



124
516
THS

HISTORY OF ROADS

Thesis for the Degree of B. S.
MICHIGAN STATE COLLEGE

Donald W. Schang

1940

THESIS

copy



PLACE IN RETURN BOX to remove this checkout from your record.
TO AVOID FINES return on or before date due.

DATE DUE	DATE DUE	DATE DUE
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

MSU Is An Affirmative Action/Equal Opportunity Institution

c:\circ\datedue.pm3-p.1

HISTORY OF ROADS

A Thesis Submitted to

The Faculty

of

MICHIGAN STATE COLLEGE

of

AGRICULTURE AND APPLIED SCIENCE

by

Donald Wooster Schang

Candidate for the Degree of

Bachelor of Science

in

Civil Engineering

June 1940

THEBIS

Acknowledgement

The author wishes to thank Professor Hitchcock, of the Civil Engineering Department, writers of books and articles as are shown in the bibliography, and the United States Bureau of Public Roads, for the help, information, or pictures which they contributed toward this Thesis.

Preface

"With so much to be legitimately ashamed of, our modern age should be cheered by the thought that at least in a few points, we are vastly superior to our fore-fathers. Consider, for instance, the matter of roads, bridges, and streets."

Following are some passages taken, as was the preceding one, from the article "Some Wicked Ways of Medeival Days", by J. T. Durkin, appearing in September, 1938 Catholic World, describing some deplorable states of affairs in times past. Modern conditions contrasting to each of these will be evident from personal experiences.

"The mending of the wicked ways, so often mentioned in medeival wills, refers not to moral delinquencies, but to the state of the roads. In 1413 there was a traffic jam on the main road thru Barnet and Saint Albans because of its being blocked 'with dung, dung heaps, pigs, pig styles, and piles of timber.'" "Conditions in city streets were just as bad, for: "such streets, by water falling out of gutters--be holed and founded, to the grete unease of all the king's subgetts." An entered public complaint read something like this: "Isabella Lucas has and maintains a foul gutter running from her yard into the King's highway, to the nuisance of the people." A traveler, John Kemp, about 1600, speaks of "this foule way, fall of holes, in which I could find no ease; Sometimes I skipt up to the waist." At Lynn "it was necessary to pass a law forbidding butchers to slaughter

their animals in the middle of the main street. Bridges, too, were in a bad state. "London bridge is falling down" is a fact of history and those words could be used for almost any of the bridges of this period. "In many a lonely corner of England there dwelt a monk on a bridge, saying mass daily in his little bridge-chapel, and looking over the slaunchy-ness and straightness of the structure."

As one travels 70 or 80 miles per hour along one of the world's modern super-highways, he is prone to observe his surroundings as they are today, or as he has known them during his lifetime from first-hand observation. How much more interesting life is for us if we cast reflections into the past, as we observe what there is for us to see in the present. Material things become much more meaningful to us, in this way, and we live a more abundant, more complete life. To some, in fact to anyone, who has not experienced it, a pleasant surprise is in store at that time when a road means something more to him than mile after mile of monotonous pavement.

With this in mind, I have chosen "History of Roads" as my thesis subject. Having compiled a tentative bibliography from numerous indexes, most of the term was spent in reading, and preparing note cards from the reading. The thesis body was written from the note cards, reference being made quite frequently to information contained in books and articles read previously.

May this brief summary of road development from animal paths to super-highways either inform the reader in a general way or lead him to the sources of more detailed information suggested by the bibliography, so that our highways might become something more to him than mere endless miles of cold concrete.

Table of Contents

	Pages
Pre-Roman Roads.....	1-4
Roman Roads.....	4-15
Incan Roads.....	15-19
Mayan Roads.....	19-21
French Roads.....	21-26
British Roads.....	26-32
American Roads.....	32-68
Famous Pioneer roads.....	45-59
Indian trail to Turnpike.....	59-63
Federal Aid.....	63-68
Super-highways the world over.....	68-74
Bibliography.....	After 75

List of Illustrations

	Page
Cross sections of Appian Wat (2).....	12
Typical Roman Road.....	14
Pavement Cross sections (a comparison).....	24
"And the streams that would float his light canoe"...	33
"and the keel-boat gave way to the 'flat'".....	36
Lancaster Turnpike in winter.....	38
Plank Road.....	40
Indiana Road in 1840.....	43
Wilderness road.....	49
Erie Canal.....	51
Masonry bridge on Cumberland road.....	53
Toll Gate.....	55
Natchez Trace.....	60
The State Line!.....	64
Co-operation yields results---1925.....	67
Milage registration chart.....	69
Comparative bar graph.....	71
Grade separation for a super-highway.....	73
Research (thickened edge).....	75

HISTORY OF ROADS

Pre-Roman Roads

It has been said that the height of civilization attained by a nation is reflected in its roads, the arteries through which the life-blood of the nation flows. A chain is no stronger than its weakest link and what link is more important in the chain that binds a nation to strong and lasting unity than a system of good roads?

A comprehensive picture of road systems in times anterior to the Romans is quite impossible to obtain because of incomplete, indefinite information left for us by historians of that period. The first roads were probably paths of animals, beaten thru the under-brush to places where food and water could be obtained. Man first following them probably tended to follow the ridges and high places where forest growth was least dense and where swamps and bogs were scarce; where the wind swept away leaves or snow and where signal fires could be seen. Migrations of tribes or families of people, in search of places where living would be easier, did much to create pathways thru the wilderness. Conversely, pathways once established, served to encourage migrations of people. Localization of natural resources which created a desire in the human heart led to definite, long-distance land routes thru Europe before 2,000 B. C. But these roads required no particular specialized effort to construct. They

were merely the natural result of trampling of plants and packing of soil by the feet of animals and human beings. Roads as we think of them today are something more than that. Roads might be defined as a means of over-land communication, including paths and highways but excluding streets, which run within the limits of cities; and we are familiar with them as "ways of travel" which have required some degree of specialized, directed effort, to create.

Road-building requires co-operative effort of a fairly high order. The wants of our savage ancestor were few and of an individual nature. He had no conscious need for roads. As he became more civilized, however, and his life became more and more of an Urban nature, the game trail and natural path became inadequate for his commerce and the movement of his conquering armies. Roads of a more advanced character were a natural outcome.

We do not know when and where man first began to build roads. Certainly it was some time before the first authentic history was written. Large cities or dense populations are impossible without roads. Just as impossible would have been the construction of the great pyramids of Egypt and the Hanging Gardens of Babylon without roads to transport materials and supplies. Herodotus tells us that a "great king" built a magnificent road across the sands for the transportation of the materials for the great pyramid, employing 100,000 men for a 10 year period to build the road. This road, ten feet thick in places, was built of massive stone blocks. Traces may be found today, near the

great pyramid, probably the oldest authentic remains of a road surfaced with stone. Roads similar to this one are said to have been built at the palace of Knossos in Crete, and at Cyrene. Early historians speak of roads radiating from Babylon, on or before 2,000 B. C. These roads extended to Susa, Ecbatana, Sardis, and Nineveh. The historian Strabo even speaks of the Babylon-Nineveh road as being paved with brick laid in a mortar of asphaltum. In the Assyrian empire roadways were maintained for messengers and the transportation of produce for the imperial house-hold. A road consisting of a foundation of bricks covered with asphalt and surfaced with limestone and red breccia was built by Nebuchadnezzar in honor of his favorite God, Marduk. The ancient Persians, Assyrians, Carthaginians, Chinese and Peruvians were all great road-builders. Their works, however, have largely disappeared and the records of their achievements have been lost or largely forgotten. Speaking of the city of Ephesus, on the river Cayster, flowing into the bay of Scala Nova on the West coast of Asia Minor, discoveries made there in the nineteenth century of remains of Persian civilization, included "a marble-paved road 35 feet wide turning Northward around Mount Caressus with four distinct chariot ruts cut deeply in it"¹ More will be included later concerning the Peruvian road-builders.

¹ Wood, J. J., "Modern Discoveries on the Site of Ancient Ephesus."

ROMAN ROADS

As a civilisation may be recognized thru its roads, so the administrative and military genius of the Romans is reflected best in her highways. Conquests were followed with extensive road-building in order to dispense administration of government, military protection and shipments of economic goods to the most remote parts of the far-flung empire. We have handed down to us quite a detailed account of the manner in which Roman roads were built and used. This is the first systematic road system of which we have a definite knowledge.

The first of the great Roman roads, and doubtless the most famous, was the Appian way, commenced in 312 B. C. during the reign of Emperor Appius Claudius Caecus, from whence the name "Appian" way is derived. This road was first built from Rome to Capua, a distance of about 142 Italian miles, and later extended to Brundisium, a total distance of 360 miles. It was probably completed by Julius Caesar. About 220 B. C. the second road was started. This road crossed the river Nar about 60 miles from Rome by a great stone-arch bridge with a central span of 150 feet and a rise of 100 feet. (Evidence that Roman engineering skill was not confined to roads alone.) After completion of the Flaminian way, road-building progressed very rapidly, till at the height of her glory, about 28 B. C., Rome had traversed every conquered province with a connecting road system which is estimated to have aggregated 53,658 miles.

At this time there were 7 main highways which had their beginning at the gates of Rome. Besides the two mentioned there

were the Latina, Salarian, Valerian, Cassian, and Aurelian Ways. Twenty-nine roads in all can be said to have radiated from Rome, reaching out to contact the vast highway network. The complete network embraced, according to the Itinerary of Antonine, 372 main roads. These were known as military, consular, or praetorian, depending on their purpose or their builder. Milages contained in component parts of the Empire, including only main public ways leading from Rome to the provinces and large cities, are given in the following tables:-

Roman Miles	Roman Miles
Italy.....13,024	Sardinia.....200
Gaul.....9,320	Corsica.....125
Spain.....7,700	Africa (less Egypt).9,348
Great Britain.....2,597	Egypt.....1500
Sicily.....1,362	Asia..... <u>8500</u>
Total 53,658 mi.	

In addition to these main public ways there was a large mileage of parish roads connecting the public ways with the secondary towns and boroughs, and of farm roads which connected the public ways and Parish roads to the farms and hamlets.

The great extent, durability, and solidity of these roads and the ingenuity of their builders has been a source of astonishment and admiration all through the ages. Such natural obstacles as mountains, swamps, lakes and rivers seemed to encourage the Romans to overcome them rather than to offer any discouragement. Topography seems to have obtained little attention, the roads being built in straight lines,

thru mountains and across valleys and swamps. Tremendous expense was gone to in order to achieve these un-usual accomplishments, but expense seemed an un-important factor in the Roman plans for a far-flung, well governed empire. Even seas did not halt progress. The roads were built to the water's edge and then continued upon the opposite shore.

Construction procedure followed a quite well defined set of "stages of development", in the majority of Roman roads. A typical method will be given here:

Where swampy, marshy, or otherwise unstable conditions were encountered, a wood frame-work was first built. The joints were made of an Oak that was not susceptible to shrinkage or warping. To protect the oak from the destructive action of the lime to be used later, mixed with other materials, it was covered with a layer of rushes or seeds, or sometimes straw. On this protective layer was laid the foundation, and remaining construction was carried out just as though it were on firm ground. Total thickness of masonry seems to have been somewhat reduced on the frame-work, however, to reduce the dead load of the road-way upon the wood frame-work and the un-stable sub-soil.

Upon solid ground, limits of the roadway were marked 40 feet apart, with a plow. Two parallel trenches were dug along these "limit lines" to determine the nature of the sub-soil and the depth required to get to a solid foundation. Earth was then removed between the trenches to the level of the road-bed and carried out by a porter with a basket on

his back. When un-suitable materials were encountered, they were removed and replaced by a suitable soil which was nicely compacted by a tamper. Wooden piles were driven into the foundation, if necessary, to secure a firm bed. The final, firm road-bed was carefully leveled to receive the surfacing materials. Sub-soil was always carefully rained, even where the excavation showed what appeared to be a comparatively firm foundation.

The Bedding Course: Upon the prepared soil foundation there was spread a 4 to 6 inch layer of coarse sand or a one inch layer of lime and sand mortar. This bedding course was to accommodate the irregularities in the rough lower side of the stones used in the first course of masonry. Water for slaking the lime used in mortar-making was carried in earthenware jars upon the heads of water-bearers. Sometimes V shape wooden troughs were used to transport water from the source of supply.

The First Course: Into the bedding course was laid the first course, consisting of two layers of flat stones cemented together with well tempered lime mortar. No stones in this course were permitted to be of a size smaller than would fill a man's hand, and the larger stones were arranged along the sides of the causeway to act as a retaining wall. Clay was sometimes used as a substitute for lime mortar in cementing, in localities where lime was not readily available. Almost any kind of stone was used in this course, its purpose being only to provide solidity. First course thickness varied from ten inches in good ground to 24 inches in less stable

ground. Ordinary masons were considered capable of placing this course. For cutting the stone they employed a chisel and mallet, iron wedges, the adze (a cutting tool), and a saw.

The Second Course: This bed was made of broken stones smaller than the first course, and mixed with lime. Freshly broken stone were used and mixed with quicklime in a 3 to 1 ratio. When aggregate came from old buildings, however, more lime was used and the ratio changed to 5:2. A rammer was used to strengthen, equalize, and smooth the mixture. The layer was built up to a thickness of nine inches after being rammed.

The initial step in laying this course consisted of spreading a layer of mortar over the first course with a rake. The gravel or broken stone was dumped onto the mortar and pounded into it with a tamper. Mortar was used only in such quantity that voids remained in the surface of the gravel or broken stone to which the next layer would form a substantial bond.

The Third Course: Composed of a gravel or coarse sand and freshly slaked hot lime cement mortar, this course is bonded into the interstices left in the surface of the preceeding layer. The course is placed in relatively thin layers, each layer being compacted with a roller. At the sides, all of the layers of this 3rd. course aggregate a thickness of about one foot. In the central section, thickness is increased to approximately one and one half feet to form the crown. This nucleus material, as the 3rd. course is called, formed

the wearing surface for the side roads, which were at a lower level than the central roadway or agger.

The Wearing Course: This last course was bedded into the freshly laid 3rd. course within the central portion of the roadway between the side curbs. A crown of about six inches in 16 feet was provided for drainage and drains were provided at intervals thru the side curbs and under the side roads to the ditches.

Especially on the larger, more important roads, like the Appian Way, the wearing surface was composed of hard, wear-resisting stone like sillex or flint-like larva. This stone was cut into the shape of polygons of various shapes and sizes from one to three feet in diameter and about six inches thick. The upper surface was cut smooth while the under surface was left rough. The joints were fitted so closely as to be hardly discernable. Occasionally the surface of the road was made of concrete.

The side curbs projected eighteen inches above the side roads, and were two feet wide. They were built upon the foundation of large stones extending through the first course, as shown in the sketches. The total thickness of all the courses varied from 3 to 4½ feet. The over-all width of the Appian way at the surface was about 36 feet.

Typical traffic upon the major highways consisted of the horse-drawn chariot, the luxurious human carried liter, the family coach, the wagon, the pack animal, and foot traffic. Roman infantry used the roads considerably, and the poor

man's method of travel was on foot, accompanied by a pack animal which carried his baggage. The "side-road" afforded an excellent place for the commanding officers to walk when on the march with the infantry.

The origin of all great military roads was marked with a golden milestone in Rome, placed there by Augustus. Romans placed milestones along all of their principle highways, spaced 1,000 Roman paces (4,861 English feet) apart. In the vicinity of Rome these milestones represented the distance from the central golden milestone. Beyond 100 miles from Rome and in the provinces, the milestones showed the distance to the nearest principle town.

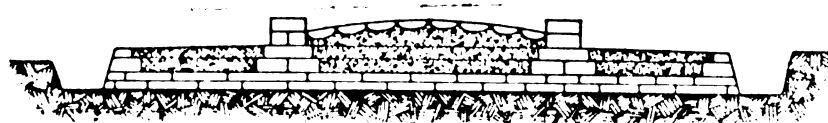
The public roads ranked high among the magnificent works of Rome. Untold wealth and labor were expended in their construction and only officials of the highest rank were considered worthy to be entrusted with the direction of work on the important roads. During the Empire, Augustus himself assumed charge of the roads.

There are many distinguishing characteristics which the Roman roads possess throughout their extent. Though undaunted by natural obstacles, the Romans took advantage of all existing natural conditions in order to make the most of the Engineering knowledge of their time. They avoided cuts whenever possible and they preferred side-hill location to the exclusion of valleys, where foundation problems presented greater difficulties. No attempt was made to balance cuts and fills, either in profile or cross-section. Except

for side-hill excavation, open cuts were usually found only in rock. No explosives were then available, and all rock excavation had to be done by the slow and laborious process of picking and wedging. When rock work was necessary, tunnels were preferred to open cuts so that the rock removal would be confined to the necessary cross-section. Among the outstanding examples of rock cuts is the one on the Appian Way near Terracine, thru a cliff of marble (117 feet high and 98 feet long), and on the Flaminian Way at the crossing of the Appenines there is a tunnel of a 984 foot length. Curves required rather large radii because of the long teams of horses, sometimes composed of ten horses driven two abreast. Sometimes short radius curves were required, however, to avoid deep cuts in sloping terrain. As a rule, Roman roads were distinguished by long tangents, undulating profiles, and crowned surfaces. A considerable amount of forced labor was used to build and maintain the roads, and garrisons of soldiers policed them. Senators and others wishing to gain favor and fame, used their private wealth for highway extension and improvement, but increasingly the populations living on or near the roads were required to maintain them.

An average Roman military road has been estimated to cost \$116,000 per mile to reproduce in the United States in 1926. This calculation is based on an average road width of twelve Roman feet between side borders with two "side roads", each two feet wide and an agger (middle section) of three and one fourth feet in thickness; all built without the aid of

statuate labor or legionary soldiers. The estimated cost of the Via Appia as based upon 1926 values in the United States is \$300,000 per mile. Military roads were constructed by the state and maintained by a tax assessed upon real property. Such means as donations, statuate labor, and requisitions, were used to obtain road funds. Before establishment of the public land register, the cost of road and bridge maintenance was met thru tolls. Parish and secondary roads were charged, during construction, to the towns and boroughs, with the help of special donations, and maintained by statuate labor provided by the owners of adjoining property.



Cross Section of the Appian Way
by Cresy
(1856)



Cross Section of the Appian Way
by Leger
(1875)

FIGURE 5.—Cross-section of the Via Appia as shown by Cresy (6) and Leger (4).

A verse description of Rome and her road system was printed in March, 1940 issue of "Roads and Streets". Being somewhat appropriate, it is reproduced here.

"That's What Old Caesar Did"

"When Caesar took a westward ride
 And grabbed the Gauls for Rome,
 What was the first thing he did
 To make them feel at home?
 Did he increase the people's loans,
 No! He dug in and built good roads—
 That's what old Caesar did.

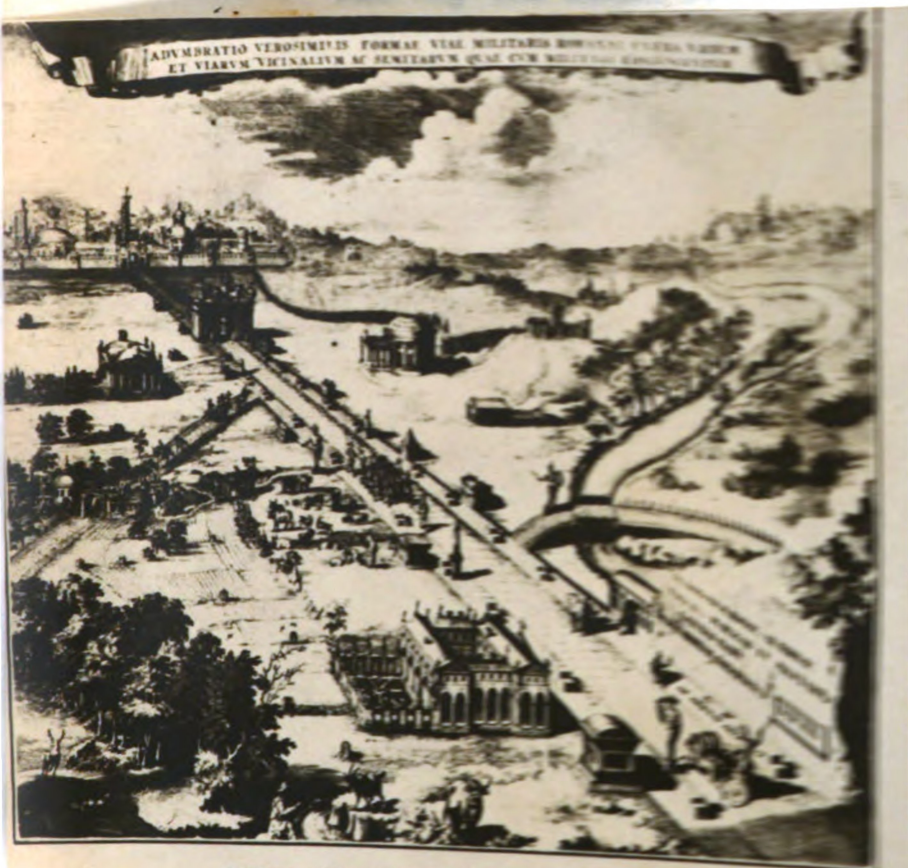
He built good roads from hill to hill,
 Good roads from vale to vale;
 He ran a good roads movement
 Till Rome got all the Kale.
 He told the folks to buy a home,
 Built roads their ruts to rid,
 Until all the roads led to Rome
 That's what old Caesar did.

And if our nation wants to be
 The center of the map,
 Where folks will want to settle down
 And live in plenty's lap;
 If this broad land its own abodes
 Of poverty would rid
 Then let us plan and build good roads,
 Just like old Caesar did!"

The Romans relied upon massive construction in their roads, to support the relatively light traffic, where-as modern roads are built on the assumption that the pavement should act as a wearing surface and roof to protect the sub-soil which bears the load. This solidity, though involving considerable waste material, is responsible for the resistance to disintegration which has preserved the Roman roads for us to see, and in some cases use.

The system of Gallic-Roman roads lasted from the fall of the Empire in the West, in A. D. 476, to the middle of the 7th. century. The roads, as a system, disappeared gradually in the following century. With rise of feudalism, Roman

roads were in many cases destroyed to prevent attack of the enemy. Thus under the chaotic political conditions of the middle ages, repairs were neglected and roads fell into a state of general dis-use.



A TYPICAL ROMAN MILITARY ROAD OR PUBLIC WAY.
From Berger (12).

Roman roads in England went thru a 1400 year period of neglect and disintegration beginning with the Anglo-Saxon invasion in the fifth century. These old roads were given English names and they were attributed to a fabulous origin. Roman roads in England underwent their worst

period of decay in the 18th. century when man used the material they afforded and destroyed them in order to make turnpikes. These un-disturbed by man became covered with a protective earth covering and seem to be little effected by the centuries of neglect.

The way the Roman roads benefited human civilization and the magnitude of such benefits are a bit uncertain. Surely one can be safe in saying that they did offer a material aid. At least if "The Glory that was Rome" benefited civilization and if the Roman methods of control of a vast civilized empire benefited civilization, then certainly the roads making possible Rome's Glory and the unity of Rome with her provinces, deserve first credit for the benefits of the Roman Empire to civilization.

Incan Roads

Centuries before the first European set foot on American soil an International highway which might be termed "America's first highway", had been constructed and was in daily use. This highway, or at least a portion of its 4,000 mile extent through the South American Andes, was built by the pre-Incan aborigines of Peru, sometime prior to the year 800 A. D.

A Peruvian tribe exercised supreme control over a region extending west of the Atlantic slope of South America between Quito in Equador and the river Maule in Chile at the time of the Spanish expedition under Pizarro in 1533.

This tribe, known as the Incas, had succeeded the Tishuamoco tribe after the "dark period", 800 to 1100 A. D. The Incas not only repeated, but surpassed the "empire" which had left the beginning of the famed Incan roads, the "King's Road".

Though known as the Incan Road and though doubtless improved, extended and maintained by the Incas, the "King's Road" developed with the Incan predecessors, about which little can be learned. The only thing that is definitely known is that they were a highly civilized race, wonderful engineers and builders, and that they left remains of their structures to tell us of their civilization. History does not tell us when the road system was started, what it cost, when its idea was conceived or how much time was consumed in its construction. Conflicts concerning details of the road are quite numerous in various accounts of its history and description. One writer, for instance, leaves one with the impression that they were not more than 3 to 5 feet wide, and shows pictures of them which substantiate this belief. Another writer, on the other hand, speaks of roads 25 feet wide. Perhaps the latter writer is speaking of a "cleared way" including more than the width of the actual pavement; or perhaps the two writers are each describing a different section of the road system as it actually existed. At any rate everyone is agreed that this South-American civilization did possess unusual engineering and handi-craft skill considering the handicaps they were facing, as will be described presently.

These early road-builders possessed no knowledge of Iron or Steel, that we know of, they possessed no true mathematical instruments, no transits, no compasses, in fact no comprehension of engineering as it is now understood. Yet they built their road thru a country that presents some of the greatest obstacles. The Incan highway followed the general line of the Andes from Quito, Ecuador to Tucuman, Chile with side roads branching off at intervals. "A second road, 25 feet wide and almost as remarkable as the first followed the shore line from Ecuador to Chile"¹

These builders are famous for the architecture and type of construction in their public buildings, remains of which can be found at the present time covered with a somewhat protective covering of tropical jungle growth. Outstanding practice was characterized by a "Cyclopean type", most of which centered in and about Cuzco, which later became the capital of the Incan Empire. No cement or mortar was used, the walls and bridges being formed of immense stone blocks, sometimes weighing 20 to 30 tons each. These stones were cut, faced and fitted with amazing accuracy. This type construction was incorporated into the roads in many sections and material for many of the walls and buildings must have been transported long distances over these roads.

Road grades in the mountains were easy and accurate. S curves were computed, shelves were hewn from solid rock, and ravines and chasms were crossed by causeways of solid

¹Verrill, Hyatt, Scientific American, July, 1930

masonry fill, or if they were too deep, by suspension bridges with cables of wool, cotton, or fiber rope. For a great portion of its length the road was paved, much of it surfaced with asphalt or bitumen, and it was so well built that long stretches of it are in use at the present time. (The use to which these roads are put at the present time is not told. If they are used for wheeled vehicles, they must have either been widened to accommodate them or, have been the 25 foot width variety to begin with. If modern use is for pack animals and foot traffic, the 3 to 5 foot width will probably still accomodate traffic.) Like all other great highways it had its auxillary structures. At intervals there were "rest houses, for the traveler, which served also as relay stations for the couriers of the Incas. There were "Imperial Inns" every 40 miles which served as store houses for food, supplies, equipment of the army, or for relief of neighboring villages in case of famine or war; and as eating places for the army when on the march. There was a continuous series of sentry stations, forts, and watch-towers, which incorporated a system of signal fires, or lights. Men were always on duty and messages were transmitted very rapidly. To transmit a message from the Chilean terminus of the road to Quito, about 4,000 miles, ordinarily required about six hours, by this method of signal lights. Important as it was for peaceful purposes, to the Incas, their highwas was primarily a military road. Power could be easily and quickly concentrated at advantageous points, through its facilities.

The roads of the Incas have had the misfortune to inspire a greater number of silly remarks than almost anything else in Andean history. The truth lies mid-way between the belittling statement of the Abbe Raynal to the effect that they were merely lines of posts intended to guide travelers, and the fantastic statement of a modern imaginalist to the effect that "the roads leaped gaily from peak to peak and across lakes". Such seems to be typical of the uncertainty of the various sources from which we learn of the famous Incan roads.

There was a fundamental difference between the purpose of the Incan roads and the roads of Europe in that period. The nan-cuma or purina-cuma, of Peru were destined only for official uses; armies, courtiers, colonists, and officials and burden bearers of the state. The people could use them only to attend the established fairs and to return home from them. There is, then a manifestation of the limited Geographical orbit within which the mass of the people spent their lives. On the contrary, vast distances were covered by the emperor, and certain privileged others, they being carried in a "liter" by state-employed burden-bearers.

Mayan Roads

Central America, too, leaves evidence of having attained a noble state of civilization. Between the fourth and tenth centuries, when central Yucatan was the home of the great civilization of the ancient Maya, paved roads of

remarkably permanent construction connected the main centers of population and radiated out to the minor cities. Greatest of these roads was 62½ miles long, connecting the cities of Coba and Yaxuna. This route was recently explored by archaeologists from Carnegie Institution. A complete report of their discoveries is published in the Carnegie Institution bulletin of September 24, 1933.

This road, long abandoned, is covered by jungle growth which causes all former Mayan civilization to remain quite inaccessible. From Yaxuna the road was found to run almost perfectly straight for 43 miles. In the remaining 19½ miles, its original direction changes only slightly but four times. Built from 30 to 34 feet wide, the road was kept from 2 to 8 feet above the surface level of the terrain.

Actual construction consisted of digging down to hard-pan, (quite near the ground surface in most sections) then erecting retaining walls of limestone set in mortar to the desired road height. Space between these retaining walls was filled with large stones chinked with smaller ones, and hammered carefully into place. Filling was accomplished in courses, each succeeding course consisting of smaller stone, until the requisite height was attained, at which stage a layer of finely broken rock was added. After hammering or rolling to a smooth surface, a fine coating of cement mortar was applied. Workers are shown to have been very careful in mixing, placing, and curing this cement mortar finish. The cement mortar used was a mixture of slaked lime and sassab.

(White earth, a conglomerate lying beneath the limestone cap-rock of the country)

Sixteen of these raised roads were built. It is difficult to be certain of dates when writing of Mayan civilization because of lack of definite evidence of time of happenings and because of lack of detailed written history, but it is probable that these roads were built between the 4th. and 7th. centuries by men quite capable of designing these great cause-ways. (It seems that an adequate design for these roads would include drainage through the "limestone retaining walls", but no such drainage is mentioned in anything I have read)

Having no beasts of burden or wheeled vehicles, the Mayans evidently built these highways for foot traffic only.

Appearance of these roads was white, as the modern Indian name of the ancient stone roads, "sacbe" ---White road, implies. They would doubtless have compared in appearance with our "great white ways" of today.

French Roads

The first world-renowned road system to develop after the decline of the Roman roads, was that of the French. As most of this program was carried out under Napoleon, the era is often referred to as "Napoleonic road-building. Road-building the world over during the "dark ages" (500 to 1150 A. D.) and the middle ages on into the 18th. century was relatively pretty much at a stand-still. When the Roman

Empire declined in power the world road system as such, broke down. Different conditions, however, prevailed in different countries. Religious pilgrimages, the crusades, the journeys of the secular rulers, and the high dignitaries of the church all leave some record of trans-state and trans-continental routes, but the records of commerce are meager. The general tendency was toward feudal government which resulted in neglect and actual tearing up of some of the ancient roads, as a means of protection. During this period the roads and also the buildings of Rome were ravaged to a much greater extent to provide building materials and metals than by conquest, fire, or any other causes.

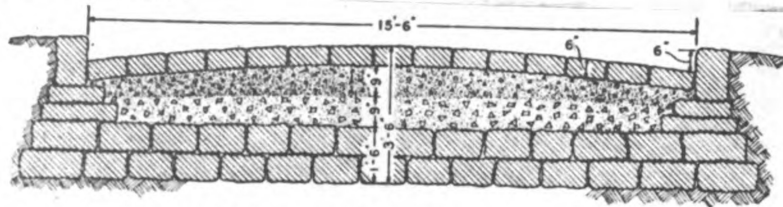
Napoleon became first consul of France in 1799 and began at once to build a system of national roads. In 1804 he became emperor by plebiscite and also crowned himself King at Milan, of the monarchy of North Italy. Thus a large part of the former Roman Empire, 12½ centuries earlier, was again brought under an empire, this time that of France. The Corps de Ponts and Chaussees had been established in 1796, and was composed of engineers trained in the art of road and bridge construction and maintenance. When Napoleon demanded and vigorously supported a big road-building program, large accomplishments were possible through the available organization. In 1811 a uniform system of highway administration was established, the basic principles of which have, to this day, been un-changed. Roads were divided, under this organization, into Imperial and depart-

mental routes. Financial responsibility was fixed upon the federal government and the departments. Fourteen Imperial roads of the first class were designated, leading from Paris to the principle cities of the frontier. Thirteen Imperial roads of the second class led from Paris to less important cities of the frontier and two hundred and two Imperial roads of the third class joined interior cities. These Imperial roads comprised a total of about 17,000 miles. There were 1,165 departmental roads comprising about 12,000 miles. The mont-Cenis, connecting Paris and Turin and the Simplon, connecting Paris with Milan, Rome, and Naples, were included in this National road system.

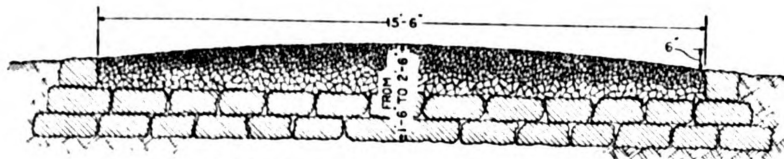
The French road system is found in history as ranking among the three outstanding road systems not only because of the fine design incorporated in these roads but also because of the high order of organization required to make such a system possible and because they served an empire of such importance; important both for its mere vastness and important for the culture it left for the rest of the world. The Roman and the American road systems have these points in common with the French systems and no other road system in history can compete for a place with these three outstanding systems because of lack of one or more of these characteristics.

The French did not invent a road design which was so far removed from the old Roman design but what their roads retained some resemblance to the old Roman roads. Massiveness of construction was largely done away with, materially

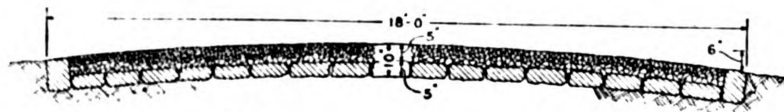
reducing the unit cost and proving the effectiveness of an efficient road-building organization. Comparison and contrast of road designs, as far as pavement thickness is concerned, can be most effectively seen, by following the evolution of road cross-sections shown pictorially below.



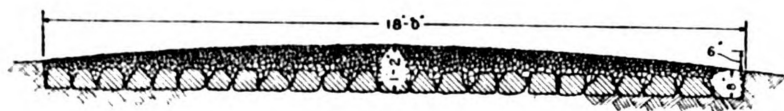
ANCIENT ROMAN 2-LANE MILITARY ROAD.



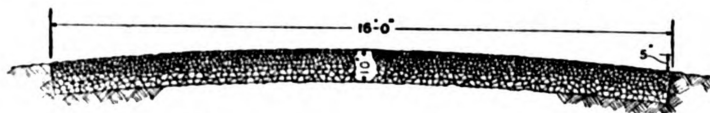
FRENCH ROAD (ROMAN METHOD) PREVIOUS TO 1775.



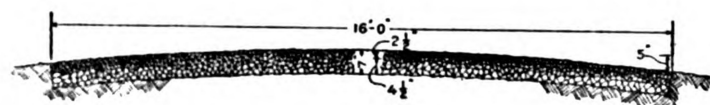
TRÉSAGUET ROAD, FRANCE, 1775 TO 1830.



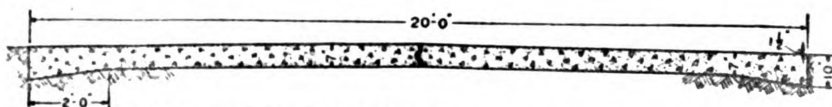
TELFORD ROAD, ENGLAND, 1820.



ORIGINAL MACADAM ROAD, ENGLAND, 1816.



MACADAM ROAD, UNITED STATES, 1900.



HEAVY-DUTY 2-LANE CONCRETE PAVEMENT, UNITED STATES, 1934.

**Cross-sections comparing the thickness of road surfaces in
Ancient and Modern times.**

Both the Roman and French road systems have come down thru history as military highways. Contrary to general belief, the greatest expenditures were made for road-building programs and the most extensive milages were added after the boundaries of both these Empires had been extended to their greatest dimensions. These roads were used for military purposes, to be sure, but both Augustus and Napoleon concentrated on a road-building program which would make possible the administration of a far-flung empire, provide sufficient food for their people, and stimulate trade and commerce. Quoting Napoleon on the question: "I fear popular insurrections due to Economic Causes, though I am not afraid of political up-risings." An adequate transportation system is fundamental to a large nation. We, here in America are prone to think of our highway system as having been built purely for economic purposes and to think of the French and Roman roads as having been built for military purposes only. If we elevate ourselves to a bit more cosmopolitan point of view, we can easily detect the similarity of purpose of these three great systems. It was just pointed out that far more road mileage was added to French and Roman roads after conquest had ceased than during expansion. Can these last-built roads (Comprising more than half the total mileage) be properly termed purely military? If the United States was to be involved in any kind of war would not our roads become military roads? Could not the roads built in the United States by the French to out-wit

the British and vice-versa, properly be called military roads? One might argue that those early roads were not really roads and our real road system began only with the closing of the World War. That is quite true but I believe that the reader will agree that there is a similarity of purpose common to the three great systems which is often overlooked; that of administrative and economic control. In spite of this similarity of purpose, because of the inherent properties of the French and Roman Empires bordering on hostile neighbors, and of the United States, in its present status, being adjacent only to friendly neighbors, the purpose of the road systems of the former two might be commonly called military and that of the latter purely economic. This latter definition of purposes, however, should always be supplemented by the ideas contained in the first part of this paragraph, showing the similarity of purpose of all great road systems.

British Roads

The earliest thoroughfares in Britain are in the form of "green Ways", or tracks for foot traffic. These were confined to open land in all cases, and more particularly to high ground, thus keeping clear of forests, undergrowth and marshy land. The traveler was taught by hard experience, in the interests of his personal safety, to keep to open ground, away from the haunts of wild animals and his still more savage fellow man, and to regard every stranger by the way as a potential enemy.

The four famous "Roman ways" built in the British Isles by the Romans while they were in power: Watling Strete, The Icknield or Ikenild way, Erming Strete, and Fosse way, were left to decay with the downfall of the Roman Empire because of the disappearance of art and inspiration which went hand in hand with Roman road-building. Consequently the material and social progress of Britain was retarded fourteen centuries. Road-building did not flourish again till "stone-breaking MoAdam", as he was known, devised a means of good-road construction. Failure of road-building to pick up again, any quicker than it did, after the Roman decline, may be attributed to existing law which compelled each Parish to maintain its own roads by statute labor, but establishment of turnpike trusts and road maintenance by tolls seemed to have effected but little improvement.

Between 1760 and 1774, 453 acts of Parliament were passed, establishing local organizations known as turnpike trusts, to deal with the transport problem. These turnpike trusts were in-effective because they were too small and too numerous to function efficiently, as they were set up. A good method of construction was the fundamental lacking element.

Condition of the English Roads during the "dark ages" can quite aptly be apprehended by reading a few quotations from Devereux's "John Loudon MoAdam": A lawyer, writing to his wife in 1690 says: "The Sussex ways are bad

and ruinous beyond imagination." This lawyer attributed the long limbs of the Sussex wenchers to the constant pulling of their feet out of the mud which he concludes "tend to strengthen the muscles and lengthen the bone." In 1736 Lord Herney complained that "the road between this place and London is so infamously bad that we live here in the same solitude as if cast on a rock in the middle of the ocean. All Londoners tell us that between them and us there is an impossible gulf of mud." Ravelagh, an amusement place, used to keep a patrol of "twelve lusty fellows" to guard their patrons from assault on their outward, and their homeward way. When returning from a visit to Lord Fitz William at Wentworth, about this time, the Prince of Wales's carriage overturned near Newark and rolled down-hill. The carriage was broken to bits when it reached the bottom but the royal occupant miraculously escaped with only a few bruises.

John McAdam, born in 1756, was the first man to realize that the development of English natural resources depended upon a coherent system of roads, scientifically planned and constructed. When Mr. McAdam was 14 years old he left his impoverished family in England to live with a merchant uncle in New York State. He set up a merchant trade of his own, with his uncle's help, got married, and lived in America for thirteen years. John and his uncle were instrumental in founding the New York Chamber of commerce and John served as its treasurer in 1774, at the age of eighteen years. On returning to England with his family, John soon found a leading place in Public life there. Having always possessed a deep-seated interest in road-building and road construction

methods, he directed his energies along this line of work. After long hard years of exhaustive work, much of it at his own expense, and after suffering many discouraging experiences with his road-building programs, Mr. McAdam was finally noticed as a man who possessed some road-building knowledge and was invited to take entire charge of 146 miles of road as general surveyor, in 1816, at 400 pounds per year. At the request of the house of commons he published a book, "The present system of road-building", so that better roads could be instituted throughout England. This writing was done after roads had been built about Bristol by McAdam, which aroused interest from all parts of the Kingdom.

The principle upon which McAdam worked was "That a road ought to be considered as an artificial flooring, forming a strong, smooth, and solid surface, at once capable of carrying great weight and over which carriages may pass without meeting any impediment." As he knew from experience, that ideal was to be attained only if the road is entirely composed of stone to a thickness of about ten inches, in which every stone is broken until none exceeds six ounces in weight. His construction procedure may be briefly summed in the following remarks: The road should be flat as possible, with just enough rise in the center to allow rain to run off into ditches on either side. A three-inch rise was advocated on a road eighteen feet wide. McAdam did not believe that the weight of a vehicle on the finished road, not the width of its wheels (points generally considered

very important) made much difference. He held that a well-made road ought to carry anything without injury. Traffic pressure was supposed to unite the sharp angles of the stones into a compact mass, entirely impervious to moisture. Any admixtures of earth, clay, chalk, or other material which will imbibe water, was strictly forbidden. McAdam considered Telford's practice of paving the road foundation unnecessary and too costly.

McAdam's tools consisted of the following: Strong, short-handle picks; small, No. 1 hammers with a face about the size of a shilling, hard-faced with a short handle; Rakes with wooden heads, ten inches in length, with strong iron teeth, used for raking out the large stones; and broad-mouth shovels for handling the road material.

After all of his discouragements and mis-fortunes, McAdam was finally held in high acclaim by his fellow-men. He had finally succeeded in transforming the old, impassable tracks into smooth highways. Coach-building flourished and the interior of England became opened up to the outside world. The coach era extended from about 1820 to 1836. At its peak there were over 3,000 coaches on the road with some 150,000 horses to draw them. About half of these traveled in and out of London. Final abolition of the turnpike trusts did not occur until about 1890 because some of them were turned over to debtors and toll gates were operated by the new owners as long as any revenue remained for them. Canal development hastened the decline of the trusts and their doom was sealed with the advent of the railroad.

As late as the first decade of this century it was quite common practice, on country roads, to repair all roads in sections. By means of obstructions placed according to which part needed compaction the most, vehicles were compelled to roll in the broken stone. Rubber tires were hardly known at that time, but cyclists were quick to attack road authorities on this practice.

Road-rolling is so common now that it is hard for the younger generation to imagine a time when road-rolling was un-known. The first reference to rolling in road material was in 1619, but no practical use of it was made till a horse-drawn roller was used in France in 1787. Parliamentary considerations in England, in 1753 gave privileges to users of the road if their wagon wheels conformed to certain specified widths. This un-usual practice reached its climax when wheels sixteen inches broad were exempted from tolls and vehicle owners with wheels less than six inches wide were required to pay double. One writer of 1764 argued that broad wheels were un-necessary if six inch wheels were used and the front axle made one foot shorter than the rear one so that a twelve inch track would be made. The "Broad Wheel Act" expired in 1765.

In 1773 "rolling carts and rolling wagons came into use and it was found that stage coaches using rollers instead of wheels, left the road in a fine, flat, smooth condition--"so smooth and clean that even foot passengers preferred them

to walking in the fields."¹ In 1816 a "tamper" was invented for tamping the road surface, and in 1817, a large, horse-drawn roller was patented.

The later history of road-rolling, more common to us, is associated with the steam-driven roller. Such a contraption was early described as a "Rotund Robust Robot." The first steam roller patent was issued in 1859.

American Roads

For the beginnings of our inland commerce routes, we must look far back into the dim, pre-historic ages of America. The earliest paths that threaded the continent were the streams and the tracks beaten out by our heavier, four-footed animals. Long before the white man, the Indian hunter followed the migrations of the animals and the streams that would float his light canoe. There was one distinction between the animal paths and the Indian trails. The former had feeding grounds for their termini while the latter connected from abiding place to abiding place; being more than mere random "Ways", these latter trails comprised a system. If this system could be restored in a chart we would doubtless be surprised to find what a network it formed, reaching out in various directions over the country. No such restoration would be possible, however, because though there are many allusions to them in our local histories, that information we have is scattered,

¹Roads and Streets, March, 1940, pps. 49-51.



"and the streams that would float his light canoe."

meager, and indefinite. The Indian path-maker frequently marked the way for the white man's thoroughfares and his work was thus perpetuated in the civilization of his successors. Out of his knowledge came the best routes and today the main, most important lines of travel and transportation cling, for the most part, to these primeval pathways. These old trails had a natural tendency to follow lines of least resistance. In so doing they pierced the Alleghany mountain barrier in numerous places which can be found in use for highway travel today.

Before anything like permanent thoroughfares could be established, a considerable population of settlers had taken up lands in the interior of the states and there had to be makeshift thoroughfares not only for guidance from place to place but for transportation of immigrant's possessions. These "traces" as they were called, were merely cleared strips thru the woods, of sufficient width to allow the settler to come thru with his wagons, with "blazes" on the trees to show the way. These "traces", like the Indian trails, have long been obliterated. Massachusetts pioneered by passing an act in 1639 which decreed that the "ways" should be six to ten rods wide "in common grounds", thus allowing sufficient room for more than one track. Similar "broad ways" were authorized in New York and Pennsylvania in 1664. Stumps and shrubs were to be cut close to the ground and "sufficient bridges" were to be built. Virginia was another state to cause early enactment of road legislation. "Road-making" we must remember, is a

mis-leading term applied at this stage in history, if we apply it with the same ideas we associate with it today. We must remember it meant simply blazing a trail thru the forests, which travelers could follow, and perhaps included cutting of some of the trees and shrubs. Streams proved a serious obstacle and the canoe or keel boat gave way to the "flat" or barge, at river crossings. The long Philadelphia road from Lancaster region into the valley of Virginia was used as early as about 1700. Wheel transportation thus road development, had to wait for development of mining to a degree that would bring down the cost of iron. During the revolutionary period a road from the York barrens toward the Patomac, two miles above Harper's Ferry, via Berkley, Staunton, Watauga, and Greenbrier regions, was the longest and most important in America. In 1785 Kentucky Legislature made the old Wilderness Trail, a wagon road 30 feet wide from Crab Orchard to Cumberland Gap. Endless difficulty was experienced on these first un-paved American roads. Lives were lost, wagons buried themselves in swamps and bogs, and horses were killed. Ingenuous devices such as block and tackle arrangements were often used to let loaded wagons down steep slopes or assist the horses in pulling the load up.

No genuine road improvement was attempted till 1784, the beginning of an era heralded by Washington's letter to Harrison. Lancaster turnpike, the first macadamized road to be built in this country, was built in Pennsylvania, from Philadelphia to Lancaster. (The age when McAdam was showing



"And the keel-boat gave way to the 'flat'."

England how to build her roads) Work on this famous American road was started in April, 1792 and completed in 1794 at a total cost of \$465,000. Allignment throughout the road's length was very straight. Starting at Lancaster, the road was paved 100 feet wide for some distance, as an experiment, with a view to making it this width all the way. Pavement this wide proved too expensive, however and it was narrowed to 24 foot pavement, continuing thus to Philadelphia, a total distance of 62 miles. Construction was financed by the sale of stock. Declaration of dividends paying as high as 15% made the road a huge financial success. Maintenance was effected by revenue collected at nine toll gates. Load and wheel width restrictions were placed upon vehicles using the road, the restrictions depending upon the condition of the road according to the time of year. The road is particularly interesting from three points of view; (1) It began a new period in American transportation. (2) It ushered in an era of speculation un-heard of in previous history of the country. (3) It introduced American law-makers to the great problem of controlling public corporations.

History of road-building in the United States parallels in but few particulars the road history of the other great civilized nations of the world. In many respects our highways bear but slight resemblance to those of the older countries. Traditions relative to the construction and management of roads which came with the first settlers to this country were practically valueless because the countries from whence they came were suffering for lack of good roads at that time.



One of the first great American roads was the old York road which ran from New York to Philadelphia, built in 1711. The old adage that "The History of Roads is the history of civilization" can well be realized from a study of the history of this old road. "The Indian Trail, the blazed trees, the foot-path, followed by the bridle path for pack trains, then the rough road for carts and wagons, which were subsequently graded and paved, making a safer and more easy means of communication, are all stepping-stones to higher degrees of civilization".¹

The first settlers built their roads with volunteer labor. When this became scarce, every able-bodied man was required to work on the roads or pay a tax for failure to do so. In the last quarter of the eighteenth century, road-building was accomplished by chartered companies, replacing the un-satisfactory "forced-labor" methods. Up-keep was financed by tolls. Hundreds of miles of roads were built in New York State and in some of the Western states, of thick, wide planks. While the planks lasted the road was good, but they decayed very rapidly and for this reason the method, proving un-successful, was gradually abandoned. As a rule, tolls proved un-successful, some of the companies losing money. The "Turnpike Company" was gradually superseded by the restoration of the forced labor system. This became almost

¹"Progress of Roadbuilding", Yearbook of U. S. Dept. of Agriculture--1899, pps. 367-380.



"While the planks lasted the road was good"

universal until about 1890, each county caring for its own highways. In 1828, with the advent of the railroad many people thought there would no longer be any need for public roads and the national roads were abandoned. Public roads were neglected, in general, almost completely, for several decades.

Not until four years after Indiana's admission to the Union was any definite system of roads projected within her borders. In 1820 there arose new reasons for the opening of highways. The vast tract of land known as "The New Purchase" comprising a good portion of the state, was thrown open to settlers in that year. In 1820, 26 state roads were projected. During the following ten years there was much legislation on the subject of state roads, showing the importance they held in people's minds in those early days. Revenue and labor for opening and maintaining these new Indiana roads was from three distinct sources. (1) Through three percent of the monies derived from the sale of Indiana public lands. (2) A road tax levied upon real estate (owner was allowed to "work out" his tax on the road) (3) Every male inhabitant except preachers and certain other exemptions, between 21 and 50 years of age, was required to work two days per year on the roads. When called out work must be done or an equivalent there-of must be paid.

[This legislative enactment was only a first and very inadequate step, however, because of self-seeking and lack of economy in public works.] After the "highways were cut out"

they were highly impracticable and many cases were noted where they became useless because of a second forest growth.

Vast areas were nothing but swamp which the streams never fully drained. Most of the year a journey over the roads was simply a slow, laborous wallowing thru mud; the bogs were passable only with corduroy and often the poles comprising this had to be weighted down with earth to prevent floating away when the swamps waters rose. A description of conditions by one traveling thru Indiana at the time would probably sound something like this; "As one proceeded he must tack to right and left, not to find the road, but to get out of it and find places where the mud was thick enough to bear. The way was a most ill-looking, dark-colored morass, enlivened by streams of pururer mud (the roads), crossing at right angles. And these streams were thick-set with stumps cut just low enough for wagons to straddle. Innumerable stubs of saplings, sharpened like spears by being shorn off obliquely, waited to impale the un-lucky traveler who might be pitched out onto them; and the probability of such accident was considerable, as the lumbering wagon plunged over a succession of ruts and roots."¹ Following are lines written by a migratory wag in the register book of a Franklin, Indiana tavern: "The roads are impassable---hardly Jack-assable; I think those that travel 'em should turn out and gravel 'em."²

¹ Indiana Magazine of History, March 1907, p. 13.

² Ibid.



Such were the characteristic conditions of Indiana's early thoroughfares, her only means of inland communication.

That they impeded growth and handicapped commerce is obvious. The difficulties overcome to build up the road system as it is seen today, less than 100 years after the days of these "wicked ways" is evidence of, and exemplifies the ambition and sturdiness of our American fore-fathers.

The first 25 years of the 19th. century was a period when various states and sections of the country were in general rivalry for the conquest of our new western trade. The Cumberland road (to be treated later), suddenly sprang into being, and New York State built the Erie canal. In rapid succession Pennsylvania, Maryland, and Virginia sent their canals into the Alleghanies toward the Ohio. With the coming of the "iron age", about 1826, land transportation on wheels took to the rails and the roads were looked upon as a secondary means of communication; merely connecting links to centers of greater transportation systems and not worthy of very much attention.

It has been written that increases in road-building or road-improvement activity can be attributed to four main forces: (1) Settlement of new land (stage-coach days). (2) Invention of the bicycle (late 1880's) (3) Advent of the auto (government road survey of 1904) and (4) Advent of motor-trucks and buses (1914 on). We have seen how the first force effects road extension. The cyclist did not have a very decided or wide-spread effect. We shall see

the effect of the remaining two forces, later in this history. It was not until the auto came into existence, in 1835, that highways really started back to their "place in the sun".

Famous Pioneer Roads

Thus far, American road history, in this paper, has been dealt with in a general sort of way, chronologically. Now let us consider some of the more important Pioneer roads from a more individualistic point of view. Washington's road (1754), Braddock's road and Wilderness road (1775), Genessee road (1794), Cumberland trail (1808), Michigan Road (1826), and "The Trail of the Spaniard", will be treated individually in this order. This order of treatment is according to the year the roads were in process of construction and has no bearing upon the relative importance, value, extent, or significance of the roads. Any of numerous other famous American roads might have been chosen for this individualistic description, but those chosen tend to give a rather typical cross-sectional view, so to speak, of American Pioneer roads, and were chosen for that reason.

Washington's road was built across the Alleghenies in 1754, from Cumberland Maryland to Pittsburg, Pennsylvania. Between these two cities, Braddock's road and Cumberland road may also be traced. In some places all three of them coincide. Built over the famous old Indian trail known, during the first half of the 18th. century as Nemocolin's path, Washington's road is so-called because it was first opened by Washington as a means of transferring his armies.

The road was un-paved and merely a widened path cut thru the forests with provisions made for crossing streams and swampy places.

Braddock's road, also across the Alleghanies, was built in 1755, the year after the Washington road. Few roads ever cost so much, ever amounted to so little at first, then finally played so important a part in the development of any continent. Throughout the latter half of the eighteenth century it was one of the main thoroughfares into the Ohio Valley, and during the first of the 19th. century, when our government built our first and greatest highway, Cumberland Road, the general alignment of Braddock's Road between Cumberland, Maryland and Laurel Hill, the last range of the Alleghanies, was the course pursued. In certain localities Cumberland road was built upon the very bed of Braddock's road and Braddock's road was built partly upon Washington's road, which followed the path of the Buffalo, Indian, and mound-building aborigines. Nowhere in America can the evolution of road-building be studied to such advantage as between Cumberland Maryland and Unionville Pennsylvania. Braddock's road was built for English military purposes in fighting the French. As early as 1795, importance of the road was recognised by Maryland and its legislature passed laws with reference to straightening and improving it. More such acts came in 1798 and 1802. It is difficult to say when Braddock's road, as a route, ceased to be used, since portions of it have never

been deserted. The rough track of this first highway westward may be followed today at almost any point in all its course between the Potomac and the Monongahela. The great caravan tracks, caverns and gullies along this track speak for themselves of the suffering and dangers of those who traveled it at the time when it offered one of the few passage-ways to the west.

A traveler in Uniontown, Pennsylvania today is within striking range of Braddock's road at its most interesting points. A six mile climb to the summit of Laurel hill, near Washington's spring, brings one to the old road. "A delightful drive along the summit of the mountain, northward, brings one near the notorious 'Dunbar's Camp' where so many relics of the campaign have been found. Many may still be seen in the Museum of the nearby Pa. soldiers orphan's home."¹ Jumonville's grove, about one fourth mile up the valley, and the view from Dunbar's camp should not be missed. Braddock's body lies less than one mile eastward of Chalk Hill, beside a brook which bears his name.

The naming of our highways is an interesting study. Like roads the world over, they are usually known by two names:--The destinations to which they lead. The Genessee road, for example, a famous old road in New York State, is known as the Genessee road in the Eastern half of the state,

¹Archer Butler Hulbert, Pioneer Roads

and as the Albany road in the western half. Few roads named after their builders, such as Braddock, Forbes, Wayne, Marin, and Boone, preserve their original names.

One road, however, The Wilderness road to Kentucky, holds the old time name with un-diminished loyalty. Every gloomy description and vile word ever spoken for it still holds true today. The road extended from Watauga settlement, on the Holston river, Tenn., to the mouth of Otter creek on the Kentucky River. It was completed a month before open revolution at Lexington and Concord and has been variously called Boone's trail, Kentucky Road, and Virginia Road, but its common name, and the one that persists today, is Wilderness road. It has been termed "the longest, blackest, hardest road of pioneer days in America." Wilderness Road opened for the "Transylvania Company" a way of settlement of the "splendid lands of Kentucky". The original Boone's road was of little consequence other than it afforded a possible route into new territory. The mountaneous portions of the road are the picturesque ones as well as the historic ones. The sig-zag pathway thru Powell's Valley and Cumberland Gap can never be effaced. Cumberland Road, as are those previously described, was not paved, and provided primarily, only means of obtaining proper direction, and means of laborous travel thru the wilderness without cutting one's own trees.

Genessee Road, previously mentioned, began at Old Fort Schuyler, New York, and went Westward "in a line as

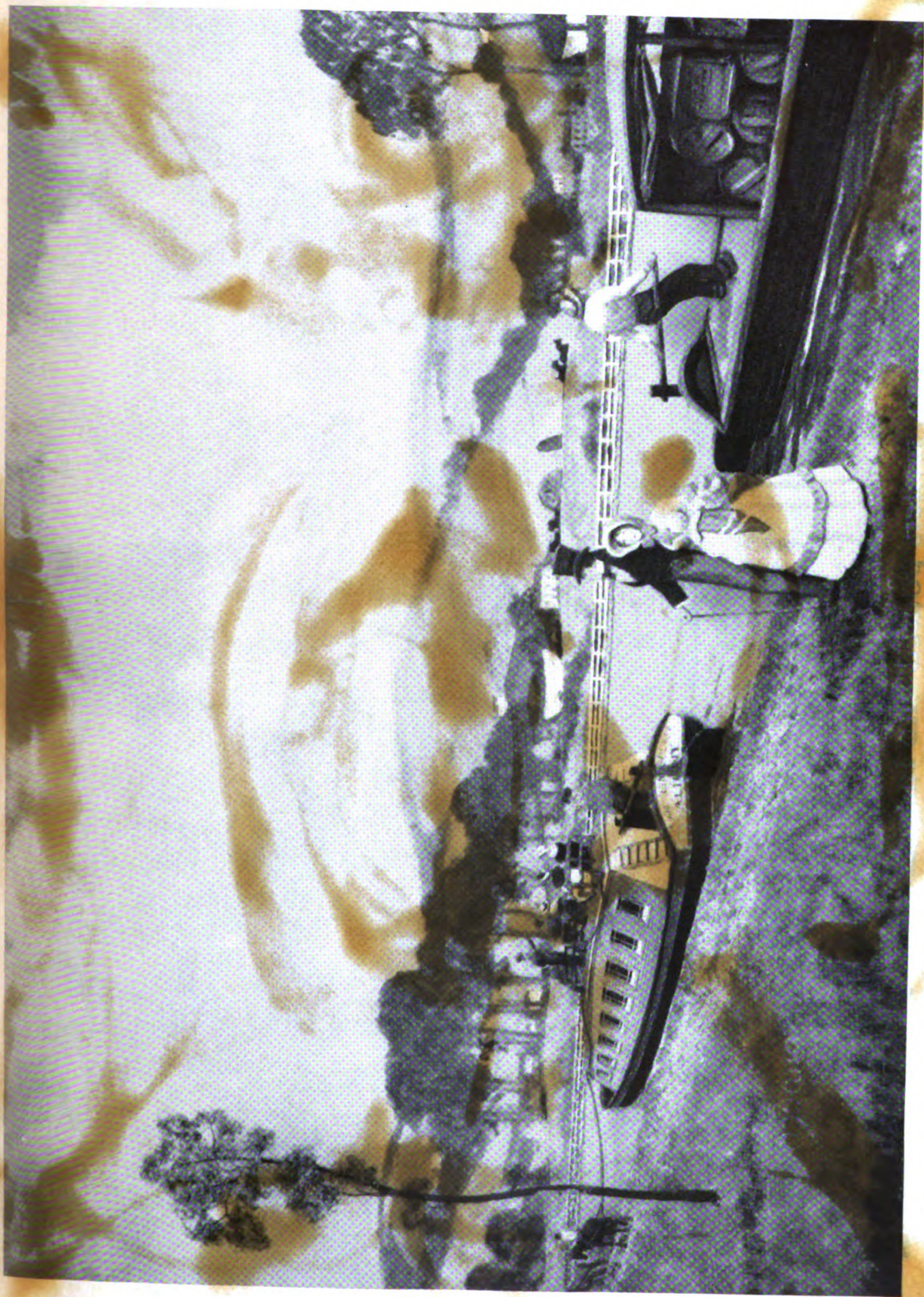


Wilderness Road

nearly straight as the situation of the country will admit." It was built to the Genessee River by a law passed in 1794. In 1798 a law was passed extending it to the western boundary of the state. It forms the main streets of Syracuse and Utica, the two largest cities thru which it passes. It is called Genessee Street in both of these cities. "The Old Genessee Road passed thru a country as romantic and beautiful as heart could wish to see or know"¹ Construction was of macadam in some sections and in others it was plank. A few years after completion, the Erie Canal was built, roughly paralleling it. Local people heartily dis-favored this experiment (the canal). Bad as the Genessee road was, in wet seasons, they thought that it could not be bettered. So poor were the roads leading into the region of the canal at the time of its construction, that contractors were compelled to do most of their hauling in winter, when the ground was frozen. Bad roads were blamed for delay in progress on certain portions of the canal.

Cumberland Road, best known in some parts of the country it crossed as "National Road", was built from the Potomac to the Mississippe, passing thru Maryland, Pennsylvania, Ohio, Indiana, and Illinois, at a cost of \$7,000,000. Building of this 700 mile highway, our first national road, was one of the most important steps in that moment of national expansion which followed the conquest of the west. By 1829, the road, having been subjected to heavy travel, was

¹Archer Butler Hulbert, Pioneer Roads



The Erie Canal
Local people heartily disavored this experiment.

badly in need of repair. Repairs were made by the macadam system to insure efficiency and permanency. Pavement of the old road was broken up and all stones were removed. The road-bed was raked smooth and made nearly flat. Ditches, drains and culverts were cleaned and made so that water at no place could stand at a higher level than eighteen inches below the lowest point in the road surface. All stone was reduced in size not to exceed four ounces in weight. It was spread on with shovels and raked smooth. No clay or sand was allowed to be mixed with the stone. Stone was spread in layers about three inches thick, admitting travel for a short period on each layer to compact it, interposing such obstructions from time to time as would insure uniform travel over every section of the road. Workmen were kept in constant attendance to rake the surface when it became un-even by wheel action. No stone except limestone, flint, or granite, were used. Thickness ranged from six inches minimum to nine inches maximum. No covering was placed on the road-bed until it had been well compacted and thoroughly dried. Bids let for preparing the roadway called for clearing a space forty feet each side of the center-line, and grubbing out all stumps and roots for a distance of 20 feet each side of the center-line.

The road was built by the United States government under the supervision of the War Department. The last appropriation was made May 25, 1838, carrying the road into Indiana. About 1830, completed portions of the road



fell into the hands of the states thru which it passed. Individual states then set up toll gates to obtain maintenance funds. The total of maintenance funds thus derived, from 1831 to 1877 inclusive, was \$1,139,795.00.

The old road carried freight, passengers, and mail. Stage-coach and tavern histories blend with the history of the old road into a romantic, thrilling, chain of events that is the real history of our America during that period in the locality which the road served. Monumental relics of the road remain for us today in the form of ponderous stone bridges such as those at Big Crossings, Smithville, Pennsylvania, and the artestic S bridge near Claysville, Pennsylvania.

About 1832 work on the road ceased abruptly, for the building of the railroad dampened the road's futur prospects. In mournful commemoration of this circumstance, a contemporary poet wrote:

"We hear no more the clanging hoof,

And the stage-coach rattling by;

For the steam-king rules the traveled world,

And the old Pike's left to die."

The old pike is perhaps even now haunted by this poet's roving ghost. If so, he sees the white stretch of concrete (the modern pike) with its stream of rubber tires twenty-four hours a day. Their piercing head-lights show nothing of the Conesota wagons, or the picturesque, swearing, hard-fighting teamsters, however. They all passed on with the Old Pike of history.



Individual states set up toll gates----

The Michigan Road depended for its existence upon a deal made with the Indians. Prior to 1826, the Potowatome Indians owned a strip of land which crossed the northern part of the newly admitted state of Indiana. There was no means of overland communication between the white settlers of the Ohio Valley and the white people of Michigan settlements. Congress therefore authorized a treaty with the Indian tribe, it being agreeable to everyone, which would provide a right-of-way for a road. A treaty was made and the Indians ceded a strip of land "commencing at Lake Michigan and running thence to the Wabash River, 100 feet wide, for a road, and also one section of good land, contiguous to said road, for each mile of the same and also for each mile of a road from the termination there-or, thru Indianapolis to some convenient point on the Ohio River."¹

Indiana was authorized to build the road, which she built, from Lake Michigan, in a generally southward direction, passing thru Indianapolis with its southern terminus on the Ohio at Madison. For years it was, in effect, a national highway. Well built for its generation, the Michigan Road was 24 feet wide, consisting, in some parts, of one foot square seasoned oak timbers, 20 feet long, covered by one and a half feet of soil taken from ditches beside the road. Importance of this road is second only to the

¹Semour Dunbar, A History of Travel in America.

Cumberland Road, as a vein of travel for the whites during the era preceeding the general appearance of the railroad.

Though in 1908 such a thing seemed to many only a fantastic dream, Ed Fletcher of the West, being impressed by the lack of a lateral southern route connecting the two oceans, determined to attempt a paved highway, connecting San Diego, California, with the Atlantic Ocean. About the same time an enterprising group of men in Mobile, Alabama were looking at possibilities of a road from Florida westward to the Mississippi River which would reduce their dependence upon the railroad and water transportation for economic purposes. (Procuring labor and raw materials, etc.) Seeking a name for an association under which a flag could be flown for their mutual support, several southern states near Alabama decided upon "The Old Spanish Trail". Seeking State legislative aid financially, the association stood still for six years. (1916-1922) Every state approached by the association deemed the plan a "senseless undertaking". Finally San Antonio, Texas became interested, for economic reasons, in the purpose of "The Old Spanish Trail," and the three groups: Far Westerners, Southerners, and Texans, became closely knit for a common purpose.

After securing aid of the United States War Department, the association was able to approach local authorities with promise of federal aid, and in this way secured action. Bridges were built in the 500 mile stretch of rivers and lowlands between Orange, Texas and Penscola, Florida,

reducing the total 39 miles of ferries to two and one half miles. Today (1929) there are only two ferries remaining, from coast to coast, and they are due to be replaced by bridges soon. In 1929, \$70,000,000 had been spent on the road, but it has meant fortunes to the land it traverses. The heavy burden the southern states had to bear during its construction, has amply repaid them. "Old Spanish Trail", now U. S. 90 from Florida to Texas and changing to U.S. 80 from there on to California, is one of the greatest of the scores of modern American highway units which gives America the greatest highway system in the world.

"It can hardly be explained why the great motor-vehicle interests, alert in business and devoting their energies to the perfection of the motor vehicle, should tax their ingenuity to perfect a machine which will withstand all sorts of deplorable road conditions, without expending some time and energy on the roads, which are so primarily essential to the success of this mode of transportation."¹

There have been five reasons set fourth for lack of road-building progress in the United States up to 1903. They are:

- (1) Excellence and rapid development of the railroad and waterway systems.
- (2) Our long familiarity with bad roads and the indifference of those in charge of highway affairs.
- (3) Lack of appreciation of social, commercial, and economic value of good roads and fear of increased taxation.
- (4) Wasteful and ineffecient system of "forced-labor" roads.
- (5) Lack of general authority and general supervision, non-equitable cost distribution, and lack of business methods in highway construction and maintenance.

Ideas and theories of proper road design and construction change quite markedly from time to time, and sometimes quite rapidly. Some points set forth as being good road practice in 1903, for instance, follow: "1. It is desirable for many reasons to preserve the old dirt road alongside and parallel to the surfaced road, whenever possible. 2. It seems wise to recommend, particularly for level country where material is scarce, the building of gravel and macadam roads from 8 to 10 feet wide. 3. A common but erroneous impression prevails, that when a road is once macadamized, it is finished and will last forever. A road needs constant attention, and unless it receives it, will dis-integrate."² These points, though sound for their time, are obviously a long way behind the modern conception of road-building.

Indian Trail to Turnpike

Archer Butler Hulbert, in his "Pioneer Roads, interestingly describes American road development in a general way by classifying the various stages of development of any particular road as "blind trail", "Pack saddle era", "Wagon stage", and "Turnpike. I believe that what little repetition will be caused by summarizing Mr. Hulbert's account of turnpike evolution, will be well worth-while.

The first evolutionary phase was broadening of the old Indian path, or "blind trail", by mere passing of wider

¹(Preceding page) U.S. Dept. of Ag. Yearbook, 1903.

²Ibid., pps. 453-61



Natchez Trace (not mentioned in this paper), of the pack
saddle era.

loads thru it. This blind trail, having become a little rougher and a little wider by mere use, became the road of the "Pack saddle era". About 1670 some of the Eastern states passed legislation for road betterment, which simply meant cutting of stumps close to the ground, clearing fallen logs, and perhaps widening or straightening the roads a bit by cutting trees. Loosely it may be said that the widened trail became a road when wheeled vehicles began to pass over it. Carts and wagons were common in the Atlantic states as early as and earlier than the American Revolution. By 1785 freight traffic by wagons had fully begun across the Alleghanies at many points, thus the pioneer roads had reached their "wagon stage" of development. (merely a path thru the woods sufficiently wide to permit passage and meeting of wagons. Each year the wagon roads grew longer and the bridle paths grew shorter. Wagons could not climb the knolls to keep on high ground, thus avoiding the low, wet, soft spots, so the grounds were made passable by corduroying (laying logs closely together to form a solid road-bed) where it was not possible to go around them. Remains of these old wagon tracks today are caused by the deep impression into the earth of the continual packing effect of the hard-tired, heavy wagons. [It is difficult, in this age of hard surfaced roads, to imagine what it meant to get stalled on one of the old "Hog Wallow" roads of the frontier. "Jonathan Tyson, a farmer, saw much difficulty in going to Philadelphia on the York road. A dreadful mire of blackish mud rested

near the present rising sun village. Tyson saw there the team of Mr. Nickum stalled. In endeavoring to draw out the fore-horse with an iron chain to its head, the chain slipped and tore off the lower jaw, and the horse died on the spot."] Charles Murray in his "Travels in North America," tells of road conditions as he observed them in Virginia: Speaking of the type of soil of which the road was composed, he says--"I am sorry that I was not sufficiently acquainted with chemistry or minerology to analyze that wonderful clay and state its constituent parts; but if I were now called on to give a receipt for a mess most nearly resembling it, I would write: Ordinary clay, 1 pound; Do pitch, 1 pound; Bird-lime, 6 ounces; Putty, 6 ounces; glue, 1 pound; Red lead (coloring matter), six ounces." He continues with: "Whether the foregoing, with a proper admixture of hills, holes, stumps and rocks, made a satisfactory draught or not, I will refer to the unfortunate team. I, alas! can answer for the effectual application of the second part of the description, according to Joe Miller's version of 'When taken, to be well shaken.'" A heavy load could not be sent over a frozen pioneer road without wrecking the vehicle.

The era of change of American vehicle from pack-horse to stage-coach must be termed that of the macadamized road or "turnpike" (turnpike road is one on which tolls are charged for its maintenance). This type road was wider than any single track of any of the routes they followed, though 30 feet was the average maximum breadth. This

turnpike age of roadbuilding saw many roadways widened and macadamized. The bulk of widening and grading, done by states or counties, was on roads that remained dirt roads. The new macadamized roads were relatively few and far between. Stagecoach travel over any but the few good roads, was less comfortable than pack-horse travel had been half a century before. [If the Virginia roads of this era (not macadamized) Thomas Moore wrote:

Dear George! Though every bone is aching,

After the shaking

I've had this week, over ruts and ridges,

and Bridges

Made of a few uneasy planks,

In open ranks

Over rivers of mud, whose name alone

Would make the knees of the souled-man rock.]

It is said that chasms across the road to the depth of six, eight or ten feet occurred at numerous intervals.

Federal Aid

Road-building by the states in the first years of the present century presented many menacing problems, some of them quite serious from the stand-point of a country of fine roads. The state line was often the end of a fine state road, the traveler encountering a road in a deplorable state of repair at that point. Connection of roads at state lines to make long, efficient, inter-state routes was practically impossible because of the lack of a central



organizing authority to plan such long routes in a systematic way. States with a very sparse population could not compete with the road-building programs of more densely settled states. The increase in auto registration the country over, from 1900 onward, evidenced new needs for more and better highways.

Realizing the plight of the roads and the emmensity of the situation, the federal government entered the field of highway improvement and in 1916 passed the Federal Aid Road Act. \$75,000,000 was appropriated to be matched by an equal amount from the states, for the construction of rural post roads over a five-year period and \$1,000,000 per year for ten years for roads within or partly within the national forests. Each state was required to have a responsible, central highway department with the requisite powers and funds to carry out the program. All of the states complied with the terms of the act and these preliminary steps were practically completed, and a vigorous road action was about to take place, when the United States entered the world war.

At the close of the war arrangements were promptly made for the vigorous persocution of road work in all sections of the country. This was done not only to repair damage wrought by heavy traffic during war-time when maintenance operations were few, or to provide adequate transportation facilities for the expanding needs of agriculture and industry, but also to provide employment for those who would otherwise be un-employed during that transition from war to Peace-time.

To facilitate operations, congress appropriated \$209,000,000 in addition to the \$85,000,000 provided by the original act, for the extension of road construction in co-operation with the states, and some important amendments to the act were also made. Definition of kind of roads that can be constructed was greatly broadened, and the limitation of the federal contribution for any one road was increased from \$10,000 to \$20,000 per mile. No formula held good for the type road to be used in every part of the country. Swampy territory, for instance, requires a heavy road. Some reactions, on the other hand, such as are caused by heavy traffic, require only light roads if in certain sections of the country where soil conditions are proper for such construction.

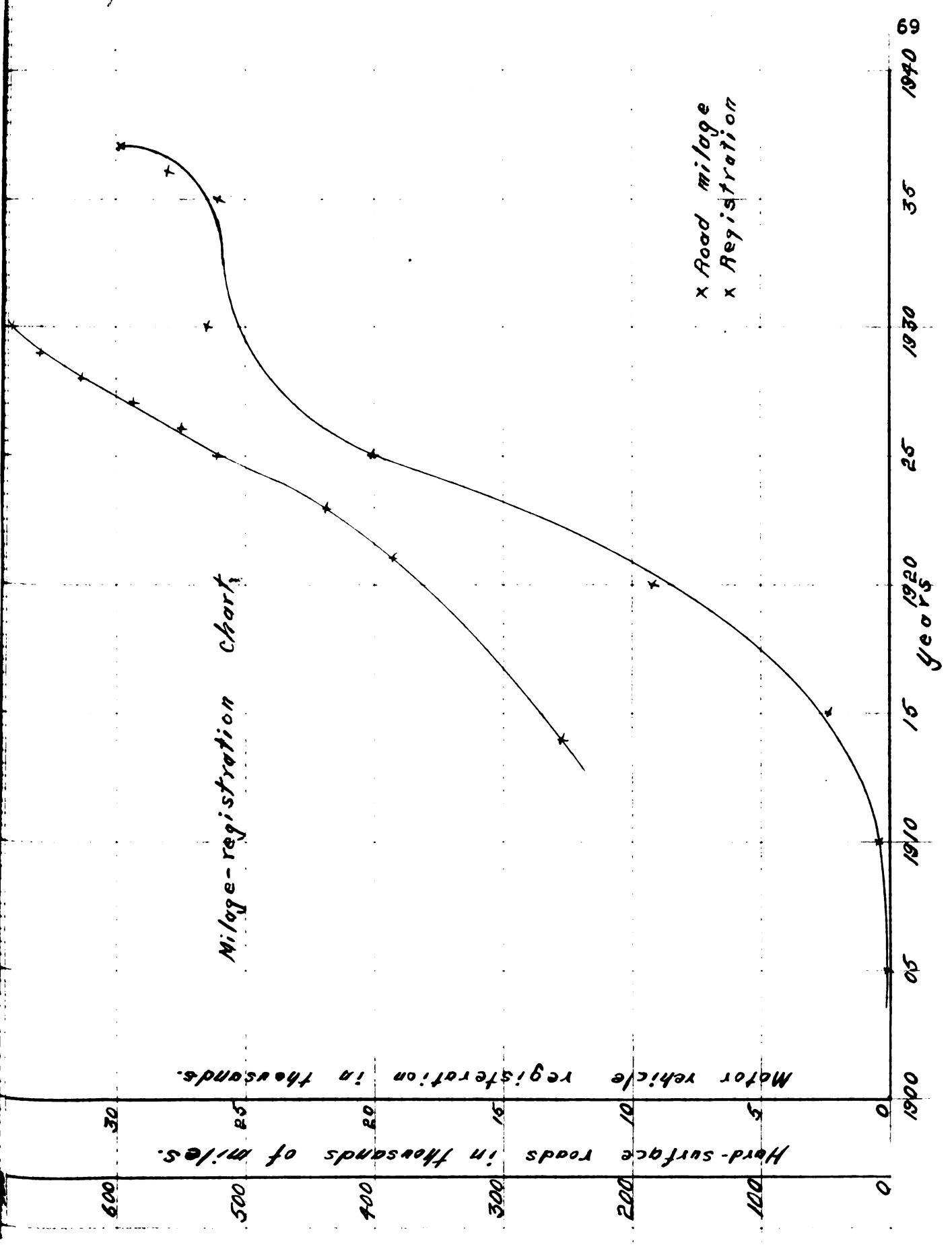
The United States did not actually commence the road-building program that was to make her road system one of the three most outstanding in history, then, until World War times. She was about to begin in 1916 but her plans being interrupted by the war, she resumed her road-building operations on even a larger scale, immediately after the armistice. Total road mileage at the present time is about 3,000,000 miles---good, bad, and indifferent. 71% of this mileage is un-improved in any way, being little better than the Indian trails. 10.5% of the total is drained and graded. 17% has some sort of impermanent surfacing; only about 2% of the total represents year-around, all-weather roads, made from base to crown according to most thorough



scientific highway engineering. The graph shown on page 69 indicates the rate of road-milage increase since 1914 and the increase in auto registration presents itself as having a bearing on road milage increase. Of course the question could be asked here: Did increase in auto registration lead increase in road milage, or vice versa? Though there is no proof to offer for the statement, it is quite obvious that demands were created by the motor car for good and safe roads and that increase in hard-surface road milage is an effect rather than a cause. - - Notice the road milage bar graphs of the following pages.]

Super Highways The World Over

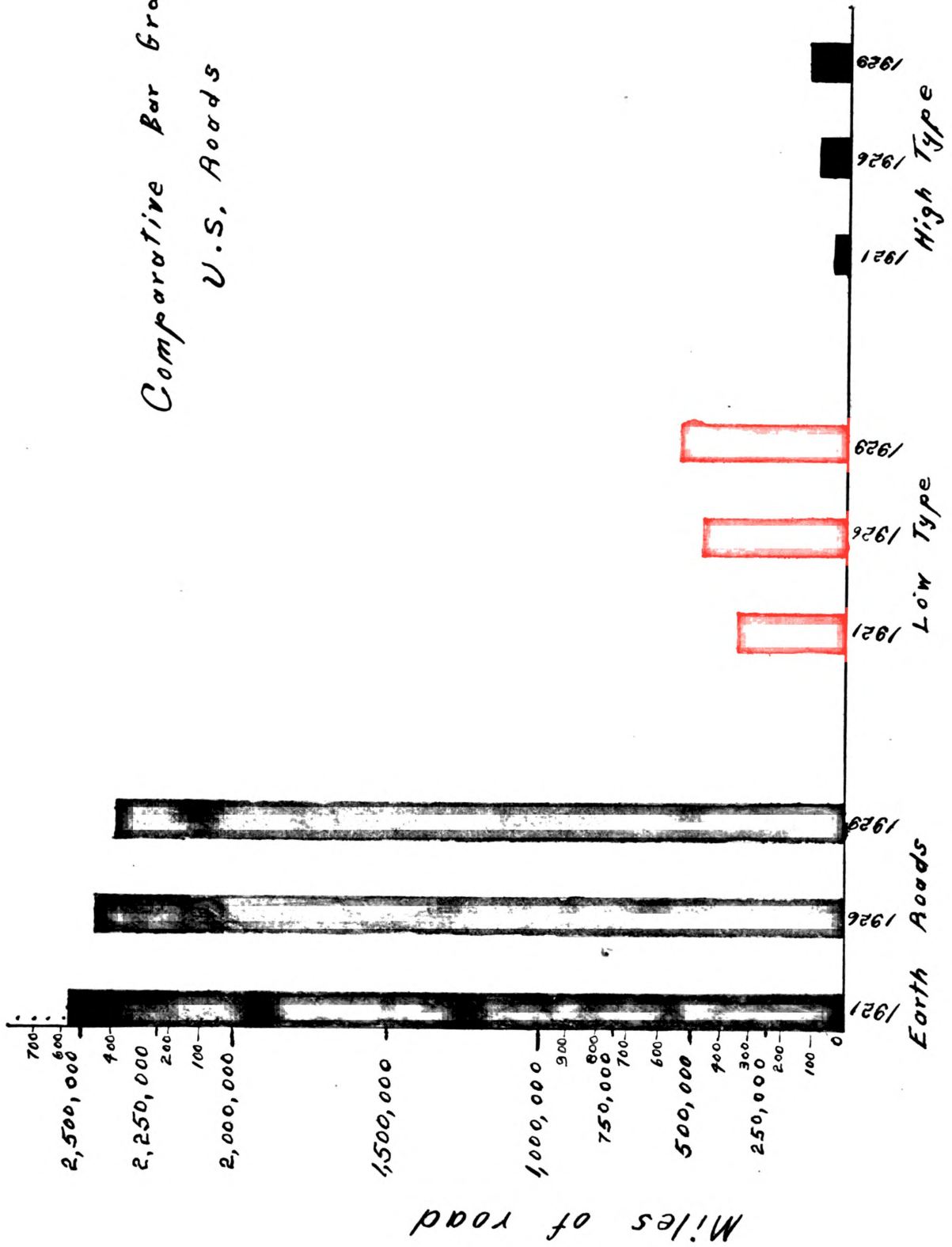
Modern needs for quick, safe, effecient transportation from town to town, and the enormous populations to which many cities have grown, requires every-day improvements and extensions for the highways of the world. Research is carried on continually, the world over (especially in the United States, the world's leading road-builder) in an effort to devise ways of making an attractive highway that is cheaper or safer, so that growing highway demands will be satisfied. The super-highway, which is the last word in highway circles, has made its appearance in several of the more advanced countries. Super-highways in this country will not be described here because it is assumed that experiences of the reader, together with the information gleaned from the next paragraph on the German super-highway will give the



The next page is devoted to a bar graph showing mileage increases in paved roads, graphically. The page is self-explanatory except for an explanation of the "Low type" and "High type" roads. These types are both hard surface. The low type includes water-bound macadam, tar, gravel, etc. The high type includes bituminous concrete, concrete block, cement concrete and wood block in bridge paving. How long will it be before the red or black bars become longer than the green ones?!

Data was obtained from Statistical Abstracts of the United States, 1932 and 1938, under the headings of Motor Vehicle registrations (for graph on page 69) and Rural Roads.

*Comparative Bar Graph
U.S. Roads*



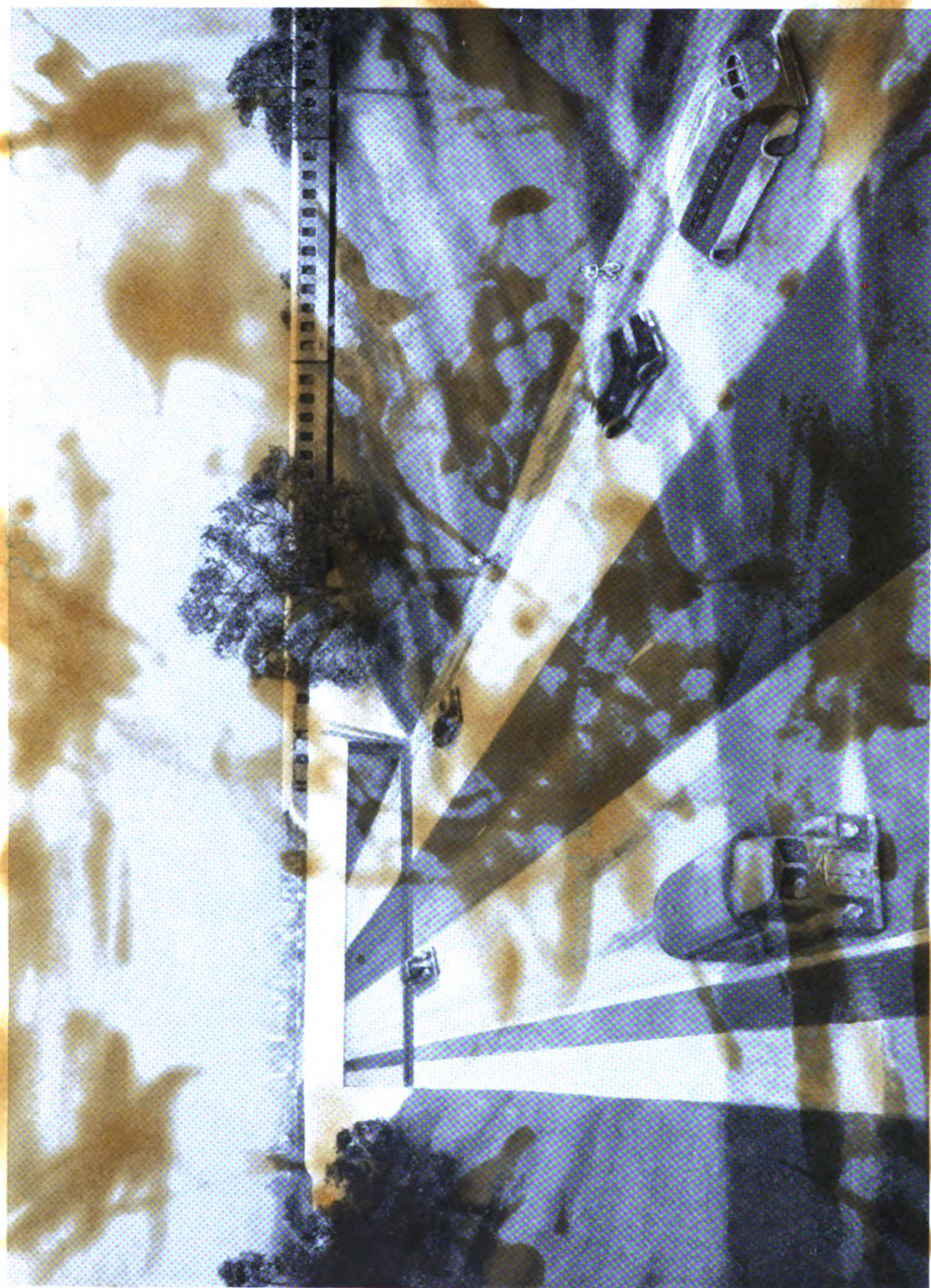
1870-1871

1872-1873

1874-1875

reader as good a picture of them, if not better, than the scope of this paper would permit here. Advanced super-highway design in this country is largely confined to the proximity of large cities, where the clover leaf intersections, grade separations, and intricate systems of traffic signals make one sense that he is observing the ultra-modern highway. Practically all of the principles embodied in the described German design are included also in the American super-highway.

At the present time there is a system of modern highways under construction by the "Reich Motor Road Society" of Germany and supervised by the "General Inspector of German roads". There are two independent roads to each highway, each 23 feet wide, separated by an unpaved strip, 17 feet wide planted to shrubs to prevent head-light glare. No crossings at grade with other highways or railroads, are permitted. Connections with other roadways will be made at special "motor road stations." The road will be harmonized with surrounding landscape and curved somewhat to prevent monotony. The two parallel roads can be planned at different heights. Constructed for a speed of 125 miles per hour and a sight distance of 2,300 feet where possible, the radius of curvature in flat country will be not less than 6,500 feet. Curves will be super-elevated, but not more than 5%. Surfacing will be of tar bound or bituminous macadam, cement concrete, or ordinary paving stones. One of the ideas involved in construction is to employ as many workmen as



possible and to use only home materials.

A 700 mile highway has been built the length of the Island of Cuba at a cost of \$100,000,000. There are no railroad crossings, there being seven under-passes and 25 crossings over the railroads. There are no greater grades than 5% and no turns with more than 4% curvature. Many expensive cuts and fills were necessary to maintain a direct route in the rugged country traversed. It is thought that this is the only national highway with grade-crossings entirely eliminated. Peculiar and often massive structures were necessary for bridges, grade separations, certain fills, etc., to care for semi-tropical storms and seasonal flooding.

Such descriptions of famous modern highways the world over, could be given without end. Such descriptions would be boresome repetition, however, and were more time available in which to prepare this paper, much time and weight would be given to various designs of modern pavement types. A picture showing beneficial effect of the thickened edge in concrete pavement design can be seen on the next page. As road design would offer more than enough material for a thesis in itself, and as time which can be allotted to writing this paper is consumed, we must be content to have followed, in its most skeleton form, the progress of man's road-building from the animal paths to the super-highway.



Bibliography

American Roads

Annual Reports of the Department of Agriculture, 1919.

Barry, Richard, "The Old Spanish Trail", World's Work,
September 1929, pps. 65-69.

Brummitt, "The Super-highway", The American City,
January 1929, pps. 85-88.

Dunbar, Seymour, "A History of Travel in America",
pps. 446-48.

Eldridge, Maurice O., "Progress of Roadbuilding in the
United States", Yearbook of U. S. Dep't of
Agriculture, 1899, pps. 367-380.

Evans, Mainwright, "Covered Wagons to Rubber Tires",
Outlook, August 28, 1929, p.686.

Hulbert, Archer Butler, "Braddocks Road".

Hulbert, Archer Butler, "Cumberland Road".

Hulbert, Archer Butler, "Pioneer Roads".

Hulbert, Archer Butler, "The Paths of Inland Commerce".

Hulbert, Archer Butler, "Washington's Road".

Indiana Magazine of History, March 1907, p. 13.

Killock, Katharine A., "The Colossus of Roads", New
Outlook, April 1934, p. 46.

MacDonald, T. H., "Two Thousand Years of Roadbuilding",
American Highways.

Richardson, R. W., "Progress of Roadbuilding in the Middle
West", Yearbook of U. S. Dep't of Agriculture, 1903
pps. 453-461.

Statistical Abstract of the United States, 1932, 1938.

Waddell, G. L., "National Old Trails Road", National Republic, December, 1930, p. 7.

Roman Roads

"How a Roman Highway was Built and Used", The American City, June 1934, pps. 62, 63, 64.

Powell, William S., "When All Roads Led to Rome", Compressed Air Magazine, June 1936, pps. 5051-4.

Roads and Streets, March 1940.

Wood, J. T., "Modern Discoveries on the Site of Ancient Ephesus", pps. 37-40.

British Roads

Devereux, Roy, "The Colossus of Roads", A Life of John McAdam.

Encyclopedia Britanica, Vol. 19, p. 340.

Salkield, "The Story of Road Rolling in Great Britain", Roads and Streets, March, 1940, pps. 49-51.

Incan Roads

Bingham, Hiram, "Machu Picchu", Report of Explorations and Excavations.

Inca, Encyclopedia Britanica, Vol. 12, 14th ed., p. 129.

Means, Philip A., "Ancient Civilization of the Andes".

Verrill Hyatt, "America's first International Highway", Scientific American, July, 1930, pps. 50, 51.

Other Roads

- Durkin, J. T., "Some Wicked Ways of Medieval Days",
Catholic World, September, 1938, pps. 716-19.
- Murray, John, "History of Egypt Under the Pharaohs",
Vol. 2.
- Rappaport, "New Highway Development and Constructions in
Germany", American City, October, 1934, p. 69.
- "Roads", Encyclopedia of the Social Sciences, Vol. 13,
p. 400.
- "Roads and Highways", The Americana Encyclopedia, Vol. 23,
p. 557.
- "The Great Paved Roads of the Mayans Civilization",
Engineering News Record, January 11, 1934, p. 47.
- Wright, H. M., "Cuba Builds a Model Highway", Scientific
American, April 1930, p. 273.

Finis!

ROOM USE ONLY

May 29 47



MICHIGAN STATE UNIV. LIBRARIES



31293011001041