

EARTH ROADS ARE EASY

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ABSTRACT

The earliest European immigrants in America traveled on waterways and on pathways worn into the earth by animals and Native Americans. Once their communities began to thrive, settlers widened paths and cleared new roads and streets then began experimenting with inexpensive surfacing to reduce dust in dry weather and mud in wet. "Earth Roads Are Easy" investigates materials and techniques used to maintain primitive thoroughfares with a minimum of effort and expense. The options range from the mundane—clay, sand, gravel, calcium chloride, oil, and tar—to the extraordinary—water glass, adobe clay, beet juice, and carpeting.

There is no more difficult problem confronting highway engineers than that of properly constructing and maintaining an earth road. The work may be less spectacular than the construction and maintenance of hard-surfaced roads, but there is greater latitude in location, methods of construction and choice of materials, consequently there is more scope for the exercise of sound judgment on the part of the engineer.¹

The earliest European immigrants in America traveled on waterways and on pathways worn into the earth by animals and Native Americans. Once their communities began to thrive, settlers widened paths and cleared new roads and streets then began experimenting with inexpensive surfacing to reduce dust in dry weather and mud in wet.

"The cheapest in first cost and consequently the most common form of road is one made entirely of earth"²—earth roads, dirt roads. Despite evidence to the contrary, citizens persist in thinking that unpaved roads are less expensive than hard-surfaced roads to build and maintain. Gary A. Tretsch's 1993 comparative study of a paved surface and an unpaved road reveals "that a graded earth road costs approximately \$26,500 per mile per year to maintain while a macadam road (including initial construction) costs approximately \$8,500 per mile per year."³

Although an earth road costs three times as much as a paved road to maintain, dirt roads are rarely maintained but are constructed as inexpensively as possible then neglected; so, in terms of cash outlay, they are cheaper than hard-surfaced roads. Opportunity costs of mud and dust are not easily translated into dollars and cents.

Even in ancient cities streets were paved, but before the twentieth century and its ubiquitous motorized vehicles, surface-treated turnpikes were rarities. Municipal engineers can cover city thoroughfares with granite, brick, wood, rubber, concrete, or asphalt and spread the costs over large numbers of residents, but country roads often

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traverse lightly populated regions where the expense of paving many miles of road would be borne by a few people, landowners likely to have neither the inclination nor the resources to support expensive public works. In 1901, Ira O. Baker, a civil engineer at the University of Illinois, wrote in *Engineering News* that “until farmers are willing to tax themselves more than \$32 per annum per mile for earth roads [a figure he derived from his analysis of a county in Illinois], it is needless to expect them to willingly pay for hard roads. Further, until they wear more expensive clothing and live in finer houses it is unreasonable to expect them to willingly support the most luxurious public highways.”⁴

When automobiles fueled the good roads movement, authorities sought ways to stretch tight public budgets to improve the most miles of city streets and county roads. The twentieth century brought vast highway construction in the United States: cities and towns, villages and hamlets paved streets; townships, counties, states, and the federal government paved rural thoroughfares, built trunk road networks, federal highways, and the Interstate Highway System.

Despite an impressive record of paving, earth roads—dirt roads—remain a part of American life, even at the close of the century. As recently as November 26, 1998, a Columbus, Georgia, resident’s comments on dirt roads in the city were published by a local columnist: “I was driving on Talbotton Road and noticed that 29th Street was paved with dirt...and I discovered even 16th Avenue is paved with dirt until it connects with Talbotton Road.... Isn’t that an incredibly creative way to pave streets? Look at all the money wasted by paving streets with asphalt when we have a cheaper alternative—DIRT!”⁵

“Earth Roads Are Easy” investigates materials and techniques used to maintain primitive thoroughfares with a minimum of effort and expense. The options range from the mundane—clay, sand, gravel, calcium chloride, oil, tar—to the extraordinary—water glass, adobe clay, beet juice, and carpeting.

Rural communities built on clay soil faced the formidable task of holding down road dust during the dry season when the clay turned to powder and, stirred by the slightest wind or lightest foot, rose in a cloud. Dust that billowed in the dry season turned to muck in the rain. Both dust and mud distorted the surface. Top soil blew away, leaving behind irregular hardpan replete with rocks and stones. On horseback or in wagons, on bicycles or on foot, travelers on the muddy clay roads left indentations that dried into rock with the passing of the wet season and the coming of the dry. Without regular attention, clay roads were barely usable for much of the year.

“Dragging clay roads is a method of maintenance which is now [1903] in great favor in Missouri.... The drag...is merely a split log 10 or 12 inches in diameter and about 10 feet long, pinned together by cross bars so that the two pieces are about 30 inches apart and both have their flat surfaces to the front. The team is hitched to the drag so that it moves the dirt toward the center of the road.... The work is done after every heavy rain, and when the road is in a bad condition to begin with, the first scraping should start when part of the surface is pretty wet. The first scraping is done

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by running the drag down the road over one rut and back over the other one. The next trip, which must wait for another good rain before it can take place, will cover a somewhat wider strip of the surface, and after a year's dragging the clay will be worked into a fairly uniform and hard surface with a good crown in the center to shed the water."⁶

Only 8½ percent of the roads in the United States were hard surfaced in 1911. "When we consider this fact together with the cost of surfacing roads under favorable conditions with stone or gravel and the impracticability of doing it at all in many sections of the country on account of the absence of the surfacing material, we realize at once that the question of the proper construction and care of our earth roads is a most vital one.

"When properly constructed, well-maintained and judicially used, the earth road fills the requirement of country traffic for much the larger portion of the year; the period of bad roads varying with climatic conditions and the material of which the road is composed.

"In order to keep earth roads in fair condition in winter, some limit should be fixed as to their use. Heavy loads hauled over them on narrow tires when they are soft will necessarily destroy the smooth surface." A general change to wide tires would do more to preserve earth roads than any other single innovation.⁷

"Dirt roads, to be satisfactory, must receive attention every day in the year, but this constant care is inexpensive. The majority of people do not consider the sand-clay top, soil, gravel and other dirt roads good simply because they are not maintained."⁸

Where sand was the predominant road material, clay surfacing was appealing. "Under the new [1917] State trunk highway law of Wisconsin the Wisconsin Highway Commission found itself with the problem of looking after the maintenance of about 700 miles of almost pure sand roads. These roads were of such a nature that many of them were impassable in dry weather and often impassable in wet weather." In communities where clay was handy, road crews spread it over the sandy surfaces; elsewhere, crews might use a coating of hay, but the hay deteriorated rapidly. In Wisconsin mats of tarred hay were spread to hold sand roads together.⁹

Unfortunately, where sandy soil predominates, a supply of alternative surfacing material is rarely to be had. "A radical departure from old methods of building roads across extensive stretches of sand has been employed successfully in the construction of some 80 miles of highway in New Mexico. The method, in brief, is to make a cut in the sand to the underlying clay and then let the wind widen this cut."¹⁰

"The [1924] development of the sand-asphalt pavement is a story of adaptation to local conditions and the utilization of local materials.... [There is] a sea of sand stretching for hundreds of miles along the coast of North Carolina and for some distance back inland. In many sections this sand is practically clean and free from clay or loam which might act as a binder. This clean, loose sand offers little tractive value to motor vehicles, particularly in dry weather, and offers great resistance to the passage of team-drawn vehicles. The driving wheels of a motor vehicle spin in the sand." Because the sandy region was sparsely populated and generated little tax revenue, money for road

building was scarce. "Gavel and top-soil are not available in this section for surfacing material. There is no stone, gravel or concrete sand available within a radius of 150 miles," and the traffic did not warrant expensive construction. North Carolina highway engineers concentrated instead on building roads with cheap, readily available sand. "About forty miles of sand-asphalt pavement have been constructed...and [that surface] has proven very satisfactory."

Road building was not limited to coarse construction-quality sand; the engineers used whatever was available, even if the local sand was light and fine. Sand mixed with asphalt was poured into forms staked along the prepared roadbed in two layers, a base layer of about three inches and a top layer of about an inch or inch and one half. The forms were left in place after the asphaltic mixture cured to protect the soft edges of the sheet of sand-asphalt.¹¹

"The name sand clay is given to a type of road surface that consists of natural or artificial mixtures of sand and clay loam The construction of sand clay roads is a slow process. The best results can only be obtained by giving the road constant attention for some time after it is completed or until such time traffic has it sufficiently compacted. In building a sand clay road where you have a sub-soil the road bed should be shaped to the desired crown.... It should be kept in shape by the use of drags or road machines."¹²

"When climate and soil are favorable and local sand is available, sand asphalt has proved to be an economical type of surfacing. It is a hot plant mix of sand, filler and bitumen; in some cases, notably in Massachusetts, stone screenings are added . . . Sand is also a good subgrade and sand asphalt gives best service on soils which contain a large amount of sand.... The roads selected for surfacing with sand asphalt have commonly been in the Atlantic coastal plain.... The state of Massachusetts first used sand asphalt in the sand hills of Cape Cod and an excellent example of this type with some modifications was laid as recently as 1930. In North Carolina the type was introduced by Charles Upham in 1922 and an appreciable mileage is still [1931] being laid annually in that state. Florida has included sand asphalt in its specifications and has laid a relatively small mileage, as has also Delaware, where several projects have been constructed. With a few minor changes sand asphalt as laid in North Carolina is now acceptable for federal aid."¹³

"The first sand and oil road was built in the town of Eastham about 1905, where the natural soil is sandy loam with a rather wide variation in grading.... In 1909 the first premixed type was constructed.... This method was used until 1914.... On Route 6 in the town of Sandwich, a surface of this type, built in 1913, is still in use...in spite of the fact that this was a hand-mixed job, it has had a useful life of seventeen years with practically no maintenance and under traffic up to as high as 8,000 daily.... The results, however, were so good and the cost of maintenance so low, that the state department felt certain it had found a type of construction, employing local materials, which was cheaper and better than other types using imported ones."

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“Roads of this type are non-skid, and, with modern day [1931] construction, especially smooth and easy driving. They take care of heavy traffic conditions; may be widened easily and rapidly as traffic increases, and with their long life and very low maintenance, make an ideal highway where sand is abundant.”¹⁴

“If local sand is available in any community, subgrade conditions suitable, and the volume of traffic does not justify a high-type expensive road, a sand-asphalt pavement will be adequate to meet all future requirements. Since 1922 North Carolina has constructed approximately 500 miles of this type, and the results have been so satisfactory that the adoption of this type of construction has been more than justified.”¹⁵

“Natural soils are very rarely found combined in the proper proportions in nature. If too much sand or gravel is present, the road lacks cohesiveness; if too much clay is present, the road lacks stability, and becomes muddy in wet weather. If these elements can be united in just the right proportions, a firm and substantial road results.”¹⁶

The addition of broken stone, or gravel, to a dirt surface is probably as ancient as road building. “The old practice in building such roads was to dump loose gravel, to be consolidated and worn down by traffic. The road was then neglected entirely until certain parts were practically destroyed, when holes and low spots would be filled with loose gravel deposited in the same way and usually in excessive quantities. Traffic would keep to the sides of these mounds of gravel, gradually forming a new roadbed and making eventually a very irregular line of road.”¹⁷

T. R. Agg details gravel road construction in Iowa during 1915. Any gravel would serve so long as the road were crowned enough to drain but not so much that it was dangerous to drive on the sides and shoulders, and drainage ditches were built. The gravel and component sand and clay must be mixed thoroughly and compacted with a roller. If the component sand and clay were inadequate to hold the road materials together, a binding clay might be added. A “serviceable double-track gravel road can be constructed for \$2,500 per mile.”¹⁸

In 1917 “the State Highway Commission of Idaho...went on record in favor of graveled roads through the lava ash soil formation of the Snake River Valley,”¹⁹ and the Michigan State Highway Department announced that “possessing both strength and supporting power, the gravel-top road with macadam base...is proving more satisfactory and can be maintained more easily and economically than a wearing course of plain water-bound limestone.” Gravel roads supported automobile traffic well, did “not ravel readily and when once compacted and maintained in such a manner as to give perfect surface drainage, demonstrated their ability to carry from 200 to 500 vehicles per day, 70 or 80% of which were automobiles, with an annual maintenance charge of from \$100 to \$300 a mile per year.”²⁰ In Maine, “where gravel roads carry a traffic of from 200 to 500 vehicles per day during five or six months in the year, and where the maximum traffic amounts to about 650 per day, no bituminous material is used in maintenance.”²¹

Highway engineers in Colorado also depended on gravel roads in the World War I era. “Colorado has thousands of miles of roads needing improvement, and is neither a

rich nor densely populated state. It is all the more necessary, then, that not a dollar of whatever money is available be wasted on unnecessarily expensive roads, and that intelligent thought be given to the problem of providing the best possible road for the least possible amount of money. It is believed that this result can be secured in many parts of Colorado by building and maintaining gravel roads according to the best practice."²²

Gravel pits in Goodhue County, Minnesota, operated a portable gravel plant that a camp crew moved four times from April to December as work progressed on local roads. The camp was equipped with a "24-man cook car, a 32-man bunk car, a water wagon, and a Ford service car," in addition to the crushing equipment and elevators needed to dig and process gravel.²³

Loss of gravel or road metal (any hard-surface road-building material) pressed highway engineers to find binders to hold the stone in place. Engineers in Missouri spread hot oil over the surface of the road,²⁴ and, in Michigan, turned to calcium chloride to reduce the dust and conserve "the gravel on the road. Roads constructed from gravel with a sand filler are very difficult to hold intact under traffic in dry weather, and this is especially true if the road is built on a sandy subgrade. On these sections, calcium chloride is of particular benefit, not only as a dust palliative but as a bonding agent to prevent raveling of the metal."²⁵ Oil was preferred in Wyoming²⁶ and Minnesota.

"In 1925, due to the evidence of a diminishing supply of gravel and also to the inherent characteristic of certain subsoils to 'eat up' gravel, experiments on gumbo and clay were tried in Minnesota in the hope of waterproofing the grade so as to hold the gravel up and the water out. It was hoped that gravel consumption could be reduced and the road made more serviceable during all seasons of the year." Once the dirt surface is smoothed and crowned, the road is oiled and gravel spread over the oil. "A thin layer of gravel is kept floating over this surfacing and with the exception of a slight discoloration the road exhibits all the characteristics of an ordinary gravel road."²⁷ Careful application of oil or calcium chloride could save stone, eliminate dust, and postpone hard-surface construction.²⁸ North Carolina highway builders used a portable crusher to reduce the size of rock tossed off the road by moving vehicles. The redressed surface was then treated with oil.²⁹

"Late in the fall of 1929, after two years of new construction with coarse washed gravel, the county board [of Logan County, Illinois] ...constructed a mile of traffic-bound gravel road at the city limits of Lincoln, the county seat.... The use of small-size gravel precludes the possibility of any great quantity of dirt accumulating between the pebbles of gravel, so that there is little chance for softening up of the roadbed once it is firmly packed. After this type of road is completed, the surface is smooth and practically waterproof. The 20-ft. gravel surface allows traffic to move about so that no regular lanes are followed and no ruts developed."³⁰

In 1930 the citizens of Roanoke Township in Woodford County, Illinois, determined to put every property in the township on a surfaced road. Traffic-bound gravel construction was chosen. The road surface was lightly covered with gravel piled alongside. As traffic bound the gravel into the roadbed new layers were added until the

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desired surface was attained.³¹ Faced with deteriorating cinder-surfaced roads in Midland, Michigan, City Engineer Karl Robertson also decided in favor of stabilized gravel roads. "Three different combinations of materials were used on the city street project, but the sand-clay gravel principle was used in all of them . . . calcium chloride is more satisfactory in this type of surface than when ordinary unbound gravel is used."³²

Road builders in the twentieth century also experimented with by-products of the expanding petroleum industry. Oil and tar paved the way for the later dominance of asphaltic materials and the hard-surfaced roads they provide. "Oil was first used on roads . . . with the idea of laying the dust." Roads were oiled to make the dust too heavy to rise, but oil then became "an important element in making a permanent road-bed, having a good wearing surface, smooth and firm, free from dust during the summer, and without mud in winter."

"In 1899, when we commenced using oil, we would have considered applying it to a surface of loose sand of considerable depth a mere waste of material. But the possibilities of oil have kept growing upon us, until now [1902] we almost look upon it as the great panacea." The road is sanded by "drawing the sand in wagons alongside the oiled surface, where two men to the load throw it out with shovels, the shovels being given the proper twist to cause the sand to fall on the surface in a thin sheet."³³

In a 1903 note on "The Use of Oil on Roads" by Hiram M. Chittenden, the editors of *Engineering News* report a difference in the results of oiling East Coast and West Coast roads. The success in the West was not matched in the East because Western crude has an asphaltic base and Eastern crude a paraffine base³⁴—and in 1904 *Engineering Record* was "convinced that the use of oil has come to stay."³⁵

"In the beginning [California, 1904], oil was used as a substitute for water to lay the dust of roads more cheaply. Its efficiency for this purpose was quickly recognized, and through the hardened and lasting surface obtained, road-makers were led to its use in making permanent road surfacing."³⁶ In 1915, California engineers anticipated the heavy road building in the second half of the century when they built "a permanent concrete base protected by a wearing coat composed of a heavy asphaltic road oil and screenings."³⁷

"Oiling dirt roads in Iowa [1915] is practised as a cheap way to eliminate mud and dust," but any "town or community that places its faith in an oiled earth road as a substitute for a strictly hard surface road is doomed to disappointment. No combination of oil and ordinary Iowa earth has yet been found which will serve as a substitute for gravel, concrete, wood blocks, or brick. No such combination can approach the road crusts commonly known as sheet asphalt and asphaltic concrete.... The oiled earth road has its place just as much as the cheap automobile. It may not stand the wear and tear of the higher priced article, but like the automobile, it will give a very satisfactory service."³⁸

The Massachusetts Highway Commission's 1915 road construction comprised "181.92 miles of roadway, divided as follows in mileage: Waterbound macadam, 23.26; gravel 58.6; sand bound with oil and asphalt, 4.13; macadam with bituminous binder

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incorporated in the top course, 38.62; waterbound macadam with oil surface applied, 19.62; gravel with top surface bound with bituminous binder, 7.65; cement concrete, 5.34; gravel with oil surface applied, 16.61; Warrenite, 1.30; granite block on concrete foundation, 0.09; dirt roads, 6.7.”³⁹

“The most disheartening feature of our experience in attempting to maintain crushed rock and gravel surfaces is the steady loss of material. In the cloud of dust behind every car you can see the dollars floating. The writer [E. B. Bail] has often speculated as to just how much it cost the State of New Mexico to dust-coat the 284,000 tourist cars which passed through the state in 1928...it may be stated that our annual loss of surfacing material is approximately one inch of compacted thickness.” The highway department’s response was road oil.⁴⁰ Likewise in Missouri oil is (1931) “used satisfactorily for the treatment of earth surfaces to provide temporary all-weather roads” if the soil is suitable, and the oil is provided in sufficient quantities and applied under appropriate conditions.⁴¹

About 1,500 miles of oiled roads had been constructed in Wyoming by 1934,⁴² and in Livingston County, Michigan, County Engineer W. J. Slavin claimed that oiled roads were so inexpensive to maintain that they would pay for themselves in five years.⁴³

“The dust nuisance on gravel roads is something on which the public has become very critical and in many instances this criticism has become so intense that a perfectly good gravel road has been replaced by a more expensive type of pavement whereas if it had been properly cared for it would have served the traffic for many years. In Michigan we are preserving our gravel roads by treating them with bituminous tar and asphalt material and calcium chloride.”⁴⁴ Superintendent R. B. Traver in Onondaga County, New York, also depended on “calcium chloride as the best surface treatment for” earth roads,⁴⁵ the U.S. Bureau of Public Roads recommended the use of rock salt to stabilize clay surfaces,⁴⁶ and as recently as 1988 *Public Works* carried an article on the use of calcium chloride to “improve the quality of unpaved roads and lower maintenance costs. Calcium chloride absorbs moisture from the air, forming a clear liquid that resists evaporation. Spread on an unpaved surface, calcium chloride immediately begins to absorb moisture from the air or from the surface itself. The resultant solution penetrates the road’s surface material, coating tiny particles of dust and gravel, binding them together. This binding action stabilizes the surface, keeping unpaved roads dense and compacted. Plus, calcium chloride solution’s resistance to evaporation helps keep the road surface damp, holding particles closely together even on hot, dry days.”⁴⁷

Another binder used to stabilize dirt roads is tar. “Tar macadam has been tried for ten years in Pawtucket . . . In 1891, the city first undertook experimental work in the use of tar concrete for the surface of streets. In 1893 a second short and narrow business street was surfaced with tar concrete on top of crushed stone, at the request of the abutters.

“The main idea of this form of construction has been to provide a binding material for the crushed stone which would prevent the surface of streets on heavy grades from being picked up by the action of horses’ feet and from being badly washed by heavy rains.”⁴⁸

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"Tar and oils on roads have been experimented with at Champigny, near Paris, under the supervision of M. Silvain Dreyfus, Ingénieur des Ponts et Chaussées for the Department of the Seine. According to *The Surveyor* the task was undertaken at the instigation of the medical authorities, who viewed with anxiety the increasing production of dust clouds resulting from motor-car traffic.... For coal-tar sprinkling a dry condition of the road is imperative. Dust must also be removed before applying tar, because otherwise much hand labor is necessary in order to obtain equal distribution and a smooth surface. Dust is not so inconvenient if the lighter oils are used. Although it is not absolutely necessary to sand roads after treatment, it was found advisable to do so; because if no sand was used a tarred road had to be left for several days, and an oiled road for several hours, before being opened to traffic.... So far, M. Dreyfus seems to give preference to the tarred roads."⁴⁹

"In the summer of 1901 a coal-tar pavement was laid on Main Street, Hanover, New Hampshire, which was to some extent experimental. During the past summer [1902] another section of this pavement was constructed, contiguous to that previously laid, and although it is too soon to say very much in regard to the wearing qualities of this pavement, it presents several features which should be of considerable interest to municipal officers, especially in small towns where it is not possible to obtain asphalt pavement except at prohibitive prices."

"Practically the same kind of pavement has been used in Woodsville, and Littleton, New Hampshire, and in St. Johnsbury and Barre, Vermont.... The pavement at Littleton was put down in 1894, '95 and '96... [and] has stood well during the eight years of its use under a heavy traffic.... In Barre, Vermont, a pavement like that at Littleton was built in 1890. It was constructed under rather adverse conditions, and it has been subjected to pretty heavy traffic, and has not proved very satisfactory."⁵⁰

"During the season of 1906 the South Park Board of Commissioners of Chicago tarred the surface of more than 106,000 sq. yd. of the most heavily traveled boulevard streets in that city, in an endeavor to overcome the excessive cost and difficulty of properly maintaining those streets under the traffic to which they are subjected."⁵¹

"It must be hoped that road tarring, which at present is solving in a practical fashion the problem of the adaptation of roads to automobilising, will not present any such disadvantages as shall necessitate its abandonment."

"The important matter for the moment is to try and suppress tarry dust. It is a serious mistake to believe that a dustless road will be obtained merely by having it tarred. Tarring does, indeed, suppress almost entirely the dust arising from the wear and tear of the roadway, but it affords no protection against the imported dust brought thither by the wind or by the traffic."⁵²

Beginning in 1927, Elizabeth City, North Carolina, began improving its gravel streets "by tar surface treatments, changing them from loose dusty gravel surfaces to smooth tight, dustless ones at a very low cost... [the] work was done under the direction of Miles W. Ferebee, city manager, who says, in a letter dated December 5th, 1930: 'The plan described in this article gave the city of Elizabeth City some excellent streets which are still in splendid condition.'"⁵³

"The well-known skid-safe qualities of tar roadways has resulted in an increased use of tar surface treatments and tar mixes to correct dangerously slippery sections of road. These surfaces are skid-safe when first built and remain so.... While the changes have not been extensive, there has been a gradual improvement in the use of tars to build low-cost, easy-riding, safe highways. Tar grades and nomenclature have been standardized so that the highway official can more easily obtain the exact consistency he desires. The new specifications also insure better and more uniform materials."⁵⁴

"The use of road tars has advanced in 1938 in the high type field by the introduction of the hot tar mix and in the low cost field by the development of the improved sand-filled retread.... In the new field of soil stabilization, tars have been used extensively, and the necessary construction operations have been practically standardized."⁵⁵

Sand, clay, gravel, calcium chloride, oil, and tar were commonly used on earth roads in America and abroad. Road builders experimented with those standard materials but also tried new products and techniques to stabilize dirt surfaces. In Galveston County, Texas, shells kept the highways to Houston passable.⁵⁶ Where roads did "not have sufficient traffic to justify construction of concrete or asphalt pavement . . . even were sufficient funds available" and there was no ready supply of gravel, engineers in Arkansas turned to shale burned hard in coal mine dumps.⁵⁷ European engineers tried a more novel material.

"The 'Annales des Ponts et Chaussees' last year [1926] described the use of water glass [sodium silicate] in rolling down the road surfaces. The application of water glass to a macadam of soft lime was found especially suitable. Similar applications of water glass have been made in Switzerland, Germany, Czecho-Slovakia and in other parts of France.

"As a rule a mixture is made of crushed or broken stone and water glass, which is spread on the road bed and rolled down.... It is reported that the old street between Le Locle and the railroad station was treated with sodium silicate. The average traffic per day is 80 motor trucks, 200 passenger automobiles and 200 horsedrawn vehicles. After three years of service no molds or depressions have appeared on the surface.

"The advantages of water glass macadam as shown in experience are as follows: The surface wears evenly. The road does not become slippery; it is elastic and therefore provides a good surface for animals as well as motor vehicles which require less power and repair."⁵⁸

In 1935 *Engineering News-Record* reported an Australian experiment in hardening an earth road with a rolling furnace that baked adobe soils to a rock-hard finish. "The machine...is a wood-fired down-draft furnace of the air-gas-producer type. It is mounted on a chassis on road wheels and is propelled either direct through gearing or by a winch hauling a rope fixed ahead. Firewood is fed at intervals into the combustion chamber of a gas generator, and air is forced into it above the fire by a fan. The gases produced by combustion are forced through an opening at the base of the furnace and mixed with more air under forced draft; they enter a shallow furnace in which the road surface

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is the floor and the top and sides are lined with firebrick with an insulating backing... As the machine advances...the soil is first subjected to the departing gases, and then gradually increases in temperature until the full intensity of the heat of the gases issuing from the generator is felt. Any particular area of soil is enclosed within the furnace for 1½ to 2 hours, the speed of the machine being from 8 to 12 ft. per hour. Work proceeds continuously, both day and night, a 6-ft.-wide machine completing about 500 ft. of roadway 18 ft. wide per week.”⁵⁹

Highway engineers in the 1990s continue to experiment with peculiar materials, like beet juice and carpeting, for controlling dust and mud on earth roads. “Molex is partially desugared beet molasses.... [It] is completely biodegradable... [even] edible but not palatable.” A 30 percent solution of Molex is a useful dust control agent for earth roads. “Molex can be useful to society by replacing products that may be harmful to the environment. Eliminating dust helps improve the quality of life in an economic way for people who live on dusty roads.”⁶⁰

Griffin, Georgia, was the 1998 site of carpeted roads. “Some dirt roads in Georgia are getting a weave. Workers are mixing carpet fibers with the clay surfaces of roads in six counties as part of an experiment to determine whether the rug-ged roads need less maintenance. No doubt, the project has raised a few eyebrows among county officials. ‘I told them I was going out to carpet a dirt road. They got a kick out of that,’ said William Wilson, an assistant county manager in Spalding County.

“On Bethany Road in Spalding County, workers spread carpet fibers over turned-up clay.

“Officials hope the fibers will help the road surface hold together and slow deterioration, meaning the county won’t have to spread rocks and scrape dirt roads as often to maintain an even surface.”⁶¹

Earth roads and the problems associated with them have changed little over the twentieth century. In 1931 a mail carrier wrote of the difficulties he faced with poorly surfaced roads. “I have been driving a 26-mile route, 4 hard surfaced, 10 graveled and 12 just plain mud for nearly nine years. The first 4 miles are plowed after each snow storm. The next two are never touched. Then five more of plowed, three unplowed, four plowed and six are scratched over after a fashion; the last two are plowed.

“This kind of route requires two horses to be kept at two different points of the swing as it is impossible to change from auto to sleigh to wagon to auto all in one trip In mud time (two months) two horses are absolutely necessary to cover 20 miles of this route—and we have mud in this country—thus my equipment consists of one automobile, two horses, sleighs, harnesses, wagons and all the other necessary incidentals that are required to go with these different means of transportation, all for \$2,100.”⁶²

More than six decades later, in 1995, the *Columbus, Georgia, Ledger-Enquirer* reported local citizens’ difficulties with unpaved roads. “When a check failed to show up in Sam McCutcheon’s mailbox on Glennhaven Road one month, he tracked it down at the Phenix City Post Office.” Inquiring at the post office, McCutcheon learned that his carrier would not “deliver his soldier’s pension to his box”; the roads are so bad that

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the postman cannot reach the mailboxes. Appeals to the Russell County Commission may bring a crew to rework the surface. "Sometimes, fresh clay full of debris will be dumped on the road. When it is scraped, large rocks or pieces of wood are visible... the dust is impossible."⁶³

Almost a century before a Russell County road crew improved Glennhaven Road by dumping debris on it, an editor of *Engineering Record* observed, in 1903, a large steam roller and gang of men working on a road...of the dirt type, excellent to ride over when in the proper condition, but bad when muddy or dry... The ditches were being cleaned out, and the dirt from them was thrown on the roadway where it was leveled off by hand. Over this... was dumped a quantity of alleged gravel, and then the steam roller was put into action. The gravel was merely coarse sand, with hardly a pebble as large as a bean.... The result of this work was wretched of course. One place about an eighth of a mile long, completed a fortnight before, had passed through the test of a heavy storm, and what parts of the sand and silt that were not washed into the ditches were lying in a loose mass, without coherence, giving out a cloud of dust whenever a carriage passed over the road."⁶⁴

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