municipalities. Such funds as are made available for road construction are from the general revenues of the State or municipality. Up to the present time no special taxes have been levied by either the State or municipalities for this work.

During the administration of Governor Magalhaes the State spent a total of \$132,000. It is unofficially reported that parts of the roads built during his administration have been constructed by the municipalities under State aid, which took the form of either a light passenger car or a truck presented on the completion of the road. During 1929 and 1930 the roads from Grajahu to Bara do Corda and from Caxias to Curralinho, and improvements in the road from Porto Franco to Grajahu, were to be made. Other less important projects were also planned.

## PARA

The State of Para is the third largest in Brazil; it is larger than any country in Europe except Russia. The estimated population on December 31, 1928, was 1,375,845. The general aspect of the State is a vast area of tropical vegetation sprinkled here and there with some low mountains from which drain numerous rivers flowing north and south to the Amazon, which cuts through the middle of the State. The climate is hot and humid, owing to its equatorial location; rains are frequent and the land extremely fertile.

For many years Para's chief wealth was in the rubber industry, but since the decline of the price of rubber and the increased cost of collecting the uncultivated rubber, Para has experienced a period of severe depression. Rubber still remains the most important product of the State, but it is far less important than in previous years. The second in importance among the products of Para are Brazil nuts; other products are lumber, mandioca, rice, hides, and skins, raw cotton, and carnauba wax. Manufacturing development in the State has been very small, and the known mineral deposits are almost negligible.

Para is one of the most fortunate States in Brazil in the matter of river transportation. The Amazon River, with its principal tributaries in the State, the Tapajos and the Zingu, and the Tocantins are navigable for long distances. Numerous smaller rivers are also navigable for small boats, and it is officially estimated that there are approximately 5,600 miles of navigable rivers in the State. In addition to the river transportation there are, of course, coastwise and foreign steamship services.



Belem, the capital of the State, is one of the important ports of Brazil and furnishes an outlet for the exports of the Amazon valley and the States through which the river flows. The port is connected with the United States and with Europe by several steamship lines and has a large river and coastwise transport.

There are only two railroads in Para; one running from Belem to Braganca with a total length of 196 miles, including short branches, and the other from Alcobaca to Praia da Rainha on the Tocantins River, a distance of about 56 miles.

#### HIGHWAYS

Apparently in the days of the Empire a fairly well-developed highway system existed in the State of Para. There are evidences of a road which was built several generations ago running from Belem to Braganca, and it is thought that this went all the way to Alcantara, across the bay from Sao Luiz in the State of Maranhao. The distance by this route from Belem to Alcantara is between 300 and 350 miles. There are also evidences of roads which paralleled the Amazon River, and undoubtedly other roads existed in this period. There are no records whatever available concerning these roads; apparently many of them were built under concessions granted by the Portuguese Government in the colonial days. Owing to the very rapid growth of vegetation in Para, all visible traces of these roads have now disappeared and are discovered only when excavations of one kind or another are made. Since the colonial period no road building has been done in the State by the Federal Government.

Because of the extensive navigable rivers in the State, the development of highways has not been as important a factor in Para as in many other States of Brazil.

There are numerous natural difficulties to be overcome in any road-building program. Unless the roads are constantly used and maintained they rapidly disappear with impenetrable growths of vines and other vegetation. Any road built requires numerous bridges, and since in the periods of high water some of the rivers overflow their banks for some distance, long bridges are required if the roads are to be used throughout the year. Furthermore, in many parts of the State there are numerous underground springs which make construction difficult. It frequently happens that after several months a spring works near enough the surface to undermine a road. It is then necessary to fill in the resulting holes constantly or to change the course of the road. Obviously, the rapid and dense growth of vegetation requires a constant cutting back to keep the road from being obliterated.

Outside of the city of Belem and a few of the more important towns, all of the roads and streets are of earth construction. In Belem most of the streets are paved with granite block. According to the official estimate of the State government there were, at the close of 1929, 159 miles of automobile roads in the State. Most of these either lead out of Belem or extend from the railroads inland. During the period of heaviest rain practically all are impassable.

Up to a few years ago there were practically no roads built, and very few exist in the interior of the State. Almost the first road was built by a firm representing American automobiles and tractors. This was constructed and maintained at the expense of the company under a concession from the State which permitted the exclusive operation of truck services over the road. It connects Santa Isabel on the Belem-Braganca Railroad with the town of Vigia, a distance of about 38 miles. The company operates a regular truck service connecting with the trains.

In addition to the 159 miles of roads which are now in service, there is an additional stretch of 36 miles under construction. The only road definitely projected is one from Braganca toward Codo, Maranhao, which is on the Sao Luis-Therezina Railroad. The total



Figure 11.—Wooden bridge in Para

length of this road would be something over 280 miles. In addition, the general State highway program includes a road from Santarem to the State of Matto Grosso, through the rich region between the Tapajos and the Xingu River, and another from the Tocantins River, undoubtedly starting at the southern end of the railroad from Alcobaca to Praia de Rainha, to Araguaya on the Goyaz boundary, and a third from Obidos to the border of Surinam. No definite routes for these roads have been projected, and in view of the serious economic depression which has existed in the State for the past several years and the rather unsatisfactory condition of the finances in the State, it is not likely that an important highway project will be undertaken for several years to come.

Figures on the expenditures of the State on road and bridge construction are practically nonexistent. According to the government figures the State spent on public works in general in 1927 and 1928

approximately \$43,000 and \$24,000, respectively. Most of these expenditures were on work other than highways. According to the governor's message of September 7, 1928, a total of approximately \$9,300 was spent on roads and bridges between January 1, 1925, and June 30, 1928.

Practically all of the roads are poorly maintained and even at best are far from what would be considered as good motor roads. In addition to the roads officially listed there are short stretches of roads which have been built by private individuals to serve their own particular needs. The total extent of these, though, is not great. The State government recently opened a trail which connects Maraba, in the Tocantine Valley, and Sao Vicente, in Goyaz. This trail and another between Oyapock and Clevelandia, in the north near French Guiana, has been built solely for driving livestock. It is planned to improve these eventually for motor-vehicle use.

#### AMAZONAS<sup>5</sup>

Amazonas is situated in the extreme northwestern section of Brazil. It is the largest Brazilian State and only slightly smaller than the combined area of that portion of the United States lying east of the Mississippi north of and including Virginia and Kentucky. With one exception it has the smallest population of any of the Brazilian States, the estimate on December 31, 1928, being 425,598. Amazonas has no coast, being one of the four inland States of Brazil.

The Equator passes across the northern section of the State, and the Amazon River and its many tributaries drain the State. That part lying north of the Amazon is considerably higher than the territory to the south and is less marshy. Amazonas is largely undeveloped; its principal product is rubber, and next in importance rank oil nuts, lumber, chicle, medicinal plants, etc.

The State has only one short railroad, the section of the Madeira-Memore line which has been finished. The principal means of transportation is the Amazon River with its tributaries, the Madeira, the Purus, the Jurua, the Jupahy, the Jupura, the Rio Negro, and their tributaries, making a total of about 7,500 miles of navigable waterways. Manaus, the capital of the State, is on the Amazon River approximately 925 miles from Belem, and is served by ocean-going vessels. Steamers operate direct from European and American ports to Manaus, and there are numerous river steamers operating on the upper Amazon and the principal tributaries of it.

#### HIGHWAY DEVELOPMENT

Amazonas suffered even more than Para from the decline of the price of rubber. Other factors have combined to retard public works. The revenues of the State are small and the natural difficulties in road building serious. Furthermore, the availability of numerous navigable rivers makes the construction of highways less essential than would otherwise be the case. In a State as large as Amazonas, the distance between settlements is very great and, with the sparse population, the traffic over roads would be very small.

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<sup>5</sup> Based on material furnished by American Vice Consul Gerald A. Drew, Belem.

Unless the roads were constantly maintained, they would quickly disappear entirely, owing to the rapid and dense growth of vegetation. Practically all of the road building which has been attempted by the State has been in the immediate vicinity of Manaus and without assistance from the Federal Government.

A small amount of road building has been under way since the beginning of 1927. In the president's (governor's) message of July, 1928, he reported that there were 48 miles of State roads in Amazonas. These are practically all passable throughout the year, though in poor condition during the rainy season, from November to May. In July, 1929, it was estimated that there were a total of 66 miles of State roads, and in addition 148 miles of roads built under Federal subvention by a private enterprise. This gives a total of 214 miles of roads in the State.

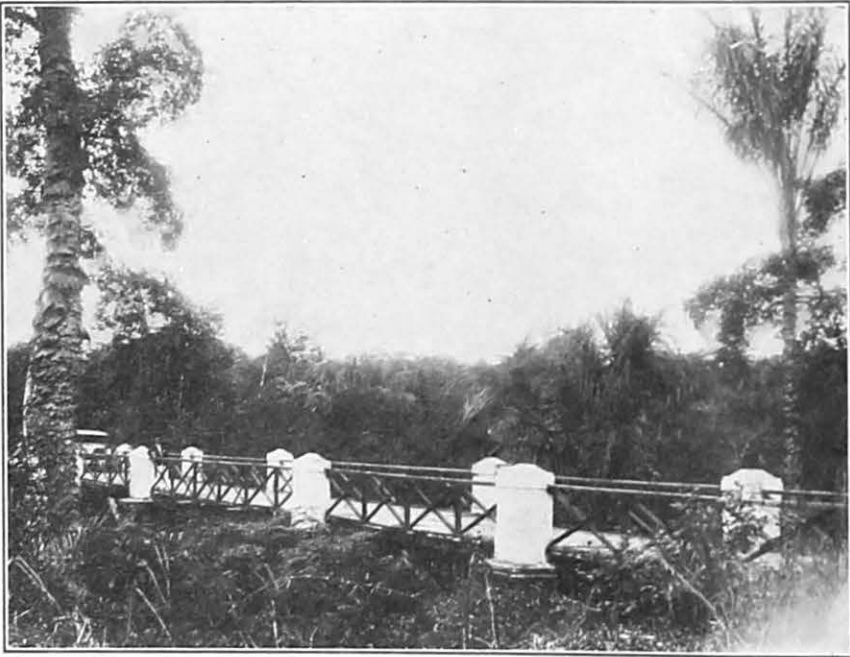


Figure 12.—Wooden highway bridge on concrete piles, near Manaus, Amazonas

The State road program calls for the construction of an additional 3 miles in the vicinity of Manaus and 2.5 miles to complete the road between Sao Gabriel and Camanaos on the upper Rio Negro. Work is also to be continued on the road from Manaus to Rio Branco, 515 miles, and to Itacoatiara.

Appropriations for road building are made from the general revenues, and it is reported that for road and bridge construction and maintenance \$108,400 was spent in 1928 and \$72,840 in the first five months of 1929; these sums may include other public works.

The Federal Government is reported to have offered aid to the extent of \$180,000 to the Companhia Agricola e Industrial do Rio Branco for the construction of roads between Caracarahy and Boa Vista, 134 miles, and between Anaua and the British Guiana border, 141 miles, both in the upper Rio Branco region. It is reported that

payment has not been forthcoming, resulting in the discontinuance of construction after completing 116 miles on the first and 39 miles on the second road.

Road building as practiced in the State of Amazonas is decidedly primitive. The road is cut through the forest without any attempt at avoiding steep grades or sharp curves, the object being to avoid large trees. Grades of 8 to 10 per cent are common. In these respects the roads in the region of the Rio Branco are better, as they were constructed under the supervision of German and Austrian engineers. The normal width of roads is 8 meters. At the present time 42 laborers are employed in road construction, 18 laborers in



Figure 13.—Road near Manaus, Amazonas, bordered with rubber trees

road-repair work, and a few prisoners in bridge building. Bridges are customarily constructed of native woods on cement and stone foundations. A steam roller is used in the city of Manaus and on the roads leading out of the city.

### GOYAZ

Goyaz, fourth in size among the States of Brazil, is an inland State slightly smaller than Texas. Several mountain ranges divide it into three distinct zones. The first of these, to the north, is low and drained by the Maranhao River; the second, to the south, is a plateau flanked by hills; the third, a sloping plain, extends in a westerly direction as far as the Araguaya River on the Matto Grosso boundary. Numerous rivers cross Goyaz, the principal one being the Tocantins, one of the greatest rivers in Brazil, formed by union

of the Maranhao and the Parana. Two branches of the Araguaya River form an important island in the State about 300 miles in length and from 60 to 75 miles wide. The estimated population of Goyaz on January 1, 1929, was 687,453.

Agriculture and cattle raising are the leading industries and constitute the chief source of wealth of the State. The principal crops are rice, coffee, tobacco, and sugar. Manufacturing is almost unknown, but there are some big coffee plantations in operation. Most of the cattle raised in the plateaus of Goyaz are sent on foot to the important market of Uberaba, Minas Geraes. Vast areas of land remain undeveloped for want of transportation facilities.

There is but one railroad in Goyaz, the Estrada de Ferro de Goyaz, which extends from the southeastern boundary as far as Caturama, a distance of approximately 218 miles. This line is also connected with Uberaba, Minas Geraes, which has connections with Rio de Janeiro, Sao Paulo, and Bello Horizonte. Several rivers in the north are navigable for long distances, but owing to the undeveloped state of that region, there is little use made of them.

#### HIGHWAY SYSTEM

Owing largely to the lack of rail and river transportation in the southern part of the State there has been considerable activity in the maintenance and construction of roads in that section; in fact, practically all of the highway development of the State has taken place in the southern third. All of the roads in the State are of simple earth construction, but the more important ones are well graded, drained, and maintained. The first road building in the State was largely the result of private initiative carried out with the assistance of the State government.

A fairly complete network of roads covers the entire southern third of the State, especially in the eastern part. From Santa Rita do Paranahyba on the Minas Geraes border two of the main trunk roads have their start. One of them goes west to Santa Rita do Araguaya, Bom Jesus, Rio Verde, Jatahy, and Mineiros, a distance of 384 miles. That road was constructed and is maintained by a private enterprise which operates an omnibus service twice weekly. Various branch lines extend from that highway and also a road from Santa Rita do Araguaya to Garimpos do Rio das Gracias, a distance of 112 miles. The other main line starting at Santa Rita do Paranahyba extends to Goyaz via Morrinhos, Pouso Alto, and Bella Vista, a distance of 260 miles. A road has been partly completed from Goyaz to Santa Leopoldina on the Araguaya River and the Matto Grosso border. It is, for the most part, passable except during the rainy season. Roads also extend from Morrinhos and Bella Vista to the Minas Geraes and Bahia borders.

Various roads extend from adjoining States to the Goyaz border. The most important is the road from Riberao Preto, Sao Paulo, which goes through Uberaba and Uberabinha in Minas Geraes to Santa Rita do Paranahyba. By that road it is possible to go all the way from Sao Paulo to Goyaz.

Many of the roads which have been built in the State follow the routes of old royal roads which were built in the days of the Empire, primarily for military purposes. These were generally 6 feet wide.

Interest in road building commenced soon after 1920, and one of the first roads to be built in the State was that from Viannopolis,

the terminal point of the State railway, to the capital, a distance of over 180 miles. Steady progress has been made since that time, but owing to the limited financial resources of the State, little more has been done than improving existing cart trails and maintaining roads in suitable condition for automobile traffic. A number of roads have been built by private enterprises under concessions granted by the State.

Up to July 3, 1929, funds for road building have come from the general revenues. On that date a law was approved, providing a State motor-vehicle tax and fixing the charges for passengers and freight using toll roads. The automobile tax ranges from \$6 for private passenger cars to \$36 for trucks of more than 2-ton capacity. The tolls allowed depend of the type of road and the type of vehicle and load using it. Many of the bridges throughout the State are privately built and tolls are collected to cover construction and maintenance costs. No data whatever are available as to the expenditures of the State on road work.

According to the best statistics available there were at the close of 1928 approximately 2,750 miles of roads in the State. These are all simple earth roads, and only about 373 miles are passable the year round.

A trip was made during August and September of 1929 from Vau, in the southwestern part of Bahia, via Formosa, Santa Luzia, Bella Vista, and Santa Rita do Paranahyba in Goyaz to Uberaba, Riberao Preto, and Sao Paulo. Part of the trip was reported to be very difficult and it would undoubtedly have been impossible to have made it during the rainy season.

#### MATTO GROSSO

Matto Grosso is the second largest of the Brazilian States and is about one-fourth larger than Texas. It is located in the west-central part of the country and forms the boundary of Brazil and Paraguay and Bolivia. The estimated population on December 31, 1928, was 336,991, which was the smallest population of any of the Brazilian States.

Matto Grosso is a pastoral State. Next to cattle, the chief source of wealth is farm products. Rubber of all kinds and fine timber exist in abundance. The agricultural possibilities in the State are great, but not developed. The most important of these is yerba maté, though some cereals, sugar, tobacco, rice, and coffee are grown. There are a few plants for the manufacture of meat extract and dried beef, but manufacturing is negligible.

The State of Matto Grosso is undeveloped and much of it is unexplored, so that very little information as to its natural resources is available.

A railroad crosses the southern part of the State from Itapura on the Sao Paulo border to Porto Esperanca, on the Paraguay River, and a line connects Guajara Mirim and Porto Velho, both on the Madeira River, a tributary of the Amazon. The total length of line in operation is approximately 725 miles.

River transportation is of great importance to the western part of the State. Corumba, on the Paraguay River, is connected with Porto Esperanca by a regular steamer service connecting with trains. Regular services are operated south to Asuncion, Buenos Aires, and

Montevideo. Regular services are also operated to Cuyaba, the capital, and other towns on the upper Paraguay River and its tributaries.

#### HIGHWAY SYSTEM

The eastern and central part of Matto Grosso is a plateau sloping off to the south, north, and west toward the various rivers which drain the State. Road building in the plateau region is relatively simple, especially in the south, where only a scrub growth is encountered. In the western and northern parts of the State, roads near the rivers frequently disappear entirely during the rainy season when large areas are flooded. Practically all the road development which has occurred in the State has taken place in the southern half. Owing to the great extent of the State, the scarcity of population, and the great distance between cities and towns, maintenance of roads has been difficult.

All of the roads in the State are of simple earth construction with a varying quality of surface. Practically none of them is passable the year around. Much of the road construction has been done by private enterprises, under concessions granted by the State, and by municipalities. The privately built roads are, for the most part, toll roads. In 1927 the State purchased some 500 miles of these roads in order to facilitate highway traffic.

Several important roads radiate from Cuyaba, the capital of the State, the two most important of these being the one to Diamantino and Guarjara Mirim and that to Ribeirao Claro, in the municipality of Tres Lagoas, on the railroad from Sao Paulo to Porto Esperanza. The first has been completed as far as Diamantino, a distance of approximately 124 miles. The balance of the road is definitely projected, and it is eventually planned to continue it to serve the State of Amazonas and the Territory of Acre. The road from Cuyaba to Ribeirao Claro is nearly 75 miles in length and goes via Santa Rita do Araguaya on the Goyaz boundary. Several branches from that road serve various outlying communities. Another road of considerable importance extends from Cuyaba to Campo Grande, a distance of 186 miles. In addition there are numerous less important roads leading out from the capital.

In addition to Cuyaba there are three other cities which are important as highway centers; Tres Lagoas, Campo Grande, and Aquidauana. Five main roads lead out from Tres Lagoas in various directions, which with branches have a total length of approximately 435 miles. When the trunk road from Sao Paulo to Porto Taboada is completed, Tres Lagoas will be directly connected with the capital of Sao Paulo by a good automobile road. In addition to the road from Campo Grande to Cuyaba, the most important roads radiating from Campo Grande are those leading to Ponta Pora, on the Paraguayan border. The two points are connected by three roads following different routes, which have a total length of approximately 620 miles. Another road goes from Campo Grande direct to the Sao Paulo border, via Porto Alegre. The most important roads radiating from Aquidauana are those connecting that city with Campo Grande, 112 miles, and Ponta Pora, 100 miles. Other roads in the district bring the total up to approximately 498 miles.

Other road centers of less importance include Miranda and Corumba. The roads in the Miranda district total approximately



870 miles, whereas those in the Corumba district total little more than 18 miles.

A fair road connects Corumba with the Bolivian border and then the road is good to Puerto Suarez.

No information is available as to the expenditure of the State in road building and maintenance. Very little has been done in the way of bridge building, which makes many of the roads, which otherwise would be passable the year around, unusable during the rainy season, when the rivers are high. The total highway mileage passable in dry weather is reported at about 2,950 miles.



Figure 14.—Stone-block pavement in Corumba, Matto Grosso

#### TERRITORY OF ACRE

The Territory of Acre is about the size of the State of Ceara and is located in the extreme northwestern part of the country. The population on December 31, 1928, was estimated at only 111,220, and it was one of the least known and least developed parts of Brazil. The principal product is rubber, but the forests contain all sorts of valuable woods and medicinal plants.

There are no railroads in the territory and practically all the transportation is by mule back or by small boats and canoes on the numerous rivers which serve the territory.

There are no roads whatever in the Territory of Acre, and such trails as exist are suitable only for single files of pack animals. The territory is administered by the Federal Government, and no figures are available to indicate that any road work has ever been done there.

## CONSTRUCTION PRACTICES

### SPECIFICATIONS

As is indicated in the preceding sections, by far the largest number of roads in Brazil are simple earth roads, or at best earth roads with a surface treatment of gravel and broken stone. Roads with hard surface are rather uncommon, though there is a marked movement in this direction at the present time. As illustrative of typical construction specifications used in Brazil, the following shows the practice followed in the municipality of Sao Paulo and in Bahia.

#### MUNICIPALITY OF SAO PAULO

The Municipality of Sao Paulo has built approximately 3 miles of concrete roads, 9 miles of penetration macadam, 2.5 miles of macadam with asphalt surface treatment, 1.8 miles of gravel roads with road-oil surface treatment, and 3 miles of water-bound macadam. The construction specifications followed are indicated below.

*Concrete.*—The first concrete road built by the municipality was laid over an old macadam road which was in bad condition. This surface was scarified, leveled, and rerolled with rollers of 5 and 12 tons. Such cuts and fills were made as were necessary to give the foundation a perfectly level surface. The concrete surface, 19.5 feet wide, was laid on this foundation. The concrete surface itself was 8 inches thick in the center and 9 inches at the outside edges. Part of the concrete was mechanically mixed and poured directly to the road and the balance mechanically mixed at the side of the road and applied manually.

The time allowed for mixing the concrete was  $1\frac{1}{2}$  minutes, the stone mix used as 1-2-3 to 1-3-5, with 660 to 770 pounds of cement per 2.6 cubic yards of stone. The space between the transverse joints ranged from 46 to 72 feet, the difference being determined, generally, by the interruption in the work. The transverse joints were 1.5 centimeters, filled with a mixture of bitumin and sand. Twenty-four hours after laying the concrete and smoothing the surface, the lateral retainers were withdrawn and the surface permanently covered with water for a period of 28 days. The foregoing specifications apply to the road to Butantan, slightly over 1 kilometer in length. The cost of laying this road amounted to \$3.25 per square meter (\$2.96 per square yard), including the cost of preparing the base but not including the gutters. Tests were made at 60 and 80 days after completing the road and the concrete showed a compression strength of 904 pounds per square centimeter (5,870 pounds per square inch). The sections giving the best results were those with a mixture of sand, No. 2 broken stone, and cement in the proportion of 350 kilos per cubic meter of stone mix.

Another concrete road of slightly less than 2.5 miles was built by the municipality to Santo Amaro. The following specifications were laid down for this road:

1. The total width of the road surface 32 feet with a longitudinal joint, and each section 15 feet in width, and the average thickness of the concrete must be practically 7 inches.
2. The concrete mixer to be used in the proportion of 1-2-3, 1.19 cubic yards of mixture containing 370 yards of cement.
3. Clean and coarse grained sand must be used.
4. The coarse material shall be hard broken stone or gravel and graduated from 1 centimeter to 7.
5. The water used in the concrete must be pure and used in the minimum proportion necessary to show a "slump test" not greater than 4 centimeters.
6. The materials must be mixed in a mixer for a minimum period of one and one-fourth minutes.
7. The base for the concrete shall be constructed in accordance with section 2 and must be well compressed by means of rollers of 8 to 10 tons.
8. The concrete surface shall be made without waves or irregularities, a maximum tolerance of 6 millimeters in 6 meters being granted.
9. In the event of suspension of work for a period of more than one-half hour it is required that an expansion joint of suitable material be placed between the concrete already laid and that to be laid later.
10. After the concrete is laid it must be maintained under water for a period of two weeks as a minimum and must not be opened to traffic prior to 20 days.

This pavement was laid at a cost of \$3.25 per square meter (\$2.96 per square yard).

*Penetration asphaltic macadam.*—Of the 15 kilometers of penetration asphaltic macadam laid by the municipality of Sao Paulo, experiments were made with natural asphalt and the petroleum asphalt prepared by four different companies. The specifications adopted by the municipalities for the construction of penetration asphaltic macadam are as follows:

1. A base of No. 5 broken stone with a thickness of 15 to 18 centimeters before compression.
2. A layer of No. 3 broken stone impregnated with asphalt 8 centimeters thick before compression.
3. The application of asphalt shall be in the proportion of 8 to 9 liters per square meter of material.
4. A second application of asphalt amounting to 2 liters per square meter.

The application of asphalt must be made at a temperature between 180° and 200° C., the first layer being applied manually with sprinklers and the second mechanically. Compression must be made with 12 to 16 ton rollers, and on completing the asphalt application a covering of very fine sand and rock dust must be applied and well rolled. The pavement should not be open to traffic until 24 hours after completion of work.

The municipal specifications for asphalt are as follows:

1. Penetration at 25° C. of 100 grams in five seconds, 60-70.
2. Penetration of the residuum under the same conditions in a ratio of 50 per cent of the original.
3. Ductility at 25° C. not less than 30 centimeters.
4. Loss at 163° C. in five hours not less than 3 per cent.
5. Flash point above 200° C.
6. The proportion of bitumin soluble in carbon tetrachloride not less than 99 per cent.

The cost of laying asphaltic penetration macadam over an old macadam base amounted to \$1.68 per square meter, including scari-

laying and leveling the old macadam, and \$1.82 per square meter for a complete pavement laid over an earth road.

#### STATE OF BAHIA

The concrete road built by the State of Bahia from Santo Amaro to Tanque da Senzola has a concrete surface 5 meters wide and at the side an earth and broken-stone surface 3 meters wide for cart traffic. A foundation wall at the outside edges of the concrete surface was laid 1 meter deep of concrete 13 centimeters in thickness, with a clay-silicate wall 4 centimeters thick inside this. Natural earth was laid between the concrete walls to a height of 50 centimeters and above this a layer of sand 20 centimeters thick, both layers being well rolled. Above this was a layer of 26 centimeters of broken stone well rolled and 4 centimeters of clay-silicate mixture, the clay content ranging between 30 and 35 per cent. A reinforced-concrete surface was then applied.

Both longitudinal and transverse joints were used in the concrete construction. The longitudinal joints were 4 centimeters in width, filled with asphalt and fine sand. The transverse joints were from 4 to 5 centimeters in width and located every 20 to 30 meters.

Other hard-surfaced roads have been built in various other States and also by the Federal Government, but standard specifications have not been adopted, and the specifications followed on individual roads are not available.

#### MARKET FOR ROAD-BUILDING MACHINERY

Much of the road-building work in Brazil is still done with pick and shovel, but there is a steady tendency for an increase in the use of machinery. The Federal Government and a number of the more progressive State governments are using a greater amount of mechanical equipment, as is also the case with a number of the larger contractors. Planers, scrapers, graders, and tractors are commonly used in most of the east-coast States as far north as Pernambuco. A comparatively small amount of concrete-making machinery has been purchased for road building, but a fairly large number of concrete mixers have been purchased in connection with bridge construction, etc. Rollers, levelers, scarifiers, and drags are used to some extent. American equipment is generally preferred, although some European equipment has been purchased, principally from Germany and England.